केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

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

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

MAHASAMUND DISTRICT, CHHATTISGARH

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

स्वच्छ जल : स्वच्छ भारत

केन्द्रीयभूमिजलबोर्ड

उत्तर मध्य छत्तीसगढ़ क्षेत्र

द्वितीय तल, एल.के. कॉर्पोरेट एवंलॉजिस्टिकपार्क,

धमतरीरोड, डूमरतराई, रायपुर (छत्तीसगढ़)–492015

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

भारत सरकार
Government of India
जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय
Ministry of Water Resources, River Development & Ganga Rejuvenation
केन्द्रीय भूमि जल बोर्ड
CENTRAL GROUND WATER BOARD

जलभृत नक्शा एवं भूजल प्रबंधन योजना
महासमुंद जिला,छत्तीसगढ़

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

केन्द्रीय भूमि जल बोर्ड
उत्तर मध्य छत्तीसगढ़ क्षेत्र
द्वितीय तल, एल.के. कॉर्पोरेट एवं लॉजिस्टिक पार्क,
धमतरी रोड, डूमरतराई, रायपुर (छत्तीसगढ़)–492015
फोन–0771–2974405, फैक्स–2974405 ईमेल–rdnccr-cgwb@nic.in

केन्द्रीय भूमि जल बोर्ड

उत्तर मध्य छत्तीसगढ़ क्षेत्र
द्वितीय तल, एल.के. कॉर्पोरेट एवं लॉजिस्टिक पार्क,
धमतरी रोड, डूमरतराई, रायपुर (छत्तीसगढ़)–492015
फोन–0771–2974405, फैक्स–2974405 ईमेल–rdnccr-cgwb@nic.in

स्वच्छ जल - स्वच्छ भारत

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

CONTRIBUTORS'

Principal Author

Dr. Suchetana Biswas : Scientist-B

Supervision & Guidance

C.Paul Prabhakar : Regional Director
Dr. O.N. Tiwari : Superintending Hydrogeologist
A K Biswal : Senior Hydrogeologist/ Scientist-D

Groundwater Exploration

Dr. Suchetana Biswas : Scientist-B

Chemical Analysis

Rakesh Dewangan : Scientist B (Chemist)
Dr. Anita Bind : STA (Chemist)

Executive summary

Aquifer mapping is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological and quality data is integrated to characterize the quantity, quality and movement of ground water in aquifers. However, due to paradigm shift in focus from development to management of ground water in last one decade, the need for more reliable and comprehensive aquifer maps on larger scale has been felt for equitable and sustainable management of the ground water resources at local scale. Volumetric assessment of ground water and strategies for future development and management are the primary objectives of aquifer mapping.

The study area comprises of the five blocks of Mahasamund district, namely Bagbahara (1379 sq.km), Mahasamund (944 sq.km), Pithora (1060sq km), Basna (901 sq.km) and Saraipali (870 sq.km)., is located in the eastern part of Chhattisgarh state. It falls in the Survey of India Degree sheet No 64K, 64L and 64O between latitudes 20º49'30" to 21º33'07" N and longitude 81º59'56" to 83º16'10" E.

The total population of the study area as per 2011 Census is 10,32,754 out of which rural population is 9,12,602 & the urban population is only 1,20,152.

The study area experiences sub-tropical climate. Average annual rainfall in the study area is 1418.3 mm taking rainfall from 2011-2015 into consideration 50 to 60 rainy days out of which the monsoon rainfall contributes about 92 %.

Geomorphologically the study area displays Structural Plains, Pediment/Pediplain, Denudational Hills and Valleys with an elevation ranging from 290 to 340 masl.

The net sown area is 39310hectare, while double-cropped area is 10148hectare. Gross cropped area accounts 1471.42 sq.km. . Rice is sown in nearly 95% of the net sown area.

The net irrigated area in the study area is 109195 hectares. The percentage of the irrigated area to net sown area in the study area is only 36%. Irrigation by surface water covers almost 41.86 % of the net irrigated area while 58.14 % of the net irrigated area is irrigated by ground water.

Mahasamund district is a backward aspirational district. It is important district for minor minerals. These minerals are Quartz, Quartzite, Granite, Limestone, Flag stone, Sand, Soil and Laterite.

The major aquifers present in the study area are (1) Raipur group limestone and shale (2) Chandrapur sandstone (3) Dongargarh granite and granitic gneiss (4) Sonakhan group amphibolite gneiss, basalt (5) Singhora group limestone, shale and sandstone; both in phreatic and fractured condition.

UNCONFINED AQUIFER: In the pre-monsoon period, it has been observed that in Raipur group limestone and shale, the maximum water level is 13.15 m at Sirpur in Mahasamund block , the average water level is 11.35 mbgl. It has been observed that in Chandrapur group sandstone, the maximum water level is 12.6 m at Mahasamund town in Mahasamund block, the average water level is 9.2 mbgl. In the pre-monsoon period, it has been observed that in Dongargarh granite and granitic gneiss, the maximum water level is 10.9 m at Hadabundh in Mahasamund block, the average water level is 7.9 mbgl. In the pre-monsoon period, it has been observed that in Sonakhan group basalts and amphibolites, the maximum water level is 10.74 m at Lambar in Basna block , the average water level is 8.03 mbgl. It has been observed that in Singhora group sedimentary formations, the maximum water level is 16.78 m at Kendua in Saraiapali block, the average water level is 7.75 mbgl.

In the post-monsoon period, it has been observed that in Raipur group limestone and shale, the water level varies from 1.71 to 8.85 mbgl with an average of 5.54mbgl. It has been observed that in Chandrapur group sandstone, the water level varies from 1.36 to 8.93 mbgl with an average of 3.44mbgl. In the pre-monsoon period, it has been observed that in Dongargarh granite and granitic gneiss, the water level varies from 1.98 to 6.5 mbgl with an average of 3.91mbgl. In the pre-monsoon period, it has been observed that in Sonakhan group basalts and amphibolites, the water level varies from 1.5 to 5.99 mbgl with an average of 3.02mbgl. It has been observed that in Singhora group sedimentary formations, the water level varies from 1.4 to 5.4 mbgl with an average of 3.42mbgl. However due to unplanned exploitation of ground water in the backdrop of more population and inadequate recharge, some of the areas shows water level deeper that is > 5mbgl. So, these places are to be given special attention with regular monitoring and artificial recharge.

The water level fluctuation in Raipur group limestone and shale varies from 3.47m to 9.67m, with average fluctuation of 5.81m. In Chandrapur group sandstone water level fluctuation varies from 1.74m to 10.08m, with average fluctuation of 5.5m . In Dongargarh granite and granitic gneiss, the water level fluctuation varies from 1.05m to 7.71m, with average fluctuation of 3.98m. In Sonakhan group basalts and amphibolites, the water level varies from 1.91m to 9.24m, with average fluctuation of 4.99m. In Singhora group sedimentary formations, the water level fluctuation varies from 0.8m to 15.38m, with average fluctuation of 4.33m.

The long-term water level trend indicates that there is decline in pre-monsoon water level in Mahasamund block, Saraipali block and no appreciable change in water level both in pre-monsoon and post-monsoon period in the other blocks.

SHALLOW CONFINED AQUIFER: In the pre-monsoon period, it has been observed that in Raipur group limestone and shale, the maximum water level is 14.23 mbgl and minimum water level is 10.4mbgl, the average water level is 12.04 mbgl. It has been observed that in Chandrapur group sandstone, the maximum water level is 21.56 mbgl, minimum water level is 6.5mbgl, the average water level is 15.39 mbgl. In the pre-monsoon period, it has been observed that in Dongargarh granite and granitic gneiss, the maximum water level is 34.2 mbgl, minimum water level is 3.8 m bgl, the average water level is 13.7 mbgl. In the pre-monsoon period, it has been observed that in Sonakhan group basalts and amphibolites, the maximum water level is 15.9 mbgl, minimum water level is 4 mbgl and the average water level is 10.07 mbgl. It has been observed that in Singhora group sedimentary formations, the maximum water level is 25.6 mbgl, minimum water level is 4.24m bgl and the average water level is 16.06 mbgl.

In the post-monsoon period, it has been observed that in Raipur group limestone and shale, the water level varies from 7.05 to 8.26 mbgl with an average of 7.64mbgl. It has been observed that in Chandrapur group sandstone, the water level varies from 4.32 to 12.85 mbgl with an average of 9.65mbgl. In the pre-monsoon period, it has been observed that in Dongargarh granite and granitic gneiss, the water level varies from 3.2 to 20.42 mbgl with an average of 8.48mbgl. In the pre-monsoon period, it has been observed that in Sonakhan group basalts and amphibolites, the water level varies from 2.8 to 7.85 mbgl with an average of 5.06mbgl. It has been observed that in Singhora group sedimentary formations, the water level varies from 4.13 to 21.32 mbgl with an average of 11.25mbgl. Due to unplanned exploitation of ground water in the backdrop of more population and inadequate recharge, some of the areas shows water level deeper that is > 5mbgl. So, these places are to be given special attention with regular monitoring and artificial recharge.

The water level fluctuation in Raipur group limestone and shale varies from 2.14m to 6.61m; with average fluctuation of 4.4m. In Chandrapur group sandstone water level fluctuation varies from 2.18m to 8.71m, with average fluctuation of 5.73m. In Dongargarh granite and granitic gneiss, the water level fluctuation varies from 0.25m to 18.4m, with average fluctuation of 5.21m. In Sonakhan group basalts and amphibolites, the water level varies from 0.6m to 12.66m, with average fluctuation of 5.01m. In Singhora group sedimentary formations, the water level fluctuation varies from 0.11m to 10.51m, with average fluctuation of 4.81m.

Argillaceous limestone (Raipur group): The average thickness of the weathered portion in the area is around 18.5 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells. The average drawdown of the formation is around 20.1 m. The thickness of fractured aquifer is around 0.2 m.

Sandstone (Chandrapur group): The average thickness of the weathered portion in the area is around 19.02 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 2 lps. The development in these formations is mostly by way of dug wells and shallow tube wells. The average drawdown is 24.06 m. The thickness of fractured aquifer is around 0.2 m.

Granitic Gneiss (Dongargarh Supergroup): The average thickness of the weathered portion in the area is around 18 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells.

The transmissivity of the formation is around 0.07 -1 m^2 per day with an average drawdown of 27 m. The thickness of fractured aquifer is around 0.2 m.

Sonakhan Group of Archean to Proterozoic age consists of basalt and amphibolite and metasediments. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 12.75 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible(<1lps). The development in these formations is mostly by way of dug wells.

Singhora Group is the oldest formation of Chhattisgarh super group. The sediments occurring in the block consist of Shale, Limestone, sandstone and siltstone. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 9.0 m. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible(<1lps). At two places, namely Chhattigirola and Birkol, discharge of 4.0 lps and 5.50 lps were obtained respectively. The development in these formations is mostly by way of dug wells.

So far as chemical quality is concerned, high fluoride content (1.6 to 2.7 mg/l) is also found in ground water in Bagbahara and Pithora blocks of Mahasamund district. Occurrence of fluoride in groundwater is mainly in the regions underlain by Dongargarh granite and granitic gneiss.

The Total Annual Replenishable Groundwater Resources and Net Available Groundwater Resources for the study area 65465.09 and 61743.05 Ham respectively. Out of this 29530.10 Ham is being used for irrigation, 4241.31 Ham for industrial and domestic sector taking the gross annual ground water draft for all uses to 33771.41 Ham. This translates to an overall stage of ground water development in the study area at 54.70 %. A ground water resource of 4716.97 Ham & 27495.98 Ham has been kept reserved for future domestic and industrial requirement and irrigation development respectively for next 25 years. So, All the blocks fall in safe category.

Sub Surface Potential to be recharged through other methods in the study area has been calculated to be 109.82 MCM respectively.

The major ground water issues identified during the survey in the study area are as follows: (i) The aquifers are low yielding ones in terms of groundwater. (ii) During summer, dug wells in most villages go dry except. Several handpumps also stop yielding water. Hence there is scarcity of water. (iii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. (iv) Poor stage of groundwater development. (v) There is water quality problem in some areas from fluoride, point of view. (vi) In some areas the water level remains below 5m during the post-monsoon period in the study area which needs to be attended for intervention.

So far as Management strategies are concerned, Artificial Recharge structures may be constructed in suitable locations especially in the areas where the water level remains deeper than 5m in the post-monsoon period, In order to achieve 60% stage of ground water withdrawal in these blocks, ground water development may be taken up by construction of suitable abstraction structures. Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also, Rain water harvesting structures may be constructed in villages to reduce stress on groundwater. Massive awareness campaigns are essential to teach people about the importance community participation in saving water. Farmers may be encouraged to take up maize/ millet's cultivation for Rabi period and practice of micro irrigation. The problem of fluoride contamination in drinking water may be tackled by setting up of small defluoridation units in affected villages.

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN MAHASAMUND DISTRICT, CHHATTISGARH

CONTENTS

1. Introduction
1.1 Objective

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

1.2 Scope of study

The demand for ground water for various types of use is increasing day by day; consequently, indiscriminate development of ground water has taken place and the ground water resource has come under stress in several parts of the country. On the other hand, there are also areas where adequate development of ground water resources has not taken place. These facts underscore the need for micro- level study of the aquifer systems of the country. The water resource managers and planners to develop and implement effective long term as well as short term aquifer management strategies, a host of scientific questions must be answered. These questions can be best answered through a comprehensive process that integrates the available scientific data. Aquifer mapping study thus is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological and quality data is integrated to characterize the quantity, quality and movement of ground water in aquifers. It primarily depends on the existing data that are assembled, analyzed and interpreted from available sources. The data gap analysis carried out helped to generate data from data newly collected through activities such as exploratory drilling, groundwater level monitoring on a regular basis for a considerable period and groundwater quality analysis. These existing as well as generated data were analyzed in ordered to prepare regional hydrogeological, thematic, water quality maps, cross-sections, 2 –D and 3-D aquifer disposition maps. The aquifer maps are the maps depicting aquifer disposition, giving lateral and vertical extension. The maps will also provide information on the quantity and quality. It explains the components of the Aquifer Classification System, outlines the assumptions underlying the map information presented and summarizes the content of an aquifer classification map. The goal is to help the map users understand the strengths and limitations of the information contained on the aquifer classification maps so that they can apply that information appropriately to their particular water and land management needs. The system and maps are designed to be used together and in conjunction with other available information as a screening tool for setting groundwater management priorities. These provide a way of comparing aquifers within a consistent hydrogeological context and prioritizing future actions at various planning levels. The maps may provide some background information for site-specific projects. However, the maps are not to be used for making site-specific decisions. The classification of an aquifer reflects the aquifer as a whole and at a specific time. Groundwater conditions, such as the degree of vulnerability and water quality, may vary locally and over time respectively. This variability in the data sometimes requires subjective decision-making and generalizing of information for anentire aquifer.

1.3 Approach and Methodology

The activities under the aquifer project can be summarized as follows:
i) **Data Compilation & Data Gap Analysis:** One of the important aspects of the aquifermapping programme was the synthesis of the large volume of data already collectedduring specific studies carried out by the Central Ground Water Board and various othergovernment organizations with a new set of data generated that broadly describe anaquifer system.The data were compiled, analyzed, synthesized and interpreted fromavailable sources. These sources were predominantly non-computerized data that wereconverted into computer-based GIS data sets. On the basis of these available data, DataGaps were identified.
ii) **Data Generation:** It was evident from the data gap that additional data should begenerated to fill the data gaps in order to achieve the objective of the aquifer mappingprogramme. This was done by multiple activities like exploratory drilling, hydrochemicalanalysis, use of geophysical techniques as well as detail hydrogeological surveys.
iii) **Aquifer map Preparation:** On the basis of integration of data generated through varioushydrogeological and geophysical studies, aquifers have been delineated and characterized interms of quality and potential. Various maps have been prepared bringing out theCharacterization 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 leveland vulnerability (quality and quantity).
iv) **Aquifer Management Plan:** Based on the integration of these generated, compiled, analyzed and interpreted data, the management plan has been prepared for sustainabledevelopment of the aquifer existing in the area.

1.4 Area Details

Under the aquifer mapping programme, an area comprising of 5 no of developmentblocks namely Mahasamund, Bagbahara, Pithora, Basna and Saraipali of Mahasamund district wastaken up covering an area of 5154 sq. km. Mahasamund district is situated in the Eastern part of the Chhattisgarh state. It falls in the Survey of India's Degree Sheet No. 64 K,O,L and G between the Latitude 20º49'30" : 21º33'07"N and Longitude 81º59'56":83º16'10" E.The district is bounded by Raipur district in the north,west and southwest,Raigarh district in the north-east, Kalahandi and Sambalpur dist. of Orissa state in the south-east,south and east.
Located on the East Coast Railway Zone, this district has three National Highway which are NH 6 (Mumbai-Kolkata highway), NH 217 and NH 216, most of the destinations are well connected with tar roads in the district. The district has awell-developed road network.

1.4.1 Administrative Division

District includes 05 blocks and 1153 villages. The block headquarters are located atMahasamund, Bagbahara, Pithora, Basna and Saraipali towns. The administrative map for the study area is given in **Fig 1.**

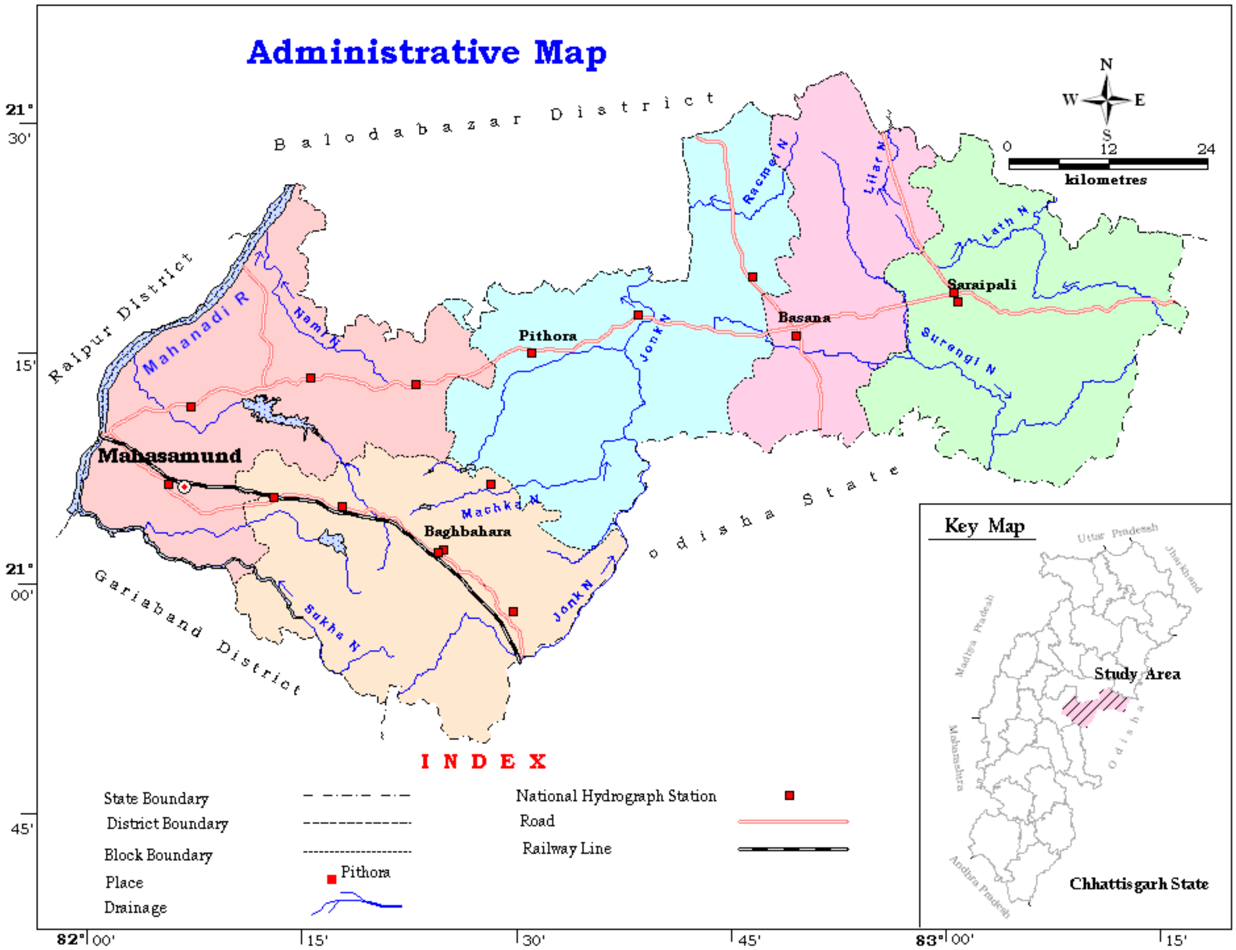


Figure 1 Administrative Map of Mahasamund District

1.5 Data Availability, Data Adequacy and Data gap Analysis

The hydrogeological data already available including number of key wells, VES, exploratory wells, chemical parameters have been collected and analyzed which shows that in the study area the required number of ground water monitoring stations is 64 against which only 23 stations are available leading to the data gap of 41. Similarly, the required number of ground water exploratory wells is 64 against which only 31 stations are available leading to the data gap of 33. Likewise, the required number of ground water quality monitoring stations is 64 against which only 23 stations are available leading to the data gap of 41. Lastly, the required number of VES is 64 against which 22 are available leading to the data gap of 42.

1.5.1 Data Gap Analysis

On the basis of the NHS data, VES data and chemical data available in the study area, the data gap analysis has been prepared to ascertain the data gap in the study area which is presented in summary in Table 2.

Table 2 Data gap analysis in Mahasamund district

Activity	Required	Available	Gap
Exploration EW/OW	64	31	33
GW Monitoring	64	23	41
Quality monitoring	64	23	41
VES	64	22	42

1.6 Rainfall

The study area receives rainfall mainly from south-west monsoon. It sets in third/fourthweek of June and continues till mid-August/September with heaviest showers in the months of July and August and nearly 95% of the annual rainfall is received during this period. The average annual rainfall for the study area is around 1416.28 mm (Average of the last three years i.e. 2010 to 2015) which is presented below in **Table 3**.

Table 3 Annual Rainfall (mm) in Mahasamund district for the years (2010 to 2015)

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Mahasamund	1310.20	1434.20	1355.70	1445.1	1536.2

Source: IMD. Raipur

1.7 Physiography/Geomorphology

Geomorphologically the study area mainly displays pediment and pediplains along with some structural plains and flood plain in the western part of the district and denudational hills and valleys in North-eastern part and structural hills and valleys in South-eastern part of the district. **Fig 2** shows the Geomorphology in the study area.

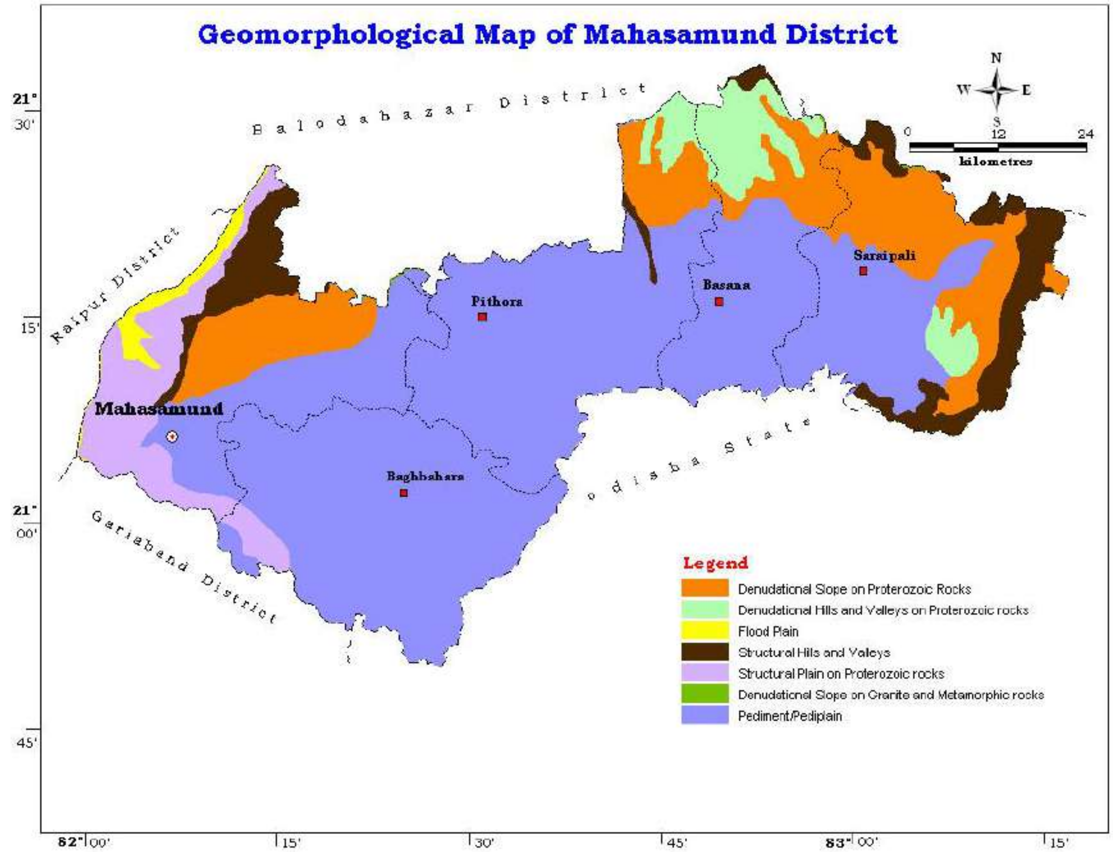


Figure 2 Geomorphology Of the study area.

1.8 Land use

There is 140602 ha revenue forest and protected forest, other forest in the district. Area not available for cultivation is 43663 ha. Details are presented in Table 4.

Table 4: District Land Use Pattern (Ha)

Total geographical area	Revenue + Protected forest area	Area not available for cultivation	Non agricultural& Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
515400	140602	43663	29930	8309	267977	35145	303122

1.9 Soil

The soils in the district are having wide variations. In all two types of soils are exists in the district and are mostly insitu in nature. They are red gravely/sandy Alfisols and the red and yellow Ultisols.

1.10 Hydrology and Drainage

The district forms a part of the Mahanadi basin. The general slope on the eastern part of the area is towards south-east, in the central part of the area is towards north and on the western part is towards northwestern direction. The western boundary of the district is running along the Mahanadi River. The Jonk River passes through the central part of the district and is running in northern direction. The Kurarnala, Nami nala, Keswanala and Sukhanadi forms part of the drainage system for Mahanadi River basin. The Machkanala, Bagh nala, Racmenala, Lath nala forms part of the Jonk River basin. The Kunti nala, Suranginala and Chirarnala form part of Ong basin. The drainage system can be classified as dendritic to sub-dendritic in pattern. The drainage density is very high on the eastern part of the area and is low on the western part. The high drainage density indicates higher run off and less infiltration (**Fig.3**).

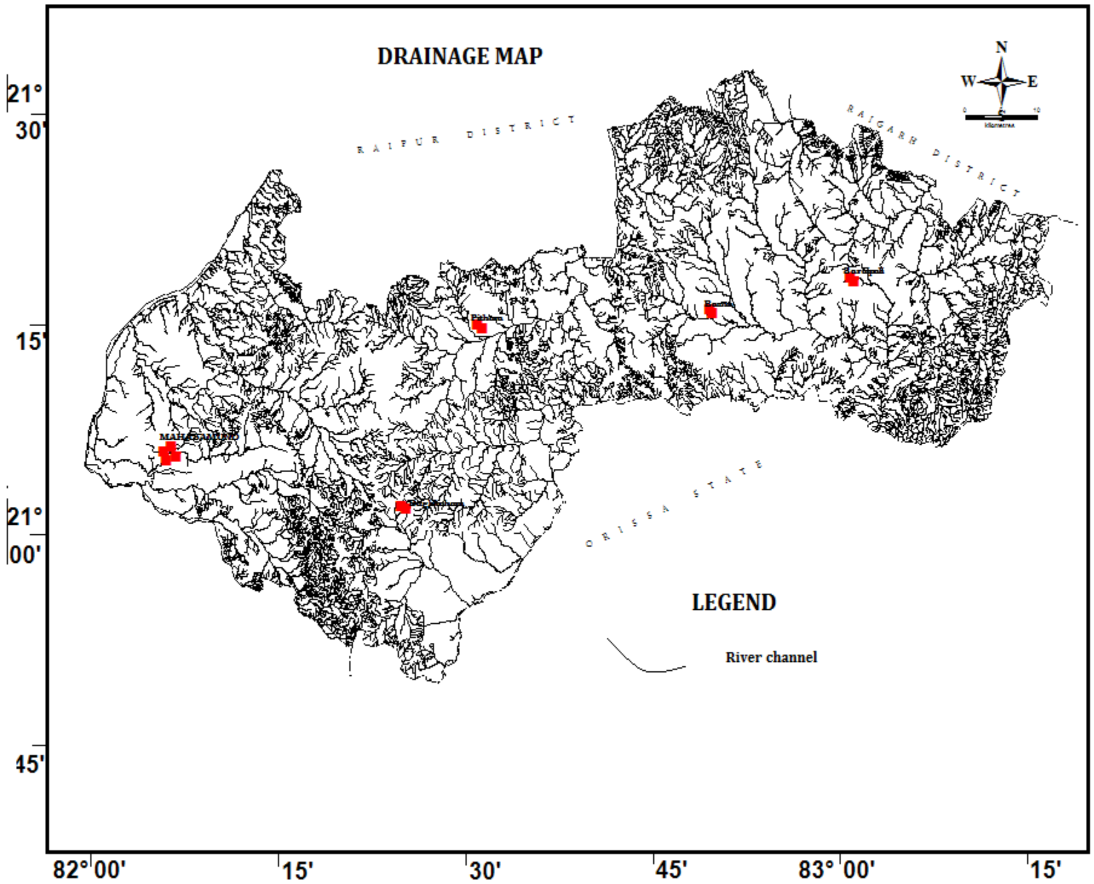


Figure 3 Drainage map of Mahasamund

1.11 Geology and Hydrogeology

Mahasamund district is mainly underlain by hard rock belonging to Precambrian age, part from these alluvium and laterite of Quaternary age occur in very isolated pocket with and limited extension. Hard rock mainly includes granites and its variants, metasediments, ultramafites, rhyolite etc and also sandstone-shale– limestone / dolomite sequence belonging to Proterozoic Purana rocks of Chhattisgarh super group. The country rocks are intruded by basic and acid intrusive like dolerite dykes and sills and quartz and pegmatite veins. Major part of the district is occupied by granitic rocks belonging to Dongargarh group followed by Purana rocks of Chhattisgarh Supergroup which mainly consists of sandstone, shale, limestone / dolomite sequence. The rock of Chhattisgarh supergroup mainly occupies the eastern and western part of

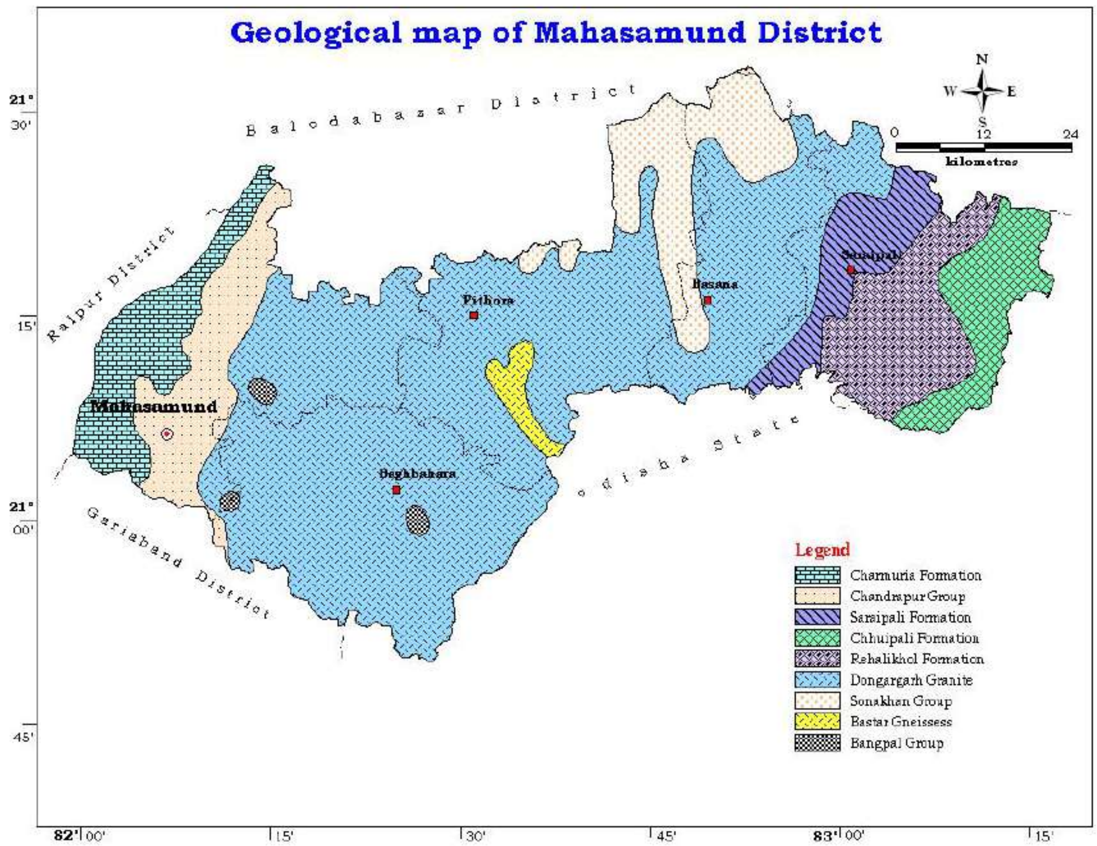


Figure 4 Geology map of Mahasamund district

the district. The Chhattisgarh supergroup consists three-group i.e. oldest Singhora group, followed by Chandrapur group and youngest Raipur group. The Singhora group is occur in eastern part of the district, Raipur group occupies western part of the district, while Chandrapur group occur both in eastern and western part, with predominant occurrence in western part. The predominant occurrence of limestone in western part in Raipur group of rocks. The rocks of Bangpal group is occur in central part and rocks of Sonakhan group occur mainly in North eastern part. The Bangpal group of rocks includes high-grade gneiss and schistose rocks and granite etc and Sonakhan group includes metasediments, ultramafics, Rhyolite, Amphibolites etc. The laterite occurs as capping over the country rock in pockets particularly in elevated area in limited thickness. The recent alluvium with limited thickness and extension occur along the major river and stream channels. (Fig.4)

Argillaceous limestone (Raipur group): The average thickness of the weathered portion in the area is around 18.5 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells. The average drawdown of the formation is around 20.1 m. The thickness of fractured aquifer is around 0.2 m.

Sandstone (Chandrapur group): The average thickness of the weathered portion in the area is around 19.02 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 2 lps. The development in these formations is mostly by way of dug wells and shallow tube wells. The average drawdown is 24.06 m. The thickness of fractured aquifer is around 0.2 m.

Granitic gneiss (Dongargarh Supergroup): The average thickness of the weathered portion in the area is around 18 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells. The transmissivity of the formation is around 0.07 -1 m^2 per day with an average drawdown of 27 m. The thickness of fractured aquifer is around 0.2 m.

Sonakhan group of Archean to Proterozoic age consists of basalt and amphibolite and metasediments. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 12.75 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible(<1lps). The development in these formations is mostly by way of dug wells.

Singhora group is the oldest formation of Chhattisgarh super group. The sediments occurring in the block consist of Shale, Limestone, sandstone and siltstone. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 9.0 m. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible(<1lps). At two places, namely Chhattigirola and Birkol, discharge of 4.0 lps and 5.50 lps were obtained respectively. The development in these formations is mostly by way of dug wells.

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

Table 5 (A): Cropping pattern (in ha)

District	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar& Maize	Kodokutki						
Mahasamund	267632	35478	984	272522	141	133	19156	6367	2944	311	461	24

Table 5 (B): Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No.of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri-gated area	Gross irrigated area	% of irrigated area wrt. Net sown area
77	4094	20626	55951	5093	881	3524	4768	6654	99047	109195	36 %

Table 5 (C): Statistics showing Agricultural land Irrigated

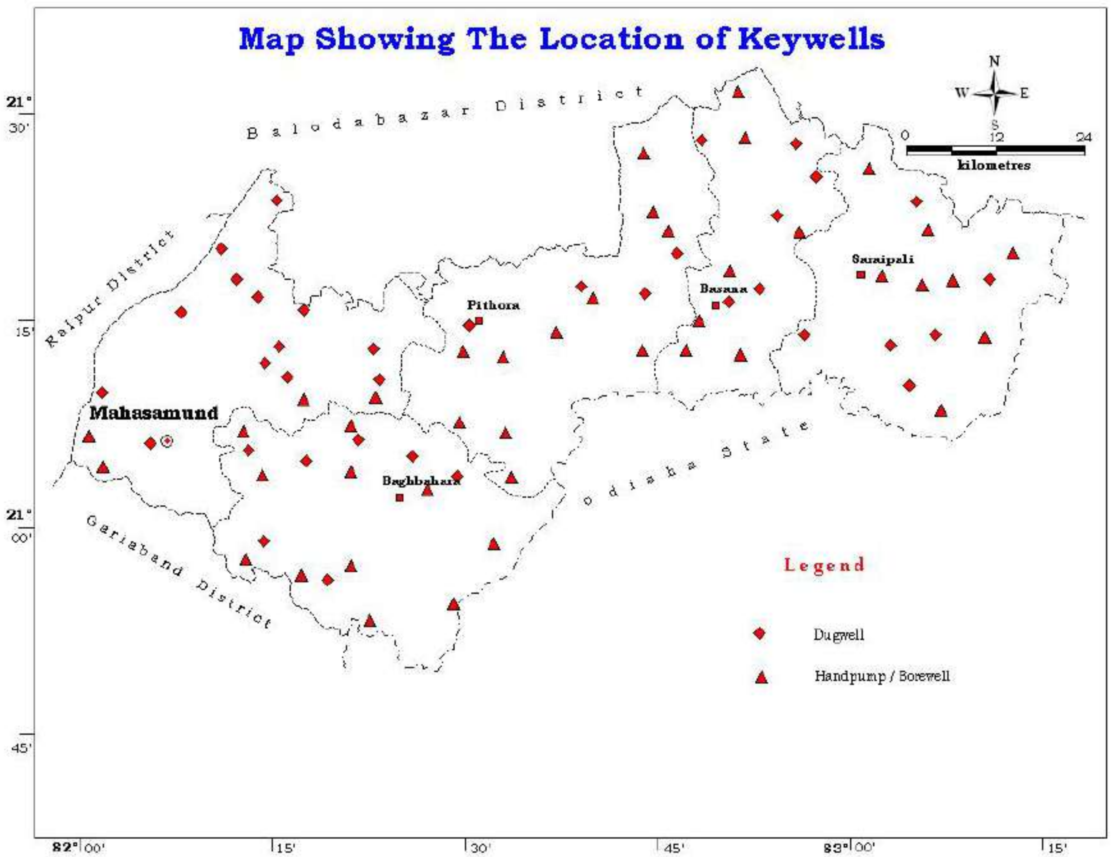
District	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Mahasamund	99047	56832	57.37

ground water as well as partly through surface water like canals and other sources. During Rabi period, 57.4% irrigated area use groundwater. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops are paddy, wheat, vegetables and pulses.

In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Mahasamund district is given in Table 5 (A, B, C).

2.0 Data Collection and Generation

2.1 Hydrogeological Data



The major aquifers present in the study area are (1) Raipur group limestone and shale (2) Chandrapur sandstone (3) Dongargarh granite and granitic gneiss (4) Sonakhan group amphibolite gneiss, basalt (5) Singhora group limestone, shale and sandstone; both in phreatic and fractured condition In general two aquifers exist in the area although both are hydraulically connected. The first shallow unconfined/ phreatic aquifer between 0-20mbgl and the second semi confined to confined aquifer below 20mbgl. It has been found that within the second aquifer, there are 2-3 set of aquifers which are not well connected. The different sets of aquifers are of different thickness as well as of varying horizontal extent. In the study area, key wells were established during the pre-monsoon period and have been subsequently monitored in the post-monsoon period. The key wells are distributed throughout the study area (Fig.5) covering all the geological formations, the details of which are presented in the Table No 6.

Figure 5 Map showing Location of wells

Table 6: Detail of Key (observation) Wells established in the study area

Sl.no.	Location	Longitude	Latitude	Type	Geology	Location
1	Mohadi	82.2118	21.1197	BW	D.Granite gneiss	Bhatapara, Mohadi, opposite to Kala Manch
2	Khallar i(Bhimkhoj)	82.2899	21.0808	DW	D.Granite gneiss	RHS road, beside Shiv Mandir, Opposite Yogesh Welding works
3	Gabaud	82.351	21.1216	BW	D.Granite gneiss	At the entrance to village, near talab, opposite to white color Shiv mandir
4	Hathigarh	82.3585	21.1059	DW	D.Granite gneiss	Adjacent to Ma Shitala Mandir, RHS of road Phokatpara
5	Patherapali	82.3508	21.0698	BW	D.Granite gneiss	Bwadjacent to lhsmain road towards Mahasamund.Akondo full r jungle
6	Kotanpali	82.4491	21.0579	HP	D.Granite gneiss	LoknathDongrijalashay, HP at village entrance, in front of first house
7	Lamkeni	82.4298	21.0829	DW	D.Granite gneiss	House of Manbodh Patel, in the garden, turn left to gram panchayat bhawan
8	Lamkeni	82.4296	21.0829	BW	D.Granite gneiss	House of Manbodh Patel, in the garden, turn left to gram panchayat bhawan
9	Mudagaon	82.4828	21.0617	DW	D.Granite gneiss	School para, DW in the house just beside irrigation canal, in the backside of garden, visible from road
10	Deori	82.5279	20.9846	BW	D.Granite gneiss	Gajar-->Terinara-->Baghamura-->Deori,bore well LHS of road, close to tower, near Godown
11	Narradw	82.4802	20.9098	DW	D.Granite gneiss	DW infront of mandir, which is about 100m from Bazaar chowk and Anganwadi Kendra
12	Narrabw	82.4786	20.9119	BW	D.Granite gneiss	Bore at the entrance to Narra, 200m from main village, LHS of road while going towards Komakhan
13	Kasekera	82.4221	20.9568	DW	D.Granite gneiss	DW in Pawan Yadav's garden, close to Bazaar chowk trijunction, turn right 100m
14	Kamraud	82.2323	21.0628	BW	D.Granite gneiss	Bore at village entrance, beside OFC BBNL post, 50-60m before big banyan tree
15	Tamora	82.2209	20.9638	BW	D.Granite gneiss	BW at village entrance,close to supply water tap, infront of house Sahu ji
16	Tamori	82.2306	20.977	DW	D.Granite gneiss	DW BEHIND Gandhi statue, 50m from Mandir and Rang Manch, just beside road
17	Borrabandha	82.2753	20.9484	BW	D.Granite gneiss	Bore in the compound of primary school
18	Teka	82.3167	20.9262	DW	D.Granite gneiss	well at the end of village
19	Hathibahra	82.3442	20.9547	BW	D.Granite gneiss	Teka-->Bijhladaddar-->Chandi mandir (take right) bore behind Middle school
20	Khairatkalan	82.3724	20.8815	HP	D.Granite gneiss	HP infront of Manch and banyan tree

21	Parsadih	82.1337	21.2618	DW	Raipur limestone	Pirda-->Khairjhiti-->LHS of road (located in school para)
22	Achanakpur	82.2302	21.2799	DW (HP sample)	Chandrapur sstn	well in the house of Deven Patel (house at trijunction, just at the entrance of bastipara)
23	Borid DW	82.2674	21.3947	DW	Chandrapur sstn	Near Borid Anganwadi Kendra
24	Borid HP	82.268	21.3949	HP	Chandrapur sstn	Under big neem tree, about 50m from Anganwadi Kendra
25	Rumekel	82.2928	21.2638	DW	D.Granite gneiss	Jogidipa-->Sinodha--> Take left for Rumekel, adjacent to boundary wall of Govt.Primary school
26	Pachri	82.3874	21.1766	DW	D.Granite gneiss	(H/O: Sundarlal Sinha, infront of big banyan tree, beside Lata tailors)
27	Nartora	82.3775	21.1557	HP	D.Granite gneiss	Khalepara, beside community dustbin
28	Ramkhera	82.2872	21.1599	HP	D.Granite gneiss	HP adj. to Gram Panchayat Bhawan, infront of big neem tree
29	Khatta	82.2688	21.1828	DW	D.Granite gneiss	Ram Narayan Tiwari house infront of big banyan tree, close to bazaar chowk cycle store
30	Nawagaon	82.2443	21.2009	DW	D.Granite gneiss	In the field, under peepal tree at the end of village
31	Laphinkhurd	82.0324	21.0744	BW	Raipur limestone	Gandhi chowk mohalla, bore in the house of Jageshwarsahoo, gully to the right of Rana cycle store
32	Nandgaon	82.0148	21.1204	BW	Raipur limestone	Laphin Khurd-->Baroda chowk-->Turn left, kirana store close to school, Chandrasekhar's house(Yadav Kirana store)
33	Bemcha	82.096	21.1379	HP	Chandrapur sstn	On the way to Mahasamund, RHS of main road, infront of Akash computer, under big peepal tree
34	Kishanpur	82.5394	21.3064	BW	Chandrapur sstn	Infront of Govt.well near Suri (previous Sarpanch's) house,ward no.5
35	Patandadar	82.6068	21.3156	BW	Chandrapur sstn	Sahoo para, infront of Firtu Naik's home, under mango tree, infront of Maharaja statue
36	Bada Temri	82.6759	21.3155	BW	Chandrapur sstn	On the way from Sankra-->Bada Temri-->Bijemal.LHS of road, blue colour pipe
37	Bhatkunda	82.717	21.3573	DW	D.Granite gneiss	Straight metalled road from Bada Temri--> Bhat Kunda, RHS of road, Darasram Patel's house, in the field behind his house
38	Bhikhapar	82.751	21.387	BW	Sonakhan group	BW on LHS of road which goes from Bhatkunda-->Jhengradih-->Bhikhapar, infront of house of ChandramaniBhui
39	ParadiyaSarai pali	82.7325	21.459	BW	Sonakhan group	BW located in field just beside transformer near Govt high school
40	Gormarra	82.7583	21.3625	BW	D.Granite gneiss	RHS infront of saw mill and 2 big banyan trees
41	Saldih	82.7264	21.2189	HP	D.Granite gneiss	adjacent to UddbhavKirana store, Sanjeev book house, gramin choice center

42	Chikhli	82.6192	21.2386	HP	D.Granite gneiss	NH-->Memra-->Chikhli(rock exposure), in the agricultural field of Deep maniHotha
43	Khaprakhol	82.5519	21.2083	BW	D.Granite gneiss	In the field where solar panel has been installed opposite to milestone (Jhangora 5km)
44	Bundeli	82.5842	21.1414	DW	D.Granite gneiss	Nandi Maharaj Statue trijunction, turn right, public well in Satnami para
45	Bhurkoni	82.5494	21.1156	HP	D.Granite gneiss	HP near Rajiv Gandhi Bhawan, LHS of main road
46	Sohagpur	82.5561	21.0628	HP	D.Granite gneiss	In the field, RHS, Close to canal and Doman Bald Baliram house
47	Kumharimura	82.4886	21.1283	BW	D.Granite gneiss	Bore infront of Anganwadi
48	Bartunga	82.4959	21.2156	BW	D.Granite gneiss	Bore at village entrance
49	Umariya	82.9357	21.3585	HP	D.Granite gneiss	HP infront of Upswasthya Kendra, opposite to Gram Panchayat Bhawan
50	Bhanwarpur	82.9057	21.3716	DW	D.Granite gneiss	DW in the house of Sh. DevlalDewangan, Sagarpali road, RHS OF Shri Sai Steel
51	Lambar DW	82.9328	21.4632	DW	Singhora group sstn.,shale	DW adjacent to road, house of Bittoo Prasad
52	Lambarbw	82.9343	21.4549	BW	Singhora group sstn.,shale	Infront of Bandana Fabrication and Shiv Furniture
53	Beltikri	82.8523	21.5291	HP	Sonakhan group	HP infront of village welcome gate
54	Kurmadih	82.8661	21.4746	HP	Sonakhan group	Beltikri--> Bade Sajapali-->Salkhand-->Bandabri-->Kurmadih(HP in Khalhepara)
55	Chanat	82.8121	21.4701	DW	Singhora group sstn., shale	Bandabri-->Jamdarrah-->take right to Chanat (take Rambhata chowk)
56	Ganekera	82.8387	21.3156	HP	D.Granite gneiss	Chanat--> straight to Pirda electric office-->take left, go uptoNaugarhi--> take right for Ganekera
57	Kudekel	82.8011	21.2513	HP	D.Granite gneiss	HP at trijunction end of village infront of milestone Potapara (2.20km), near school (primary) &peepal tree, loharpara
58	Mohka	82.9296	21.282	HP	D.Granite gneiss	HP in front of Gram Panchayat Bhawan and big banyan tree
59	GarhPhuljhar	82.8527	21.2139	HP	D.Granite gneiss	HP infront of Anganwadi no.1 , 500m from village entrance
60	MedinipurSar aipali	82.7935	21.2209	BW	D.Granite gneiss	Bore near Anganwadi Kendra
61	Toshgaon	82.9428	21.2325	DW	Singhora group sstn.,shale	Well in the house of Govardhan Seth, Kirtan Mandali Chowk, Raju Hotel,
62	Bijatipali	83.0623	21.3988	BW	Singhora group sstn.,shale	BW at village entrance opposite to Karan Singh Chauhan's house, near Baithakkhana& Banyan tree.

63	Kendua	83.0587	21.3995	DW	Singhora group sstn.,shale	H/O Bhubaneshwar Patel, near bazar chowk
64	Mohanmuda	83.0228	21.4296	HP	Singhora group sstn.,shale	HP near trijunction, entrance to village, close to transformer
65	Boresara	83.0827	21.3969	DW	Singhora group sstn.,shale	RHS of road to Birkol, opposite to ChiranjilalMahadeblal Agrawal's house
66	Birkol	83.1126	21.4016	DW	Singhora group sstn.,shale	Take right turn from Nawagarh chowk for Birkol--> end of Nawagarh, turn left (H/O Kirtan Patel in a small gully)
67	Baradoli	83.1	21.3634	BW	Singhora group sstn.,shale	BW at entrance to village, Bazarpara, near co-operative society
68	Khamharpali	83.0937	21.2968	HP	Singhora group sstn.,shale	Baradoli-->Damodarah--> HP in Durga pandal maidan, RHS OF nh-53 on the way to Singhora
69	Rura	83.1344	21.3028	HP	Singhora group sstn.,shale	DW in the premises of Govt.Middle school
70	Singhora	83.1775	21.2988	DW	Singhora group sstn.,shale	Infront of Atal Chowk & village choice centre, water sample taken from HP in front of Govt. Primary school
71	Charbhata	83.2105	21.3381	HP	Singhora group sstn.,shale	Nayadipa HP
72	Kasturabahal	83.1679	21.2369	HP	Singhora group sstn.,shale	For Kasturbahal take left from Chhuipali, HP Govt Primary School Campus
73	Dumarpali	83.0736	21.1701	DW	Singhora group sstn.,shale	School para,ward no.1, beside H/O:Mangal Sai, LHS of road when going towards Baloda
74	Jampali	83.1146	21.1468	HP	Singhora group sstn.,shale	Schoolpara, new HP 06-06-2016
75	Saldih	83.0501	21.2154	DW	Singhora group sstn.,shale	Gayapara, Talab Chowk, RHS of road
76	Bastipali	83.1103	21.2339	DW	Singhora group sstn.,shale	DW in Harijanpara,HP in Bastipali primary school

2.2 Hydrochemical Data

To know the hydro chemical behavior of the ground water in the study area, 73 nos. of ground water samples were collected from the key wells and (NHNS) during pre-monsoon period of measurement (June, 2017). and analyzed in the chemical laboratory of Central Ground Water Board, NCCR, Raipur for determination of various chemical parameters. The results and findings are presented in Figure 6 and Table no. 7(A), 7(B).

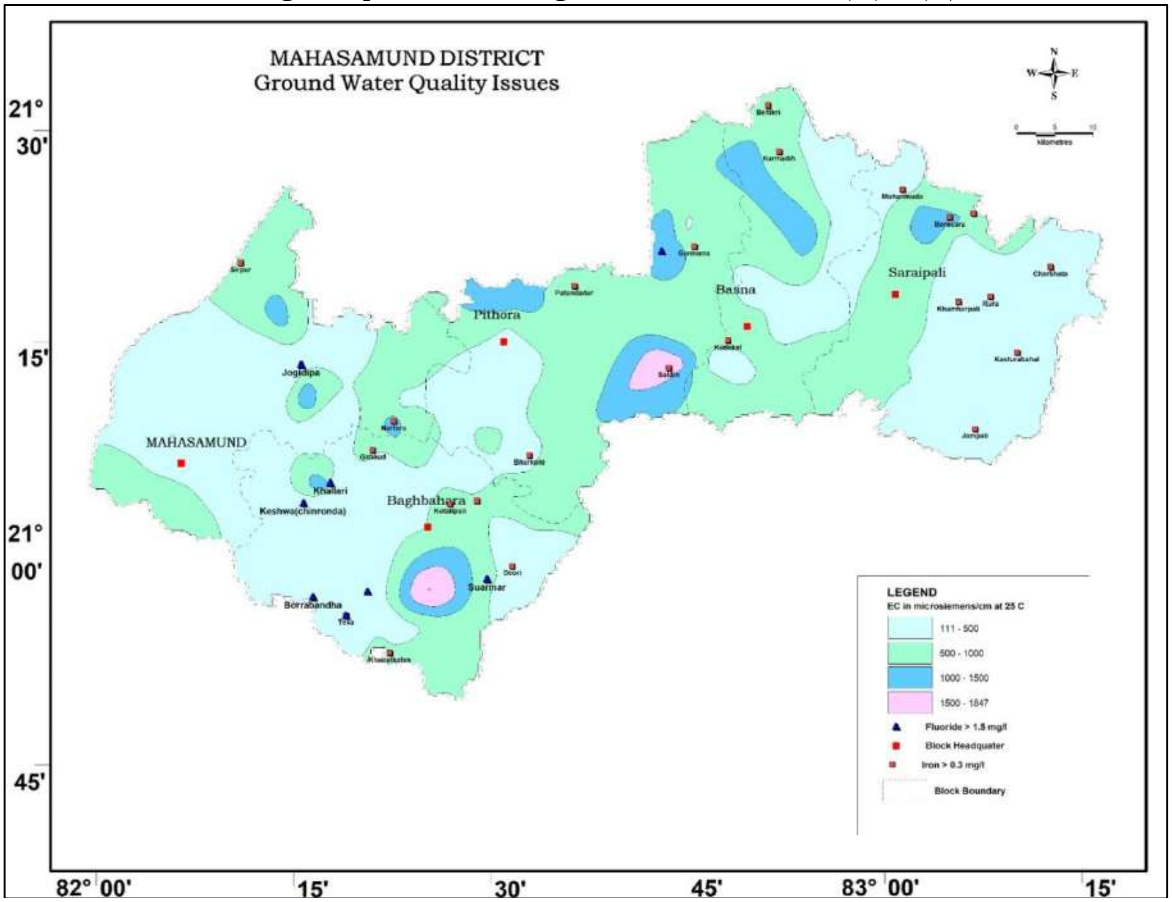


Figure 6 Ground Water Quality Issues, Mahasamund District

Table-7 (A): Result of chemical analysis of ground water (NHNS), year 2016-17 (concentration in mg/l, EC in µS)

S.No	Block	Village	Long	Lat	pH	EC	TA	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	F	Fe
1	Bagbahara	Awaradabri	82.3005	21.0847	7.75	433	105	175	64	3.6	9.9	4.5	128.1	63.9	3.5	0.6	0
2	Bagbahara	Bagbahara	82.4083	21.0333	7.46	473	110	160	36	16.8	32	0.7	134.2	60.35	6.9	1.2	0.023
3	Mahasamund	Baldidih	82.6417	21.2917	7.41	533	130	200	44	21.6	29.4	2.4	158.6	85.2	1.1	0.7	0.71
4	Basna	Barbaspur	82.8816	21.2908	7.64	367	140;’	145	24	20.4	18.4	0.8	170.8	28.4	13.6	0.9	0.1
5	Basna	Basna	82.8264	21.2694	7.67	591	95	240	38	34.8	15.1	0.6	115.9	99.4	1.0	0.9	0.16
6	Mahasamund	Belsunda	82.0271	21.1634	7.12	279	35	100	34	3.6	8.3	1	42.7	42.6	21.7	0.5	11.3
7	Bagbahara	Bhimkhoj	82.29583	21.0680	7.7	219	70	70	20	4.8	17.5	0.6	85.4	7.1	33.4	1.1	0.62
8	Pithora	Deori	82.7293	21.2742	7.59	636	125	270	46	37.2	14.7	0.6	152.5	92.3	10.3	0.7	0.046
9	Bagbahara	Hadabundh	82.2183	21.0933	7.15	184	45	60	14	6	11.6	1.7	54.9	28.4	5.3	0.7	1.4
10	Pithora	Jagdishpur	82.775	21.3333	7.61	623	125	265	44	37.2	14.8	0.6	152.5	92.3	4.1	0.7	0.115
11	Mahasamund	Jalki	82.2116	21.2433	7.62	722	135	210	56	16.8	38.3	23.5	164.7	106.5	3.7	0.7	1.3
12	Mahasamund	Jhalap	82.3831	21.2158	7.65	607	140	210	64	12	30.8	1.9	170.8	67.45	0.7	1.2	0.023
13	Mahasamund	Jhalkhamhariya	82.14528	21.0772	7.26	450	60	165	52	8.4	23.3	1.2	73.2	60.35	8.9	0.7	0
14	Mahasamund	Jogidipa	82.2599	21.2231	7.54	290	125	110	32	7.2	17.1	0.9	152.5	14.2	3.0	1.5	0.07
15	Bagbahara	Keshwa (chinronda)	82.26306	21.05917	7.75	259	105	85	24	6	21.8	0.3	128.1	21.3	10.9	3.2	0.2
16	Bagbahara	Khallari	82.2972	21.0833	7.53	395	165	155	40	13.2	21.8	1.5	201.3	21.3	8.2	3.2	0.1
17	Mahasamund	Mahasamund.1	82.0958	21.1083	7.19	278	35	115	42	2.4	8.4	1.1	42.7	42.6	0.7	0.5	0.33
18	Bagbahara	Palsipani	82.3833	20.9042	7.53	234	80	95	28	6	9.5	0.4	97.6	28.4	1.5	1.2	0.099
19	Mahasamund	Pithora	82.5167	21.2514	7.4	313	85	105	38	2.4	22.2	1	103.7	39.05	24.2	1.3	0.152
20	Pithora	Sankra	82.66222	21.28389	7.54	626	155	265	48	34.8	15	0.6	189.1	28.4	39.1	0.8	0.144
21	Basna	Saraipali	83.0083	21.3167	7.58	616	155	200	60	12	48	1.2	189.1	106.5	3.4	1.2	0.07
22	Mahasamund	Sirpur	82.1833	21.3431	7.71	413	55	165	58	4.8	14.8	4	67.1	7.1	127.7	0.6	0.26
23	Bagbahara	Suarmar	82.4958	20.9694	7.63	758	220	215	70	9.6	68.5	8.1	268.4	56.8	0.9	1.9	0.095
25	Bagbahara	Tendukonda	82.4708	21.1083	7.52	237	80	100	30	6	9.7	0.4	97.6	28.4	0.7	1.2	3.97
26	Mahasamund	Tumgaon	82.1208	21.1917	7.14	191	50	80	26	3.6	6	1.4	61	28.4	0.7	0.6	12.2

Table 7 (B): Result of chemical analysis of ground water (key wells), year 2017 (concentration in mg/l, EC in µS)

S.No.	Block	Location	pH	TDS	EC	HCO3	Cl	F	SO4	Ca	Mg	Na	K	TH	PO4	SiO2
1	Bagbahara	Mohadi	6.73	176	267	97.6	24.9	1.3	0.7	20	2.4	26.4	1	60	0.09	36.23
2	Bagbahara	Khallari (Bhimkhoj)	7.07	809	1226	335.5	170.4	1.1	63.2	82	26.4	99.4	21.5	315	0.09	11.69
3	Bagbahara	Gabaud	7.12	389	589	128.1	88.8	0.2	16.7	60	14.4	21.7	0.6	210	0.08	30.06
4	Bagbahara	Hathigarh	7.21	218	332	128.1	32.0	0.6	15.6	38	6	15	0.8	120	0.08	25.85
5	Bagbahara	Patherapali	7.5	281	426	219.6	24.9	0.9	10.8	50	10.8	21.3	1.4	170	0.08	25.58
6	Bagbahara	Kotanpali	7.24	419	634	201.3	78.1	1.3	19.2	72	13.2	29.4	0.5	235	0.09	25.42
7	Bagbahara	Lamkeni	7.44	305	463	183	42.6	0.9	14.0	48	12	23	15.6	170	0.08	24.28
8	Bagbahara	Mudagaon	7.45	344	521	262.3	35.5	0.6	15.7	52	16.8	35.9	2.1	200	0.07	26.98
9	Bagbahara	Deori	7.2	117	178	54.9	24.9	0.3	1.9	16	4.8	13.1	0.6	60	0.06	25.79
10	Bagbahara	Narrabw	7.65	383	600	280.6	42.6	1.2	13.2	60	15.6	39.9	2.5	215	0.09	21.52
11	Bagbahara	Kasekera	7.27	1221	1849	335.5	294.7	0.4	85.8	102	31.2	52.9	168	385	0.12	13.74
12	Bagbahara	Kamraud	7.45	258	391	164.7	35.5	1.2	12.7	38	12	28.2	0.6	145	0.08	26.06
13	Bagbahara	Tamora	7.33	294	446	115.9	56.8	1.4	19.9	40	4.8	43.1	0.9	120	0.09	33.90
14	Bagbahara	Tamori	7.58	228	345	158.6	32.0	1.2	5.1	34	13.2	17.3	1.3	140	0.10	24.66
15	Bagbahara	Borrabandha	7.27	171	260	115.9	17.8	1.6	2.2	32	6	14.7	1	105	0.09	30.77
16	Bagbahara	Teka	7.5	116	176	85.4	17.8	2.4	3.3	18	2.4	16.9	0.5	55	0.08	29.04
17	Bagbahara	Hathibahra	7.48	200	302	158.6	21.3	2.7	5.5	28	8.4	23.5	1.5	105	0.10	26.06
18	Bagbahara	Khairatkalan	7.58	449	680	256.2	53.3	1.3	24.9	76	14.4	42.9	0.8	250	0.06	27.96
19	Mahasamund	Parsadih	7.24	253	383	183	17.8	0.2	3.6	56	4.8	12.1	0.6	160	0.05	8.39
20	Mahasamund	Achanakpur	7.59	711	1078	372.1	131.4	0.1	61.6	70	12	101.2	89.5	225	0.05	11.90
21	Mahasamund	Borid HP	7.43	440	667	207.4	71.0	0.2	30.5	78	7.2	35.2	5.2	225	0.05	16.88
22	Mahasamund	Sirpur	7.28	427	647	262.3	46.2	0.3	20.4	70	13.2	17.8	20	230	0.05	14.77
23	Mahasamund	Jalki	7.66	175	266	140.3	17.8	0.6	3.3	30	6	16.8	0.8	100	0.06	30.71
24	Mahasamund	Rumekel	7.32	144	218	97.6	17.8	0.1	7.3	20	3.6	11.1	15.1	65	0.05	8.06
25	Mahasamund	Pachri	7.21	312	473	97.6	81.7	0.3	12.6	40	14.4	19.9	1.3	160	0.09	23.74
26	Mahasamund	Nartora	7.54	719	1089	213.5	174.0	0.3	43.2	106	27.6	41.1	1.6	380	0.05	23.36
27	Mahasamund	Ramkhera	7.33	147	222	91.5	21.3	0.5	1.9	24	6	13.3	1.3	85	0.06	33.90
28	Mahasamund	Khatta	7.64	961	1346	390.4	177.5	0.3	80.5	86	19.2	83.6	110	295	0.07	17.85
29	Mahasamund	Nawagaon	7.06	267	404	122	56.8	0.1	4.5	38	13.2	20.1	4.4	150	0.06	31.90

S.No.	Block	Location	pH	TDS	EC	HCO3	Cl	F	SO4	Ca	Mg	Na	K	TH	PO4	SiO2
30	Mahasamund	Laphinkhurd	7.21	551	836	176.9	145.6	0.1	13.4	24	56.4	22.6	7.8	295	0.09	13.47
31	Mahasamund	Nandgaon	7.18	344	522	207.4	60.4	0.3	11.2	62	14.4	16.2	0.5	215	0.08	8.82
32	Mahasamund	Bemcha	6.93	72	110	36.6	17.8	0.0	1.0	12	3.6	2.9	0.7	45	0.07	8.06
33	Pithora	Kishanpur	7.21	776	1175	231.8	184.6	0.3	50.5	118	28.8	45.3	3.9	415	0.05	35.15
34	Pithora	Patandadar	7.32	442	670	341.6	53.3	0.4	20.3	72	38.4	30.5	1.4	340	0.05	22.12
35	Pithora	Bada Temri	7.42	346	525	335.5	14.2	0.3	3.3	42	22.8	31.6	1	200	0.06	23.79
36	Pithora	Bhatkunda	7.47	947	1435	555.1	159.8	2.3	56.0	156	56.4	18.4	7.8	625	0.11	27.15
37	Pithora	Bhikhapar	7.38	318	482	164.7	56.8	0.4	24.0	54	10.8	17.3	0.2	180	0.06	29.42
38	Pithora	ParadiyaSaraipali	7.27	558	846	280.6	85.2	0.4	35.7	76	40.8	24.1	0.2	360	0.06	20.39
39	Pithora	Gormarra	7.66	505	765	225.7	88.8	0.4	31.2	78	27.6	12.8	0.4	310	0.06	17.90
40	Pithora	Saldih	7.17	1346	1742	250.1	383.4	0.1	84.5	168	84	38.9	1.4	770	0.06	26.23
41	Pithora	Chikhli	7.48	362	549	195.2	53.3	0.5	20.9	52	18	19.4	1.1	205	0.05	18.66
42	Pithora	Khaprakhol	7.31	325	492	244	21.3	0.8	10.7	48	18	20.7	0.5	195	0.07	17.96
43	Pithora	Bundeli	7.53	390	591	201.3	74.6	0.8	21.0	62	14.4	27.8	1.6	215	0.08	24.93
44	Pithora	Bhurkoni	7.58	288	437	219.6	32.0	1.0	11.4	46	9.6	25.7	1	155	0.05	29.79
45	Pithora	Sohagpur	7.32	441	668	219.6	85.2	0.7	15.6	74	9.6	37.3	0.6	225	0.05	26.44
46	Pithora	Kumharimura	7.3	341	527	176.9	60.4	0.3	15.6	50	12	38.1	1	175	0.06	24.17
47	Pithora	Bartunga	7.1	148	297	115.9	32.0	0.8	15.9	28	8.4	18.7	1.6	105	0.06	30.01
48	Basna	Umariya	7.54	196	293	134.2	24.9	0.4	7.7	36	7.2	15.1	0.1	120	0.06	25.20
49	Basna	Bhanwarpur	7.34	862	1106	183	230.8	0.2	95.0	96	24	107.5	12.5	340	0.06	9.90
50	Basna	Lambar DW	6.8	82	124	30.5	17.8	0.0	4.3	8	4.8	6.4	2.4	40	0.05	6.61
51	Basna	Beltikri	7.31	500	757	207.4	74.6	0.2	45.0	56	39.6	21.8	1.4	305	0.06	14.17
52	Basna	Kurmadih	7.88	607	920	286.7	120.7	0.3	4.4	14	85.2	15.2	17.5	390	0.07	11.85
53	Basna	Chanat	7.53	701	1068	347.7	120.7	1.0	46.1	96	27.6	83.7	7.3	355	0.06	15.47
54	Basna	Ganekera	7.3	250	379	207.4	17.8	0.7	4.5	48	10.8	13.5	0.4	165	0.05	21.36
55	Basna	Kudekel	7.55	372	564	195.2	63.9	0.3	16.4	62	16.8	20	0.2	225	0.06	24.06
56	Basna	Mohka	7.52	255	387	158.6	35.5	0.3	5.6	44	13.2	12.7	0.3	165	0.06	22.44
57	Basna	GarhPhuljhar	7.76	361	547	305	39.1	1.4	14.5	46	16.8	65	1.8	185	0.06	21.96
58	Basna	MedinipurSaraipali	7.76	174	263	122	21.3	0.7	3.9	32	9.6	9.2	0.4	120	0.08	29.04
59	Saraipali	Toshgaon	7.25	441	668	225.7	81.7	0.2	25.9	52	26.4	28.2	1.2	240	0.06	6.93
60	Saraipali	Kendua	7.62	897	1357	317.2	181.1	0.2	60.3	68	9.6	92	159.9	210	0.53	11.85
61	Saraipali	Mohanmuda	7.12	338	473	256.2	14.2	0.3	2.2	50	12	22.6	0.7	175	0.06	21.15

S.No.	Block	Location	pH	TDS	EC	HCO3	Cl	F	SO4	Ca	Mg	Na	K	TH	PO4	SiO2
62	Saraipali	Boresara	7.19	1006	1100	85.4	316.0	0.3	25.3	108	37.2	73.6	3.9	425	0.06	10.39
63	Saraipali	Birkol	7.45	549	830	256.2	110.1	0.3	28.9	68	19.2	34.3	85	250	0.06	18.71
64	Saraipali	Baradoli	7.41	240	363	176.9	21.3	0.0	8.0	18	7.2	51.2	0.7	75	0.05	7.74
65	Saraipali	Khamharpali	7.48	265	403	207.4	14.2	0.1	4.6	28	22.8	14.1	4.4	165	0.11	5.25
66	Saraipali	Rura	7.66	201	305	152.5	17.8	0.2	1.3	26	19.2	9.5	0.7	145	0.05	5.20
67	Saraipali	Singhora	7.53	199	302	158.6	17.8	0.2	1.6	30	13.2	10.1	1.2	130	0.05	4.93
68	Saraipali	Charbhata	7.61	234	390	183	32.0	0.4	1.9	50	8.4	8.5	2.3	160	0.11	9.85
69	Saraipali	Kasturabahal	7.63	267	357	158.6	17.8	0.2	1.2	34	14.4	12.2	0.2	145	0.05	4.88
70	Saraipali	Dumarpali	7.36	142	405	170.8	21.3	0.2	3.8	38	15.6	8.6	3.2	160	0.05	9.47
71	Saraipali	Jampali	7.49	217	217	109.8	17.8	0.0	1.0	24	8.4	13.7	2.9	95	0.05	3.47
72	Saraipali	Saldih	7.32	257	481	152.5	42.6	0.1	10.3	38	13.2	27.6	1	150	0.05	5.69
73	Saraipali	Bastipali	7.45	315	478	183	32.0	0.1	3.1	36	21.6	11.2	2.3	180	0.05	5.69

2.3 Geophysical Data

Geophysical surveys (Vertical Electrical Sounding or VES) have been conducted in the study area to delineate the disposition of the existing aquifer system and 30 nos. of soundings were carried out.

Table 8 Geophysical surveys (Vertical Electrical Sounding or VES) Results

S.No.	Location	Block	Longitude	Latitude	Resistivity in (ohm-m)					Layer Thickness in (m)				Fracture Zones Identified from Factor Calculation method in (mbgl)
					□1	□2	□3	□4	□□	h_1	h2	h3	h4	
1	Lamkeni	Bagbahara	82.43214	21.08292	46	19	73	91278		3	1.2	15		NIL
2	Sirri	Bagbahara	82.3755	21.08865	202	60.1	8843			0.9	9			40-50
3	Kotanpali	Bagbahara	82.44548	21.05861	84	17.5	130	3521		2.5	2.8	18		40-50
4	Gaboud	Bagbahara	82.35696	21.12262	105	27	72	560		1.2	5.3	17		10-15,60-70,100-120
5	Shikaripali	Bagbahara	82.49364	21.11255	140	85	870			1.3	8			15-20
6	Tendukona	Bagbahara	82.46109	21.11308	280	24.6	119	1993		1.56	8.54	12		20-25,80-90
7	Patewa	Mahasamund	82.26558	21.22242	317	26.7	34089			0.6	4.6			NIL
8	Kishanpur	Pithora	82.53288	21.30728	78	31	954			2	7.6			NIL
9	Gopalpur	Pithora	82.55729	21.28394	161	46.6	1804			1.9	8			50-60
10	Navagaon Kala	Pithora	82.55251	21.09058	150	46	273	879		0.95	6	26		40-70,120-150
11	Tupakbora	Bagbahara	82.50839	21.06332	62.2	48.2	723	174		1.41	7.09	41.4		20-25
12	Salhebhata	Bagbahara	82.53609	20.95149	189	68	1897			1.6	15.6			25-30,80-90
13	Suvarmar	Bagbahara	82.47424	20.98139	270	26.4	63.7	3206		0.78	4.91	20.5		20-25,60-80
14	Temri	Bagbahara	82.50897	20.93968	637	121	73.4	1240		0.65	3.07	14.3		25-30,100-120
15	Hathibahara	Bagbahara	82.34542	20.95775	115	43.2	33194			1	17.6			25-30,70-90
16	Mohadi	Bagbahara	82.21023	21.11517	334	28.9	19.2	28382		3.2	10.4	11.5		20-40
17	Khairatkala	Bagbahara	82.37459	20.88467	52	17.5	31.7	187	18343	1.2	1.31	8.45	97.6	40-60,100-150
18	Khamharia	Bagbahara	82.2504	20.98307	75.4	25.5	52.3	459		0.8	2.7	7.86		40-50,100-150
19	Tamori	Bagbahara	82.2311	20.97772	67.3	16.7	743	30.8		2.04	4.65	23.4		25-30,70-80
20	Barnaidadar	Pithora	82.71899	21.37518	51.6	17.9	111	10.5	1129	1.11	1.32	2.38	9.44	25-40,60-120

S.No.	Location	Block	Longitude	Latitude	Resistivity in (ohm-m)					Layer Thickness in (m)				Fracture Zones Identified from Factor Calculation method in (mbgl)
					□$_1$	□$_2$	□$_3$	□$_4$	□$_□$	h_1	h2	h3	h4	
21	Limdhara	Pithora	82.79686	21.43864	796	97.13	333.5	3976		0.77	2.19	11.6		30-35,100-120
22	Bade Sajapali	Basna	82.86565	21.52798	8.3	1269				2.86				NIL
23	Padkipali	Basna	82.8715	21.3798	57.8	22.2	383	41609		0.9	1.43	45.2		60-70,100-120
24	Saraipali	Basna	82.86693	21.32565	18.08	4.21	31.12	5405		4.5	3.55	30.66		25-50,90-100
25	Ponsara	Basna	82.87782	21.30249	250	39.2	14338			2.58	18.4			20-25,80-100
26	GarghPhuljhar	Basna	82.85165	21.2057	120	52.5	46550			5.08	23.8			30-60,80-100
27	Dudhipali	Basna	82.83311	21.24906	19.8	7.49	1320			1.52	3.57			40-50,100-150
28	Devri	Pithora	82.7	21.28888	22.8	14.1	4215			1.05	1.57			NIL
29	Rewa	Pithora	82.61632	21.06001	235	13.1	18465			1.54	9.64			10-15,70-90
30	Kenduwan	Saraipali	83.05454	21.4058	92.7	27.1	974			1.19	7.82			40-50
31	Bijatipali	Saraipali	83.0652	21.40084	43.1	90.7	4299	191		2.23	9.72	74.4		100-150
32	Tibhupali	Saraipali	83.06831	21.14452	1935	232	91.3	317		2.75	38.8	30.2		50-70,90-150
33	Bastipali	Saraipali	83.11388	21.23815	332.6	80.98	34.79	182.9	2.77	4.66	8.74	23.8	54.88	40-60,90-100
34	Dumarpali	Saraipali	83.0768	21.1727	18.09	6.56	406.3			1.07	4.78			40-50,120-150
35	Saldih	Saraipali	83.05262	21.21358	15.1	9.01	30.5	137	4989	1.02	1.9	11.8	150	60-70
36	Rura	Saraipali	83.13524	21.29751	630	272	185	158		1.3	3	16		50-60,90-100,150-200
37	Singhora	Saraipali	83.19626	21.30292	29.5	223	1304			5.25	96.6			NIL
38	Charbhata	Saraipali	83.20727	21.33859	399	81.6	123	5371		2.09	22.5	84.6		50-80,100-120
39	Somaliya	Saraipali	82.94469	21.28982	10.2	15.3	371			2.36	16			100-200
40	Merhapali	Basna	82.94373	21.3819	20.3	39.9	629	13.5		3.47	9.22	59.4		40-50,100-120
41	Lalitpur	Basna	82.88699	21.45543	49.11	21.33	103.8	80.04	213.9	2.29	1.89	30.22	69.7	40-50,100-120
42	Khursipahar	Pithora	82.77469	21.2676	52.8	26.5	1303			4.19	9.67			25-30,60-70,100-120
43	Paraskol	Saraipali	83.11671	21.34958	114	21.2	145	667		0.75	3.4	41.9		40-50,150-200
44	Baradoli	Saraipali	83.09416	21.36206	343	76.6	43.6	123		1.19	5.25	11.7		25-60,100-120
45	Nawapara	Pithora	82.29476	20.95003	90	33.7	961			1.52	8.22			NIL

2.4 Exploratory Data

2.4.1 Status of Groundwater Exploration

A total of 43 bore wells exist in the study area as on 31-03-2016 out of which 38 nos. are exploratory bore wells and 5no's areobservation bore wells in the study area. Table 9 (A, B) summarizes the status of exploratory wells in the study area.

Table 9(A) Detail of Exploration in the study area (old)

Sl.no	location	Y	X	Depth	casing	Formation	Zone encountered	SWL	Discharge	Drawdown
Mh01	Banigirola	21.35417	83.02222	150.81	11	Shale and Sandstone	11-12,114-115	5.04	0.27	20
Mh02	Paikin	21.29167	83.1125	150.81	6.5	Limestone Cavernous	40.5-41, 95.9-96.5	5.05	1.04	21
Mh03	Bothaldih	21.28611	83.07778	127.96	10	Shale and limestone	33.8-34, 49.75-51	12.8	2.04	23.98
Mh04	Birkol	21.4	83.11667	150.81	10.7	Shale and limestone	11-12, 18-19, 52-53, 98-99, 122-123, 140-141	5	5.5	20.8
Mh05	Pandapara	21.22083	82.95417	150.8	11.15	limestone	28-29,64-65, 128-129	24	0.47	
Mh06	Singhanpur	21.30556	82.93333	127.96	13	Granite/ Granodiorite	13-14, 82.5-83	3.9	1.04	30
Mh07	Pausara	21.29444	82.87778	146	29.35	Granite/ Granodiorite	29.8-30, 68.5-69, 95.4-96,	4.77	4.55	26
Mh08	Rasora	21.2875	82.77556	132.53	21.68	Granite/ Granodiorite	21.9-22, 68-69	3.76	0.5	
Mh09	Baratiyabhata	21.39778	82.91778	132.53	22.15	Granite/ Granodiorite	52-53	0.5	0.62	
Mh10	Chhprikona	21.40833	82.86944	146.24	7.15	Basalt	7.7-10.1, 50.54	4	1.3	
Mh11	Patharala	21.40139	82.75278	100.54	10.18	Basalt	13.71-18.5	2.3	3.51	32.27
Mh12	Bamhnidih	21.48056	82.73444	127.96	10.95	Basalt	12--18	7.55	1.9	22
Mh13	Akori	21.18889	82.89028	123.29	12.18	Granite	22-26	9.4	7.9	13.78
Mh14	Saldih	21.21528	82.73056	127.06	20.25	Basic Intrusive, Dolerite Dyke	14.4-15, 54.6-55, 91.3-	9.42	3.51	21

Sl.no	location	Y	X	Depth	casing	Formation	Zone encountered	SWL	Discharge	Drawdown
Mh15	Khorara	21.25278	82.91167	141.67	13.9	Granite/ Granodiorite	18-19, 22.4-23, 40.5-42.5, 118-119	9.27	8.4	18
Mh16	Dongripali	21.25833	82.55694	127.96	9.42	Granite/ Granodiorite	36.7-37	9.85	0.47	
Mh17	Lakhagarh	21.25056	82.52917	146.26	13.59	Granite/ Granodiorite	14.9-15, 54.6-55, 118.7-119	6.66	1.06	19.8
Mh18	Bhurkoni	21.11528	82.55417	127.96	7.6	Shale, Sandstone	8.1-9, 54.8-55, 63.8-64	8.6	0.63	26.4
Mh19	Kherigaon	21.10833	82.53667	146.26	18.93	Granite/ Granodiorite	54.6-55, 63.3-64, 73-74,	5.9	0.81	28.6
Mh20	Chhattigirola	21.29222	83.05889	275.8	9.15	Limestone/ Dolomite	30--40	8	4	
Mh21	Chuipali	21.29222	83.14306	292.7	10	Shale, limestone, Sandstone	12--18	12	0.25	35
Mh22	Bundeli	21.14028	82.58944	150	9		10--25	5	1	
Mh23	Bihajhar	21.02778	82.43056	171.1	13.5	Granite/ Granodiorite	28.2-29, 80-80.5, 86.8-87	17.07	2.5	52
	Bihajhar	21.02778	82.43056							
Mh24	Khallari	21.09583	82.28667	200.6	9.1	Granite/ Granodiorite	10--20	5	1.5	
Mh25	Tandukona	21.11111	82.46944	150	14	Granite	12--20	8	0.1	
Mh26	Kutela	21.30417	83.02361	222.35	9.65		12--15	9	0.5	
Mh27	Basna	21.275	82.76361	205.62	14.15	Granite/ Granodiorite	13.65-14, 23-24, 31-32, 36.5-37, 53.5-54, 68.8-69, 84-85, 123-126, 137-137.5, 145-145.5	12	4	
Mh28	Mahasamund	21.08889	82.09306	182.52	22.72	Chandrapur Sst	10--15	8	2	
Mh29	Pithora	21.24583	82.52083	178.85	21.5	Granite	12--25	12	1	
Mh30	Paterpali	21.2375	82.34722	182.82	18.45	Sand	15--20	6	1.2	
Mh31	Birkoni	21.18278	82.05833	123	15.5	Sandstone, Granite/	43-43.5, 54-54.5, 60-60.5, 68-68.5	5.1	5	36
Mh32	Birkoni	21.18278	82.05833	125	12.7	Shale, Sandstone, Granite/ Granodiorite	26-27.5,48.3-49,104.5-105	5.4	3	13

Sl.no	location	Y	X	Depth	casing	Formation	Zone encountered	SWL	Discharge	Drawdown
	Birkoni(OW)	21.18278	82.05833			do				
Mh33	Pichi	21.23667	82.10417	86.1	32.2	Charmuria limestone	43.40, 733.80	13.35	10	23.75
	Pichi	21.23667	82.10417	86.1	31.75	Charmuria limestone, Sirpur	70.8	12.86	0.24	30.24
Mh34	Amlore	21.37278	82.23083	86.1	14	Charmuria Chandrapur Sandstone	52.5	19.53	0.5	33.52
Mh35	Belsonda	21.14306	82.04722	110.5	11	Charmuria Chandrapur Sandstone	107.5	6.5	1.2	23.5
Mh36	Sher	21.06056	82.04722	98.3	11.4	Chandrapur Granite	28.10, 54.0	11.7	12	14.6
	Sher	21.06056	82.04722	131.9	12.62	Chandrapur Granite	31.20, 67.80, 49.50, 59.20, 58.60, 119.70	10.66	19	13.64
	Sher	21.06056	82.04722	61.7	12.5	Chandrapur Granite	312, 58.60	8.42	16	115
Mh37	Baghbahara	21.03833	82.38917	183.8	25	Granite Dongargarh	2810, 86.20	9.22	3	34.1
	Baghbahara	21.03833	82.38917	120	24	Granite Dongargarh	85.6	11.05	12	38
Mh38	Bodaridadar	21.01694	82.51944	202	18.5	Granite Dongargarh	54	18	4.26	29
	Bodaridadar	21.01694	82.51944	120	22.5	Granite Dongargarh	34		0.24	

Table 9(B) Exploration in the study area (Year 2017-18)

Sl.no	Location	Y	X	Total Depth(m)	Depth of casing(m)	Formation	Zone encountered	SWL(m bgl)	Discharge (lps)	Drawdown (m)	Transmissivity (m^2/day)
1	Tumgaon	21.1848	82.1315	201.5	26.74	Shale,Sandstone,Ganite gneiss	--	9.9	<1	--	0.07
2	Sirri	21.0882	82.3755	201.10	17.40	Granite gneiss	--	--	DRY	--	--
3	Tupakbora	21.0632	82.5083	201.10	18.50	Granite gneiss	63.80-66.90	9.82	<1	--	0.58
4	Salhebhata	20.9514	82.5358	201.10	24	Granite gneiss	32.30	10.42	<1	--	0.49
5	Lamkeni	21.0827	82.4316	201.10	14.70	Granite gneiss	--	--	DRY	--	--
6A	Nawagaon Kala EW	21.0734	82.5516	143.10	21.90	Granite gneiss	21.10-22.30, 108.50, 143.10	12.65	10	10.73	50.07
6B	Nawagaon Kala OW	21.0734	82.5516	136	21.60	Granite gneiss	33.30-36.40, 39.50-42.40, 134-136	12.40		10.05	
7A	Shikaripali EW	21.1175	82.4927	201.10	18.50	Granite gneiss	57.70-60.80, 182.80-185.80	8.6	4	34.6	4.18
7B	Shikaripali OW	21.1175	82.4927	201.10	20.50	Granite gneiss	21.00, 176.70-179.70	5.23	3.5		

3. Data Interpretation, Integration and Aquifer Mapping

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

Water Level Behavior: (i) In the pre-monsoon period, it has been observed that in Raipur group limestone and shale, the maximum water level is 13.15 m at Sirpur in Mahasamund block, the average water level is 11.35 mbgl. It has been observed that in Chandrapur group sandstone, the maximum water level is 12.6 m at Mahasamund town in Mahasamund block, the average water level is 9.2 mbgl. In the pre-monsoon period, it has been observed that in Dongargarh granite and granitic gneiss, the maximum water level is 10.9 m at Hadabundh in Mahasamund block, the average water level is 7.9 mbgl. In the pre-monsoon period, it has been observed that in Sonakhan group basalts and amphibolites, the maximum water level is 10.74 m at Lambar in Basna block, the average water level is 8.03 mbgl. It has been observed that in Singhora group sedimentary formations, the maximum water level is 16.78 m at Kendua in Saraiapali block, the average water level is 7.75 mbgl.

Table 10A: Aquifer wise Depth to Water Level, mbgl (Pre-monsoon)

District Name	Formation	Phreatic Aquifer		
		Min	Max	Avg
Mahasamund	Raipur group limestone and shale	9.54	13.15	11.35
	Chandrapur group sandstone,	3.1	12.6	9.2
	Dongargarh granite and granitic gneiss	4.45	10.9	7.9
	Sonakhan group basalts and amphibolites,	5.46	10.74	8.03
	Singhora group sedimentary formations	3.2	16.78	7.75

Table10B: Aquifer wise Depth to Water Level, mbgl (Pre-monsoon)

District Name	Formation	Fractured Aquifer		
		Min	Max	Avg
Mahasamund	Raipur group limestone and shale	10.4	14.23	12.04
	Chandrapur group sandstone,	6.5	21.56	15.39
	Dongargarh granite and granitic gneiss	3.8	34.2	13.7
	Sonakhan group basalts and amphibolites,	4	15.9	10.07
	Singhora group sedimentary formations	4.24	25.6	16.06

(ii) In the post-monsoon period, it has been observed that in Raipur group limestone and shale, the water level varies from 1.71 to 8.85 mbgl with an average of 5.54mbgl. It has been observed that in Chandrapur group sandstone, the water level varies from 1.36 to 8.93 mbgl with an average of 3.44mbgl. In the pre-monsoon period, it has been observed that in Dongargarh granite and granitic gneiss, the water level varies from 1.98 to 6.5 mbgl with an average of 3.91mbgl. In the pre-monsoon period, it has been observed that in Sonakhangroup basalts and amphibolites, the water level varies from 1.5 to 5.99 mbgl with an average of 3.02mbgl. It has been observed that in Singhora group sedimentary formations, the water level varies from 1.4 to 5.4 mbgl with an average of 3.42mbgl

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

District Name	Formation	Phreatic Aquifer		
		Min	Max	Avg
Mahasamund	Raipur group limestone and shale	1.71	8.85	5.54
	Chandrapur group sandstone,	1.36	8.93	3.44
	Dongargarh granite and granitic gneiss	1.98	6.5	3.9
	Sonakhan group basalts and amphibolites,	1.5	5.99	3.02
	Singhora group sedimentary formations	1.4	5.4	3.42

Water Level (in mbgl)

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

District Name	Formation	Fractured Aquifer		
		Min	Max	Avg
Mahasamund	Raipur group limestone and shale	7.05	8.26	7.64
	Chandrapur group sandstone,	4.32	12.85	9.65
	Dongargarh granite and granitic gneiss	3.2	20.42	8.48
	Sonakhan group basalts and amphibolites,	2.8	7.85	5.06
	Singhora group sedimentary formations	4.13	21.32	11.25

(iii) Seasonal water level fluctuation: The water level fluctuation in Raipur group limestone and shale varies from 3.47m to 9.67m, with average fluctuation of 5. 81m.In Chandrapur group sandstone water level fluctuation varies from 1.74m to 10.08m, with average fluctuation of 5.5m. In Dongargarh granite and granitic gneiss, the water level fluctuation varies from 1.05m to 7.71m, with average fluctuation of 3.98m. In Sonakhangroup basalts and amphibolites, the water level varies from 1.91m to 9.24m, with average fluctuation of 4.99m. In Singhora group sedimentary formations, the water level fluctuation varies from 0.8m to 15.38m, with average fluctuation of 4.33m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

District Name	Formation	Phreatic Aquifer		
		Min	Max	Avg
Mahasamund	Raipur group limestone and shale	3.47	9.67	5.81
	Chandrapur group sandstone,	1.74	10.08	5.5
	Dongargarh granite and granitic gneiss	1.05	7.71	3.98
	Sonakhan group basalts and amphibolites,	1.91	9.24	4.99
	Singhora group sedimentary formations	0.8	15.38	4.33

Water Level (in mbgl)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

District Name	Formation	Fractured Aquifer		
		Min	Max	Avg
Mahasamund	Raipur group limestone and shale	2.14	6.61	4.4
	Chandrapur group sandstone,	2.18	8.71	5.73
	Dongargarh granite and granitic gneiss	0.25	18.4	5.21
	Sonakhan group basalts and amphibolites,	0.6	12.66	5.01
	Singhora group sedimentary formations	0.11	10.51	4.81

The long-term water level trend indicates that there is decline in pre-monsoon water level in Mahasamund block, Saraipali block and no appreciable change in water level both in pre-monsoon and post-monsoon period in the other blocks.

4. AQUIFER DISPOSITION AND GROUND WATER RESOURCES

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Mahasamund block upto 200 m depth is given in the table-4.

Table – 6: Aquiferwise Ground Water Resources of Mahasamund district in Ham

Block	Dongargarh granite and gneiss			
	Phreatic		Fractured	Total resource
	Dynamic	Static (below pre monsoon water level up to weathered Zone)	In-storage (below Weathered Zone to 200 meter)	
Mahasamund	38350.28	10312.05	895.13	49557.46
	Argillaceous limestone (Raipur group)			
	3219.59	368	97.58	3685.17
	Sandstone (Chandrapur group)			
	4031.48	276.48	122.19	4430.15
	Basalt & Amphibolite gneiss (Sonakhan group)			
	4871.14	771.04	46.6	5688.78
	Shale &Sandstone (Singhora group)			
	7146.74	1523.52	73.62	8743.88

Existing and Future Water Demand (2025)*:* The existing demand for irrigation in the area is 29530.10 Ham while the same for domestic and industrial field is 4241.31 Ham. To meet the future demand for ground water, a total quantity of 32212.95 ham of ground water is available for future use.

Table – 7: Ground Water Resources of Mahasamund district in Ham

Sl. No	District Assessment Unit / Block	Total Annual Recharge in Ham	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation For Domestic & Industrial Water Supply in Ham	Net Ground Water Availability for Future Irrigation Development in Ham	Stage of Ground Water Development in %
1.	Bagbahara	15156.06	14311.47	5780.00	428.93	6208.93	460.99	8070.48	43.38
2.	Basna	13337.32	2615.07	7468.00	418.47	7886.47	469.21	4677.86	62.52
3.	Mahasamund	14175.69	13214.30	6607.10	2507.34	9114.44	2828.61	3778.59	68.97
4.	Pithora	13856.84	13164.00	6822.00	453.95	7275.95	490.61	5851.39	55.27
5.	Saraipali	8939.18	8438.21	2853.00	432.62	3285.62	467.55	5117.66	38.94
	DISTRICT TOTAL	65465.09	61743.05	29530.10	4241.31	33771.41	4716.97	27495.98	54.70

Aquifer Geometry and Characterization

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer. The major aquifers present in the study area are (1) Raipur group limestone and shale (2) Chandrapur sandstone (3) Dongargarh granite and granitic gneiss (4) Sonakhan group amphibolite gneiss, basalt (5) Singhora group limestone, shale and sandstone;

5. GROUND WATER RELATED ISSUES

(i) During summer, dugwells in villages are dry except a few locations. Several handpumps also stop yielding water. The aquifer itself is a low yielding one.

(ii) High value of Fluoride (>=1.5 mg/l) has been reported from villages underlain by Dongargarh granite. (Fig 6, Table 8)

Table – 8: Locations showing high value of fluoride

Location	Block	Concentration of Fluoride
Jogidipa	Mahasmund	1.5
Borrabandha	Bagbahara	1.6
Teka	Bagbahara	2.4
Hathibahra	Bagbahara	2.7
Keshwa	Bagbahara	3.2
Khallari	Bagbahara	3.2
Suarmar	Bagbahara	1.9

iii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system.

Reasons for groundwater issues:

(i) Mahasamund block experienced drought situation because of poor monsoon in 2016-2017.

(ii) Drying up of dug wells and depletionof groundwater level during pre-monsoon is due to excessive groundwater withdrawal for irrigation of paddy in Rabi season and wastage during domestic uses.

(ii) Uneven distribution of yield potential and fractures in rocks.

(iii) In Chhattisgarh, power available at subsidized cost has been continuously leading to long duration and uncontrolled pumping of ground water withdrawal.

6. GROUND WATER MANAGEMENT PLAN

a) Supply side interventions:

(i) Mahasamund district experiences drought like situation because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken "Nal Jal Yojana" to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water. So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to understand people about the importance community participation in saving water.

(iii) De-siltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.

(iv) In command or non-command area wherever ground water has been used for field irrigation of pulses and vegetables should be replaced with micro irrigation methods such as sprinklers, drip irrigation etc, which can save upto 30% to 40% groundwater.

(v) It has been observed that though the long-term trend lines are insignificant, still we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area.

(vi) The practice of providing free electricity to operate irrigation borewells should be strictly monitored and put to an end in case of overconsumption. After a simple calculation it has been found that Rs 16000/ hectare is the expenses of electricity (@Rs. 2.5/unit) for paddy field. So, monitoring mechanism for electricity consumption should be strengthened for farmers taking summer rice.

Even if farmers use solar pump or other method of ground water irrigation for summer paddy, it should not be flooding method. Proper pipes are to be used to transfer water from one plot to another.

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

(vii) Fluoride removing filters or plants may be set up at appropriate locations.

(viii) Furthermore, in order to strike a balance between the ground water draft and the available resource, suitable artificial structures at appropriate locations be constructed through successive phases after tentatively every 20 nos. of groundwater abstraction structures become operative.

AQUIFER MAPS AND MANAGEMENT PLANS
MAHASAMUND BLOCK, MAHASAMUND DISTRICT

1. Salient Information:

About the area: Mahasamund Block is situated on the western part of Mahasamund district of Chhattisgarh and is bounded on the north and west by Balodabazar district andRaipur district respectively, in the south-west by Gariaband district of Chhattisgarh, in the south by Bagbaharablock and in the west by Pithora block. The area lies between 21.00 and 21.33 N latitudes and 82.00 and 82.33 E longitudes. The geographical extension of the study area is 944 sq.km representing around 18 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Geomorphology comprises of structural plains in the western part, pediment and pediplains in the eastern part and structural hills and denudational plains in the north central part of the block. Geomorphology map is shown in Figure 2. Mahanadi, flowing northwards forms the western most limit of the block separating Raipur and Mahasamund district. Bagnainala, Kurarnala and Hathi nala, all flowing north-westward are a part of Mahanadi basin. Baaghnainala flowing north-west is also tributary of Mahanadi river. Drainage map shown in Fig.3.

Population: The total population of Mahasamund block as per 2011 Census is264115out of which rural population is 202308while the urban population is 61807.The population break up i.e. male- female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Mahasamund	264115	131779	132336	202308	61807

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 20.26 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015)1392.02 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Mahasamund block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Annual rainfall	1424.70	1545.30	1493.00	1208.70	1288.40

Source: IMD

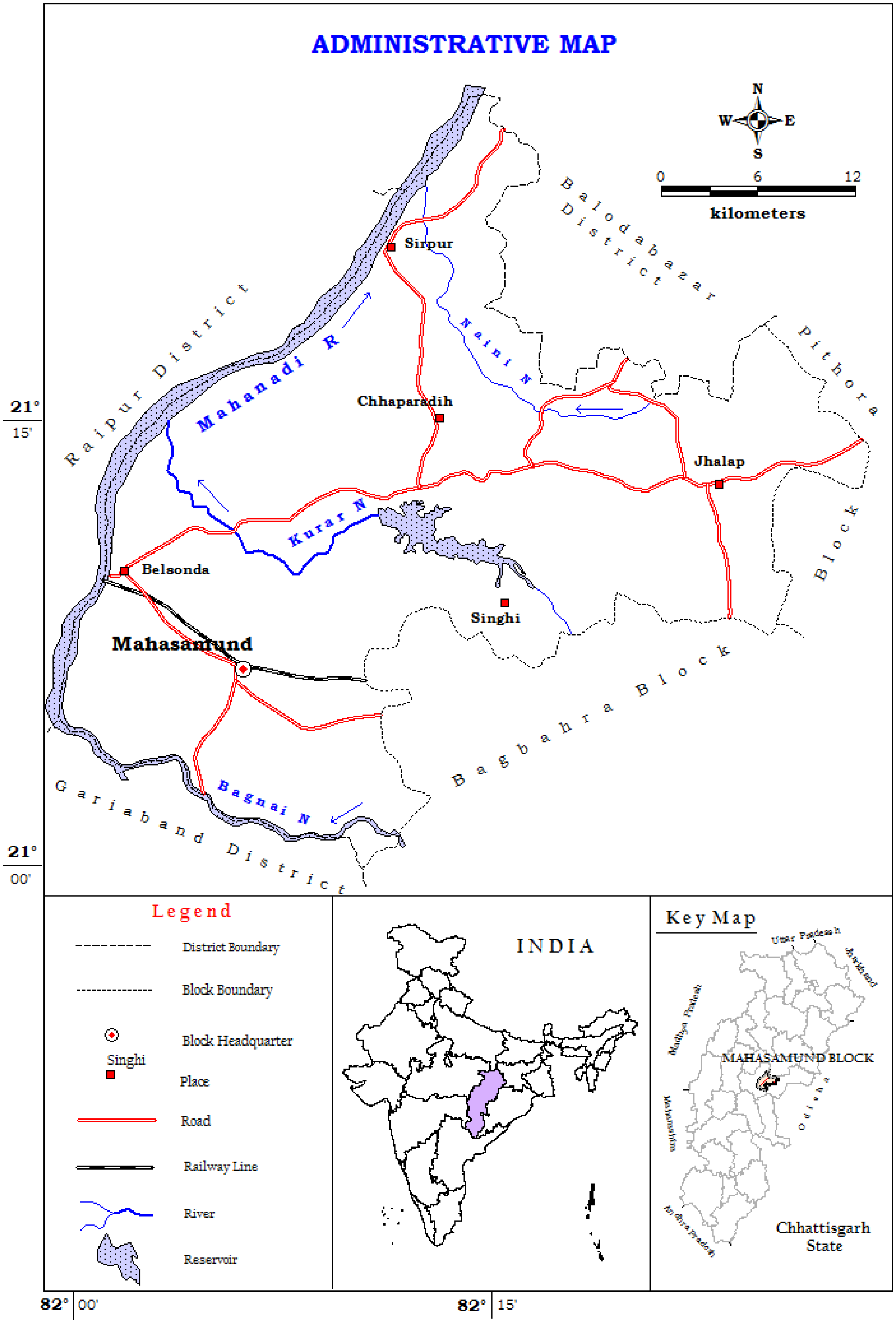


Figure: 1 Administrative Map of Mahasamund Block

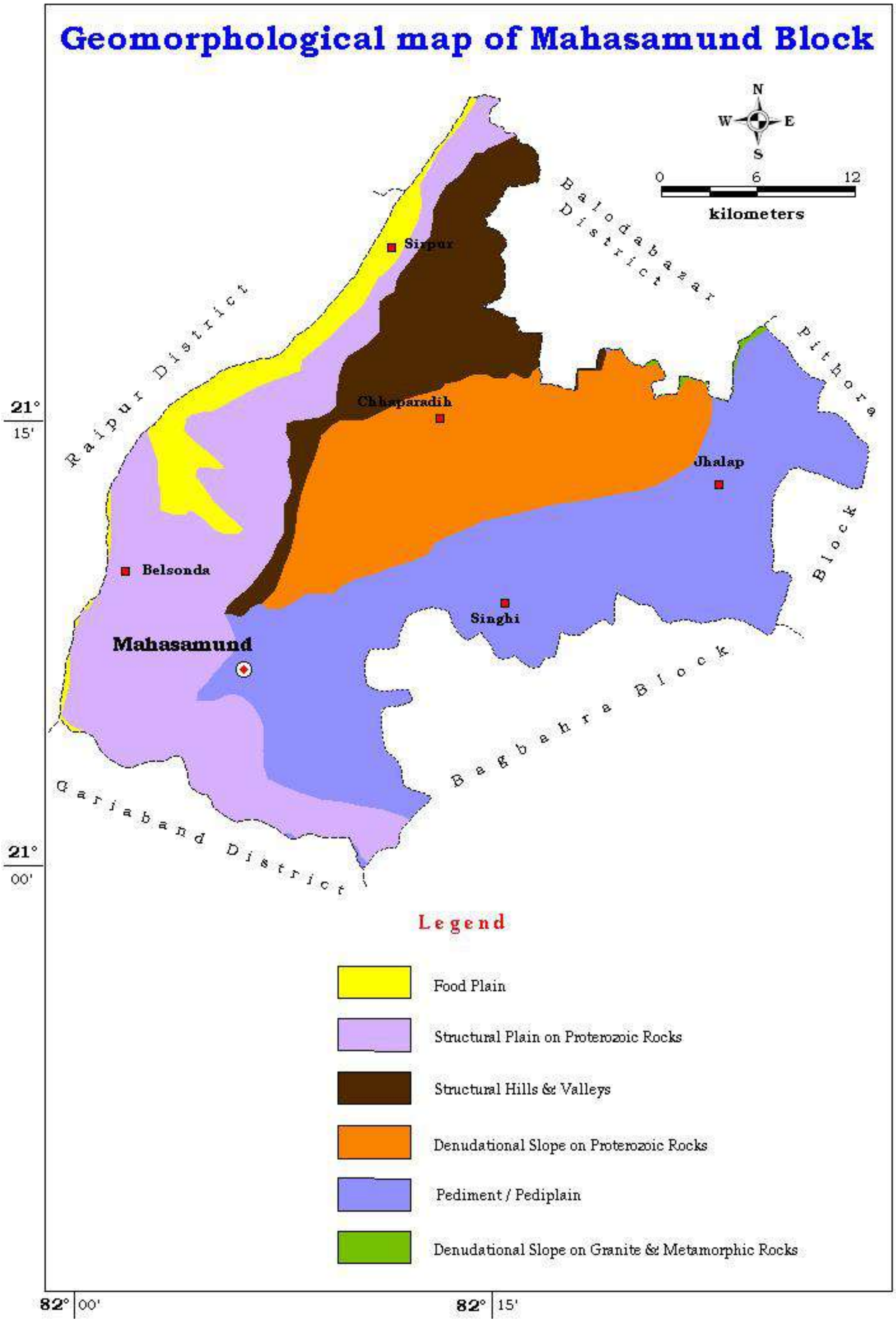


Figure 2: Geomorphology Map of Mahasamund Block

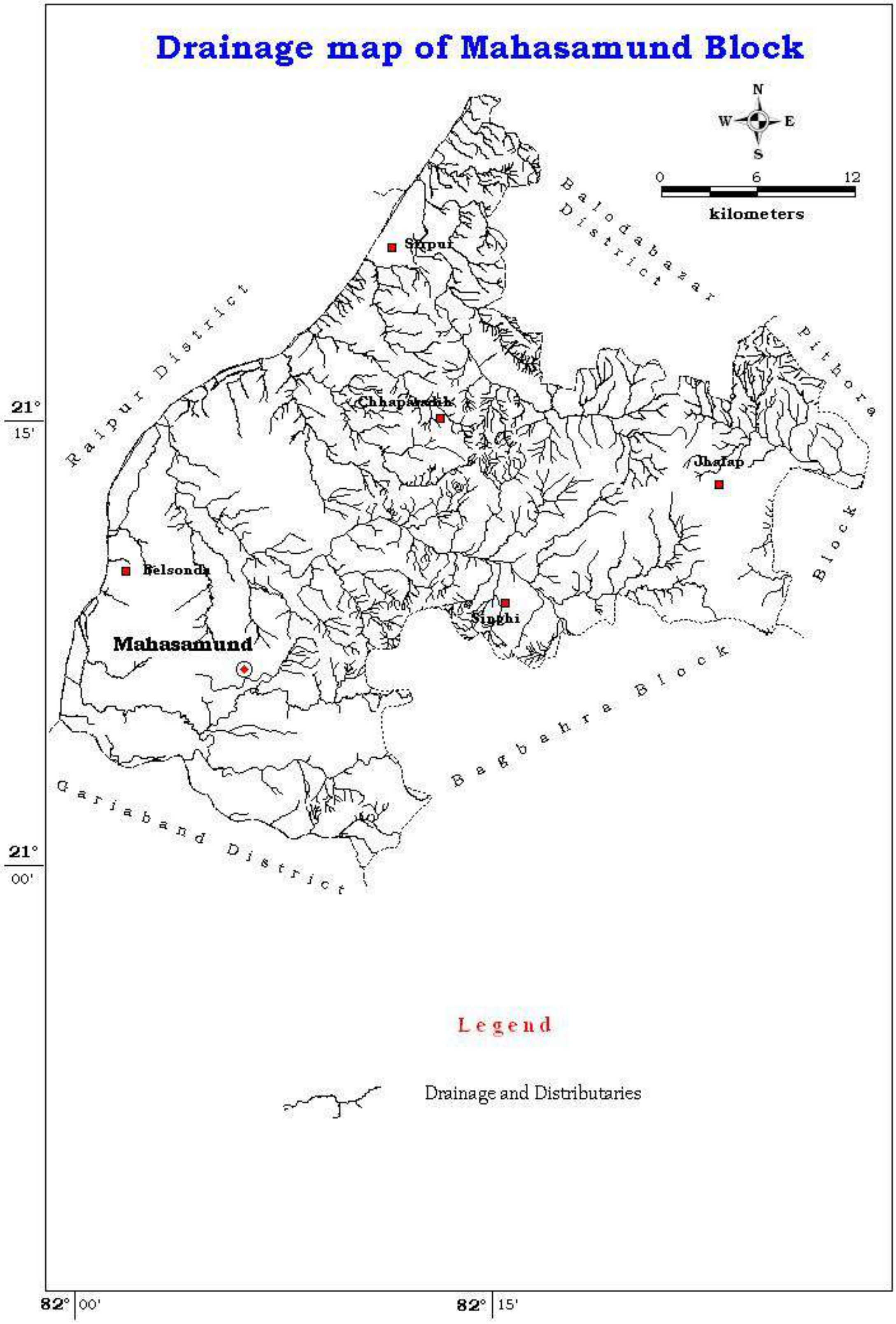


Figure 3: Drainage Map of Mahasamund Block

Agriculture and Irrigation**:** Agriculture is practiced in the area during Kharifand Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are Paddy, Wheat, Vegetables and pulses.

In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Mahasamundblock is given in Table 3 (A, B, C, D, E).

Table 3 (A): Agricultural pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Mahasamund	94400	46303	10932	48805	8927	57732

Table 3 (B): Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non agricultural& Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Mahasamund	94400	46303	10932	6349	2205	48805	8927	57732

Table 3 (C): Cropping pattern (in ha)

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar& Maize	Others						
Mahasamund	48781	8951	220	55137	10	11	1305	341	573	nil	55	4

Table 3 (D): Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No. of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri-gated area	Gross irrigated area	% of irrigated area wrt. Net sown area
9	23731	6621	13500	846	78	563	140	465	37914	37914	66 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Mahasamund	37914	13578	35.81

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Mahasamund block upto 200 m depth is given in the table-4.

Table – 4: Ground Water Resources of Mahasamund block in Ham

Block	**Dongargarh granite and gneiss**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Mahasamund	5962.29	1022.4	180.71	**7165.4**
	Argillaceous limestone			
	3219.59	368	97.58	**3685.17**
	Sandstone			
	4031.48	276.48	122.19	**4430.15**

Existing and Future Water Demand (2025): The existing demand for irrigation in the area is 6607.10 Ham while the same for domestic and industrial field is 2507.34 Ham. To meet the future demand for ground water, a total quantity of 6607.20 ham of ground water is available for future use.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in Mahasamund block, water level in dug wells varies between 3.1 to 13.5 mbgl with average water level of 9.18m bgl. In deeper fractured aquifer, the maximum water level is 21.56mbgl, the average water level is 13.91mbgl.

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

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Mahasamund	3.1	13.5	9.18

Water Level (in mbgl)

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

Block Name	FracturedAquifer		
	Min	Max	Avg
Mahasamund	6.5	21.56	13.91

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 1.36 to 8.93 mbgl with an average of 4.02 mbglin phreatic aquifer. Infracturedformation, the post monsoon water level variation range is 4.32 to 15.75mbgl with average of 9.05mbgl.

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

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Mahasamund	1.36	8.93	4.02

Water Level (in mbgl)

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

Block Name	Fractured Aquifer		
	Min	Max	Avg
Mahasamund	4.32	15.75	9.05

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Mahasamundblock, water level fluctuationin phreatic aquifer varies from 1.24 to 10.08m with an average fluctuation of 5.16 m. Water level fluctuationin fractured aquifer varies from 2.14 to 8.71 m with an average fluctuation of 4.86m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	PhreaticAquifer		
	Min	Max	Avg
Mahasamund	1.24	10.08	5.16

Water Level (in m)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	FracturedAquifer		
	Min	Max	Avg
Mahasamund	2.14	8.71	4.86

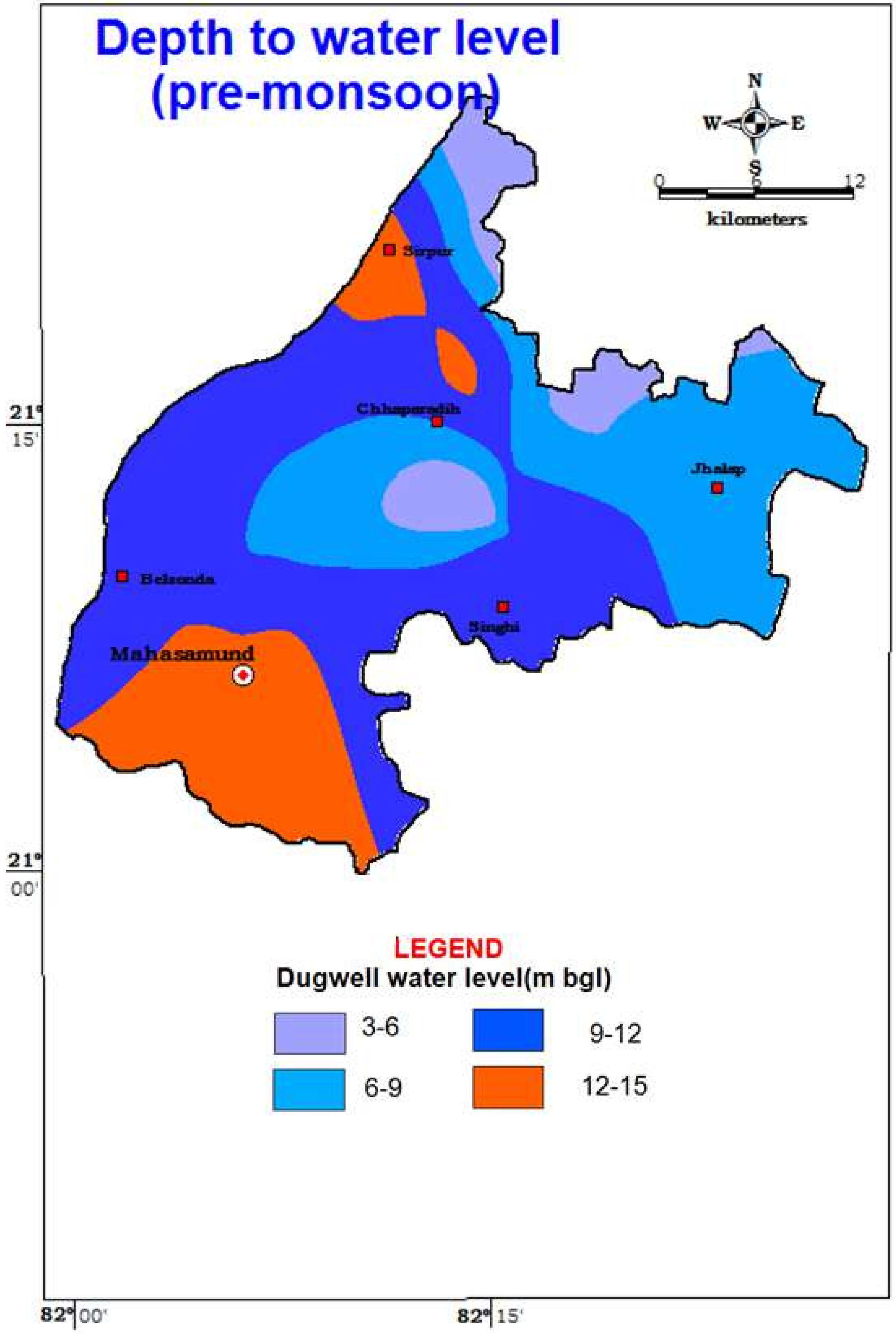


Figure-4: Depth to water level map Phreatic Aquifer (Pre-monsoon)

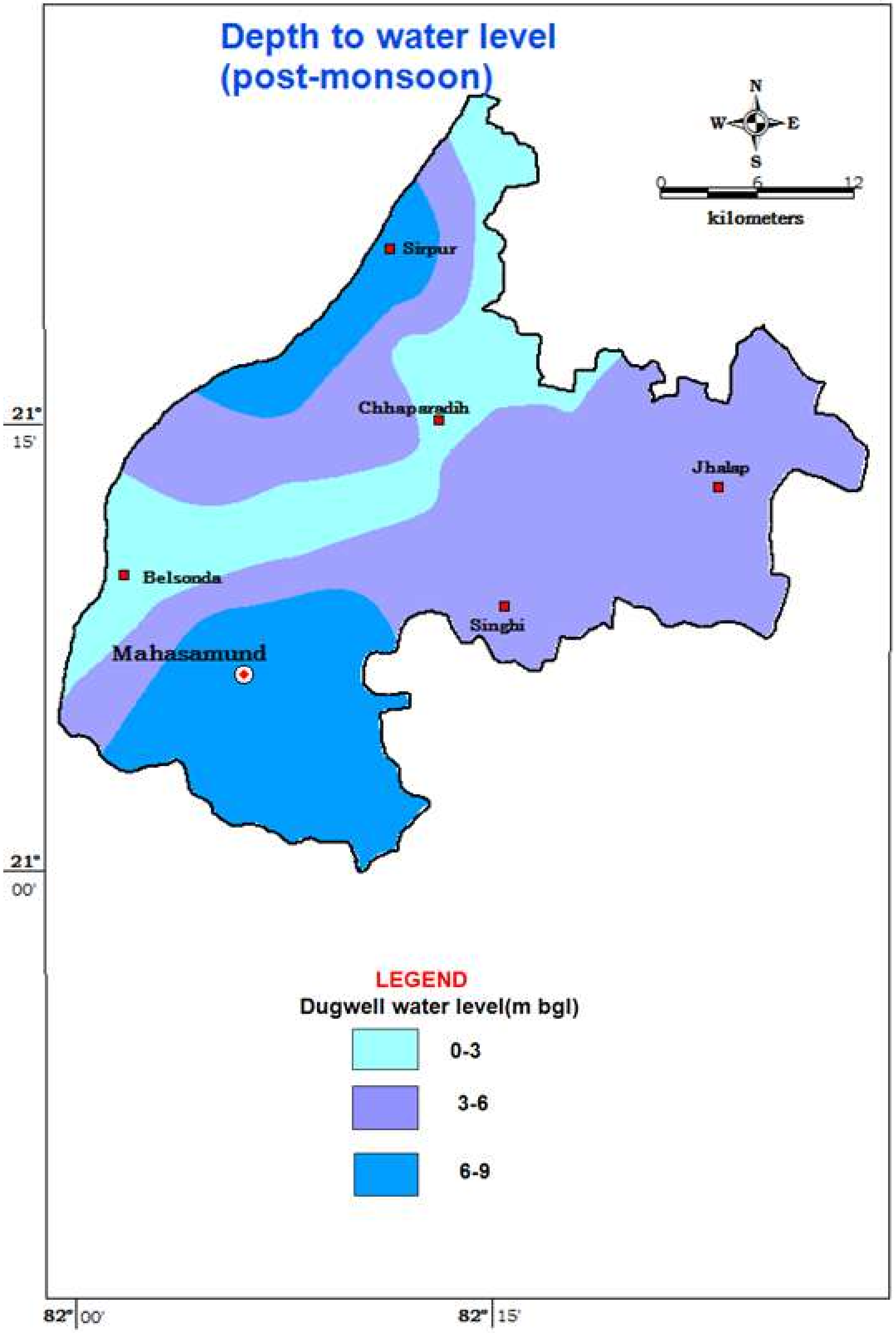


Figure 5: Depth to water level map Phreatic Aquifer (Post-monsoon)

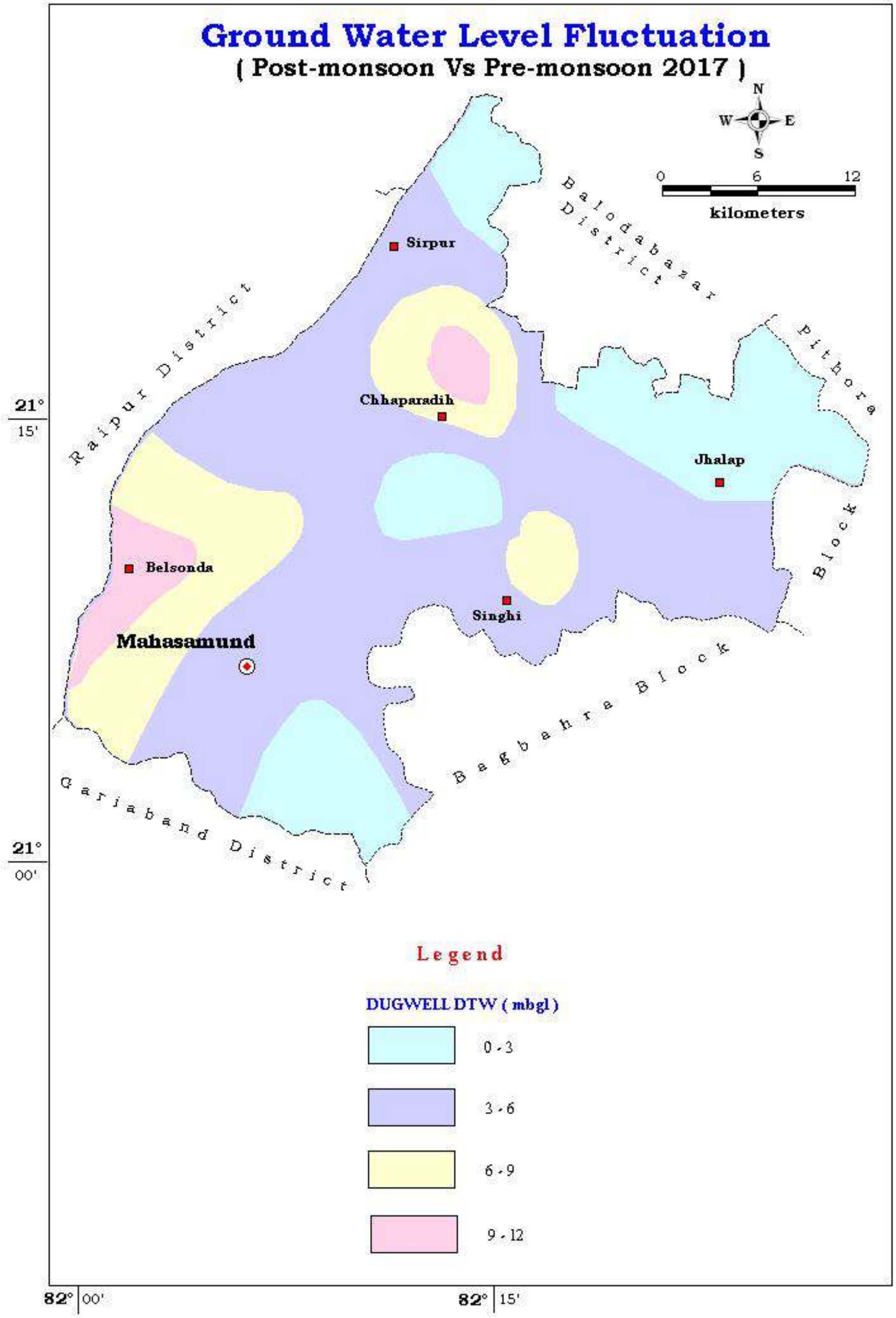


Figure 6: Depth to water level fluctuation map of Phreatic Aquifer

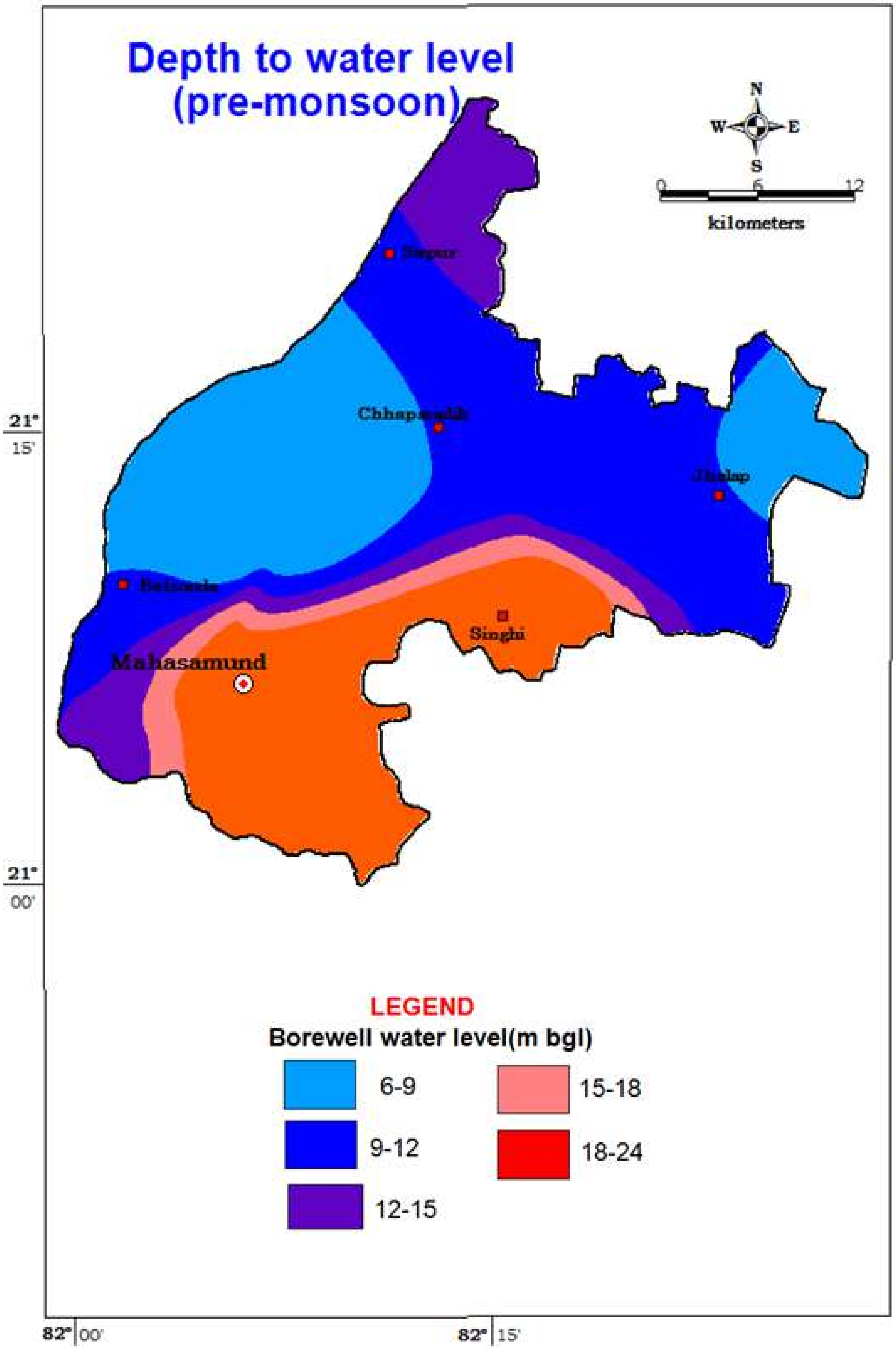


Figure-7: Depth to water level map Fractured Aquifer (Pre-monsoon)

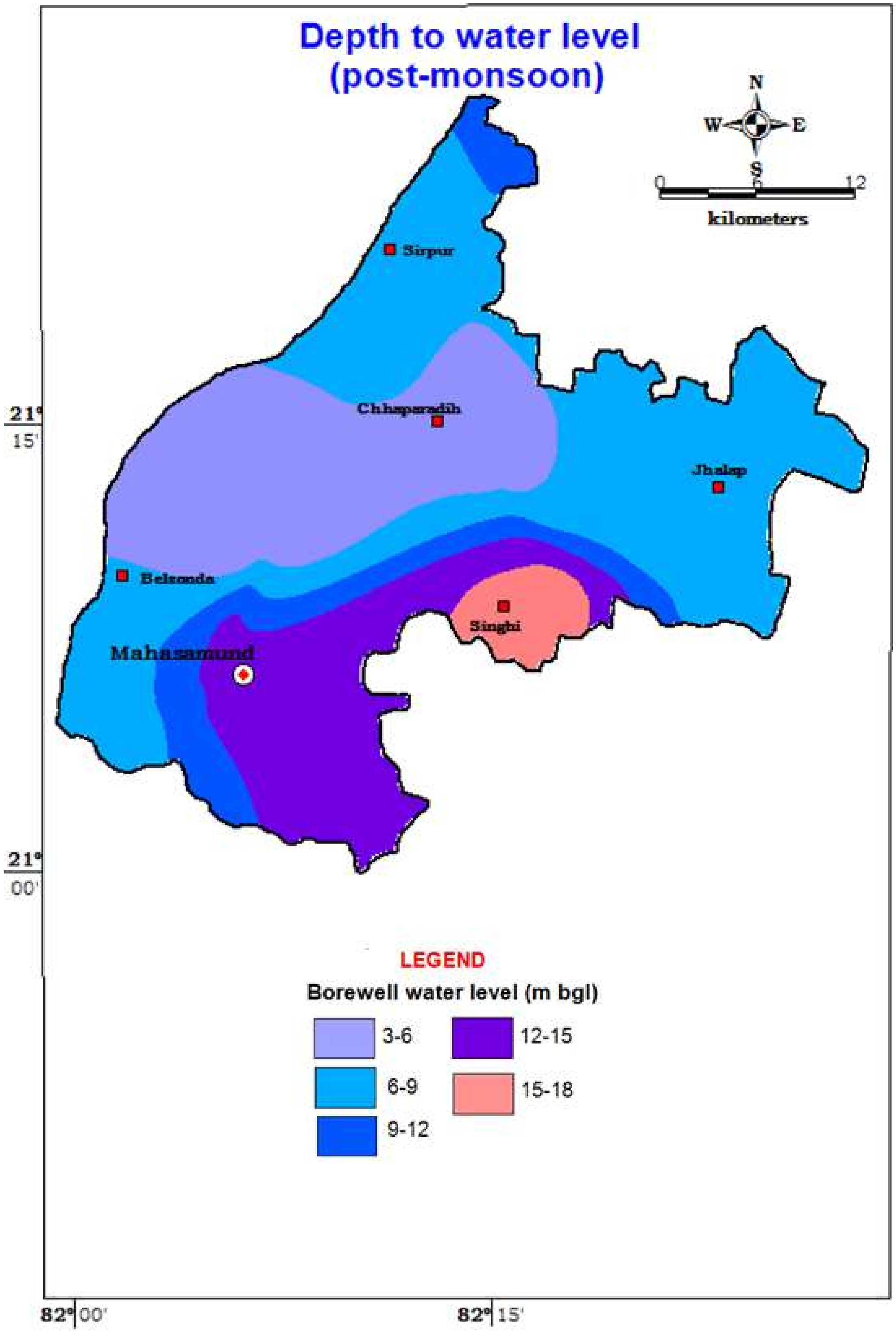


Figure-8: Depth to water level map Fractured Aquifer (Post-monsoon)

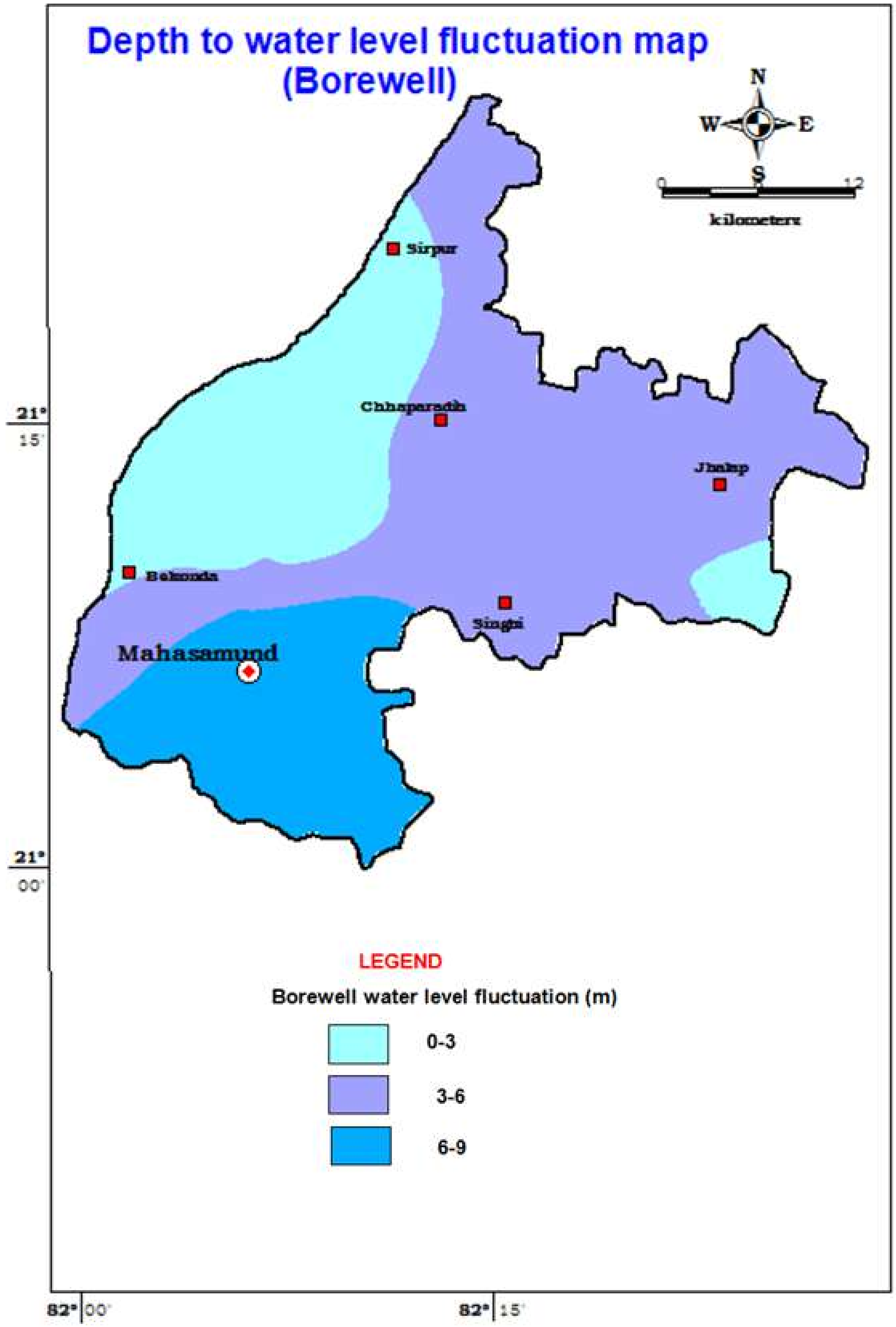


Figure 9: Depth to water level fluctuation map of Fractured Aquifer

(iv) The long-term water level trend: During pre-monsoon period, there is decline in water level (as indicated by dotted red trend line), about 5m over a 10 year period.

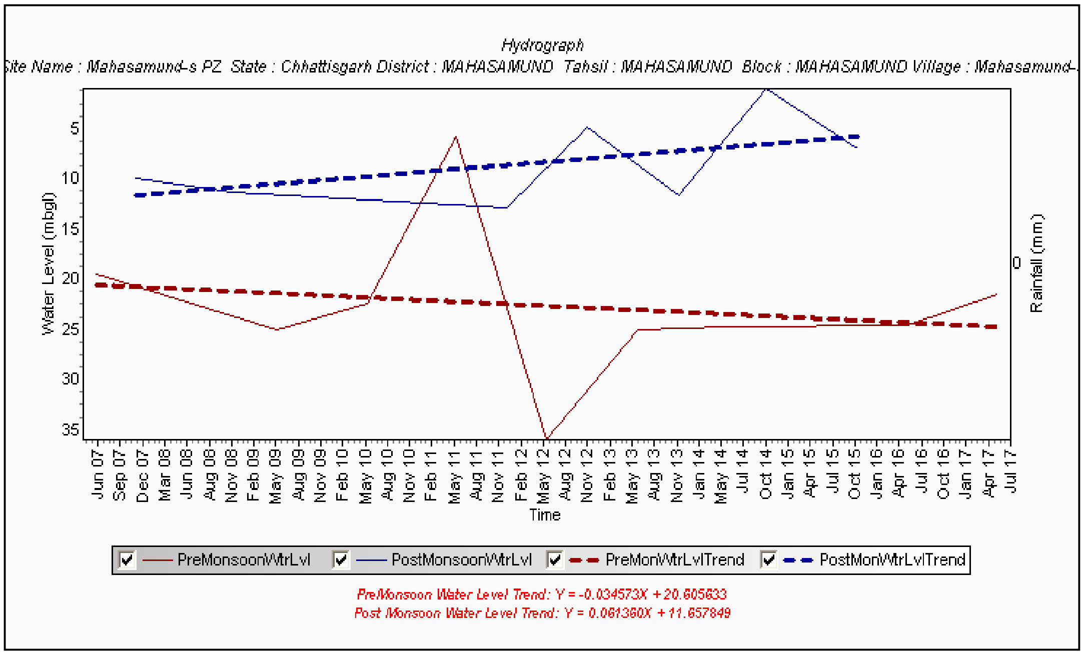


Figure 10: Hydrograph of Mahasamund town, Mahasamund block

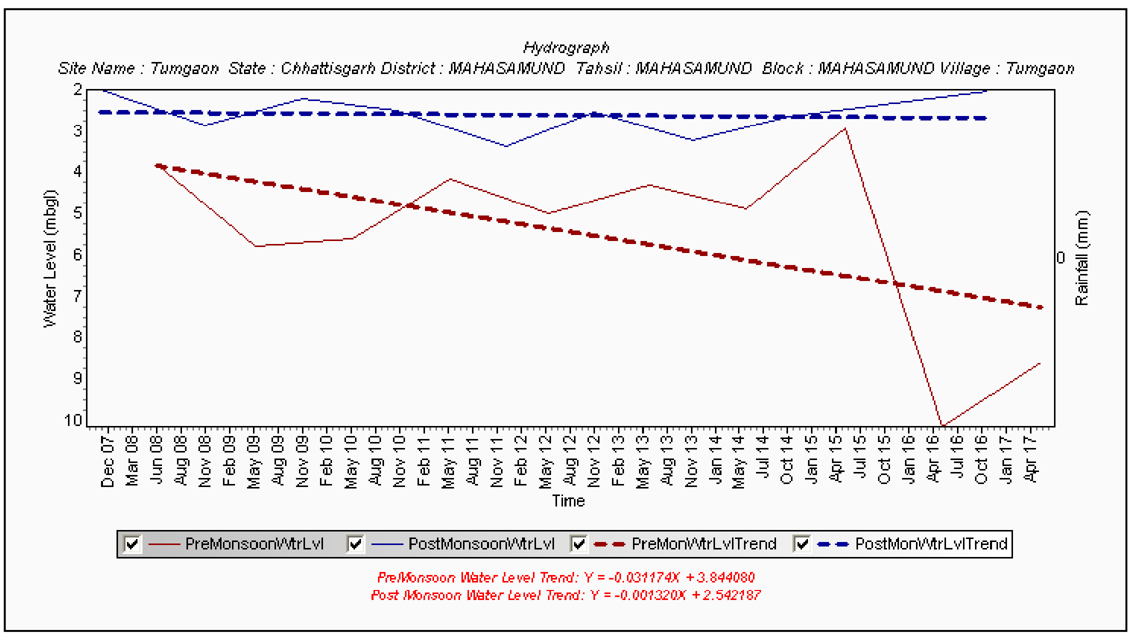


Figure 11: Hydrograph of Tumgaon village, Mahasamund block

2. Aquifer Disposition:

Number of Aquifers: There arethree major aquifersviz. Argillaceous limestone (Raipur group), sandstone (Chandrapur group) and granitic gneiss (Dongargarh Supergroup), which in phreatic and fractured condition serve as major aquifer system in the block.

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

Geology: Geologically the block exhibits lithology of Meso to Neo Proterozoic agedominated by Argillaceous limestone (Raipur group), sandstone (Chandrapur group) and granitic gneiss (Dongargarh Supergroup).

I. Argillaceous limestone (Raipur group): The average thickness of the weathered portion in the area is around 18.5 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells. Theaverage drawdown of the formation is around 20.1 m. The thickness of fractured aquifer is around 0.2 m.

II. Sandstone (Chandrapur group): The average thickness of the weathered portion in the area is around 19.02 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 2 lps. The development in these formations is mostly by way of dug wells and shallow tube wells. The average drawdown is 24.06 m. The thickness of fractured aquifer is around 0.2 m.

III. Granitic gneiss (Dongargarh Supergroup): The average thickness of the weathered portion in the area is around 18 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells. The transmissivity of the formation is around 0.07 -1 m^2 per day with an average drawdown of 27 m. The thickness of fractured aquifer is around 0.2 m.

Table 6: Distribution of Principal Aquifer Systems in Mahasamund

Mahasamund	Phreatic and fractured argillaceous limestone	
	230	24% of total area
	Phreatic and fractured sandstone	
	288	31% of total area
	Phreatic and fractured granite gneiss	
	426	45% of total area

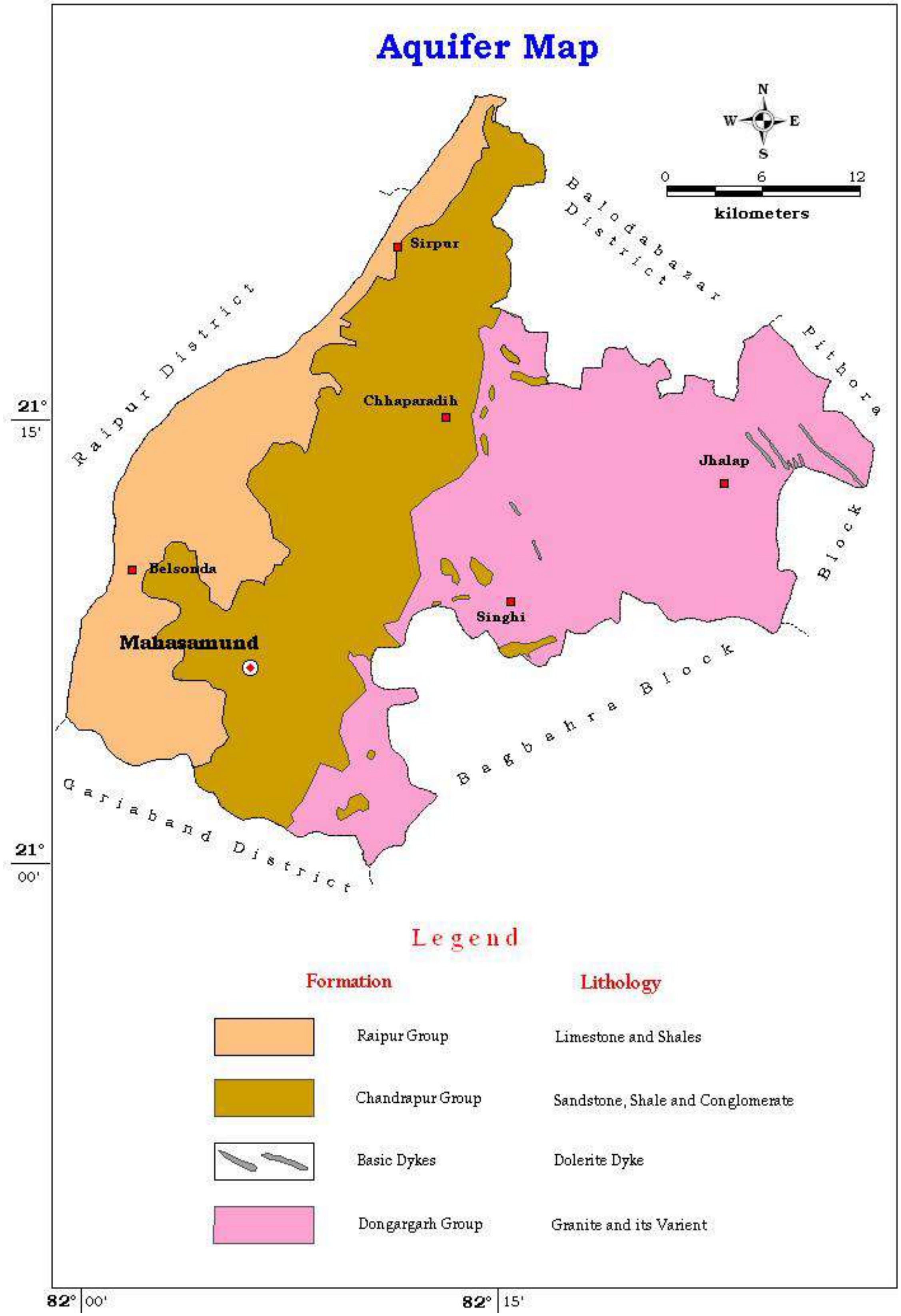


Figure 12: Aquifer map of Mahasamund block

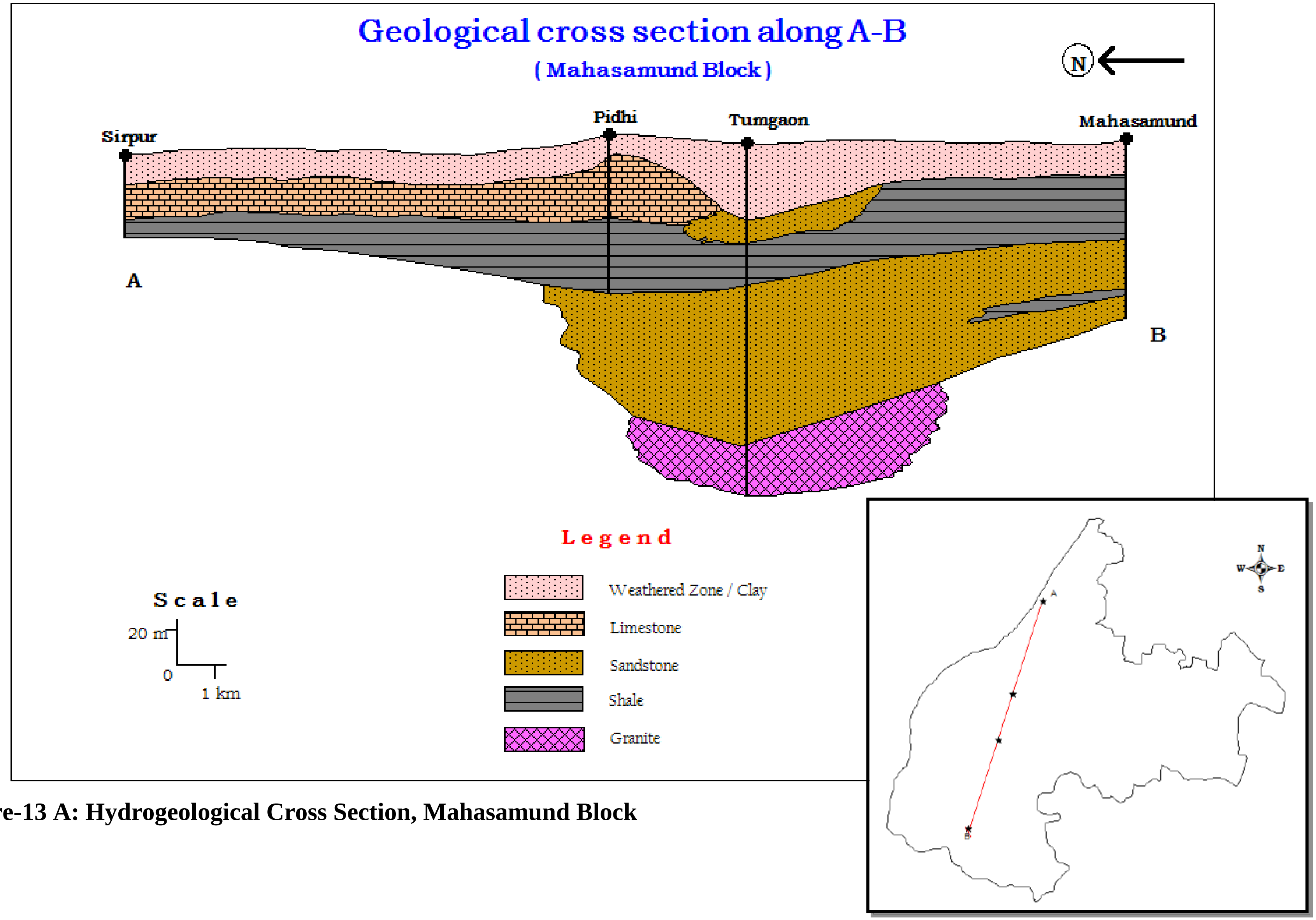


Figure-13 A: Hydrogeological Cross Section, Mahasamund Block

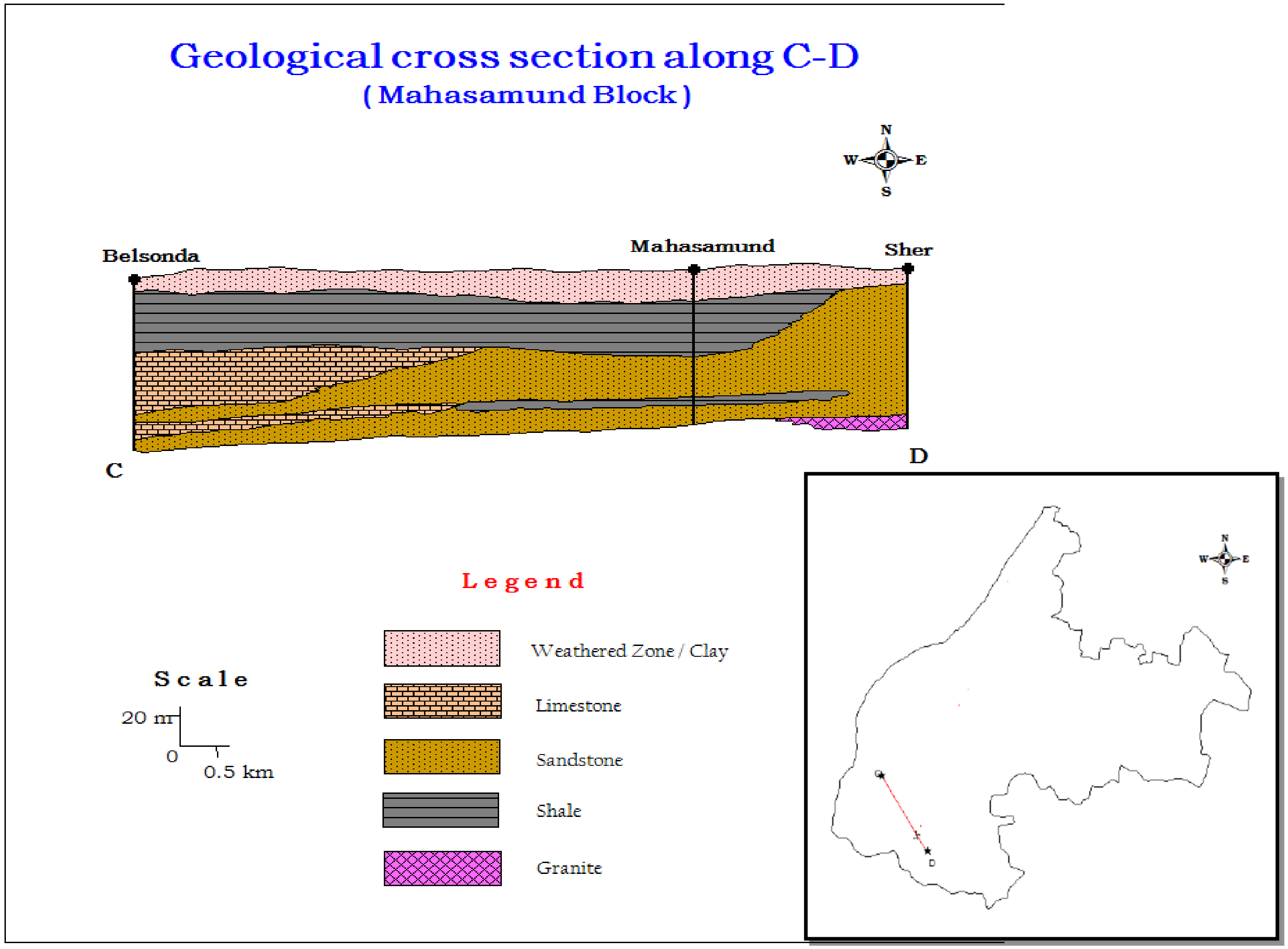


Figure-13 B: Hydrogeological Cross Section, Mahasamund Block

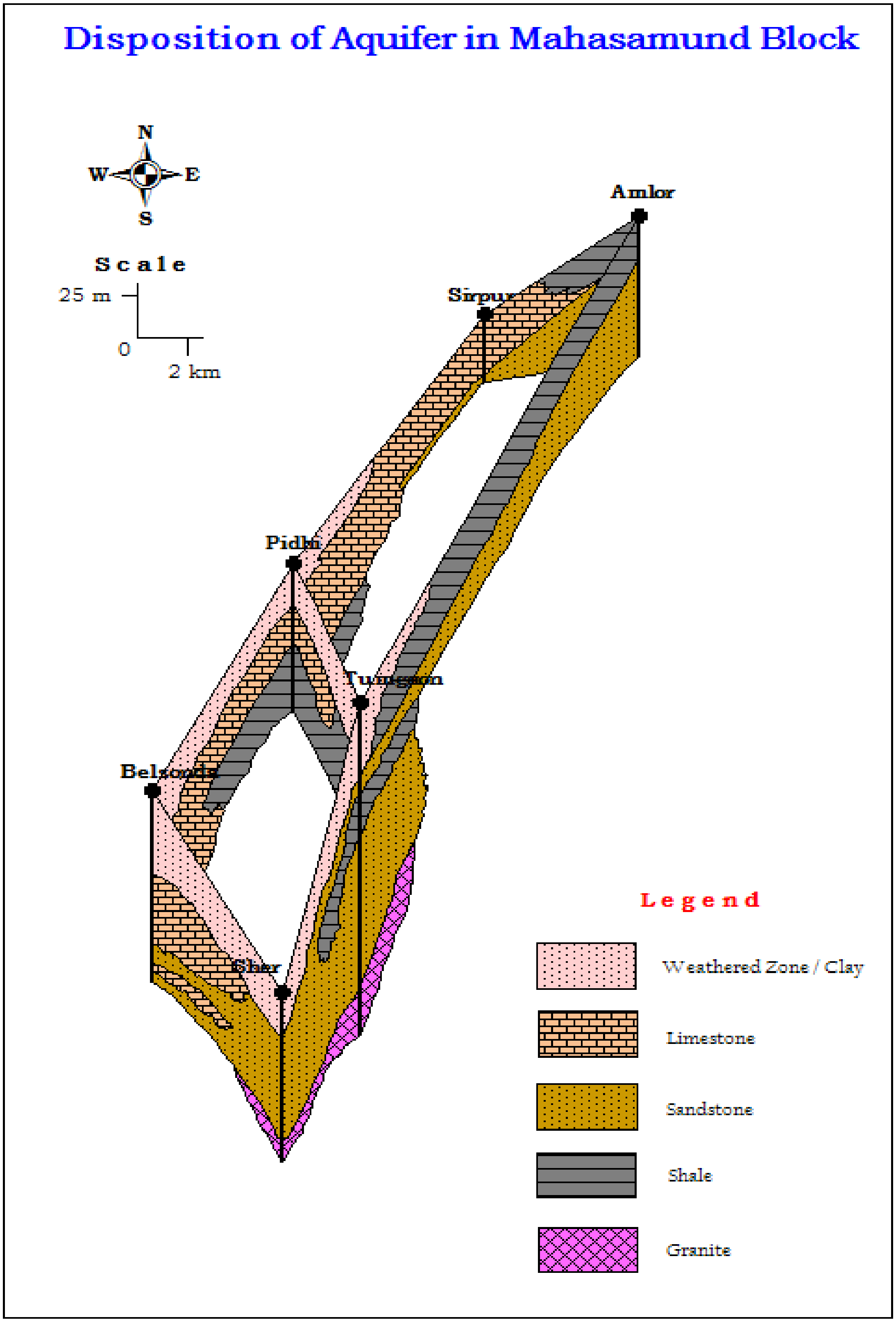


Figure-13 C, Disposition of Aquifer, Mahasamund Block

3. Ground water Resource, extraction, contamination and other issues:

Aquifer wise resource availability is given in the table -4 where the total resource available in Mahasamund block is 13214. 30ham.The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-7 & 8.

Table-7: Ground water Resources of Mahasamund block

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation for Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Mahasamund	Mahasamund	13214.30	6607.10	2507.34	9114.44	2828.61	3778.59

Table 8 Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorization
Mahasamund	Mahasamund	68.97	Safe

<u>Categorization:</u> Mahasamund block falls in safe category. The stage of Ground water development is 68.97%. The Net Ground water availability is 13214.30 ham. The Ground water draft for all uses is 9114.44 Ham. The Ground water resources for future uses for Mahasamund Block is6607.20Ham.

<u>Chemical Quality of Ground water and Contamination</u>**:** Throughout the study area, the water quality (phreatic aquifer) is good and all the parameters are within permissible limit. In conclusion it may be said that the groundwater in the block is suitable for drinking as well as for irrigation purposes.

4. Ground Water Resource enhancement:

<u>Aquifer wise space available for recharge and proposed interventions</u>:

Table -9: Summarised detail of Volume of porous space available for recharge (Aquifer wise)

Formation	Area (sq.m)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (m3)
Argillaceous limestone	153 x 106	1.5,4.5	0.020	8.68 x 106
Sandstone	205 x 106	1.5,4.5	0.020	13.68 x 106
Granite-gneiss	407x 106	1.5,4.5	0.020	15.22 x 106

5. Issues:

(iii) During summer, dugwells in villages are dry except a few locations. Several handpumps also stop yielding water. The aquifer itself is a low yielding one.

(iv) High value of Fluoride has been reported from Jogidipa village. (1.5 mg/l)

6. Supply side interventions:

I. Mahasamund block experienced drought situation because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

II. It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken “Nal Jal Yojana” to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water.

III. So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to understand people about the importance community participation in saving water.

IV. Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.

V. It has been observed that the long-term trend lines are declining in pre-monsoon period, so we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table-10.

Table-10: Types of Artificial Recharge structures feasible

Name of Block	Area Feasible for recharge (sq.km)	Volume of Sub Surface Potential to be recharged through other methods (MCM)	Types of Structures Feasible and their Numbers			
			P	NB & CD	RS	G
Mahasamund	627	37.08	116	385	697	928
	Recharge Capacity		22.16	3.85	6.43	4.64
	Estimated cost (Appx.)		Rs. 65.1 crore			

VI. The practice of providing free electricity to operate irrigation bore wells should be strictly monitored and put to an end in case of overconsumption. After a simple calculation it has been found that Rs 16000/ hectare is the expenses of electricity (@Rs. 2.5/unit) for paddy field. So monitoring mechanism for electricity consumption should be strengthened for farmers taking summer rice. Even if farmers use solar pump or other method of ground water irrigation for summer paddy, it should not be flooding method. Proper pipes are to be used to transfer water from one plot to another.

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

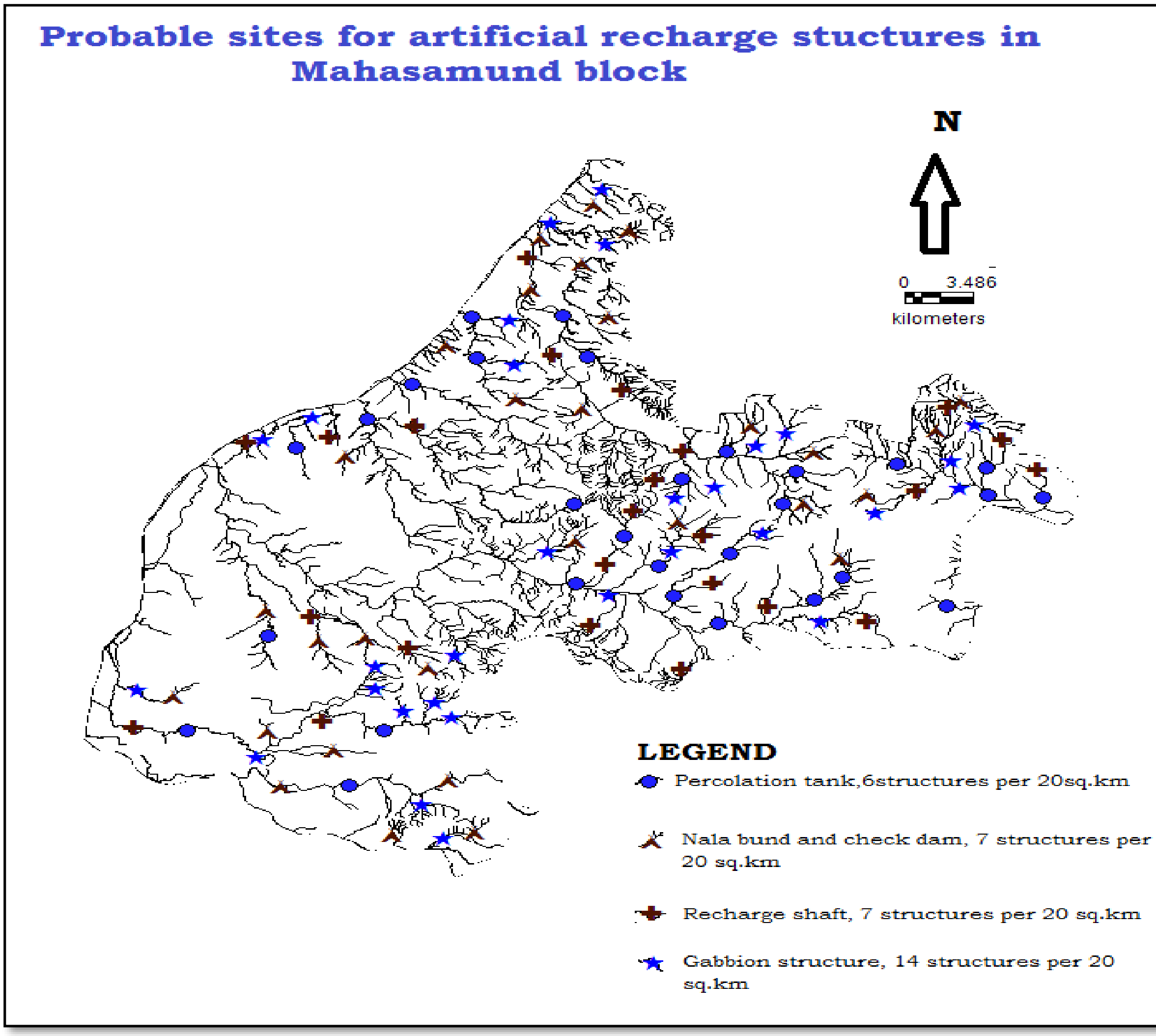


Figure 14: Map of proposed sites for artificial recharge of groundwater in Mahasamund block

Table-11: Probable sites of Artificial Recharge structures

PT (Percolation tank)	NB & CD (Nala bund & Check dam)	RS (Recharge Shaft)	GB (Gabbion structure)
Parsadih	Nawapara	Garhshivni	Rumekel
Achanakpur	Sher	Joba	Pasid
Borid	Singhrupali	Bamhani	Borid
Rumekel	Marod	Patewa	Sher
Pachri	Singhi	Chirko	Pachera
Nartora	Jhara	Bemcha	Kurrubhata
Ramkhera	Amurda	Lohardih	Dhank
Khatta	Pali	Kaundkera	Bansiwni
Nawagaon	Kaundkera	Banskurha	
Laphinkhurd		Raitum	
Nandgaon		Phusera	

7. Demand Side Interventions

Since the stage of development in the block is 68.97%. Change in cropping pattern & irrigation pattern can lead to groundwater savings, as per the following table:

Table 12: Detail of groundwater saved through change in cropping pattern

Detail of groundwater saved through change in cropping pattern								
Block	Paddy cultivation area in Rabi season (ha)	Water required (m) per ha (m)		Difference (m per ha)	Total saving of water (ham)	Existing Gross Ground Water Draft for All Uses in Ham	Available Resource (ham)	Improved Status of Stage of groundwater Development
		Paddy	Maize					
Mahasamund	8600	0.9	0.5	0.4	3440.0	9114.44	13214.30	42.94

In command or non-command area wherever ground water has been used for field irrigation should be replaced with micro irrigation methods such as sprinklers, drip irrigation etc. which may save 30 to 40% ground water.

Detail of groundwater saved through change in irrigation pattern	
Water saved through micro irrigation	154 Ham

8. CONCLUSIONS:

An area of 944 sq.km of Mahasamund block of Mahasamund district has been considered for Aquifer Mapping and Management Plans. The total G.W resource is 13214.30 Ham with stage of G.W development 68.97 % and categorized as “safe”. 35.81 % of the area is irrigated by groundwater. The groundwater level is deeper in south-western part and showing declining trend. The major aquifer groups are Raipur Group limestone & shale, Chandrapur Groupsandstone, Dongargarh granite and granitic gneiss. In terms of Demand side management, by change in cropping pattern and irrigation pattern (micro irrigation methods) 3440.0Ham and 611 Ham water can be saved respectively. In terms of Supply side management, by constructing artificial recharge structure 37.08 MCM water can be recharged.

AQUIFER MAPS AND MANAGEMENT PLANS
PITHORA BLOCK, MAHASAMUND DISTRICT

1. Salient Information:

About the area: Pithora Block is situated in the central part of Mahasamund district of Chhattisgarh and is bounded on the north by Baloda Bazar and Raigarhdistrict, in the west by Mahasamund block of Chhattisgarh, in the east by Basna block, in the south west by Bagbahara block and in the south by Odisha state. The area lies between 21.05 and 21.50 N latitudes and 82.25 and 82.83 E longitudes. The geographical extension of the study area is 1060 sq.km representing around 21 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Geomorphology dominantly comprises of pediment and pediplains with some denudational hills and slopes in the northern part. Geomorphology map shown in Figure 2. Baghnala, Jonknala and Mechkanala flowing north-westwards are tributaries of Mahanadi river. Drainage map shown in Fig.3.

Population: The total population of Pithora block as per 2011 Census is204666out of which rural population is 196238while the urban population is 8428.The population break up i.e. male- female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Pithora	204666	100746	103920	196238	8428

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 17.46 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015)1434.38 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Pithora block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Annual rainfall	1237.20	1434.20	1128..80	1857.60	1514.10

Source: IMD

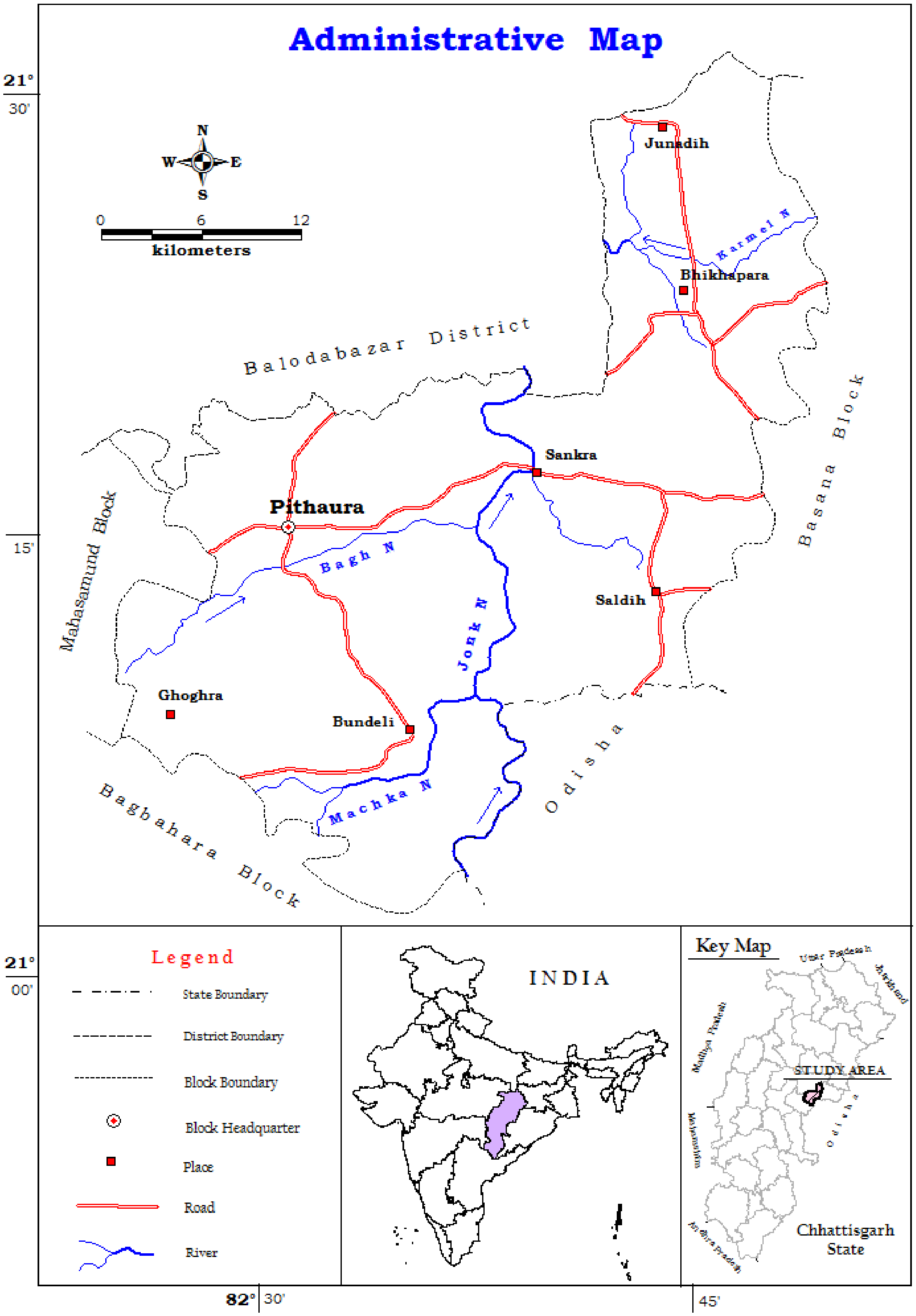


Figure: 1 Administrative Map of Pithora Block

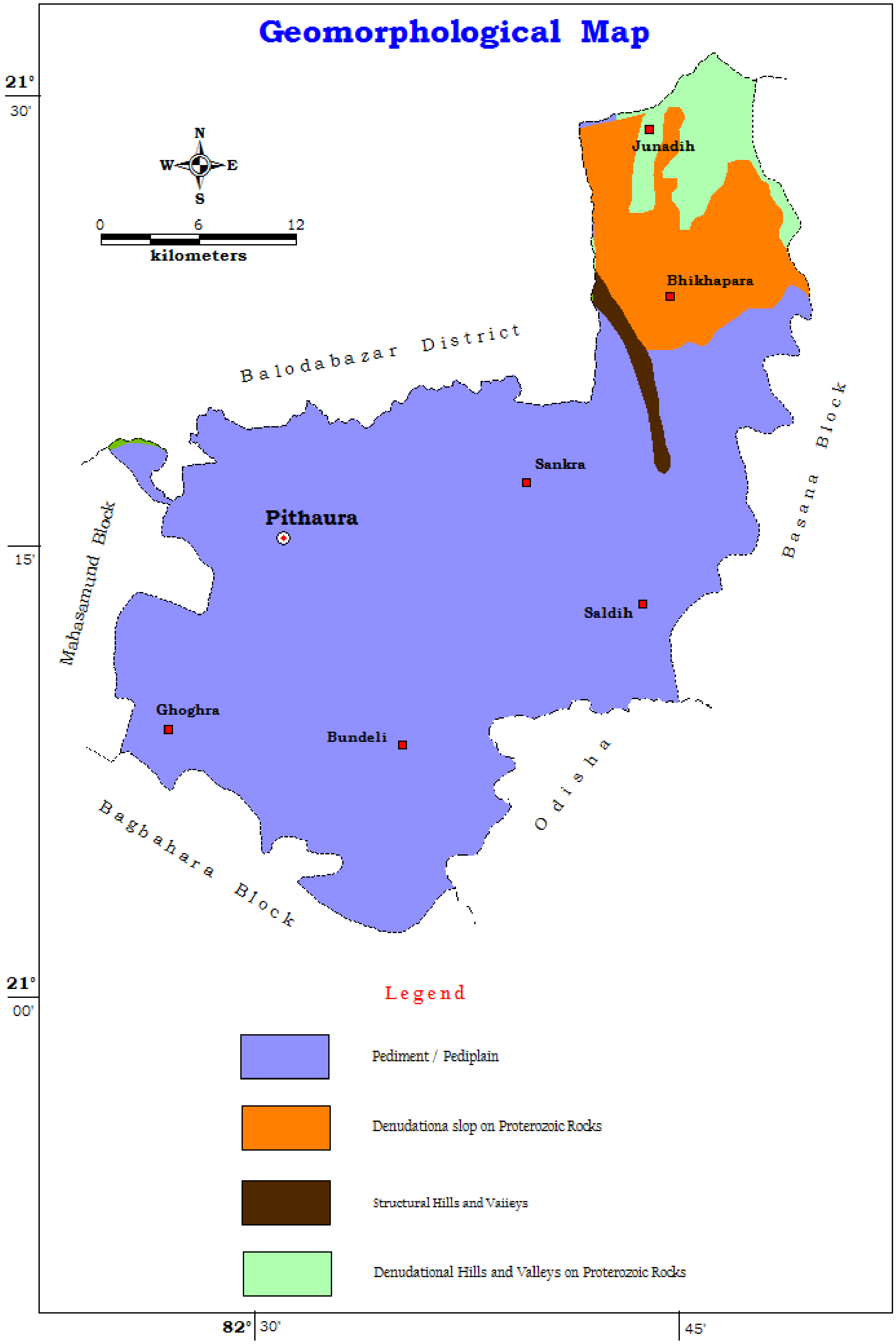


Figure 2: Geomorphology Map of Pithora Block

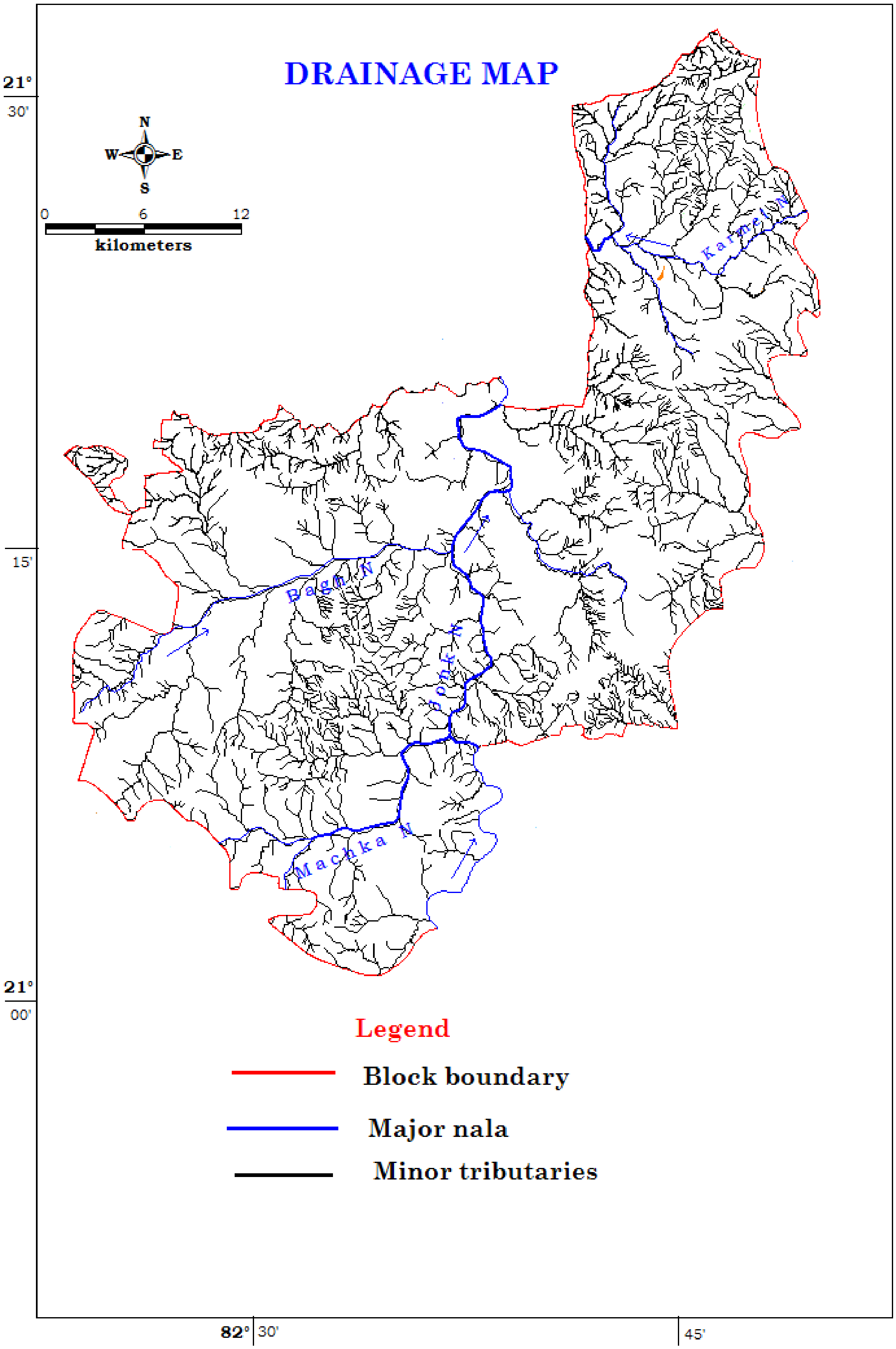


Figure 3: Drainage Map of Pithora Block

Agriculture and Irrigation: Agriculture is practiced in the area during Kharif and Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season; it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dug wells, Bore wells /tube wells. The principal crops in the block are Paddy, Wheat, Kodokutki, pulses and vegetables.

In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Pithora block is given in Table 3 (A, B, C, D, E).

Table 3 (A): Agricultural pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Pithora	10600	19149	8795	62674	7294	69968

Table 3 (B): Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non agricultural land	Fallow land	Net sown area	Double cropped area	Gross cropped area
Pithora	10600	19149	8795	3912	1468	62674	7294	69968

Table 3 (C): Cropping pattern (in ha)

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar& Maize	Kodo, Kutki						
Pithora	62358	7610	287	61388	36	96	5720	1586	586	104	157	8

Table 3 (D): Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No. of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri-gated area	Gross irrigated area	% of irrigated area wrt. Net sown area
7	4672	3091	10817	1652	258	669	1580	654	14372	17981	26 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Gross Irrigated Area	Area Irrigated by ground water	Percentage of Area Irrigated by ground water
Pithora	17981	11075	61.05

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Pithora block upto 200 m depth is given in the table-4.

Table – 4: Ground Water Resources of Pithora block in Ham

Block	**Dongargarh granite and gneiss**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Pithora	**11102.47**	**840.36**	**89.4**	**12032.23**

Block	**Basalt/Amphibolite gneiss**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Pithora	2061.53	156.04	16.6	**2234.17**

Existing and Future Water Demand (2025): The existing demand for irrigation in the area is 6822 Ham while the same for domestic and industrial field is 453.95 Ham. To meet the future demand for ground water, a total quantity of 5851.39 ham of ground water is available for future use.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that the water level varies from 6.02 to 10.76mbgl with an average of 8.46mbglin phreatic aquifer. In fractured formation, the pre monsoon water level variation range is 3.8 to 15.9mbgl with average of 12.74mbgl.

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

Block Name	Phreatic		
	Min	Max	Average
Pithora	6.02	10.76	8.46

Water Level (in mbgl)

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

Block Name	Fractured		
	Min	Max	Average
Pithora	3.8	15.9	12.74

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 1.94 to 5.99mbgl with an average of 3.83mbglin phreatic aquifer. In fractured formation, the post monsoon water level variation range is 3.2 to 6.75mbgl with average of 5.11mbgl.

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

Block Name	Phreatic		
	Min	Max	Avg
Pithora	1.94	5.99	3.83

Water Level (in mbgl)

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

Block Name	Fractured		
	Min	Max	Avg
Pithora	3.2	6.75	5.11

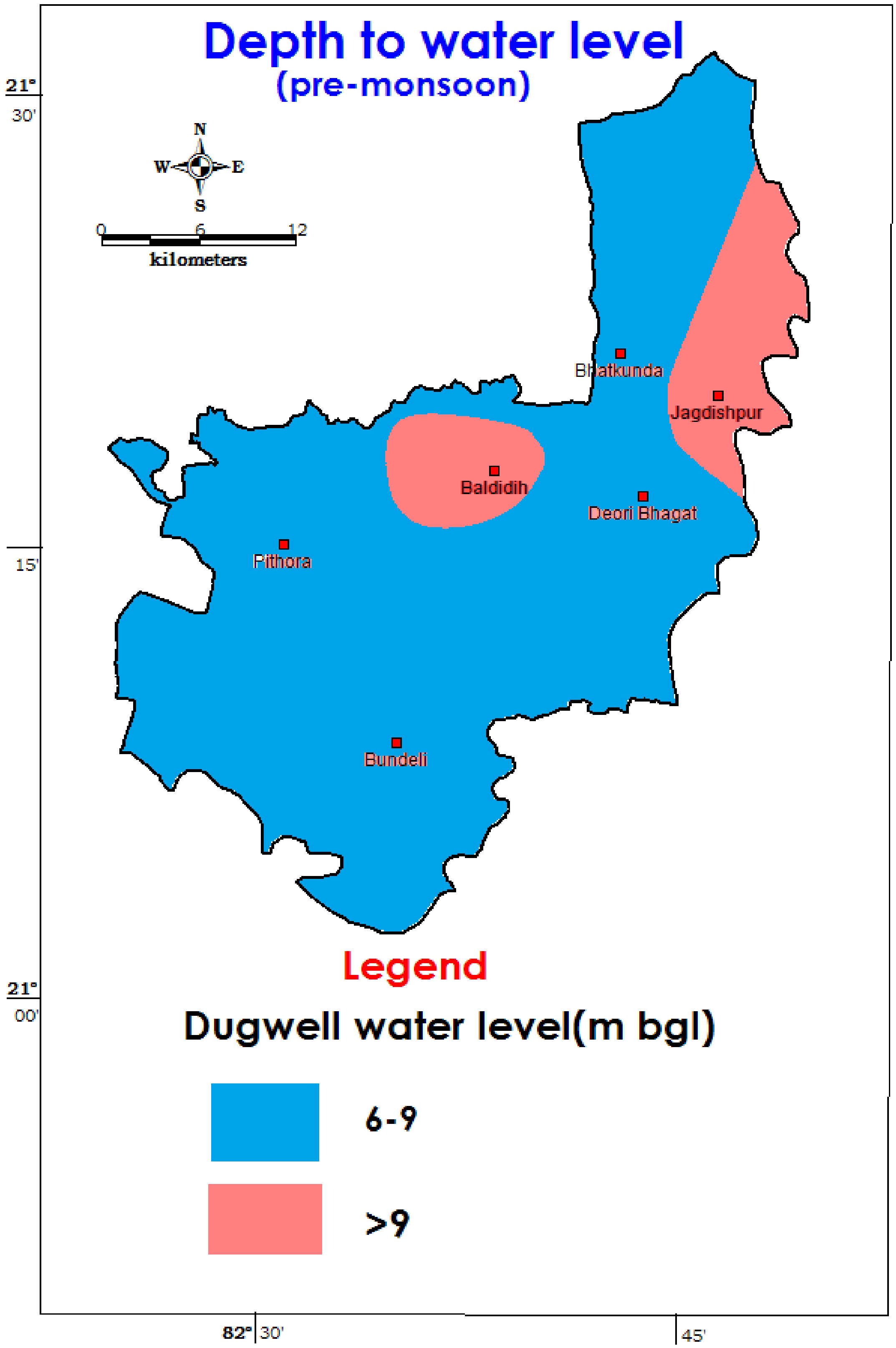


Figure-4: Depth to water level map Phreatic Aquifer (Pre-monsoon)

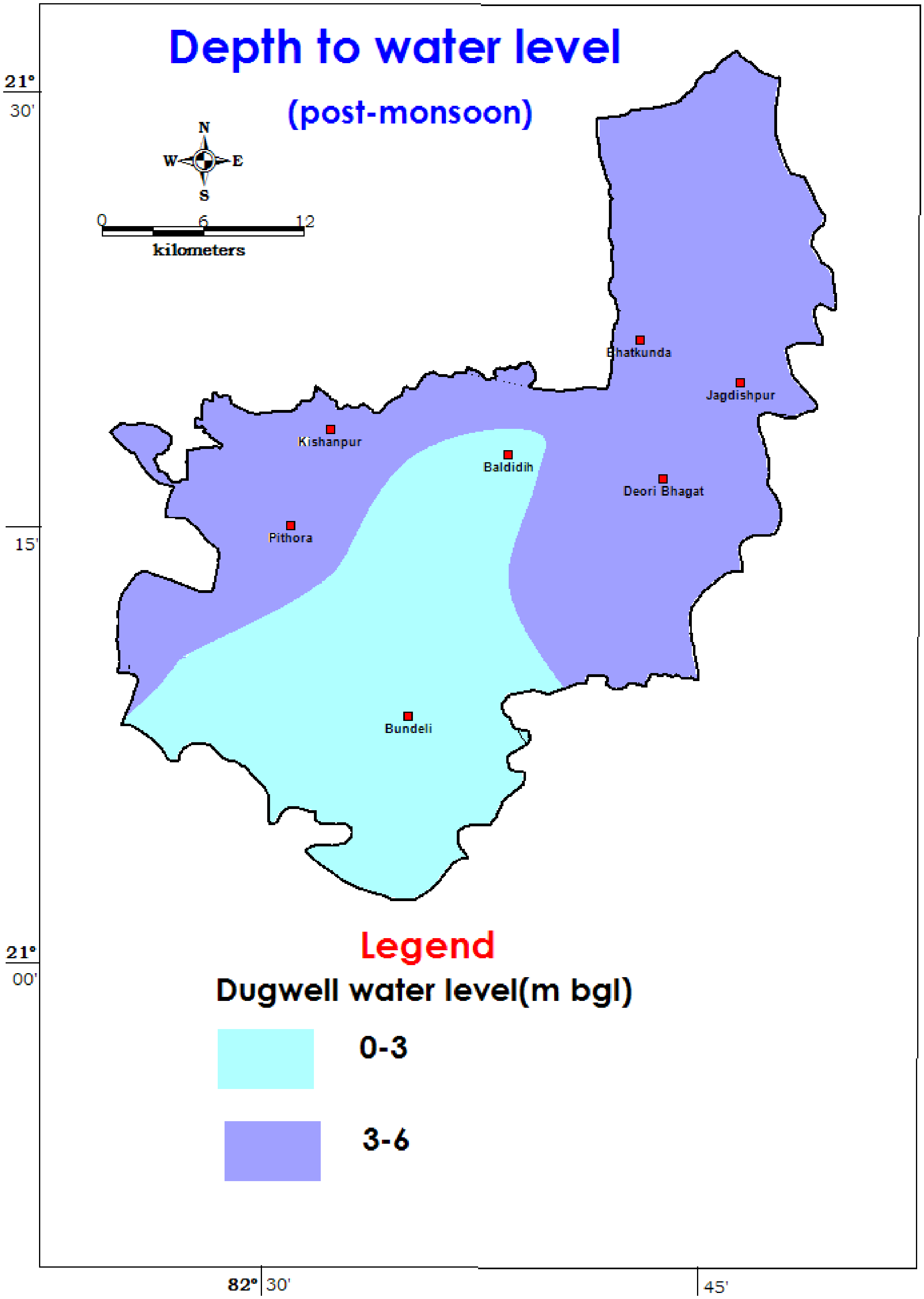


Figure 5: Depth to water level map Phreatic Aquifer (Post-monsoon)

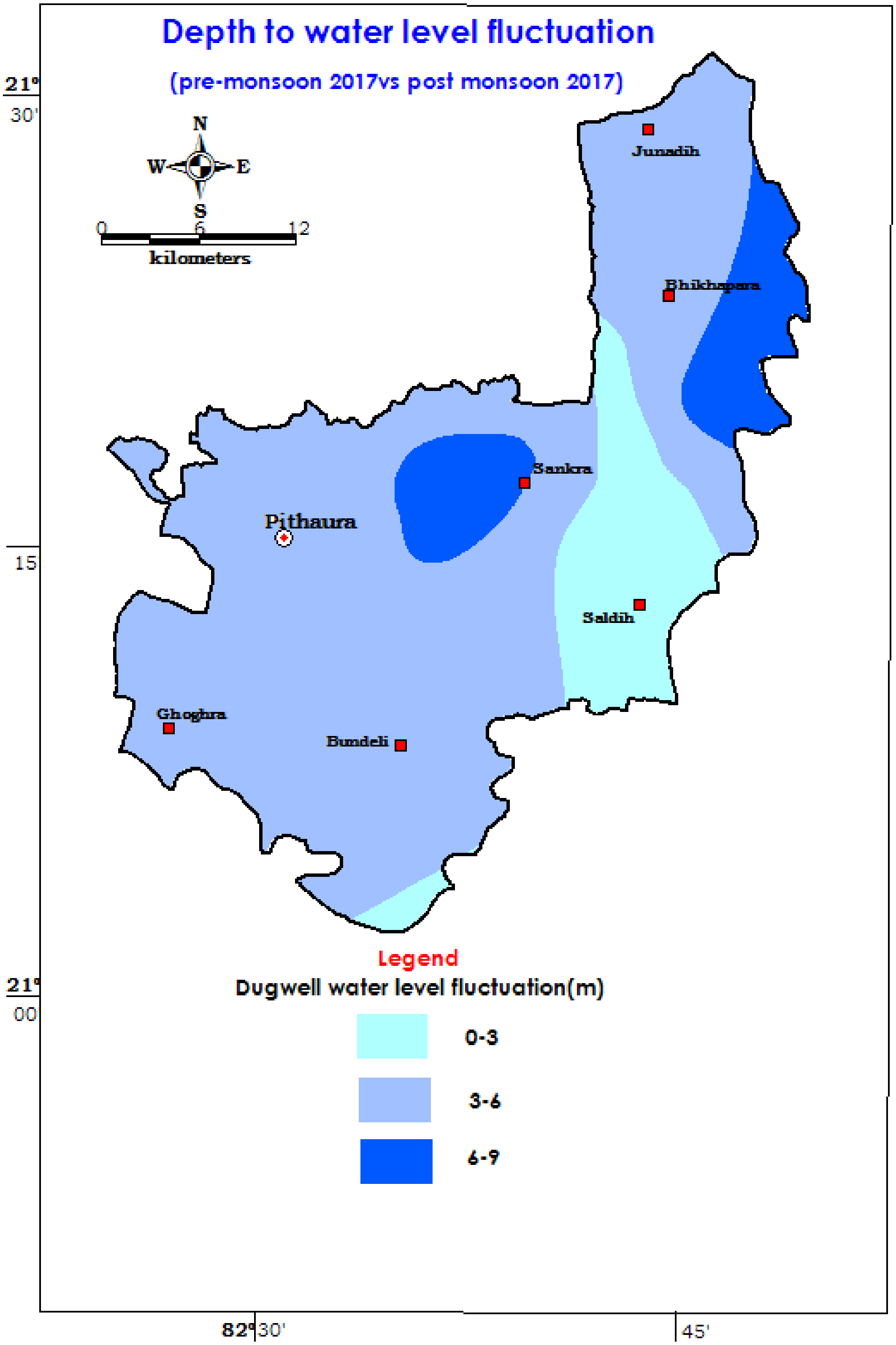


Figure 6: Depth to water level fluctuation map of Phreatic Aquifer

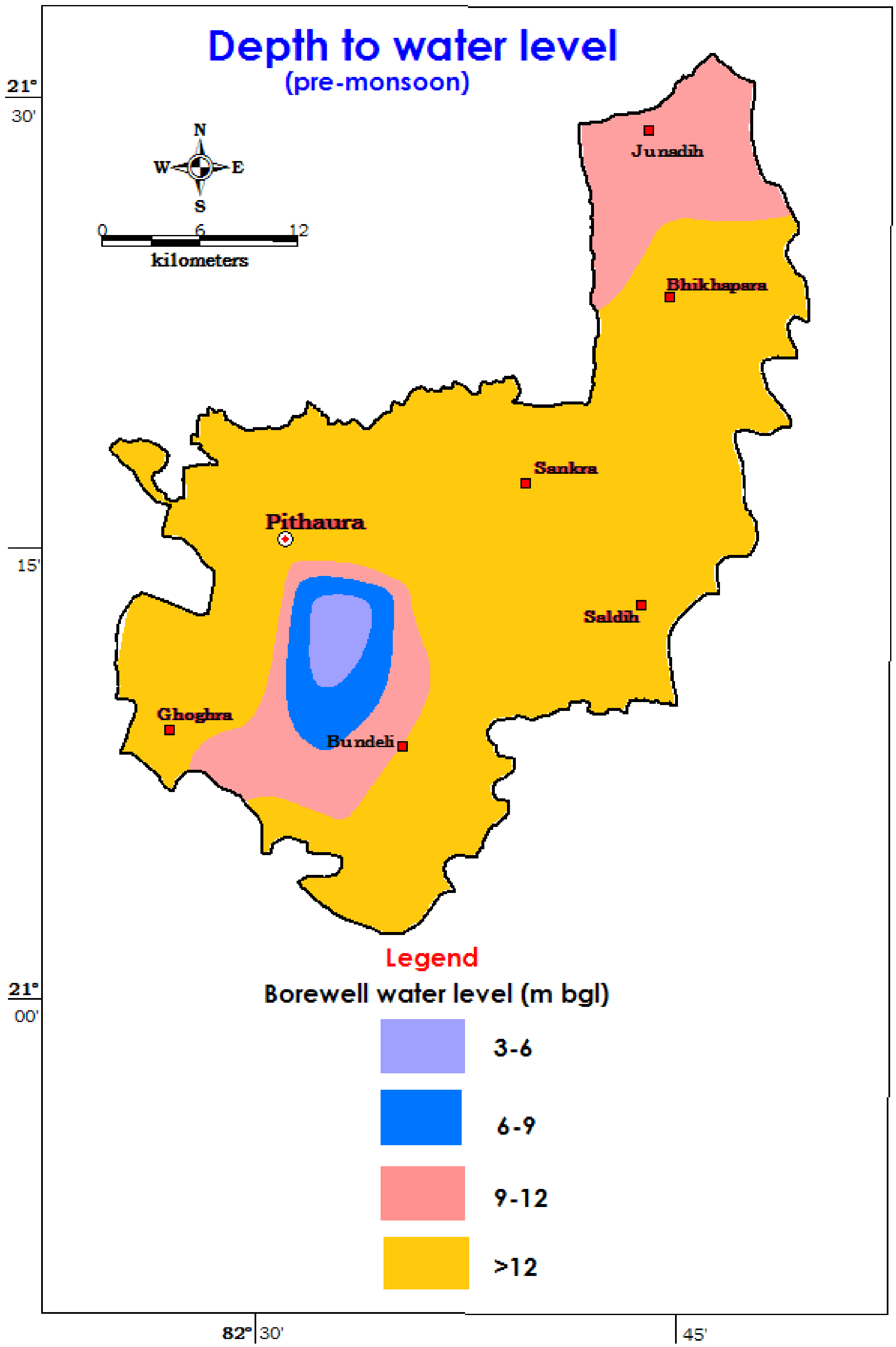


Figure-7: Depth to water level map Fractured Aquifer (Pre-monsoon)

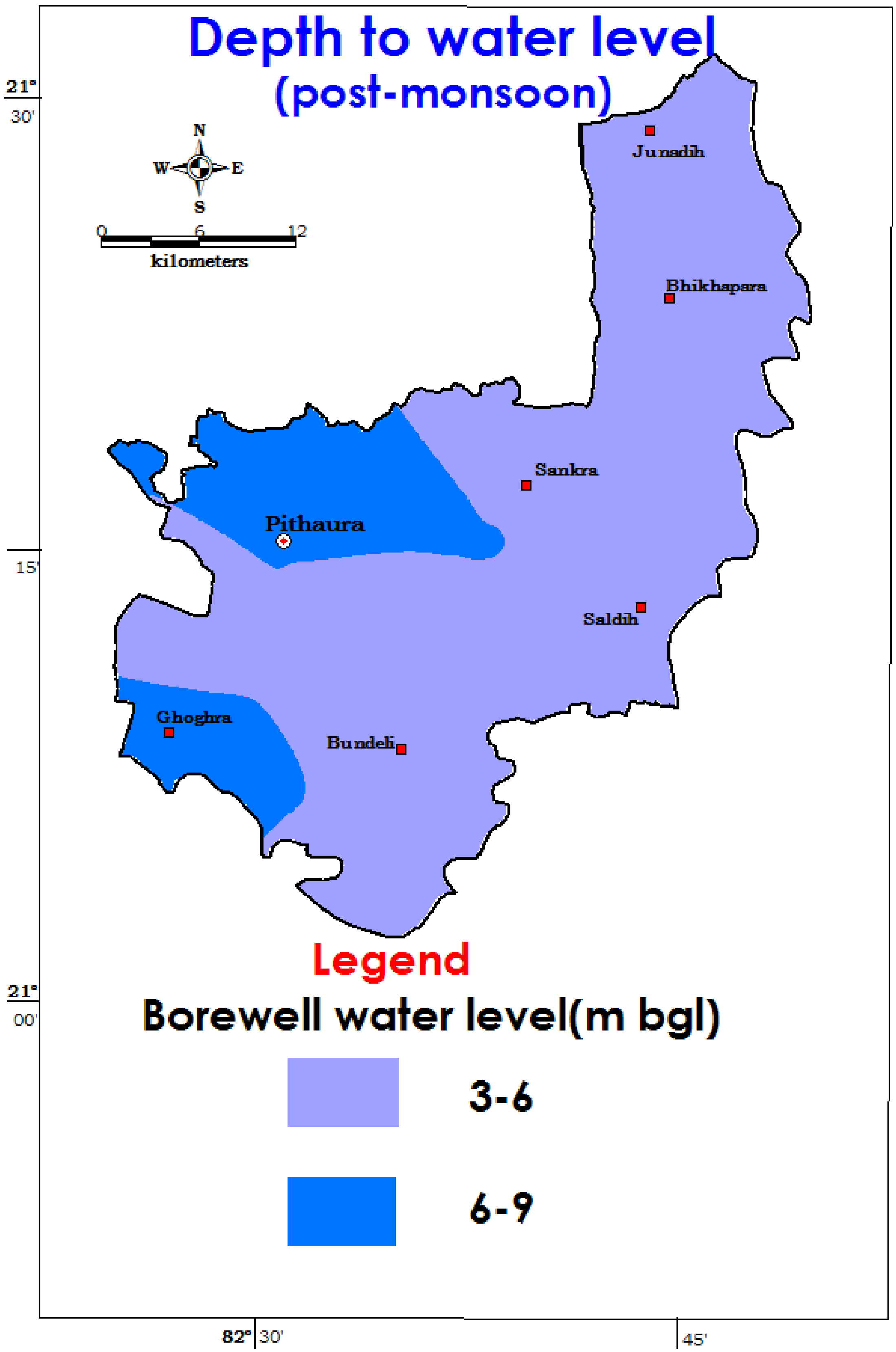


Figure-8: Depth to water level map Fractured Aquifer (Post-monsoon)

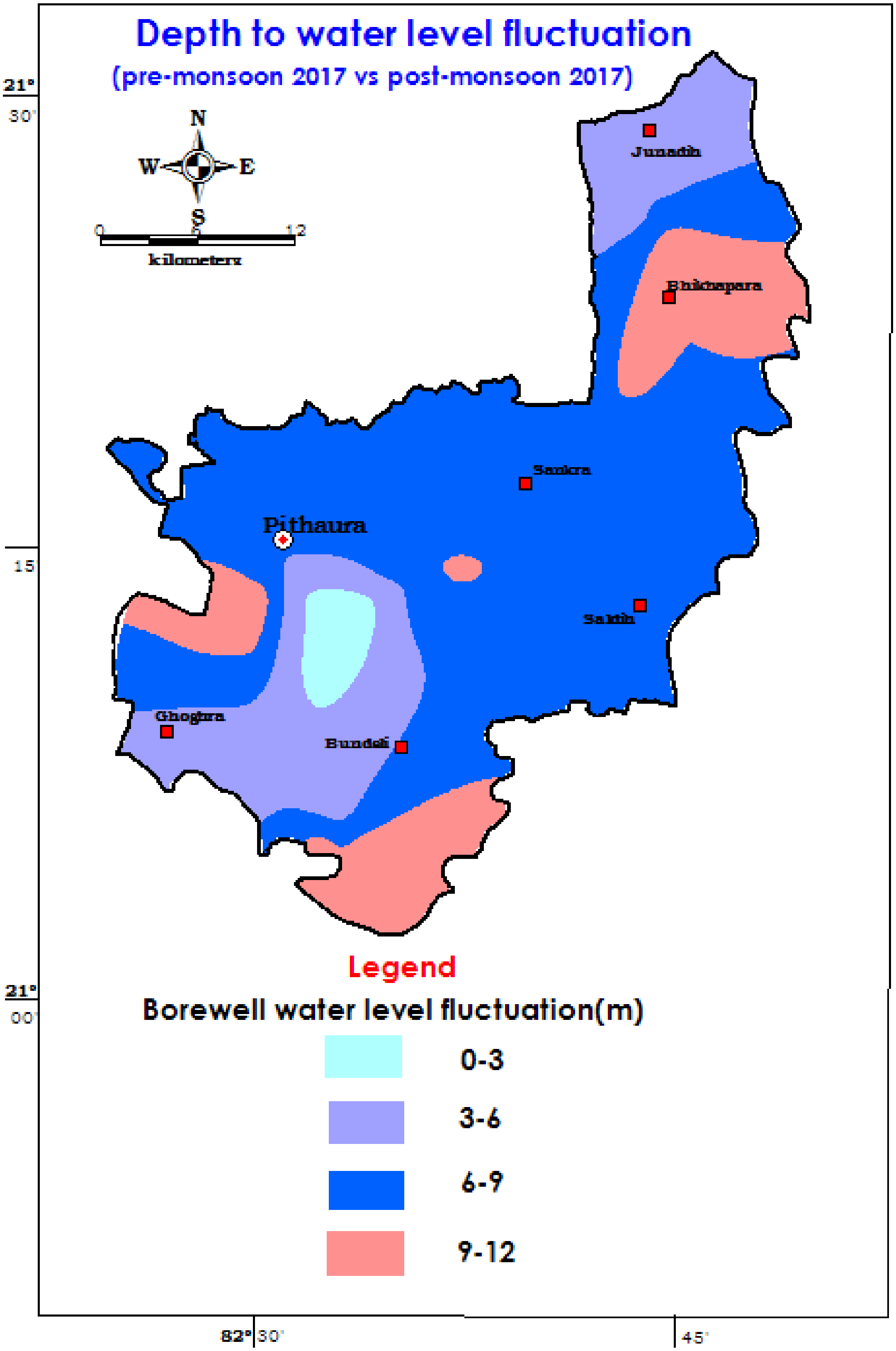


Figure 9: Depth to water level fluctuation map of Fractured Aquifer

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Pithora block, water level fluctuation in phreatic aquifer varies from 1.91 to 7.37 m with an average fluctuation of 4.71m. Water level fluctuation in fractured aquifer varies from 0.6 to 12.66 m with an average fluctuation of 7.63 m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic		
	Min	Max	Average
Pithora	1.91	7.37	4.71

Water Level (in m)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Fractured		
	Min	Max	Average
Pithora	0.6	12.66	7.63

(iv) The long term water level trend: It indicates that there is no significant decline in water level in pre-monsoon as well as post-mosoon period.

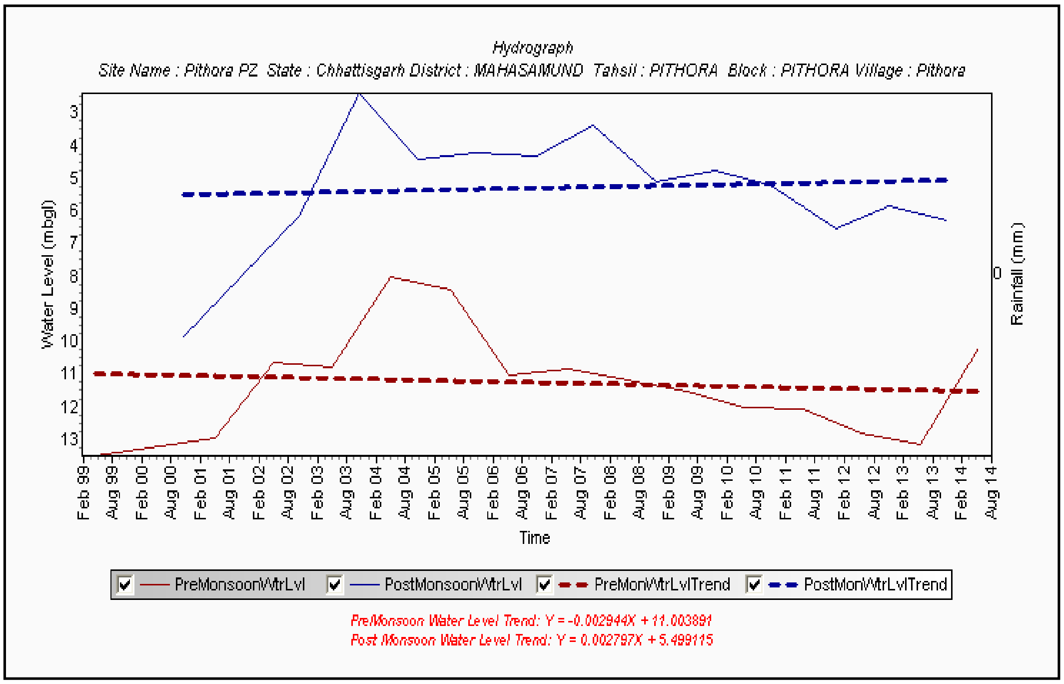


Figure 10: Hydrograph of Pithoratown, Pithora block

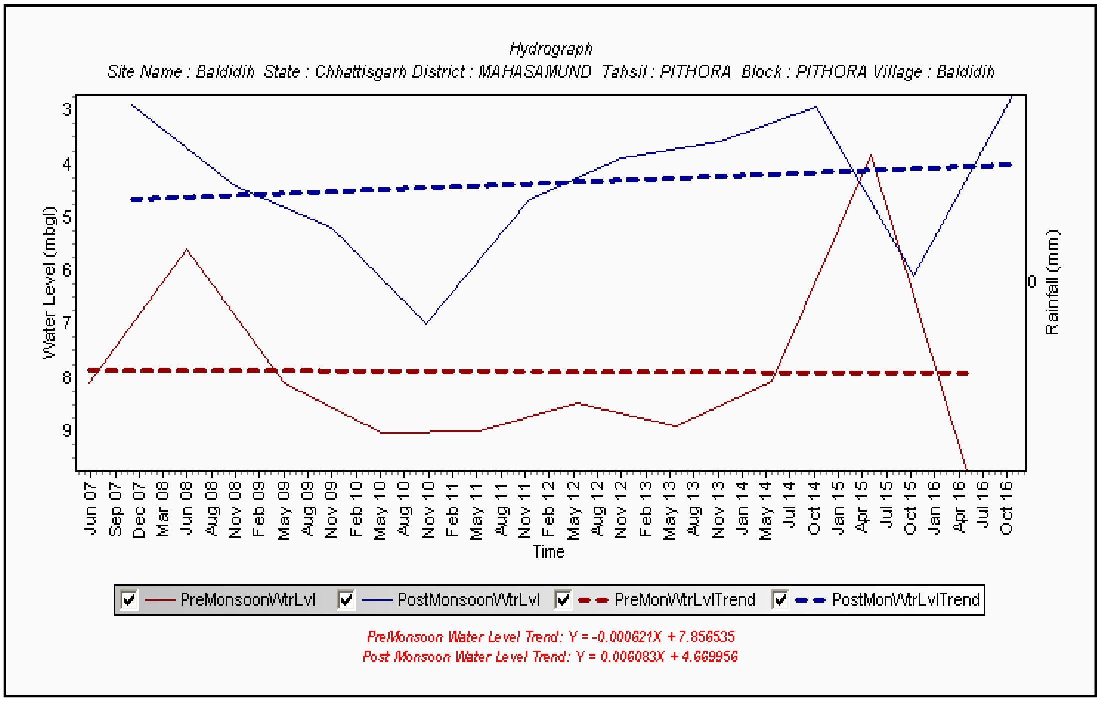


Figure 11: Hydrograph of Baldidih village, Pithora block

2. Aquifer Disposition:

Number of Aquifers: There aretwo major aquifers, viz. Dongargarh granite and granitic gneiss and Sonakhan group basalt and amphibolites gneiss, which in phreatic and fractured condition serve as major aquifer system in the block.

3-D aquifer disposition and basic characteristics of each aquifer:

(A) Geology: Geologically the block exhibits lithology of Meso to Neo Proterozoic agedominated by Dongargarh granite and granitic gneiss and Sonakhan groupbasalt and amphibolites gneiss.

(i) Dongargarh granite and granitic gneiss: The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 10.30 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present in less than 50 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells and shallow tubewells. The transmissivity of the formation is around 6 m^2 per day with an average drawdown of 27 m. The thickness of fractured aquifer is around 0.2 m.

(ii) Sonakhan group of Archean to Proterozoic age consists of basalt and amphibolite and metasediments. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 12.75 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible(<1lps). The development in these formations is mostly by way of dug wells.

Table 6: Distribution of Principal aquifer systems in Pithora

Block	Phreaticand fractured granite gneiss (sq.km.)	Phreaticand fractured basalt, amphibolite(sq.km.)
Pithora	894	166

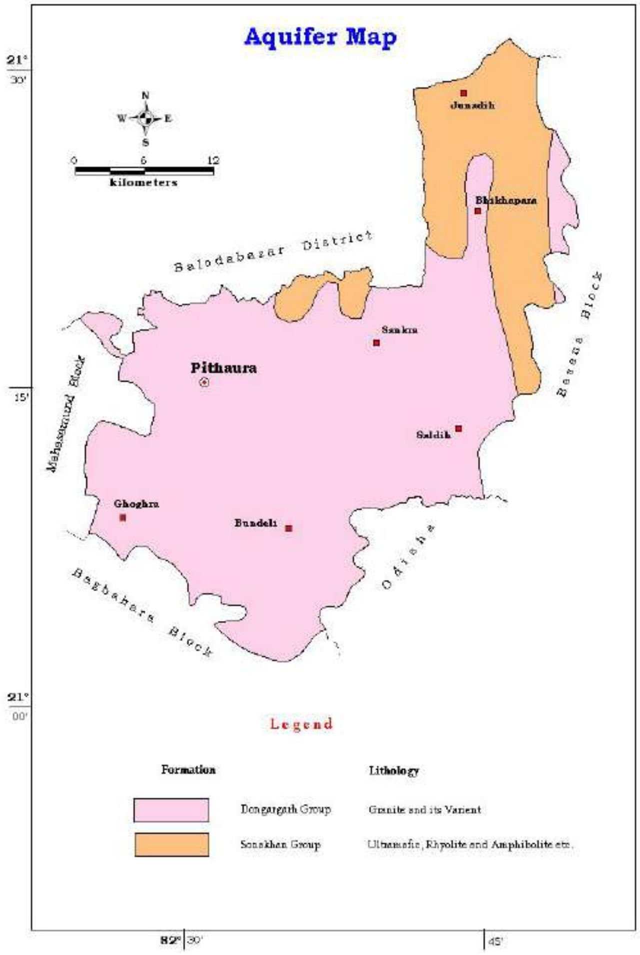


Figure 12: Aquifer map of Pithora block

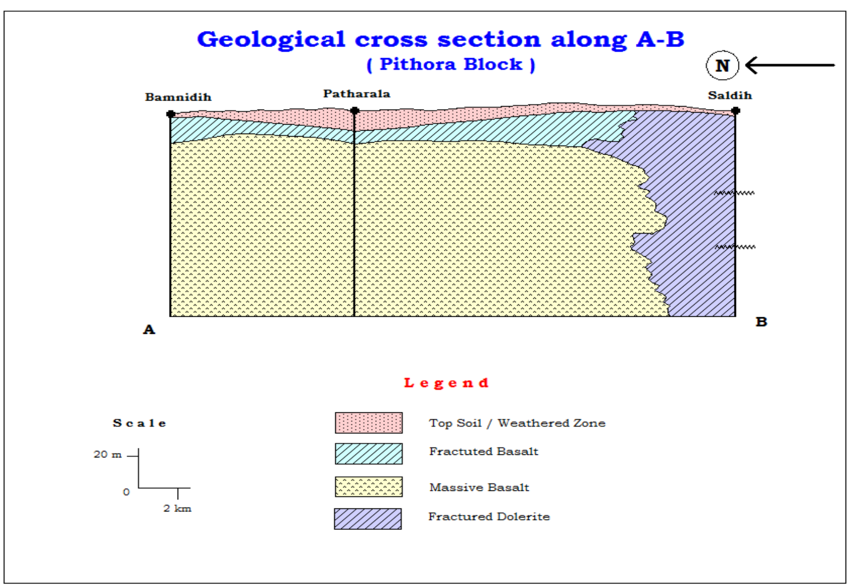


Figure-13: (a)Hydrogeological Cross Section(A-B) Pithora Block

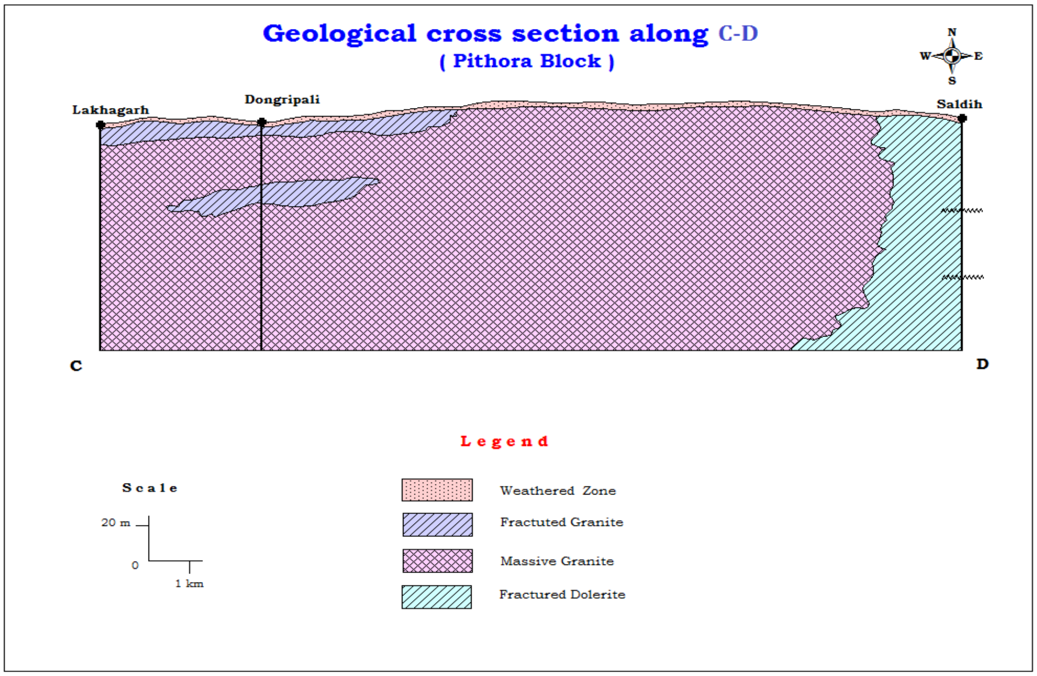


Figure 13: (b) Hydrogeological Cross Section(C-D), Pithora Block

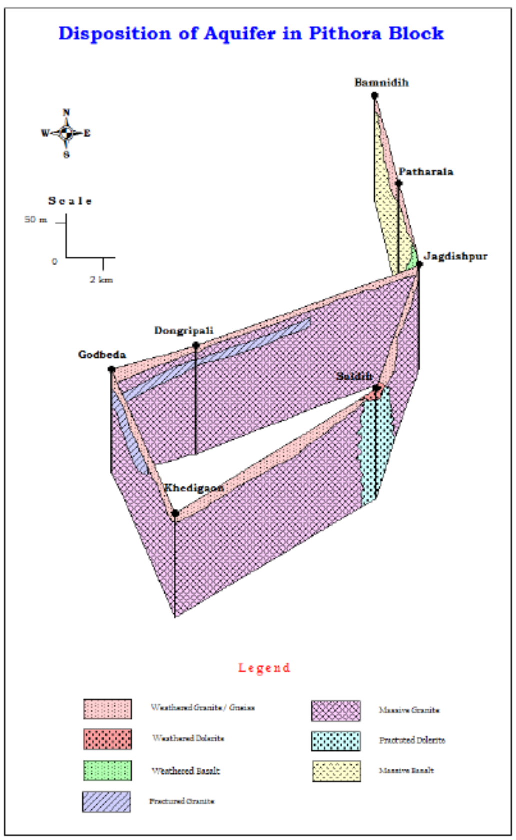


Figure-14: Disposition of aquifer in Pithora block

3. Ground water Resource, extraction, contamination and other issues:

Aquifer wise resource availability is given in the table -4 where the total resource available in Pithora block is 13164. 0ham.The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-7 & 8.

Table-7: Ground water Resources of Pithora block

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation for Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Mahasamund	Pithora	13164.0	6822.0	453.95	7275.95	490.61	5851.39

Table-8: Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorization
Mahasamund	Pithora	55.27	Safe

Categorization: The Pithora block falls in safe category. The stage of Ground water development is 55.27%. The Net Ground water availability is 13164.0ham. The Ground water draft for all uses is 7275.95 Ham. The Ground water resources for future uses for PithoraBlock is6342.0Ham.

Chemical Quality of Ground water and Contamination**:** Throughout the study area, the water quality (phreatic and semi-confined aquifer) is good and all the parameters are within permissible limit. In conclusion it may be said that the groundwater in the block is suitable for drinking as well as for irrigation purposes.

4. Ground Water Resource enhancement:

Aquifer wise space available for recharge and proposed interventions:

Table -9: Summarised detail of Volume of porous space available for recharge (Aquifer wise)

Formation	Area (sq.m)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (m^3)
Granite-gneiss	$378*10^6$	1.5	0.03	17.01×10^6
Basalt/ Amphibolite	$130*10^6$	1.5	0.03	$\times 10^6$

5. Issues:

(i) The aquifer itself is a low yielding one due to which during summer, dugwells in almost all villages are dry except a few locations. Several handpumps also stop yielding water.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system.

(iii) There is further scope of groundwater development.

6. Supply side interventions:

(i) Pithora block experienced drought situation in 2017because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken "Nal Jal Yojana" to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water. So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to understand people about the importance community participation in saving water.

(iii) Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also, Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.

(iv) It has been observed that though the long-term trend lines are insignificant, still we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table-10.

Table-10: Types of ArtificialRecharge structures feasible

Name of Block	Area Feasible for recharge (sq.km)	Volume of Sub Surface Potential to be recharged through other methods (MCM)	Types of Structures Feasible and their Numbers			
			P	NB & CD	RS	G
Pithora	508	22.04	70	190	340	457
	Recharge Capacity		14.43	1.89	3.43	2.29
	Estimated cost (Appx.)		Rs. 22.36 crore			

(v) The practice of providing free electricity to operate irrigation borewells should be strictly monitored and put to an end in case of overconsumption. After a simple calculation it has been found that Rs 16000/ hectare is the expenses of electricity (@Rs. 2.5/unit) for paddy field. So monitoring mechanism for electricity consumption should be strengthened for farmers taking summer rice. Even if farmers use solar pump or other method of ground water irrigation for summer paddy, it should not be flooding method. Proper pipes are to be used to transfer water from one plot to another.

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

(vii) Since the stage of development in the block is 55.27 %. So, there is scope of development. In order to achieve 60% stage of ground water withdrawal in the block, development may be taken up as per the following table:

Table-11: Number of structures recommended in block for 60 % stage of development

Block	Net Groundwater availability (ham)	Stage of ground water Development (%)	Present ground water draft (ham)	Ground water draft at 60% stage of development (ham)	Surplus ground water at present Stage of Development (ham)	Number of TW Recommended in each block (Assuming unit draft as 2 ham/structure/ year)	Number of DW Recommended in each block (Assuming unit draft as 0.72 ham/structure/ year)
Pithora	13856.84	55.27	7275.95	7898.4	622.45	311	865

7. Demand side interventions:

(i) Change in cropping pattern & irrigation pattern can lead to groundwater savings, as per the following table:

Table 12: Detail of groundwater saved through change in cropping pattern

Block	Paddy cultivation area during Rabi season (ha)	Water required for cultivation (in m) per ha		Difference (m) per ha	Total saving of water (ham)	Existing gross groundwater draft for all uses in ham	Available resource (ham)	Improved status in Stage of groundwater development
		Paddy	Maize					
Pithora	5978	0.9	0.5	0.4	2391.2	7275.95	13164.0	37%

(ii) In command or non-command area wherever ground water has been used for field irrigation should be replaced with micro irrigation methods such as sprinklers, drip irrigation etc. which may save 30 to 40% ground water.

Table 13: Detail of groundwater saved through change in irrigation pattern

Block	irrigated crop area under rabi 2016(ha)	water required for cultivation of pulses(m)	30 % groundwater saved through micro irrigation	water saved through microirrigation (ham)
Pithora	5978	0.3	0.3	347.67

Water thus saved can help arrest declining groundwater levels during summer. This may lead to ample drinking water resource in months of May-June.

Table 14: Proposed sites for artificial recharge of groundwater in Pithora block

PT (Percolation tank)	NB & CD (Nala bund and Check dam)	RS (Recharge shaft)	GB (Gabbion structure)
Patparpali	Bagarpali	Kokobhatha	Saraipali
Sona silli	Dadargaon	Bagarpali	Janghora
Thakurdayakalan	Badgaon	Kotadadar	Lahraud
Ghoghra	Lakhagarh	Gadbeda	Bhitidih
Kotadadar	Rampur	Kasahibahara	Charbhatha
Laxmipur	Khairkhuta	Bagarpali	Kishanpur (Kisanpur)
Charbhatha	Dongripali	Dhanora	Gabaud
Atharagudi	Charbhatha	Laxmipur	Kurmadih
Kurmadih	SalheTarai	Thakurdiyakhurd	Ansula
Pilawapali	Rampur tukda	Gopalpur	Badetemri
Dewalgarh	Gardih	Ansula	Dhabakhar
Sankara	Pandripani	Dhabakhar	SalheTarai
Saldih	Jabalpur takdanaya	Deosaral	Khursipahar
Jamjuda	Rampur	Bijemal	Padakipali
BadetemriNaktinala	NarsaiyaPallam (Nars	Chhuwalipatera (Chhu	Dhodarkasa
Thelkodadar	Gadbeda	Bahadurpur	Saisaraipali
Jadamuda	Santemri	Sankarpur	Arangi
Bamhanpuritukda (Vir	Pendrawan	Arangi	Rajpalpurtukda
Jhagrandih	Bhatkhunda	Khamhan	Kesharpur
Rajpur	LohrinDongani	Pirda	Rampur
Pardhiyasaraipali	Jarabharan	Bamhani	
Dalalkhar	Utekel	Rajpalpur	
Lawamauha (Lawamauta)	Chhoteloramtukda N		
	Burodih		
	Durugpali		

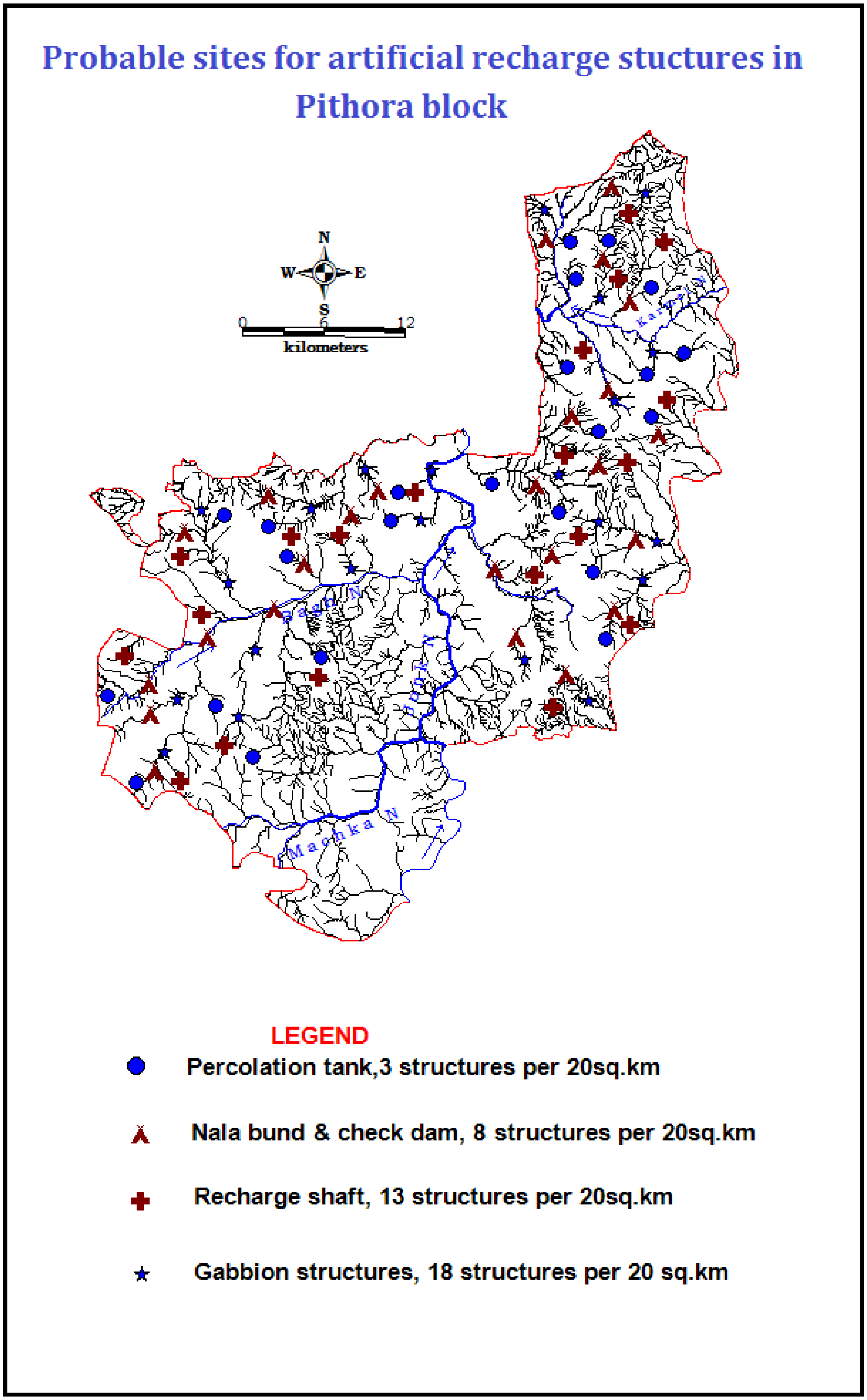


Figure 15: Map of proposed sites for artificial recharge of groundwater in Pithora block

8. CONCLUSIONS:

An area of 1060 sq.km of Pithora block of Mahasamund district has been considered for Aquifer Mapping and Management Plans. The total G.W resource is 13164.0 Ham with stage of G.W development 55.27 % and categorized as “safe”. 61.05 % of the irrigated area is uses groundwater for irrigation. The major aquifer groupsareDongargarh Granite and Granite gneiss and Sonakhan Group Amphibolite gneiss and basalt. In terms of Demand side management, by change in cropping and irrigation pattern (micro irrigation methods) 2391.2Ham and 347.67 Ham water can be saved respectively. In terms of Supply side management, by constructing artificial recharge structure 22.04 MCM water can be recharged and constructing of tubewell at suitable locations, drinking water needs may be fulfilled.

AQUIFER MAPS AND MANAGEMENT PLANS
BASNA BLOCK, MAHASAMUND DISTRICT

1. Salient Information:

About the area: Basna Block is situated in the eastern part of Mahasamund district of Chhattisgarh and is bounded on the north by Baloda Bazar andRaigarhdistrict, in the west by Pithora block of Chhattisgarh, in the east by Saraipali block and in the south by Odisha state. The area lies between 21.15 and 21.50 N latitudes and 82.75 and 82.88 E longitudes. The geographical extension of the study area is 901 sq.km, representing around 17 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Geomorphology comprises of pediment and pediplains in the southern part, denudational hills and slopes in the northern part. Geomorphology map shown in Figure 2. Suranginala flowing eastwards is a tributary of Ong riverand Billanala flowing northwards is a tributary of Mahanadi river. Drainage map shown in Fig.3.

Population: The total population of Basna block as per 2011 Census is175617out of which rural population is 165272while the urban population is 10345.The population break up i.e. male- female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Basna	175617	86852	88765	165272	10345

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 14.18 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015)1212.16 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Basna block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Annual rainfall	1336.50	1378.70	1507.80	1468.80	1831.20

Source: IMD

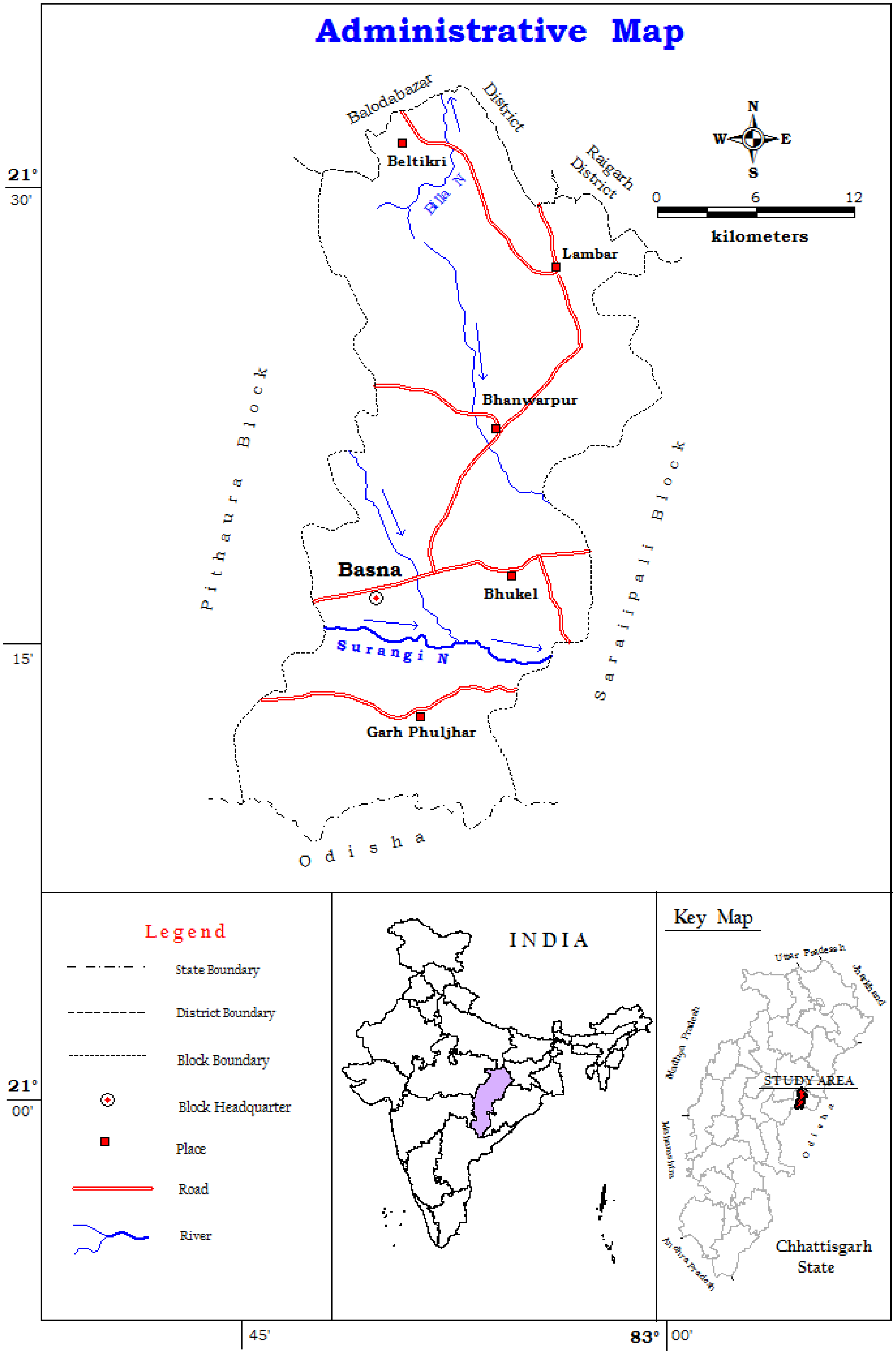


Figure: 1 Administrative Map of Basna Block

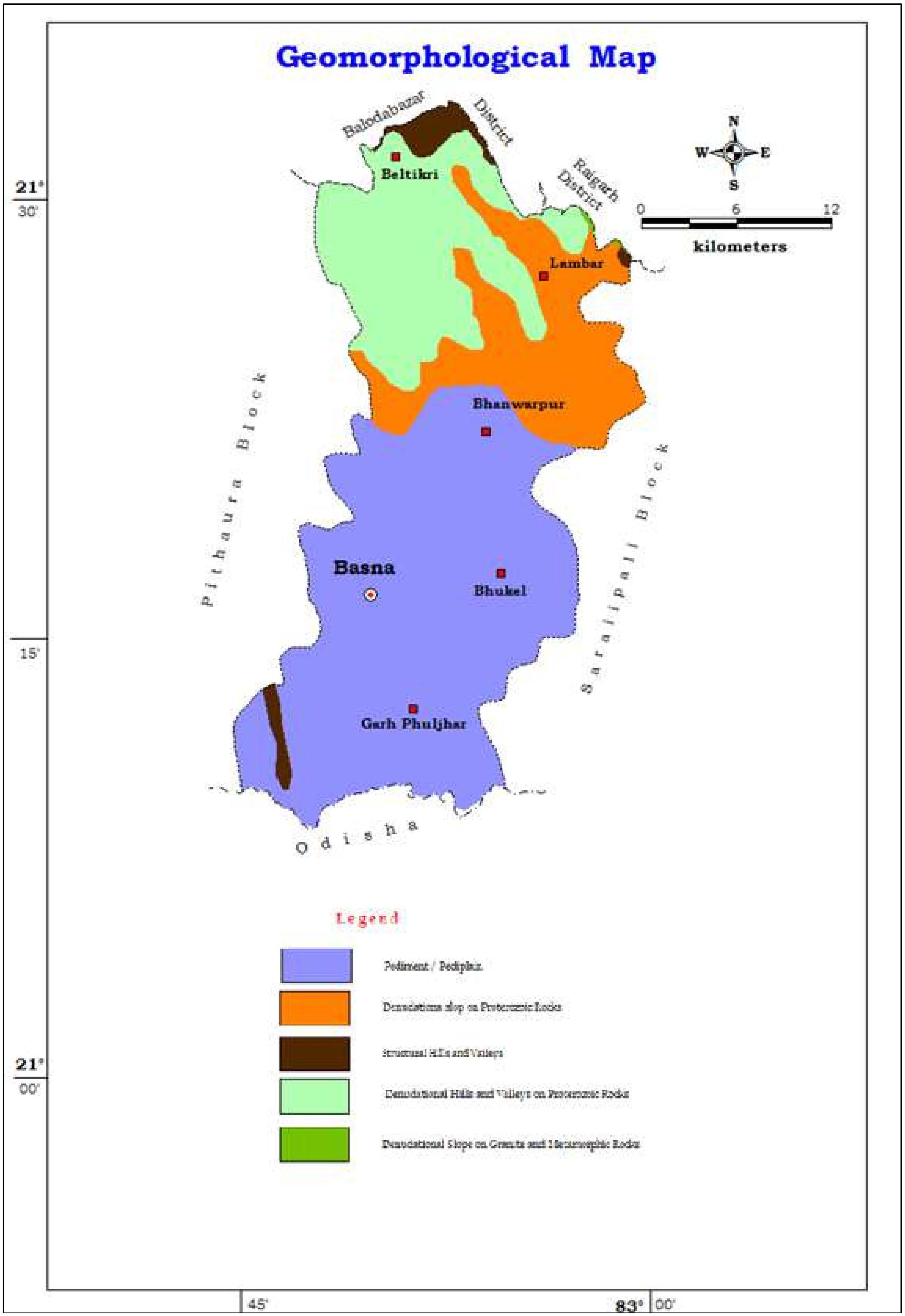


Figure 2: Geomorphology Map of Basna Block

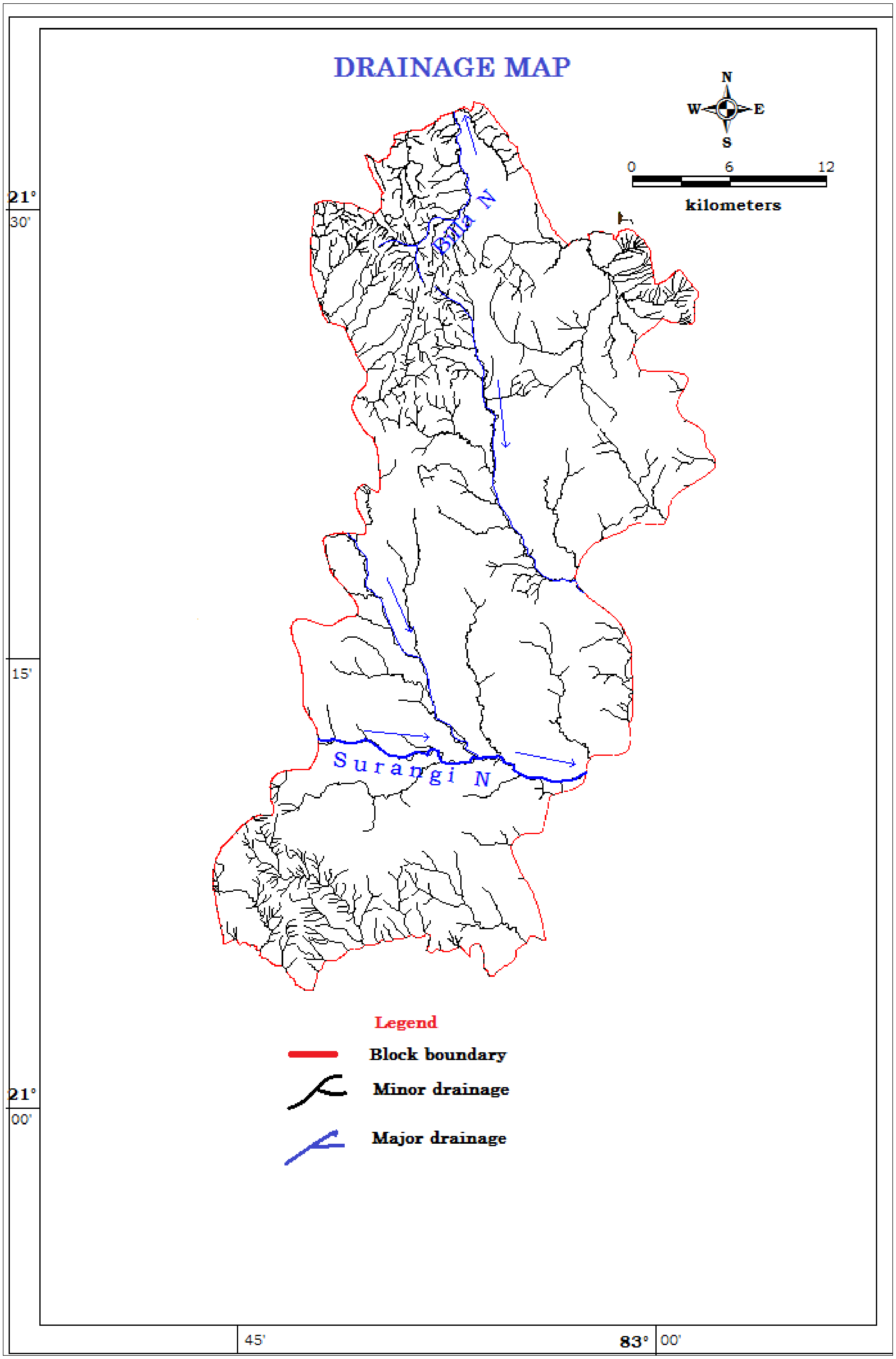


Figure 3: Drainage Map of Basna Block

<u>Agriculture and Irrigation</u>**:** Agriculture is practiced in the area during Kharifand Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are Paddy, Wheat, pulsesand vegetables.
In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Basnablock is given in Table 3 (A, B, C, D, E).

Table 3 (A): Agricultural pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Basna	90100	6899	5080	48174	7526	55700

Table 3 (B): Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non agricultural& Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Basna	90100	6899	5080	2844	931	48174	7526	55700

Table 3 (C): Cropping pattern (in ha)

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar& Maize	Others						
Basna	48171	7612	208	49002	48	11	4266	1498	539	60	68	1

Table 3 (D): Area irrigated by various sources (in ha)

No. of canals (private and Govt.)	Irrigated area	No. of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri-gated area	Gross irrigated area	% of irrigated area wrt. Net sown area
8	1789	5347	12810	1571	128	747	330	525	15582	15582	36 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Basna	15582	12938	83.03

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Basna block upto 200 m depth is given in the table-4.

Table – 4: Ground Water Resources of Basna block in Ham

Block	Dongargarh granite and gneiss			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Basna	5682.59	1803	60.1	7491.69

Block	Basalt/Amphibolite gneiss			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Basna	2809.61	615	30	3454.61

Existing and Future Water Demand (2025)*:* The existing demand for irrigation in the area is 7468 Ham while the same for domestic and industrial field is 418.47 Ham. To meet the future demand for ground water, a total quantity of 5147.07 ham of ground water is available for future use.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that the water level varies from 4.45 to 10.74mbgl with an average of 7.78mbglin phreatic aquifer. In fracturedformation, the pre monsoon water level variation range is 4.00 to 34.2mbgl with average of 13.97mbgl.

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

Block Name	Phreatic		
	Min	Max	Avg
Basna	4.45	10.74	7.78

Water Level (in mbgl)

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

Block Name	Fractured		
	Min	Max	Avg
Basna	4.00	34.2	13.97

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 1.5 to 4.8mbgl with an average of 2.67mbglin phreatic aquifer. Infracturedformation, the post monsoon water level variation range is 2.8 to 17.44mbgl with average of 10.32mbgl.

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

Block Name	Phreatic		
	Min	Max	Avg
Basna	1.5	4.8	2.67

Water Level (in mbgl)

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

Block Name	Fractured		
	Min	Max	Avg
Basna	2.8	17.44	10.32

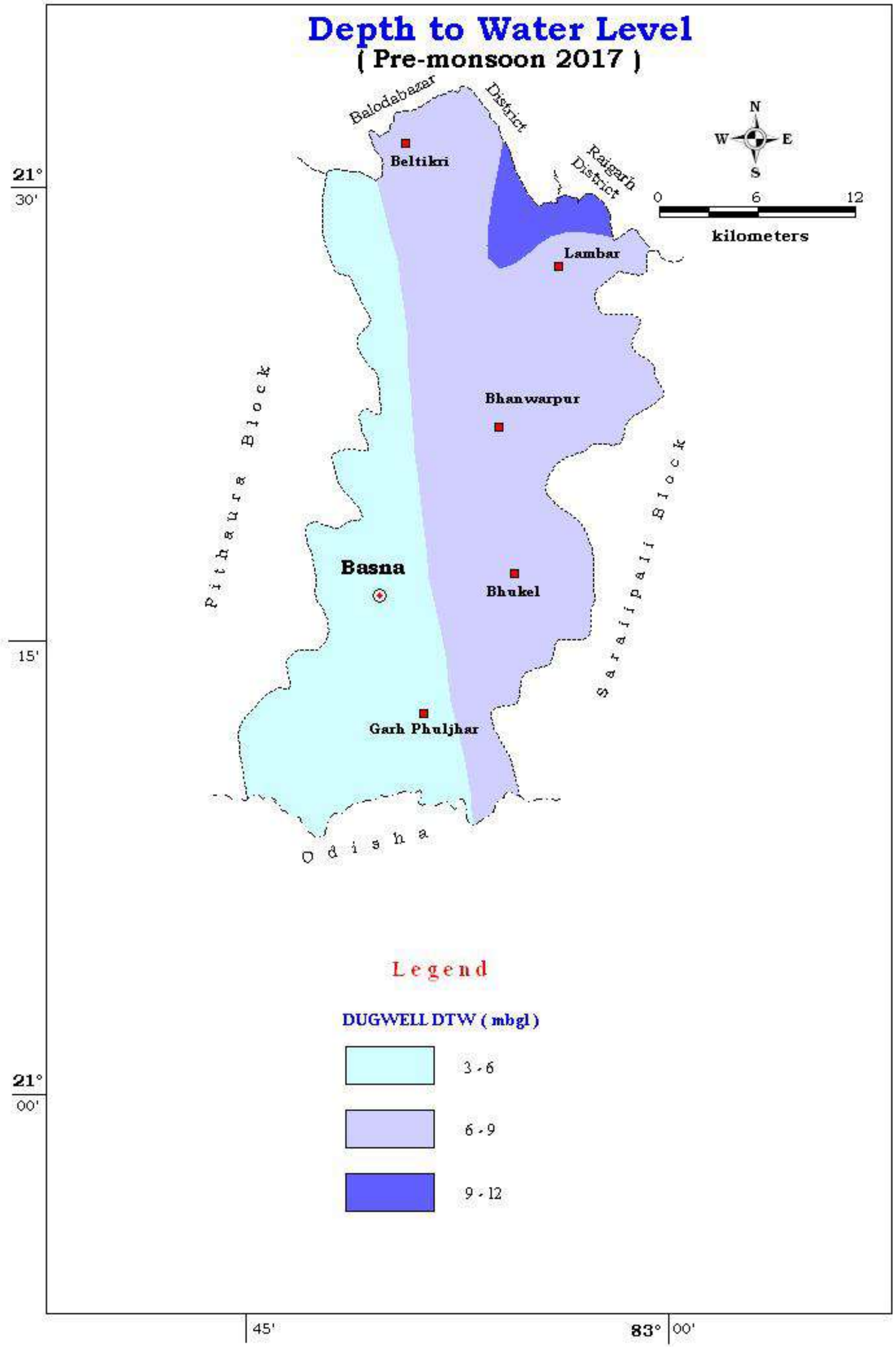


Figure-4: Depth to water level map Phreatic Aquifer (Pre-monsoon)

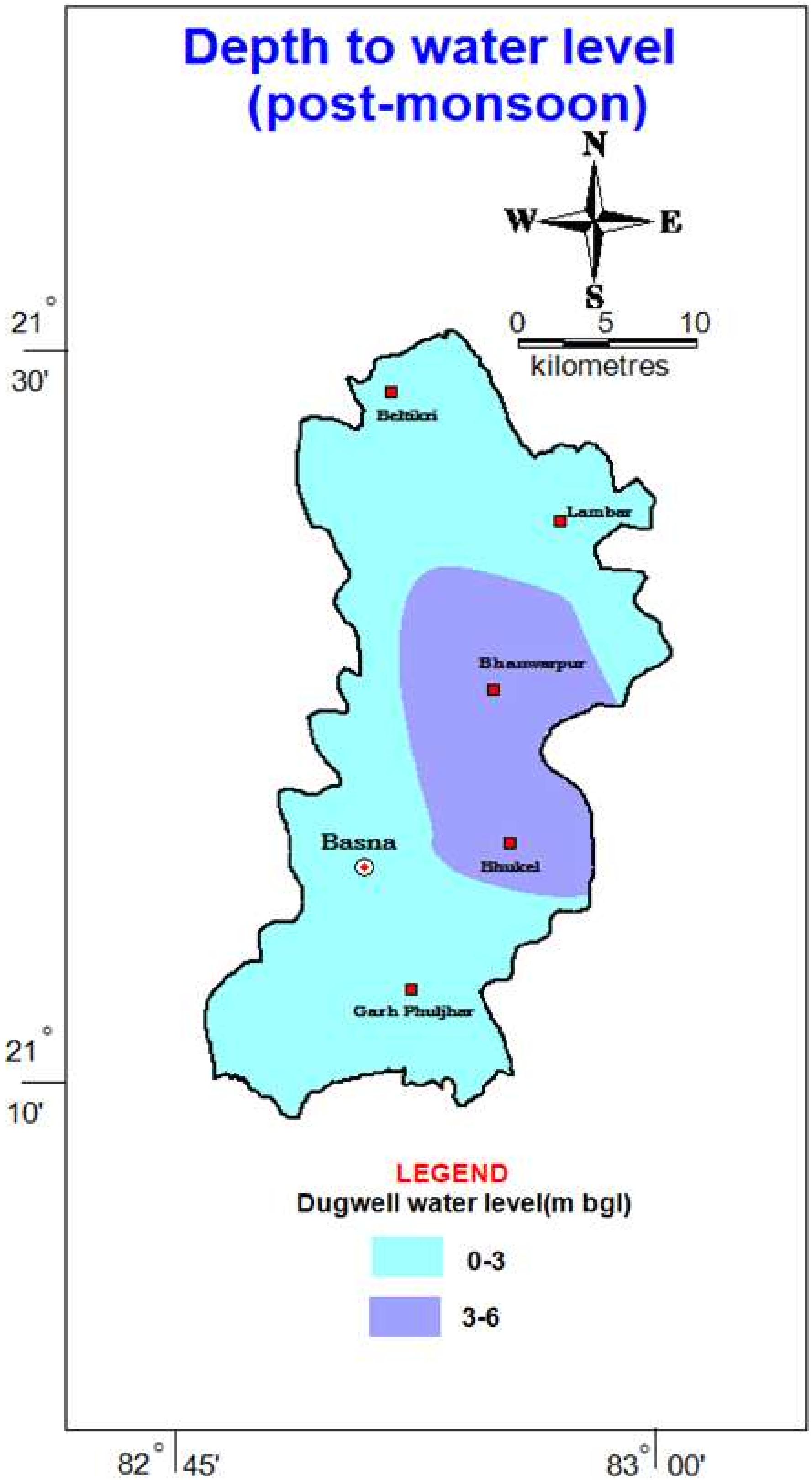


Figure 5: Depth to water level map Phreatic Aquifer (Post-monsoon)

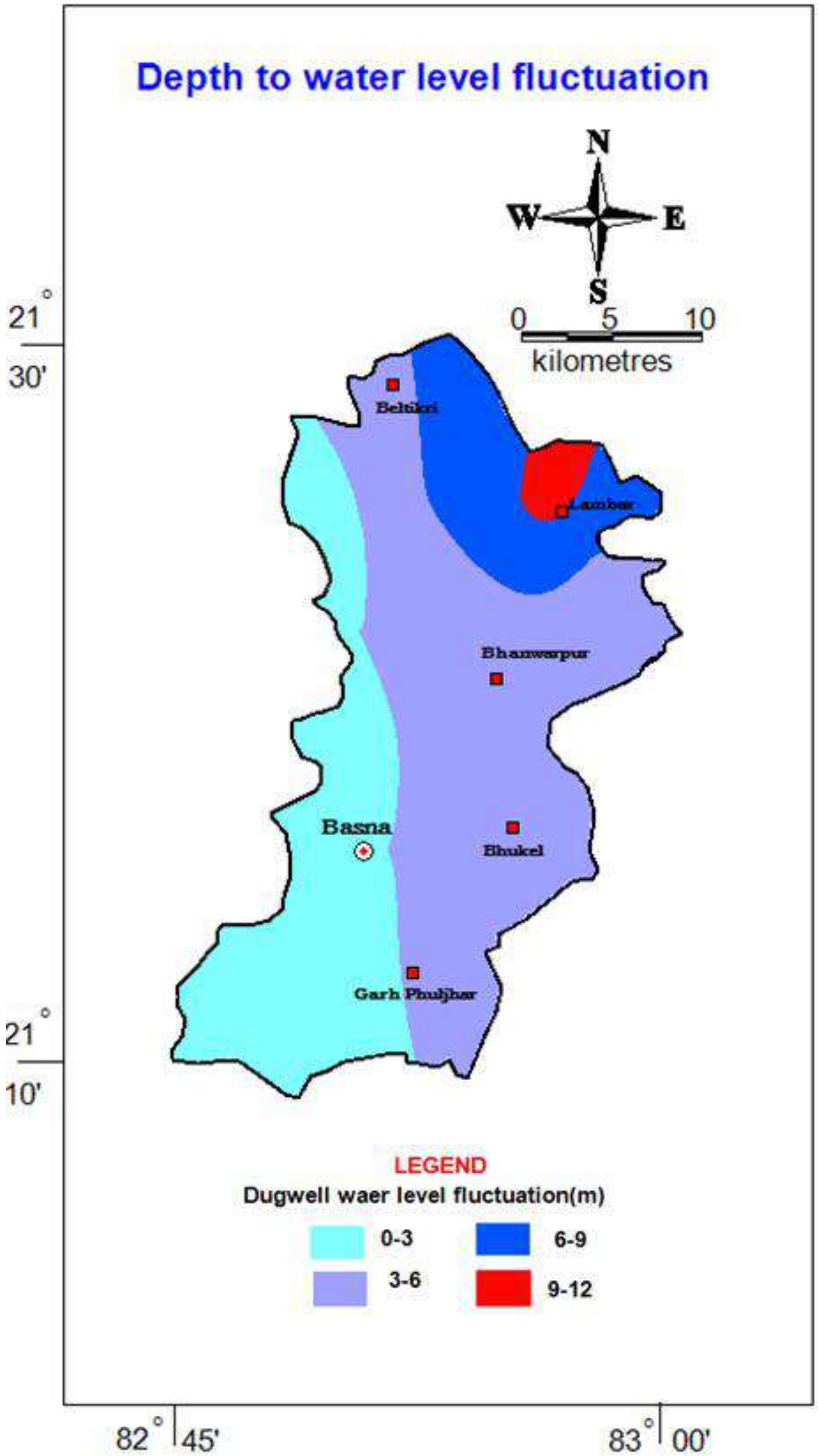


Figure 6: Depth to water level fluctuation map of Phreatic Aquifer

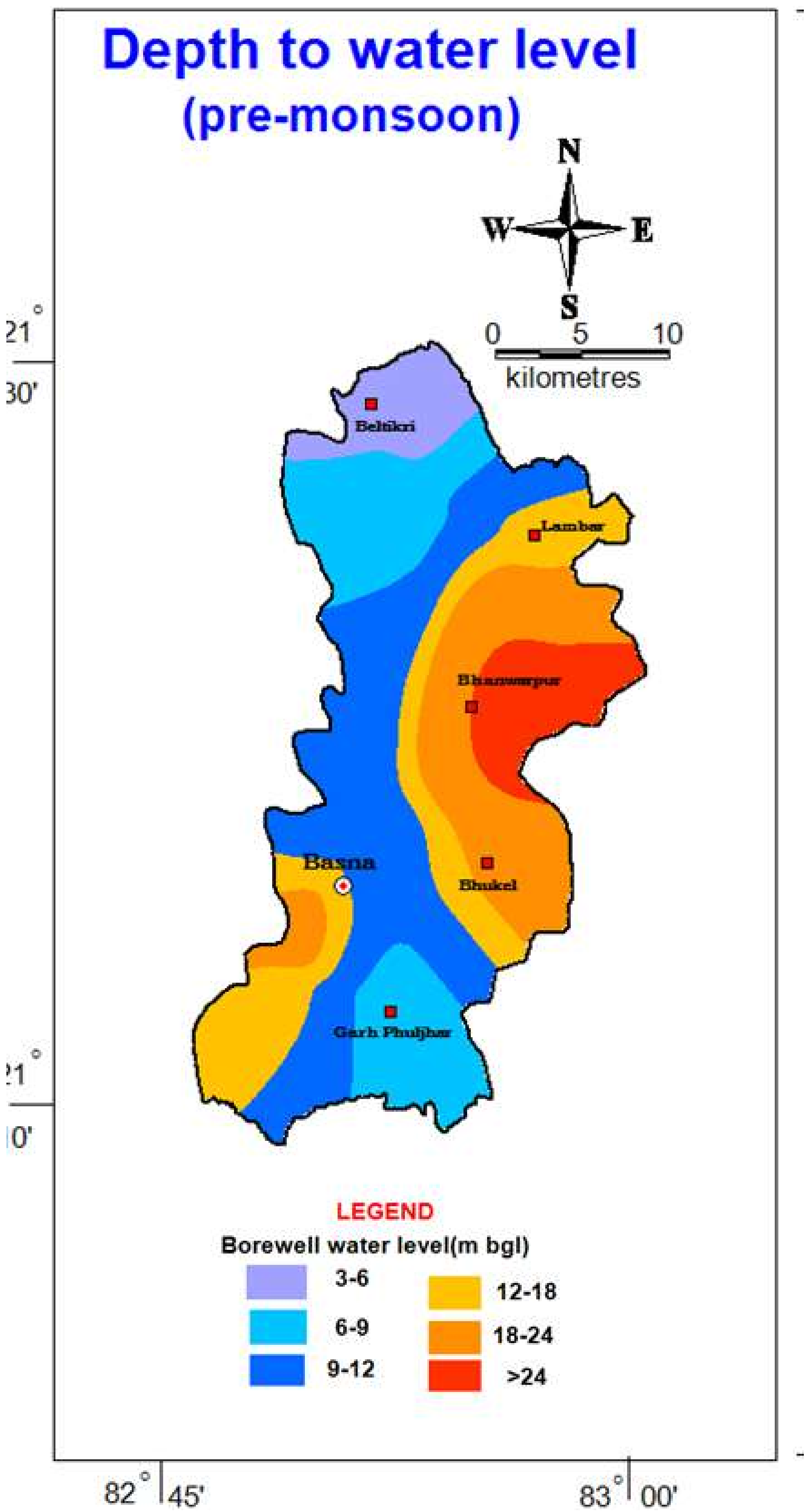


Figure-7: Depth to water level map Fractured Aquifer (Pre-monsoon)

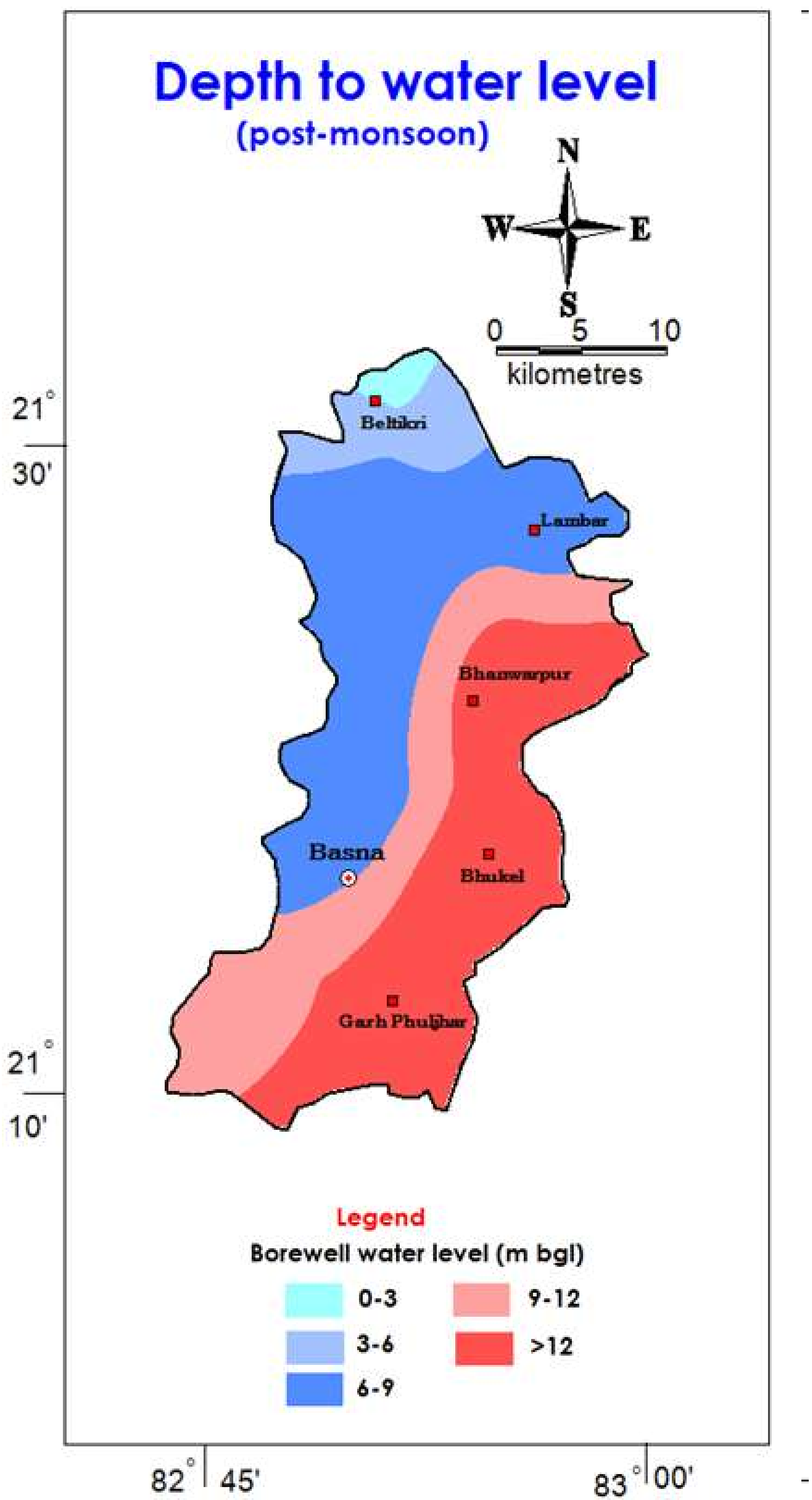


Figure-8: Depth to water level map Fractured Aquifer (Post-monsoon)

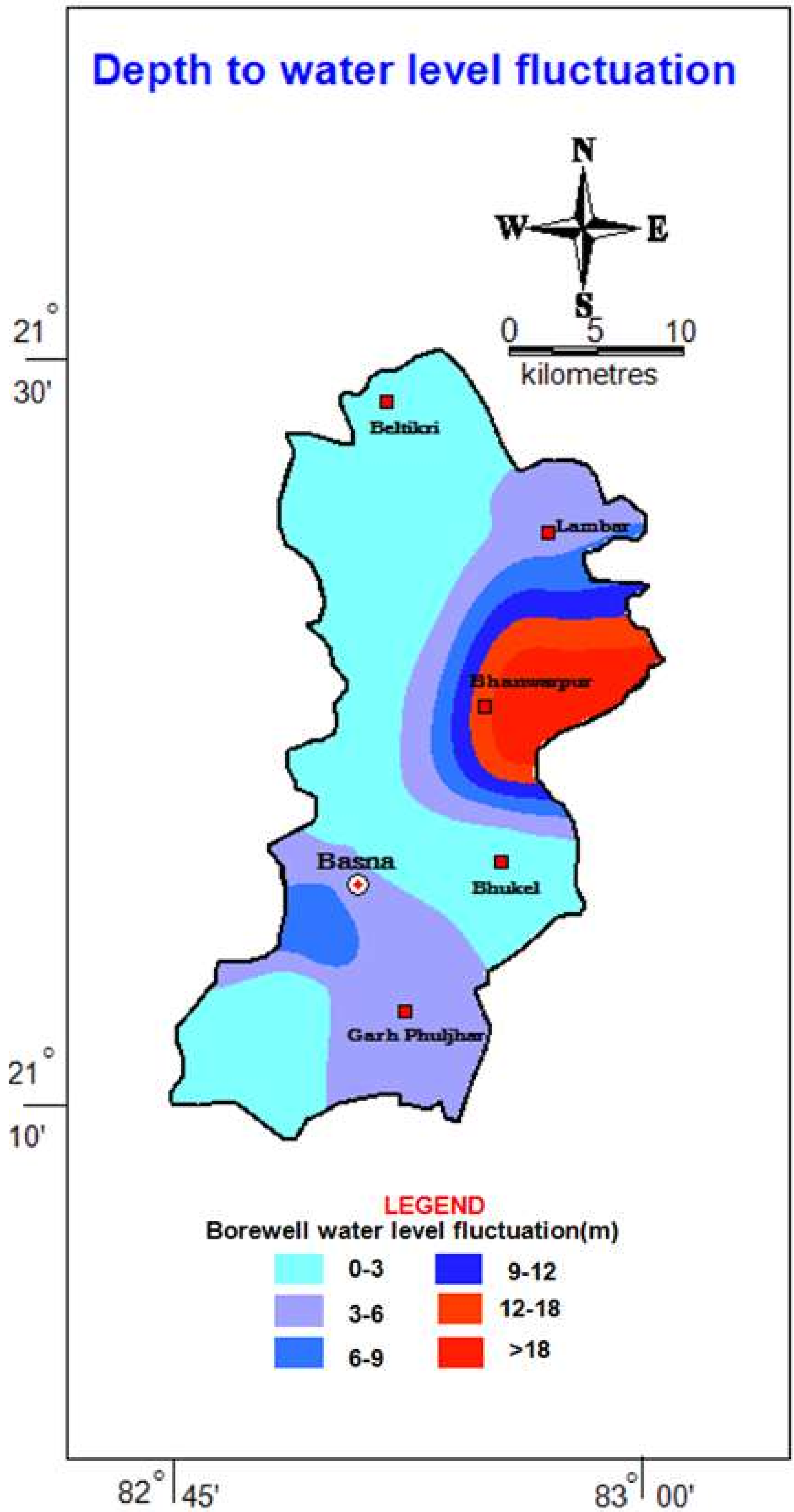


Figure 9: Depth to water level fluctuation map of Fractured Aquifer

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Basnablock, water level fluctuationin phreaticaquifervaries from 2.47 to 9.24 m with an average fluctuation of 5.10m. Water level fluctuationin fracturedaquifervaries from 0.6 to 18.4 m with an average fluctuation of 4.77 m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic		
	Min	Max	Avg
Basna	2.47	9.24	5.10

Water Level (in m)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Fractured		
	Min	Max	Avg
Basna	0.6	18.4	4.77

(iv) The long-term water level trend: It indicates that there is no significant decline in water level in pre-monsoon as well as post-mosoon period.

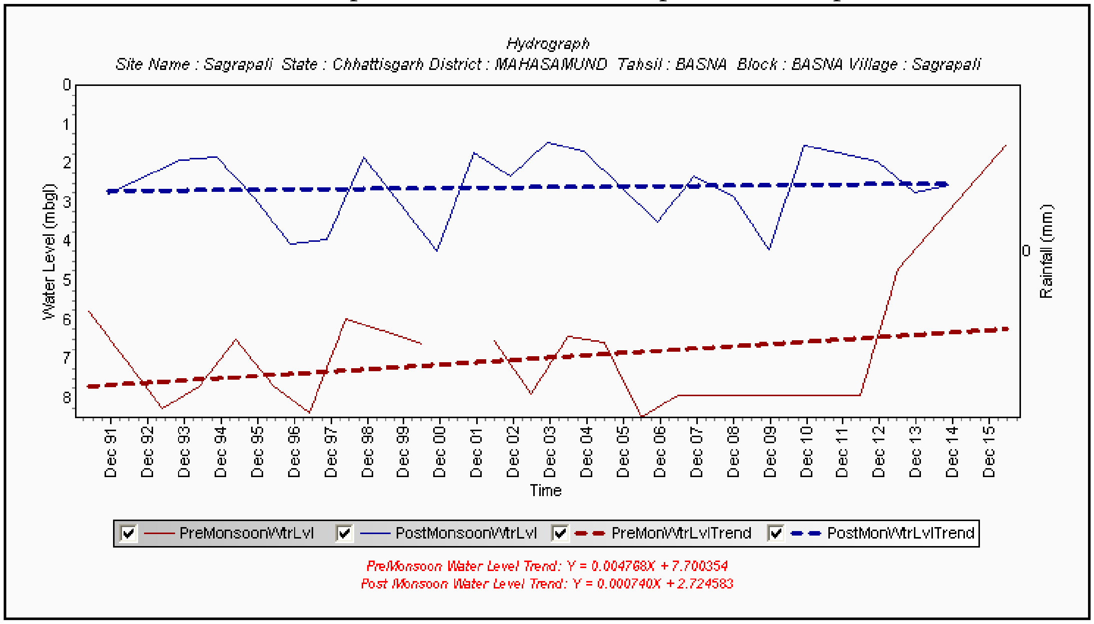


Figure 11: Hydrograph of Sagrapali village, Basna block

2. Aquifer Disposition:

Number of Aquifers: There aretwo major aquifers, viz. Dongargarh granite and granitic gneiss and Sonakhan group basalt and amphibolite, which in phreatic and fractured condition serve as major aquifer system in the block.

3-D aquifer disposition and basic characteristics of each aquifer:

Geology: Geologically the block exhibits lithology of Meso to Neo Proterozoic agedominated by Dongargarh granite and granitic gneiss and Sonakhan groupbasalt and amphibolites gneiss.

I. The Gneissic Complex of Archean to Proterozoic age consists of granite gneiss and granitoids, containing enclaves of metasedimentary and meta-igneous suites comprising schists, quartzites, amphibolites and dolomitic marbles. The average thickness of the weathered portion in the area is around 10.30 m. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present in less than 50 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells and shallow tubewells. The average drawdown is 27 m. The thickness of fractured aquifer is around 0.2 m.

II. Sonakhan group of Archean to Proterozoic age consists of basalt and amphibolite and metasediments. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 12.75 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible (<1lps). The development in these formations is mostly by way of dug wells.

Table 6: Distribution of Principal aquifer systems in Basna

Block	Phreaticand fractured granite gneiss (sq.km.)	Phreaticand fractured basalt, amphibolite(sq.km.)
Basna	601	300

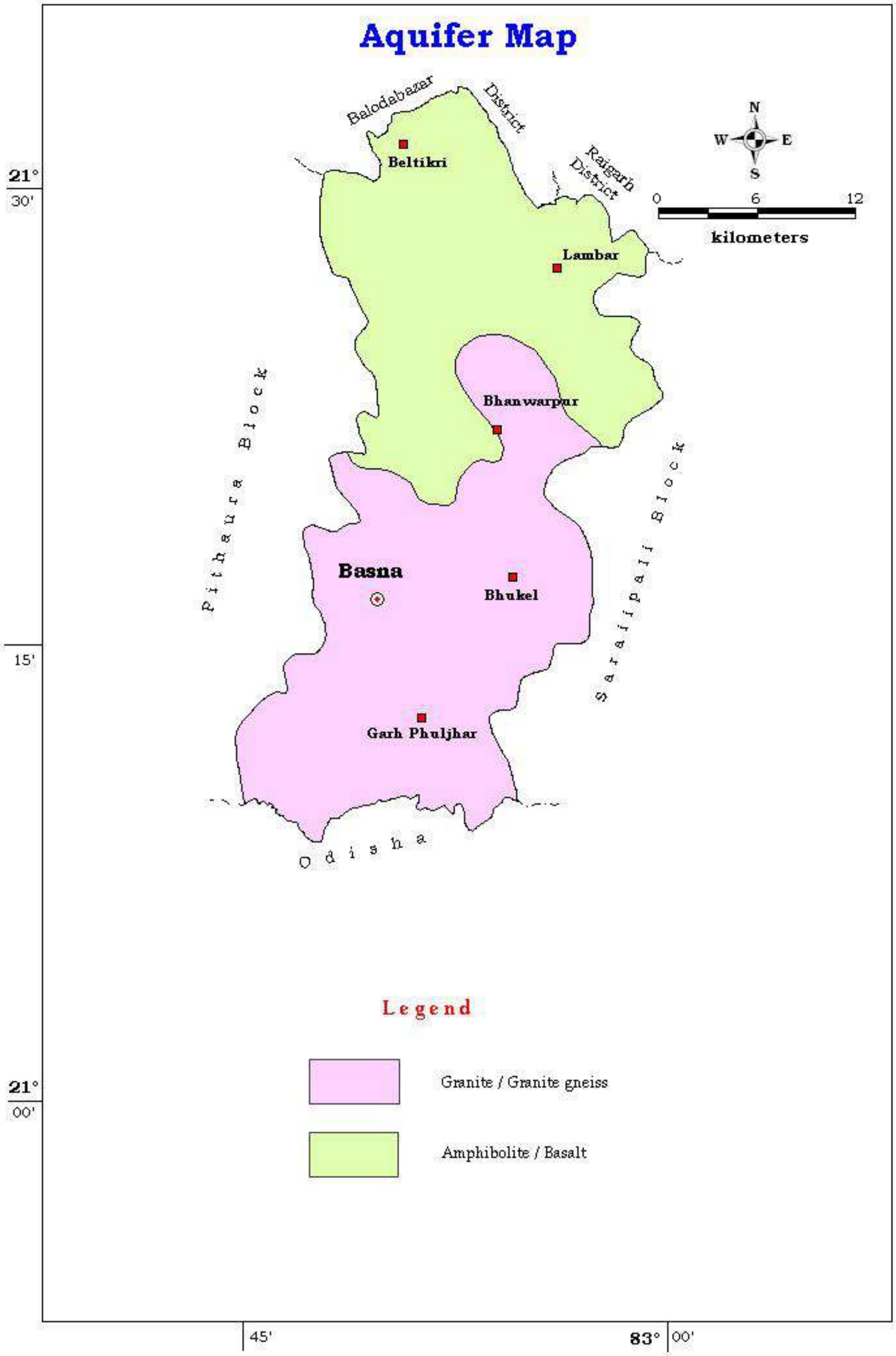


Figure 12: Aquifer map of Basna block

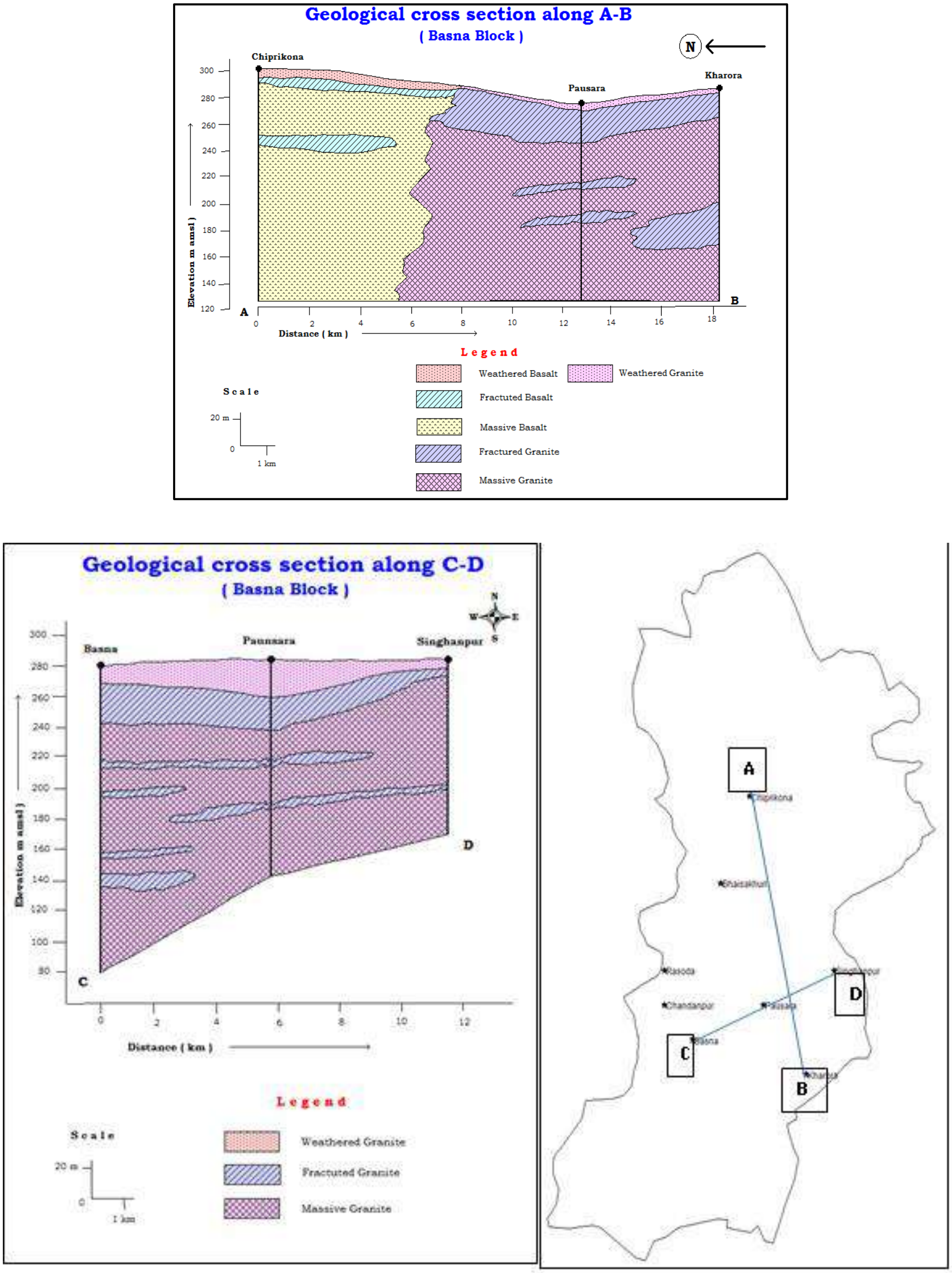


Figure-13: (a) Hydrogeological Cross Section(A-B),(b) Hydrogeological Cross Section(C-D),Basna Block

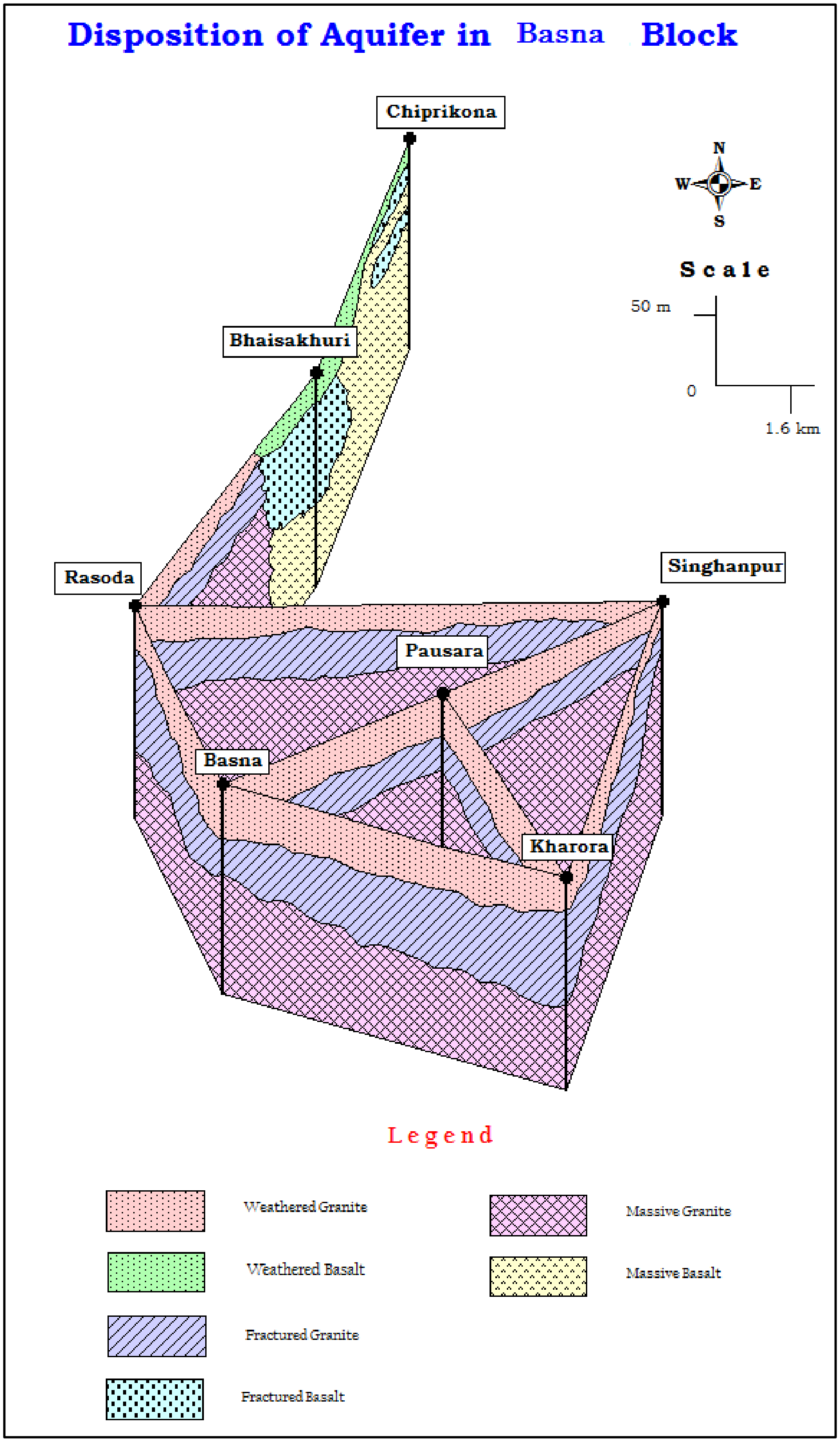


Figure-14: Disposition of aquifer in Basna block

3. Ground water Resource, extraction, contamination and other issues:

Aquifer wise resource availability is given in the table -4 where the total resource available in Basna block is 12615. 07ham.The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-7 & 8.

Table-7: Ground water Resources of Basnablock

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation for Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Mahasamund	Basna	12615.07	7468.0	418.47	7886.47	469.21	4677.86

Table-8: Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorization
Mahasamund	Basna	65.52	Safe

Categorisation: The Basna block falls in safe category. The stage of Ground water development is 65.52%. The Net Ground water availability is 12615.07. The Ground water draft for all uses is 7886.47 Ham. The Ground water resources for future uses for Basna Block is4677.86Ham.

Chemical Quality of Ground water and Contamination**:** Throughout the study area, the water quality (phreatic and semi-confined aquifer) is good and all the parameters are within permissible limit. In conclusion it may be said that the groundwater in the block is suitable for drinking as well as for irrigation purposes.

4. Ground Water Resource enhancement:

Aquifer wise space available for recharge and proposed interventions:

Table -9: Summarised detail of Volume of porous space available for recharge (Aquifer wise)

Formation	Area (sq.m)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (m^3)
Granite-gneiss	$115*10^6$	1.5	0.020	3.45×10^6
Basalt/ Amphibolite gneiss	$53*10^6$	1.5	0.020	1.59×10^6

5. Issues:

(i) The aquifer itself is a low yielding one due to which during summer, dugwells in almost all villages are dry except a few locations. Several handpumps also stop yielding water.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system.

6. Supply side interventions:

I. Basna block experienced drought situation in 2017 because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

II. It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken “Nal Jal Yojana” to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water.So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to teach people about the importance community participation in saving water.

III. Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also, Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.

IV. It has been observed that though the long-term trend lines are insignificant, still we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table-10.

Table-10: Types of ArtificialRecharge structures feasible

Name of Block	Area Feasible for recharge (sq.km)	Volume of Sub Surface Potential to be recharged through other methods (MCM)	Types of Structures Feasible and their Numbers			
			P	NB & CD	RS	G
Basna	168	4.20	13	46	72	100
	Recharge Capacity		2.52	0.42	0.76	0.50
	Estimated cost (Appx.)		Rs. 4.9 crore			

(iii) The practice of providing free electricity to operate irrigation borewells should be strictly monitored and put to an end in case of overconsumption. After a simple calculation it has been found that Rs 16000/ hectare is the expenses of electricity (@Rs. 2.5/unit) for paddy field. So, monitoring mechanism for electricity consumption should be strengthened for farmers taking summer rice. Even if farmers use solar pump or other method of ground water irrigation for summer paddy, it should not be flooding method. Proper pipes are to be used to transfer water from one plot to another.

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

7. Demand side interventions:

(i) Since the stage of development in the block is 65.52%. Change in cropping pattern & irrigation pattern can lead to groundwater savings, as per the following table:

Table 11: Detail of groundwater saved through change in cropping pattern

Block	Paddy cultivation area during Rabi season (ha)	Water required for cultivation (in m) per ha		Difference (m) per ha	Total saving of water (ham)	Existing gross groundwater draft for all uses in ham	Available resource (ham)	Improved status in Stage of groundwater development
		Paddy	Maize					
Basna	3956	0.9	0.5	0.4	1582.4	7886.47	12615.07	49.97

(ii) In command or non-command area wherever ground water has been used for field irrigation should be replaced with micro irrigation methods such as sprinklers, drip irrigation etc. which may save 30 to 40% ground water.

Table 12: Detail of groundwater saved through change in irrigation pattern

Block	Irrigated Crop Area Under Rabi 2016(Ha)	Water Required For cultivation ofPulses(M)	30 % Groundwater Saved Through Micro irrigation	Water Saved Through Microirrigation (Ham)
Basna	5354	0.3	0.3	481.86

Table 13: Probable sites for artificial recharge structures in Basna block

ID	Name	Block	AR Structure	ID	Name	Block	AR Structure
1	Mungadih	Basna	Percolation Tank	19	Bhanwarpur	Basna	Nala Bund/ Check Dam
2	Bhawarchuwa	Basna	Percolation Tank	20	Chandarpuri	Basna	Nala Bund/ Check Dam
3	Karnapali	Basna	Percolation Tank	21	Bhaisakhuri	Basna	Nala Bund/ Check Dam
4	Bhuneswarpur	Basna	Percolation Tank	22	Pitaipali	Basna	Recharge Shaft
5	Madhopali	Basna	Percolation Tank	23	Nawagaon	Basna	Recharge Shaft
6	Dhalan	Basna	Percolation Tank	24	Jagat	Basna	Recharge Shaft
7	Ghutikona	Basna	Percolation Tank	25	Bargaon	Basna	Recharge Shaft
8	Lalitpur	Basna	Percolation Tank	26	Bhuneswarpur	Basna	Recharge Shaft
9	Kusmur	Basna	Percolation Tank	27	Ghutikona	Basna	Recharge Shaft
10	Gayatripur	Basna	Percolation Tank	28	Gayatripur	Basna	Gabion Structure
11	Paserlewa	Basna	Percolation Tank	29	Rohina	Basna	Gabion Structure
12	Khogasa	Basna	Percolation Tank	30	Santpali	Basna	Gabion Structure
13	Rohina	Basna	Percolation Tank	31	Bhanwarpur	Basna	Gabion Structure
14	Jamnidih	Basna	Nala Bund/ Check Dam	32	Bhaisakhuri	Basna	Gabion Structure
15	Santpali	Basna	Nala Bund/ Check Dam	33	Nawagaon	Basna	Gabion Structure
16	Lohadipur	Basna	Nala Bund/ Check Dam	34	Jagat	Basna	Gabion Structure
17	Chipari Kona	Basna	Nala Bund/ Check Dam	35	Bargaon	Basna	Gabion Structure
18	Chapiya	Basna	Nala Bund/ Check Dam				

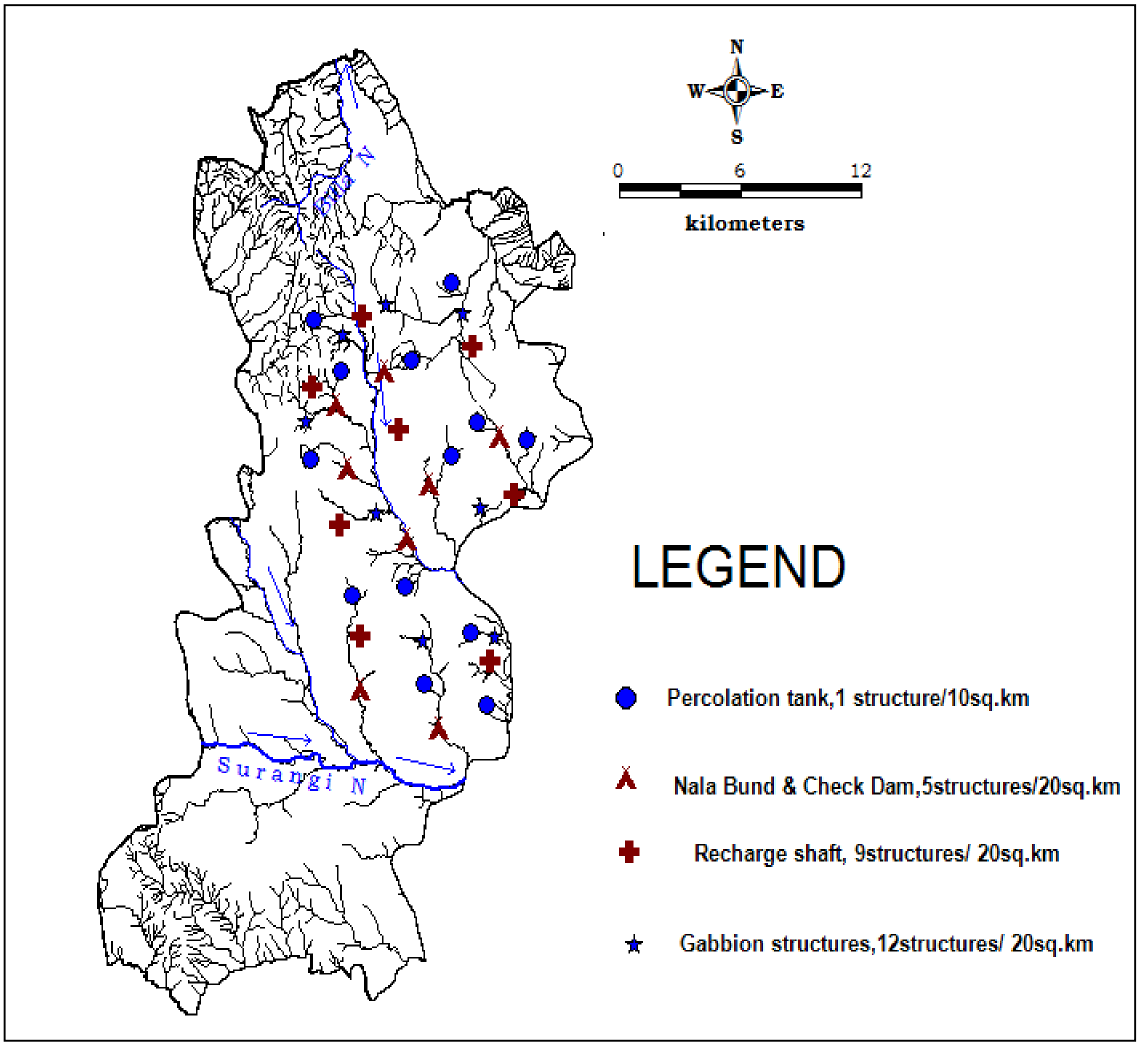


Figure 15: Map of proposed sites for artificial recharge of groundwater in Basna block

8. CONCLUSIONS:

An area of 901 sq.km of Basna block of Mahasamund district has been considered for Aquifer Mapping and Management Plans. The total G.W resource is 12615.07 Ham with stage of G.W development 65.52 % and categorized as “safe”. 83.03 % of the irrigated area is uses groundwater for irrigation. The major aquifer groupsareSonakhan Group amphibolite gneiss, basalt and Dongargarh Granite and Granite gneiss. In terms of Demand side management, by change in cropping and irrigation pattern (micro irrigation methods) 1582.4Ham and 481.86 Ham water can be saved respectively. In terms of Supply side management, by constructing artificial recharge structure 4.20 MCM water can be recharged.

AQUIFER MAPS AND MANAGEMENT PLANS
BAGBAHARA BLOCK, MAHASAMUND DISTRICT

1. Salient Information:

About the area: Bagbahara Block is situated in the southern part of Mahasamund district of Chhattisgarh and is bounded on the north and north-west by Mahasamund and Pithora block, in the south-west by Raipur district of Chhattisgarh, in the south by Gariaband district and in the west by Odisha state. The area lies between 20.83 and 21.12 N latitudes and 82.17 and 82.62 E longitudes. The geographical extension of the study area is 1379 sq.km representing around 27 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Jonknala, flowing northwards forms the western most limit of the block separating Chhattisgarh and Odisha state. Keshwainala, Kurarnala both flowing north-westward are a part of Mahanadi basin. Baaghnainala flowing north-west is also tributary of Mahanadi river. Drainage map shown in Fig.3.

Population: The total population of Bagbahara block as per 2011 Census is193359out of which rural population is 173830while the urban population is 19529.The population break up i.e. male- female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Bagbahara	193359	95401	97958	173830	19529

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 23.98 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015)1369.84 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Bagbahara block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Annual rainfall	1376.20	1434.20	1242.70	1719.20	1076.90

Source: IMD

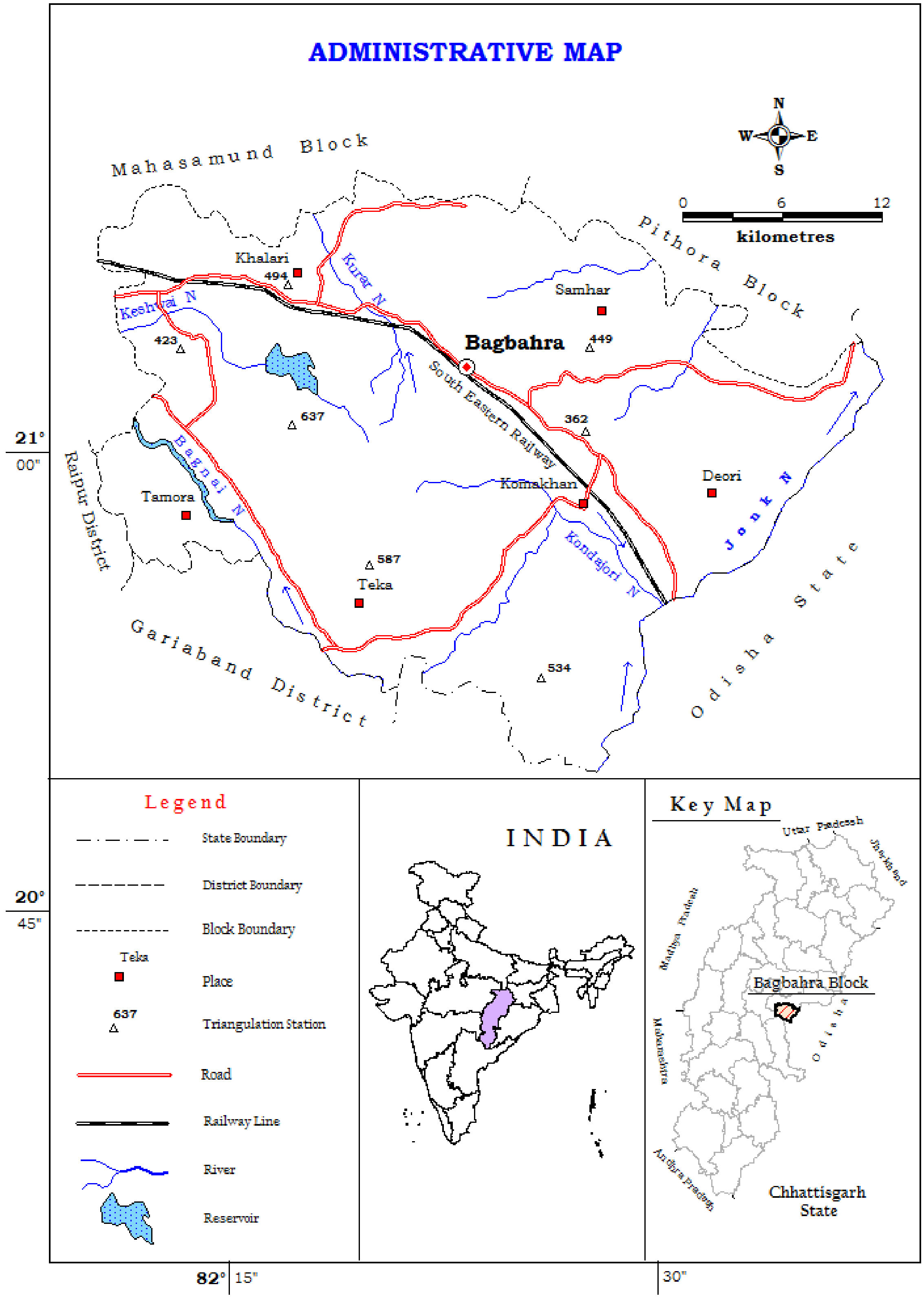


Figure: 1 Administrative Map of Bagbahara Block

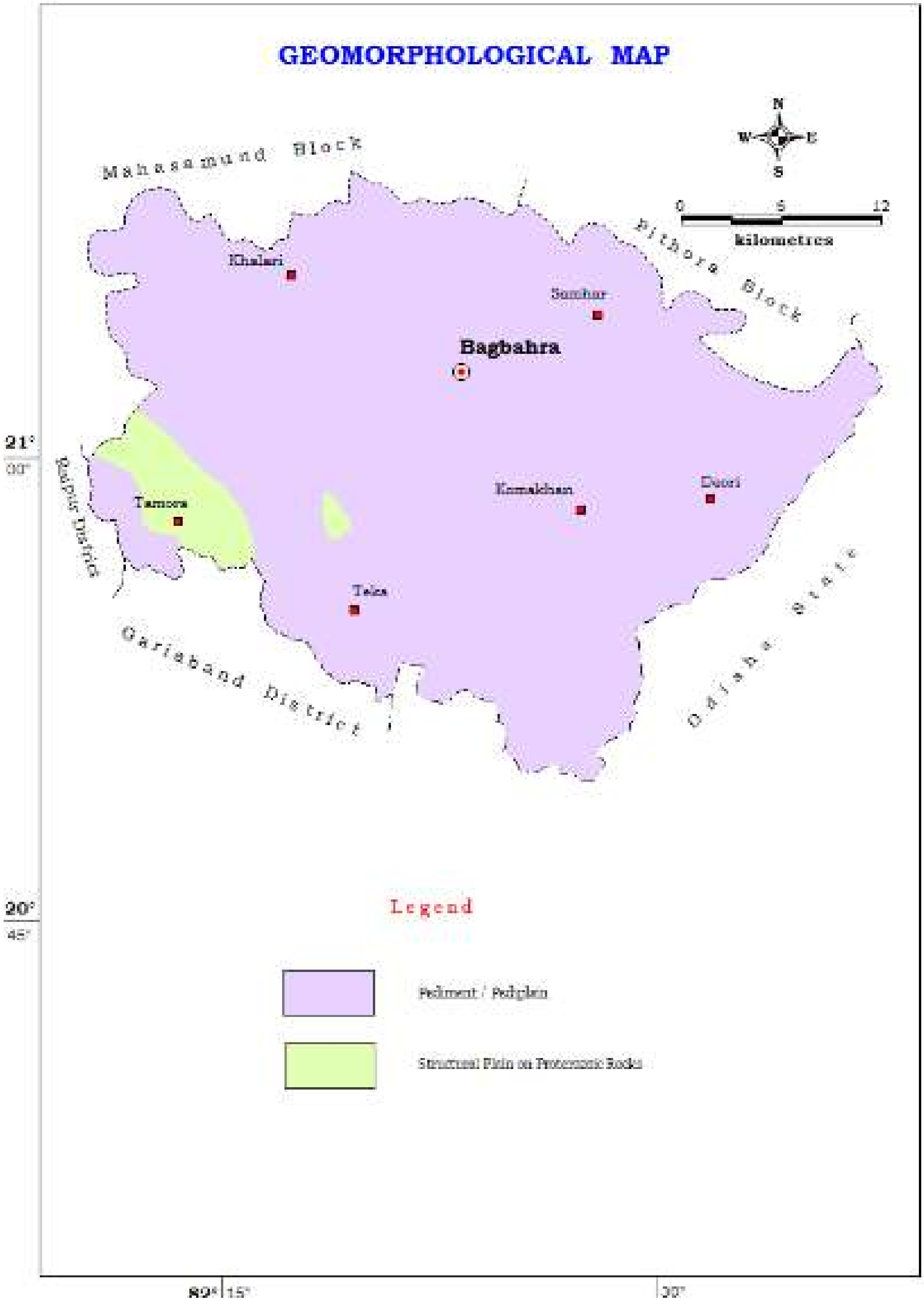


Figure 2: Geomorphology Map of Bagbahara Block

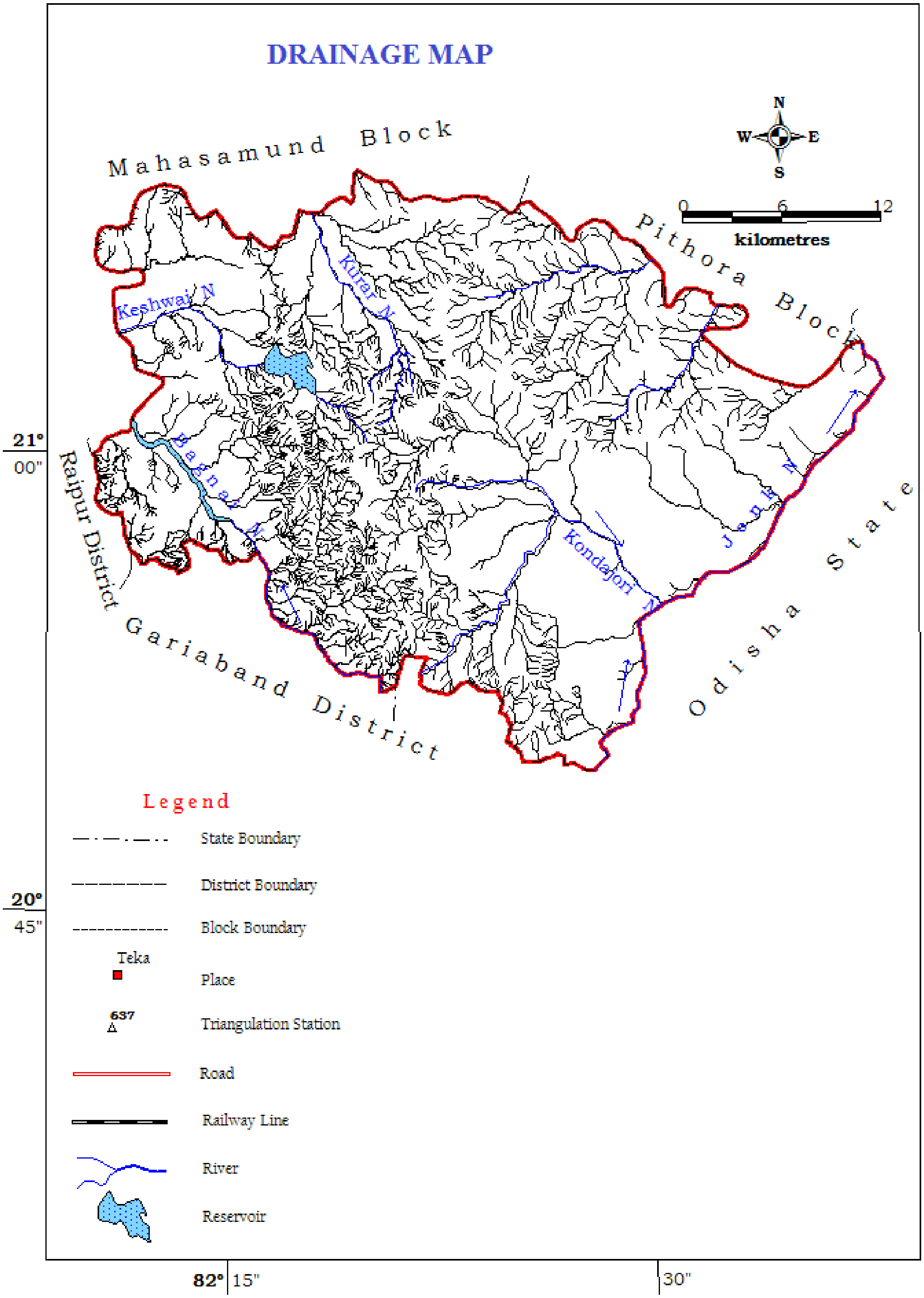


Figure 3: Drainage Map of Bagbahara Block

Agriculture and Irrigation**:** Agriculture is practiced in the area during kharifand Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are Paddy, Wheat and pulses. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Bagbaharablock is given in Table 3 (A, B, C, D, E).

Table 3 (A): Agricultural pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Bagbahara	137900	38554	10624	55309	6183	61429

Table 3 (B): Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Nonagricultural& Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Bagbahara	137900	38554	10624	2413	9269	55309	6183	61429

Table 3 (C): Cropping pattern (in ha)

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar& Maize	Others						
Bagbahara	55309	6171	92	55614	13	16	4065	846	680	nil	93	1

Table 3 (D): Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No. of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigate d area	Irrigated area by other sources	Net Irri-gated area	Gross irrigat ed area	% of irrigated area wrt. Net sown area
32	7776	2757	10778	932	400	626	826	934	15657	20714	34 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Bagbahara	15657	10778	68.84

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Bagbahara block upto 200 m depth is given in the table-4.

Table – 4: Ground Water Resources of Bagbahara block in Ham

Block	**Dongargarh granite and gneiss**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Bagbahara	14311.47	6370.98	551.6	**21234.05**

Existing and Future Water Demand (2025)*:* The existing demand for irrigation in the area is 5780 Ham while the same for domestic and industrial field is 428.93 Ham. To meet the future demand for ground water, a total quantity of 8070.48 ham of ground water is available for future use.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in Bagbaharablock, dugwellsdry up in phreaticgranite-gneiss. In deeper fractured granite-gneiss, the maximum water level is 24.17mbgl, the average water level is 12.31mbgl.

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

Block Name	PhreaticGranite-gneiss		
	Min	Max	Avg
Bagbahara	5.16	8.51	7.09

Water Level (in mbgl)

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

Block Name	Fractured Granite-gneiss		
	Min	Max	Avg
Bagbahara	5.3	24.17	12.31

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 2.33 to 6.81mbgl with an average of 4.56mbglin phreatic granitic gneiss area. Infracturedformation, the post monsoon water level variation range is 3.08 to 7.16mbgl with average of 4.85mbgl.

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

Block Name	Phreatic Granite-gneiss		
	Min	Max	Avg
Bagbahara	2.33	6.81	4.56

Water Level (in mbgl)

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

Block Name	Fractured Granite-gneiss		
	Min	Max	Avg
Bagbahara	3.08	7.16	4.85

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Bagbaharablock, water level fluctuationin phreaticgranitic gneissvaries from 0.92 to 10.65 m with an average fluctuation of 6.25 m. Water level fluctuationin fracturedgranite gneissvaries from 2.54 to 7.52 m with an average fluctuation of 4.79 m.

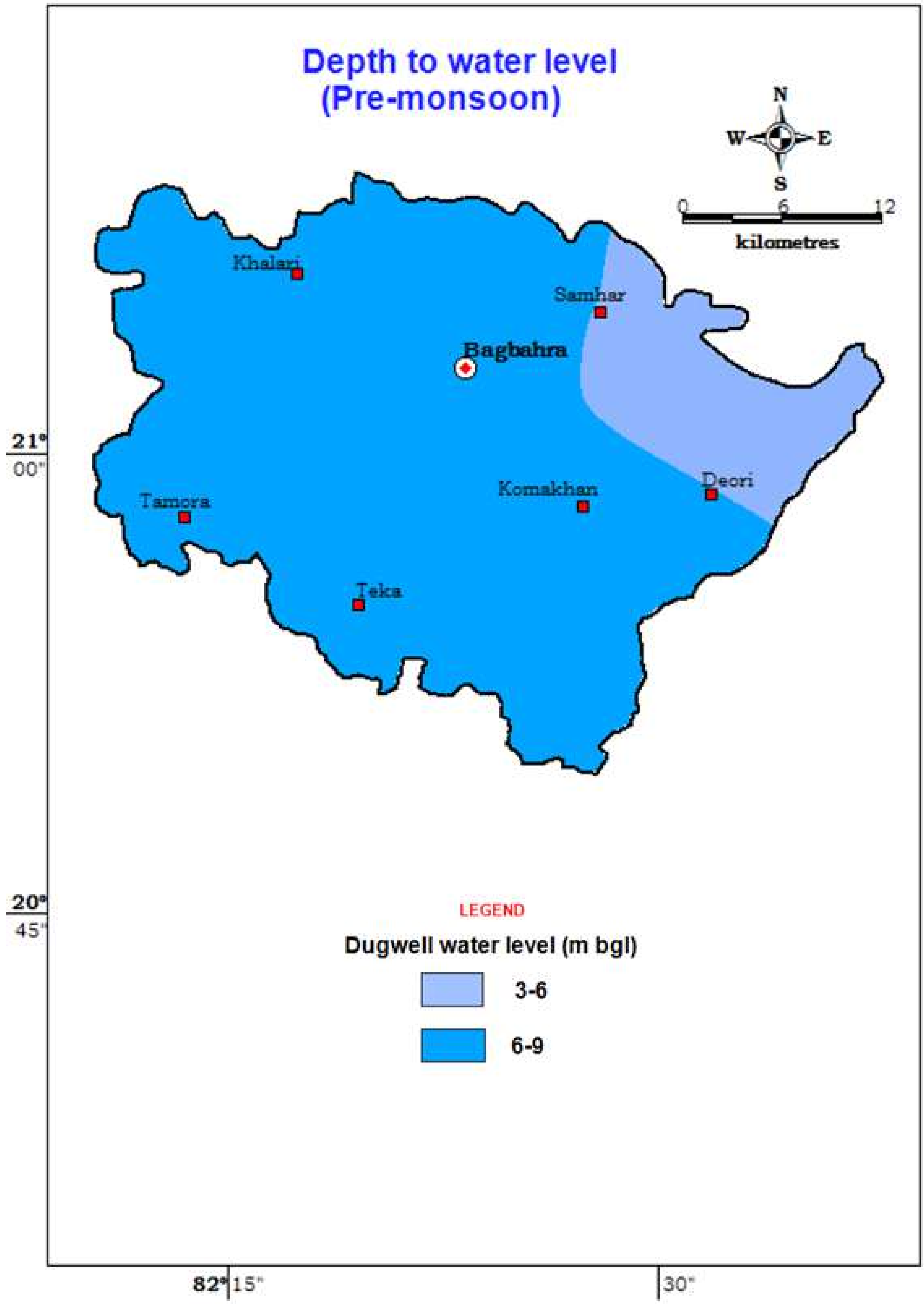


Figure-4: Depth to water level map Phreatic Aquifer (Pre-monsoon)

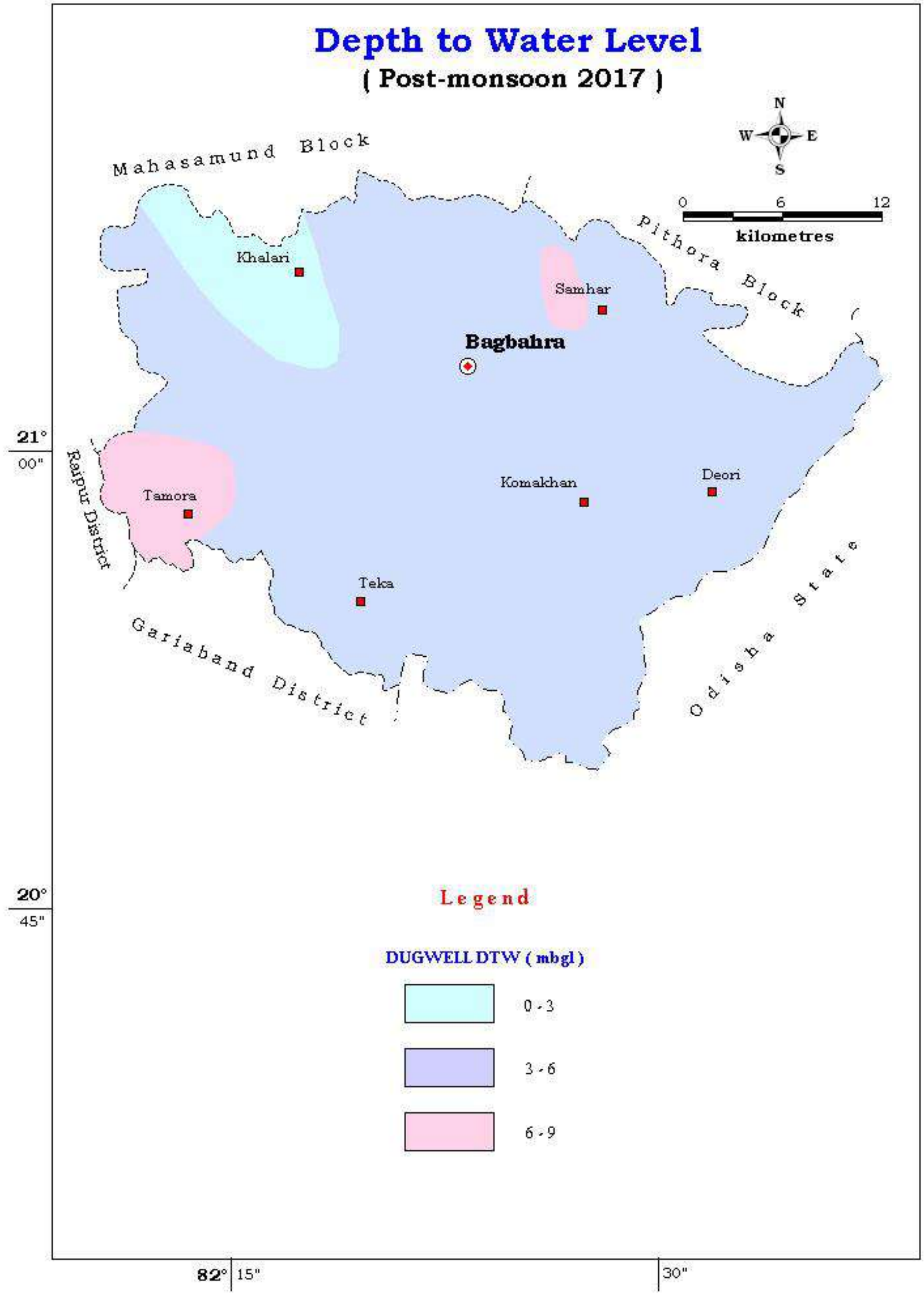


Figure 5: Depth to water level map Phreatic Aquifer (Post-monsoon)

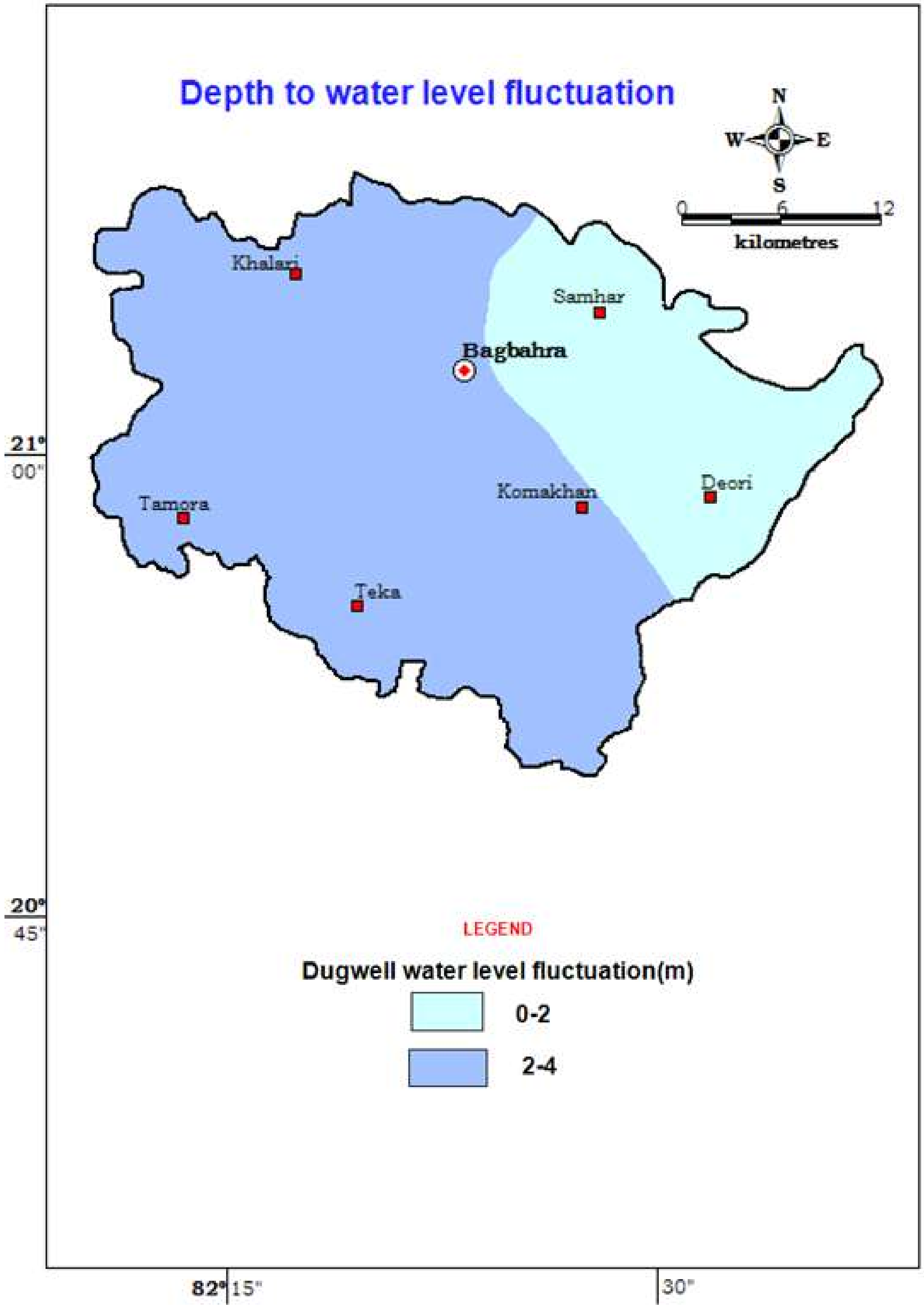


Figure 6: Depth to water level fluctuation map of Phreatic Aquifer

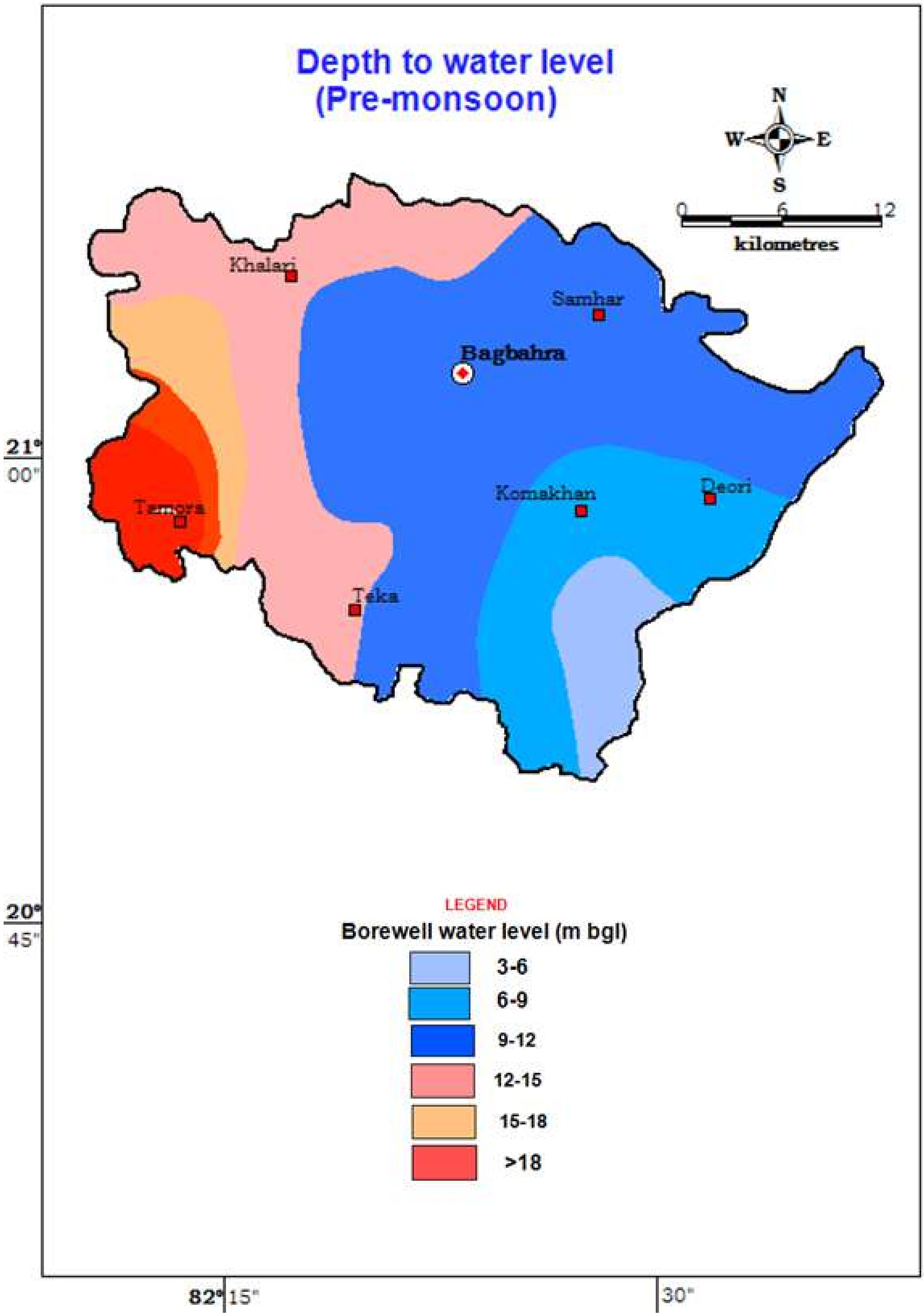


Figure-7: Depth to water level map Fractured Aquifer (Pre-monsoon)

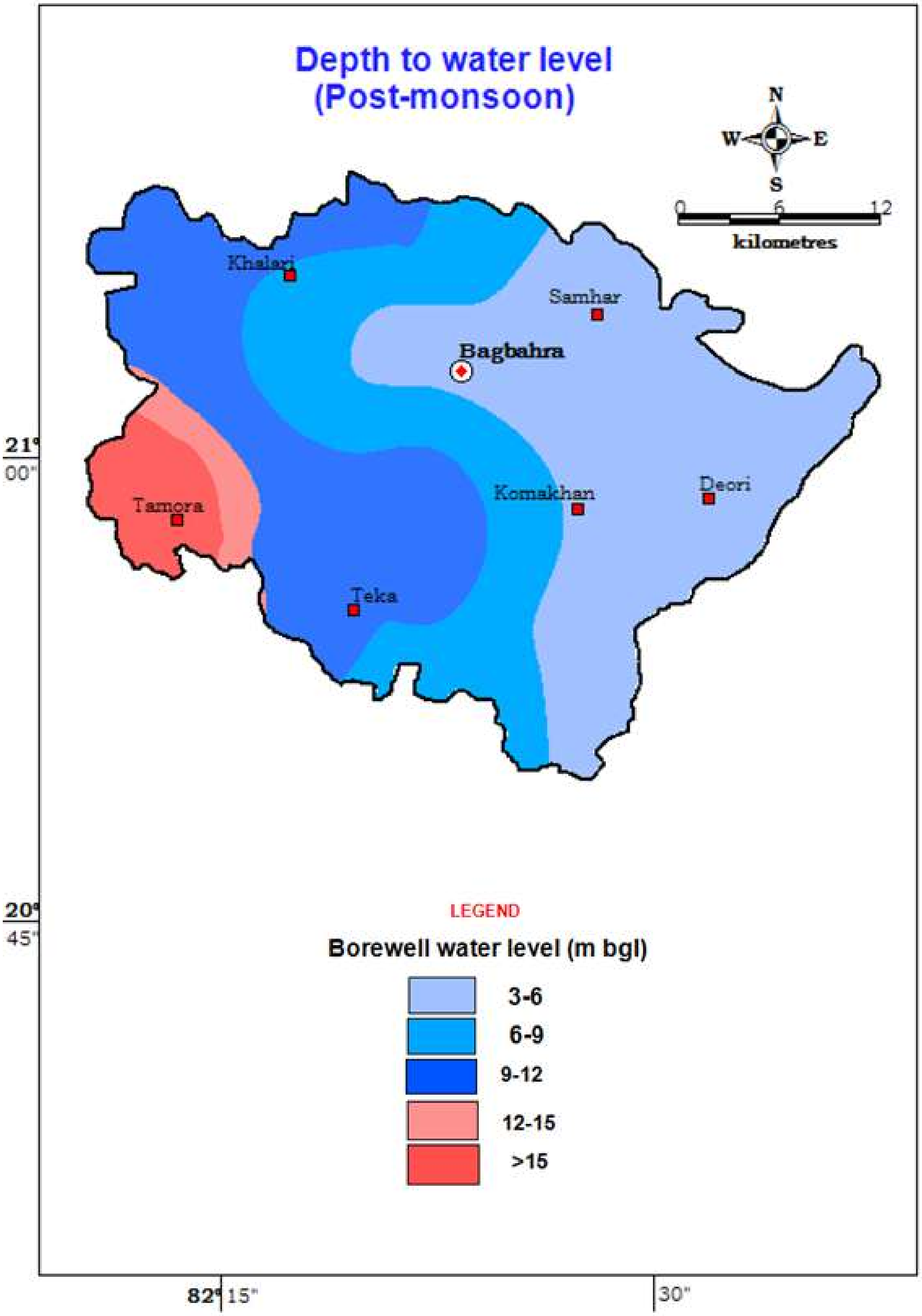


Figure-8: Depth to water level map Fractured Aquifer (Post-monsoon)

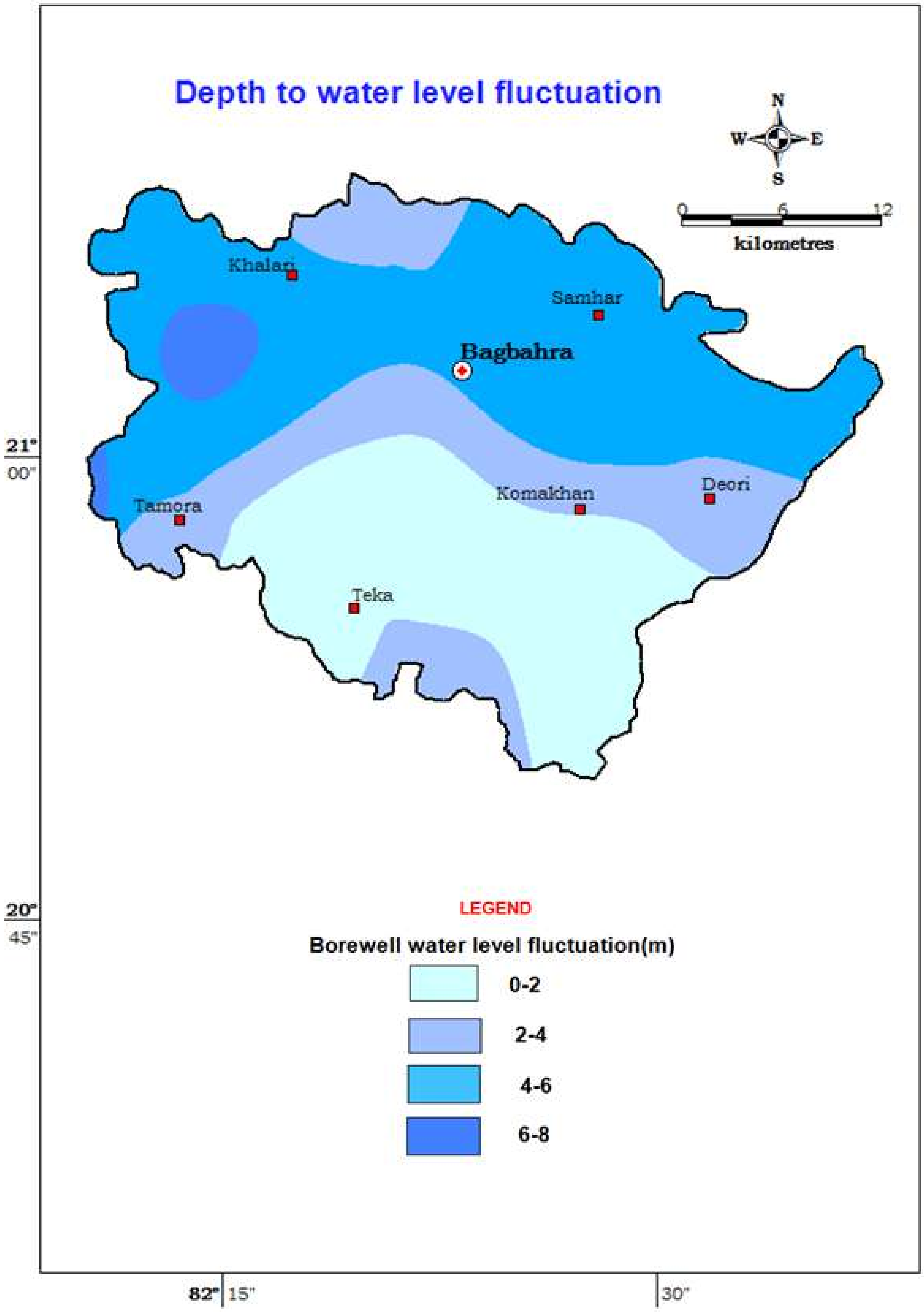


Figure 9: Depth to water level fluctuation map of Fractured Aquifer

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic Granite-gneiss		
	Min	Max	Avg
Bagbahara	0.92	10.65	6.25

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Fractured Granite-gneiss		
	Min	Max	Avg
Bagbahara	2.54	7.52	4.79

(iv) <u>The long term water level trend</u>: It indicates that there is no significant decline in water level in pre-monsoon as well as post-mosoon period.

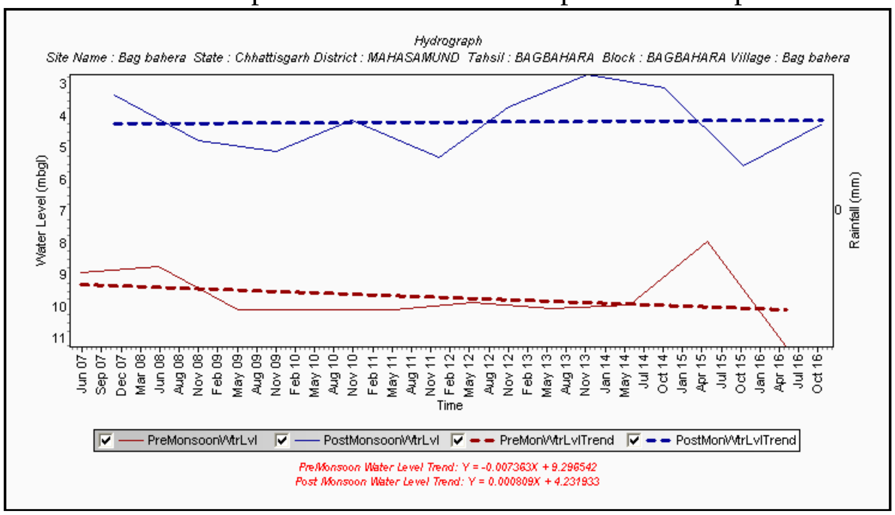


Figure 10: Hydrograph of Bagbaharatown, Bagbahara block

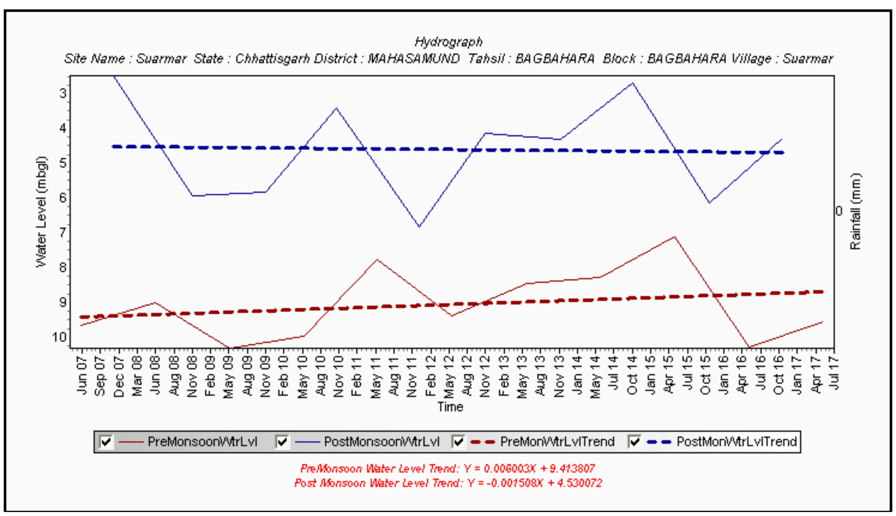


Figure 11: Hydrograph of Suarmar village, Bagbahara block

2. Aquifer Disposition:

Number of Aquifers: There isone major aquiferviz. Dongargarh granite and granitic gneiss, which in phreatic and fractured condition serves as major aquifer system in the block. There is also Bengpal group granitic gneiss, but it is minor. Entire granite and granitic gneiss is treated as single hydrostatic unit since it is not possible to differentiate them on the basis of hydrogeological characteristics.

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

(B) Geology: Geologically the block exhibits lithology of Meso to Neo Proterozoic agedominated by Dongargarh granite and granitic gneiss.

(iii)The Gneissic Complex of Archean to Proterozoic age consists of granite gneiss and granitoids, containing enclaves of metasedimentary and meta-igneous suites comprising schists, quartzites, amphibolites and dolomitic marbles. The unclassified metamorphics are composed of quartzites, mica schists, dolomitic marbles, phyllites and biotite chlorite schists (occasionally associated with quartzite bands). All these rocks are intruded by metabasic bodies/dykes and quartz and pegmatite veins. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 18 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present from 60 to 100 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The The development in these formations is mostly by way of dug wells. The transmisiivity of the formation is around 6 m^2 per day with an average drawdown of 27 m. The thickness of fractured aquifer is around 2 m.

Table 6: Distribution of Principal Aquifer Systems in Bagbahara

Block	Phreaticand fractured granite gneiss	%
Bagbahara	1379	100

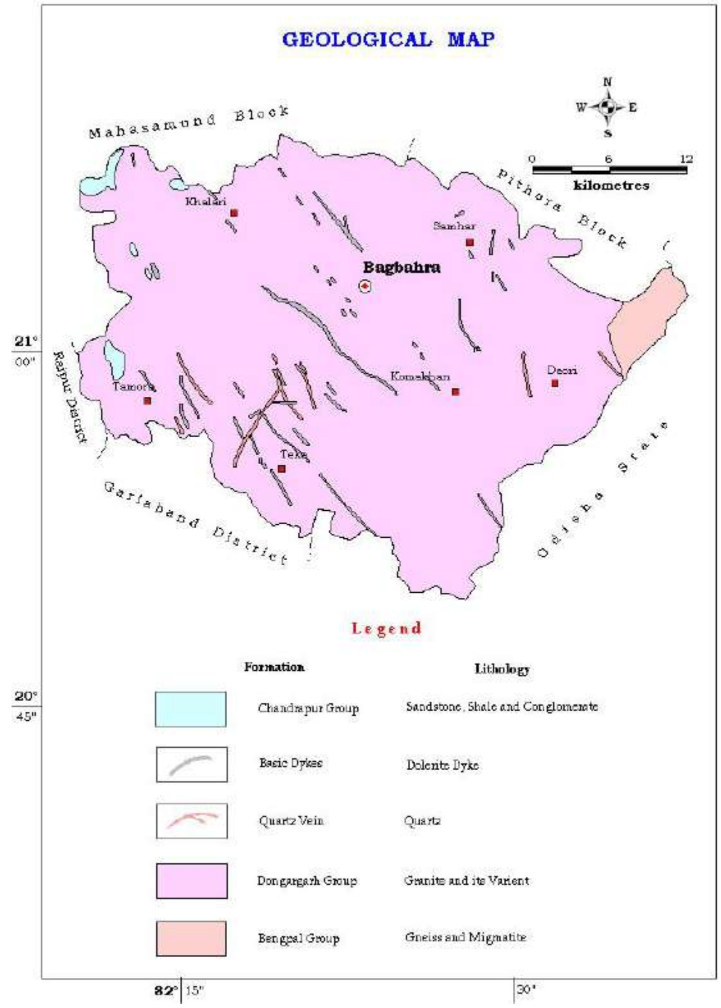


Figure 12: Aquifer map of Bagbahara block

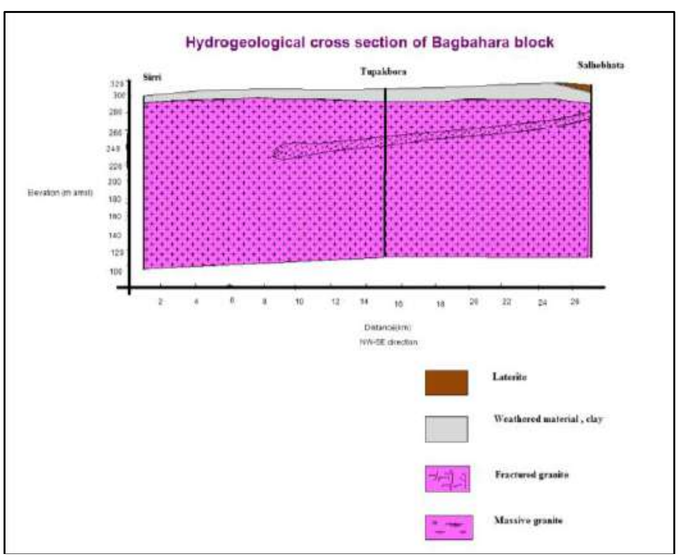


Figure-13: Hydrogeological Cross Section, Bagbahara Block

3. Ground water Resource, extraction, contamination and other issues:

Aquifer wise resource availability is given in the table -4 where the total resource available in Bagbahara block is 14311. 47ham.The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-7 & 8.

Table-7: Ground water Resources of Bagbaharablock

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation for Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Mahasamund	Bagbahara	14311.47	5780.00	428.93	6208.93	460.99	8070.48

Table 8Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorisation
Mahasamund	Bagbahara	43.38	Safe

Categorisation: TheBagbahara block falls in safe category. The stage of Ground water development is 43.38%. The Net Ground water availability is 14311.47. The Ground water draft for all uses is 6208.93 Ham. The Ground water resources for future uses for Bagbahara Block is8070.48Ham.

Chemical Quality of Ground water and Contamination**:** Throughout the study area, the water quality is suitable for irrigation purposes. At several locations there is fluoride contamination in groundwater of shallow aquifer.

location	Concentration of Fluoride
Borrabandha	1.6
Teka	2.4
Hathibahra	2.7
Keshwa	3.2
Khallari	3.2
Suarmar	1.9

4. Ground Water Resource enhancement:

Aquifer wise space available for recharge and proposed interventions:

The Volume of porous space available for recharge (m^3) in the unsaturated zone of granite-gneiss is 32.19x 10^6 m^3 assuming the specific yield of granite-gneiss as 0.020, considering the void space depthi.e. the desirable thickness of unsaturated zone as 1.5 m and 4.5m (not considering the top 3m of the average post-monsoon water level) and the area is 945 sq. km. This is summarized in Table 9.

Table -9: Summarised detail of Volume of porous space available for recharge (Aquifer wise)

Formation	Area (sq.m)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (m^3)
Granite-gneiss	945×10^6	1.5,4.5	0.020	32.19×10^6

5. Issues:

(i) During summer, dugwells in almost all villages are dry except a few locations. Several handpumps also stop yielding water. The aquifer itself is a low yielding one.

(ii) Low stage of ground water development in block.

(iii) Fluoride contamination in groundwater.

6. Supply side interventions:

(i) Bagbahara block experiences drought like situation because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken “Nal Jal Yojana” to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water. So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to understand people about the importance community participation in saving water.

(iii) De-siltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.

(iv) In command or non-command area wherever ground water has been used for field irrigation of pulses and vegetables should be replaced with micro irrigation methods such as sprinklers, drip irrigation etc which can save upto 289.17Ham water in Bagbahara block.

(v) It has been observed that though the long-term trend lines are insignificant, still we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table-10.

Table-10: Types of ArtificialRecharge structures feasible

Name of Block	**Area Feasible for recharge (sq.km)**	**Volume of Sub Surface Potential to be recharged through other methods (MCM)**	**Types of Structures Feasible and their Numbers**			
			P	**NB & CD**	**RS**	**G**
Bagbahara	945	32.19	107.3	356.236	643.8	858.4
	Recharge Capacity		21.46	3.56236	6.438	4.292

(vi) The practice of providing free electricity to operate irrigation borewells should be strictly monitored and put to an end in case of overconsumption. After a simple calculation it has been found that Rs 16000/ hectare is the expenses of electricity (@Rs. 2.5/unit) for paddy field. So, monitoring mechanism for electricity consumption should be strengthened for farmers taking summer rice. Even if farmers use solar pump or other method of ground water irrigation for summer paddy, it should not be flooding method. Proper pipes are to be used to transfer water from one plot to another.

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

(viii) Since the stage of development in the block is only 43.38 %. So, there is ample scope of development. In order to achieve 60% stage of ground water withdrawal in theblock, development may be taken up as per the following table:

Table-11**:** Nos of structures recommended for further development

Block	Total Annual Replenishable Groundwater Resources (ham)	Stage of ground water Development (%)	Volume of ground water required to achieve 60% Withdrawal for block (ham)	Surplus ground water at present Stage of Development (ham)	No of TW Recommended in the block (Assuming unit draft as 2 ham/structure/year)
Bagbahara	15156.06	43.38	8586.88	2377.95	1189

(ix) Fluoride removing filters or plants may be set up at appropriate locations.

(x) Furthermore, in order to strike a balance between the ground water draft and the available resource, suitable artificial structures at appropriate locations be constructed through successive phases after tentatively every 20 no.s of groundwater abstraction structures become operative.

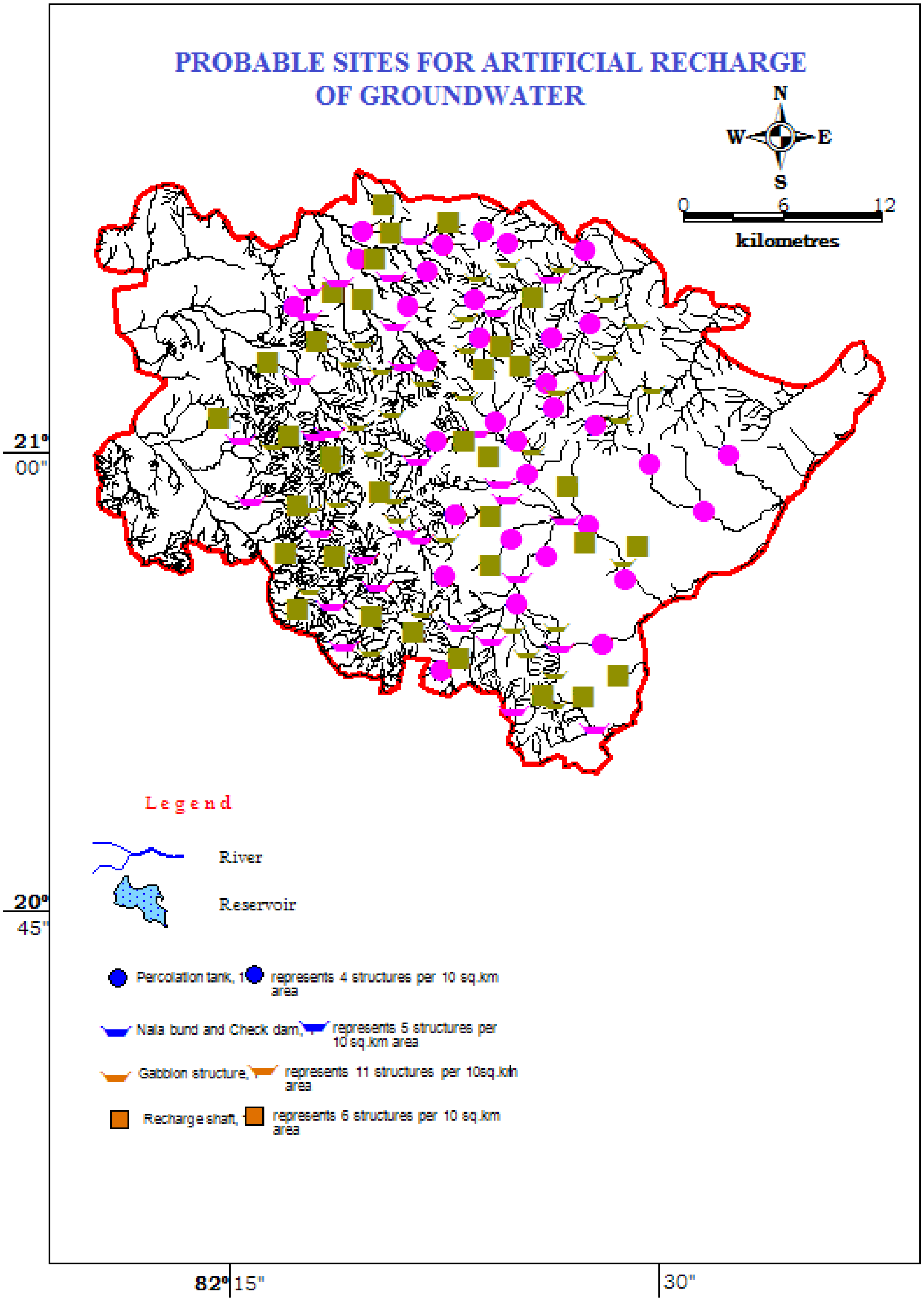


Figure 14: Map of proposed sites for artificial recharge of groundwater in Bagbahara block

7. CONCLUSIONS:

An area of 1379 sq.km of Bagbahara block of Mahasamund district has been considered for Aquifer Mapping and Management Plans. The total g.w resource is 14311.47 Ham with stage of g.w development 43.38 % and categorized as “safe”. 68.84 % of the irrigated area is uses groundwater for irrigation. Most of the ground water development has been concentrated in western part of the block and water level is deeper in south western region. The major aquifer group is Dongargarh Granite and Granite gneiss. In terms of Demand side management, by change in irrigation pattern (micro irrigation methods) 289.17 Ham water can be saved In terms of Supply side management, by constructing artificial recharge structure 32.19 MCM water can be recharged and constructing of tubewell at suitable locations, drinking water needs may be fulfilled. The block is also affected by geogenic Fluoride contamination of groundwater. So proper fluoride removal plants in those particular villages and public awareness is necessary.

AQUIFER MAPS AND MANAGEMENT PLANS
SARAIPALI BLOCK, MAHASAMUND DISTRICT

1. Salient Information:

About the area: Saraipali Block is situated in the easternmost part of Mahasamund district of Chhattisgarh and is bounded on the north by Raigarhdistrict, in the west by Basna block of Chhattisgarh, in the east and in the south by Odisha state. The area lies between 21.10 and 21.48 N latitudes and 82.88 and 83.28 E longitudes. The geographical extension of the study area is 870 sq.km, representing around 17 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Geomorphology comprises of pediment and pediplains in the central and south-western part, denudational hills and slopes in the northern and eastern part. Geomorphology map shown in Figure 2. Suranginala flowingeastwards is a tributary of Ong riverand Lath nala, Kholtinala flowing northwards is a tributary of Mahanadi river. Drainage map shown in Fig.3.

Population: The total population of Saraipali block as per 2011 Census is194997out of which rural population is 174954while the urban population is 20043.The population break up i.e. male- female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Saraipali	194997	97189	97808	174954	20043

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 25.76 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015)1380.92 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Saraipali block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Annual rainfall	1176.80	1378.70	1407.40	971.20	1970.50

Source: IMD

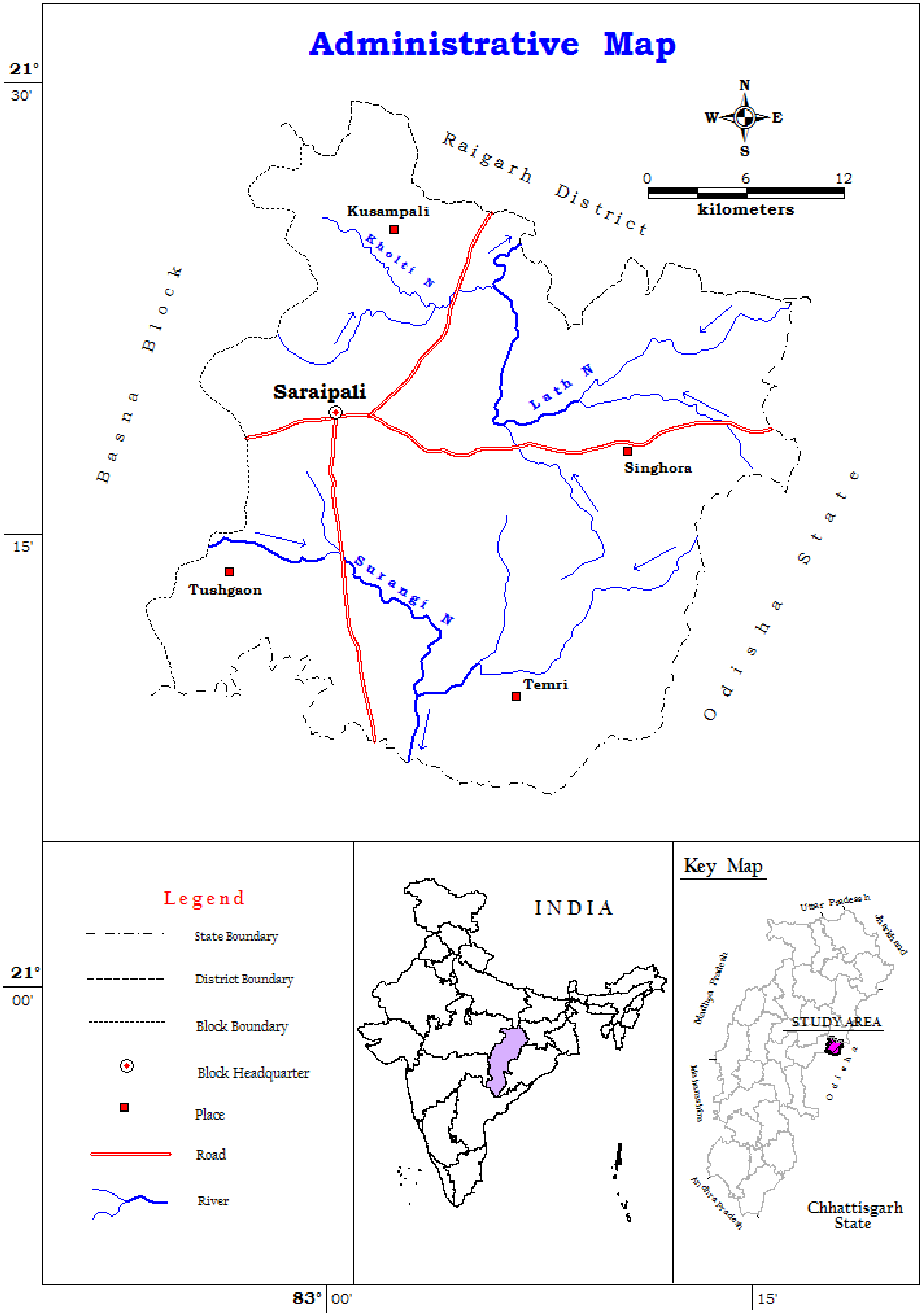


Figure: 1 Administrative Map of Saraipali Block

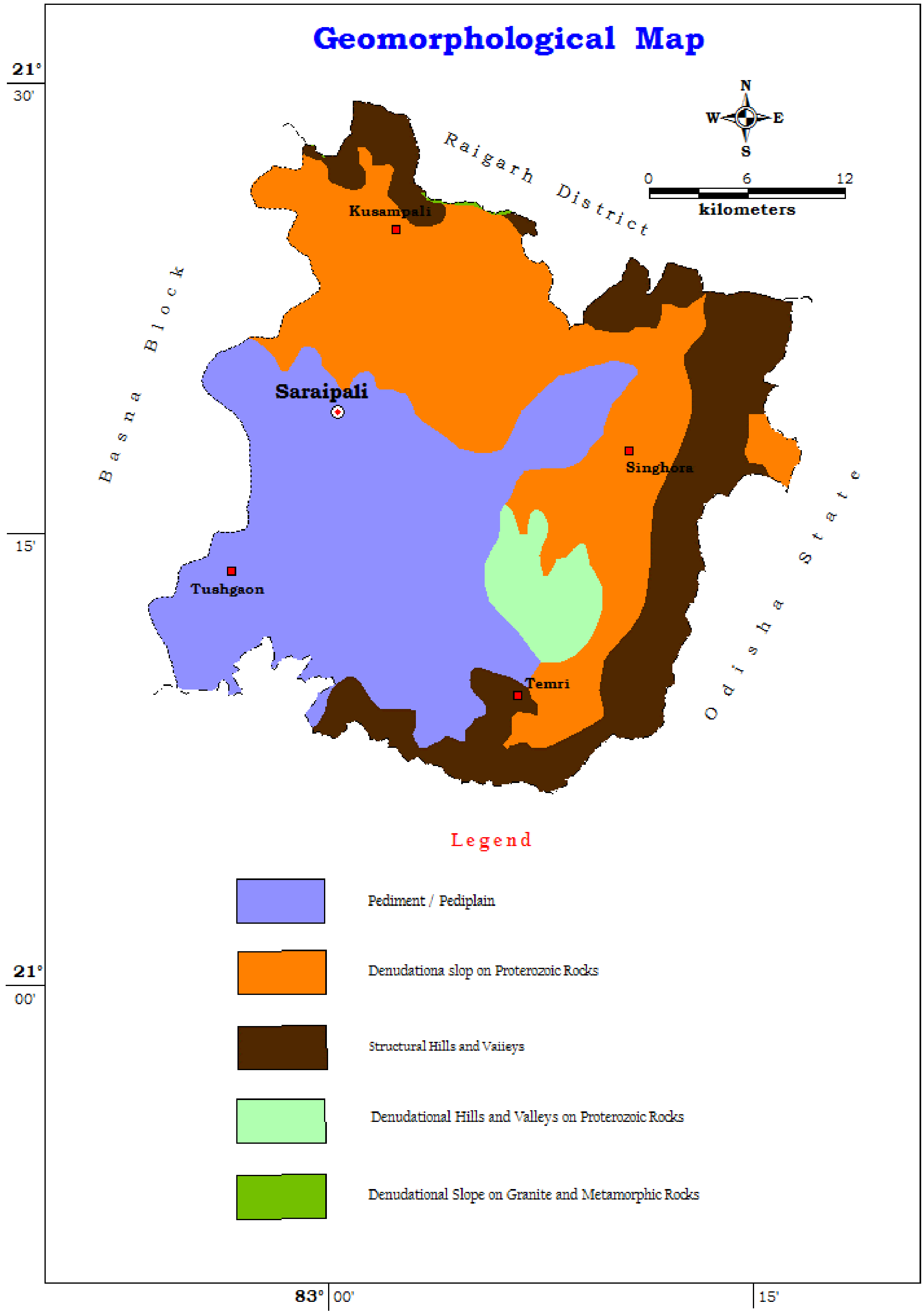


Figure 2: Geomorphology Map of Saraipali Block

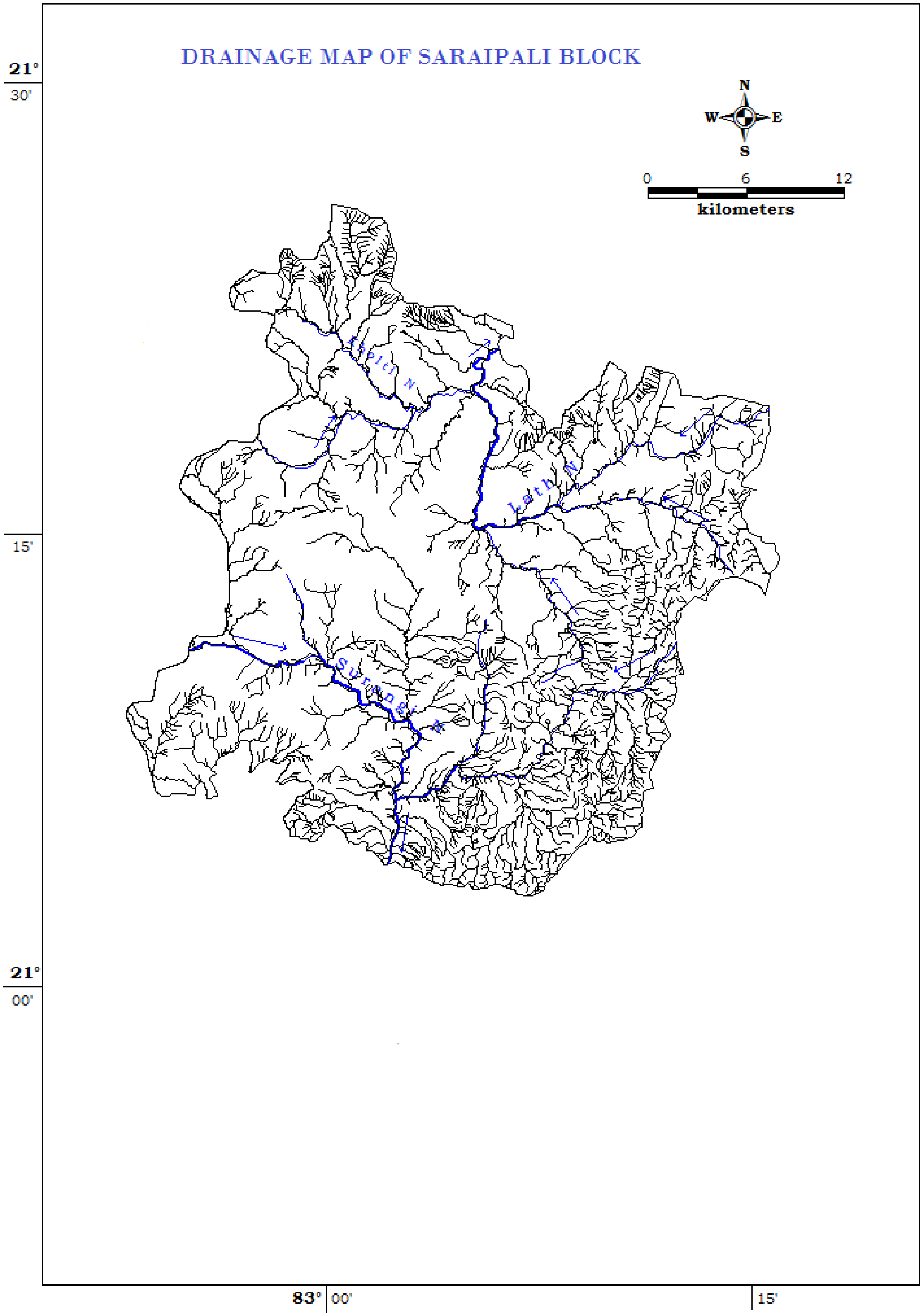


Figure 3: Drainage Map of Saraipali Block

Agriculture and Irrigation**:** Agriculture is practiced in the area during Kharifand Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are Paddy, Wheat, pulsesand vegetables.

In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Saraipaliblock is given in Table 3 (A, B, C, D, E).

Table 3 (A): Agricultural pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Saraipali	87000	29697	8232	53015	5215	58230

Table 3 (B): Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non-agricultural& Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Saraipali	87000	29697	8232	7556	1292	53015	5215	58230

Table 3 (C): Cropping pattern (in ha)

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Resh	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar& Maize	Others						
Saraipali	53013	5217	600	51411	154	0	3800	2096	564	48	88	10

Table 3 (D): Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	Irrigated area	No. of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri-gated area	Gross irrigated area	% of irrigated area wrt. Net sown area
21	2973	2810	8046	92	17	919	1892	4076	15522	17004	29 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Saraipali	15522	8063	51.9

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Saraipali block upto 200 m depth is given in the table-4.

Table – 4: Ground Water Resources of Saraipali block in Ham

Block	**Dongargarh granite and gneiss**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Saraipali	1291.46	275.31	13.32	**1580.09**

Block	**Calcareous shale**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Saraipali	5835.86	1244.07	60.1	**7140.03**

Block	**Sandstone**			
	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Saraipali	1310.88	279.45	13.52	**1603.85**

Existing and Future Water Demand (2025)*:* The existing demand for irrigation in the area is 2853.0 Ham while the same for domestic and industrial field is 432.62 Ham. To meet the future demand for ground water, a total quantity of 5585.21 ham of ground water is available for future use.

Water Level Behaviour: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that the water level varies from 3.2 to 16.78 mbgl with an average of 7.75 mbglin phreatic aquifer. In fracturedformation, the pre monsoon water level variation range is 4.24 to 25.6 mbgl with average of 15.34 mbgl.

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

Block Name	Phreatic		
	Min	Max	Avg
Saraipali	3.2	16.78	7.75

Water Level (in mbgl)

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

Block Name	Fractured		
	Min	Max	Avg
Saraipali	4.24	25.6	15.34

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 1.4 to 5.43 mbgl with an average of 3.42 mbglin phreatic aquifer. In fractured formation, the post monsoon water level variation range is 4.13 to 21.32 mbgl with average of 10.68 mbgl.

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

Block Name	Phreatic		
	Min	Max	Avg
Saraipali	1.4	5.43	3.42

Water Level (in mbgl)

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

Block Name	Fractured		
	Min	Max	Avg
Saraipali	4.13	21.32	10.68

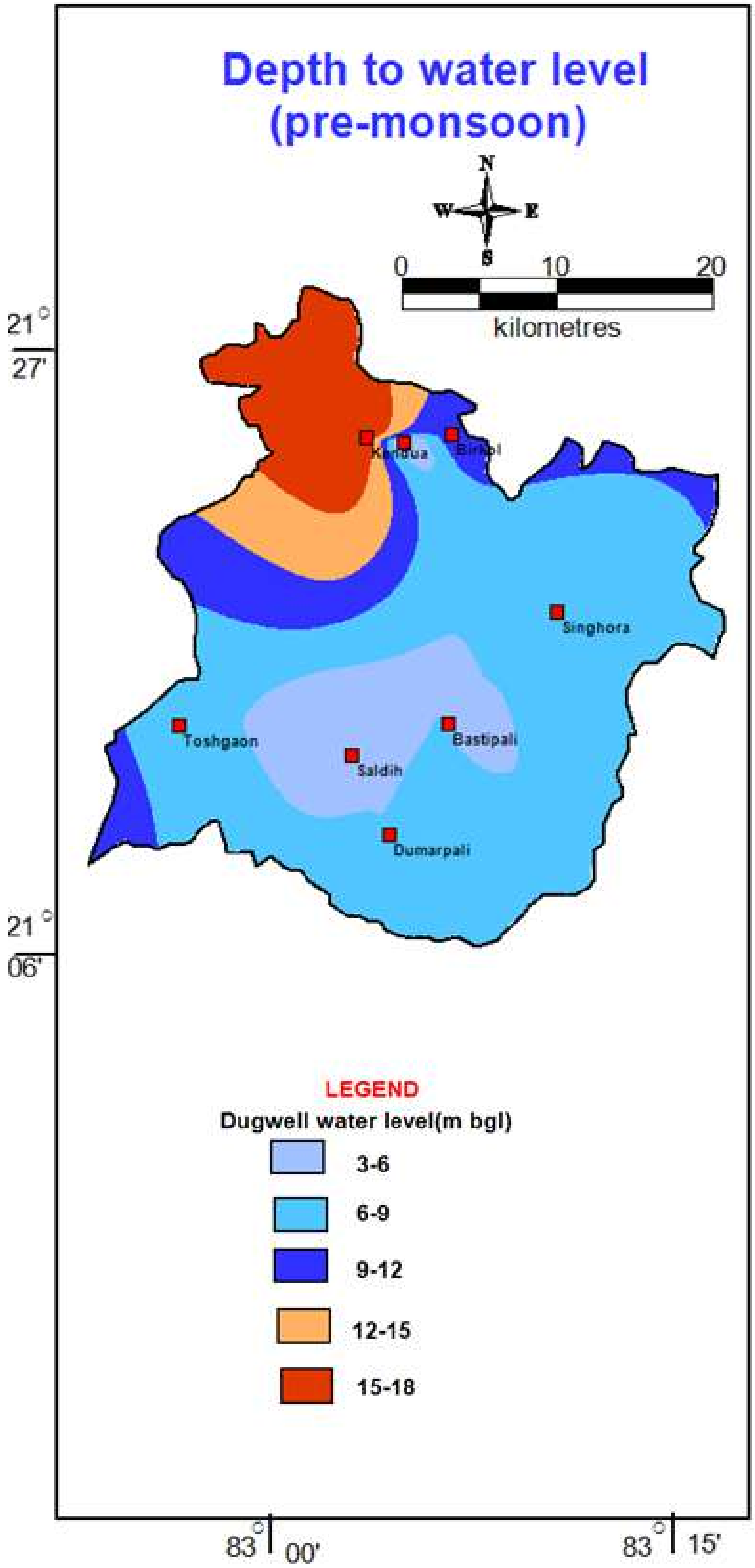


Figure-4: Depth to water level map Phreatic Aquifer (Pre-monsoon)

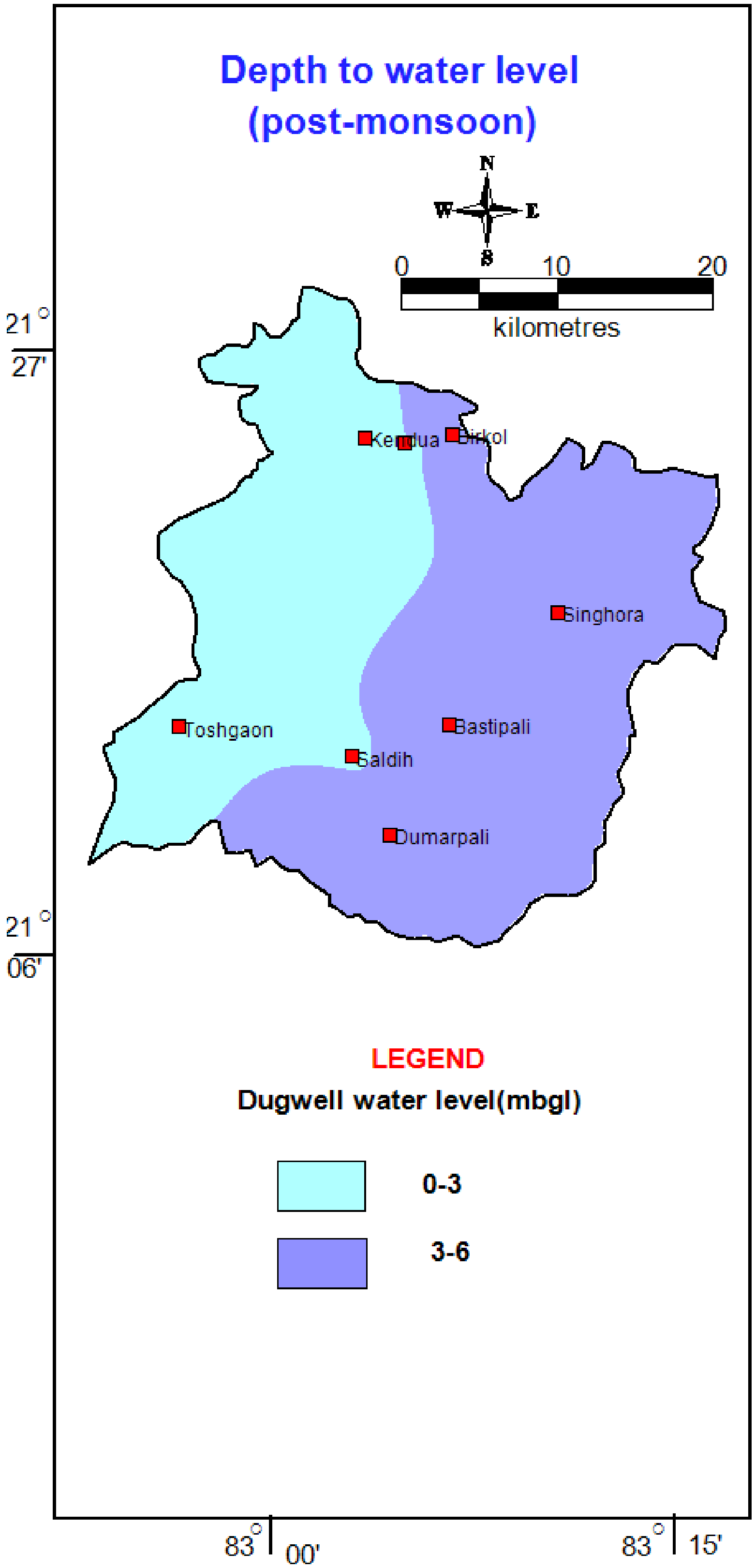


Figure 5: Depth to water level map Phreatic Aquifer (Post-monsoon)

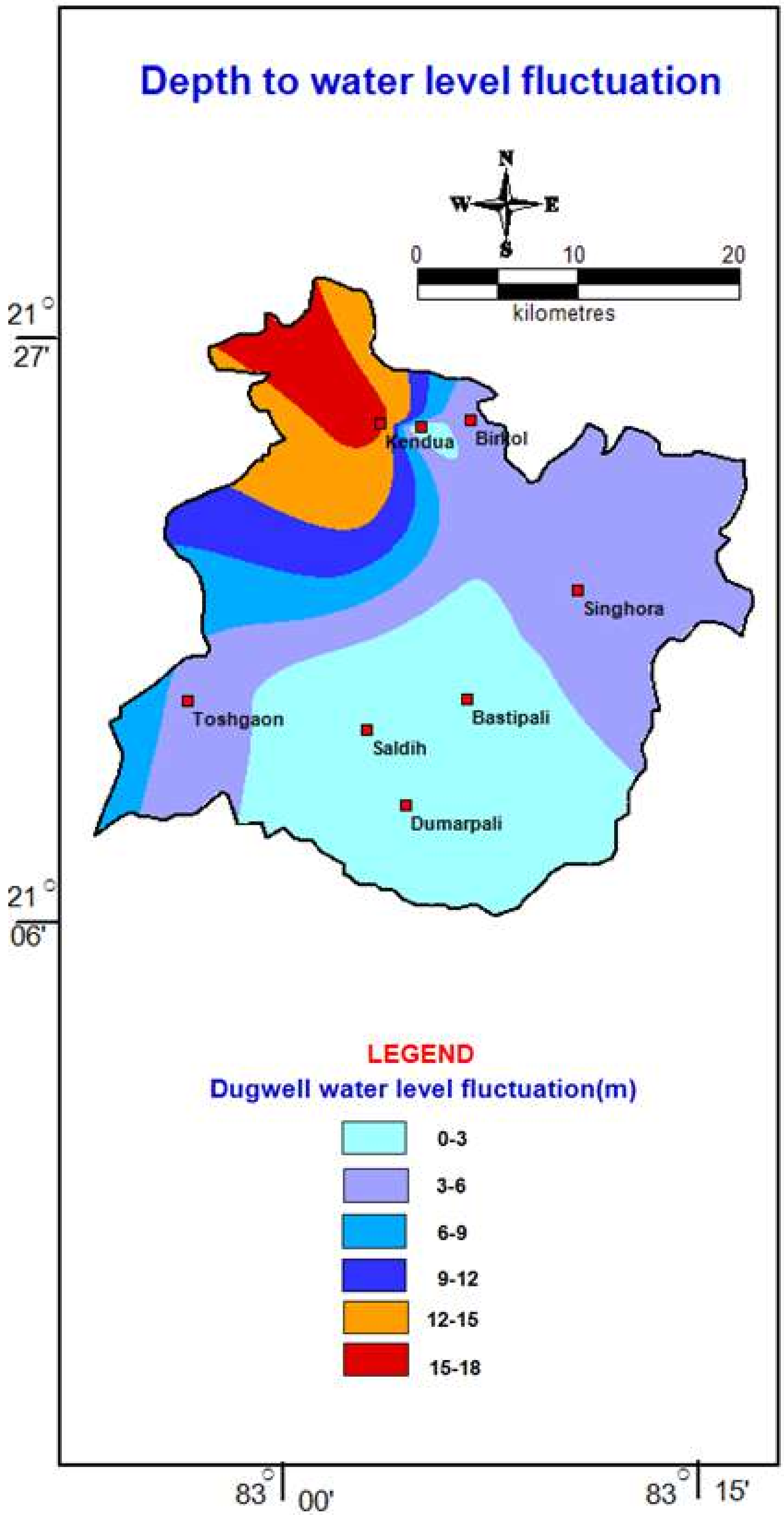


Figure 6: Depth to water level fluctuation map of Phreatic Aquifer

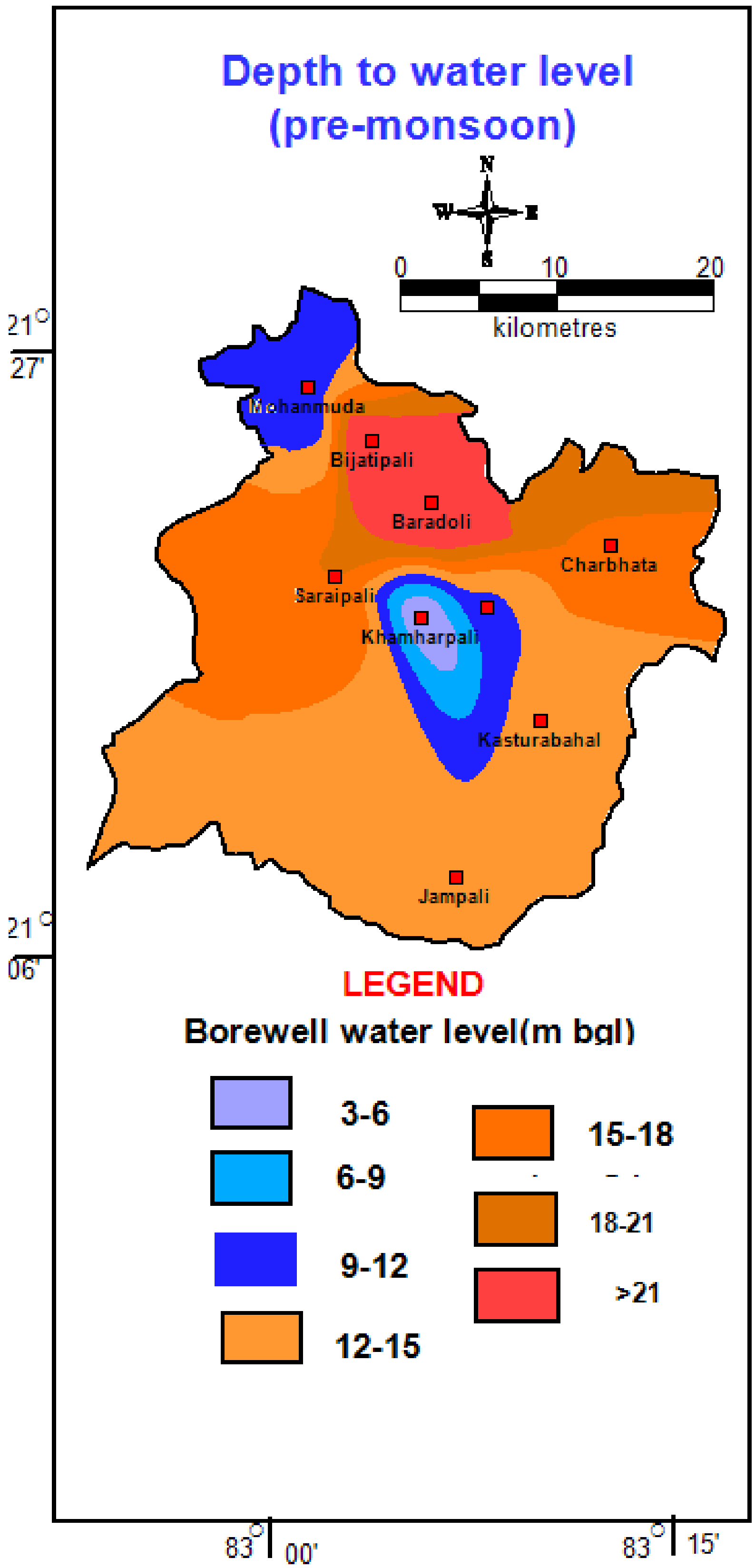


Figure-7: Depth to water level map Fractured Aquifer (Pre-monsoon)

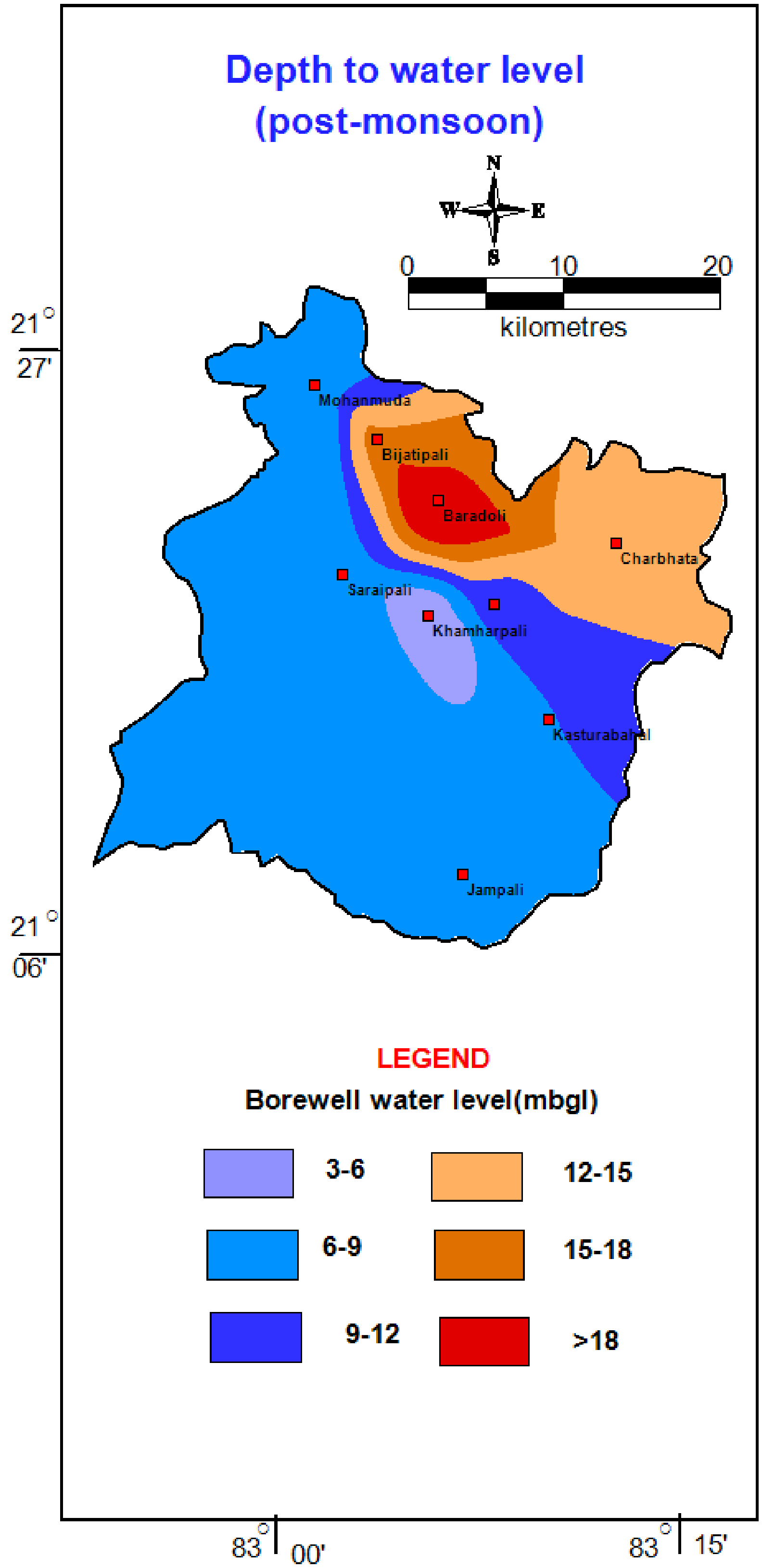


Figure-8: Depth to water level map Fractured Aquifer (Post-monsoon)

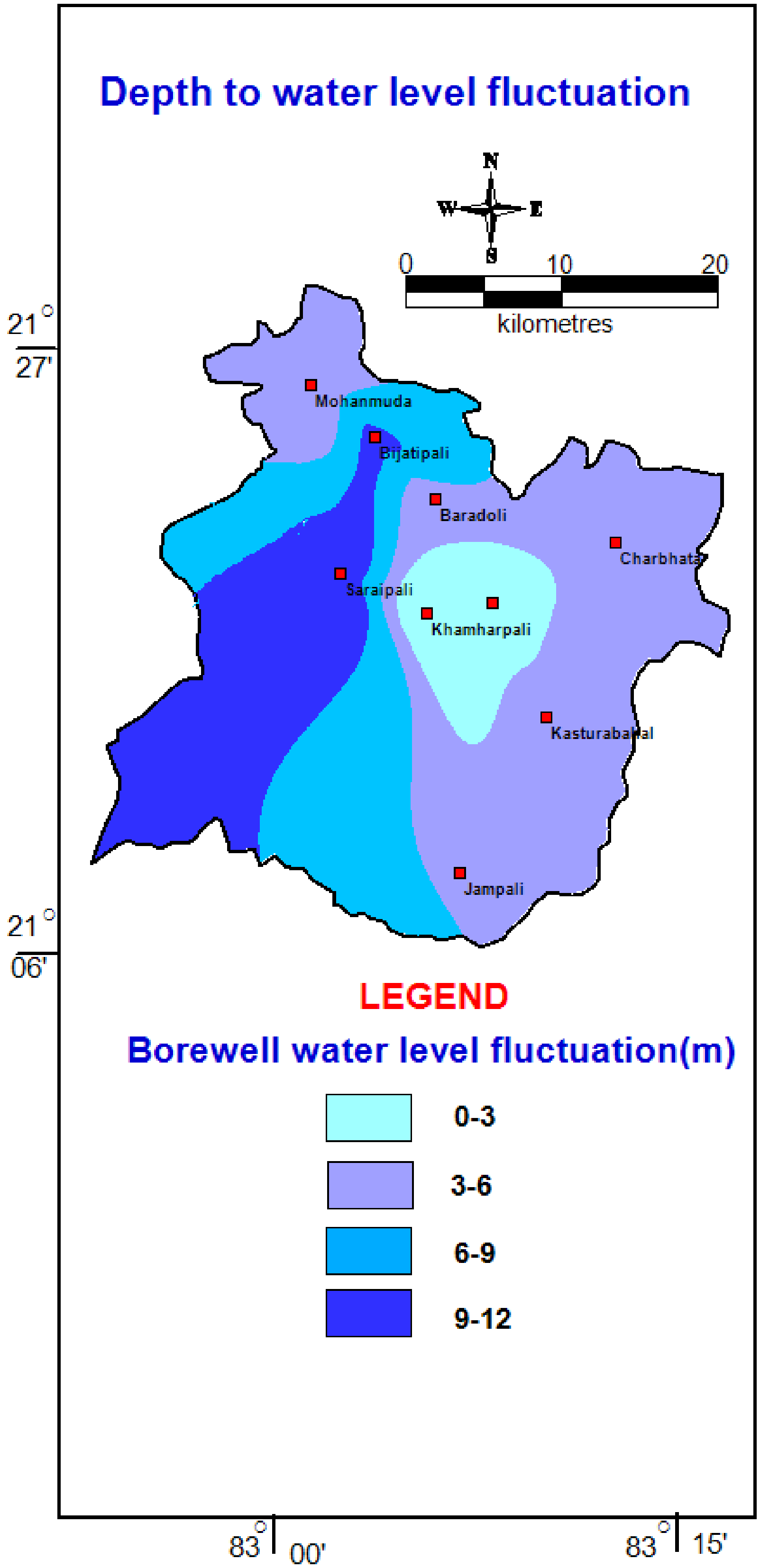


Figure 9: Depth to water level fluctuation map of Fractured Aquifer

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Saraipaliblock, water level fluctuationinphreaticaquifervaries from 0.44 to 15.38 m with an average fluctuation of 4.32 m. Water level fluctuationinfracturedaquifervaries from 0.11 to 10.51 m with an average fluctuation of 4.66 m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

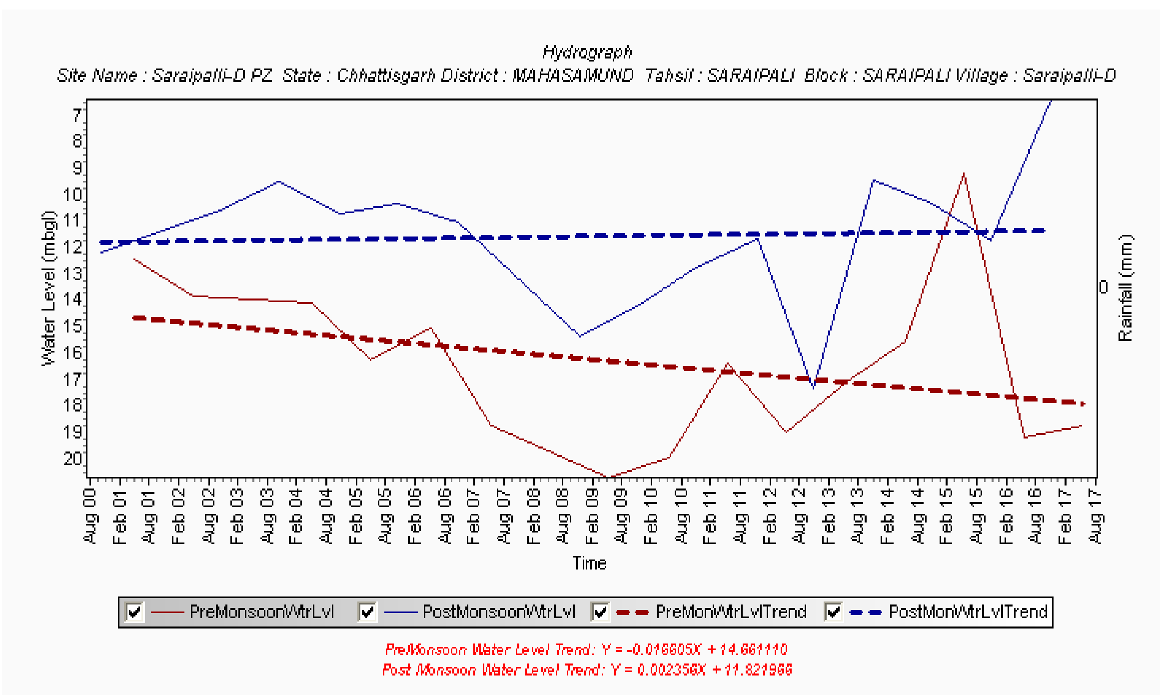
Block Name	Phreatic		
	Min	Max	Avg
Saraipali	0.44	15.38	4.32

Water Level (in m)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Fractured		
	Min	Max	Avg
Saraipali	0.11	10.51	4.66

(iv) The long-term water level trend: During pre-monsoon period, there is decline in water



level (as indicated by dotted red trend line), about 2m over a 10-year period.

Figure 11: Hydrograph of Saraipali village, Saraipali block

2. Aquifer Disposition:

Number of Aquifers: There arethree major aquifers, viz. Singhora group (Calcareous shale), Singhora group (Sandstone) and Dongargarh granite and granitic gneiss, which in phreatic and fractured condition serve as major aquifer system in the block.

3-D aquifer disposition and basic characteristics of each aquifer:
Geology: Geologically the block exhibits lithology of Meso to Neo Proterozoic agedominated by Singhora group (Calcareous shale) and Singhora group (Sandstone).

(i) Singhora group - Singhora group is the oldest formation of Chhattisgarh super group. The sediments occurring in the block consist of Shale, Limestone, sandstone and siltstone. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 9.0 m. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 1 to 2sets of fractures are encountered within 60 to 200 m depth. The discharge is negligible(<1lps). At two places, namely Chhattigirola and Birkol, discharge of 4.0 lps and 5.50 lps were obtained respectively. The development in these formations is mostly by way of dug wells.

(ii) Dongargarh granite gneiss- Archean to Proterozoic age . The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 10.30 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 60 m depth and 2 to 3 sets of fractures are encountered within 60 to 200 m depth. The potential zones are present in less than 50 m depth below ground level. In general, the discharge varies from negligible to 3 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells and shallow tubewells. The thickness of fractured aquifer is around 0.2 m.

Table 6: Distribution of Principal aquifer systems in Saraipali

Block	Phreatic and fractured calcareous shale (sq.km.)	Phreaticand fractured sandstone(sq.km.)	Phreaticand fractured granite gneiss (sq.km.)
Saraipali	601	135	133

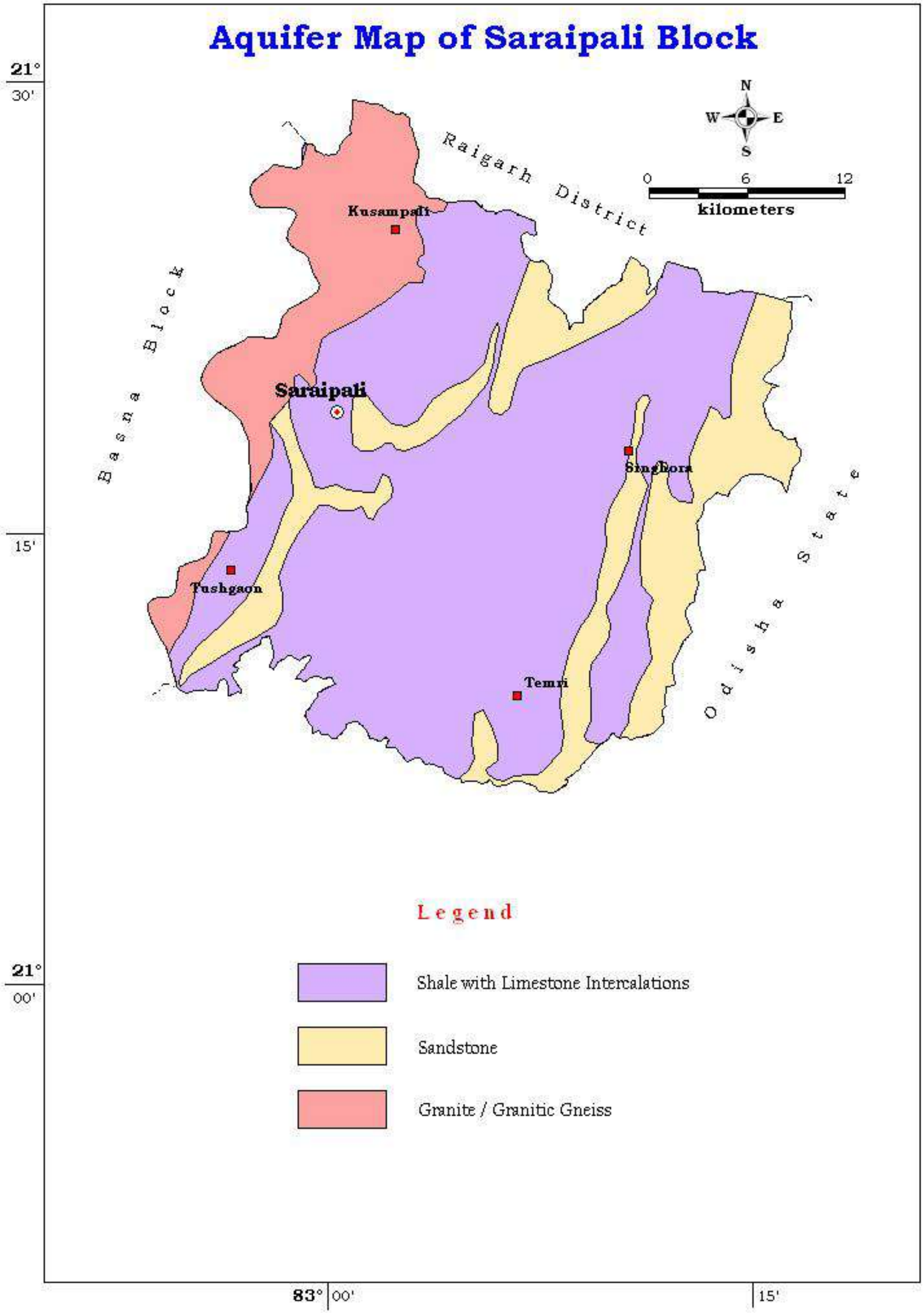
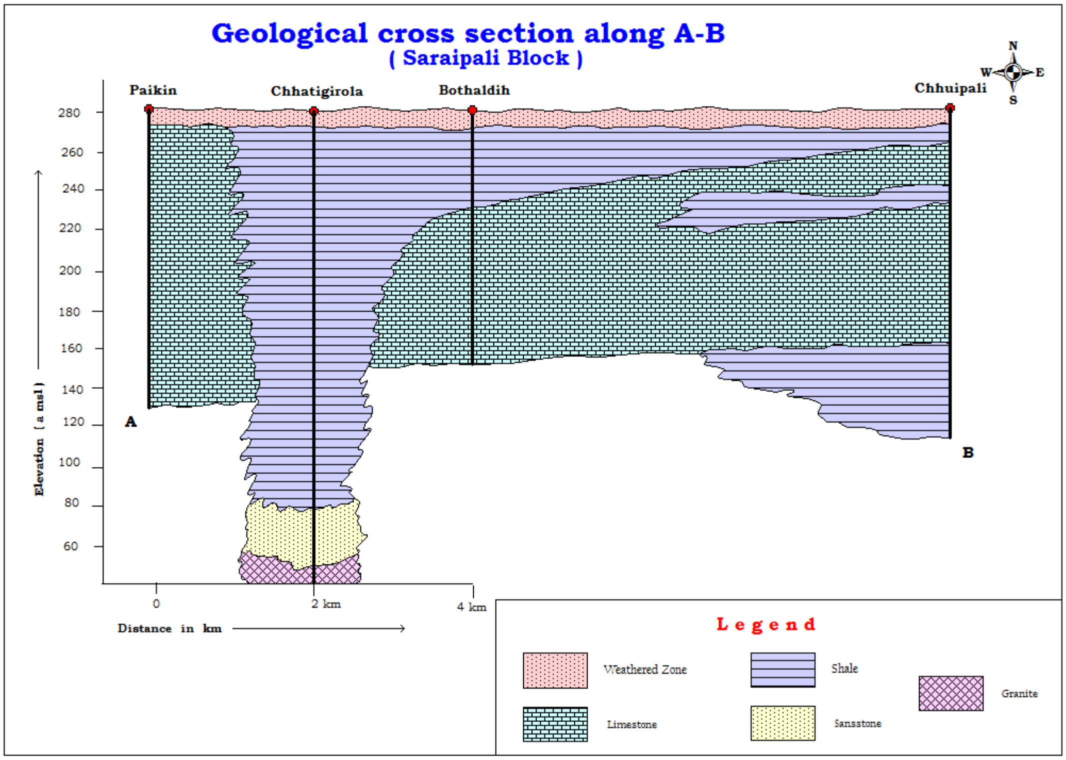


Figure 12: Aquifer map of Saraipali block



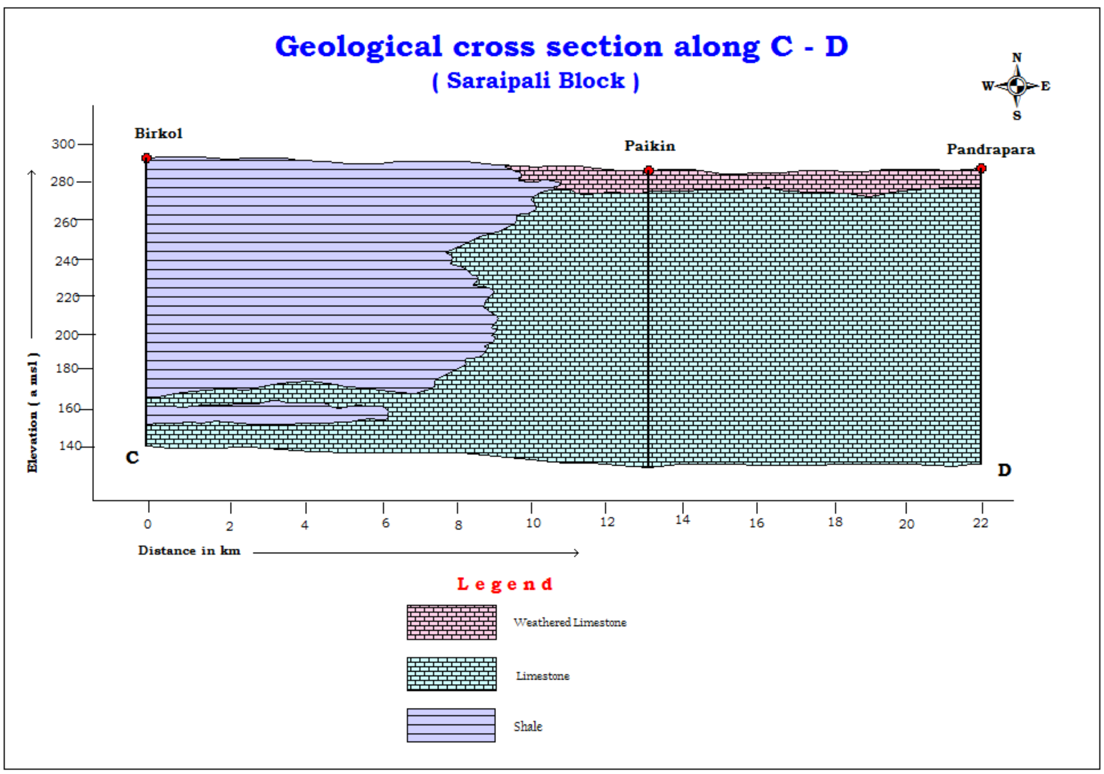


Figure-13: (a)Hydrogeological Cross Section(A-B),(b) Hydrogeological Cross Section(C-D),Saraipali Block

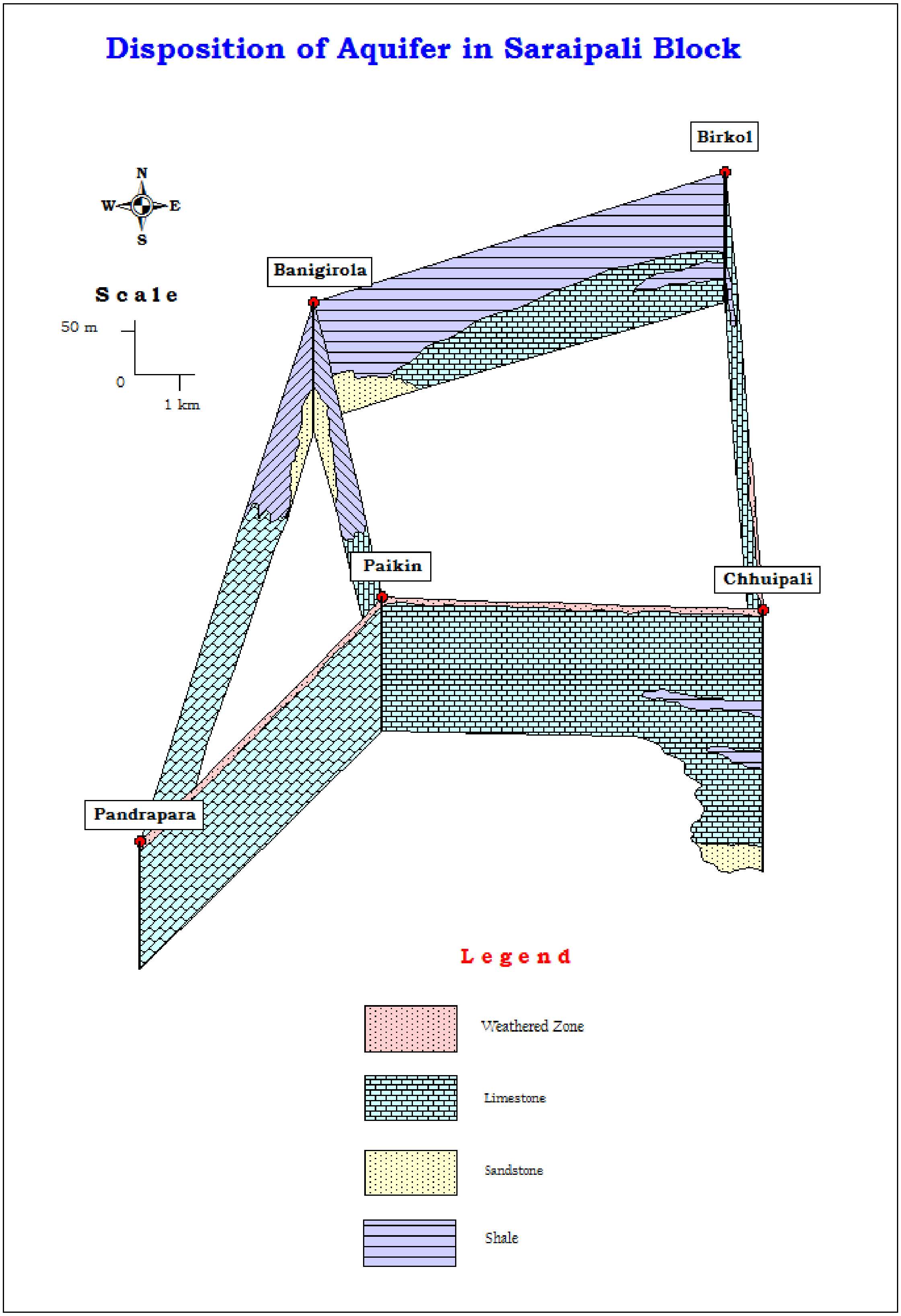


Figure-14: Disposition of aquifer in Saraipali block

3. Ground water Resource, extraction, contamination and other issues:

Aquifer wise resource availability is given in the table -4 where the total resource available in Saraipali block is 8438. 21ham.The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-7 & 8.

Table-7: Ground water Resources of Saraipaliblock

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation For Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Mahasamund	Saraipali	8438.21	2853.0	432.62	3285.62	467.55	5117.66

Table-8: Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorisation
Mahasamund	Saraipali	38.94	Safe

Categorisation: TheSaraipali block falls in safe category. The stage of Ground water development is 38.94%. The Net Ground water availability is 8438.21 ham. The Ground water draft for all uses is 3285.62 Ham. The Ground water resources for future uses for Saraipali Block are5585.21Ham.

Chemical Quality of Ground water and Contamination**:** Throughout the study area, the water quality (phreatic and semi-confined aquifer) is good and all the parameters are within permissible limit. In conclusion it may be said that the groundwater in the block is suitable for drinking as well as for irrigation purposes.

4. Ground Water Resource enhancement:

Aquifer wise space available for recharge and proposed interventions:

Table -9: Summarised detail of Volume of porous space available for recharge (Aquifer wise)

Formation	Area (sq.m)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (m^3)
Limestone/Shale	$238*10^6$	1.5	0.03	10.71×10^6
Sandstone	$80*10^6$	1.5	0.03	3.6×10^6

5. Issues:

(i) The aquifer itself is a low yielding one due to which during summer, dugwells in almost all villages are dry except a few locations. Several handpumps also stop yielding water.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system.

(iii) Poor stage of groundwater development.

6. Supply side interventions:

(i) Saraipali block experienced drought situation in 2017because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken "Nal Jal Yojana" to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also, the pipes are not fitted with taps to control the flow of water. So, Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to understand people about the importance community participation in saving water.

(iii) Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.

(iv) It has been observed that though the long-term trend lines are declining in pre-monsoon, so we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table-10.

Table-10: Types of ArtificialRecharge structures feasible

Name of Block	Area Feasible for recharge (sq.km)	Volume of Sub Surface Potential to be recharged through other methods (MCM)	Types of Structures Feasible and their Numbers			
			P	NB & CD	RS	G
Saraipali	318	14.31	40	150	280	380
	Recharge Capacity		8.3	1.5	2.8	1.9
	Estimated cost (Appx.)		Rs. 16.88 crore			

(v) The practice of providing free electricity to operate irrigation borewells should be strictly monitored and put to an end in case of overconsumption. After a simple calculation it has been found that Rs 16000/ hectare is the expenses of electricity (@Rs. 2.5/unit) for paddy field. So, monitoring mechanism for electricity consumption should be strengthened for farmers taking summer rice. Even if farmers use solar pump or other method of ground water irrigation for summer paddy, it should not be flooding method. Proper pipes are to be used to transfer water from one plot to another.

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

(vii) Since the stage of development in the block is 38.94 %. So, there is scope of development. In order to achieve 60% stage of ground water withdrawal in the block, development may be taken up as per the following table:

Table-11: Number of structures recommended in block for 60 % stage of development

Block	Net groundwater availability (ham)	Stage of GW development (%)	Present GW draft (ham)	Groundwater draft at 60% stage of development (ham)	Surplus groundwater at present stage of development (ham)	No. of TW recommernded in each block (assuming unit draft as 2 ham/structure/year)	No. of DW recommended in block (assuming unit draft as 0.72ham/structure/year)
Saraipali	8438.21	38.4	3285.72	5062.93	1777.31	889	2468

7. Demand side interventions:

(i) To arrest the declining groundwater levels during pre-monsoon period, change in cropping pattern & irrigation pattern is suggested for Rabi season, as per the following table:

Table 12: Detail of groundwater saved through change in cropping pattern

Block	Paddy cultivation area during Rabi season (ha)	Water required for cultivation (in m) per ha		Difference (m) per ha	Total saving of water (ham)	Existing gross groundwater draft for all uses in ham	Available resource (ham)	Improved status in Stage of groundwater development
		Paddy	Maize					
Saraipali	4992	0.9	0.5	0.4	1996.8	3285.62	8438.21	15.27

In command or non-command area wherever ground water has been used for field irrigation of pulses and vegetables should be replaced with micro irrigation methods such as sprinklers, drip irrigation etc. which may save 30 to 40% ground water.

Table 13: Detail of groundwater saved through change in irrigation pattern

block	irrigated crop area under rabi 2016(ha)	water required for ultivation of pulses(m)	30 % groundwater saved through microrrigation	water saved through microirrigation (ham)
Saraipali	5217	0.3	0.3	181.8

Table 14: Proposed sites for artificial recharge of groundwater in Saraipali block

PT (Percolation Tank)	NB & CD (Nala bund & Check dam)	RS (Recharge Shaft)	GB (Gabbion structure)
Bhuthiya	Kanpal	Paterapali	Kena
Balouda	Jangalbeda	Bhothaldih	Kurludhudha (Kurluda
Bhothaldih	Kisdi	Kurludhudha (Kurluda	Bastipali
Temri	Palidih	Dewanpali	Sukda
Manpali	Palsapali	Antarjhala	Bajibahal
Sargunabhata	Jampali	Kokdi	Pudagarh
Daugudi	Jamadalkha	Amaldih	Belmundi
Nawagarh	Bajibahal	Gaurbahali	Pujaripali
Batki	Samdaraha	Dongarrakasa	Pelagarh
Dongaripali	Kasturabahal	Dongarrakasa	Debrigarh
Charbhatha	Palsapali	Birkol	Chiwarakuta
	Majarmati	Saraipali (Bhagta)(Sa	Banjhapali
	Paraskol	Raksha	
	Kalenda (Kelenda)	Sagarpali	
	Chhindpali	Dewangudi	
	Bormal	Banjhapali	
	Singbahal	Murmuri	
	Ghatkachhar		

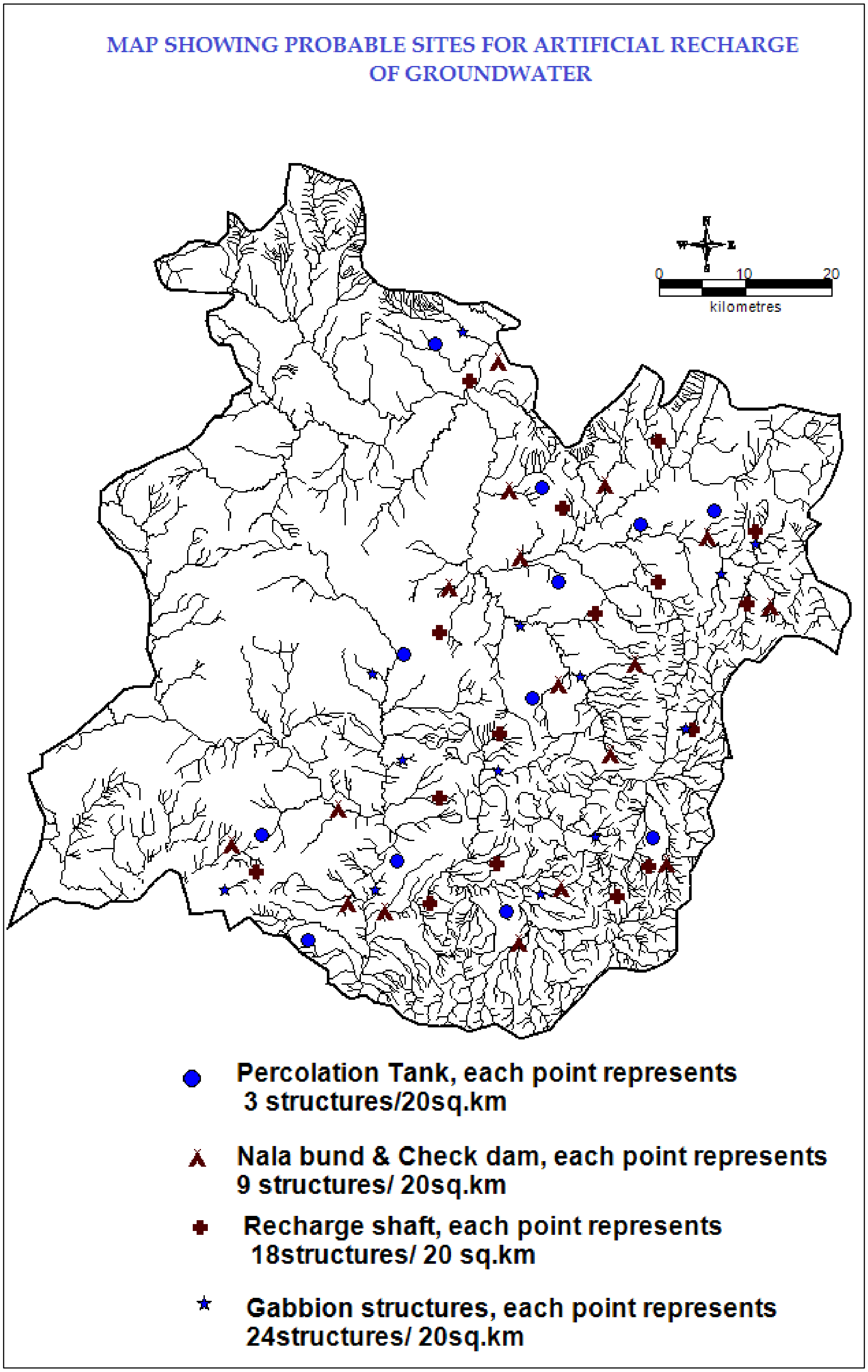


Figure 15: Map of proposed sites for artificial recharge of groundwater in Saraipali block

7. CONCLUSIONS:

An area of 870 sq.km of Saraipali block of Mahasamund district has been considered for Aquifer Mapping and Management Plans. The total g.w resource is 8438.21 Ham with stage of g.w development 38.94 % and categorized as “safe”. 51.9 % of the irrigated area is uses groundwater for irrigation. The major aquifer groupsareSinghora Group calcareous shale, limestone and Dongargarh Granite and Granite gneiss, in terms of Demand side management, by change in cropping and irrigation pattern (micro irrigation methods) 1996.8Ham and 181 Ham water can be saved respectively. In terms of Supply side management, by constructing artificial recharge structure 14.31 MCM water can be recharged and constructing of tubewell at suitable locations, drinking water needs may be fulfilled.