केंद्रीय भूमि जल बोर्ड
जल संसाधन, नदी विकास और गंगा संरक्षण
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भारत सरकार
Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

MUNGELI DISTRICT, CHHATTISGARH

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

2021-22

भारत सरकार

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

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

केन्द्रीय भूमि जल बोर्ड

Central Ground Water Board

मुंगेली जिला, छत्तीसगढ़ के जलभृत नक्शे एवं भूजल प्रबंधन योजना

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

केन्द्रीय भूमि जल बोर्ड

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रायपुर

FOREWORD

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

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

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

The report titled "A REPORT ON AQUIFER MAPS AND GROUNDWATER MANAGEMENT PLAN OF MUNGELI DISTRICT, CHHATTISGARH" is prepared by Sh. Sidhant Kumar Sahu, Scientist-B under supervision of Sh. A.K. Biswal, Scientist-E. I appreciate the concerted efforts put by the author to make it possible to bring the report in its present shape. I hope this report will no doubt be useful and worthy for the benefit of Mungeli district and would be a useful document for academicians, administrators, planners and all the stakeholders in ground water.

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

Dr. P. K. Naik
(REGIONAL DIRECTOR)

Author's View

The contour maps prepared in this report, taking the limited available number of aquifer parameters may vary from the real scenario in the field. Specifically, such maps for the fracture aquifers and their yield potentials have been prepaired to depict their broader geographic distribution, which may bear limited practical value in the field condition.

Executive summary

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

Under the aquifer mapping Programme, all the development blocks of Mungeli District namely Lormi, Mungeli and Pathariya were taken up for study covering an area of 2669 sq. km It falls in the Survey of India's Degree Sheet No. 16, F (6, 7, 10, 11, 12, 14, 15 & 16), G (9, 13) and K 1 between the Latitude 21° 80'- 22° 70'N and Longitude 81° 45' to 82° 05'E. Mungeli district is situated in the NNW corner of Chhattisgarh (Fig.1). The northern part is bordered by Madhyapradesh. On the western and south-western part has common boundaries with Kabirdham district and Bemetara district respectively. The southeren part is bordered by Bolodabazar district and the eastern boundary is shared by Bilaspur district. All-important places within the district are well connected by a network of the state highways and all-other roads.

The total population of the study area as per 2011 Census is 7,01,707 out of which rural population is 6,36,268 & the urban population is only 65,439.

The study area experiences sub-tropical climate. The average annual rainfall for the study area is around 1138 mm (Average of the last five years i.e. 2014 to 2021)

Geomorphologically the study area displays Structural Plains, Pediment/Pediplain, Denudational Hills, Denudational plateau and Flood plains with an elevation ranging from 250 to 1038 msl.

The net sown area is 128780 Ha, while double-cropped area is 91610 Ha. The gross cropped area of the district is 220390 Ha. The net Irrigated cropped area is 80471 Ha, while the area under groundwater irrigation is 37034 Ha which is about 46% of net cropped area.

Based on the exploratory drilling data generated for the blocks, the existing aquifer systems in the area may be divided into phreatic and fractured aquifer. The major aquifers present in the

study area are 1. Shale (Maniari and Terenga), 2. Limestone (Pandaria and Hiri) and Granite gneiss (Bastar gneiss), Discharge varies from negligible to 26 lps in fractured aquifer and 10 to 130 m3/day in weathered aquifer. Higher yields are obtained where thick weathered zones are associated with bedrock fracturing.

As per 2020 ground water resource calculation stage of ground water development in the study area is only 58.12 %. So, there is scope of utilizing more ground water for future irrigation purpose and other purposes. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources.

The existing demand for irrigation in the area is 6558.94 Ham while the same for domestic use is 1713.68 Ham and for industrial field is 15.768 Ham. to meet the future demand for ground water, a total quantity of 5448.97 Ham of ground water is available for future use.

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

In study area because of complex hydrogeological conditions ground availability is scattered. In area where ground water availability is limited, surface water may be conserved and utilized. Iron filter may be used for the villages having high Iron concentration. Regular ground water quality monitoring is also required.

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

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

Sidhant Kumar Sahu
Scientist-B (JHG)

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

(03 BLOCKS- LORMI, MUNGELI & PATHARIYA)

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ABBREVIATIONS

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

1. INTRODUCTION

1.1 Objective

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

1.2 Scope of study

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

a) Identifying the aquifer geometry

b) Aquifer characteristics and their yield potential

c) Quality of water occurring at various depths

d) Assessment of ground water resources

e) Preparation of aquifer maps and

f) Formulate ground water management plan

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

1.3 Approach and Methodology

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

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

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

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

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

1.4 Area Details

Under the aquifer mapping Programme, an area comprising of 3 no of blocks of Mungeli district was taken up covering an area of 2669 sq. km. Mungeli district is situated in the NNW corner of Chhattisgarh (Fig.1). The northern part is bordered by Madhyapradesh. On the western and south-western part has common boundaries with Kabirdham district and Bemetara district respectively. The southeren part is bordered by Bolodabazar district and the eastern boundary is shared by Bilaspur district. It falls in the Survey of India's Degree Sheet No. 16, F (6, 7, 10, 11, 12, 14, 15 & 16), G (9, 13) and K 1 between the Latitude 21° 80'-22° 70'N and Longitude 81° 45' to 82° 05'E. The nearest airport to the District is at Bilaspur. All-important places within the district are well connected by a network of the state highways and all-other roads.

1.4.1 Administrative Division

District includes 03 blocks and it is further divided in 370 gram panchayats and 701 villages. The name of the 3 blocks are given below.

1. Mungeli Block
2. Lormi Block
3. Pathariya Block

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

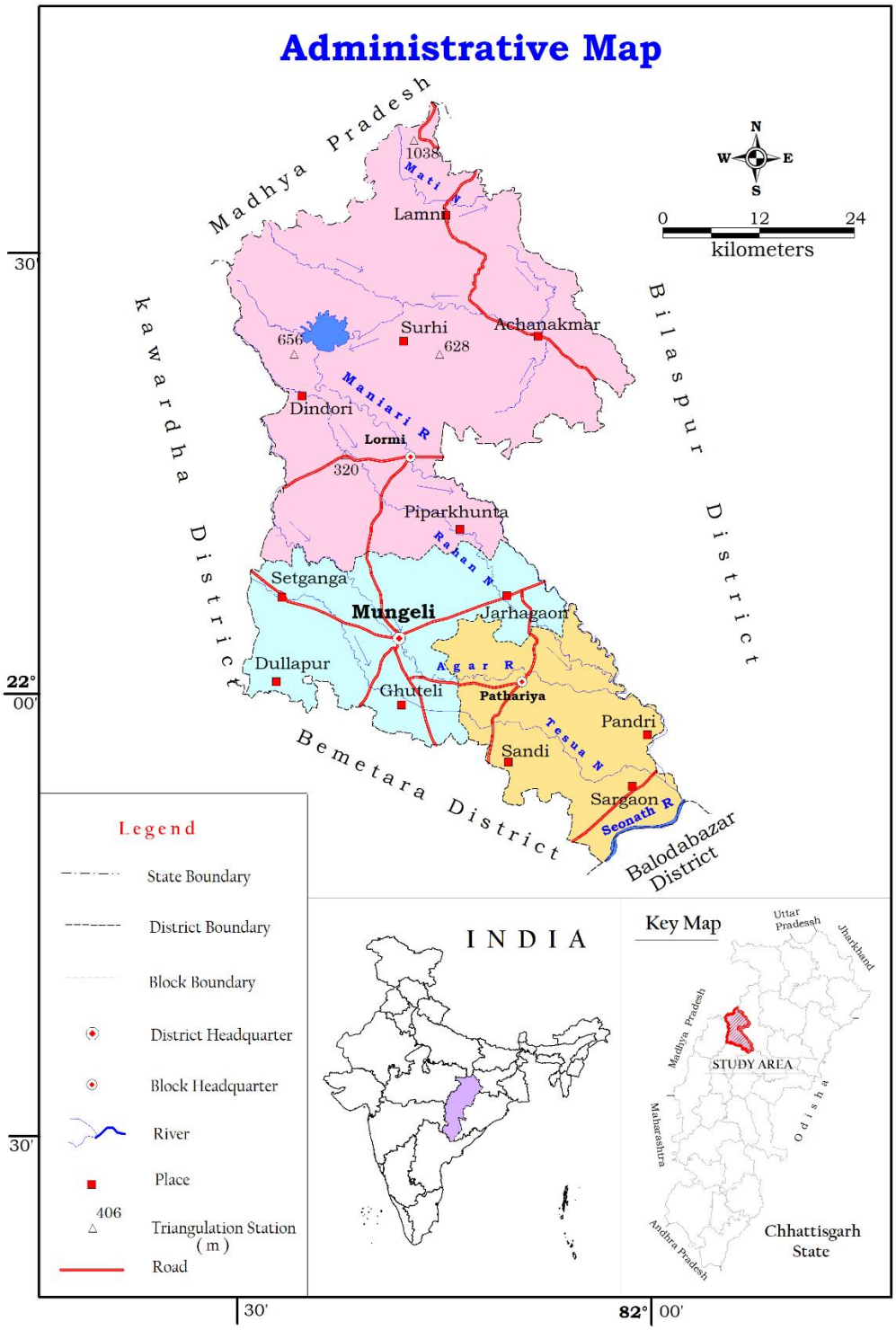

Figure 1 Administrative Map of Mungeli District

1.5 Data Availability, Data Adequacy and Data gap Analysis

Table 1 Data Integration

Districts	Blocks	Existing				Data Generation			
		EW	CHEM	VES	WL	EW	CHEM	TEM	WL
Mungeli	Mungeli	11	08	01	08	0	07	14	07
	Lormi	06	14	06	14	01	09	05	09
	Pathariya	07	05	0	05	05	07	07	07
TOTAL		**24**	**27**	**07**	**27**	**06**	**23**	**26**	**23**

1.6 Rainfall

The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August and nearly 95% of the annual rainfall is received during this period. The average annual rainfall for the study area is around 1138 mm (Average of the last seven years i.e. 2014 to 2021) which is presented below in Figure 2. Source: Statistical handbook Mungeli district.

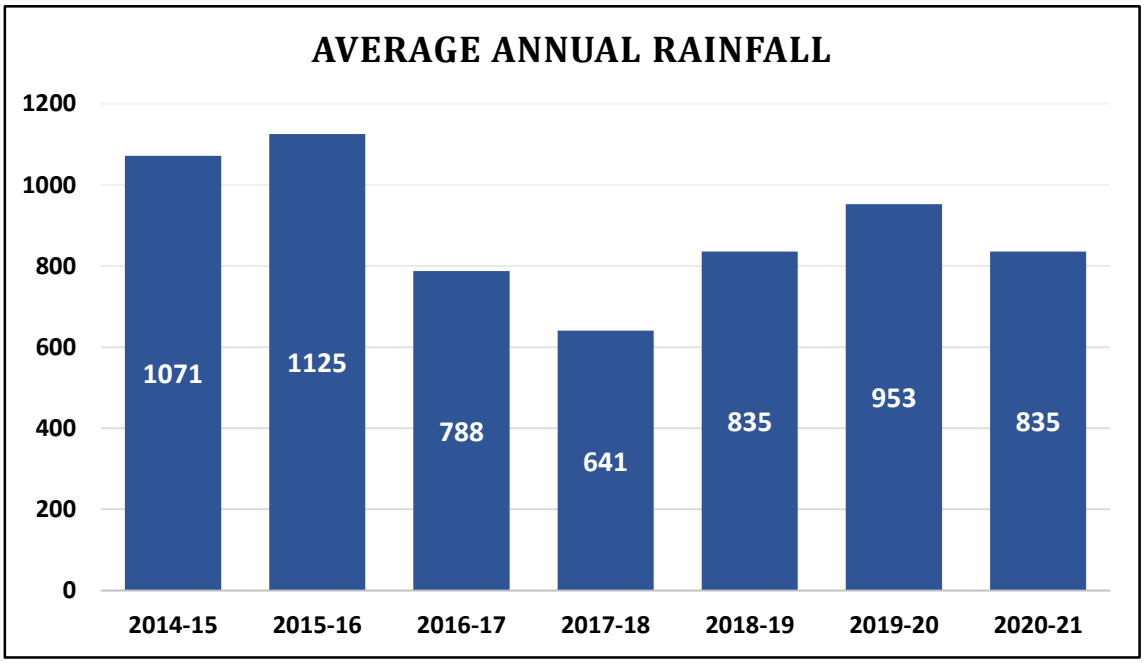

Figure 2 Avg. Rainfall in Mungeli District

1.7 Physiography/Geomorphology

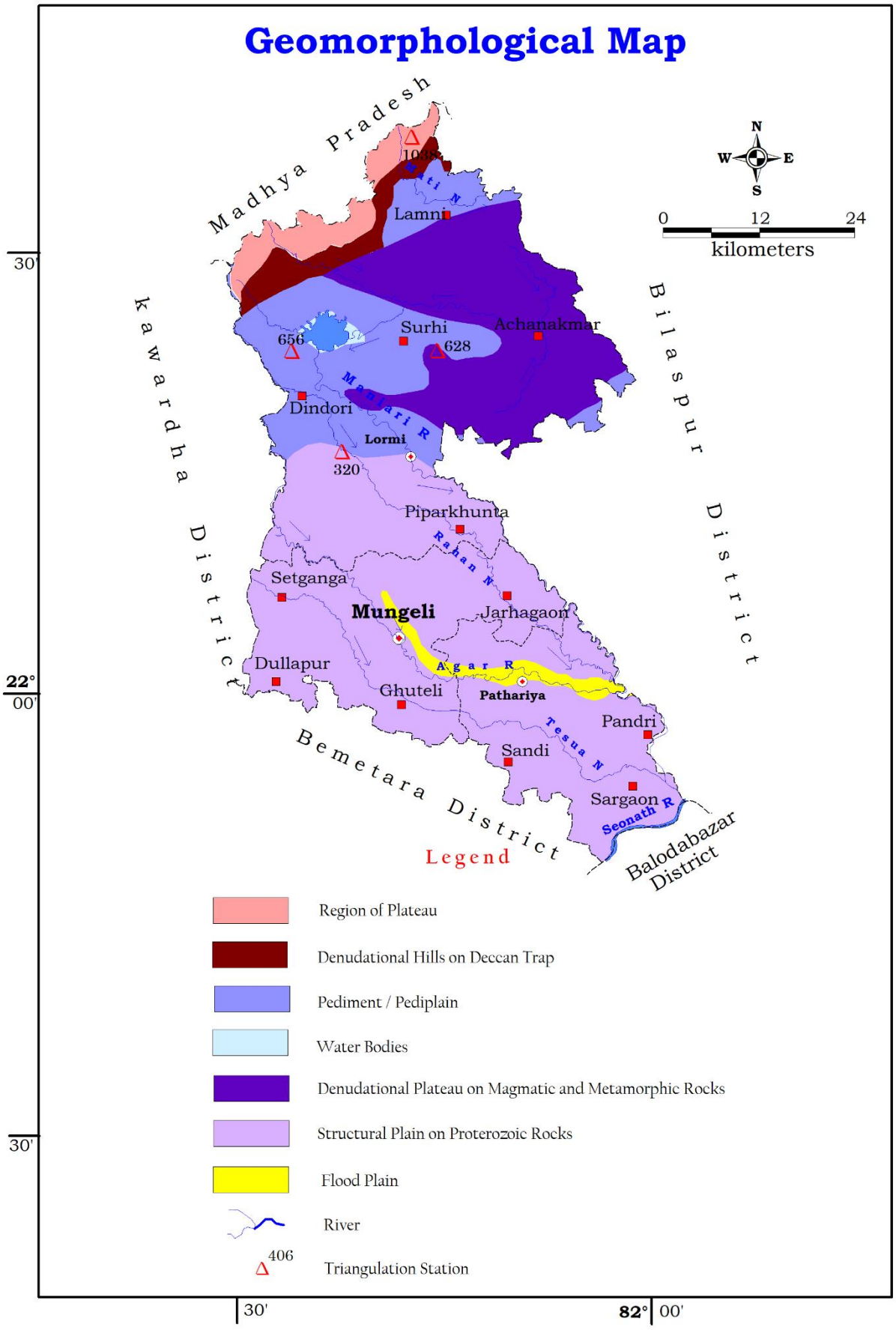

Figure 3 Geomorphology Map of the Study area

The southern part of the district is a plain land with gentle slopes. It is also called the Chhattisgarh plains. The land is very fertile and is mostly used for the agriculture purposes. The northern part of the district is mostly hilly with highly undulating topography where the agriculture is restricted to few patches only. Physiographically the Mungeli district can be divided into two parts. The first part consists high plateau area covering northern part of the district (covering Lormi blocks) separated by the intermittent narrow valleys and steeply slopping plains. The second part is the gently slopping plain land covering southern parts of the district (Mungeli and Pathariya blocks). The high topographic area on the northern part of the district forms water divide between the rivers Ganges and Mahanadi. The hill ranges on the northwestern part is the water divide between Mahanadi and Narmada Rivers. Major part of the Chhattisgarh basin is drained by Mahanadi River. The topography varies between 250 m amsl in the southern plains and 1038 m amsl in the northern hills. Basically the hill ranges on northern part are due to structural activities and the area on southern part (Chhattisgarh plain) can be categorised as structural plain on Proterozoic rocks.

1.8 Land use

There is 111094 ha revenue forest, protected forest and other forest in the district. Area not available for cultivation is 13501 ha. Details are presented in Table no.2. Figure 4 shows the Landuse pattern in the study area.

Table 2 Land use pattern (in ha)

Blocks	Total Geographical Area (In ha)	Revenue forest area (In ha)	Area not available for cultivation (In ha)	Non-agricultural & Fallow land (In ha)	Agricultural Fallow land (In ha)	Net sown area (In ha)	Double cropped area (In ha)	Gross cropped area (In ha)
Mungeli	61332	0	135	4032	50777	49986	39932	89918
Lormi	51146	111094	3986	4461	40632	39431	30198	69629
Pathariya	51464	0	9380	403	40721	39363	21480	60843
Mungeli (Total)	**163942**	**111094**	**13501**	**8896**	**132130**	**128780**	**91610**	**220390**

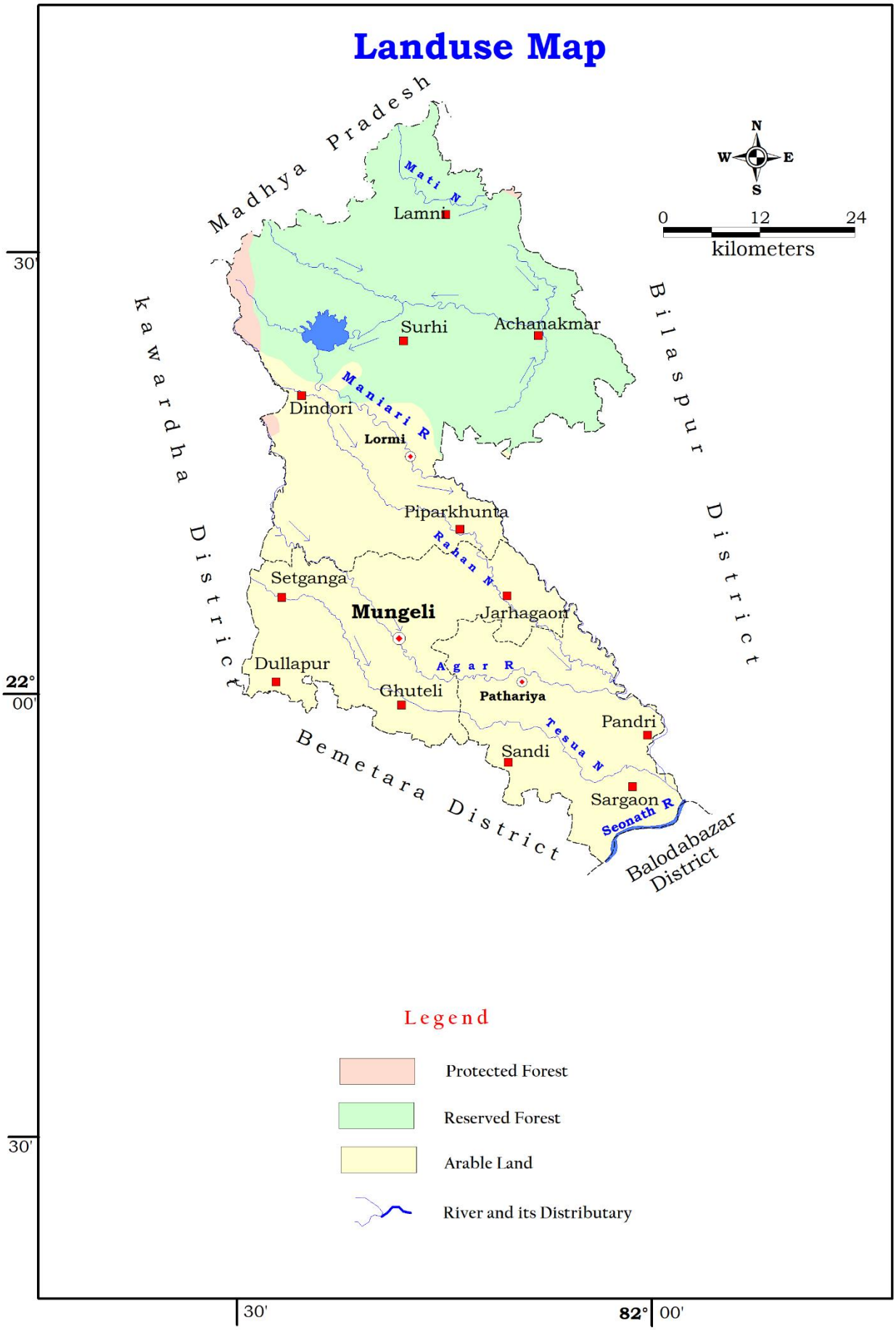

Figure 4 Landuse map of the study area

1.9 Soil

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

1. **Vertisol:** The vertisol are mostly found in south and southeastern parts of the district. They range from grey/red to deep black colour and are almost impermeable when saturated. They are sticky in wet season and are very hard in dry season.
2. **Ultisol:** The ultisol types of soil are found in east and northern parts of the district and is red to yellow in colour. This colour is attained mainly due to the accumulation of iron oxide, which is highly insoluble in water.
3. **Inceptisol:** Inceptisol soils occupy mostly hill slopes and are found along the western boundary of the district.
4. **Alfisol:** Alfisol soils are fertile leached soils found in humid areas where annually dropping leaves form a thick humus layer. These soils cover maximum area in the northern and central parts of the district.

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

Table 3 Details of different kind of soil

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

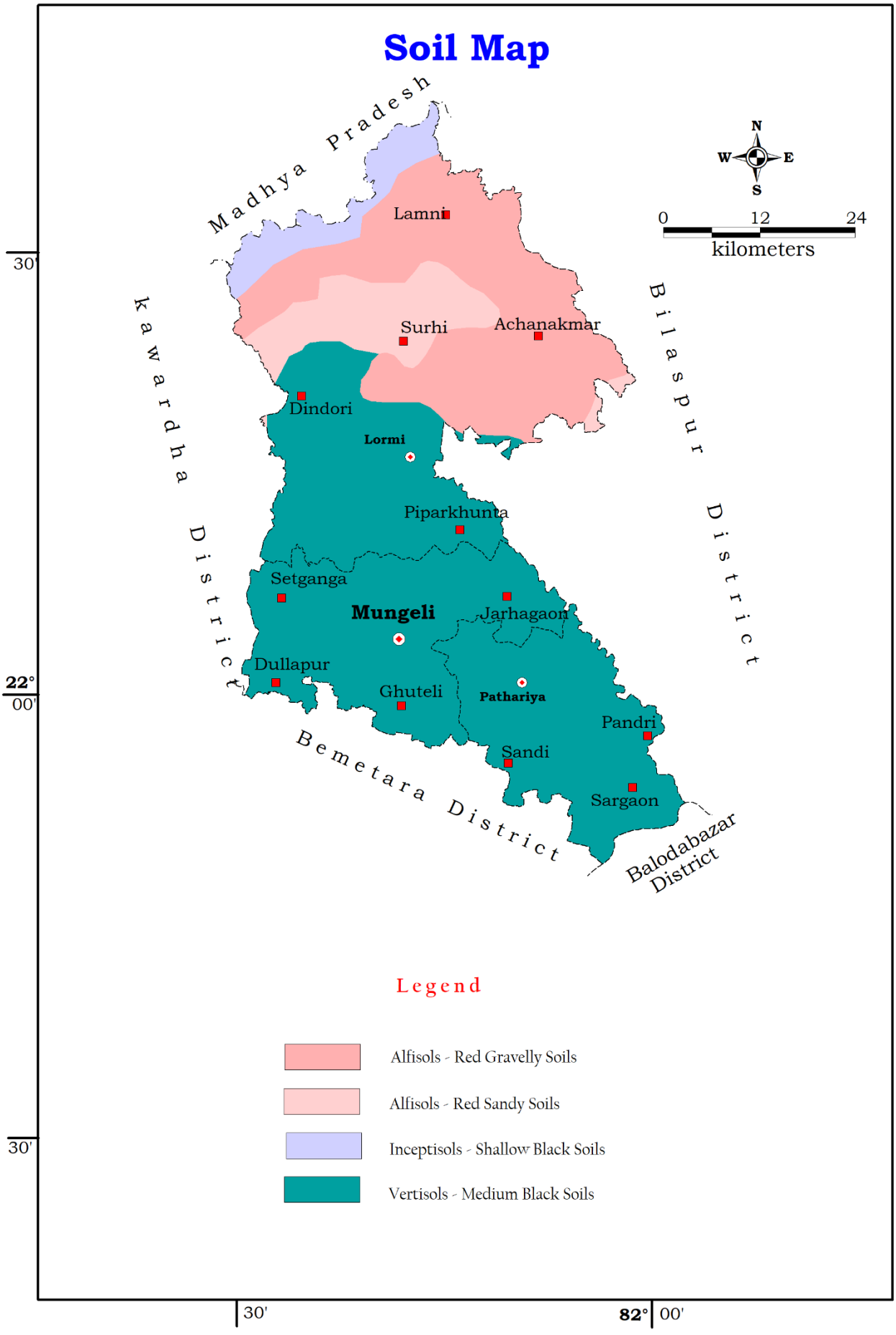

Figure 5 Soil map of the study area

1.10 Hydrology and Drainage

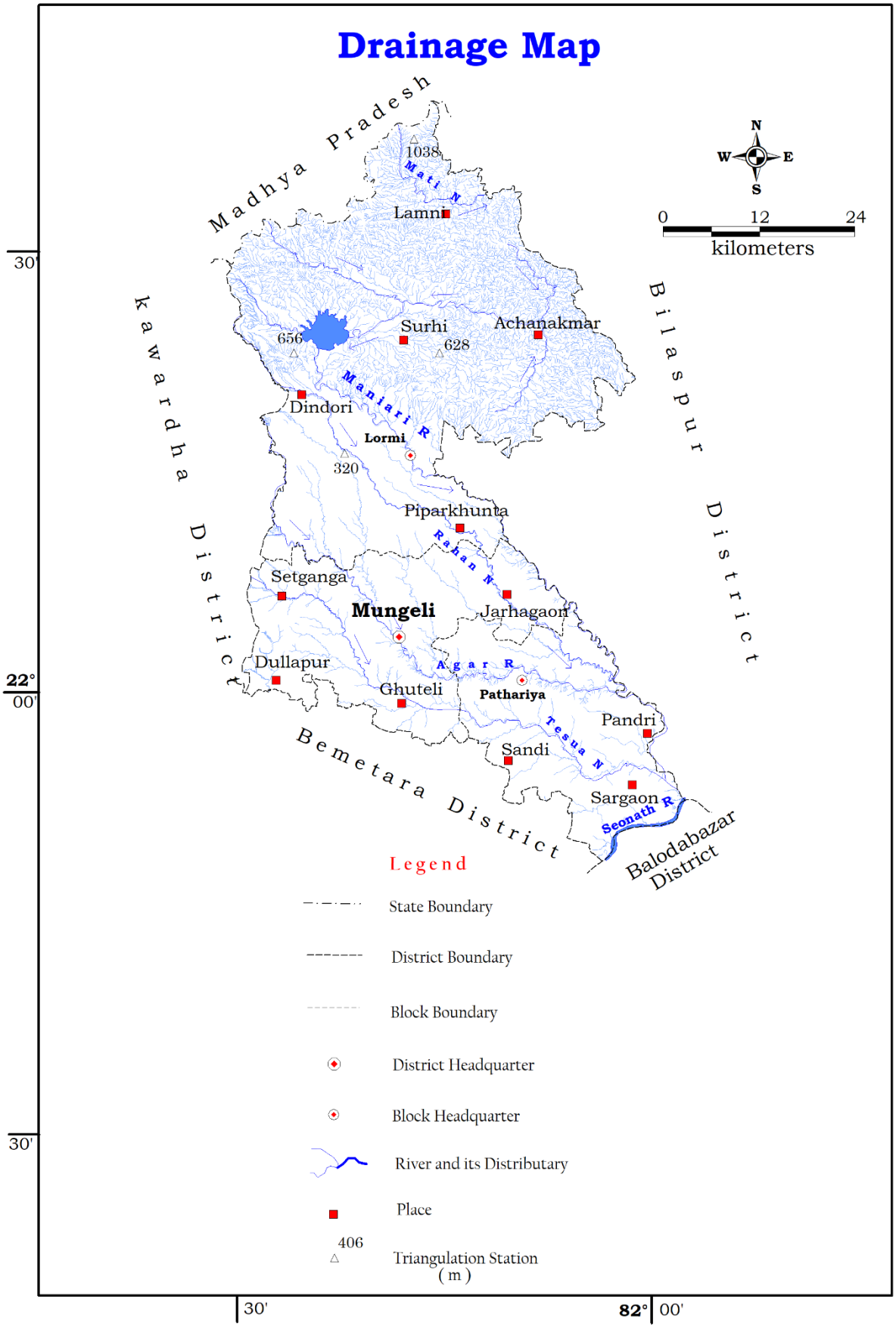

Figure 6 Drainage map of the study area

The Mahanadi River drains about 90% of the area in the district. The Major tributaries of Mahanadi are Seonath, Maghdhara, Sukhad, Jaswa, Sagar, Teswa, Agar, Maniari, Chhotinarmada, Gongha, Arpa, Khurung and Lilagar. Son is the major tributary to the Ganges. The Tipan and Alan nalas are the tributaries to the Son River.

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

1.11 Geology

Geologically the district can be categorised into three groups.

i. **The Archaean Crystallines**: It consists of granites, gneisses, schists, phyllites and quartzites. Generally occurs in Lormi block of Mungeli district.
ii. **Precambrian Sedimentaries:** It belongs to Chhattisgarh Supergroup mainly consisting of limestone, shales and dolomites. Generally occurs in Pathariya, Mungeli and Lormi block of Mungeli district.

i. **Archaean Crystallines:**

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

ii. **Precambrian Sedimentaries**

- **Pandaria formation:** This formation represent the calc-argillite facies developed all along the northern part of the Hirri sub-basin. This lithounit overlies the Chandrapur arenite along the northern margin and is characterized by predominance of pink to purple-colored calcareous shale with lenses and pockets of bedded flaggy limestone,

stromatolitic limestone and dolomite (Thorat et al., 1990) and bedded limestone associated with the chert bands. These lenses and pockets vary widely in dimension from a few meters to several hundred meters in length.

- **Terenga formation:** The Chandi Formation is conformably overlain by Tarenga Formation which is classified into Kusmi argillite, Dagauri green clay-chert and Bilha dolomitic argillite from bottom to top.

  Kusmi Member consists of cherty shale, calcareous shale, brown-colored bedded argillaceous dolomite and splintery violet shale. At places, intraformational flat pebble conglomerate are present.

  Dagauri Member comprises green and white clay of suspected volcanic origin associated with chert and carbonate bands. Green clay is composed of mainly clay groundmass with quartz and feldspar phenocrysts.

  Bilha Member the topmost unit of Tarenga is a monotonous dolomite argillite. The rock is medium to fine grained, purple colored and bedded in character. It is predominantly composed of argillaceous material with considerable amount of dolomite. At places, the rock is dolomitic containing 90% of dolomite crystals.

- **Hiri formation:** This is well developed around the central part of Hirri sub-basin and forms an oval-shaped outcrop pattern. Although, it attains a considerable thickness in south, it is very thin along the northern fringes and is interpreted from outcrop exposures and/ or local excavations. At places, intraformational conglomerate, dolomite and black shale contain gypsum as layers, parallel to bedding and as disseminated grains/ crystals. The stromatolitic are columnar having a wide inter columnar space.

- **Maniari formation:** It is named after the river along which the rock is best developed and shows an oval-shaped outcrop in the central part of the sub-basin. It represents the closing phase of deposition in Chhattisgarh basin and consists of lower gypsiferous grey siltstone and shale followed by reddish brown calcareous and non-calcareous shale with limestone and dolomite.

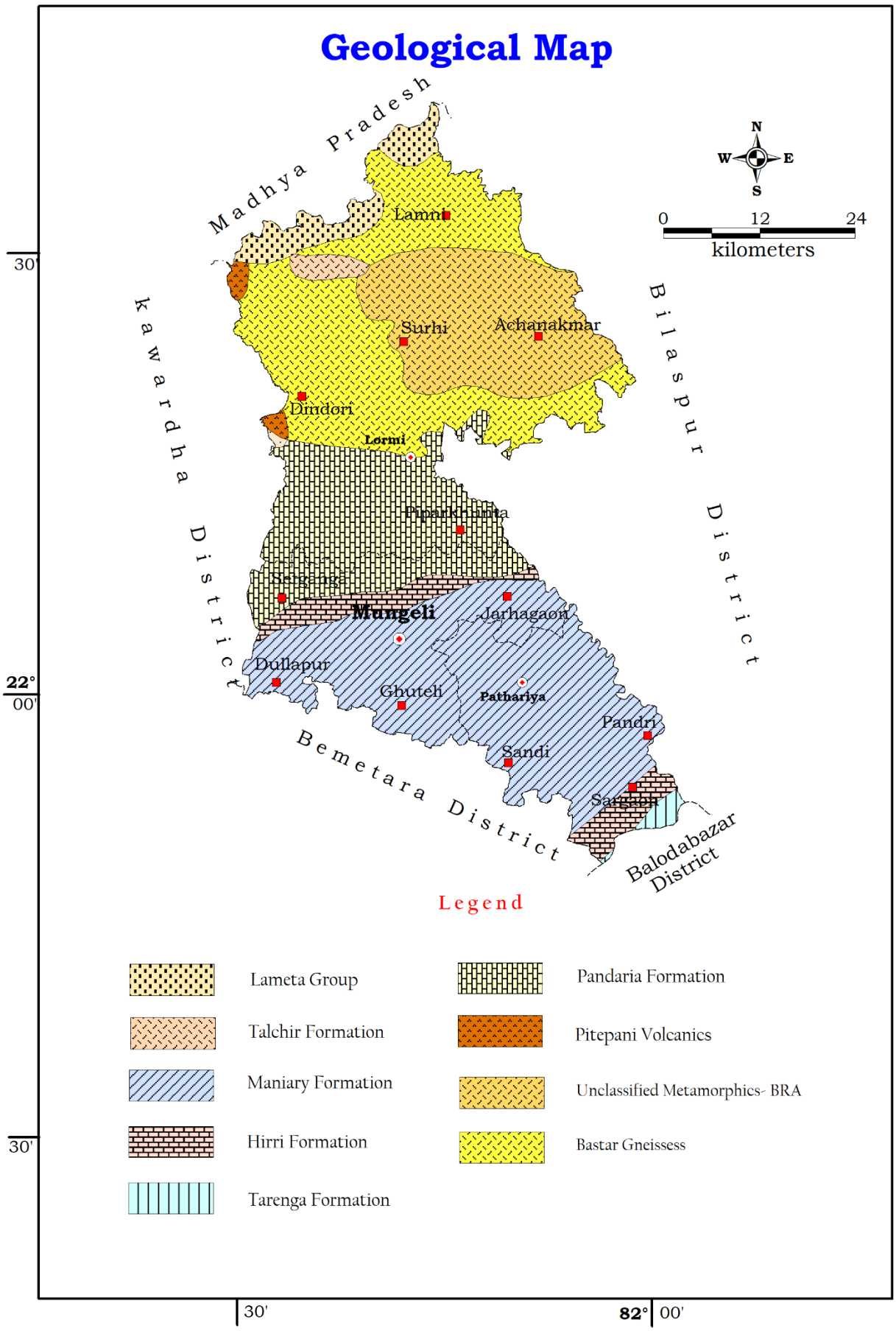

Figure 7 Geological map of the study area

1.12 Agriculture, Irrigation, Cropping Pattern

Agriculture is practiced in the area during Kharif and Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops are paddy, wheat, vegetables and pulses. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Mungeli district is given in Table No. 3 (A, B, C).

Table 4(A) Cropping pattern (in ha)

			Cereal									
Kharif	**Rabi**	**Paddy**	**Wheat**	**Jowar & Maize**	**Kodo Kutki**	**Others**	**Pulses**	**Tilhan**	**Fruits Vegetables**	**Reshe**	**Mirch Masala**	**Sugarcane**
125654	93003	125251	5722	45	187	919	80830	3330	1838	73	36	552

Table 4(B) Area irrigated by various sources (in ha)

No. of canal s (private and Govt.)	**Irrigated area**	**No.of bore wells/ Tube wells**	**Irrigated area**	**No. Of dug wells**	**Irrigated area**	**No. of Ponds**	**Irrigated area**	**Irrigated area by other sources**	**Net Irrigated area**	**% of irrigated area wrt. Net sown area**
6	60653	8565	36999	428	35	432	5	110	80471	62

Table 4(C) Contribution of Groundwater in Irrigation Pattern (in ha)

Area Irrigated through Borewells/Tube wells	**Area Irrigated through Dug wells**	**Area Irrigated through Groundwater**	**Net Area Irrigated through all sources**	**% Groundwater contribution in Irrigation wrt Net Irrigated Area**
36999	35	37034	80471	46

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

2.1 Hydrogeological Data

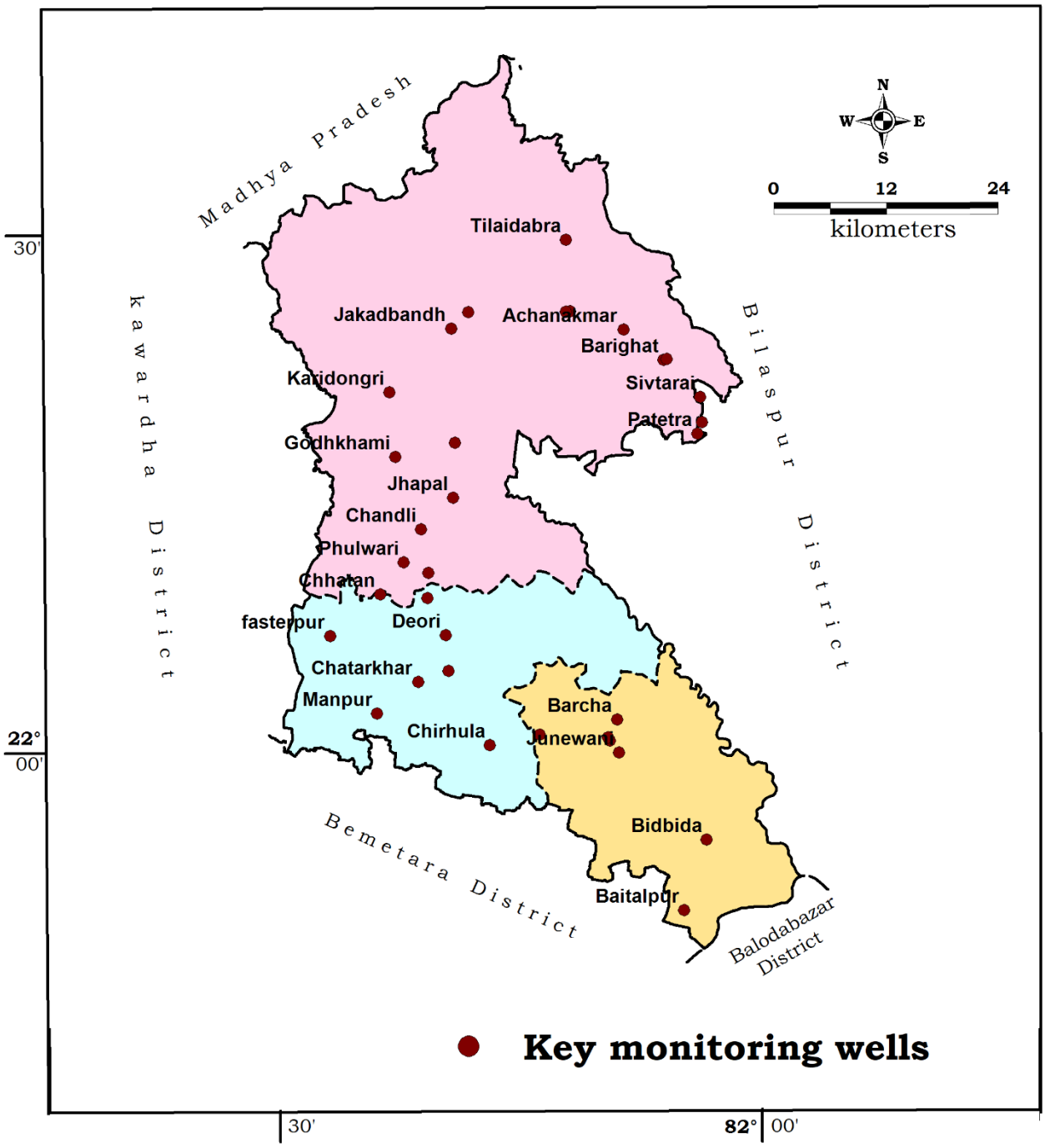

Figure 8 Key Montoring Wells of the study area

The semi-consolidated rocks of study area mainly represented by Bastar gneiss and Chhattisgarh Super Group of rocks (Predominantly by Maniyari Formation followed by Hirri, Tarenga and Pandaria formation) which consists mainly of shale and limestone. In general two aquifers exist in the area. The depth range of the first shallow unconfined/ phreatic

aquifer between 5.6 to 39 mbgl and the second fractured aquifer below 20 mbgl. It has been found that within the fractured aquifer, there are 1-6 nos. of water bearing zones are found with 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 covering all the geological formations, the details of which are presented in the Figure 8 and Annexure 1.

2.1.1 Water level behavior

Pre-monsoon and Post-monsoon depth to water level maps as well as seasonal fluctuation maps have been prepared on the basis of the depth to waterlevel periodically monitored data of the key wells established in the study area.

i. Pre- monsoon waterlevel

In the pre-monsoon period, it has been observed that in the study area water level in phreatic aquifer vary between 3.64 to 18.8 m bgl with average water level of 8.17 m bgl. shown in Table 5(A).

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

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Mungeli	**Phreatic aquifer**	3.64	18.8	8.17

ii. Post- monsoon waterlevel

In the post-monsoon period, it has been observed that in the study area, water level in phreatic aquifer varies between 0.8 to 7.9 m bgl with average water level of 3.33 m. In deeper fractured aquifer, water level varies between 2.3 to 36.66 m bgl with average water level of 8.38 m bgl shown in Table 5(B).

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

District	Aquifer Type	Min (m. bgl)	Max (m. bgl)	Avg (m. bgl)
Mungeli	**Phreatic aquifer**	0.8	7.9	3.33
	Fractured Aquifer	2.3	36.66	8.38

iii. Seasonal water level fluctuation:

The water level fluctuation data indicates that in the study area, water level fluctuation in phreatic aquifer varies from 0.15m to 9m with an average fluctuation of 4.51m shown in Table 5(C).

Table 5(C) Aquifer wise Depth to Water Level Fluctuation

District	Aquifer Type	Min	Max	Avg
Mungeli	**Phreatic aquifer**	0.15	9	4.51

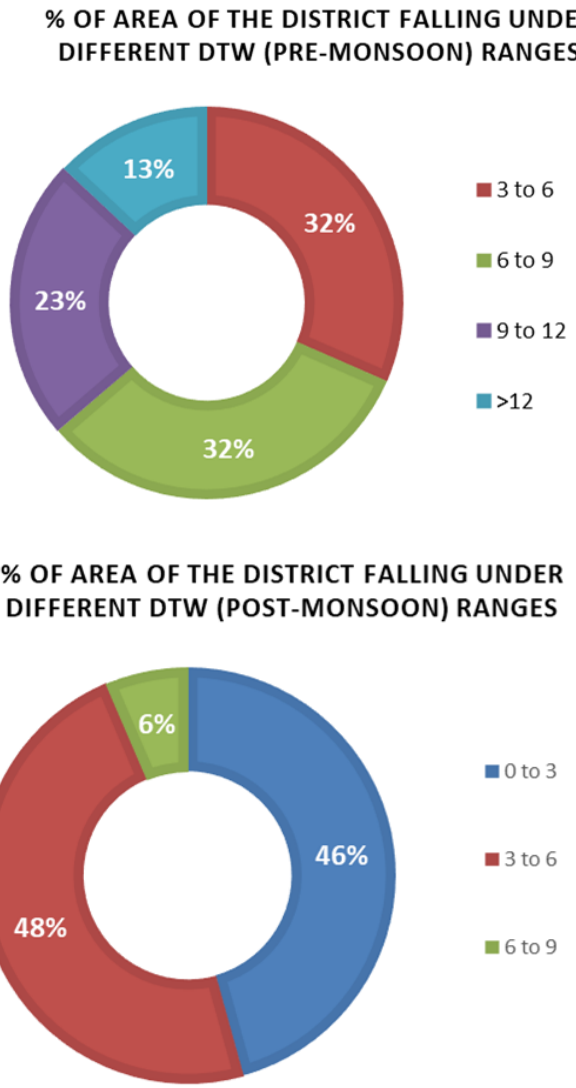

Figure 9 Pie diagram depicting the percentage of study area falling under different DTW (in m) ranges during premonsoon and postmonsoon

Pre-monsoon Depth to Waterlevel Map (Phreatic Aquifer)

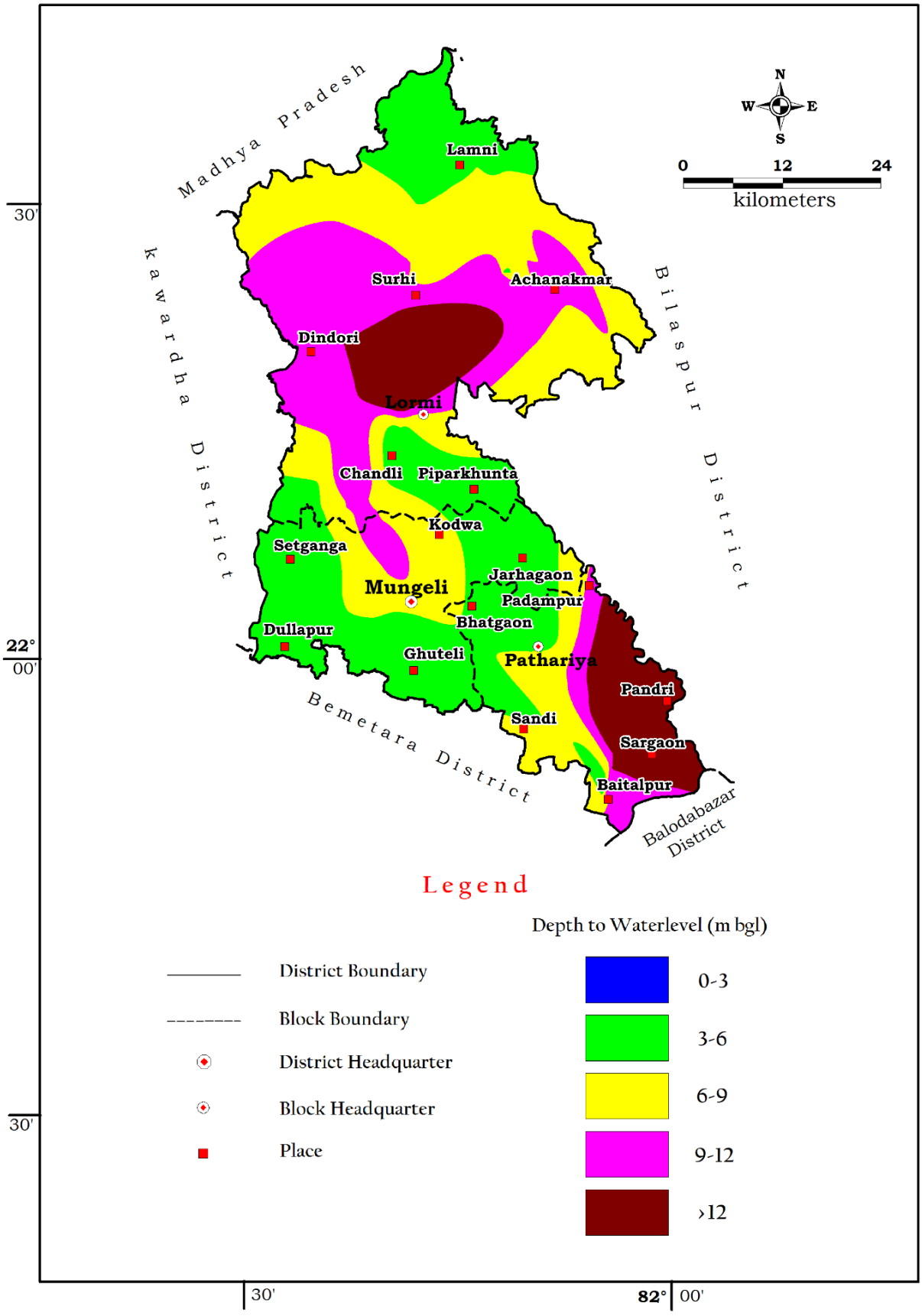

Figure 10 Pre-monsoon Waterlevel Map of Phreatic Aquifer

Post-monsoon Depth to Waterlevel Map (Phreatic Aquifer)

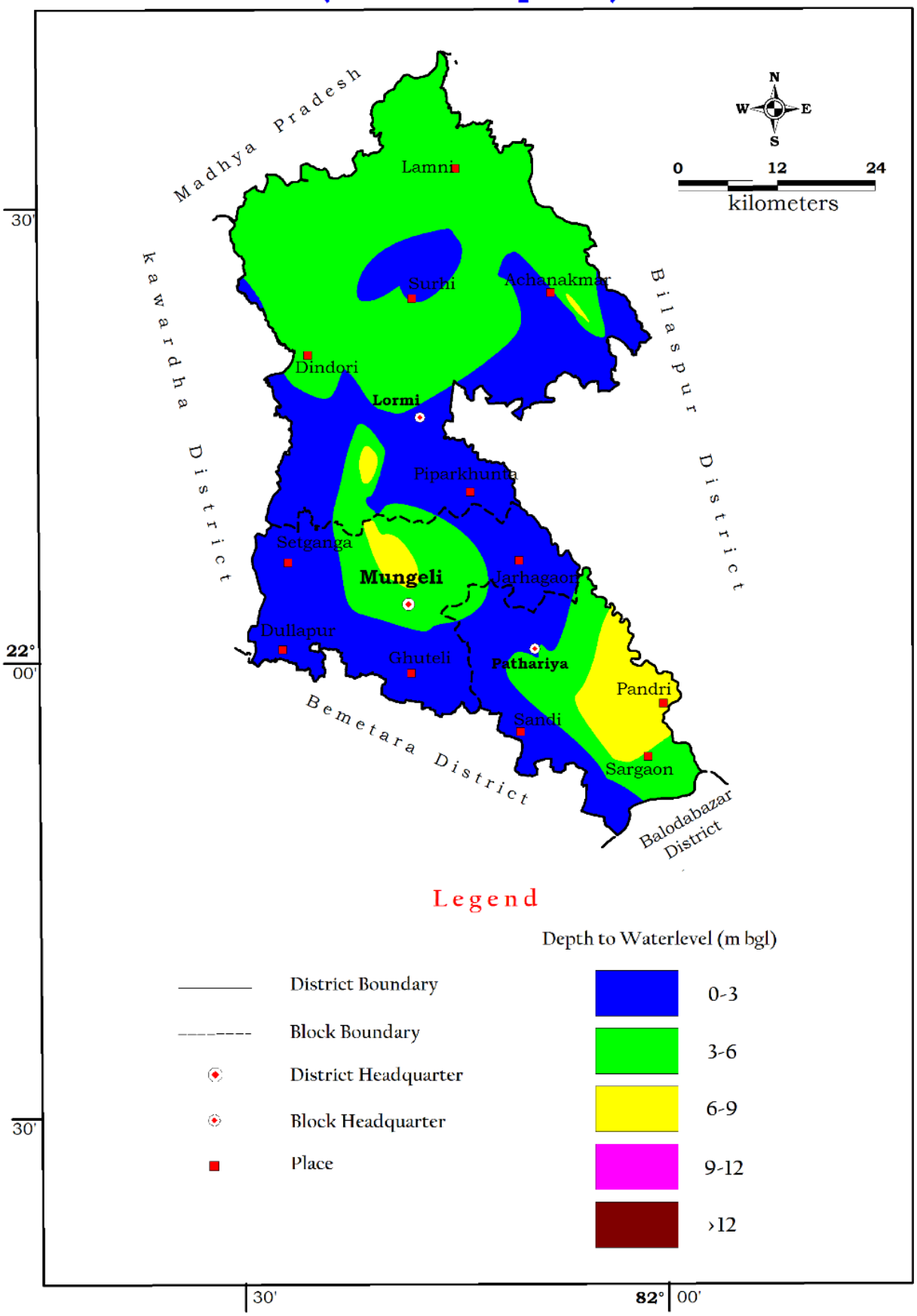

Figure 11 Post monsoon Water Level Map of Phreatic Aquifer

Post-monsoon Depth to Waterlevel Map (Fractured Aquifer)

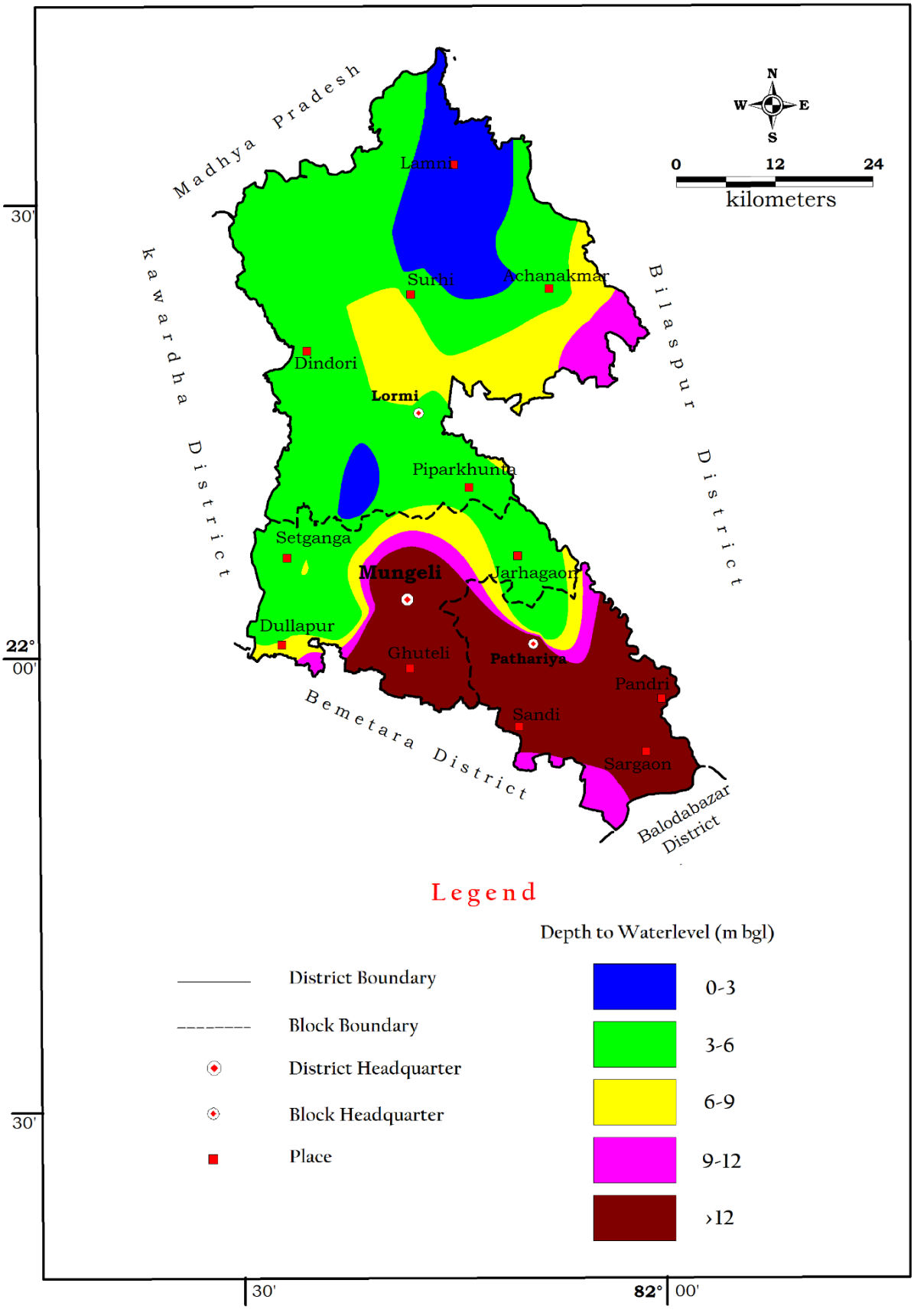

Figure 12 Post monsoon Water Level Maps of Fractured Aquifer

Ground Waterlevel Fluctuation Map
(Phreatic Aquifer- Pre monsoon Vs Post-monsoon)

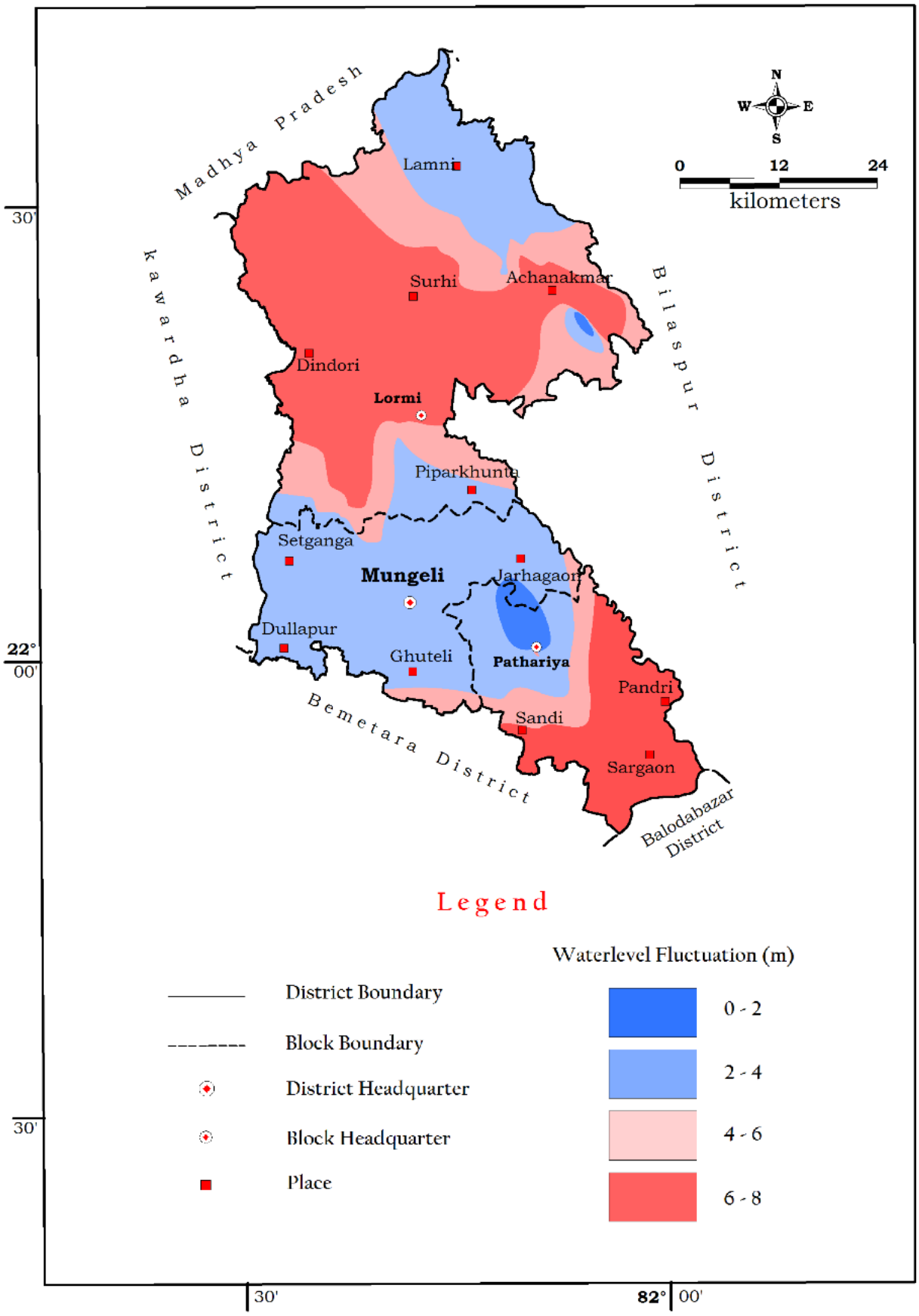

Figure 13 Water level fluctuation of phreatic aquifer

2.2 Hydrochemical Data

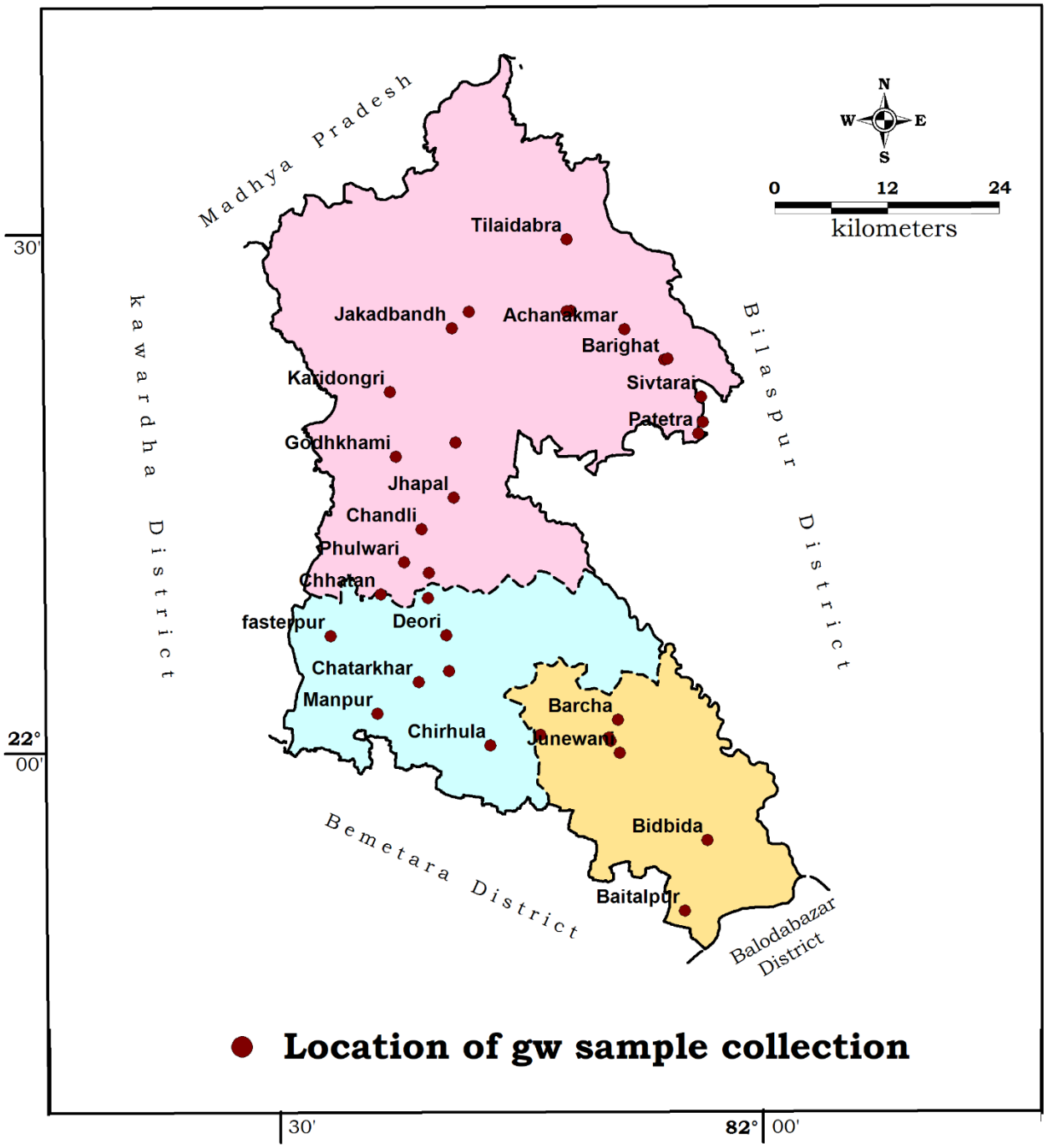

Figure 14 Location of hydrochemical data collection

To know the hydro chemical behaviour of the ground water in the study area, ground water samples were collected from the key wells and (NHNS) during pre-monsoon period of measurement. Also water samples were collected from borewells during exploration carried out in the area and analysed in the chemical laboratory of Central Ground Water Board, NCCR, Raipur for determination of various chemical parameters. The results and findings are presented in Annexure 3

2.3 Exploratory Data

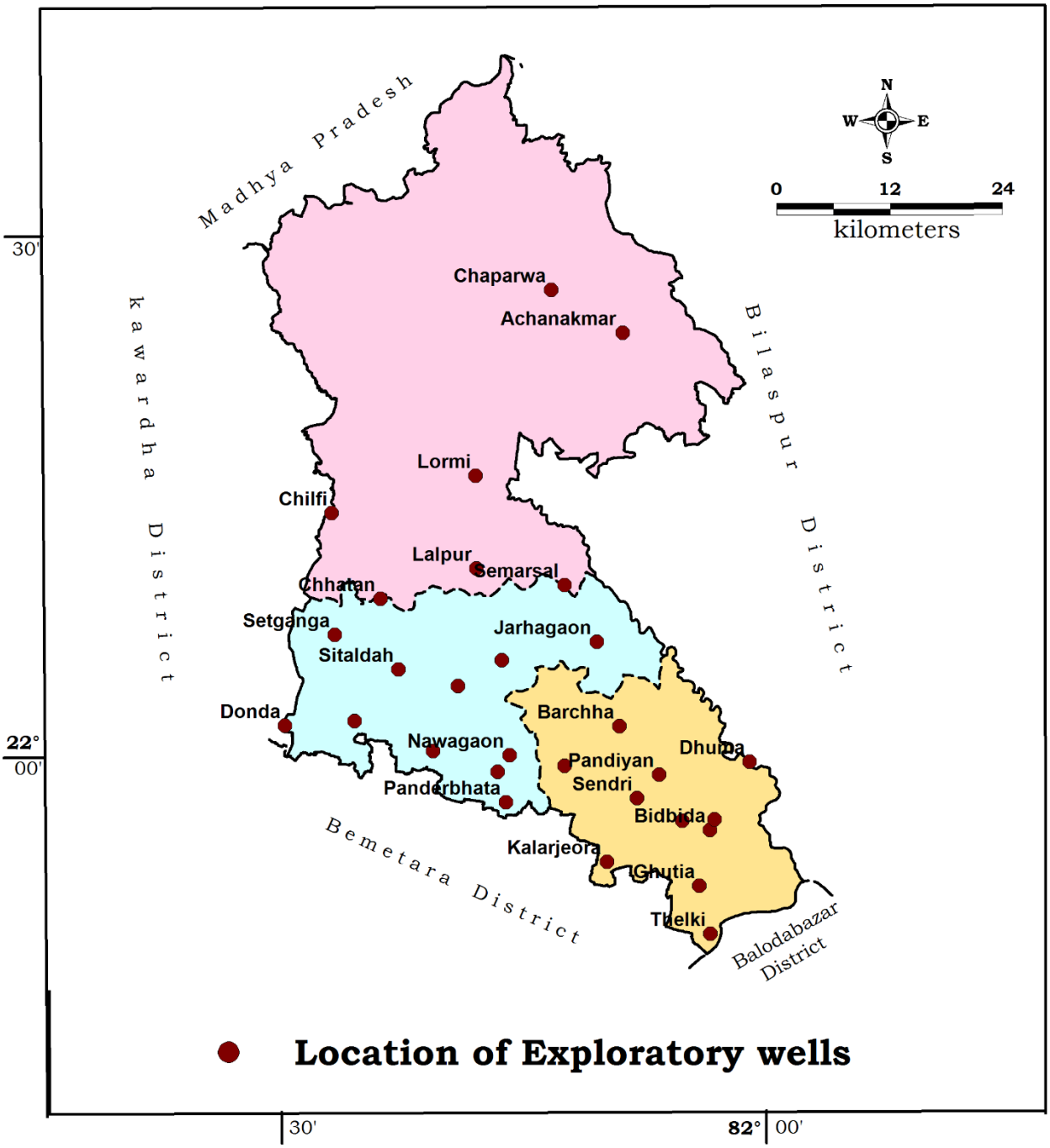

Figure 15 Location of Exploratory wells in the study area

A total of 30 Exploratory well exist in the study area out of which 24 nos. are existing exploratory well and and 06 nos. are newly generated exploratory wells in the study area. Location of the exploratory wells shown in Figure 14. The results and findings are presented in Annexure 2

2.4 Geophysical Data

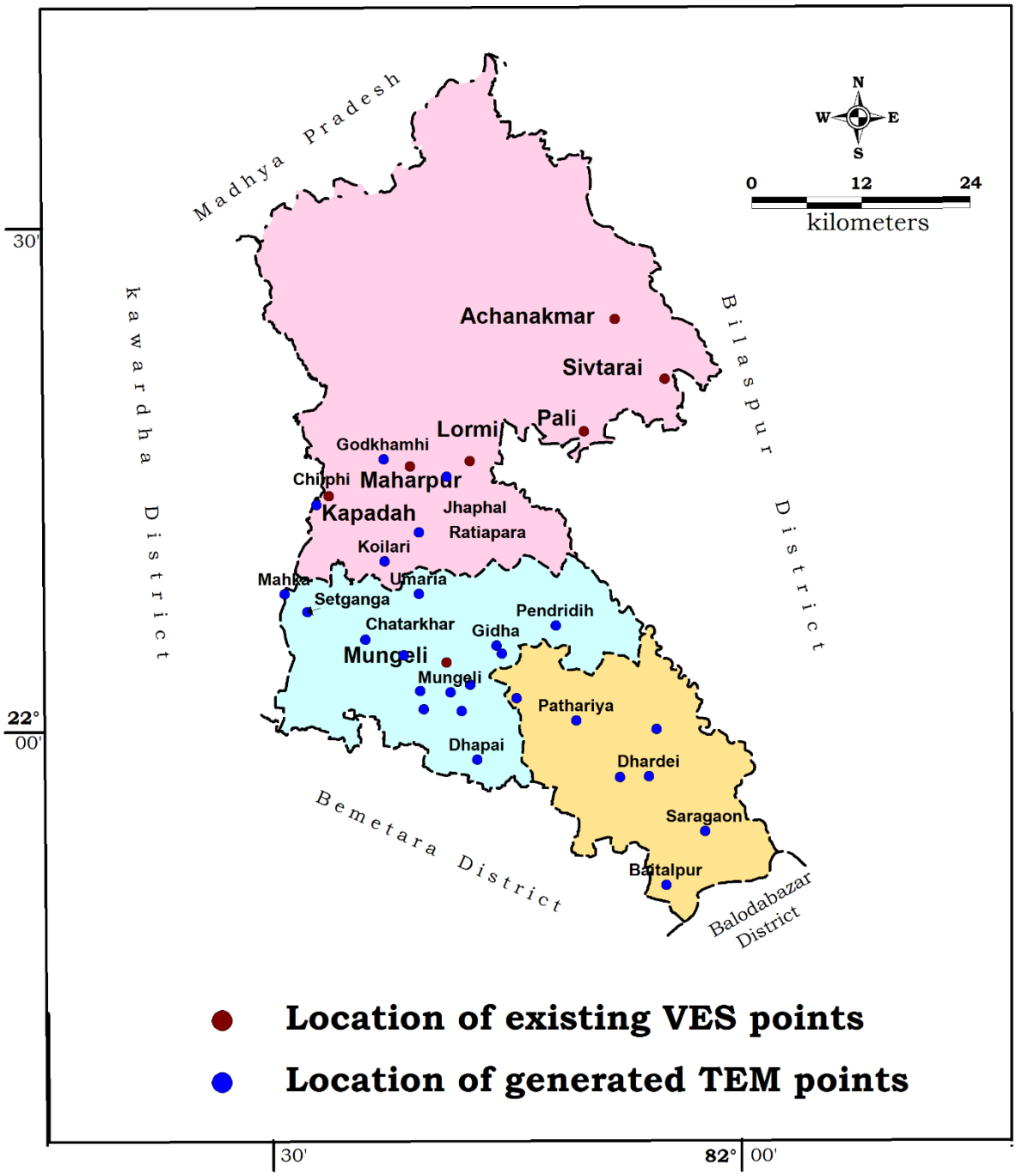

Figure 16 Location of VES and TEM survey

A total of 33 geophysical survey was done in the study area out of which 07 nos. are existing VES survey and 26 nos. are newly TEM survey in the study area. Location of both the VES survey and TEM survey shown in Figure 16.

3. AQUIFER DISPOSITION AND GROUND WATER RESOURCES

3.1 Aquifer Geometry and Characterization

Based on the exploratory drilling data generated for the blocks (Annexure 3), the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer. The major aquifers present in the study area is 1. Shale (Maniari), 2. Limestone (Pandaria and Hirri) and Granite gneiss (Bastar gneiss). Details are represented in Table 6.

Table 6 Aquifer Characteristics of Mungeli District

CHARACTERISTICS	**AQUIFER SYSTEM**	
	Weathered	**Fractured**
Major Rock type	Shale, Limestone, Granite gneiss	Shale, Limestone, Granite gneiss
Weathered thickness (mbgl)	5.6 to 39	-
Depth range of the aquifer (mbgl)	5.6 to 39	14 to 50
Fracture encountered (mbgl)	-	12 to 155
No. of waterbearing zones	-	1 to 6
Transmissivity (m^2/day)	-	0.2 to 235 (Avg- 75.63 m^2/day)
Yield	10 to 130 m3/day	Up to 26 lps
Sustainability	1 to 4 hours	0.5 to 7 hours

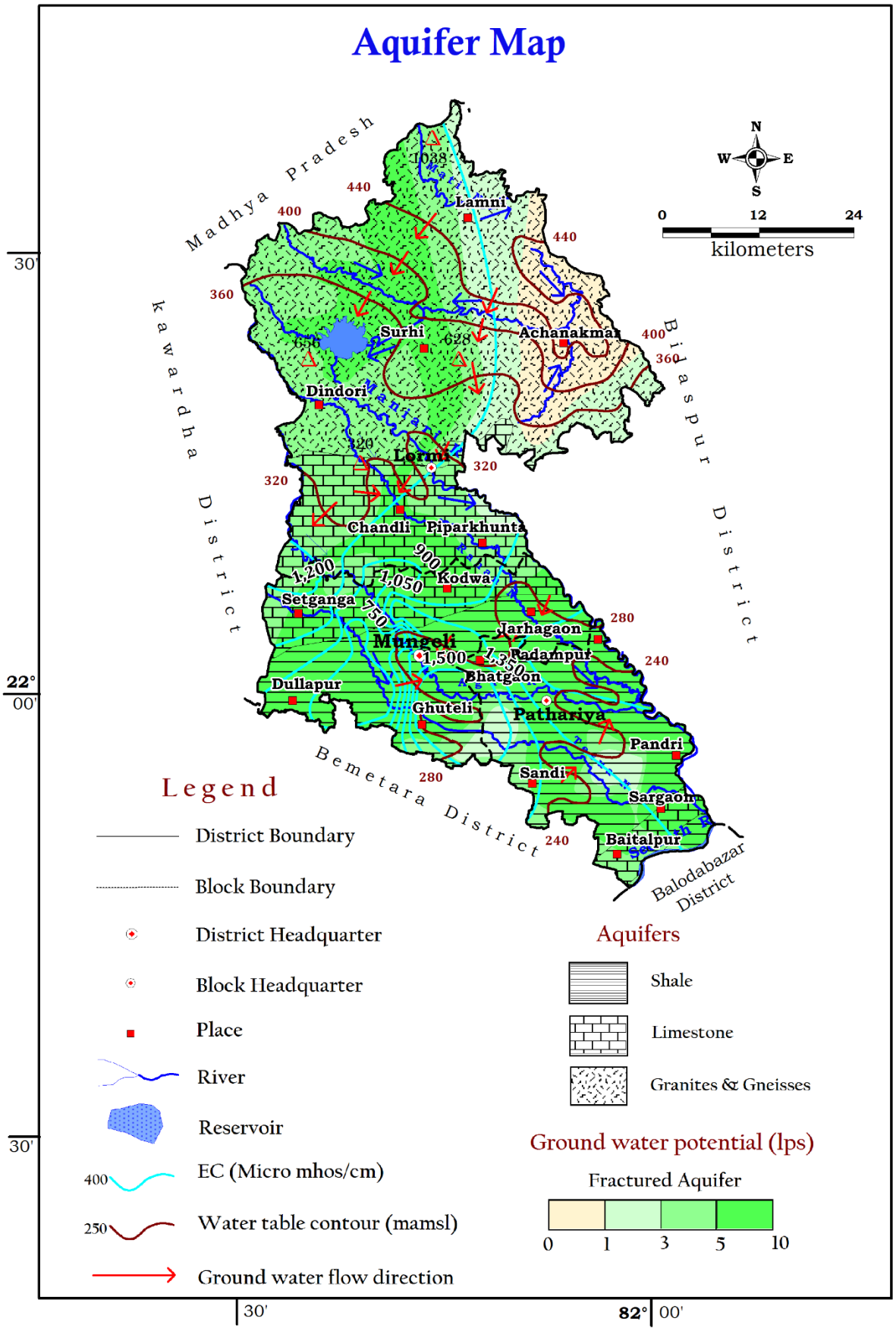

Figure 17 Aquifer Map of Study Area

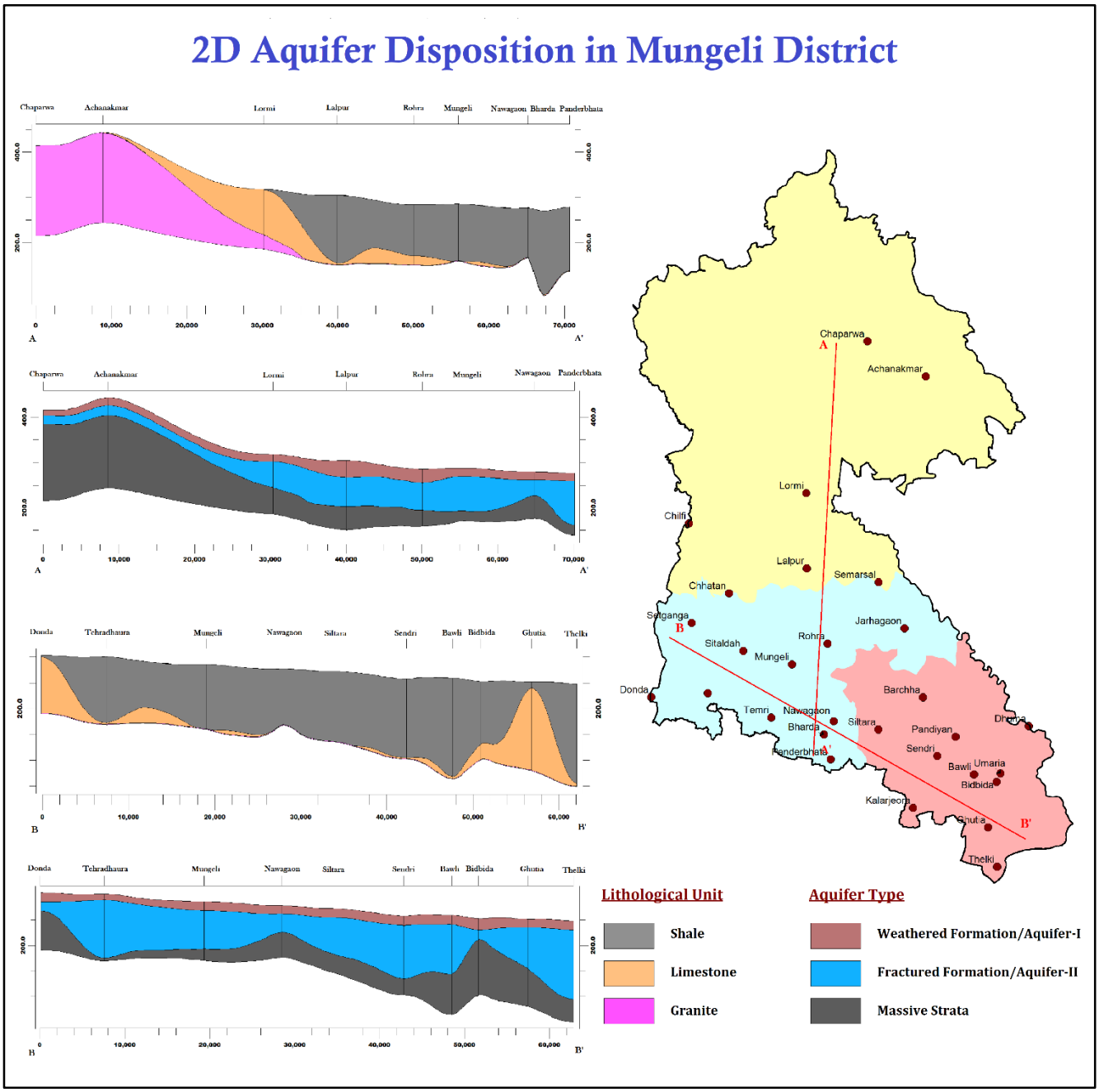

Figure 18 Cross-section of Study area

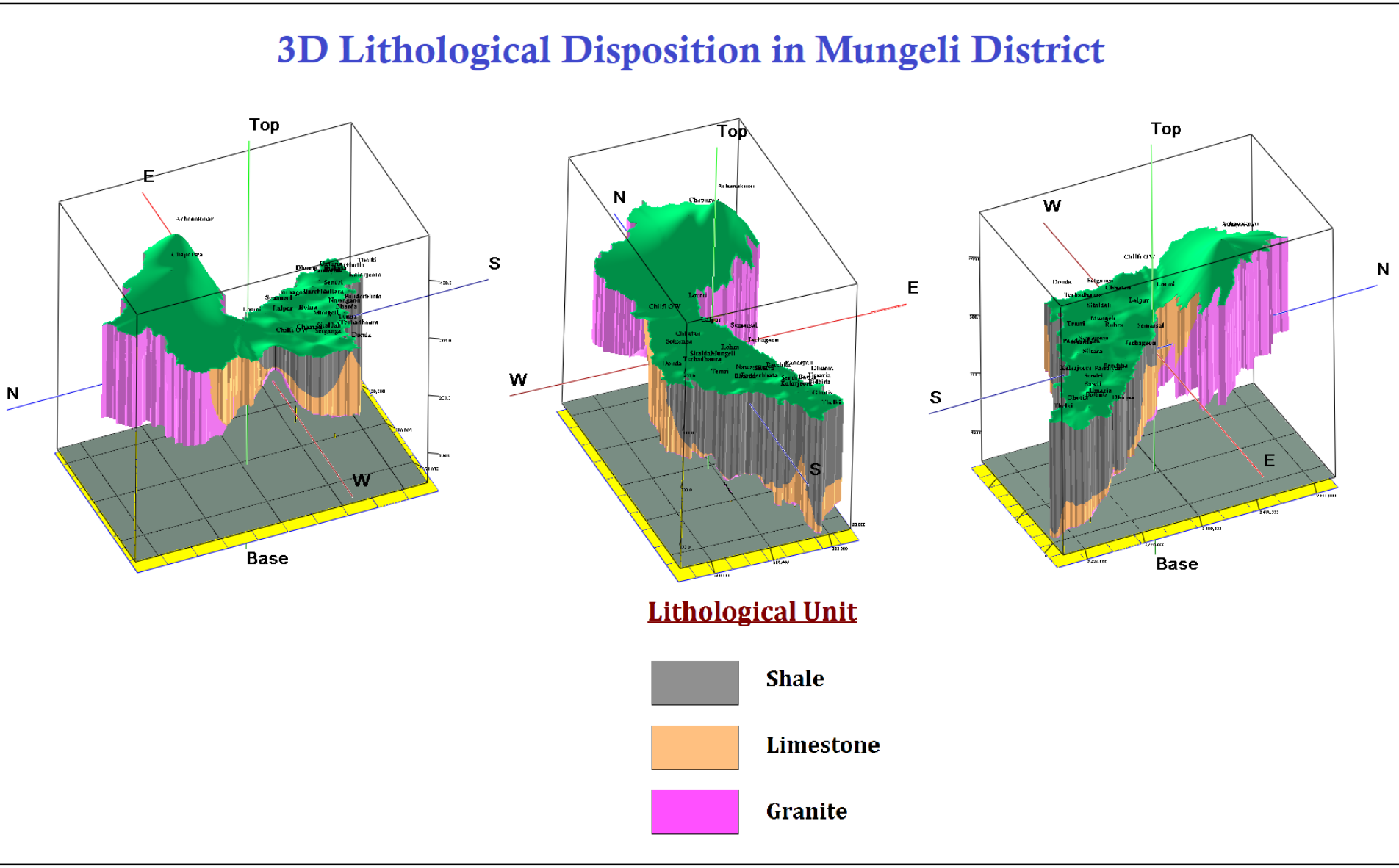

Figure 19 3D lithological disposition in study area

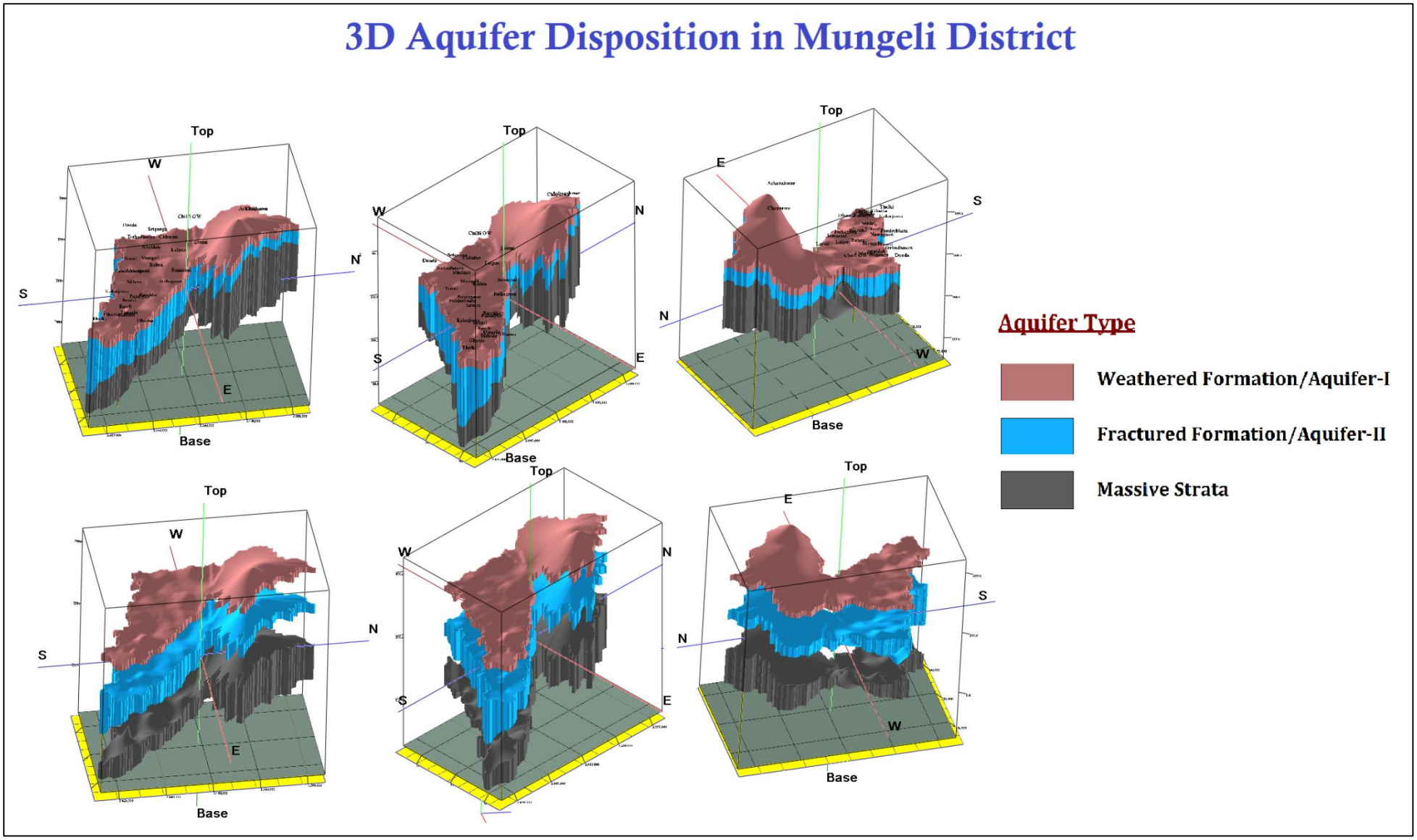

Figure 20 3D Aquifer disposition in study area

3.2 Groundwater Resources Availability and Extraction

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

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

Stage of ground water extraction of the Mungeli district is **58.12%**. The category and stage of ground water extraction of all the blocks in the district are given in the Table 7. Based on the resource assessment made, the resource availability in Block wise in Mungeli district upto 200m depth is given in Table 8.

Table 7 Blockwise stage of extraction and Category

District	Block Name	Stage of Ground Water Extraction (%)	Category
Mungeli	**Lormi**	52.81	Safe
	Mungeli	62.52	Safe
	Patharia	58.16	Safe

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

District	Block	Dynamic Resources (Ham)		Insitu Resources (Ham)		Total Resources (Ham)
		Aquifer I	Aquifer II	Aquifer I	Aquifer II	
Mungeli	Lormi	4757.33	80.78	140.29	2365.90	7344.30
	Mungeli	5767.49	198.55	184.52	2715.78	8866.34
	Pathariya	3735.87	51.78	162.94	2278.83	6229.42

3.3 Existing and Future Water Demand (2025)

Table 9 Ground Water Resources of the Study area in Ham

Block	Total Annual Ground Water (Ham) Recharge	Total Natural Discharge (Ham)	Annual Extractable Ground Water Resourse (Ham) (3=1-2)	Current Annual Ground Water Extraction (Ham)				Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use (9=3-4-5-8)	Stage of ground water Extraction in % (7/3 *100)
				Irrigation Use	Industrial Use	Domestic Use	Total Extraction (7=4+5+6)			
	1	2	3	4	5	6	7	8	9	
Lormi	5285.92	528.59	4757.33	2132	0.072	380.24	2512.32	457.89	2167.36	52.81
Mungeli	6408.34	640.85	5767.49	2874.15	0.252	731.31	3605.72	899.63	1993.45	62.52
Pathariya	4150.97	415.1	3735.87	1552.803	15.444	602.13	2170.38	879.46	1288.16	58.10
TOTAL	**15845.23**	**1584.54**	**14260.69**	**6558.94**	**15.768**	**1713.68**	**8288.42**	**2236.98**	**5448.97**	**58.12**

Total annual ground water recharge and annual extractable ground water resource of the district have been estimated to be 15845.23 Ham and 14260.69 Ham respectively. Gross ground water Extraction for all uses in the district is 8288.42 Ham. The existing demand for irrigation in the area is 6558.94 Ham while the same for domestic use is 1713.68 Ham and for industrial field is 15.768 Ham. To meet the future demand for ground water, a total quantity of **5448.97** Ham of ground water is available for future use.

4. GROUND WATER RELATED ISSUES

- **Drying of Dugwells during summer-** At several places of Mungeli and Pathariya block phreatic aquifer i.e. zone of dugwells dried up in summer due to large number of shallow borewells in the area.
- **Inherent hydrogeological character of aquifer-** The fractures are also very localised which results very low yield and less transmissivity in aquifers.
- **Drilling difficulty:** Due to clay inclusion in cavernous limestone drilling can not be progressed beyond the clayey zone so well construction in Limestone aquifer system is problemetic in Bilashpur district.
- **Iron concentration-** Iron concentration observed at places of Mungeli district more than permissible limit.

5. GROUND WATER MANAGEMENT STRATEGY

- It has been observed during fieldwork, there is colossal wastage of groundwater through private well and public water supply system. So, Information, Education and Communication (IEC) activities need to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to aware people about the importance of community participation in saving water.
- Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures may be constructed in villages to reduce stress on groundwater.
- It has been observed that the demand of ground water is increasing for irrigation, industrial and domestic uses. At locations where water level is declining, we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in the district to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial recharge structures feasible in the block are described in Table 10.

Table 10 Types and number of Artificial Recharge structures feasible

Block/District	Area Identified for Artificial recharge (sq.km)	Vol. of Sub Surface Potential for Artificial recharge (MCM)	Types of Structures Feasible and their Numbers			
			Percolation tank	Nalas bunding cement plug/ check dam	Gravity head /Dug well/ tube well/Recharge shaft	Gully plugs Gabion structures
Recharge Capacity - (MCM)/structure			**0.2192**	**0.0326**	**0.00816**	**0.0073**
Lormi	172.35	17.072	52	174	420	311
Mungeli	342.64	15.419	47	157	380	281
Pathariya	435.96	23.914	73	244	589	436
Total (Mungeli)	**950.95**	**56.405**	**172**	**575**	**1389**	**1028**

- Abandoned tube well and dug well may be used for the recharge through shaft especially in urban and water stressed areas.
- In urban areas STP may be installed for the treatment of sewage water in proper numbers to avoid contamination of ground water. Treatment of sewage water in village through soak pit for the individual houses and Seechewal model or similar model for community level may be adopted to avoid contamination of ground water. Treated water may also be reused for irrigation and other industrial purposes.
- Since the stage of development in the district is 58.12 %. There is scope of utilizing more ground water for future irrigation purpose. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources in the district (Figure 18). The ground water is presently developed through dug wells and tube wells. Yield potential for the block has been shown in Aquifer map (Figure 15). Sites for wells need to be selected only after proper scientific investigation. The ground water quality also needs to be ascertained and the wells used for water supply should be first checked for Iron, Fluoride and other pollutants.

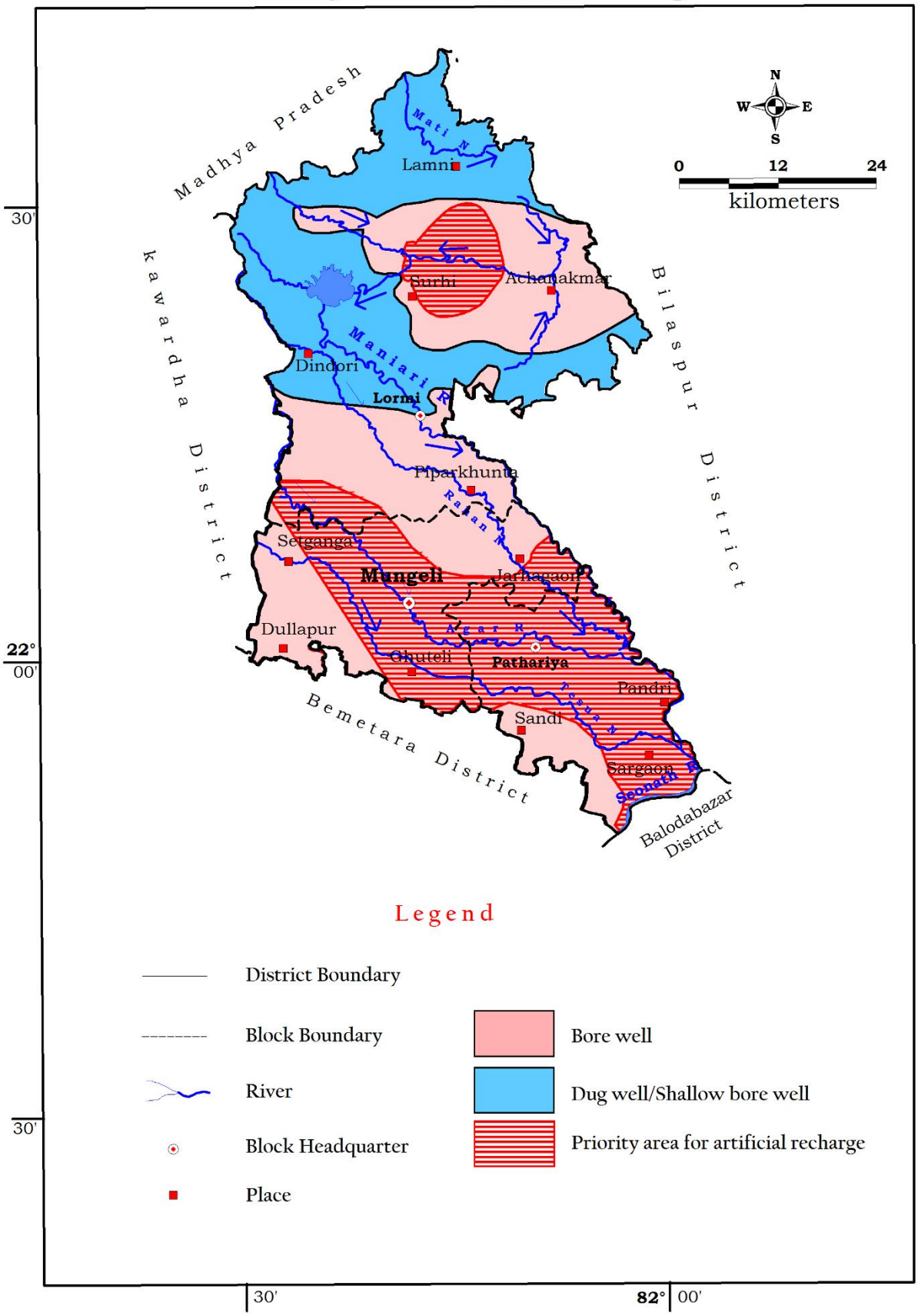

Figure 21 Feasibility of GW Abstraction and Area Identified for Artificial Recharge Map

Table 11 Additional groundwater abstraction structure proposed

Block	Annual Extractable Ground Water Resource (ham)	Stage of ground water Development (%)	Present ground water draft (ham)	Ground water draft at 60% stage of development (ham)	Surplus ground water at present Stage of Development (ham)	Number of TW Recommended in each block (Assuming unit draft as 1.6 ham/structure/ year)	Number of DW Recommended in each block (Assuming unit draft as 0.72 ham/structure/ year)	Additional Irrigation potential creation for Maize/ wheat in winter season in Ha (Assuming 500 mm water requirement)	Additional Irrigation potential creation for Paddy in Ha (Assuming 900 mm water requirement)
Lormi	4757.33	52.81	2512.32	2854.40	342.08	128	190	684.156	307.8702
Pathariya	3735.87	58.1	2170.38	2241.52	71.14	27	40	142.284	64.0278
TOTAL (Mungeli)	**8493.20**	**110.91**	**4682.70**	**5095.92**	**413.22**	**155.00**	**230.00**	**826.44**	**371.90**

6. CONCLUSION:

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

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

Block	Existing Gross Ground Water Draft for Irrigation in Ham	Additional Saving of GW after using Micro Irrigation methods in Ham(Assuming 30 % saving)	GW recharge through Artificial recharge structure in Ham	Total GW Resource Enhancement	Stage of Ground Water Extraction (%) As per 2020 GWRE	Expected Stage of Ground Water Extraction (%) after intervention
Lormi	2132	639.60	1707.20	2346.80	52.81	35.36
Mungeli	2874.15	862.25	1541.90	2404.15	62.52	44.12
Pathariya	1552.803	465.84	2391.40	2857.24	58.1	32.92
TOTAL (Mungeli)	**16945.33**	**5083.61**	**6059.84**	**11143.45**	**308.85**	**251.55**

Annexure 1 Details of key monitoring wells established

District	Block	Village	Lattitude	Longitude	Premonsoon waterlevel	Postmonsoon waterlevel	Fluctuation
Mungeli	Pathariya	Baitalpur	21.849937	81.917892	8.9	1	7.9
Mungeli	Pathariya	Bidbida	21.918088	81.941387	15.3	7.5	7.8
Mungeli	Pathariya	Junewani	22.002112	81.850457	7.8	4.9	2.9
Mungeli	Pathariya	Baitalpur	21.8583	81.9167	4.15	1	3.15
Mungeli	Pathariya	Chirhula	22.009167	81.716111	4.05	1.99	2.06
Mungeli	Pathariya	Chandargarhi	22.019	81.768	5.75	1.98	3.77
Mungeli	Pathariya	Chorbhatti	22.0167	81.8389	4.18	2.9	1.28
Mungeli	Pathariya	Pathariya	22.013256	81.840974	6.9	1.2	5.7
Mungeli	Mungeli	Deori	22.115	81.670556	9.6	6.9	2.7
Mungeli	Mungeli	Chatarkhar	22.0701	81.64173	6.7	3	3.7
Mungeli	Mungeli	Manpur	22.039465	81.59885	5.4	1.8	3.6
Mungeli	Mungeli	Fasterpur	22.11437	81.550396	4	1	3
Mungeli	Mungeli	Chhatan	22.154134	81.602117	6.5	3	3.5
Mungeli	Mungeli	Phulwari	22.185301	81.626852	11.08	3.8	7.28
Mungeli	Mungeli	Rajpur	22.1752	81.6522	7.3	2.2	5.1
Mungeli	Mungeli	Kanteli	22.150934	81.651389	11.58	6.6	4.98
Mungeli	Lormi	Barighat	22.3814	81.8997	11.93	3.2	8.73
Mungeli	Lormi	Bindabal	22.426667	81.795	10.12	4.98	5.14
Mungeli	Lormi	Rajpur	22.1752	81.6522	7.3	2.2	5.1
Mungeli	Lormi	Tilaidabra	22.496111	81.795	7.06	4.18	2.88
Mungeli	Lormi	Jhapal	22.247568	81.677897	4.8	0.8	4
Mungeli	Lormi	Godhkhami	22.287008	81.617814	11.5	2	9.5
Mungeli	Lormi	Nawagaon	22.300576	81.679759	18.8	4.9	13.9
Mungeli	Lormi	Karidongri	22.34923	81.611853	12	3.5	8.5
Mungeli	Lormi	Jakadbandh	22.410611	81.676095	10.8	3.6	7.2
Mungeli	Lormi	Ataria	22.426609	81.69371	8.18	1	7.18
Mungeli	Lormi	Saraipali	22.320305	81.936602	7.4	3.3	4.1
Mungeli	Lormi	Sivtarai	22.344827	81.934495	7.2	1.4	5.8
Mungeli	Lormi	Achanakmar	22.409636	81.855179	10.63	1.5	9.13
Mungeli	Lormi	Bindawal	22.427132	81.799465	5.7	2	3.7

Annexure 2 Details of Exploration in Mungeli District

Block	Location	Lattitude	Longitude	Depth	Casing	Lithology	Zonen encountered	Discharge (lps)	Draw down (m)	Transmissivity (m2/day)
Mungeli	Nawagaon	22.0031	81.735	101	15.7	Shale	22-26, 50	7	18.01	60.9
Patharia	Bidbida	21.9317	81.9417	138	22.38	Shale and Limestone	21-24	0		
Patharia	Ghutia	21.8783	81.9308	106	16.3	Limestone	16-18, 70.5, 86, 95	9.37	3.33	219.63
Mungeli	Jarhagaon	22.1119	81.825	150	17.8	Shale	20.5-25, 58.5, 118	7	19.84	92.37
Patharia	Dhuma	21.9972	81.9828	87	9.15	Shale	14-19,40.5, 54, 57.5	12.5	5.83	65.92
Patharia	Barchha	22.0311	81.8483	81	15.1	Shale	19.2, 27, 61	12	15.86	21.53
Patharia	Siltara	21.9933	81.7917	152	18	Shale	27-29,40	2	34	9.74
Patharia	Kalarjeora	21.9014	81.8358	152	14.3	Shale	28-31,64	5	3.82	186.14
Mungeli	Panderbhata	21.9583	81.7311	141	11.5	Shale	20, 60, 70, 118	3	21.35	18.48
Mungeli	Sitaldah	22.0856	81.6203	113	11.7	Shale and Limestone	30-34, 72, 103.5	14	16.73	119.83
Mungeli	Mungeli	22.0697	81.6819	132	17.9	Shale	14-16,32, 41.3	12.4	23	
Patharia	Pandiyan	21.9847	81.8897	152	26.45	Shale	24-26,40	5	7.06	102.08
Mungeli	Donda	22.0314	81.5033	113	17.8	Limestone	22, 27,35	9.5	13.65	136.75
Mungeli	Terhadhaura	22.0358	81.575	132	11.7	Shale	33-37, 68, 124, 127	9	10.93	67.86
Mungeli	Rohra	22.0942	81.7272	115	28.3	Shale	20-27,114.25	11	27.16	48.11
Mungeli	Chhatan	22.1531	81.6019	138	15.8	Limestone	16, 25, 44.5, 97.5, 134.9	3	24.29	2.69
Lormi	Lormi	22.2708	81.7	95	15.75	Limestone	18.5-20,30	3.5	16.73	9.74
Lormi	Semarsal	22.1661	81.7919	133	17.5	Shale	14-16,72	3.5	7.06	27.16
Lormi	Chilfi	22.235	81.5511	31	17	Limestone	20-24,42	14.5	6.19	16.73
Mungeli	Temri	22.0072	81.6558	107	11.6	Shale	23, 53, 68, 102	19	10.75	82.42
Mungeli	Setganga	22.1185	81.5546	92	5.6	Limestone	9-15, 32, 52.7	7	25.54	21.35
Lormi	Chilfi OW	22.235	81.5511	45	18	Limestone	25-26,35	35.6	13.04	86.74
Lormi	Achanakmar	22.4079	81.8518	200	18	Granite	38	0.5		0.09
Lormi	Chaparwa	22.449	81.7778	200	11.75	Granite	20-24,30	0		
Patharia	Thelki	21.832182	81.94248	200	18.1	Shale	21-24,39-42,57-60,94-97,152-155	3.5	16.34	14.59
Patharia	Sendri	21.962257	81.866498	155	18.2	Shale	21-24,45-48,63-66,76-79,91-94,121-124	10.16	8.8	
Patharia	Umaria	21.941697	81.946588	200	24.15	Shale	53, 93, 98	1.431	7.63	
Patharia	Bharda	21.987454	81.722536	200	11.9	Shale	0	0	0	0
Patharia	Bawli	21.9405508	81.9133071	200	18.15	Shale	27-30, 69-73, 97-100, 118-121	1.796	35.14	
Lormi	Lalpur	22.182298	81.700857	155	39	Shale	50-54,57-62,84-88,100-103	7.164	7.2	13.04

Annexure 3 Details of Chemical Analysis

Block	Location	Longitude	Lattitude	pH	EC	CO3	HCO3	Cl	F	SO4	TH	Ca	Mg	Na	K	Si
						mg/l										
Lormi	Achanakmar	81.8597	22.422	7.6	609	0	232	14	0.5	60	260	48	34	29	1.7	5
Lormi	Chandli	81.6446	22.2172	7.4	685	0	366	7	0.2	25	250	44	34	52	1.1	10
Lormi	Chhaparwa	81.7823	22.4504	7.5	796	0	183	14	0.4	110	300	64	34	52	1.4	22
Lormi	Fulwari	81.6262	22.1667	7.3	2030	0	683	20	0.2	85	700	68	127	145	0.5	18
Lormi	Jhapal	81.6794	22.2391	7.2	470	0	256	14	0.2	10	180	40	19	17	0.6	9
Lormi	Konchua	81.5849	22.3244	7.3	681	0	305	28	0.2	30	300	68	31	22	1.8	14
Lormi	Lormi	81.7069	22.2708	7.3	599	0	281	35	0.2	14	270	60	29	15	0.8	14
Lormi	Rajpur	81.6522	22.1752	7.3	688	0	366	7	0.3	16	300	40	48	32	0.9	10
Lormi	Tilaidabra	81.7865	22.1849	7.5	604	0	207	14	0.7	96	260	40	38	28	1.5	8
Mungeli	Amadob	81.7281	22.0781	7.5	1230	0	256	28	0.7	166	380	100	31	90	2.3	12
Mungeli	Chatarkhar	81.6417	22.0701	7.6	814	0	305	64	0.3	56	250	40	36	81	3.9	10
Mungeli	Chirhula	81.7161	22.0092	7.2	1940	0	647	220	1	112	780	192	72	69	96	10
Mungeli	Daukapa	81.8393	22.1176	7.3	1080	0	403	35	0.2	120	400	80	48	89	1.6	11
Mungeli	Deori	81.6706	22.115	7.2	1310	0	464	50	0.2	150	540	100	70	71	2	14
Mungeli	Godkhami	81.6456	22.019	7.5	605	0	207	14	0.7	87	270	40	41	27	1.6	10
Mungeli	Jaroundha	81.5644	22.1535	7.3	1216	0	451	21	0.4	140	520	140	41	55	1.4	10
Mungeli	Kanteli.1	81.65	22.1528	7.3	844	0	427	14	0.2	45	340	60	46	50	1.2	15
Mungeli	Khamaria	81.8435	22.0695	7.4	982	0	366	21	0.2	110	300	76	26	92	1.2	12
Mungeli	Mungeli	81.6868	22.0675	7.5	1221	0	549	21	0.4	80	330	40	55	146	1.2	12
Mungeli	Sitalkunda	81.6134	22.0826	7.5	698	0	415	7	0.1	4	340	68	41	16	1	6
Mungeli	Surada	81.6702	22.0868	7.5	666	0	220	28	0.7	55	220	40	29	59	1.5	11
Patharia	Baitalpur	81.9167	21.8583	7.5	713	0	329	21	0.2	55	330	72	36	23	1.4	8
Patharia	Barcha	81.8483	22.0336	7.4	1826	0	610	92	0.5	115	590	156	48	85	77	16
Patharia	Bindabal	81.795	22.0336	7.6	680	0	171	92	0.8	55	210	44	24	62	2.2	9
Patharia	Chandargarhi	81.768	22.019	7.4	1013	0	342	35	0.5	113	420	96	43	56	1.7	8
Patharia	Chandrakuri	81.9044	21.8388	7.5	666	0	220	28	0.7	55	220	40	29	59	1.5	11
Patharia	Patharia (chorbhatti)	81.8389	22.0167	7.2	2730	0	549	390	0.6	220	900	184	106	210	4.6	10