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

UMARIA DISTRICT, MADHYA PRADESH

उत्तर मध्य क्षेत्र, भोपाल

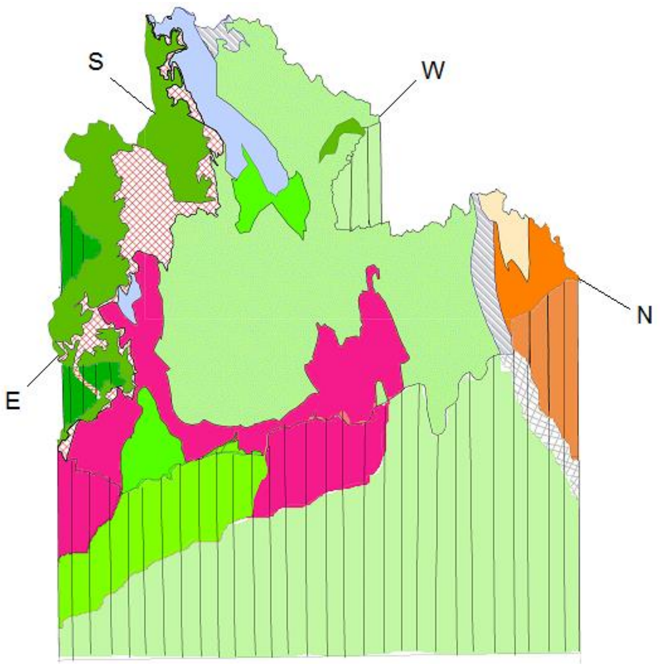
North Central Region, Bhopal

CENTRAL GROUND WATER BOARD

Department of Water Resources, RD& GR

Ministry of Jal Shakti

Aquifer Mapping and Ground Water Management Plan of Umaria District, Madhya Pradesh



By

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SOUTH EASTERN COASTAL REGION

CHENNAI

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Introduction

Groundwater is of paramount importance for an agriculture-based country like India. Being a predominant asset, the use of groundwater, primarily for irrigation and for various development activities over the years, has adversely affected the ground water regime in many parts of the country. This has in turn led to an emergent need for comprehensive and realistic information pertaining to various aspects of groundwater resources available in different hydro-geological settings through a process of systematic data collection, compilation, data generation, analysis and synthesis, which together brings in the concept of an Aquifer Mapping and Management Plan.

Objectives and scope of the study

The primary objective of Aquifer Mapping can be specified as “Know your Aquifer, Manage your Aquifer”. Systematic mapping of an aquifer incorporates activities such as collection and compilation of available information on aquifer systems, demarcation of their extents and their characterization, analysis of data gaps, generation of additional data for filling the identified data gaps and finally, preparation of aquifer maps at the desired scale.

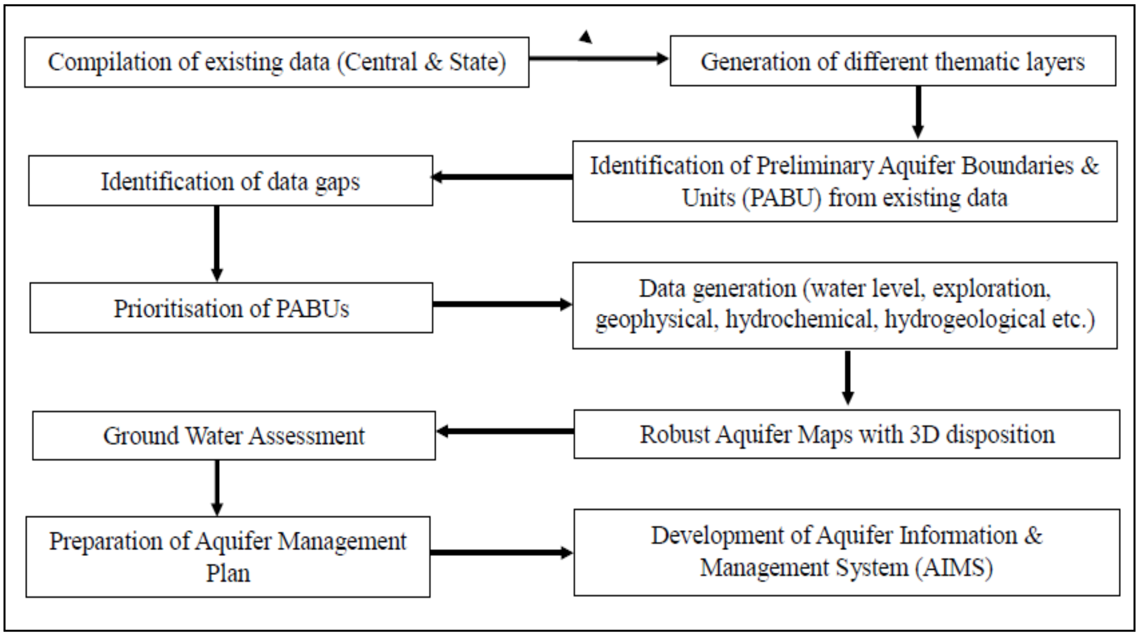
The two major objectives of the aquifer mapping are the delineation of lateral and vertical disposition of aquifers and their characterization at 1: 50,000 scale in general and further detailing up to 1: 10,000 scale in identified priority areas and the quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

Approach and Methodology

The aquifer mapping study in this report has been compiled on the basis of existing data that were assembled, analyzed and interpreted from available sources. The collected data was further prepared to generate regional hydro-geological maps, thematic maps, water quality maps, cross-sections, 2-D and 3-D aquifer dispositions and potentiometric maps eventually to define the aquifer geometry, type of aquifers, ground water regime behavior, hydraulic characteristics and geochemistry of multi-layered aquifer systems on 1:50000 scale. To achieve the objectives the following approach and methods have been adopted and stepwise details have been shown in the Fig 1.

- Data compilation
- Data gap analysis
- Data generation
- Preparation of block-wise aquifer maps and management plan

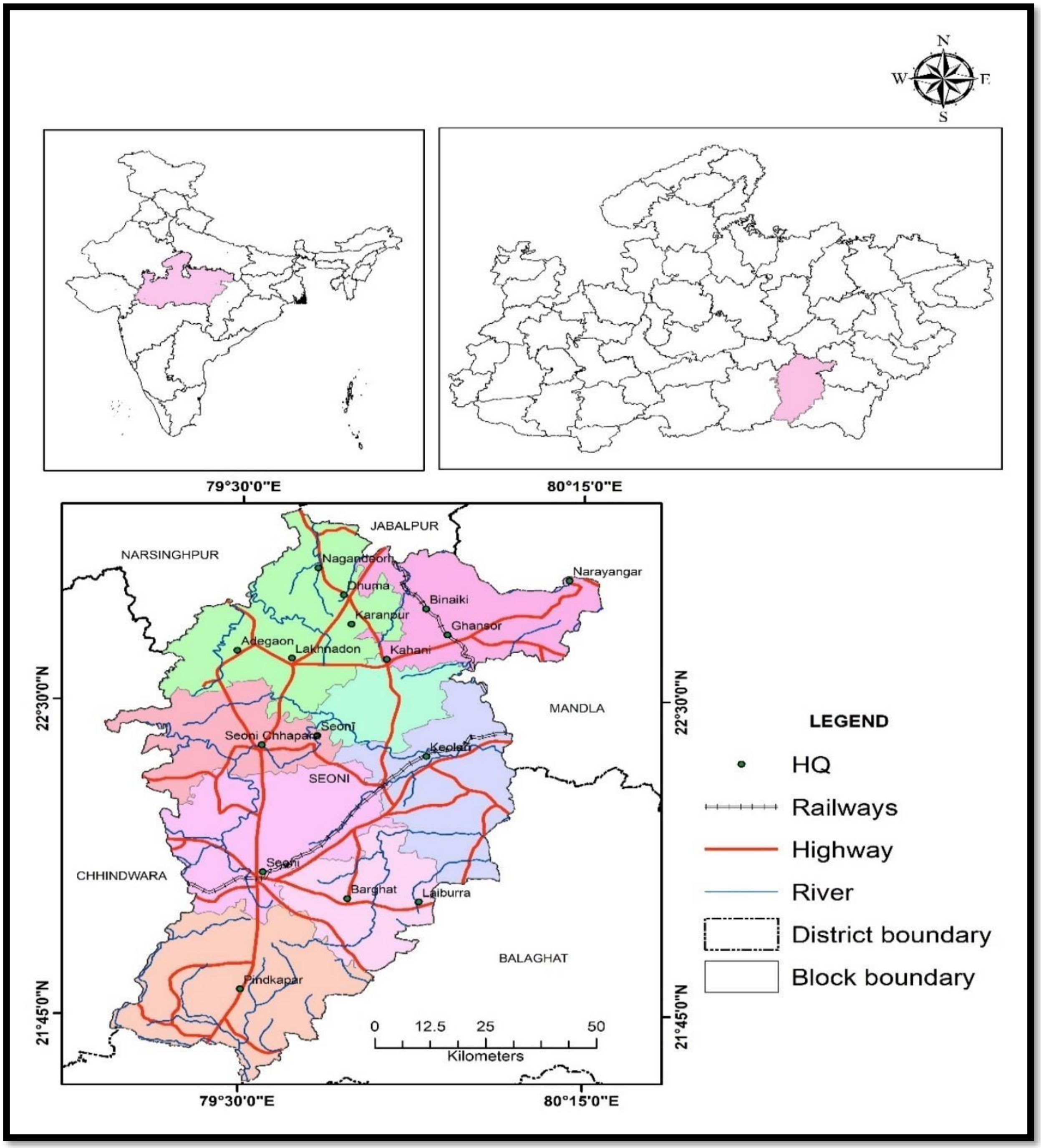
Figure 1: Aquifer mapping approach and methodology



Study Area

Umaria district is one of the newly formed district of Vindhyan region. Presently district headquarters Umaria was also formerly district head quarters of South - Rewa district of Rewa State till year 1948. The Umaria district is famous for Bandhogarh fort, which was formerly capital of Magha Kingdom, and is place of importance of Archaeological and historical considerations. Bandhogarh is also famous for its National Park having highest density of tigers in reserve forest of Tala. Umaria is a tribal district, where tribal population is 46% of the total population. Umaria district is also full of natural resources. About 53% of the area is covered with forest and it is abundance in mineral resources including coal and clay minerals. Coal based power plant is also located at Pali-Birsinghpur in the district having 840 Mega Watt Power Generation capacity. Umaria district lies in eastern part of Madhya Pradesh. It is bounded by Satna district in North, Dindori district in South, Shahdol district in ceast and Katni district in West. The district lies between north latitudes 23° 05' and 24° 20' and east longitudes 80° 40' and 81° 17'. Umaria district is falling under Survey of India Toposheets No. 63D/16, 63H/4, 64A 10,11,13,14,15, 15,16 64E 1,2,3,4,6,7 and 8.It extends for about 100 Kms from North to South and 66 Kms from East of West. The area of district is 4503 Sq.km.

Figure 2: Location map of Umaria district



Administrative Details

There are total 234 village panchayat in the district. District Head Quarters is located at Umaria town, which is also Tehsil Head Quarters Katni - Amarkantak State Highway is passing through the district. Broad-guage Railway line connection Katni - Bilaspur section is running parallel to State Highway. Important town and villages of Umaria district are connected by Pitch roads. Umaria district has been divided into two Tehsils namely Bandhogarh and Pali and three blocks namely Manpur, Karkeli and Pali for convenience of administrations.

Figure 3: Administrative Map

Table 2: Umaria District Profile

Description	2011	2001
Population	6.45 Lakhs	5.16 Lakhs
Actual Population	644,758	515,963
Male	330,674	265,128
Female	314,084	250,835
Population Growth	24.96%	22.60%
Area Sq. Km	4,076	4,076
Density/km2	158	127
Proportion to Madhya Pradesh Population	0.89%	0.85%
Sex Ratio (Per 1000)	950	946
Child Sex Ratio (0-6 Age)	943	959
Average Literacy	65.89	59.13
Male Literacy	76.02	72.89
Female Literacy	55.23	44.54
Total Child Population (0-6 Age)	103,414	97,729
Male Population (0-6 Age)	53,237	49,883
Female Population (0-6 Age)	50,177	47,846
Literates	356,672	247,303
Male Literates	210,907	156,899
Female Literates	145,765	90,404
Child Proportion (0-6 Age)	16.04%	18.94%
Boys Proportion (0-6 Age)	16.10%	18.81%
Girls Proportion (0-6 Age)	15.98%	19.07%

Table 3: Administrative Divisions

Station	Rainfall (mm)	Rainfall (m)	Area (Sq Km)	Area suitable for recharge (Sq Km)	Average post-monsoon water level (m)	Unsaturated zone (m)	Average SP Yield (%)
KARKELI	1248.8	1.2488	1730	1560	4.45	1.45	0.02
MANPUR	1248.8	1.2488	1899	1846	6.21	3.21	0.02
PALI	1248.8	1.2488	910	813	6.34	3.34	0.02
TOTAL			4539	4219	5.666667	2.666667	0.02

Chapter-2:

Data Availability, Adequacy, Data Gap Analysis and Data Generation

The data collection and compilation for various components was carried out as given below.

Hydrogeological Data: Current and historical water levels along with water level trend data of Dug wells representing Shallow aquifer (Aquifer-I) and piezometers representing Deep aquifer (Aquifer-II) of Central Ground Water Board. The water levels of private borewells wells representing Aquifer-II were also collected and compiled. Key wells were established, monitored during Pre-monsoon, Post-monsoon and water level data was generated at a larger scale.

Hydrochemical Data: Ground water quality data of 50 sampling points, which includes dugwells for shallow aquifer, borewells & hand pumps in the district representing deeper aquifer.

Exploratory Drilling: Ground water exploration data of drilled wells data collected from State Govt. of Madhya Pradesh.

Geophysical Data: The soil and weathered zone thickness of the district from the vertical electrical sounding data collected from State Govt. of Madhya Pradesh.

Hydrometeorological Data: 24 years (1998-2021) rainfall data from State Govt. of Madhya Pradesh was collected.

Water Conservation Structures: Numbers, type of water conservation structures prevailing in the district from MGNREGA.

Agricultural Data: Data on prevailing cropping pattern, Irrigation details collected from District Irrigation Plan prepared by PMKSY.

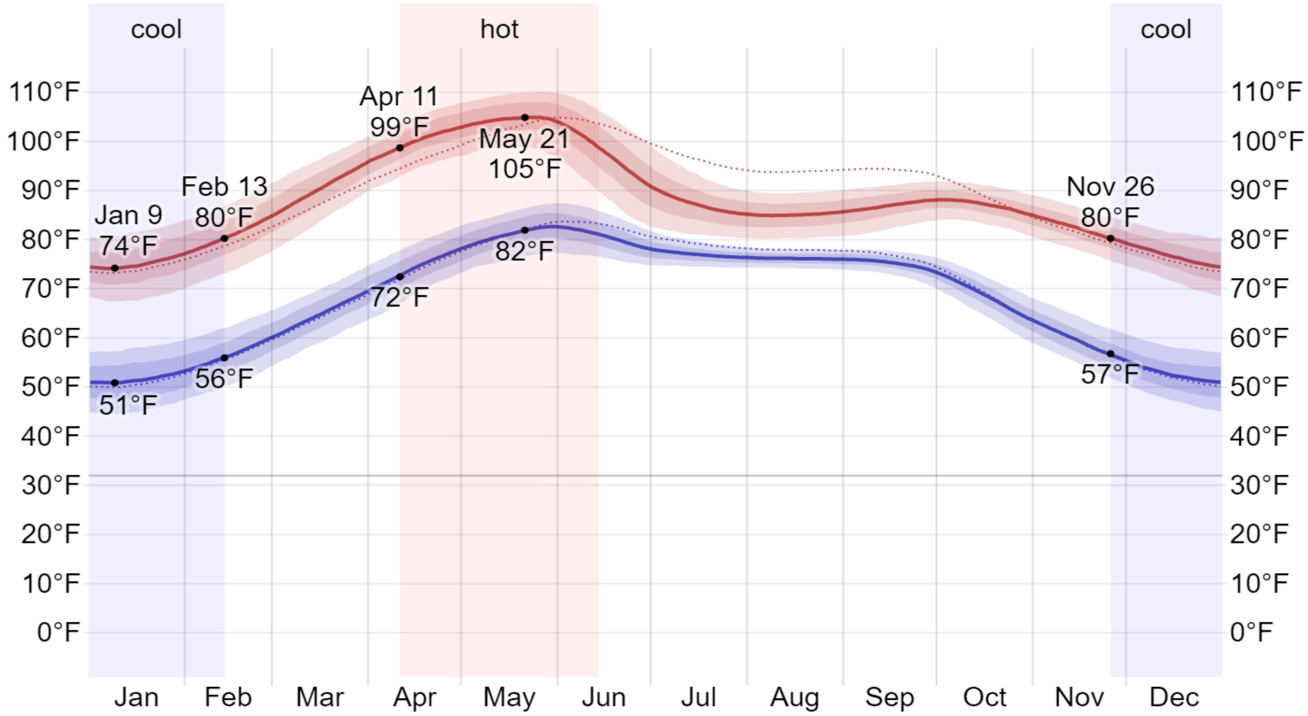
Climate and Rainfall distribution

Climate

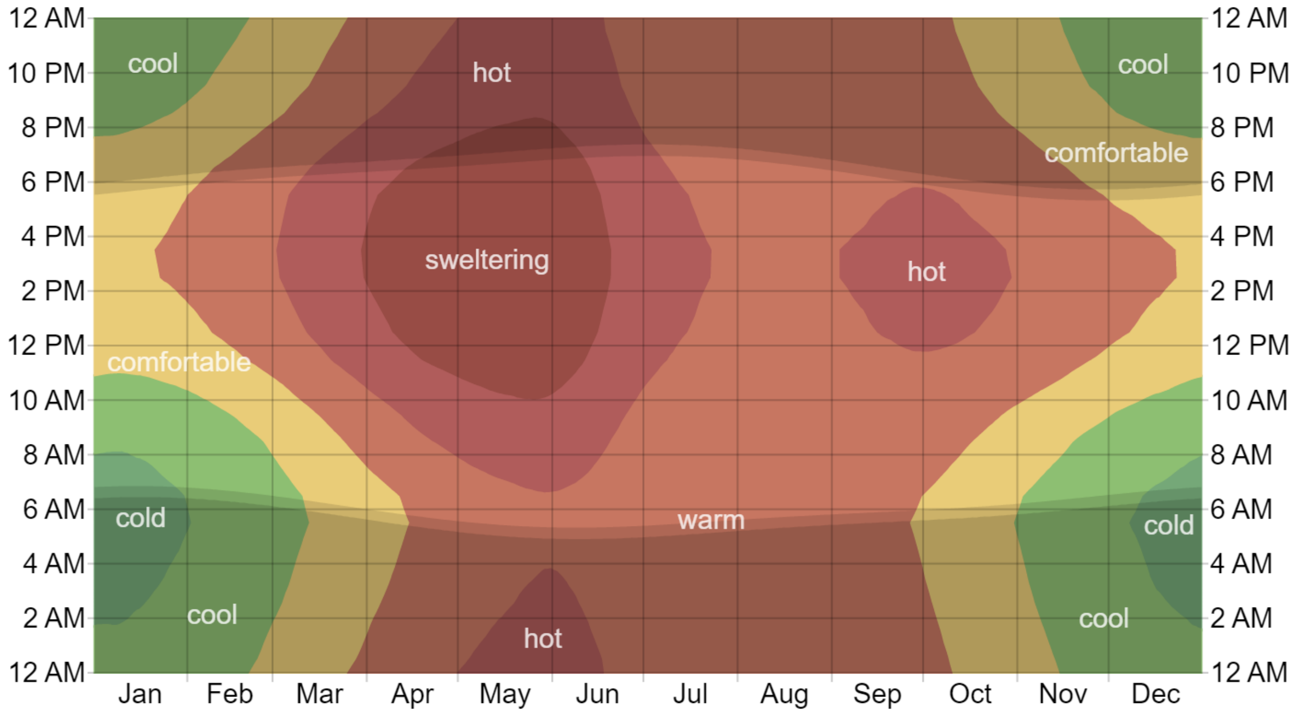
The Climate of this district is characterized by a hot summer and general dryness, except during southwest monsoon season. The year may be divided into four seasons. The cold season, December to February is followed by the hot season from March to about the middle of June. The period from the middle June to September is the southwest monsoon season. October and November from the post monsoon or transition period. There is only one IMD meteorological observatory located at district headquarters Umaria. Meteorological data of this observatory has been used for analysis.

Rainfall

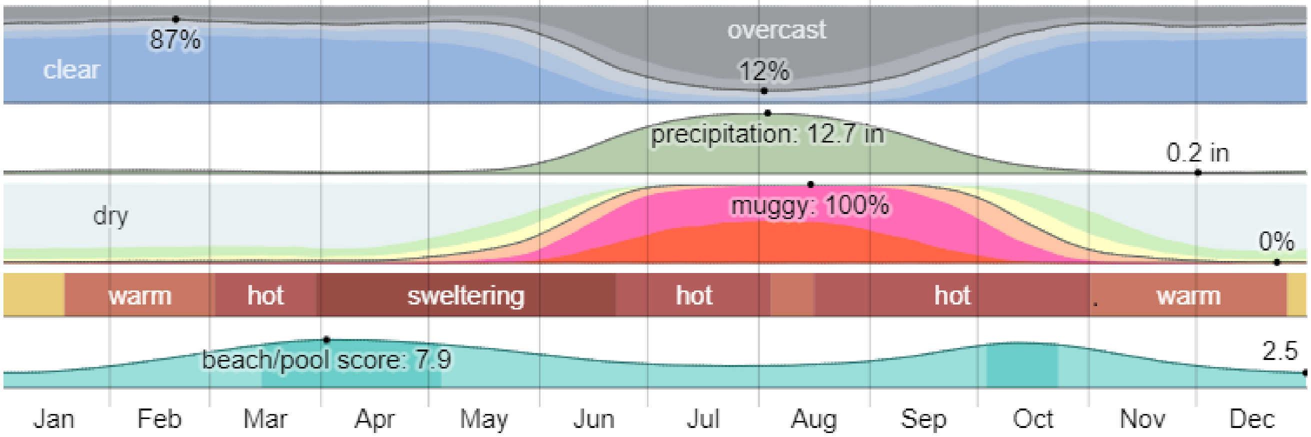
The average annual rainfall of Umaria district is about 1248.8 mm. The maximum rainfall takes place during the south-west monsoon period i.e. from June to September. The August month is the wettest month of the year and about 30% of the annual rainfall takes place only during this month. During winter & summer season about 10% & 3% of respectively rainfall takes place. From October to May, only 13% of the annual rainfall takes place.



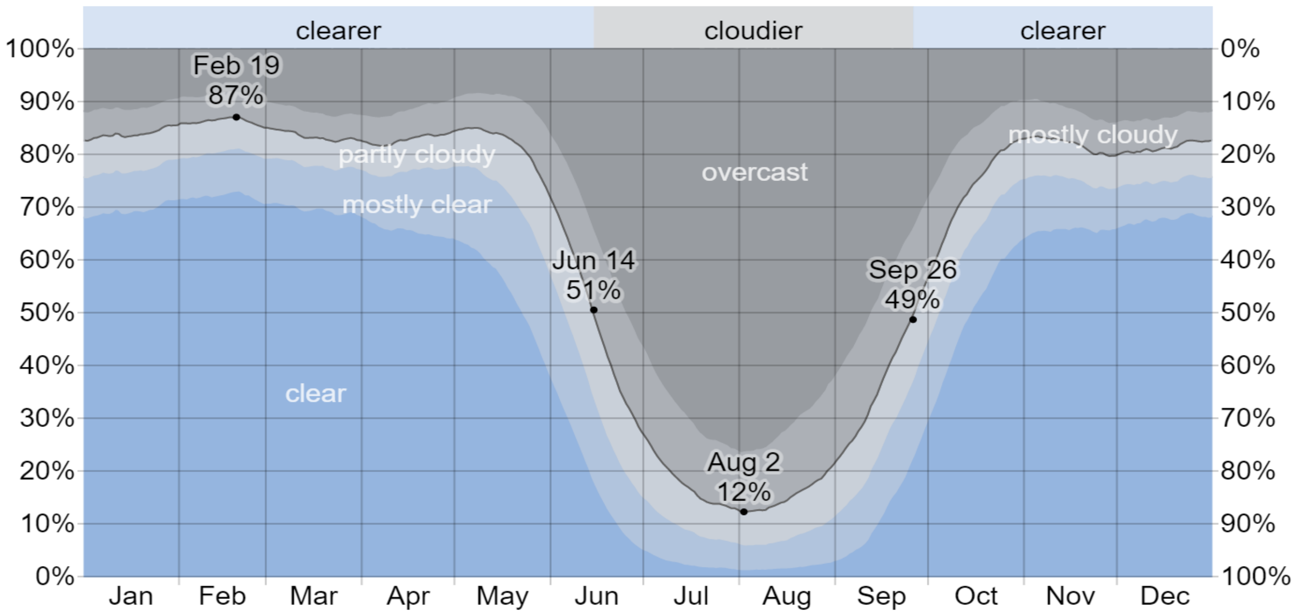
AVERAGE HIGH LOW TEMPERATURE IN UMARIA



AVERAGE HOURLY TEMPERATURE IN UMARIA

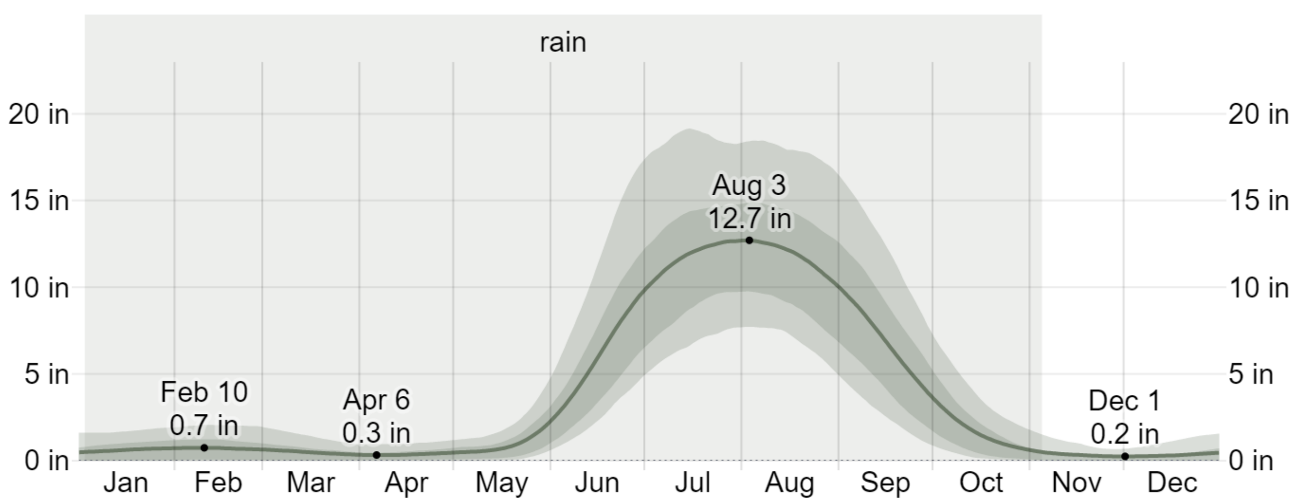


CLIMATE IN UMARIA



CLOUD COVER CATEGORIES IN UMARIA

Table 4 : Rainfall of Umaria District



Physiography/Digital Elevation Model

Figure 4: Digital Elevation Model

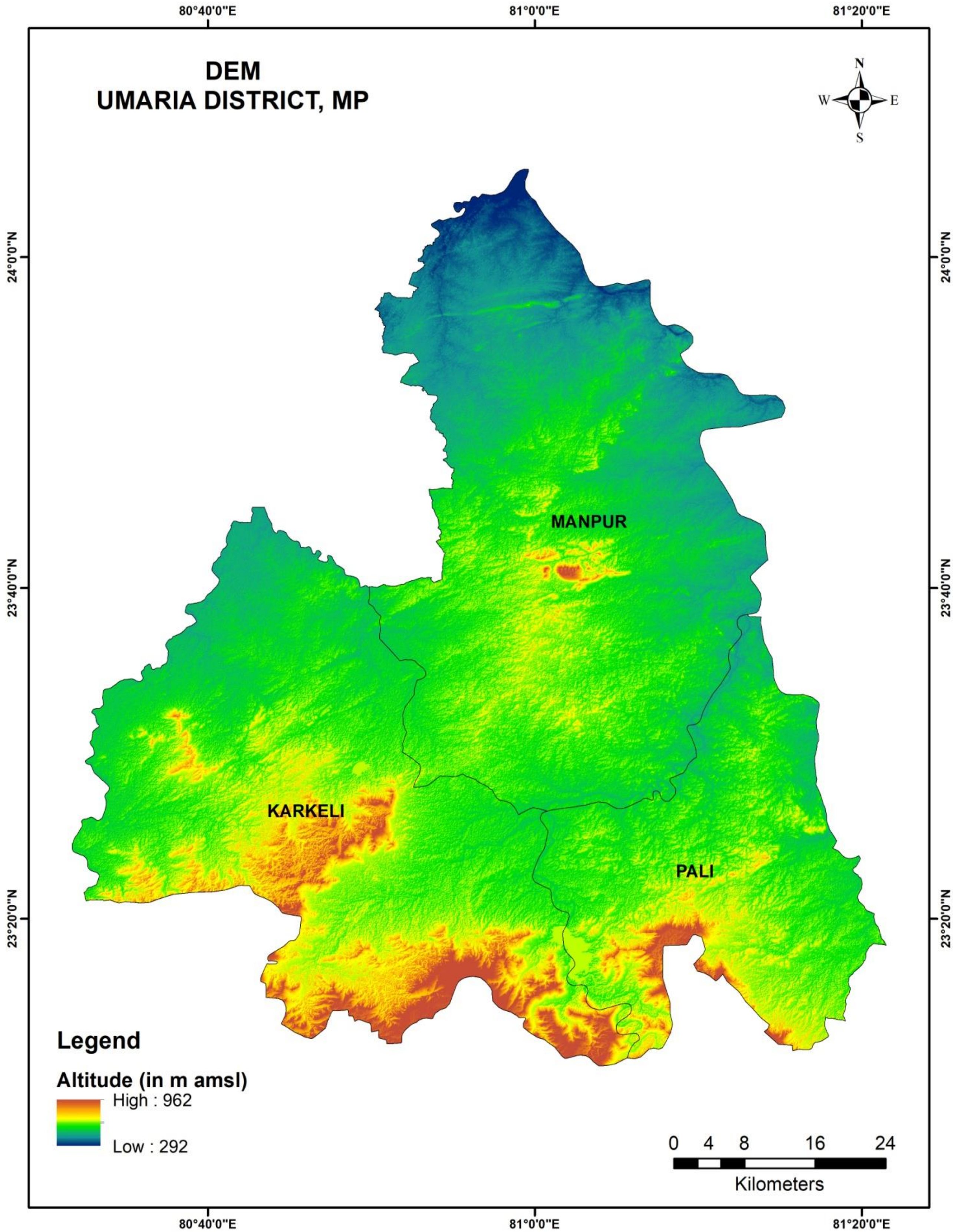
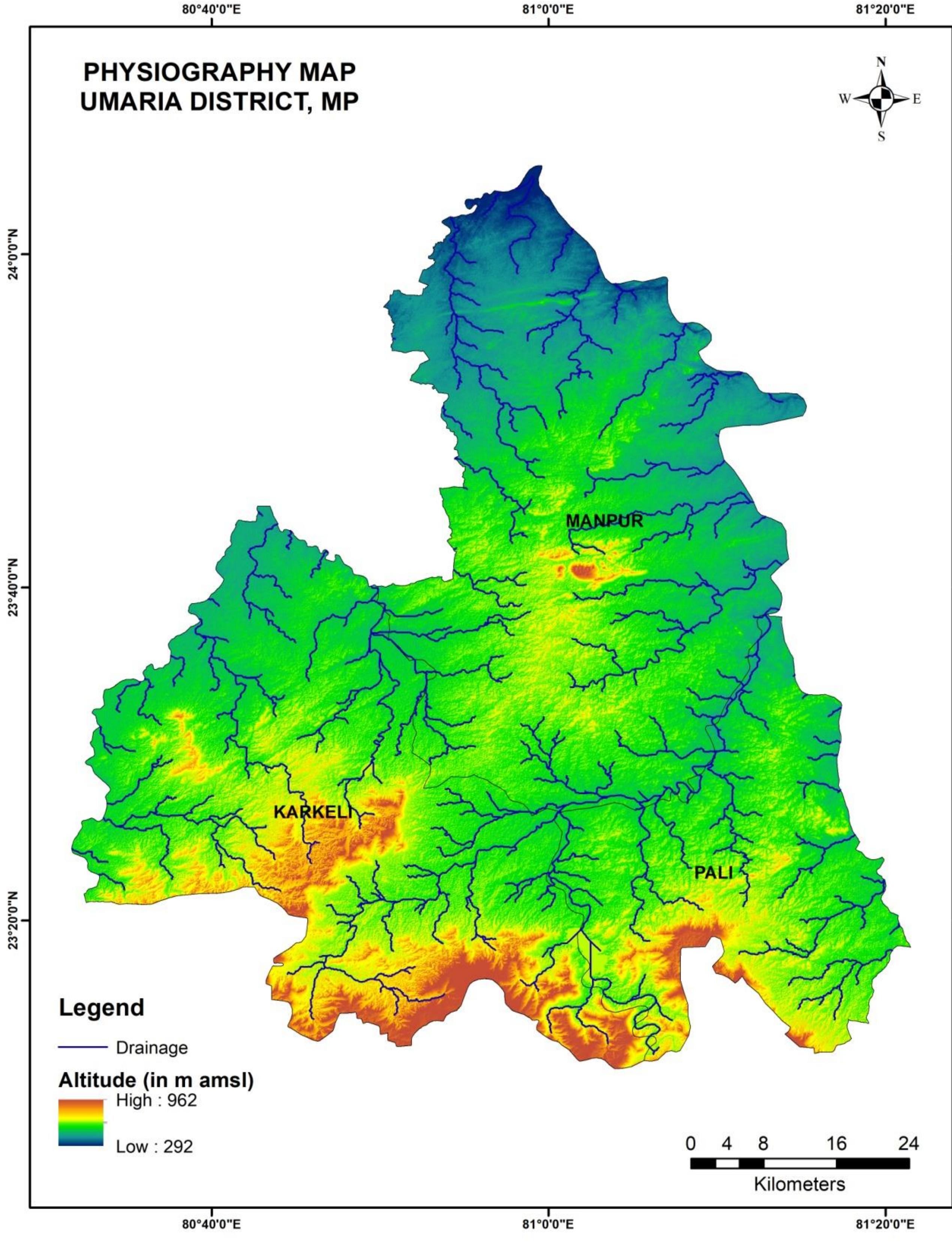


Figure 5 : Physiographic Map



Geomorphology

Physiographically, structural land forms represented by plateau, hills and valleys have developed in central, southern and north eastern part of the district.The southern part of this district is represented by hilly terrain, which is northern part of Amarkantak hills extending in East-west direction. The highest elevation of the district is located on southern boundary of the district near village Singhpur having an elevation of 980 m above mean sea level, comprising of basaltic rocks. Other prominent hills are also located on southern and south western part near villages Mangthar, Manri and Surajpura having elevation 856 m, 678 m and 760 above mean sea level respectively. The elevation of the district 355 m above mean see level is located near village Darbai (10°59'-24^{0}04') near the junction of river son and with Chhoti Mahanadi.

The northern part of the district in Manpur block area there is prominent valley which, almost originates from the Achaean hills and extends north wards. The physiographic features developed in the area bounded between Johilla river in the east and Chhoti Mahanadi in the west are hilly and undulating plains which attains the maximum elevation of 842 m (approximately) above mean level (Donadi hill) near village Aganhuri (23°28°15' : 80°50'30", 46/A15) and minimum elevation of above 362 m above mean sea level neer Jogia (23°42'50: 80°41'45,64A/15).

In central part of the district prominent hill range is Bondhogarh - Shahagur range which extends North-East from western boundary of Bandhogarh tehsil, marks the old historical fort extends across the son at Kursaria and towers the conference of the Son River with Sandin nala. This hill range is consisting of Gondwana Sedimentary formations and it riser to 779 m above mean sealevel. Slopes of southern hill range is between 1:50 to 1:100, while it is 1:100 to 1:200 for Bandhogarh hill range.

Drainage

The entire Umariya distnct is falling under Son sub basin area of the Ganga basin the main river of the district is the son which flows from south -west to north- east direction and forming district boundary between Shahdol and Umariya district.

The Son or Survarna means the gold is one of the biggest tributary of the rivers Ganga, and it is considered as sacred river. The river Son originates from Son kund (22°42°32" : 2°01°10") from Amarkantak plateau, located in Anuppur district of Madhya Pradesh. Rivers Johila and Chhoti Mahanadi are main tributaries of Son river in Umariya district.

The Johila is the most important tributary of the Son in the Umariya district. The Johila also originals from Amarkantak plateau (Maikhal rang) in Anuppur district and flows to north East direction upto Pali and turns to the north until it meets the Son from Pali to confluence point with son river, further in north-east direction covering about 40 kms distance.

The Chhoti Mahanadi is also important tributary of the river Son and it is forming western boundary between Umariya and Katni districts and it merges with son on northern part of the district. Chhoti Mahanadi originates from Tordara (761 m above mean sea level) from Satpura hills of Dindori district. Important tributary of Chhoti-Mahanadi river in Umariya district is Umrar river which drain north central part of the area, and flows in north west direction and joins Chhoti Mahanadi river near village Pipariya-kalan in Katni district.

Figure 6: Geomorphology Map

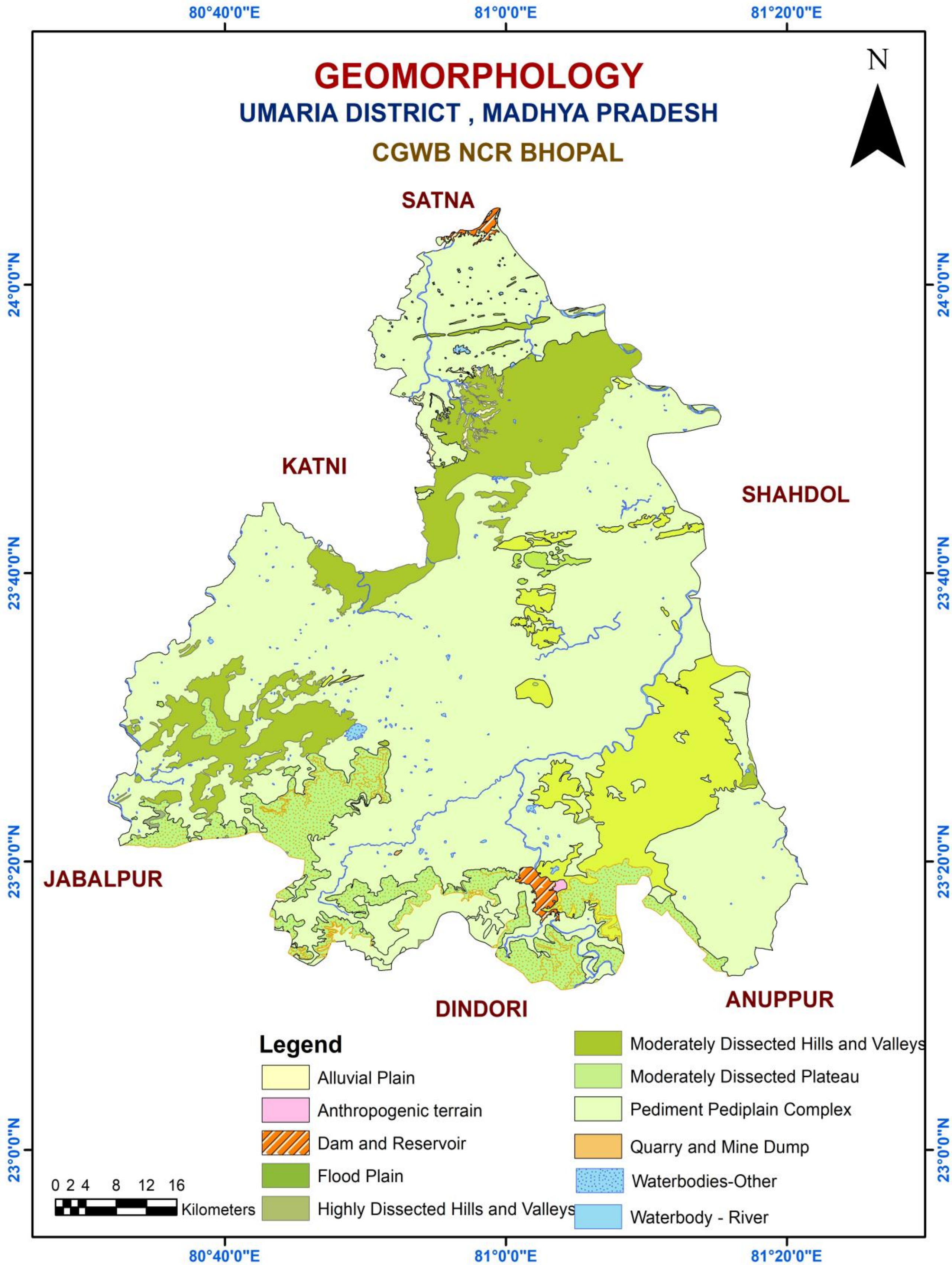
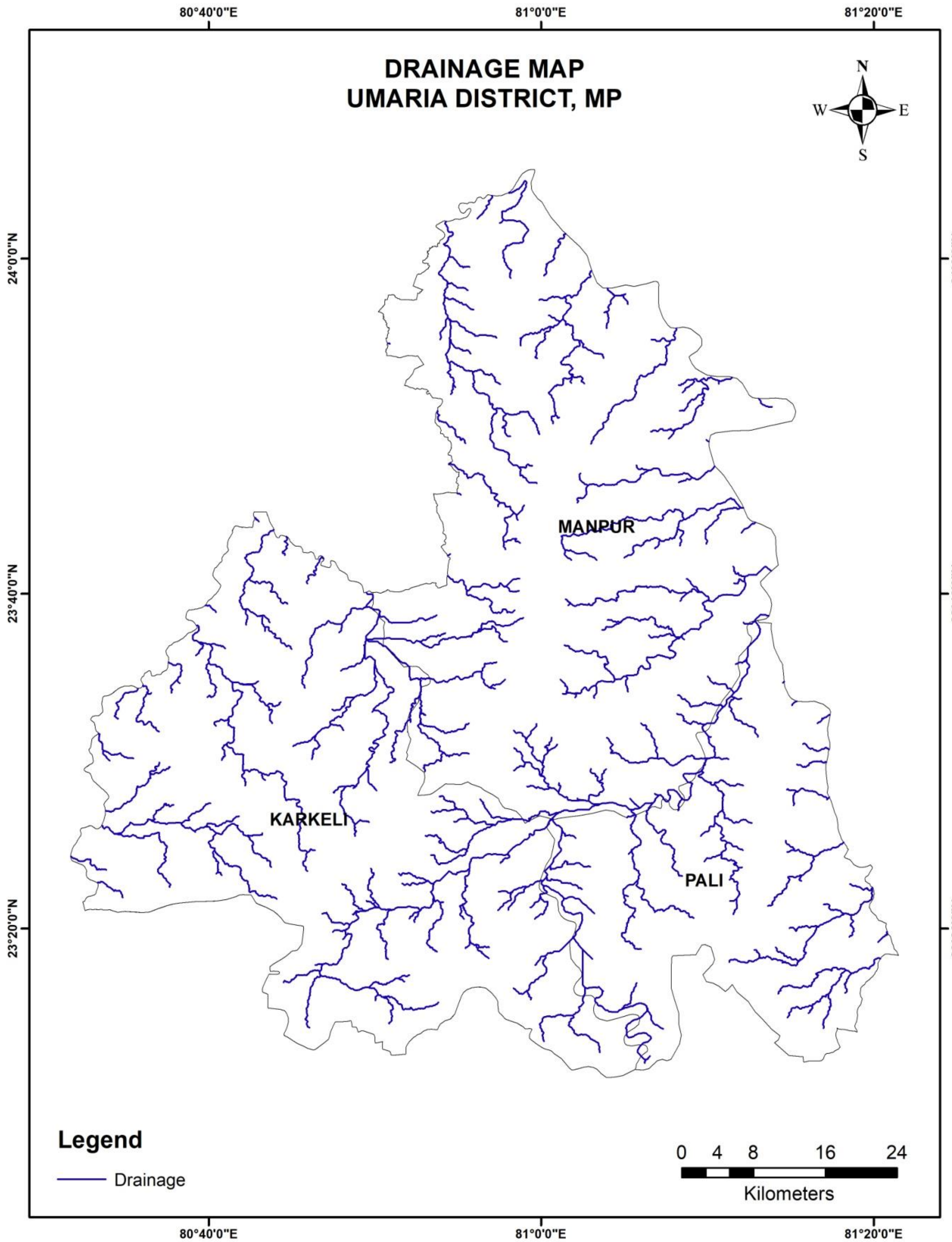


Figure 7: Drainage Map



Landuse

Analysis of the irrigation details of the district reveals that irrigation facilities in the district are minimum. Only about 4% of the total is area of the district is coming under irrigation facility and rest of the area is un-irrigated. Ground water is next main source of irrigation in Umaria district, after Irrigation from other sources (Lift Irrigation and Irrigation from Ponds/ Tanks etc). Dugwells are the main ground water structures used for irrigation purpose.. There were 3062 open wells for irrigation in the district and density of wells was 0.7 wells per sq.kms area. Other structure for irrigation from ground water reservoir are tubewells. Total 1002 tube were recorded in the district during year 2006 and density of tubewells is 0.22 tubewell per sq.km area.Canal irrigation in the district is minimum and reported area from canal irrigation was 2931 hectares which is about 15 % of total irrigation of the districts. Total 205 ponds were also in use for irrigation in the district and area irrigated from them is reported 811 hecates, which is about 4 % of the irrigation of the district. Irrigation from other sources, which includes lift irrigation was 8225 hectares which accounts for 42 % of the total irrigation.

Figure 8 : Land Use Land Cover Map

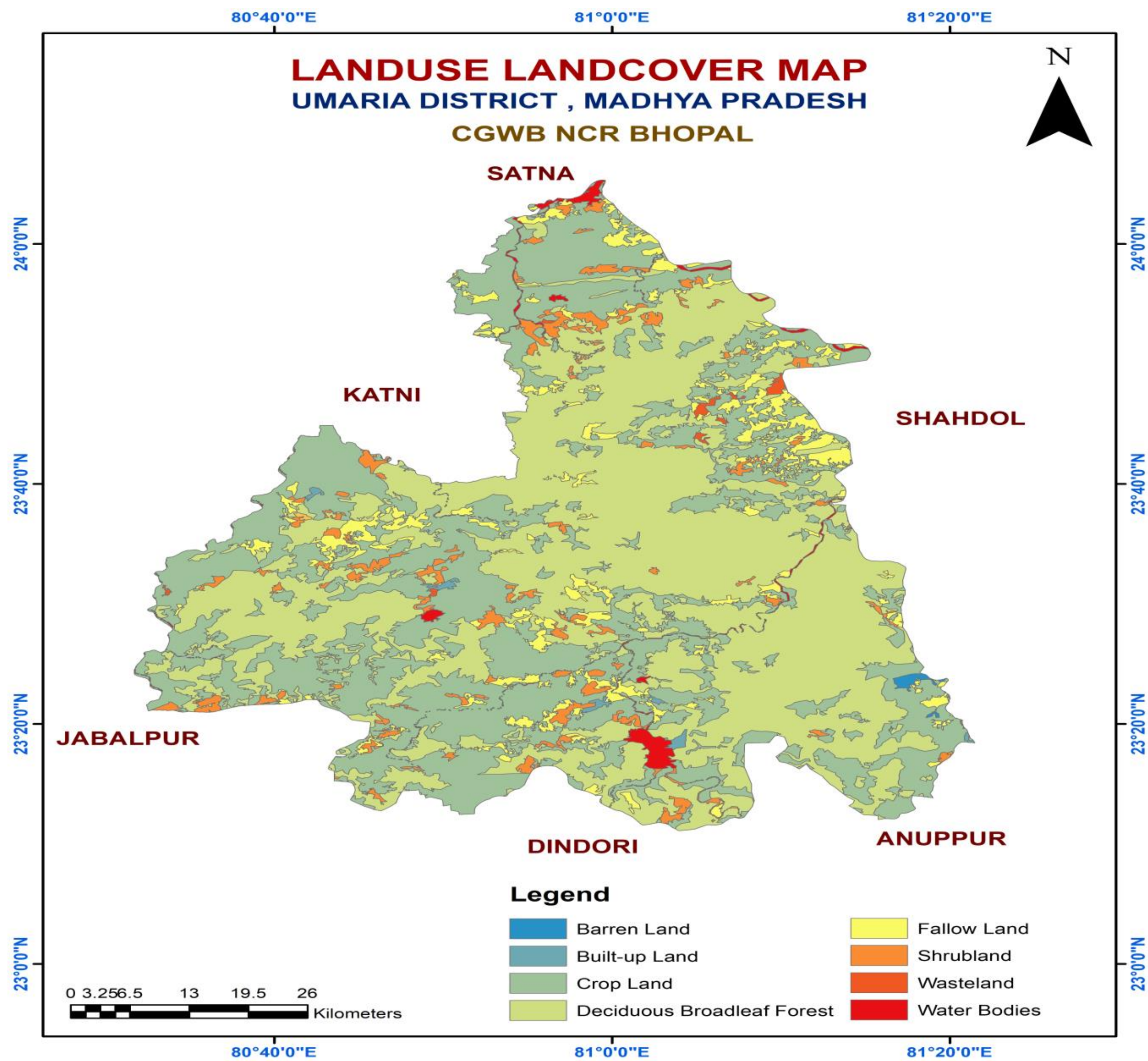


Table 5: Landuse Classification in Umaria district

District and category wise distribution of Land Use / Land Cover in Madhya Pradesh (2015-16)

L 1	L 2	Umaria
Agriculture	Crop land	1487.32
	Current Shifting cultivation	
	Fallow	115.74
	Plantation	2.54
Barren/unculturable/ Wastelands	Barren Rocky	0.05
	Gullied / Ravinous Land	6.43
	Rann	
	Salt Affected Land	
	Sandy Area	
	Scrub Land	556.44
Builtup	Mining	2.62
	Rural	28.19
	Urban	6.94
Forest	Deciduous	1268.25
	Evergreen/Semi evergreen	
	Forest Plantation	2.83
	Scrub Forest	79.56
	Swamp / Mangroves	
Grass / Grazing	Grass / Grazing	
Snow and Glacier	Snow and Glacier	
Wet lands / Water bodies	Inland Wetland	
	Coastal Wetland	
	River/Stream/Canals	21.61
	Water bodies	100.48

(Area in sq. km.)

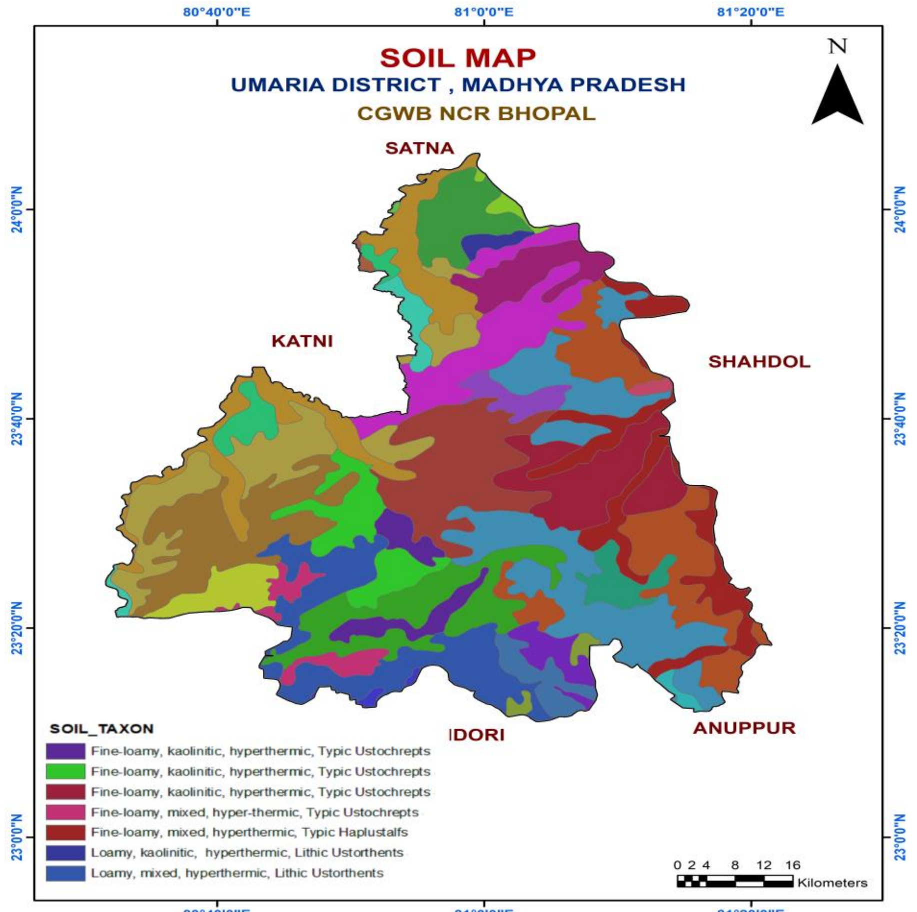
Soil Classification

The Umaria district is covered by various rock types viz Basaltic, Sedimentary and Grainitic terrains. Soil type also depends upon the lithology of the area. As per classification of National Bureau of soil survey and land use planning, Nagpur, soils of the area have been described in following groups.

Soil Type	Description	Soil Taxonomy
(A) Soils of Laterite Terrain	1) Soils of Undulating Land	Slightly deep-to-deep, well-drained loamy skeleton to loamy soils with moderate erosion.
(B) Soils of Basaltic Rocks	1) Soils of Hills and Hill Ranges:	Very thin Stony with severe erosion

	2) Soils of undulating Plateau:	Deep, moderately well drained clayey soils on gently slopping plateau with moderate erosion.
(C)Soils of Sedimentary Rocks (Gondwanas)	1) Soils of Hills and Ridges:	Very Shallow, excessively drained, loamy skeleton soils on moderately to steep sloping hills with severe erosion.
	2) Soils of Dissected Plateau :	Deep drained moderate erosion.
	3)Soils ofundulatingplateauAnd plains:	Deep, moderately well drained clayey to loamy soils on gently slopping plateau with moderate erosion.
	4) Soils of undulating plateau:	Deep, moderately well drained clayey soils on foothills slopes with moderate erosion.

Figure 9: **Soil Map**



Agriculture, Irrigation and cropping patterns

District is very rich in the field of agriculture due to good sources of irrigation and fertile alluvial and black cotton soil. paddy 44, wheat 26, kodokutki 18 are the main crops grown during Rabi season. Cotton, Soyabean, Mustard, Til and Groundnut are the main oilseeds produced here. The farmers have started the production of Sunflowers.

Over a period, geographic pattern of agricultural land use are the outcome of concurrent interaction between the variable combinations of natural condition and human circumstances. Primarily, these are influenced by natural condition and thereafter affected by human circumstances because of their Colonizing capability. The human circumstances are mainly responsible for dynamism in agriculture land use or changing cropland occupancy. Therefore, efficient cropland occupancy, say cropping pattern, implies the most successful use of agriculture land, consequent upon development of irrigation facilities and application of modern methods of farm technology. The key to the most important aspect of land use lies in the relation of population to land. The crux of the review, therefore, refers to the study of the problems in use of land by man. According to R.H. Best, the term land use deals with the spatial aspects of human activities on the land and with the way in which the land surface is adapted or could be adapted, to serve human needs. (Table 5 & 6)

Table 6: Land use pattern in Umaria District

Name of District	No of Gram Panchayat Covered	Total Geographical Area	Gross Cropped in sq.km	Net Sown area Sq.Km	Area Under forest in Sq.Km	Area under Agriculture use in Sq.Km	Net Irrigated Area
Umaria	234	4539	1941	1604	765	1600.60	1414

Table 7: Crop-wise Irrigation Status in Umaria

	Kharif (Area in ha)			Rabi (Area in ha)			Summer crop (Area in ha)			Total (Area in ha)			Horticulture & Plantation (Area in Ha0		
Crop type	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total
A) Cereals	0	9100	9100	139260	0	139260	0	0	0	139260	9100	148360			
B) Coarse Cereals	0	200	200	0	0	0	0	0	0	0	200	200			
C) Pulses	0	3350	3350	12168	28075	40243	27000	0	27000	12168	31425	43593			
D) Oil seeds	0	165200	165200	0	0	0	0	0	0	0	165200	165200			
E) Fiber	0	330	330	0	0	0	0	0	0	0	330	330			
F) Any other crops…	0	0	0	497	0	497	0	0	0	497	0	497	5840	1376	7216
total	0	178180	178180	151925	28075	180000	27000	0	27000	151925	206255	358180	5840	1376	7216

Chapter-3:

Hydrogeology

The main source of ground water recharge in Umariya district is rainfall. The major part of the district is underlain by Gondwana sedimentary formations, which are potential aquifers in the area. the other geological formation occurring in the districts are Archaeans lower vindhyans. Granular zones govern occurrence and movement of ground water in semi consolidated Gondwana formations. Within these formations and impervious horizons like coal seams trapped in between this rock occurrence and movement of ground water in Hard rocks is essentially by development and nature of secondary joints and fractures while priming vesicular in basalt also plays on important role. Ground water in general in hard rocks areas occurs under unconfined to semi confined conditions while in Gondwana rocks it is also found under confinedconditions.The occurrence and movement of ground water in different lithological units is briefly described in the following paragraphs.

Granitic gneiss (Archaeans)

These are unclassified crystalline hard rocks of Archaeans group which form the basement rock in the district. They yield water through fractures, joints and secondary porosity developed in the weathered thickness of the weathered overlying the massive rock. The open well that exist in these formations range depth from 8 to 12 m bgl generally the column of water available during pre monsoon period varies between 2m to4m.

Bijawar Series

This consists of Phytllite, quartzite, dolomite, limestone etc representing meta sediments and these are moderately weathered and jointed. Weathering in quartzites is reported as high as 10m in Bamhangaon. That village in Manpur block ground water occurs in secondary fracture portion of these rocks. Yield of dug wells is reported between 400 to 40000 liter per day. The wells during summer i.e in pre monsoon water level in wells is as deep as 12m.

Lower Vindhyans

Semri series of rocks represent lower vindhyan. They also support development of ground water through open wells. Porcellanite shales one quite disintegrated (about 15 m thick). Due to disintegrated shale layer and its stratification, some percentage of precipitation is allowed to percolate downward and move along bedding planes and water gets pooled up in weathered /disintegrated crushed zones, along the contact planes. In Manpur blocks, where semri series of rocks (Porcellanite & shales) are exposed in northern part, semi weathered yellowish shale forms poor to moderate yielding aquifers, in the area. the dug wells in vindhyan aquifers range in depth range from 16.00-20 mbgl. The depth to water level in the wells during pre monsoon ranges between 4.80 to 15.00mbgl.

Gondwanas

The Gondwana group of rocks, that less coal deposit, is a potential aquifers in the district. The fieldspathic medium to coarse grained sandstone, bears ground water in the inter connected primary pores in the formation as well as the contact plain between shales and sandstone, coal seams in Barakar sandstone act as confining layers and at places they give rise over flowing conditions while negotiating under laying aquifers below coal seams. Ground water is also met along with the coal in almost all coal fields in the district. Ground water occurs in both unconfined and confined conditions in the Gondwana formation of the district.Due to excessive pumpage of ground water from under coal mines, lowering of water levels in the phreatic ground water regime overlying the coal field layers is reported. Gondawan formation particularly the upper part of Baracker sandstone supports development of phreatic aquifers, which extends from few meter below ground level to 25 m below land surface Gondwana formation is providing sufficient moisture content to vegetation resulting in thick presets in the area, specially observed in Bandogarh area. the fluctuation in ground water level is between 3-5 m. The ground water mover over a gradient of 1 in 220 laterally then moves down wards from phreatic aquifers. Into the deeper section upto the coal seams.

Lametas :

These are sedimentary deposits resting over Gondwana formations generally these are compact and impervious rocks (siliceous limestone). However at places the nodular limestone and poorly consolidated sandstone have allowed the development of ground water in confined and confined conditions.The Karkali blocks area lametas are occupying hilly and thickly forested areas and in these area density of population and habitants is quite low. However there are quite a few number of dug wells that are used for drinking purposes by tribal populations. It is noticed that about 80% of dug wells one within the depth range of 8 m to 16 m bgl having diameter from 3 m to 4 m. The pre monsoon depth to water level goes as deep as 17 m to 20 m (Tendua 23^{0}43’ 80^{0} 45’ and Pondi 23^{0} 18’ : 80^{0} 17’ villages in Karkali blocks). The yield of the well is between 50000litersperday (Pinoura23^{0}21’00”:80^{0}56’30”) to 75000literperday (Jarha23^{0} 24’ 00” : 80^{0} 49’ 15”).

Deccan Traps :

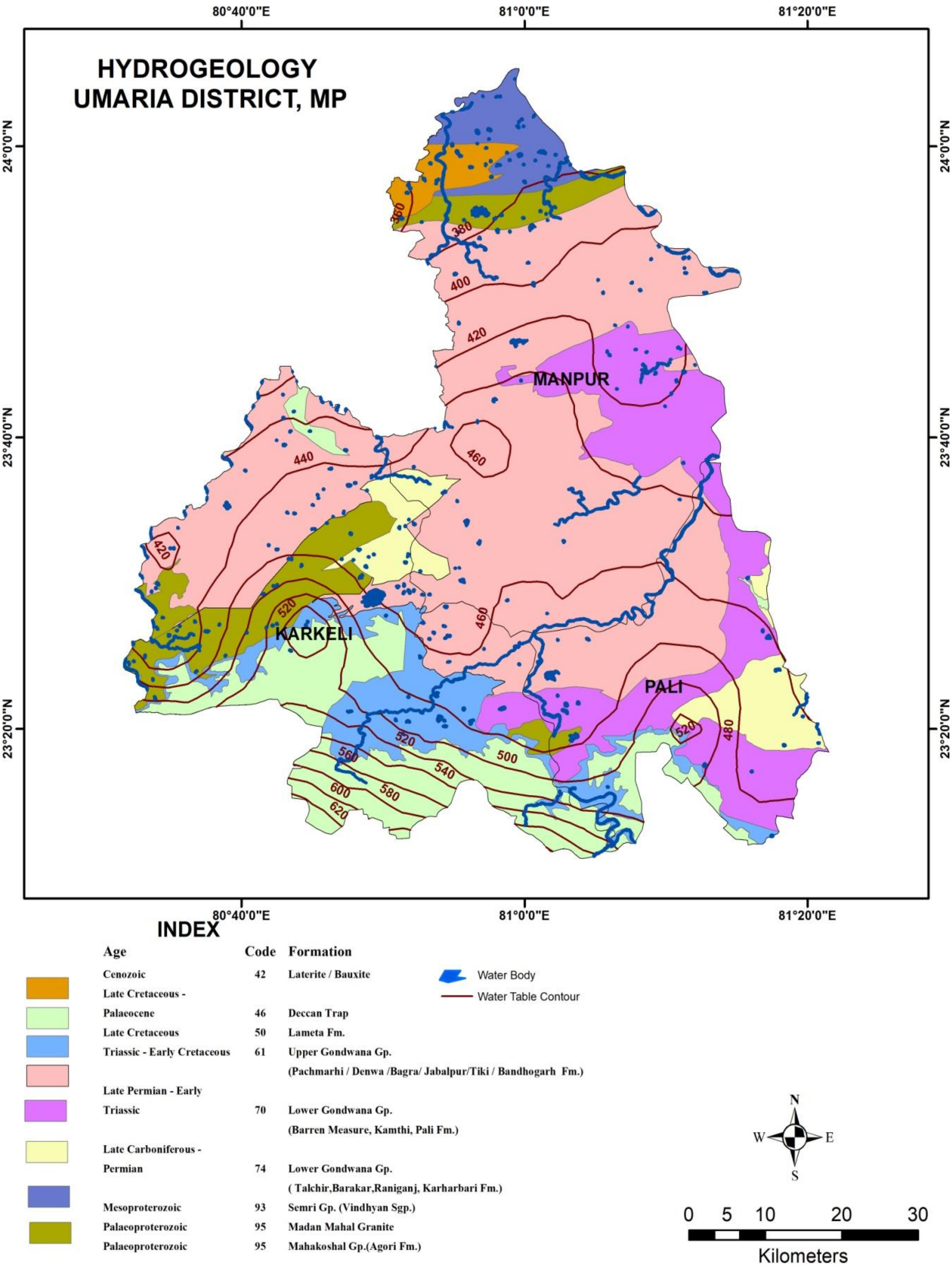
These are basaltic lava flows forming hill ranges in the district. Basaltic rocks occurring in valley section and pediplains are weathered. Because of jointing and fracturing in basalts, development of secondary porosity in such area. however yield is limited in this rock unit and vary from place to place depending on thickness of weathered mantle, and degree of jointing and fracturing.The wells in the basaltic flows of deccan traps vary in depth between the range of 6-9 mbgl with a diameter of 2 m to 3 m most of wells go dry during summer. The yield varies between pre monsoon and post monsoon from 70000 liters per day to 13,00,00 liters per day.

Alluvium :

There are two kinds of alluvium in the district, the younger alluvium and river banks Machhrar, Jahila, joner, umrar, chkoti Mahanadi and son rivers. This younger alluvium consist of silt clays associated with pebbles and gravels.The older alluvium generally occupies the faulted through. In Karkeli blocks there is a vast alluvial plain between Pararia nala and Ghor, Chhatra river with a thickness of about 30m. this alluvial fill is in the faulted through created between Gondwanas and Lametas.

The older alluvium yield moderately good quantity of water from dug wells (900 kilo litre per day) and these wells are also used for irrigation purposes in the area.

Figure 10: Hydrogeology of Umaria District, M.P



Depth to Water levels

Pre-monsoon water level (May 2022)

The pre-monsoon depth to Water levels ranges from a minimum of 2.48 meters below ground level (mbgl) 4.32 at Manpur block to a maximum of 16.77 m bgl at Panpatha of Umaria district. About 16% very shallow water levels up to 2-5m bgl have been recorded in a small patch in part of district. About 50 % of monitoring wells recorded water level in the range of 5-10 m bgl category, spreading in patches and major pockets in the north-western and eastern part of area. About 30% of monitoring wells recorded water level in the depth range of 10-20 m bgl occurring in broad patches all over the region. Deeper ground water levels ranging >20 m bgl constituting only about 4% of wells in this category have been observed only in small pocket in the northern and south-western part of Umaria district. Ground water levels of more than 15 m bgl have been recorded in the eastern part of the area. The pre-monsoon Depth to Water Level map has been shown in the Fig. 11. Key well location and Depth to water level in Umaria District shown in Table.7

Table 8 Pre-monsoon Depth to Water Level in Umaria District

ESTABLISHMENT OF KEY WELLS, MAY 2022, UMARIA DISTRICT

STATE	DISTRICT	BLOCK	VILLAGE	LATITUDE	LONGITUDE	SITE_TYPE		WATER_LEVEL (MBGL)
1.Madhya Pradesh	UMARIA	BANDHAVGARH	Manpura	23.58	80.76	Dug Well		7.37
2.Madhya Pradesh	UMARIA	BANDHAVGARH	Parasi	23.69	80.68	Dug Well		6.3
3.Madhya Pradesh	UMARIA	BANDHAVGARH	Tala	23.79	80.53	Dug Well		7.33
4.Madhya Pradesh	UMARIA	BANDHAVGARH	Umaria	23.92	80.02	Dug Well		7.38
5.Madhya Pradesh	UMARIA	KARKELI	Akhdar	23.98	80.58	Dug Well		8.9
6.Madhya Pradesh	UMARIA	KARKELI	Bichua	23.72	81.02	Dug Well		7.82
7.Madhya Pradesh	UMARIA	KARKELI	Bilaspur	23.77	81.04	Dug Well		7.62

8.Madhya Pradesh	UMARIA	KARKELI	Choti Pali	23.87	81.00	Dug Well		4.65
9.Madhya Pradesh	UMARIA	KARKELI	Karkeli	23.92	80.96	Dug Well		9.51
10.Madhya Pradesh	UMARIA	KARKELI	Karkeli	23.95	80.90	Dug Well		9.68
11.Madhya Pradesh	UMARIA	KARKELI	Nigari	23.51	80.87	Dug Well		7.2
12.Madhya Pradesh	UMARIA	KARKELI	Nowrozabad	23.51	80.87	Dug Well		6.32
13.Madhya Pradesh	UMARIA	MANPUR	Dhamokhar	23.44	80.92	Dug Well		8.97
14.Madhya Pradesh	UMARIA	MANPUR	Mahroi	23.40	80.98	Dug Well		4.92
15.Madhya Pradesh	UMARIA	MANPUR	Manpur New	23.38	81.00	Dug Well		7.92
16.Madhya Pradesh	UMARIA	MANPUR	Panpatha	23.36	81.07	Dug Well		16.77
17.Madhya Pradesh	UMARIA	MANPUR	Pataur	23.35	81.19	Dug Well		6.28
18.Madhya Pradesh	UMARIA	PALI	Amiliya	23.31	81.35	Dug Well		10.2
19.Madhya Pradesh	UMARIA	PALI	Birsinghpur	23.54	80.85	Dug Well		7.65
20.Madhya Pradesh	UMARIA	PALI	Ghunghuti New	23.59	80.89	Dug Well		13.15
21.Madhya Pradesh	UMARIA	PALI	Gungutti	23.67	80.90	Dug Well		9.03
22.Madhya Pradesh	UMARIA	KARKELI	Bharola	23.70	80.88	Dug Well		4.85
23.Madhya Pradesh	UMARIA	KARKELI	Dhanwahi	23.68	80.86	Dug Well		8.78

24.Madhya Pradesh	UMARIA	MANPUR	Didaori	23.71	80.84	Dug Well		9.66
25.Madhya Pradesh	UMARIA	MANPUR	Anchala	23.81	80.82	Dug Well		7.64
26.Madhya Pradesh	UMARIA	MANPUR	Tali	23.90	80.81	Dug Well		7.45
27.Madhya Pradesh	UMARIA	MANPUR	Jhamaiya	23.97	80.84	Dug Well		8.45
28.Madhya Pradesh	UMARIA	MANPUR	Kodar	23.60	80.93	Dug Well		4.32
29.Madhya Pradesh	UMARIA	MANPUR	Uchera	23.58	80.93	Dug Well		7.45
30.Madhya Pradesh	UMARIA	PALI	Kudari Tola	23.54	80.94	Dug Well		14.64
31.Madhya Pradesh	UMARIA	PALI	Chirki	23.53	80.97	Dug Well		5.53
32.Madhya Pradesh	UMARIA	BANDHAVGARH	Gajwahi	23.51	81.00	Dug Well		9.53
33.Madhya Pradesh	UMARIA	BANDHAVGARH	Chouri	23.55	80.97	Dug Well		8.45
34.Madhya Pradesh	UMARIA	KARKELI	Karri	23.48	80.77	Dug Well		8.45
35.Madhya Pradesh	UMARIA	KARKELI	Kalleh	23.46	80.74	Dug Well		8.56
36.Madhya Pradesh	UMARIA	KARKELI	Nagnaudi	23.43	80.70	Dug Well		5.47
37.Madhya Pradesh	UMARIA	KARKELI	Sichaura	23.32	80.68	Dug Well		9.23
38.Madhya Pradesh	UMARIA	KARKELI	Matohar	23.25	80.68	Dug Well		8.56
39.Madhya Pradesh	UMARIA	KARKELI	Jamthan	23.22	80.69	Dug Well		7.59

40.Madhya Pradesh	UMARIA	KARKELI	Medkhai	23.18	80.69	Dug Well		7.65
41.Madhya Pradesh	UMARIA	KARKELI	Karela	23.18	80.63	Dug Well		6.64
42.Madhya Pradesh	UMARIA	KARKELI	Ramagada	23.20	80.51	Dug Well		5.54
43.Madhya Pradesh	UMARIA	KARKELI	Jogiya	23.53	80.58	Dug Well		8.45
44.Madhya Pradesh	UMARIA	MANPUR	Kanti	23.47	80.75	Dug Well		7.32
45.Madhya Pradesh	UMARIA	MANPUR	Bujbuja	23.44	80.58	Dug Well		6.77
46.Madhya Pradesh	UMARIA	MANPUR	Mudgudi	23.60	80.75	Dug Well		7.89
47.Madhya Pradesh	UMARIA	PALI	Govarde	23.46	80.91	Dug Well		8.46
48.Madhya Pradesh	UMARIA	PALI	Nigai	23.46	80.91	Dug Well		5.36
49.Madhya Pradesh	UMARIA	KARKELI	Neusi	23.41	80.68	Dug Well		8.45
50.Madhya Pradesh	UMARIA	KARKELI	Badwahi	23.39	80.98	Dug Well		13.76

Figure 11: Premonsoon Depth to Water Level Map (2022)

Post-monsoon water level (Dec 2022)

The pre-monsoon depth to Water levels ranges from a minimum of 2.03 meters below ground level (mbgl) at Chirki in Pali block to a maximum of 10.6 m bgl at Panpatha of Umaria district. About 18% very shallow water levels up to 0-2m bgl have been recorded in a small patch in part of district. About 30 % of monitoring wells recorded water level in the range of 2-5 m bgl category, spreading in patches and major pockets in the north-western and eastern part of area. About 40 % of monitoring wells recorded water level in the depth range of 5-10 m bgl occurring in broad patches all over the region. Deeper ground water levels ranging 5-10 m bgl constituting only about 12% of wells in this category have been observed only in small pocket in the northern and south-western part of Umaria district. The Post-monsoon Depth to Water Level map has been shown in the Fig. 12, Key well location and Depth to water level in Umaria District shown in Table.8

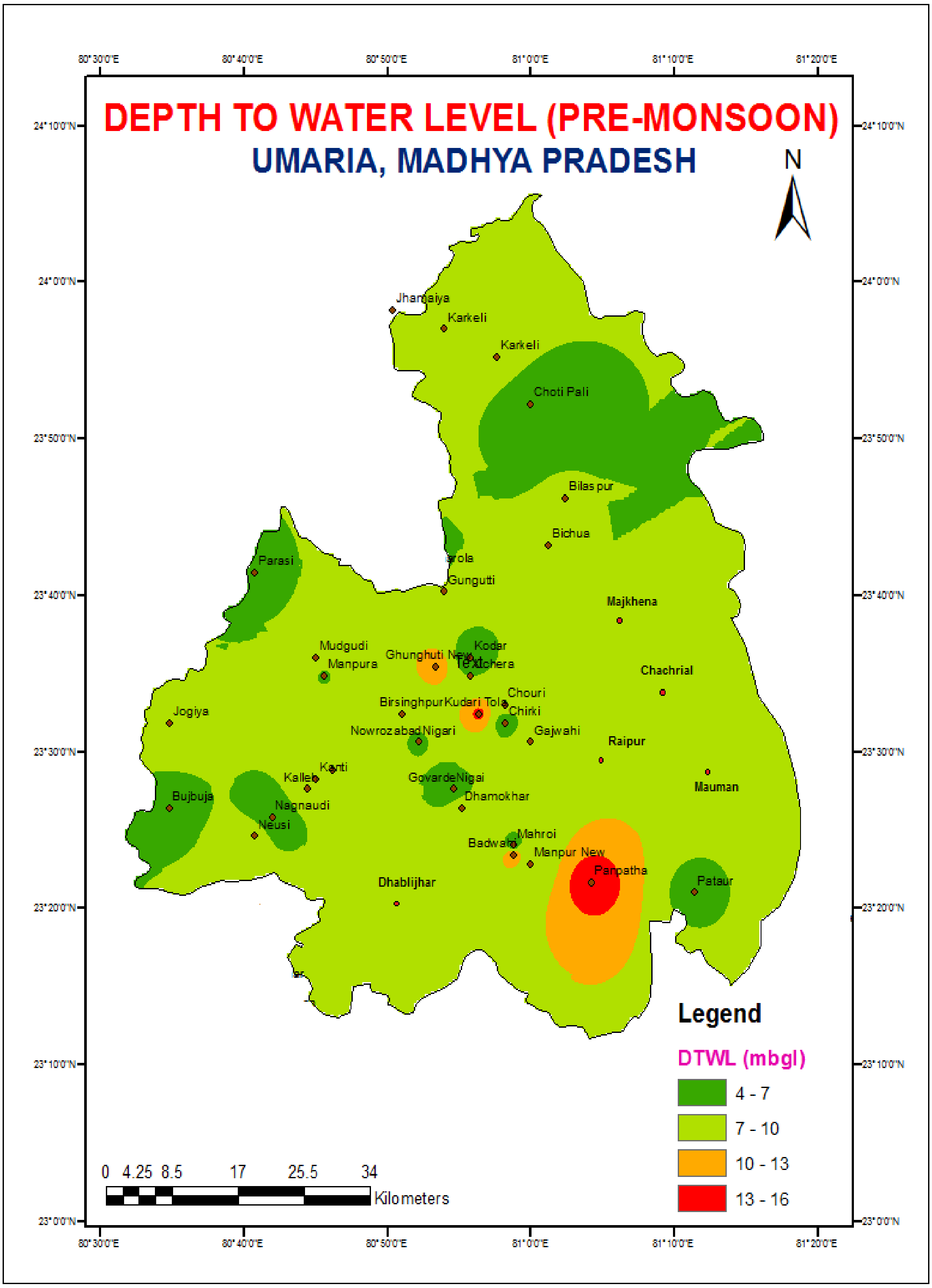


Table 11: Pre-monsoon Depth to Water Level in Umaria District

POST MONSOON WATER LEVEL OF KEY WELLS, DEC 2022, UMARIA DISTRICT

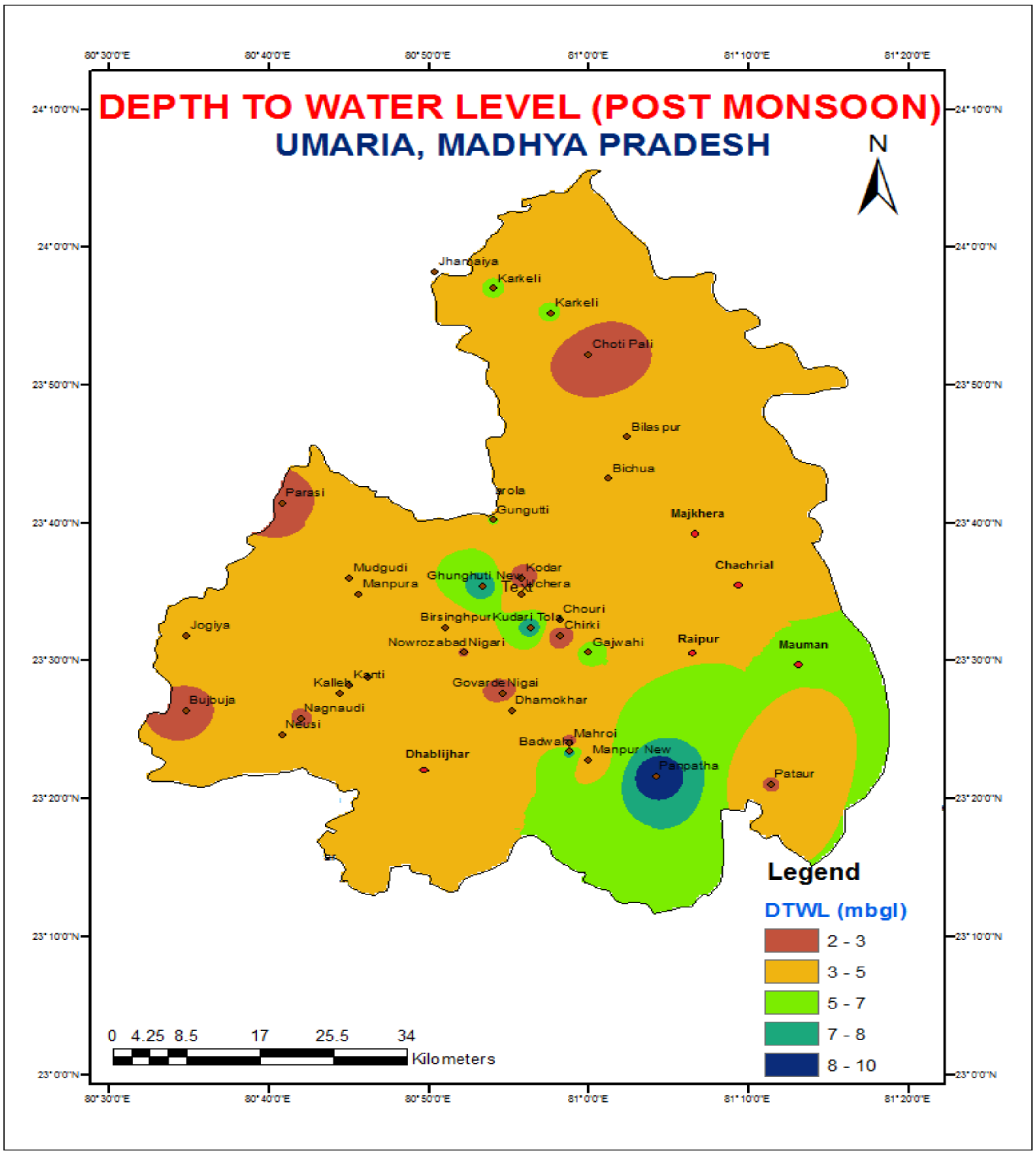
STATE	DISTRICT	BLOCK	VILLAGE	LATITUDE	LONGITUDE	SITE_TYPE		WATER_LEVEL (MBGL)
1.Madhya Pradesh	UMARIA	BANDHAVGARH	Manpura	23.58	80.76	Dug Well		3.87
2.Madhya Pradesh	UMARIA	BANDHAVGARH	Parasi	23.69	80.68	Dug Well		3.2
3.Madhya Pradesh	UMARIA	BANDHAVGARH	Tala	23.79	80.53	Dug Well		3.56
4.Madhya Pradesh	UMARIA	BANDHAVGARH	Umaria	23.92	80.02	Dug Well		3.88
5.Madhya Pradesh	UMARIA	KARKELI	Akhdar	23.98	80.58	Dug Well		5.4
6.Madhya Pradesh	UMARIA	KARKELI	Bichua	23.72	81.02	Dug Well		4.32
7.Madhya Pradesh	UMARIA	KARKELI	Bilaspur	23.77	81.04	Dug Well		4.12
8.Madhya Pradesh	UMARIA	KARKELI	Choti Pali	23.87	81.00	Dug Well		2.3
9.Madhya Pradesh	UMARIA	KARKELI	Karkeli	23.92	80.96	Dug Well		5.6
10.Madhya Pradesh	UMARIA	KARKELI	Karkeli	23.95	80.90	Dug Well		5.55
11.Madhya Pradesh	UMARIA	KARKELI	Nigari	23.51	80.87	Dug Well		3.7
12.Madhya Pradesh	UMARIA	KARKELI	Nowrozabad	23.51	80.87	Dug Well		2.82
13.Madhya Pradesh	UMARIA	MANPUR	Dhamokhar	23.44	80.92	Dug Well		5.47
14.Madhya Pradesh	UMARIA	MANPUR	Mahroi	23.40	80.98	Dug Well		2.36
15.Madhya Pradesh	UMARIA	MANPUR	Manpur New	23.38	81.00	Dug Well		4.42

16.Madhya Pradesh	UMARIA	MANPUR	Panpatha	23.36	81.07	Dug Well		10.6
17.Madhya Pradesh	UMARIA	MANPUR	Pataur	23.35	81.19	Dug Well		3.7
18.Madhya Pradesh	UMARIA	PALI	Amiliya	23.31	81.35	Dug Well		6.7
19.Madhya Pradesh	UMARIA	PALI	Birsinghpur	23.54	80.85	Dug Well		4.15
20.Madhya Pradesh	UMARIA	PALI	Ghunghuti New	23.59	80.89	Dug Well		8.95
21.Madhya Pradesh	UMARIA	PALI	Gungutti	23.67	80.90	Dug Well		5.53
22.Madhya Pradesh	UMARIA	KARKELI	Bharola	23.70	80.88	Dug Well		3.1
23.Madhya Pradesh	UMARIA	KARKELI	Dhanwahi	23.68	80.86	Dug Well		5.28
24.Madhya Pradesh	UMARIA	MANPUR	Didaori	23.71	80.84	Dug Well		6.16
25.Madhya Pradesh	UMARIA	MANPUR	Anchala	23.81	80.82	Dug Well		4.14
26.Madhya Pradesh	UMARIA	MANPUR	Tali	23.90	80.81	Dug Well		3.95
27.Madhya Pradesh	UMARIA	MANPUR	Jhamaiya	23.97	80.84	Dug Well		4.95
28.Madhya Pradesh	UMARIA	MANPUR	Kodar	23.60	80.93	Dug Well		2.75
29.Madhya Pradesh	UMARIA	MANPUR	Uchera	23.58	80.93	Dug Well		3.95
30.Madhya Pradesh	UMARIA	PALI	Kudari Tola	23.54	80.94	Dug Well		8.62
31.Madhya Pradesh	UMARIA	PALI	Chirki	23.53	80.97	Dug Well		2.03

32.Madhya Pradesh	UMARIA	BANDHAVGARH	Gajwahi	23.51	81.00	Dug Well		6.03
33.Madhya Pradesh	UMARIA	BANDHAVGARH	Chouri	23.55	80.97	Dug Well		4.95
34.Madhya Pradesh	UMARIA	KARKELI	Karri	23.48	80.77	Dug Well		4.95
35.Madhya Pradesh	UMARIA	KARKELI	Kalleh	23.46	80.74	Dug Well		5.06
36.Madhya Pradesh	UMARIA	KARKELI	Nagnaudi	23.43	80.70	Dug Well		3.48
37.Madhya Pradesh	UMARIA	KARKELI	Sichaura	23.32	80.68	Dug Well		5.73
38.Madhya Pradesh	UMARIA	KARKELI	Matohar	23.25	80.68	Dug Well		5.06
39.Madhya Pradesh	UMARIA	KARKELI	Jamthan	23.22	80.69	Dug Well		4.09
40.Madhya Pradesh	UMARIA	KARKELI	Medkhai	23.18	80.69	Dug Well		4.15
41.Madhya Pradesh	UMARIA	KARKELI	Karela	23.18	80.63	Dug Well		3.14
42.Madhya Pradesh	UMARIA	KARKELI	Ramagada	23.20	80.51	Dug Well		2.94
43.Madhya Pradesh	UMARIA	KARKELI	Jogiya	23.53	80.58	Dug Well		4.95
44.Madhya Pradesh	UMARIA	MANPUR	Kanti	23.47	80.75	Dug Well		3.82
45.Madhya Pradesh	UMARIA	MANPUR	Bujbuja	23.44	80.58	Dug Well		3.27
46.Madhya Pradesh	UMARIA	MANPUR	Mudgudi	23.60	80.75	Dug Well		4.39
47.Madhya Pradesh	UMARIA	PALI	Govarde	23.46	80.91	Dug Well		4.96

48.Madhya Pradesh	UMARIA	PALI	Nigai	23.46	80.91	Dug Well		2.85
49.Madhya Pradesh	UMARIA	KARKELI	Neusi	23.41	80.68	Dug Well		4.95
50.Madhya Pradesh	UMARIA	KARKELI	Badwahi	23.39	80.98	Dug Well		8.48

Figure 12: Post-monsoon Depth to Water Level Map



Exploratory drilling

CGWB under its exploration program drilled 25 bore wells (Fig. 13). On the basis of samples collected during exploration, litho logs have been prepared. The aquifer parameters are calculated on the basis of pumping tests. The salient details of the some of the drilled bore wells and piezometers are given in Table No 9.

Figure 13: Map showing locations of Existing Exploratory Wells & VES Locations

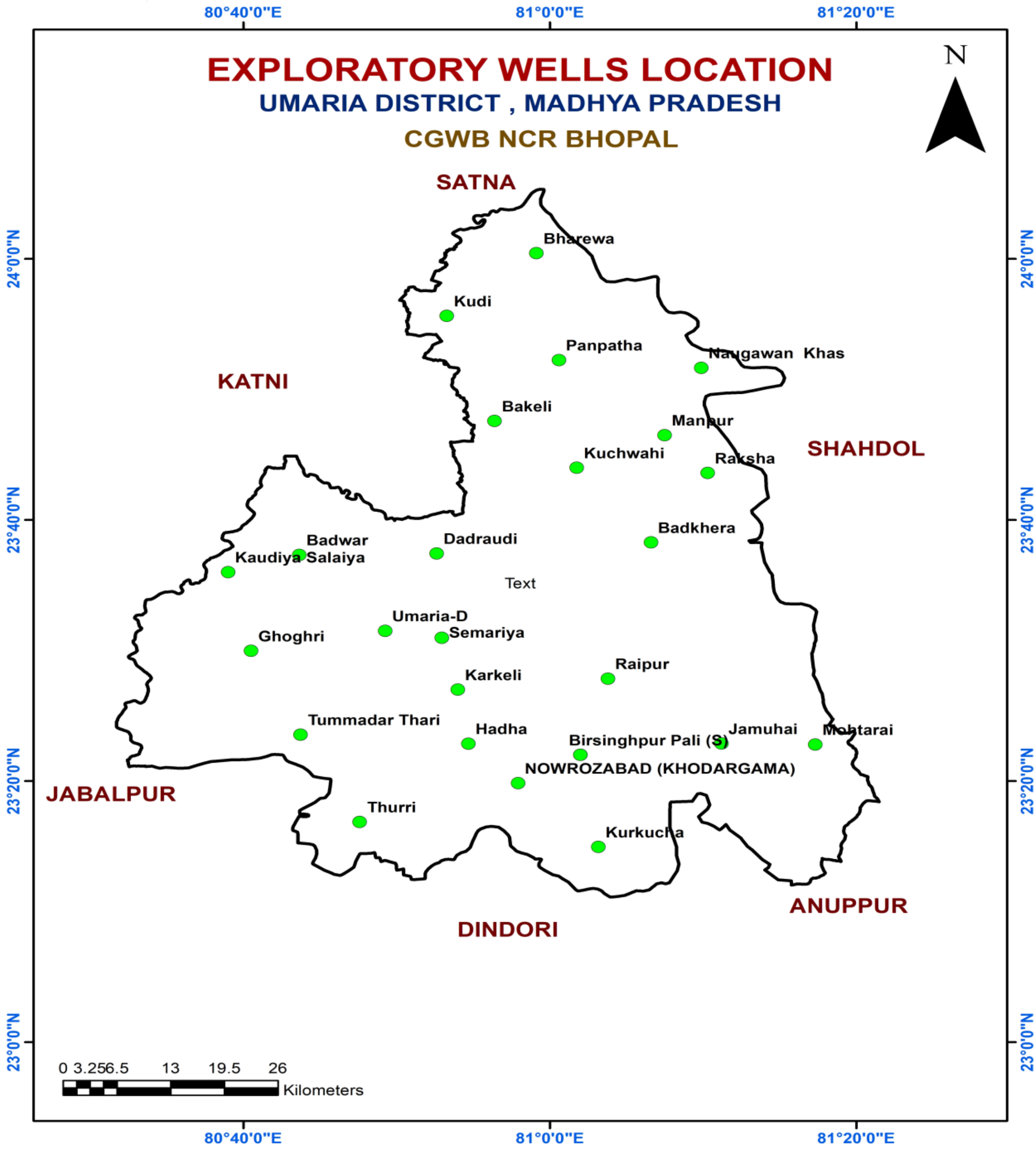


Table 9: Salient Hydrogeological Details of Exploratory Wells of Umaria District.

S. No.	Location	Year of Exploratory	Well Completion depth (m)	Aquifer zones (m)		SWL (m) bgl	Yield (L.P.M.)	Draw down (m)	Transmissivity (m^2/day)	Storage coefficient (s)	EC in micro mhos/cm at 25^0 C.
1.	Panpatha	1996-97	155.00	90.00	100.00	0.43	128	52.25	-	-	493
				104.00	107.00						
				112.00	117.00						
				121.00	127.00						
				135.00	155.00						
	Manpur	1994-95	171.00	60.00	69.00	4.43	114	11.24	-	-	327
				73.00	79.00						
				76.00	102.00						
				114.00	126.00						
3.	Kaudiya-Salaiya	1995-96	105.00	140.00	152.00	3.70	2340	14.00	-	-	520
				40.00	49.00						
				52.00	58.00						
				88.00	91.00						
				97.00	103.00						
4.	Karkehi	1994-95	200.00	45.00	55.00	7.99	224	19.86	-	-	703
				81.00	97.00						
				114.00	120.00						
				137.00	148.00						
				163.00	200.00						
5.	Pali	1994-95	119.00	56.00	62.00	24.59	306	33.94	-	-	813
				70.00	76.00						
				87.00	93.00						
				105.00	117.00						
6.	Ghunghutti	1994-95	236.00	80.00	102.00	0.48	180	28.67	16.95	$1.42x10^{-4}$	104
				120.00	128.00						
				171.00	187.00						

				195.00	213.00						
				218.00	234.00						
7.	Majhagawan	1995	245.00	113.00	119.00	0.50	80	35.00	-	-	808
				131.00	143.00						
				156.00	162.00						
				197.00	179.00						
				229.00	242.00						

Chapter-4:

Data Interpretation, Integration and Aquifer Mapping

The lithological data collected from CGWB Borewells, Piezometers and State GroundWater Piezometers were studied, compiled and integrated as per Rockworks software format to prepare the 3-Dimensional Stratigraphic model, 2-Dimensional Cross section and Fence diagrams. The sub-surface lithology of the Umaria district as inferred from the 3-D Model, 2-D Section and Fence diagram is presented below.

3-D Lithological models

A 3-Dimensional lithological model was prepared for the Umaria district, Madhya Pradesh after detailed analysis of the pre-existing and available bore-log data collected from the Basic Data Reports of CGWB (Fig 14). A comprehensive analysis was made as per lithology and stratigraphy of the area. The location details with RL values and their corresponding stratigraphic details as per the Rockworks format is provided in the Annexures- I and II.

The 3-D Model results showed that the region is dominantly occupied by Basalt, Alluvium Sandstone, Quartzite and Granite respectively. The sub-surface lithology has been broadly classified into Top soil/Unsaturated zone / Alluvium, underlain by Weathered Basalt and which has beenconsidered as shallow aquifer (upto a depth of 30 mts). Massive Basalt was encountered in few bore wells mainly occupying the southwestern region of Umaria. This overlies the Fractured Basalt Sandstone that forms the deeper aquifer (from 30-200 mts). The fractured aquifer lies between Vesicular Baslt and predominantly Masive Baslt.

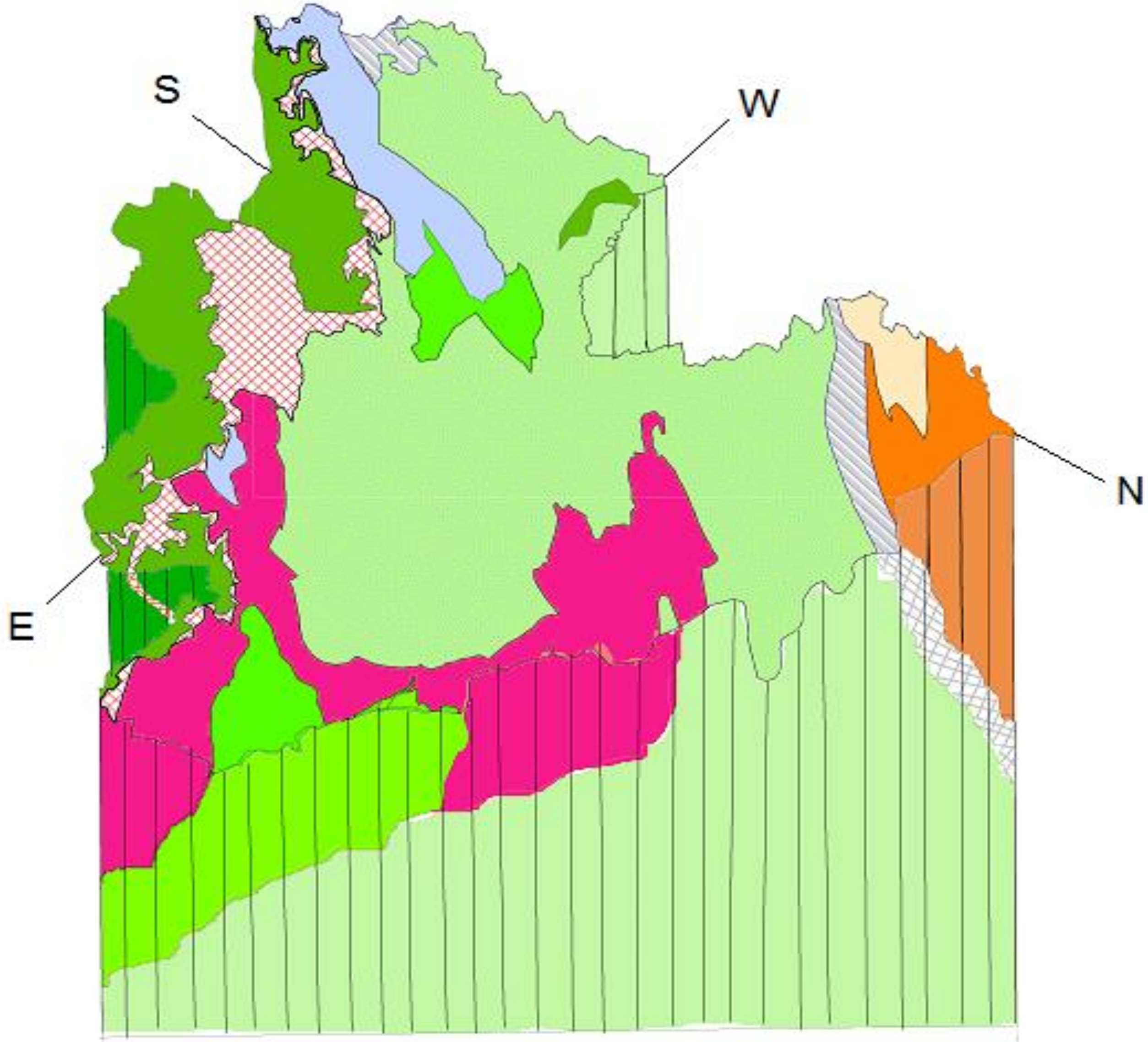
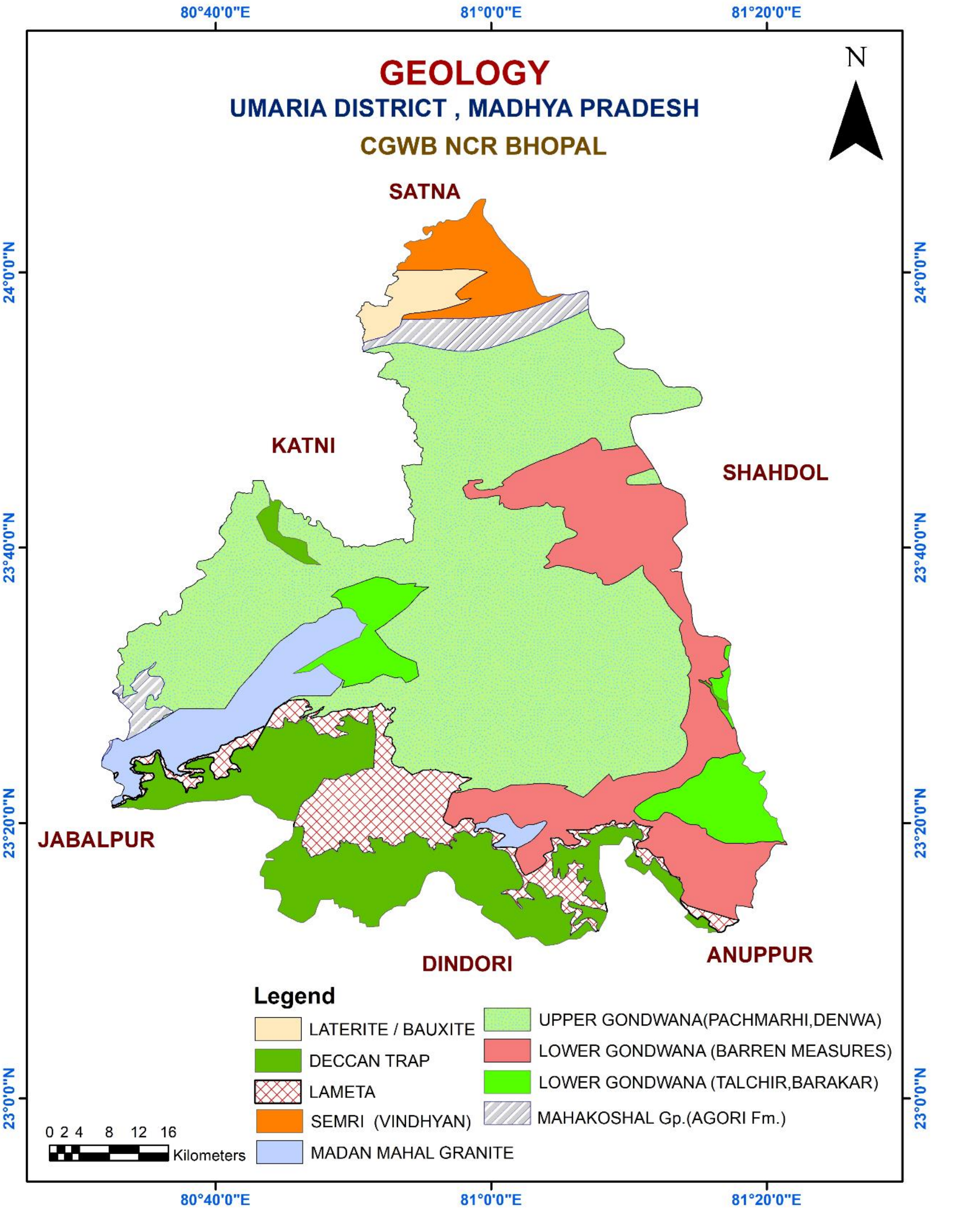


Figure 14 : 3-D Lithological Model of Umaria District, Madhya Pradesh



Fence Diagram

The Fence diagram was also prepared using the Rockworks software (Fig. 15). The pattern for the Fence was chosen as such to cover the maximum portion of the region to represent the enhanced picture of the sub-surface as deciphered from the 3-D stratigraphic model. It has also been interpreted from the diagram that the shallow and deeper aquifers are not in connection to each other.

Figure 15 : Fence Diagram, Umaria District, Madhya Pradesh

2-D Cross Section

2-Dimensional cross-section along the section line A-A' (SW-NE), B-B' has been prepared using Rockworks and later refined in Mapinfo (Fig. 16). The cross-section shows that theshallow aquifer is not continuing for the whole region and occurs as narrow pinches in the western portion of Umaria. The deeper aquifers whereas, occurs throughout the section lineand can be encountered at depth where fractures are present.

Figure 16 : 2-D Cross section Umaria District, Madhya Pradesh

Chapter-5:

Ground Water Resources

Dynamic Ground Water Resource (2022)

Umaria district is characterized by alluvial formations and Deccan trap basaltic lava flow. Dynamic ground water resources of the district have been estimated for base year - 2021-22 on block-wise basis. Out of 453900 ha of geographical area, 421900 ha is ground water recharge worthy area and 32000 ha is hilly area. There are three numbers of assessment units in the district which fall under command (29%) and non-command (71%) categories sub units. All blocks of the district are categorized as safe blocks, with highest stage of ground water development of 28.05% in Karkeli block. As per Dynamic Ground Water Resource of Madhya Pradesh – 2022, the annual extractable ground water resource in the district 32238.77 ham and ground water extraction for all uses is 6376.02 ham, making Stage of Ground water extraction 57.92 % as a whole for district. After making allocation for future domestic supply for year 2025, balance available ground water for future use would be 25689.02 ham (Table 10).

Table 10 : Dynamic Ground Water Resources (2022)

Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
KARKELI	1524.096	359.70	661.8509	2545.65	736.45	6456.28	28.04651	safe
MANPUR	2423.52	0	638.8033	3062.33	710.81	12926.1	19.06753	safe
PALI	347.328	180.130	240.5825	768.04	267.7	6306.64	10.81472	safe
DISTRICT TOTAL	4294.944	539.837	1541.237	6376.02	1714.96	25689.02	19.31	safe

Ground Water Resource & Draft (Outcome of NAQUIM)

The Ground Water Resource of Umaria district has been calculated block-wise considering the variable lithology and their associated aquifer parameters like specific yield. The In-storage resource for the shallow aquifer below zone of fluctuation (upto 30 mbgl) is computed to be around 167.0724mcm. The static resource for the deeper aquifer (30-200 mbgl) is computed as 189.855 mcm. The block-wise detail of ground water resources and draft as an outcome of NAQUIM is presented in the Table No.11

Block	Karkeli	Manpur	Pali	**DISTRICT TOTAL**
Shallow Aquifer				
Dynamic Resources (MCM)	90.7653	160.604	71.01	322.3793
In Storage Resources (MCM)	39.546	46.242	9.024	167.0724
Total Resources (MCM)	**130.31**	**206.85**	**80.03**	417.1919
Irrigation Draft	15.24096	24.2352	3.47328	42.94944
Domestic+Industries	10.21558715	6.3880329	4.20712505	20.81075
Deeper Aquifer				
Static Resources (MCM)	70.200	96.915	15.854	189.855
GW Draft (MCM	21.46	20	**23**	64.94
Total GW Resources (MCM)	200.51	303.76	95.89	600.1604

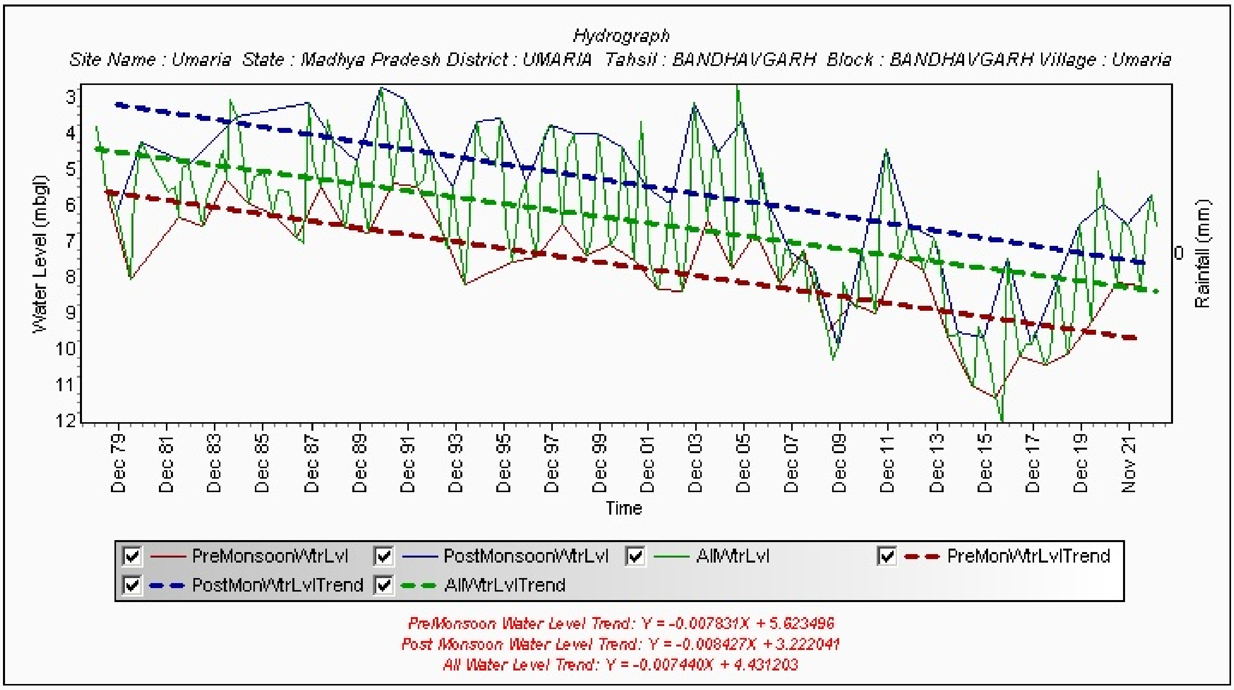
Table 11 : Ground Water Resources (Outcome of NAQUIM)

Chapter -6:

Ground Water Related Issues

Declining of water level

The long-term water level trend analysis indicates mixed results. During pre-monsoon season, out of 24 Hydrograph Stations, 17 are showing declining trend (Fig. 17). Similarly, during post-monsoon season, out of 24 stations 14 stations are showing falling trend in the district and all stations of Umaria blocks are showing depletion of water levels in the area.



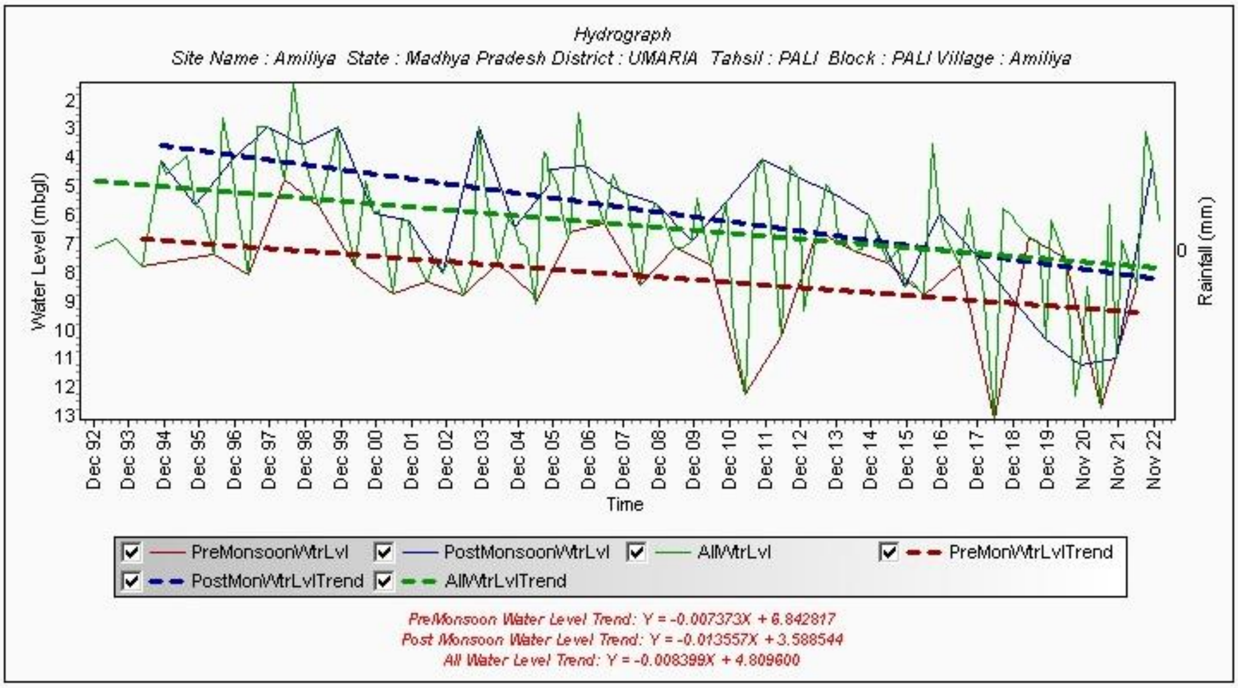


Figure 17 : Hydrographs showing declining water level trend during Pre-monsoon and Post-Monsoon at **sites Bandhavgarh and Pali villages ,** Umaria District, Madhya Pradesh

Ground Water Quality of Umaria District

The water samples were collected from Key wells in clean double stopper poly ethylene bottles from 50 different locations of Umaria district during May 2022 and selective wells samples has been collected during November 2022. All the collected water Samples are submitted to Chemical lab NCR, for analysis.

Quality of Ground Water for Drinking Purpose:

The ground water samples collected from Umaria district having pH range from 6.03 to 8.5. As per BIS(IS 10500 : 2012) recommendation, almost all the water samples have pH recorded within the permissible limits of 6.0 to 8.5, except Dhanwahi village shows 6.03, the maximum pH recorded in the water sample of Neusi (8.5). The ground water of the study area can be assessed as neutral to slightly alkaline. The electrical conductivity of ground water samples in Umaria district varies from 95 to 1350 µS/cm at 25°C. In the 50 nos. of water samples 47 shows electrical conductivity less than 1000µS/cm; in 3 nos. of samples EC in between 1000 to 1500 µS/cm. So, overall ground water quality in Umaria district is good. The maximum electrical conductivity has been observed in the water sample of Kodar village i.e. 1350 µS/cm at 25 °C.

The fluoride concentration in Umaria district lies in between 0.01 to 1.37 mg/l, which represent that almost all the samples are within the permissible limit i.e. 1.5 mg/l as per BIS (IS 10500: 2012) except Dhablijhar village of Karkeli block i.e 10.58 mg/l. Nitrate in ground water samples of Umaria district fall within limits of 1 to 35 mg/l. It is observed that 100% samples have Nitrate concentration less than the acceptable limit i.e. 45 mg/l. highest nitrate is reported in the water sampleof Karela (35mg/l). High nitrate in ground water samples may be due to anthropogenic activities or excessive use of fertilizers. The range of Total Hardness (as $CaCO_3$) in ground water samples of study area is 15 to 405 mg/l. In all locations, total hardness concentrations are within the permissible limit of 600 mg/l. The maximum concentration of total hardness observed in the village of Karela (405 mg/l).

Piper diagram has three parts: a Cat ion triangle, an Anion triangle, and a Central diamond-shaped field. In Cat ion triangle, the relative percentages of the major cations (Ca^{2+}, Mg^{2+}, Na^+, K^+) are plotted. In An ion triangle the major anions (HCO_3^-+CO_3^{2-}, SO_4^{2-}, Cl^-) are plotted. These points are then projected to the central diamond shaped field. The piperdiagram of Umaria district shows the ground water samples are Calcium-Bicarbonate type; hence show temporary hardness; Calcium Chloride type (permanent hardness); Mixed type and Sodium Chloride (saline) types.

Quality of Ground Water for Irrigation Purpose:

In classification of water for irrigation purpose, it is assumed that the water will be used for irrigation purpose based upon its soil texture, infiltration rate, drainage and climate. The chemical data of all the water samples from Umaria district is plotted on U.S. Salinity Laboratory diagram.

It is clear that approx. 42% samples shows that the ground water are C_2-S_1 Class (Medium Salinity & Low Sodium); 50% samples of study area are observed under C_3-S_1 Class (High Salinity & Low Sodium) and 8% samples of study area are observed under C_3- S_2 Class (High Salinity & Medium Sodium) which means that these waters can be used for Irrigation purpose for most of the crops, Water from these areas can be used for irrigation, considering the salinity content of the ground water.

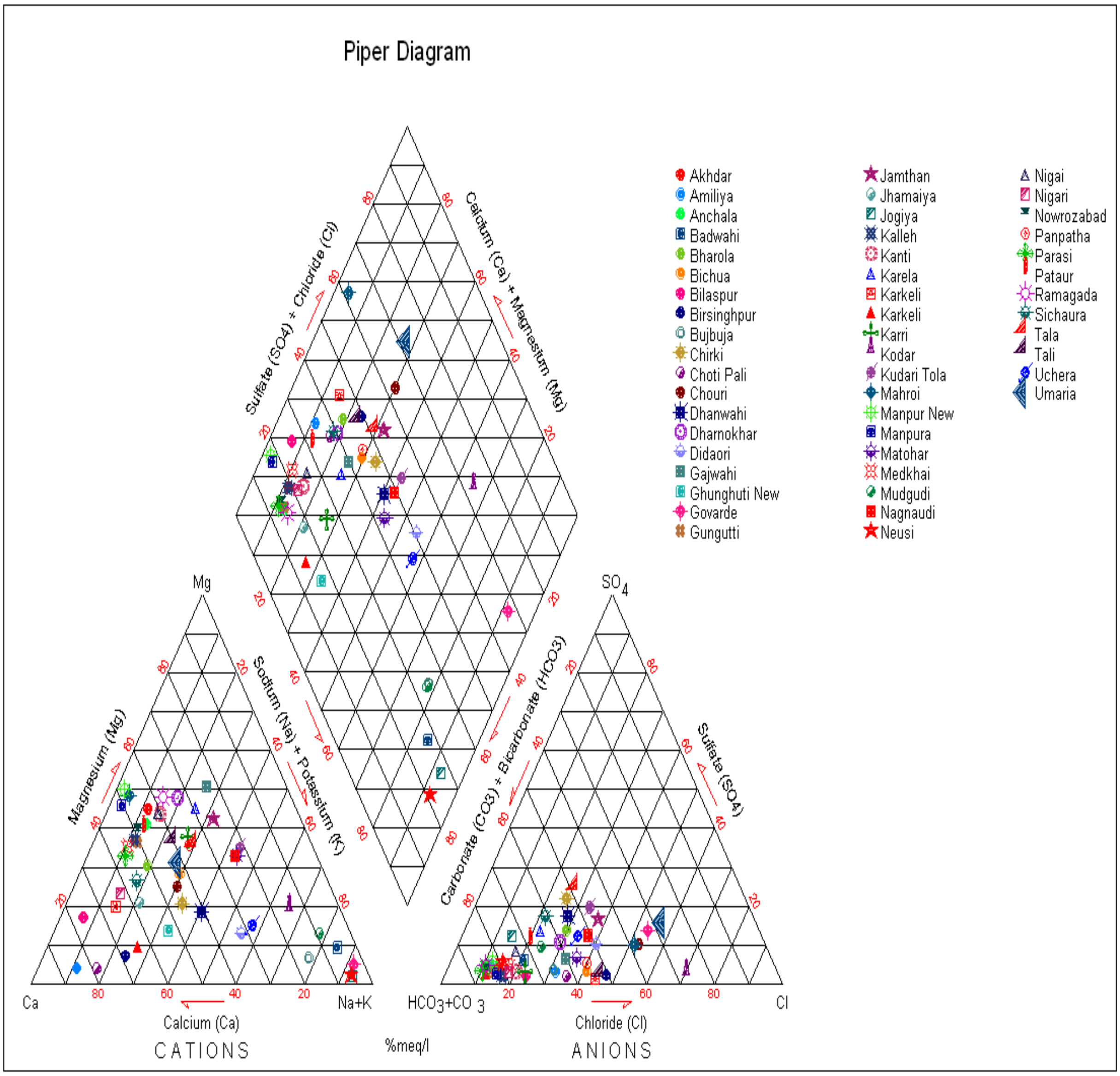


Figure 18 : Hill Piper Diagram representing classification of water samples collected from Key wells of Umaria District, Madhya Pradesh

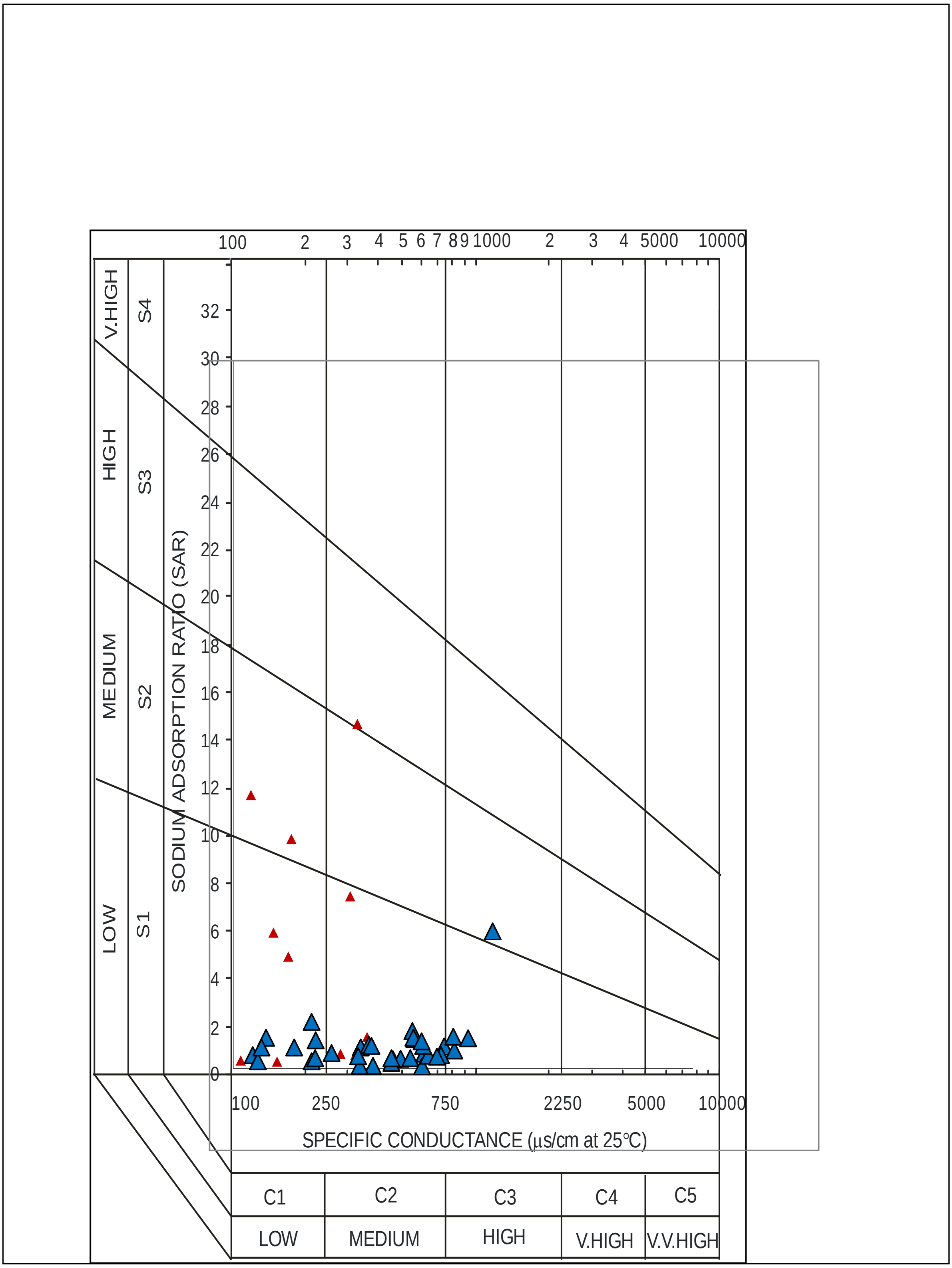


Figure 19 : US Salinity Diagram for water samples collected from National Hydrograph Stations of Umaria District, Madhya Pradesh

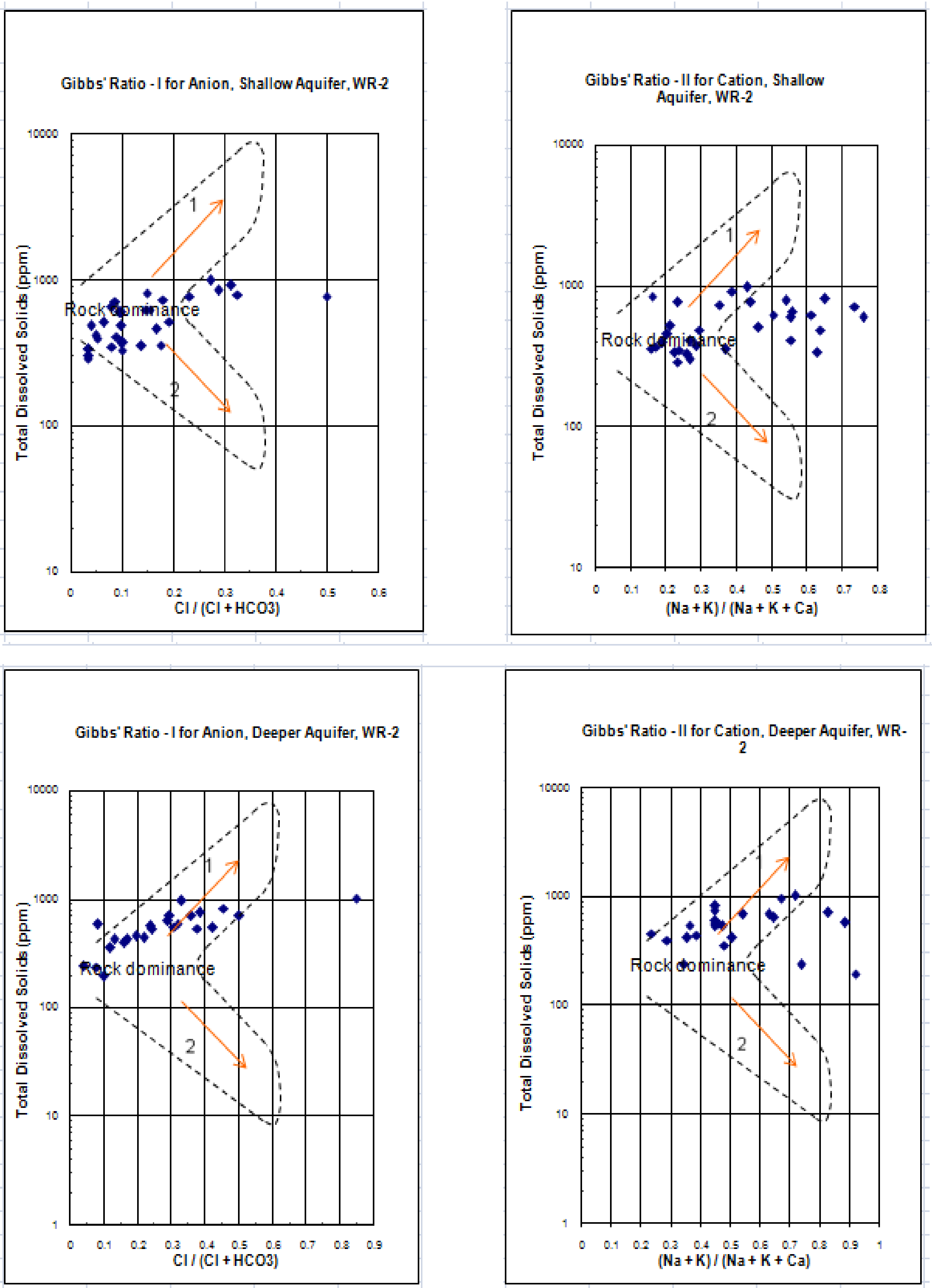
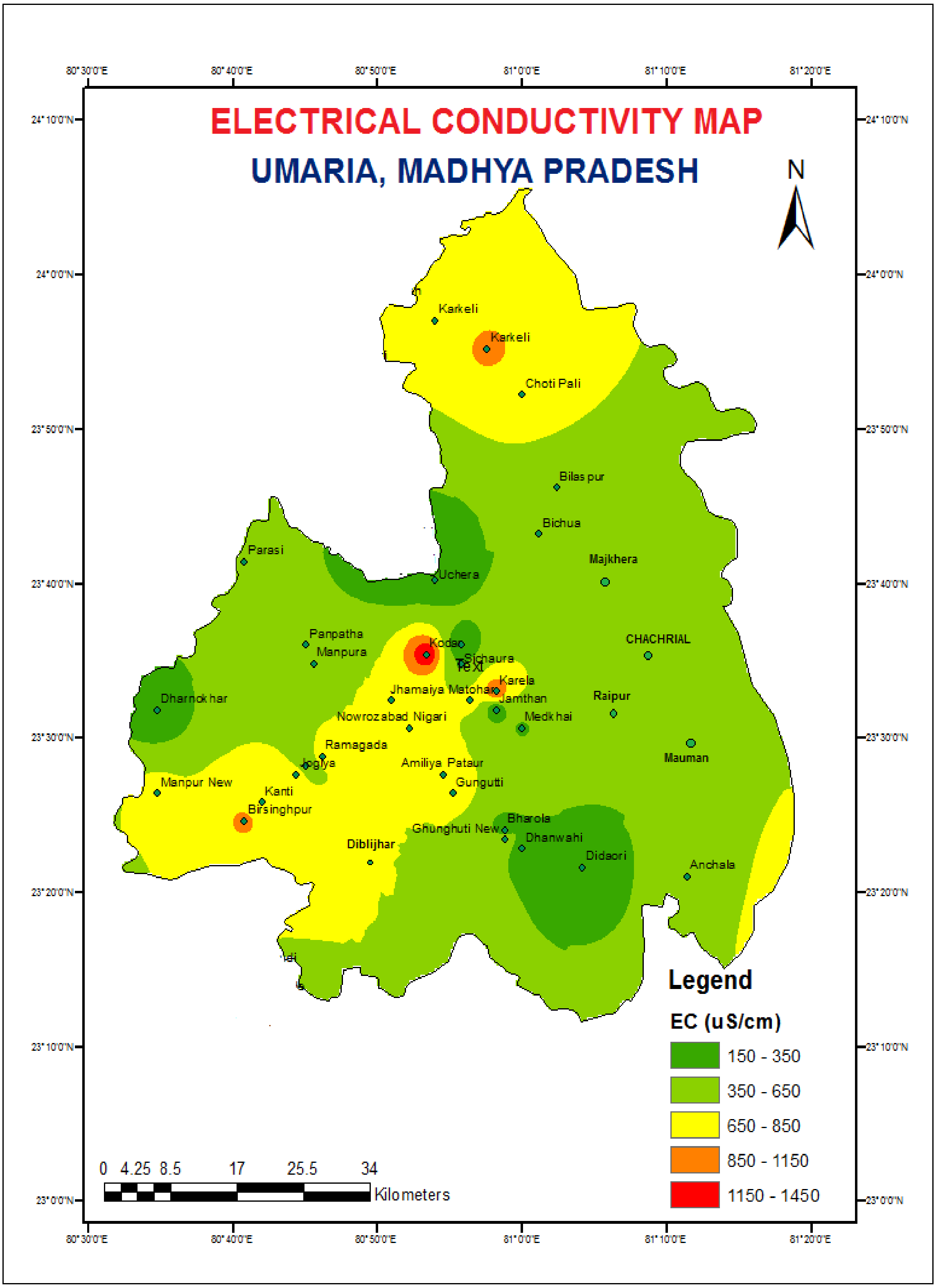
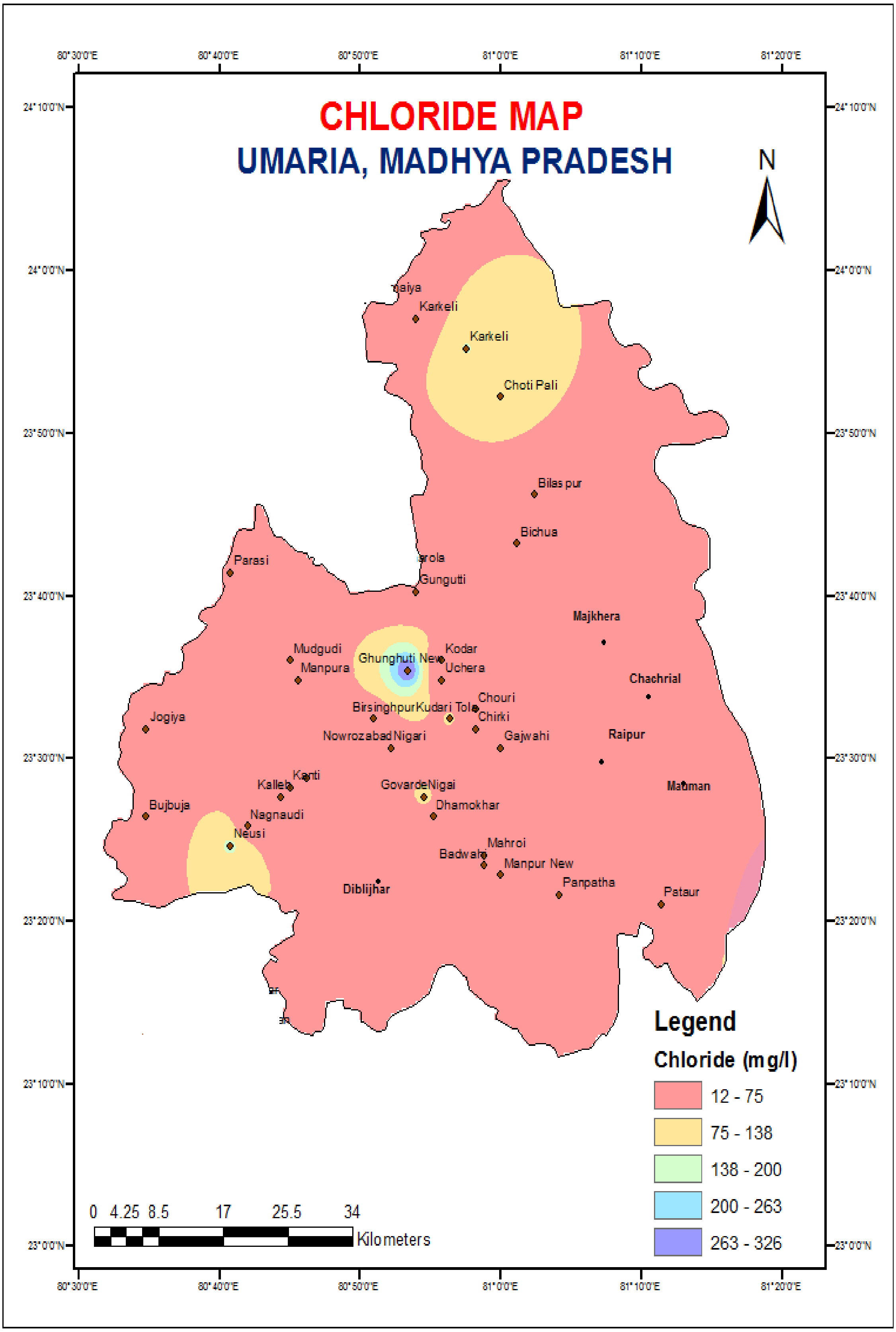
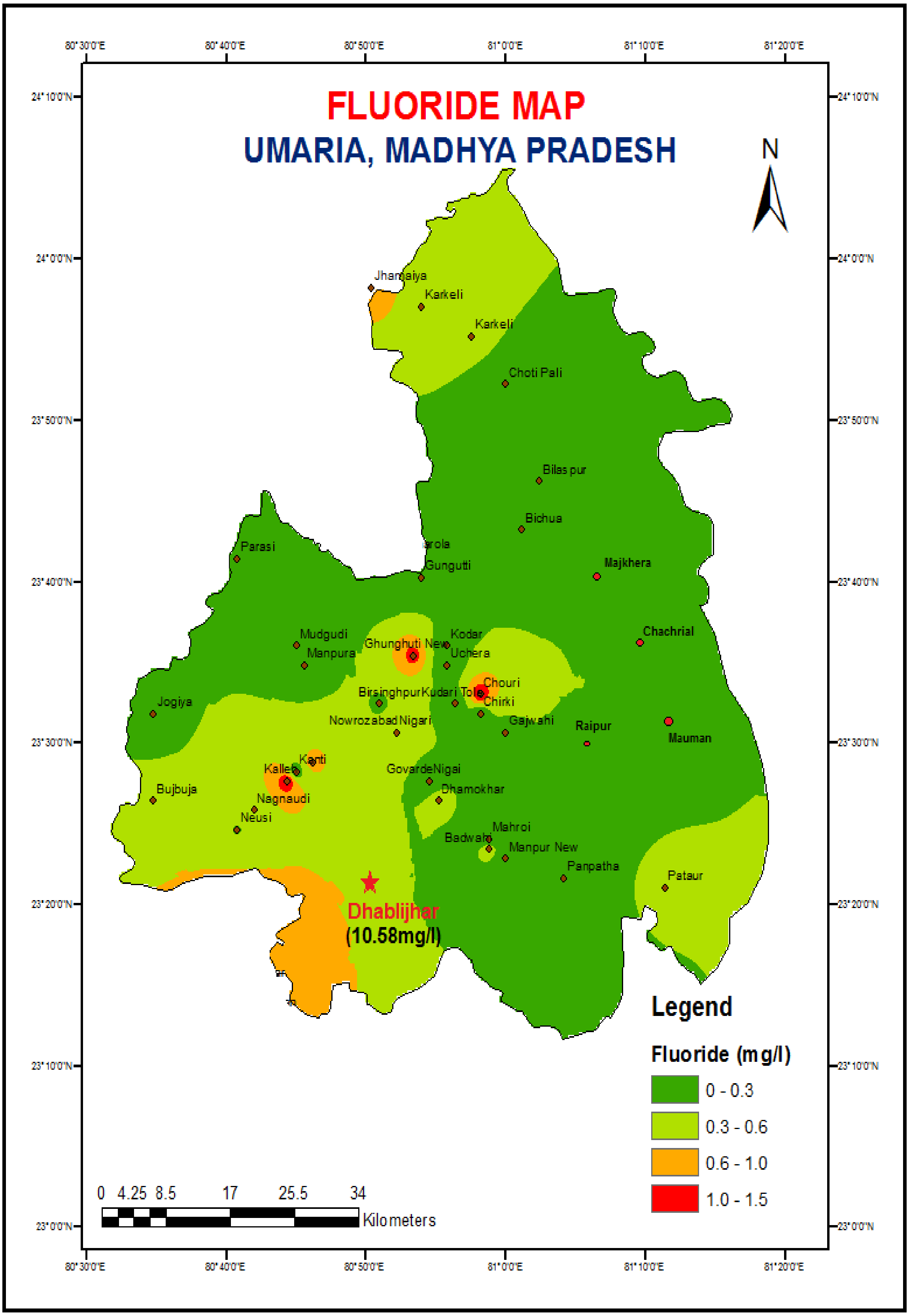
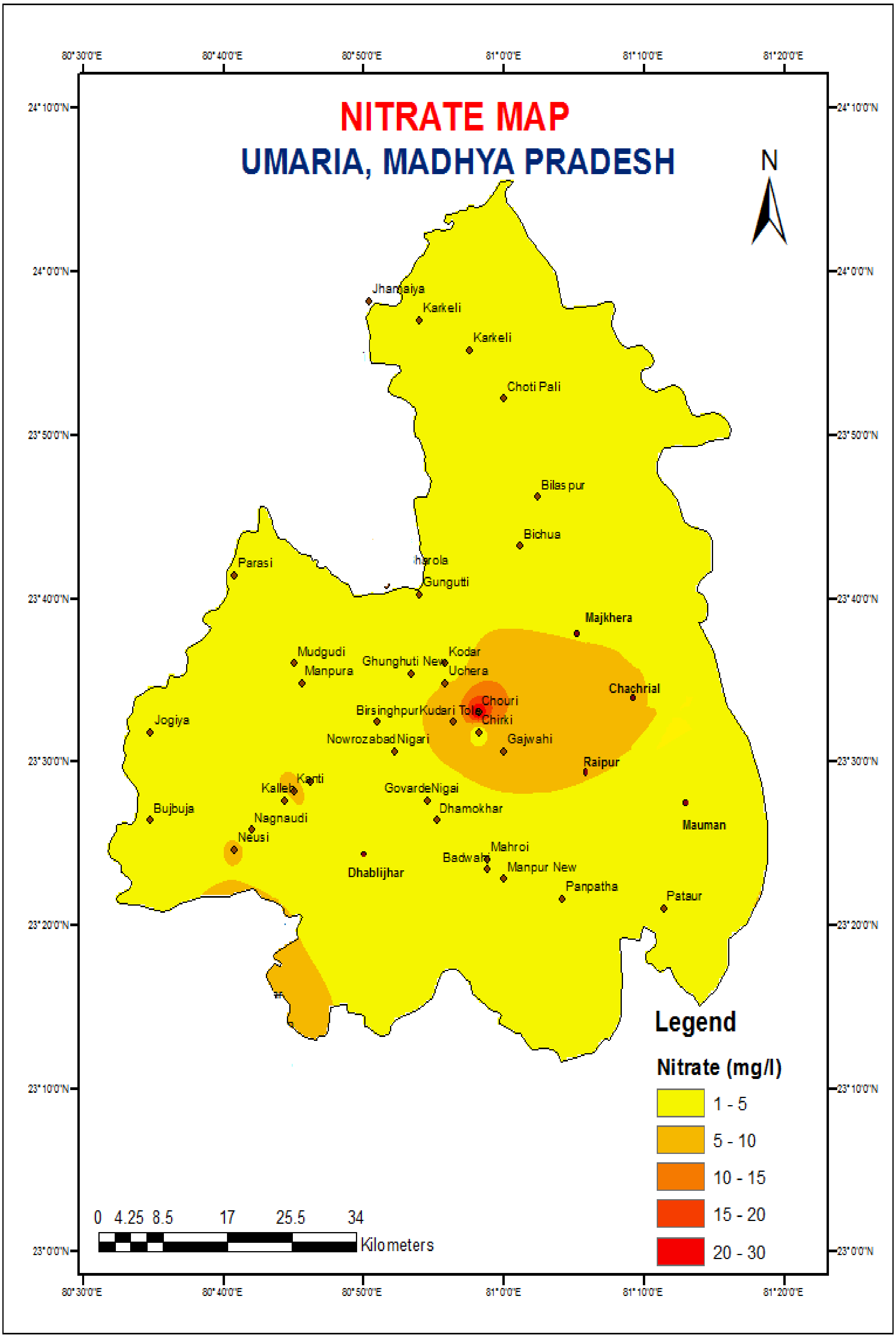


Figure 20 : Gibbs plot for water samples collected from National HydrographStations of Umaria District, Madhya Pradesh.

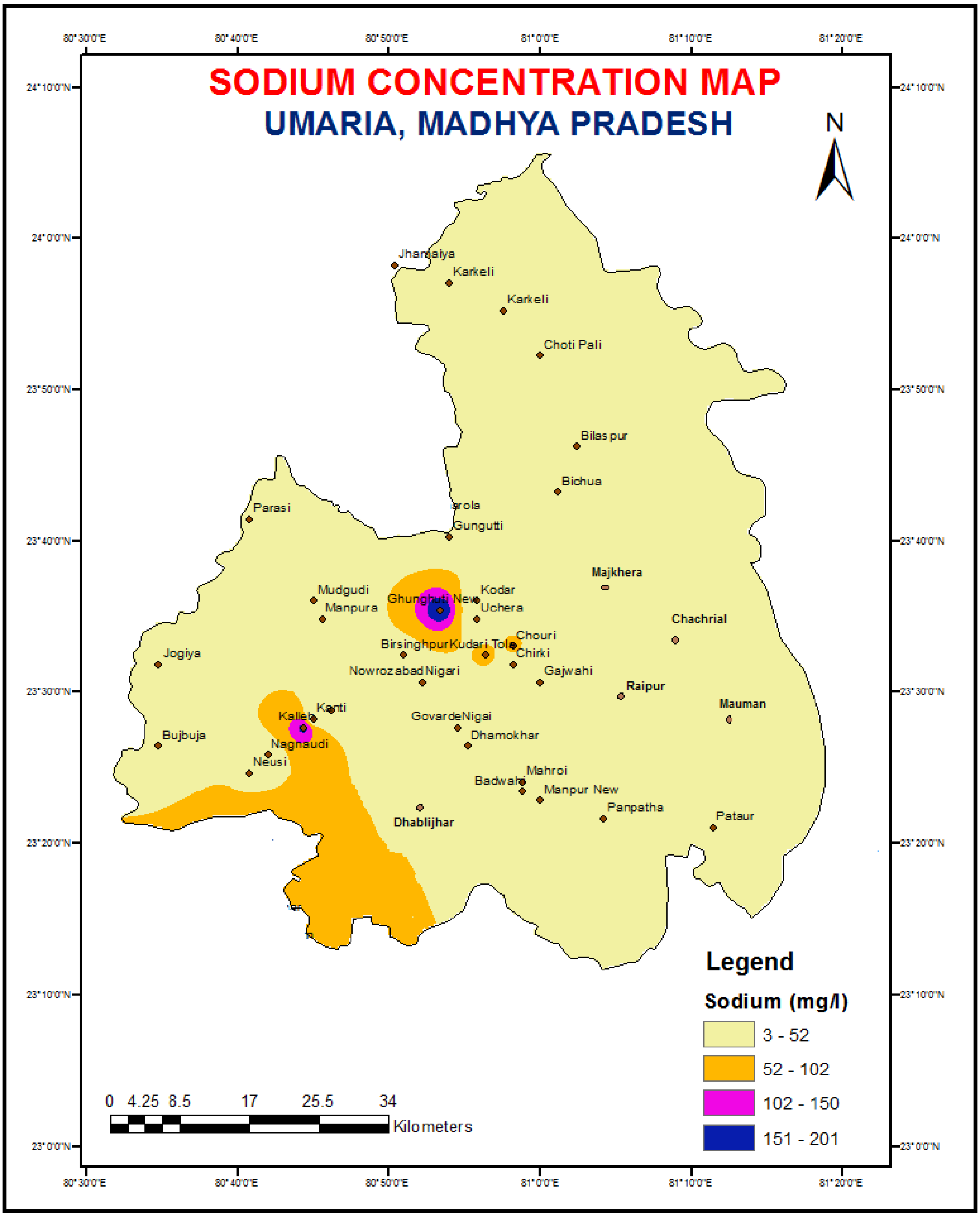

ELECTRICAL CONDUCTIVITY MAP
UMARIA, MADHYA PRADESH
N
Karkeli
Karkeli
Choti Pali
Bilas pur
Bichua
Majkhera
Parasi
Uchera
Panpatha
Manpura
Kodar
Sichaure
Karela
Jhamaiya Matohar
Jamthan
Medk hai
Raipur
CHACHRIAL
Dharnok har
Nowrozabad Nigari
Ramagada
Joglya
Amiliya Pataur
Gungutti
Mauman
Manpur New
Kanti
Birsinghpur
Ghunghuti New
Bharola
Dhanwahi
Didaori
Diblijhar
Anchala
Legend
EC (u S/cm)
150 - 350
350 - 650
650 - 850
850 - 1150
1150 - 1450
0 4.25 8.5 17 25.5 34
Kilometers


CHLORIDE MAP
UMARIA, MADHYA PRADESH
N
Karkeli
Karkeli
Choti Pali
Bilas pur
Bichua
Parasi
Gungutti
Majkhera
Mudgudi
Manpura
Ghunghuti New
Kodar
Uchera
Chachrial
Chouri
Birsinghpur
Kudari Tola
Chirki
Jogiya
Nowrozabad
Nigari
Gajwahi
Raipur
Kallel
Kanti
GovardeNigai
Dhamokhar
Bujbuja
Nagnaudi
Neusi
Mahroi
Badwahi
Manpur New
Panpatha
Diblijhar
Pataur
Legend
Chloride (mg/l)
12 - 75
75 - 138
138 - 200
200 - 263
263 - 326
0 4.25 8.5 17 25.5 34
Kilometers
80°30'0"E
80°40'0"E
80°50'0"E
81°0'0"E
81°10'0"E
81°20'0"E
24°10'0"N
24°0'0"N
23°50'0"N
23°40'0"N
23°30'0"N
23°20'0"N
23°10'0"N
23°0'0"N


FLUORIDE MAP
UMARIA, MADHYA PRADESH
N
Jhamaiya
Karkeli
Karkeli
Choti Pali
Bilaspur
Bichua
Parasi
Gungutti
Majkhera
Mudgudi
Manpura
Ghunghuti New
Kodar
Uchera
Chachrial
Chouri
Chirki
BirsinghpurKudari Tola
Jogiya
Nowrozabad Nigari
Gajwahi
Raipur
Mauman
Kanti
Kallen
Bujbuja
GovardeNigai
Dhamokhar
Nagnaudi
Neusi
Mahroi
Badwahi
Manpur New
Panpatha
Pataur
Dhablijhar
(10.58mg/l)
Legend
Fluoride (mg/l)
0 - 0.3
0.3 - 0.6
0.6 - 1.0
1.0 - 1.5
0 4.25 8.5 17 25.5 34
Kilometers



NITRATE MAP
UMARIA, MADHYA PRADESH
N
Legend
Nitrate (mg/l)
1 - 5
5 - 10
10 - 15
15 - 20
20 - 30
0 4.25 8.5 17 25.5 34
Kilometers
Karkeli
Karkeli
Choti Pali
Bilas pur
Bichua
Parasi
Gungutti
Majkhera
Mudgudi
Manpura
Ghunghuti New
Kodar
Uchera
Chachrial
Jogiya
Chouri
Chirki
Gajwahi
Raipur
Kanti
GovardeNigai
Dhamokhar
Bujbuja
Nagnaudi
Neusi
Mauman
Mahroi
Dhablijhar
Manpur New
Panpatha
Pataur



SODIUM CONCENTRATION MAP
UMARIA, MADHYA PRADESH
N
Jharnaiya
Karkeli
Karkeli
Choti Pali
Bilaspur
Bichua
Gungutti
Parasi
Majkhera
Mudgudi
Manpura
Ghunghuti New
Kodar
Uchera
Chachrial
Jogiya
Chouri
Birsinghpur
Kudari Tola
Chirki
Nowrozabad
Nigari
Gajwahi
Raipur
Mauman
Kanti
Kalleh
GovardeNigai
Dhamokhar
Bujbuja
Nagnaudi
Neusi
Mahroi
Badwahi
Manpur New
Panpatha
Pataur
Dhablijhar
Legend
Sodium (mg/l)
3 - 52
52 - 102
102 - 150
151 - 201
0 4.25 8.5 17 25.5 34
Kilometers

Parameters					Field Temp. (ºC)	pH	EC	CO_3	HCO_3	Cl	SO_4	NO_3	F 40	PO_4	SiO_2	TH	Ca	Mg	Na	K	
ocation	Source	Lat.	Long.	Date of Collection		at 25°C	µS/cm at 25°C	mg/liter													
Ianpura	Hand Pump	23.580	80.760	04.06.2022	25	7.65	406	0	193	20	5	2	0.09	0.01	28	188	40	22	3	0.4	264
arasi	Hand Pump	23.690	80.680	04.06.2022	25.2	7.21	496	0	248	17	8	3	0.05	BDL	26	213	53	19	12	0.3	322
ala	Hand Pump	23.790	80.530	04.06.2022	24.3	6.24	122	0	30	10	12	5	0.07	0.01	13	40	8	5	8	0.2	79
maria	Hand Pump	23.920	80.020	05.06.2022	25.4	6.07	359	0	48	59	22	25	0.01	BDL	19	124	28	13	22	0.4	233
khdar	Hand Pump	23.980	80.580	05.06.2022	24.3	7.3	534	0	254	27	10	4	0.40	BDL	22	233	46	29	14	0.38	347
ichua	Hand Pump	23.720	81.020	05.06.2022	24.6	6.55	389	0	127	54	6	1	0.01	BDL	23	134	32	13	25	0.67	253
ilaspur	Hand Pump	23.770	81.040	05.06.2022	23.5	6.72	487	0	211	39	5	2	0.15	BDL	20	223	73	10	7	0.56	317
hoti Pali	Hand Pump	23.870	81.000	06.06.2022	22.5	6.71	826	0	302	100	8	4	0.20	0.02	22	337	129	4	32	0.44	537
arkeli	Hand Pump	23.920	80.960	06.06.2022	23.6	6.84	915	0	296	140	6	6	0.42	BDL	28	386	119	22	30	1.69	595
arkeli	Hand Pump	23.950	80.900	07.06.2022	24	7.13	614	0	308	24	8	3	0.47	BDL	27	223	77	7	36	0.51	399
igari	Hand Pump	23.510	80.870	07.06.2022	24	7.25	676	0	314	42	10	3	0.62	BDL	24	287	83	19	22	0.44	439
owrozabad	Hand Pump	23.510	80.870	07.06.2022	24.9	7.36	589	0	290	22	10	5	0.47	BDL	22	257	57	28	15	0.46	383
harnokhar	Hand Pump	23.530	80.580	09.06.2022	24.9	6.25	128	0	42	12	6	3	0.13	0.012	14	50	8	7	5	0.42	83

lahroi	Hand Pump	23.470	80.750	09.06.2022	24.1	6.08	355	0	72	56	15	13	0.07	BDL	18	163	32	20	3	0.71	231
lanpur New	Hand Pump	23.440	80.580	09.06.2022	22	7.15	663	0	320	27	18	6	0.42	BDL	22	322	63	40	3.2	0.65	431
anpatha	Hand Pump	23.600	80.750	04.06.2022	24.8	6.57	400	0	127	54	10	2	0.11	BDL	19	139	28	17	25	0.85	260
ataur	Hand Pump	23.460	80.910	04.06.2022	24	6.93	219	0	85	15	10	2	0.23	BDL	22	89	20	10	6.2	0.5	142
miliya	Hand Pump	23.460	80.910	05.06.2022	23	6.68	804	0	302	86	12	5	0.2	0.025	25	347	133	4	20	0.56	523
irsinghpur	Hand Pump	23.410	80.680	07.06.2022	24	6.8	910	0	272	147	10	8	0.34	0.01	29	342	123	8	48	1.72	592
hunghuti New	Hand Pump	23.390	80.980	04.06.2022	24.1	7.13	602	0	290	24	13	5	0.55	BDL	23	198	63	10	45	0.61	391
ungutti	Hand Pump	23.440	80.920	04.06.2022	25	7.28	707	0	344	29	10	2	0.44	BDL	21	297	69	30	20	0.9	460
harola	Hand Pump	23.400	80.980	05.06.2022	23.6	6.4	227	0	72	22	14	4	0.02	BDL	23	89	22	8	9	0.6	148
hanwahi	Hand Pump	23.380	81.000	05.06.2022	25.1	6.03	229	0	66	20	17	6	0.1	BDL	18	64	18	5	20	0.74	149
idaori	Hand Pump	23.360	81.070	05.06.2022	26.5	6.39	139	0	36	17	6	3	0.08	BDL	14	30	8	2	15	1.39	90
nchala	Hand Pump	23.350	81.190	05.06.2022	24.7	7.02	488	0	242	17	10	3	0.41	BDL	19	208	44	24	14	0.98	317
ali	Hand Pump	23.310	81.350	06.06.2022	27.1	6.97	1051	0	314	162	10	10	0.42	0.26	32	396	83	46	57	1.03	683
amaiya	Hand Pump	23.540	80.850	06.06.2022	24.3	7.28	670	0	320	32	13	3	0.31	BDL	20	262	77	17	32	0.67	436
odar	Hand Pump	23.590	80.890	07.06.2022	24.3	7.47	1350	0	217	328	15	5	1.16	0.22	28	228	40	31	202	1.24	878
chera	Hand Pump	23.670	80.900	07.06.2022	23.4	6.4	219	0	66	24	12	4	0.12	BDL	17	45	12	4	28	0.76	142

udari Tola	Hand Pump	23.700	80.880	09.06.2022	24	5.99	95	0	24	10	8	3	0.03	BDL	12	25	4	4	9	0.64	62
hirki	Hand Pump	23.680	80.860	04.06.2022	25	6.05	184	0	60	17	20	2	0.06	BDL	15	64	18	5	15	0.66	120
ajwahi	Hand Pump	23.710	80.840	04.06.2022	24.2	9.34	268	0	91	29	8	3	0.41	BDL	19	94	12	16	15	0.77	174
houri	Hand Pump	23.810	80.820	05.06.2022	23.5	4.9	608	0	127	105	28	15	0.12	0.012	22	208	53	18	40	1.56	395
arri	Hand Pump	23.900	80.810	07.06.2022	25	7.11	661	0	284	51	10	5	0.52	BDL	23	238	46	30	40	0.7	430
alleh	Hand Pump	23.970	80.840	04.06.2022	23.3	6.89	769	0	362	44	7	4	1.03	BDL	20	332	77	34	20	0.66	500
agnaudi	Hand Pump	23.600	80.930	04.06.2022	24	5.82	133	0	36	15	7	2	0.15	BDL	17	35	6	5	12	0.69	86
ichaura	Hand Pump	23.580	80.930	05.06.2022	24	6.64	349	0	115	24	26	8	0.06	BDL	15	139	38	11	13	1.26	227
Iatohar	Hand Pump	23.540	80.940	05.06.2022	24	6.47	664	0	211	78	20	11	0.04	0.021	22	183	30	26	62	5.08	432
mthan	Hand Pump	23.530	80.970	05.06.2022	23.8	6.03	171	0	42	20	12	3	0.05	BDL	14	54	8	8	11	0.93	111
Iedkhai	Hand Pump	23.510	81.000	05.06.2022	23.9	6.93	355	0	155	20	8	8	0.25	BDL	19	155	38	15	8	0.72	231
arela	Hand Pump	23.550	80.970	06.06.2022	25.9	7.94	1110	0	383	77	65	35	1.37	0.024	25	405	64	60	63	0.8	722
amagada	Hand Pump	23.480	80.770	06.06.2022	24	7.08	676	0	341	25	15	3	0.79	BDL	20	285	50	39	22	0.74	439
ɔgiya	Hand Pump	23.460	80.740	07.06.2022	23.2	7.92	820	0	347	40	46	4	1.33	BDL	28	30	8	2	170	0.83	533
anti	Hand Pump	23.430	80.700	07.06.2022	25	7.3	656	0	293	45	10	7	0.41	0.01	23	270	52	34	23	0.76	426
ujbuja	Hand Pump	23.320	80.680	05.06.2022	25.2	7.24	856	0	323	89	15	10	1.35	BDL	27	95	26	7	150	0.76	556

ludgudi	Hand Pump	23.250	80.680	07.06.2022	24.3	7.44	450	0	173	37	20	3	0.92	BDL	20	50	8	7	78	0.77	293
ovarde	Hand Pump	23.220	80.690	04.06.2022	25.4	8.78	643	0	120	114	40	20	1.03	0.01	20	25	4	4	135	0.72	418
igai	Hand Pump	23.180	80.690	04.06.2022	24.3	7.25	256	0	108	15	10	2	0.13	BDL	18	105	20	13	8	0.77	166
eusi	Hand Pump	23.180	80.630	05.06.2022	24.6	8.5	392	0	179	20	10	3	0.96	BDL	17	15	4	1	80	0.71	255
adwahi	Hand Pump	23.200	80.510	05.06.2022	23.5	7.57	350	0	149	25	10	2	0.87	BDL	19	25	4	4	67	0.74	228

Chapter -7:

Ground Water Management Strategies

Groundwater has been contributing more to agricultural wealth than surface irrigation since ages. Tube wells are now the largest source of irrigation in the country. Since this sectorhas almost no dependence on the government, it is growing at a rapid rate and it is estimated that one million wells are added every year (Shah and Deb, 2004). Being an individually managed source, ground water irrigation is also a more efficient form of irrigation, with crop yields per cubic meter of water being 1.2 to 3 times higher than surface irrigation. However, since this sector has grown through investment by individual farmers, with little state involvement compared to canal irrigation, government support for understanding this sector and improving its performance is negligible. The major issues for the future growth of groundwater irrigation is declining resource base, demand driven growth, and a lack of policyand regulatory framework. Since groundwater extraction is primarily driven by the needs of the population and the density of farmer population and not the quality of resource, groundwater irrigation is scaling up even in such hard rock areas causing irreversible depletion of the resource base (Shah and Deb, 2004). To warrant the current situation effective groundwater management strategies needs to be evolved.

District Ground Water Management Plan (Outcome of NAQUIM)

Umaria district has been facing problems of ground water exploitation which in turn are depleting the ground water resources in the non-command area. This has led toevolve sustainable water conservation and management practices through an integrated approach. The ground water management plan for Umaria district has been made keeping in view the area specific details and includes the strategies like enhancing the ground water resources through construction of artificial recharge structures such as percolation tanks, check dams/ Nala bunds, recharge shafts, etc. and ensuring water use efficiency through maintenance/ renovation of existing water bodies/water conservation structures. Also, adoption of micro-irrigation techniques such as sprinkler irrigation has been proposed, that would not only conserve ground water resources by reducing the draft, but would also increase the net cropping area thereby augmenting the agricultural economy of the district.

Supply Side Management

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost-effective technology to mitigate the problems of over exploitation of ground water resources. The artificial recharge techniques simultaneously rejuvenate the depleted ground water storage, reduce the ground water quality problems and also improve the sustainability of wells in the affected areas.

The supply side management plan for Umaria district has been formulated using the basic concepts of hydrogeology. Sub-surface storage is calculated by multiplying the total area with the respective specific yield (considering the variable lithology) and the unsaturated zone thickness obtained by subtracting 3 mts from the post-monsoon water level. The volume of ground water recharge generated through pre-existing rain water harvesting/water conservation structures is subtracted from the sub-surface storage to assess the available storage potential. Thus, the surface water requirement to completely saturate the sub-surface storage is obtained by multiplying a factor of 1.33 to available storage potential. A runoff coefficient factor of 0.23 has been considered for Umaria district to calculate the total surface water runoff, 30% of which accounts to the non-committed runoff which is available to sustain the proposed artificial recharge structures. Further, the number of structures has been calculated by allotting 35%, 35% and 20% of non-committed runoff to Percolationtanks, Recharge shafts/Tube wells and Nala bunds/Check dams/Cement Plugs respectively. The remaining 10 % runoff is considered to restore the pre-existing village tanks, ponds and water conservation structures. A detailed calculation of the proposed artificial recharge structures is presented in the Table No.12

A financial outlay plan has also been chalked out, assuming the cost for the artificial recharge structures to be Rs. 20 lakhs each for percolation tanks, Rs. 10 lakhs each for Nala bunds/Check Dams/Cement Plugs, Rs. 5 lakhs each for Recharge shafts/Tube wells and Rs. 2 lakhs each for renovation of Village tanks/ponds/WCS. This accounts to a total of Rs. 278 Crores to successfully implement the supply side management strategy. Table No. 13 represents the complete financial outlay plan for the district.

Demand Side Management

Micro irrigation technologies such as drip and sprinkler systems are being increasingly promoted as technological solutions for achieving water conservation. Micro-irrigation comprises two technologies-drip and sprinkler irrigation. Both saves conveyance losses and improve water application efficiency by applying water near the root-zone of the plant some benefits of the micro-irrigation have been listed below:

1. The increase in yield for different crops ranges from 27 per cent to 88 per cent and water saving ranges from 36 per cent to 68 per cent vis-à-vis conventional flow irrigation systems (Phansalker and Verma, 2005).
2. It enables farmers to grow crops which would not be possible under conventional systems since it can irrigate adequately with lower water quantities.
3. It saves costs of hired labour and other inputs like fertilizer.
4. It reduces the energy needs for pumping, thus reducing energy per ha of irrigation because of its reduced water needs. However, overall energy needs of the agriculture sector may not get reduced because most farmers use the increased water efficiency tobring more area under irrigation.

Adoption of Sprinkler irrigation techniques in 50% of the area irrigated by ground water has been suggested for the Umaria district Also, the 60% of additional recharge created by construction of artificial recharge structures can be utilized to increase the total cropping area,thereby enhancing the productivity and economy of the district.

Table 12: Ground Water Management– Supply Side, Umaria District, Madhya Pradesh

Block	Net GW Availability	GW Draft for Irrigation	GW Draft for Domestic & Industrial	Gross Draft	Stage of Development	Saving by Sprinklar in MCM	Additional recharge created by AR	After intervention of AR Structure Net GW AvL.	After intervention of AR Structure & utilisation of 60% of additional GW created.	Draft after sprinkler & additional area created for agriculture	Stage of Development W/O GW use for addidtional Area Irrigation	Additional area irrigated by GW after intervention
KARKELI	90.765	15.241	10.216	25.457	**28.05**	3.05	45.24	136.0053	27.1440	49.55	**36.43**	6786
MANPUR	160.604	24.235	63.880	30.623	**19.07**	4.85	118.51	279.12	71.1079	154.38	**55.31**	17777
PALI	71.018	3.473	4.207	7.680	**10.81**	0.69	54.31	125.33	32.5850	39.57	**31.57**	8146
DISTRICT TOTAL	322.388	42.949	78.303	63.760	**19.31**	8.59	218.06	540.45	130.8370	243.50	**45.05**	32709

Block	Area Suitable for AR	Volume of Surface Water available for AR (MCM)	Volume of Water required for recharge (MCM)	Proportionate Surface water for planning AR (MCM)	Percolation Tanks		CD/Recharge shaft/ Tube well			NB/ CP		Renovation of Village Ponds		Total Cost of RS in crores
					structure	cost	structure	cost		structure	cost	structure	cost	
					Nos	(crores)	Nos	(crores)		Nos	(crores)	Nos	(crores)	
KARKELI	1560	129.75	432.5	30.96963	60	8.2	211	16.5		241	45	45	32.8	102.5
MANPUR	1846	129.9566	433.1885	157.6226	158	31.52451	552	55.2		630	31.5	85	1.7	119.9245
PALI	813	68.25	227.5	72.23017	72	14.44603	253	25.3		289	14.45	69	1.38	55.57603
TOTAL	4219	327.9566	1093.189	260.8224	290	57.97055	1016	101.6		290	90.95	199	3.98	278.0005

Post-Intervention

The expected outcome of the proposed interventions from both supply side and demand side has been described in Table No 14. It can been revised that the Stage of groundwater development for the entire Umaria district, would increase to 45.05 % as compared to the present stage of groundwater development of 19.31% after implying and successful implementation of proposed interventions.

Table 13: Post-Intervention Impact, Umaria District, Madhya Pradesh (in MCM)

Block	Net GW Availability	GW Draft for Irrigation	GW Draft for Domestic & Industrial	Gross Draft	Stage of Development	Saving by Sprinklar in MCM	Additional recharge created by AR	After intervention of AR Structure Net GW AvL.	After intervention of AR Structure & utilisation of 60% of additional GW created.	Draft after sprinkler & additional area created for agriculture	Stage of Development W/O GW use for addidtional Area Irrigation	Additional area irrigated by GW after intervention
KARKELI	90.765	15.241	10.216	25.457	**28.05**	3.05	45.24	136.0053	27.1440	49.55	**36.43**	6786
MANPUR	160.604	24.235	63.880	30.623	**19.07**	4.85	118.51	279.12	71.1079	154.38	**55.31**	17777
PALI	71.018	3.473	4.207	7.680	**10.81**	0.69	54.31	125.33	32.5850	39.57	**31.57**	8146
DISTRICT TOTAL	322.388	42.949	78.303	63.760	**19.310**	8.59	218.06	540.45	130.8370	243.50	**45.05**	32709

Block	Karkeli	Manpur	Pali
Geographical area	1730	1899 50	910
Basin/Sub Basin	Son sub basin	Son sub basin	Son sub basin
Principal Aquifer System	Granite Gneiss / Alluvium	Basalt	Basalt / Alluvium
Major Aquifer System	Alluvium / Fractured Gneiss	Fractured Basalt	Fractured Basalt / Alluvium
Normal Annual Rainfall	1248.8	1248.8	1248.8
Aquifer Disposition	Two Types of Aquifer System Shallow Aquifer system (Aquifer-I): Depth range from 3 to 30 m, Weathered Granite Gneiss / Alluvium Deeper Aquifer System (Aquifer-II): Depth range from 30-180m, Fractured Gneiss /sandstone	Two Types of Aquifer System Shallow Aquifer system (Aquifer-I): Depth range from 3 to 30m, Weathered Basalt Deeper Aquifer System (Aquifer-II): Depth range from 30-170m, Fractured Basalt	Two Types of Aquifer System Shallow Aquifer system (Aquifer-I): Depth range from 2 to 30m, Weathered Basalt / Alluvium Deeper Aquifer System (Aquifer-II): Depth range from 30-180 m, Fractured Basalt
Status of GW Exploration	Piezometer - 2	Explorotary Well- 1	Piezometer - 1
Aquifer Characteristic	Aquifer I : Depth of Occurrence (m bgl): 3 to 30, Thickness average (m):15 DTWL (m bgl): 3-14 Yield (lps): 1 to 4.5 Specific yield :0.02 Aquifer II : Depth of Occurrence (m bgl): 30 m to 180 m, Thickness average (m): 0.5 to 6 DTWL (m bgl): 11 - 28 Yield (lps): Meager to 12 T (m2/day), Specific yield :0.010	Aquifer I : Depth of Occurrence (m bgl): 3 to 30, Thickness average (m):15 DTWL (m bgl): 3-14 Yield (lps): 1 to 4.5 Specific yield :0.02 Aquifer II : Depth of Occurrence (m bgl): 30 m to 180 m, Thickness average (m): 0.5 to 6 DTWL (m bgl): 11 - 28 Yield (lps): Meager to 7 T (m2/day), Specific yield :0.010	Aquifer I : Depth of Occurrence (m bgl): 2 to 30, Thickness average (m):13 DTWL (m bgl): 3-14 Yield (lps): 1 to 4.5 Specific yield :0.02 Aquifer II : Depth of Occurrence (m bgl): 30 m to 180 m, Thickness average (m): 0.5 to 6 DTWL (m bgl): 11 - 28 Yield (lps): Meager to 12 T (m2/day), Specific yield :0.010
Ground water Monitoring Status	NHS: DW - 3, PZ-1	NHS: DW - 5, PZ-1	NHS: DW - 4
Groundwater Quality	Generally shallow and Deeper Aquifer Groundwater Quality potable	Generally shallow and Deeper Aquifer Groundwater Quality potable	Generally shallow and Deeper Aquifer Groundwater Quality potable
Aquifer potential	Mainly aquifer potential in weathered / Fracture Granite Gneiss and in Alluvium	Mainly aquifer potential in weathered / Fracture Basalt	Mainly aquifer potential in weathered / Fracture Basalt and in Alluvium

Groundwater Resource	GW Availability 90.7653 ham GW Draft 24.457 ham Stage of GW Development 28.05 %	GW Availability 160.604 GW Draft 30.623 ham Stage of GW Development 19.07%	GW Availability 71.018 GW Draft 7.680 ham Stage of GW Development 10.81%
Existing and Future water Demand	Present Demand for All usage 6341.53 ham Future Demand for Domestic and Industrial Use 457.79 ham	Present Demand for All usage 4482.49 ham Future Demand for Domestic and Industrial Use 435.1 ham	Present Demand for All usage 4820.97 ham Future Demand for Domestic and Industrial Use 437.96 ham

Table 14: Block wise Management Plan

Chapter -8:

Conclusions and Recommendation

On the basis of NAQUIM studied in the area, the following conclusions are drawn. The studied area occupies an area of 4503 Sq. Km. Umaria district has been divided into two Tehsils namely Bandhogarh and Pali and three blocks namely Manpur, Karkeli and Pali for convenience of administrations.

Physiographically, structural land forms represented by plateau, hills and valleys have developed in central, southern and north eastern part of the district.The southern part of this district is represented by hilly terrain, which is northern part of Amarkantak hills extending in East-west direction. The highest elevation of the district is located on southern boundary of the district near village Singhpur having an elevation of 980 m above mean sea level, comprising of basaltic rocks.

The entire Umariya distnct is falling under Son sub basin area of the Ganga basin the main river of the district is the son which flows from south -west to north- east direction and forming district boundary between Shahdol and Umariya district.
The Son or Survarna means the gold is one of the biggest tributary of the rivers Ganga, and it is considered as sacred river. The river Son originates from Son kund (22°42°32" : 2°01°10") from Amarkantak plateau, located in Anuppur district of Madhya Pradesh. Rivers Johila and Chhoti Mahanadi are main tributaries of Son river in Umariya district.

The major part of the district is underlain by Gondwana sedimentary formations, which are potential aquifers in the area. the other geological formation occurring in the districts are Archaeans lower vindhyans. Granular zones govern occurrence and movement of ground water in semi consolidated Gondwana formations. Within these formations and impervious horizons like coal seams trapped in between this rock occurrence and movement of ground water in

Hard rocks is essentially by development and nature of secondary joints and fractures while priming vesicular in basalt also plays on important role. Ground water in general in hard rocks areas occurs under unconfined to semi confined conditions while in Gondwana rocks it is also found under confinedconditions

The pre-monsoon depth to Water levels ranges from a minimum of 2.48 meters below ground level (mbgl) 4.32 at Manpur block to a maximum of 16.77 m bgl at Panpatha of Umaria district. About 16% very shallow water levels up to 2-5m bgl have been recorded in a small patch in part of district. About 50 % of monitoring wells recorded water level in the range of 5-10 m bgl category, spreading in patches and major pockets in the north-western and eastern part of area. About 30% of monitoring wells recorded water level in the depth range of 10-20 m bgl occurring in broad patches all over the region. Deeper ground water levels ranging >20 m bgl constituting only about 4% of wells in this category have been observed only in small pocket in the northern and south-western part of Umaria district.

The pre-monsoon depth to Water levels ranges from a minimum of 2.03 meters below ground level (mbgl) at Chirki in Pali block to a maximum of 10.6 m bgl at Panpatha of Umaria district. About 18% very shallow water levels up to 0-2m bgl have been recorded in a small patch in part of district. About 30 % of monitoring wells recorded water level in the range of 2-5 m bgl category, spreading in patches and major pockets in the north-western and eastern part of area. About 40 % of monitoring wells recorded water level in the depth range of 5-10 m bgl occurring in broad patches all over the region. Deeper ground water levels ranging 5-10 m bgl constituting only about 12% of wells in this category have been observed only in small pocket in the northern and south-western part of Umaria district.

Umaria district is characterized by alluvial formations and Deccan trap basaltic lava flow. Dynamic ground water resources of the district have been estimated for base year - 2021-22 on block-wise basis. Out of 453900 ha of geographical area, 421900 ha is ground water recharge worthy area and 32000 ha is hilly area. There are three numbers of assessment units in the district which fall under command (29%) and non-command (71%) categories sub units. All blocks of the district are categorized as safe blocks, with highest stage of ground water development of 28.05% in Karkeli block. As per Dynamic Ground Water Resource of Madhya Pradesh – 2022, the annual extractable ground water resource in the district 32238.77 ham and ground water extraction for all uses is 6376.02 ham, making Stage of Ground water extraction 57.92 % as a whole for district. After making allocation for future domestic supply for year

2025, balance available ground water for future use would be 25689.02 ham Under the prevailing hydrogeological conditions, Aquifer Mapping and Characterization, the following recommendations are made for the development & management of ground water.

As per the Management plan prepared under NAQUIM of all the Block of Umaria District, a total number of 290 Percolation Tanks, 1016 Recharge Shafts/Tube wells and 290 Nala Bunds/Check Dams and 199 Village pond / Cement Plugs have been proposed .

Financial expenditure is expected to be Rs 278 Crores in Umaria District for sustainable development and management of ground water resources.

The number of artificial recharge structure and financial estimation has been proposed based on the CGWB Master plan 2020. It may be differ from the field condition as well as changes in dynamic Ground water resources.

After the implemented of project interventions in the report, the stage of ground water extraction is expected to increase by 25.74 % i.e. from 19.31 % to 45.05 % for the Umaria district and additional area for the irrigation will be 327.07 Sq.Km

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