



केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga

Rejuvenation

Government of India

Report
on

AQUIFER MAPPING AND MANAGEMENT PLAN

Durg Block, Durg District, Chhattisgarh

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur



**REPORT ON
AQUIFER MAPPING AND MANAGEMENT PLAN
OF DURG BLOCK, DURG DISTRICT, CHHATTISGARH**

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**AQUIFER MAPPING AND MANAGEMENT PLAN FOR DURG BLOCK
(DURG DISTRICT), CHHATTISGARH**

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BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information:

About the area: Durg Block is situated in the western part of Durg district of Chhattisgarh and is bounded on the north by Dhamdha block, east by Patan block, in the west by Rajnandgaon district of Chhattisgarh, in the south and south-east by Balod district. The area lies between 21.04 and 21.37 N latitudes and 81.16 and 81.40 E longitudes. The geographical extension of the study area is 578 sq.km. Administrative map of the block is shown in Fig. 1. Shivanth, flowing northwards cuts through the block from south to north. Tandula river lies south of the block. Drainage map shown in Fig.2. Geomorphology indicates presence of structural plains.

Population: The total population of Durg block as per 2011 Census is 1126731 out of which rural population is 200696 while the urban population is 926035. The population break up i.e. male-female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Durg	1126731	576597	550134	200696	926035

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 12.01 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. It sets in third/fourth week of June and continues till mid-August/September with heaviest showers in the months of July and August. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015) 1213 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Durg block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Avg.annual rainfall	1262.2	1094.1	1061.7	1465.6	1181.4

Source: IMD

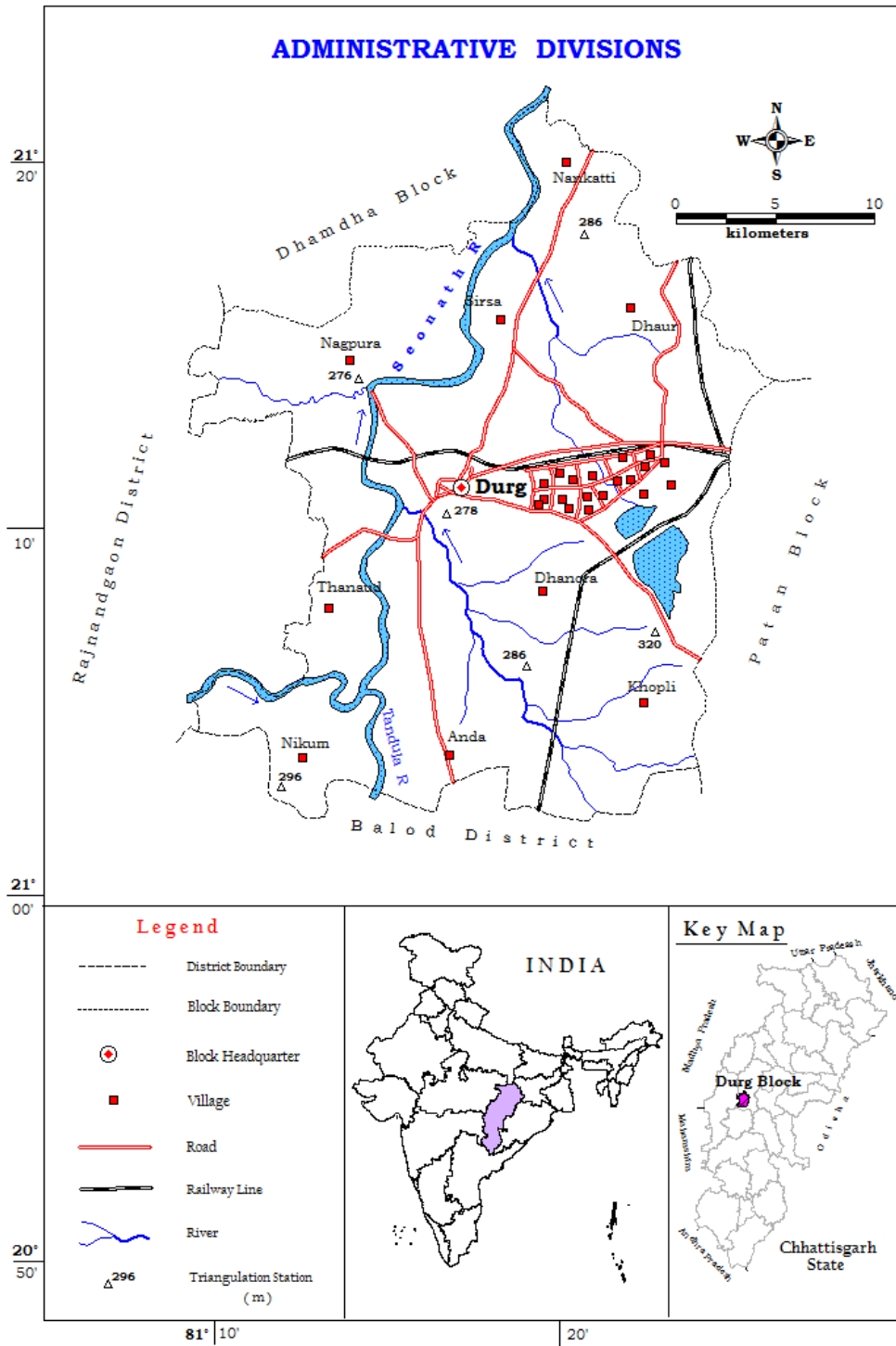


Figure: 1 Administrative Map of Durg Block

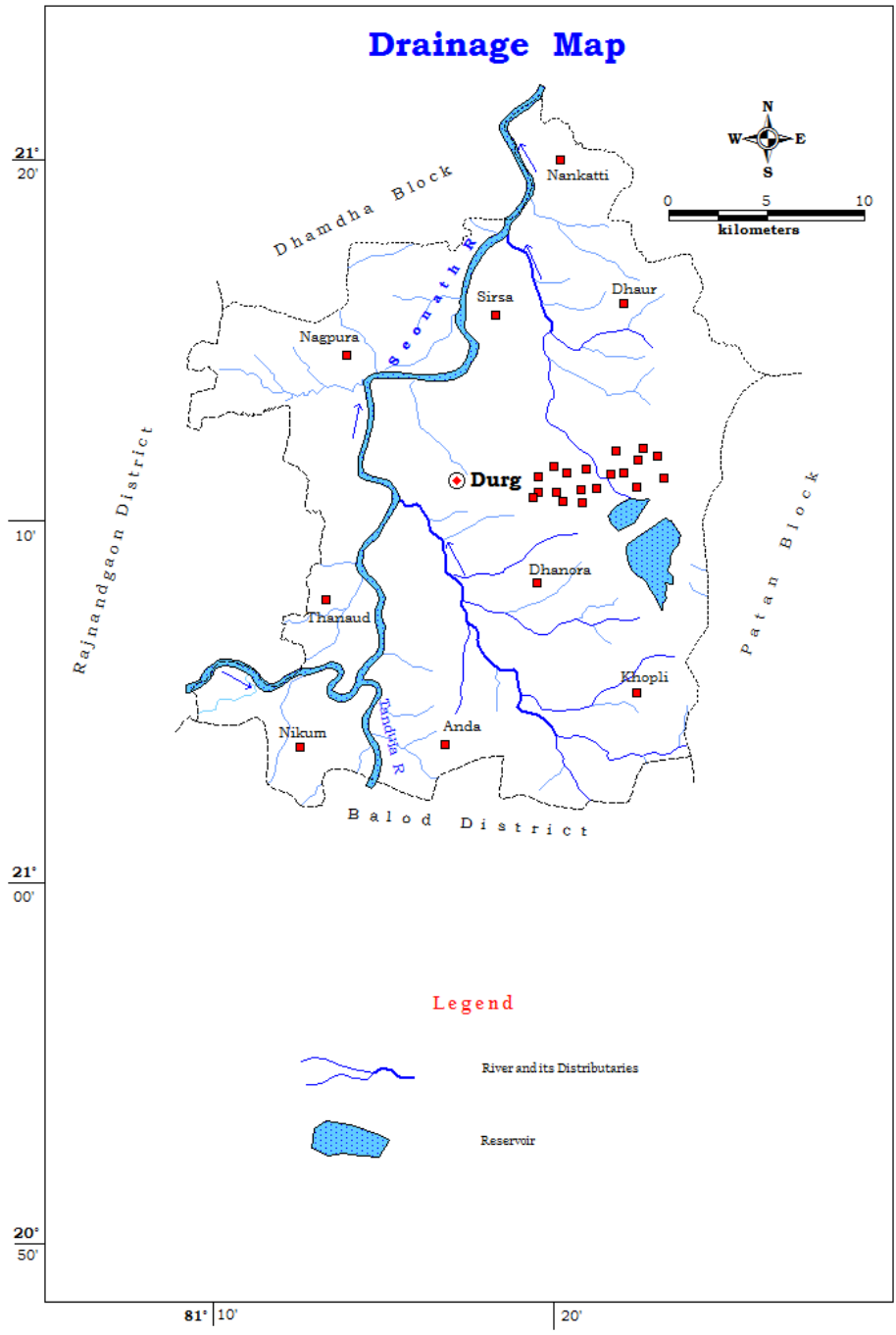


Figure 2: Drainage Map of Durg Block

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

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

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

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Durg	57800	nil	22021	33548	10946	44494

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

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non agricultural & Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Durg	57800	nil	22021	5403	4342	33548	10946	44494

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

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar & Maize	Others						
Durg	33099	11395	1537	32673	77	6	7026	2773	2530	nil	1	41

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

No. of canals (private and Govt.)	Irrigated area	No.of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irrigated area	Gross irrigated area	% of irrigated area wrt. Net sown area
14637	14637	11005	851	425	425	857	nil	1482	23773	23033	64 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Durg	23773	8261	34.75 %

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

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

Block	Purple calc.shale(Gunderdehi)				Stromatolitic limestone			
	Phreatic		Fractured	Total resource	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage		Dynamic	Static	In-storage	
Durg	394.438	331	4.89	730.328	6239.29	4250	77.36	10566.65

Existing and Future Water Demand (2025):The existing demand for irrigation in the area is 3918.23 Ham while the same for domestic and industrial field is 2579.25 Ham. To meet the future demand for ground water, a total quantity of 3253.37 ham of ground water is available for future use.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in Durg block, in phreatic limestone, though the maximum water level is 9.95 m, the average water level is 5.16 mbgl. In fractured limestone, the maximum water level is 17.92m bgl, the average water level is 13.96m bgl. In shale terrain average water level is around 3.08mbgl which is not a matter of concern.

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

Block Name	Phreatic limestone			Phreatic shale		
	Min	Max	Avg	Min	Max	Avg
Durg	2.40	9.95	5.16	1.48	5.41	3.08

Water Level (in mbgl)

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

Block Name	Fractured limestone			Fractured shale		
	Min	Max	Avg	Min	Max	Avg
Durg	5.6	17.92	13.96	12.03	14.42	13.23

(ii) Post- monsoon water level: In the post-monsoon period, it has been observed that the water level varies from 0.99 to 3.26mbgl with an average of 2.20mbgl in limestone area. In fractured limestone, the maximum water level is 12.22m bgl, the average water level is 8.41m bgl. In shale terrain, the post monsoon water level also does not show any variation as the range is 1.13 to 1.53mbgl.

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

Block Name	Phreatic limestone			Phreatic shale		
	Min	Max	Avg	Min	Max	Avg
Durg	0.99	3.26	2.20	1.13	2.53	1.83

Water Level (in mbgl)

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

Block Name	Fractured limestone			Fractured shale		
	Min	Max	Avg	Min	Max	Avg
Durg	5.55	12.22	8.41	6.4	7.62	7.01

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Durg block, water level fluctuation in phreatic limestone terrain varies from 0.25 to 6.61 m with an average fluctuation of 2.89 m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic Limestone			Phreatic Shale		
	Min	Max	Avg	Min	Max	Avg
Durg	0.25	6.61	2.89	0.35	2.88	1.61

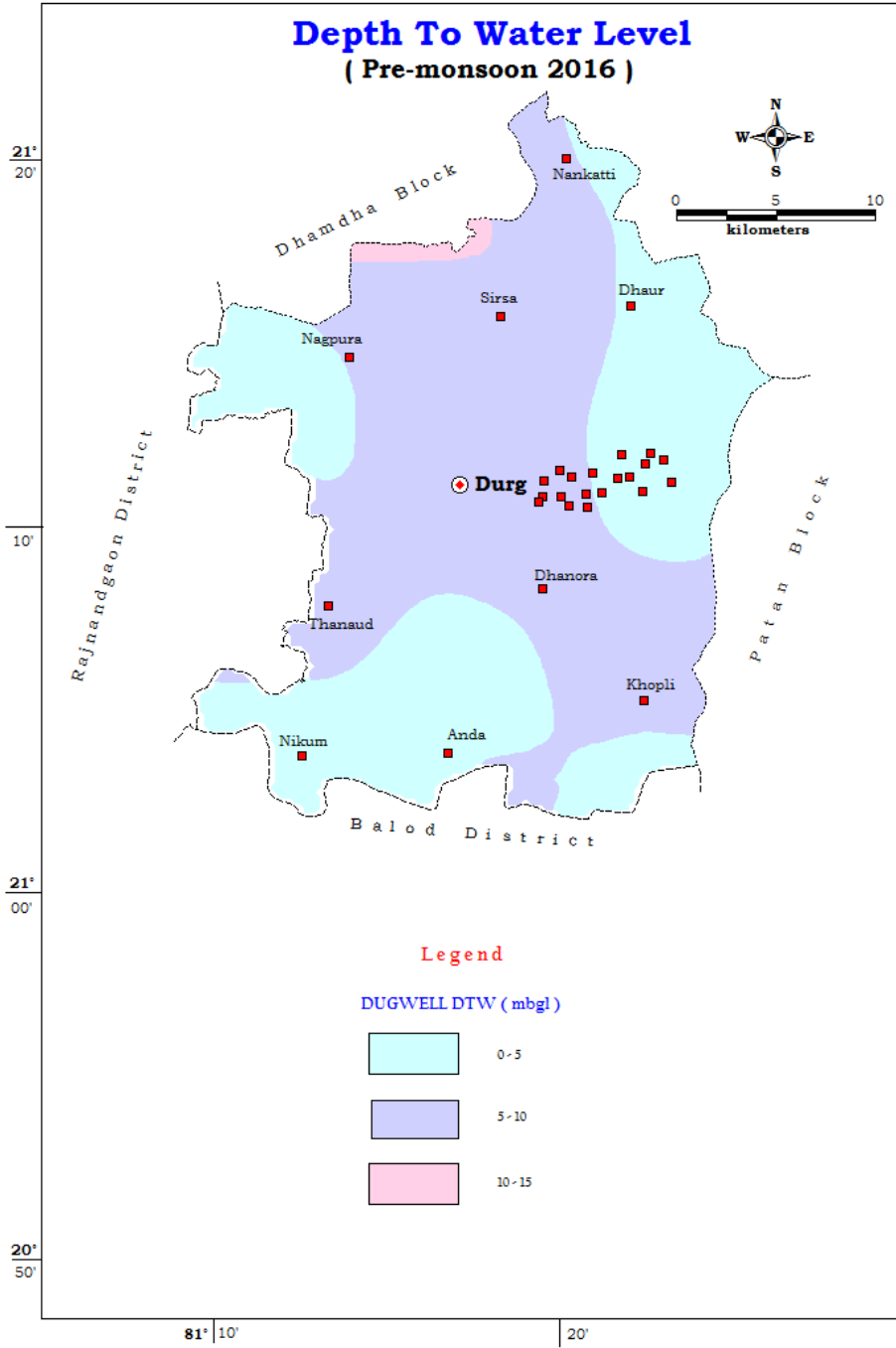


Figure-3: Depth to water level map Phreatic Aquifer (Pre-monsoon)

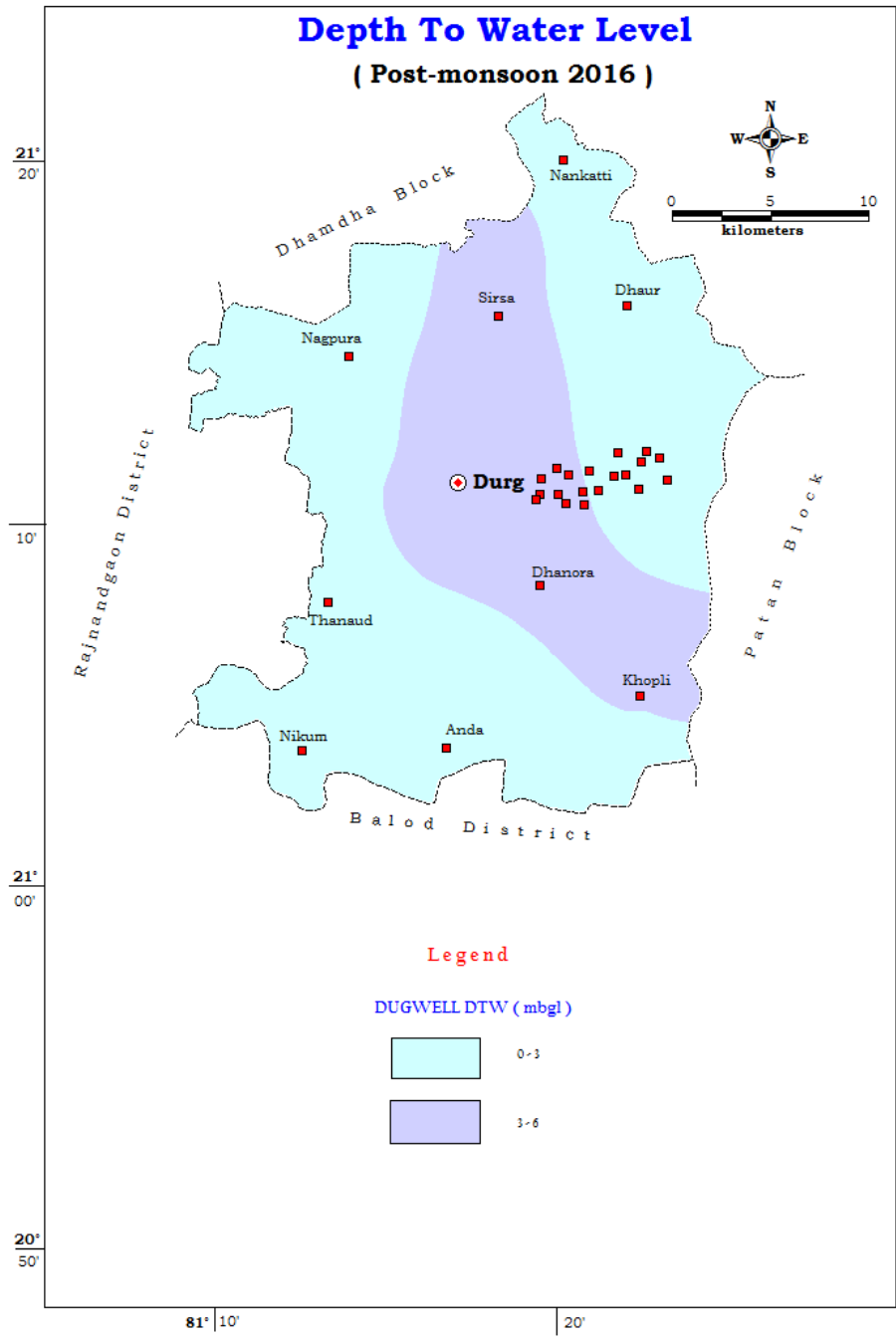


Figure 4: Depth to water level map Phreatic Aquifer (Post-monsoon)

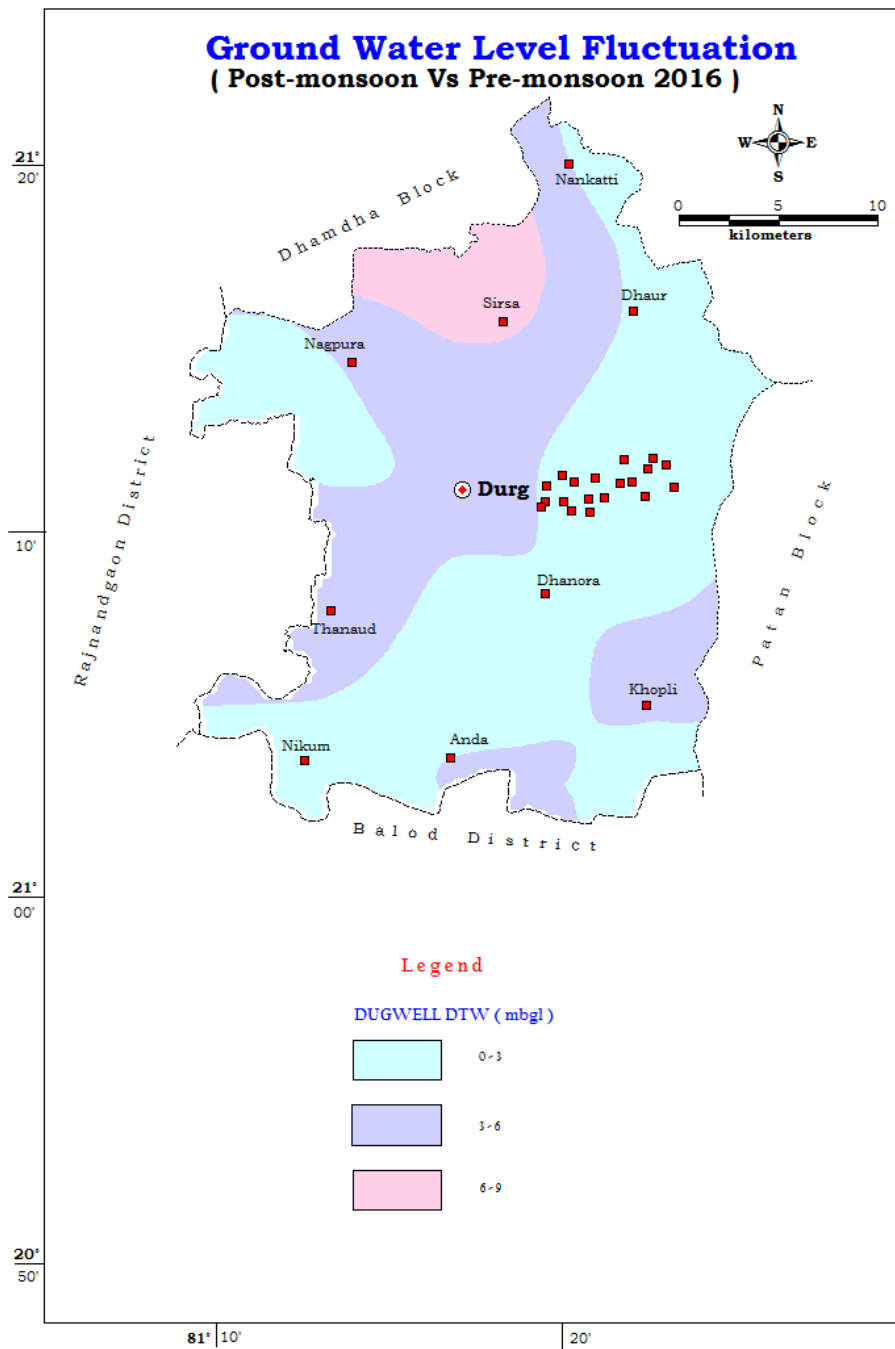


Figure 5: Depth to water level fluctuation map of Phreatic Aquifer

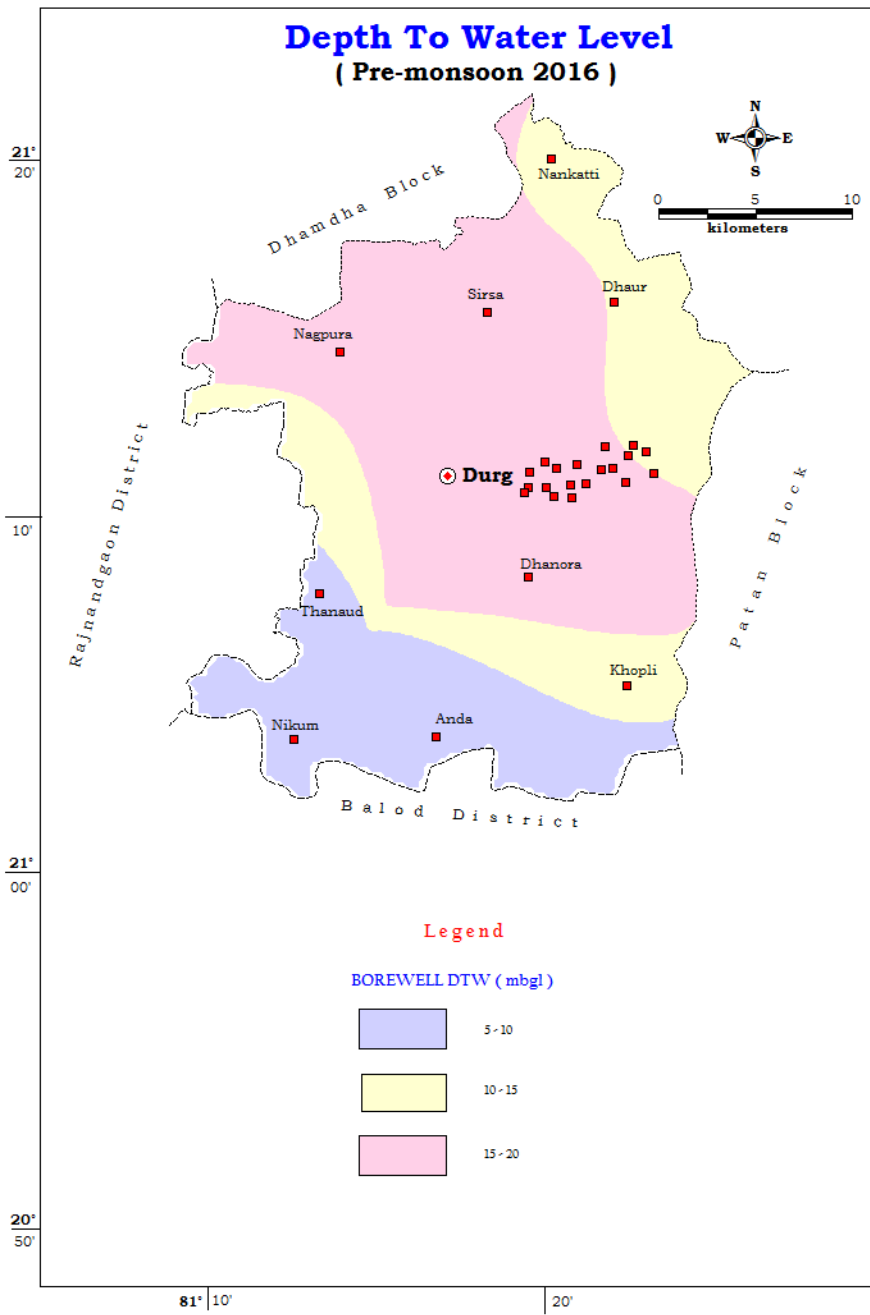


Figure-6: Depth to water level map Fractured Aquifer (Pre-monsoon)

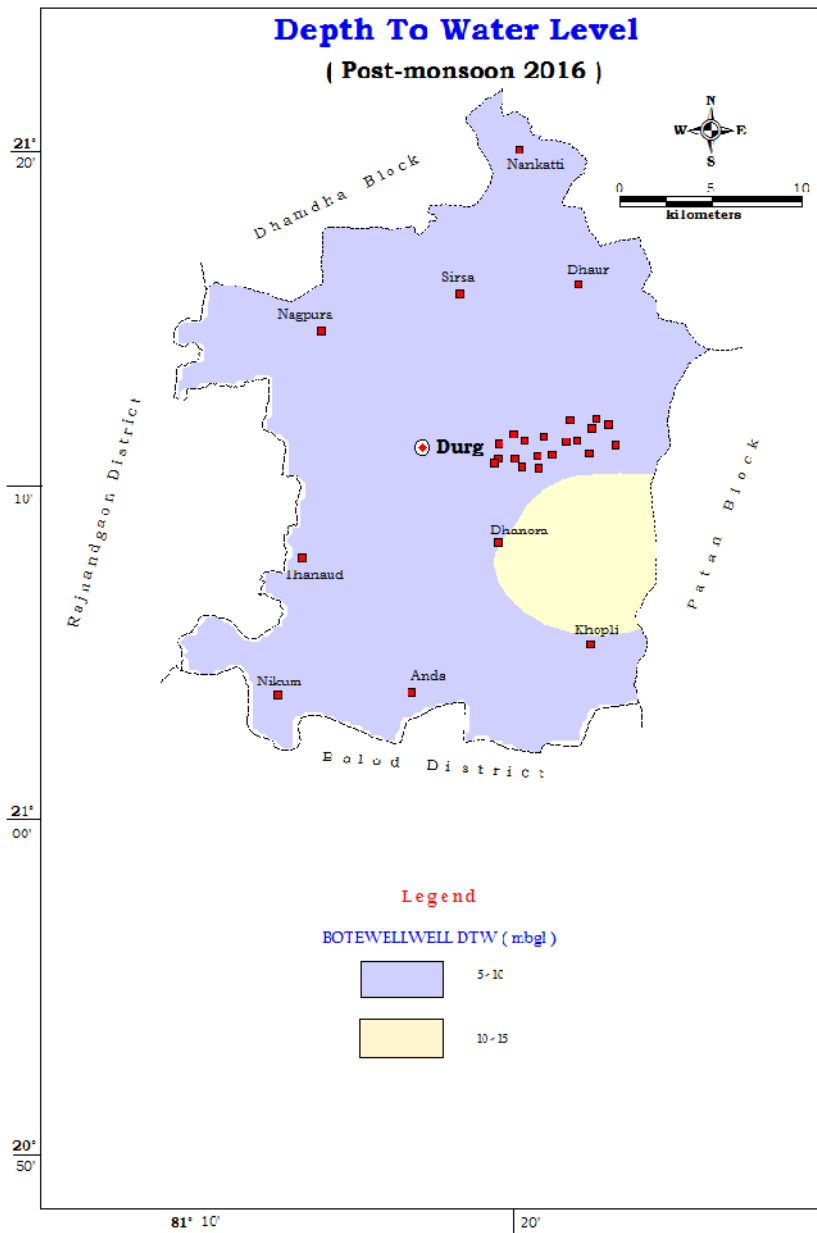


Figure-7: Depth to water level map Fractured Aquifer (Post-monsoon)

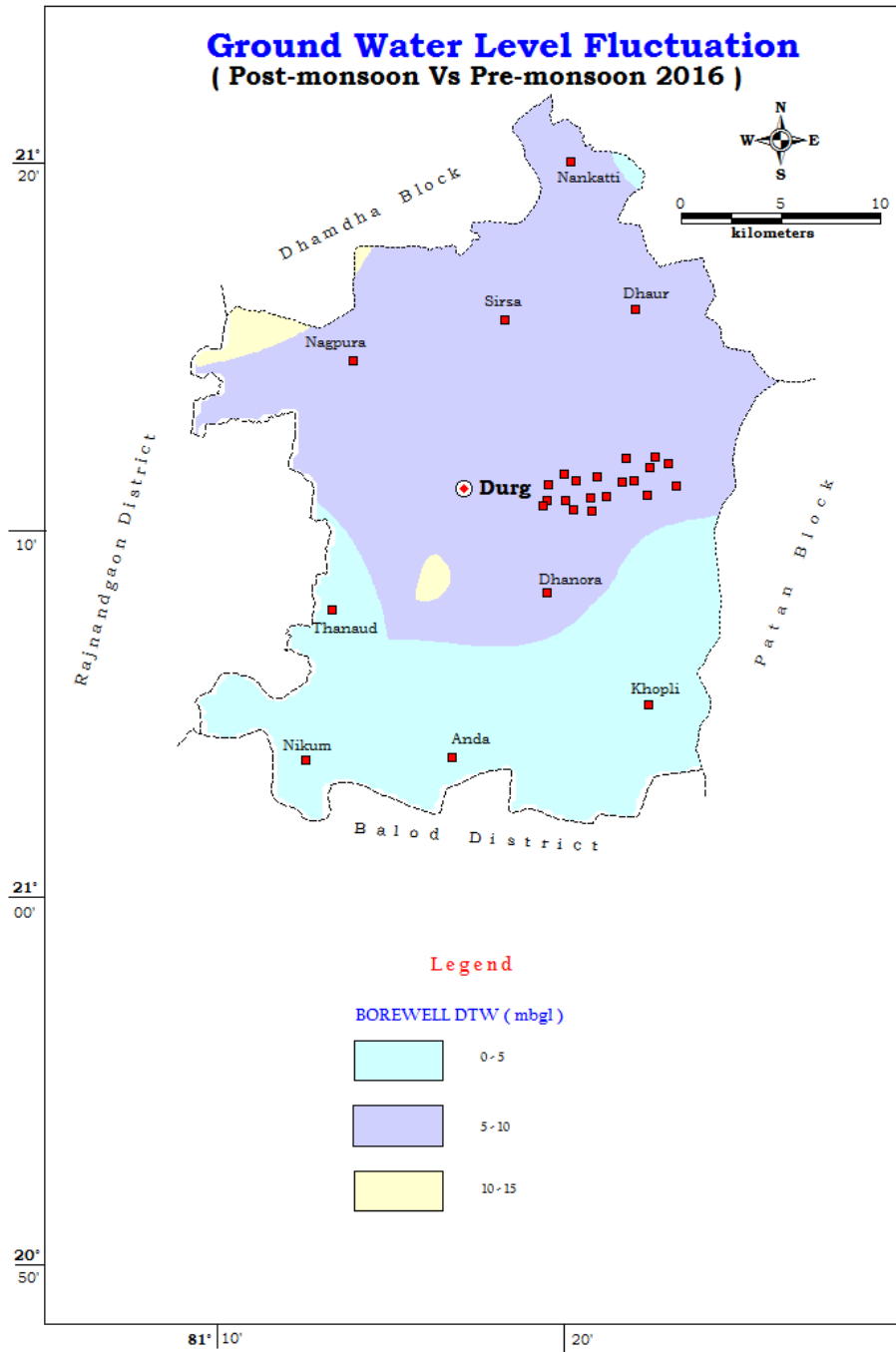


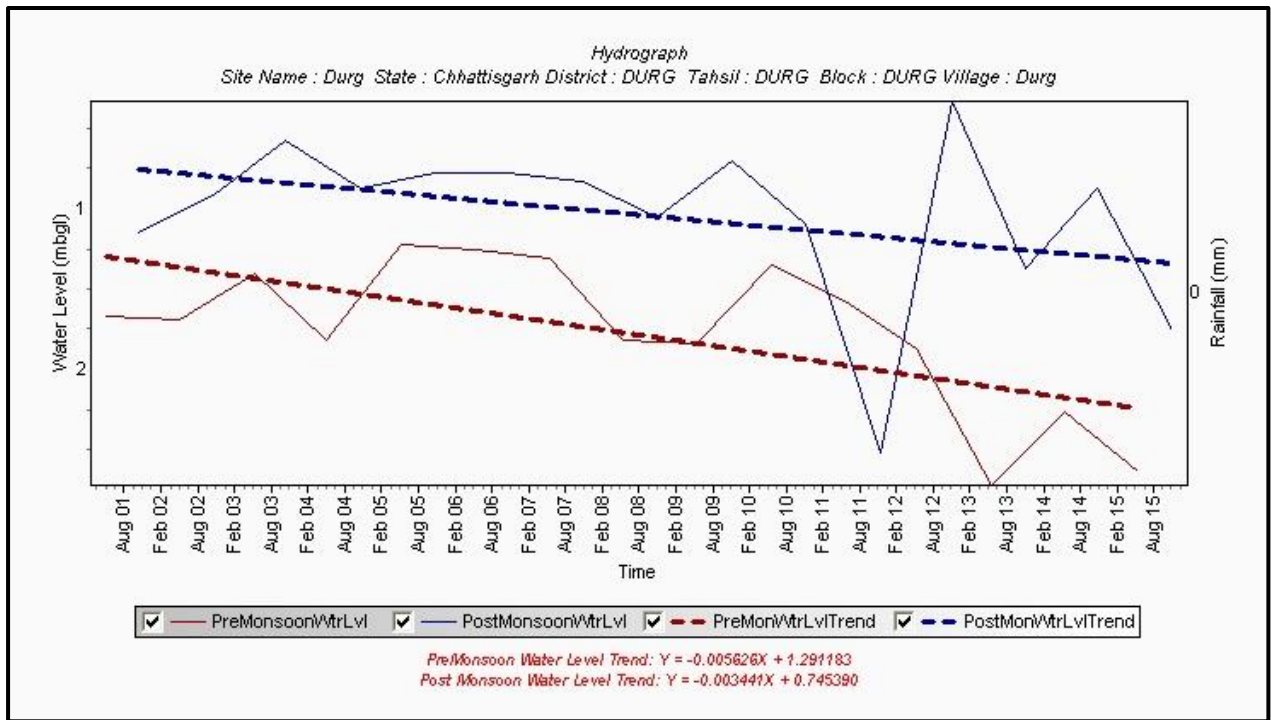
Figure -8: Depth to water level fluctuation map of Fractured Aquifer

Table 5F: Aquifer wise Depth to Water Level Fluctuation (m)

Block Name	Fractured Limestone			Fractured Shale		
	Min	Max	Avg	Min	Max	Avg
Durg	0.05	10.19	5.55	5.63	6.80	6.22

(iv) The long term water level trend: It indicates that there is decline in water level both in pre-monsoon and post-monsoon period.

Figure 9: Hydrograph of Durg block, Durg site, Durg district



2. Aquifer Disposition:

Number of Aquifers: There are three aquifers viz. (i) Chandi limestone (Proterozoic) (ii) Chandi Sandstone (Proterozoic) and (iii) Gunderdehi shale; Chandi limestone and Gunderdehi shale, both in phreatic and fractured condition serve as major aquifer system in Durg.

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

(A) Geology: Geologically the block exhibits lithology of Archean to Proterozoic age occupied by limestone, sandstone and shale.

a) Chandi Formation: Chandi-formation occupying about 87% of the block covers about 503 Sq.km area in Durg block. It comprises a thick sequence of organic limestone, sandstone & shale. Stromatolitic limestone & dolomite has a gradational contact with the underlying Gunderdehi shale. The limestone is pink to light grey in color with extensive development of stromatolitic structure and is thickly bedded. Minor shale partings are present. Stromatolites are grey to brown in colour with intercolumnar space filled with argillaceous carbonate material. In middle horizon of this formation; stromatolitic limestone and flaggy limestone are associated with green calcareous shale. The green shale is friable and splintery, calcareous and at places itself contains columnar stromatolitic structure inclined to bedding plane. Upper horizon is predominantly pink to purple, medium to coarse grained dolomitic limestone with characteristic development of stromatolites. The rock has a mottled appearance due to dolomite crystals. It is generally massive in look and is associated with purple to grey shale intercalations. Towards upper part, the rock gradually changes and devoid of stromatolitic structure. The rock is also gypsiferous containing gypsum in vug cavities.

b) Gunderdehi Formation: Gunderdehi formation occupy an area of about 43 sq.km in parts of Durg block. Gunderdehi formation is primarily an argillaceous sequence consisting of a very thick succession of purple shales attaining the maximum thickness of about 250 m. Association of thin band of siltstone of greenish and pale grayish colour are seen in the upper portion. The shales forming high grounds generally are capped by laterite with a thickness ranging from 3-9 mts. The upper most portion of shale contains thin bands of stromolitic limestone of 20 to 30 cm thick band and contact between the two has been inferred as disconformity.

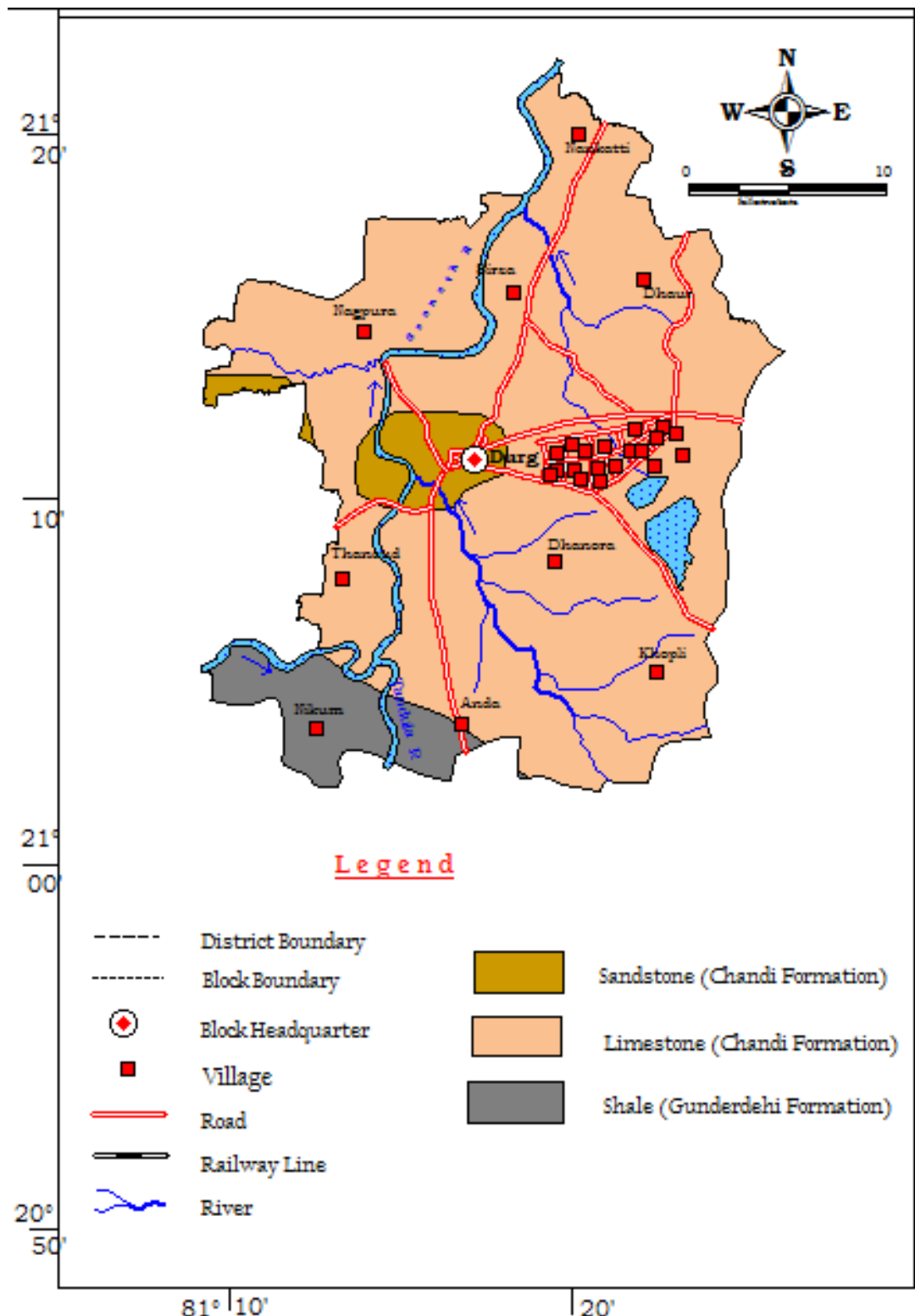


Figure 10: Aquifer map of Durg block

Laterite: Laterite occurs as small cappings over the sandstone, limestone and shale and its contact with underlying formation is always sharp. The lateritic capping over the sandstone is generally very hard & massive, while on the limestone it gradually passes into pisolitic ones with lesser amount of clayey material. The Laterite on shale is soft and clayey and more ferruginous.

Alluvium: The alluvial deposits in the area are mainly confined to all along the flood plains of (Seonath, Tendula, Kharun, Hanp rivers. The thickness of alluvium varies from 5-15 m. These are comprised mostly of gravels, coarse to fine sand, clay, silt and kankar. The colour varies from brown to dark grey. Alluvium consisting of fine to medium grained sand derived from catchment.

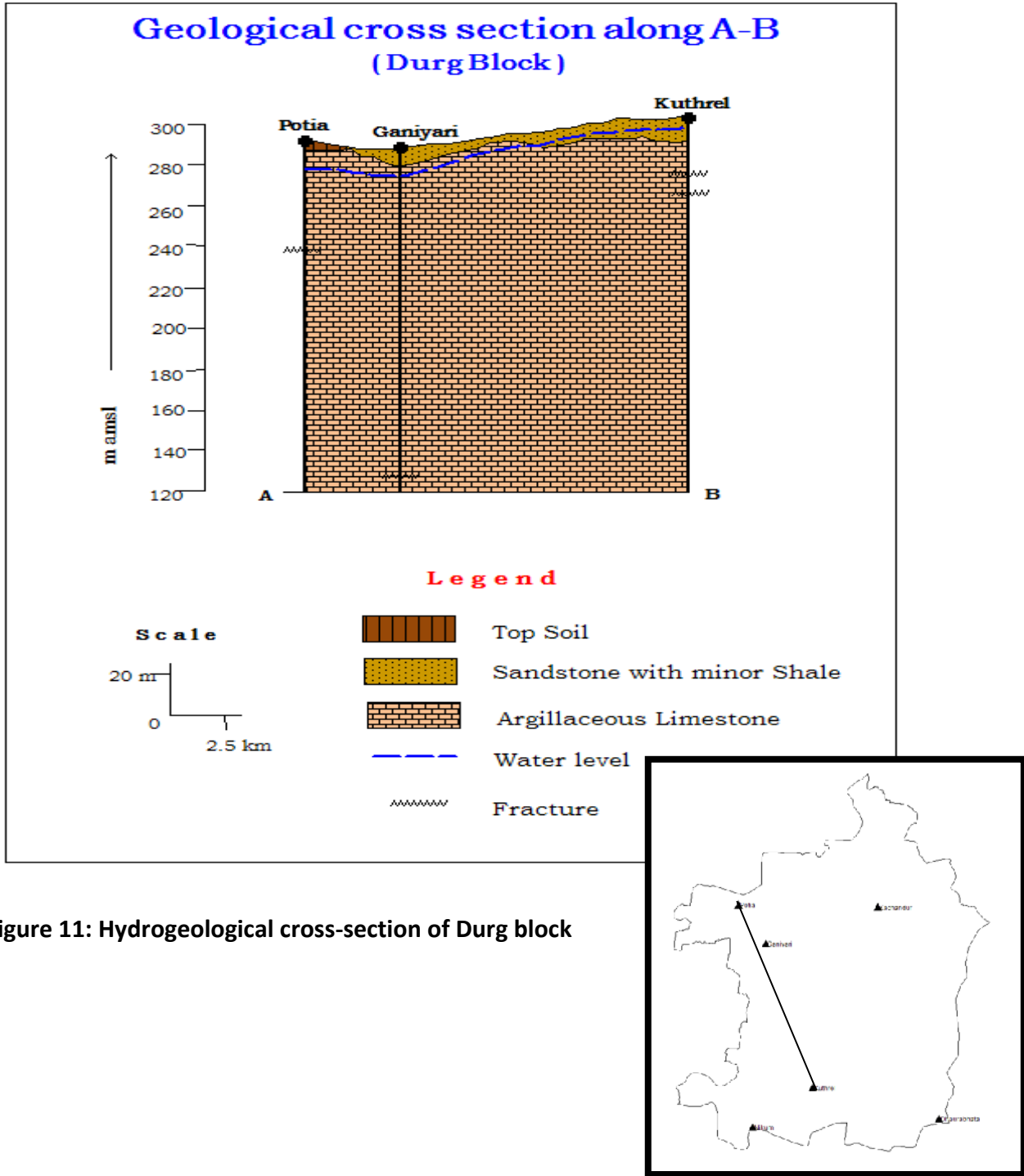


Figure 11: Hydrogeological cross-section of Durg block

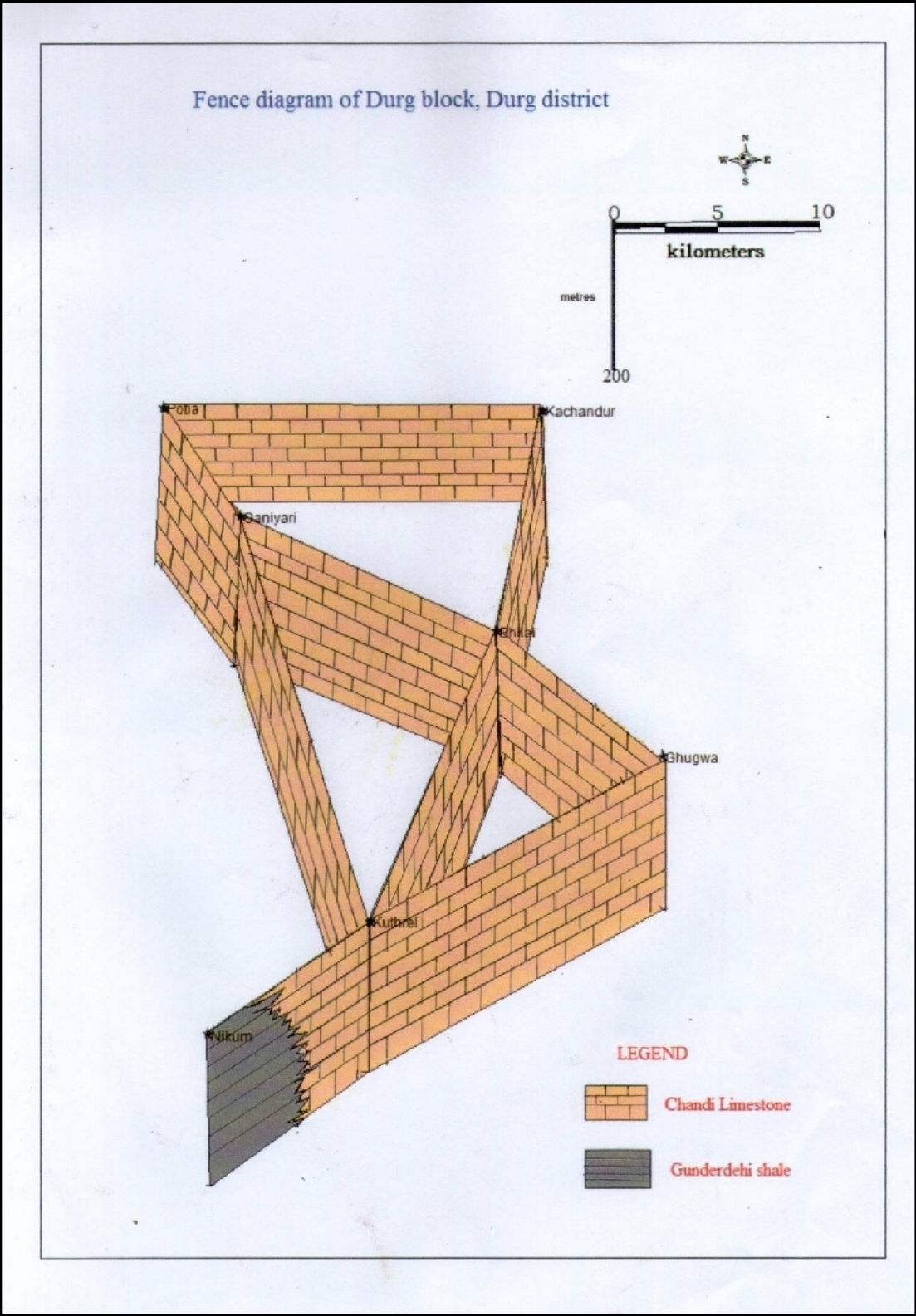


Figure 12: Fence diagram of Durg block

Aquifer wise characteristics:

- (i) The ground water movement in Chandi limestone is controlled by the solution cavities, joints and fractures. The average thickness of the weathered portion in the area is around 13 m. Generally 1 to 2 sets of fractures are encountered within 50 m depth, 1 to 3 sets of fractures within 50 to 200 m depth. The discharge varies from 0.1 to 2.0 lps. The drawdown varies widely from 2m to 29.7m, the thickness of fracture is around 0.36 m. These formations are mostly developed by the way of dug wells, bore wells and tube wells.
- (ii) The ground water in Gunderdehi shale occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consisting of fractures. The average thickness of the weathered portion in the area is around 12.7 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Generally, 1 to 2 sets of fractures are encountered within 50 m depth and 1 to 2 sets of fractures are encountered within 50 to 200 m depth. The potential zones are present within 50 m depth below ground level. In general, the discharge varies from negligible to 0.5 lps. The development in these formations is mostly by way of bore wells. The average drawdown of 35.08 m. The thickness of fractured aquifer is around 0.33 m.

Table 6: Distribution of Principal Aquifer Systems in Durg

Block	Phreatic and fractured limestone	%	Phreatic and fractured sandstone	%	Phreatic and fractured shale	%	Total Area (sq.km)
Durg	503	87	32	6	43	7	578

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

Aquifer wise resource availability is given in the table -4 where the total resource available in Durg block is 7260.515ham out of which the resource available with limestone area is 6316.64ham, with sandstone is 544.56ham and with shale is 399.32ham. The dynamic resource of the block is 7171.6 ham out of which the limestone area contributes 6239.29ham, sandstone contributes 537.88ham and the shale terrain contributes 394.43 ham. The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-7&8.

Table-7: Ground water Resources of Durg block

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation For Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Durg	Durg	7171.60	3918.23	2579.25	6497.48	3058.07	195.30

Table 8 Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorization
Durg	Durg	90.60	Semi-critical

Categorization: The Durg block falls in semi-critical category. The stage of Ground water development is 90.60%. The Net Ground water availability is 7171.60 Ham. The Ground water draft for all uses is 6497.48 Ham. The Ground water resources for future uses for Durg Block is 3253.37 Ham. There is no scope for further Ground water development. Focus should be on judicious use and augmentation of groundwater.

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

4. Issues and Management plan:

Aquifer wise space available for recharge and proposed interventions:

There is no unsaturated space available for artificial recharge as the post-monsoon water level is less than 3.00m bgl. This is summarized in Table 9.

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

Formation	Area (sq.m)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (m ³)
Limestone	503x 10 ⁶	0	0.015	nil
Shale	43x 10 ⁶	0	0.015	nil

Issues:

1. Stage of ground water development in Durg block of Durg district is relatively high (90.6%) and in semi-critical stage.
2. Nitrate contamination has been found at the following locations: - Ahiwara, Ravelidih, Anda, Jeora-Sirsa and Pauwara.
3. Locations around Bhilai Industrial Cluster have problem of following contaminants:

Table 11: Contaminants in GW of Bhilai Industrial Cluster

Element	Location	Conc.(mg/l),
Fluoride	Sirsabhata	1.8
	Parewadih	1.6
Iron	Bhilai sector 1	0.83
	Bhilai E block	0.47
	Utai	0.5
	Somni	0.64
Chromium	Somni	0.106

Element	Location	Conc.(mg/l),
	Utai	0.53
	Maroda	0.53
Lead	Somni	0.046
	Dundera	0.027
	Maroda	0.01
	Bhilai	0.01

4. In some areas the water level remains more than 5m in the post-monsoon period in this block which may be a matter of concern in future.

Management plan:

1. Field to field irrigation (flooding method) should be replaced with channel irrigation in command area as there is about 30-40% conveyance loss in field irrigation. Same amount of water can be saved through channel irrigation.
2. Double cropping of paddy using groundwater is to be discouraged. More water efficient crops like, Maize and Millet to be substituted for paddy during second cropping.

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

Detail of groundwater saved through change in cropping pattern								
Block	Paddy cultivation area in Rabi season (ha)	Water required (m) per ha (m)		Difference (m per ha)	Total saving of water (ham)	GW saving in command area (ham)	Available Resource (ham)	Improved Status of groundwater Development
		Paddy	Maize					
Durg	2663	1.5	0.5	1.0	2663	2194.43	7171.60	60

3. Government should provide attractive incentives and subsidies to encourage farmers to take up alternative crops to paddy, which are equally profitable and adopt micro-irrigation practices such as drip and sprinkler irrigation.
4. Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Need for massive mass awareness among the farmers to shift from summer rice to Maize/Ragi, advantages of taking such crops, crop methodology and its related aspects.

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

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

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

7. In Durg district it has been observed that some farmers have started switching to vegetables and plantation crops from traditional crops. But they are using very deep tubewell (600-700 ft) which ultimately results in the decline of water level and also leads to contamination of groundwater.

Taking note of this point, it is required to frame a clear guideline for Durg district regarding the depth of BW drilling. Diameter and spacing of Bore wells and the same should be strictly implemented.

8. The source of nitrate in ground water is mostly anthropogenic. Hence, dug wells in the affected areas are to be substituted by bore wells or tube wells to avoid the use of the phreatic aquifer.

9. Keeping in view of the increasing ground water development in these areas, a system of robust ground water monitoring system should be implemented to assess the prevailing ground water scenario at any point of time.

10. Hydrogeological studies and chemical analysis of groundwater samples to be carried out around industrial clusters to analyse the groundwater conditions at regular time intervals. In industrial areas, strict monitoring and regulation of industries should be done. Govt. should provide alternate drinking water facilities.

