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

Patan Block, Durg District, Chhattisgarh

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

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

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Ganga Rejuvenation & River Development
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AQUIFER MAPPING AND MANAGEMENT PLAN FOR PATAN BLOCK (DURG DISTRICT), CHHATTISGARH

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BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information:

About the area: Patan Block is situated in the south-eastern part of Durg district of Chhattisgarh and is bounded on the north by Dhamdha block, in the west by Durg and Balod block of Chhattisgarh, in the east by Raipur and Dhamtari district. Kharun river forms its easternmost boundary. The area lies between 20.90 and 21.53 N latitudes and 81.38 and 81.6 E longitudes. The geographical extension of the study area is 907 sq.km representing around 36 % of the district's geographical area. The administrative map of Patan block is shown in Fig. 1. River Kharaun flowing northward forms the eastern boundary of the block. Fig.2.

Population: The total population of Patan block as per 2011 Census is325227out of which rural population is 212061while the urban population is 113166.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
Patan	325227	163736	161491	212061	113166

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 15.24 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)1305.34 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Patan block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Avg.annual rainfall	1197.0	1263.0	1248.5	1558.0	1260.2

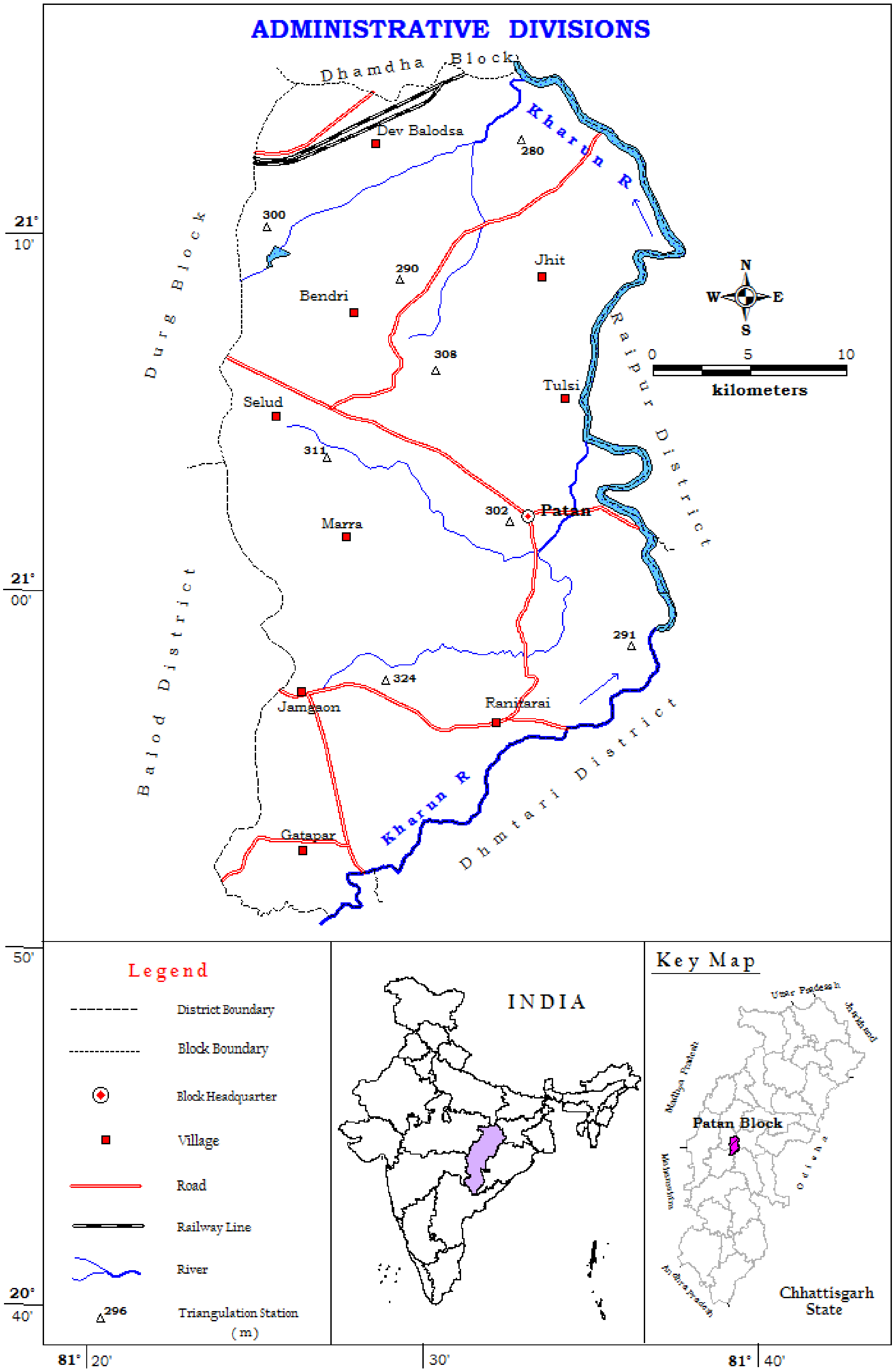


Figure: 1 Administrative Map of Patan Block

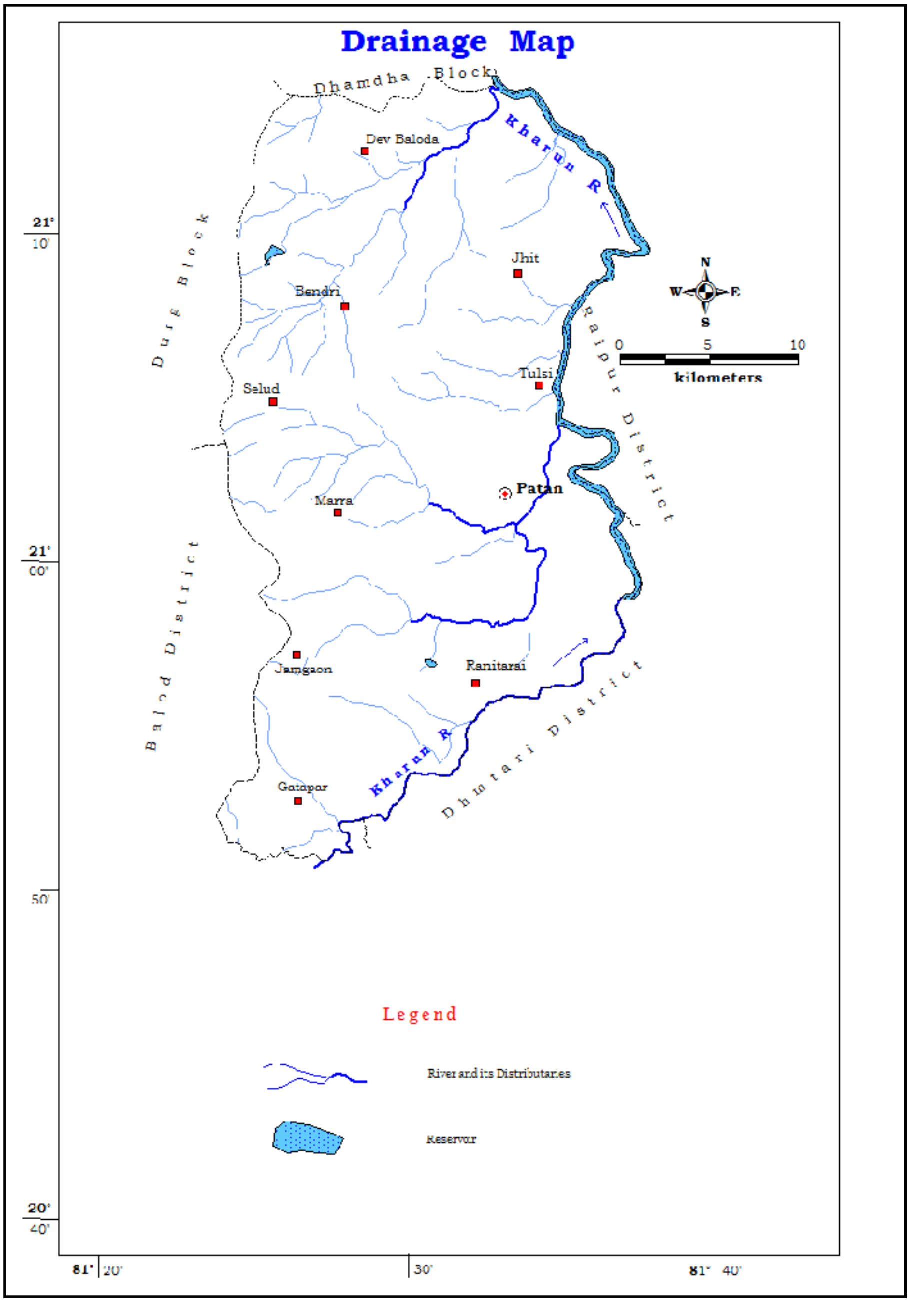


Figure 2: Drainage Map of Patan Block

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 Patan 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
Patan	90700	nil	8299	53949	15456	69405

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
Patan	90700	nil	8299	2839	8380	53949	15456	69405

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

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Jute	Mirch Masala	Sugar-cane
			Wheat	Rice	Jowar & Maize	Others						
Patan	53624	15654	1442	54893	331	0	9900	678	2060	nil	62	39

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

No. of canal s (private and Govt.)	Irrigated area	No.of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri gated area	Gross irrigate d area	% of irrigated area wrt. Net sown area
33194	33194	12763	10548	123	123	424	nil	1015	41525	41526	69 %

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
Patan	41525	10671	25.7 %

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

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

Block	Stromatolitic limestone (Chandi)				Purple calc.shale(Gunderdehi)				Chandi sandstone			
	Phreatic		Fractured	Total resource	Phreatic		Fractured	Total resource	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage		Dynamic	Static	In-storage		Dynamic	Static	In-storage	
Patan	6647.54	7507.41	136.04	**14290.99**	1041.18	177	21.31	**1239.49**	320.36	181.08	6.56	**508.00**

Existing and Future Water Demand (2025)*:* The existing demand for irrigation in the area is 5274.28 Ham while the same for domestic and industrial field is 951.28 Ham. To meet the future demand for ground water, a total quantity of 1728.58 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 Patan block, in phreatic limestone, though the maximum water level is 9.4 m, the average water level is 5.05 mbgl. In fractured limestone, the maximum water level is 23.1 mbgl, the average water level is 13.18 mbgl. The maximum pre-monsoon water level in phreatic shale is 9.72m bgl and average water level is around 7.1mbgl which is not a matter of concern.

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

Block Name	Phreatic limestone			Phreatic shale		
	Min	Max	Avg	Min	Max	Avg
Patan	1.69	9.4	5.05	4.48	9.72	7.1

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
Patan	5.78	23.1	13.18	3.5	6.2	4.85

(ii) Post- monsoon water level: In the post-monsoon period, it has been observed that the water level varies from 0.84 to 3.51 mbgl with an average of 1.92 mbgl in limestone area. In fractured limestone terrain water level varies from 3.62 to 11.24 mbgl with an average of 7.66 mbgl. In shale terrain, the post monsoon water level varies from 1.41 to 2.05mbgl with an average of 1.73mbgl.

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

Block Name	Phreatic limestone			Phreatic shale		
	Min	Max	Avg	Min	Max	Avg
Patan	0.84	3.51	1.92	1.41	2.05	1.73

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
Patan	3.62	11.24	7.66	1.73	2.27	2.0

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Patan block, water level fluctuation in phreatic limestone terrain varies from 0.84 to 7.34 m with an average fluctuation of 3.13 m. In fractured limestone terrain, water level fluctuation varies from 2.16 to 11.86 m, with an average fluctuation of 5.53m. In shale dominated terrain, the fluctuation varies from 3.07 to 7.67 m with an average fluctuation of 5.37 m.

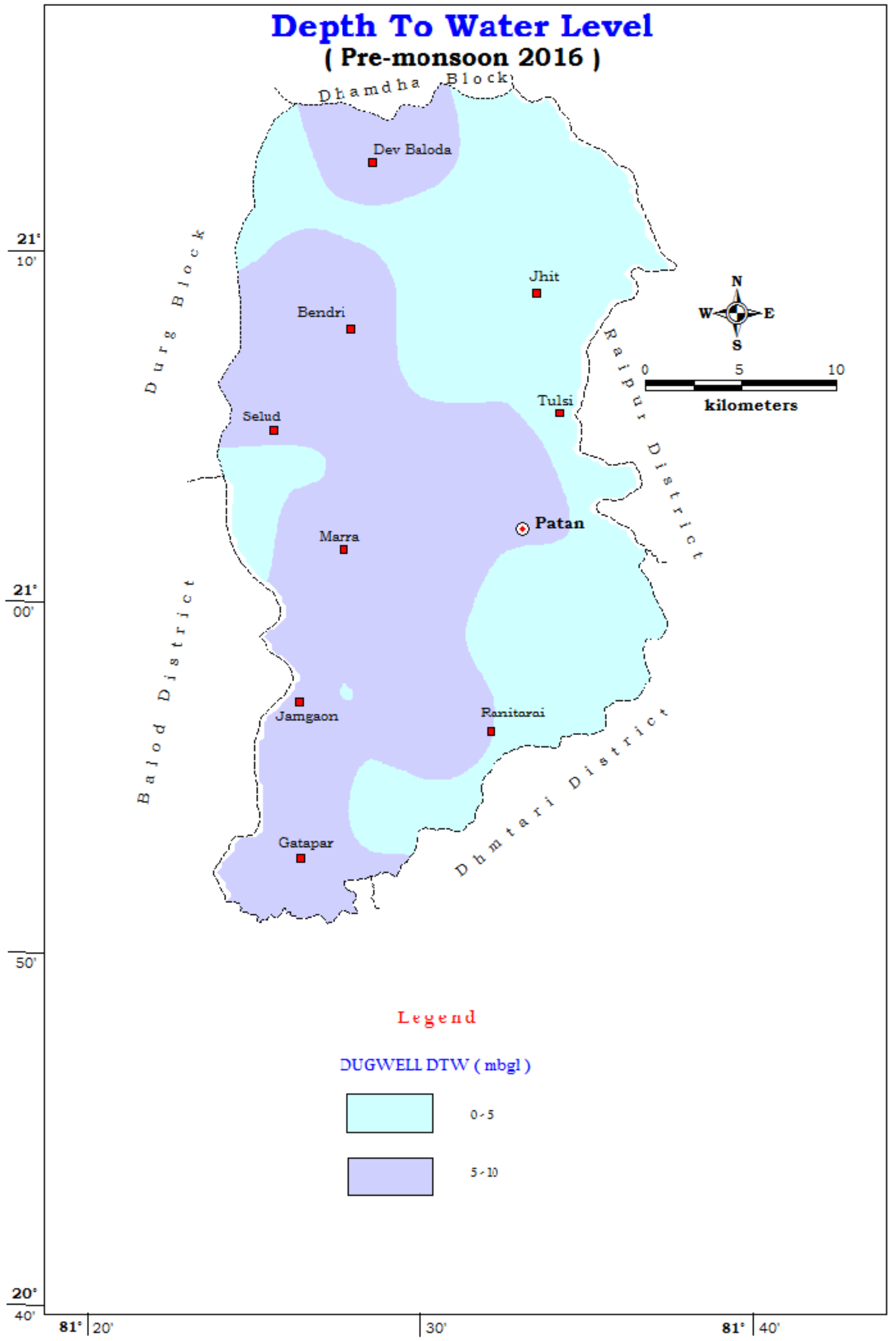


Figure-3: Depth to water level map Phreatic Aquifer (Pre-monsoon)

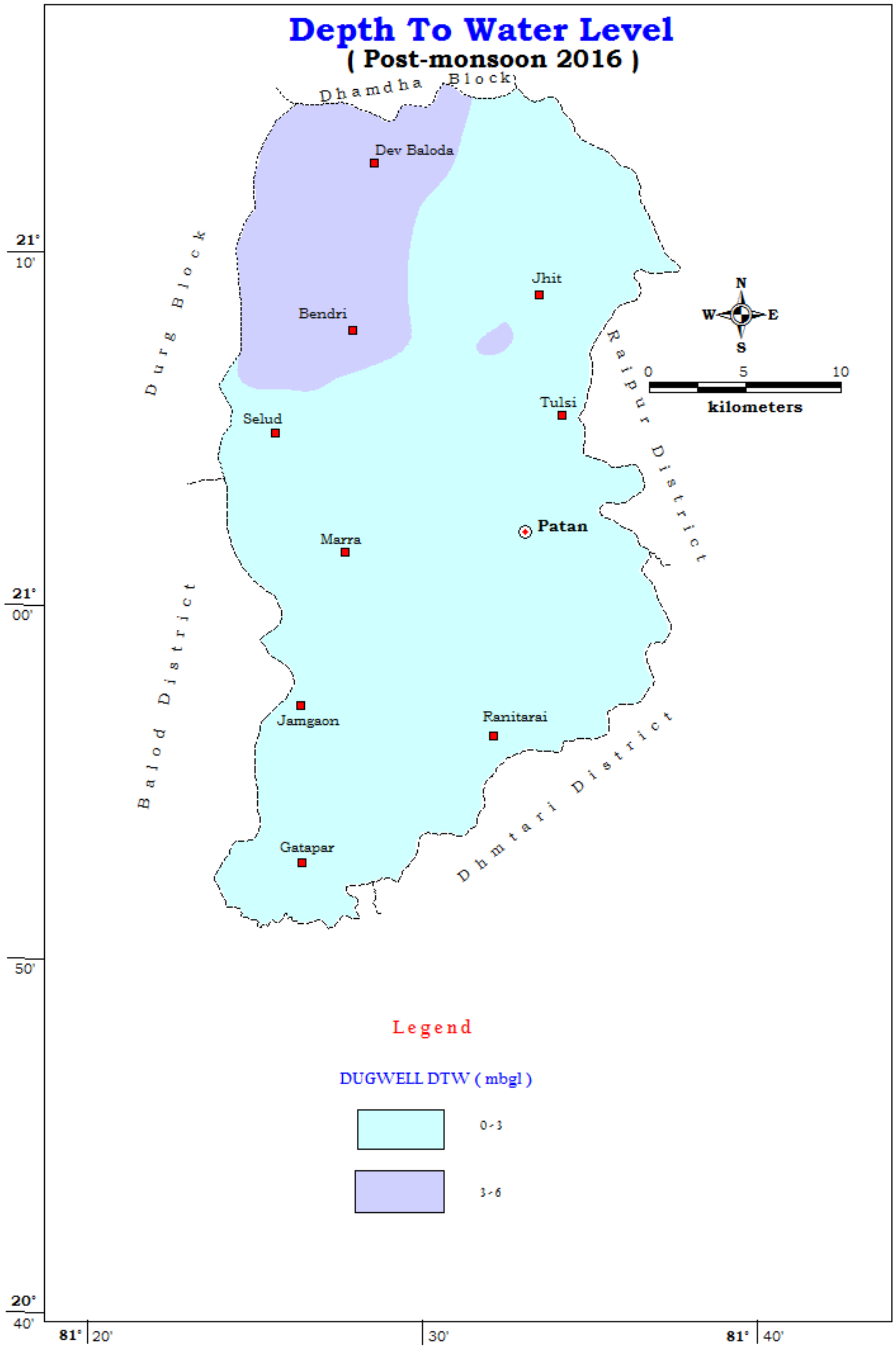


Figure 4: Depth to water level map Phreatic Aquifer (Post-monsoon)

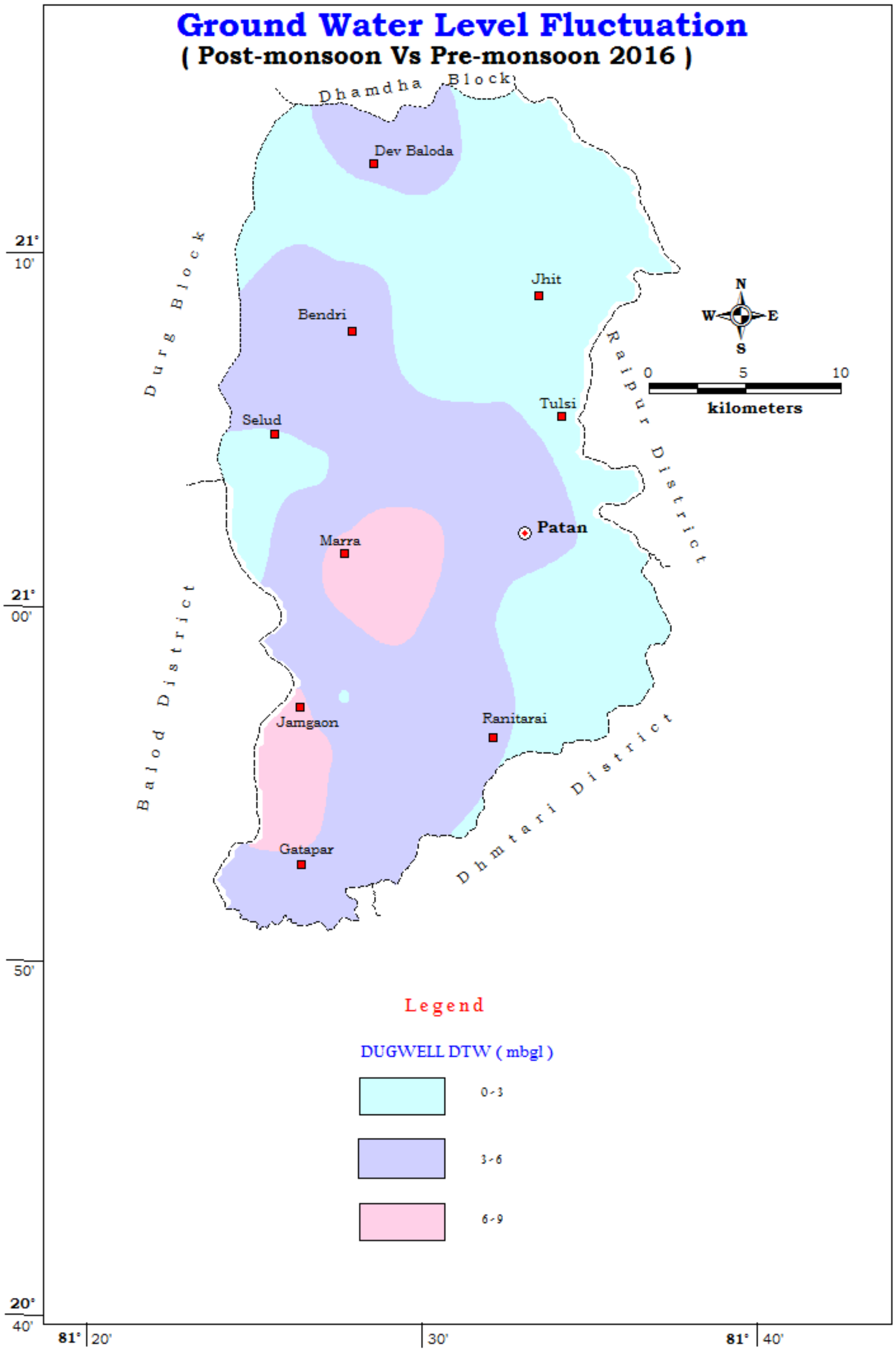


Figure 5: Water level fluctuation map of Phreatic Aquifer

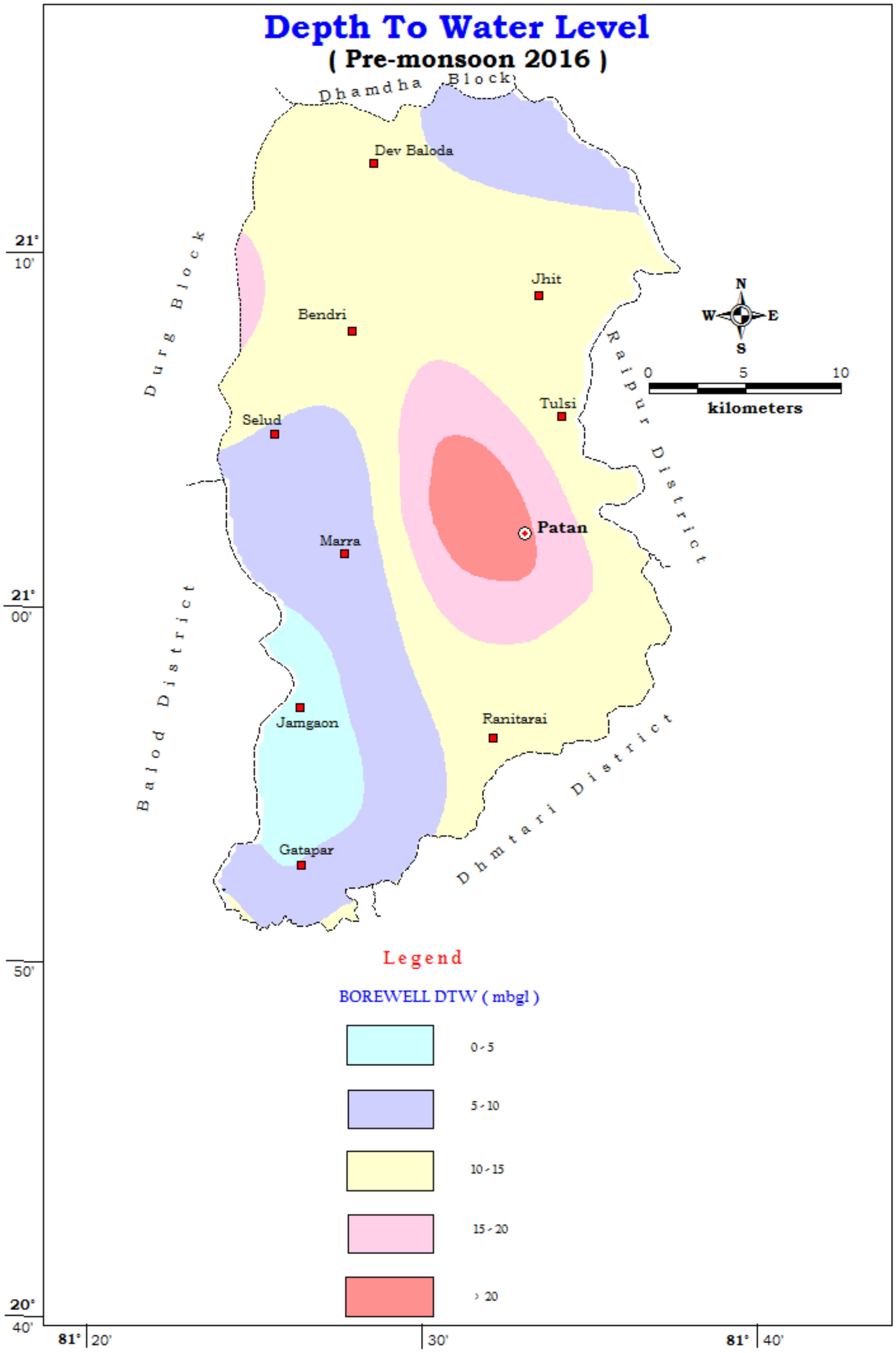


Figure-6: Depth to water level map Fractured Aquifer (Pre-monsoon)

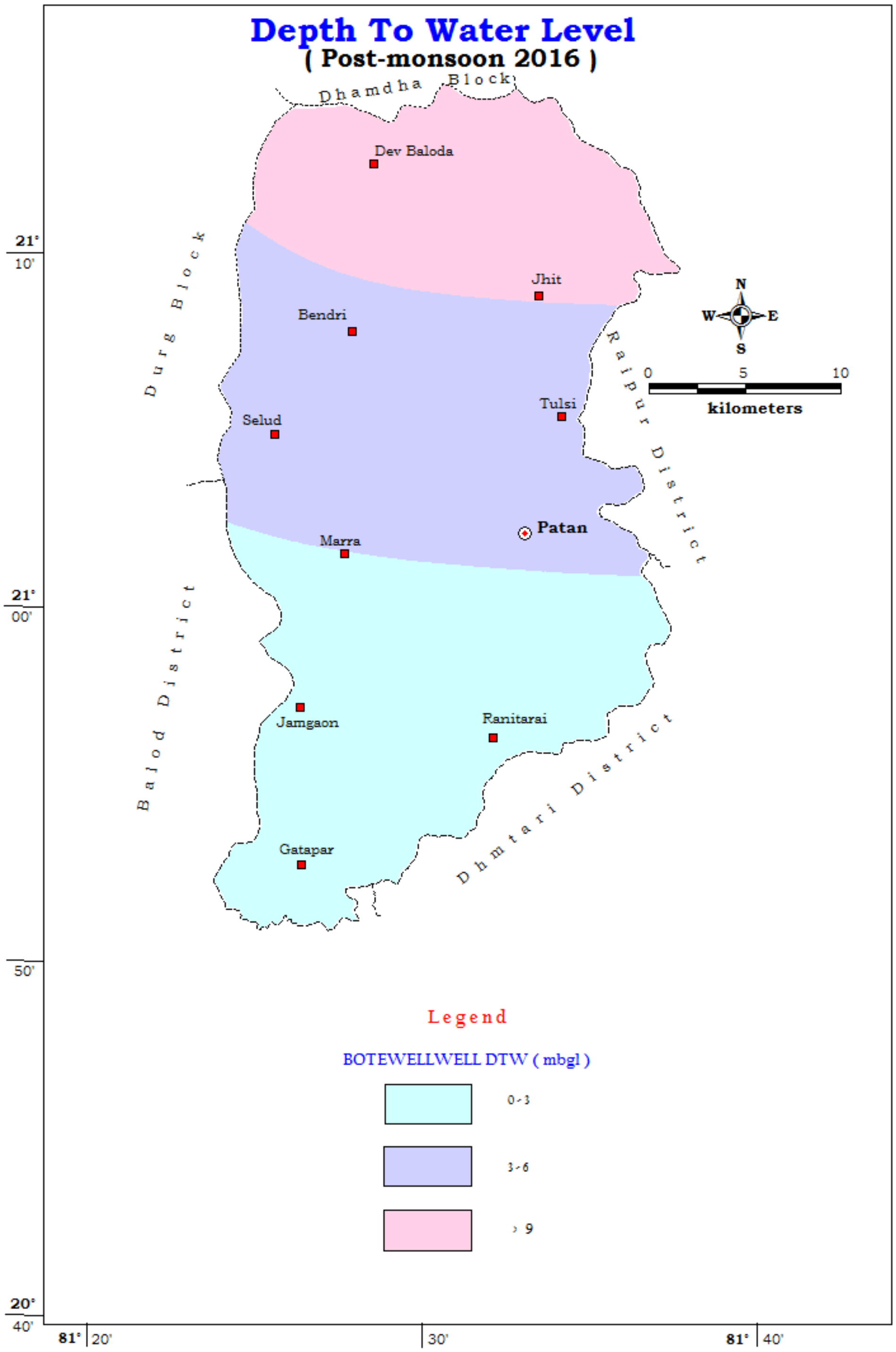


Figure-7: Depth to water level map Fractured Aquifer (Post-monsoon)

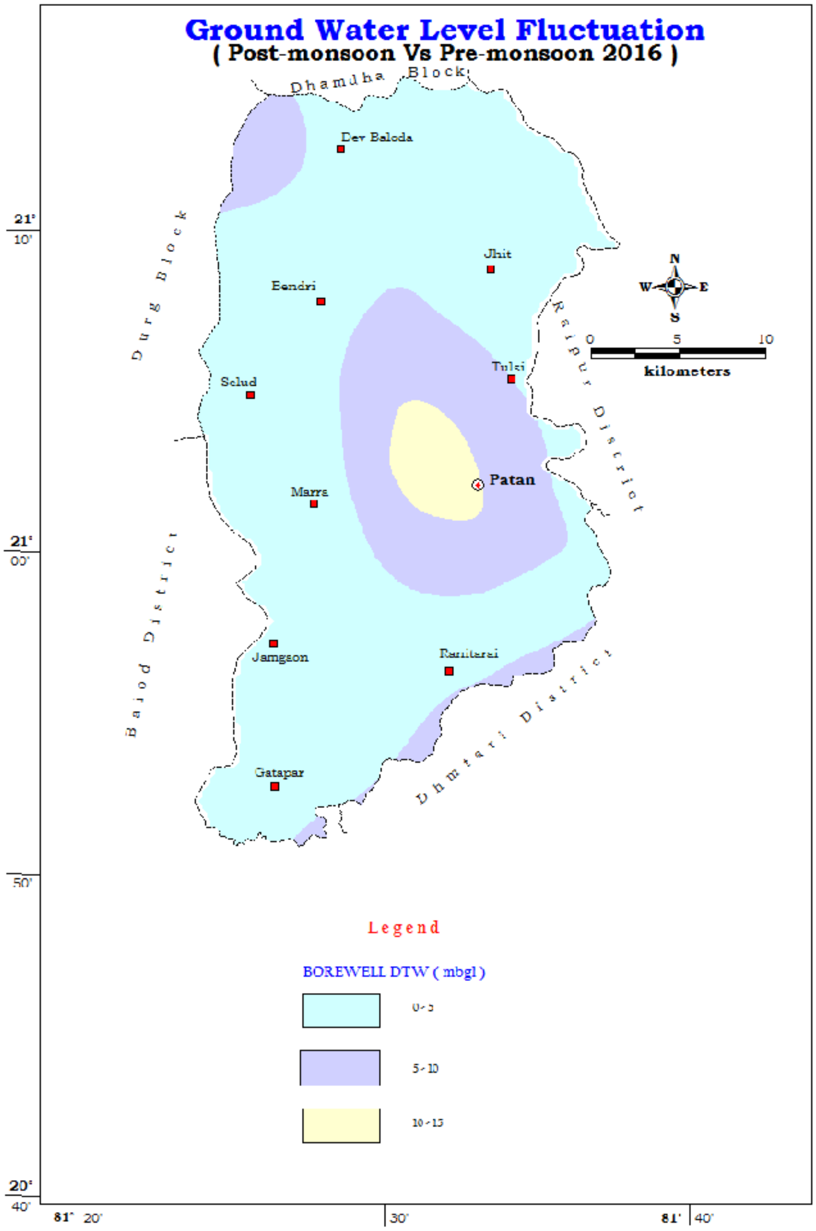


Figure 8: Depth to water level fluctuation map of Fractured Aquifer

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic Limestone			Phreatic Shale		
	Min	Max	Avg	Min	Max	Avg
Patan	0.84	7.34	3.13	3.07	7.67	5.37

Water Level (in m)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Fractured Limestone			Fractured Shale		
	Min	Max	Avg	Min	Max	Avg
Patan	2.16	11.86	5.53	1.77	3.93	2.85

Water Level (in m)

(iv) The long term water level trend: It indicates that there is no appreciable change in water level both in pre-monsoon and post-monsoon period.

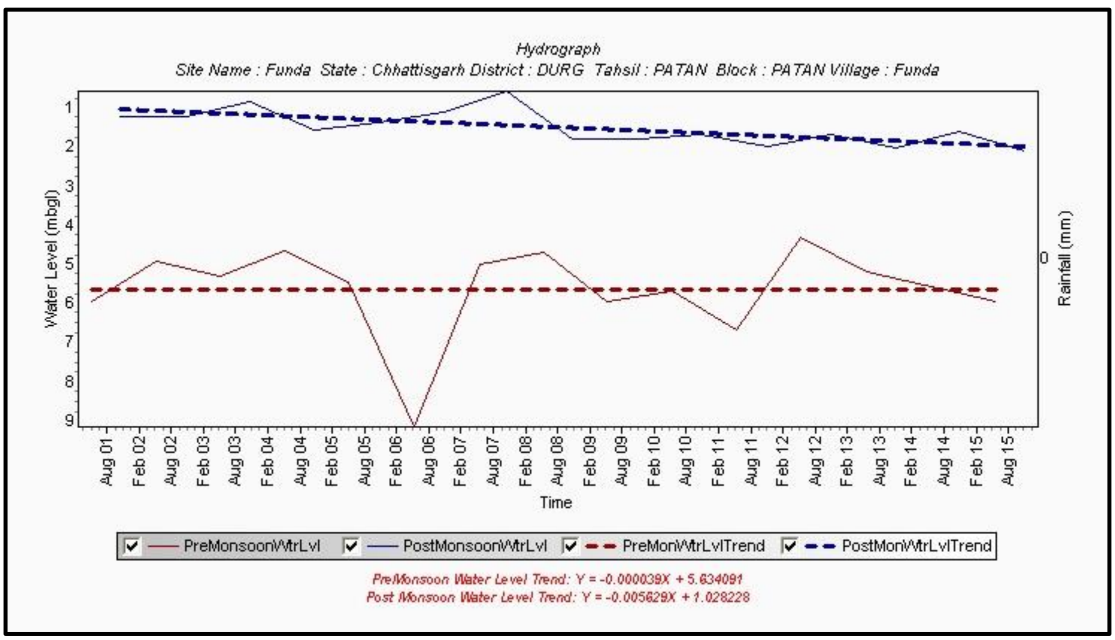


Figure 9: Hydrograph of Funda village, Patan block

2. Aquifer Disposition:

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

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

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

a) Chandi Formation: Chandi formation occupying almost 83% of the block covers about 753 Sq.km area. 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. fine grained 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 stromatalitic structure. The rock is also gypsiferous containing gypsum in vug cavities.

b) Gunderdehi Formation: Gunderdehi formation occupies an area of about 118 sq.km in southern part of Patan block of the district, 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 (around Patan village) 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.

c) Laterite: Laterite occurs as small cappings over the sandstone, limestone and shale and its contact with underlying formations 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.

d) Alluvium: The alluvial deposits in the area are mainly confined to all along the flood plains of (Seonath, Tandula, 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.

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 13.5 m. Generally, 1 set of fracture is encountered within 50 m depth, 1 to 2 sets of fractures within 50 to 200 m depth. The discharge varies from 0.1 to 4.0lps. The drawdown varies widely from 7.4m to 32.29m, 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 13.2 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 1to 2 sets of fractures are encountered within 50 to 200 m depth. The potential zones are present wthin50 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 Patan

Block	Limestone	%	Shale	%	Sandstone	%	Total Area (sq.km)
Patan	753	83.02	118	13.01	36	3.97	907

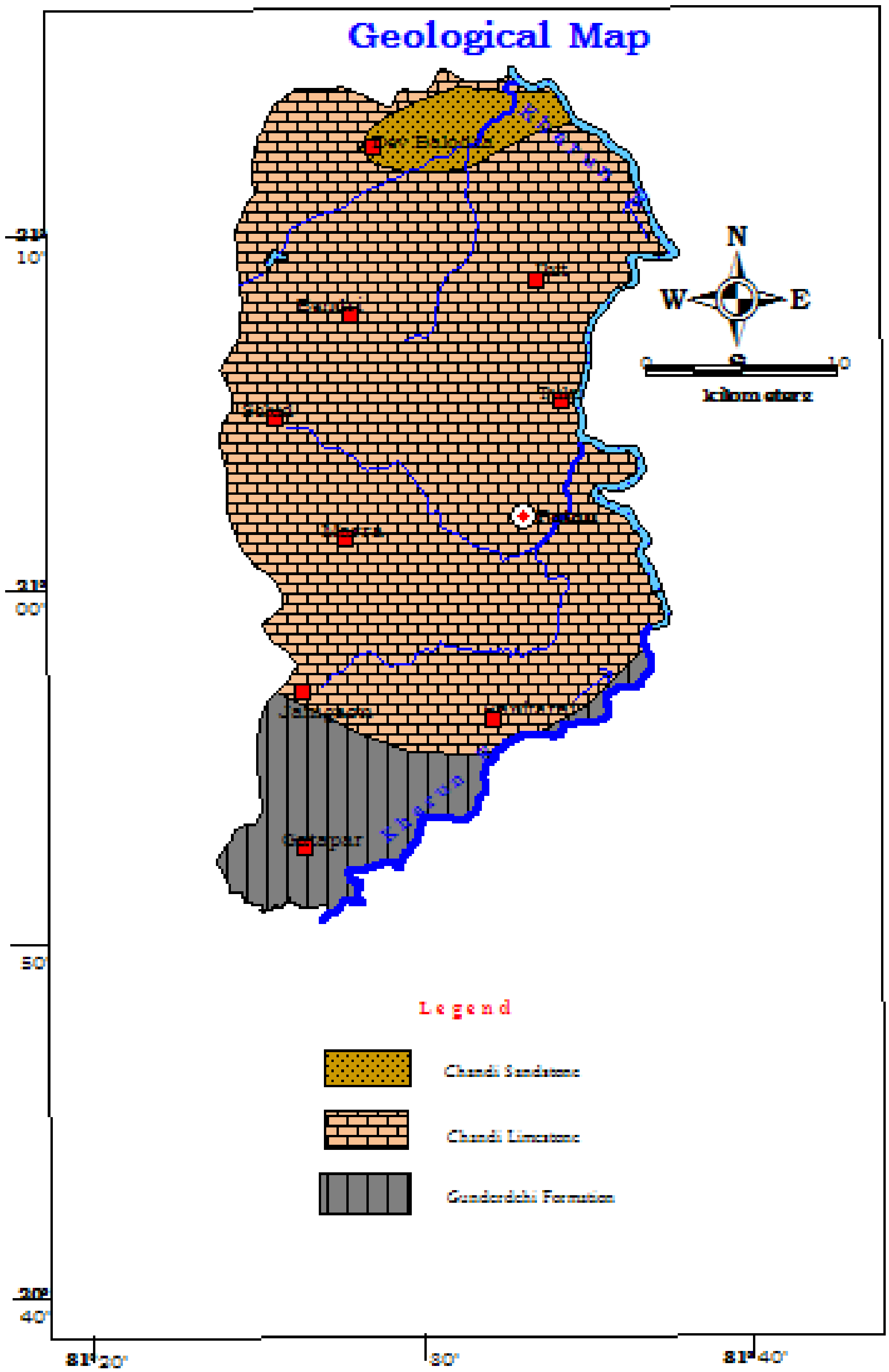
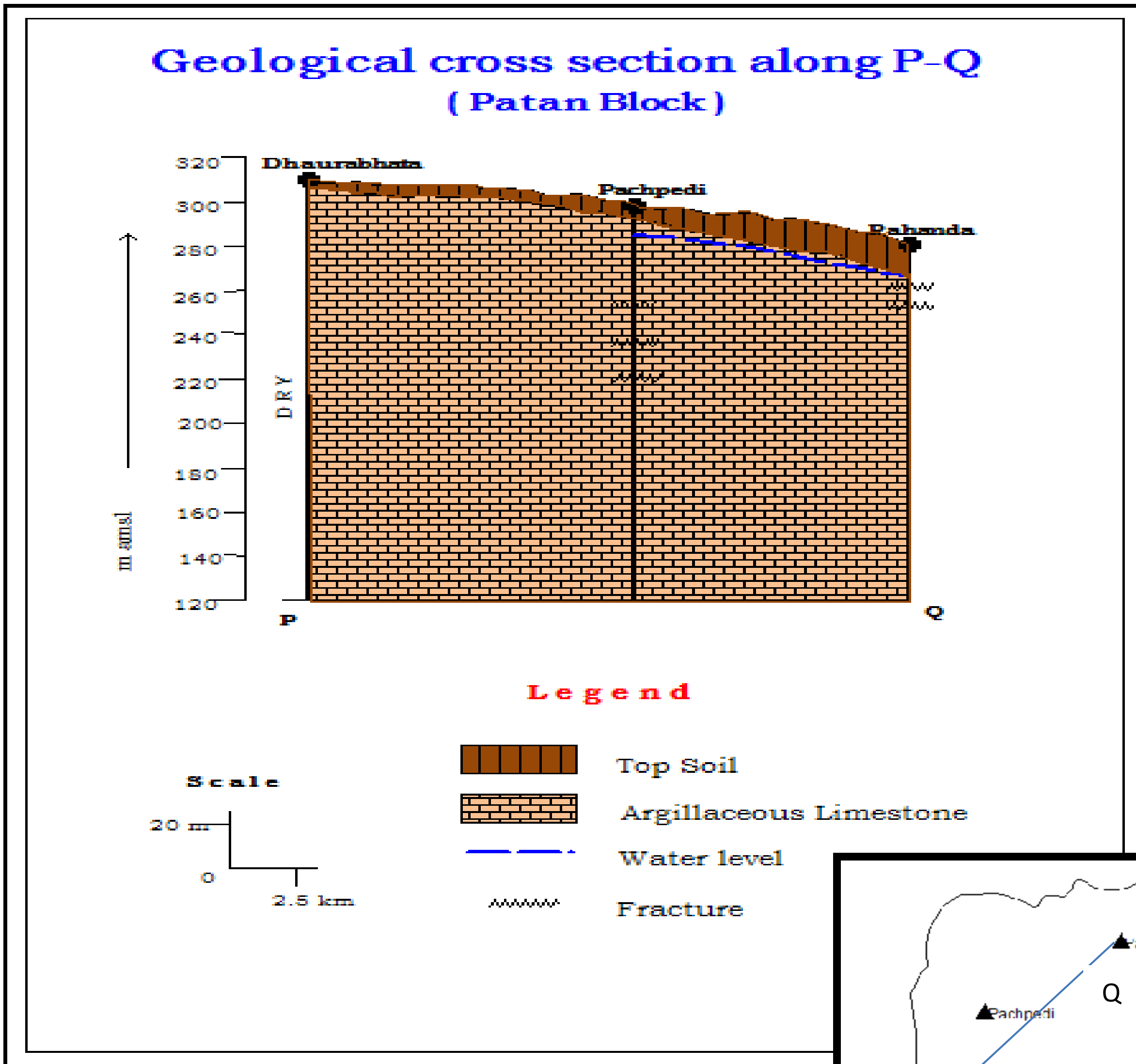


Figure-10: Aquifer Map of Patan Block



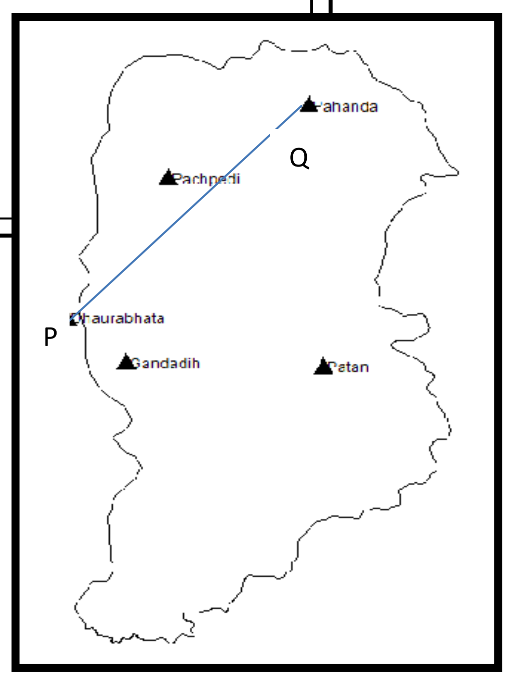


Figure-11: Hydrogeological Cross Section, Patan Block

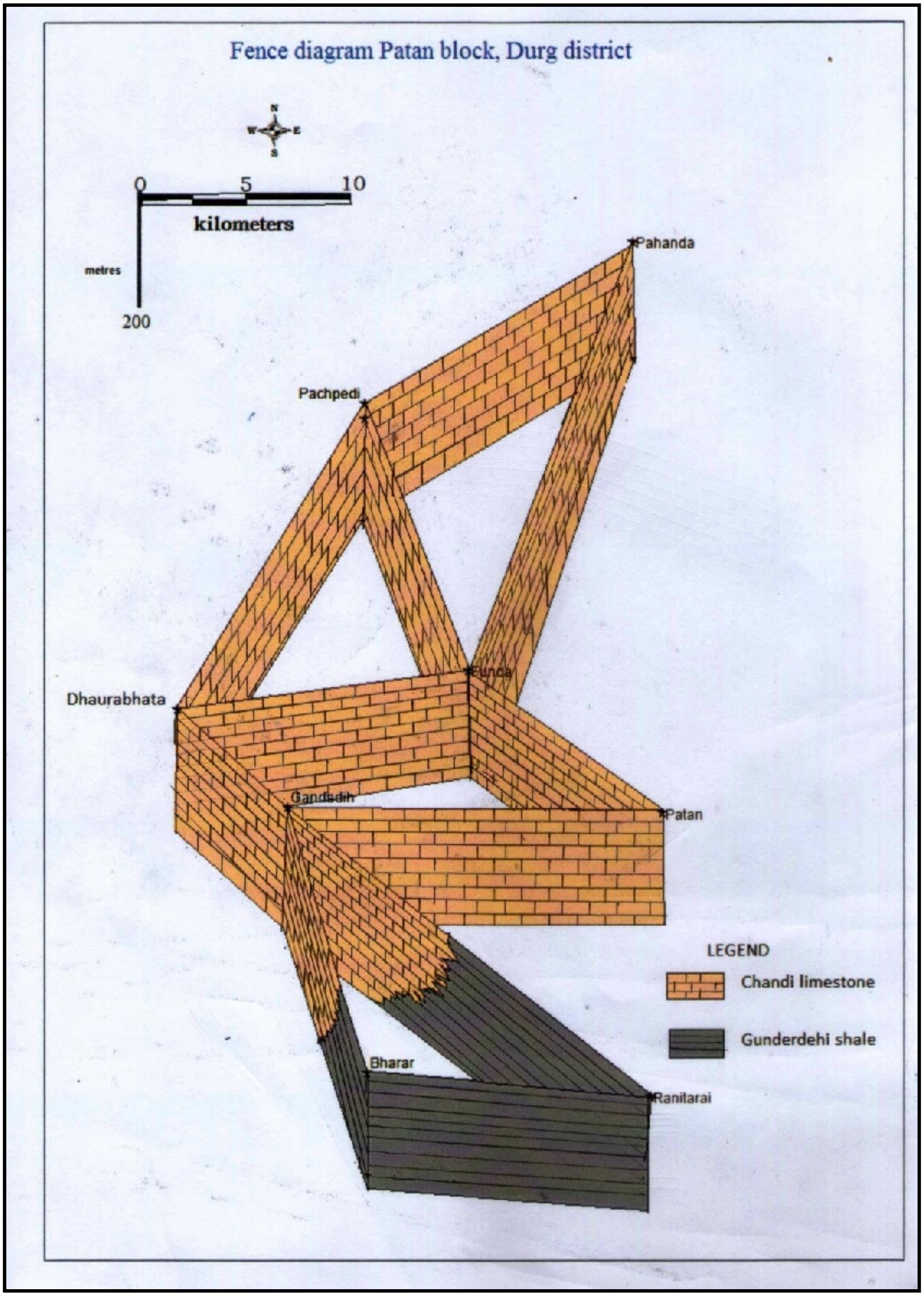


Figure 12: Fence diagram of Patan block

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

Aquifer wise resource availability is given in the table -4 where the total resource available in Patan block is 8009.08 ham out of which the resource available within limestone (Chandi formation) area is 6647.54, Sandstone (Chandi formation) is 1041.18ham and shale (Gunderdehi formation) is 320.36ham. 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 district, Patan block

District	Assess ment 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)
Patan	Patan	8009.08	5274.28	951.28	6225.26	1006.22	1728.58

Table 8: Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorization
Patan	Patan	78	Semi-critical

<u>Categorization:</u> The Patan block falls in semi-critical category. The stage of Ground water development is 78%. The Net Ground water availability is 8009.08Ham. The Ground water draft for all uses is 6225.26 Ham. The Ground water resources for future uses for Patan Block is 1728.58Ham. There is little scope for further Ground water development. More focus should be on judicious use and augmentation of groundwater.

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

4. Issues and Management plan:

Aquifer wise space available for recharge and proposed interventions: The Volume of porous space available for recharge (m^3) is nil in both limestone and shale as the average 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	$753x\ 10^6$	0	0.015	nil
Shale	$118x\ 10^6$	0	0.015	nil

So there is no scope of artificial recharge of groundwater. Yet in terms of dynamic groundwater resource and stage of development, the block is classified as Semi-critical.

Issues:

1. Aquifers are not sustainable yet Stage of ground water development in Patan block is relatively high (78%).
2. Throughout the study area, the water quality (of the shallow aquifer) is good although in 2 place (Villages Sandi and Patan), Nitrate content is considerably high in shallow groundwater.

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 11: 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 in (ha)	Water required (m) per ha (m)		Difference (m per ha)	Total saving of water (ham)	Available g.w. Resource	Improved stage of g.w. Development	Present stage of g.w. of Development
		Paddy	Maize					
Patan	1773	1.5	0.5	1	1773	8009.08	42%	78%

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 borewells should be strictly monitored and put to an end in case of over consumption. 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. Deepening of ponds and tanks, desiltation of nalas to be done to store rainfall runoff. This will augment groundwater use.

8. The water user association body should be strengthened so that there will be a balance between cropping time and availability of surface water through canal.

9. Hence Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) must be given priority in implementation to extend the coverage of irrigation 'Har Khet ko pani' and improving

water use efficiency 'More crop per drop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities.

10. In Patan Block it has been observed that the farmers have started switching to vegetables 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 patan block regarding the depth of BW drilling. Diameter and spacing of Bore wells and the same should be strictly implemented.

11. The source of nitrate in ground water is mostly anthropogenic. Hence, dug wells in the affected areas are to be substituted by borewells or tubewells to avoid the contaminated phreatic aquifer.

12. However, 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.