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

Dhamtari Block, Dhamtari District, Chhattisgarh

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

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

Prepared By

Uddeshya Kumar

Scientist-B

Under Guidance of

Shri A. K.Biswal

Scientist-D

Central Ground Water Board
North Central Chhattisgarh Region, Raipur
Ministry of Water Resources,
Ganga Rejuvenation & River Development
Government of India

RAIPUR
2016-17

Acknowledgement

I wish to express my sincere gratitude and indebtedness to Shri D. Saha, Member (SAM), CGWB, for giving the opportunity to prepare and write this block report.

I wish to express my sincere gratitude and indebtedness to Shri C. Paul Prabhakar, Regional Director, CGWB, NCCR, Raipur for his useful suggestions and technical guidance from time to time. to prepare and write this report.

I am extremely grateful to Sh. A.K. Biswal, Scientist-D, for his continuous guidance and technical support during preparation of this report.

I would like to acknowledge the help rendered by Shri A.K. Patre, Scientist-D, for their constant support and improvement during compilation of the report.

The efforts made by Sh. T.S. Chouhan, Draftsman, for digitization of maps are thankfully acknowledged.

The author is thankful to Technical Section, Data Centre, Chemical Section, Report Processing Section and Library of CGWB, NCCR, Raipur for providing the various needful data without which the report could not have been completed.

The author is also thankful to the state agencies for providing the various needful data without which the report could not have been completed.

Lastly I offer my thanks to all the individuals who helped at various stages in this endeavour.

Uddeshya Kumar
Scientist-'B'

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

CONTENTS

DHAMTARI BLOCK AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information:

About the area: The Dhamtari Block is situated in the western part of Dhamtari district of Chhattisgarh and is bounded on the north by Kurud block, in the west by Balod block of Chhattisgarh, in the south by Kanker district and in the east by Magarlod block. The area lies between 20.4924 and 20.86 N latitudes and 81.4128 and 81.7597 E longitudes. The geographical extension of the study area is 742 sq.km representing around 22 % of the block's geographical area. Major River in the block is Mahanadi River flowing south to north east in the block along with its tributaries. Geomorphologically the area exhibits structural plain. The area is served by a good road network from the capital city Raipur. The administrative map of Dhamtari block is shown in Fig. 1.

Population: The total population of Dhamtari block as per 2011 Census is 279833 out of which rural population is 183373 & the urban population is 96460. 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
Dhamtari	279833	139451	140382	183373	96460

Source: CG Census, 2011

Growth rate: The ten-year population growth rate of the block is 12.03 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 80% 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. 2010-11 to 2014-15) 1258.12 mm with 50 to 60 rainy days whereas the normal rainfall as per IMD is 1,008.80 mm.

Table-2: Rainfall data in Dhamtari block in mm

Year	2010-11	2011-12	2012-13	2013- 14	2014- 15
Average rainfall	1305.20	1146.70	1035.60	1472.60	1330.5

Source: District Statistical Handbook 2014, Dhamtari

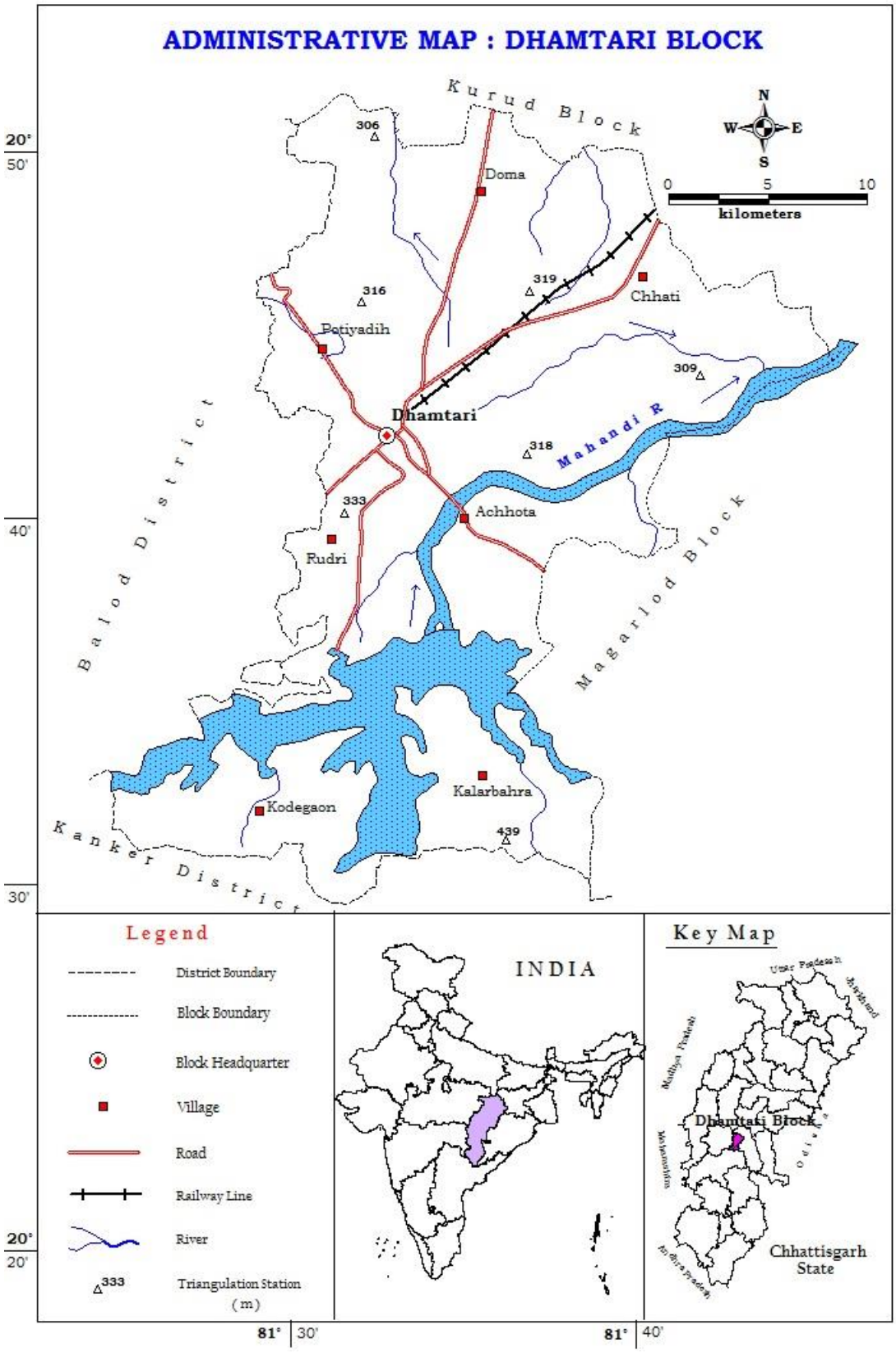

Fig-1: Administrative Map of Dhamtari Block

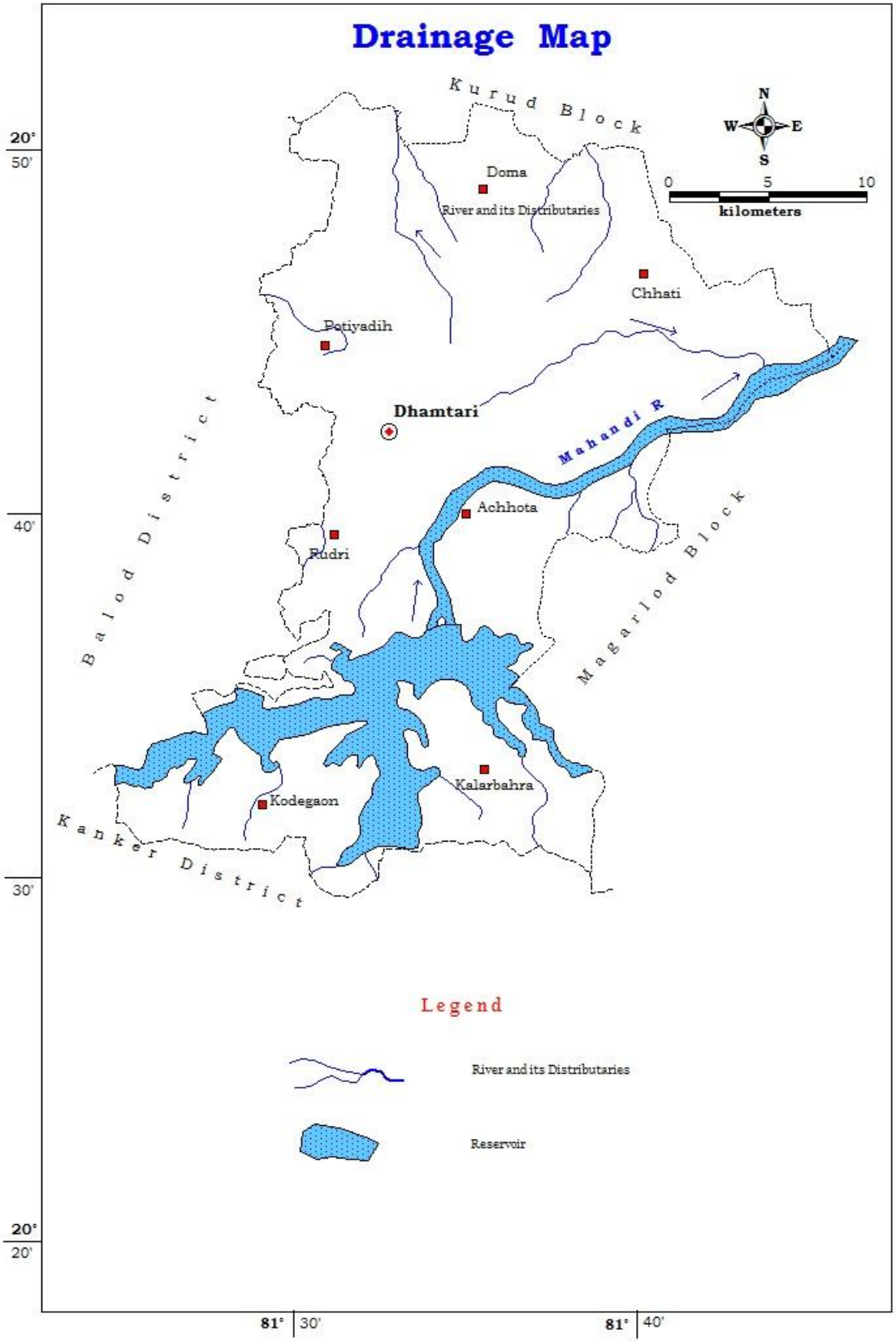

Fig-2: Drainage Map of Dhamtari Block

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 canal water and ground water as well as partly through ponds and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are paddy, pulses (mainly gram and millets) and oil seeds.

. In some areas, double cropping is also practiced. The agricultural pattern, cropping pattern and area irrigated data of Dhamtari block is given in Table3 (A, B, C, D).

Table 3 (A): 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
Dhamtari	67883	1222	14388	4578	621	34935	20994	55929

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

Block	Kharif	Rabi	Cereal			Pulses	Tilhan	Fruits/ Vegetables	Others (Fibre, Medicine)
			Rice	Wheat	Others				
Dhamtari	27874	14844	51510	93	36	3154	261	813	57

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

No. of canals (private and Govt.)	Irrigated area	No.of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigated area	Irrigated area by other sources	Net Irri-gated area	Gross irrigated area	% of irrigated area wrt. Net sown area
2	34451	6627	11513	11	15	6	40	305	31067	46324	88.92

Table 3 (D): Contribution of Groundwater in Irrigation Pattern (ha)

Block	Area irrigated through Borewell/ Tubewell	Area irrigated through Dugwell	Area irrigated through Groundwater	Net area irrigated through all sources	GW contribution in Irrigation (%)
Dhamtari	6627	15	6642	31067	21.38

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

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

Formation	Phreatic		Fractured	Total resource
	Dynamic	Static	In-storage	
Limestone	8221.635	1489.63	96.05	9807.289
Sandstone	2845.951	2957.57	33.248	5836.769
Granite	1581.084	1506.6	18.471	3106.155

Existing and Future Water Demand: The existing demand for irrigation in the area is 9781.50 Ham while the same for domestic and industrial field is 1612.04 Ham. To meet the future demand for ground water, a total quantity of 1255.13 ham of ground water is available for future use.

Water Level Behavior (Phreatic Aquifer): (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in Dhamtari block, in Charmuria Formation, though the maximum water level is 7.80 mbgl at Doma, the average water level is 4.32 mbgl. In Chandarpur Formation the maximum water level is 6.95 at Maradev, the average water level is 5.38 mbgl. In Granitic gneiess the maximum water level is 6.90 mbgl at Urputti, the average water level is 5.41 mbgl. The average water level in the block is 4.81 mbgl.

(ii) Post- monsoon water level: In the post-monsoon period, it has been observed that in Dhamtari block, in Charmuria Formation, though the maximum water level is 5.00 m at Siyadehi, the average water level is 2.99 mbgl. In Chandarpur Formation the maximum water level is 3.87 mbgl at Kodegaon_R, the average water level is 3.15 mbgl. In Granitic gneiess the maximum water level is 2.50 mbgl at Bhirawar, the average water level is 2.04 mbgl. The average water level in the block is 2.81 mbgl.

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Dhamtari block, water level fluctuation varies from 0.5 to 4.59 m with an average fluctuation of 2.32 m as the highest fluctuation in the order of more than 4.59 m is only observed at Urputti.

Table 5: Aquifer wise Depth to Water Level Characteristics

Formation	Premonsoon			Postmonsoon			Fluctuation
	Min	Max	Avg	Min	Max	Avg	
Charmuria Limestone	0.90	7.8	4.32	1.72	4.13	2.87	1.84
Chandrapur Sandstone	3.2	6.95	5.38	2.75	3.87	3.14	2.24
Granitic gneiss	2.50	6.90	5.41	1.32	2.50	2.04	3.36

Water Level (in mbgl)

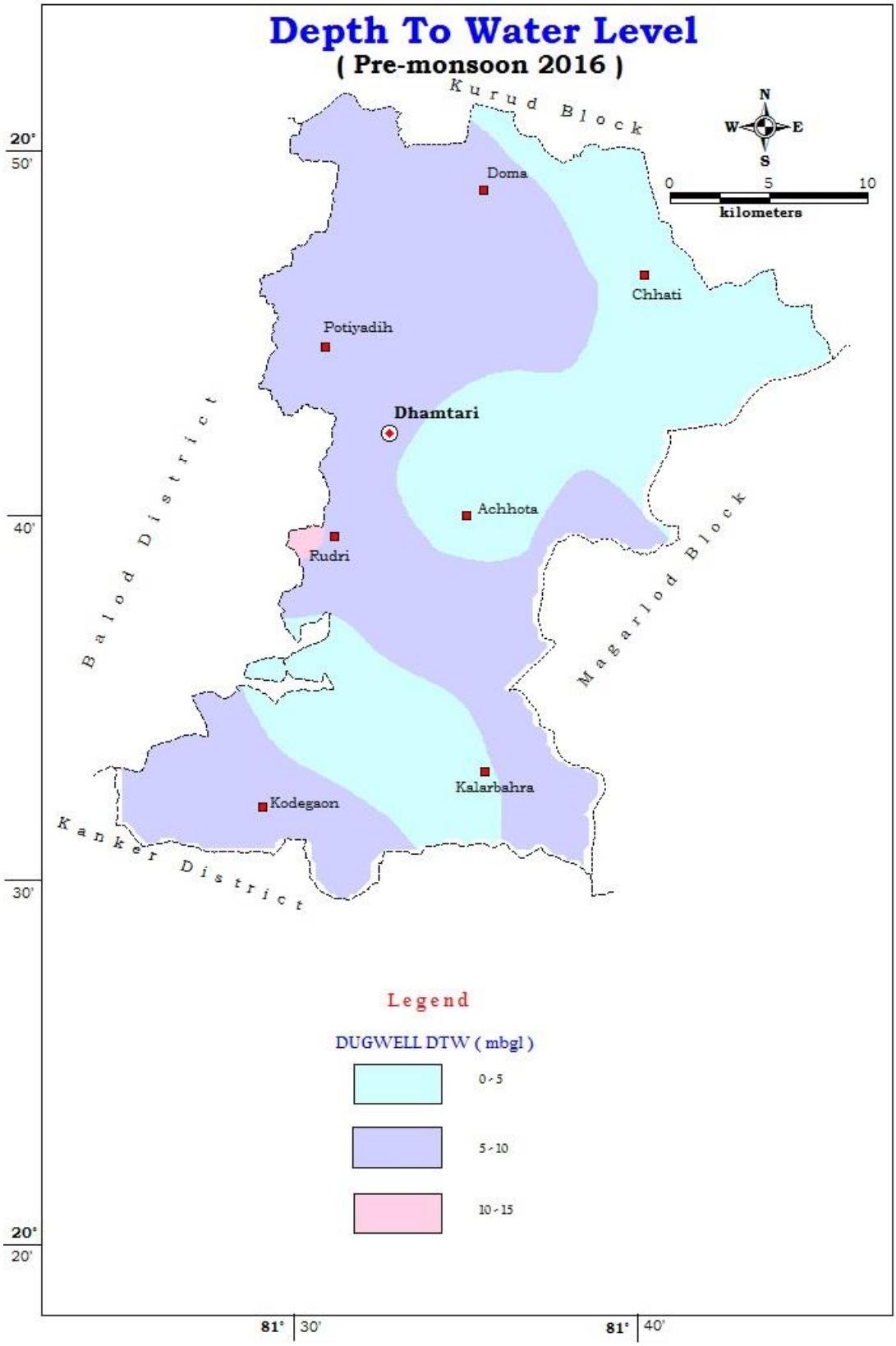

Fig -3: Depth to water level map Phreatic Aquifer (Pre-monsoon)

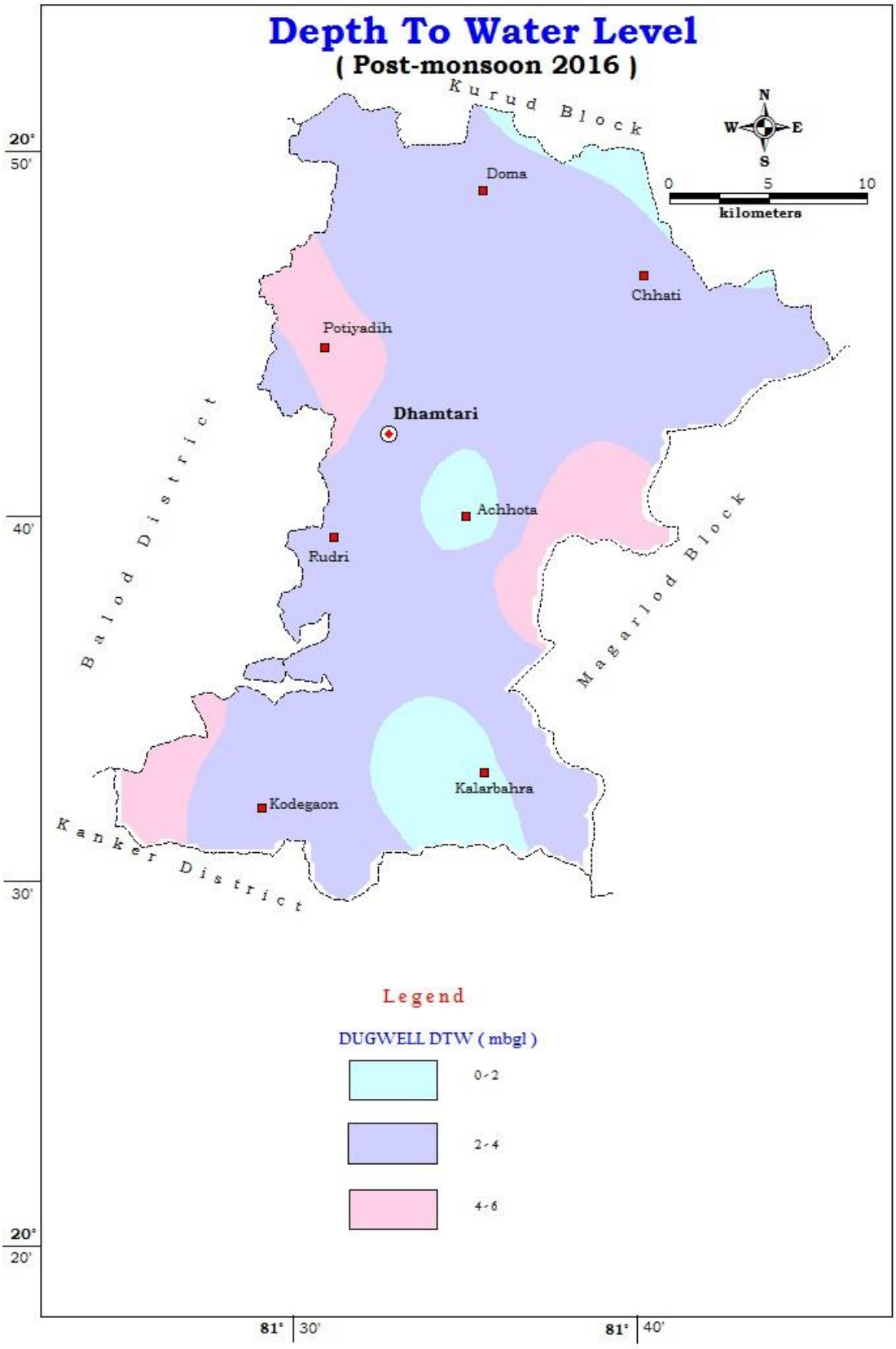

Fig -4: Depth to water level map Phreatic Aquifer (Post-monsoon)

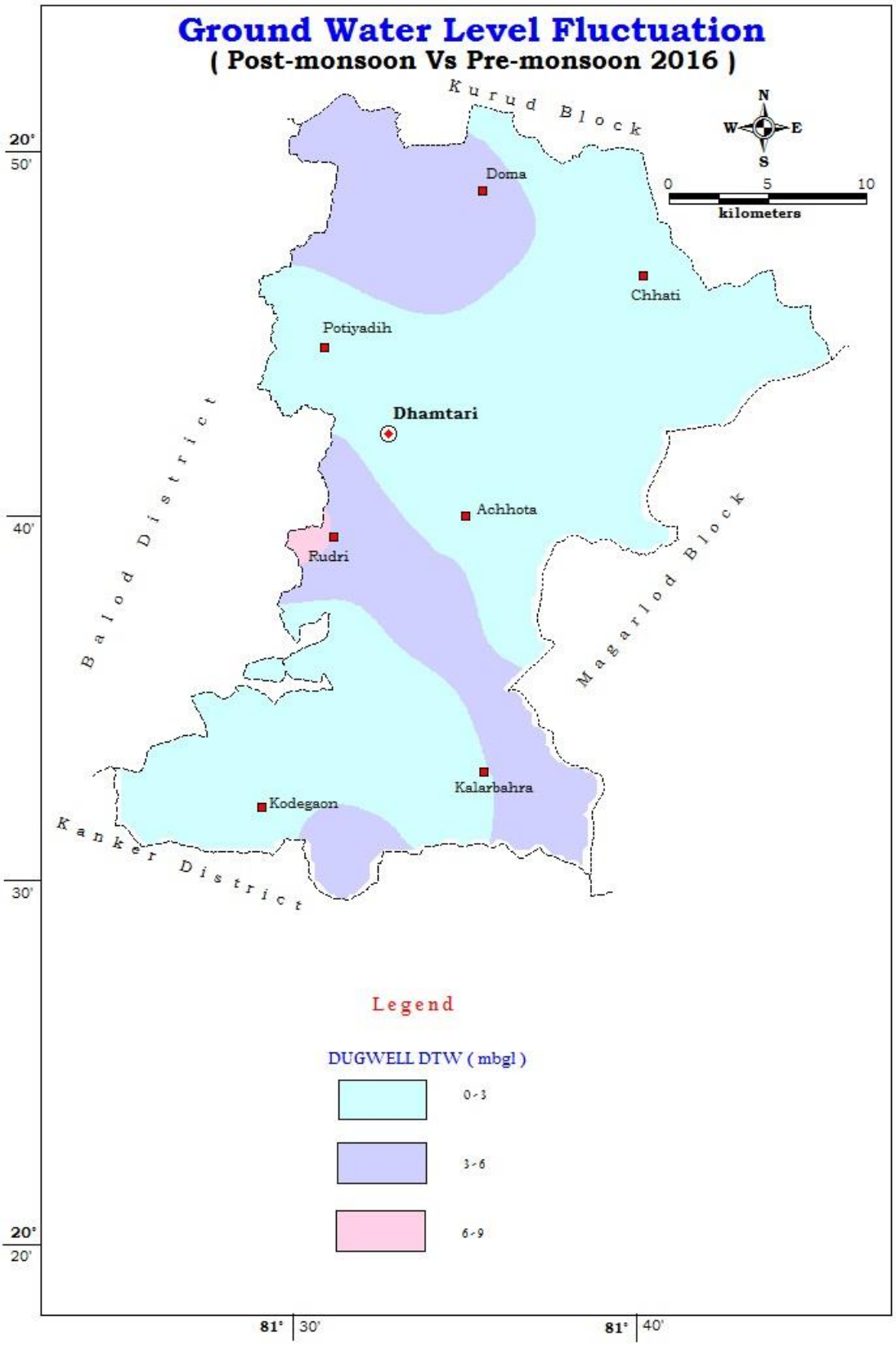

Fig -5: Water Level Fluctuation Map, Phreatic Aquifer

(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.

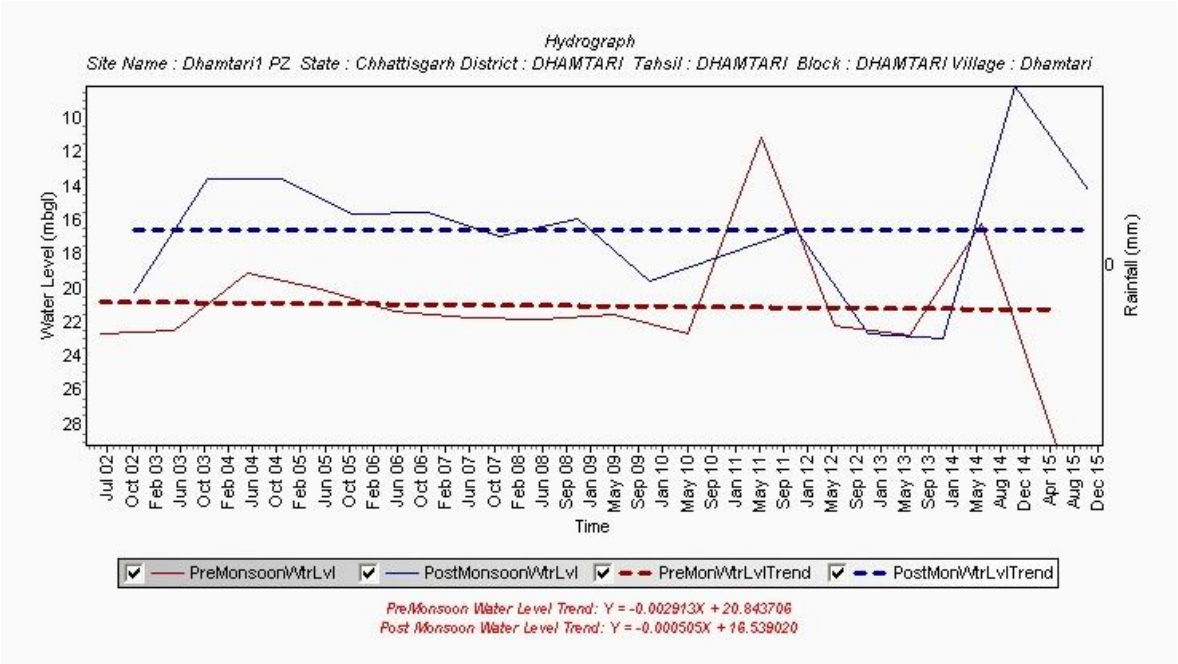

Fig-6: Hydrograph of Dhamtari Piezometer, Dhamtari

Water Level Behaviour (Fractured Aquifer):

(i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in fractured aquifer, the maximum water level is 22.7 mbgl at Arjuni, the average water level in the block is 15.17 mbgl.

(ii) Post- monsoon water level: In the post-monsoon period, it has been observed that the water level varies from 2.80 to 17.56 mbgl with an average of 11.20 mbgl in Dhmatari block.

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Dhmatari block, water level fluctuation varies from 1.80 to 8.70 m with an average fluctuation of 4.45 m as the highest fluctuation in the order of more than 8.70 m is only observed at Ravan village.

Table 5: Aquifer wise Depth to Water Level Characteristics

Formation	Premonsoon			Postmonsoon			Fluctuation
	Min	Max	Avg	Min	Max	Avg	
Charmuria Limestone	4.70	22.70	16.20	2.80	17.56	11.05	4.67
Chandrapur Sandstone	12.70	18.50	15.13	13.40	14.80	14.00	1.50
Dongargarh Granite	6.20	19.45	12.83	3.72	14.30	9.01	3.81

Water Level (in mbgl)

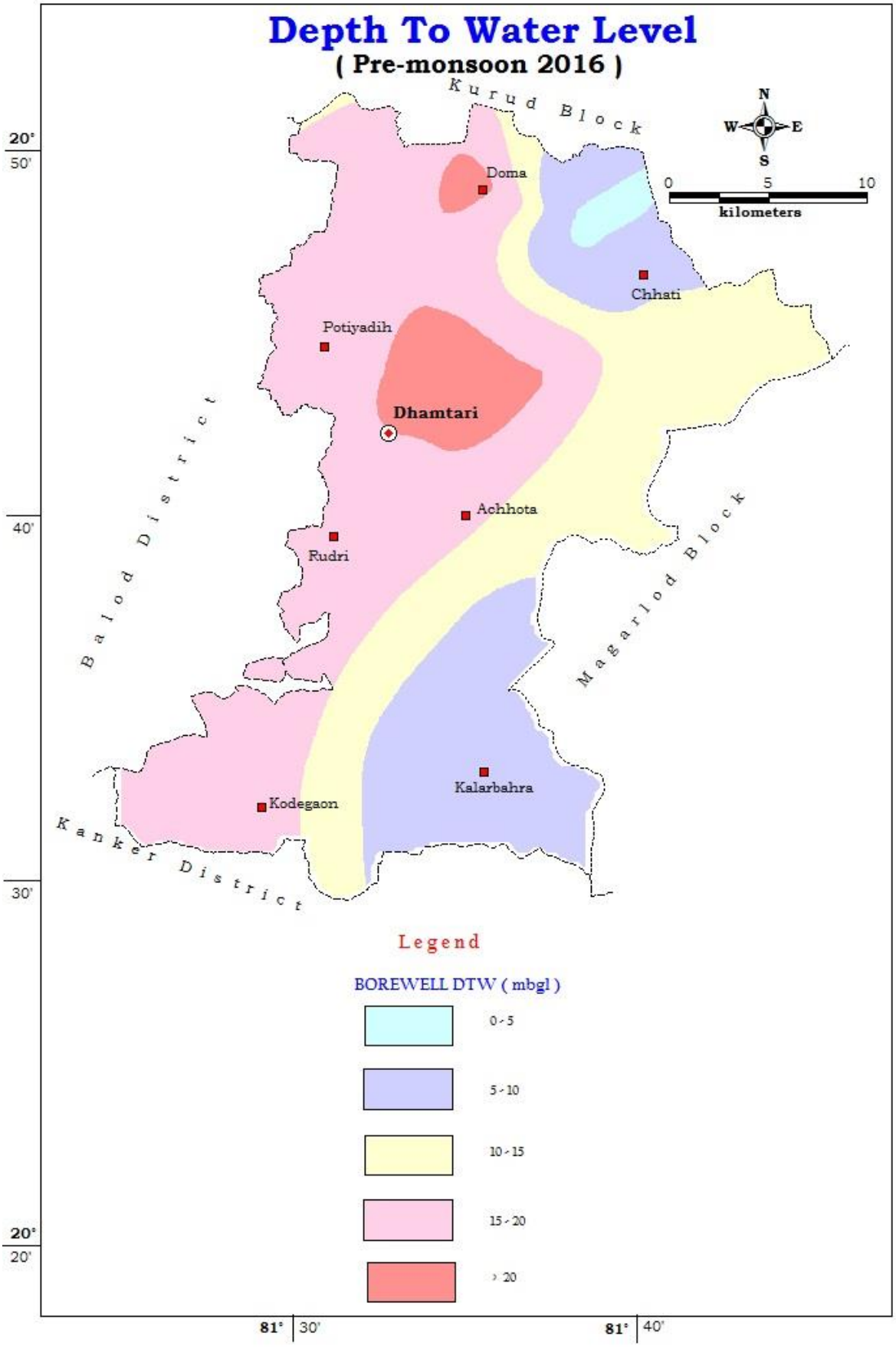

Fig -7: Depth to water level map Fractured Aquifer (Pre-monsoon)

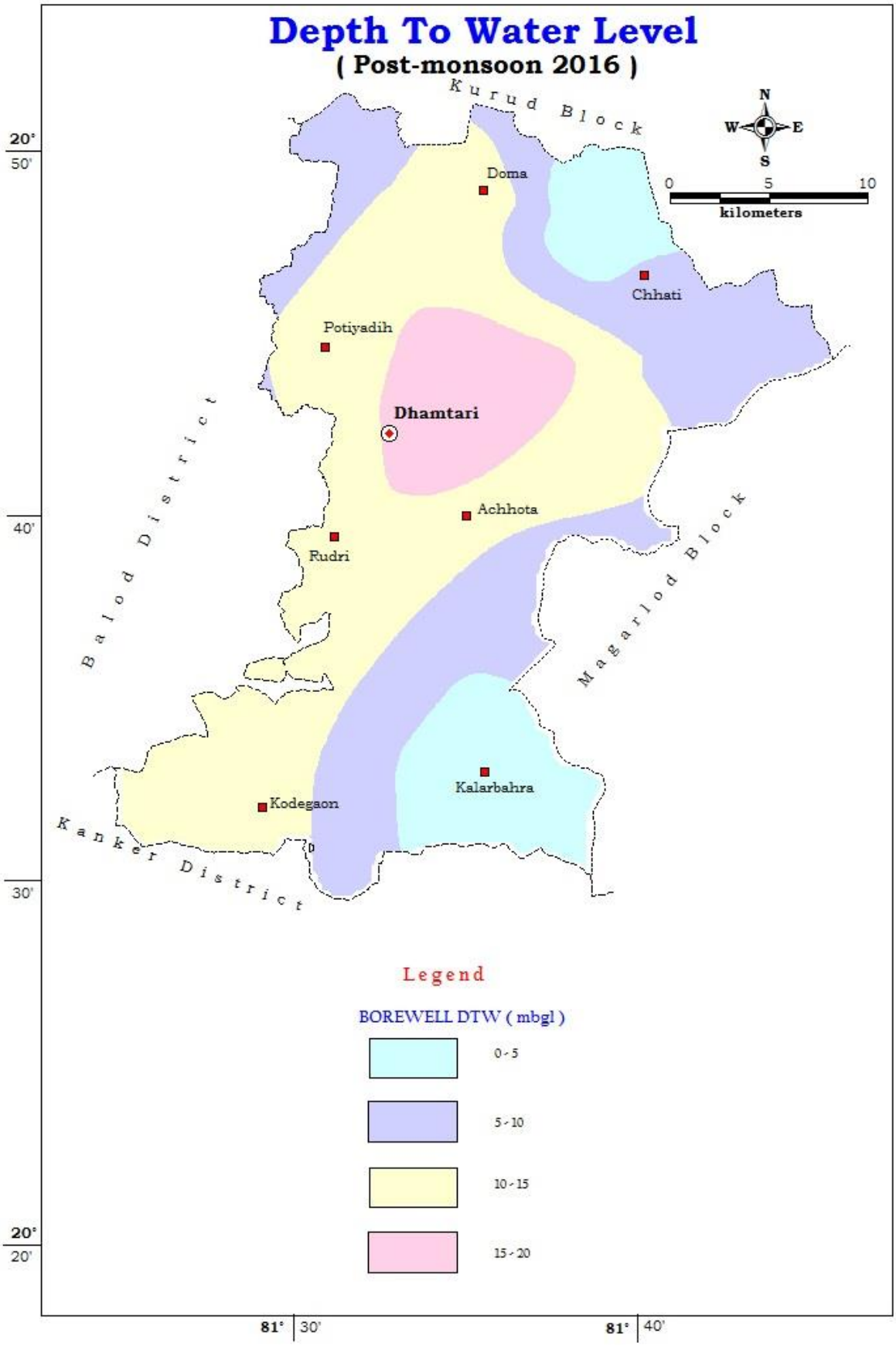

Fig -8: Depth to water level map Fractured Aquifer (Post-monsoon)

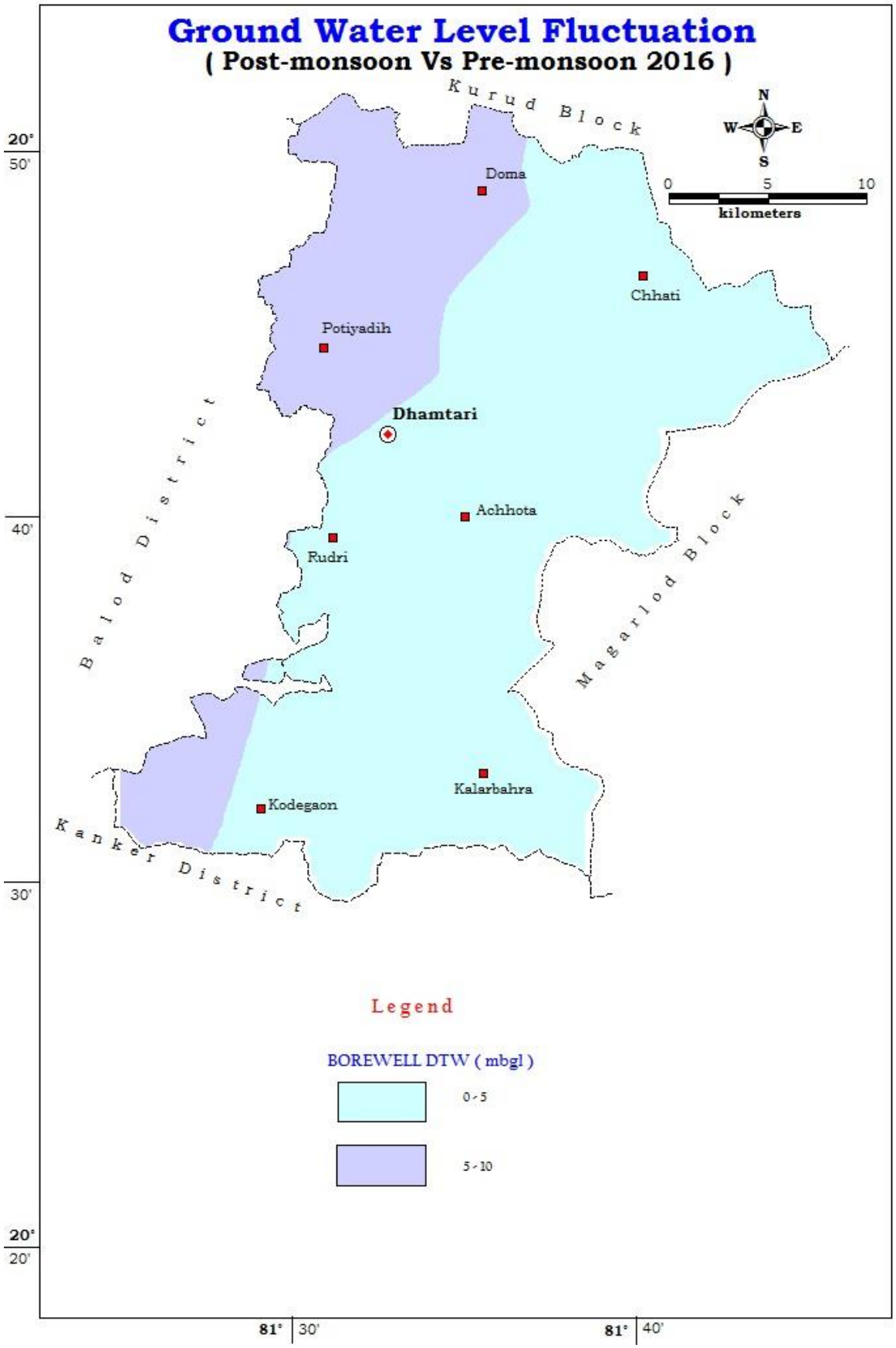

Fig -9: Water Level Fluctuation Map, Fractured Aquifer

2. Aquifer Disposition:

Number of Aquifers: There are three major aquifers viz. (i) Granitic terrain (Archean) & (ii) Sandstone (Chandrapur formation) (iii) Limestone/shale (Charmuria Formation) both in phreatic and fractured condition serves as major aquifer system in Dhamtari block.

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

Geology: Geologically the block exhibits lithology of Precambrian age having Basement Gneissic Complex, Chandarpur sandstone and Charmuria limestone.

a. Basement Gneissic Complex: The Basement crystalline province of Archaean age consists of the basement granite gneiss with enclaves of quartzite, quartz-mica schist and amphibolite belonging to the Bengpal Group.

b. Chandarpur Group: This group is of Mesoproterozoic age represented by the arkosic and orthoquarzite arenites/sandstones. This is the oldest formation lying at the bottom of the Hirri sub basin and unconformably overlying the crystalline basement.

c. Charmuriya Formation: mainly comprises grey bedded limestone with minor phosphatic clay bands. The Charmuriya limestones with intercalated shales are good aquifers.

Aquifer wise characteristics:

(i) The Basement crystalline province of Archaean age consists of the basement granite gneiss with enclaves of quartzite, quartz-mica schist and amphibolite belonging to the Bengpal Group. The ground water in this group of rocks occurs under phreatic/water table conditions in the weathered portion while semi-confined to confined conditions in deeper part consist of fractures. The average thickness of the weathered portion in the area is around 9.50 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. But near the vicinity of Gangrel reservoir fracture encountered just below the weathered portion have good yield. Generally, 1 sets of fractures are encountered within 50 m depth and 1 set of fractures are encountered within 50 to 200 m depth. In general, the discharge varies from 0.5 to 4.75 lps with an average yield of 1.5 lps. The transmissivity of the formation is around 87 m^2 per day with an average drawdown of 24.20 m. The thickness of fractured aquifer is less than 0.5 m.

(ii) The Chandarpur Group of rock mainly consist of sandstone which is massive, hard and compact with almost no primary porosity. Only 01 set of fractures has been encountered in Chandarpur Sandstone which is exclusively below 50 m. No fracture in any well has been encountered below 50m to 200m. The average thickness of the weathered portion in the area is around 22 m. The transmissivity of the aquifer is very low 2.37 to 10 m^2 per day with an

average drawdown of 25.50 m. The discharge in this formation ranges from dry to 1.5 lps. The thickness of fractured sandstone is less than 0.2 m. These formations are mostly developed by the way of shallow tube wells and bore wells.

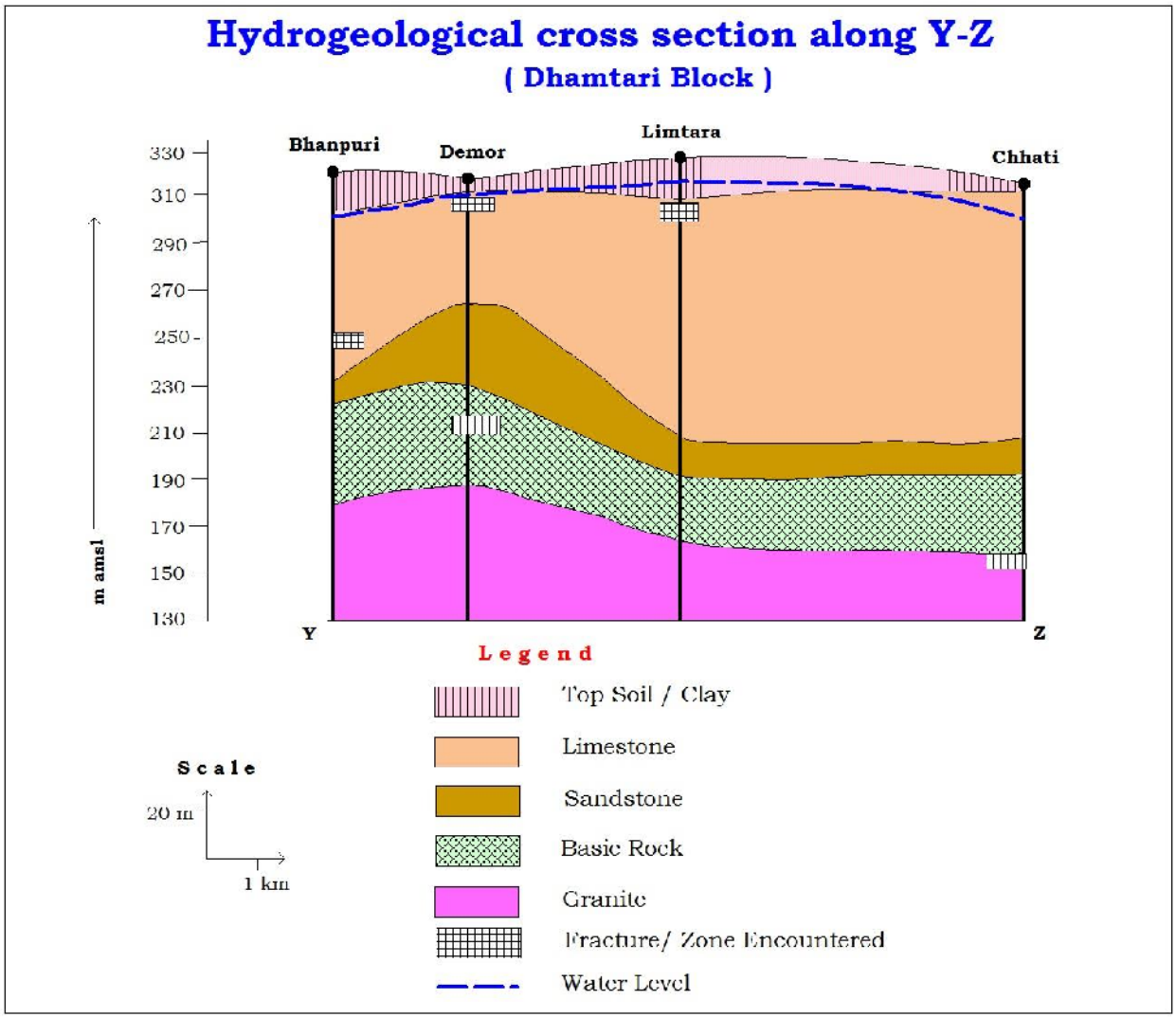

Fig-10: Hydrogeological cross Section, Dhamtari Block

(iii) Charmuriya Formation mainly comprises grey bedded limestone with minor phosphatic clay bands. The Charmuriya limestones with intercalated shales are good aquifers. The average weathered thickness Charmuriya formation is 19 m. Most of the potential aquifer are below 50m where an average of 02 sets of fracture may encounter. Although 01 set of fracture may encounter between 50 to 100m. Average transmissivity is 101 m^2per day with an average drawdown of 13.84m. The discharge in this formation ranges from negligible to 14 lps having an average discharge of 1.79 lps. Cumulative thickness of fracture in this formation is up to 1m. The development in this formation is by the way of tubewells and borewells.

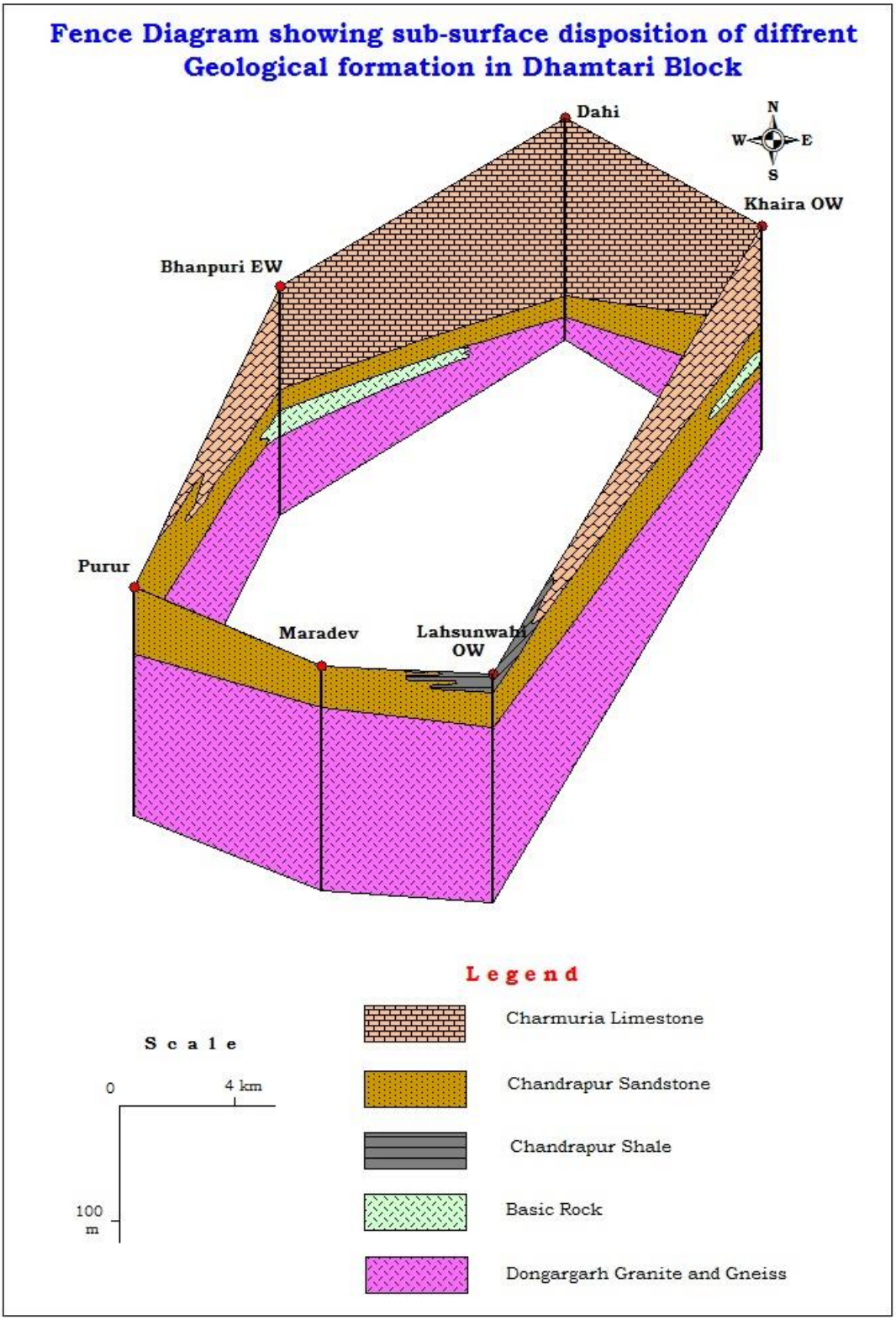

Fig-11: Fence Diagram showing sub surface disposition, Dhamtari block

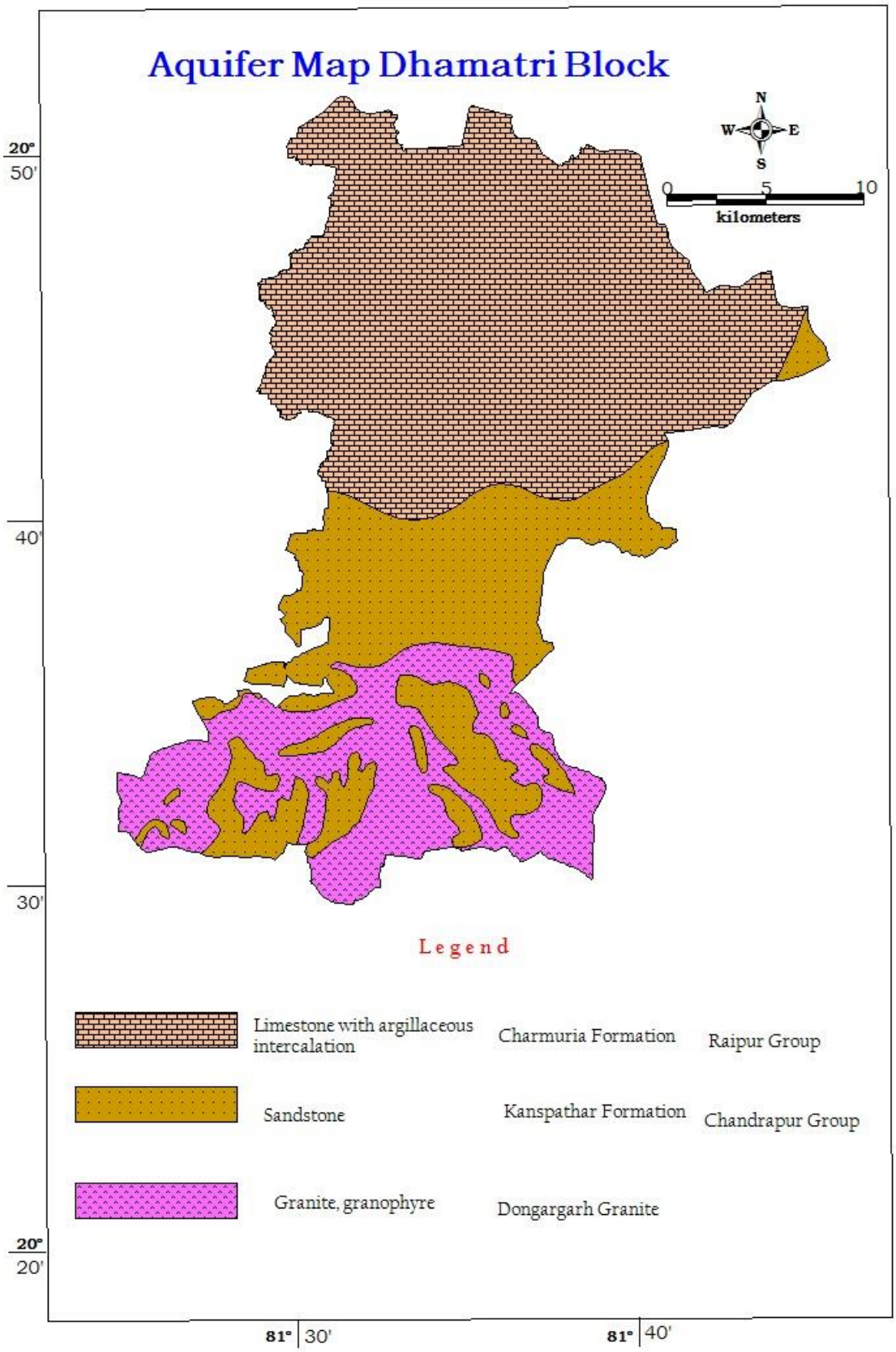

Fig-12: Aquifer Map of Dhamtari Block

Table 6: Distribution of Principal Aquifer Systems (Sq. Km) in Dhamtari

Block	Phreatic and fractured granitic gneiss	%	Phreatic and fractured Chandarpur sandstone	%	Phreatic and fractured Charmuria Limestone	%	Total Area (sq.km)
Dhamtari	93	12.5	167	22.5	482	65	742

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 Dhamtari block is 18750 ham out of which the resource available with shale (charmuria) is 1320.48 ham, limestone (Charmuria) area is 8486.83ham, Sandstone (chandrapur) is 5836.76 ham and with granite & gneiss is 3106.15 ham. The dynamic resource of the block is 12648.67 ham out of which shale is 1011.8936 ham, limestone (Charmuria) area is 7209.74 ham, Sandstone (chandrapur) is 2845.95 ham and with granite & gneiss is 1581.08 ham.

The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-9 & 10.

Table-7: Ground water Resources of Dhamtari 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)
Dhamtari	Dhamtari	12648.67	9781.50	1612.04	11393.54	1769.59	1097.58

Table-8: Categorization of assessment

District	Block	Stage of Ground water development (%)	Categorisation
Dhamtari	Dhamtari	90.08	Critical

Categorisation: The Dhamtari block falls in critical category. The stage of Ground water development is 90.08 %. The Net Ground water availability is 12648.67Ham. The Ground water draft for all uses is 9781.50 Ham.

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 except Fe concentration which is detected as 1.41 mg/l as detected in Chhati village. So there is need of installing Iron filter at places where iron concentration is higher than permissible limit.

4. Issues and Management Plan:

Aquifer wise space available for recharge and proposed interventions: The Volume of porous space available for recharge (m3) in all the formations after taking consideration of Sp yield for respective formations and considering the void space depth i.e. the desirable thickness of unsaturated zone (not considering the top 3m of the average post monsoon water level) has not been available. Although the block comes under critical category but due to hydrogeological constraint it may not be artificially recharged. So the resource enhancement can be achieved by reducing the ground water draft.

Issues: Stage of ground water development in Dhamtari Block is high (90.08%) and hence categorises as critical. The reasons behind very high development of groundwater is as follows.

1) Around 22 % of the irrigation is contributed by groundwater which ultimately results excessive withdrawal of groundwater.
2) Inherent hydrogeological character of aquifer which have very low yield and transmissivity as discussed above in chapter 2. The fractures are also very localised.
3) In summer farmers are cultivating summer rice which require 1500 mm of irrigation water.

Management Plan:

1) As several studies clearly indicate that the summer rice requirement of irrigation water is very high i.e. 1500 mm, so the framers need to discourage the take the summer rice. Instead of taking summer rice the farmers should be encouraged to take less water consuming crop such as Maize/ Finger Millet (Ragi) which require only 500 mm of water which is one tenth of the irrigation water required by summer rice.
2) After replacing the paddy in summer season with Maize/ Ragi there will be no ground water draft in command area, so the groundwater development can be lower down up to 58 % (Table-11).

3) 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.
4) In command or non-command area wherever ground water has been used for field irrigation should be replaced immediately with micro irrigation methods such as sprinklers, drip irrigation etc.
5) There are other factors also need to be considered simultaneous with above points.
   a. 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.
   b. Need for the incentives, assured prices, better marketing for the farmers shifting their crop to less water consuming crops.
   c. Supports for the technology development for harvesting and disposal of by products in agriculture fields which will also increase the fertility of soil.
   d. More model crop specific to the area may be developed which consume less water.
   e. Animal grazing in summer is also a common problem so group or community fencing is required.
   f. Mass awareness may be carried out through training programmes and with the help of other media like print, electronics and social media.
6) For the discouragement of farmers taking summer rice the following steps may be taken into consideration.
   a. Mass awareness to farmers regarding the depleting of water level due to summer rice.
   b. If there is tubewell irrigation to paddy field, then no subsidy or no free electricity to those farmers. 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 strengthen for farmers taking summer rice.
   c. Even if the farmers using solar pump or other method for ground water irrigation to summer paddy fields then it should not be through field irrigation.

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 (ha)	Water required (m) per ha (m)		Difference (m per ha)	Total saving of water (ham)	GW saving in command area	Available Resource	Improved Status of Development (%)
		Paddy	Maize					
Dhmatari	16575	1.5	0.5	1	16575	7051.5	12648.67	58