Bulletin of Pure and Applied Sciences.
Vol.38 F (Geology), No.2,
July-December 2019: P.206-217

Print version ISSN 0970 4639
Online version ISSN 2320 3234
DOI: 10.5958/2320-3234.2019.00015.5

Available online at www.bpasjournals.com

Original Article

Hydrogeological Investigation of Ground Water Levels Variation around Meghnagar Area, Jhabua Distict, Madhya Pradesh, India

Dharmishtha Nigwal [1], Pramendra Dev[2,]*

Author's Affiliations:
[1]School of Studies in Earth Science, Vikram University, Ujjain, Madhya Pradesh 456010, India.
[2]House No. 9 Adarsh - Vikram Nagar, Ujjain, M. P. India.

***Corresponding Author: Pramendra Dev**, House No. 9, Adarsh Vikram Nagar, Ujjain, Madhya Pradesh 456010, India.
E-mail: drpdev@yahoo.com

(Received on 06.08.2019, Accepted on 03.10.2019)

ABSTRACT

The recent paper embodies results of the hydrogeological setting in the area around Meghnagar, Jhabua District of Madhya Pradesh. The usual hydrogeological survey has been carried out covering an area of 246.01 Sq. km. Well inventory involves examination of 61 dug wells existing in study area. 30 dug wells have been selected as Observation wells. Data were recorded in respect of location of well, diameter and depth of well, and measurement of static water level during post- and pre-monsoon periods to observe variations of seasonal ground water levels. The static water level during the post - monsoon period reveals a fluctuation range from 0.08 m to 4.71 m bgl, during pre - monsoon period the range of static water level varies from 3.18 to 9.10 m bgl. The fluctuations of ground water level from post- to pre- monsoon season have been observed as 2.00 to 7.42 m bgl. Based on static water level data, ground water level contour maps have been prepared. The ground water level contour maps have helped in computing direction of ground water movement. The post monsoon water level contour trend contributes in demarcations of ground water potential zones in study area. The change in direction of ground water movement can be assigned to the lithology and structural characters. The trends of ground water level fluctuation have been described as a result of excessive removal of ground water.

KEYWORDS: *Hydrogeology, Fluctuation, Static water level, measurements, Ground water, Meghnagar, Madhya Pradesh.*

1. INTRODUCTION

Hydrogeology is a combination of two words *Hydro* = water + *geology* = study of the Earth and it has been usually defined as the occurrence, distribution and movement of water below the surface of the earth. It deals with the study of geological conditions controlling the occurrence and movement of ground water. The subject passes into the realm of Geohydrology (Todd, 1959, Davis and Dewiest,

1966). The distribution is however; arbitrary generally the study of one cannot be separated from the study of the other, in order to understand the interrelationship between the geologic and hydrologic environments. The general flow of fluids (water, hydrocarbons, and geothermal fluids) in deeper formations is also a concern of the geologists, geophysicists and petroleum geologists (Todd, 1980, Raghunath, 1985, Fetter, 1988, Karanth, 2003, and others).The major objective of chemical analysis of ground water in the study area is to evaluate (a) the quality appraisal of ground water and (b) to delineate its utility for domestic, drinking, and irrigation purposes. The ground water quality explanation is conducted on the basis of comparing the values with the standard values suggested by various organizations and workers. Analysis carried out is based on the procedures specified by APHA (1998), Todd (2001) and Karanth (2003) and others. Results of the analysis are reported in terms of equivalents per million (epm).

Water resources of the earth are involved in and endless circulation linking the waters that are present in the atmosphere, surface and sub-surface parts of the earth crust, hence water in any zone cannot be studied separately disregarding other parts, which are supplementary. To complete studies of water in any part of the system a proper background in the other constituent part is essential.

1.1 LOCATION AND GEOLOGYCAL STUDY AREA

The study area is located around the Meghnagar, which is at a distance of 25 km away from the Jhabua city in Madhya Pradesh. Meghnagar lies within the latitude 22^0 50′ to.22^0 55′ N and longitude 74^0 30′ to 74^0 40′ E (Survey of India Toposheet No 46 J/9, Figure 1.1). The area is approachable by rail and road through the year.

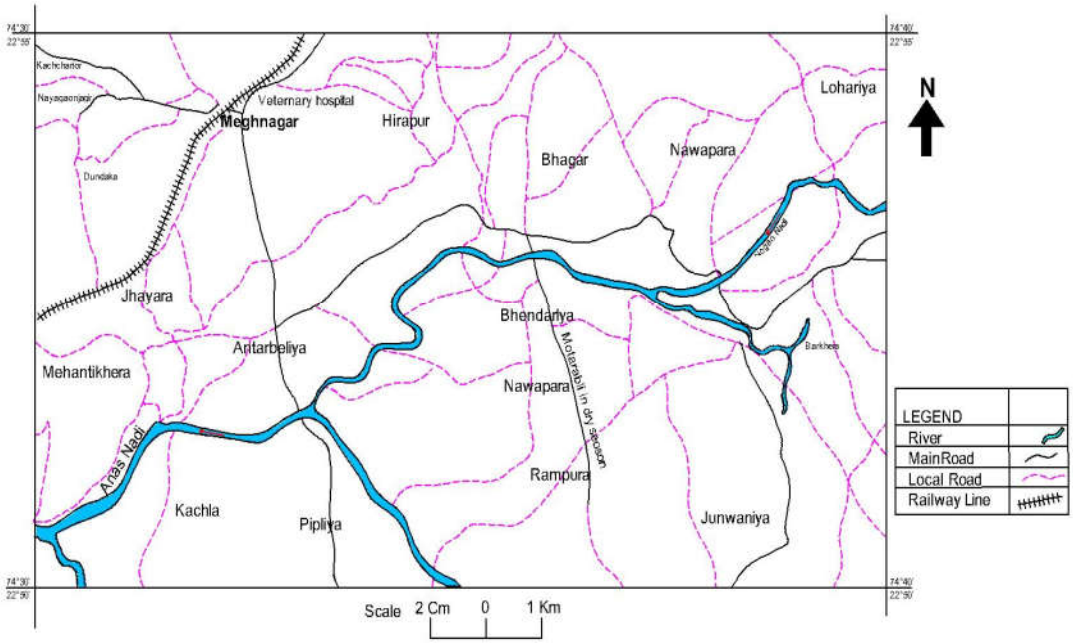

Figure 1: Location map of the study area, Jhabua District, Madhya Pradesh.

1.2 GEOLOGICAL SETTING OF STUDY AREA

Present study has been carried out i around Meghnagar area located in Jhabua district of Madhya Pradesh. The characteristic rock formations developed in the study area are exhibited herein (Table 1).

Table 1: Generalized geological succession of Meghnagar Study Area, Jhabua district, Madhya Pradesh.

Age	Formation	Rock Type
Recent	--	Alluvium soil
Upper Cretaceous to Lower Eocene	Deccan Traps	Basalts
…… Unconformity……		
Cretaceous	Bagh beds	Sandstone, limestone
Archaean	Aravalli Super Group	Quartz vein, Quartzo - Feldspethoic, gneissic, Granite pink, green, grey Phyllite, quartzites
.....……...Unconformity …….....		

The Archaean rock comprises quartz vein, quartzo-feldspethoic, gneissic, pink granites, green granites, grey granites, phyllites, quartzites. Metamorphic rocks are represented by phyllites and gneisses. Archaean are overland by the Deccan traps, which one composed of several basalt lava flaws. Deccan traps having uncomfortable contact with Bagh beds.

2. HYDROGEOLOGICAL INVESTIGATION

Hydrogeological exploration involves following four components - (a) collection of data on ground water level, (b) Interpretation by data on quality, distribution, source of replenishment and discharge of study area, (c) knowledge of basic principal and relationship and (d) the systematic hydrogeological exploration of a ground basin on a particularly geographic sector that includes monitoring of ground water levels, replenishment relationship with surface water pollution and volume of ground water as well as quality for various applications (Walton 1970).

Ground water investigation has been conducted by various organizations for formulation of development and management plans of watershed. This investigation programme includes collection analysis and interpretation of data in respect of ground water resource. In present study, well inventory in Meghnagar area forming a part of Anas River Basin. The relevant data pertaining to location of dug wells, measurement of the diameter, and total depth of walls, static water levels and mode of lifting water have been recorded during course of the systematic hydrogeological survey. The well data have been analyzed and interpreted for delineation of the nature of shallow ground water regime. An attempt has been made to assess the ground water potential on the basis of aquifer performance test data of selected open dug wells.

2.1 WELL INVENTORY

The study area covers about 246.01 sq. km. around Meghnagar area (Toposheet No. 46 J/9). In the present work, 61 open dug wells were inventoried during the months of October 2015 and April 2016. Details of well inventory such as the location of well, diameter of well, static water level, name of owner, mode of water lifting and measurement water levels are displayed (Table 2). The water level in these wells were taken up during post monsoon (October, 2015) and pre-monsoon (April 2016) periods to observe the variation in water level and study of ground water by preparing water levels contour maps for different reasons. Present work has been confined to nature of shallow ground water regime, as bore holes data are not available to the analysis (Table 2, Figure 2).

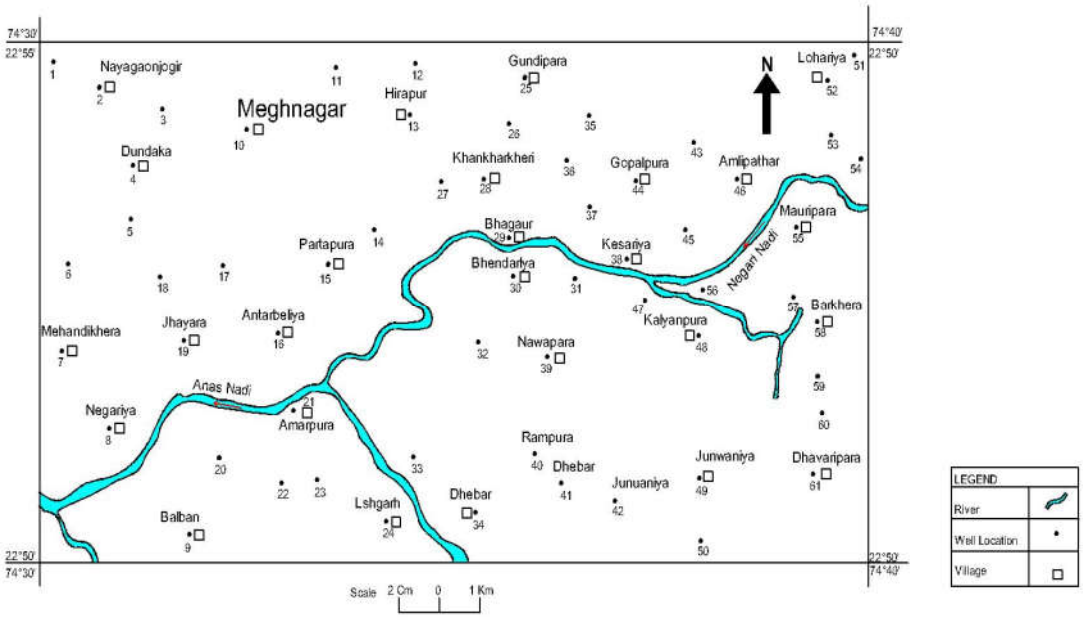

Figure 2: Location of Open dug wells in the Meghnagar study area.

Table 2: Dug well data measured in Meghnagar the study area.

Well No.	Name of the owner	Location	Diameter of well (m)	Total Depth of well (m)	Static water level post monsoon	Static water level pre-monsoon	Mode of lifting
1.	Bhura Singh	Kachchartori	5.45	8.35	4.10	5.65	PB
2.	Ramesh	Nayagaonjagir	6.20	9.23	4.65	6.28	P
3.	Rupsingh	Nawapara dhanna	4.52	10.25	Dry	Dry	P
4.	Ram Bhursingh	Dundaka	4.35	7.65	5.13	6.23	P
5.	Ramsee Patel	Phuleri	4.15	6.66	3.27	4.75	PB
6.	babusingh	Naharpura	4.50	7.00	Dry	Dry	P
7.	Nansingh	Mehandikhera	5.20	9.20	5.31	7.40	P
8.	Karan	Negariya	4.25	8.23	3.32	6.20	PB
9.	Rajesh	Balban	4.40	9.35	4.21	8.20	P
10.	Government	Meghnagar	5.81	7.20	3.25	5.35	PB
11.	Ramesh	Phatepura	5.35	12.19	Dry	Dry	P
12.	Talsinghlal	Amlipathar	5.67	9.24	Dry	Dry	P
13.	Naniya	Hirapur	4.65	7.90	2.65	4.15	PB
14.	Tolsingh	Kallipura	4.27	7.12	Dry	Dry	P
15.	Kalu	Partappura	4.62	7.65	4.00	6.19	P
16.	Mangliya	Antarbeliya	5.67	9.35	5.25	7.03	PB
17.	Mangee	Piplipara	6.28	8.23	Dry	Dry	P
18.	Talsingh	Jhayara	5.60	11.27	4.34	7.21	PB
19.	Karru	Jhayara	5.80	7.00	Dry	Dry	PB
20.	Chandan	Kachla	5.60	10.20	Dry	Dry	P
21.	Bhura	Amarpura	5.35	7.00	2.23	4.19	P
22.	Vasna	Runkhera	3.85	7.65	Dry	Dry	P
23.	Kaliya	Pipliya	5.40	8.61	Dry	Dry	P

24.	Somla	Lshgarh	4.30	9.60	5.20	8.32	P
25.	Sakra Parmar	Gundipara	4.50	8.21	2.00	4.22	PB
26.	Vasta	Manpur	5.52	8.10	Dry	Dry	PB
27.	Raju	Khutawa	4.68	7.30	Dry	Dry	P
28.	Pema	Khankharkheri	6.42	9.32	5.42	8.00	PB
29.	Governmen	Bhagaur	5.52	10.36	Dry	Dry	P
30.	Kalu lal	Bhendarlya	8.23	9.21	4.13	7.22	P
31.	Dinesh	Barorh	5.81	8.31	Dry	Dry	PB
32.	Vasna	Bijalpur	5.66	12.00	3.22	6.15	PB
33.	Surtain Maida	Kankradongra	5.81	10.56	Dry	Dry	P
34.	Kapil	Dhebar	4.30	6.00	2.32	4.00	P
35.	Babu	Ejanpura	5.81	12.10	Dry	Dry	P
36.	Dinesh	Bhagaur	4.50	12.15	Dry	Dry	PB
37.	Nirach	Bhagaur	4.07	14.30	5.25	8.35	PB
38.	Lalsingh	Kesariya	3.80	10.62	6.23	8.21	P
39.	Rupsingh	Nawapara	5.54	11.35	Dry	Dry	P
40.	Ramesh	Rampura	6.42	6.65	2.00	3.18	P
41.	Government	Dhebar	3.85	7.00	3.05	5.21	P
42.	Madu	Junwaniya	7.00	9.21	6.50	8.32	P
43.	Bhura	Nawapara	6.30	8.35	2.10	4.50	PB
44.	Ramu Parmar	Gopalpura	4.57	9.35	4.13.	7.00	P
45.	Kisanlal	Sandla	3.85	9.25	Dry	Dry	PB
46.	Indu	Amlipathor	6.15	7.60	3.25	5.00	PB
47.	Goralal	Kheri	6.15	9.35	Dry	Dry	P
48.	Ratan	Kalyanpura	5.81	8.25	5.40	7.12	P
49.	Bilwaliya	Junwaniya	3.75	5.27	4.20	5.00	P
50.	Ramla	Khrmal	4.32	7.15	Dry	Dry	P
51.	Ram Damor	Hirakhadan	7.16	16.61	Dry	Dry	P
52.	Tolya	Lahoriya	8.00	7.66	4.30	6.21	P
53.	Government	Barlipara	4.88	11.00	Dry	Dry	P
54.	Devla	Mokhari	4.50	9.10	Dry	Dry	P
55.	Jabran	Mauripara	5.35	9.25	7.42	9.10	PB
56.	Sankar	Gulabi	4.50	15.61	Dry	Dry	PB
57.	Buda	Bhamarda	6.00	9.20	Dry	Dry	P
58.	Gajraj	Barkhera	3.35	6.25	4.00	5.17	P
59.	Birma	Dhavaripara	7.00	11.15	Dry	Dry	PB
60.	Anil Barmar	Bisauli	3.85	6.12	Dry	Dry	P
61.	Pidia Damor	Dhavaripara	6.30	9.21	6.00	7.25	PB

Abbreviation: P = Pulleu B = Bucket

2.2 WELL DATA ANALYSIS

The hydrogeological data in respect of 61 dug wells during post and pre monsoon have been recorded and analyzed. The analysis of well data is given below.

[A] Diameter of Dug wells

The analysis of diameter of 61 dug wells examined in Meghnagar area reveals a range from 3.35 m (Barkhera) to 8.23 m.(Bhendarlya) displayed herein (Table 3). The lowest diameter range of 3-4 has been observed in 7 dug wells constituting 11.4 % of total wells. The 5 wells of large diameter are within the range of 7-9 m constituting 8. 18% of total dug wells (Table 3 Figure 3). The maximum numbers of 40 wells are within the diameter range of 4-6 m.

Table 3: Diameter measurement of dug wells of the study area

S. No.	Diameter range (m)	No. of wells	Percentage (%)
1.	03-04	7	11.47
2.	04-05	20	32.78
3.	05-06	20	32.78
4.	06-07	09	14.75
5.	07-08	03	04.91
6.	08-09	02	03.27
	Total	**61**	**99.96**

Figure 3: A view of large diameter open dugwell located near Dhebar.

[B] Total depth of wells

The wells show a range of depth from 5.27 to 16.61 m. b.g.l. (Table 4). The measured values of well depth reveal that the maximum numbers of wells have a depth range from 9 to 10 m. b.g.l. forming 26.22% of total examined wells. Dug wells having a maximum depth range of 16-17 m. are rare in the study area. (Table 4)

Figure 4: A view of total depth of open dugwell located near Balban.

Table 4: Total depth of dug wells in Meghnagar study area, Jhabua.

S. No.	Total depth range of well (b.g.l.)	No. of wells	Percentage (%)
1.	05-06	01	01.63
2.	06-07	05	08.19
3.	07-08	14	22.95
4.	08-09	09	14.75
5.	09-10	16	26.22
6.	10-11	05	08.19
7.	11-12	04	06.55
8.	12-13	04	06.55
9.	13-14	00	00
10.	14-15	01	01.63
11.	15-16	01	01.63
12.	16-17	01	01.63
	Total	**61**	**99.92**

[C] Depth of static water levels

The pattern of variation in groundwater levels was observed on the basis of static water level data collected from the observation well during the post- and pre-monsoon periods (Table 5 Figure 5).

Figure 5: Photograph showing a view of open dug well located at Antarbeliya, Meghnagar, Jhabua District, M.P.

The variation analysis of water levels recorded from the observation wells during post and pre-monsoon intervals indicate a fluctuation range from 0.08 to 4.71 m. b.g.l. The analysis indicates that out 30 observation wells, four wells indicate seasonal fluctuation of static water levels within the range of 3-5 m.b.g.l.

3. GROUND WATER MOVEMENT

Ground water exploration programme involves determination of the trend of ground water movement in study area of investigation. In present study, the ground water flow direction has been interpreted with the help of ground water level contours maps (Figure 7, 8) constructed on the basis of record of static water level measurements carried out during post-monsoon and pre-monsoon intervals.

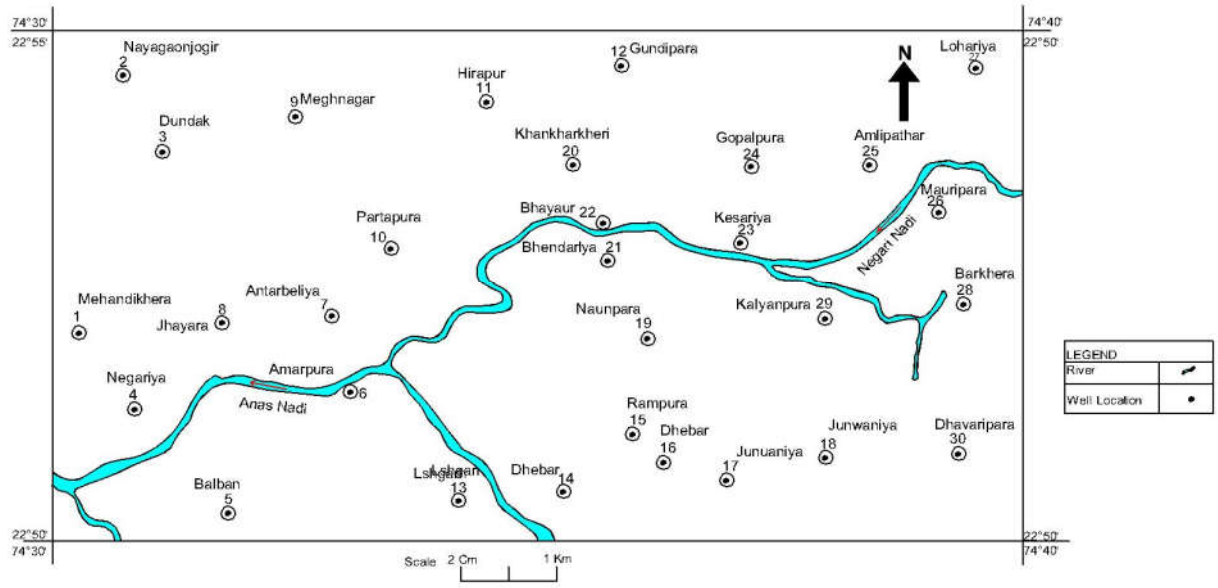

Figure 6: Location map of Observation wells in Meghnagar study area, Jhabua district, M.P.

Table 5: Observation well data of Meghnagar study area, Jhabua district, M.P.

S. No	Observation Well	Bench Mark (m)	Post-Monsoon (m)	Pre-monsoon (m)	Reduced level Post - Monsoon	Reduced level Pre-monsoon (m)	Fluctuation (m)
1.	Mehandikhera	295	5.31	7.40	289.69	287.06	2.63
2.	Nayagaonjagir	299	4.65	6.28	294.35	292.72	1.63
3.	Dundak	300	5.13	6.23	294.87	293.77	1.11
4.	Negoriya	290	3.32	6.20	286.68	283.08	3.06
5.	Balban	280	4.21	8.20	275.79	271.08	4.71
6.	Amarpura	282	2.23	4.19	279.77	277.81	1.96
7.	Antarbeliya	299	5.25	7.03	293.75	291.97	1.78
8.	Jhayara	285	4.34	7.21	280.66	277.79	2.87
9.	Meghnagar	320	3.25	5.35	316.75	314.65	2.1
10.	Partappura	301	4.00	6.19	297.00	292.68	4.32
11.	Hirapur	317	2.65	4.15	314.35	312.85	1.5
12.	Gundipara	320	2.00	4.22	318.00	315.78	2.22
13.	Ishgarh	300	5.20	8.32	294.08	291.68	2.4
14.	Dhebor	301	2.32	4.00	298.68	297.00	1.68
15.	Rampura	320	2.00	3.18	318.00	316.82	1.18
16.	Dhebar	305	3.05	5.21	301.95	299.79	2.16
17.	Junwaniya	320	6.50	8.32	313.05	311.68	1.37
18.	Junwaniya	390	4.20	5.00	385.08	385.00	0.08
19.	Nawapara	300	2.10	4.50	297.09	295.05	2.04
20.	Khnkharkheri	318	5.42	8.00	312.58	310.00	2.58
21.	Bhendarlya	324	4.13	7.22	319.87	316.78	3.09
22.	Bhagaur	318	5.25	8.35	312.75	309.65	3.10
23.	Kesariya	325	6.23	8.21	318.77	316.79	1.98
24.	Gopalpura	331	4.13	7.00	326.87	324.00	2.87

25.	Amlipathar	332	3.25	5.00	328.75	327.00	1.75
26.	Mauripara	320	7.42	9.10	312.58	310.09	2.49
27.	Lohariya	340	4.30	6.21	335.07	333.79	1.28
28.	Barkhera	340	4.00	5.17	336.00	334.83	1.17
29.	Kalyanpura	324	5.40	7.12	318.06	316.88	1.18
30.	Dhavaripara	385	6.00	7.25	379.00	377.75	1.25

3.1 Post-Monsoon Ground water Level Contour Map

Ground water level contour map for the post-monsoon period has been prepared on basis of static water level measurement carried out on the observation wells during post-monsoon. (Table 5, Figure 7). The direction of ground water flow has been inferred on the basis of dropping perpendiculars from higher water level contour lines to lower water level contour lines. The contour lines indicating direction of ground water flow have been revealed on the ground water level contour maps by the symbol arrows. The examination of ground water contour map (Figure 1.7) reveals nature of ground water level contours reflecting the trend of ground water extraction. Ground water contours in the North-Western area reveals different trend the ground water level Nayagaonjagir, Hirapur, Mehandikhera, and Jhayara Ground water level contour of widely spaced indicates a very good condition for ground water exploration. In Mehandikhera, contours are fairly spaced indicating good condition of ground water in Jhayara and Meghnagar sector. The contours, which are nearly spaced, indicate poor ground water potential sites in Meghnagar town area. The ground water level contours are closely spaced pointing out poor condition. Ground water contours in the area of Patipura there are indicating good ground water condition. In the North-Eastern sector, the trend of ground water level contours is similarities different the ground water level contours are widely spaced it Rampura, Bhagaur, Gopalpura, Amlipathar, and Lohariya the ground water contour levels indicate good condition for ground water, Near Mauripura, ground water level contours are closely spaced indicating poor condition of ground water potential. In south-west sector, Negariya, and lshgarh area, the ground water contours are ferly widely spaced indicating good condition of ground water. In South-East sector, ground water level contours are indicating poor condition of ground water potential in general, however the Barkhera, Dhavoripara, Junwaniya and Nawapara the contours are indicating fairly good condition of ground water potential. The nature of ground water level contour trend is helpful in the selication of favourable ground water potential locations.

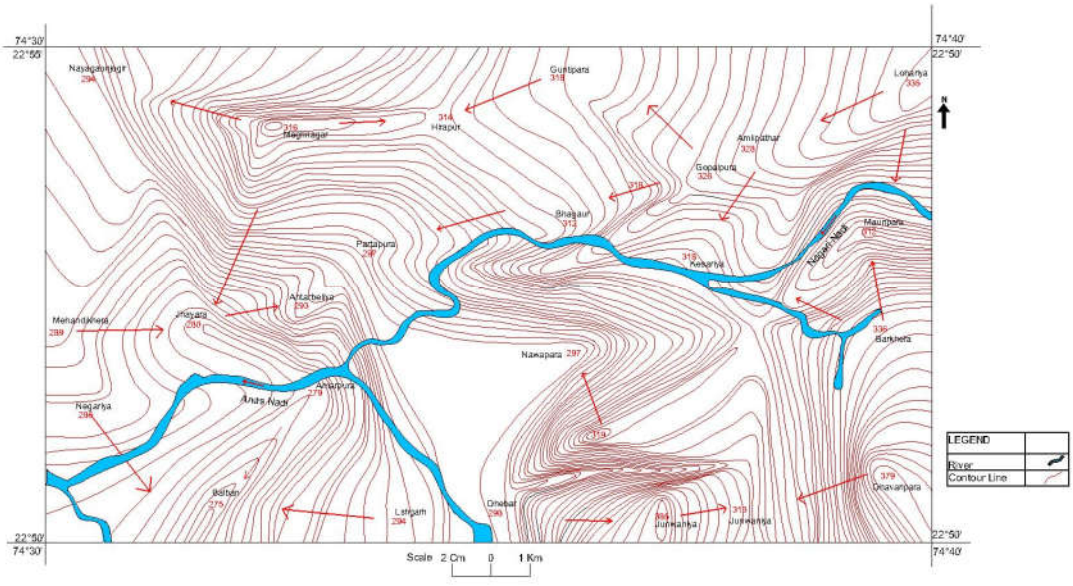

Figure 7: Ground water level contour map of study area during post-monsoon.

3.2 Pre-monsoon ground water level contour map

The pre-monsoon ground water level cotour map is showing rather different condition in the nature of ground water level contours observed during post-monsoon period. The changes are observed in North-West, North-East, South-East and South-West sector in the nature of spacing of contour levels. Pre-monsoon ground water level contour map indicates that the widely and fairly spaced contour point out good potential sits at Negariya, Mehandikhera, Hirapur, Guntipara, Gopalpura, Amlipathar, Lohariya, Barkhera, and Balban. In general, the pre-monsoon ground water level contour map indicates fluctuation in the nature of ground water contours reflecting less potential of favourable ground water location as compared to post monsoon periods.

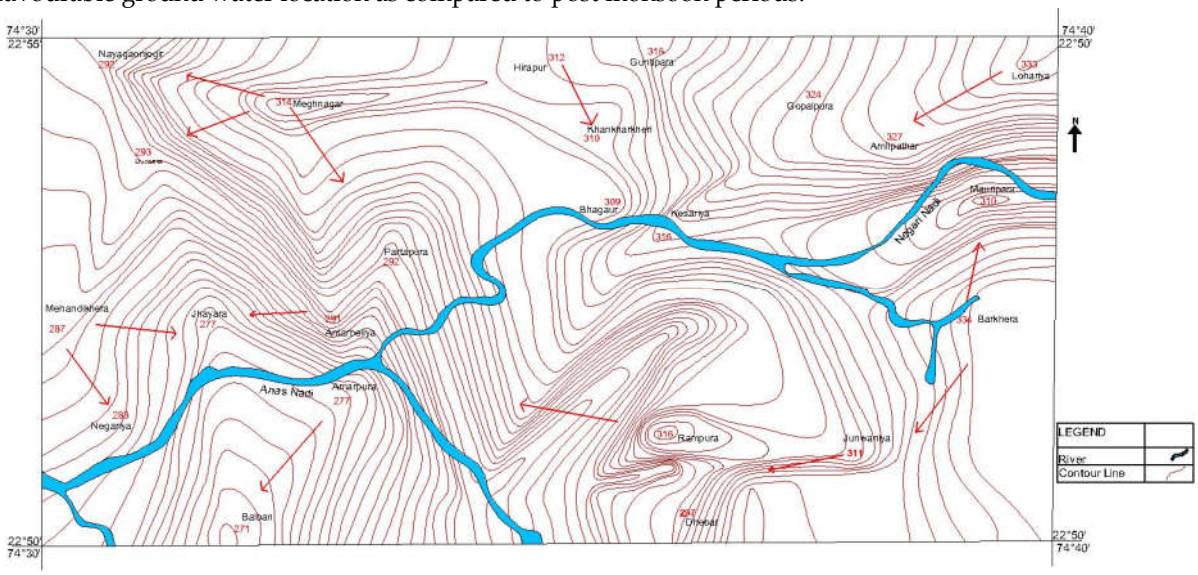

Figure 8: Ground water level control map of study area during pre-monsoon.

4. FLUCTUATION ANALYSIS OF GROUND WATER LEVELS

The fluctuation of ground water levels in study area has been observed by monitoring the post-monsoon and pre-monsoon ground water levels. Seasonal variation in static water levels is normally caused by the trend of rainfall, nature of topography and increase on decrease of the water levels (Davis and De Wiest, 1966). The water table fluctuations have been assigned to the following four basic types

- Fluctuation due to owing to change in ground storage.
- Fluctuations caused by atmosphere pressure in contact with the water surface in wells.
- Fluctuations resulting due to deformation of aquifers and,
- Fluctuations as a result of disturbance within the well.

Table 6: Variation range of ground water levels in study area

S. No.	Fluctuation Range (m.)	No. of well	Percentage (%)
1.	0-1	01	03.33
2.	1-2	14	46.66
3.	2-3	10	33.33
4.	3-4	03	10.00
5.	4-5	02	6.66
	Total	**30**	**99.98**

The analysis of ground water level fluctuation during post-monsoon and pre-monsoon static water levels in dug wells indicate a fairly good range of fluctuation from 0.08m (Junwaniya) to 4.71 m (Balban).

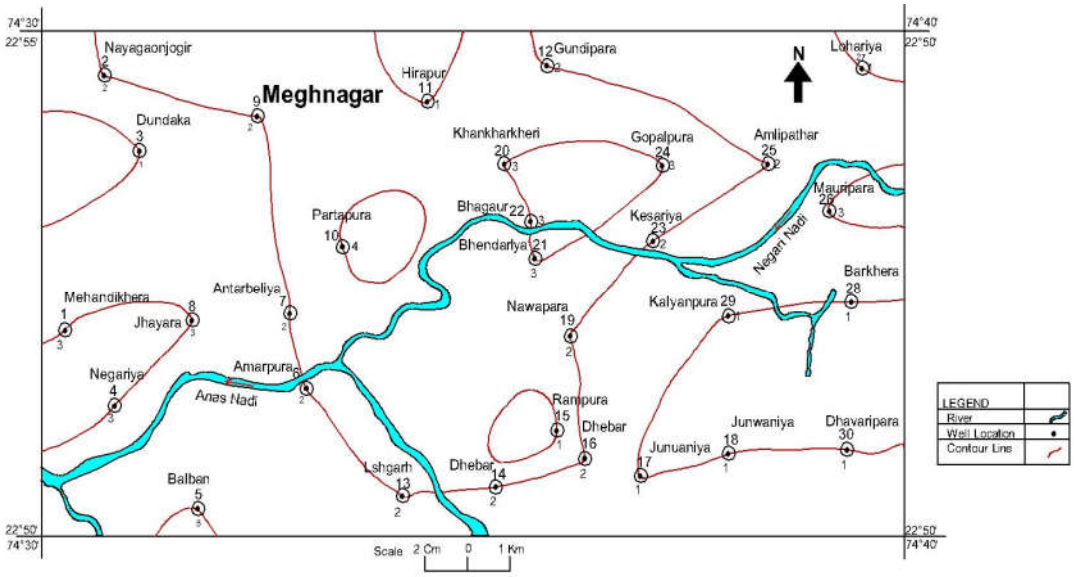

Figure 9: Fluctuation map of ground water levels during Post- and Pre-monsoon periods of the Meghnagar study area.

The seasonal fluctuation analysis of ground water levels indicate a minimum range from o -1 m having only one well constituting 03.33 % .The maximum fluctuation range of 4-5 m has been exhibited by 2 wells making 6.66 %. The majority of 14 dug wells reflect the fluctuation range of 1-2 m representing 46.66 %. The wells revealing low fluctuation value indicate very good ground water potential for constructing a new dug well.

5. CONCLUSION

The study reveals that conventional well inventory process is of very help occupied for demarcations of ground water potential sites. Meghnagar study area of Jhabua District of Madhya Pradesh is facing the problem of sensitive scarcity of water provide particularly during the period from January to June. The identified localities for construction of open dug wells are in Rampura, Bhagaur, Gopalpura, Amlipathar, and Lohariya villages indicating ground water potential sites in study area.

AKNOWLEDGMENTS

Authors are extremely indebted to the authorities of Vikram University, Ujjain, to provide research amenities. One of the authors (D. Nigwal) is obliged to Government of India for the award of Rajeev Gandhi National Fellowship. The present paper forms a part of the Ph.D. Thesis (Nigwal, 2019). The obligation is recorded to all the family members for their support. We are thankful to a galaxy of Professor, Lectures, Research scholars, and Staff members of the Vikram University, Ujjain.

REFERENCES

[1]. A.PH.A. (American Public Health Association), 1998 : Standard Methods for the examination of water and wastewater, 19th edition APHA, Washington D. C. USA.

[2]. Davis, S.N. and De Wiest, R.J.M., 1966. Hydrogeology. John Wiley and Sons, New York, 463. p.

[3]. Fetter, C.W., 1988. Applied hydrogeology. Merrill Publ. Co., A. Bell Howell Information Co., Columbus, U.S.A, 529 p.

[4]. Karanth, K.R., 2003. Groundwater assessment, development and management. Tata Mc-Graw Hill Publ. Co. Ltd. New Delhi, 696 p.

[5]. Nigwal, D. (2019). A Study on Exploration and Management of Ground water Resource Around Meghnagar, Jhabua District, Madhya Pradesh, Vikram University, Ujjain, Unpublished Ph. D. Thesis, 145 p.
[6]. Raghunath, H. M. (1985): Ground Water, Wiley Eastern Limited, New Delhi, 456 p
[7]. Todd, D.K., 1959. Ground water hydrology. JohnWiley and Sons,New York, 336 p.
[8]. T odd, D.K., 1980. Groundwater Hydrology. John Wiley and Sons, Inc., New York, 287 p.
[9]. Todd, D.K. (2001): Groundwater Hydrology. John Wiley and Sons Publication, Canada (P .280-281).
[10]. Todd, D. K. (2010): Groundwater Hydrology. John Wiley and Sons New York 527p.