Bulletin of Pure and Applied Sciences
Geology (Geological Science), Vol.42F, No.2,
July-December 2023: P.201-210
Original Research Article

Print version ISSN 0970 4639
Online version ISSN 2320 3234
DOI: 10.48165/bpas.2023.42F.2.3
Available online at www.bpasjournals.com

Hydrological Analysis of Khargone Area, Khargone District, Madhya Pradesh, India

[1]Lal Singh Solanki*, [2]Sujata Salve and [3]Dayaram Solanki

Author's Affiliations:
[1]Assistant Professor, Dept. of Geology, Jata Shankar Trivedi Govt. P G College, Balaghat, Madhya Pradesh 481001 India.
[2]Assistant Professor, Dept. of Geology, Jata Shankar Trivedi Govt. P G College, Balaghat, Madhya Pradesh 481001 India.
[3]School of Studies in Earth Science, Vikram University, Ujjain, Madhya Pradesh 456010 India.

***Corresponding Author:** Lal Singh Solanki, Assistant Professor, Dept. of Geology, Jata Shankar Trivedi Govt. P G College, Balaghat, Madhya Pradesh 481001 India.
E-mail: solankilalu@gmail.com

(Received on 18.05.2023, Revised on 18.08.2023, Approved on 22.08.2023, Accepted on 09.09.2023, Published on 15.12.2023)

How to cite this article: Solanki L.S., Salve S. and Solanki D. (2023). Hydrological Analysis of Khargone area, Khargone District, Madhya Pradesh, India. *Bulletin of Pure and Applied Sciences- Geology,* 42F(2), 201-210.

Abstract:
The paper is focused on hydrogeological analysis Khargone area, Khargone District, Madhya Pradesh, India. The study area typically consists of basalt rock formations dating from the Late Cretaceous to the Paleocene era of the Deccan Traps. The alluvium is clearly visible along the Kunda River's course. The hydrogeological examination of 70 open dug wells reveals well diameter range between 3 meters and 9 meters, Depth of well within the range of 6-7 m.b.g.l. Static water levels ranged from 1 m. to 17 m.b.g.l. The fluctuation ranges between 2 to 12 m respectively. The ground water level maps of post and pre monsoon periods indicate that in general the ground water movement is towards the kunda River. The suitable sites for ground water development have been suggested in the villages of Nangalda, Ibrampura, Thibgaon Khurd and Dongargaon.

Keywords: *Hydrogeological Analysis Kunda River, Well Diameter, Depth Of Well, Static Ground Water Level Maps of Post and Pre Monsoon Periods Water, Khargone District, Madhya Pradesh, India.*

INTRODUCTION

The study of the distribution and movement of groundwater beneath the soil and rocks that make up the Earth's crust is known as hydrogeology. The term hydrogeology used for the first time in 1880. The study of groundwater is part of Hydrogeology, a branch of Earth Science that is concerned with the development and management of groundwater resources. A groundwater program in the specific area includes investigations regarding its occurrence, exploration, extraction, quantity, quality and management, (Davis and De Wiest 1966). According to Todd (1959, 1980), hydrogeology is the study of the occurrence, distribution, and movement of groundwater under the surface of the earth. Pinker, E.V. (1983) defines hydrogeology as "not underground, but rather the water-bearing system of the earth's crust and the processes that occur within it to allow the subsurface hydrosphere to exist". According to Tolman, C.F. (1937), He defined hydrogeology as "a synthesis of all the sciences, in which geology has the greatest significance for studying subsurface water". Groundwater beneath the soil and rocks of the Earth's crust.

STUDY AREA

Location and Physiographic Features of Study Area:

The present study Khargone area is situated in the Khargone district. Khargone district lies in between longitude E 74^0 25' to 76^0 15' and latitude N 21^0 30' to $22^0$35'. It occupies a space of roughly 13485 sq. km. and situated on the south western boundary of Madhya Pradesh. The proposed study area is confined to latitude 21^0 50' 0'' to 21^0 55' 0'' N and longitude 75^0 35' 0'' to 75^0 45' 0'' E (Survey of India Toposheet No.46O/9). The study area is 159.97 sq. km.

The study area is composed of flat terrain with gentle slope, which consists of basaltic lava flows. The topography of district and command area is undulated as well as plains. Some of undulating lands are surrounded by forested hillocks. The variation of slopes in undulating area is from 3% to 10%. The climate is tropical to sub- tropical. The average annual temperature is recorded as 25^0C. Temperature becomes maximum during April and May as 47^0C. The annual average rainfall varies between 600 to 832.5 mm. Maximum rainfall was recorded at 330.4 to1130.1 mm. A rainfall average of 751.93 millimeters.

In the study area, three types of soils e.g., Black cotton soil, Alluvium soil, and red bole are observed.

Geology of Study Area:

Basaltic lava flows of Deccan trap occupy a major part of area in the district. They have been classified into two groups viz. To the north and south of the Narmada River, respectively, are the Malwa and Satpura Groups. The Narmada valley delineates a contact between these two groups. The Malwa Groups include a total of 40 basaltic flows, majority of the flow of an Aa type while few are of compound pahoehoe type.

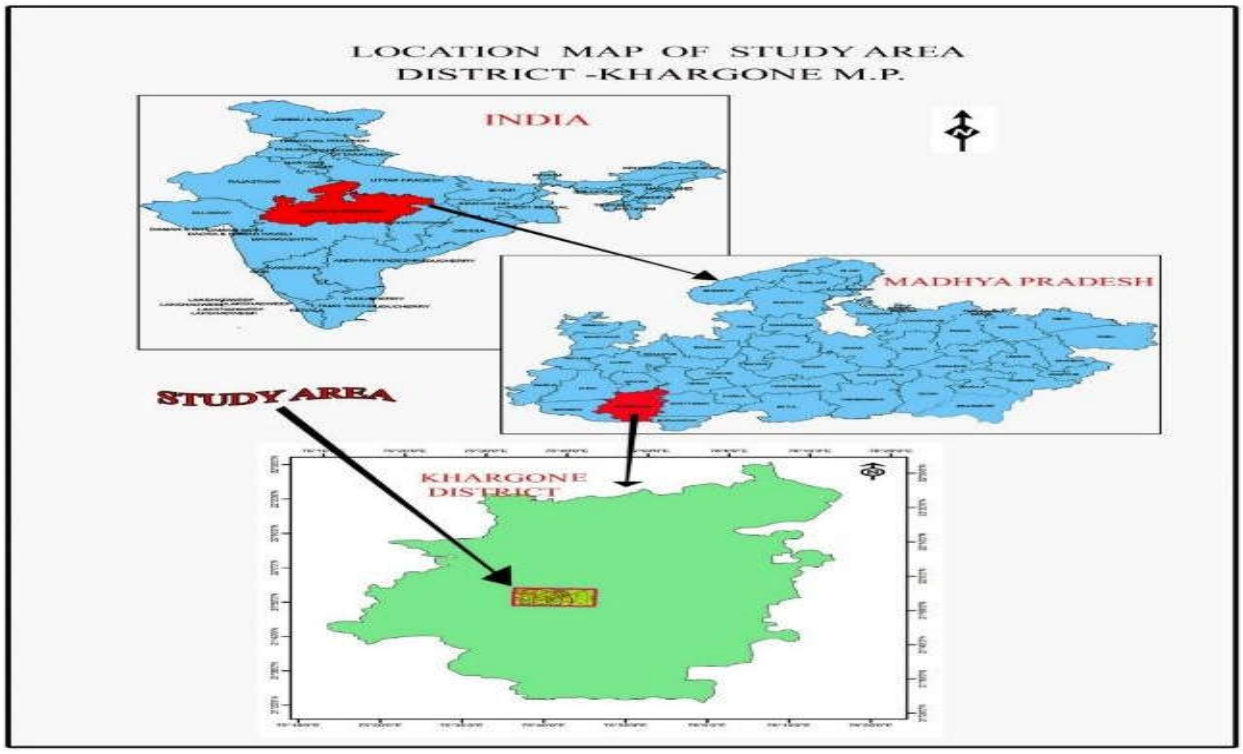

Figure 1: Location map of study area Khargone district M.P.

Hydrogeological Survey of Study Area:

In the Khargone study area, a systematic hydrogeological survey was conducted to characterize existing wells. The next step in the investigation is the well inventory, which is an extensive investigation of the wells. Examining different types of wells located in the study area is part of this process. Data have been collected from 70 open-dug wells by recording information regarding the well location, name of the village, owner, benchmark, type of well, and measurements of the well diameter, depth, static water levels, and mode of lifting the water. The study area is 159.97sq. km. In around Khargone town (Survey of India Toposheet No.46O/9), Khargone district, Madhya Pradesh. 70 open dug well have been inventoried during the months of October 2014 and April 2015. The detailed well inventory includes recording of the location of well, type of well, diameter of well, total depth of well, static water level, and mode of water lifting water (Table 1). The water level measurements in open dug wells, were taken up during post-monsoon (October, 2014) and pre-monsoon (April, 2015) periods to observe the seasonal variations in water levels to study the movement of ground water by preparing water level contour maps for different seasons. (Figure 2, Table 1).

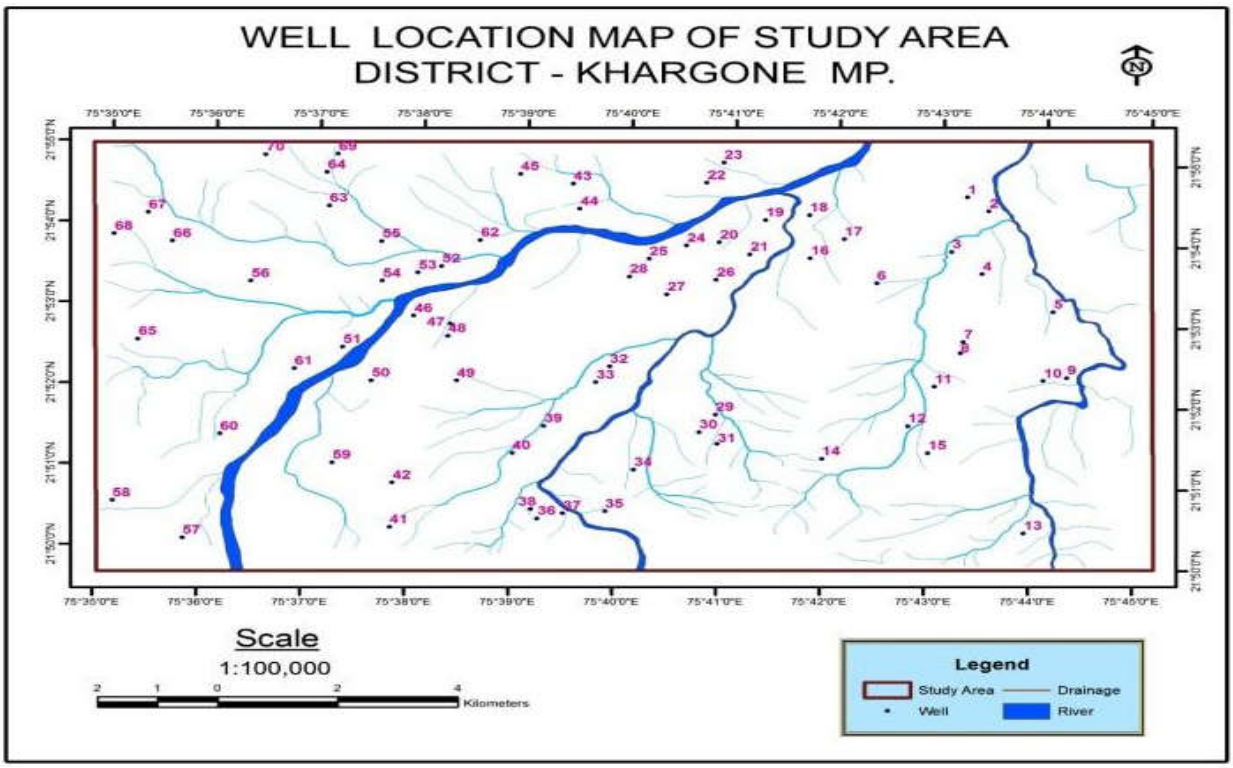

Figure 2: Well location map of study area Khargone district M.P.

Table 1: Showing the detailed the well inventory and water level fluctuation of Khargone Area, Khargone district, Madhya Pradesh

S.N.	Name of the village	Owner name of well	Ground level (m.) AMSL	Total depth of well (MBGL)	Diameter of well (in m)	Post - Monsoon		Pre - Monsson		Fluctuation	Uses D/I
						Static Water level (m.b.g.l.)	Reduced water level (m.b.g.l.)	Static Water level (m.b.g.l.)	Reduced water level (m.b.g.l.)		
1	Surpala	Dinesh	226	9.10	6.90	2.98	223.02	8.00	218.00	5.02	I
2	Surpala	Govt.Well	226	6.20	3.80	0.96	225.04	3.12	222.88	2.16	D
3	Surpala	Narayan Soni	223	10.00	5.00	2.00	221.00	7.88	215.12	5.88	I
4	Vaijapur	Ibrahim	230	11.00	5.00	4.96	225.04	9.86	220.14	4.90	I
5	Vaijapur	Kailash	230	7.90	5.80	3.00	227.00	3.98	226.02	0.98	I
6	mausampura	Rajendra	220	16.00	6.90	2.00	218.00	4.97	215.03	2.97	I
7	Kharda	Kailash	220	14.00	6.80	3.98	216.02	6.97	213.03	2.99	I
8	Kharda	Shobharam	221	12.00	8.00	4.84	216.16	9.98	211.02	5.14	I
9	Mohhamdpur	Jashvant	222	13.90	9.00	5.00	217.00	9.00	213.00	4.00	I
10	Mohhamdpur	Ashok	220	12.10	6.90	3.91	216.09	8.93	211.07	5.02	I
11	Jamniya	Monsingh	220	11.20	4.80	2.13	217.87	5.00	215.00	2.87	I/D
12	Jamniya	Krishna	226	10.00	5.00	2.11	223.89	3.97	222.03	1.86	I
13	Balapur	Govt.Well	226	9.80	3.00	2.97	223.03	7.82	218.18	4.85	D
14	Gavari	Mohan	226	12.00	7.10	2.00	224.00	4.95	221.05	2.95	I
15	Gavari	Ratan	220	10.00	4.20	1.14	218.86	4.00	216.00	2.86	I
16	Kundiya	Govt.Well	220	9.10	3.00	2.92	217.08	9.62	210.38	6.70	D
17	Kundiya	Anaadram	223	16.00	5.00	4.00	219.00	8.84	214.16	4.84	I/D
18	Ibrampura	Ramesh	223	17.40	6.50	3.14	219.86	8.34	214.66	5.20	I
19	ThibgaonKhurd	Gopal	220	17.00	4.30	2.34	217.66	7.33	212.67	4.99	I
20	ThibgaonKhurd	Totaram	221	13.00	4.00	5.00	216.00	9.87	211.13	4.87	I
21	TibgoanKhurd	AmbaramGopal	221	11.00	5.20	5.15	215.85	9.92	211.08	4.77	I
22	Nangalda	Bhagirath	223	15.00	4.10	3.93	219.07	7.84	215.16	3.91	I
23	Nangalda	Anok	223	14.70	5.30	3.12	219.88	15.70	207.30	12.58	I
24	Dongargaon	Ramlal	222	20.00	6.10	0.95	221.05	11.60	210.40	10.65	I
25	Dongargaon	Shivram	223	1.008	4.90	2.44	220.56	3.60	219.40	1.16	I
26	Dongargaon	Anvar	223	10.70	4.00	2.32	220.68	3.40	219.60	1.08	I
27	Dongargaon	Omprashad	223	10.60	6.00	3.13	219.87	10.7	212.30	7.57	I
28	Dongargaon	Mansur	223	14.00	4.80	2.17	220.83	3.00	220.00	0.83	I
29	Baijalgaon	Parasram	223	12.00	5.30	1.97	221.03	11.00	212.00	9.03	I
30	Baijalgaon	Bhagwan	220	27.00	3.90	2.35	217.65	6.10	213.90	3.75	I
31	Baijalgaon	Shobharam	220	9.90	6.10	2.98	217.02	6.98	213.02	4.00	I
32	Bari Bir	Shubhash	220	14.00	5.00	3.15	216.85	6.80	213.20	3.65	I
33	Bari Bir	Shubhashke pass	220	12.00	5.90	3.00	217.00	4.96	215.04	1.96	I
34	Sonipura	Ramesh	220	15.00	6.80	1.13	218.87	4.80	215.2	3.67	I
35	kheri	Govt.Well	220	9.90	6.00	2.12	217.88	6.00	214.00	3.88	D
36	Sonipura	Balram	220	8.10	7.10	2.00	218.00	4.97	215.03	2.97	I
37	Sonipura	Ramshyam	220	11.00	4.30	1.00	219.00	3.30	216.70	2.30	I
38	Sonipura	Arjun	220	9.70	4.10	2.15	217.85	6.40	213.60	4.25	I
39	Balvori	Sohan	220	9.80	3.30	3.44	216.56	5.20	214.80	1.76	D
40	Balvori	Gokul	220	11.00	5.00	4.24	215.76	6.20	213.80	1.96	I
41	Jaitapura	Ganpat	226	12.00	7.00	3.11	222.89	5.10	220.90	1.99	I
42	Jaitapura	Govind	220	11.70	6.90	2.00	218.00	4.97	215.03	2.97	I
43	Avarkacch	Ramesh Patel	220	12.80	7.10	3.00	217.00	8.70	211.30	5.70	I
44	Avarkacch	Ganpat	221	12.00	3.90	2.10	218.90	4.96	216.04	2.86	I
45	Avarkacch	Gopal	221	9.00	6.30	1.30	219.70	4.10	216.90	2.80	I
46	MangrulKhurd	Kaluram	220	9.80	5.10	3.70	216.30	9.00	211.00	5.30	I
47	MangrulKhurd	Anita	220	13.00	5.20	2.87	217.13	9.70	210.30	6.83	I
48	Mangrul Buzurg	Gajendra	220	12.00	3.80	4.97	215.10	11.30	208.70	6.40	I

49	Chhoti Bir	Sanjay	220	13.10	3.70	3.00	217.00	12.10	207.90	9.10	I
50	Mangrul Buzurg	Gangaram	220	15.10	6.90	4.40	215.60	12.30	207.70	7.90	I
51	Bhadli	Hariom	220	16.00	8.00	3.32	216.70	14.20	205.80	10.9	D/I
52	Navalpura	Bhagirath	221	16.20	4.00	2.12	218.88	12.80	208.20	10.68	D/I
53	Navalpura	Chogalal	220	15.00	3.70	1.14	218.86	10.60	209.40	9.46	D/I
54	Navalpura	Dinesh	220	14.00	4.10	2.85	217.15	15.00	205.00	12.15	I
55	Borgoan	Gopal	230	17.00	5.80	1.98	228.02	5.94	224.06	3.96	I
56	Piprata	Sitaram	220	13.70	4.90	2.12	217.88	4.40	215.60	2.28	D/I
57	Sukhpuri	Laxman	220	12.20	4.10	2.23	217.77	7.00	213.00	4.77	D
58	Sukhpuri	Kasiram	220	9.00	4.20	2.30	217.70	6.20	213.80	3.90	I
59	Sukhpuri	Madan	220	8.90	5.00	0.98	219.02	6.10	213.90	5.12	I
60	Bhadli	Ram	220	7.80	4.90	1.00	219.0	6.00	214.00	5.00	I
61	Bhadli	karan	220	8.00	3.80	0.80	219.20	4.10	215.90	3.30	D/I
62	Bhulgaon	Mahesh	230	7.00	4.00	2.00	228.00	8.30	221.70	6.30	D/I
63	Bhulgaon	Kailash	230	12.00	5.00	1.62	228.38	6.00	224.00	4.38	I
64	Rahimabad	Sitaram	230	9.70	3.90	1.71	228.29	5.80	224.20	4.09	I
65	Beriya	Vinod	230	8.80	3.70	1.63	228.37	5.10	224.90	3.47	I
66	Mangaonn	Rakesh	230	8.00	6.00	3.00	227.00	6.70	223.30	3.70	I
67	Gopalpur	Rakesh	230	11.00	5.00	2.25	227.75	6.00	224.00	3.75	D/I
68	Gopalpur	Ramesh	230	9.70	3.70	1.75	228.25	5.10	224.90	3.35	I
69	Nimgul	Jagan	230	9.00	4.90	1.72	228.28	6.30	223.70	4.58	D/I
70	Nimgul	Ramu	230	8.90	4.80	2.97	227.03	4.20	230.00	1.23	I

Abbreviation: MBGL = Meter Below Ground Level, I = Irrigation, D = Domestic.

DATA ANALYSIS

The hydrogeological data in respect of 70 dug wells have been collected during October, 2014 and April, 2015 (Table 1) and analyzed. The analysis of dug well parameters are given below-

(a) Diameters of Dug wells:

In the Khargone study area, the standard diameter of wells falls between 3 meters and 9 meters, based on the analysis of dug wells. The majority of wells have diameters of 4-5 meters, accounting for 32.85% of all wells. The number of wells within the range of 9 m is 1, representing 1.42 % of the overall number of wells examined (Table 2)

Table 2: Diameter Range of Dug Wells of the Khargone study area

S. No.	Diameter Range (in m)	Number of well	Percentage (%)
1	0-1	-	--
2	1-2	-	--
3	2-3	_	--
4	3-4	03	4.28
5	4-5	23	32.85
6	5-6	20	28.57
7	6-7	10	14.28
8	7-8	11	15.71
9	8-9	02	2.85
10	9-10	01	1.42
Total		**70**	**100**

(b) Total Depth of Well:

In khargone area wells range in depth from 6.8 meters (Surpala) to 27.5 meters (Baijalgaon).6-7 m.b.g.l. is the depth of the well has been observed in one well representing 1.42% of the total examined dug wells. The maximum depth in one well is between 27 and 28 m.b.g.l., making up 1.42%. Within the depth range of 10-11 m.b.g.l. and 12-13 m.b.g.l., a maximum of eleven wells each have been observed, representing 15.71% of the total wells examined in (Table 3).

Table 3: Total Depth of Dug Wells in the Khargone study area

S. No.	Depth Range (in m)	Number of well	Percentage (%)
1	6-7	1	1.428
2	7-8	1	1.428
3	8-9	5	7.142
4	9-10	8	11.428
5	10-11	11	15.714
6	11-12	8	11.428
7	12-13	11	15.714
8	13-14	4	5.714
9	14-15	6	8.571
10	15-16	5	7.142
11	16-17	4	5.714
12	17-18	3	4.285
13	18-19	1	1.428
14	19-20	--	--
15	20-21	1	1.428
16	21-22	--	--
17	22-23	--	--
18	23-24	--	--
19	24-25	--	--
20	25-26	--	--
21	26-27	--	--
22	27-28	1	1.428
Total		**70**	**100**

(c) Static Water Level:

On the basis of static measurements of groundwater levels, the variation in groundwater levels was observed. After monsoon, static water levels ranged from 1 m. (Surpala) to 17 m.b.g.l. (Nangalda) whereas before monsoons, static water levels ranged from 1 m (Gavari, Dongargaon, Sonipura, and other places) to 6 m.b.g.l. (Mangrul Buzurg and Tibgaon Khurd). During the post-monsoon period, it was observed that 13 wells are within maximum number of wells, 13 are within range of 6-7 m.b.g.l. and 18.57% are within range. There are 22 wells within a range of 2-3 m. b. g. l. or 31.42% during the pre-monsoon period. There is a reduction of water levels in dug wells before monsoons as compared to after monsoon. Due to the highly variable nature of this formation, yields are higher in dug wells (CGW Report, 2013, 2014).

Table 4: Analysis of Static Water Level during Post and Pre - Monsoon Period in the Khargone study area

S. No.	Depth Range of Water Level (m b.g.l.)	No. of Dug Wells and their percentage			
		Post- Monsoon		Pre- Monsoon	
		Well Nos.	Percentage	Well Nos.	Percentage
1	1 – 2	14	20	1	1.42
2	2 – 3	22	31.42	--	--
3	3 – 4	19	27.14	4	5.71
4	4 – 5	8	11.42	7	10
5	5 – 6	5	7.14	12	17.14
6	6 – 7	2	2.85	13	18.57
7	7 – 8	--	--	5	7.14
8	8 – 9	--	--	6	8.57
9	9 – 10	--	--	4	5.71
10	10 – 11	--	--	7	10
11	11 – 12	--	--	4	5.71
12	12 – 13	--	--	3	4.28
13	13 – 14	--	--	1	1.42
14	14 – 15	--	--	1	1.42
15	15 – 16	--	--	1	1.42
16	16 – 17	--	--	--	--
17	17 – 18	--	--	1	1.42
Total		**70**	**100%**	**70**	**100%**

Groundwater Level Contour maps:

The contour maps of groundwater are primarily separated into two sections. A pre-monsoon groundwater level map is presented first, followed by a post-monsoon groundwater level map. The groundwater contour maps depend on changes in ground surface water levels and water circulation.

(a) Post-Monsoon Groundwater Level Contour Map:

A contour map of the groundwater level for the Khargone study area for the post Monsoon period (Figure 3) illustrates how the groundwater level changed. According to the findings in the study area, the lowest water level elevation in this area is 216 meters AMSL (Above Mean Sea Level) at the BadiBir village, almost in the north-east part of the Khargone area. Borgoan, village, located in the north of the region, has the highest water level of 228 meters AMSL.

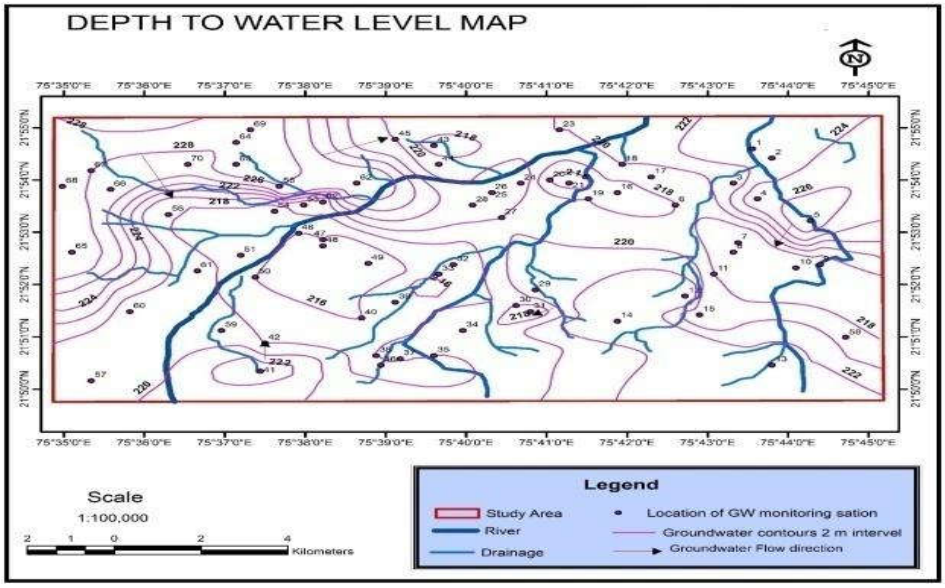

Figure 3: Post-Monsoon Water Level Contour Map of study area, Khargone.

(b) Pre-Monsoon Groundwater Level Contour Map:

On the pre-monsoon period, groundwater contour maps the maximum and minimum contours are Nangalda village, 207 m and Surpala, 225 m respectively (Figure 4). Observations of closed-spaced contour lines as compared to post-monsoon conditions have been observed in the north-east region between Kundiya, Mausampur, and Vaijapur villages following the post-monsoon. According to a comparison of the flow direction of groundwater during pre-and post-monsoon periods, the direction generally stays the same, with a few variations here and their places.

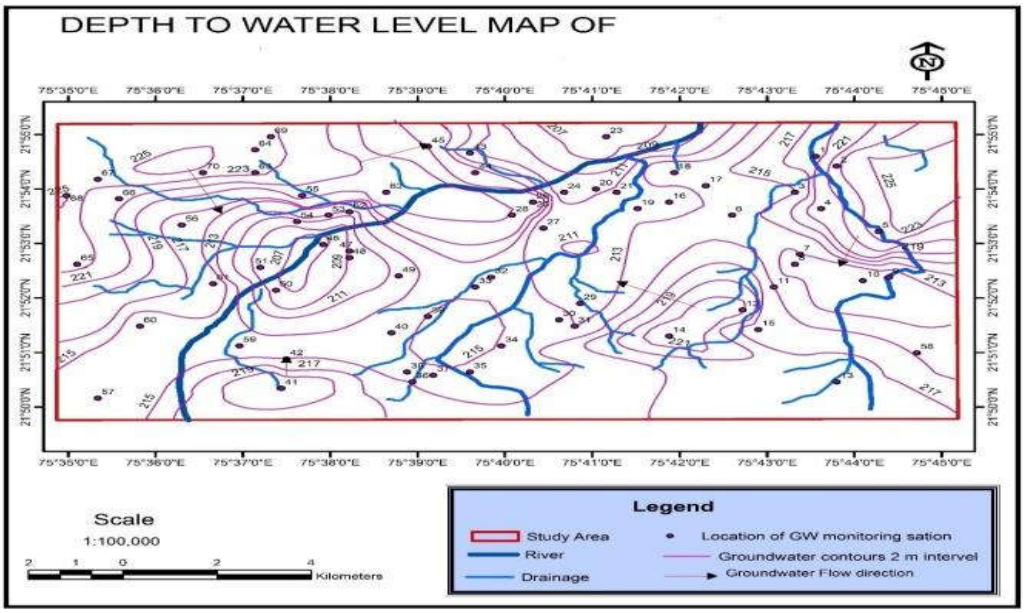

Figure 4: Pre – Monsoon Water Level Contour Map of study area, Khargone.

(c) Groundwater Level Fluctuation:

Based on the characteristics of the study area, the variations in groundwater levels between post and pre-monsoon periods can be attributed to the excess drawl of water (overdraft), the amount and intensity of rainfall, and the nature of the topography. The groundwater level fluctuation map (Figure 5) shows that the fluctuation ranges between 2 to 12 m respectively. Most of the fluctuation is the up north (Nangalda, Ibrampura, Thibgaon Khurd and Dongargaon) and north- west (Piprata, Borgaon, Bhulgaon and Mangrul Khurd) part of the area. The fluctuation range 2-8 is found in Bari Bir, Balvori, Sonipura and Gawari villages.

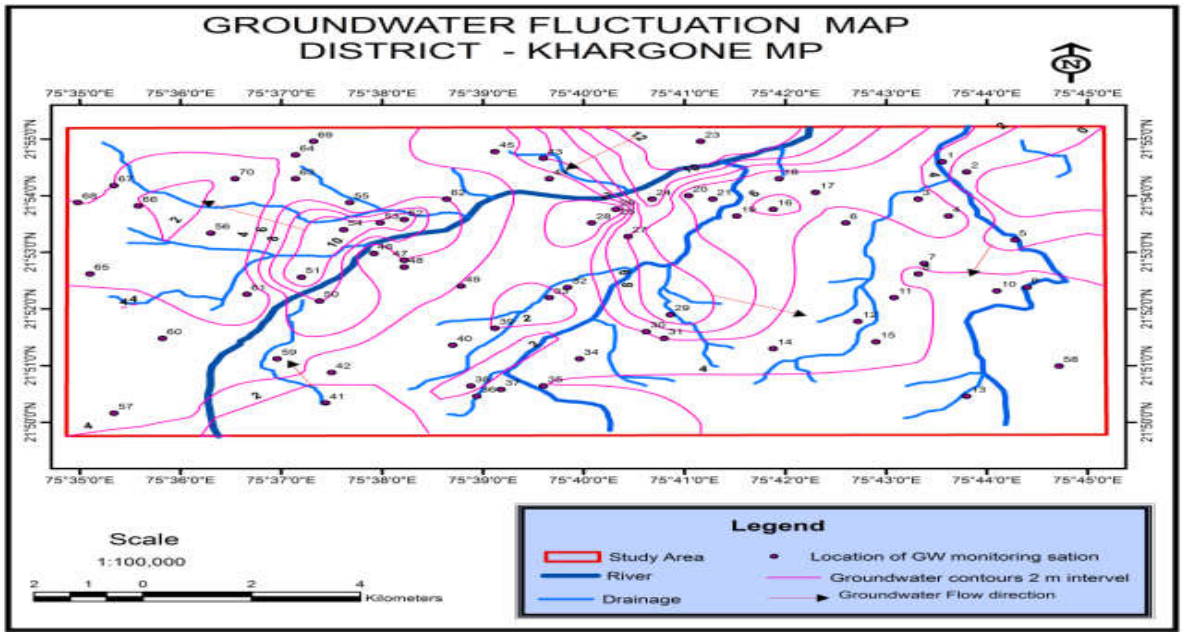

Figure 5: Fluctuation water level contour map of Khargone area.

According to the general topography of the land surface, groundwater is normally directed in a downward direction. Groundwater flow is controlled by the porosity and permeability of rocks. The gravitational force moves the groundwater downwards most commonly.

The author has examined 70 open dug wells for seasonal monitoring during post-monsoon and pre-monsoon periods to observe the trend of ground water movement based on the ground water level contour maps in a particular area, groundwater level contour maps are used to determine the nature of groundwater movement. There are fairly widely spaced contours on the groundwater contour map almost everywhere in the study area, except in the northern and northern-eastern parts of the map in the villages Nangalda, Ibrampura, Thibgaon, Dongargaon, Kundiya, and Mausampur. As shown on the contour map, the south direction of Sonipura, Gawari, and Balapur villages, and the south-western area of Shukhpuri, Bhadii, and Beriya villages highlight the wide-spaced groundwater levels indicative of favorable recharge zones. The movement of groundwater is determined by drawing perpendicular lines from higher-level contours to lower-level contours on the map and attributing arrows to the effluent nature of rivers, i.e., the groundwater movement is towards the river.

CONCLUSION

The grand water conditions are depleting and streamed steps have to be taken to enhance the groundwater level and storage. Systematic and prudent hydrological studies are required to

locate potential groundwater Jones in any area. The Khargone area has flat terrain with gentle slopes. The area is covered with facility Lava flow of Deccan traps in the hydrological survey the open the valves wear investigation and the data collected was analyzed.

The data in respect of 70 open dug wells have been monitored and analyzed. The well data reveal a fairly good range of variation. Based on static ground water levels the seasonal groundwater level maps have been prepared, which exhibit the trend of ground water levels and movement of groundwater towards the Kunda River. The groundwater level fluctuation, trend of ground water level contours and direction of groundwater help in demarcation of favorable groundwater potential sites.

It is recommended that suitable artificial recharge structures should be constructed at potential sites monitored by experiment hydrologists to obtain successful results.

****

Beside suitable management of both surface and groundwater is mandatory.

REFERENCES

1. Central Groundwater Board (2013). District Groundwater Information Booklet, Barwani District Madhya Pradesh. Ministry of water resources Central groundwater Board North Central Region Bhopal, 14 pp.
2. Central Groundwater Board (2014): North Central Region, Govt. of India Bhopal 20 p. (vide google.com).
3. Davis, S. N. and De Wiest, R. J. M. (1966). Hydrogeology. John Wiley & Sons, Inc. New York, 463 p.
4. Pineker, E.V. (1983). General hydrogeology, Cambridge univ. press Cambridge, p. 138
5. Todd, D. K. (1959). Groundwater hydrology.John Wiley and Sons, New York, 336 p.
6. Todd, D. K. (1980). Groundwater hydrology, John Wiley and sons, Inc., New York, 535p.
7. Tolman, C. F. (1937). Groundwater, McGraw Hill Book Co. Inc. New York, 593p.