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Study of Ground Water Behaviour in the Tons Pump Canal Command Area of Karchhana Tehsil, Prayagaraj

Sachchida Nand Singh [a*] and Mohd. Aftab Alam [a]

[a] *Department of Irrigation and Drainage Engineering, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The study of groundwater behaviour in the Tons Pump canal command area of Karchhana Tehsil was carried out by utilizing ground water table data from 1997 to 2021 (25 years). During the study period, the pre-monsoon water table depth ranged from 3.25 m to 19.55 m, whereas the post-monsoon depth ranged from 1.71 m to 17.70 m. The water table trend in the study area during the pre-monsoon season revealed that at 83.55% of the locations having falling trend, while the remaining 16.45% experienced neither rising nor falling trend in the water table. During post-monsoon season, the water table was falling at 89.99% locations, with the rest 10.10% having neither rising nor falling trend. Therefore, the study found that the majority of the study area was experiencing water table fall due to over-exploitation of ground water in the both pre and post-monsoon season. Development stages of the groundwater utilization study from 1997 to 2021 showed that during the year 1997, all block of the study area was found under safe category.The overall utilisation of groundwater development stage was determined to be 44.93%. In 2021, the overall development stage of groundwater utilization was found to be 64.11% and the entire study area comes under safe category of groundwater utilization. It was found that groundwater levels in

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*Corresponding author: E-mail: snsingh181992@gmail.com;

the study area were progressively rising. Therefore, it was necessary to enhance the surface water supply through canal systems to reduce the draft of groundwater as well as artificial groundwater recharge is necessary to arrest the groundwater at the desired level in the study area.

Keywords: Water table depth; water table fluctuation; water table trend; groundwater utilization; Pre-post monsoon.

1. INTRODUCTION

It is common knowledge that water and land are two most critical needs for human life, and in which water is depleting at an alarming rate due to rapid urbanization and intensive irrigation systems [1,2]. The population is rapidly growing, putting a strain on agricultural land to produce more food to meet the population's needs. Irrigation uses two-thirds of the world's fresh water, with groundwater supplies contributing significantly. Groundwater use for irrigation has risen significantly over the last two decades or so. India's agriculture capacity must be maximized in order to meet that demand due to its ever-increasing population. In our nation, the estimated groundwater capacity is about 350 billion cubic meters, which can be used for commercial, domestic, agricultural, and human consumption, among other things. Agricultural water needs cannot depend alone on surface water due to irregular rainfall and insufficient access to water from rivers. Groundwater is a reasonable option for meeting agricultural needs, but overexploitation should be avoided, as the decrease in groundwater levels in India, as well as many other parts of the world, has been a critical issue [3,4].

Groundwater is a major source of water for domestic, urban, agricultural, and industrial uses in many areas, particularly in arid and semi-arid climate zones. Overexploitation of groundwater and excessive groundwater usage and management, on the other hand, will result in significant water-level falls, well drying up, water-quality depletion, increased pumping costs, land surface subsidence, loss of pumpage in residential water supply wells, and aquifer compaction. These issues are becoming increasingly serious around the world, especially in developing countries. The effective use of groundwater resources in combination with surface water has become an urgent need to secure water for the future.

Allowing enough time for surface water to percolate will help improve the health of existing groundwater condition. For groundwater sustainability, there must be hydrological equilibrium between all inlets and outlets of a basin. In fact, groundwater should only be depleted to the point that it can be recharged. The behavior of water tables in various regions must be studied for this reason. Regional ground water behavior experiments have also been performed by a number of researchers [5-9,10,11]; (Chitsazan et al., 2013). Keeping this in mind, the study have been undertaken to investigate groundwater behaviour in the Tons Pump Canal Command area of Karchhana Tehsil in order to develop a proper groundwater utilization strategy for the sustainable use of groundwater resources and the maintenance of the required groundwater level.

1.1 General Description of the Study Area

The Tons pump canal command area of Karchhana Tehsil is located in Prayagraj district of Uttar Pradesh as shown in Fig. 1. There are total three blocks comes under the study area namely Chaka, Karchhana, Kondhiyaar. Prayagraj district lies between 24˚47' and 25˚43' N latitude and 81˚31' and 82˚21' E longitude. The total geographical area and total Population of Prayagraj district is 5482.00 km^2 and 5959798, respectively. The Tons pump Canal command of Karchhana Tehsil lies between 25˚09'15" and 25˚25'02" N latitude and 81˚48'25" and 82˚04'45" E longitude. The total geographical area and total Population of the study area is 546.03km^2 and 583658, respectively.

1.2 Data Collection

The latitude and longitude of the observation wells and well wise pre and post-monsoon groundwater level data (below ground surface) were collected from Central Groundwater Board Prayagraj Centre. Data on number of minor irrigation structures were collected from minor irrigation department of Prayagraj, as well as from statistical department of Prayagraj.

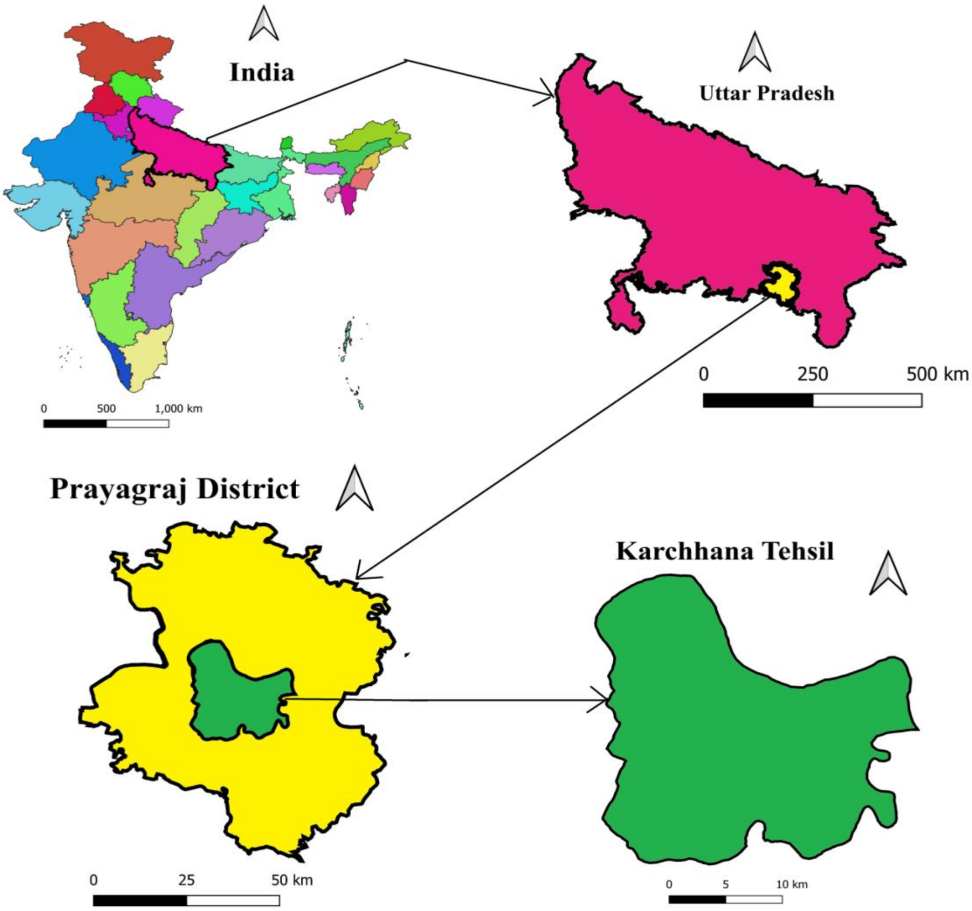

Fig. 1. Index map of the study area

2. METHODOLOGY

2.1 Groundwater Behaviour in the Study Area

The following approach was used to analyze groundwater behaviour in the study area by utilizing water table depth data of 25 observation wells located throughout the study area.

2.2 QGIS Applications

QGIS V.3.30.0 software was used to prepare the following maps.

(a) Boundary map (b) Observation well location map (c) Nodal network(d) Contour map (e) Water fluctuation map.

2.3 Depth to Water Table

Pre and post-monsoon period's water table depth data of 25 observation wells of the study areawere collected. The water table trends over period of 25 years (1997-2021) were investigated by using the contour maps for pre and post-monsoon period at 6 years intervals.

2.4 Groundwater Table Trend

In the pre and post-monsoon seasons for the period 1997-2021, the water table trend in the study area was predicted using the least square method (given by Ground Water Department of Uttar Pradesh). It was suggested that if the percent regression coefficient (Z_r^*) of depth to water table will be less than -5%, water table will be on rising trend and if it is more than +5%, the water table will be on falling trend, if it will be range between -5 to +5, this water table would not be a trend that would either rise or fall [3].

$$Z_r^* = \{(N\sum x_i y_i - \sum x_i \sum y_i)/(N\sum x^2 - xi)2 \quad (1)$$

Where

Z_r^* = regression coefficient

x_i = n^{th} years
y_i = depth to water table of n^{th} year

2.5 Rise and Fall of Water Table Depth

In response to different discharging and recharging components of groundwater during pre and-post monsoon periods, variation in the water table depth takes place. To study the water table fluctuation in the study area from the twenty five years' data, the average annual seasonal fluctuation maps were prepared. Average annual seasonal fluctuation maps for the year 1997-2003, 2003-2009, 2009-2015, and 2015 to 2021 were prepared for relative comparison of the fluctuation of the water table.

2.6 Groundwater Development Stage

The intention of any quantitative hydrologic estimation is to determine recharge and discharge of water from the groundwater reservoir or aquifers of the area under study and to determined groundwater development stage. The net recharge and the net discharge were estimated as 85% of gross recharge and 70% of gross discharge, respectively. For the study area, the difference between net annual recharge and net annual discharge were expressed as the groundwater balance and the ratio of net annual discharge and net annual groundwater recharge was defined as the stage of development of groundwater utilization. The groundwater development stage was categorized on the basis of the norms given by Groundwater Department, Uttar Pradesh and suggested by Groundwater Resource Estimation Committee (Table 1).

Table 1. Groundwater stage of development

Groundwater Utilization	Range in Percent (%)	Category
Utilization of groundwater resource	Up to 65%	Safe
	From 65% to 85%	Semi critical
	From 85% to 100%	Critical
	Above 100%	Overexploited

2.7 Nodal Network

There are large variations in climate and hydrological conditions in the study area. By separating the large area into smaller area, called nodal area, these variations can be counted. The nodal network of the study area was developed by applying Theissen polygon method. The observation wells and nodal network are shown in Fig. 2. The study area was sub-divided into 25 nodes and the each node area in hectare is given in Table 2. Interpolation was used to determine the data of these arbitrary nodes.

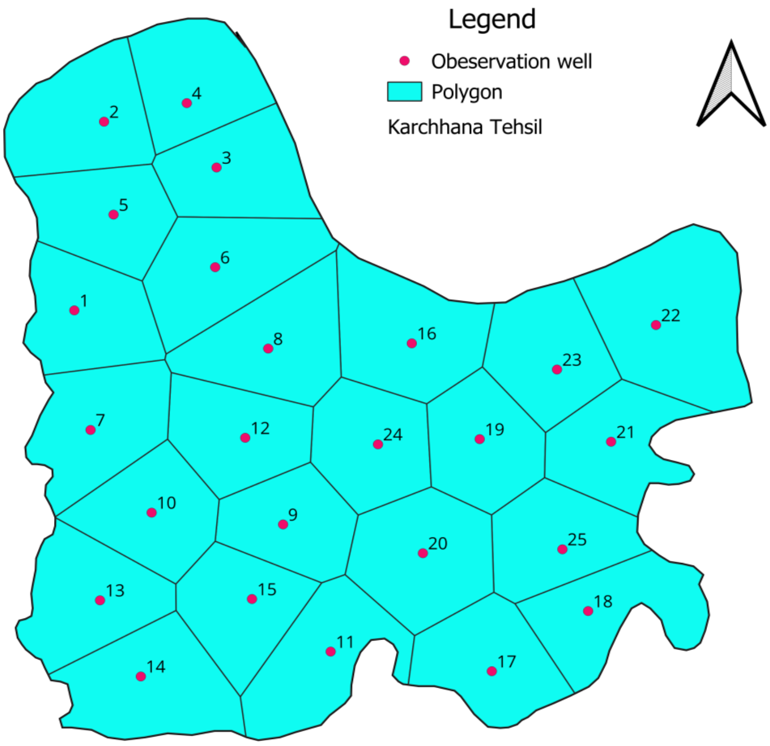

Fig. 2. Nodal network of the study area

Table 2. General description of the nodes of hydrograph station

Block	Well I.D.	Hyd_Name	Latitude	Longitude	No. of sides of polygon	Polygon Area (ha)
Chaka	1	Ghoorpur	25.3131	81.8284	4	2048.32
	2	Mahewa	25.3852	81.8394	4	2279.62
	3	Naini (I.T.I)	25.3677	81.8810	5	2016.07
	4	Naini Jail	25.3923	81.8700	4	2045.79
	5	Ubhari	25.3497	81.8429	5	1938.53
	6	Hathigawan	25.3296	81.8805	5	2434.12
Kaundhiyara	7	Belsara	25.2674	81.8344	5	2274.14
	8	Karma	25.2985	81.9001	5	2402.47
	9	Ramgadva	25.2313	81.9056	6	1774.92
	10	Sehra	25.2358	81.8570	5	2007.73
	11	Kulmai-1	25.1827	81.9232	6	2277.58
	12	Akodha	25.2644	81.8916	5	1971.03
	13	Kaundhiyara	25.2023	81.8379	4	2200.98
	14	Niraudha	25.1732	81.8530	4	2498.59
	15	Kulmai-2	25.2028	81.8941	5	1922.28
Karchhana	16	Chanaini	25.3005	81.9532	5	2508.87
	17	Dharwara	25.1752	81.9828	5	2076.51
	18	Katka Bridge	25.1982	82.0184	5	2126.91
	19	Panasha-1	25.2639	81.9783	6	1935.59
	20	Panasha-2	25.2203	81.9573	6	2445.03
	21	Bhirpur	25.2629	82.0269	7	1954.71
	22	Deeha Uperhar	25.3075	82.0435	5	3445.07
	23	Ghonedeeh	25.2905	82.0069	5	2092.95
	24	Karchhana	25.2619	81.9407	6	1946.85
	25	Khain	25.2218	82.0089	5	1978.66
Total area						**54603.31**

3. RESULTS AND DISCUSSION

3.1 Depth to Water Table

Pre-monsoon and post-monsoon depth to water table contour maps for 1997, 2003, 2009, 20015, and 2021 are shown in Figs. 3 to 7. During the study period, the pre-monsoon depth to the water table ranged from 3.25 m to 19.55 m, whereas the post-monsoon depth ranged from 1.71 m to 17.70 m. The minimum depth to water table in pre-monsoon season was observed at Kulmai-1 in Kandhiyara block as well as in post-monsoon season at Karma in Kandhiyara block. The maximum depths to water table in pre and post-monsoon seasons were observed at Ghoorpur in Chaka block. In 1997, the minimum depth to the water table was found as 3.80 m at Sehra hydrograph station in Kaundhiyara block, and the highest depth to the water table was observed as 15.15 m at Ghonedeeh hydrograph station in Karchhana block during the pre-monsoon season.During the post-monsoon season, the minimum depth to the water table was observed as 2.15 m at the Sehra hydrograph station in Kaundhiyara block and the maximum depth to the water table was found as 11.25 m at the Ghoorpur hydrograph station in Chaka block. The minimum and maximum depths to the water table during the pre-monsoon season in the year 2003 were observed as 4.20 m and 15.65 m at Ramgadva hydrograph station in Chaka block and Bhirpur hydrograph station in Karchhana block, respectively. Whereas, in post-monsoon season the minimum and maximum depths to the water table were found as 2.35 m at Niraudha hydrograph station in Kaundhiyara block and 13.55 m at Ghoorpur hydrograph station in Chaka block.The minimum and maximum depth to groundwater level during 2009 in pre–monsoon season were observed as 4.95 m at Kulmai-1 in Kaundhiyara block and 16.35 m at Ghunedeeh hydrograph station in Karchhana block, respectively. However, during the post-monsoon season, the groundwater table depth varied, with the minimum value 1.71 at Karma hydrograph station in Kaudhiyara block to the maximum depth 13.65 at Ghonedeeh in Karchhana. In the year 2015, the minimum depth to the groundwater table was found as 5.85 m at the Karma hydrograph station in Kaundhiyara block and the maximum depth to the water table was observed 19.55 m at the Ghoorpur hydrograph station in Chaka block during the pre-monsoon season. However, in the post-monsoon, the depth to water table ranged from 4.20 m at Kulmai hydrograph station in Kaudhiyara block to 17.70 m at Ghoorpur hydrograph station in Chaka block. In the year 2021, the minimum and maximum depth to groundwater table in pre-monsoon season was observed as 4.65 m at Karma hydrograph station in Kaudhiyara block 16.05 m at Akodha Chak hydrograph station in Kaudhiyara block, respectively. Whereas, in the post-monsoon, the depth to water table varied from 2.95 m at Ramgadva hydrograph station in Kaudhiyara block to 15.45 m at Akodha hydrograph station in Kaudhiyara block.

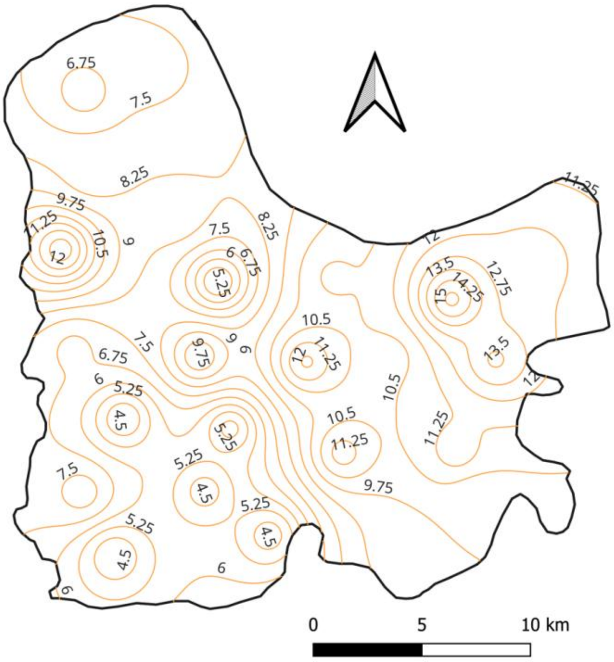

Fig. 3(a). Pre-monsoon water table depth contour map during the year 1997

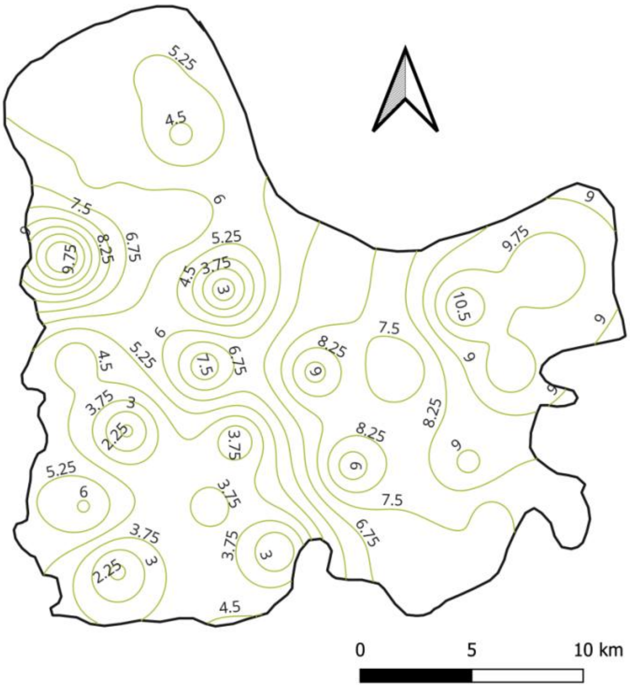

Fig. 3(b). Post-monsoon water table depth contour map during the year 1997

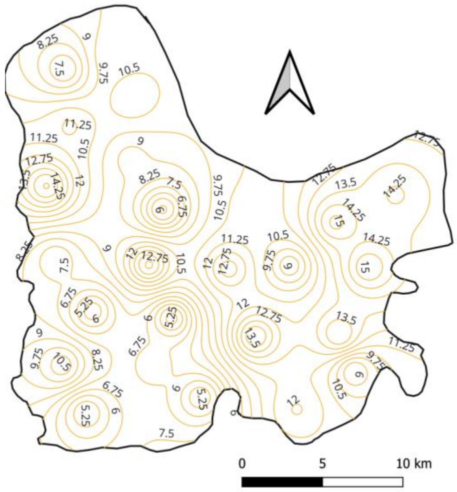

Fig. 4(a). Pre-monsoon depth to water table contour map during the year 2003

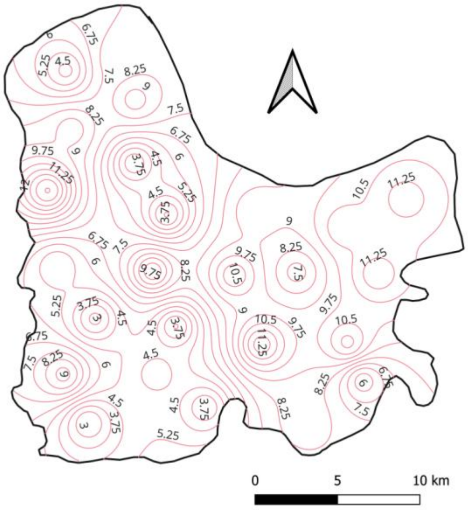

Fig. 4(b). Post-monsoon water table depth contour map during the year 2003

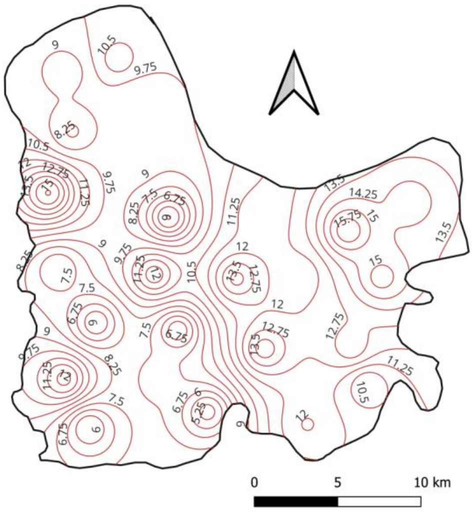

Fig. 5(a). Pre-monsoon depth to water table contour map during the year 2009

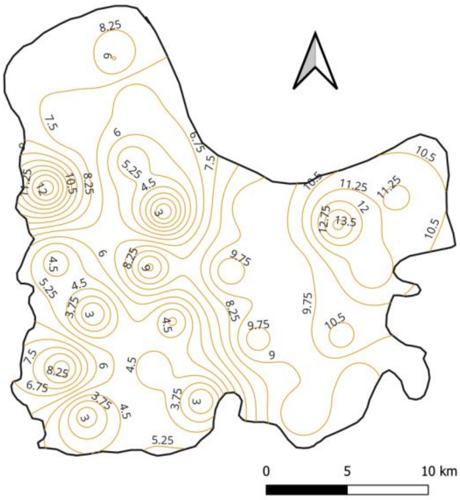

Fig. 5(b). Post-monsoon water table depth contour map during the year 2009

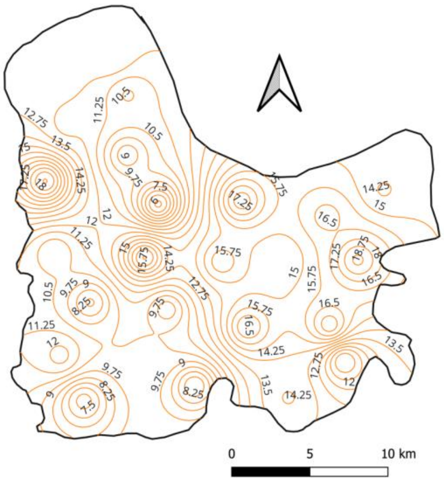

Fig. 6(a). Pre-monsoon depth to water table contour map during the year 2015

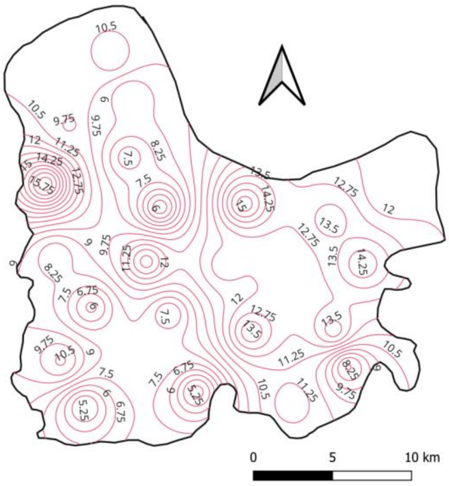

Fig. 6(b). Post-monsoon water table depth contour map during the year 2015

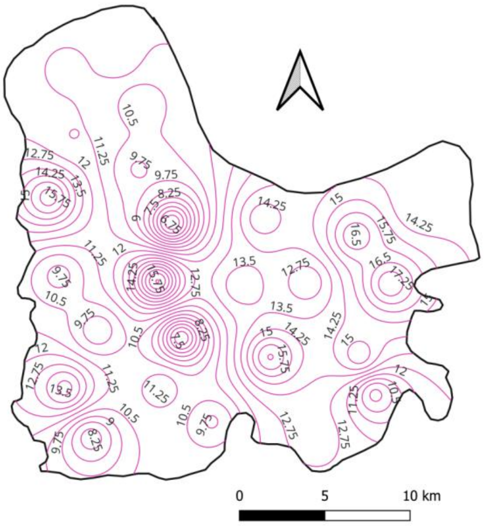

Fig. 7(a). Pre-monsoon depth to water table contour map during the year 2021

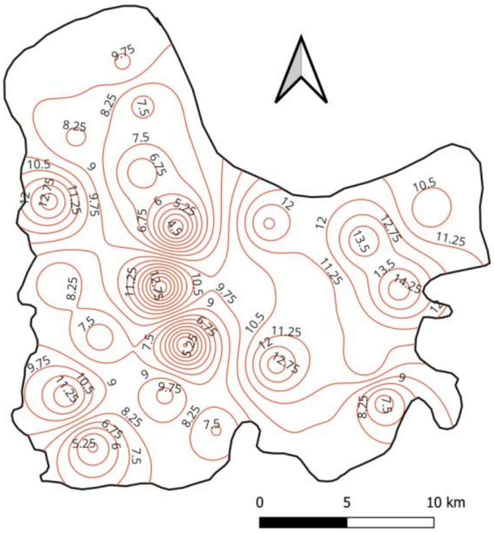

Fig. 7(b). Post-monsoon water table depth contour map during the year 2021

3.2 Groundwater Table Trend

The water table trend from the years 1997 to 2021 was investigated in order to study the behaviour of groundwater in the study area. The trend of depth to water table in pre and post-monsoon is given in Table 3. During pre-monsoon season, in terms of overall area, the water table was falling at 83.55% of the locations, with the remaining 16.45% having neither rising nor falling trend. The study found that the water table was constantly dropping in the majority of the study area during the pre-monsoon season. During post-monsoon season, in terms of overall area, the water table was falling at 89.99% of the locations, with the rest10.10% having neither a rising nor a falling trend. Therefore, the investigation found that the majority of the study area was experiencing water table fall due to over-exploitation of ground water in the post-monsoon season.

3.3 Average Yearly Seasonal Fluctuation of Groundwater Table

The average yearly seasonal fluctuation of the water table is caused by the recharge and discharge components of groundwater in every region. The average yearly seasonal fluctuation of the groundwater table throughout several time periods is given Table 4.

Table 3. Depth to groundwater table trend during pre and post-monsoon seasons in the study area during the period (1997-2021)

Trend of depth to water table during pre -monsoon and post-monsoon seasons in the study area in study period (1997-2021).													
Node No.	**Block**	**Hyd name**	**No. of year (N)**	**Year ∑x**	**Depth to water table (m)**		**∑x^2**	**∑xy**	**∑xy'**	**(z*) Pre-Monsoon**	**(z*) Post-Monsoon**	**Water table trend during interval**	
					Pre-Monsoon (∑y)	**Post-Monsoon (∑y')**						**Pre-Monsoon**	**Post-Monsoon**
1	Chaka	Ghoorpur	25	325	404.38	350.47	5525	5507.75	4787.49	19.29	17.80	Falling	Falling
2	Chaka	Mahewa	25	325	228.68	184.88	5525	3272.46	2703.62	23.05	23.09	Falling	Falling
3	Chaka	Naini (I.T.I)	25	325	254.40	196.03	5525	3312.50	2570.88	0.41	1.73	Neither rising nor falling	Neither rising nor falling
4	Chaka	Naini Jail	25	325	279.26	228.19	5525	3866.66	3191.54	18.18	17.31	Falling	Falling
5	Chaka	Ubhari	25	325	246.64	192.32	5525	3374.67	2651.88	12.95	11.67	Falling	Falling
6	Chaka	Hathigawan	25	325	231.67	144.78	5525	3053.20	1955.42	3.19	5.64	Neither rising nor falling	Falling
7	Kaundhiyara	Belsara	25	325	201.17	138.16	5525	2804.47	2001.51	14.56	15.80	Falling	Falling
8	Kaundhiyara	Karma	25	325	136.25	86.54	5525	1808.80	1253.07	2.89	9.85	Neither rising nor falling	Falling
9	Kaundhiyara	Ramgadva	25	325	147.91	101.84	5525	2208.67	1494.88	21.99	13.15	Falling	Falling
10	Kaundhiyara	Sehra	25	325	159.81	105.37	5525	2367.46	1661.50	22.30	22.44	Falling	Falling
11	Kaundhiyara	Kulmai-1	25	325	142.30	94.53	5525	2148.70	1454.59	22.98	17.36	Falling	Falling
12	Kaundhiyara	Akodha	25	325	364.75	296.45	5525	5076.00	4142.20	25.71	22.18	Falling	Falling
13	Kaundhiyara	Kaundhiyara	25	325	286.00	227.07	5525	4050.25	3212.60	25.56	20.05	Falling	Falling
14	Kaundhiyara	Niraudha	25	325	142.63	84.25	5525	2051.92	1280.00	15.21	14.21	Falling	Falling
15	Kaundhiyara	Kulmai-2	25	325	205.80	150.71	5525	3055.15	2315.99	29.21	27.44	Falling	Falling
16	Karchhana	Chanaini	25	325	342.65	269.95	5525	4768.30	3880.80	24.14	28.57	Falling	Falling
17	Karchhana	Dharwara	25	325	318.42	234.15	5525	4343.12	3195.35	15.67	11.65	Falling	Falling
18	Karchhana	Katka Bridge	25	325	235.15	169.31	5525	3108.60	2410.02	3.97	16.08	Neither rising nor falling	Falling
19	Karchhana	Panasha-1	25	325	285.50	220.90	5525	3949.85	3199.80	18.33	25.24	Falling	Falling
20	Karchhana	Panasha-2	25	325	366.27	287.41	5525	5055.98	4080.62	22.65	26.48	Falling	Falling
21	Karchhana	Bhirpur	25	325	412.88	324.31	5525	5601.62	4550.54	18.01	25.73	Falling	Falling
22	Karchhana	Deeha Uperhar	25	325	342.83	279.10	5525	4553.24	3610.25	7.42	-1.39	Falling	Neither rising nor falling
23	Karchhana	Ghonedeeh	25	325	390.95	316.50	5525	5252.20	4341.50	13.07	17.46	Falling	Falling
24	Karchhana	Karchhana	25	325	358.92	281.22	5525	4855.71	3761.19	14.60	8.10	Falling	Falling
25	Karchhana	Khain	25	325	364.85	283.75	5525	4992.80	3849.55	19.21	12.37	Falling	Falling

Where, x = n^{th} year, y = depth to groundwater table of n^{th} year and z = regression coefficient

Table 4. Percentage area under various ranges of average yearly seasonal fluctuation of the groundwater table during various time periods

Period	**Percentage area under different ranges of average yearly seasonal fluctuation of groundwater table**			
	< 1 m	**1 to 2 m**	**2 to 3 m**	**> 3 m**
1997 - 2003	35.79	29.92	11.18	23.11
2003 - 2009	64.76	16.38	18.86	0
2009 - 2015	22.53	20.59	10.91	45.97
2015 - 2021	34.41	42.63	7.19	15.77
1997 - 2021	22.31	18.39	19.71	39.59

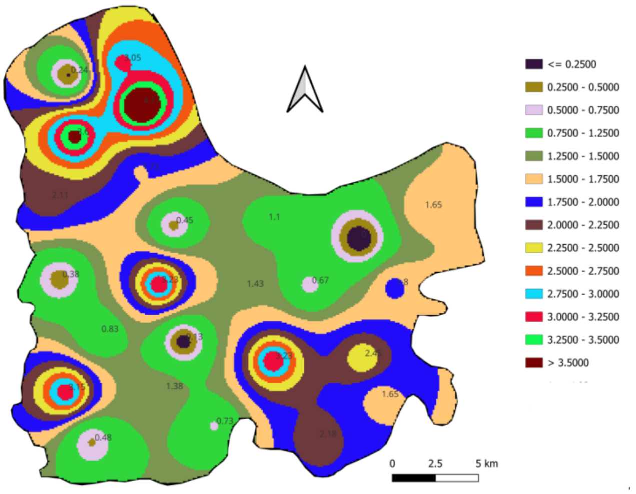

Fig. 8. Average yearly seasonal fluctuation of groundwater table (1997-2003)

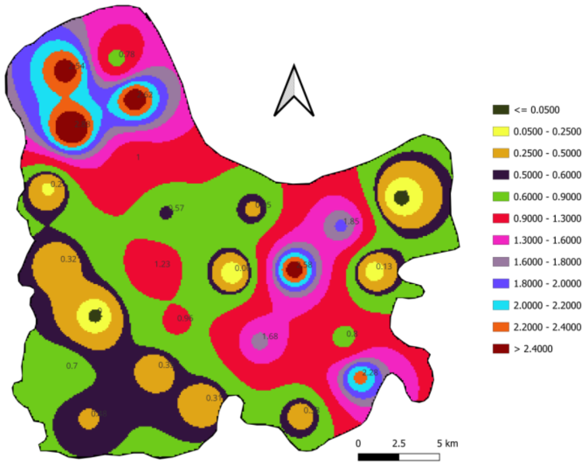

Fig. 9. Average yearly seasonal fluctuation of groundwater table (2003-2009)

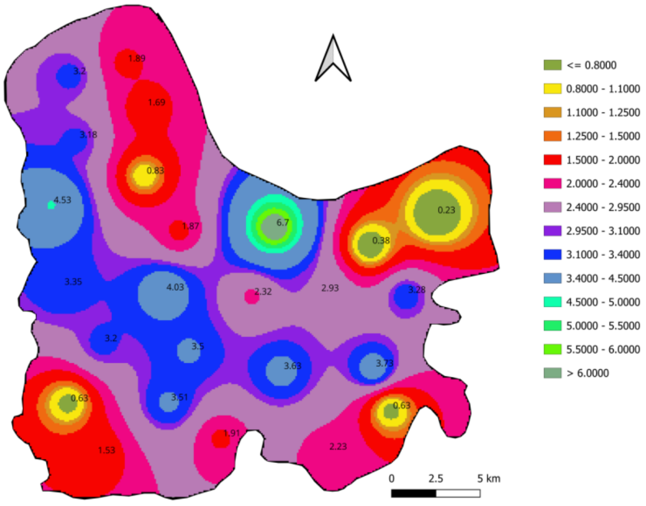

Fig. 10. Average yearly seasonal fluctuation of groundwater table (2009-2015)

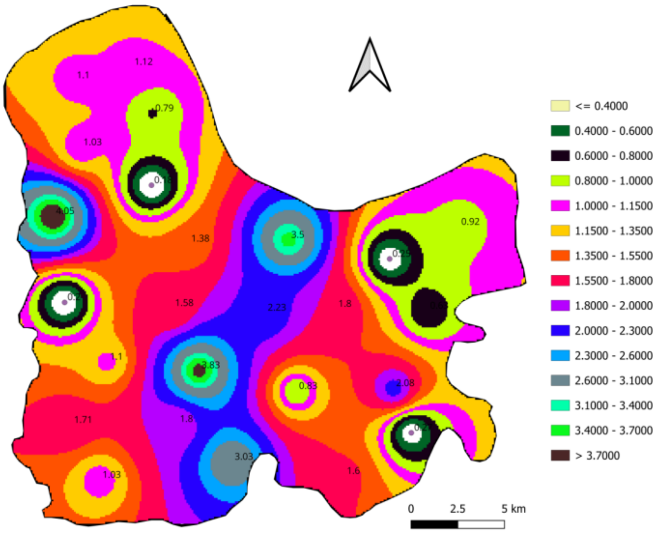

Fig. 11. Average yearly seasonal fluctuation of groundwater table (2015-2021)

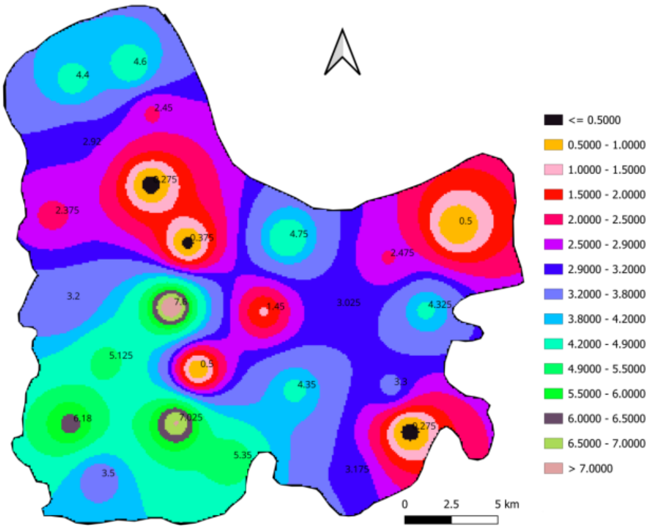

Fig. 12. Average yearly seasonal fluctuation of groundwater table (1997-2021)

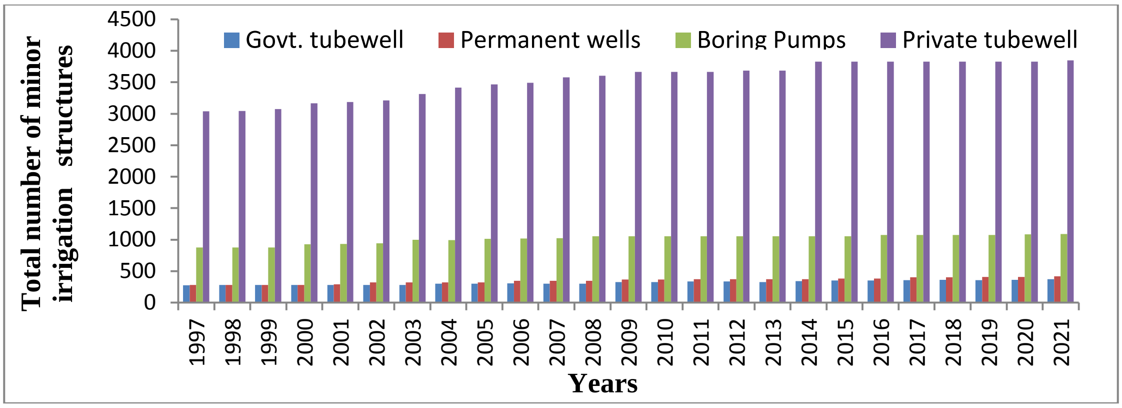

Fig. 13. Variation of total number of minor irrigation structures during year 1997-2021

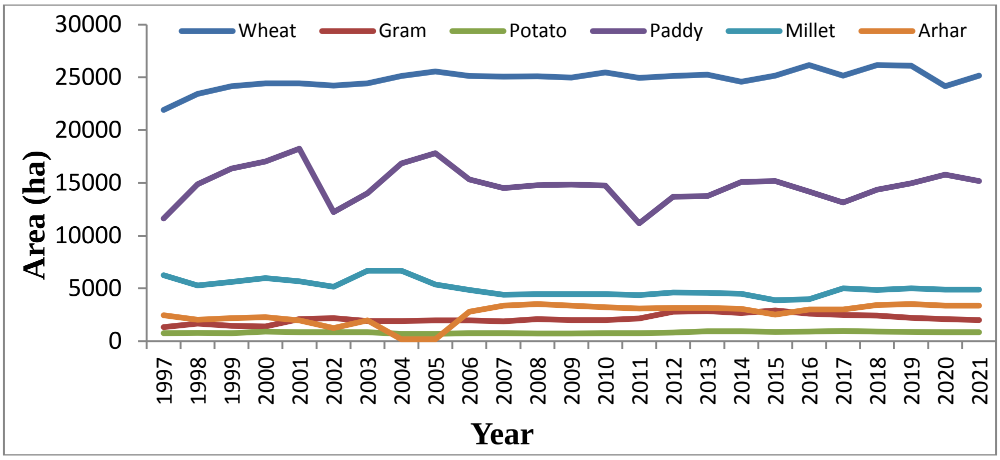

Fig. 14. Change in the area covered by major crops from 1997 to 2021

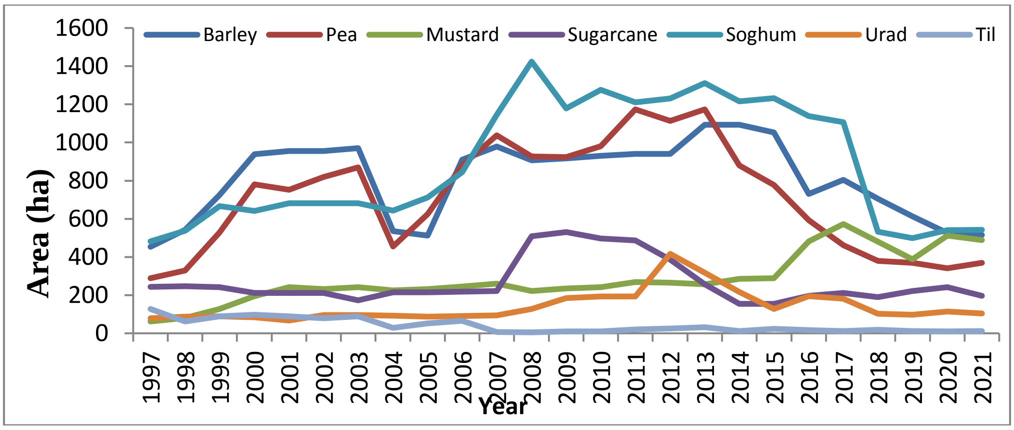

Fig. 15. Change in the area covered by minor crops from 1997 to 2021

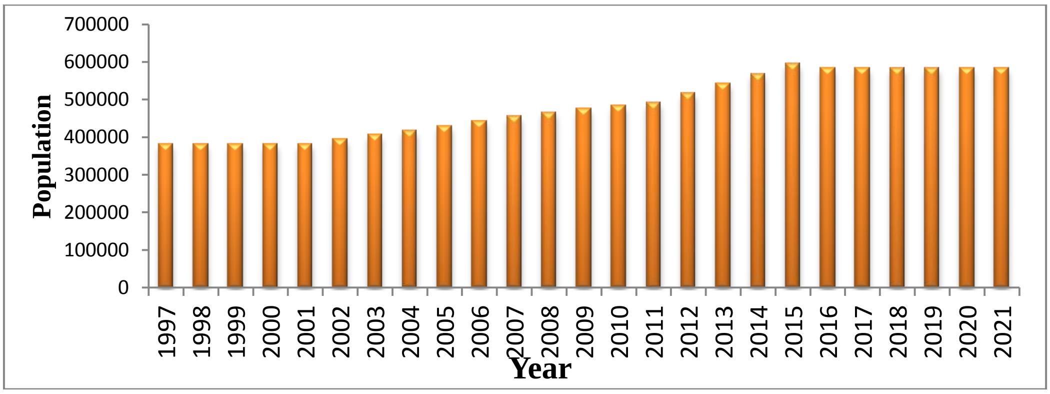

Fig. 16. Change in human population from 1997 to 2021

The average yearly seasonal fluctuation map of groundwater table for the year 1997-2003, 2003-2009, 2002-2015, 2015-2021 and 1997-2021 are shown in Figs. 8,9,10,11 and 12, respectively. During the five-year period from 1997 to 2003, the area covered by various average yearly seasonal groundwater table fluctuation ranges was found to be 35.79%, 29.92%, 11.18%, and 23.11% under various fluctuation ranges, namely less than 1 m, 1 to 2 m, 2 to 3 m and more than 3 m, respectively. During the years 2003 to 2009, around 64%, 16.38%, 18.86%, and 0.00% of the study area was having seasonal groundwater table fluctuation in the range of less than 1 m, 1 to 2 m, 2 to 3 m and more than 3 m, respectively. During the period 2009-2015, the area covered by the various ranges of the average yearly seasonal variation of the groundwater table, i.e., <1 m, 1 to 2 m, 2 to 3 m and >3 m, was determined to be 22.53%, 20.59%, 10.91% and 45.97%, respectively. In the subsequent five years (2015–2021), the average yearly seasonal groundwater table fluctuation was found in the range of less than 1 m, 1 to 2 m, 2 to 3 m and more than 3 m which are covering around 34.41%, 42.63%, 7.19%, and 15.77% of study area, respectively. It indicates that for the whole 25-year period (1997-202021), around 22.31% of the region had yearly seasonal fluctuations of groundwater table less than 1 m. Whereas about 18.39% of the study area having fluctuation from 1m to 2 m, 19.71% of the study area having fluctuation from 2 to 3 m, and the rest of the 39.59% of the study area having fluctuation more than 3 m [12,13].

3.4 Causes of Declining GroundwaterTable

Survey of the study region, assessment of groundwater behaviour revealed the probable factors of water table falling in the study area, as following [11,14,15]:

I. Increase in the total number of minor irrigation structures

The total number of minor irrigation structures varies year to year is shown Fig. 13. Because canal water was not available in the acceptable quantity and at the desired time, groundwater pump age was required for irrigation, which was increasing year after year. The total number of minor irrigation structures was also growing for this purpose, which led to excessive groundwater extraction and ultimately led to a decline in the water table. According to the study, the number of government tube wells, permanent wells, pumping sets and private tube wells increased by around 33.93%, 49.10%, 24.71% and 26.60%, respectively, over the duration of the 25-year study period (1997-2021).

II. Cropping patterns

In the study area, wheat, gram, potato, paddy, millet, and *arhar* were the main crops grown. Other minor crops included barley, mustard, pea, sorghum, *urad*, *til*, and sugarcane was also planted. The yearly change in the area covered by both these major and minor crops is shown in Figs. 14 and 15, respectively. According to Fig. 14, rice and wheat crops covered the most amount of agricultural land when compared to other crops that were commonly cultivated. Rice cultivation in soils with a high proportion of sand requires more frequent irrigation and groundwater pumping.

III. Increase in the demand of groundwater for human and industrial usage

The annual variation in human population is shown in Figs. 16. This figure show that the population increased year by year, there is also increased the need of groundwater for daily domestic usage (drinking, cooking, washing, bathing, and so on). Furthermore, as the area has become more industrialised over the last 25 years, the demand of groundwater for industrial purposes has also increased, resulting in excessive groundwater pumping.

4. CONCLUSIONS

During the pre-monsoon in the Chaka block, the water table trend showed that there was a falling trend in 65.84% of the areas and at in the remaining 34.16% locations had neither rising nor falling trend. In the Kaundhiyara block, 87.51% of the areas had a falling trend, while the remaining 12.49% locations had neither a rising nor a falling trend. In the Karchhana block, 90.48% of the area showed a falling trend, while the remaining 9.52% showed neither a rising nor a falling trend. During post-monsoon season in Chaka block trend to water table showed that, at 84.52% locations had falling trend whereas remaining 15.48% locations had neither rising nor falling trend. In Kaundhiyara block at 100% area had falling trend. In Karchhana block at 84.58% places had falling trend whereas remaining 15.42% places had neither rising nor falling trend. In terms of total area, the study showed that the water table was steadily declining in the major portion of the study area during the both seasons.

Therefore, the study found that the majority of the study area was experiencing water table fall due to over-exploitation of ground water. It was found that there was less canal water available than needed for irrigation. Sand content in the soils was very high, their ability to store water was very low and existing cropping pattern needed more number of irrigation with more water for irrigation, resulting in a decline in water table. As a result, timely water resource management planning for the study area is essential in order to keep the water table at the desired level.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Alam MA, Kumar Y, Sharma HC, Jafri A, Wesley CJ, Singh V. Study of groundwater behaviour in the Bellan canal command in Allahabad district of Uttar Pradesh. International Journal of Agriculture Sciences. 2014;9(29):4385-4390.
2. Alam MA, Kumar Y, Sharma HC, Jafri AMD, Wesley JC, Singh V. Study of groundwater behaviour inthe Bellan canal command in Allahabad district of Uttar Pradesh. International Journal of Agriculture Sciences. 2017;9(29):4385-4390.
3. TamtaH, Garg S. Groundwater table trend in Bijnor, India. International Research Journal of Modernization in Engineering Technology and Science. 2014;2(11):14-19.
4. Sonu, Kumar S, Brar B. Study of fluctuations in the groundwater depth in Rohtak: A part of South-Western Haryana: A spatial temporal approach. The Pharma Innovation Journal. 2022;11(7):118-131.
5. Bonacci O. Ground water behaviour in karst: Example of the Ombla Spring (Croatia). Journal of Hydrology. 1995; 165(1–4):113-134.
6. KumarD, Ahmed S. Seasonal behaviour of spatial variability of groundwater level in a granitic aquifer in monsoon climate. Current Science. 2003;84(2):189-196.
7. Pavelic P, Smakhtin V, Favreau G, Villholth KG. Water-balance approach for assessing potential for smallholder groundwater irrigation in Sub-Saharan Africa. International Conference on Groundwater Special Edition. 2012;38(3). ISSN 1816-7950.
8. Dinka MO, Loiskandl W, Furst J, Ndambuki JM. Seasonal behavior and spatial fluctuations of groundwater levels in long-term irrigated agriculture: The case of a sugar estate. Pol. J. Environ. Stud. 2013;22(5):1325-1334.
9. Nandargi S, Patekar TA, Mulye SS. Rainfall and groundwater level variation in Pune District, India. Studies in Atmospheric Science. 2014;1:24-40.
10. Naveen A, Alam MA, Wesley CJ, Singh V. Study of ground water behaviour in Kaushambhi district of Uttar Pradesh (U.P). Advances in Life Sciences. 2017;6(1):47-55.
11. Tamta H, Garg S. Groundwater table trend in Bijnor, India. International Research Journal of Modernization in Engineering Technology and Science. 2022;2(11):14-19.
12. Srivastava PK, Singh RM. Groundwater assessment in a canal command area for sustainable irrigation in a part of the Indo-Gangetic alluvial plain. Current Science. 2017;112(3):478-489.
13. Pradhan P, Kumar S, KumarY, Sharma HC. Assessment of groundwater utilization status and prediction of water table depth using different heuristic models in an Indian inter basin. A Fusion of Foundations, Methodologies and Applications. 2018;23(20):10261-10285.
14. Nema S, Awasthi MK, Nema RK. Spatial and temporal ground water responses to seasonal rainfall replenishment in an alluvial aquifer. Biosci. Biotech. Res. Comm.2017;10(3):431-437.
15. Demir S. Effect of groundwater level on site response behavior of a one-layered liquefiable soil. Journal of Engineering Sciences and Design. 2021;9(3):796-808.

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