European Journal of Biotechnology and Bioscience
ISSN: 2321-9122; Impact Factor: RJIF 5.44
Received: 09-02-2019; Accepted: 12-03-2019
www.biosciencejournals.com
Volume 7; Issue 3; May 2019; Page No. 80-83

Physico-chemical analysis of selected underground water samples of Mauganj blocks district Rewa (M.P.) (India)

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Abstract
During present study was carried out to assess the status of the underground water in Mauganj blocks. The range of physicochemical parameters like pH (6.9-7.6), EC (2150-3550 mmhos), TDS (1240-1850 mg/l), Turbidity (6.4-20.6 NTU), Total Alkalinity (345-530 mg/l), Total hardness (580-860 mg/l), Chloride (310-530 mg/l), Calcium (80-165 mg/l), Magnesium 70.5-124 mg/l), Sodium (130-330 mg/l) and Potassium (8.6-34.5 mg/l) were found to be higher than the natural background level of groundwater. This indicates the groundwater pollution in selected water samples from 10 sampling sites from Feb. to May 2018 of Mauganj blocks. The results considered that the groundwater of the study area in general cannot be considered as good quality.

Keywords: Underground water, physicochemical parameters, Mauganj blocks

1. Introduction
Water plays vital role in human life. It is extremely essential for survival of all living organisms. Groundwater is ultimate, most suitable fresh water resource with nearly balanced concentration of the salts for human consumption. Over burden by means of population pressure, unplanned urbanization, unrestricted exploration policies and dumping of the polluted water at inappropriate place enhance, the infiltration of harmful compounds to the groundwater (Pandey *et al.*, 2008) [1]. The quality of water is of vital concern for the mankind since it is directly linked with human welfare. There are several states in India where more than 90% populations are dependent on groundwater for drinking and other purpose (Ramachandraiah, 2004; Tank and Singh, 2010) [2-3]. The uncontrolled disposal of industrial and urban wastes and the use of chemical substances in agriculture (fertilizers, herbicides and pesticides) are the primary causes of groundwater contamination (Ullah *et al.*, 2009) [4]. During last decade, this is observed that groundwater get polluted drastically because of increased human activities. Consequently, number of cases of water borne diseases has been seen that is a cause of health hazards.
Mauganj is a town and a nagar panchayat in Rewa district in the Indian state of Madhya Pradesh. Bagheli is the regional language of Mauganj. The area is famous for waterfalls.
Mauganj was the capital of Mau, which was a principality before the capture of Rewa. The Rajas of Mau were of the Sengar (a Rajput clan). It is notable for the monuments built by the Sengar, who ruled in the area before Indian sovereignty. Major Population in Mauganj are Brahman, Kshatriya, Vaishya and other minority group.

2. Materials and Methods
Mauganj is located at 24.68°N and 81.88°E. It has an average elevation of 313 metres (1,026 feet). Mauganj is 65 km from Rewa, and villages Panni, Dhera, Barahata, Pakara Pande, Khatkhari, Padar, Nandanpur.
Some sites of religious significance around Mauganj are:
- Mahadev Temple in Devatalab (17 km from Mauganj).
- Asht Bhuji temple
- Hanuman Mandir, Ram janki mandir and Alopan Mandir

Sample Collection
Water Samples from the ten selected sites namely (Mau (S1), Dagdaua (S2), Panni (S3), Khatkhari (S4), Barahta (S5), Padar (S6), Nandanpur (S7), Jamui (S8), Bahuti (S9) and Ganj (S10) were collected during Feb. to May 2018 and taken in pre-cleaned polyethylene bottles. Samples were analyzed immediately for parameters, which need to be determined instantly and rest of samples were refrigerated at 40°C to be analyzed later.

Physico-Chemical Analysis
The collected samples were analysed for major physical and chemical water quality parameter like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Alkalinity (TA), Total Hardness (TH), Chloride (Cl^-), Calcium (Ca^{++}), Magnesium (Mg^{++}), Sodium (Na^+) and Potassium (K^+) were carried out referring the 'standard methods 2002 [13].

Statistical Analysis
The simple linear correlation analysis has been carried out to find out correlation between two tested parameters.

3. Result and Discussion
The average results of the physicochemical parameters for water samples are presented in Table 1 and matrix of correlation among different parameters are shown in table 2.
The quality of water resources depends on the management of the water sources. This would include anthropogenic discharge as well as the natural physicochemical properties

of the area.

pH: pH is considered as an important ecological factor and provides an important piece factor and piece of information in many type of geochemical equilibrium or solubility calculation (Shyamala *et al.*, 2008) [5]. The maximum pH was recorded as 7.6 at sampling location S8 and minimum was 6.9 at S2. When composed with the standard values of WHO and IS 10500-91, the samples are found to be in the permissible limit as prescribed.

EC: Electrical Conductivity is a useful tool to evaluate the purity of water (Acharya *et al.*, 2008) [6]. EC values were in the range of 2150 micromhos/cm (S1) to 3550 micromhos/cm (S6). EC values for all the investigated samples were found to be greater than the limit prescribed by WHO. High EC values indicate the presence of high amount of dissolved inorganic substances in ionized form.

TDS: Total Dissolved Solids usually related to conductivity. Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supplies, though more highly mineralized water maybe used where better quality water is not available (Jain, 2002) [7]. The maximum value of TDS during the study period was found as 1850mg/l at sampling location S10 and minimum was1240 mg/l at S1. The TDS values of all the water samples of the selected places are greater than the limit prescribed by IS-10500-91.

Turbidity: In most waters, turbidity is due to colloidal and extremely fine dispersions. The turbidity values varied between 6.4 NTU (S7) to 20.6 NTU (S5). Of the total investigated samples, 50% water samples shows greater value than the limit prescribed by WHO.

Total Alkalinity: Alkalinity value in water provides an idea of natural salts present in water. The cause of alkalinity is the minerals which dissolve in water from soil. The various ionic species that contribute to alkalinity includes bicarbonate, hydroxide, phosphate, borate and organic acids. These factors are characteristics of the source of water and natural processes taking place at any given time (Sharma, 2004)[8]. The maximum value of alkalinity was found as 530 mg/l at sampling location S9 and minimum 345 mg/l at S1 and found greater than the limit prescribed by WHO [14].

Total Hardness: Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water (Patil and Patil, 2010) [9]. Total Hardness was found in the sample water ranges from 580 mg/l (S8) to 860 mg/l (S6), which shows the values higher than the permissible limit prescribed by WHO. According to some classifications, water having hardness upto 75 mg/l us classified as soft, 76-150 mg/l is moderately soft, 151-300 mg/l as hard and more than 300 mg/l as very hard (Saravanakumar and Ranjith Kumar, 2011) [10].

Chloride: Chloride usually occurs as NaCl, $CaCl_2$ and MgCl in widely varying concentration, in all natural waters. They enter water by solvent action of water on salts present in the soil, from polluting material like sewage and trade wastes (Shaikh and Mandre, 2009) [11]. The maximum value of chloride was recorded as 530 mg/l at sampling location S9 and minimum was 310 mg/l (S1).

Calcium and Magnesium: The source of calcium and magnesium in natural water are various types of rocks, industrial waste and sewage (Trivedy and Goel, 1984) [12]. The values of calcium varied from 80 mg/l (S1) to 165 mg/l (S5) and the values of magnesium ranged from 70.5 mg/l (S1) to 124 mg/l (S4).

Sodium: Sodium concentration was found in between 130 (S8) mg/l to 330 mg/l (S1). All the samples were found greater than the permissible limit of WHO except the sampling point S2, S3, S4, S8 and S10.

Potassium: The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water (Trivedy and Goel, 1984) [12]. It was varied between 8.6 mg/l (S1) to 34.5 mg/l (S8).

Statistical analysis

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2 \,][\, n\Sigma y^2 - (\Sigma y)^2 \,]}}$$

Interrelationship studies between different variables are very helpful tools in promoting research and opening new frontiers of knowledge. The study of correlation reduces the range of uncertainty associated with decision making. The correlation co-efficient 'r' was calculated using the equation (Patil and Patil, 2010) [9].

Where, X and Y represents two different parameters, N= Number of total observation.

Correlation among physical and chemical water quality parameters

The high positively correlated values were found between TA and TDS (0.688), TH and Turbidity (0.717), Chloride and TH (0.493), Calcium and Total Hardness (0.725), Calcium and Chloride (0.747), Magnesium and pH (0.407), Magnesium and EC (0.613), Magnesium and Ca (0.420) and Potassium and Magnesium (0.349) While the negatively correlated values were found between Cl and pH (-0.161), Ca and pH (-0.040), Na and pH (-0.036), Na and TDS (-0.435), Na and Turbidity (-0.152), Na and TA (-0.216), NA and TH (-0.259), NA and Ca (-0.019) and NA and Mg (-0.432). pH is negatively correlated with most of the parameters. However, Na is negatively correlated with all parameters.

Table 1: Average results of the physicochemical parameters.

S. No.	Parameters	Sampling sites										WHO (1993)	IS (10500-91)
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10		
1.	pH	7.2	6.9	7.4	7.1	7.5	7.2	7.3	7.6	7.1	7.4	-	6.5-8.5
2.	EC	2150	2200	2360	3250	3400	3550	3370	3480	3140	2670	250	-
3.	TDS	1240	1460	1320	1480	1560	1400	1480	1610	1460	1850		500
4.	Turbidity	8.5	10.6	12.5	18.5	20.6	14.8	6.4	7.5	10.8	16.6	<5	10
5.	TA	345	450	360	410	520	480	375	480	530	525	-	200
6.	TH	585	610	820	805	745	860	630	580	755	815	150-500	300
7.	Cl-	310	455	410	365	515	465	370	340	530	440	250	250
8.	Ca	80	130	85	110	165	86	102	96	145	132	-	75

9.	Mg	70.5	78.6	90.6	124	115	80.6	90.8	118	104	96	-	30
10.	Na	330	160	145	136	280	240	280	130	215	148	200	200
11.	K-	8.6	10.5	20.6	15.4	12.8	26.8	8.9	34.5	20.8	22.6	-	-

All parameters are in mg/L except pH, EC and Turbidity. EC in micromhos/cm, Turbidity in NTU.

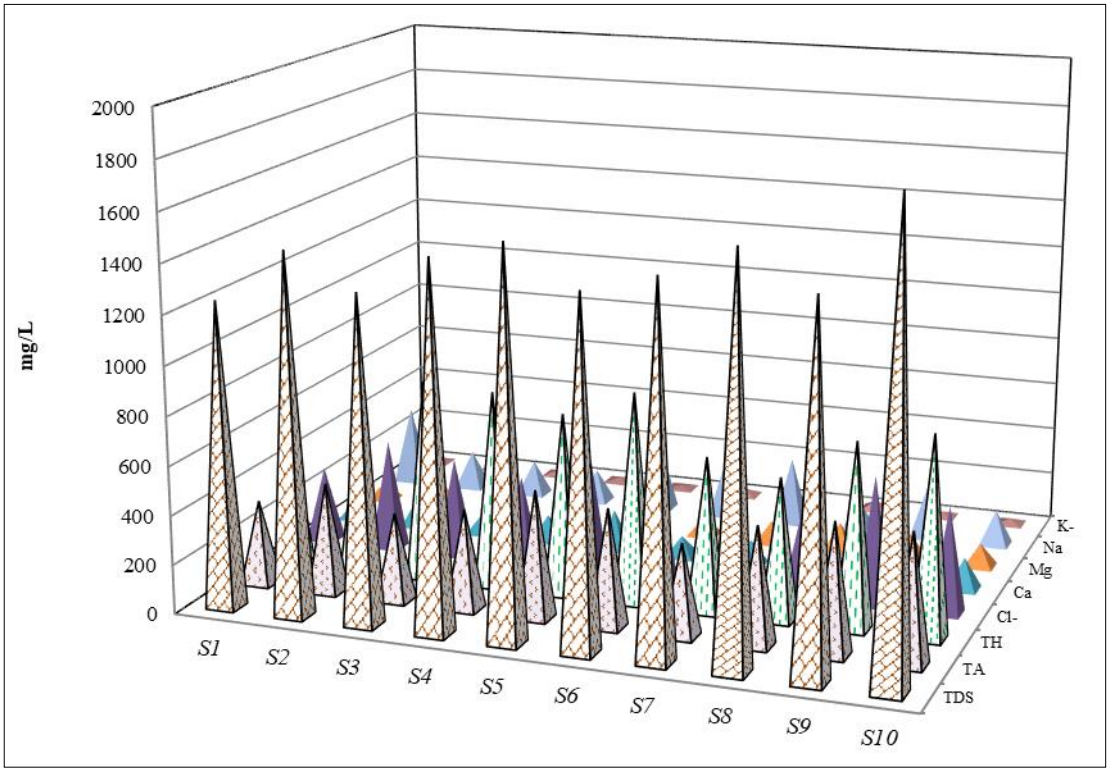

Fig 1: Graphics analysis of Average results of the physicochemical parameters.

Table 2: Matrix of correlation among water quality parameters.

Parameters	pH	EC	TDS	Turbidity	TA	TH	Cl-	Ca^{2-}	Mg^{2-}	Na^{+}	K^{-}
pH	1										
EC	0.366	1									
TDS	0.385	0.301	1								
Turbidity	0.072	0.198	0.326	1							
TA	0.151	0.434	0.688	0.425	1						
TH	0.010	0.222	0.158	0.717	0.293	1					
Cl-	-0.161	0.198	0.236	0.475	0.731	0.493	1				
Ca	-0.040	0.165	0.524	0.497	0.725	0.120	0.747	1			
Mg	0.407	0.613	0.470	0.420	0.402	0.181	0.100	0.420	1		
Na	-0.036	0.035	-0.435	-0.152	-0.216	-0.259	0.000	-0.019	-0.432	1	
K-	0.478	0.423	0.366	0.003	0.465	0.276	0.058	-0.180	0.349	-0.551	1

4. Conclusion

Analysis of water samples collected from various locations of Mauganj blocks revealed that all water samples do not comply with WHO standards and Indian Standards- 10500-91. Underground water in Mauganj region requires precautionary measures before drinking so as to prevent adverse health effects on human beings.

5. Acknowledgement

Authors are thankful to authority of Environmental Biology Deptt. of A.P.S. University, Rewa (M.P.) India for providing facilities to carry out this work.

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