An Analysis of Quality of Ground Water of Patan Tehsil of Durg District, Chhattisgarh, India

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Abstract: ***This study is to monitor the pollution level of ground water samples from random five villages of patan tehsil of durg district, chhattisgarh, India. In this study five water samples were collected from different locations of a village viz. hand pumps, tube-wells, boreholes, electrically operated pumps of patan tehsil during June2015–Dec2015 and various water quality parameters have been considered and analyzed by ICMR and BIS satandard. In this block several people are suffering from health problems such as skin disease, jaundice , typhoid, malaria, influenza, teeth problem, bone problem, gastric trouble and arthritics etc. The present investigation revealed that the some of the ground water samples are not suitable for drinking purpose and they needs some treatment before consumption.***

Keywords: Drinking water, Water quality Index, Ground water, Human health and Diseases.

1. Introduction

Water is one of the most indispensable resources and is the elixir of life. Life is not possible on this planet without water[1]. Ground water is a good source of fresh water available on the earth. Safe drinking water is a fundamental human need and it is an important factor that determines the physical and social health of the people[2]. Effluents generated by industries are sources of pollution. Contaminated air, soil, and water by Industrial effluents are associated with disease burden like flurosis, diarrhea, dysentery, typhoid, dengu, malaria, hepatitis, skilling, cancer, gastroenteritis, liver and intestinal infection etc[3]. Chemical contamination of drinking water may not cause time intake may be fatal for human health and this could be reasons for the current shorter life expectancy in chhattisgarh state and in the country [4]. Hence, quality index assessment of water is important to assess the quality of groundwater in any rural areas that influences the suitability for drinking, domestic, bathing, irrigation and industrial needs[5-7].

Water quality index assessment describes the overall quality of the water based on several water quality variables. The quality of water may depend on geology of particular area and also vary with depth of water label and is governed by the extent and composition of the dissolved salts depending upon source of the salt and soil-surface environment. The objective of water quality index assessment is to give information to mankind regarding the quality of a particular water body for multipurpose usages[8].

1.1 Objective of the Analysis

The main objective of the present work is to emphasize on the quality of ground water and its suitability for human consumption .

1.2 Study Area

ArcGIS (version 9.0) software has been used for the present study. Patan tehsil of durg district is an major industrial area of bhilai situated on the central fertile plain of Chhattisgarh. It is situated between 21.03000N latitude and 81.5300° E longititude, on the Howrah-Mumbai NH-6 road. Patan is one of the tehsil of durg district 32.5 km far away from durg city. It is 25-30 km far away from its state main city raipur . The ground water quality of patan block is continuously degraded due to industrial activities. The study area of the proposed work is shown in the Figure1.

Figure1: GPS locations of ground water of patan block

of durg district in Chhattisgarh

2. Material and Methods

In the present study five water samples were collected from the different villages of patan tehsil during June 2015–Dec2015 and taken in pre-cleaned 1 litre polyethylene bottles. The samples after collection were immediately placed in dark boxes and processed within 6 h of collection. The analysis of water was done using procedure of standard methods.

Parameters	*Methods*
pH	Systronics pH meter
Turbidity	Digital Nephlo-Turbid meter-132
Alkalinity	Titration with acid HCl
TH	EDTA Method
TDS	HM digital meter TDS-3
EC	Systronic Conductivity Meter-304
Arsenic	Elico flame photometer
Calcium	Elico flame photometer
Magnesium	Elico flame photometer
Chloride	Argentometric titration
Fluoride	Ion Selective Electrode
Iron	Elico flame photometer
Manganese	Elico flame photometer

1.3 Water Quality Index (WQI):

Water quality index assessment describes the overall quality of the water based on several quality varibles. It is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water . The WQI has been investigating Indian drinking water standards[10] and calculated from the point of view of the suitability of ground water for human consumption[6] by adopting the Brown and coworkers methods[11] shown in table2.

Table 2: Quality of Water Classified on the basis of WQI

Class	*WQI Value*	*Water Quality Status*
I	Less than 50	Excellent Water
II	50-100	Good Water
III	100-200	Poor Water
IV	200-300	Very poor Water
V	More than 300	Unsuitable for drinking

The WQI values obtained from eight water samples and it is calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council for Medical Research (ICMR)[12]. The calculation of WQI was using a weighted arithmetic index method.

Calculation of quality rating (qn) :
qn = 100[(Vn - Vi) / (Sn - Vi)]
Where, qn = quality rating for the nth W.Q. parameter.

Vn = Obs.value of the nth parameter, Sn = standard permissible value of nth parameter and Vi = ideal value of nth parameter in pure water.
Generally,Vi = 0 except in certain parameters like pH=7.0(natural water) and permissible value pH=8.5 (polluted water). similarly for dissolved oxygen=14.6mg/L and Fluoride=1.0 mg/L etc.
Calculation of quality rating for pH , Fluoride and DO as below :

q_{pH} = 100 (V_{pH} – 7.0) / (8.5-7.0), q_F= 100 (V_{pH} – 1.0) / (1.5-1.0), and q_{DO} = 100 (V_{DO} – 14.6) / (5.0-14.6)

Calculation of unit weight(*Wn*) :
Wn = K/ Sn,
Where, *Wn* = unit weight for n^{th} parameter, *Sn*= standard value for n^{th} parameters, K = proportionality constant.
$K= 1/[1/S_1+1/S_2+\ldots\ldots\ldots+1/S_n]$

Calculation of WQI :
WQI is calculated from the following equation as below

$$\mathbf{WQI} = \sum_{n=1}^{n} q_n w_n / \sum_{n=1}^{n} w_n$$

Table 3: Drinking water standards, recommending agencies

S. No.	*Parameters*	*Sn*	*Reco .Agency*	*Unit Weight(Wn)*
1	pH	8.5	ICMR/BIS	0.083
2	EC(µs/cm.)	300	ICMR	0.002
3	Turbidity	10	BIS	0.01
4	TDS	500	ICMR/BIS	0.001
5	Fluoride	1.5	BIS	0.471
6	Hardness	300	ICMR/BIS	0.002
7	Calcium	75	ICMR/BIS	0.009
8	Magnesium	30	ICMR/BIS	0.024
9	Chloride	250	ICMR	0.003
10	Sulphate	150	ICMR/BIS	0.005
11	Alkalinity	120	ICMR	0.006
12	Nitrate	45	ICMR/BIS	0.016

***** *All the parameters are expressed in mg/l except pH, Turbidity (NTU).*

Table 4: Seasonal variations of the Physico-Chemical Parameters of ground Water

Parameters	*Seasons*	*Sampling Stations*					Average
		GW_1	GW_2	GW_3	GW_4	GW_5	
pH	Rainy	7.4	7.8	8.2	7.5	7.2	7.6
	Winter	9.0	8.4	8.9	8.5	8.3	8.6
Turbidity	Rainy	1.8	2.1	1.3	2.5	2.1	1.9
	Winter	1.1	1.8	1.1	1.9	1.4	1.4
Alkalinity	Rainy	118	111	102	92	89	102.4
	Winter	187	190	213	226	275	218.2
TH	Rainy	232	250	398	231	367	295.6
	Winter	378	376	534	412	421	424.2
TDS	Rainy	385	345	298	333	310	334.2
	Winter	565	343	520	423	421	454.4
EC	Rainy	765	823	932	956	810	857.2
	Winter	798	876	987	969	894	904.8
Calcium	Rainy	41	58	53	57	49	51.6
	Winter	58	60	57	51	54	56
Magnesium	Rainy	12	10	11	12	14	11.8
	Winter	11	12	14	15	17	13.8
Chloride	Rainy	53	57	59	67	76	62.4
	Winter	57	59	68	87	84	71
Fluoride	Rainy	0.33	0.31	0.28	0.47	0.58	0.39
	Winter	1.44	0.32	0.91	0.84	1.34	0.97
Iron	Rainy	5.9	7.2	6.3	11.2	4.2	6.96
	Winter	16.5	15.9	14.7	18.2	19.1	16.8
Manganese	Rainy	0.3	1.0	1.1	1.4	0.9	5
	Winter	1.4	2.8	1.9	2.7	1.5	5.5
DO	Rainy	5.5	6.1	5.6	5.9	5.7	5.7
	Winter	4.9	5.6	5.2	5.7	5.1	5.3
BOD	Rainy	6.4	5.7	6.8	6.1	6.6	6.3
	Winter	5.9	6.1	6.3	5.5	6.4	6.0

***** *GW_1= Ground waterKhorpa,GW_2=Tulsi,GW_3=Bodal,Gw_4=Kharra, GW_5=Bodal villages of Patan tehsil*

Table 5: Calculation of Water Quality Index in Rainy Season

Rainy Season						
S.No	*Parameters*	*Standard Value (S_n)*	*Unit Weight (W_n)*	*Observed Values*	*Quality Rating (q_n)*	*Weighted ($W_n q_n$)*
1	pH	8.5	0.083	7.6	40	3.32
2	EC	300	0.002	857.2	322.8	0.645
3	Turbidity	10	0.010	1.9	18.6	0.186
4	TDS	500	0.001	334.2	17.1	0.017
5	Hardness	300	0.471	295.6	-2.2	-1.03
6	Fluoride	1.5	0.002	0.39	-122	-0.244
7	Calcium	75	0.009	51.6	6.4	0.057
8	Magnesium	30	0.024	11.8	-91	-2.1
9	Chloride	250	0.003	62.4	6.2	0.018
10	DO	5	0.141	5.7	92.70	13.07
11	BOD	5	0.100	6.3	26	2.6
12	Alkalinity	120	0.006	102.4	-176	-1.05
			$\sum w_n$ =0.898			$\sum q_n w_n$ = 15.489
			WQI = $\sum q_n w_n / \sum w_n = 17.24$			

Table 6: Calculation of Water Quality Index in Winter Season

Winter Season						
S. No.	*Parameters*	*Standard Value (S_n)*	*Unit Weight (W_n)*	*Observed Values*	*Quality Rating (q_n)*	*Weighted ($W_n q_n$)*
1	pH	8.5	0.083	8.6	106.6	8.847
2	EC	300	0.002	904.8	341.9	0.684
3	Turbidity	10	0.010	1.4	13.56	0.135
4	TDS	500	0.001	454.4	77.2	0.077
5	Hardness	300	0.471	424.2	62.1	29.25
6	Fluoride	1.5	0.002	0.97	-6	-0.012
7	Calcium	75	0.009	56	24	0.216
8	Magnesium	30	0.024	13.8	-81	-1.944
9	Chloride	250	0.003	71	10.5	0.031
10	DO	5	0.141	5.3	96.87	13.65
11	BOD	5	0.100	6.0	20	2.0
12	Alkalinity	120	0.006	218.2	984	5.90
			$\sum w_n$ =0.898			$\sum q_n w_n$ = 58.834
			WQI = $\sum q_n w_n / \sum w_n = 65.51$			

Figure 2: Snap of patan tehsil villager of durg , chhattisagarh suffering from different diseases

3. Results and Discussions

Analytical results obtained for different study parameters from different sampling locations in different seasons of June-Dec 2015 are summarized in table 4. Permissible limits and recommended agenesis are described in table 3. On the plotting of graph between pH value and seasonal variation of ground water slop was slight higher than the permissible limit. The pH value of natural water changes probably due to biological activity and industrial contamination. pH of the samples was found in the range of 7.2 to 9.0. Higher pH value imparts bitter taste.

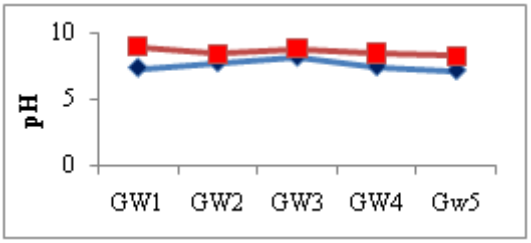

Figure 3: pH values of variable season

Electrical conductivity of ground water was found to higher

than that of permissible zone as mentioned in table 3. EC indicates that the content of soluble and high conducting salts present in the ground water sample. Here the EC of all samples in variable seasons are not in the permissible limit as shown in figure 4.

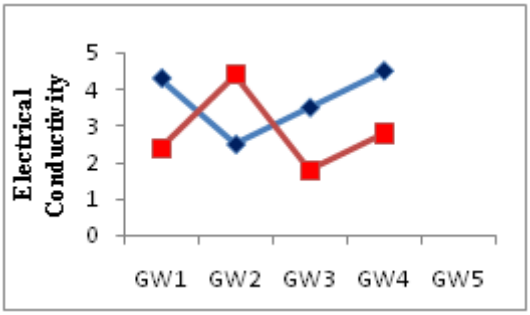

Figure4: EC values of variable season

TDS of the samples in different location in the range of 298 to564. In winter seasons the value is above the permissible limit, while rest of the samples have within the highest permissible limit. The high value may be due to the addition of solids from run off water, swage, industrial effluents.

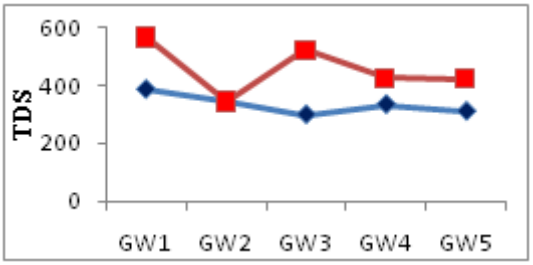

Figure 5: TDS values of variable season

On the plotting of graph between the concentration of fluoride and ground water the values of GW is slightly higher than that of the permissible limit. Graph shows that the value of GW1, GW3 and GW5 is higher than limitations. Peoples of villagers are suffering form different dieases. Fluoride concentrations in the range of 0.28 to 1.44 with the mean value of 0.39 to 0.97.

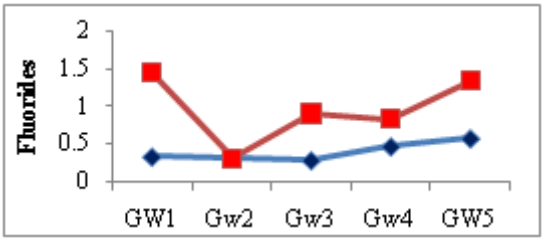

Figure 6: Fluorides values of variable season

The average value of DO in rainy seasons was 4.9, in winter season, while 6.1 in rainy season. This shows that the DO above the permissible limit is good for health.

The average value of BOD in rainy seasons was 5.5 in winter season, while 6.8 in rainy season. Result indicates the mean value was above the permissible limit.

Alkalinity is an important if it is less than 100 ppm is desirable for domestic but not suitable for drinking purpose.**uses** ; however in large quantities it imparts bitter taste to water. In the present investigation alkalinity was found in rainy seasons mean was 218.2 in winter season, while 102.4 mean in rainy season. Result indicates the mean value was above the permissible limit.

Water Quality Index out of five samples was computed for the study area in the rainy and winter season are presented in Table4, 5 and 6 respectively. The computed WQI for rainy season indicate that the overall WQI was 17.24 as compared to winter season 65.51 respectively. The high values of WQI have been found in winter season and lower value in rainy season. All the seasons the ground water quality is found good in compare to surface water. The high value of WQI in winter season is because of high concentration of TDS, fluoride, Iron ,alkalinity , hardness and EC in ground water. Water quality of some samples tends to poor quality during winter season.

4. Conclusions

The study has been conducted in patan tehsil of durg district in Chhattisgarh for measuring quality of ground water for drinking purpose. The samples shown that the pH of the ground water was above the permissible limit as prescribed by Indian Council for Medical Research and Bureau of Indian Standard. Fluoride, TDS and Iron values are above the permissible level. The results shows that some parameters shown higher values in rainy and winter seasons and which don't within the limits of standards and also water quality index. So highest priority should be given to water quality monitoring and there indigenous technologies should be adopted to make water fit for domestic, bathing and drinking purpose after treatment.

5. Acknowledgement

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