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GROUND WATER QUALITY IN MAYURBHANJ DISTRICT, ODISHA

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ABSTRACT

Ground water is an essential and vital component of our life support system. The ground water resources are being utilized for drinking, irrigation and industrial purposes. There is growing concern on deterioration of ground water quality due to geogenic and anthropogenic activities. Groundwater samples were collected from various points in the Mayurbhanj district for determining the it's quality and for assessing the level of contamination by analyzing different parameters like cations (Na, K, Ca, and Mg) and anions (Cl, CO_3, HCO_3 and SO_4). The results of the present study indicated that the values of all the parameters are well within the permissible limits. They are found to be suitable for both drinking and agriculture.

***Keywords**: Groundwater, Hard rock ware geochemistry.*

INTRODUCTION

Ground water is an essential and vital component of our life support system. The quality of ground water has undergone a change to an extent that the use of such water could be hazardous. Increase in overall salinity of the ground water and/or presence of high concentrations of fluoride, nitrate, iron, arsenic, total hardness and few toxic metal ions have been noticed in large areas in several states of India. Ground water contains wide varieties of dissolved inorganic chemical constituents in various concentrations as a result of chemical and biochemical interactions between water and the geological materials through which it flows and to a lesser extent because of contribution from the atmosphere and surface water bodies.

Water has been proved the most important component for the mankind to survive. From time immemorial, civilizations have thrived, grew and evolved. It is seen that the ancient civilizations took their root in river valleys. Around these river valleys, all over the world, water proved itself the driving mechanism for the mankind to grow. It is not only the water on the surface, but also groundwater played an important role in the holistic development of ancient societies. Though we have very little knowledge about the uses of groundwater by the ancient civilization, it is quite well known that the present society is completely dependent on groundwater. Groundwater is only a very small component of the total fresh water available on the surface of the earth. Groundwater is not only utilised for the purpose of drinking but also it finds its use in agriculture and industries too. Therefore, it becomes pertinent on the part of the mankind that this resource should be utilised judiciously and carefully. Groundwater is found under various aquifer conditions. It is richly available in porous and permeable sedimentary rocks. Along the course and in alluvial terrains, groundwater exists in small pores of alluvium. If we look at the geology of Odisha, a major part (except the coast) is constituted of crystalline hard rocks. Under such geological conditions, groundwater is generally available in fractured domain as well as in the weathered part of the hard rock terrain. Since the study area is coming under crystalline hard rock terrains, normally the groundwater is found in the fractured and weathered parts of the rock terrain. For its use by society, it is important that its hydrochemistry should be analysed.

Ground water in shallow aquifers is generally suitable for use for different purposes and is mainly of Calcium bicarbonate and mixed type. However, other types of water are also available including Sodium-Chloride water. The quality in deeper aquifers also varies from place to place is generally found suitable for common uses. The main ground water quality problems in India are as follows.

Inland Salinity

Coastal Salinity

Fluoride

Arsenic

Iron

Nitrates

STUDY AREA

The present study has focused on the quality of groundwater in Mayurbhanj District, Odisha. The study area (Fig-1) is bounded by 21^0 39′ 21.6″ to 21^0 54′ 18″ N latitude and 85^0 48′ 25.2″ to 86^0 21′ 28.8″ E longitude. Mayurbhanj District got separated from Kendujhar District by Baitarani River in the south-west. Geographically, it has occupied an area of 314.76 sq.km. and is located about 221 km North of Bhubaneswar. It falls in series of Survey of India toposheet nos. F45O1, F45O2, F45O6, F45N13. The average elevation of the block is about 389 meters MSL.

Fig-1. Location map of the study area

GEOMORPHOLOGY AND GEOLOGY

Geomorphology of an area strongly affects the occurrence of groundwater. The Distric is a highland area which occupies some part of the Baitarani River Basin. Denudation hills, plateau, pediplain, structural hills and water bodies are the most dominated landforms in the study area. The eastern part of the block is mostly occupied by structural hills where as plateau and pediplain occupy the western part. The north-eastern part of the block is surrounded by Similipal Reserve Forest. The central part of the district is occupied by Similipal Complex in circular pattern. It is surrounded by intrusive bodies of gabbro, granophyre and pyroxene granite. Three alternative volcano sedimentary bands of ring like structure are found in this complex. These bands indicate sub-marine conditions of origin. The central part of the complex is covered with Amjori sill. Similipal complex is uncomfortably overlain by Singhbhum Granite of Palaeo- Proterozoic age and underlain by Gorumahishani and Older Metamorphic Group of Archean age. Baripada Bed of Miocene age is found in the eastern part of the district, which is a marine continental shelf deposits (Sahu, 2018).

Gabbro, schist, epidiorite, granite, pegmatite and quartzite are considered as the major rock types of the study area. The area has rich sources of hard massive, laminated, biscuit, shaly, lateritic and gruneritic types iron ore minerals. Titaniferous and vanadiferous magnetite deposits are accompanied by gabbro and anorthosite suite of rocks. These are mainly composed of magnetite and illmenite and some minor minerals of haematite, limonite, rutile, coulwsonite and sulphides. Karanjia block is well known for its china clay deposits of Late Pleistocene to Early Holocene age. Lenticular bodies of copper (chalcopyrite variety) are found in the tail part of the Singhbhum thrust belt. Some amount of tremolite variety of asbestos, kayanite and soapstone are reported from the area (Sahu, 2018).

METHODOLOGY

The groundwater samples were collected from 50 tube-wells of the study area. The samples were collected in clean 1000 ml plastic bottles. The bottles were rinsed before sampling and tightly sealed after collection, and numbered by marker. After collection of the water samples, the samples were preserved and shifted to the laboratory for physico-chemical analysis. Physical parameters like pH, electrical conductance(EC), total dissolved solid (TDS), total hardness as $CaCO_3$(TH) and ionic concentrations of calcium(Ca^{2+}), magnesium (Mg^{2+}), sodium(Na^+), potassium(K^+), bicarbonate(HCO_3), chloride(Cl^-), sulphate(SO_4^{2-}) were determined in the laboratory and then compared with standard values recommended by World Health Organization(WHO, 1993) and Indian Standards Institution (ISI,1991). pH of the samples were measured using Systronics water analysis kit. Conductivity meter was used for TDS and EC measurement. By volumetric titration procedure,

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Ca^+, Cl^- and HCO_3^- were determined and concentration of Mg^+ is derived by conversion method. Flame photometer was used to determine Na^+ and K^+ ions.

RESULTS

The physical and chemical parameters for the collected samples are shown in Table- 1. These are expressed in mg/l. The negative logarithm of the H^+ ion concentration is known as pH value. The minimum pH value of the study area is 5.78 and that of maximum is 7.59. Average pH value is 6.69. TDS depends on the concentration of minerals, salts, metals, cations and anions in water. The TDS values of the collected samples vary from 25mg/l to 535mg/l, all these values are below max permissible limit as pas ISI standards. In natural water, the concentrations of Ca^{2+} and Mg^{2+} determine the TH value. In my study area, the TH value ranges from 51 mg/l to 420 mg/l. The concentrations of major cations like Ca^{2+}, Mg^{2+}, Na^+ and K^+ vary from 230.183 mg/l to 30.024 mg/l, 0.904 mg/l to 189.817 mg/l, 1.73 mg/l to 54.41 mg/l and 0.08 mg/l to 13.50 mg/l respectively and that of anions like Cl^-, HCO_3^- and SO_4^{2-} range from 14.2mg/l to 163.3mg/l, 30mg/l to 230mg/l and 408mg/l to 466mg/l respectively.

DISCUSSION

The chemical contents found in the groundwater are thought to have derived from the weathering of lithology units forming the aquifers and their variation is due to prolonged interaction of groundwater with surrounding rocks and aquifer materials. The resulted analytical values are used to find the suitability of water for drinking and irrigation purposes.

Groundwater for drinking purpose

Drinking water should be free from turbidity, pathogenic bacteria and radioactive minerals, and also colourless, odourless and tasteless. The polluted water is harmful for living beings. Results of analysis are presented in Table- 1 and they are compared with the permissible drinking water standards (Table-2) specified by Indian Standard Specification as per IS: 10500-1993 and WHO international standards(2004).

Table. 1. Water Quality Parameters and their concentrations (in mg/l)

LOCATION	Ca	Mg	Na	K	HCO_3	Cl	SO_4	TDS	P^H	TH	%Na
Karanjia (NAC) Word no-11	230.18	189.82	54.41	13.50	180	163.3	446	535	6.69	420	9.10
Karanjia (NAC) MCL bank	120.1	0.90	7.55	0.23	80	35.5	442	102	6.70	121	5.22
Karanjia (NAC) Bus stand	50.04	29.96	8.40	0.72	70	28.4	442	74	6.57	80	7.18
Sanadeuli	80.06	19.94	9.11	0.19	80	28.4	456	102	6.87	100	6.65
Badadeuli	70.06	29.94	12.38	0.32	90	28.4	432	97	6.66	100	8.40
Bhaunra	60.05	0.95	8.41	0.53	60	14.2	451	63	7.0	61	10.98
Pingu	60.05	29.95	9.55	0.51	50	14.2	456	72	6.59	90	7.28
Pahadbhanga	80.06	0.94	13.67	0.37	50	71	437	92	6.22	81	12.92
Sarangard	60.05	19.95	10.48	0.42	70	21.3	451	79	6.79	80	9.14
Asanbani	110.09	29.91	17.75	0.33	70	85.2	456	175	6.37	140	8.94
Chitraposi	100.08	89.92	16.44	1.55	150	35.5	442	180	7.59	190	5.74
Murgapat	100.08	69.92	11.65	0.08	110	42.6	451	151	7.03	170	4.52
Chadheibhol	80.06	59.94	14.68	0.26	110	35.5	456	140	7.36	140	6.74
Ghosda	60.05	9.95	11.47	0.25	50	35.5	461	68	6.60	70	11.7
Mahadev Deuli	60.05	29.95	13.04	0.12	80	21.3	466	93	6.51	90	9.46
Ghodaghaguri	50.04	9.96	7.91	0.90	50	21.3	451	47	6.45	60	9.97
Rasantala	130.10	49.9	8.30	2.90	90	56.8	451	178	6.38	180	3.95
Mandua	100.08	29.92	15.73	1.40	40	71	437	133	6.09	130	8.81
Kudarsahi	30.02	39.98	5.16	0.46	40	21.3	456	47	6.56	70	4.70
Kadadiha	70.06	10.06	1.92	0.80	50	35.5	437	33	6.17	60	2.35
Kuliposi	60.05	49.95	6.61	0.73	80	28.4	432	79	6.43	110	4.13

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Tanguru sahi	50.04	29.96	6.12	0.99	50	28.4	446	60	6.24	80	5.55
Kalakad	60.05	49.95	8.29	0.51	70	35.5	456	106	6.58	110	5.0
Baliposi	100.08	9.92	15.43	1.65	50	71	461	140	6.29	110	10.94
Kerkera	80.06	49.94	11.67	0.29	90	35.5	451	110	6.84	130	5.98
Badasarei	60. 05	59.95	9.0	1.26	70	28.4	456	62	6.35	120	5.07
Chandusahi	50.04	29.96	7.32	0.08	60	28.4	451	60	6.75	80	6.07
Dori	20.02	59.98	2.73	1.20	30	28.4	446	25	5.82	80	2.46
Kath- karanjia	130.1	20.10	4.69	1.06	80	28.4	456	98	6.48	110	2.76
Jarali	90.07	9.93	6.35	0.59	80	21.3	446	80	6.61	100	5.20
Nakuda	100.08	59.92	5.93	1.69	100	35.5	456	149	6.62	160	2.95
Tato	50.04	0.96	5.33	2.81	40	28.4	442	35	6.14	51	10.55
Bandhasahi	40.03	19.97	4.92	3.44	40	35.5	456	44	5.78	60	7.66
Badagaon	70.06	59.94	5.85	0.42	90	28.4	451	112	6.96	130	3.05
Sangaon	90.07	69.93	7.48	1.12	120	21.3	456	125	7.25	160	3.34
Ranipat	90.07	59.93	20.40	20.27	110	78.1	456	241	6.77	150	12.98
Sialinai	110.09	19.91	4.78	0.58	110	28.4	451	111	6.95	130	3.03
Batpalasa	90.07	59.93	4.10	1.03	110	21.3	461	119	6.69	150	2.13
Kudarsahi	110.09	79.91	7.10	0.45	170	28.4	456	180	7.51	190	2.59
Patulidih	110.09	29.91	3.80	0.39	110	21.3	427	130	6.75	140	2.16
Hatibari	170.14	129.86	5.75	0.31	230	35.5	408	259	7.22	300	1.33
Kiapanposi	100.08	69.92	2.36	1.66	120	21.3	451	126	7.0	170	1.33
Kia	120.10	29.90	1.73	0.56	110	28.4	446	131	6.73	150	1.05
Bala	120.10	19.90	2.36	1.19	80	28.4	451	123	6.42	140	1.71

Table 2: Water Quality Standards of various agencies

Sl. No.	Parameters	Observed Range of values	ISI Maximum Permissible limits	ICMR Maximum Permissible limits	WHO Guidelines
1	Colour	-	10	25	
2	Test	-	Agreeable	Unobjectionable	
3	Odor	-	Unobjectionable	Unobjectionable	
4	Turbidity	-	10 NTU	25 JTU	
5	pH	7.12-8.9	6.5 – 8.5	6.5 – 9.2	
6	TDS (in mg/l)	595-5448	500	1500-3000	
7	TH (in mg/l)	110-1250	300	600	
8	Ca (in mg/l)	3.80-1089	75	200	200
9	Mg (in mg/l)	4.89-400	30		
10	Fe (in mg/l)	-	0.3	1.0	10 (Total Iron)
11	Cu (in mg/l)	-	0.05	1.5	1.5
12	Mn (in mg/l)	-	0.1	0.5	0.5
13	SO_4 (in mg/l)	21.94-643.50	150	400	400
14	Cl (in mg/l)	35.49-3164.97	250	1000	250
15	NO_3 (in mg/l)	-	45	100	10
16	F (in mg/l)	-	0.6 – 1.2	1.5	1.5
17	Hg (in mg/l)	-	0.001	0.001	
18	Cd (in mg/l)	-	0.01	0.01	
19	As (in mg/l)	-	0.05	0.05	
20	Cn (in mg/l)	-	0.05	0.05	
21	Pb (in mg/l)	-	0.1	0.05	
22	Zn (in mg/l)	-	0.5	0.10	
23	Cr (in mg/l)	-	0.05		
24	Na (in mg/l)	38.31-1931	-		200

According to WHO and ISI standards, all the P^H values of the samples are under maximum permissible limit. Davis and De Wiest (1966) categorized the groundwater with TDS < 500mg/l is desirable and 500-1000 mg/l is permissible limit for drinking purpose. In my study area all the samples have TDS below desirable limit except sample no. 1, which is in permissible limit. As par ISI 1993, all the TH values of the study area are under maximum permissible limit.

Groundwater for irrigation purpose

The suitability of groundwater for irrigation purposes are determined by using sodium percentage (Na %), sodium absorption ratio (SAR). The %Na in water is a common parameter to evaluate its suitability for irrigational purposes (Wilcox, 1955). Higher sodium content reduces the permeability of soil and replaces Calcium and Magnesium concentration of clay. The sodium percent (%Na) values are obtained by using the following equation and they are listed in table 1

$$\%\text{Na} = \frac{\text{Na+K}}{\text{Ca+Mg+Na+K}} \text{X } 100$$

Where Na, K, Ca, Mg are in Meq/l. According to Wilcox's (1955) classification (table 3) of groundwater, the study area has excellent groundwater condition for irrigation.

Table 3 Classification of groundwater according to sodium percentage by Wilcox (1955) for irrigation purposes:

Percentage of sodium	Water quality	Percentage of samples
<20	Excellent	100%
20-40	Good	0%
40-6-	Permissible	0%
60-80	Doubtful	0%
>80	Unsuitable	0%

CONCLUSION

The groundwater of this area is dominated by Calcium and bicarbonate ions as compared to other major ions. The overall hydrochemistry is suitable for drinking water and agriculture purposes. Therefore, the local villagers should not be worried about the quality of groundwater for the above purposes.

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