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Evaluation of Ground Water and Surface Water of Central University of Jharkhand Campus and Adjoining Areas

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Abstract

Due to increased human population, industrialization, use of fertilizers and manmade activity, water is highly polluted with different harmful contaminants. Ground water gets contaminated due to weathering of rocks, leaching of soils, mining processes, etc. It is, therefore, necessary that the quality of drinking water should be checked at regular time interval, because use of contaminated drinking water by human population leads to various water borne diseases. In the present study, ground and surface water were collected from different site of Brambe and Central University of Jharkhand Campus, at Brambe, Ranchi District located in India for investigation of its physiochemical parameters. The local community is dependent on the groundwater and surface water for drinking and irrigation purpose. The objective of this study is to find out the quality of ground water and surface water around Brambe, and CUJ campus and report its suitability for domestic and agricultural purpose after appropriate treatment. These parameters are essential in determining quality of ground water and surface water. The results were compared with the drinking water guidelines of Indian Standard IS 10500 and IS 2296. Laboratory experiments were done using titrimetric method for analysis of various parameters like acidity, alkalinity, conductivity, pH, total hardness, free carbon dioxide and total solid and TDS (Total Dissolved Solid) were done using drying oven (105°C). Result of all parameters are within IS standard except alkalinity.

Keywords: Physiochemical parameters; Ground water, Surface water, Brambe

Introduction

Ground water, surface water (rivers, streams, and ponds), atmospheric water (rain-water, snow and hail) and springs are the main source of water available to the people in general. A tremendous increase in the population increased the stress on both surface and the groundwater. It is believed at the beginning of the human civilization itself, groundwater was the most trusted form of drinking water because of the filtering effect of the aquifer. However, in the present world drinking the water directly from the source without proper treatment is a tough task. The groundwater analysis for physical and chemical properties is

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very important for Public health studies. These studies are also main part of pollution studies in the environment. The groundwater contains such as odour, taste and temperature are physical characteristics. The natural quality of groundwater depends upon the physical environment, the origin, and the movement of water. As the water moves through the hydrological cycle, various chemical, physical and biological processes change its original quality through reactions with soil, rock and organic matter. Natural processes and human activities cause the changes in groundwater quality, directly or indirectly. According to WHO organization, about 80% of all the diseases in human beings are caused by water. Water is a vital natural resource which is essential for multiple purposes. Its major uses include drinking and other domestic uses, industrial cooling, power generation, agriculture (irrigation), transportation, and waste disposal. Water is also used in generation of hydropower. Water gets treated naturally as it circulates through hydrological cycle. Nevertheless, water still needs to be treated before being used for potable purpose. This can be attributed to presence of pollutants, contaminants, and pathogenic microorganisms in the environment. The hydrological cycle provides the supply of water for us to use for consumption by continuously cycling. The five basic processes in the hydrological cycle include condensation, precipitation, infiltration, runoff, and evaporation. Around 97% of the water on the earth is salt water and majority of the rest is fresh water which is found mainly as ground water, with only a small fraction present above ground as surface water or in the air as moisture. Fresh water is a renewable resource, yet that world's supply of ground water is steadily decreasing with depletion occurring most prominently in Asia due to its over exploitation.

Availability of Water Resources in India

Ground water availability in India

Ground water plays a key role in meeting the water needs of various sectors in India. Central ground water board has been vested with the responsibilities of assessing and managing the ground water resources of India through ground water measurement studies, exploration, evaluation, and monitoring of ground water regime. The overall contribution of rainfall to countries annual replenishable ground water resources is 67% and the share of other sources taken together is 33%. The contribution from other sources such as canal seepage, return flow from irrigation, seepage from water bodies in annual replenishable resources is more than 33 present in the state of Andhra Pradesh, Delhi, Haryana, Jammu and Kashmir, Jharkhand, Tamil Nadu, Utter Pradesh, Uttaranchal, and UT of Pondicherry.

Surface water availability in India

The ultimate source of surface water is rainfall. Nearly 80% of the annual rainfall takes place in only three to four month. Nearly 1110 km^3 of surface water is available in India. The Brahmaputra and Ganges are the major source of surface water in India. The Brahmaputra-Ganga basin accounts for about 60% of total surface water resources. Since the time-distribution of precipitation in India is quite uneven, floods are frequently observed in many parts of the country during July to September. The same region might experience acute water scarcity during the dry season. In India, per capita water availability since 1951 was 5177 m^3/capita/yr. But it has decreased to 1820 m^3/capita/yr as per the data of 2001.

Inorganic chemical composition of natural water

Water gets contaminated by several chemicals. The pH of fresh water is in the range of 6.5 to 8.5. Due to the contamination of water with chemicals, there are changes in the chemical properties of water. The major ions present in water are Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, SO^{2-}, Cl^{-1}, and HCO_3^{2-}. The most abundance ion in natural waters is Ca^{2+} followed by Mg^{2+}, Na^{+} and K^{+}. In

water bodies not affected by human activities and away from coastal areas, Cl^- usually is the least abundant anion in island water with humid climates. Chlorides salts are so much soluble that they do not persist in soil formations in humid environment. But halite (NaCl) crystals are commonly found within sedimentary rocks of marine origin.

Brackish and saline water have higher concentration of Na^+ than the divalent cations because of solubility constraints of the divalent ions, especially Ca^{2+}. The chemistry of the major cations is relatively simple. None participates in redox reactions, and as strong base cations they form soluble salts rather than complexes and insoluble minerals with hydroxide. Their acid base behaviour is limited. However, divalent cations especially Mg^{2+} react with OH^- at high pH which is important in removing hardness from waters [1]. In the present study, the groundwater and surface water of Central University of Jharkhand and its adjoining area has been determined to assess its quality. The objective of this study is to find out the quality of ground water and surface water around Brambe, and CUJ campus and report its suitability for domestic and agricultural purpose after appropriate treatment.

Methodology

The Bore wells water samples of drinking water and surface water were collected from seven different site of village Brambe. Sampling time is 10 am to 12 am and sample collected in plastic sampling bottles with essential protections. Double distilled water was used for the preparation of reagents and solutions. In this study, the water quality parameters measured for the inspection were temperature, conductivity, pH, total solids, TDS, acidity, alkalinity, free carbon dioxide, total hardness (TABLE 1). The analysis of all the parameters were done as per the standard methods [2,3].

TABLE 1. **Methods of physicochemical parameters of ground water and surface water.**

Parameters	**Method/Instrument**
Temperature (degree Celsius)	Thermometer
Conductivity	Conductivity meter
pH	pH meter
Total solids	Drying oven (105°)
Total dissolved solid (TDS)	Drying oven (105°)
Free Carbon dioxide	Titrimetric method
Acidity	Titrimetric method
Alkalinity	Titrimetric method
Total hardness	Titrimetric method

Results and Discussion

The pH, electrical conductivity, total hardness, acidity, free CO_2, alkalinity, total solids, and total dissolved solids of ground water and surface water of various sites of Brambe village near Central University of Jharkhand, Brambe, Ranchi, India was determined. The result obtained has been depicted in Tables (TABLE 2).

TABLE 2. **Temperature of ground water.**

Name of sample site	Temperature (°C)	IS Standard
Near Administrative block of CUJ	26.9	-
CUJ campus	23.1	-
Brambe chowk, Ranchi	23.1	-

As per the IS specification, IS 10500:2012, temperature of drinking water was not specified [4]. The ground water sample at the sites near Administrative block of CUJ, CUJ campus, and Brambe chowk were within the specification. However, the ground water at Brambe Hospital did not meet the specifications of IS 10500:2012 (TABLES 3 and 4).

TABLE 3. **Temperature of surface water.**

Name of the site	Temperature (°C)	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	30.4	-	-	-	-	-
Brambe Village Area, Ranchi	30.4	-	-	-	-	-
Near Carmel School Pond, Brambe, Ranchi	29.9	-	-	-	-	-

TABLE 4. **pH of ground water sample.**

Name of the site	pH	IS Standard
Near Administrative block of CUJ	7.0	6.5 and 8.5
CUJ campus	6.9	6.5 and 8.5
Brambe chowk, Ranchi	6.1	6.5 and 8.5
Brambe Hospital, Ranchi	5.8	6.5 and 8.5

As per the IS specification, IS 10500:2012, the pH of drinking water purpose should lie between 6.5 and 8.5 [4]. The ground water sample at the sites near administrative block of CUJ, CUJ campus, and Brambe chowk were within the specification but sample of Brambe chowk, Brambe Hospital, Ranchi did not within specification. However, the ground water at Brambe chowk and Brambe Hospital did not meet the specifications of IS 10500:2012 (TABLE 5).

TABLE 5. **pH of surface water sample.**

Name of the site	pH	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	8.9	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5

Brambe Village Area, Ranchi	8.9	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Near Carmel School Pond, Brambe, Ranchi	7.4	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5

As per the IS specification, IS 2296 the surface water quality standards for various uses (drinking water, bathing, fish culture, wildlife propagation, irrigation) requires the pH of water to be in the range 6.5 and 8.5 [5]. While, the Carmel School Pond fulfilled the specification, the pH value was out of range for Brambe Hospital and Brambe Village Area (TABLES 6-8).

TABLE 6. **Electrical conductivity of ground water sample.**

Name of the site	Electrical conductivity (µs/cm)	IS Standard
Near Administrative block of CUJ	30	-
Near CUJ campus	40	-
Brambe chowk, Ranchi	40	-
Brambe Hospital, Ranchi	20	-

Electrical conductivity shows the concentration of ions present in the water. There is no specification for the electrical conductivity for the drinking water specified in IS 10500:2012

TABLE 7. **Electrical conductivity of surface water sample.**

Name of the site	Electrical conductivity (µs/cm)	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	90	-	-	-	1000×10^{-6}	2250×10^{-6}
Brambe Village Area, Ranchi	116	-	-	-	1000×10^{-6}	2250×10^{-6}
Near Carmel School Pond, Brambe, Ranchi	20	-	-	-	1000×10^{-6}	2250×10^{-6}

The specification for Electrical conductivity given in IS 2296 is 1000×10^{-6} µs/cm and 2250×10^{-6} at 25°C for fish culture and wild life propagation; and irrigation, industrial cooling and controlled waste disposal respectively. The Electrical conductivity of the surface water samples of the selected sites were within the specifications for the uses specified in IS 2296.

TABLE 8. **Acidity of ground water sample.**

Name of the site	Value (mg $CaCO_3$/L as)	IS standard
Near Administrative block of CUJ	44	no specification
Near CUJ campus	52	no specification
Brambe chowk, Ranchi	68	no specification
Brambe Hospital, Ranchi	68	no specification

Acidity of water is its quantitative capacity to react with a strong base to a designated pH [3]. The acidity of the samples of ground water was found to be moderate. For the purpose of drinking water there is no specification for acidity given in IS 10500:2012 (TABLE 9).

TABLE 9. **Acidity of surface water sample.**

Name of the site	Acidity (mg/l)	IS Standard				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	16.0	-	-	-	-	-
Brambe Village Area, Ranchi	40.0	-	-	-	-	-
Near Carmel School Pond, Brambe, Ranchi	30.0	-	-	-	--	-

The acidity of the samples of surface water was found to be moderate. For surface water, there is no specification for acidity given in IS 2296.

TABLE 10. **Total hardness of ground water sample.**

Name of the site	Total Hardness (as $CaCO_3$ mg/l)	IS Standard (as $CaCO_3$)
Near Administrative block of CUJ	80	600
Near CUJ campus	78	600
Brambe chowk, Ranchi	138	600
Brambe Hospital, Ranchi	58	600

As per the specification of IS 10500:2012, the acceptable value of total hardness for drinking water should be 600 mg/L as $CaCO_3$. In case of absence of alternative sources, the permissible limit may go up to 600 mg/L as $CaCO_3$. The values of total hardness obtained were within the acceptable limit specified by Indian specification (IS) (TABLES 10 and 11).

TABLE 11. **Total hardness of surface water sample.**

Name of the site	Total Hardness (as $CaCO_3$ mg/l)	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	180	300	-	-	-	-
Brambe Village Area, Ranchi	120	300	-	-	-	-
Near Carmel School Pond, Brambe, Ranchi	124	300	-		-	-

The value of Total Hardness specified by IS 2296 for surface water is 300 mg/L for Class A: Drinking water without conventional treatment but after disinfection. The surface water samples in the selected sites are within the specifications of IS 2296 for Class A.

TABLE 12. **Free CO_2 of ground water sample.**

Name of the site	Value (mg/L)	IS Standard
Near Administrative block of CUJ	28.6	-
Near CUJ campus	24.2	-
Brambe chowk, Ranchi	63.8	-
Brambe Hospital, Ranchi	70.4	-

It is reported that surface waters normally contain less than 10 mg free carbon dioxide (CO_2) per liter while some concentration in ground waters may easily exceed the value [3]. The CO_2 content of the water may contribute significantly to corrosion (TABLES 12 and 13).

TABLE 13. **Free CO_2 of surface water sample.**

Name of the site	Free CO_2	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	17.6	-	-	-	61	-
Brambe Village Area, Ranchi	33.0	-	-	-	61	-
Near Carmel School Pond, Brambe, Ranchi	44.0	-	-	-	61	-

The free CO_2 specified in IS 2296 for Class D-Water for fish culture and wild life propagation is 6 mg/L. The surface water samples had a higher value of free CO_2 and hence not suitable for the use for Class D purposes.

TABLE 14. **Alkalinity of ground water sample.**

Name of the site	Alkalinity (mg/l)	IS Standard 6 (mg/l)
Brambe Chowk	790	600
Brambe Hospital	1185	600
Brambe village	650	600

Alkalinity of water is its acid-neutralizing capacity and is the sum of all the titration bases. As per the specification of IS 10500:2012, the acceptable value of total alkalinity for drinking water should be 200 mg/L as $CaCO_3$. In case of absence of alternative sources, the permissible limit may go up to 600 mg/L as $CaCO_3$ [5]. The values of total alkalinity were high in all the ground water obtained was higher than the acceptable limit specified by Indian specification (IS). There exists no specification for acidity in IS 2296 for surface water (TABLES 14 and 15).

TABLE 15. **Alkalinity of surface water.**

Name of the site	Alkalinity (mg/l)	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	1975	-	-	-	61	-

Brambe Village Area, Ranchi	2495	-	-	-	61	-
Near Carmel School Pond, Brambe, Ranchi	1580	-	-	-	61	-

TABLE 16. **Total solid of ground water sample.**

Name of the site	Total solid (mg/L)	IS Standard (mg/L)
CUJ admin.	0.36	No specification
Near CUJ	0.36	No specification
Brambe chowk	0.28	No specification
Brambe hospital	0.12	No specification
There is no specification for total solids in either IS 10500:2012 or IS 2296		

TABLE 17. **Total dissolve solid of ground water.**

Name of the site	Total dissolve solid (mg/L)	IS Standard (mg/L)
CUJ admin.	36	2000
Near CUJ	36	2000
Brambe chowk	28	2000
Brambe hospital	12	2000

The total dissolved solids as per the specification of IS 10500: 2012, the acceptable value of total dissolved solids (TDS) is 500 mg/L (maximum) for drinking water and the permissible limit is up to 2000 mg/L in the absence of alternate sources. Hence, it can be assumed that the total dissolved solid is within the prescribed limits of 10500:2012 for drinking water (TABLES 16 and 17) [6].

TABLE 18. **Total dissolve solid of surface water.**

Name of the site	Total dissolve solid (mg/l)	IS Standard (Tolerance limit)				
		Class A	Class B	Class C	Class D	Class E
Brambe Hospital, Ranchi	180	500	-	1500	-	2100
Brambe Village Area, Ranchi	120	500	-	1500	-	2100
Near Carmel School Pond, Brambe, Ranchi	124	500	-	1500	-	2100

The total dissolved solids as per the specification of IS 10500:2012, the acceptable value of total dissolved solids (TDS) is 500 mg/L (maximum) for bathing, agriculture purpose and other purpose and the permissible limit is up to 2000 mg/L in the absence of alternate sources. Hence, it can be assumed that the total dissolved solid is within the prescribed limits of 10500:2012 for surface water (TABLE 18) [7-11].

Conclusion

In the present study, ground and surface water were collected from different site of Brambe and Central University of Jharkhand Campus, at Brambe, Ranchi District located in India for investigation of its physiochemical parameters. The local community is dependent on the groundwater and surface water for drinking and irrigation purpose. The ground water and surface water quality of different site of Brambe, and Central University of Jharkhand Campus, Brambe, Ranchi were tested to ascertain its quality. Laboratory experiments were done using titrimetric method for analysis of various parameters like Acidity, Alkalinity, Conductivity, pH, Total Hardness, Free Carbon Dioxide and Total solid and TDS (Total Dissolved Solid) were done using drying oven (105°C). Result of all parameters are within IS standard except alkalinity. All parameters were tested, almost all parameters except total alkalinity was within the specification of Indian Standard for drinking water. The high value of alkalinity will render the ground water suitable for drinking only after treatment.

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