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Physico-Chemical Characteristics of Selected Ground Water Samples of Ballarpur City of Chandrapur District, Maharashtra, India

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Abstract

The ground water quality is one of the most important criterion to ascertain its suitability for human beings and irrigation. This paper presents the ground water quality of Ballarpur city of Chandrapur district, Maharashtra. The ground water samples were collected from ten different locations and analyzed for physico-chemical characteristics such as pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), dissolved oxygen (DO), calcium (Ca^{2+}), chloride (Cl^-), fluoride (F^-), phosphate (PO_4^{3-}) and iron (Fe).The obtained results were compared with WHO (World Health Organization) and BIS (Bureau of Indian Standards) limits. The results revealed that some parameters were in high concentration and quality of the potable water has deteriorated to a large extent at some sampling locations.

Keywords: Ground water, physico-chemical characteristics, TDS, DO, Ballarpur.

Introduction

Water is an indispensable natural resource on earth. Two-thirds of the earth surface is covered by water. It is an essential and vital component for survival of all the living beings. It constitutes about 70% of the body weight of almost all living organisms. Potable water is the water that is free from disease producing micro-organisms and chemical substances. The scarcity of clean and potable drinking water has emerged as most serious environment issue of the twenty first century[1]. Ground water is the principal source of drinking water in both rural and urban parts of India. Now a day it is a source used for industrial and agricultural sector. The quality of ground water vary with geology of the particular area, depth of water table, seasonal changes, composition of dissolved salts depending upon sources of salt and surface environment.

The consequences of industrialization and urbanization leads to spoiling the water. This is observed that ground water get polluted due to increased human population, agricultural runoff, domestic sewage, industrial effluents, addition of various kinds of pollutants and human activities. Due to use of contaminated drinking water number of cases of water born diseases has been seen which a cause of health hazards [2-4]. It is up to the people to provide security to protect and maintain quality of water. Water quality data is essential for the implementation of responsible water quality regulations for characterizing and remediating contamination and for the protection of the health of humans and the ecosystem.

It is therefore necessary that the quality of drinking water should be checked at regular time interval as well as to find out various sources which increased ground water pollution. Thus in this present study an attempt has been made to assess the physico-chemical characteristics of ground water of different locations of Ballarpur city.

Material and Methods

Ballarpur is a city and municipal council in Chandrapur district in the state of Maharashtra, India. It lies within longitudes 79^0 21' 0" E and latitudes 19^0 50' 0" N, situated 20 km away from Chandrapur. Balharshah was the king of Ballarpur. The town was named Balharshah after him. Balharshah has 9 coal mines nearby owned by public sector company Western coalfields limited, a subsidiary of coal India limited, which gives a huge opportunity to fresh graduates for their jobs. Avantha group established their flagship paper factory, BILT in Ballarpur. BILT is the largest manufacturer of writing and printing paper in India. Geographical location of study area is shown in the figure 1. The ground water samples were collected from ten different locations of Ballarpur city, during monsoon period, July-2013 to September-2013, in good quality screw-capped polythene bottles of one liter capacity in the moring hours between 9 to 11 a.m. and labeled properly. The samples were taken to laboratory as early as possible and kept for further analysis. The parameters like temperature and pH were measured in the field at the time of sample collection by using thermometer and pocket digital pH-meter while other parameters such as electrical conductivity, total dissolved solids, dissolved oxygen, total hardness, total alkalinity, calcium, chloride, fluoride, phosphate and iron were estimated in the laboratory, using standard procedures by APHA[5]. The sampling locations are given in table 1.

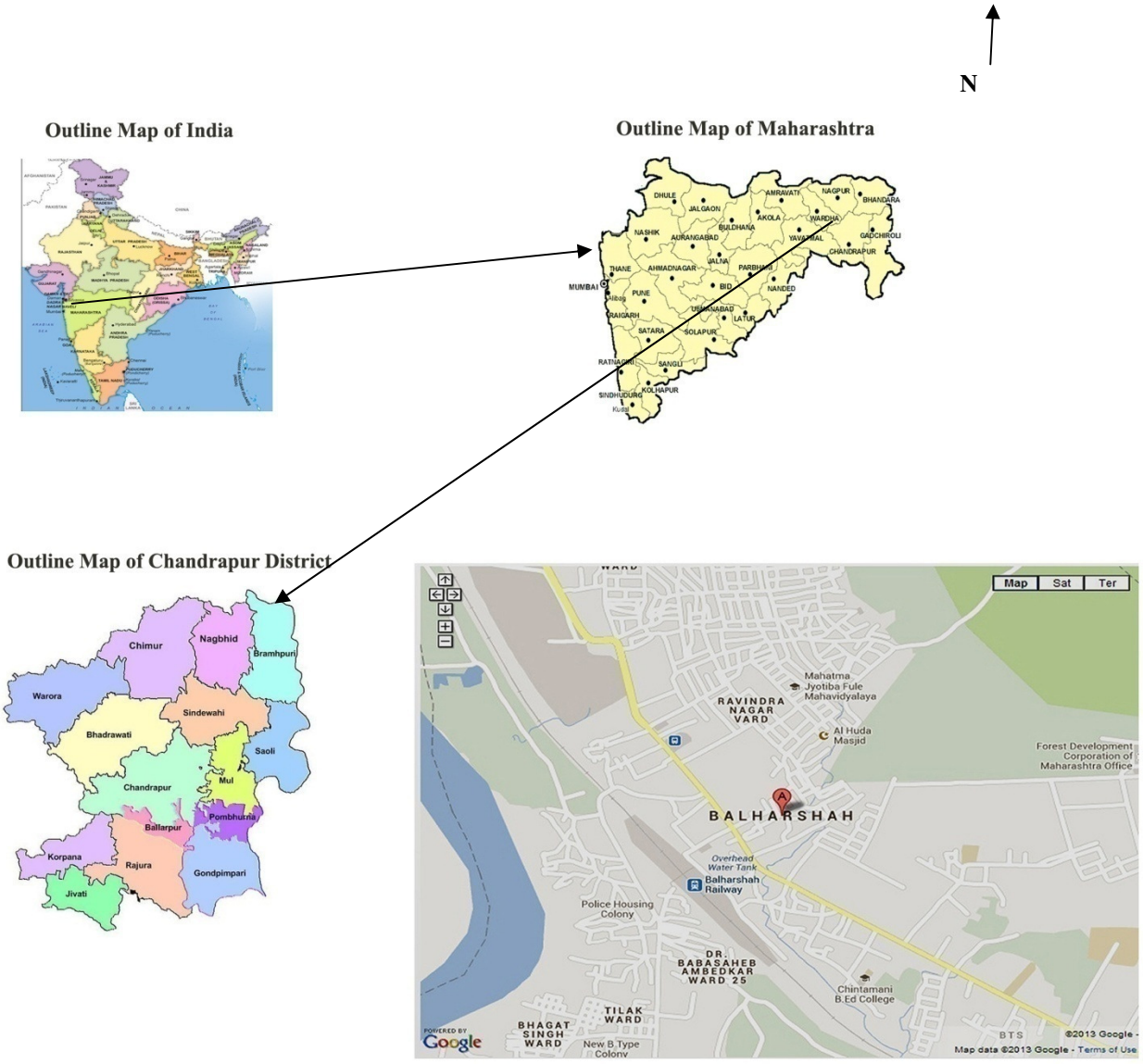

Figure-1
Map of CHandrapar Dist. MS, India

Table-1
Sampling locations

Sample No.	Sampling locations	Source
S_1	Police housing colony	Bore Well
S_2	Dr.Babasaheb Ambedkar ward	Bore Well
S_3	Tilak ward	Bore Well
S_4	Bhagat Sing ward	Bore Well
S_5	New B-type colony	Bore Well
S_6	Balharshah railway	Bore Well
S_7	Ravindra nagar	Bore Well
S_8	Al Huda Masjid	Bore Well
S_9	Mahatma J. F. Mahavidyalaya	Bore Well
S_{10}	Forest colony	Bore Well

Results and Discussion

The various physico-chemical characteristics were analyszed for ground water from ten different sampling locations. The details of the average results were summarized in table 2.

pH: The pH value of water source is a measure of the hydrogen ion concentration in water and indicates whether the water is acidic or alkalinity[6]. Most of the biological and chemical reactions are influenced by the pH of water system . In the present study all the ground water samples have pH values between 6.08 -7.17. The standard value of pH for drinking water by BIS is between 6.5 - 8.5 while, WHO is between 7.0-8.5.The samples S_4, S_7, S_8, and S_9 have lower value of pH than the permissible limits.

If pH is beyond the permissible limit, it damages the mucous membrane of cells[7].

Electrical conductivity (EC): Electrical conductivity is the measure of the ability of water to conduct electrical current. This capacity depends on the concentration of ions, ionic mobility, valence of ions and temperature. Electrical conductivity of water is a direct function of its total dissolved salts[8]. The WHO permissible limit for electrical conductivity in water is 600 µS/cm. Electrical conductivity values in the study area ranged from 440 to 2120 µS/cm, indicating the presence of high amount of dissolved inorganic substance in ionized form.

When electrical conductivity exceeds 3000 µS/cm affected the germination of almost all the crops and it may result in very less amount of yield.

Total dissolved solids (TDS): The total dissolved solids in water are due to presence of all inorganic and organic substances. The solids can be iron, manganese, magnesium, potassium, sodium, calcium, carbonates, bicarbonates, chlorides, phosphates and other minerals. The high values of TDS causes gastrointestinal irritation to the human beings but long time use of water with high TDS can cause kidney stones and heart diseases[9].

In the present analysis, the TDS values were observed from 290 to 1390 mg/l. The most desirable limit of TDS is 500 mg/l and maximum allowable limit is 1500 mg/l. The TDS value for all the ground water samples are well within the permissible limit of 1500 mg/l.

Total alkalinity (TA): Alkalinity of water is the measure of the ability to neutralize a strong acid. The bases like carbonates, bicarbonates, hydroxides, phosphates, nitrates, silicates, borates etc are responsible for alkalinity of water[10]. Alkalinity provides an idea of natural salts present in water. Alkalinity is a parameter which is not harmful to human beings. The alkalinity values were recorded within the range of 130 to 300 mg/l. All samples exceed the desirable limit for drinking water 100 mg/l (WHO).

Total hardness (TH): Hardness of water is an aesthetic quality of water and is caused by carbonates, bicarbonates, sulphates and chlorides of calcium and magnesium. It prevents the lather formation with soap and increases the boiling point of water. The maximum permissible limit of total hardness for drinking purpose is 300 mg/l (BIS). The water having hardness up to 75 mg/l is 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 . Hardness more than 300 mg/l may cause heart and kidney problems[11-12].

The total hardness in ground water samples collected from the study area ranged from 200-1042 mg/l. Except sample S_1 all the ground water samples are very hard and hence require suitable treatments before use.

Calcium (Ca^{2+}): The rock, lime stone and industrial waste are the rich sources of calcium from where it is leached in the ground water. Calcium plays an important role for proper bone growth[13]. The permissible limit of calcium is 100 mg/l according to WHO. The concentration of calcium in the area varied from 85-175 mg/l. The high concentration of calcium in the ground water of the region is due to rapid industrialization and urbanization.

Chloride (Cl^-): Chloride in ground water can be caused by industrial or domestic waste. The chloride concentration serves as an indicator of pollution by sewage. Soil porosity and permeability also has a key role in building up the chloride concentration[14]. High chloride content in water bodies, harms agricultural crops, metallic pipes and injurious to people suffering due to heart and kidney diseases[15].

The chloride content varied from 71-269 mg/l. Most of the ground water samples show chloride concentration within the permissible limit (250 mg/l) of WHO, which indicates less contamination of chloride. The ground water samples S_3 and S_5 have slightly excess chloride concentration, which causes some physical disorders.

Fluoride (F^-): Fluoride is the 13th most abundant element on earth. It exists combining with other substances to become fluoride. The main source of fluoride in ground water is fluoride bearing rock such as fluorspar, fluorite, cryolite, fluorapatite and hydroxylapatite[16]. High fluoride content in ground water causes serious damage to the teeth and bones of human body, diseases caused called dental fluorosis and skeletal fluorosis[17].

Hence excess fluoride should be removed from water and this process is called defluoridation. The value of fluoride concentration in ground water samples lie between 0.0-0.5 mg/l. All the ground water samples have fluoride concentration within permissible limit (1.0 mg/l) of WHO and are safe for drinking purpose.

Phosphate (PO_4^{3-}): The major sources of phosphate in ground water are domestic sewage, detergents, industrial effluents and agricultural runoff with fertilizers. Due to ability of soils to retain phosphate and low solubility of native phosphate minerals, the ground water contains minimum phosphate level[18-19]. The phosphate content have observed from 0.00 to 0.05 mg/l, which are within permissible limit of WHO (0.1mg/l)

Dissolved oxygen (DO): Dissolved oxygen in water is of great importance to all aquatic organisms. It reflects the physical and biological process taking place in the water body. In water, the oxygen is generally reduced due to respiration of biota, rise in temperature, oxygen demanding waste, decomposition of organic matter and inorganic reactant[20]. An ideal DO value of 5.0 mg/l is the standard for drinking water. The ranges of DO have been found in between 6.4 -9.3 mg/l.

Iron (Fe): The concentration of iron in natural water is very low. The main sources of iron in ground water are naturally as a mineral from sediment and rocks or from mining, industrial waste and corroding metal. It is present in ground water as ferrous bicarbonate $Fe(HCO_3)_2$, Ferric hydroxide $Fe(OH)_3$, organic complex iron or corrosion product such as Fe_3O_4. Iron is essential element to all organisms and present in haemoglobin system. The high concentration causes a bitter astringent taste to water and a brownish color to laundered clothing and plumbing fixtures[21]. The shortage of iron causes a disease called anaemia and continues consumption of drinking water with high concentration of iron for a long time can lead to liver disease called as haermosiderosis. The range of iron have been found in between 0.1-0.4 mg/l, which are within WHO guideline (1.0 mg/l).

Conclusion

The present study was undertaken with an aim to analyze certain physico-chemical characteristics in the ground water samples of Ballarpur city. Samples were collected from ten different locations of Ballarpur city and analyzed weekly, for pH, EC, TDS, TA, TH, DO, Cl^-, Ca^{2+}, F^-, PO_4^{3-} and Fe using standard procedures. This analysis reveals that EC, TH, TA, Ca^{2+}, Cl^- and DO exceed the permissible limit prescribed by WHO in most of the ground water samples. From obtained result it is suggested to monitor the ground water quality and assess periodically to prevent the further contamination.

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Table-2
Average values of physico-chemical characteristics of ground water samples

Sample no.	pH	EC	TDS	TH	TA	Ca^{2+}	DO	F^-	Cl^-	PO_4^{3-}	Fe
S_1	7.12	860	560	200	140	110	7.5	0.0	106	0.00	0.2
S_2	7.06	1080	710	512	190	130	7.3	0.5	126	0.02	0.3
S_3	6.86	2120	1390	1000	300	150	9.3	0.3	269	0.04	0.0
S_4	6.20	1650	1080	1042	290	125	8.1	0.3	241	0.05	0.3
S_5	7.17	2040	1340	860	230	115	8.3	0.5	262	0.03	0.3
S_6	6.83	1020	670	336	150	175	7.0	0.4	170	0.02	0.4
S_7	6.40	740	480	528	180	120	6.4	0.0	134	0.00	0.0
S_8	6.33	450	290	360	150	90	7.5	0.4	92	0.02	0.0
S_9	6.08	650	420	540	170	85	7.3	0.3	127	0.03	0.3
S_{10}	6.60	440	290	380	130	135	7.8	0.0	71	0.02	0.0

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