EVALUATION OF GROUND WATER QUALITY OF CHANDRAPUR CITY, VIDARBHA REGION, CENTRAL INDIA

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ABSTRACT

Groundwater is the most vital natural resource used for drinking purpose by many us people around the world, especially in arid and semi-arid areas. This resource cannot be used sustainably unless the quality of groundwater is assessed. The present investigation deals with the study of physicochemical parameters i.e. Temperature, pH, Electrical Conductivity, Turbidity, Total Solids, Total Dissolved Solids, Total Suspended Solids, Dissolved Oxygen, Alkalinity, Hardness, Chloride, Sulphate and Fluoride in water samples of dug wells and bore well in Chandrapur city, Vidarbha Region, Central India. The sample were collected from six different sapling location of Chandrapur city. This all dug well and bore well are in daily use and some are used for drinking purpose. All the results were compared with the standards prescribed by Bureau of Indian standards 10500-2012. Most of results are within permissible limits but some are above permissible limit, hence the water cannot be used directly for portable purposes.

Keywords: *Evaluation; Groundwater; Physicochemical, Chandrapur, Vidarbha, BIS.*

Introduction

Water is a most important natural resource, it is an essential human need and it is also a valuable national asset. In addition to drinking, water is also required for other human activities like agriculture, industry, bathing, cooking, washing, recreation, navigation, fisheries etc. [1]. The term “water quality” includes the water column and therefore the physical channel required to sustain aquatic life. The sustainable socioeconomic development of each and every community depends on the availability of freshwater resources. Among different types of freshwater resources available on the earth, groundwater provides a significant fraction of the total supply for domestic, industrial and agricultural sectors of many countries. The shortage of water has become an increasingly serious problem, especially in the arid and dry regions of India, where the average annual precipitation is less than 500 mm [2]. The goal of Federal Clean Water Act, “To protect and maintain the chemical, physical and biological integrity of the nation's waters,” establishes the importance of assessing both water quality and the habitat required for maintaining another aquatic organism. Water is the precious gift of nature to human being and it is being to be polluted day-by-day with rapid increase in urbanization and industrialization that tremendously increases the groundwater demand. It is now recognized that the quality of the groundwater is just as important as quantity of ground water [3]. Water covers almost 78% of the earth’s surface, yet water available for human use is limited. Groundwater pollution is very critical, as once an aquifer becomes polluted, it is very difficult, expensive and time consuming affair to clean it up and may remain unusable for decades [4]. Understanding the potential impacts of human activity on ground water quality is important for protection and sustainable use of ground water resources [5].

Park and Park [6] divided wells into two namely shallow and deep wells depending on the location of the impervious strata for which the water is obtained. Also, based on the mode of construction, wells can be classified into three categories namely: Hand-dug well, Bore well and Driven well [7].

Ground water is used for agricultural, industrial and domestic purposes accounts for about 50% of livestock and irrigation usage and just under 40% of water supplies, whilst in rural areas, 98% of domestic water use is from groundwater [8].

High concentrations of normally occurring substances like calcium, sodium, iron, manganese, etc. can pose harmful effects on aquatic flora and fauna. Their concentration is the main key in determining the natural component of water and the contaminant also. Other natural and anthropogenic substances may cause turbidity and other negative effects [9].Water is said to be polluted when its quality is degraded as a result of human activities to an extent that it's become less suitable for its intended use. The municipal water treatment plant is not that much upgraded sufficiently to provide treated water in each one house in this city, therefore near about 40% peoples give preference to bore well and dug well water for drinking purpose. Due to increase, industrialization and development the ground water level are decrease day by day, inverse impact on quality of water. The improvement of water quality through low-cost treatment processes thus reducing the rate of water borne diseases. Some of the appropriate technologies being used include: Pot storage, pot chlorination, disinfection among others [10].

Materials and Methods

Study Area

The Chandrapur district is situated in the far east of Maharashtra state. It is part of Nagpur division and it is in the eastern part of the Vidarbha region. The Chandrapur district is located between 19.30' N and 20.45' N latitude and at 78.46' E longitude with an area of about 11,443 km^2. According to Survey of India degree sheet, it falls in NOS 55 LF and 56 I M. Chandrapur has a hot and dry climate. May is the hottest month with average maximum temperature of 43 °C, while December is the coldest month, with average minimum temperature of 9 °C. The mean altitude of Chandrapur is 188 m above the sea level. The annual rainfall for city is about 1280 mm.

Methodology

In order to evaluate the ground water quality of Chandrapur city, twelve sample were collected from six different residential locations from city, which are shown in **Table No. 1**.

Prior to sampling, all the sampling containers (plastic/glassware) leached with 2 M reagent grade nitric acid for 48 hrs at room temperature and rinsed with double distilled water. All the samples were preserved as per standard preservation technique prior to its transportation to the laboratory. Field parameters viz. temperature, pH, dissolved oxygen were analysed immediately after collection. The main aim of the study was to investigate the physicochemical characteristics of ground water samples. Physicochemical parameters were analysed as per standard procedures given in APHA. All these samples were analyzed for Temperature, pH, Electrical Conductivity (EC), Turbidity, Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), Alkalinity, Hardness, Chloride, Sulphate and Fluoride. The wide ranges of variations in the values of those parameters are reported, thereby making it quite convenient to comment on the overall quality of the ground water from its pollution points of view.

Result and Discussion

The data compiled from physicochemical characteristics of ground water sample which were collected from dug well and bore well of various locations of Chandrapur city are summarized in **Table No. 2-3**:

pH: pH is one of the important factor of groundwater it indicates hydrogen ion concentration in water [5]. The pH of water is the important parameter because it controls many of the geochemical reactions or solubility calculations within groundwater. Moreover, pH is an important operational parameter in treatment plant [11]. The pH values of dug well varies with the range of 6.8 to 8.0 and bore well 8.7 to 9.5 during sample analysis respectively (**Table No. 2**) which indicates the slightly alkaline nature of groundwater in all studied locations. Permissible limits of pH ranges between 6.5 to 8.5 as per IS 10500-2012. Due to bicarbonates concentration in the ground, the pH values are above permissible limit.

EC: Electrical Conductivity is a measure of waters capacity to conduct electric current [12]. If conductivity increases, it indicates the presence of dissolved ions. Conductivity can serve as an indicator of water quality problems [13]. Electrical conductivity is a decisive parameter in determining suitability of water for particular purpose and classified according to electrical conductivity as follows [12]. The range of electrical conductivity of dug well and bore well in study area is 542 µS/cm -1519 µS/cm and 345 µS/cm to 1836 µS/cm respectively (**Table No. 2)**.

Turbidity: It is an expression of light scattering and absorbing properties of the water sample caused by the presence of clay, silt, suspended matter, colloidal particles, plankton and other microorganisms [14]. The range of turbidity of dug well and bore well is 2 NTU -6 NTU and 5 NTU to 7 NTU respectively (**Table No. 2)**. Permissible limits of turbidity ranges between 1 NTU to5 NTU as per IS 10500-2012. Due to slightly high concentration of solids in ground, the turbidity values is increase and shown above permissible limit.

TS, TDS and TSS: The presence of dissolved solids in water may impair its taste. The range of total solids, total dissolved solids and total suspended solids of dug well of study area is 399 to 512 mg/l, 354 to 461mg/l 37 to 62 mg/l and bore well of study area is 357 to 496 mg/l, 326 to 448 mg/l and 29 to 62 mg/l respectively (**Table No. 2)**. The results shown that the TDS of study area is below permissible limit. Permissible limits of TDS ranges between 500 to 2000 mg/l as per IS 10500-2012.

Dissolved oxygen: Dissolved oxygen attributed to the extent of free, non-compound oxygen present in water or other liquids. It is an key parameter in assessing water quality because of its influence on the organisms living within a body of water. A dissolved oxygen level that is too high or too low can harm aquatic life and affect water quality [15]. DO values of dug well and bore well varied from 3.5 mg/l to 4.4 mg/l and 1.8 mg/l to 3.0 mg/l values in the present study **Table No. 2**.

Alkalinity: Alkalinity is the sum total of components in the water that tend to elevate the pH value to the alkaline side of neutrality. Alkalinity is the buffering capacity of water and is an important parameter of water quality. In the present study the alkalinity values in samples collected from dug well ranged from 46.4 mg/l to 78.5 mg/l and dug well ranged from 120.7 mg/l to 172.3 mg/l **Table No. 3**. As per IS10500-2012 the range of alkalinity value is 200mg/l to 600 mg/l. The results from the present study found within acceptable limits.

Hardness: The effect of hardness is scale in utensils and hot water system in boilers [16]. In groundwater hardness is mainly observed due to bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. The total hardness, calcium hardness and magnesium hardness of dug well varied from 265mg/l to 440 mg/l, 210mg/l to 350mg/l and 35mg/l to 90 mg/l and the values of bore well is varied from 280mg/l to 480 mg/l, 220mg/l to 340 mg/l and 50mg/l to 140 mg/l respectively**Table No. 3**.As per IS10500-2012 the range of total hardness is 200 mg/l to 600mg/l. Hardness of groundwater in the study area is slightly above acceptable limit but within permissible limits

Chloride: Chloride found in groundwater as a result of saline infusion, brine in oil well operations, sewage discharge, irrigation water being drained, and contamination from refuse leachate. The chloride of dug well in study area sample varies from 45 mg/l to 86 mg/l and bore well in study area sample varies from 38 mg/l to 77 mg/l**Table No. 3**. As per IS10500-2012 the range of chloride is 250 mg/l to 1000mg/l. the chloride in ground water in study area within permissible limit.

Sulphate: Ground water impacts from anthropogenic sources of sulphate, however, are typically much smaller than from natural sources. Gypsum is an important source in many aquifers having high concentrations of sulphate [17]. The results of dug well samples in study area is varies from 0.5 mg/l to 2.5 mg/l and bore well samples is varying from 2.22 mg/l to 3.80 mg/l **Table No.3**. As per IS10500-2012 the range of sulphate is 200 mg/l to 400mg/l.

Fluoride: In the present study the fluoride values in samples collected from dug well ranged from 0.2 mg/l to 0.5 mg/l and bore well ranged from 0.2 mg/l to 0.5 mg/l respectively. As per IS10500-2012 the range of fluoride value is 1.0 mg/l to 1.5 mg/l **Table No. 3**. The concentration of in ground water in study area is within permissible limit.

Table No. 1: Location of Ground Water Sampling

Sr. No.	Location	Source type	Latitude & Longitude	Depth	Age of Source
1	Shastri Nagar	Dug well	19⁰97'39.18''N 79⁰32'42.31'' E	30 – 40 m	30 Yr
		Bore well	19⁰97'44.68''N 79⁰32'51.33'' E	90 m	19 Yr
2	Arwat	Dug well	19⁰91'97.85''N 79⁰27'84.97'' E	25 – 30 m	70 Yr
		Bore well	19⁰91'98.61'' N 79⁰27'84.14'' E	80 m	12 Yr
3	Rayatwari	Dug well	19⁰95'19.49'' N 79⁰30'64.67'' E	35 m	10 Yr.
		Bore well	19⁰95'19.36'' N 79⁰30'64.85'' E	90 m	20 Yr
4	Babupeth	Dug well	19⁰93'59.51'' N 79⁰32'09.75'' E	40 m	22 Yr
		Bore well	19⁰93'59.46'' N 79⁰32'09.79'' E	70 m	20 Yr
5	Durgapur	Dug well	19⁰93'54.61'' N 79⁰32'01.98'' E	55 m	40 Yr
		Bore well	20⁰00'66.11'' N 79⁰30'43.36'' E	90 m	15 Yr
6	Tukum	Dug well	37⁰47'28.04'' N 33⁰55'00.50'' E	30 -40 m	30 Yr
		Bore well	37⁰47'28.04'' N 33⁰55'00.50'' E	90 m	15 Yr

Table No. 2: Water Quality - Physical & Demand Parameters

Sr. No.	Location name		pH	Temp (°C)	Turbidity (NTU)	TSS (mg/l)	TDS (mg/l)	TS (mg/l)	EC (µS/cm)	DO (mg/l)
1	Shashtri Nagar	Dug well	6.8	25	2	62	393	455	653	4.1
		Bore well	9.4	24	5	54	332	386	345	2.5
2	Arwat	Dug well	7.2	27	6	37	385	422	1519	3.9
		Bore well	8.9	23	6	47	432	479	1836	3.0
3	Rayatwari	Dug well	6.9	24	2	51	461	512	578	4.0
		Bore well	8.7	23	5	62	434	496	349	2.8
4	Babupeth	Dug well	7.5	25	3	45	354	399	542	4.4
		Bore well	9.3	25	7	32	448	480	900	3.0
5	Durgapur	Dug well	8.0	26	6	41	434	475	1267	4.1
		Bore well	9.5	24	5	29	326	357	1005	2.2
6	Tukum	Dug well	7.5	25	4	37	372	409	897	3.5
		Bore well	9.2	23	5	54	438	492	600	1.8
IS 10500-2012 Standard			**6.5-8.5**	**-**	**1**	**-**	**500**	**-**	**-**	**-**

Table No. 3: Water Quality- Inorganic Parameters

Sr. No.	Location name		Total Alkalinity	Total Hardness	Calcium Hardness	Magnesium Hardness	Chloride	Sulphate	Fluoride (mg/l)
1	Shashtri Nagar	Dug well	65.2	290	210	80	45	1.0	0.2
		Bore well	158.5	480	340	140	62	2.2	0.4
2	Arwat	Dug well	46.4	440	350	90	71	0.5	0.4
		Bore well	120.7	350	265	85	54	3.0	0.3
3	Rayatwari	Dug well	61.8	340	280	60	86	2.1	0.4
		Bore well	149.6	360	250	110	38	3.4	0.2
4	Babupeth	Dug well	78.5	310	250	60	54	2.2	0.2
		Bore well	168.1	290	270	50	77	3.6	0.3
5	Durgapur	Dug well	66.8	290	230	60	49	2.5	0.5
		Bore well	172.3	375	310	65	58	3.8	0.4
6	Tukum	Dug well	49.8	265	230	35	62	1.3	0.5
		Bore well	164.0	280	220	60	45	2.7	0.5
IS 10500-2012 Standard			**200**	**200**	**-**	**-**	**250**	**200**	**1**

Conclusion

In this present paper the physicochemical characteristics of ground water of Chandrapur city Vidharbha region has been evaluated. The data indicate that the groundwater quality of Chandrapur city, not so polluted. Most of the parameters were either more than permissible limit and parameters like pH, turbidity and hardness is above permissible limit and all other parameters slightly below permissible limit. Therefore, the ground water of

Chandrapur city is not potable to direct drinking purpose, but after simple treatment like installation of RO, boiling of water or deep the alum stone for 1-2 min in water, that water can be used for cooking and drinking only after this simple prior treatment. To maintain quality of groundwater, the continuous monitoring of physic-chemical parameters should be done.

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