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Physico-chemical studies of ground water samples from villages of Narkhed and Warud tehsil of Vidarbha region Maharashtra, India

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ABSTRACT

The study concerned with ground water quality in villages of Narkhed and Warud Tehsils in Vidarbha region, Maharashtra (India). Five villages were selected for study namely Jamathi, Ganeshpur, Ekkalvihir, Urad and Pusla. Ground water samples were collected in February 2015 from bore wells of sampling sites. These samples were tested for Physico-chemical properties such as pH, Alkalinity, EC, TDS, Ca^{2+}, Mg^{2+}, Cl^{-}, Silica, PO_4^{3-}, SO_4^{2-}, DO, COD, Hardness and Turbidity as per standard methods. The results are compared with standards of World Health Organization (WHO), United States Public Health (USPH) and Indian Council of Medical Research (ICMR). The study showed that some water quality parameters do not meet the drinking water quality standards and water is unfit for drinking purpose.

Keywords: Physicochemical status, Ground water, Narkhed, Warud.

INTRODUCTION

Studies of groundwater chemical composition lead to improved understanding of hydrochemical systems in the area. Such studies contribute to effective management and utilization of the groundwater resources [1]. Exploitation of groundwater has increased greatly, particularly for agricultural purpose. Poor quality of water adversely affects the plant growth and human health [2]. The development of agriculture is a key factor in the economic development of a country like India, as the agriculture is the main source of sustenance for the majority of the population (about 130 crore) in the country and contributes 46% to the gross national product. Groundwater irrigation started with only 6.5 million hectares (Mha) in 1950–1951 (CGWB 1992), which was increased to 46.5 Mha in 2000–2001 (Sivanappan 2002), meeting about 70% of the irrigation water requirements of the country. This clearly indicates the growing pressure on groundwater resources. Poor quality of groundwater adversely affects the plant growth and human health (Wilcox 1948; Thorne and Peterson 1954; US Salinity Laboratory Staff 1954; Holden 1971; Todd 1980; ISI 1983; WHO 1984; Hem 1991; Karanth 1997). Adverse conditions increase investment in irrigation and health, and decrease agricultural production, which, in turn, reduces economy, retards improvement in the living conditions of rural people and results in unsustainable development [3].

Suitability of groundwater for drinking, irrigation and industrial purposes depends upon its quality. The groundwater quality changes due to variation in climatic conditions, aquifer materials and inputs from soil during percolation of water [4]. Application of uncontrolled fertilizers and manure is one of the main sources of groundwater pollution, especially in developing countries, like India, where domestic sewage contributes to pollute groundwater [5].

In this study, bore wells frequently being used by the public were surveyed to analyze physicochemical characteristics of groundwater for the assessment of safe drinking water source. To study water quality parameters with respect to locations four villages from Narkhed Tehsil and one from Warud Tehsil were selected. The study area is well known for orange cultivation in India. Most of the groundwater is utilized for irrigation purposes.

MATERIALS AND METHODS

Study Area

The study area is located in Central India in Vidarbha region of Maharashtra State as shown in figure 1. The area is in the tropical climate zone, with three seasons: summer (March to May), monsoon (June to September) and winter (November to February). Temperature varies from 25°C to 36°C in rainy season, while it is between 18°C and 24°C in dry season. The mean annual rainfall is 1470 mm. The vegetation is of savanna type (*Loutetia demeusi)* and presents a formation to sparse gramineous carpet, with a shrubby layer of *hymenocardia acida*. Jamathi, Ganeshpur, Ekkalvihir, Urad from Narkhed tehsil and Pusla from Warud tehsil was selected as sampling sites (Table-1). All sources providing their water to these small villages.

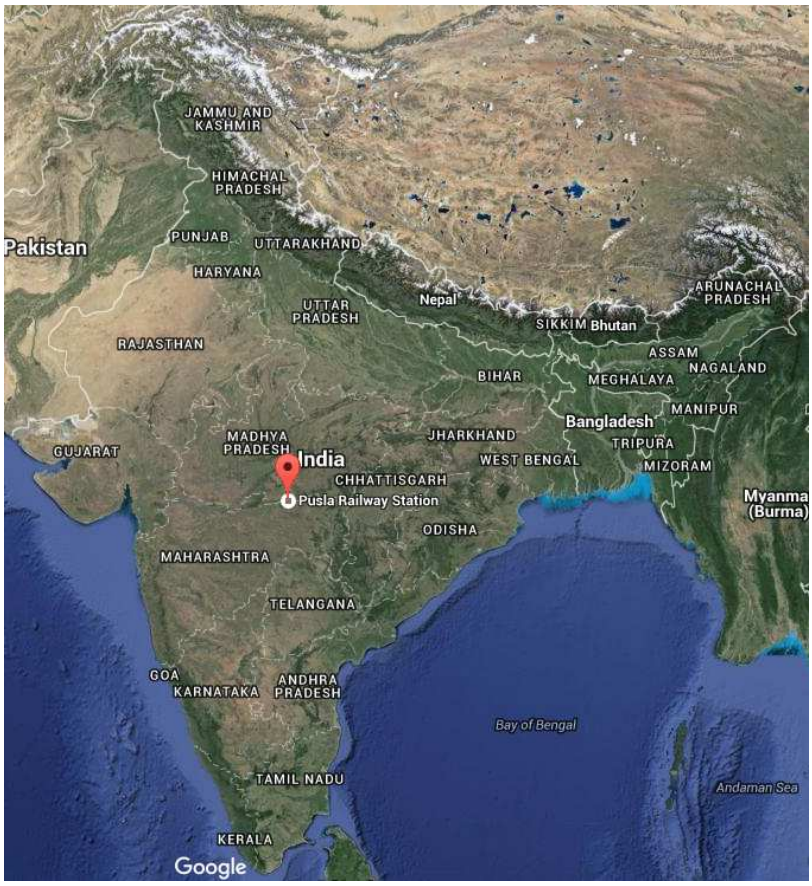

Fig. 1: Satellite View of India

Table 1: Sampling Sites

Sample No.	Sampling Points	Tehsil
S1	Bore Well from Jamathi	Narkhed
S2	Bore Well from Ganeshpur	Narkhed
S3	Bore Well from Ekkalvihir	Narkhed
S4	Bore Well from Urad	Narkhed
S5	Bore Well from Pusla	Warud

Fig. 2: Satellite View of Study Area

Sampling and Analysis

The entire samples were collected in the first week of February 2015 from bore wells. The samples were collected in previously sterilized and dried polyethylene bottles of capacity 2 litter. Temperature and pH was measured and DO was fixed at the time of sampling. Standard methods were used for the determination of physicochemical parameters of collected groundwater samples. The parameters analyzed were pH, Alkalinity, EC, TDS, Ca^{2+}, Mg^{2+}, Cl^{-}, Silica, PO_4^{3-}, SO_4^{2-}, DO, COD, Hardness and Turbidity.

RESULTS AND DISCUSSION

The quality of a ground water resource depends on the anthropogenic discharges as well as the natural physico-chemical characteristics of the areas [6]. The study zone was chosen because it presents the main agriculturally rich area of the central India, and therefore has a great probability for the deterioration of ground water resources. The physico-chemical parameters of water samples are given in **Table 2**.

One of the important factors that serve as an indicator of pollution of water body is pH. The pH of natural water can provide important information about many chemical and biological processes and provides indirect correlations to a number of different impairments. pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions [7]. At the period of study, the pH of ground water samples ranges from 5.1 to 6.4. The result shows that the slightly acidic pH is particularly due to bicarbonate. The mild acidic nature may be due to some geological reasons. The pH in this area does not meet the standards prescribed by WHO and ICMR.

The alkalinity of water is due to presence of minerals. The various ionic species that contribute to alkalinity include bicarbonate, phosphate, borate and organic acid [8, 9]. The maximum (232 ppm) and minimum (123 ppm) values of total alkalinity was observed in Ekkalvihir and Jamathi respectively. As per Indian standard (ICMR) the desirable limit of total alkalinity in drinking water is 200 ppm. In this study, the total alkalinity was near the desirable limit at all stations.

Electrical conductivity (EC) is a measure of ionic content of water. Conductivity is typically reported in units of micro Siemens per centimeter [10]. EC of study area ranges from 770 µS/cm (S2) to 1181 µS/cm (S4). These values are within the permissible limits of drinking water standards (1400 µS/cm) prescribed by WHO.

Table 2: Physicochemical Parameters

Sr. No.	Parameters	S1	S2	S3	S4	S5	WHO	USPH	ICMR
1	pH	5.1	6.2	6.4	5.9	6.1	6.5-9.2	6.0-8.5	6.5-8.5
2	Alkalinity (ppm)	123	156	232	169	167	120	--	200
3	EC (µS/cm)	770	865	887	889	1181	1400	--	--
4	TDS (ppm)	456	544	546	543	732	1000	500	500
5	Ca^{2+} (ppm)	111	108	122	119	109	100	75	75
6	Mg^{2+} (ppm)	52	64	61	57	62	50	30	50
7	Cl^{-} (ppm)	94	65	98	114	101	250	200	250
8	Silica (ppm)	19	30	44	48	49	--	--	--
9	PO_4^{3-} (ppm)	0.069	Nil	0.044	0.243	0.163	--	--	--
10	SO_4^{2-} (ppm)	0.21	0.24	0.47	0.44	0.26	250	250	200
11	DO (ppm)	2.2	2.4	2.1	2.5	2.2	--	--	4-6
12	COD (ppm)	254	267	178	245	179	50	--	--
13	Hardness (ppm)	112	254	356	432	44	500	--	300
14	Turbidity (NTU)	0.65	0.71	0.50	0.89	1.41	5	--	--

The salinity of groundwater can be indicating by Total Dissolved Solids (TDS). Water containing more than 500 ppm TDS is not considered desirable for drinking water supplies [11, 12]. In the present study TDS values of the area varied from 456 ppm (S1) to 732 ppm (S5). The sampling points S1 showed TDS values lower than the prescribed limits ICMR (500 ppm) whereas all samples has TDS within prescribed limits of WHO (1000 ppm).

Calcium (Ca^{2+}) is directly related to hardness of water [13]. Calcium content of ground water samples of study area ranged between 108 ppm (S2) to 122 ppm (S3) and all samples found above permissible limit of WHO and USPH. Magnesium (Mg^{2+}) is also directly related to hardness. Magnesium content in the investigated ground water samples was ranging from 52 ppm (S1) to 64 ppm (S2) which is found above the permissible limits of WHO (50 ppm) and USPH (30 ppm).

Chloride (Cl^{-}) is minor constituent of the earth's crust. Rain water contains less than 1 ppm Chloride [14]. Chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt, and saline intrusion (WHO, 1993). Its concentration in natural water is commonly less than 100mg/L unless the water is brackish or saline (Fetter, 1999). High concentration of chloride gives a salty taste to water and beverages and may cause physiological damages. In the present study Water with high chloride content usually has an unpleasant taste and may be objectionable for some agricultural purposes. The maximum chloride concentration of study area is ranges from 64 ppm (S2) to 114 ppm (S4) which indicates that the chloride content of groundwater was within the prescribed limits of WHO and ICMR.

All natural water bodies contain some dissolved silica, it exist as silicic acid or silicate ion, depending upon the pH. It is found in surface and ground water in the range of 1-100 ppm [15]. In the present investigation higher value of silica was found to be 49 ppm at S5 which is higher than other ground water samples.

Phosphate (PO_4^{3-}) occurs in groundwater as a result of domestic sewage and agricultural effluents with fertilizers [16]. The maximum phosphate content in the study area was found in S4 site only it was 0.243 ppm.

Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. Dosage above permissible limits may cause gastro intestinal irritation. Discharge of agricultural waste and domestic sewage tends to increase its concentration [17]. The maximum values of sulphate recorded in the ground water sample from site S3 which was 0.47 ppm indicating very low sulphate content than maximum permissible limits of WHO and ICMR.
DO is an important parameter in water quality assessment. It reflects the biological suitability water for drinking purposes [18]. The presence of DO gives taste to drinking water. The DO values are also indicates the degree of pollution in water bodies. The levels of DO in ground water samples varied from 2.1 ppm (S3) to 2.5 ppm (S4), which is below the range prescribed by ICMR (4-6 ppm).

Chemical oxygen demand (COD) is the amount oxygen required for chemical oxidation of most organic matter and oxidizable inorganic substances with the help of strong chemical oxidant [19]. The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances [20]. The COD value of ground water of the study area was ranging from 178 ppm (S3) to 267 ppm (S2). It exceeded the norm of WHO (50 ppm) may be due to agricultural activity.

Water that require considerable amount of soap to produce foam or lather and generate scale in hot-water pipes, heaters, boilers and others are called hard water. It reflects the nature of the geological formations with which it has been contact. The principal hardness causing cations are calcium, magnesium, strontium, ferrous iron, and manganous ions associated with bicarbonate, sulphate, chloride, nitrate and silicate respectively. Among them calcium and magnesium cause by far the greatest portion of the hardness occurring in natural waters [20]. Water is commonly classified in terms of the degree of hardness namely 0-75 mg/l, 75-150 mg/l, 150-300 mg/l and 300 mg/l above as soft, moderately hard, hard and very hard respectively[21]. The hardness of ground water sample from S5 was 44 ppm indicating soft water; from S1 was 112 ppm (moderately hard); from S2 was 254 ppm (hard) and that of S3 and S4 was 356 ppm and 432 ppm (very hard) respectively. It exceeded the maximum permissible limit of ICMR at locations S3 and S4.

Turbidity is an expression of certain light scattering and light absorbing properties of the water sample caused by the presence of clay, silt, suspended matter, colloidal particles, plankton and other microorganisms (WHO, 1984). Turbidity can be measured by turbidimetry. Turbidity of water affects other water quality parameters such as colour, when it is imparted by colloidal particles. It also affects the chemical quality of drinking water through the formation of complexes between the turbidity causing humic matter and heavy metals [22, 23]. Turbidity of all water samples was found within the permissible limit of WHO.

CONCLUSION

The results obtained from the physic-chemical analysis of the samples revealed that the quality of ground water in rural areas of Narkhed and Warud tehsils been assessed by comparing each concentration with the standard desirable limit of that parameter in drinking water as prescribed by WHO, USPH and ICMR. The analytical data of pH, TDS, calcium, magnesium, COD and Hardness were not in the permissible limit. The concentration of chloride, sulphate and phosphate ion was within the permissible limit and turbidity was lower than the maximum permissible limit given by WHO.

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