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Research Article

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Physico-chemical analysis of drinking water quality in Hanamkonda area, Warangal District, Andhra Pradesh, India

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ABSTRACT

The suitability of water quality for drinking purpose in the Hanamkonda area was assessed by measuring physicochemical parameters, including major cation and anion compositions, pH, total dissolved solid, electrical conductivity, and total hardness. The nitrate concentration ranged between 6 to 100 mg/l with mean value of 39.44 mg/l. On the basis of nitrate concentration it is illustrated that 61% of samples are suitable for drinking purpose. The chloride content in 27.7% of groundwater samples is above the WHO standard. The Values obtained for different parameters, are compared with the standard values given by WHO/TSE and suitable suggestion were made. In Hanamkonda area, water investigation was carried out to identify groundwater geochemistry and its suitability for drinking purpose.

Keywords: Physico-chemical analysis, anions, cations and drinking water quality

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INTRODUCTION

Groundwater is a vital natural resource. Depending on its usage and consumption it can be a renewable or a non renewable resource. It is estimated that approximately one third of the world's population use groundwater for drinking [7]. Groundwater is the major source of water supply for domestic purposes in urban as well as rural parts of India. The WHO [14] has clearly stated that the quality of drinking water is a powerful environmental determinant of health. Drinking-water quality management has been a key pillar in the prevention and control of waterborne diseases. Water is essential for life, but it can and does transmit disease in all countries of the world from the poorest to the wealthiest. Safe drinking water therefore is a basic need and hence, an internationally accepted human right [13], and reducing the number of people without access to sustainable safe drinking water supply has been enlisted as one of the ten targets of the millennium development goals. The importance of water quality in human health has also recently attracted a great deal of interest [8]. The evaluation and management of groundwater resources require an understanding of hydrochemical investigation and the same was carried out to identify groundwater geochemistry and its suitability for drinking purpose.

EXPERIMENTAL SECTION

The selected groundwater samples are used for agricultural and domestic purposes. Polyethylene bottles cleaned with HNO_3 were used for sample collection. All bottles were rinsed with deionized water. The samples were collected after 10 min of pumping and stored in polyethylene bottles. pH and electrical conductivity (EC) were measured pH and EC meters. Samples were analyzed in the laboratory for the major ions employing standard methods [2]. Calcium (Ca^{2+}) and magnesium (Mg^{2+}) were determined titrimetrically using standard EDTA. Chloride (Cl^-) was determined by the standard AgNO3 titration method. Carbonate CO_3^{2-} and bicarbonate (HCO_3^-) were determined by titration with HCl. Sodium (Na^+) and potassium (K^+) were measured by flame photometry, and sulfate SO_4^{2-} and NO_3^- by spectrophotometric turbidimetry.

RESULTS AND DISCUSSION

The physico-chemical quality of drinking water varied drastically among different sites of Hanmakonda area. We referred the standard ranges for different chemicals in drinking water as prescribed by [15] and [12]. Understanding the groundwater quality is important as it is the main factor determining its suitability for drinking, domestic, agricultural, and industrial purposes [11 & 1]. Table 1 illustrates the physicochemical parameters of groundwater in the Hanmakonda area, indicating the minimum, maximum, mean and standard deviation values. The values were compared with the [15] and [12] standards (Table 2).

The results of the chemical analysis of the groundwater of the area show a wide variation in different individual parameters (Table 1). The pH value of groundwater samples ranges from 7.2 to 8.04 with mean value of 7.5. This shows that the groundwater in the study area is generally neutral to slightly alkaline. Although pH has no direct effect on human health, it shows close relationship with some other chemical constituents of water. For groundwater, conductivity is directly related to the concentration of ions present in it. Higher conductivity may be attributed to high salinity and high mineral percentage in groundwater samples, which are generally due to the ion exchange and solubilization process taking place within the aquifers [10]. EC of water in the study area varies from 520 to 2,180 μS/cm at 25°C with mean value of 1,163 μS/cm. The TDS of the water samples ranges from 332.8 to 1,395.2 mg/l with mean value of 744.5 mg/l. The allowable limit of TDS for drinking water is 1,000 mg/l according to the [15] standard, and 16.6 % of the samples have a higher TDS value than this limit (Table 2).

Table 1 Statistical summary of the chemical composition of groundwater

Chemical parameters	Expressed	Minimum	Maximum	Mean	St. dev
pH		7.2	8.04	7.5	0.23
EC	μS/cm	520	2180	1163	412.78
TDS	mg/l	332.8	1395.2	744.5	264
HCO_3^-	mg/l	42.7	200	118.5	56.7
CO_3^{2-}	mg/l	0	144	48	58.9
SO_4^{2-}	mg/l	20	65	32.17	1.56
NO_3^-	mg/l	6	100	39.44	29.53
Cl^-	mg/l	42.6	298	161.1	98
Na^+	mg/l	15	46	33.1	10.8
K^+	mg/l	2.1	45.4	6.3	9.8
Ca^{2+}	mg/l	100	330	158.8	59.8
Mg^{2+}	mg/l	3	95	29.6	30.5
TH	mg/l	110	570	280	149.7

Table 2 Groundwater samples of the study area exceeding WHO and TSE standards for domestic purposes

Parameters	Expressed	WHO (2004) guideline value	TSE (1997) guideline value	% of samples exceeding allowable limits
pH		6.5 – 8.5	6.5 – 9.2	nil
TDS	mg/l	1, 000	1, 500	16.6[a]
Ca^{2+}	mg/l	200	200	11
Mg^{2+}	mg/l	150	150	nil
Na^+	mg/l	200	175	nil
K^+	mg/l	20	12	5.5[b]
Cl^-	mg/l	250	400	27.7[a]
SO_4^{2-}	mg/l	250	250	nil
NO_3^-	mg/l	45	50	39[a]
TH	mg/l	-	500	11.1[b]

[a] *Number of samples exceeding [15];* [b] *Number of samples exceeding [12]*

The hardness values of the water samples range from 110 to 570 mg/l with mean value of 280 mg/l (Table 1). The allowable limit of hardness for drinking water is 500 mg/l according to the [12] standard, and 11.1 % of the samples have higher hardness value than this limit (Table 2). Bicarbonate is a major ion in human body, which is necessary for digestion. When ingested, for example, with mineral water, it helps buffer lactic acid generated during exercise and also reduces acidity of dietary components. The concentration of HCO_3^- is observed from 42.7 to 200 mg/l (Table 1).

The concentration of Na^+ is varied from 15 to 46 mg/l (Table 1) than that of the recommended limit of 200 mg/l for safe water and all groundwater samples are within the safe limit. Generally, the concentration of K^+ is less than 10 mg/L in the drinking water. It maintains fluids in balance stage in the body. The K^+ ion concentration ranges between 2.1 and 45.4 mg/l, which is with 5.5% of samples exceeding the prescribed limit (Table 2). The chloride concentration varies between 42.6 and 298 mg/l with mean value of 161.1 mg/l. The chloride content in 27.7% of groundwater samples is above the [15] standard, distribution map of chloride is shown in Fig. 1. Potassium contents range from 2.1 to 45.4 mg/l with mean value of 6.3 mg/l in the samples. One samples out of 12 have K^+ concentration above the allowable value of 12 mg/l according to [12] (Table 2). Ca^{2+} and Mg^{2+} ions are important ions for total hardness of water. The concentration of Ca^{2+} and Mg^{2+} ions in drinking water varied from 100 to 330 mg/l and 3 to 95 mg/l, respectively. In general, Ca^{2+} is associated with carbonates and minerals, e.g., calcite and domite, which commonly occur in veins and secondary minerals in granite. The concentration of Ca^{2+} in most of the samples was within the guidelines and only 11% of samples are exceeding limits [15]. Mg^{2+} is an essential ion for cell functioning by playing role in enzyme activation, but at higher concentration it is considered as laxative agent.

The nitrate ion concentration varies from 6 to 100 mg/l with mean value of 39.44 mg/l. The concentration of nitrogen in groundwater is derived from the biosphere [9]. Nitrogen is originally fixed from the atmosphere and then mineralized by soil bacteria into ammonium. 39% of samples exceed the desirable limit of 45 mg/l as per WHO standard. The high concentration of nitrate in drinking water is toxic and causes blue baby disease/methaemoglobinaemia in children and gastric carcinomas [3 & 5]. Nitrogen in the form of nitrate is known to cause contamination of groundwater beneath agricultural lands [4]. Distribution map of nitrate is shown in Fig. 2.

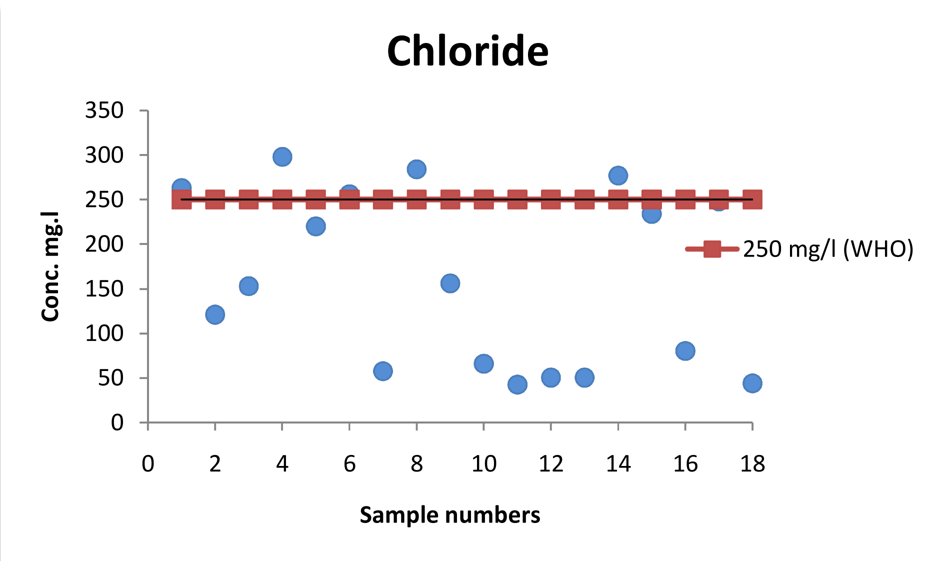

Fig. 1 Distribution map of Chloride

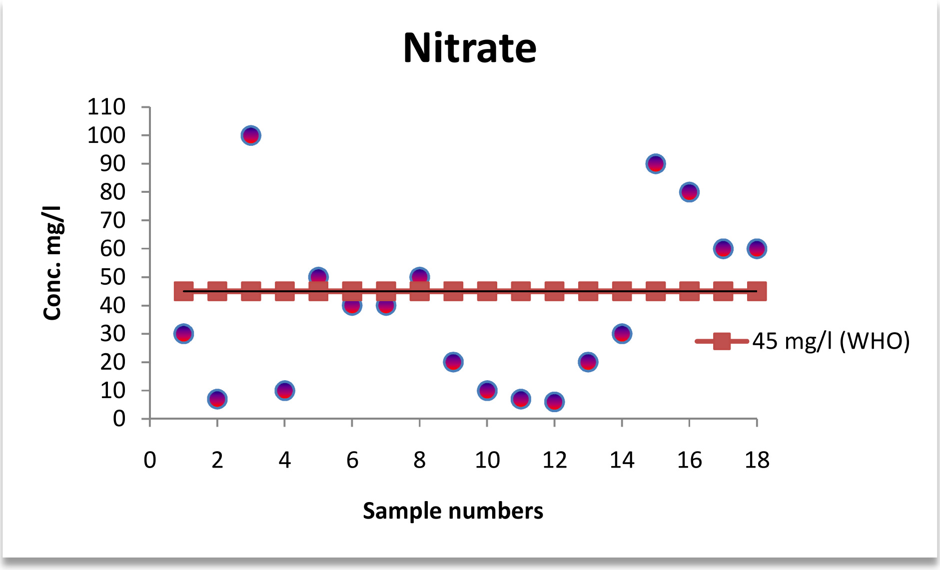

Fig. 2 Distribution map of Nitrate

SO_4^{2-} is a naturally occurring ion in almost all kinds of water bodies and plays an important role in total hardness of water. Moreover, its concentration of more than 200 mg/l is objectionable for domestic purposes. At higher concentration, SO_4^{2-} may cause gastro-intestinal irritation particularly when Mg^{2+} and Na^{+} are also present in drinking water resources. In this study SO_4^{2-} concentration ranged from 20 to 65 mg/l with mean 32.17 mg/l. The main source of SO_4^{2-} in water may be rainfall, fertilizers and dissolutions of surface minerals present in granites [6].

CONCLUSION

The study revealed that the groundwater in the Hanamkonda was of good quality. Although some of the parameters exceeded the World Health Organization guideline values, most of the physico-chemical parameters analyzed were satisfactory. Data clearly indicate that groundwater quality is severely affected by local physiographic structure and possibly groundwater flow. 39% of samples exceed the desirable limit of 45 mg/l as per WHO standard. The average level of TDS was greater in 16.6% of water samples. SO_4^{2-} in the study area within the permissible limit.

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