Physico-Chemical Analysis of Ground Water in the Selected Area of Visakhapatnam, AP, India

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ABSTRACT

Ground water is important source for industrial, agricultural and domestic purpose. Recent decades, due to over exploration of ground water is drastically decreased. Our present study, carried out of physico-chemical analysis of ground water, Visakhapatnam, AP, India. Major parameters like pH, Electrical Conductivity, Total Dissolved Solids (TDS), Chlorides, Sulphate, Total Hardness, Total Alkalinity, Nitrates and Dissolved Oxygen (DO) were analyzed. Results showed that the most of the parameters were exceeded the recommended ground water quality levels of Bureau of Indian Standards (BIS). Results indicated ground water is slightly polluted and recommended to treatment of ground water it’s before use.

Keywords

Ground water, Physico-chemical analysis and over exploration.

Introduction

Ground Water quality plays an important role in groundwater protection and quality conservation. Hence, it is very important to assess the groundwater quality not only for its present use but also from the viewpoint of a potential source of water for future consumption (Kori et al., 2006). It is well known that occurrence of ground water and its availability for various uses is controlled by the nature of rock formation in which it occurs as well as geological structures, geomorphologic and hydrological setting and hydrometeorological conditions. This resource is generally developed through ponds, lakes, wells and tube wells depending up on the need for which it is being used and its availability in the area (Raju, 1983).

An uncontrolled use of bore-well technology has lead to the extraction of ground water at such a high rate that often recharge is not sufficient. Water intended for human consumption should be “safe and wholesome” i.e. free from pathogenic agent and harmful chemicals, pleasant to taste and useable for domestic purpose (Parashar et al., 2006). The study area selected was all over urban area of Visakhapatnam for ground water quality testing. The city is dividing into five different zones, and six samples are collected from
The physico-chemical parameters like pH, EC, Total hardness, Total alkalinity, Chloride, Sulphate, Sodium, Potassium, Mg and Nitrate were studied to analyze the potable ground water quality of the city of lakes. Water is the principal need of life on earth, the requirement of water in all lives, from microorganism to man is a serious problem today because all water resource have been reached to a point of crises due to unplanned urbanization and industrialization (Singh et al., 2002). Water pollution is the state of deviation from pure condition, whereby its normal functioning and properties are affected. Aggravated environment problems often reflect the misuse or misunderstanding of technology (Petak, 1980).

Materials and Methods

The study area selected was total urban area of the city of Destiny, Visakhapatnam, Andhra Pradesh, India. The study area is located between latitude- 17° 30′ 15″ to 18° 11′ 15″ North and longitude- 82° 57′ 37″ to 83° 28′ 12″ East. Visakhapatnam has been notified as one of the most polluted industrial cluster by central pollution control board of India. The study area experiences a semi-arid climate, with temperature in the range of 14–38°C. The annual average rainfall is 1080 mm. The sub-surface geology indicates that the average weathered rock portion extends up to 16m and the fractured rock zone up to 30m depth from the ground surface. The red sediments vary in depth from 1 to 3m, with an average of about 2m, from surface level, depending upon the topography. Water samples were drawn from bore-wells and hand pumps during Post-monsoon period of the year 2013. The water samples were collected in plastic container as possible to avoid unpredictable changes in physico-chemical characteristics. The testing of samples was done according to the procedure prescribed by APHA (2005). Present study comprises of interpretation and analysis of water samples collected from thirty different stations at all over city. In our study, first we mark the sampling stations in five different zones of the city, then stations were established and water samples were collected. The samples were analyzed for different chemical, physical parameters and the results were carefully studied and analyzed.

Results and Discussion

Ground-water has been considered a safe source of potable water since the ages and till date a lot of people depend on it for drinking. But the quality of ground water is deteriorating and it is of paramount importance to assess the quality regarding various parameters. The physico-chemical, heavy metal and biological parameters of ground-water need to be studied to determine its quality. The present study mainly focuses on the physico-chemical characteristics in the ground water from the study area and the results (Table 1) were compared with BIS standards.

In the groundwater regime, all chemical and biological reactions directly depend on the pH of the system. The chemical state of groundwater is usually defined in terms of pH, temperature and oxidation-reduction potential (Nelson, 2002). In the present study the pH of the ground water ranges from 7.12 to 8.20 with mean of 7.47. None of the samples found to have exceeded the BIS limit (6.5-8.5) of pH for drinking water.

The conductivity of the ground water indicates its ionic strength and its degree of ionic mineralization, e.g. elevated concentrations of heavy metals (Naudet et al., 2004). The electrical conductivity (EC) of the ground water samples of the study area were ranges from 490 to 3711 μS/cm, with mean of
1372 µS/cm (Table 1). Maximum value was recorded at Dabagardens (3711 µS/cm) while lowest value recorded at Tatichetlapalem (490 µS/cm). It is significant to mention that electrical conductivity of water at all the study sites was found to exceed the maximum permissible limits of 750 µS/cm for drinking water (BIS, 1991). High values of conductivity indicate high concentration of soluble salts present in groundwater sources and reflect the contribution from seepage of domestic, industrial and municipal sewage (Hussain et al., 2002).

The concentration of total dissolved solids in water can be approximated in the field by measuring the specific conductance of a sample (Hem, 1985). Fresh water is usually considered to be water containing less than 1,000 mg/L total dissolved solids (Drever, 1988). The total dissolved solids (TDS) of the ground water samples of the study area ranges from 330 to 2487 mg/L, with mean of 920 mg/L (Table 1). Maximum value recorded at Dabagardens (3711 µS/cm) while lowest value recorded at Tatichetlapalem (330 µS/cm). The reason of these changes could be the dissolution of salts and minerals, which are present in soil due to rise in water table. Kripanidhi (1984) reported similar trend in groundwater of a typical hard rock terrain and pollution in village wells in Karnataka state.

Chlorides are leached from various rocks into soil and water by weathering (WHO, 1996). Chloride is the most abundant ion in seawater, with a concentration greater than 19,000 mg/L (Stumm and Morgan, 1996). The concentration of chloride in the ground water samples of the study area were ranges from 100 to 565 mg/L, with a mean of 275 mg/L. The concentration of chloride Maximum value was recorded at Dabagarden (565 mg/L) while lowest value recorded at Tatichetlapalem (100 mg/L) may be due to low water level and minimum in the rainy season due to dilution factor.

**Fig.1** Showing sampling locations
As per Indian Drinking Water Standard IS 10500: 1991 the desirable limit for chloride is 250 mg/l as Cl, beyond this limit the taste become salty, corrosive and palatability is affected. Permissible limit in the absence of alternative source is 1000 mg/l (Sameer et al., 2011). Higher values of chlorides indicate pollution of water and give an undesirable taste. Higher values are hazardous to human consumption and create health problems (Kataria and Iqbal, 1995). People who are not accustomed to high Chloride in water are subjected to laxative effect as suggested by Raviprakash and Krishna Rao (1989).

Ground water impacts from anthropogenic sources of sulfate, however, are typically much smaller than from natural sources.
Gypsum is an important source in many aquifers having high concentrations of sulfate (MPCA, 1999). The concentration of sulphate in the present study varies from 26 to 229 mg/L, with a mean of 81 mg/L. Except one sampling location i.e. Dabagardens (229mg/L) is exceeded and other of these samples below the BIS desirable limits (200 mg/L) and within the safe limit and ground water appears to be suitable for drinking purpose. The Minnesota Department of Health (MDH) recommends a limit of 400 mg/L for water used in infants.

Hardness of water is due to the presence of divalent metallic cations, like calcium, magnesium, iron, and manganese ions (Sharma.2004). TH is normally expressed as the total concentration of Ca$^{2+}$ and Mg$^{2+}$ in mg l$^{-1}$, equivalent CaCO$_3$ (Suman, 2006). The total hardness represented by CaCO$_3$ concentrations in water ranges from 158 to 1045 mg/L, with a mean of 381 mg/L (Table 1). Maximum concentrations were recorded at Dabagardens (1045 mg/L) while lowest concentration was recorded at Tadichetlapalem (158mg/L). According to BIS, desirable limit of Total hardness and maximum permissible limits are 300mg/L and 600mg/L in ground water. The total hardness is relatively high in all samples due to the presence of calcium, magnesium, and chloride and sulphate ions to be found in areas with mainly igneous rock formations, while areas with mainly sedimentary rock tended to have greater water hardness (Rafi et al., 2011).

The constituents of Alkalinity in natural system mainly include Carbonate, Bicarbonate and Hydroxide. These constituents result from dissolution of mineral substances in the soil and atmosphere (Mittal and Verma, 1997). The alkalinity of ground water ranges from 16 to 156 mg/L, with a mean of 99mg/L (Table 1). Maximum concentrations were recorded at Sriharipuram (156mg/L) while lowest value at Kapuluppada Village (16mg/L). The samples were detected to have alkalinity lower than the desirable limits of 200 mg/L. A decrease in alkalinity value in the study area is ascribed to dilution due to rainfall (Khabede et al., 2003. Alkalinity itself is not harmful to human health: still water supplies with less than 100 mg/L are desirable for domestic use (Trivedi and Goel, 1984). Ramaswamy and Rangaraju (1991) reported higher alkalinity values in the ground water of Tirrupur, Tamil Nadu that may be due to the contamination of these resources with domestic and industrial wastes. High values of alkalinity in the water samples indicate pollution of organic nature and give an unpleasant taste. In the absence of alternate source of water, alkalinity up to 600 mg/L is permissible (BIS, 1991).

Nitrate in aquatic system usually originates from nitrogenous fertilizers, domestic waste discharge and animal wastes (Peavy et al., 1986). The nitrogenous fertilizer used in intensive agriculture percolates down to ground water and it is probably one of the reasons for high concentration of nitrate.

The Nitrate concentration varies from 1.2 to 16mg/L, with a mean of 9.3mg/L. Maximum value was recorded at Lawsons Bay Colony (16mg/L) and lowest value recorded at Maridi (1.2mg/L). The desirable limit of nitrate in drinking water is 45mg/L (BIS, 1991) / 50 ppm (WHO, 1984). The nitrate contents of ground water samples are well within the desirable limit in the present study.

Oxygen is the regulator of metabolic process of plant and animal communities and indicator of water condition (Gautham and Sharma, 2011). Dissolved oxygen is a highly fluctuating factor and this value varies depending upon water temperature and the partial pressure of oxygen in its gas phase.
In the present study the value of DO ranges from 1.2 to 5.9 mg/L with mean of 4.3 mg/L. Maximum value recorded at Dwarkanagar (5.9mg/L) while minimum values were recorded at Maridi (1.2mg/L). About most of the sampling locations not up to permissible according to drinking water quality standards (BIS, 2006) is >5 mg/L (tolerance level). Due to physical chemical and biological activities in water, the dissolved oxygen was low in all the groundwater. The DO values may also vary with the temperature and altitudinal change. Low DO in certain sites may be due to sewage, industrial and domestic solid waste seepage (Raja et al., 2002).

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