RESEARCH PAPER:

A study on ground water quality in Mangalore city, India

N.C. THARAVATHY

Asian Journal of Environmental Science (December, 2009 to May, 2010) Vol. 4 No. 2 : 142-145

Correspondence to :
N.C. THARAVATHY
Department of Bioscience, Mangalore University, MANGALORE (KARNATAKA) INDIA

SUMMARY

Nine groundwater samples were analyzed for pH, dissolved oxygen, alkalinity, solids, hardness, chloride, phosphate, sulphate, calcium, magnesium and iron contents by adopting standard methods. The results were evaluated in accordance with the WHO and BSI standards. pH showed marked increase when compared to the values of twenty years back. In two stations namely, Panamboor and Hoige Bazaar, the pH was above the WHO drinking water standards. The values of DO, alkalinity, solids, hardness, chloride, phosphate, calcium, magnesium and iron in the present study met below the BSI and WHO drinking water standards. The quality of sulphate in all samples except in Konaje and Kavoor was more than the standards prescribed by the BSI and WHO.

Key words :
Ground water, Dissolved oxygen, pH, Hardness, Sulphate

Accepted :
August, 2009

Water is one of the most precious natural resources and is essential for everything on our planet to grow and prosper (Buragohain *et al*., 2007). 97.2% of world's water is found in oceans and seas and the remaining 2.8% of water is found as ground water and surface water. The volume of ground water (0.59%) is 30 times greater than the surface water (0.02%). Surface water is generally easy and economic to harvest but its availability varies with the season and its use for irrigation frequently brings in its wake problem like water logging. Ground water, on the other hand, is obtained throughout the year. When seen from the country as a whole, there appears to be considerable groundwater available for future development (Raju, 1990). This water is disregarded now by the developmental activities like industrialization, urbanization etc. When water is unfit for its intended use, it is considered as polluted. WHO has given a set of guideline values for drinking water quality (WHO, 2004).

Ground water is the water held in regolith and underlying bedrock between the saturated zones in which all pore spaces are occupied by water (Strahler, 1981). Atmospheric precipitation is the main source of fresh ground water. It is estimated that about 25% of the precipitation becomes groundwater (Nace, 1960). Ground water of atmospheric origin that has been isolated from hydrologic cycle for thousands of years is called meteoric water and that isolated from millions of years is called connate water. Juvenile water or primary water is formed within the earth itself and is arised from volcanic activity (Guines, 1963). Groundwater is explored by digging the wells. There are three types of wells namely bore well, open well and dug cum bore well (Garg, 1978). The indiscriminate disposal of industrial wastes on mother earth slowly makes the ground water susceptible to pollution (Prakash *et al*., 2007). Literature on groundwater revealed that the scientific investigation was rarely carried out with regard to the physico-chemical quality of ground water in Mangalore taluk. Hence, the present work is a small effort to give an idea of ground water quality and its usefulness for domestic, industrial, agricultural and other needs in Mangalore city.

MATERIALS AND METHODS

Mangalore city is situated in the southern part of India on the coastal side of Karnataka. It is a fast growing city and has been urbanized and industrialized rapidly during the past 15 years. It harbored the mega industries like Mangalore Chemicals and Fertilizers Ltd. (MCF), Kudremukh Iron Ore Company Ltd. (KIOCL), New Mangalore Port Trust (NMPT), Mangalore Refinery and Petroleum Ltd. (MRPL), Nagarjuna Industrial Thermal Power Plant (NITPP) and several small and medium scale industries in and all around. Since all these industrial establishments have triggered the growth of urban population, transport facilities etc., abatement of pollution of water, air and soil have become a challenging problem in Mangalore city.

The site of ground water is selected randomly from open wells and bore wells of various regions of Mangalore city. Totally, 8 urban stations (Kuloor, Panamboor, Bajal, Bhondel, Kavoor, Kunjathbail, Nanthoor and Hoige Bazar) were selected in Mangalore city and a station belongs to the rural area (Konaje) was also selected just to compare the samples of urban and rural areas. All the samples were collected during the month of January, 2009. The samples were protected from direct sunlight during transportation.

The determination of physico-chemical parameters was done according to the procedure given by APHA (1995). The results were evaluated in accordance with BSI and WHO standards. Totally, six trials were done for each sample and average values plus or minus standard deviation were calculated for each parameter.

RESULTS AND DISCUSSION

Colour, odour and taste of all groundwater samples did not report any objectionable features.

The physico-chemical characteristics and BIS and WHO standards of drinking water are presented in Table 1 and 2.

pH:

It is a measure of hydrogen ion concentration in water. Most natural waters have a pH of 4-9 and majority of them are slightly alkaline due to carbonates and bicarbonates of calcium and magnesium dissolved in water. Bureau of Indian Standards (BIS) prescribed a pH of 7.75 and WHO prescribed a range of 6.5-8.5 for drinking water. Water with a pH of above and below this range is likely to be contaminated indicating intrusion of acidic or alkaline materials. The pH of the water samples tested here contained a pH range from 6±0.0 to 10.5±0.4. Panamboor area which is also called as industrial area was recorded highest pH value of 10.5±0.4 and minimum level of pH (6.0±0.0) was recorded in Bajal and Nanthoor station. Narayana and Suresh (1989) estimated the pH of groundwater of Mangalore city in the range of 3.1 to 7.5. This difference in the pH values after 10 years may be due to the industrialization and anthropogenic activities.

Dissolved oxygen (DO):

It is the amount of oxygen dissolved in water. Non-polluted surface waters are normally saturated with dissolved oxygen. DO values in the present water samples ranged from 6.0±0.05 to 10.1±0.2 which were recorded below the drinking water standards. Bhondel and rural area (Konaje) were recorded highest DO value which may be due to the highest rate of photosynthesis by the producers. Depletion of oxygen in water indicates that the water is polluted by an organic waste.

Alkalinity:

Alkalinity in natural water is due to free hydroxyl ions and hydrolysis of salts formed by weak acids and strong bases. Most of the alkalinity in natural waters is formed due to dissolution of carbon dioxide in water. In the present study the total alkalinity recorded in the water samples ranged from 40±1.0 to 200±2.2 mg/l. The values of alkalinity in all the samples fall below the prescribed standards. Excess alkalinity gives bitter taste to water.

Dissolved solids:

The amount of dissolved solids denotes mainly various kinds of minerals present in the water (Trivedy and Goel, 1986). The total dissolved solids varied from 100±0.0 to 400±2.0 mg/l which was within the desirable limits. Hoige Bazar groundwater sample was recorded highest amount

Table 1 : Physico-chemical characteristics (Av±SD)of 5 samples and BIS and WHO drinking water standards

Sampling stations	Kuloor	Panam-boor	Bajal	Bhondel	Kavoor	BIS drinking water standards	WHO drinking water standards
pH	8.0±0.01	10.5±.01	6.0±0.0	8.0±0.0	8.0±0.01	6.5-8.5	6.5-8.5
DO	7.0±0.41	7.0±0.86	6.2±0.33	9.5±0.41	8.0±0.41	6-12	6-12
Alkalinity	70±2.0	90±1.0	40±1.0	90±5.0	50±2.0	<100	<100
Solids	100±5.0	200±4.08	100±0.0	200±4.08	200±2.2	500	<1500
Hardness	34±2.45	34±1.63	26±2.0	40±0.0	28±2.45	300	300-600
Chloride	30.2±1.2	90.7±0.0	33±0.07	30.2±0.1	35.5±0.0	200	200
PO_4^-	0.0±05	0.01±0.0	0.03±0.0	0.03±0.0	0.02±0.0	0.1	<0.1
SO_4^-	460±2.0	490±8.0	520±1.0	630±8.0	300±0.0	<150	200-400
Ca^{2+}	7.8±0.41	8.6±0.73	8.6±0.0	7.4±0.08	7.4±0.73	<200	75-200
Mg^{2+}	2.8±0.0	2.4±0.0	-	4.8±0.4	1.9±0.03	30	30-150
Iron	0.02±0.0	0.06±0.01	0.02±0.0	0.04±0.0	0.003±0.0	0.3	0.3-1.0

Table 2 : Physico-chemical characteristics (Av±SD) of 4 samples and BIS and WHO drinking water standards

Sampling stations	Kunjthbail	Nanthoor	Hoige -Bazaar	Konaje	BIS drinking water standards	WHO drinking water standards
pH	8.0±0.01	60±0.0	9.0±0.0	6.5±0.0	6.5-8.5	6.5-8.5
DO	6.5±0.0	6.0±0.05	6.0 ±0.41	10.1±0.02	6-12	6-12
Alkalinity	60±2.0	45±1.0	200±2.2	52±3.6	<100	<100
Solids	100±3.27	200±4.08	400±0.0	300±3.2	500	<1500
Hardness	28±1.63	30±0.0	52±1.63	50±2.45	300	300-600
Chloride	33±1.8	32±0.0	44±0.0	20±0.5	200	200
PO_4^-	0.01±0.0	0.002±0.0	0.02±0.0	0.09±0.01	0.1	<0.1
SO_4^-	510±0.41	570±0.0	420±0.41	-	<150	200-400
Ca^{2+}	8.6±0.41	8.0±0.73	10.2±0.41	16.2±0.02	<200	75-200
Mg^{2+}	1.4±0.0	1.9±0.05	6.3±0.04	17.3±0.9	30	30-150
Iron	0.09±0.02	0.03±0.0	0.02±0.0	0.04±0.0	0.3	0.3-1.0

All values are in mg/l except pH

(400±0.0) of dissolved solids compared to other samples.

Hardness:

It is a measure of variable complex mixtures of anions and cations. In freshwater, the principal cations which impart hardness are calcium and magnesium. Hard water is objectionable for domestic purpose since it needs lot of soap for lather formation (Trivedy and Goel, 1986). BIS standard for hardness is 300 mg/l. The total hardness varied from 26±2.0 to 52±1.63 mg/l. Hoige Bazar station recorded the highest value of hardness which may be due to the presence of ions.

Chloride:

It naturally occurs in all types of water. In natural fresh waters, the concentration of chloride is quite low and is generally less than that of sulphates and bicarbonates. The chloride content in the water sample varied from 20±0.5 to 90.7±0.0 mg/l. According to BIS standards the desirable limit of chloride content in water is 250 mg/l. Panamboor station which is an industrial area, recorded the highest value of chloride and lowest was recorded in Konaje rural area.

Phosphate:

In fresh water, phosphate is present mostly in inorganic forms such as $H_2PO_4^-$, HPO_4^{-2} and PO_4^{-3}. According to BIS standards, the phosphate content should not exceed more than 0.1mg/l. The phosphate content in the present water sample varied from 0.002±0.0 to 0.09±0.01 mg/l which was recorded within the BIS standards.

Sulphate:

It is a naturally occurring anion in all kinds of natural waters. Higher concentration of sulphate indicates the pollution by industrial and domestic waste and also by the biological oxidation of sulphur to sulphate. Most of the salts of sulphate are soluble in water and so it is not precipitated. The sulphate content in the water sample varied from 100±0.0 to 630±8.0 mg/l.

According to WHO standards for drinking water, the concentration of sulphate should be up to 400 mg/l. In the present study in all sites except in Konaje and Kavoor, sulphate was highest than the standard value. Highest value of sulphate *i.e.* above 400 mg/l produces an objectionable (bitter) taste to water. In rural area (Konaje), it was recorded minimum (100±0.0) which may be due to the minimum discharge of industrial or domestic waste.

Calcium:

In natural waters an important source of calcium is the dissolution of carbonate minerals. According to WHO standards for drinking water the amount of calcium should be 75 mg/l and not more than 200 mg/l. The amount of calcium varied from 7.4±0.08 to 10.2±0.41 mg/l. The value of calcium recorded was high in sample collected from Hoige Bazar and Konaje which may be due to the presence of carbonate minerals leached from rocks.

Magnesium:

It also occurs in all kinds of natural water with calcium but its concentration generally remains lower than the calcium. According to BIS standards, the concentration of magnesium in drinking water should be 30 mg/l. The amount of magnesium recorded during the study period ranged from 1.4±0.0 to 15.3±0.08 mg/l. Rural area (Konaje) recorded the highest value of magnesium which may be due to the release of magnesium from weathering of rocks.

Iron:

It is one of the important elements in igneous rocks and gives metallic taste to water. It plays an important biochemical role in the metabolism of plants and animals. Microorganisms are influenced by iron for its occurrence in groundwater (Matlhes and Harvey, 1982). All kinds of water including groundwater have appreciable quantities of iron. It has more solubility at acidic pH, therefore large quantities of iron are leached out from the soils by acidic water. According to WHO standards, the concentration of iron in drinking water should range from 0.3 to 0.1 mg/l. In the present study, the values of iron in all samples were within the acceptable range prescribed by BSI and WHO.

Conclusion:

Ground water is better in quality than surface water because it is free from pathogenic bacteria due to excellent soil filtering mechanism. During the study period, it was noticed that the samples of study area did not contain any physico-chemical parameter above the standards prescribed by the BIS and WHO standards except sulphate and pH. Hardness values indicated that Hoige Bazar water sample was hard in nature than other samples. Rural area was recorded high DO value than the urban area because of water saturation by the enough oxygen. The low level of sulphate in village sample indicated that the water was not polluted by any external sources.

The present work on ground water quality concludes that the ground waters of Mangalore city can be used for domestic, industrial and agricultural purposes but the discharge of sulphate should be minimized in future. Otherwise, there is a chance of crossing the standard level of phosphate in future also. Since the volume of ground water is more than the surface water, exploration of ground water by geological, remote sensing, hydrologic and geophysical techniques can partially solve the water shortage problems.

Acknowledgement:

The author is thankful to Mangalore University for providing laboratory facilities.

REFERENCES

APHA (1995). Standard methods for the examination of water and wastewater. American Public Health Association, New York.

Buragohain, M., Bhuyan, B. and Sarma, H.P. (2007). Drinking water quality with respect to fluoride, nitrate, arsenic and iron content in Dhemaji district, Assam. *Eco. Env. & Cons*., **13** (4) : 795-798.

Garg, S.P. (1978). Groundwater Tube Wells. Oxford IBH Publ. Co., New Delhi.

Guines, C.L. (1963). The role of groundwater suppliers, U.S. Geological Survey Circular 1800, Washington.

Matlhes, G. and Harvey, J.C. (1982). The properties of groundwater, A. Wiley- Inter Science Publ., New York.

Nace (1960). Water management agriculture and groundwater supplies. *U.S. Geological Survey Circular 415*, Washington.

Narayana, A.C. and Suresh, G.C. (1989). Chemical quality of groundwater of Mangalore city, *Indian J. Environ. Hlth.*, **31**(3), p.228.

Prakash, N.J., Babu, K.H., Kumara, V. and Puttaiah, E.T. (2007). Physico-chemical characteristics of groundwater quality in the vicinity of Tarikere, Chickmangalore (Dist.), Karnataka state, *Eco. Env. & Cons*., **13**(3) : 535-538.

Raju, T.S. (1990). Editorial note on groundwater development, *BHU-JAL NEWS,* Special issue on groundwater development, 5(3), New Delhi.

Strahler, A.N. (1981). *Physical geology*, Harper and Row Publ., New York, 1981.

Trivedy, R.K. and Goel, P.K. (1986). *Chemical and biological methods for water pollution studies*, Enviro Media, Karad.

W.H.O. (2004). *Guidelines for drinking water quality*, 3rd Ed., World Health Organization, Geneva.