INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 3, No 5, 2013

Research article **ISSN 0976 – 4402**

Assessment of ground water quality in an industrial agglomeration of Visakhapatnam, A. P

Byragi Reddy. T, Prasada Rao. P.V.V, Ch.Venkata Ramana,
Hema Latha. S, Syam Kumar. B
Department of Environmental Sciences, Andhra University,
Visakhapatnam – 530 003
tbyragireddy@yahoo.com
doi:10.6088/ijes.2013030500008

ABSTRACT

Ground water is increasingly used for domestic, agricultural, industrial and other activities. Quality of water is the most important factor for any use; be it domestic or any other purposes. Indiscriminate use of ground water deteriorates the quality and quantity of water. The present work reports the physico-chemical characteristics of the ground waters collected from an industrialized urban agglomeration of Visakhapatnam city, Andhra Pradesh. The physico-chemical parameters include pH, Turbidity, Conductivity, Total Dissolved Solids, Chlorides, Sulphates, Total Hardness, Calcium, Magnesium, Total Alkalinity, Nitrates and Fluorides. Though the data show that majority of the values are compatible with the maximum allowable standards recommended by BIS, still in depth studies are to be carried out to decide its suitability for safe drinking and domestic use. It is possible that the concentration of the dissolved impurities may increase further if the recommended norms for discharging industrial effluents are not adhered.

Keywords: Ground water, Water quality, urban agglomeration, Physico-chemical parameters, Standards

1. Introduction

Water is the elixir of life and is abundantly available natural resource on the Planet Earth. Though water is available in plenty it is a finite resource (Bouwer, 2000). In majority of the areas ground water has become the main resource to meet the domestic, agricultural, industrial and other activities since surface water from streams, lakes, ponds and rivers are being contaminated continuously by anthropogenic activities. Since the suface water is being contaminated, the pressure on the usage of ground water is steadily increasing hence the quality of ground water has been deteriorating. Over exploitation of ground water also causes depletion of the ground water level (Jha and Sinha, 2007)

Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and sub-surface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrologic and human factors may cause periodic changes in groundwater quality. The quality of groundwater is steadily deteriorating at a faster rate due to pollution ranging from septic tanks (Olaniya and Saxena, 1977; Gillison and Patmont, 1983), land fill leachates, domestic sewage (Eison and Anderson, 1980; Sharma and Kaur, 1995; Subba Rao, 1995), agricultural operations (Banerji, 1983; Handa; 1986, Ramachandra et al., 1991; Datta and Sen Gupta, 1996, Somashekar et al., 2000) and industrial wastes (Sharma and Kaur, 1995; Todd, 1995 and Rengaraj et al., 1996; Indra Raj, 2000). Water pollution not only affects water quality but also threatens human health,

Received on December 2012 Published on March 2013

economic development and social prosperity. Degradation of water quality affects the animals, plants or human beings when the polluted water is consumed. Contamination of drinking water sources by sewage can occur from raw sewage overflow, septic tanks, leaking sewer lines, land application of sludge and partially treated waste water (Jain and Vivek Sharma, 2011). Potable water should contain salts, minerals and compounds within the permissible limit as suggested by the regulatory body BIS. The growing population and urbanization is increasing the vertical growth thereby increasing the density of the population per square kilometer. This generates huge quantities of various types of wastes putting additional strain on the ground water quality (Byragi Reddy *et.al* 2012).

The present study is an attempt to assess the physico-chemical characteristics of the ground water of an industrial urban agglomeration of Visakhapatnam city, India.

2. Methodology

Study Area: The study area has an approximate extent of 40 km^2 and lies between latitudes 17^o 42' 53'' N and 17^o 41' 24'' N longitudes 83^o 12' 18'' E to 83^o 15' 17'' E in Visakhapatnam city (Google Earth, 2011). The pictorial representation of the study area is shown in Figure 1. Visakhapatnam is an important industrial city in India and has a major port transacting nearly 67 millon tons/year.

Figure 1: Study area (source: Google earth, 2011)

Sample collection: Grab sampling has been employed to collect groundwater samples. The samples were collected in polythene containers of 2 liters capacity for physicochemical analysis after pumping out sufficient quantity of water from the source such that, the sample collected served as a representative sample. The samples thus collected were transported to the laboratory by observing all precautions laid down in the Standard methods (APHA, 1995). The Sampling locations and the nearest industries are given in Table1.

Table 1: Sampling locations and proximity to industries.

1. Mindi	Hindustan Zinc Smelter.
2. Akkireddypalem	Visakha Dairy.
3. Sriharipuram	Bharath Heavy Plates and Vessels.
4. Malkapuram	HPCL and newly established HP Petro Park.

3. Results

The data relating to the physicochemical parameters reported in the work are an average of five samples and is presented in Table 3. The observed values of the samples were compared with Bureau of Indian Standards (BIS- 10500: 1991). The samples collected showed considerable variations in the quality of groundwater. This might be due to their proximity to the industrial activity or may be due to variation in the depth of sample points. In general, the quality of ground drawn from deep installations is better than the shallow installations, since the latter is prone for contamination by various materials.

Table 3: Physico-chemical parameters of the four study locations along with IS 10500

Parameter	S_1	S_2	S_3	S_4	Standards IS 10500 mg/l	
					Acceptable	Maximum
pH	7.34	7.28	6.81	6.39	6.5-8.5	No relaxation
Turbidity	1.2	2.0	1.0	1.1	5	10
Conductivity	2380	2600	1126	846	1500	3000
TDS	1646	1713	796	588	500	2000
Chlorides	720	809	246	155	250	1000
Sulphates	142	96	51	41	200	400
Phosphates	2.6	5.2	3.3	1.8	-	
Total Hardness	752	518	392	302	300	600
Total alkalinity	369	350	325	290	200	400
Nitrates	10	13	9	6	45	100
Fluorides $^-$	0.73	0.8	0.80	0.45	1.0	1.5

4. Discussion

pH: The pH value of the water samples in the study area varied from 6.39 – 7.34 with a mean of 6.995 indicating slight acidic to slight alkaline nature. High values of pH may induce the formation of trihalomethanes, which are toxic, while pH below 6.5 corrodes the water pipe lines thereby releasing toxic metals such as zinc, lead, cadmium and copper (Shrivastava and Patil, 2002). It was also observed that the relative quantities of calcium, carbonates and bicarbonates influence the pH value of the water. The water tends to be more alkaline when it possesses carbonates (Zafar, 1966; Suryanarayana, 1995).

Turbidity in the study area ranged from 1.0 – 2.0 NTU and found to be well within the acceptable limits of BIS. Leaching of organic matter, industrial, domestic wastes etc., also contribute to turbidity in groundwater samples. The presence of inorganic nutrients such as nitrogen and phosphorus which may stimulate the growth of algae, also contributes to turbidity (Sawyer et. al., 2000). There are chances for the pathogenic organisms to be enclosed in the turbidity causing particles, leading to health hazards (Manivasakam, 2000).

Electrical conductivity value of the study area varied from 846 – 2600 µmhos/cm with a mean of 1738 µmhos/cm and found to be complying with the acceptable limits proposed of

BIS. Electrical conductivity is a measure of water's capacity to conduct electric current since most of the salts in the water are present in the ionic form. In general, groundwater tends to have high electrical conductivity due to the presence of high amount of dissolved salts. Electrical conductivity is a decisive parameter in determining suitability of water for a particular purpose.

The Total Dissolved Solids (TDS) in the study area varied from 518 – 1713 mg/l with a mean value of 1185.75 mg/l and all the samples were found complying with the standards of BIS. TDS is contributed by dissolved materials consisting mainly inorganic salts, small amounts of organic matter and dissolved gases.

The chlorides varied widely from 155 – 809 mg/l with a mean value of 482.5 mg/l and Mindi and Akkyreddypalem samples were found exceeding the acceptable limit of BIS. In general, chlorides occur in all types of waters and the contribution of chloride in the groundwater is due to minerals like apatite, mica, and hornblende and also from the liquid inclusions of igneous rocks (Das and Malik, 1988). Leachate from landfills (Eison and Anderson, 1980, Sharma and Kaur, 1995, Subba Rao and Subba Rao, 1995), septic tanks and pit latrines (Olaniya and Saxena, 1977, Craig and Anderson, 1979, Gillison and Patmont, 1983, Vates, 1986, Todd, 1995, Sharma and Kaur, 1995, Polprasert, 1996) also contribute considerable amount of chlorides to groundwater.

Sulphate in the study area varied between 41 – 142 mg/l with a mean value of 82.5 mg/l which indicates that the groundwater in the study area has not been affected by sulphate. Sulphate ion is one of the major anions occurring in natural waters since they are readily soluble in water. Most of them originate from the oxidation of sulphite ores, gypsum and anhydrite. In the absence of dissolved oxygen, nitrate and sulphates serve as a source of oxygen for biochemical oxidation produced by anaerobic bacteria. Under anaerobic conditions, sulphate ion is reduced to sulphide ion, which establishes equilibrium with hydrogen ion to form hydrogen sulphide. The presence of hydrogen sulphide leads to corrosion of pipes (Sawyer et al., 2000).

The Total Hardness of the ground water samples ranged between 302 - 752 mg/l as CaCO3 with a mean value of 491 mg/l and only samples from Mindi area were found exceeding the acceptable limit of BIS. Hardness in water is caused by salts like carbonates, fluorides and sulphates of calcium and magnesium. The principal hardness causing cations are calcium, magnesium, strontium, ferrous and manganese ions. The cations plus the most important anions that contributes are bicarbonates, sulphates, chlorides, nitrates and silicates. The hardness may be advantageous in certain conditions; it prevents the corrosion in the pipes by forming a thin layer of scale, and reduces the entry of heavy metals from the pipe to the water (Shrivastava et al., 2002).

The Alkalinity in the study area ranged between 290 – 369 mg/l as CaCO3 with a mean value of 333.5 mg/l, indicating that all the samples were complying with the standards of BIS. The presence of ionic species like bicarbonates, carbonates, hydroxides, phosphates, borates, silicates and organic acids contributes alkalinity to waters. In some cases, ammonia or hydroxides are involved in causing alkalinity (Sawyer et. al., 2000).

Nitrate concentration in the study area ranged from 6.0 – 13.0 mg/l with a mean concentration of 9.5 mg/l which indicates that the groundwater in the study area has not been affected by nitrate. Human and animal wastes, industrial effluents, application of agro chemicals, seepage and silage through drainage system are the main sources of nitrate contamination in groundwater (Robertson et al., 1991 and Agrawal et al., 1999). The high concentration of nitrates in drinking water causes methenoglobinemia in infants, a disease characterized by blood changes.

Fluoride content in the study area varied from 0.45 – 0.80 mg/l with a mean value of 0.695 mg/l and all the samples were found complying BIS standards. Fluoride is considered as an essential element though health problems may arise from either deficiency or excess amount (Gopal et al, 1985). Much of the fluoride entering the human body is obtained from drinking water (Saralakumari and Rao, 1993). Fluoride concentration of 0.4 ppm in drinking water causes mild type of dental fluorosis (Dinesh, 1999; Gupta et al., 1993; Yadav and Lata, 2004).

5. Conclusion

Groundwater is a precious natural resource and it is an important component of the hydrologic cycle. In comparison with the surface water pollution, the groundwater contamination is difficult to control. Though the data relating to ground water of the present study indicate that majority of the physic-chemical parameters analyzed are complying with maximum standards proposed in BIS, more studies are to be undertaken to elucidate the utility of the ground water for domestic use. The present study also indicates that groundwater quality is gradually getting deteriorated and it may continue with time. Hence the local government needs to initiate remedial measures.

6. References

1. Bouwer, H., (2000), Integrated water management: Emerging issues and challenges, agricultural water management, pp 45-46.

2. Jha, B. M. and Sinha, S. K., (2007), Towards better management of ground water resources in India. Central ground water board.

3. Olaniya, M.S. and K.L. Saxena., (1977), Groundwater pollution by open refuse dumps at Jaipur, Environmental Health, 19, pp 176-188.

4. Gillison, R.J and C.R. Patmont., (1983), Lake phosphorus loading from septic systems by seasonally perched groundwater, Journal of Water Pollution, 55, pp 1297-1304.

5. Eison, C. and M.P. Anderson., (1980), The effects of urbanization on groundwater quality in Milwankee, Wisconsin, USA In. Jackson, pp 378-390.

6. Sharma, H. and B.K. Kaur., (1995), Environmental chemistry. Goel Publishing House, Meerut.

7. Subba Rao, C. and N.V. Subba Rao., (1995), Groundwater quality in a residential colony, Indian journal of environmental health, 37(4), pp 295-300.

8. Banerji, A.K., (19/83), Importance of evolving a management plan for groundwater development in the Calcutta region of the Bengal basin in eastern India, Proceedings of International symposium on groundwater resources and planning, Koblent, Germany, pp 45-54.

9. Handa, B.K., (1986), Hydrochemical zones of India. Proc. Seminar on groundwater development, Roorkee, pp 439-450.

10. Ramachandra, S., A. Narayanan and N.V. Pundarikathan., (1991), Nitrate and pesticide concentrations in groundwater of cultivated areas in north Madras. Indian Journal of environmental health, 33(4), pp 421-424.

11. Datta, N.C. and S. Sen Gupta., (1996), Effect of artificial aeration on the hydrographic regime of pesticide treated aquatic system, Pollution research, 15(4), pp 329-333.

12. Somashekar, R.K., V. Rameshaiah and A. Chethana Suvarna., (2000), Groundwater chemistry of Channapatna Taluk (Bangalore rural district) – Regression and cluster analysis, Journal of environmental pollution, 7(2), pp 101-109.

13. Todd, D.K., (1995), Groundwater hydrology. John Wiley and Sons, New York.

14. Rengaraj, S., T. Elampooranan, L. Elango and V. Ramalingam., (1996), Groundwater quality in suburban regions of Madras city, India, Pollution research, 15(4), pp 325-328.

15. Indra Raj., (2000), Issues and objectives in groundwater quality monitoring programme under hydrology project, Proceedings of National symposium on groundwater quality monitoring, Bangalore, pp 1-7

16. Dr. Jain, S. K. and Dr. Vivek Sharma., (2011), Contamination of ground water by sewage. Central ground water board, Ministry of water resources government of India.

17. Byragi Reddy.T, Prasada Rao. P.V.V., Venkata Ramana, Ch Bhaskar, Ch. and Jagadeeshchandrababu, P., (2012), Assessment of heavy metal study on ground water in and around Kapuluppada Msw Site, Visakhapatnam, AP, International journal of science and nature, 2, pp 468-471.

18. APHA. (1995), Standard methods for the examination of water and waste water 19th (ed). American public health association and water pollution control federation, Washington D.C

19. Shrivastava, V.S. and P.R. Patil., (2002), Tapti river water pollution by industrial wastes: A statistical approach, Nature environment and pollution technology, 1(3), pp 279-283.

20. Zafar, A.R., (1966), Limnology of Hussain Sagar lake, Hyderbad. Phykos, 5, pp 115-126.

21. Suryanarayana, K., (1995), Effect of groundwater quality on health hazards in parts of eastern ghats, Indian journal of environmental protection, 15(7), pp 497-500.

22. Sawyer, Clair N., Perry L. McCarty and Gene F. Parkin., (2000), Chemistry for environmental engineering. IVth Ed., Tata McGraw-Hill. New Delhi.

23. Manivasakam, N., (2000), Physicochemical examination of water, sewage and industrial effluents. IVth Ed., Pragati Prakashan, Meerut.

24. Craig, E. and M.P. Anderson., (1979), The effects of urbanization on groundwater quality – A case study groundwater, 17, pp 456-462.

25. Vates, M.V., (1986), Septic tank density and groundwater contamination, Groundwater, 23(5), pp 586-590.

26. Polprasert, C., (1996), Organic waste recyling – Technology and management. IInd Ed., John Wiley and Sons, Chinchester.

27. Robertson, W.D., J.A. Cherry and E.A. Sudicky., (1991), Groundwater contamination from two small septic systems in sand aquifers, Groundwater, 29(1), pp 82-91.

28. Agrawal, G.D., S.K. Lunkad and T. Malkhed., (1999), Diffuse agricultural nitrate pollution of groundwater in India, Water science and technology, 39(3), pp 67-75.

29. Gopal, Ram and P.K. Gosh., (1985), Fluoride in drinking water – Its effects and removal, Defense science journal, 35(1), pp 71-88.

30. Saralakumari, D. and Rao, P.R., (1993), Endemic fluorosis in the village Ralla, Anantapuram in Andra Pradesh. An epidemiological study, Fluoride, 26(3), pp 177-180.

31. Dinesh, C., (1999), Fluoride and human health – cause for concern, Indian Journal of Environmental protection, 19(2), 81-89 (1999).

32. Gupta, S.C., G.S. Rathore and C.S. Doshi., (1993), Fluorida distribution in ground waters of South-eastern Rajasthan, Indian journal of environmental health, 35(2), pp 97-106

33. Yadav, J.P. and S. Lata., (2004), Fluoride levels in drinking water sources in rural areas of block Jhajjar, district Jhajjar, Haryana, Journal of Indian water works association, pp 131-136.