WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 4, 1007-1019. Research Article ISSN 2277– 7105

WATER QUALITY ANALYSIS IN DIFFERENT LOCATIONS OF SIVAGANGAI TOWN, TAMIL NADU, INDIA

S. Deivendran* and N. Alaguchamy

*PG and Research Department of Zoology, Dr.Zakir Husain College, Ilayangudi-630702, Sivagangai, Tamil Nadu, India.

PG and Research Department of Zoology, Raja Doraisingam Govt. Arts College, Sivagangai-630561, Tamil Nadu, India.

Article Received on
03 February 2017,

Revised on 23 February 2017,
Accepted on 15 March 2017

DOI: 10.20959/wjpr20174-8120

***Corresponding Author**
S. Deivendran
PG and Research Department of Zoology, Dr.Zakir Husain College, Ilayangudi-630702, Sivagangai, Tamil Nadu, India.

ABSTRACT

Groundwater is an important source of water supply throughout the world. The quantity and the suitability of ground water for human consumption and for irrigation are determined by its physical, chemical and bacteriological properties. The present study was carried out in 10 different locations of Sivagangai town and the physico-chemical parameters of 10 water samples collected from the sites were analyzed. The water samples were collected from borewells of 10 different locations in and around Sivagangai town, Tamil Nadu, India. The same results are observed in the physical factors such as appearance (clear), colour (colourless) and odour (agreeable) in all the selected ten different locations. The maximum turbidity is recorded in the locations IV, VII, IX, X and minimum in the remaining locations. The electrical conductivity is ranged from 810 to 2710. The location IX, X showed the maximum conductivity (2710) and the minimum is observed 810 in III location. The pH values of the samples are slightly alkaline and it's ranged from 7.1 to 7.4. The maximum pH value is observed in the water samples II & IX and minimum in III, V & VI locations. The pH alkalinity value is zero in all the ten different selected water samples. The total hardness of the selected water samples ranged from 72 to 520 mg/L. The maximum hardness value is recorded in the sample X, the minimum in the sample IV and the average value of hardness is 256.2. The maximum calcium content (139) is observed in the sample X and the minimum content of calcium (16) in the sample IV. The maximum sodium content is about 420 mg/L in the locations such as II & IV followed by 370 in the sample X and 360 in the samples VII &

X and the minimum sodium content 120 is noted in the sample III. The potassium content was minimum in (08 mg/L) the sample III and the maximum content (40 mg/L) was recorded in the sample X. The results pertaining to water quality from different locations of Sivagangai town, Tamil Nadu revealed that all the tested physico-chemical parameters such as appearance, colour, odour, turbidity, total dissolved salts, electrical conductivity, pH, alkalinity, hardness, calcium, magnesium, sodium, potassium, iron, manganese, ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate are at the prescribed standards of WHO and EPA. However, careful attention towards contamination of water sources is recommended so that future risk in terms of environmental pollution and human health concerns could be minimized or controlled. Similar studies are also recommended in all human settlements (villages and towns) so that reliable data could be available for health care departments, planners, community welfare organizations and researchers.

KEYWORDS: Physico-Chemical Parameters, turbidity, electrical conductivity, Alkalinity, WHO, EPA.

INTRODUCTION

India is endowed with a rich and vast diversity of natural resources, water being one of them. Water is nature's most astonishing, abundant and useful compound. Of the many essential elements for the existence of human beings, animals and plants, water is rated to be of the greatest importance. Groundwater is an important source of water supply throughout the world. The quantity and the suitability of ground water for human consumption and for irrigation are determined by its physical, chemical and bacteriological properties (Ravindran, 2012; Manimaran, 2012; Ramesh & Jegadeeswari, 2012). Monitoring of ground water regime is an effort to obtain information on ground water levels and chemical quality through representative sampling. Due to inadequate supply of surface waters, most of the people in India are depending mainly on groundwater resources for drinking and domestic, industrial and irrigation uses. Innumerable large towns and many cities in India derive water supply from groundwater for different uses through municipality network and also from large number of private boreholes. About one billion people are directly dependent upon groundwater resources in Asia alone, and In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the

groundwater to become polluted and created health problems. In recent years, because of continuous growth in population, rapid industrialization and the accompanying technologies involving waste disposals, the rate of discharge of the pollutants into the environment is far higher than the rates of their purification (Murhekar *et al.*, 2012). The dependence on groundwater has increased tremendously in recent years in many parts of India. Hence, physico-chemical analysis of water is important to assess the quality of groundwater in any basin and/or urban area that influences the suitability of water for domestic, irrigation, and industrial needs. Because of the importance of groundwater in drinking and in other uses, its environmental aspects such as contamination transport have been significantly studied. Many researchers have focused on hydro chemical characteristics and contamination of groundwater in different basins as well as in urban areas that resulted due to anthropogenic intervention mainly by agricultural activities and industrial and domestic wastewater (Shivayogimath *et al.*, 2012; Raju, 2007). Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water (Parikh Ankita and Mankodi, 2012).

In the past, mankind has been plagued by countless epidemics of water-transmitted diseases caused by the failure of water treatment systems. Even today, pathogenic contamination of drinking water still poses the most significant health risk to humans. About one fifth of human population does not have access to safe water, and pathogens in water still cause more than 2 million deaths every year in the poorest parts of the World (WHO, 2008). Water contamination due to pathogenic agents, chemicals, heavy metals, pesticides, water disinfectants and their by-products as a consequence of industrial and agricultural activities, leaching from soil, rocks and atmospheric deposition and other human activities has become an environmental risk leading to hazard of human health in several regions of the world. Several chemicals are being introduced into water bodies or aquifers usually as a consequence of leaching from soil, rock or via atmospheric deposition, through the dissolution of mineral/ores, industrial effluents and agricultural runoff. Due to indiscriminate withdrawal of ground water causes deterioration of groundwater quality (Klimas and Gregorauskas, 2002). The Physico-chemical study could help in understanding the structure and function of particular water body (Patil Shilpa *et al.*, 2012; Sargaonkar & Deshpande, 2003; Singh *et al.*, 2008). Hence, the present study was designed to analysis the physico-chemical parameters of the water samples collected in the bore wells from the selected places in on and around the Sivagangai down, Tamil Nadu, India.

MATRIALS AND METHODS

Study area

The present has been carried out in 10 different sites of Sivagangai town and the physico-chemical parameters of 10 water samples collected from the sites were analyzed. The water samples were collected from borewells of 10 different locations in and around Sivagangai town, Tamil Nadu, India. All these details have been given in table 1

Sample Collection

The water samples were collected from each locations using spot sampling procedure. The samples were collected in the pre-cleaned (Sterilized) polythene bottles with necessary precautions (APHA, 1998) and analyzed for various physico-chemical parameters of water samples as per standard procedures followed in District Water Testing Laboratory, TWAD Board, Sivagangai, Tamil Nadu, India.

Sample Analysis

In the present study twenty three physico-chemical parameters were analyzed by the following standard procedure given by WHO, 1996; APHA, 1998 & 2002. From this the physical factors such as appearance, colour, odour, turbidity, total dissolved salts and electrical conductivity and the chemical factors including pH, alkalinity, hardness, calcium, magnesium, sodium, potassium, iron, manganese, ammonia, nitrate, nitrite, chloride, fluoride, sulphate and phosphate were analyzed.

RESULTS AND DISCUSSION

The present study includes the analysis of the physico-chemical parameters of drinking water samples collected from bore wells in the selected ten (I to X) different locations. The physical parameters are analyzed and the results have been given in **table 2.** In this analysis the same results are observed in the physical factors such as appearance (clear), colour (colourless) and odour (agreeable) in all the selected ten different locations. The maximum turbidity is recorded in the locations IV, VII, IX, X and minimum in the remaining locations. The electrical conductivity is ranged from 810 to 2710. The location IX, X showed the maximum conductivity (2710) and the minimum is observed 810 in III location. The **figure 1** shows that the total dissolved salt content in all the selected locations. The highest salt content was observed in the location IX, X (1895) and the lowest (565) in III location.

The chemical parameters were also analyzed in this study and the results are given in table **3**. The pH values of the samples are slightly alkaline and it's ranged from 7.1 to 7.4. The maximum pH value is observed in the water samples II & IX and minimum in III, V & VI locations. The pH alkalinity value is zero in all the ten different selected water samples. The total hardness of the selected water samples ranged from 72 to 520 mg/L. The maximum hardness value is recorded in the sample X, the minimum in the sample IV and the average value of hardness is 256.2. The total alkalinity of the ten samples value is plotted in **figure 2**. In this figure maximum alkalinity is recorded in the sample IV (865) followed by sample II (810) and the minimum alkalinity content (245) in the sample IX.

The maximum calcium content (139) is observed in the sample X and the minimum content of calcium (16) in the sample IV. The average value of magnesium is 27.0 and it's ranged from 8 to 57mg/L. The level of magnesium is high (57) in the water sample collected from the location IX and the low value (8) in the sample IV (**Table 3**). The maximum sodium content is about 420 mg/L in the locations such as II & IV followed by 370 in the sample X and 360 in the samples VII & X and the minimum sodium content 120 is noted in the sample III (**figure 3**).

The potassium content was minimum in (08 mg/L) the sample III and the maximum content (40 mg/L) was recorded in the sample X. The average content of potassium in all the ten different samples is 21.4mg/L. Very low iron content (0.2 mg/L) was recorded in the locations IV, VII, IX & X and in the remaining locations no iron content was recorded. In the present study, the manganese content is zero in all the ten different locations studied. The ammonia is present only in the sample IV (0.65mg/L) and other locations are free from ammonia. The amount of nitrite is zero in all the samples except the sample IX, which contains 0.07 mg/L. The maximum of nitrate content (3mg/L) was observed in the locations II, III, VIII & X followed by 2mg/L in the locations I, IV, VII & IX and the rest of locations are free from nitrate (**table 3**).

The chloride content of the samples were analyzed and presented in the **figure 4**. Maximum amount of chloride (710mg/L) was recorded in the IXth location followed by 700mg/L in location X and the minimum amount of chloride (100mg/L) was observed in the location III. The fluoride content is ranged from 0.2 to 0.6mg/L and the average value is 0.38 mg/L. The maximum fluoride (0.6 mg/L) was recorded in the locations II, IX & X followed by 0.4 mg/L in the locations IV, VII & VIII and the minimum in I, III, V & VI locations respectively.

Phosphate is present only in the locations IV and V. Maximum phosphate (0.32 mg/L) was noted in the Vth location and the minimum (0.24 mg/L) was observed in the location IV and in the remaining locations no phosphate content was recorded. The maximum sulphate (10mg/L) was recorded in the locations such as I, II, IV, VI & VII followed by Vth location (9mg/L) and the minimum content (7mg/L) was recorded in the rest of locations (**table 3**).

Water is one of the most essential natural resources for eco-sustainability and is likely to become critical scarce in the coming decades due to increasing demand, rapid growth of urban populations, development of agriculture and industrial activities especially in semi-arid regions (Hajalilou and Khaleghi, 2009). Variations in availability of water in time, quantity and quality can cause significant fluctuations in the economy of a country. Hence, the conservation, optimum utilization and management of this resource for the betterment of the economic status of the country become paramount (Singh *et al.*, 2009). The results pertaining to water quality from different locations of Sivagangai town, Tamil Nadu revealed that all the tested physico-chemical parameters such as appearance, colour, odour, turbidity, total dissolved salts, electrical conductivity, pH, alkalinity, hardness, calcium, magnesium, sodium, potassium, iron, manganese, ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate are at the prescribed standards of WHO and EPA. However, careful attention towards contamination of water sources is recommended so that future risk in terms of environmental pollution and human health concerns could be minimized or controlled. Similar studies are also recommended in all human settlements (villages and towns) so that reliable data could be available for health care departments, planners, community welfare organizations and researchers.

Table1. Collection details of selected localities of water quality analysis from Sivagangai town, Tamil Nadu, India.

Sl. No.	Location	Sample Code	Source	Date of collection
1	Railway Station	I	Bore Well	24.12.2013
2	Kanchirangal	II	Bore Well	24.12.2013
3	Veethakovil Street	III	Bore Well	24.12.2013
4	Ram Nagar	IV	Bore Well	24.12.2013
5	Sunnambu Kalavasal	V	Bore Well	24.12.2013
6	ARR Quoters	VI	Bore Well	24.12.2013
7	Bus Stand	VII	Bore Well	24.12.2013
8	Sivaji Street	VIII	Bore Well	24.12.2013
9	Indra Nagar	IX	Bore Well	24.12.2013
10	Vaniyankudi	X	Bore Well	24.12.2013

Table2. Physical Parameters of drinking water samples from ten different sites of Sivagangai town, Tamil Nadu

Water Quality Analyzed Sites	Physical Parameters					
	Appearance	Colour	Odour	Turbidity (NT units)	Total Dissolved Salts (mg/L)	Electrical conductivity (micro mho/cm)
I	Clear	Colourless	Agreeable	1	925	1320
II	Clear	Colourless	Agreeable	1	1520	2170
III	Clear	Colourless	Agreeable	1	565	810
IV	Clear	Colourless	Agreeable	2	1490	2130
V	Clear	Colourless	Agreeable	1	975	1390
VI	Clear	Colourless	Agreeable	1	790	1130
VII	Clear	Colourless	Agreeable	2	1730	2470
VIII	Clear	Colourless	Agreeable	1	1015	1450
IX	Clear	Colourless	Agreeable	2	1895	2710
X	Clear	Colourless	Agreeable	2	1895	2710

Table 3. Chemical Parameters of drinking water samples from ten different localities of Sivagangai town, Tamil Nadu, India

Physical Parameters	Water Quality Analyzed Sites									
	I	II	III	IV	V	VI	VII	VIII	IX	X
pH	7.2	7.4	7.1	7.2	7.1	7.1	7.3	7.2	7.4	7.3
pH Alkalinity (mg/L)	0	0	0	0	0	0	0	0	0	0
Total Alkalinity (mg/L)	305	810	250	865	430	270	410	295	245	255
Total Hardness (mg/L)	290	80	130	72	250	240	330	160	490	520
Calcium (mg/L)	64	18	29	16	53	50	69	35	102	139
Magnesium (mg/L)	31	9	14	8	28	28	37	17	57	41
Sodium (mg/L)	150	420	120	420	170	130	360	230	370	360
Potassium (mg/L)	12	24	8	24	16	12	26	16	36	40
Iron (mg/L)	0	0	0	0.2	0	0	0.2	0	0.2	0.2
Manganese (mg/L)	0	0	0	0	0	0	0	0	0	0
Ammonia (mg/L)	0	0	0	0.65	0	0	0	0	0	0
Nitrite (mg/L)	0	0	0	0	0	0	0	0	0.07	0
Nitrate (mg/L)	2	3	3	2	0	0	2	3	2	3
Chloride (mg/L)	200	125	100	110	175	190	530	260	710	700
Fluoride (mg/L)	0.2	0.6	0.2	0.4	0.2	0.2	0.4	0.4	0.6	0.6
Sulphate (mg/L)	10	10	7	10	9	10	7	10	7	7
Phosphate (mg/L)	0	0	0	0.24	0.32	0	0	0	0	0

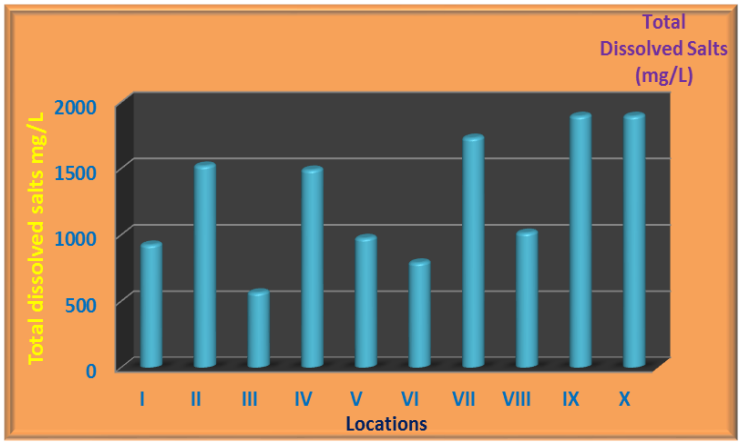

Figure1. The total dissolved salts present in the ten different locations of Sivagangai town, Tamil Nadu, India

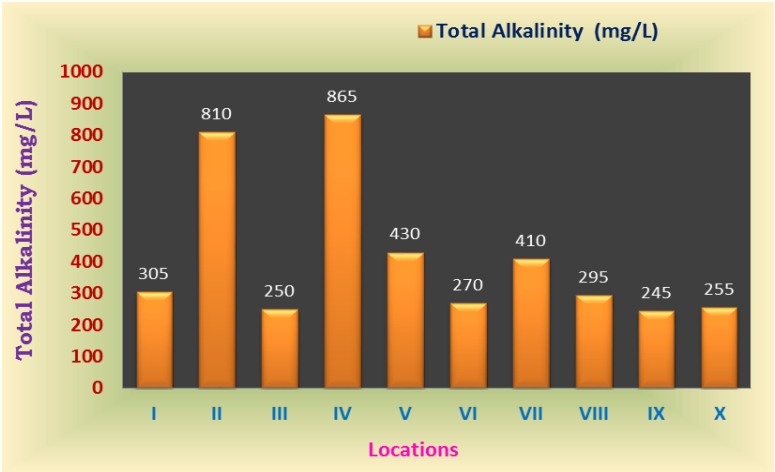

Figure 2. The total alkalinity present in the ten different locations of Sivagangai town, Tamil Nadu, India

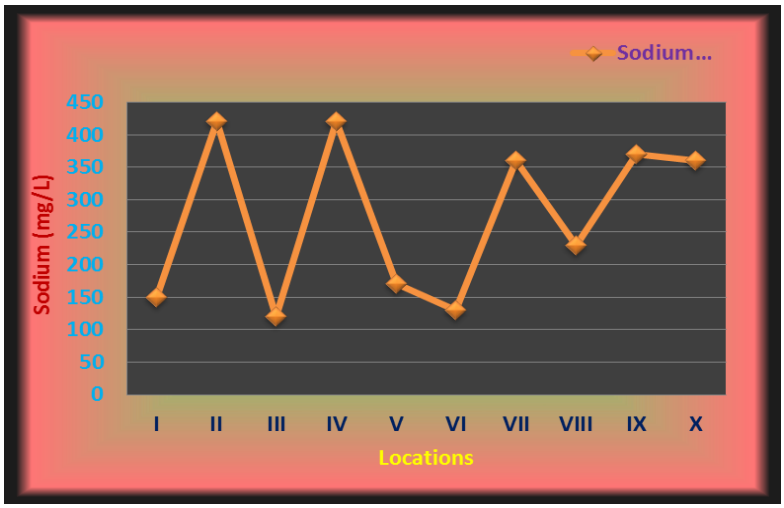

Figure 3. The sodium present in the ten different locations of Sivagangai town, Tamil Nadu, India

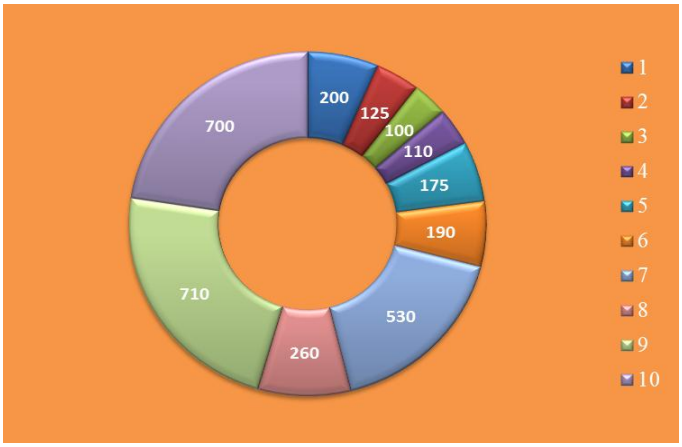

Figure 4. The chloride present in the ten different locations of Sivagangai town, Tamil Nadu, India

REFERENCES

1. Abati, T (2005). Water Sources and treatment, food forum, a publication of the Nigeria Institute of food science and Technology (NIFST), 4(1): 49.
2. Ali, S., Hussain, A., Hussain, A., Ali, A and Saeed Awan, M (2012). Drinking water quality assessment in some selected villages of Nagar Valley Gilgit-Baltistan, Pakistan. J.Chem. Bio. Phy. Sci. Sec. B, 3(1): 567-574.
3. APHA (1998). Standard Methods for the Examination of Water and Wastewater. APHAAWWA-WPCF, Washington D.C.
4. APHA (2002). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington DC. (20).
5. Arumugam, G., Elizabeth, S.H., Thirumagal, J., Nasimun islam, N and Panneerselvam, A (2013). Evaluation of water quality of Pulliyakanu lake with reference to physico-chemical aspects at Vellore District, *World journal of pharmacy and pharmaceutical sciences*, 2(5): 3641-3649.
6. Environmental Protection Agency (2001). Parameters of Water Quality Interpretation and Standards, Johnstown Castle, Co. Wexford, Ireland.
7. Gosselin, R.E., Smith, R.P and Hodge, H.C (1984). Clinical toxicology of commercial products, 5th ed.Baltimore, MD, Williams & Wilkins.
8. Hajalilou, B and Khaleghi, F (2009). Investigation of hydro geochemical factors and groundwater quality assessment in Marand Municipality, northwest of Iran: a multivariate statistical approach. *Journal of food, Agriculture and environment*, 7(3&4): 930-937.

9. Hirsch, R.M., Alexander, R.B and Smith, R.A (1991). Selection of methods for the detection and estimation of trends in water quality, *Water resources research*, *27*(5): 803–813.
10. Iqbal, M., Sajjad, H., Bhat, F.A and Ahmad, I (2013). Monitoring of Water Quality Parameters in Upper and Lower Reaches of Dudhganga Catchment, India, *Intech*, 5: 97-105.
11. Iyer, C.S., Sindhu, M., Kulkarni, S.G., Tambe , S.S and Kulkarni, B.D (2003). Statistical analysis of the physico-chemical data on the coastal waters of Cochin, *Journal of Environment, Monitoring*, 5: 324.
12. Kamble, S. M.; Kamble A. H. and Narke S.Y (2009): Study of physico-chemical parameters of Ruti dam, Tq. Ashti, dist. Beed, Maharashtra. *J. Aqua. Biol.* 24(2): 86-89.
13. Karanth, K.R (1987): Groundwater Assessment Development and Management Tata McGraw Hill publishing company Ltd., New Delhi, 725.
14. Klimas, A., Gregorauskas, M (2002). Groundwater abstraction and contamination in Lithuania as geoindicators of environmental change, *Environmental Geology*, 42: 767-772.
15. Manimaran, D (2012). Groundwater Geochemistry study using GIS in and Around Vallanadu Hills, Tamilnadu, India, *Res. J. Recent Sci*. 1(7): 52-58.
16. Manjare, S.A., Vhanalakar, S.A and Muley, D.V (2010). Analysis of water quality using physico-chemical parameters Tamdalge Tank in Kolhapur District, Maharashtra. *International Journal of Advanced Biotechnology and Research*, 1(2): 115-119.
17. Mayur, S. C., Shilpkar Prateek C. and Acharya Pradip B. (2008): Ground water quality of Gandhinagar taluka, Gujarat, *India. J. of Chemistry*, 5(3): 435-446
18. Neeraj, D and Patel, J.N (2010). Evaluation of Groundwater Quality Index of the Urban Segments of Surat City, India, *International journal of geology*, 4.
19. Parikh Ankita, N and Mankodi, P.C (2012). Limnology of Sama Pond, Vadodara City, Gujarat, *Res.J.Recent Sci.*, 1(1): 16-21.
20. Patil Shilpa, G., Chonde Sonal, G., Jadhav Aasawari, S and Raut Prakash, D (2012). Impact of Physico-Chemical Characteristics of Shivaji University lakes on Phytoplankton Communities, Kolhapur, *India, Research Journal of Recent Sciences*, 1(2): 56-60.
21. Payal, P and Bhatt, S.A (2010). Fluoride Contamination in Groundwater of Patan District, Gujarat, India *International Journal of Engineering Studies*, ISSN 0975- 6469, 2: 171–177.

22. Rajiv, P., Hasna Abdul Salam, Kamaraj, M., Rajeshwari Sivaraj and Sankar, A, I (2012). Physico Chemical and Microbial Analysis of Different River Waters in Western Tamil Nadu, India, *I Res. J. Environmen Sci.*, 1(1): 2-6.
23. Rajkumar, N., Raikar, V and Sneha, M.K (2012). Water quality analysis of Bhadravathi taluk using GIS- a case study, *International Journal of Environmental Sciences* 2(4): 2443-2453.
24. Raju, N.J (2007). Hydrogeochemical parameters for assessment of groundwater quality in the upper Gunjanaeru River basin, Cuddapah district, Andhra Pradesh, South India, *Environmental Geology*, 52:1067–1074.
25. Ramesh, K. and Bhuvana Jagadeeswari, P (2012). Hydrochemical Characteristics of Groundwater for Domestic and Irrigation Purposes in Periyakulam Taluk of Theni District, Tamil Nadu, *I Research Journal of Environment Sciences*, 1(1):19-27.
26. Raval, V.H and Malik, G.H (2010). Physico- Chemical Characteristics of Groundwater in and around Surat City (India), *J. Environmental Science and Engineering*, 52(4): 343-348.
27. Ravindran, A (2012). Azimuthal Square Array Resistivity method and Ground water Exploration in Sanganoor, Coimbatore District, Tamilnadu, India, *Research Journal of Recent Sciences*, 1(4): 41-45.
28. Restuccio, A (1992). Fatal hyperkalaemia from a salt substitute. *American Journal of Emergency.*
29. Roy, Y. and R. A. Kumar (2002). A study of water quality of the rivers of Ranchi district. Ind. J. Environ. Protec., 21(5); 398-402.
30. Rupal, M., Tanushree, B and Sukalyan, C (2012). Quality characterization of ground water using water quality index in surat city, Gujarat, India. *International Research Journal of Environmental Sciences,* 1(4): 14-23.
31. Rupal, M., Tanushree, B and Sukalyan, C (2012). Quality characterization of ground water using water quality index in surat city, Gujarat, India. *International Research Journal of Environmental Sciences,* 1(4): 14-23.
32. Sargaonkar, R and Deshpande, V (2003). Development of an overall index of pollution for surface water based on a general classification scheme in Indian context. *Environ. Monit. Assess*. 89(1): 43-67.
33. Shivayogimath, C.B., Kalburgi, P.B., Deshannavar, U.B and Virupakshaiah, D.B.M (2012).Water Quality Evaluation of River Ghataprabha, India, *I Research Journal of Environment Sciences*, 1(1): 12-18.

34. Singh, P.K., Singh, U.C and Suyash Kumar (2009). An integrated approach using remote sensing, GIS and geoelectrical techniques for the assessment of groundwater conditions: A case study, GIS development e-magazine, 5(35).
35. Singh, U.K., Kumar, M., Chauhan, R., Jha, P.K., Ramanathan, A.L. and Subramanian, V (2008). Assessment of the impact of landfill on groundwater quality: A case study of the Pirana site in western India, *Environmental Monitoring and Assessment,* 141: 309–321.
36. Sivakumar, K.K., Balamurugan, C and Ramakrishnan, D (2011). Studies on physicochemical analysis of ground water in Amaravathi River Basin at Karur (Tamil Nadu), India. Water Research and Development 1(1): 36-39.
37. Soylak, M., F. Armagan Aydin, S. Saracoglu, L. Elci, M. Dogan (2002). Chemical Analysis of Drinking Water Samples from Yozgat, Turkey. *Polish Journal of Environmental Studies,* 11(2): 151-156.
38. Srinivasa, Rao, B. and P. Venkateswarlu (1999). Evaluation of ground water quality in chirala town (Prakasam district). Ind. J. Environ. Protec., 20(3):161-164.
39. Sundarakumar, K., Sundarakumar, P., Ratnakanth Babu, M.J and Hanummantha Rao, CH (2010). Assessment and mapping of ground water quality using geographical information systems. *International Journal of Engineering Science and Technology*, 2(11): 6035-6046.
40. Tiwari, V.M., Wahr, J and S. Swenson, S (2009). Dwindling groundwater resources in northern India, from satellite gravity observations. Geophysical Research Letters, 36: 1-5.
41. WHO (1984). Guidelines for Drinking Water Quality in Health Criteria and Other Supporting Information, 2: 336.
42. WHO (1993). Guidelines for drinking water quality 2 ed., 1, 188.
43. WHO (1994). Guidelines for drinking water quality (Recommendations). World Health Organization,Geneva.
44. WHO (1996).Guidelines for drinking water quality: health criteria and other supporting information. 2.
45. WHO (1997) Guidelines for drinking-water quality, 2nd ed. Vol. 3. Surveillance and control of community supplies. Geneva, World Health Organization. Available at http://www.who.int/water_sanitation_health/dwq/guidelines4/en/.
46. WHO (2001). Guidelines standards and Health: Assessment of Risk and Risk Management for water related infectious diseases. World Health Organization, Geneva.
47. WHO (2002). The Guideline for drinking water quality (Recommendations). World Health Organization, Geneva.

48. WHO (2006). Burden of Disease and cost effectiveness estimates. World Health Organization, Geneva. *Asian J. Exp. Sci., 26(1)*: 39-48.
49. WHO (2008). "Guidelines for Drinking-Water Quality, Third Edition, Incorporating the First and Second Addenda, Volume 1: Recommendations," WHO, Geneva.
50. Wright, P and C. F. Mason (1996). *Sci. Total Environ*. 226; 139-156.