International Journal of Pharmacy and Biological Sciences
ISSN: 2321-3272 (Print), ISSN: 2230-7605 (Online)
IJPBS | Volume 9 | Special Issue 2 | 2019 | 197-207
| Research Article | Biological Sciences |Open Access |MCI Approved|
|UGC Approved Journal|

Water Quality Index of Groundwater Near the Polluted Urban Pond of Tiruchirappalli District, Tamil Nadu, India.

J. Sirajudeen*

PG and Research Department of Chemistry, Jamal Mohamed College, Tiruchirappalli, Tamil Nadu, India

Received: 30 Jan 2019 / Accepted: 20 Feb 2019 / Published online: 01 Apr 2019
Corresponding Author Email: siraju.deen2003@yahoo.com

Abstract

Ground water samples were collected from different localities near the urban pond of Tiruchirappalli District, Tamil Nadu. Twenty one groundwater samples were collected and analysed for physic-chemical parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand(COD), Calcium(Ca),Magnesium(Mg),Total Hardness (TH), Chloride (Cl) , Nitrate (NO_3),Phosphate (PO_4),Sodium (Na) and Potassium (K) in order to understand the different geochemical processes affecting the groundwater quality. The analytical data were compared with WHO. The analytical results indicate that the majority groundwater samples are unsuitable for drinking and bathing purpose.

Keywords

Groundwater, physicochemical parameter, and water quality index.

*****

INDRODUCTION

Water is the basic of life on this planet and the foundation of civilization. Water contamination can be classified as having either natural or anthropogenic sources. In this situation, water quality and chemistry gain their importance for the management and assessment of groundwater. Hence, the study focuses on the assessment of the quality and geochemistry of groundwater in the Tiruchirappalli district of Tamil Nadu. Detailed works on groundwater assessment, evaluation and management in relation to hydrology and water resources engineering were initiated by several authors [1]The use of water for drinking and other domestic purposes is generally conceded to be its highest and most essential purpose. Pollution of water bodies is increasing steadily due to rapid population growth, industrial proliferation, urbanization, increasing living standards and wide sphere of human activities. Groundwater has been a very important source of water for various uses since ancient times. Much of the drinking water used by human and other living beings is derived from groundwater. During the recent years due to urbanization and industrialization, groundwater is increasingly laced with pollutants from industries, municipal sewers, and agricultural fields that are

treated with fertilizers and pesticides. Today, human activities are constantly adding industrial, domestic sewage, and agricultural wastes to groundwater resources at an alarming rate. Groundwater contamination is generally irreversible, i.e., once it is contaminated it is difficult to restore the original water. Tiruchirappalli is one of the most important industrial cities in Tamil Nadu; Industries of diverse fields such as tanneries, fertilizer plants, dairy, steel rolling mills and distillery plant are located in and around Tiruchirappalli town. Groundwater chemistry can be modified by a variety of anthropogenic sources. These include point sources, such as waste disposal facilities, industrial pollution, wastewater treatment works and many others [2],[3].There has been tremendous increase in the demand for fresh water due to over exploitation and growth in population. Since groundwater is a renewable natural resource and a valuable component of the ecosystem, it is vulnerable to natural and human impacts. It is estimated that approximately one-third of the world's population use groundwater for drinking.

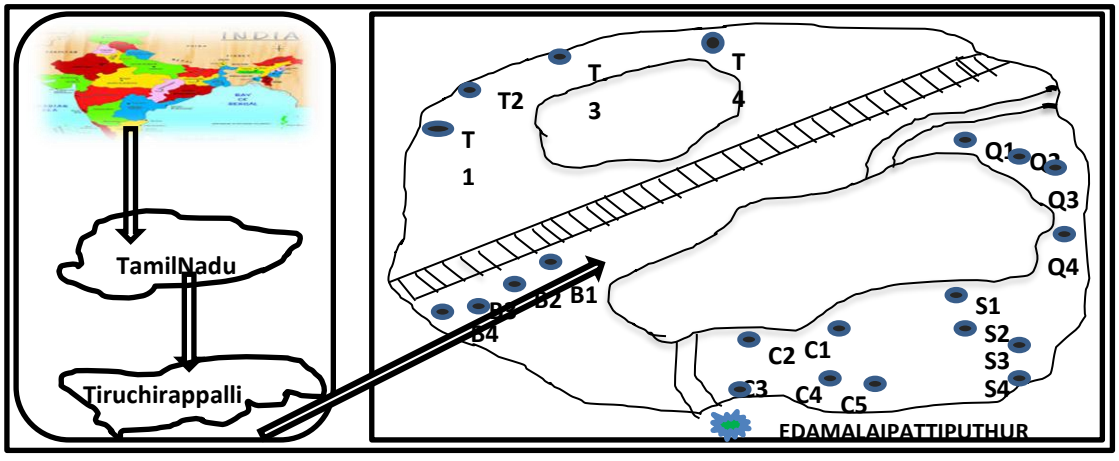
In most parts of India, groundwater forms the major source of water supply for drinking and agricultural purposes. Quality of groundwater is equally important to its quantity owing to the suitability of water for various purposes.

Variation in groundwater quality in an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities. Hence the present study has been carried out to evaluate the spatial extent of groundwater quality and its suitability for drinking and agricultural uses in the coastal stretch of Tiruchirappalli district.

STUDY AREA

The study area Edamalaipatti pudhur is located at Tiruchirappalli District. The population of the area is around 50,000. Many Hospitals and small-scale industries are located in and around this area. They are discharging the hospital wastes, untreated effluents' and domestic sewages into the open lands and polluting ground water through percolation. Edamalaipatti pudhur has quite a large population depending only on the ground water as the main source for drinking and other purposes. This contamination poses serious health impacts in the local residents.

Fig: 1 LOCATION MAP OF THE STUDY AREA



MATERIALS AND METHODS:

Twenty-one ground water samples were collected from either side of urban pond. The distance between one station to another was maintained about 0.75 kilometer. Samples were collected in a clean and dry polyethylene cane from bore wells after running it for 3 mins. All the samples were collected from August 2017 to April 2018. Groundwater samples were collected near urban pond Edamalaipatti puthur area Trichirappalli district. A total of twenty-one ground water samples were collected in three different seasons (pre monsoon, monsoon and post monsoon from the year 2017 to 2018. The physicochemical parameters such as pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Hardness (TH), Total Dissolved Solids (TDS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), calcium (Ca), Chloride (Cl). Magnesium (Mg), sodium (Na),

potassium (K), and nitrate (NO_3), of ground water samples were determined using standard procedures.

Water quality index

Water Quality index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameter on the overall quality of water. It is calculated from the point of view of human consumption.

The Calculation Involves the Following Steps:

First, the calculation of weight age of i^{th} parameter.

Second, the calculation of the quality rating for each of the water quality parameters.

Third, the summation of these sub-indices in the overall index.

The Weight age of i^{th} Parameter

$W_i = k/S_i$ (1)

Where W_i is the unit of weight age and S_i the recommended standard for i^{th} parameter (I = 1-12), k is the constant of proportionality.

Individual quality rating is given by the expression

$Q_i = 100V/S_i$ (2)

Where Qi is the sub index of ith parameter, Vi is the monitored value of the ith parameter in mg/l and S_i the standard or permissible limit for the i^{th} parameter. The Water Quality Index (WQI) is then calculated as follows

$$\mathbf{WQI} = \sum_{i=1}^{n}(QiWi)/\sum_{i=1}^{n}Wi \quad (3)$$

Where, Q_i is the sub index of i^{th} parameter. W_i is the unit weight age for i^{th} parameter, n is the number of parameters considered. Generally, the critical pollution index values is 100

Table 1: Mean physico- chemical parameters of ground water samples collected near urban pond Edamalaipatti puthur area from Auguest-2017 to April 2018

Sampling stations	PH	EC	TDS	TH	DO	BOD	COD	Cl	NO_3	PO_4	k	SO_4	Ca	Mg
Q1	7.6	1387	965	656	6.0	11.0	32.3	252	28	0.1	63	15	122	78
Q2	7.4	1629	1300	855	3.3	13.6	37.1	322	27	0.1	63	15	124	78
Q3	7.4	1979	1336	883	4.3	9.0	35.8	271	20	0.1	67	16	122	78
Q4	7.5	1556	1082	818	4.6	10.0	40.3	276	22	0.2	65	18	122	72
T1	7.5	1784	1241	780	4.6	11.2	35.9	252	28	0.1	83	18	127	74
T2	7.7	1681	1170	816	5.0	10.0	49.5	291	31	0.2	83	20	135	79
T3	7.7	1454	1011	690	4.6	11.2	39.9	241	32	0.2	83	23	143	77
T4	8.2	1735	1207	865	4.3	8.4	42.8	266	29	0.3	83	22	127	80
B1	7.8	1761	1294	655	5.0	6.8	33.6	338	31	1.6	82	22	133	79
B2	8.0	1557	1152	725	5.0	13.4	35.9	419	31	0.2	82	19	137	78
B3	7.7	1555	1291	738	3.3	12.6	35.4	323	26	0.2	82	17	136	76
B4	7.8	2011	1399	715	4.0	15.6	47.0	378	26	0.1	85	21	139	79
C1	8.1	2133	1286	860	3.3	11.6	47.3	541	18	0.4	59	20	119	71
C2	8.3	1754	1220	805	3.7	11.2	50.8	349	21	0.2	89	20	124	70
C3	8.1	1421	989	596	6.3	11.0	53.3	223	32	0.2	87	21	125	72
C4	7.7	1443	1004	710	6.3	14.4	49.2	412	27	0.1	85	20	123	68
C5	7.5	1556	1082	675	4.6	19.0	40.3	276	22	0.2	87	21	126	67
S1	7.5	1971	1371	863	6.3	8.8	41.6	383	16	0.2	74	19	126	69
S2	7.8	1656	1152	668	5.6	14.2	43.2	309	18	3.6	74	24	133	74
S3	7.7	1624	1229	670	4.6	10.2	47.5	337	14	3.3	79	18	126	70
S4	7.6	1747	1215	806	3.6	11.2	47.2	328	13	3.6	80	12	145	69

All the values are expressed in ppm expect pH, and EC- micro-mhos

RESULTS AND DISCUSSION

pH

pH is affected not only by the reaction of carbon dioxide but also by organic and inorganic solute present in water. Any alteration in water pH is accompanied by the change in other physico-chemical parameters[5]. pH maintenance (buffering capacity) is one of the most important attributes of any aquatic system since all the biochemical activities depend on pH of the surrounding water. It was concluded that the pH of ground water is slightly alkaline (7.4 to 8.3) High value of pH may results due to waste discharge, and

microbial decomposition of organic matter in the water body[6]. The high pH may be attributed to sewage discharge by surrounding human population.

Electrical conductivity (EC)

It is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts[7]. EC values are in the range of 1387 micro-mhos/cm to 2133 micro- mhos /cm. (WHO-600 ppm) High EC values indicating the presence of high amount of dissolved inorganic substance in ionized form.

Total Dissolved Solid (TDS)

Total Dissolved Solid (TDS) range for drinking water is (WHO-500 ppm). The TDS values of all the samples are above the permissible limits. In the present investigation the TDS range is recorded between 965 mg/l to 1399 mg/l. High TDS in ground water is due to excess salts.

Total Hardness (TH)

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values are ranged from 596ppm to 883 ppm (WHO-500ppm).

Dissolved Oxygen (DO)

DO is a very important parameter of water quality and an index of physical and biological process going on in water. In the present study the DO values are in the range between 3.3ppm to 6.3 ppm. All samples showed below the permissible limit. (WHO - 6 ppm) It may be due to direct diffusion from air and photosynthetic activity of autotrophs. Concentration of DO is one of the most important parameters to check the water purity and to determine the distribution and abundance of various algal groups.

Biological Oxygen Demand (BOD)

Biological oxygen demand depends on aquatic life; variation in BOD indicates dynamism in aquatic life. BOD refers the oxygen used by the microorganism in the aerobic oxidation of organic matter. Therefore, with the increase in the amount of organic matter in the water the BOD increases. The BOD value ranged from 6.8 ppm to 19.0 ppm. In present study all the water samples are found to be above the permissible limit set by WHO (10 ppm). The higher value of BOD was due to input of organic wastes and enhanced bacterial activity.

Chemical Oxygen Demand (COD)

COD is another measure of organic material contamination in water. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. COD values varied from 32.3 ppm to 49.5ppm. In present study all the water samples are found to be above the permissible limit set by (WHO 10 ppm). High COD may affect the aquatic life.

Calcium (Ca)

Calcium is directly related to hardness. Calcium concentration ranged between 119 ppm to 145 ppm (WHO 100ppm) and High Ca values observed in S4, and B4. Hypocalcaemia (hypo=too little) is usually associated with eating disorders or lack of parathyroid hormone. Symptoms include weakness, muscle spasms, and heart rhythm disturbance.

Chloride (Cl)

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects. In the present analysis, chloride concentration is ranged from 223ppm to 541 ppm. All the values are above the permissible limit (WHO - 250ppm).

Magnesium (Mg)

Magnesium is directly related to hardness. Exessive presence of magnesium in the water is totally unhygienic because it causes diarrhea and irritations in gasro - intestione. Magnesium content in the investigated ground water samples are ranged from 67 ppm to 80 ppm. (WHO 150ppm).

Nitrate (NO_3)

Nitrogen is a major constituent of atmosphere. Soil bacteria convert it into nitrate and nitrate. Nitrate is a major constituent of rocks. Part of the nitrate is fixed by the plants before the rain water percolates below the root zone. Natural ground water contains less than 10.4 ppm of nitrate. But the polluted waters contain high concentration of nitrate. The concentration of nitrate ranged from 13 ppm to maximum 32 ppm. Whereas according to WHO the nitrate concentration up to 50 ppm is desirable limit for drinking. Beyond this limit, methaemoglobinaemia takes place, mostly in babies.

Sulphate (SO_4)

The concentration of sulphate ranged from 15 ppm to maximum 24 ppm. Whereas according to WHO the sulphate concentration up to 250 ppm is desirable limit

for drinking. Diarrhoea is caused due to high amount of sulphate in water

Phosphate (PO_4)

Phosphate is retained in the soil by a complex system of biological uptake, absorption, and mineralization. Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphate. The soluble or bio-available phosphate is then used by plants and animals. The phosphate becomes incorporated into the biological system. In the present analysis, phosphate concentration is ranged from 0.1ppm to 3.6 ppm. All the values are above the permissible limit (WHO – 0.1ppm).

Potassium (K)

The major source of potassium in natural fresh water is the weathering of rocks, but the quantities increased in the polluted water are due to disposal of wastewater. The mean values of potassium are within the range of 59 – 87 ppm for groundwater samples in season respectively. All the values are below the permissible limit (WHO – 500ppm).

Table 2: Calculation of WQI values for the physico-chemical parameters of ground water samples collecded near urban pond Edamalaipatti puthur area

Parameters	Mean value in ppm (V_i)	Highest permitted value (WHO) (S_i)	Unit weightage (wi)	$W_i \times Q_i$
pH	7.7	8.5	0.117	16.652
EC	1709	600	0.001	0.569
TDS	1190	500	0.002	0.709
TH	754	500	0.002	0.452
DO	4.6	6	0.166	20.069
BOD	11.6	10	0.1	18.212
COD	42.1	10	0.1	66.097
PO_4	0.7	10	0.1	1.572
Ca	129	100	0.01	1.935
Cl	323	250	0.004	0.775
Mg	74.5	150	0.006	0.493
No_3	24	50	0.02	1.488
K	78.8	500	0.002	0.045
SO_4	19	250	0.004	0.045

WQI =$\sum_{i=1}^{n}(QiWi)/ \sum_{i=1}^{n} Wi$WQI = 130.02

Table 3: Status categories of WQI

WQI	Quality of water
0 - 25	Very good
26 - 50	good
51 - 75	poor
Above 75	Very poor (unsuitable for drinking)

In this study, the computed WQI value is 130.02 and therefore can be categorized into unsuitable water for drinking (Table 3) the high value of WQI at is mainly due to the higher values of EC, TDS, TH, BOD and COD in the ground water.

Fig 1: Variation in mean values of P^H collected from different sampling stations near urban pond Edamalaipatti puthur area

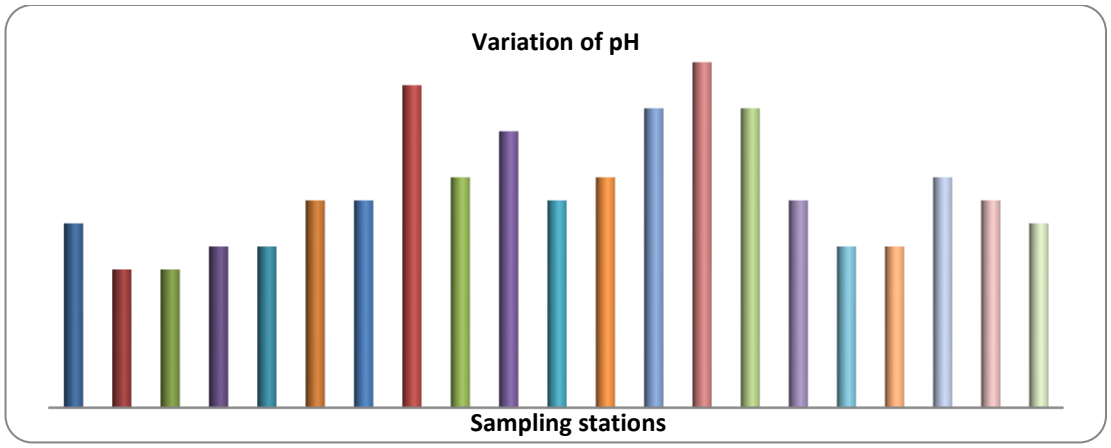


Fig 2: Variation in mean values of EC collected from different sampling stations near urban pond Edamalaipatti puthur area

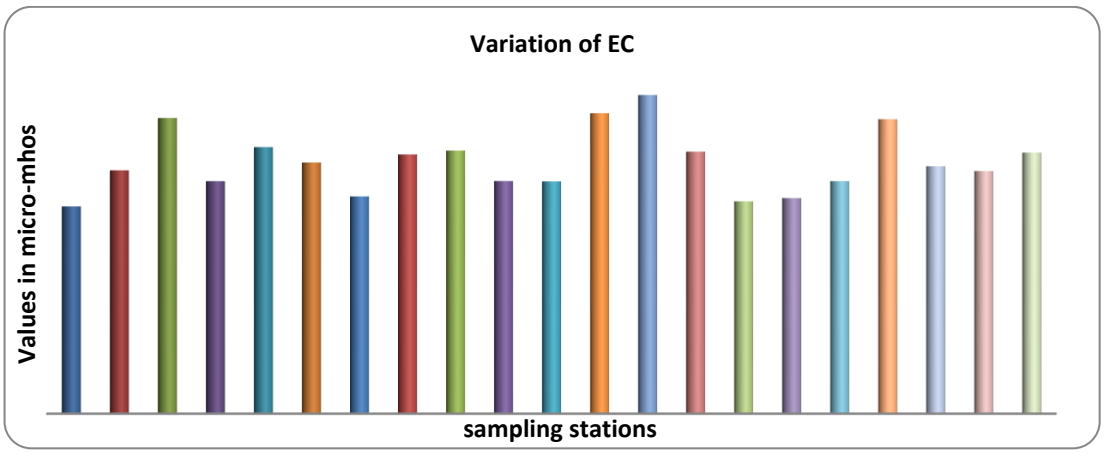


Fig 3: Variation in mean values of Total Dissolved solids collected from different sampling stations near urban pond Edamalaipatti puthur area

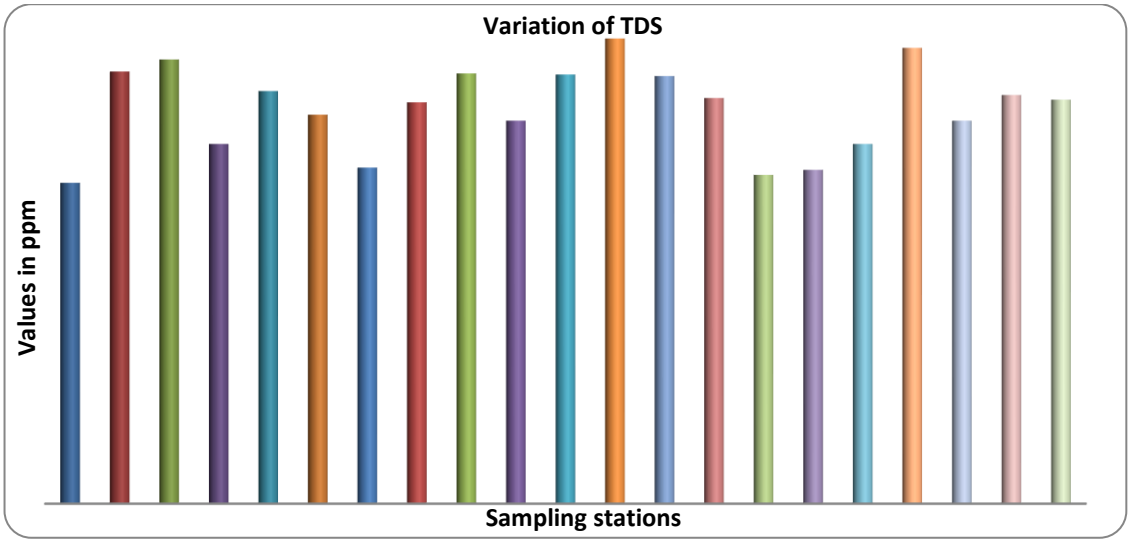


Fig 4: Variation in mean values of Total Hardness collected from different sampling stations near urban pond Edamalaipatti puthur area

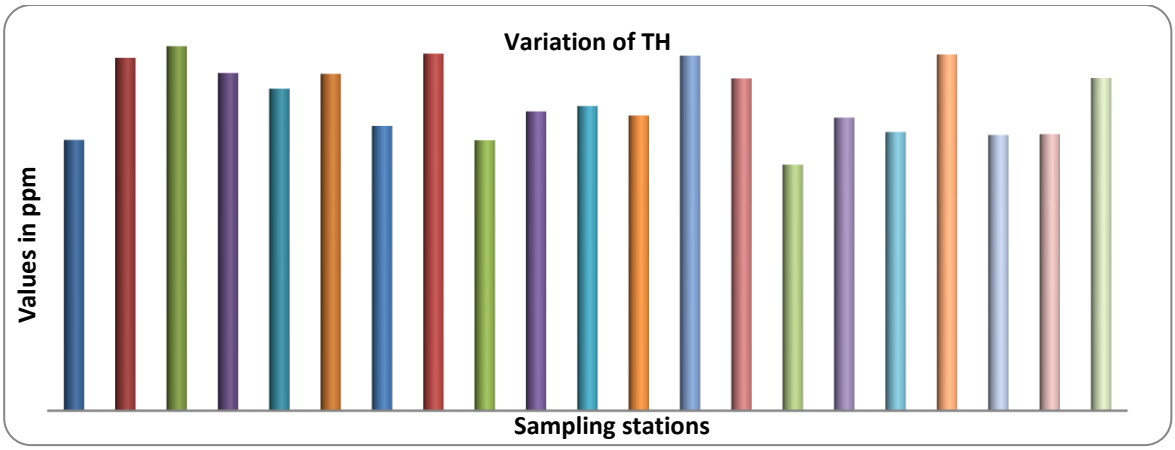


Fig 5: Variation in mean values of DO collected from different sampling stations near urban pond Edamalaipatti puthur area

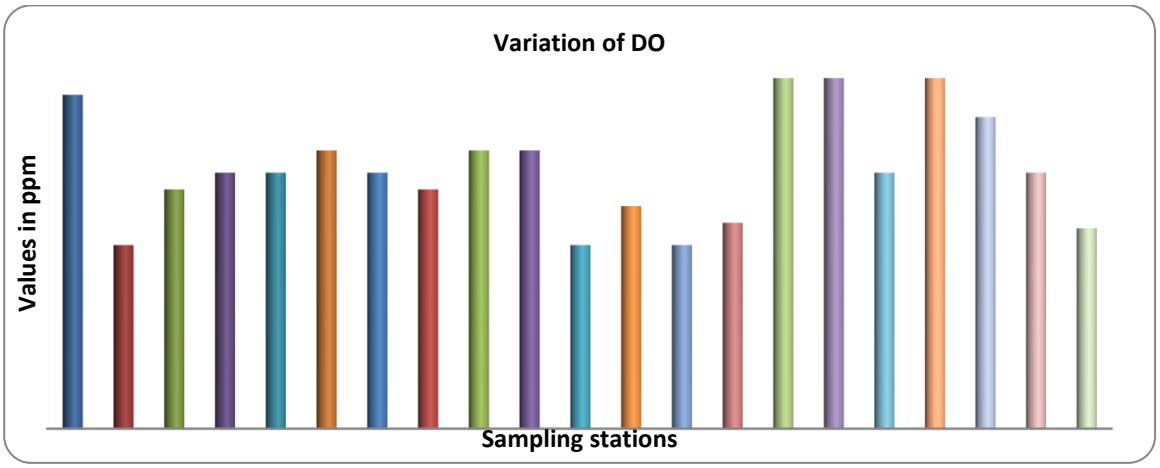


Fig 6: Variation in mean values of BOD collected from different sampling stations near urban pond Edamalaipatti puthur area

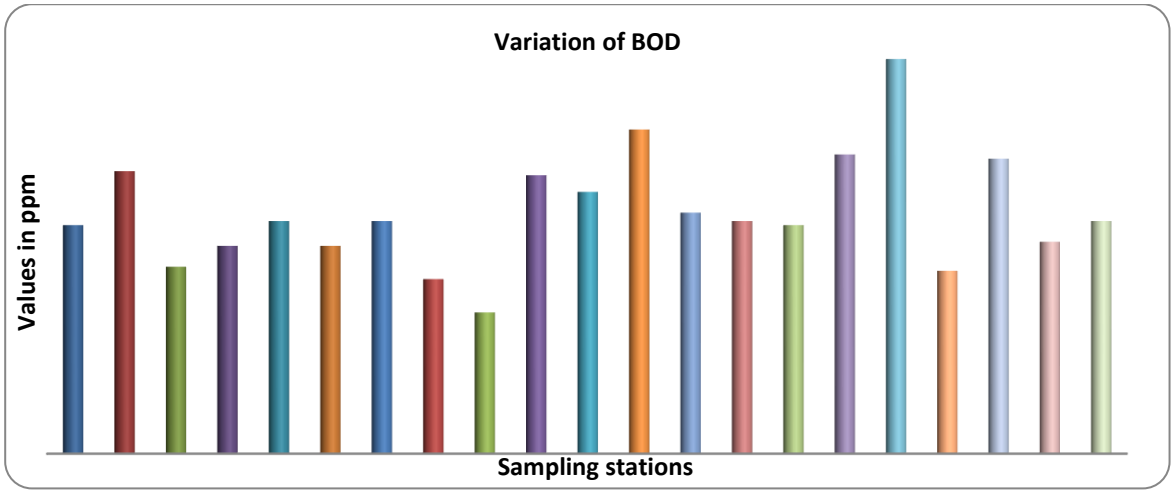


Fig 7: Variation in mean values of COD collected from different sampling stations near urban pond Edamalaipatti puthur area

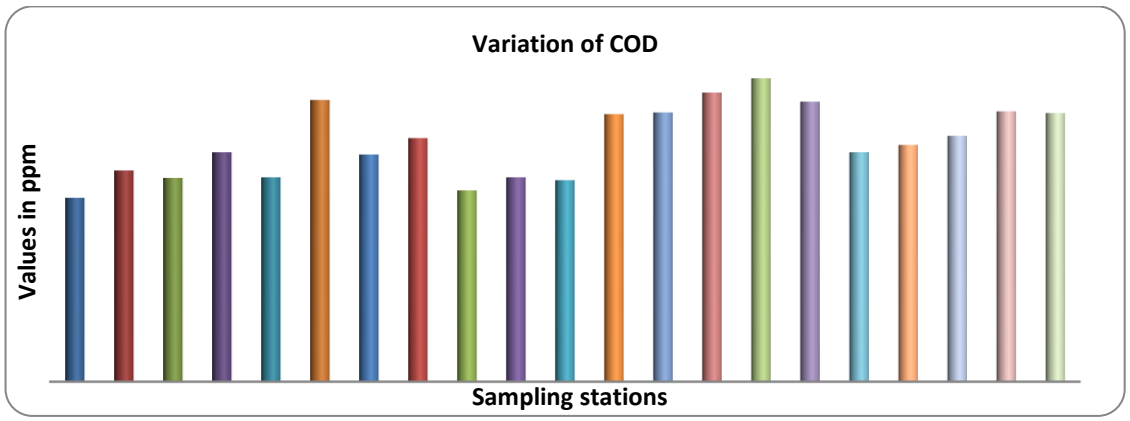


Fig 8: Variation in mean values of Chloride collected from different sampling stations near urban pond Edamalaipatti puthur area

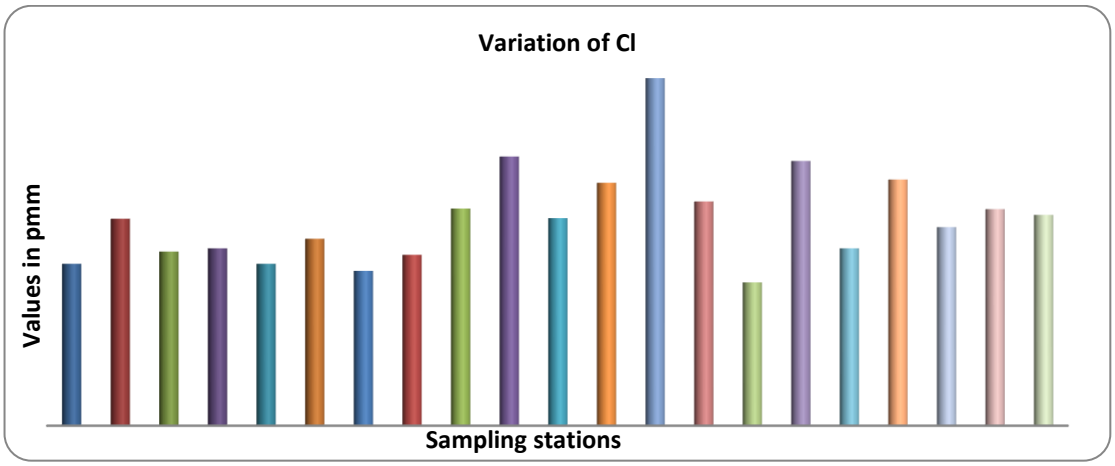


Fig 9: Variation in mean values of Nitrate collected from different sampling stations near urban pond Edamalaipattiputhur area

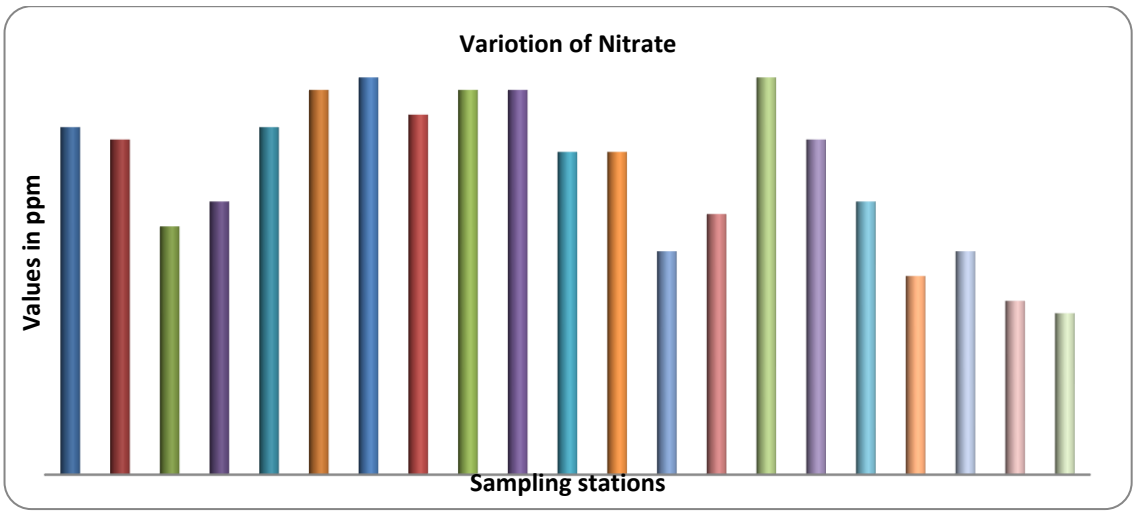


Fig 10: Variation in mean values of Phosphate collected from different sampling stations near urban pond Edamalaipatti puthur area

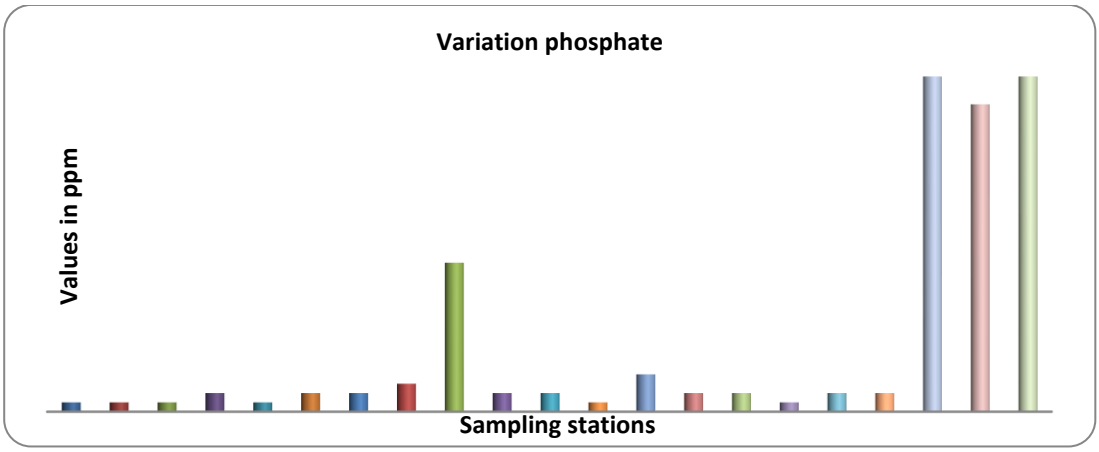


Fig 11: Variation in mean values of Potassium collected from different sampling stations near urban pond Edamalaipatti puthur area

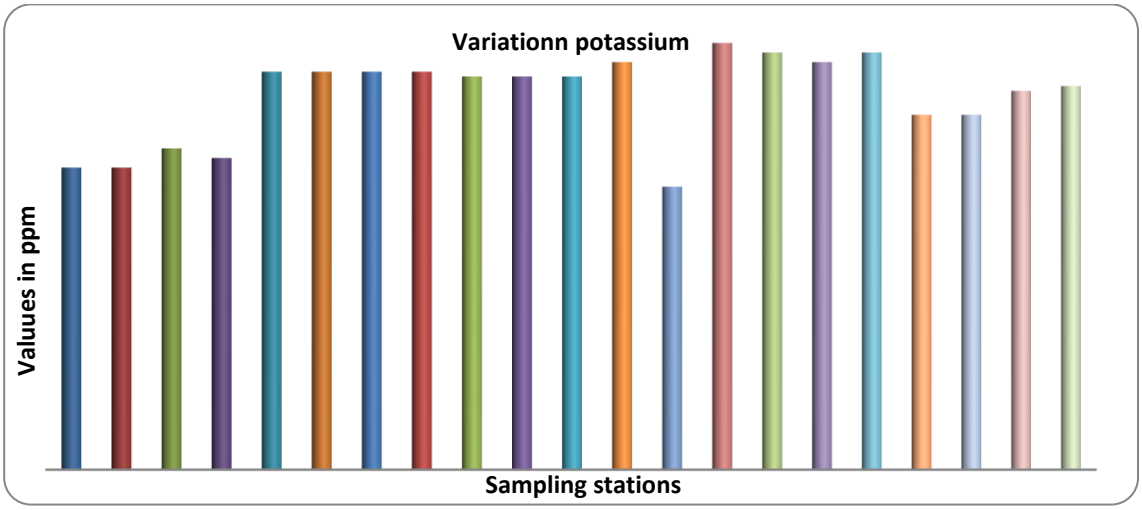


Fig 12: Variation in mean values of Sulphate collected from different sampling stations near urban pond Edamalaipatti puthur area

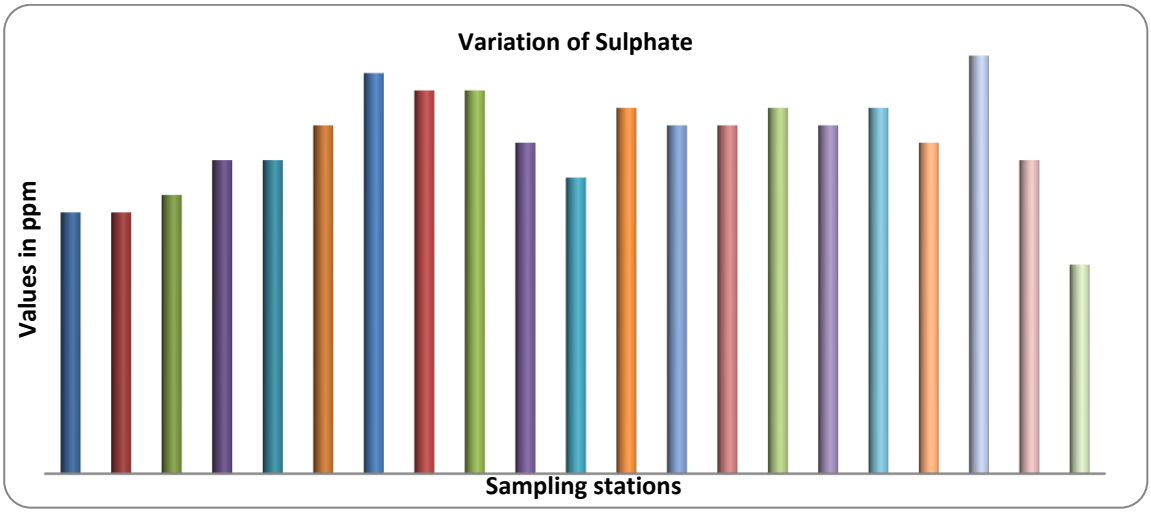


Fig 13: Variation in mean values of Calcium collected from different sampling stations near urban pond Edamalaipatti puthur area

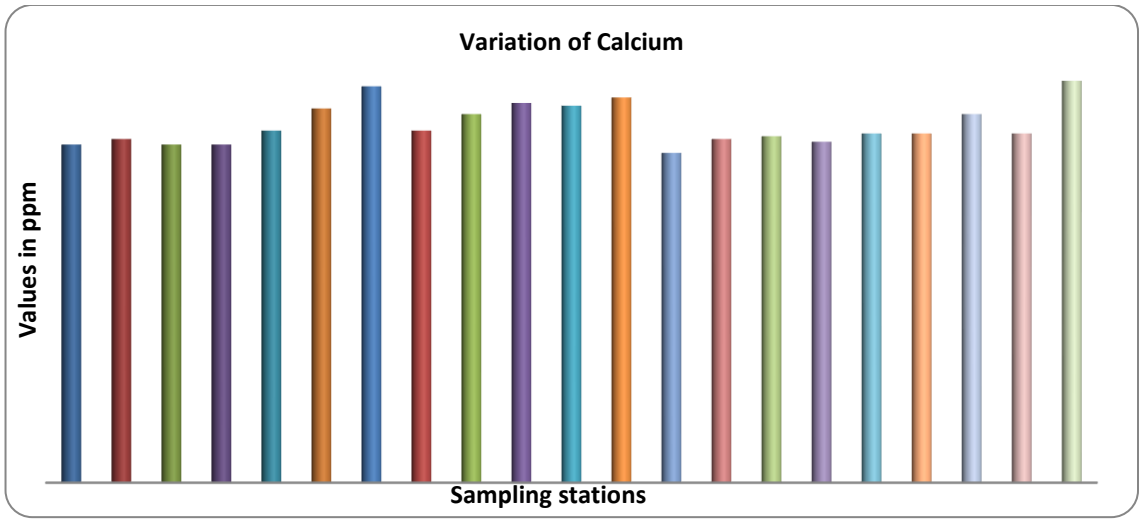
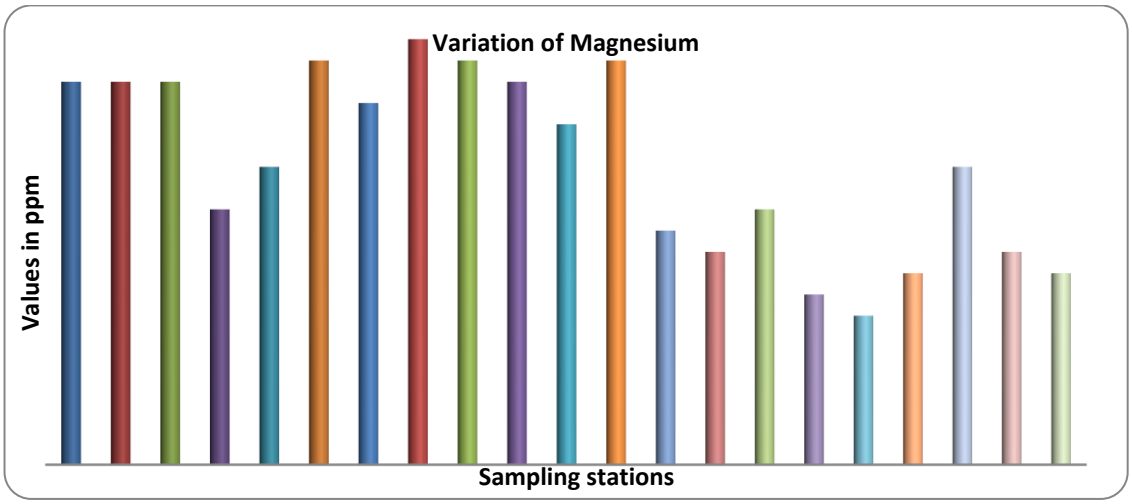


Fig 14: Variation in mean values of Potassium collected from different sampling stations near urban pond Edamalaipatti puthur area



CONCLUSIONS

The ground water samples were collected near urban pond of Edamalaipatti puthur area. Twenty one ground water samples were collected from near the urban pond of Edamalaipatti puthur area. The water samples were subjected to physico-chemical analysis. The results of the above work showed that most of the physico-chemical parameters like EC, TDS, TH, BOD, COD, Cl, Ca and Mg were well above the permissible limit. The WQI calculated values ranged above 100. This shows that the water quality of the study area is very poor and not suitable for drinking purpose. These results showed that most of the ground water sampling stations near urban pond in Edamalaipatti puthur area are much polluted. The above results confirm that the ground water quality of this area is highly affected by the nearby urban pond of Edamalaipatti puthur area.

ACKNOWLEDGMENT

The author is thankful to the management of Jamal Mohamed College (Autonomous), Thiruchirappali-20 for providing necessary facilities and University Grants Commission, Hyderabad for providing funding to carry out this work.

REFERENCES:

1. Anon (1993) Ventura seeks desalted independence. US water news 9,8
2. Alam M, Rais S, Aslam M (2012) Hydrochemical investigation and quality assessment of ground water

in rural areas of Delhi, India. Environ Earth Sci 66(1):97–110

3. Biswassp and boruah s: Ecology of the river Dolphin (Platanista Gangetica) in the upper Brahmaputra. Hydrbiologia 2000; 430:97-101.
4. Mishra KR and Tripathi SP: Groundwater Quality of open Wells and Tube Wells, Acta Cienciaindica, XXXIIIC 2002:2:179.
5. Tahir MA, Rasheed H and Malana A: Method development for arsenic Analysis by modification in spectrphotometricn technique, Drik. Water Eng. Sci. Dicuss 2008; 1:135-154.
6. APHA: Standard Methods for the Examination of Water and Waste water, APHA, AWWA, WEF. Washington DC,20th Edition 1998.
7. Wetzel R.G., Limology, Saunders Co., Philadelphia, USA, 743(1975)
8. SudhirDahiya and Amarjeetkaur: physic chemical characteristics of underground water in rural areas of Tosham subdivisions, Bhiwani district, Haryana, j. Environ poll. 1999; 6 (4): 281.
9. Sabata B.C. and Nayar M.P., River pollution in India: A case study of Ganga river, 33 (1995).
10. Trivedy RK and Goel PK: Chemical and Biological methods for water pollution studies, Environmental publication, karad, 1986.
11. Bhatt L.R., Lacoul H.D., Lekhak H. and JhaP.k., Physicochemical characteristics and phytoplankton of Taudahalake, Kathmandu, poll. Res., 18(4), 353-358 (1999).
12. APHA: Standard Methods for the examination of water and waste water, American Public Health Assiciation, Washington DC,17th Edition 1989.