

Environmental Impact of Ground Water in Dindigul District Tamil Nadu, India.

Jesu A^{1,3*}, Prabudoss Kumar L^{2, 3}, Dheenadayalan MS³

¹Department of Chemistry, Kathir College of Engineering, Neelambur, Coimbatore, Tamil Nadu, India.

²Department of Chemistry, S Veerasamy Chettier College of Engg and Tech, Puliankudi, Tamil Nadu, India.

³PG and Research Department of Chemistry, GTN Arts College, Dindigul, Tamil Nadu, India.

Research Article

Received: 13/07/2013

Revised: 14/08/2013

Accepted: 09/09/2013

*For Correspondence

Department of Chemistry, Kathir
College of Engineering,
Neelambur, Coimbatore, Tamil
Nadu, India.
Mobile: +91 9976790677

Keyword: hospital waste, sewage
water, physico-chemical analysis,
pond water, TDS

ABSTRACT

The present study is attempted to evaluate the extent of pollution of ground water and pond water due to the percolation of sewage and hospital waste water in and around Pillayarpalayam located near Trichy road of Dindigul. The ground water quality is very much affected due to discharge of hospital waste water and Sewage water from the Multi-specialty hospital with five hundred beds in to the pond. Sewages and hospital waste water are discharged in to streams, which drain into Maruthanikulam pond, thereby polluting the ground water sources, for the past thirty years. Pollution is caused by hospital waste including soaps, detergents, bleaching powder, acids, clinical agents, agents septic tank wastages, vegetables, polythene bags, insecticides, Antiseptics, bandages, disposal cups, plates, needles, syringes, bottles, cottons. The hospitals need a large amount of water for various purposes and depend on the ground water sources for their daily requirements. The discharged sewages and waste water from the hospitals are percolated into the ground and causes ground water pollution. Thus the ground water sources are exploited to their fullest potential and polluted to a greater extent. The effect of hospitals waste water have damaged the environment and affected the people living on the back side of the hospital. Hospital wastes and sewages are affecting the environment and health of the people. The hospital waste water has affected the health of the people. The people are also prone to epidemic diseases, like Cholera, jaundice and Malaria. This study was carried out to assess the magnitude of the water pollution problem in Pillayarpalayam area due to the impact of hospital waste water. The study was attempted understand the toxic effects of sewage water and hospital waste water among the people nearby Pillayarpalayam pond. Since the pond water and the ground water become unfit for human consumption, an attempt was made to find the extent of water pollution by analyzing the various water quality parameters in eleven sites. Water sample were analyzed and compared with BIS limit for water standards. Investigation of physico-chemical characteristics of ground water, grounds were under taken. The utility pattern of groundwater in and around Pillayarpalayam area is undertaken to find the suitability of drinking water. The water is found to be hard with high TDS, hardness and salinity. People are not able to drink the water due to poor taste. From the water samples collected the water quality parameters like P^H conductivity, Chloride, Fluoride, Nitrate, Phosphate, Calcium, Magnesium turbidity were analyzed. The study reveals the high degree of water pollution by comparing the various waste water quality parameters with BIS permissible limit. Hence the polluted water is subjected to water treatment. Contaminated water is treated using reverse Osmosis system. To reduce the TDS in ground water, but this water cannot be used for drinking purpose.

INTRODUCTION

The flow of liquid waste from the St. Joseph hospital with 250 beds in to Pillaiyarpalayam continues to be unchecked, posing serious health hazard^[1]. The hospital waste flowing in to the drainage public place. The waste water flowing in to the drainage canal through the compound wall of the hospital and finally reaches the pond, located on the back side of the pond^[3]. What makes the situation worse is that the drainage carrying the hospital waste empties in to the pond a few meters downstream of the pond. The waste flowing from the hospital has been a problem in Pillaiyarpalayam for quite a long time^[2].

Ironically, the authorities have constructed a drainage along the hospital road to the hospital waste with any treatment, violating the hospital waste management rules, as they thought it the 'easiest' way to pacify the traders in the areas who had been protesting against the free flow of the hospital waste on to the public drain^[4,6]. The courtyard of the maternity ward attached to the hospital has literally been turned into a waste dumping yard, making it an ideal breeding place for mosquitoes and other pests^[5]. The strength emanating from the hospital premise as well as the drainage has made life miserable to the local residents, the trading community in the area. The district authorities concerned have not taken any step so far to solve the pollution problem due to hospital waste water^[7].

HEALTH EFFECTS OF EXPOSURE TO SEWAGE

Tetanus is caused by a toxin produced by the bacterium *Clostridium tetani* that is common in soil and in sewage. The bacterium enters the body via open wounds. There is a high risk of death occurring if infected. Anyone who may be exposed to sewage or soil should have prophylaxis tetanus vaccinations every ten years. Leptospirosis is caused by the parasitic worm *Leptospira interrogans*. It is transmitted from water and damp earth contaminated primarily by rats that harbor the organism^[8,10]. The initial septicemia phase lasted for 4 - 7 days and causes acute headache, chills, fever; severe muscle aching, anorexia, nausea and vomiting. The immune phase, characterized by aseptic meningitis, follows a 24 - 72 hour asymptomatic period. Approximately 10.15% of patients present with Weil's disease jaundice, hemorrhage and renal damage^[9].

Hepatitis A is caused by the Hepatitis A virus (HAV) that is transmitted primarily by ingestion. The virus must be present in sufficient quantities to cause infection. Infection occurs after an incubation period of three to four weeks^[11]. Hepatitis is often mild, but can be severe or even fatal in some cases; symptoms are fever, headache, nausea and pain in the abdomen, dark urine and jaundice. People can spread the disease to others in the immediate period before they become ill and while they are ill. Recovery from hepatitis A can be slow and require several weeks or months of increased rest^[12]. A majority of patients make a complete recovery but the disease can be more severe in older patients. *Giardia* and *Cryptosporidium* are protozoan parasites, commonly found in sewage and surface water, that can cause diarrhea, stomach cramps, nausea and sometimes fever, symptoms may last for only a few days or can last for months or years. Many people, especially children, have no symptoms, cysts from infected person or animals enter sewage and if untreated may infect other people who ingest the cysts. Gram - negative bacteria such as *E. coli* can cause gastrointestinal diseases if ingested or airway problems, headache, tiredness and nausea if inhaled. Substances called endotoxins, that are released at the time of death of the bacterium have been suggested as the cause of a wide variety of occupational diseases such as mill fever and grain fever^[13].

Scope of the Present Study

Pillaiyarpalayam residential area is located behind the St. Joseph's hospital at Trichy road, Dindigul. The hospital waste water mixed with sewage water. During the rainy season all the waste water and sewage water flow into the Pillaiyarpalayam residential area and collect in Maruthanikulam at R.M. Colony. All the people living in the residential area are depending upon the well water and bore well water. The pond water due to percolation reaches the ground water in the residential area. The pond water is already polluted by hospital sewage water.

The pond water percolates into nearby residential area around 3Km. Around the pond there are so many hospitals discharge their waste into pond. The pond gets highly polluted. The pond water is highly coloured and become unfit for any use with full of hospital waste and sewage water. It is badly polluted beyond redemption. The rain water during rainy season contaminated by hospital and sewage water percolates through the ground water and reaches the well and bore wells and in turn affects the quality of water. It makes the water hard and unfit for drinking and domestic purpose. Hence the study is undertaken in and around Pillaiyarpalayam residential area to find the ground water quality.

OBJECTIVES

- 1) To analyze the Physico-chemical quality of water in the pond, contaminated by hospital waste water
- 2) Evaluate the ground water quality in the residential area behind the hospital.
- 3) To suggest a suitable remedial measure for the treatment of polluted ground water.

Guidelines of bureau of standard (BIS) and significance / health effects of chemical parameters.

Parameters	BIS Guideline	Significance/ Health Effects
Color in pt/co scale	25	Consumer acceptance decreases
Turbidity	10 NTU	Consumer acceptance decreases
TDS	200mg/L	Undesirable taste, gastro-intestinal irritation, corrosion
PH	6.5-8.5	Beyond this range ,mucous membranes affected, corrosion, Life affected
CaCO ₃	600mg/L	Poor lather with soap, scale forming, skin irritation, food poor in quality, boiled meat, deterioration of cloths.
Ca	200mg/L	Poor lather with soap and deterioration of cloths scale formation.
Mg	100mg/L	Poor lather with soap and deterioration of clothes, with sulfate laxative, encrustation in water supply structure.
Mn	0.3	Poor lather with soap, scale forming, skin irritation, food poor in quality, boiled meat, deterioration of cloths.
Al	0.2 mg/l	Neurological disorders, alzheimer's disease
Fe	1.0mg/L	Poor or sometime bitter taste, stinging of materials, iron bacteria, iron causing slime.
NH ₃	-	Indicates pollution, growth of algae.
NO ₂	-	Forms nitrosamine's which are carcinogenic.
NO ₃	100mg/L	Blue baby disease, algal growth.
SO ₄	400mg/L	Taste affected, laxative effect, gastro intestinal irritation.
Cl	100mg/L	Taste affected corrosive.
F	1.5mg/L	Dental and skeletal flourish, non-skeletal manifestation
PO ₄	-	Algal growth
Cu	0.5 mg/l	Astringent taste, discoloration and corrosion of pipes and utensils liver damage and muscoal irritation.
Pesticide	0.5 mg/l	Affects central nervous system.
Zn	15 mg/l	Astringent taste, opalescence in water, gastero intestinal irritation, vomiting, nausea and dizziness.
As	0.05 mg/l	Toxic bio-accumulation; central nervous system affected; carcinogenic.
Hg	0.001 mg/l	Highly toxic; causes 'minamata' disease; mutagenic.
Cd	0.01 mg/l	Highly toxic; causes 'itai-itai' disease; gastro intestinal upsets and hyper tension.
Pb	0.05 mg/l	causes plumbism, lassitude, abdominal discomfort, irritability, anemia, bio-accumulation
Cn	0.05 mg/l	carcinogenic; ulcerations, respiratory problems and skin complaints.
Anionic detergents	1.0 mg/L	Undesirable froth, foaming.

METERIALS AND METHODS

Location of the Study Area

Dindigul is an inland District of Tamilnadu. It lies between 10.3 and 10.48 of North latitude 77.15 and 78.20 of East congitude. The District has extensive hilly and rocky areas with undulating plains covered mostly by red soil North East monsoon benefits Dindigul with a mean annual rainfall of 42.66%. The mean sea level 80.11 M Dindigul a small town near Madurai in the State of Tamil Nadu in South India lies in hard rock terrain gramote/ Ground water in Dindigul area is highly polluted.

Choice of the Study Area

Houses, schools and hospitals around the Pillayarpalayam are situated at backside of the St. Joseph's Hospital at Dindigul. The pillayarpalayam is in the down limit located in the downward area. People living in around the Pillayarpalayam are depending on ground water and well water. Bore well water and well water are the source of Pillayarpalayam in town limit. Water is highly polluted due to sewage and hospital wastage.

Places where the Water Samples were Collected

During the Monsoon and post monsoon seasons, St. Joseph's Hospital discharges the hospital and sewage water without any treatment in to the Pillaiyarpalayam area. Many houses are also continuously discharging waste water in to the street. The polluted water seeps in to the ground water. Due to percolation the quality of ground water in and around the Pillaiyarpalayam is affected very much. The ground water is highly saline and unfit for drinking purpose. But the people have to depend on the ground water only. On seeing the sufferings of the people around the Pillaiyarpalayam, Sincere and serious attempt were made to find the ground water quality and also suggest a suitable remedy for a water treatment.

The investigator collecting samples from ground water and maruthanikulam pond water

Figure: 1



Figure: 2



Figure: 3



RESULTS AND DISCUSSION

The physical and chemical parameter analysis of ground water and Maruthanikulam pond are presented and discussed.

S.no	water quality parameters	CPHEEO STD A	CPHEEO STD B	S1	S2	S3	S4	S5	S6	S7	S8	S9
Physical parameters:												
1	Colour, (Hazen units, Max)			Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
2	Odour	Unobjectona ble	Unobjectona ble	None	None	None	None	None	None	None	None	None
3	Turbidity (NTU, Max)	2.5	10	2	2	2	2	2	1	1	2	3
4	Total dissolved solids mg/lit	500	2000	1750	1505	700	1200	1500	1780	1700	1560	1950
5	Electrical Conductivity			2500	2150	960	1950	1750	2330	2710	2700	2180
Chemical parameters:												
6	pH	7.0-8.5	6.5-9.2	8.14	7.69	7.95	8.04	8.09	8.2	8.06	8.13	8.16
7	Alkanity Total	200	600	408	380	329	254	267	277	216	284	283
8	Total Hardness as CaCO ₃ (Mg/l)	200	600	720	540	260	472	340	600	342	500	520
9	Calcium (as Ca) mg/lit,Max	75	100	167	120	56	99	72	130	80	102	112
10	Magesium as Mg mg/l	30	150	77	58	29	54	38	66	34	59	58
11	Sodium as Na mg/l			196	112	204	156	260	296	54	59	54
12	Potassium as K mg/l			31	24	34	35	68	86	8	15	8
13	Iron as Fe mg/l	0.1	1	1.0	1.25	1.13	0.6	0.63	0.65	0.02	0.18	0.19
14	Manganese as Mnmg/l	0.05	0.1	0	0	0	0	0	0	0	0	0
15	Ammonia as NH ₃ mg/l			5.78	7.2	6.5	0.08	0.07	0.08	0.08	0.04	0.08
16	Nitrite as NO ₂ mg/l			0.14	0.2	0.02	0.01	0.02	0.02	0.03	0.01	0.02
17	Nitrate as NO ₃ mg/l	45	45	3	3.7	19	26	4	8	17	15	2
18	Chloride as Cl mg/l	200	1000	5	6	118	310	250	560	606	364	320
19	Fluoride as F mg/l	1	1.5	1.4	0.4	0.4	0.1	1.2	0.4	1.2	0.7	2
20	Sulphate as SO ₄ mg/l	200	400	2.26	2.24	33	94	40	75	128	193	130
21	Phosphate as PO ₄ Tidys's test 4 hrs as			0.23	0.14	0.45	0.25	0.3	0.27	0.1	0.087	0.096
22	O ₂ mg/l			0.32	0.32	0.16	0.19	0.24	0.28	0.28	0.32	0.28

CPHEEO: Central Public Health Engineering and Environmental Organization
CPHEEO STD A – Acceptable limit, CPHEEO STD B – Cause for Rejection

DISCUSSION

The result of water samples for the several of physico-chemical analyses various sites in the pillaiarpalayam are presented. The variation in the various physico-chemical characteristics of ground water quality by the seepage of the effluents from the hospital and sewage gives the overall picture of means and standard deviations of the physico-chemical parameters of all the samples are given in the table.

Sensitive Parameter

TDS, Hardness, Calcium, Magnesium, Chloride and pH are taken as sensitive parameters to indicate the water pollution by hospital waste water and sewage from various sources.

pH

The pH remained mostly alkaline in the pre monsoon season study. The pH of the ground water varies from minimum 7.69 to maximum 8.16 physical and chemical changes in water are dependent on pH variations of the water. pH shows the suitability of water for drinking and irrigation purpose. In nature pH changes according the seasons. And it's an index a water quality in ground water. It was observed that the pH of water was found a higher a pond and low a

bore wells. The water P^H decrease slightly with increasing distances from pond water. As per the standards of ground water quality for pot ability all the water was within the permissible limits prescribed by BIS standards. The values of P^H ranges from 7 to 8.5 are the safe range for drinking as well as growth of plants.

Electrical Conductivity

Electrical conductivity of water varies from maximum of 2700 micro mhos/cm to minimum of 380 micro mhos/cm electrical conductivity is an important parameter to find out the dissolved electrolyte in water. The higher value was recorded at well water and low at site 2. Conductivity indicates the presence of dissolved solids so that the conductivity of well water is high. High values of dissolved solids found near the source of sewage. The results correlated with the findings of Cheery and Mcfarlane et al.

Total Dissolved Solids

A total dissolved solid varies from minimum 673 mg/L to maximum 1974 mg/L. The higher level was recorded at pond shows the water level should be low.

All water samples showed higher TDS value. The total dissolved solid in ground water include all the dissolved solids. In the present study the total dissolved solids ranges from 673 mg/L to 1974 mg/L during pre-monsoon season.

The higher values may be due to low water level and various kinds of polluted ions present in the water. The desirable limits of TDS in drinking water are 500mg/L. The values are exceeds the prescribed limit as per BIS. The values recorded by Dheenadhayalan M.S (1996) were almost higher than the prescribed limit.

Turbidity

Turbidity of ground water varies from minimum 1 NTU to maximum 3 NTU. The presence of finely suspended matter observed only in small amount. Hence it shows Lower value of TDS. The presence of suspended matter may be due to the discharge of solid wastewater in the areas at pond water. Turbidity of the ground water ranges from 1 to 3 NTU units during analysis. The desirable limit prescribed by BIS (1991) is 5 NTU. All the samples show below the prescribed limit. It shows the water from all sites is acceptable for drinking purpose.

The study of Raj Kauretal (2003) shows maximum turbidity 2 to 35.7 NTU during premonsoon particularly the industrial discharge increases turbidity 100 to 110 NTU.

Chloride

The concentration of Chloride level varies from minimum 118 mg/L site 3 to maximum of 606 mg/L at site 8 was recorded during the period of study. The chloride levels are found in variable amounts in water. The chloride content ranges 118 mg/l to 606 mg/l. According to BIS 1991 the highest desirable limits of chloride concentration is specified as 250 mg/l for drinking water. Chlorides values are compared with BIS limit and found that chloride impart bad tastes to water. The increase of chloride ions 420 mg/l to 703 mg/l. Rahman has indicated that the discharging of sewage water and hospital wastage had polluted ground water quality. Analysis reveals that the chloride level is higher than the ISI limit.

Calcium

Calcium content was found to be maximum of 160 mg/l at site 3 and minimum of 56 mg/l during the period of study. Calcium is one of the most abundant substances in nature water Ragothaman. Clearly states that increase of Calcium and contributes to hardness in water and thereby reducing the utility of water for domestic use. The domestic and industrial wastewater contains high amount of inorganic and organic pollutants and the present of calcium observed maximum in premon soon period. In the presents study the calcium ranges from 300 mg/l to 404mg/l which exceeds the acceptable limit of 75 mg/l prescribed by BIS 1991. The increase in Calcium is high due to continuous discharges of wastewater in to the water resources.

The wastewater percolates into the groundwater and affects the water and soil quality according to MS Dheenadhayalan.

Magnesium

Magnesium content varied from 29 mg/l at site 3 to 77 mg/l at site 1. Values of magnesium level concentration were within the prescribed limit. Magnesium is also found in all kinds of natural water along with calcium but its concentration remains generally lower than the concentration of Calcium. In the present study the Magnesium concentration varies from 19 mg/l to 122 mg/l. Its values are 12-49 mg/l in well by Babar et al.

Iron

Iron content of water ranges from 0 mg/l to 0.18 mg/l. Low range was found at all bore wells. All the bore well water has higher prescribed iron content as compared to BIS level. Thus the water is used for domestic purpose.

Nitrate

Nitrate in water samples varies from 2 mg/l. The lower level observed at site 9 and the higher level observed at site 4.

Sulphate

The concentration of sulphate was observed maximum at site 1 and minimum at site 3. Sulphate contributes to the hardness of the water along with Calcium and Magnesium. The Sulphate concentration varies from 33 mg/l to 226 mg/l. The concentration of sulphate prescribed as per BIS 1991 is 250 mg/l. The values in all sites are appreciable limit. Thus the water is used for drinking purpose.

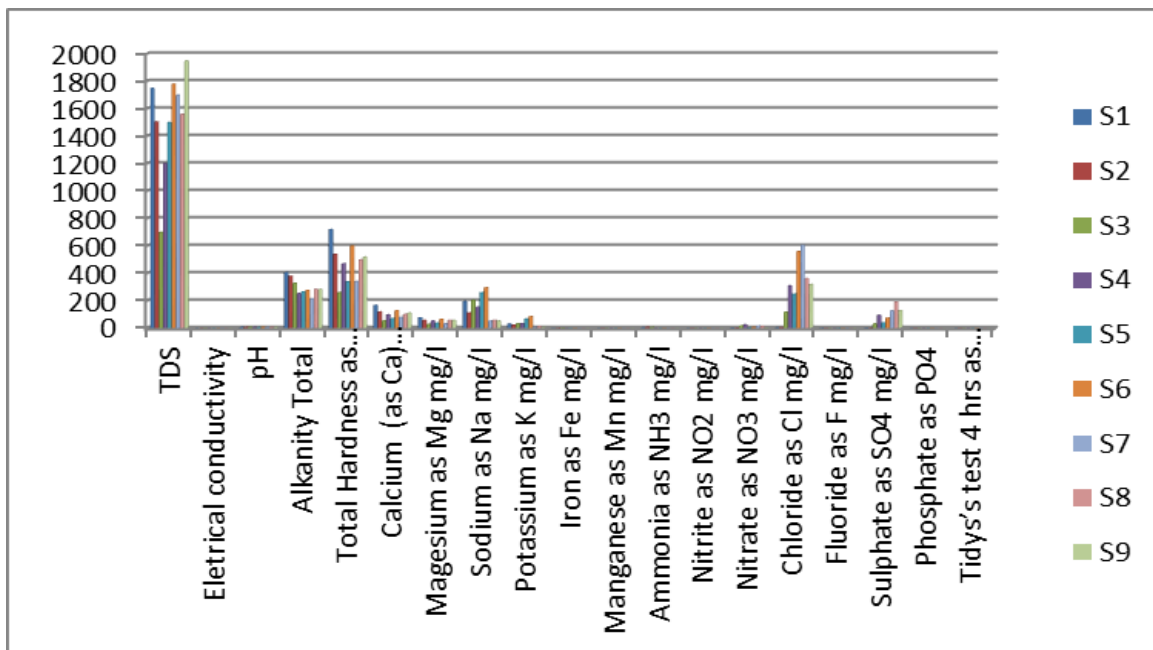
Phosphate

Phosphate concentration was observed minimum at site 3, 5, 8 and maximum at site 1.

Fluoride

The concentration of fluoride varies from 0.1 mg/l 1.5 mg/l. The fluoride level are acceptable as prescribed by ISI 1991 is 1.5 mg/l. The presence of fluoride in ground water is more pronounced in the western side of catchments area. The excess of fluoride in water causes dental and skeletal fluorosis and assessment was done by Somashekara Reddy.

Physical and Chemical Parameters of Various Samples Graph



CONCLUSION

The contamination at Maruthanikulam is insidious. The ground water is highly polluted due to continuous flow of hospital and sewage water from the hospital area. Analysis of physical-chemical characteristic reveals that the pond is polluted to an extremely dangerous level beyond redemption. The pond water cannot be reclaimed due to a very high degree of mixing of sewage and hospital waste water. It is observed from present study that Maruthanikulam is naturally favorable for its collection of various waste water during rainy season because of the natural gradient level. The ground water is collected at various sites cannot be used for domestic, drinking and irrigation purpose. People living in and around the area suffer from the water borne disease like diarrhea, cholera and dysentery. Water borne diseases are prevalent in the study area.

Once an aquifer is polluted percolation of the contaminated hospital waste water and sewage water, it's very difficult for reclamation in the study area. In many areas of sampling sites, the water was found to be high hardness and the areas are totally abandoned mainly due to the impact of sewage and hospital waste water. The hardness, high TDS, high content of chloride causes the water to be saline. It was also observed in many causes that heavy contamination of well water and bore wells. Hence people have to wait for the corporation water for drinking purpose. People do not use the ground water in their own house for drinking or domestic use. It is concluded that the domestic sewage and the hospital waste water from the study area should not be discharged in to that pond. They should know the purpose of the pond Pillaiyarpalayam people get rainfall once in a year. People have to depend on the rain water for the rest of the year. For the use of rain water the ancestors formed a big pond. Hence people in the study area should wake up to safe guard the ground water because their life liquid is water. Pollution control board should give suitable recommendation for the treatment of hospital waste combine sewage water.

REFERENCES

1. Bhattacharya T, Chakraborty S, Tuck Neha. Physico chemical Characterization of ground water of Anand district, Gujarat, India. *I Res J Environment Sci.* 2012;1(1):28-33.
2. Venkateswara Rao B. Physico-chemical analysis of selected groundwater samples of Vijayawada rural and urban in Krishna district, Andhra Pradesh, India. *Int J Environm Sci.* 2011;2(2):710-714.
3. Indrani Gupta, Abhaysingh Salunkhe, Nanda Rohra, Rakesh Kumar. Groundwater quality in Maharashtra, India, Focus on Nitrate pollution. *J Environm Sci Eng.* 2011;43(4):453-462.
4. Rajmohan N, Elango L. Nutrient chemistry of groundwater in an intensively irrigated region of southern India. *Environm Geol.* 2005;47:820-830.
5. Muhammad Barzani Gasim BS, Ismail, Ekhwan Toriman, Sujaul Islam Mir, Tan Choon Chek. A Physico-Chemical Assessment of the Baber River, Pahang, Malaysia, *Global J Environm Res.* 2007;1(1):07-11.
6. Sahu BK, Rao RJ, Behara SK, Pandit RK. Effect of pollutants on the dissolved oxygen concentration of the river ganga at Kanpur, In pollution and bio monitoring of Indian rivers, ABD publication, Jaipur. India, 168-170 (2000).
7. Sivakumar AA, Jaganathan R. Hydrology of River Bhavani, Tamilnadu, India, Ecology and conservation of lakes, reservoirs and rivers, 1246 (2002).
8. Pradeep Jain K. Hydrology and quality of groundwater Hirapur district, Sagar (M.P). *Poll Res.* 1998;17(1):91-94.
9. Bhattacharya T, Chakraborty S, Tuck Neha. Physico chemical Characterization of ground water of Anand district, Gujarat, India. *I Res J Environment Sci.* 2012;1(1):28-33.
10. Zahir Hussain A, Abdul Jameel M. Monitoring the quality of groundwater on the bank of Uyyakondan channel of river Cauvery at Tiruchirappalli, Tamilnadu, India. *Environm Monitor Assess.* 2011;11:1910-14.
11. Lenin Sundar, Saseetharan, Groundwater quality in Coimbatore, Tamilnadu along Noyyal River. *J Environm Sci Eng.* 2008;50(3):187-190.
12. Jain CK, Bhatio KK, Kumar SR. Groundwater quality in malaprabha sub-basin Karnataka. *Int J Environ Prot.* 2005;23(3):321-329.
13. Chari KVR, Lavanya MG. Groundwater contamination in Cuddapah urban area, Andhra Pradesh, In Proceedings on regional Workshop of Environmental aspects of groundwater development. KU, Kurukshetra Oct. 17-19, Kurukshetra, India, 130-134 (1994).