Assessment of Heavymetal in and Around the Industrial Zone of Tuticorin

A. Kayalvizhi
Post Graduate Student,
Department of Civil Engineering,
Bit Campus, Trichirappalli-620024

Dr. S. Evany Nithya
Assistant Professor,
Department of Civil Engineering,
Bit Campus, Trichirappalli-620024

***Abstract*—Ground water is one of the most vital resources for the sustenance of human, plants and other living beings.The hazardous ill effect of heavy metals on environment and public health is a matter of serious concern. Heavy metals in water resource are one of the most important environmental problems of countries. In this study, the groundwater in the industrial zone in tuticorin is investigated for heavy metal contamination.The chief part of the sources of drinking water in the area are to make moist which udder up to the distance below the surface of 10-15m in almost taken separately house.The study consist of the determine parameters quality in heavy metals properties of drinking water. The results of groundwater samples were compared with WHO found that most of the groundwater samples are highly toxic contaminated with like A_r, S_e, P_b, A_l, Z_e,H_g,….etc. The selenium level was taller then 0.01mg/l in 61.5% of the try hard region and the arsenic 0.01 mg/l in 35% of the region.**

***Index Terms*:- Ground water, heavy metals, WHO.**

1. INTRODUCTION

Water pollution is the most serious environmental quality issues in India. It is caused by the disposal of solid and liquid wastes on land and surface water. The most significant waste is sewage, industrial effluent, agricultural residues and chemicals. Today the cry of "Environmental Pollution" is heard from all corners of the world.Pollution has now become a distinct threat to the very existence of mankind on this earth. It is now a major challenge of our times.

Ground water contaminants come from two categories of sources.[i] point source [ii] non-point source. **Point source**→It is pollution caused by discharge of effluents at one point.Due to large scale entry of pollutants at one point. The contamination and harmful effect on quality of water is maximum. Treatment plants can be installed in the area of flow of effluents. Other type of control measures are not required. **Non -point sources**→ It is pollution caused by discharge of pollutants over a wide area. There is some dilution of the effect of pollutants due to large size of area. Treatment plants is useless for this type of pollution. Control measures are required on a large scale for non- liberation of pollutants.Heavy metals are defined as metallic elements that have a relatively high density compared to water. Heavy Metals are defined as high density metallic elements with atomic no. >20.Heavy metals in groundwater are toxic even at low concentrations. Human activities have increased the concentrations of heavy metals in the environment. For example, industry, agriculture, and solid waste disposal increase the contents of heavy metals in water, soil, air, fruits, vegetables, fish, etc. There are 35 metals that concern us because of occupational or residential exposure, of which 23 are heavy metals: antimony, arsenic, bismuth, cadmium, cerium, selenium chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium,thallium, tin, uranium, vanadium, and zinc . Although small amounts of these are common in our environment and diet and some are necessary for good health, large amounts of any of them may cause acute or chronic toxicity.

Health risks of heavy metals include reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Exposure to some metals, such as mercury and lead, may also lead to autoimmunity. Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. As noted above, heavy metals may enter the human body via food, water, air, or absorption through the skin in agriculture, industrial, or residential settings Many studies have investigated the occurrence and monitoring of heavy metals in groundwater and drinking water.

2 SCOPE & OBJECTIVES

Physical and chemical analysis of surface water and groundwater has been performed with regards to:

1. To determine the various physical, chemical characteristics of water quality parameters present in the water and also the ground water
2. To assess the quality of the ground water and its suitability for portable purposes.
3. To carry out the studies variation of WQP and to find out the pollution potential of the ground water
4. To analyze of the sample variations of selected physico-chemical parameters in the water together in the selected heavy metals in the surface water.
5. To estimate and analyze the correlation between the selected physico-chemical parameters in the water.

3.1 STUDY AREA

Tuticorin is the one of the major city in tamil nadu. The city located at 8.7642°N, Latitude 78.1348°E Longitude in the southern part of Tamil Nadu, India.Thoothukudi city and surrounding areas have considerable presence of industries in several industrial sectors. The large industries (other than infrastructure providers, i.e. the Port and the Tamil Nadu Electricity Board Power Plant) are Sterlite (copper), Southern

Petrochemical Industrial Corporation (fertilisers and chemicals) and Kilburn Chemicals (titanium dioxide). There are also several textile mills in the district. The presence of these large industries can lead to the establishment of industries that have product synergies with these units (Selvam et al. 2013a, b). Several medium and small industries, including traditional ones, are situated in Thoothukudi and its neighbourhood. The major segments include salt—industrial and domestic, marine products, minerals (Ilmenite, Garnet, etc.), dry flower exports, edible oil extraction, readymade garments and senna (medicinalherbs) exports (Selvam 2014e, 2015). This study reports the levels of dissolved trace elements and heavy metals in the groundwater system. A large number of researchers have also worked on trace element contents of groundwater in Indian subcontinent and along its coastal area (Ramesh et al. 1995; Mandal and Sengupta 2006).

4.COLLECTION OF SAMPLES

In the present investigation of 7 groundwater samples were collected from seven wells & borewells of different rural areas of Tuticorin. monomer cans of 1 L capacity were made use for collection of water samples.These polythene cans were first washed with tap water, soaked in chromic acid solution for about 10-15 minutes to remove any impurities, again washed with tap water. Finally, they were rinsed with de-ionised distilled water. Then the polythene cans were taken for sample collection. the samples were collected in one liter high density monomer bottles pre washed with dilute hydro-chloric acid and rinsed 3 times with the water sample before filling and labeled.

4.1 PRESERVATION OF SAMPLES

Samples collected in the field should be conveyed to the laboratory in the shortest possible time, to avoid deterioration in their quality.Measurements of colour, odour, temperature, EC, pH and TDS are considered to be 'Field Determinations' and should be made as soon as possible after collecting a sample.Measurement of these parameters can be made in the field if field meters are available. This is the best option, as the analyses will be made immediately.

A) Gis based analysis

The base map of Tuticorin coastal area was digitized from survey of India toposheet no 58L/1&2 and 58L/5 using ArcGIS 9.2 software. The precise locations of sampling points were determined in the field GARMIN 12 Channel GPS and the exact longitudes and latitudes of sampling points and imported in GIS platform. The spatial distri-bution for groundwater quality parameters such as hard-ness, pH, TDS, HCO_3, SO_4, NO_3, Ca, Mg, Cl and heavymetals in Pb,Se,Ar & Fe were done with the help of spatial analyst modules in ArcGIS 9.2 software.

5) GENERAL PROPERTIES

Measurements of colour, odour, temperature, EC, pH and DO are considered to be 'Field Determinations' and should be made as soon as possible after collecting a sample.Measurement of these parameters can be made in the field if field meters are available. This is the best option, as the analyses will be made immediately. If samples are brought to the laboratory, the travel time should be very short, so that parameter values do not change between the time the sample is collected at the time of analysis .

1) pH parameters

The pH of a solution is a measure of hydrogen (H+) ion concentration, which is, in turn, a measure of acidity. The intensity of Acidic and basic character of a solution is indicated by ph or hydrogen ion ,at a given temperature.

As the H+ concentration increases the pH decreases. For example, if the H+ concentration is the pH is 4, and the solution is acidic. In this solution, we see that the OH concentration is 10-14/10-4 , or 10-10. Since 10-4 is much greater than 10-10 the solution contains a large excess of H+ ions, confirming that it is indeed acidic. Any solution where the H+ concentration is less than 10-7 or the pH is greater than 7, would be basic. The pH range in dilute samples is from 0 (very acidic) to 14 (very alkaline), and in water samples is rarely below 4 or above 10. The measurement of pH is now almost universally done using electronic pH meters. The pH of an effluent or water sample is important in almost all phases of drinking water and wastewater treatment.

2) Electrical Conductivity (EC)

The units of k are 1/ohm-cm or mho per centimeter. Conductivity is customarily reported in micromhos per centimeter (□mho/cm). In the International System of Units (SI) the reciprocal of the ohm is the siemens (S) and conductivity is reported as millisiemens per meter (mS/m); 1 mS/m = 10 □mhos/cm and 1 □S/cm = 1 mho/cm.

3) Total dissolved solids (TDS)

Is the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. Volatile solids: is the weight loss on ignition. It includes losses due to decomposition or volatilization of some mineral salts. The theoretical relations between TDS and EC

TDS (mg/L)= 0.6 EC (µS/cm)S

Samples	pH	EC	TDS	Ca^{2+}	M_g^{2+}	K^+	Na^+
Terkuveera pandyapuram	7.6	3850	2464	64	29	10	288
Silverpuram	7.32	10380	6643	192	144	41	5.6
Mappilaiurani	7.46	9100	5824	320	366	76	1475
Sipcot	8.12	4800	3072	880	128	839	115
Ayynadupuram	8.10	5230	3347	368	221	21	382
Pudur pandiapuram	7.70	400	256	22	13	2	52
kumargiri	7.70	3370	2157	275	83	8	271

TABLE I. (a) Tables of general parameters of water quality

Location Name	Latitude	Longitude
Meelavitan	78.1321	8.7937
Sipcot	78.0855	8.8024
Sterlite	78.0866	8.8192
Muthiapuram	78.1297	8.7466
Periyanayaga Puram	78.1016	8.7785
Siluvaipatti	78.1545	8.8395
Mapilaiurani	78.1338	8.8357
Shunmugapuram	78.1449	8.7987

(b)Table of location of the sample area

6) RESULT & DISCUSSION

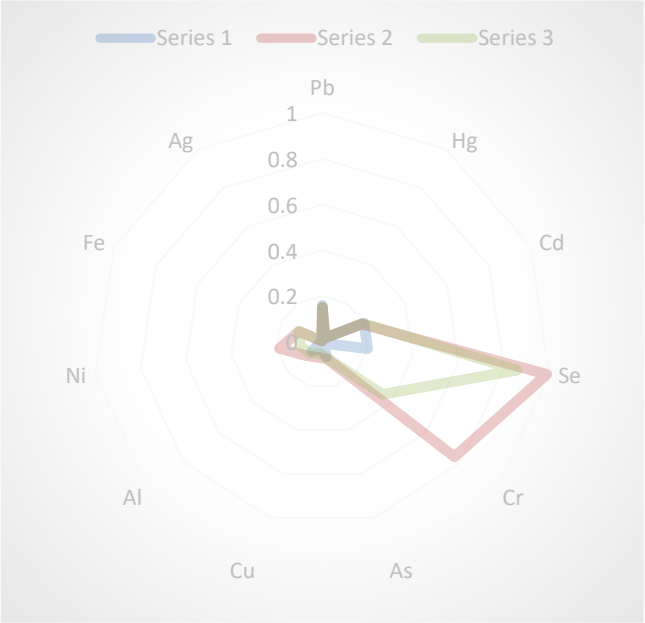
a) Salient features of major ion chemistry

The various physical & chemical parameters including statistical measures such as minimum,maximum, average and standard deviation analysed groundwater samples from the study area. TDS values ranges from 256 to 6643 mg/l, with an average value of 2157 mg/l. the high concentration of TDS in ground water samples in due to leaching of salts from soil and also by anthropogenic activities. The EC value is measured in micro -semens per centimetre and is mesure of salt content of water in the form of ions. The EC values range from 400 to 10380 µs/cm with an average value 3370 µs/cm. To determine the suitability of ground water of any purposes, it is essential to classify the groundwater depending upon their hydrochemical properties based on their EC values (selvam et al.2014b, c). the negative logarithm of hydrogen ion concentration (pH) ranges from 7.6 -8.12 with an averaage value 8.00 the pH value as low as 7.6 was recorded in Sipcot and the highest was found in mappilaiurani near siluvaipuram with a value of 8.12. this shows that the groundwater of the study area dominantly alkaline in nature. The slight alkalinity may be due to presence of bicarbonate ions, which are produced by the free combination of CO_2 with water to form carbonic acid, which affects the pH of the water(Azzez et al.2000). Almonst the cations, the concentration of Na, Ca, Mg and K ions range from ,5.6-1475,22-880,13-366and 2-839 mg/ l.The order of abundance of chemical concentrations is $Na^+ > K^+ > Mg^{2+} > Ca^{2+}$, respectively.

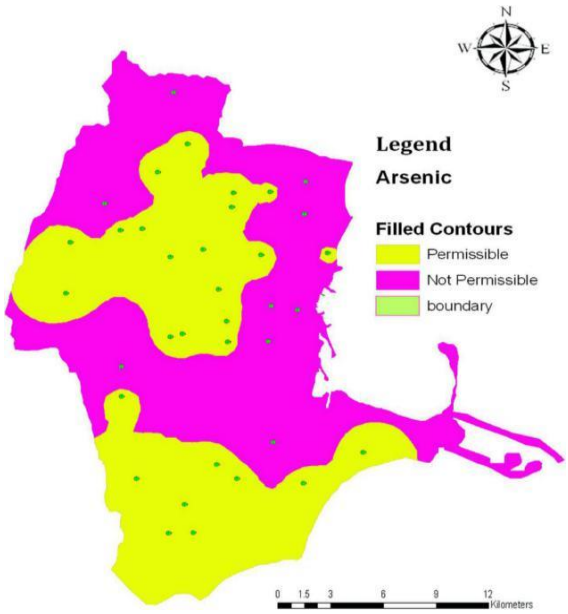
b) Heavy metal distribution

For the protection of human health, guidelines for the presence of heavy metals in water have been set by different International Organizations such as United States Environmental Protection Agency, World Health Organization (WHO) and the European Union Commission (Marcovecchio et al. 2007). thus,heavy metals have permissible limits in water as specified by these organizations. The summary of the heavy metals results of laboratory analyses conducted on the samples.

A.Heavy metals



The concentration of lead in groundwater varies from 0.000 to 0.018 mg/l with an average concentration of 0.004 mg/l,which is beyond the desirable limit of 0.001 mg/l as recommended by WHO (2004). the lead concentration in groundwater of the study area is within the maximum allowable limit in all the sample locations. The main sources of lead contamination are industrial discharges from smelters, battery manufacturing units, run off from contaminated land areas, atmospheric fall out and sewage effluents.



Spatial distribution map ARSENIC

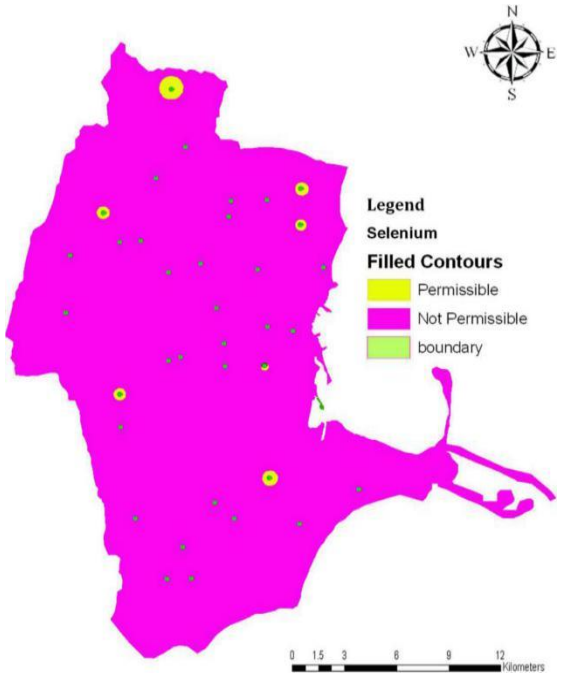
Arsenic concentration in the groundwater varies from 0.000 to 0.083 mg/l with an average concentration of 0.015 mg/l. The maximum allowable limit of arsenuc ion concentration in groundwater is 0.001 mg/ l as per WHO 2004 classification. According to WHO standards, 42% of the samples have exceeded the permissible limits and 58 % of the samples are within the permissible limit. Not permissible limit

of arsenic was observed towards North West, North East and central portion . A higher concentration of Arsenic in the study area is due to industrial waste leaching or percolating through the sub-surface. The study area STERLITE is one of the copper industries located near Thoothukudi town which produces copper from copper concentrates. Arsenic trioxide is obtained as a by product from dusts and residues that are produced during the treatment of other metal ores such as gold and copper (puthiyasekar et al. 2010). the high arsenic concentration is due to the anthropogenic activities like poultry waste, brick making and agricultural practices (selvam et al. 2014a). Chromium concentration in the groundwater varies from the 0.001 to 0.080 mg/l with an average concentration of 0.013 mg /l. as per WHO 2004 standard only one sample exceeds the permissible limit, which may be due to industrial activity.the most common man-made sources of chromium in groundwater are burning of fossil fuels, mining effluent, effluent from metallurgical, chemical and other industrial operations (Leung and Jiao 2006). the risk to human health is through ingestion only-drinking, cooking and teeth brushing. Well water with chromium levels greater than 0.005 mg/l may safely be used for bathing, hand washing and dish washing (selvam et al.2015).

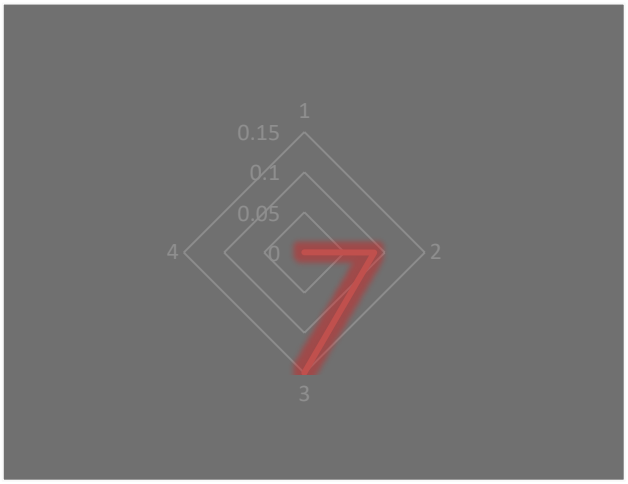
The concentration of iron (Fe) in the groundwater varies from 0.001 to 0.357 mg/l, with an average of 0.123 mg/l. the maximum allowable limit of iron ion concentration. It is found that 85 % of the samples are within the desirable limit and 15 % of the samples have crossed the permissible limit in the area, according to the WHO standard 2012. the NP limit of 0.3 mg/l was observed in small patches of central portion due to the anthropogenic activity. Iron can be found in meat, whole meal products, potatoes and vegetables. The human body absorbs iron in animal products faster than iron in plant products. Iron is an essential part of haemoglobin, the red colouring agent of the blood that transports oxygen through our bodies. Higher Fe concentration in the aquifers might have been the results of interaction from oxidized Fe minarls and organic matters and subsequent dissolution of Fe $_2CO_3$ at a comparatively lower pH (Mondal et al. 2010). this type of water was clear when drawn from the well, but shortly changes into cloudy and then turns brown due to precipitation of Fe(OH_3). Another reason for high Fe concentration may be due to the removal of dissolved oxygen by organic matter, leading to reduced conditions. Under reducing conditions, of dissolved iron in groundwater (Applin and zhao 1989; white et al. 1991).

The concentration of selenium in the groundwater varies from 0.000 to 0.149 mg/l with an average concentration of 0.086 mg/l. the maximum allowable limits of selenium ion concentration in groundwater is 0.01 mg/l as per WHO 2012 classification. According to WHO standards 82% of the samples exceed the permissible limits and only 18% of the samples are within the permissible limits. Selenium is a natural heavy metal associate with specific geological formations and in groundwater it occurs as a mixture of selenite and selenate. Diminutive amount of selenium was benefical, but excess amount was toxic in ground water.

Spatial distribution map SELENIUM



SELENIUM level chart



The concentration of antimony in the groundwater varies from 0.000 to 0.007 mg/l with an average concentration of 0.001 mg/l. the maximum allowable limits limits of selenium ion concentration in groundwater is 0.005 mg/l as per WHO 2012 classification.Especially, people who work with antimony suffer the effects of exposure by breathing in antimony dusts. Human exposure to antimony may take place not only by breathing air, drinking water and by eating foods that contain it but also by skin contact with soil, water and other substances that contain it (sang et al 2008).

Water quality parameters	Minimum concentration	Maximum concentration	Average	SD	%of samples exceeding allowable limitsin WHO (2012)
Al	0.011	0.837	0.084594	0.136	12
Cr	0.0015	0.08	0.013086	0.013	3
Fe	0.0018	0.357	0.123033	0.080	15
Ni	0.000082	0.011	0.005192	0.003	0
Zn	0.00094	0.87	0.203493	0.197	0
As	0.00087	0.0837	0.015796	0.025	35
Se	0.00027	0.1497	0.086987	0.050	80
Cd	0.000012	0.0021	0.000296	0.000	0
Pb	0.00045	0.018	0.004375	0.003	9
Cu	0.0027	0.2365	0.031661	0.060	0

(C)Tables of heavy metal in groundwater samples

6.1 CONCLUSION

This study shows that the tuticorin city of tamilnadu has been affected by trace elements in groundwater. The study reveals that Arsenic, Selenium,Lead,Aluminum & Iron are, in general, concentrated above the permissible limits (WHO 2012) in groundwater of the area of investigation. In view of these findings, there is a need to monitor more closely the environment under review and put in place appropriate checks and balances to preserve the health of communities within the vicinity areas, as the effects of heavy metals are bio-accumulative and pose great dangers to the health of humans, animals and plants. From the results of the present study, wecan hint that the government should adopt nearly the process of treating anything technologies in the following try hard regions to minimize these heavy metals in groundwater & surface water for providing a protected from danger of drinking water for all the people.

7.1 REFERENCES

[1] ***Husam Malassa, Mohamad Hadidoun, Mahmoud Al-Khatib, Fuad Al-Rimawi, Mutaz Al-Qutob***Assessment of Groundwater Pollution with Heavy Metals in North West Bank/Palestine by ICP-MS.

[2] ***S.Selvam • A. Antony Ravindran • S. Venkatramanan • C. Singaraja***Assessment of heavy metal and bacterial pollution in coastal aquifers from SIPCOT industrial zones, Gulf of Mannar, South Coast of Tamil Nadu, India.

[3] ***Ravisankar Tadiboyina, and Prasada Rao Ptsrk***Trace Analysis of Heavy Metals in Ground Waters of Vijayawada Industrial Area.

[4] ***Santhanakrishnan, C. Lakshmanan and *V. Radhakrishnan***heavy metaldistributioninthesaltpansof tuticorin, tamil nadu, india.

[5] ***S.Selvam, S. Venkatramanan & C. Singaraja***A GIS-based assessment of water quality pollution indices for heavy metal contamination in Tuticorin Corporation, Tamilnadu, India.

[6] ***T.Zohreh Marbooti, Rezvan Khavari*, Farhad Ehya*** Heavy Metal Contamination Assessment of Groundwater Resources in Behbahan Plain Southwest Zagros.

[7] T.***Somvir Singh, N.C. Mondal and V.S. Singh***Groundwater quality in and around Tuticorin town, Southeast coast of India.

[8] ***Enriqueta Anticó, Sergi Cot, Alexandre Ribó , Ignasi Rodríguez-Roda and Clàudia Fontàs***Survey of Heavy Metal Contamination in Water Sources in the Municipality of Torola, El Salvador, through In Situ Sorbent Extraction.

[9] ***Firmi P. Banzi1, Peter K. Msaki1, Najat K. Mohammed***assessment of Heavy Metal Concentrationin wateraroundtheproposedMkujuriver Uraniumprojectin tanzania.

[10] ***Ramesh Pandian R. and Sashik Kumar M.C.*** GIS Based Groundwater Quality Assessment in Tuticorin District Tamilnadu, India.

[11] ***Jacob Vincent***Assessment of Physico-Chemical Quality of Groundwater in rural areas of Thoothukudi District, Tamilnadu, India.

[12] ***WHO (2012)***Guidelines for drinking water quality, ***vol 1***. world health organization, geneva.