Studies on Heavy Metal Pollution Index of Groundwater of Edamalaipatti Pudhur Area near Korai River Tiruchirappalli District Tamil Nadu, India

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Abstract— Groundwater samples were collected from different localities in and around Edamalaipatti pudhur area, near Korai River, Tiruchirappalli District Tamil Nadu. Samples were collected from ten different locations during pre monsoon, monsoon and post monsoon during the year 2014. They are analyzed for heavy metals such as Zine, lead, Nickel, copper, and Iron using Atomic Absorption Spectrophotometer (AAS). The analytical data was compared with the guidelines given by WHO. The Calculated values HPI 163.8. The results reveal that the concentration of lead and nickel are higher than the permissible limit prescribed by the WHO. The result shows that the water quality of the study area is very poor and not suitable for drinking purpose. The heavy metal contamination may due to the discharge of waste, industrial and municipal wastewater, disposal of solid waste by land filling, and other anthropogenic influences in this region.

Key words: Groundwater, Heavy Metal Pollution Index, Edamalaipatti Pudhur Area

I. INTRODUCTION

Quality of drinking water is a necessity for mankind. Unfortunately, more than one billion people all over the world do not get safe drinking water and among these, 800 million live in rural areas. In India Ponds, rivers, and ground water are major sources of water used for the domestic and agriculture purposes in India. In many developing countries, including India, urbanization and industrialization has resulted in many problems, one of which is environmental pollution. The major source of environment pollution is improper management of solid wastes and effluents. Dumping these toxic wastes into local water bodies' results in accumulation of toxic and hazardous metals in local ground water. Heavy metal is a general collective term which applies to the group of metals and metalloids with an atomic density greater than 4 g/cm³. Heavy metals in subsurface environments come from natural and anthropogenic sources. Natural sources include weathering of minerals whereas, anthropogenic sources include fertilizers, industrial effluent, and leakage from service pipes. Industrial and agricultural activities are the major contributors of contamination. Other factor maybe (1) high density of buildings, (2) extensive construction of subsurface drainage systems. Permissible limits for the sheave metals in drinking water given by Indian standard institution (ISI) and World Health Organization (WHO). Many studies of heavy metal contamination derived from mining activities have been undertaken for river sand groundwater in India. In India, herbal medicines are popular among rural peoples they are freely available and hence can be used by anyone. Heavy metals toxicity in microorganisms, aquatic environments, plant and animals have been recognized for a long time. The natural water analysis for the detection of heavy metals is very important for public health studies. To the best of our knowledge, in this first report concerning the heavy metals contaminants, we found the, concentrations of heavy metals (Zn, Pb, Ni, Fe and Cu) in drinking water samples in these communities. Due to the adverse health effects of heavy metals Zn, Pb, Ni, Fe and Cu detection of even trace amount of these elements in any environmental samples can contribute to future research for eliminating these toxic metals from polluted samples.

II. STUDY AREA

The study area Edamalaipatti pudhur is located in near Korai River at heart part of the city. Population of the Edamalaipatti pudhur area is around 30,000. Many industries and some small scale oil industries are located in and around this area (Fig 1). Most of the people depend upon groundwater for bathing, domestic and other purposes. The typical sewage comprising of domestic and other waste are discharged directly in to the open land without any proper treatment will cause contamination. This contamination poses serious health impacts in the local residents.

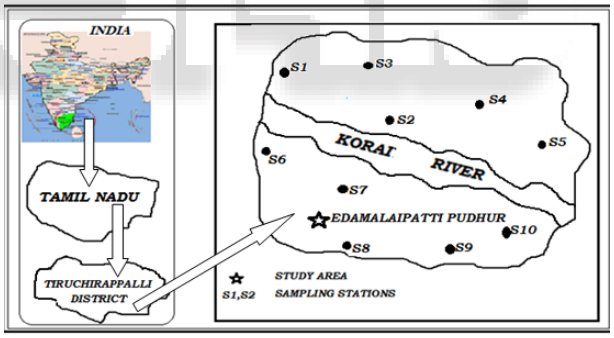

Fig: 1 Location Map Of The Study Area

III. MATERIAL AND METHODS

Ten groundwater samples were collected from on either side of Korai River near Edamalaipatti pudhur area. The distance between one stations to another was maintained about 0.75 kilometers. The groundwater samples were collected from ten different locations during pre monsoon (May), monsoon (August) and Post monsoon (November) during the year 2014. Samples were collected in a clean and dry polyethylene cane from bore wells after running it for 3 min. The concentration of heavy metals such as Zn, Pb, Ni, Fe and Cu were determined by using atomic Absorption spectrometer and the results were compared with WHO standard values (2003).

IV. RESULTS AND DISCUSSION

Stations	Parameters

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	Zn	Pb	Ni	Fe	Cu
S1	0.6	0.04	0.05	0.02	0.03
S2	0.08	0.05	0.04	0.07	0.07
S3	0.11	0.04	0.06	0.02	0.05
S4	0.4	0.02	0.06	0.05	0.2
S5	0.27	0.02	0.03	0.08	0.04
S6	0.03	0.05	0.04	0.3	0.07
S7	0.07	0.04	0.03	0.02	0.3
S8	0.4	0.02	0.02	0.5	0.07
S9	0.04	0.04	0.02	0.04	0.04
S10	0.2	0.02	0.02	0.7	0.2

Table 1: The heavy metal concentrations of groundwater samples in and around Edamalaipatti pudhur area Tiruchirappalli District Collected during the pre monsoon May 2014.

Stations	**Parameters**				
	Zn	**Pb**	**Ni**	**Fe**	**Cu**
S1	0.09	0.02	0.02	0.04	0.07
S2	0.4	0.03	0.02	0.2	0.1
S3	0.2	0.06	0.04	0.9	0.3
S4	0.02	0.04	0.04	0.07	0.04
S5	0.14	0.02	0.03	0.2	0.02
S6	0.5	0.02	0.02	0.10	0.05
S7	0.07	0.06	0.02	0.04	0.08
S8	0.4	0.01	0.04	0.3	0.1
S9	0.03	0.02	0.01	0.2	0.08
S10	0.6	0.02	0.03	0.2	0.03

Table :2 The heavy metal concentrations of groundwater samples in and around Edamalaipatti pudhur area Tiruchirappalli District Collected during the monsoon August 2014.

Stations	**Parameters**				
	Zn	**Pb**	**Ni**	**Fe**	**Cu**
S1	0.08	0.02	0.02	0.05	0.04
S2	0.05	0.02	0.07	0.07	0.06
S3	0.10	0.03	0.08	0.07	0.02
S4	0.08	0.02	0.05	0.4	0.1
S5	0.03	0.01	0.04	0.3	0.09
S6	0.4	0.04	0.02	0.2	0.04
S7	0.2	0.03	0.03	0.3	0.03
S8	0.09	0.03	0.03	0.2	0.02
S9	0.4	0.04	0.03	0.09	0.1
S10	0.4	0.05	0.02	0.6	0.07

Table 3: The heavy metal concentrations of groundwater samples in and around Edamalaipatti pudhur area Tiruchirappalli District Collected during the Post monsoon November 2014.

Stations	**Parameters**				
	Zn	**Pb**	**Ni**	**Fe**	**Cu**
S1	0.14	0.19	0.12	0.36	0.10
S2	0.32	0.04	0.04	0.30	0.18
S3	0.21	0.04	0.06	0.39	0.17
S4	0.20	0.03	0.05	0.45	0.16
S5	0.34	0.02	0.03	0.32	0.18
S6	0.18	0.04	0.02	0.35	0.16
S7	0.22	0.04	0.02	0.19	0.17
S8	0.28	0.02	0.03	0.38	0.16
S9	0.32	0.03	0.02	0.39	0.18
S10	0.27	0.03	0.02	0.26	0.16

Table 4: Mean values of heavy metal ions concentrations of groundwater samples in and around Edamalaipatti pudhur area Tiruchirappalli District.

A. Calculation of HPI values for the Heavy metal concentration of Groundwater around Edamalaipatti Pudhur area.

Heavy metals	Mean value in ppm(Vi)	Highest permitted value (WHO) (Si)	Unit weightage (wi)	Wi×Qi
Zn	0.23	3	0.01	0.76
Pb	0.02	0.01	0.4	80
Ni	0.03	0.02	0.4	120
Fe	0.15	1.0	0.004	0.06
Cu	0.08	2.0	0.002	0.008

$HPI=\sum_{i}^{n}=1\,(QiWi)\,/\,\sum_{i}^{n}=1W_i$ HPI= 163.8

1) Zinc

Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complexes. Zinc deficiency in human body may results in infantilism, impaired wound healing and several other diseases. The values of zinc concentration obtained in this study, ranged from 0.02 to 0.27 ppm compare to Pre monsoon, monsoon and post monsoon season. Zinc content in all sampling sites, are within the permissible limit prescribed by WHO (3.0).

2) Lead

Lead is a dangerous element it is harmful even in small amount. Distribution of lead at different sites during pre monsoon, monsoon and post monsoon are shown in table 1, 2 and 3. The maximum lead content ranged from 0.01 to 0.06 ppm. This study shows most of the ground water samples has high lead content. All the sampling stations have above the permissible limit prescribed by WHO (0.01).

3) Nickel

Nickel is a natural element of the earth's crust therefore, small amounts are found in food, water, soil and air. Nickel occurs naturally in the environment at low levels. Nickel is used for nickel alloys, electroplating, machinery parts, stainless steel, spark plugs and also as catalysts. Nickel is found in ambient air at very low levels as a result of releases from oil and coal combustion, nickel metal refining, sewage sludge incineration and other sources. Nickel in general, is associated with basic and ultra basic rocks. The values of Nickel concentration obtained in this study, ranged from 0.01to 0.08 ppm. All the three season above the permissible limit prescribed by WHO (0.02). Nickel dermatitis, consisting of itching of the fingers, hands and fore arms, it the most common effect in humans from chronic skin contact with nickel.

4) Iron

Iron is biologically an important element which is essential to all organisms and present in haemoglobin system. High concentration causes slight toxicity, inky flavour, bitter and astringent taste. Iron contained water makes the teeth and nail black and weak, stickiness of hair and water. In our study the concentration of Fe ranged from is 0.02 ppm to 0.10 ppm. The Fe values in all ground water samples were found within the limit prescribed by WHO (1.0 ppm). The deficiency of iron causes a disease called anaemia and prolonged consumption of drinking water with high

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concentration of iron may lead to liver disease called as haermosiderosis.

5) Copper

Copper is an essential substance to human life, but chronic exposure lead to the development of anemia, liver and kidney damage. Copper in large doses is dangerous to infants and people with certain metabolic disorders. In this present study area, the concentration of copper content ranged in ground water from 0.03 to 0.3 ppm. The results shows that the concentration of copper found in the samples were below the permissible limit prescribed by WHO (2.0). On the other hand, lack of copper intake causes anemia, growth inhibition and blood circulation problems.

B. Heavy Metal Pollution Index

Heavy metal pollution index (HPI) is a technique of rating that provides the composite influence of individual heavy metal on the overall quality of water. The rating is a value between zero and one, reflecting the relative importance of individual quality considerations and inversely proportional to the recommended standard (Si) for each parameter. The calculation of HPI 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 heavy metal. The weight age of i^{th} parameter

$$Wi = k/si \quad (1)$$

Where Wi is the unit weight age and Si the recommended standard for i^{th} parameter, (i=5), While k is the constant of proportionality.

Individual quality rating is given by the expression

$$Qi = 100vi / Si \quad (2)$$

Where Qi is the sub index of i^{th} parameter, Vi is the monitored value of the i^{th} parameter in µg/l and Si the standard or permissible limit for the i^{th} parameter.

The Heavy Metal Index (HPI) is then calculated as follows

$$HPI = \sum_{i}^{n}=1 (QiWi) / \sum_{i}^{n}=1 W_i \quad (3)$$

Where Qi is the sub index of i^{th} parameter. Wi is the unit weight age for i^{th} parameter, n is the number of parameters considered. The critical pollution index value is 75, above this value is not suitable for drinking purposes.

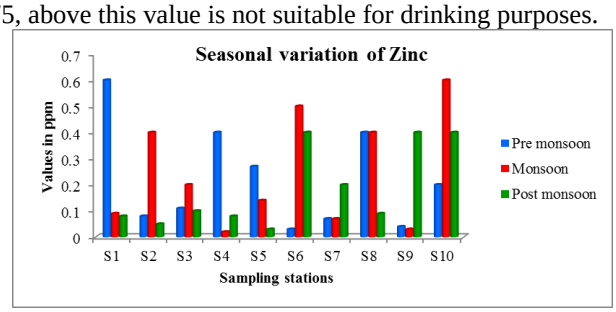

Fig. 2: Variation of Zinc values collected are different seasons from Edamalaipatti pudhur area Tiruchirappalli District.

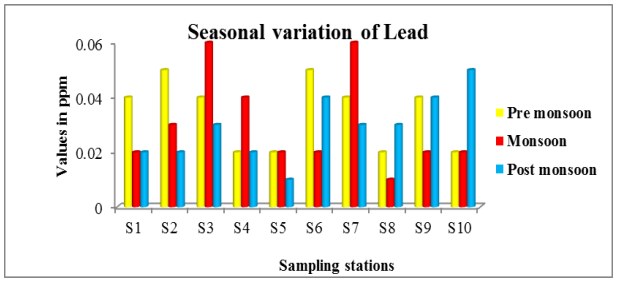

Fig. 3: Variation of Lead values collected are different seasons from Edamalaipatti pudhur area Tiruchirappalli District.

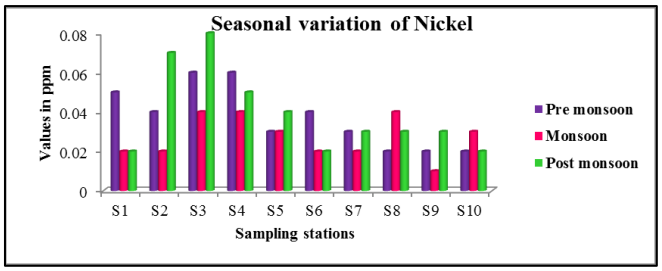

Fig. 4: Variation of Nickel values collected are different seasons from Edamalaipatti pudhur area Tiruchirappalli District.

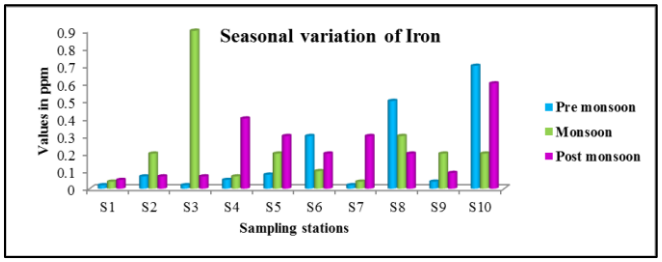

Fig. 5: Variation of Iron values collected are different seasons from Edamalaipatti pudhur area Tiruchirappalli District.

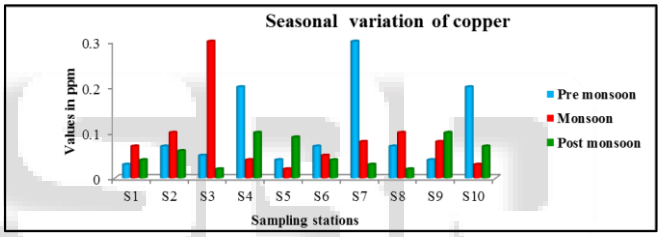

Fig. 6: Variation of Copper values collected are different seasons from Edamalaipatti pudhur area Tiruchirappalli District.

V. CONCLUSION

The concentration of heavy metals like Zn, Pb, Ni, Fe and Cu have been determined by using Atomic Absorption Spectroscopy during pre monsoon, monsoon and post monsoon. Based on the experimental data, the concentration of heavy metals during pre monsoon is high compared to monsoon. This is due to evaporation during pre monsoon. This study shows that most of the ground water samples have high content of Pb and Ni. On the basis of above discussion it may conclude that the underground drinking water at almost all sites in Edamalaipatti pudhur is highly contaminated. People dependants on this water are often prone to health hazards due to contaminated potable water. The high in the groundwater causes nausea, vomiting, diarrhea and if exceeding high in human system threatens life.

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