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# Studies on heavy metal pollution of ground water sources between Tamilnadu and Pondicherry, India

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**ABSTRACT**

*Eight ground water samples were collected in and around Karaikal areas during monsoon, winter and summer seasons and analyzed in order to find out pollution impact. The heavy metal analyses of Cu, Fe, Mn, Cr and Pb were performed for the water samples. This study aims at detecting the possibilities of ground water quality deteriorations due to the improper solid waste dumping with special reference to heavy metal pollution. From the data, it is shown that except Pb, the other heavy metals are present within the permissible limit. It is a well known fact that the heavy metal ions are potentially toxic to human health and could be quite detrimental for human life. Our study suggests the preventive measures which are to be adopted to control the contamination of excess Pb present in the ground water around this region.*

**Key words**: Groundwater, heavy metal pollution, seasonal variation.

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## INTRODUCTION

Of all the natural resources, water is unarguably the most essential and precious. Life began in water and life is nurtured with water. Ninety seven percent of the world's water is found in oceans. Only 2.5% of the world's water is non-saline fresh water. There are organisms, such as anaerobes, which can survive without oxygen. But no organism can survive for any length of time without water. It is a universal solvent and as a solvent it provides the ionic balance and nutrients, which support all forms of life. In India the major source of water used to meet the domestic, agricultural and industrial needs is the ground water. The ground water is defined as water that is found underground in cracks and spaces in soil, sand and rocks. This source has two distinct functions; firstly, it is a significant source of both urban and rural population's water supply and secondly it sustains many wetland ecosystems.

Groundwater is used for domestic, agriculture and industrial purpose in most parts of the world. The human activities like agriculture and domestic release large number of pollutants into the water bodies. In India ponds, rivers and ground water are used for the domestic and agriculture purposes [1]. The major sources of water are rainfall, surface water involving rivers, lakes and groundwater involving wells bore wells *etc*. In recent years, the growth of industry, technology, population and water use has increased the stress upon both our land and water resources. Locally, the quality of ground water has been degraded. Municipal and industrial wastes, chemical fertilizers, herbicides and pesticides have entered the soil, infiltrated some aquifers and degraded the ground-water quality. Other pollution problems include sewer leakage, faulty septic-tank operation and landfill leachates. In some coastal areas, intensive pumping of fresh ground water has caused salt water to intrude into fresh-water aquifers.

As the urbanization process continues, water pollution problems have become increasingly evident and have led to serious ecological and environmental problems. Industrial production without adequate regard for environmental impacts has increased water and air pollution, and has led to soil degradation and large scale global impacts such as acid rain, global warming and ozone depletion. All metabolic and physiological activities and life processes of aquatic organisms are generally influenced by water temperature [2].

The sources for ground water supply mostly depend upon the rainfall and the resulting percolation of the water into the earth. Another important factor is the quality of the soil. The heavy metals play a vital role in the normal functioning of human body. Imbalance of any of the heavy elements will disturb the normal function of human beings. Heavy metals are added to water system both from natural and man-made sources.

Heavy metals in water refers to the heavy, dense, metallic elements that occur in trace levels, but are very toxic and tend to accumulate, hence are commonly referred to as trace metals. The major anthropogenic sources of heavy metals are industrial wastes from mining sites, manufacturing and metal finishing plants, domestic waste water and run off from roads. Many of these trace metals are highly toxic to humans, such as Hg, Pb, Cd, Ni, As, and Sn. Their presence in surface and underground water at above background concentrations is undesirable. Some heavy metals such as Hg, Pb, As, Cd, Fe, Co, Mn, Cr etc., have been identified as deleterious to aquatic ecosystem and human health.

## MATERIALS AND METHODS

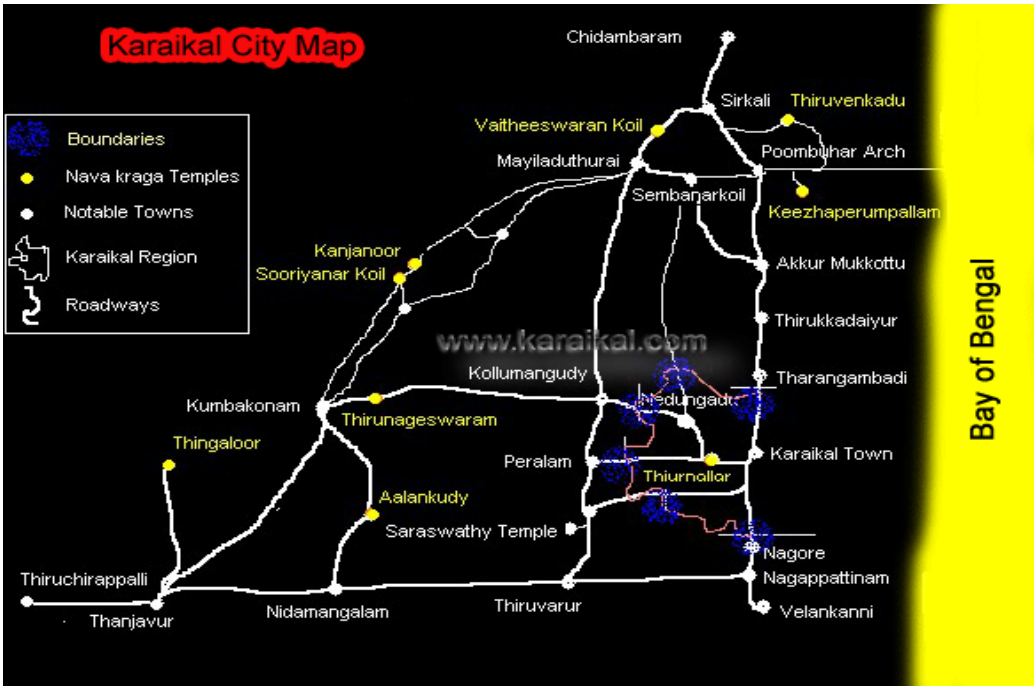
**Study Area:**
Karaikal is a very old temple town in Pondicherry. It is on the east coast, about 135 km from Pondicherry and 300 km from Chennai towards south. The town is small with a total of 161 sq Km with marine time climate and located on the Koramandel coast of the Bay of Bengal. This small town is much seen by tourists as well as pilgrims. The town of Karaikal is the second largest region of the union territory of Pondicherry on the delta of the Cauvery River. Karaikal has a rich architectural and religious heritage with special mention of Sri Dharbarenyeswaraswamy Temple, the famous $7^{th}$ century temple which is one of the most well known of all Lord Shiva's temples in India.

**Geology:**
The total geographical rural area of the district is 140355.56 hectares; the percentage of cultivable area to total area and percentage of irrigated area to total cultivable area are 84.92 and 82.81 respectively. This shows that karaikal is predominantly an agricultural area. Agriculture is the most important economic activity in the district, both in terms of employment and output. Higher production is due to the existence of the coastal alluvium soil which is very suitable for the cultivation of paddy and pulses.

**Sample collection:**
The heavy metals analyses for the ground water samples are performed during monsoon, winter and summer seasons (October-2010 to May-2011).The heavy metals such as Copper (Cu), Iron (Fe), Manganese (Mn), Chromium (Cr) and Lead (Pb) were analysed. The areas in and around Karaikal were taken for our study. The karaikal areas were selected based on the Tamil Nadu and Puducherry border where the waste water flows into ocean. In different seasons water samples were collected at various stations such as 1)Poraiur(S1) 2)Varichikkudi(S2) 3)Malavangiyur(S3) 4)Nagore(S4) 5)Ambakarathur(S5) 6) Kollapuram(S6) 7) Kottucherry(S7) 8) T. R. Pattinam(S8).

The samples were collected in polyethylene bottles (1.5 litres capacity) which had been thoroughly washed and filled with distilled water, and then taken to the sampling site. The bottles were emptied and rinsed several time with the water to be collected. Also, the sample bottles were partially filled with the collected water and vigorously shaken to note the odour. The sample bottles were covered immediately after collection and the temperature taken. The above said heavy metals have been analyzed using atomic absorption spectrometer as per the standard methods of [3].

**AREA MAP**




**RESULTS AND DISCUSSION**

The result of the AAS analysis of all the samples are shown in Tables & Figures below

**Table: 1 Concentration of metal ions in the groundwater samples collected during Monsoon period- 2010.**

| Station | Cu | Fe | Mn | Cr | Pb |
|---|---|---|---|---|---|
| S1 | 0.03 | 0.10 | 0.08 | 0.01 | 0.04 |
| S2 | 0.03 | 0.36 | 0.06 | 0.01 | 0.04 |
| S3 | 0.03 | 0.26 | 0.04 | 0.01 | 0.03 |
| S4 | 0.02 | 0.21 | 0.05 | ND | 0.02 |
| S5 | 0.02 | 0.12 | 0.03 | ND | 0.02 |
| S6 | 0.05 | 0.46 | 0.09 | 0.06 | 0.08 |
| S7 | 0.04 | 0.36 | 0.05 | 0.05 | 0.06 |
| S8 | 0.03 | 0.22 | 0.03 | 0.02 | 0.04 |

**Table: 2 Concentration of metal ions in the groundwater samples collected during Post-Monsoon period -2010.**

| Station | Cu | Fe | Mn | Cr | Pb |
|---|---|---|---|---|---|
| S1 | 0.02 | 0.36 | 0.05 | 0.01 | 0.02 |
| S2 | 0.02 | 0.32 | 0.05 | 0.01 | 0.02 |
| S3 | 0.02 | 0.35 | 0.04 | ND | 0.01 |
| S4 | 0.02 | 0.28 | 0.04 | ND | 0.01 |
| S5 | 0.01 | 0.24 | 0.02 | ND | 0.01 |
| S6 | 0.02 | 0.36 | 0.05 | 0.04 | 0.06 |
| S7 | 0.02 | 0.30 | 0.04 | 0.03 | 0.04 |
| S8 | 0.02 | 0.29 | 0.04 | 0.03 | 0.03 |

**Table: 3 Concentration of metal ions in the groundwater samples collected during Pre-Monsoon period -2011.**

| Station | Cu | Fe | Mn | Cr | Pb |
|---|---|---|---|---|---|
| S1 | 0.01 | 0.28 | 0.02 | 0.01 | 0.01 |
| S2 | 0.01 | 0.23 | 0.02 | 0.01 | 0.01 |
| S3 | 0.01 | 0.25 | 0.02 | ND | 0.01 |
| S4 | 0.01 | 0.21 | 0.02 | ND | 0.01 |
| S5 | 0.01 | 0.21 | 0.02 | ND | 0.01 |
| S6 | 0.01 | 0.34 | 0.03 | 0.02 | 0.03 |
| S7 | 0.01 | 0.32 | 0.02 | 0.02 | 0.04 |
| S8 | 0.01 | 0.30 | 0.02 | 0.02 | 0.02 |

*ND – (Non-Detectable), All the values are expressed in ppm.*

**Figure: 1 Seasonal variations of Copper**

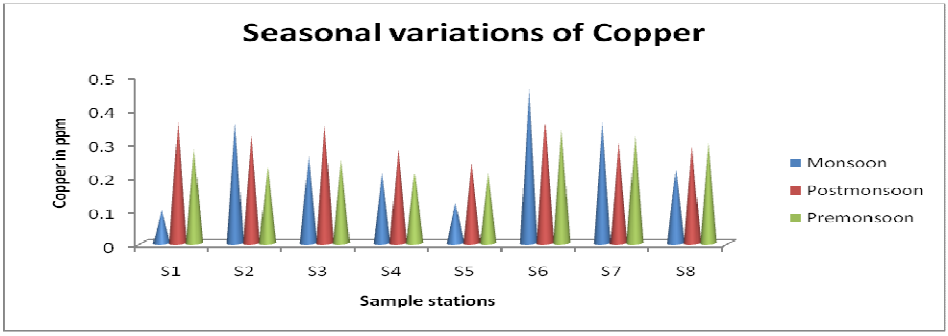



**Figure: 2 Seasonal variations of Iron**

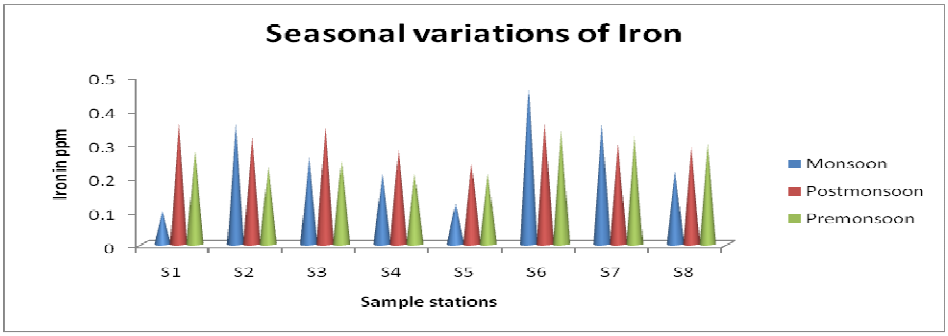



**Figure: 3 Seasonal variations of Manganese**

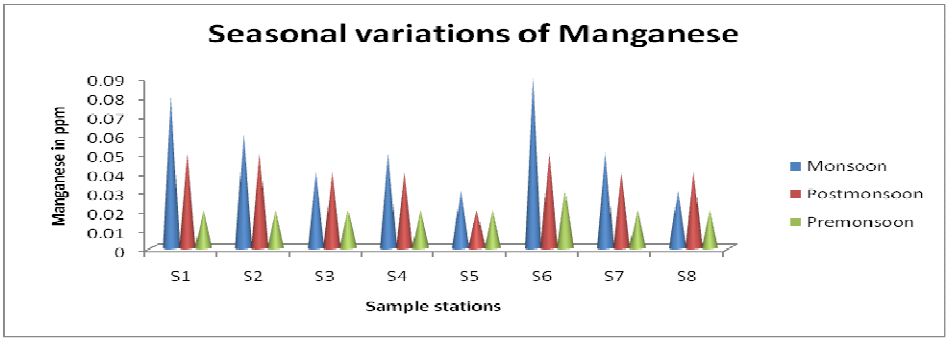


**Figure: 4 Seasonal variations of Chromium**

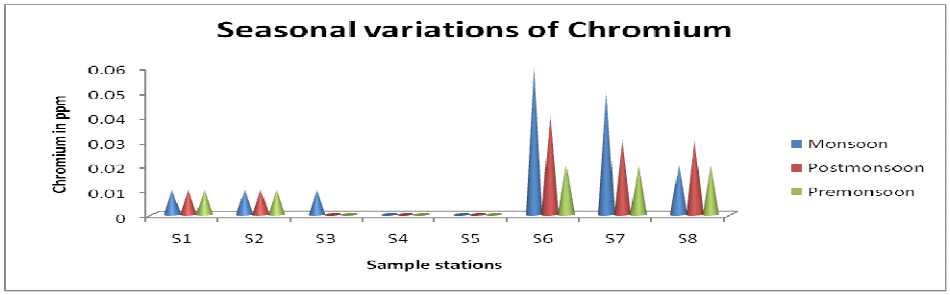
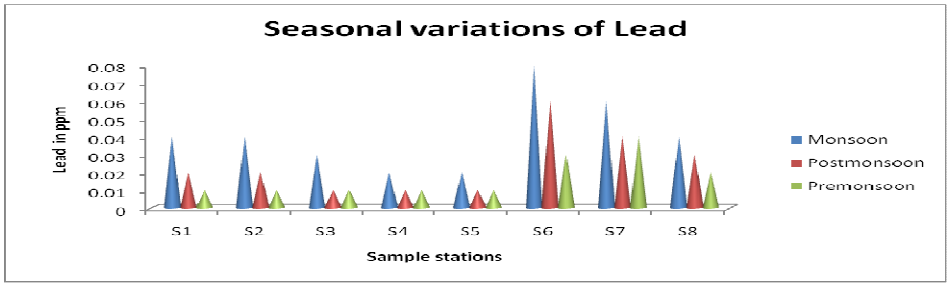



**Figure: 5 Seasonal variations of Lead**




During monsoon 2010, the copper content in the ground water samples recorded the highest value of 0.05ppm at S6 and minimum of 0.02ppm at S4 and S5. During post monsoon 2010, the highest level of copper was found to be 0.02ppm in all stations except S5 with a minimum of 0.01ppm. During pre monsoon 2011, the concentrations of copper in the groundwater sample were similar in all stations (0.01ppm). Lower amount of Cu content was found in most of the samples, which are within the permissible limit (WHO permissible limit of Copper is 1.0ppm). [4].The source of copper may be due to the intrusion of industrial and domestic wastes [5]. Corrosion of brass and copper pipes also contributes to copper level in water. The alkaline pH of the medium can also be the cause of low level of copper, as heavy metals are precipitated as their salts at high pH and are deposited as sediments [6].

Iron is the most commonly available metal on planet earth[7]. The iron content of the water sample is also within the permissible limit of WHO(1.0ppm). During monsoon, iron content of the ground water sample has maximum value of 0.46ppm at S6 and minimum of 0.12ppm at S5. The level of iron could be the result of clay deposits in the area. The high concentration of iron is also of concern as large amount of ground water is abstracted by drilling water-wells both in rural and urban areas for drinking and irrigation purposes [8]. Also the presence of iron is responsible for the brownish – red colour of the water when allowed to stay for some minutes [9]. Excess of iron will also influence the presence of bacteria (iron-reducing) in ground water [10]. Other sources of iron are drinking water, iron pipes, and cookware. It affects target organs which are the liver, cardiovascular system and kidneys.

The value of Manganese is within the permissible limit of WHO(0.5ppm), but according to ISI for drinking water, permissible limit for manganese is 0.3ppm and it is said that the water is affected above the value of 0.1ppm. In this study, during monsoon 2010, the manganese content in the groundwater samples was estimated to be the level of 0.09ppm at S6. The values are slightly less than 0.1ppm [Table.1 and Figure.3]. During post-monsoon 2010 and pre-monsoon 2011, some of the groundwater sample showed minimum of 0.02ppm [Table.2, 3 and Figure.3]. However, slight rise in its level may be accounted for by the influence of domestic waste, natural geological rocks and industrial effluent [11]. Sometimes manganese containing water is not suitable for domestic purpose.

Both lead and chromium are highly toxic metals and they should normally be present only in traces. Lead (Pb) is used principally in the manufacturing of lead acid battery and alloys. In the present study, the levels of lead and chromium during monsoon 2010, chromium were found to be maximum of 0.06ppm at S6, lead 0.06ppm at S7 and 0.08ppm at S6[Table.1 and Figure.4, 5]. This shows that lead is generally toxic and it accumulates in kidney and

skeleton. Infact, children up to the age of 6 years and pregnant women are most susceptible to its adverse effects [12]. It is seen that all the samples has lead level above the WHO standard of 0.01ppm. This could be as a result of the use of leaded petrol in cars, generators and even some mechanic workshops around these areas especially battery chargers [13]. Lead contamination of the ground water may be the result of entry from industrial effluents, old plumbing, household sewages, agricultural run-off containing phosphatic fertilizers and human and animal excreta [14]. In addition to the symptoms found in acute lead exposure, symptoms of chronic lead exposure could be allergies, arthritis, hyperactivity, mood swings, nausea, numbness, lack of concentration, seizures and weight loss.

Chromium is present in small quantities in nature. It is maximum present in rocks than in those of silica type. The toxicity of chromium depends on its physico-chemical shape; hexavalent salts are considered the most dangerous [15]. During post monsoon and pre monsoon of 2011, its level is slightly less than the permissible limit [Table.2,3 and Figure.4]. The chromium level above the WHO limit could pose a threat to human health in these localities. The high level of chromium in these two samples could be due to the presence of chromium in varying concentrations in nearly all uncontaminated aquatic and terrestrial ecosystem. Also, the presence of chromium in soaps and detergents used for washing and bathing could be responsible for the high chromium level in the two samples [16]. The chromium level above the WHO limit could pose a threat to human health in these localities.

## CONCLUSION

The ground water quality assessment helps to identify the significant parameters of getting better information about source of pollution. From the obtained results it is evident that, at present the metal ion concentration is not at the levels which could be hazardous for humans. But still the study clearly points out that the concentrations of toxic metals like Pb, Cr, etc are present in slight excess in one or two stations that too in only one season. Even though, the condition is not very bad at present, there may be problems if the same continues in future and the ground water source will be completely polluted and become unfit for drinking and other purpose. Hence, this is high time to preserve and protect this precious resource. For this, precautionary measures should be immediately taken to avoid the consequences.

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