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Heavy Metal Contamination of Ground Water Near South Bank Canal between Karur and Tiruchirappalli Districts, Tamil Nadu, India

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ABSTRACT

This paper ardently deals with the heavy metal contamination of ground water near south bank canal between Karur and Tirichirappalli districts of Tamil Nadu, India. The heavy metal contaminations around these areas are analyzed according to the guidelines provided by WHO. The south bank canal is starting from Mayanur and ends at Pettavaithalai. This area is located in between Karur and Tirichirappalli which is in central part of Tamil Nadu state. There are few industries in the vicinity now and many more shall come up in near future. There are many stations where surface, sub surface and ground water are threatened by the existing industries. Two surface water and twenty two groundwater samples were collected near south bank canal area in monsoon, post monsoon and pre monsoon seasons over a period from August 2010 to June 2011. The heavy metal analysis results shows that towards right to canal water are highly contaminated compared to stations towards left of canal water. The water quality assessment is an attempt to provide a comprehensive guide to interpret, the industrial activities around this area. Municipal contaminating activities and hydro geological characteristics are also other contaminating sources.

Keywords: Surface waters and Ground waters, Heavy metal contaminations, seasonal variations.

INTRODUCTION

Heavy metal contamination of groundwater more often goes unnoticed and remains hidden from the public view. Presently, it has raised wide spread concerns in different parts of the world and results reported by various agencies have been alarming [1], [2].There is also evidence for the prevailing heavy metal contamination of groundwater in many areas of India[3-5]. Cadmium is today regarded as the most serious contaminant of the modern age. Toxic effects of trace heavy metals such as Cd, Pb, and Hg etc to man, other animals and organisms are well known. This category of metals is not required by man even in small amounts .Although some of the heavy metals such as Zn, Mn, Ni, and Cu act as micronutrient at lower concentrations, they become toxic at higher concentrations. Chromium is classified as a priority pollutant because of its adverse health effects. Manganese is most often a concern for systems that use a groundwater source. Zinc is an essential element and is generally considered to be non-toxic below 3.0 ppm.

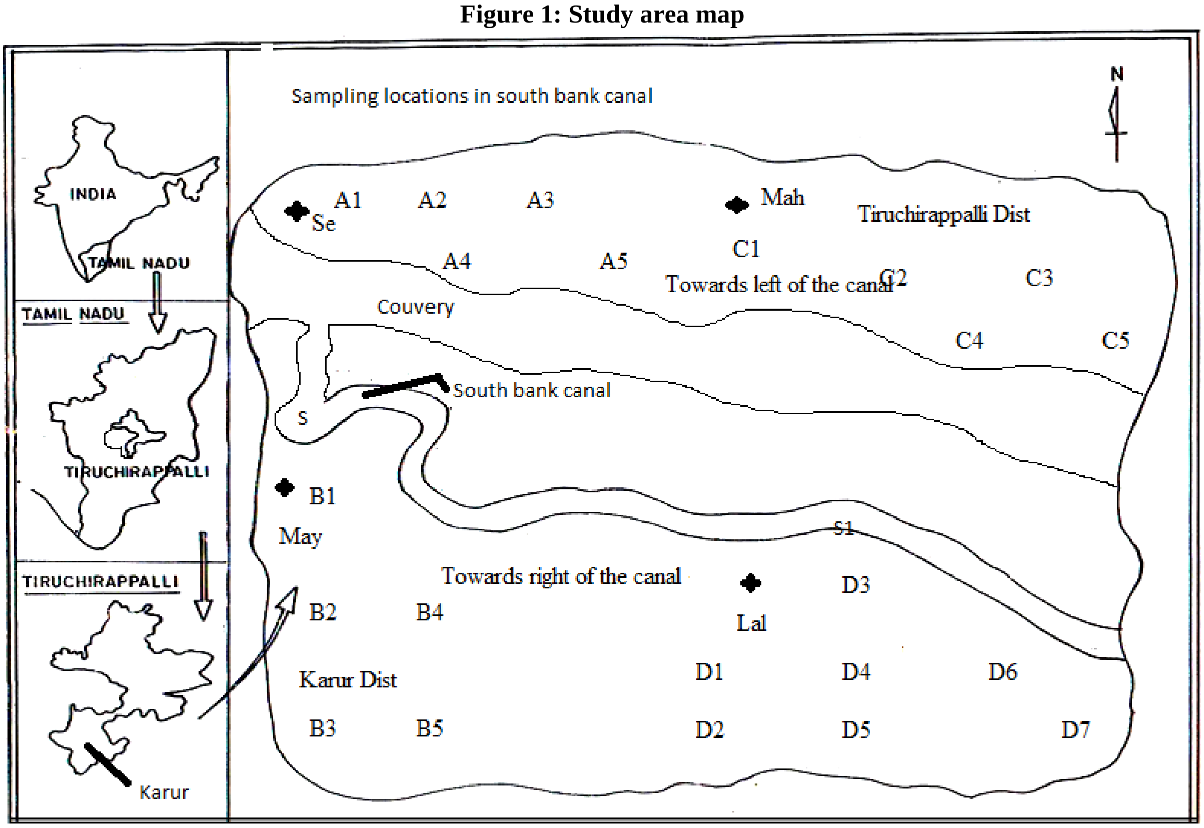
The discharge of large quantities of toxic metals into the air, water and soils inevitably results in the transfer of pollutant metals to the human food chain [6].Thus, the ground water quality has been universally recognized as the quality of ground water which cannot be restored once it is contaminated just by stopping the flow of pollutants from the source. The presence of heavy metals such as Pb and Cd in the environment has been a source of worry to environmentalists, government agencies and health practitioners and this is mainly due to their health implications since they are non-essential metal and of no benefit to human [7]. Nickel is a commonly occurring toxic metal in natural ecosystems due to the effluents of refineries electroplating, casting industries storage batteries and nickel plating plants. Nickel is widely used in electroplating industry as a protective coating for iron and steel and in alloys with other metals [8].

There are many different situations where water qualities are threatened by the existing industries in this area. There is a textile industry, a spinning mill, and one sugar industry that are located around this area. The waste water disposed by these industries, which in turn contaminate surface and groundwater contain hazardous elements such as cadmium, chromium, lead, nickel and manganese in more than the maximum limits as prescribed by WHO [9]. These parameters are controlled by the volume and flux of water in the system, which in turn depend on climate, topography and hydraulic conductivity. In the present study the groundwater contamination of metals with respect to cadmium, manganese, zinc and copper in the near south bank canal between Karur and Tirichirappalli districts has been thoroughly examined.

Topography

The south bank canal is a branch of river Cauvery. South bank canal is starting from Mayanur and the water has been distributed to the surrounding villages over 50 km spreading over 300 hectares. Mayanur is located in Krishnarayapuram taluk of Karur District. The Mayanur area is located in the north eastern extreme of Tamil Nadu state lying between 10°56′00’’ north and 78°14′00’’ east latitudes.

Figure 1: Study area map



Se-Seelapillayarputhur, Mah-Mahendramangalam, May-Mayanur, Lal-Lalapet

MATERIALS AND METHODS

Ground water samples were collected in clean and sterile one liter polythene cans. Samples were protected from direct sun light during transportation to the laboratory and metals were analyzed as per the standard procedures [10] by using atomic absorption spectrometer (Perkin Elmer, model 2380). The instrument was used in the limit of précised accuracy and chemicals used were of analytical grade. Double-distilled water was used for all purposes.

Particularly seven metals were analyzed in these ground water samples i.e. Manganese, cadmium, chromium, nickel, zinc, copper and lead. One surface water and twenty two groundwater samples were collected from stations towards left and right of south bank canal in three different seasons viz., monsoon(August 2010),post monsoon (November 2010) and pre monsoon (May 2011).

Table 1. Water sampling locations and sources

S No	Sampling Station	Source
S	Starting Point of Mayanur	Surface water from canal
A1	Towards left to surface water(S) Seelapillayarputhur	Bore Well
A2	Towards left from surface water(S)	Bore Well
A3	Towards left from surface water(S)	Bore Well
A4	Towards left from surface water(S)	Bore Well
A5	Towards left from surface water(S)	Bore Well
B1	Towards right from surface water(S) Mayanur	Bore Well
B2	Towards right from surface water(S)	Bore Well
B3	Towards right from surface water(S)	Bore Well
B4	Towards right from surface water(S)	Bore Well
B5	Towards right from surface water(S)	Bore Well
S1	Sampling from Lalapet	Surface water from canal
C1	Towards left from surface water(S_1) Mahendramangalam	Bore Well
C2	Towards left from surface water(S_1)	Bore Well
C3	Towards left from surface water(S_1)	Bore Well
C4	Towards left from surface water(S_1)	Bore Well
C5	Towards right from surface water(S_1)	Bore Well
D1	Towards right from surface water(S_1)	Bore Well
D2	Towards right from surface water(S_1)	Bore Well
D3	Towards right from surface water(S_1)	Bore Well
D4	Towards right from surface water(S_1)	Bore Well
D5	Towards right from surface water(S_1)	Bore Well
D6	Towards right from surface water(S_1)	Bore Well
D7	Towards right from surface water(S_1)	Bore Well

RESULTS AND DISCUSSION

The heavy metals such as Cd, Mn, Cr, Cu, Zn, Ni &Pb were analyzed for two canal water samples and 22 sampling stations towards right and left side of canal water of the study area and the datas are given in table 1.The mean heavy metal distribution pattern in groundwater towards left and right side of the south bank canal were tabulated separately in the table 2, 3,4,5,6 and 7 respectively. Variations in the mean heavy metal of different sampling stations at three different seasons were graphically represented in figures 2, 3,4,5,6 &7.

In most of the samples under investigation, the cadmium content was much above the permissible limit of 0.003ppm as set by WHO [9].Above the permissible limit it can potentially cause nausea, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure along with liver and bone damage from a life time exposure. The mean value is high (0.01 ppm – 0.08 ppm) in three seasons for all sampling sites. Cadmium is present as an impurity in several products, including phosphate fertilizers and detergents. The cadmium contamination of groundwater in the area should be accorded maximum attention due to the above mentioned adverse effects.

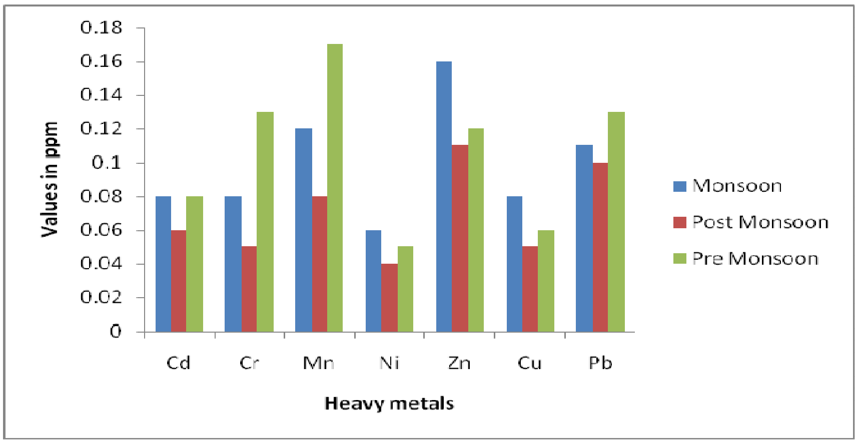
Manganese is naturally occurring in many surface and ground water sources and in soils that may erode into these waters. However, human activities are also responsible for much of the manganese contamination in water. Manganese at concentrations above 0.38 ppm stains laundry and plumbing fixtures as well as produces undesirable taste in drinks. The WHO [9] limit for manganese in drinking water is 0.4ppm. It is observed that all samples under observation contains manganese either at toxic or alert level (0.40 ppm – 0.63 ppm) except canal water S & S1. Farmers used the pesticides frequently against pests,which automatically rises the manganese content of groundwater around this area and hence needs proper attention. The mean values are high in monsoon (0.12 ppm – 0.56 ppm) which is much greater than post monsoon (0.07 ppm-0.60 ppm) and pre monsoon (0.07 ppm – 0.60 ppm) seasons.

The permissible limit for nickel in drinking water is 0.02 ppm. The distribution of nickel in groundwater of the study area is found to be above the permissible limit of WHO[9] with an average of 0.039ppm.In all samples nickel concentration is slightly high (0.01 ppm – 0.06 ppm).Only samples collected from stations towards right of S_1 shows below permissible limit (0.01 ppm). Nickel is directly emitted from various industries through discharge in to the surface waters. Nowadays people are using increasingly the nickel-cadmium batteries. Although the groundwater of the study area is by and large safe with regard to nickel as may be seen from the chart, its distribution is still not uniform in the area.

Table 2: **Seasonal variations of mean values of heavy metal concentration in canal water**

Seasons	Mean Heavy Metal Concentration (ppm)						
	Cd	Cr	Mn	Ni	Zn	Cu	Pb
Monsoon	0.08	0.08	0.12	0.06	0.16	0.08	0.11
Post Monsoon	0.06	0.05	0.08	0.04	0.11	0.05	0.10
Pre Monsoon	0.08	0.13	0.17	0.05	0.12	0.06	0.13

Figure 2: **Variations in mean values of heavy metal concentration in canal water at different seasons**



The permissible limit of chromium in drinking water is 0.05 ppm. chromium concentration is above the limit in all water samples (0.02 ppm -- 0.13 ppm).The mean value is high for all seasons i.e. ., monsoon (0.04 ppm – 0.09 ppm), post monsoon(0.02 ppm – 0.07 ppm) and pre monsoon (0.02 ppm – 0.13 ppm). Chromium occurs naturally in many vegetables, fruits, meats, grains and yeast and is also generally produced by industrial processes in these areas.

In monsoon season the lead concentration is high in many samples. The lead contents were much above the guideline value of 0.01ppm as set by WHO [9]. These values are gradually increases from monsoon to post monsoon and at the same time shows a decrease in pre monsoon. Exposure to lead causes a variety of health effects especially in children. Since the lead contamination of the ground water source is high in the study area, maximum attentions is accorded. The mean values of copper and zinc are below the permissible limit in all the stations.

Table 3: **Seasonal variations of mean values of heavy metal concentration collected from different sampling stations towards left of canal water**

Seasons	Mean Heavy Metal Concentration (ppm)						
	Cd	Cr	Mn	Ni	Zn	Cu	Pb
Monsoon	0.04	0.08	0.56	0.04	0.41	0.21	0.02
Post Monsoon	0.02	0.04	0.37	0.02	0.37	0.12	0.01
Pre Monsoon	0.01	0.06	0.55	0.03	0.43	0.20	0.02

Figure 3: **Variations in mean values of heavy metal concentration collected from different sampling stations towards left of canal water in different seasons**

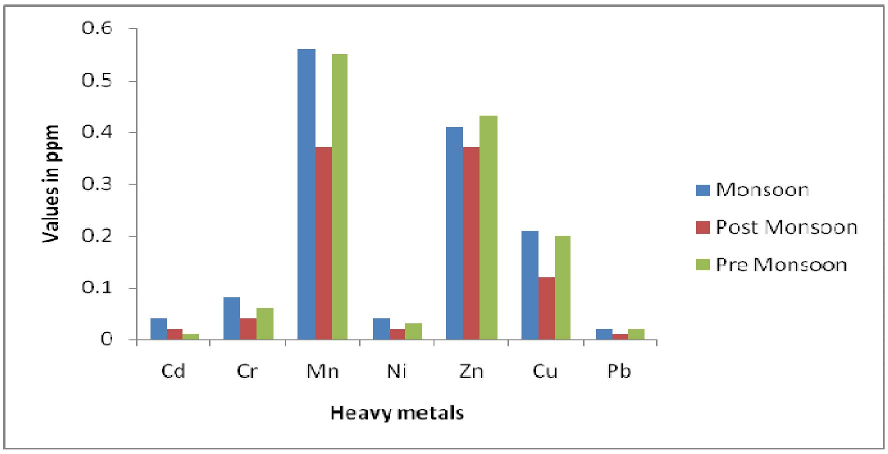


Table 4: **Seasonal variations of mean values of heavy metal concentration collected from different sampling stations towards right of canal water**

Seasons	Mean Heavy Metal Concentration (ppm)						
	Cd	Cr	Mn	Ni	Zn	Cu	Pb
Monsoon	0.05	0.04	0.55	0.04	0.41	0.15	0.03
Post Monsoon	0.03	0.04	0.63	0.02	0.30	0.10	0.03
Pre Monsoon	0.04	0.03	0.60	0.03	0.32	0.15	0.03

Figure 4: **Variations in mean values of heavy metal concentration collected from different sampling stations towards right of canal water in different seasons**

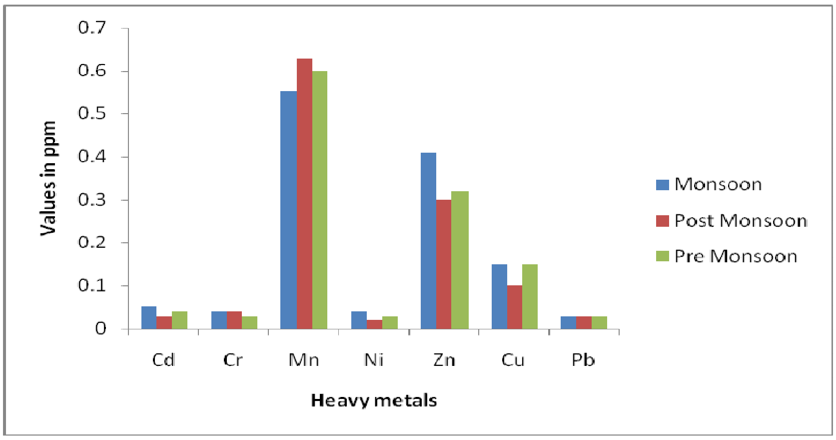


Table 5: **Seasonal variations of mean values of heavy metal concentration collected from canal water**

Seasons	Mean Heavy Metal Concentration (ppm)						
	Cd	Cr	Mn	Ni	Zn	Cu	Pb
Monsoon	0.08	0.08	0.12	0.06	0.16	0.08	0.11
Post Monsoon	0.05	0.05	0.05	0.04	0.08	0.04	0.08
Pre Monsoon	0.06	0.07	0.07	0.06	0.07	0.05	0.09

Figure 5: **Variations in mean values of heavy metal concentration collected from canal water in different seasons**

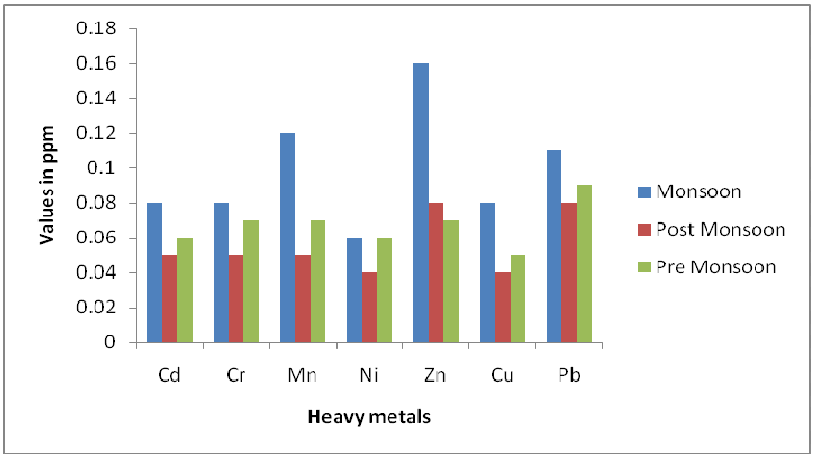


Table 6: **Seasonal variations of mean values of heavy metal concentration collected from different sampling stations towards left of canal water**

Seasons	Mean Heavy Metal Concentration (ppm)						
	Cd	Cr	Mn	Ni	Zn	Cu	Pb
Monsoon	0.03	0.09	0.38	0.05	0.05	0.02	0.02
Post Monsoon	0.03	0.07	0.43	0.03	0.03	0.01	0.01
Pre Monsoon	0.02	0.07	0.32	0.02	0.04	0.01	0.01

Figure 6: **Variations in mean values of heavy metal concentration collected from different sampling stations towards left of canal water in different seasons**

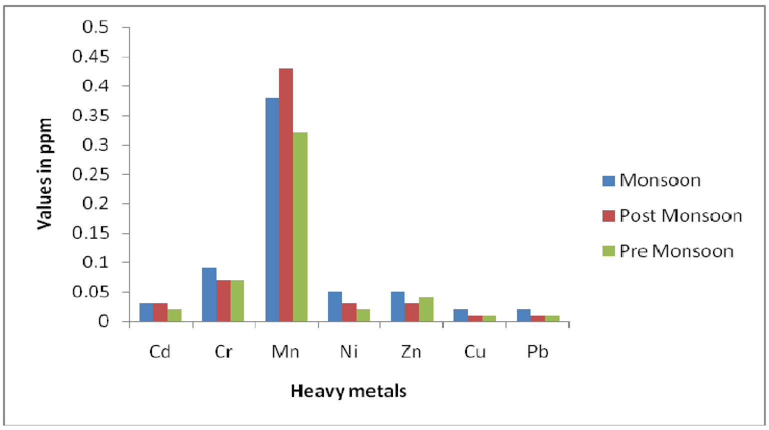
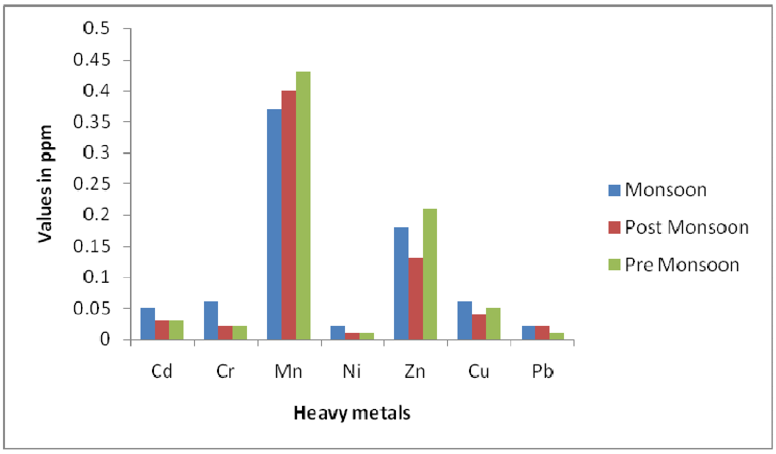


Table 7: Seasonal variations of mean values of heavy metal concentration collected from different Sampling stations towards right of canal water

Seasons	Mean Heavy Metal Concentration (ppm)						
	Cd	Cr	Mn	Ni	Zn	Cu	Pb
Monsoon	0.05	0.06	0.37	0.02	0.18	0.06	0.02
Post Monsoon	0.03	0.02	0.40	0.01	0.13	0.04	0.02
Pre Monsoon	0.03	0.02	0.43	0.01	0.21	0.05	0.01

Figure 7: Variations in mean values of heavy metal concentration collected from different sampling stations towards right of canal water in different seasons



CONCLUSION

The observations on Cd, Mn, Cr, Pb, Cu, Zn and Ni in groundwater near south bank canal between Karur and Tiruchirappalli districts, Tamil Nadu showed the presence of toxic metals in slightly excess level. In monsoon season the heavy metal content is high in all samples. It is observed that the groundwater of this area is highly contaminated with cadmium. A sizeable number of groundwater samples contain manganese at an alert level. The concentrations of lead and nickel in the groundwater of the area are either low or moderate and within the guideline values of WHO: Keeping in view of the unusually high concentrations of the harmful metals, *viz*. cadmium, lead and manganese, it is advisable to test the potability of groundwater of the area before using it for drinking. This study therefore, recommends that the well water should be purified before human consumption.

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