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Heavy Metal Concentrations in Ground water: An Analytical Study of Coastal Taluks in Tiruvallur District - Tamilnadu

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Abstract: ***A massive environmental pressure has been imposed upon the water resources of the coastal Taluks in Tiruvallur District, in Northern Tamilnadu, because of rapid industrialization and the consequent solid waste from several industries, especially from the chemical industries. The drinking water quality standards have been jeopardized at large, owing to an expansion in human society. One of the critical issues faced by metropolitan cities of developing countries, is the groundwater pollution due to the presence of high toxic chemical contents, which is an aftermath of industrial effluents being dumped into water bodies. Coastal Taluks in Tiruvallur District are surrounded by various industries, resulting in many water issues. Heavy metal concentration in the groundwater of Ponneri and Tiruvottiyur Taluks were analyzed to assess the acquisition process. On the whole, a total of 37 groundwater samples were collected, in order to evaluate the heavy metal concentration in groundwater. Using atomic absorption spectrophotometry (AAS), heavy metals such as Fe, Ni, and Cr were assessed in the groundwater samples. From this analytical study, it is revealed that the anthropogenic activities are the prime source for biodegradable toxic metals in the ground water of Tiruvallur coastal zone.***

Keywords: Heavy Metals, Ground water, Spatial Distribution, BIS Guidelines and Coastal Taluks

I. INTRODUCTION

In industrial areas, ground water and soil contamination are of great concerns (Hussain et al. 2014). Anthropogenic inputs contribute to the presence of heavy metals in ground water. Industrialization and agricultural activities such as atmospheric deposition, waste disposal, waste incineration, urban effluent, fertilizer application and long terms application of sewage, sludge in river (Bilos et al, 2001' Koch et al., 2001) are the main reasons for groundwater contamination. After the industrial revolution, point sources from mining, municipal waste, industries and non-point sources from both agriculture and urban storm water runoff have collected in the water bodies. The extreme use of pesticides and fertilizers are dangerous to human life, as the agrochemical heavy metals in them, break down, get infused into the water system through leaching, and eventually get accumulated in soils (Nicholson et al. 2003; Wong et al. 2003). Heavy metals, being toxic in nature, are affecting plant growth. Heavy metals such as lead, arsenic, selenium, cadmium, copper, zinc, uranium, mercury and nickel pose threat to all organisms, as serious health hazards are caused due to the dispersion of these contaminants into the food chain. Thus, it is essential to protect the groundwater as well as the soil and to make them free of heavy metal contamination (Hussain et.al.2014).

II. STUDY AREA

Tiruvallur district is one of the administrative districts in Tamil Nadu and is a blend of both urban and rural characteristics. Due to the extension of Chennai Boundary limit, The Eastern and Southern part of Tiruvallur district is dominated by urban features. The culture of Andhra Pradesh heavily influences the northern part of the district as it shares it's boundary with Nellore District, Andhra Pradesh. Tiruvallur district has a total of 13 taluks out of which only two taluks in the coastal regions are being studied for the research. Ponneri taluk is a taluk of Tiruvallur district of the Indian state of Tamil Nadu. As per census of 2011, the taluk of Ponneri had a population of 385,620 with 193,043 males and 192,577 females. Tiruvottiyur Taluk, is located at 13.16°N 80.3°E. It is an esplanade located on the shores of Bay of Bengal (Figure 1).

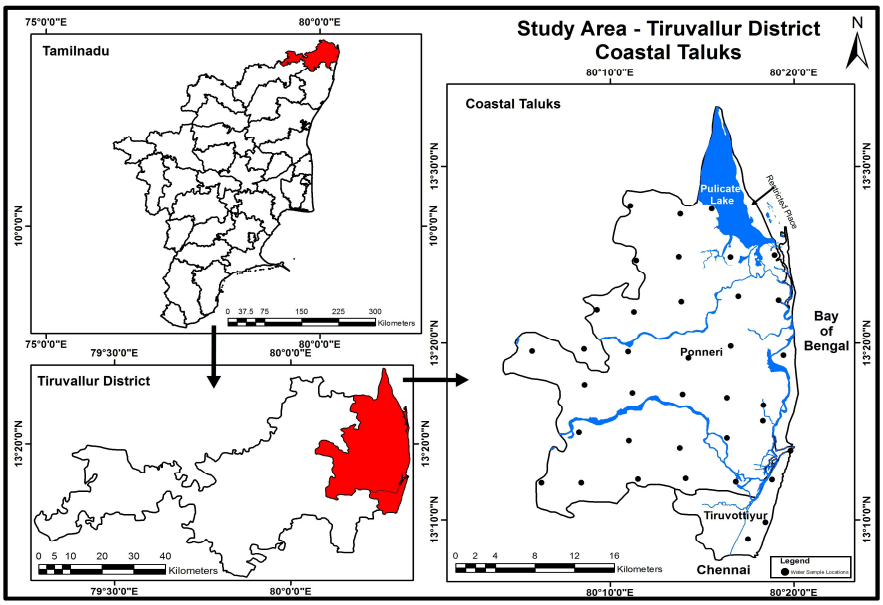

Figure 1: Study Area – Ponneri and Tiruvottiyur Taluks

III. MATERIALS & METHODS

Water samples were collected from bore wells, open wells and Handpumps, in clear acid-washed polyethylene bottles. Total 37 groundwater samples were collected (Figure 2) for examining the heavy metals such as Chromium, Nickel and Iron. GIS interpretation techniques were used to show the spatial variation of regions ground water was affected. The Water quality analysis was studied using BIS 2012 standards. The data was collected in the year 2017.

S.No	Parameters	Acceptable Limit (Mg/l)	Permissible Limit
1	Chromium	0.05	No relaxation
2	Nickel	0.02	No relaxation
3	Iron	0.3	No relaxation

Table No 1: BIS 2012 Chemical Concentration

Figure 2: Water Sample Collection , Industrial Region with polluted Environment and Leakage of Chemicals from an Industrial Plant

IV. RESULTS AND DISCUSSION

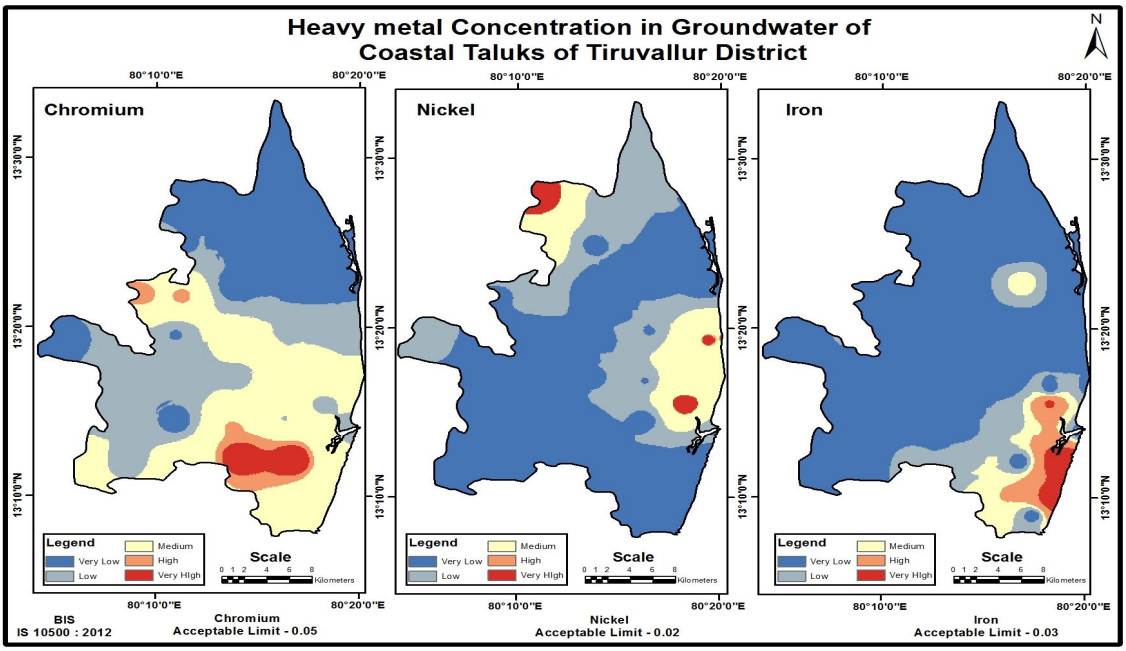

Figure 3: Spatial Interpretation of Heavy Metals

A. Iron (Fe)

Iron is an essential element in human nutrition. The WHO (WHO, 2004) states that values of iron up to 2 mg/l (10 times the parametric value) do not present a hazard to health. But excess iron in groundwater compromises its quality and will be deemed unfit for any kind of domestic usage. Presence of iron can be noticed through a change in the colour of groundwater and higher concentration of iron will lead to astringent, bitter inky taste of the water. Encrusting of water supply pipes due to scaling, fixtures plumbing, discoloring of the clothes are the other symptoms of iron contamination (Jain et al., 2010). Major sources of iron contamination in groundwater are the Non-treated waste effluents from steel industry as they have alloys containing iron as constituent (European Commission Report, 2002). Iron may be released in groundwater as results of various reduction oxidations, ion-exchange-physico-chemical processes (Drever, 1997). Bureau of Indian Standard has standardized the desirable-permissible limit for Iron in drinking water as 0.3 and 1.0 mg/l. Violation of the permissible level were recorded in 13.5% of the collected samples. In the study area, the minimum and maximum concentrations of Iron (Fig 3) were 0.002 to 0.917 mg/l, with an average of 0.109 mg/l, respectively, while the maximum allowable limit for Iron as per BIS guidelines is 0.3 mg/L. The maximum concentration of iron was recorded at Ennore Burma Nagar (9.17 mg/l) followed by Chellapa Nagar (8.14 mg/l), while lowest iron concentration was found at Ooplibedu (0.002mg/l).

B. Chromium (Cr)

Chromium is an essential industrial metal that is used in varied merchandises and processes. Chromium is a key trace element involved in stimulation of enzymes, peripheral action of insulin, lipid metabolism and possibly in the stabilization of nucleic acids (Anderson et al., 1983, Anderson et al., 1998, Vincent et al., 2000). Chromium is used in the manufacture of alloys, corrosion inhibitory paints, wood preservatives, fixatives for dyes and tanning, photographic sensitizers and as anticorrosive in cooking systems and boilers (Cotman et al., 2004). Chromium contamination usually occurs via poor storage, leakage or incorrect disposal methods. High concentrations of chromium are toxic and carcinogenic. It enters the body when people breathe, eat or drink, with certain Cr (IV) compounds particularly affecting the lungs of humans.

Bureau of Indian Standard (Table 1) has standardized the desirable-permissible limit for Chromium in drinking water as 0.05mg/l. In the present study, the concentration of Chromium (Fig 3) ranges from 0.001 mg/l to 0.09 mg/l. Maximum concentrations of chromium were recorded at New Manali Town (0.09 mg/l) and Vichoor (0.082 mg/l), while minimum concentrations at Telugu Colony (0.001 mg/l). Violation of the permissible level were recorded in 16% of the collected samples. Analysis showed high

concentration in the study area which are results of the anthropogenic input from the nearby manufacturing and processing industries.

C. Nickel (NI)

For several animal species, micro-organisms and plants, Nickel is essential for survival. Nickel concentration depends on the source, treatment and containers of water. Nickel contamination occurs due to the process of leaching of metals through water systems, from pipes used in plumbing. Also, nickel concentration is growing in some areas through activities such as mining, phosphate fertilizers and pesticides, sewage and burning of fossil fuels. Nickel easily makes its way into the ground water table, through these ways. This leads to severe skin allergies, resulting in rashes and abrasions. BIS 2012 (Table 1), has set the acceptable limit of nickel in drinking water as 0.02 mg/L. In the study area, the concentrations of Nickel (Fig 3) varied from 0.001 to 0.03 mg/l. The maximum concentration of Nickel was recorded at Arasur & Telugu colony (0.03 mg/l) followed by Attipattu Pudu Nagar (0.021) mg/l), while lowest iron concentration was found at Pazhaverkadu (0.001mg/l). Violation of the permissible level were recorded in 13% of the collected samples.

V. CONCLUSION

The collected data when analyzed, revealed that heavy metals such as Iron, Chromium and Nickel were found near the coastal areas and majority of the sample points are below the permissible limit. Chromium (Cr) recorded the highest, while Iron (Fe) and Nickel had the least concentration. Majority of heavy metal concentrations are below acceptable limit and the region near the harbor area and the southern part of taluks has high concentrations of heavy metals. This analytical study of the water samples reveals that the ground water is contaminated the most, at specific points deeming them unfit for drinking and for other domestic purposes, as the rate of concentration of heavy metals is alarming; the major source of Cr, Ni and Fe pollution is the interference of anthropogenic activities such as dumping of municipal solid waste and sewage from nearby towns/habitations, agricultural runoff, dumping of non-treated industrial effluents, encroachment of water bodies and native soil erosion, which result in degradation of the quality of the ground water. It can be concluded that rapid population growth and industrialization have brought about resource degradation and a decline in environmental quality.

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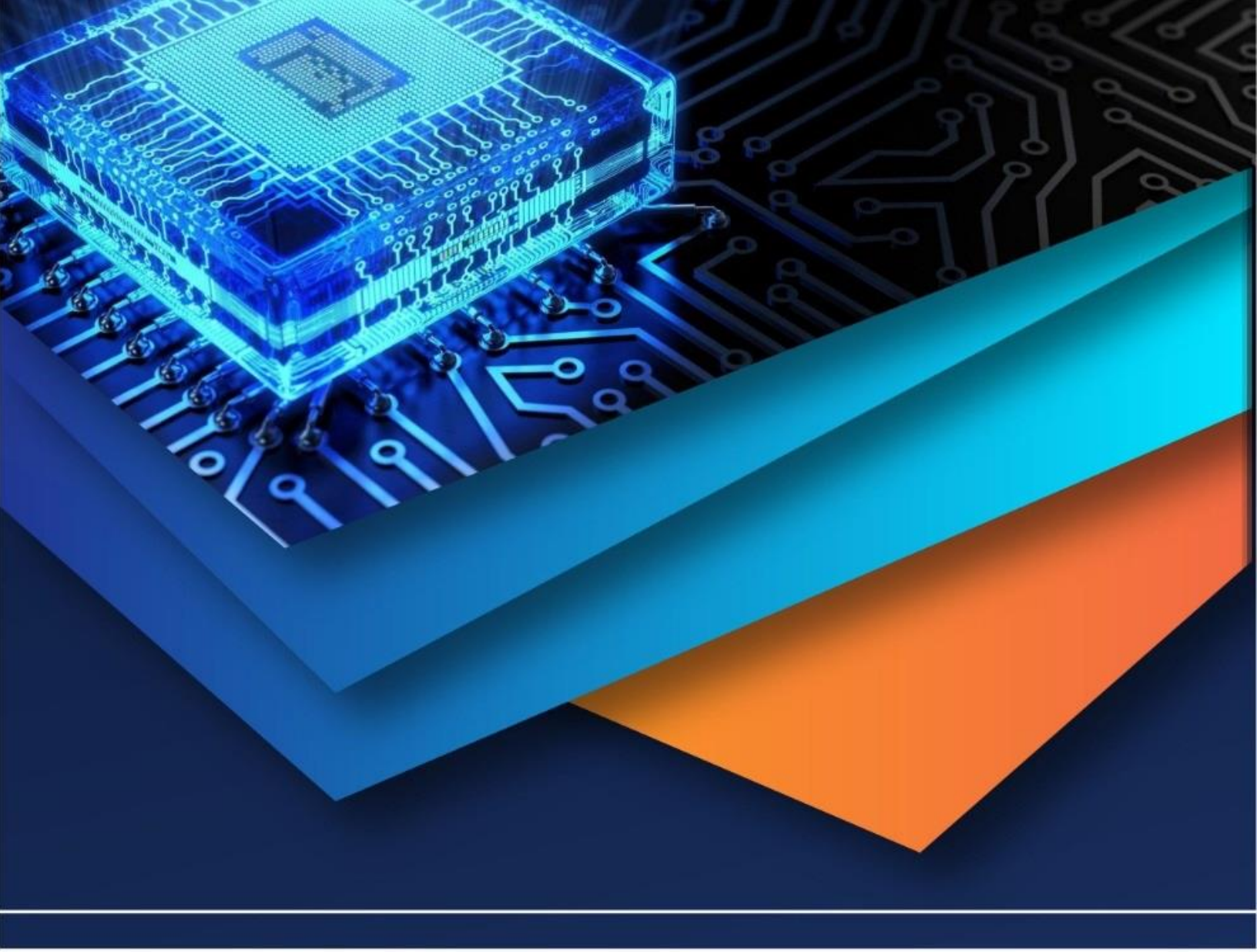

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