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**Research Article**

# STUDY OF TRACE METALS CONCENTRATIONS IN GROUNDWATER OF DINDIGUL TOWN, TAMILNADU, INDIA

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**ABSTRACT**

The aim of the present study was to assess the concentration of heavy metal in the groundwater samples in and around Dindigul town in summer and rainy seasons. Dindigul is situated in the southwest of the Chennai. Dindigul town does not have underground drainage system. The study area is facing the problem of water pollution because of various industries. Tanneries are thickly situated in and around Dindigul town. Forty groundwater samples were collected and subjected to heavy metal analysis. The results were compared with WHO standard. The result revealed that the mean concentration of Cu, Fe, Cr, Pb and Cd are within the permissible limit of WHO in most of the groundwater sampling stations in summer and rainy seasons. The mean concentration value of Zn and Mn exceed the permissible limit of WHO in most of the sampling stations. The groundwater samples were more polluted beside industrial area. The high level of chromium in some station is due to the discharge of effluents and solid wastes from tannery industries.



## INTRODUCTION

Water is one of the most important commodities which man has exploited than any other resources for the sustenance of his life (Megha Rai, 2017). Groundwater is a natural precious resource that sustains the basic needs of all living creatures. Groundwater serves as a vital source for domestic, agricultural and industrial uses. Urbanization, industrial activities and agricultural practices are major sources of ground water contamination. In India, almost 70% of the water has become polluted due to the discharge of domestic sewage and industrial effluents into natural water sources (Imamuddin Ustad, 2017).
Municipal and industrial waste water discharge constitutes a constant polluting source (Singh, 2004). However the untreated/partially treated waste water may contain toxic compounds. Discharge from industries, mining, domestic and commercial areas enter the surface water body they get dissolved or lie suspended in water (Panda *et al*, 2006). Industries such as plating, ceramics, glass, mining, battery manufacturing and leaching from landfills are considered the main sources of heavy metals. Heavy metals impart vital role in water pollution when its concentration is beyond the permissible limit. Heavy metals are environmentally stable and non–biodegradable toxic to living being and tend to accumulate in plants and animals causing chronic adverse effect on human health. Hence the present study has been attempted to determine the concentration of heavy metals of groundwater in and around Dindigul town in summer and rainy seasons.

### *Study Area*

Dindigul town is located in the south state of Tamilnadu between 10° 18' to 10° 25' N latitude and 77° 56'to 78° 01' E longitude. It is the administrative headquarters of the Dindigul district. Dindigul is situated 420 km southwest of the state capital, Chennai covering an area of 14.01 $km^2$ and has an average elevation of 265 m (869 ft). Dindigul is located in the foothills of Sirumalai hills. The topography is plain and hilly with the variation resulting in climatic changes. The map of the study area is shown in Fig.1.

### *Sampling Stations*

S1. Central Bus Stand, S2. Dudley School, S3. Dindigul Government Hospital, S4. St. Mary's School, S5. East Govindapuram, S6. Dindigul Taluk Office, S7. Mariamman Kovil, S8. Begambur Mosque, S9. District Treasury Office, S10. Annamalai Mills Girls HSS, S11. Government Industrial Estate, S12. Railway Station, S14. MSP School, S15. St. Joseph Hospital, S16. Cauvery Water Tank, S17. Chatra Kulam, S18. West Ashok Nagar, S19. K.K Nagar, S20. Rockfort, S21. Paraipatti, S22. Poochinaickan Patti, S23.

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Bharathipuram, S24. Nehruji Nagar, S25. Anumand Nagar, 26. RR Pudur, S27. Koil Street, S28. Don Bosco Nagar, S29. Burma Colony, S30. Ganapathy Colony, S31. Santhai Road, S32. Guru Nagar, S33. Kuttiapatti Koil, S34. Malai Kovil, S35. Krishna Paper Mill, S36. Pillayarnatham, S37. Vatlagundu Bye Pass, S38. Harini Nagar, S39. Pudur and S40. Ponmandurai Road

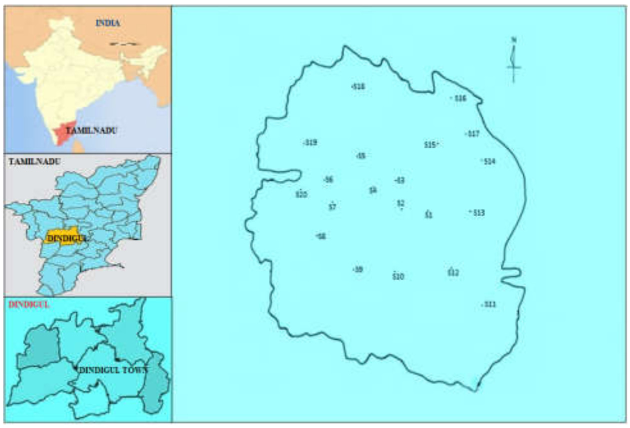


**Figure 1** Map of the study area

### *Sampling Collection and Analysis*

Forty groundwater samples were collected in and around Dindigul town, Tamilnadu, India for the present study. The sampling was done in summer and rainy seasons for three successive years (2012, 2013 and 2014). Groundwater samples were collected from bore well after discarding water for the first two minutes in 2 litre plastic container. Before collecting the sample, the containers were rinsed with distilled water and finally rinsed with the water sample to be collected. After that, the groundwater samples from different locations were sealed, labeled and then brought into the laboratory for detailed heavy metal analysis. All necessary precautions were taken during sampling and analysis. Preservatives such as conc. HCl and conc. $H_2SO_4$ were added to the samples. The collected groundwater samples were subjected to heavy metal analysis such as zinc, copper, iron, manganese, chromium, lead and cadmium. The standard methods of APHA adopted for analysis of heavy metals (APHA, 1998). The obtained results are compared with WHO standard of water quality parameters (WHO, 2011).

## RESULTS AND DISCUSSION

### *Zinc*

The mean values of zinc are recorded in the range of 0.1-4.4 mg/l and 0.2-4.6 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). The values of zinc are well within the permissible limit of 5 mg/l (WHO 2011) in all the groundwater sampling stations. The value of zinc is slightly higher at station S11, which may be due to percolation of domestic and industrial wastes (Abdul Jameel and Sirajudeen, 2006). During summer, depletion of groundwater may lead to higher concentrations of zinc (Mridul Buragohain, 2010). The concentrations of zinc beyond the permissible limit in water may create opalescent state and develop a greasy film on boiling (Shrivastava, 2010).

**Table 1** The mean values of trace metals concentration of groundwater samples during April 2012, 2013 and 2014

| Stations | Zn | Cu | Fe | Mn | Cr | Pb | Cd |
|---|---|---|---|---|---|---|---|
| S1 | 2.3 | 0.03 | 0.38 | 0.05 | 0.04 | 0.06 | 0.003 |
| S2 | 0.6 | 0.02 | 0.23 | 0.07 | 0.03 | 0.04 | 0.002 |
| S3 | 0.5 | 0.03 | 0.37 | 0.02 | 0.04 | 0.05 | 0.002 |
| S4 | 1.3 | 0.03 | 0.28 | 0.07 | 0.03 | 0.03 | 0.003 |
| S5 | 3.9 | 0.03 | 0.65 | 0.04 | 0.02 | 0.02 | 0.003 |
| S6 | 0.4 | 0.05 | 0.23 | 0.02 | 0.01 | 0.08 | 0.002 |
| S7 | 3.1 | 0.01 | 0.71 | 0.02 | 0.05 | 0.10 | 0.003 |
| S8 | 4.4 | 0.03 | 0.29 | 0.03 | 0.08 | 0.12 | 0.003 |
| S9 | 1.2 | 0.02 | 0.46 | 0.03 | 0.04 | 0.05 | 0.003 |
| S10 | 0.4 | 0.02 | 0.49 | 0.03 | 0.02 | 0.08 | 0.002 |
| S11 | 2.4 | 0.04 | 1.19 | 0.18 | 0.07 | 0.16 | 0.007 |
| S12 | 1.2 | 0.03 | 0.70 | 0.02 | 0.02 | 0.03 | 0.003 |
| S13 | 1.5 | 0.02 | 0.41 | 0.02 | 0.04 | 0.05 | 0.003 |
| S14 | 0.3 | 0.03 | 0.36 | 0.03 | 0.02 | 0.03 | 0.003 |
| S15 | 0.6 | 0.03 | 0.62 | 0.02 | 0.04 | 0.06 | 0.002 |
| S16 | 0.2 | 0.02 | 0.22 | 0.02 | 0.04 | 0.03 | 0.003 |
| S17 | 0.5 | 0.05 | 0.39 | 0.09 | 0.04 | 0.05 | 0.002 |
| S18 | 0.2 | 0.02 | 0.27 | 0.04 | 0.03 | 0.03 | 0.003 |
| S19 | 0.6 | 0.02 | 0.44 | 0.02 | 0.06 | 0.07 | 0.003 |
| S20 | 1.6 | 0.06 | 0.29 | 0.06 | 0.05 | 0.11 | 0.004 |
| S21 | 0.3 | 0.03 | 0.35 | 0.04 | 0.07 | 0.12 | 0.003 |
| S22 | 0.7 | 0.02 | 0.23 | 0.04 | 0.06 | 0.10 | 0.003 |
| S23 | 0.8 | 0.03 | 0.31 | 0.02 | 0.02 | 0.03 | 0.003 |
| S24 | 0.2 | 0.04 | 0.21 | 0.03 | 0.04 | 0.03 | 0.002 |
| S25 | 0.2 | 0.07 | 0.80 | 0.08 | 0.03 | 0.03 | 0.003 |
| S26 | 0.1 | 0.05 | 0.62 | 0.17 | 0.03 | 0.05 | 0.003 |
| S27 | 1.1 | 0.04 | 0.40 | 0.06 | 0.02 | 0.12 | 0.002 |
| S28 | 0.8 | 0.06 | 0.38 | 0.09 | 0.05 | 0.09 | 0.004 |
| S29 | 0.3 | 0.12 | 1.25 | 0.02 | 0.01 | 0.02 | 0.001 |
| S30 | 0.9 | 0.12 | 0.21 | 0.05 | 0.03 | 0.20 | 0.001 |
| S31 | 0.5 | 0.05 | 0.57 | 0.04 | 0.03 | 0.05 | 0.004 |
| S32 | 0.7 | 0.21 | 0.28 | 0.02 | 0.05 | 0.14 | 0.003 |
| S33 | 0.6 | 0.23 | 0.82 | 0.34 | 0.05 | 0.08 | 0.005 |
| S34 | 0.6 | 0.36 | 0.44 | 0.03 | 0.08 | 0.05 | 0.003 |
| S35 | 3.0 | 0.74 | 0.38 | 0.06 | 0.44 | 0.10 | 0.002 |
| S36 | 1.2 | 0.71 | 0.29 | 0.02 | 0.02 | 0.03 | 0.003 |
| S37 | 1.2 | 0.11 | 0.71 | 0.06 | 0.07 | 0.05 | 0.003 |
| S38 | 0.3 | 0.26 | 0.29 | 0.04 | 0.06 | 0.06 | 0.003 |
| S39 | 0.7 | 0.06 | 0.51 | 0.06 | 0.45 | 0.04 | 0.003 |
| S40 | 0.2 | 0.47 | 0.05 | 0.20 | 0.07 | 0.07 | 0.004 |

All the values are expressed in mg/l

**Table 20** The mean values of trace metals concentration of groundwater samples during December 2012, 2013 and 2014

| Stations | Zn | Cu | Fe | Mn | Cr | Pb | Cd |
|---|---|---|---|---|---|---|---|
| S1 | 1.5 | 0.03 | 0.22 | 0.05 | 0.03 | 0.03 | 0.002 |
| S2 | 0.6 | 0.04 | 0.28 | 0.06 | 0.02 | 0.02 | 0.002 |
| S3 | 0.3 | 0.02 | 0.29 | 0.02 | 0.03 | 0.01 | 0.002 |
| S4 | 1.1 | 0.05 | 0.26 | 0.11 | 0.02 | 0.02 | 0.002 |
| S5 | 3.3 | 0.03 | 0.24 | 0.07 | 0.02 | 0.02 | 0.003 |
| S6 | 0.2 | 0.08 | 0.15 | 0.04 | 0.02 | 0.03 | 0.002 |
| S7 | 2.2 | 0.04 | 0.51 | 0.03 | 0.04 | 0.01 | 0.002 |
| S8 | 3.5 | 0.02 | 0.26 | 0.02 | 0.07 | 0.02 | 0.002 |
| S9 | 0.8 | 0.03 | 0.41 | 0.04 | 0.03 | 0.03 | 0.002 |
| S10 | 0.3 | 0.05 | 0.29 | 0.06 | 0.02 | 0.02 | 0.001 |
| S11 | 4.6 | 1.73 | 0.89 | 0.13 | 0.05 | 0.02 | 0.003 |
| S12 | 1.1 | 0.04 | 0.61 | 0.03 | 0.03 | 0.03 | 0.002 |
| S13 | 1.2 | 0.03 | 0.30 | 0.03 | 0.04 | 0.02 | 0.001 |
| S14 | 0.3 | 0.02 | 0.28 | 0.04 | 0.01 | 0.03 | 0.003 |
| S15 | 0.5 | 0.06 | 0.30 | 0.03 | 0.04 | 0.01 | 0.002 |
| S16 | 0.2 | 0.02 | 0.22 | 0.05 | 0.03 | 0.02 | 0.002 |
| S17 | 0.5 | 0.06 | 0.28 | 0.07 | 0.04 | 0.03 | 0.002 |
| S18 | 0.2 | 0.03 | 0.29 | 0.03 | 0.02 | 0.03 | 0.002 |
| S19 | 0.3 | 0.04 | 0.27 | 0.02 | 0.03 | 0.03 | 0.003 |
| S20 | 1.4 | 0.04 | 0.23 | 0.09 | 0.05 | 0.02 | 0.002 |
| S21 | 0.3 | 0.11 | 0.37 | 0.03 | 0.05 | 0.02 | 0.002 |
| S22 | 0.4 | 0.04 | 0.26 | 0.08 | 0.04 | 0.03 | 0.002 |
| S23 | 0.4 | 0.02 | 0.26 | 0.02 | 0.03 | 0.02 | 0.001 |
| S24 | 0.3 | 0.06 | 0.22 | 0.02 | 0.03 | 0.02 | 0.002 |
| S25 | 2.9 | 0.12 | 0.33 | 0.08 | 0.03 | 0.03 | 0.003 |
| S26 | 0.3 | 0.06 | 0.26 | 0.06 | 0.02 | 0.02 | 0.001 |
| S27 | 2.4 | 0.08 | 0.79 | 0.05 | 0.02 | 0.02 | 0.002 |
| S28 | 0.6 | 0.10 | 0.27 | 0.07 | 0.04 | 0.01 | 0.002 |
| S29 | 2.1 | 0.17 | 0.67 | 0.03 | 0.04 | 0.02 | 0.003 |
| S30 | 0.6 | 0.11 | 0.21 | 0.07 | 0.04 | 0.03 | 0.004 |
| S31 | 1.7 | 0.09 | 0.24 | 0.03 | 0.04 | 0.03 | 0.003 |
| S32 | 0.5 | 0.20 | 0.30 | 0.02 | 0.05 | 0.02 | 0.003 |
| S33 | 0.5 | 0.23 | 0.19 | 0.09 | 0.29 | 0.02 | 0.002 |
| S34 | 0.5 | 0.33 | 0.14 | 0.05 | 0.03 | 0.03 | 0.002 |
| S35 | 2.6 | 0.52 | 0.38 | 0.04 | 0.18 | 0.02 | 0.003 |
| S36 | 1.3 | 0.70 | 0.26 | 0.02 | 0.06 | 0.03 | 0.002 |
| S37 | 0.3 | 0.18 | 0.23 | 0.06 | 0.08 | 0.01 | 0.003 |
| S38 | 0.2 | 0.21 | 0.29 | 0.04 | 0.06 | 0.02 | 0.003 |
| S39 | 0.5 | 0.12 | 0.28 | 0.04 | 0.27 | 0.01 | 0.001 |
| S40 | 0.3 | 0.12 | 0.25 | 0.03 | 0.16 | 0.01 | 0.002 |

All the values are expressed in mg/l

***Copper***

The mean values of copper are found to be in the range of 0.01-2.04 mg/l and 0.02-1.73 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). The copper values exceed the permissible limit of 0.05 mg/l (WHO 2011) at stations S20, S28S30 and S32-S40 in summer and S6, S11, S15, S17, S21, S24-S40 in rainy seasons. This may be due to anthropogenic influences (Subba Rao, 1993). The values of copper are higher in rainy than summer seasons. This may be due to the intrusion of domestic, industrial wastes and agricultural land run off.

***Iron***

The mean values of iron are recorded in the range of 0.05-1.25 mg/l and 0.14-0.89 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). The iron values exceed the permissible limit of 0.3 mg/l (WHO 2011) in most of the groundwater sampling stations in summer and rainy seasons. The maximum value of iron is recorded at station S29 in summer season. This may be due to disposal of scrap iron in open areas and industrial activities. Long time consumption of drinking water with high concentrations of iron can lead to liver diseases like hemosiderosis (Khadsan and Kadu, 2003).

***Manganese***

The mean value of manganese is found in the range of 0.02-0.34 mg/l and 0.02-0.13 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). The manganese values are well within the permissible limit of 0.5 mg/l (WHO 2011) in all the groundwater sampling stations. The manganese values are higher in rainy seasons which may be due to influence of rocks and intrusion of industrial effluents in the study area (Dash *et al*, 2016). Even though manganese is an essential micronutrient, its excess accumulation in humans results in neuronal disorders, bone diseases in babies, rheumatoid arthritis and diabetes (Abbasi, 1998).

***Chromium***

The mean values of chromium are found to be in the range of 0.01-0.45 mg/l and 0.01-0.29 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). The chromium values are within the permissible limit of 0.05 mg/l (WHO 2011) in most of the groundwater sampling stations except at stations S8, S11, S19, S21, S22, S33-S35, S37-S40 in summer and S8, S33, S35 and S37-S40 in rainy seasons. The high values of chromium may be due to seepage of industrial wastes, old plumbing wastes and household sewage (Aggarwal *et al*, 2000). The maximum value of chromium is recorded at station S39 in summer season. This may be due to the intrusion of tanning wastes. Chromium toxicity causes dermatitis, irritation with ulcers and other skin problems. In human, long term exposure of chromium causes lung cancer and severe respiratory problems (Towill, 1978).

***Lead***

The mean values of lead are recorded in the range of 0.01-0.08 mg/l and 0.01-0.03 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). In the present investigation, the values of lead are found within the permissible limit of 0.05 mg/l (WHO 2011) in most of the groundwater sampling stations. The slight variation of lead value is observed at stations S1, S6 - S8, S10, S11, S15, S19-S22, S27, S28, S30, S32, S33, S35 and S38 in summer. This may be due to the penetration of industrial wastes, household sewage, phosphate containing fertilizers, human and animal excreta Tiwari *et al*, 2013). The consumption of lead in higher quantities, may cause hearing loss, blood pressure and hypertension and eventually it may be proving to be fatal[16] (Tiwari *et al*, 2013).

***Cadmium***

In the present study, the mean values of cadmium are found to be in the range of 0.001-0.007 mg/l and 0.001-0.004 mg/l for the groundwater samples in summer and rainy seasons respectively (Table 1 & 2). The cadmium values are found within the permissible limit of 0.003mg/l (WHO 2011) in most of the groundwater sampling stations except at stations S11, S20, S28, S31, S33 and S40 in summer and S30 in rainy seasons. The high value of cadmium may be contributed from the impurity of fossil fuels, fertilizers and cement (Debajit Dutta and Hari, 2015).

## CONCLUSION

The present study provides significant information on the quality of groundwater with respect to heavy metals in and around Dindigul town. The result of heavy metal analysis reveals that the parameters such as Cu, Fe, Cr, Pb and Cd are within the permissible limit of WHO in most of the groundwater sampling stations in summer and rainy seasons. But the values of Zn and Mn exceed the permissible limit of WHO in most of the sampling stations in summer and rainy seasons. The high value of these two parameters is due to the discharge of industrial effluent and anthropogenic activities in the study area. High level of Cr contamination is noted at some sampling stations which are due to the intrusion of the effluent and solid waste discharged from tannery industry near the study area. The result suggests that the contamination of groundwater with heavy metal in groundwater samples require periodic monitoring of groundwater in the present study area.

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