Occurrence of Chromium and Copper in Groundwater Around Tanneries in Chromepet Area of Tamil Nadu

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Effluent resulting due to various processes from tanning industries may lead to groundwater pollution when they are disposed off without proper treatment. This study was carried out with the objective of studying the impact of effluent let out by these industries on groundwater quality in Chromepet area of Chennai, Tamil Nadu which is the home town of a number of small and large scale leather tanning industries. 36 samples were collected during March 2008 and the groundwater samples were analysed for the concentration of chromium and copper using atomic absorption spectrophotometer. About 86% of the groundwater samples possessed concentration of chromium above the permissible limit while 28% of the groundwater samples had copper concentration above the limits. Thus this study indicates the impact of effluent from tanning industries on the deterioration of groundwater quality in this area.

KEYWORD
Groundwater, Chromium, Copper, Tannery, Chromepet.

INTRODUCTION
Groundwater pollution is of major concern around the world as it is the easily available source of drinking water. As there has been a tremendous increase in the number of industries in the last few decades, a number of environmental problems have also been established. One of the problems is the pollution of water bodies, especially groundwater which is the only reliable source of drinking water. Tanneries are one among those industries which cause high pollution to groundwater as they use a wide range of chemicals, such as sodium chloride, sodium sulphate, chrome sulphate, vegetable oils, lime and dyes. A large quantity of water is also utilised by these industries for the tanning process. Of the 1,200 tanneries in India, Tamil Nadu accounts for more than 75% of these leather processing industries (Tamil Nadu Social Development Report, 2000). One of the major problems caused by these industries is high salinity. In addition there is also huge quantity of solid waste which results from the hides and skins. Since the solid waste is carelessly disposed off, it finds its way into the groundwater during the seasonal rain. It is established that a single tannery can cause the pollution of groundwater around the radius of 7–8 km (Bhaskaran, 1977; CLRI, 1990; Ansari et al., 1999). This study was carried with the aim of determining the concentration of heavy metals, such as chromium and copper and thereby assessing the present status of groundwater quality in this region.

Study area
The study was carried out in Chromepet area, Chennai (Figure 1) which is well known for tanneries. The area serves as a home town for lots of large scale and small scale tanning industries. Chrome tanning is the popular method practiced in this area and hence the place got its name as ‘Chrome’ pet. It is situated in the outskirts of Chennai city, Tamil Nadu. The study area is 13 km away from the Bay of Bengal. The climate of the area is with low humidity and high temperature. The temperature is around 20°C during winter and during summer has a maximum of 44°C. The southwest monsoon (May-
Sept) contributes nearly 40% of the annual rainfall and northeast monsoon (Oct-Dec) contributes more than 60% of the annual rainfall. The vegetation in this area is not much varied. Most of the study area consists of barren land and the land use pattern of this area is mainly of buildings, roads, schools, colleges and industries.

METHODOLOGY

Based on a well investigation survey 36 representative wells were chosen for collection of groundwater samples. The groundwater samples were collected from 24 dug wells and 12 bore wells (Figure 2) during the month of March 2008. Groundwater samples were collected in cleaned polythene bottles of 500 mL capacity. The sampling bottles were cleaned before sampling with detergent. They were then soaked in 10% nitric acid for one day followed by washing with distilled water. While collecting the samples, the bottles were washed twice with the groundwater to be sampled. After collecting, the samples were kept in a cool place away from sun light. Analysis of trace elements, such as chromium and copper was done using atomic absorption spectrophotometer (Varion Spectra 200).

RESULT AND DISCUSSION

The statistical summary of chromium and copper concentration analysed in this study is given in table 1. The concentration of chromium and copper obtained was compared with the BIS (1991) standards in order to understand the quality of groundwater in this area.

Chromium
Tannery effluents are mostly characterized by high salinity, high organic loading, and
Figure 2. Location of sampling wells in the study area

Figure 3. Spatial distribution of chromium (mg/L) in groundwater of the study area, in mg/L

specific pollutants, such as chromium (Tunay et al., 1999; Song et al., 2000). Chromium which is present in effluents is usually in the less toxic trivalent form, Cr (III). But when this effluent is discharged into the soil, due to varying environmental conditions, Cr (III) is oxidized to toxic hexavalent form, which seldom remains as Cr (VI) (Anderson, 1999; Govil et al., 2004; Gowd et al., 2005). This Cr (IV) is toxic to humans and also they are carcinogenic. The major source of chromium is the effluent from tanneries as they use chrome sulphate which is an essential chemical in the tanning process. The chromium concentration in the study area ranges from 0.01 to 0.99 mg/L. As per Indian standard specifications for drinking water, the required desirable limit for chromium is 0.05 mg/L. Out of the 36 groundwater samples analysed, only five samples (Figure 3) were within the prescribed range. The standard gives no relaxation for chromium concentration in drinking water. Therefore, 86.11% of the samples are above the limit thereby creating an awareness to take suitable steps in curtailing the excess chromium concentration in groundwater by properly treating the effluent from tanning industries before being let into public sewers.

Copper

Copper concentration was found to be very low in the study area, ranging from below detection limit to 0.18 mg/L. Majority of the
Table 1. Statistical summary of heavy metal concentration in groundwater samples, in mg/L

<table>
<thead>
<tr>
<th>Heavy metal</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>0.004</td>
<td>0.99</td>
<td>0.48</td>
<td>0.33</td>
</tr>
<tr>
<td>Copper</td>
<td>bd1</td>
<td>0.18</td>
<td>0.04</td>
<td>0.05</td>
</tr>
</tbody>
</table>

bdl - Below detection limit

samples analyzed (72.22%) were below the permissible limit of 0.05 mg/L (Figure 4) set by BIS (1991). Only 27.78% of groundwater samples were above the desirable limit. However, the same standard relaxes the concentration of copper upto 1.5 mg/L in cases when there is no alternate source. When considering 1.5 mg/L of copper as the maximum permissible limit in drinking water, all the samples were found to be below 1.5 mg/L, thus posing no significant environmental concern. Trace amounts of copper are required for the synthesis of hemoglobin and several human enzymes (Cohen, 1979). Whereas if high concentration of copper is consumed it may lead to neurological complications, hypertension, liver and kidney problems (Larocque and Rasmussen, 1998; Rao et al., 2001; Krishna and Govil, 2004).

CONCLUSION

The present study carried out to assess the impact of effluent from tanning industries on groundwater quality indicates that out of 36 samples, 86.11% of groundwater samples were above the standard limits of chromium prescribed for drinking purpose. Other heavy metal that was determined in groundwater samples is copper. The copper concentration was above the permissible limit of 0.05 mg/L in 27.78% of groundwater samples. Overall the groundwater in this area possesses chromium and copper concentration beyond desirable limits thereby making the groundwater not potable. High levels of these elements were observed in some groundwater samples collected from sampling wells located very close to tannery industries, which indicate the impact effluent from the tanning industries which are let onto land and sewerage systems without proper treatment. Therefore, steps should be taken to improve the groundwater quality in this area by treating the tannery wastes by proper methods before disposing.

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