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Metal Concentration of Water of Amaravathi and Thirumoorthy Reservoirs in Tamil Nadu, India

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ABSTRACT

Reservoirs are the major source of water supply in many localities for meeting the water demand of the people, and hence it is important to monitor the metal concentration of the water stored in such reservoirs for the benefit of the people in terms of drinking water and irrigation. The main objective of this study is to monitor the metal concentrations of Arsenic (As), Boron (B), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Nickel (Ni), Lead (Pb), Selenium (Se), and Zinc (Zn) in the water of the Amaravathi and Thirumoorthy reservoirs located in the Tiruppur district of the state of Tamil Nadu, India. Results indicate that the water collected from the Thirumoorthy reservoir is free from metal contamination while that from the Amaravathi reservoir has a marginal contamination of Fe concentration. Thus, the water stored in these reservoirs is suitable for drinking and irrigation purpose.

INTRODUCTION

Surface water is one of the major sources of water supply used to meet the overall demand of the urban and rural population. Sources of water supply such as rivers, lakes, reservoirs, and groundwater are being directly or indirectly being polluted due to rapid industrialization as well as urbanization. Discharges from the municipal and industrial wastewaters are the main sources of water pollution since they contain organic pollutants, chemicals, metals (Goldar & Banerjee 2004). Metal pollution of water bodies is highly dangerous because of its toxicity, bioaccumulation, biomagnification of the food chain, prolonged persistence, and thus considered to be a worldwide problem. The metal concentration in aquatic ecosystems is generally monitored based on their concentrations in water and sediment samples (Ebrahimpour & Mushrifah 2008). Metal pollution in water bodies can severely affect the biotic communities (Badantoni et al. 2004). Moreover, the metal pollution also affects the health of human beings and disturbs the balance of the ecosystem, and social and economic development of the society (Milovanovic 2007). It is very essential to monitor the quality of the water resources keeping in view of the impact of human activities on the degradation of the water quality (Mansouri et al. 2011). The assessment of the water quality also plays a major role in developing an appropriate water quality management plan for a locality in order to reduce the effects of water pollution (Sanchez et al. 2007).

Several studies have been conducted in the past to illustrate the significance of monitoring the metal concentrations in the water bodies and sediments of various water sources. Rajaei et al. (2012) analysed the metal concentrations in the water of Chah Nimeh reservoirs in Zabol, Iran. They concluded that there were significant differences between Cr, Ni, Pb and Se in the water of Chah Nimeh reservoir. Hussein et al. (2014) monitored the monthly variations in the concentration of heavy metals (Pb, Ni and Fe) in Shatt Al-Hilla river water during November 2011-October 2012 to study the extent of contamination of the river with those metals. They observed a wide range of variations in the heavy metal concentration levels varying from high concentration of one of the metals at a certain site to low content at the other. Sayadi et al. (2015) studied the contribution of the natural and concentration factors of heavy metals such as Cd, Pb, and Cu in the sediments of six stations of Chah Nimeh reservoir, Sistan, Iran in 2013. They observed the highest concentrations of Cd and Pb in station one and maximum Cu concentration in station five. Bing et al. (2016) investigated the spatial distribution of the heavy metal concentration (Cu, Cd, Pb and Zn) in the sediments of the Three Gorges reservoir and also assessed their potential risk by multiple indices and metal fraction. They concluded that the sediments were moderate to highly contaminated by Cd, and slightly contaminated by other heavy metals.

Azadi et al. (2018) conducted a review on studies carried out on the contamination of lead in the coastal sediments of north and south Iran during 2006 to 2016. They observed that the variability in the Pb mean concentration was considerable and statistically significant.

Amaravathi and Thirumoorthy reservoirs are the major sources of water supply for drinking and irrigation for the Tiruppur district. Our study is aimed at investigation of the concentration of As, B, Cd, Cr, Cu, Fe, Ni, Pb, Se and Zn in the water of the Amaravathi and Thirumoorthy reservoirs so as: (1) to compare the concentration of various metals and (2) to assess its suitability for drinking by comparison of the results with IS: 10500:2012.

STUDY AREA

Tiruppur district is bounded by Karur district in the east, Coimbatore in the west, Erode in the north and Dindigul district in the south. The district lies between 11°14' N to 11°20' N latitude and 27°77'E to 77°56' E longitude with an area of 2296 sq. km. The study area consists of 13 blocks, 265 villages and 3597 habitations. The southern part of the district is covered by hill ranges of Western Ghats and the rest of the district consists of undulating plain sloping gradually from west to east. The major rivers flowing through the district are Noyyal and Amaravathi, which come under the Cauvery basin. Chinnar and Tenar are the main tributary of Amaravathi river, which is the main source of irrigation in the district. The average annual rainfall for the last six years, namely 2013, 2014, 2015, 2016, 2017 and 2018 are 703 mm, 360 mm, 278 mm, 411 mm, 680 mm and 618 mm respectively. The aquifers located in this region are semi-confined or unconfined aquifers and depth of water in these reservoirs can range from 7 m to 25 m. The water supply status as on 1.4.2017 indicates that out of 3597 inhabitants, 785 are partially covered (10-39 lpcd) and 2812 are fully covered (40 lpcd).

The Amaravathi dam is a dam constructed across the Amaravathi river in 1957. It is located at Amaravathinagar, 25 kilometers south of Udamalpet in the Indira Gandhi Wildlife sanctuary, Tiruppur district in the state of Tamil Nadu, India. The associated reservoir is 9.31 km^2 in area and 33.53 m deep. The dam was primarily built for irrigation and flood control and four megawatts of electricity generation capacity was installed in 2003-2004. The surface elevation is 427 m and the volumetric capacity is 3×10^9 cubic feet. Amaravathi dam is located south of the Thirumoorthy dam. Thirumoorthy dam is 20 km from Uduamlpet on the highway from Palani to Coimbatore. The dam has been constructed adjoining the Thirumoorthy hill. The dam is located close to a perennial stream and a waterfall. The dam is located amidst the rolling hills. The topographical location

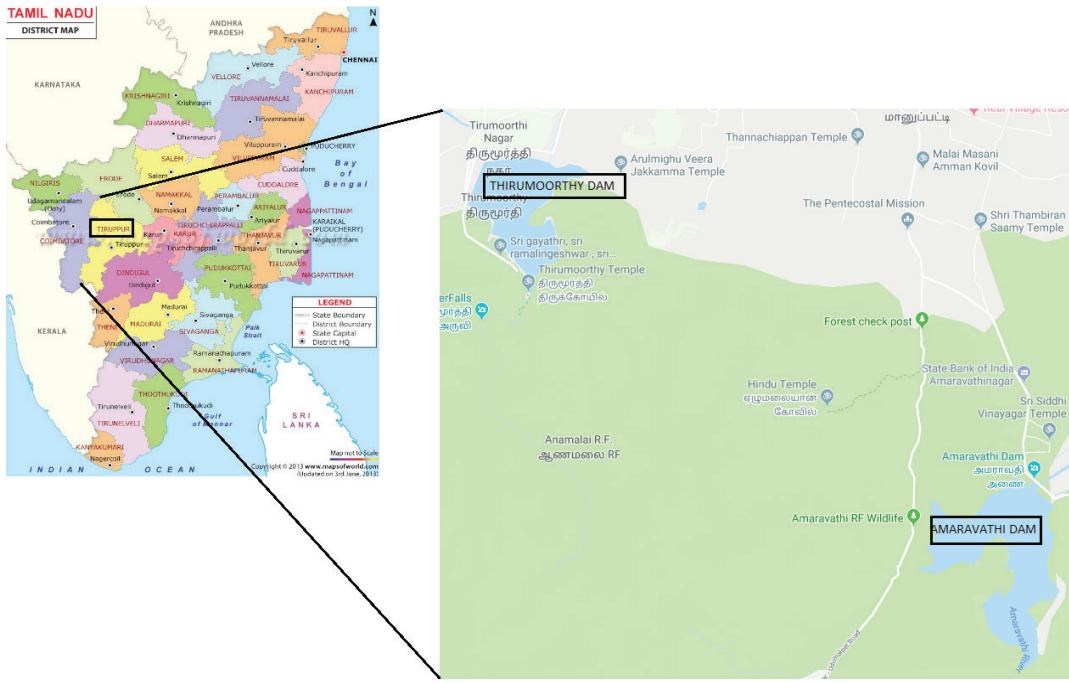

Fig. 1: Location of Amaravathi dam and Thirumoorthy dam in the district of Tiruppur, Tamil Nadu, India.

of the dams in the Tiruppur district has been depicted in Fig. 1.

MATERIALS AND METHODS

Water samples were collected from four different site locations of each reservoir. The concentration of the metals was determined using the test method of IS 3025:1964 in NABL accredited laboratory. Table 1 provides the sections of IS 3025:1964 that was adopted for the determination of the metal concentration of various metals.

RESULTS AND DISCUSSION

The metal concentration of As, B, Cd, Cr, Cu, Fe, Ni, Pb, Se, and Zn in the water of Amaravathi and Thirumoorthy reservoirs were analysed in this study. The results obtained are given in Tables 2 and 3.

It is observed from Table 2 that the concentration for As, B. Cd, Ni, Se and Zn lies below the detectable limit of 0.001 ppm. The concentration of Cr is 0.01 ppm at site 1 but still within the standard limit of 0.05 ppm. The concentration of Cu (0.06 ppm) is marginally above the standard limit of 0.05 ppm at site 1 and within the prescribed limits at all other sites of the reservoir. The iron concentration was found to be 0.18 ppm, 0.16 ppm, 0.16 ppm and 0.12 ppm at the four sites, which is above the standard limit of 0.1 ppm. Since, the concentration is only marginally higher than the standard limit, it would not cause any serious health impacts for the people consuming this water. Chaturvedi & Dave (2012) indicated that iron intake has a positive effect on our health in moderate doses, since it is an essential nutrient. They have also mentioned that the recommended intake of iron can vary from 10 to 50 mg/L depending on age, sex, and physiological status. Even the concentration of lead (Pb) is within the limits prescribed by IS 10500:2012. Thus, the water from the Amaravathi reservoir was found to be suitable for drinking as well as irrigation purposes.

It is observed from Table 3 that the metal concentrations of As, B, Cd, Cr, Cu, Fe, Ni, Pb, Se and Zn are well below the detectable limit of 0.001 ppm as per the results obtained. Thus, the water from the Thirumoorthy dam is potable for the people of Tiruppur district.

CONCLUSION

The metal concentrations of As, B, Cd, Cr, Cu, Fe, Ni, Pb, Se and Zn were determined in the water of the reservoirs of Amaravathi and Thirumoorthy dams located in the Tiruppur district of the state of Tamil Nadu, India. The concentration of the metals was found to be well below the detectable limit of 0.001 ppm in the Thirumoorthy dam water. The concentration of Fe was found to be marginally higher than the limits prescribed by IS 10500: 2012 at the

Table 1: Sections of IS 3025: 1964 adopted for testing of metal concentration.

Sl. No.	Metal	Section
1	As	Part 37
2	B	Part 29
3	Cd	Part 41
4	Cr	Part 38
5	Cu	Part 36
6	Fe	Part 32
7	Ni	Part 54
8	Pb	Part 47
9	Se	Part 28
10	Zn	Part 39

Table 2: Metal concentration (ppm) at different site locations of Amaravathi dam.

S. No.	Metal	Concentration				Limits (IS 10500:2012)
		A1	A2	A3	A4	
1	As	<0.001	<0.001	<0.001	<0.001	0.05
2	B	<0.001	<0.001	<0.001	<0.001	5.0
3	Cd	<0.001	<0.001	<0.001	<0.001	0.01
4	Cr	0.01	<0.001	<0.001	<0.001	0.05
5	Cu	0.06	0.05	<0.001	0.02	0.05
6	Fe	0.18	0.16	0.16	0.12	0.1
7	Ni	<0.001	<0.001	<0.001	<0.001	0.02
8	Pb	0.01	<0.001	0.01	<0.001	0.01
9	Se	<0.001	<0.001	<0.001	<0.001	0.01
10	Zn	<0.001	<0.001	<0.001	<0.001	5.0

Table 3: Metal concentration in ppm at different site locations of Thirumoorthy dam.

S. No.	Metal	Concentration				Limits (IS 10500:2012)
		T1	T2	T3	T4	
1	As	<0.001	<0.001	<0.001	<0.001	0.05
2	B	<0.001	<0.001	<0.001	<0.001	5.0
3	Cd	<0.001	<0.001	<0.001	<0.001	0.01
4	Cr	<0.001	<0.001	<0.001	<0.001	0.05
5	Cu	<0.001	<0.001	<0.001	<0.001	0.05
6	Fe	<0.001	<0.001	<0.001	<0.001	0.1
7	Ni	<0.001	<0.001	<0.001	<0.001	0.02
8	Pb	<0.001	<0.001	<0.001	<0.001	0.01
9	Se	<0.001	<0.001	<0.001	<0.001	0.01
10	Zn	<0.001	<0.001	<0.001	<0.001	5.0

four sites from where water was collected but this would not have any major impact on the human health. Thus, the water from both the reservoirs is suitable for drinking and irrigation purposes.

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