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Review Article

Status of Heavy Metal Elements in River Cauvery and its Impact

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Abstract

The present short-review briefly summarizes the status of heavy metal in Cauvery River and its sources and the status and effect of heavy metals in the river sediments and water on organisms. The difference in the heavy metals in different parts of the pathways of the river Cauvery is provided in addition to the pollution level and the effect of polluted water or enriched heavy metals on living systems. The pollution status and heavy metal contaminants level varies in water and in sediments with reference to different locations. According to the report of Central Pollution Control Board, the pollution stretch due to the inflow of sewage from Erode, Erode district in Cauvery, Tamil Nadu a higher BOD level of 38 mg/l was reported. Literature indicates that the pollution to the River Cauvery and its tributaries is mainly due to anthropogenic activities.

Keywords

Cauvery River
Contamination
Heavy metals
Pollution
Sediments

Introduction

Fresh water sources like rivers are the major resources for dependent living beings. Due to anthropological activities, river waters are becoming un-usable due to the changes in physico-chemical nature brought about by various kinds of pollutants. On the other hand, due to the reduced rainfall as a consequence of climate change, these water resources are being depleted of water and increased in alarming rate of pollution. Recent report indicated that India is expected to face critical levels of water stress by 2025 and there will be serious water shortages (UN Climate Report, 2014).

Cauvery is a sacred river of southern India, rising on Brahmagiri Hill in the Western Ghats in Coorg district of Karnataka state, flowing in a south-easterly direction for 475 mi (765 km) through Karnataka and Tamil Nadu states across the Deccan Plateau, and descending the Eastern Ghats in a series of great falls. Before emptying into the Bay of Bengal south of Cuddalore, Tamil Nadu, it breaks into a large number of distributaries forming a wide delta. As far as the present review is concerned, the special emphasis on the heavy metal pollution status in river Cauvery has been summarized.

Latest pollution control board report pinpoints that the pollution stretch due to Erode sewage in Cauvery was in Erode district, Tamil Nadu with a BOD level of 38 mg/l (CPCB, 2014). Heavy metals in Cauvery River are chemically in the form of exchangeable, bound to carbonates or organic matter or Fe-Mn Oxides and or residual forms (Vaithiyanathan et al., 1992). The accumulation of heavy metals in the bottom sediments of river bodies and their remobilization are two of the most important mechanisms in the regulation of pollutant concentrations (Linnik and Zubenko, 2000). By analyzing water and sediment, it is possible to determine the extent, distribution and possible hazards of contamination.

Effects of heavy metals on human life

Heavy metals can be adsorbed from the water column into/on fine particle surfaces and later reside and move thereafter towards sediment matrices. Metals also participate in various biogeochemical processes, have significant mobility, can affect the ecosystems through bio-accumulation and biomagnification processes and are potentially toxic for environment and for human life (Manahan, 2000; Abdul Aziz et al., 2010). Various effects of heavy metals, in general, on human life are summarized in Table 1. When these heavy metals exceed permissible level, they may find roots in the effects on human health.

Table 1. Health hazards of selective heavy metals to human beings*.

Heavy metal	Major sources	Effects of heavy metals on human health
Cadmium	Electroplating, preparation of Cd-Ni batteries, control rods, shields within nuclear reactors, television phosphors.	Kidney and liver damage; renal dysfunction, gastrointestinal damage.
Chromium	Mines, electroplating.	Gastrointestinal, hepatic, renal, neuronal damage.
Copper	Electroplating, pesticide production, mining.	Headache, nausea, vomiting, diarrhea and kidney malfunctioning.
Lead	Paint, pesticide, batteries, crystal glass preparation.	Cognitive impairment in children, peripheral neuropathy in adults, developmental delay.
Nickel	Stainless steel manufacturing units, electroplating factory discharge.	Neurotoxic, genotoxic, and carcinogenic agent, nickel dermatitis.
Zinc	Effluents from electroplating, industries, sewage discharge, the immersion of painted idols.	Vomiting, diarrhea, icterus, liver and kidney damage.

* Malik et al. (2014)

Status and the effect of heavy metals in Cauvery river water and sediments

Different aquatic organisms often respond to external contamination in different ways, where the quantity and form of the element in water, sediment, or food will determine the degree of accumulation (Begum et al., 2008 and 2009). The region of accumulation of heavy metals within fish varies with route of uptake, heavy metals, and species of fish concerned. Their potential use as biomonitors is therefore significant in the assessment of bioaccumulation and biomagnification of contaminants within the ecosystem. Many dangerous chemical elements, if released into the environment, accumulate in the soil and sediments of water bodies. The lower aquatic organisms absorb and transfer them through the food chain to higher trophic levels, including fish. Under acidic conditions, the free divalent ions of many metals may be absorbed by fish gills directly from the water. Hence, concentrations of heavy metals in the organs of fish are determined primarily by the level of pollution of the water and food Under certain conditions, chemical elements accumulated in the silt and bottom sediments of water bodies can migrate back into the water, i.e. silt can become a secondary source of heavy metal pollution. The collection source, organisms tested and the important findings of various studies conducted in river Cauvery is summarized in Table 2.

Pollution of the river by various sources

Water pollution due to anthropogenic activities in Cauvery River and many of its tributaries are reported to be the source of pollution, such as effluents from pulp and paper manufacturing, chemical industries, dyeing and bleaching units, and sewage are the major anthropogenic sources of water pollution in Cauvery River (Annalakshmi and Amsath, 2012).

Table 2. Status of heavy metals in sediments and organisms collected from Cauvery River and its tributaries.

Sampling site	Sample tested	Salient findings	Reference
Five channels of river Cauvery in Manachanallur and Lalgudi taluks, Tiruchirappalli, Tamil Nadu.	Sediments	The trace metal concentrations were low and they were in order of Pb>Cr>Cu>Zn>Cd. The sediment of Koolayar channel at Thirumangalam was found to be slightly contaminated by the surface run-off followed by Panguni channel at Alangudi.	Ravikumar and Rakesh Sharma (2014)
Cauvery River Estuarine Region, Southeastern Coast, Tamil Nadu	Sediments	Environmental risk of metals evaluated using risk-assessment code and mobility factor showed low to high risk for Pb, Zn, and Cu. The results of the present study also hint at notable enrichment of heavy metals in certain pockets of the Cauvery Estuary.	Dhanakumar et al. (2013)
Anaikarai dam, Tamil Nadu.	Fish: *Channa melanosoma*, *Silurus wynaadensis*, *Mughil cephalus*, *Oreochromis mosambicus*, *Parastromateus niger* and *Scardinius erythrophthalamus*	The mean concentrations of Co, Cr, Mn and Zn were found to be higher in gills; The mean concentrations of Cr, Mn and Fe in the muscle were exceeding the permissible limit of FAO and WHO.	Bhuvaneshwari et al. (2012)
Cauvery river basin, from Talacauvery (Coorg district) to Arkavathi Sangam, Karnataka.	Sediments, soil and water	The spatial trends of heavy metal enrichment in river sediments reflected the sources/activities of the corresponding catchments in the study area. As such the downstream stations of Cauvery are enriched with heavy metals due to the influx of pollutants.	Venkatesha Raju et al. (2013)
Random collection from agricultural fields across Vrishabhavathi river, a tributary river of Cauvery, Karnataka.	Spinach, fenugreek, *Amaranthus* randomly collected from agricultural fields across Vrishabhavathi river.	Cr content is lower in leafy vegetable species. Spinach has higher transfer factor for the heavy metals followed by fenugreek and *Amaranthus*. The average transfer factor observed in the selected green leafy vegetables is in the order of Zn>Mn>Fe>Cu>Ni>Pb>Cr.	Jayadev and Puttaih (2013)
Hanagadu, Marchinahalli, Kamenahalli, Bannur, Sosale, Bilagale and Nanjangud, Karnataka	Fish, planktons	Zn, Pb and Cr concentration exceeded the upper limit of standards; metal concentrations in the downstream indicate an increase in the pollution load due to movement of fertilizers, agricultural ashes, industrial effluents and anthropogenic wastes.	Begam et al. (2009)
Kabini river, a tributary of Cauvery at Nanjangud, Karnataka	Sediments	Pb was the highest in terms of contamination level, especially at point of influx of paper mill effluents, followed by Zn and Cu.	Hajebi et al. (2010)

The study by Hema et al. (2010) indicated that some of the samples from four major tributaries of Cauvery such as Bhavani River, Noyal River, Amaravathi River and Thirumanimuthar River during February 2009 exceeded the permissible limit for drinking. The study further reveals that the variation of water quality with respect to space and time is not uniform. Agricultural runoff, sewage and industrial effluents are the probable sources for the variation of water quality in the study region. The vulnerability of shallow groundwater to contamination in and around part of Cauvery basin between Mettur dam and Erode town, Tamil Nadu, India, is evaluated using the "LGRSIDWQ" method within a Geographic Information System (GIS) by Ravikumar et al. (2011). Their study indicated that 50% of the area is highly vulnerable to industrial and municipal pollutants and more than 81% of the area is highly vulnerable to industrial waste pollutants. Many of the heavy metals reported in various studies are found to be higher than the permissible limits which in turn affect the organisms in Cauvery water. Moreover, the elemental composition also showed the similar trend, indicating the pollution discharge into the river from various sources.

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