



Heavy Metal Analysis of Cauvery River Water around KRS Dam, Karnataka, India

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Abstract: Water quality is an index of health and is one of the areas of major concern to environmentalists since industrialization, urbanization and modern agriculture practices have a direct impact on the water resources. Hence, the study of the reservoirs and river water quality monitoring is most essential aspect of sustainable development and river conservation. The upstream and KRS reservoir both are the important sources of potable water supply for the Mysore city. The study area were selected the upstream and KRS reservoir of Mysore District of Karnataka, India. In this paper, an attempt has been made to evaluate water quality parameter and heavy metal of upstream and KRS Dam during 2008. Ecological parameters like dissolved oxygen, chemical oxygen demand, biochemical oxygen demand and chemical parameters like total hardness, total alkalinity, chloride, nitrate, phosphate and physical parameters like temperature, pH, turbidity and heavy metals were analyzed and the results were compared with standard permissible limits, WHO and they were studied to ascertain the drinking water quality. Results revealed that in three rivers of upstream (Hemavathi, Cauvery, and Lakshmana Theertha) carried high loads of arsenic, iron, nickel on upstream. In other words, arsenic is a dominant risk to more than the maximum permissible standard of water quality and is a risk factor in this river.

Keywords: Cauvery river; KRS Dam; Water quality; Heavy metals.

1. Introduction

Cauvery River is also under environmental stress due to siltation, human encroachment and sewage input from various resources. There is a number of discharging loads of sewage, domestic wastewater, and industrial effluents directly into the river. This dam has influence of various anthropogenic activities and rapid pace of industrialization in the catchment areas upstream. Therefore, the river has received silt-containing fertilizers, insecticides, pesticides that are used for agriculture resulted in a variety of changes in the hydrology and water quality of the river. The water qualities of the reservoir have negative impact due to discharge of sewage and municipal wastes into water bodies (Mohapatra and Singh, 1999). Some loads of waste from industries, domestic sewage and agricultural practices find their way into rivers resulting in large-scale deterioration of the water quality. Cauvery River at present is highly fragmented by various impoundments (Kathiresan, 2000). Further, more than

50 percent of the drinking water supply of Mysore city is collected from the Cauvery River (CPCB Report, 1996) hence it is important to study the water quality of Cauvery River. The permissible limits of domestic water supplies for drinking water, as laid down by the World Health Organization (WHO, 1996). In the present study, heavy metal analysis of Cauvery River around Krishna Raja Sagara (KRS) Dam have been carried out in order to determine the sources responsible for deterioration of water quality for various uses. There have been no systematic studies on this river in upstream and downstream or KRS Dam, till now, although well-planned monitoring has been done in the river Cauvery (Easa and Shaji, 1995).

1.1 Study Area

Cauvery River originates at in the State of Karnataka and flows generally south and east through Karnataka has many tributaries. Before the dam, there has been a confluence of three main rivers, namely, Cauvery, Hemavathi and Lakshmana Theertha.

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The study area is situated at an elevation of about 600 meters above mean sea level (MSL) and lies between latitude 12°25' 30 "N and longitudes 76°34' 34 "W. It serves as a major source of domestic, irrigation and industrial water supply.

Subsequently, it receives untreated domestic wastewater. This research work is focused on the KRS dam and it's upstream. The sampling locations are spread throughout the study area and divided into as upstream of KRS Dam were selected (Fig. 1).

The KRS Dam was constructed on the Cauvery River near Mysore and Mandya districts. It is 15 km far from Mysore. All around the area of the reservoir is covered with forest. Thus the water of the reservoir is runoff from the forest. The submerged area was also a part of the forest before the construction of the reservoir and thus numbers of trees are submerged in the reservoir. Two different sampling stations of upstream namely BD₁, BD₂, BD₃ and KRS reservoir D₁, D₂ and downstream R₁, R₂ were selected.

2. Materials and Methods

Water samples were collected as per standard method of sampling techniques, APHA (1999). Various physicochemical parameters like temperature, pH, turbidity (NTU), alkalinity, total hardness, chloride (Cl⁻), nitrate (NO₃⁻), phosphate (PO₄⁻³), BOD and COD were determined following standard methods (Tables 1 & 2). Sampling and physicochemical investigation was carried out according to standard methods (APHA, 1999; NEERI, 1991).

- Water temperature - Recorded in the field using a sensitive mercury thermometer.
- The pH - Determined using a digital pH meter.
- Turbidity - Determined by Nephelo – turbidity meter.
- Total Hardness - Determined titrimetrically using EDTA method (APHA, 1999).

- Total Alkalinity - Determined by titrimetric method.
- BOD - Determined as per standard method (NEERI, 1991).
- COD - Determined by potassium dichromate Open Reflux Method (NEERI, 1991).
- Chlorides - Determined by Mohr's Argentometric Method (APHA, 1999).
- Nitrate and Phosphate - Determined as per standard method (APHA, 1999).
- All the heavy metals - Determined by ICP instrument (APHA, 1999).

3. Results and Discussion

The water analysis is carried out as per the methods described by APHA (1999); Trivedy & Goel (1986) and Hooda & Kaur (1999). The maximum water temperature (18.2°C) was observed at stations BR₃, D₁, R₂ and the minimum was (22.8°C) at station BD₂ (Tables 1 & 2). The variation of water temperature due to different timing of collection and the influence of season (Jayaraman *et al.*, 2003). Temperature controls behavioral characteristics of organisms, solubility of gases and salts in water. No other factor has so much influence as temperature (Welch, 1952).

3.1 pH

The maximum value of pH was recorded as 8.4 at station D₁ and the minimum value of pH was recorded as 8.18 at station R₁ (Tables 1 & 2). In general, the pH was within the limits of the standard values (APHA, 1999). For drinking water, a pH range of 6.0–8.5 is recommended (De, 2002).

3.2 Turbidity

The present study shows turbidity in the range of 0.3–13.44 NTU. Upstream KRS shows higher values than KRS reservoir as shown in Tables 1 and 2. WHO (1996) prescribed highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU.

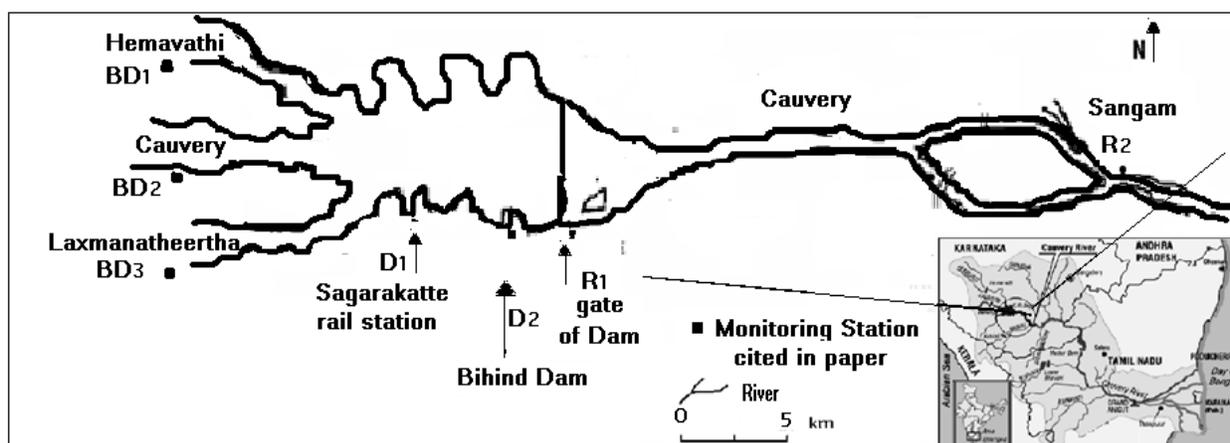


Fig. 1. Map of site stations in KRS Dam and Cauvery River.

3.3 Total alkalinity

The maximum alkalinity was recorded as 64mg/l at stations R₁ and D₂ and the minimum value was recorded as 40mg/l at most stations. BIS (1991) has set a desirable level of alkalinity in drinking water to be 200mg/l, whereas its value has been prescribed to be 600mg/l in the absence of alternative sources.

3.4 Total Hardness

Total hardness was observed in the range of 56-89mg/l at upstream of KRS (BD₁, BD₂, BD₃) and KRS reservoir (D₁, D₂). The hardness of water is not a pollution parameter, but indicates water quality. KRS reservoir sampling stations have higher value than the upstream of KRS sampling stations (Tables 1 and 2).

3.5 Biochemical Oxygen Demand

Biochemical Oxygen Demand is usually defined as the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. BOD gives an idea about the extent of pollution. In the present study water samples of upstream KRS (BD₁, BD₂, BD₃) and KRS reservoir (D₁, D₂) sampling stations BOD was found in the range of 0.8-1.8mg/l as shown in Tables 1 and 2.

3.6 Chemical Oxygen Demand

The Chemical Oxygen Demand is a measure of oxygen equivalent to the requirement of oxidizing organic matter contents by a strong chemical agent. The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances. The maximum COD value was recorded as 42.8mg/l at station BD₂ and the minimum value was recorded as 16mg/l at station R₂ (Tables 1 and 2). The present observations indicate that COD of KRS reservoir is comparatively lower than upstream. This is due to low level of pollutants present in KRS water.

3.7 Chloride

The chloride contents normally increase as the mineral content increases (Dubey, 2003). In the present study the range of chloride 58.4-92.3mg/l (Tables 1 and 2). The maximum chloride content was observed in upstream of KRS reservoir as compared to upstream of KRS due to the addition of natural contaminants and pollutants into the KRS Dam.

3.8 Nitrate

The Nitrate content of both the water bodies was found in the range of 0.2-21mg/l as shown in Tables 1 and 2. The amount of nitrates in both the stations of upstream KRS (BD₁, BD₂) and KRS reservoir (D₁, D₂) was found to be much below the accepted drinking

water standards (20mg/l – ICMR 1975; 45mg/l – ISI 1991). Except BD₃ due to additional fertilizer and anthropogenic activities.

3.9 Phosphate

The phosphate content of both the water bodies was founded in the range of 1.14-1.6mg/l. The highest value of 1.6mg/l was recorded at station BD₃, while the minimum value 1.14mg/l was recorded at station BD₂ as shown in Tables 1 and 2. The United States Public Health Standards limit for phosphates in drinking water is 0.1mg/l (Dec 2002). The amount of phosphate in the upstream and KRS reservoir water comes out within the acceptable limits that are due to runoff and high agricultural impact.

3.10 Heavy Metals

In general, most sources of iron and other heavy metals in water include contamination from municipal sewage sludge, agricultural or mining wastewater and/or groundwater near landfill sites. In this study concentration of Fe is increased in upstream (maximum 10mg/l) and there are decreasing Fe (0.01mg/l) in downstream at monsoon in compare of other times (Fig. 2). It indicates that the concentration of Fe dependent on runoff in the raining season. Other heavy metals like Mn, Ni, Pb, Zn, Cu, and as have been determined, and all have the same variation in spatial and temporal. This study revealed that arsenic is more than the value of WHO standard (0.05mg/l), and is a risk factor in this river. WHO International Standards for Drinking water recommended a maximum allowable concentration of (As = 0.05mg/liter for Arsenic, Fe = 0.5, Mn = 0.3, Ni = 0.02, Cu = 1, Zn = 5, Pb = 0.05mg/l) based on health concerns (WHO, 1996). The concentration of nickel ranges from 0.1–0.01mg/l in the study area with an average of 0.05mg/l. It was found that Fe and Ni have a similar curve and it is the same sources and has a relationship with runoff in monsoon, Fig. 2 and 3 indicating that an increase in Ni concentration in water leads to a corresponding increase in the levels of Fe, Zn and Mn. Also, dilution of concentrations of heavy metals by reservoir has been a strong role in decreasing concentration of heavy metal. Arsenic is one of the few substances shown to cause cancer in humans through consumption of drinking water. Levels in natural waters generally ranged between 1 and 2mg/l although concentrations may be elevated (up to 12mg/l) in areas containing natural sources. Since the maximum limit of arsenic detection is 0.1mg/l by ICP/MS; the 0.676mg/l with 0.41 standard deviation in upstream is very high risk for any purpose of Cauvery River (Fig. 3).

Table 1. Variation in physicochemical parameters at three stations, namely BD₁, BD₂ and BD₃ of Upstream KRS.

S. No.	Physicochemical Parameters	Hemavathi Station	Cauvery Station	Lakshmana Theertha station
		BD ₁	BD ₂	BD ₃
1	Temperature (°C)	23	22	25
2	pH	7.44	7.36	7.31
3	Turbidity (NTU)	4.4	13.44	13.8
4	Total alkalinity (mg/l)	48	40	40
5	Total hardness (mg/l)	64	80	56
6	BOD (mg/l)	1	1.6	1.1
7	COD (mg/l)	28.7	42.6	34.9
8	Chloride (mg/l)	78.1	71	58.4
9	Nitrate (mg/l)	6.5	7	21
10	Phosphate (mg/l)	1.25	1.14	1.6
11	Fe (mg/l)	3.535	8.154	5.697
12	As (mg/l)	0.558	0.21	0.676
13	Cu (mg/l)	0.06	0.057	0.094
14	Ni (mg/l)	0.221	0.229	0.255
15	Mn (mg/l)	0.943	0.484	0.366
16	Pb (mg/l)	0.23	0.203	0.219
17	Zn (mg/l)	0.146	0.148	0.118

Table 2. Variation in physicochemical parameters at four stations, namely D₁, D₂ and R₁ of KRS reservoir and downstream.

S. No.	Physicochemical Parameters	KRS reservoir station	KRS reservoir Station	Gate of KRS Station	Downstream of KRS
		D ₁	D ₂	R ₁	R ₂
1	Temperature (°C)	25	23	23	25
2	pH	7.81	8.1	8.18	8.4
3	Turbidity (NTU)	9.96	0.3	0.47	6.3
4	Total alkalinity (mg/l)	40	48	48	74
5	Total hardness (mg/l)	89	88	84	64
6	BOD (mg/l)	1.6	1.8	0.8	1.3
7	COD (mg/l)	25	32.25	32	16
8	Chloride (mg/l)	64	92.3	85.2	59.64
9	Nitrate (mg/l)	14	4.5	1	0.2
10	Phosphate (mg/l)	1.3	1.42	1.35	1.15
11	Fe (mg/l)	0.024	0.104	0.101	0.017
12	As (mg/l)	0.062	0.245	0.11	0.0001
13	Cu (mg/l)	0.0001	0.018	0.013	0.0001
14	Ni (mg/l)	0.017	0.138	0.131	0.02
15	Mn (mg/l)	0.0001	0.107	0.106	0.0001
16	Pb (mg/l)	0.005	0.125	0.12	0.0001
17	Zn (mg/l)	0.0001	0.055	0.051	0.0001

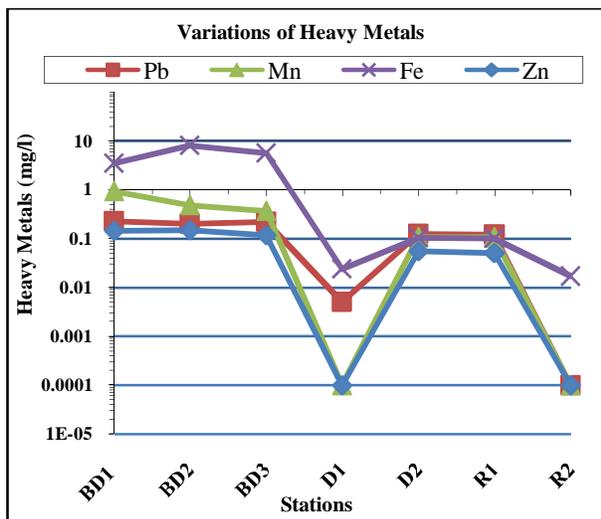


Figure 2.

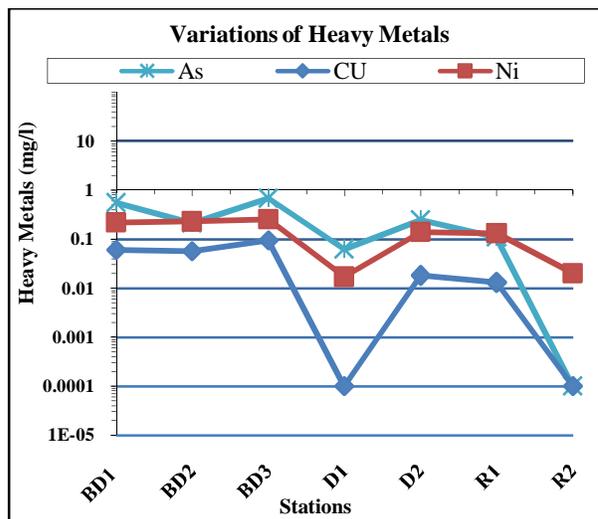


Figure 3.

4. Conclusion

The physicochemical parameters studied were all within the desirable limit for drinking water quality recommended by WHO (1996). The above data on the water quality parameters of Cauvery River in downstream clearly revealed that river water was safe for drinking water supply, fishery, irrigation, and industrial purposes, as most of the parameters are found within the permissible limits. The analysis indicates that the relative importance of the water of KRS reservoir is moderately soft, with moderate alkalinity, transparent, low BOD, COD level as apparent in comparison to upstream KRS.

During the monsoon, season runoff could change heavy metals concentration in a critical situation. The present study thus clearly revealed the extent of phosphate, nitrate in upstream and at the reservoir during monsoon time and highest nitrate, turbidity, COD in Lakshmana Theertha (BD₃) upstream. Also, the value of pH, total alkalinity, TH, chloride was in lowest condition. The overall water quality of downstream of the reservoir is much better than the upper KRS Dam as it is prone to more human intervention. Finally, our results revealed that the Cauvery River carried high loads of arsenic, iron, nickel, on upstream. In other words, arsenic is more than value standards of water quality and is a risk factor in this river. The reservoir is exposed to sewage and wastewater from three tributaries in upstream, with sewage outlets, urban wastewater, and agricultural runoff all contributing to the current condition of the sources contaminating the reservoir. The overall water quality of KRS reservoir is much better than the upstream of KRS as an agricultural area and thick forest and upstream KRS are surrounded by habitation and are prone to more human intervention. To conclude with a sentence the status of KRS water outflow is "cheers" all the way.

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