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Occurrence of chromium metal in Siddheshwar Reservoir at Hingoli, India

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ABSTRACT

This research work aims to study the presence of chromium metal in water using UV-VIS spectrophotometer from Siddheshwar dam at Taluka Aundha of district Hingoli, Maharashtra state of India was studied during the study period of July 2009 to June 2010. This metal is estimated by Diphenylcarbazide method. Chromium, a heavy metal, is used in a variety of industrial applications. It is highly toxic to humans, animals, plants and microorganisms. Chromium is found in all natural waters both in hexavalent and trivalent forms. Oxidative form of chromium is very important relative to its mobility and its role in plant and human nutrition. The water was found to be contaminated with chromium when compared with their standard limits for drinking water prescribed by different organizations like World Health Organization (WHO) and Bureau of Indian Standards (BIS). Several changes occurred during the study period in chromium concentrations from selected sampling sites.

Keywords: Trace metal, Drinking water, Permissible limit, Siddheshwar dam, Chromium.

INTRODUCTION

Water is one of the most essential elements to life on the Earth without which there would be no life [11, 26]. In its purest form, it's odorless, colorless and tasteless but due to human and animal activities, it is usually contaminated with solid and human waste, effluents from chemical industries and dissolved gases [16, 21]. Nowadays most major metropolitan cities face the ever increasing problem of environmental pollution due to toxic metals. The toxic metals entering the ecosystem may lead to bioaccumulation geo-accumulation, and biomagnifications. Metals like iron, copper, zinc and other trace metals are important for proper functioning of biological systems and their deficiency or excess concentration could led to a number of disorders [23].

Besides, the presence of toxic metals such as lead, mercury and cadmium in the environment has been a source of worry to the environmentalists, government agencies and health practitioners. This is mainly due to their health implication since they are non - essential metals of no benefits to human being [4].The presence of these metals in ecosystem has far reaching implications directly to the biota and indirectly to man. In addition, food chain contamination by toxic metals has become a burning issue in recent years because of their potential accumulation in bio-system through contaminated water, soil and air. Therefore, a better understanding of toxic metal source, their accumulation in the soil and the effect of their presence in water and soil or plant system seem to be particularly important issue of present day research on risk assessments [17].

Dams are sinks for heavy metals that continuously wash off rocks and soils that are directly exposed to surface waters. The common sources of heavy metals are from dead and decomposing plant and animal matter, geological activities like; weathering and erosion, wet and dry fallouts of atmospheric particulate matters and from man's activities [25]. The role of trace metals in biochemical life processes of aquatic plants and animals and their presence in trace amounts in the aquatic environment are essential. However, the high concentrations of these trace metals become toxic [1].

Temperature is a limiting factor in the aquatic environment [5, 15]. Water temperature is probably the vital environmental variable. It affects metabolic activities, growth, feeding, reproduction, distribution and migratory behaviour of aquatic biota [13, 22]. It affects solubility of gases in water, gas solubility decreases with increased temperature. Temperature is affected by time of the day; high temperatures may be recorded in daytime and become low at night [6].

Hydrogen ion concentration or pH as one of the most vital environmental parameter decides the survival, metabolism, physiology and growth of aquatic organisms recommended optimum range of pH 6.8-8.7 for maximum growth and production of shrimp and carp [18]. The pH of water is influenced by acidity of the bottom sediment and biological activities. High pH may result from high rate of photosynthesis by dense phytoplankton blooms. The pH value higher than 7 but lower than 8.5 is ideal for biological productivity, but pH at below 4 is detrimental to aquatic life [2]. The pH may be affected by total alkalinity and acidity, surface run off from surrounding rocks, decaying of organic matter and water discharges.

Chromium is the transition metal; with an average atomic weight of 52 and [Ar] 3d5 4s1 an electron configuration. On the periodic table, chromium is the 24th element and a member of group VI B along with molybdenum and tungsten [8].

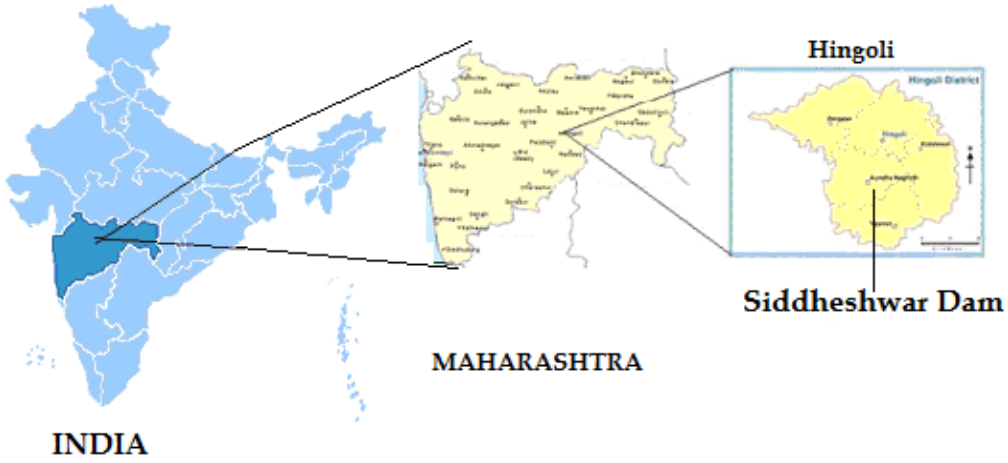

Figure 1: Location of Siddheshwar dam near Hingoli.

The sources of chromium are anthropogenic sources which includes industrial and municipal wastes. The excess of chromium cause diarrhoea, nausea, low blood pressure, lung irritation, CNS disease, cancer, dermatitis, etc. in human beings [14, 20].

The Present study is focused on assessment of chromium metal in surface water.

STUDY AREA

Siddheshwar dam constructed on Purna River at Siddheshwar village in the Aundha Taluka, Hingoli district of Maharashtra state. The river Purna, a tributary of Godavari River rises in the hills of Aurangabad district and after a winding course of about 250 miles, it joins Godavari below Purna Railway Junction.

Siddheshwar dam serve as an important source of several benefits and facilities to the region of Hingoli, Parbhani and Nanded districts. This has been selected for carrying out the present research work. It is situated at northern part of Marathwada region of Maharashtra. The location of dam is at $19^0$35'-$19^0$40' N latitude $76^0$5'-77^0E longitude.

MATERIALS AND METHODS

The present investigation work has been undertaken for the systematic analysis of few metals from this reservoir. The water samples were collected from three sampling sites and named S_1, S_2 and S_3. The sampling site S_1 is near the wall of reservoir, S_2 is at middle of the dam and S_3 is near the pump house. The water sampling was carried out for the period of one year. Water containers were cleaned properly before use. The chromium metal was estimated by the Diphenylcarbazide method [3]. The Mean, Standard deviation, Variance, Minimum and Maximum also calculated.

The Mean, Standard deviation and Variance are calculated by formulas as,

$$\text{Mean} = \frac{\sum x}{N}$$

$$\text{Variance} = \frac{\sum (x - \bar{x})^2}{N-1}$$

$$\text{Standard daviation} = \sqrt{\frac{\sum (x - \bar{x})^2}{N-1}}$$

In this formulas, $\bar{X}$ and $\bar{Y}$ are the values of the mean, N is the sample size and X and Y are two variables [10].

RESULTS AND DISCUSSION

Table 1: Variations in chromium concentration (mg/L) of Siddheshwar dam water during July 2009 to June 2010

Months	Sampling Site	Temperature (^{0}C)	pH	Chromium (mg/L)
July	S_1	26.0	7.5	0.008
	S_2	26	7.5	0.01
	S_3	26.0	7.5	0.012
August	S_1	27.4	7.79	0.01
	S_2	26.9	7.66	0.012
	S_3	26.5	7.53	0.014
September	S_1	27.6	7.8	0.012
	S_2	27.5	7.75	0.013
	S_3	27.5	7.7	0.014
October	S_1	27.7	7.8	0.186
	S_2	27.6	7.8	0.23
	S_3	27.6	7.8	0.274
November	S_1	27.8	7.51	0.014
	S_2	27.9	7.52	0.015
	S_3	28.0	7.35	0.016
December	S_1	25.0	7.5	0.002
	S_2	25	7.4	0.007
	S_3	25.0	7.3	0.012
January	S_1	26.4	7.02	0.002
	S_2	26.3	7.01	0.011
	S_3	26.2	7.01	0.02
February	S_1	31.6	7.9	0.002
	S_2	31.7	7.9	0.002
	S_3	31.8	7.91	0.002
March	S_1	33.0	8.05	0.0136
	S_2	33	8.06	0.0135
	S_3	33.1	8.07	0.0134
April	S_1	33.0	8.08	0.0118
	S_2	33.1	8.09	0.0113
	S_3	33.2	8.10	0.0108
May	S_1	33.1	8.2	0.02
	S_2	33.1	8.2	0.02
	S_3	33.2	8.2	0.02
June	S_1	30.0	7.3	0.0
	S_2	30.0	7.3	0.0
	S_3	30.1	7.3	0.0

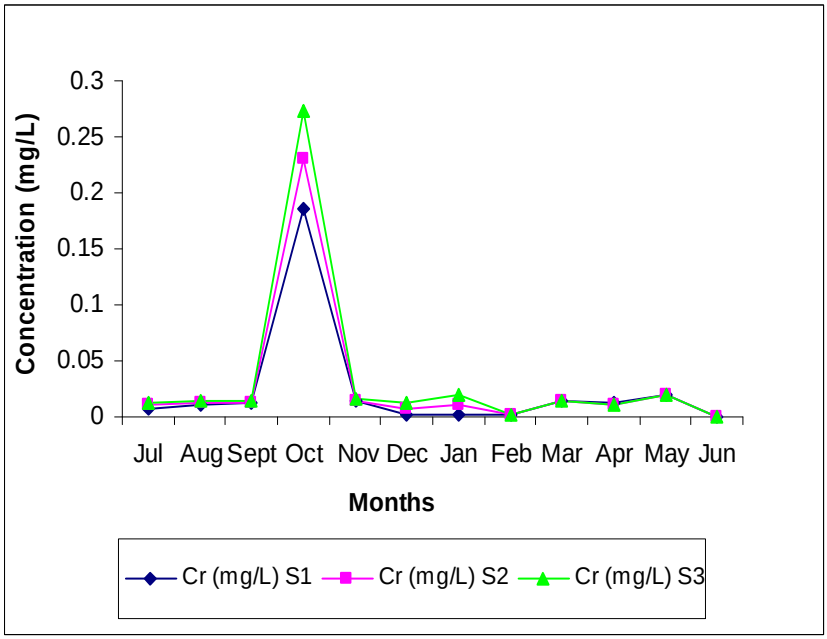

Figure 2: Monthly variations of Chromium (mg/L) content in the Siddheshwar dam water during July 2009 to June 2010.

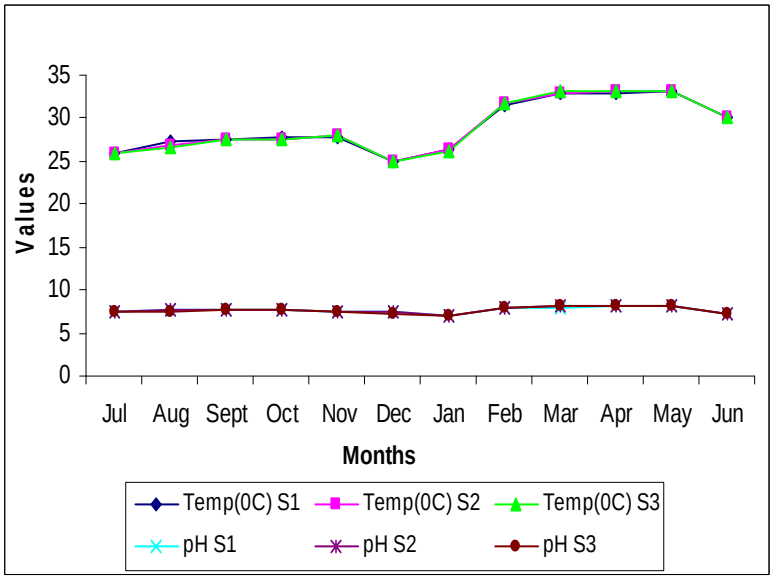

Figure 3: Temperature (^{0}C) and pH of the Siddheshwar dam water during July 2009 to June 2010.

The highest temperature 33.1^{0}C in the month May 2010 and lowest 25^{0}C in the month of December 2009 at sampling station-1. The sampling station-2 showed the maximum temperature 33.1^{0}C in the month of May 2010 and minimum 25^{0}C in the month of December 2009. The sampling station-3 showed the maximum temperature 33.2^{0}C in the month of May 2010 and minimum 25^{0}C in the month of December 2009. The highest temperature found in summer and lowest in winter season.

The water quality of a 'Killi AR' a river at Thiruvananthapuram, Kerala during September 1999 – August 2000 from different selected sites. The monthwise data on water temperature varied from 21 ^{0}C in December at site 1 to 29^{0}C in April at site 8. The seasonal values showed a maximum of 27.6 ^{0}C at station VIII during pre-monsoon and a minimum of 22.5 ^{0}C observed at station I during post-monsoon season [19].

Table 2: Descriptive statistical data of surface water of Siddheshwar dam

Months	Sampling Site	Temperature (^{0}C)	pH	Chromium (mg/L)
Mean	S_1	29.03333	7.704	0.02345
	S_2	29.00833	7.682	0.028733
	S_3	28.96667	7.647	0.034017
Standard Deviation	S_1	2.961674	0.346	0.051555
	S_2	3.015553	0.354276	0.063614
	S_3	3.118663	0.376	0.075815
Variance	S_1	8.771515	0.120	0.002658
	S_2	9.093561	0.125511	0.004047
	S_3	9.726061	0.141	0.005748
Minimum	S_1	25	7.02	0.0
	S_2	25	7.01	0.0
	S_3	25	7.01	0.0
Maximum	S_1	33.1	8.2	0.186
	S_2	33.1	8.2	0.23
	S_3	33.2	8.2	0.274

The highest pH 8.2 in the month May 2010 and lowest 7.02 in the month of January 2010 at sampling station-1. The sampling station-2 showed the maximum pH 8.2 in the month of May 2010 and minimum 7.01 in the month of January 2010.The sampling station-3 showed the maximum pH 8.35 in the month of May 2010 and minimum 7.01 in the month of January 2010. In present work the mean values of pH was observed within the permissible limit. The maximum pH values occur in summer season could be by low water level, uptake of CO_2 by the photosynthetic organisms like phytoplanktons, microorganisms or aquatic plants, formation of carbonates, bicarbonates and hydroxides. And the low pH may be due to decaying of organic matter.

The obtained pH ranged from 7.82-8.52 and 7.75-8.56 at station S_1 and S_2 respectively from Ganga river during 1995-96. Water was low alkaline at the upstream than downstream though not significant. In general, pH was more in winter as compared to other seasons in this stretch [7].

The chromium concentration was highest in the month of October 2009 that is 0.186 mg/L and lowest 0.0 mg/L in the month of June 2010 at sampling station-1. The chromium concentration was highest in the month of October 2009 that is 0.23 mg/L and lowest 0.0 mg/L in the month of June 2010 at sampling station-1. The sampling station-3 showed the maximum 0.274 mg/L concentration in the month of October 2009 and minimum 0.0 mg/L in the month of June 2010.

The peak level of chromium 0.186, 0.23 and 0.274 mg/L obtained in the month of October 2009 may be due to mixing of colour pigments from idol immersion. The minimum concentration obtained in June 2010 due to dilution by rainfall. The dominance of chromium concentration in water sampling sites followed the sequence S3 > S2 > S1. The chromium content increased in water from monsoon to summer and to the winter season.

The total chromium found below detectable limit to 0.652 mg/L and 0 to 0.171 mg/L from surface water samples (Kagina river) of Gulburga district in post and pre-monsoon respectively. Also they observed total chromium ranged from 0.008 to 2.332 and 0.007 – 0.104 mg/L in Bagalkot district (Krishna river) of Karnataka in post and pre-monsoon river. The higher concentration of chromium in post monsoon may be due to natural weathering of rock and soil and urban run-off [9].

The chromium toxic metal found in ninety three samples of ninety six samples of Ganga river at West Bengal in the range 0.001 – 0.044 mg/L during 2004-05 . The average seasonal concentration of chromium was in the range of 0.010 – 0.022 mg/L and highest mean concentration 0.018 mg/L at Dakshineshwar and Ulueria sites of the river [12].

CONCLUSION

The recorded temperature maximum during summer and minimum in winter seasons. The observed mean values of pH were within the permissible limit (6.5-8.5).

The concentrations of chromium in water varied throughout the study period. In present work mean chromium concentration was observed below than the permissible limit i.e. 0.05 mg/L [24].

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