



## Water Quality Evaluation of Satluj River with reference to Heavy Metals at Himachal Pradesh, India

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**ABSTRACT:** Rivers are natural water bodies having various beneficial uses for mankind but these are severely polluted. In this study the analysis of Heavy Metals of Satluj river was undertaken. For this study four sampling stations were identified on the basis of pollution sources and samples from different stations were collected from May, 2015 to April, 2016. Heavy metals as Copper (Co), Cadmium (Cd), Chromium (Cr), Manganese (Mn), Nickel (Ni), Zinc (Zn) and Mercury (Hg) were analyzed. The analyses were carried out according to APHA, 2012 procedures. The results revealed that the different conditions Satluj river in different sampling stations showed fluctuations in some heavy metals. The analysis of data reveals that Cadmium, Chromium and Manganese were found to be higher than the permissible limit prescribed by Bureau of Indian standards (BIS), 2012 for drinking water in India and WHO, 2011 standards. The average values of Copper, Nickel, Zinc and Mercury was within permissible limit proposed by WHO, 2011 and BIS, 2012.

**Keywords:** Water quality, heavy metals, Satluj river, Cadmium, Chromium and Manganese.

### INTRODUCTION

Water is the most abundant on the planet as a whole, but fresh potable water is not always available for human or ecosystem use (Sharma and Walia, 2016, Sharma et al., 2012). India is facing a problem of natural resources scarcity especially in terms of river water due to population growth, unplanned urbanization and rapid growth of industrialization (Maity, 2009, Sharma and Walia, 2015, Sharma and Walia, 2014, Sharma and Walia, 2015, Sharma and Walia, 2016). The Satluj river is the easternmost tributary of the Indus river and origin is located close to Lake Rakhastal in Tibet in the vicinity of the Kailash Mountain Range. The Satluj river usually runs according to a west to southwest itinerary moving into India via the Shipki La Pass located in Himachal Pradesh after that entered in the Punjab. For Satluj river major sources of water pollution are municipal sewage, industrial sewage, agricultural runoff, siltation etc. Studies related to water pollution of rivers have received greater attention from time to time and during recent years (Shivayogimath *et al.*, 2012, Kumar *et al.*, 2010, Kumar *et al.*, 2012). In Satluj river domestic and municipal sewage, industrial effluents, agricultural run-off and siltation are added

daily. As no systematic study has been undertaken to assess the water quality of Satluj river with reference to Heavy Metals so an attempt has been therefore made to study water pollution in Satluj river of Himachal Pradesh with reference to Heavy Metals (FWPCA, 1968, GSI, 2012).

In this study the analysis of Heavy Metals of Satluj river was undertaken. For this study four sampling stations were identified on the basis of pollution sources and samples from different stations were collected from May, 2015 to April, 2016. Heavy metals such as Copper (Co), Cadmium (Cd), Chromium (Cr), Manganese (Mn), Nickel (Ni), Zinc (Zn) and Mercury (Hg) were analyzed and analyses were carried out according to APHA, 2012 procedures.

### MATERIALS AND METHODS

In order to assess the water quality of Satluj river with reference to Heavy Metals, four sampling stations (Fig. 1) i.e. First Sampling Station (SS-1) – Khab, Kinnaur, Himachal Pradesh; Second Sampling Station (SS-2) – Wangtoo, Near dam site of Karcham Wangtoo Hydroelectric Plant, Kinnaur, Himachal Pradesh.

Third Sampling Station (SS-3) – Bayal at the Rampur city, Shimla, Himachal Pradesh and Fourth Sampling Station (SS-4) - Kol dam, Bilaspur, Himachal Pradesh were selected on the basis of identified pollution sources. The water samples were collected for one year

from May, 2015 to April, 2016. All the Heavy Metals were analyzed by the procedures using standard methods of APHA, 2012. (Flame Atomic Absorption Spectrometer: Shimarju AA-6300 and LABINDIA AA7000).



Fig. 1. Location of different Sampling Stations on Satluj River.

**RESULTS**

The results of various Heavy Metals analysis were recorded during from May, 2015 to April, 2016 in present study with Average values, standard deviation

values, Maximum and Minimum values are presented in Table 1. Comparison of various Heavy Metals analysis at all the four sampling stations for Average values is presented in Fig. 2.

**Table 1: Heavy Metal analysis of Satluj River at Himachal Pradesh during May, 2015 to April, 2016 at different sampling stations.**

Values/Sampling Stations	SS-1	SS-2	SS-3	SS-4	SS-5
<b>Copper values (mg/l)</b>					
Maximum	0.0024	0.0380	0.0137	0.0054	0.0076
Minimum	0.0007	0.0012	0.0016	0.0014	0.0024
Average	0.0017	0.0077	0.0039	0.0023	0.0036
SD ( )	±0.00055	±0.01124	±0.00401	±0.00150	±0.00183
<b>Cadmium values (mg/l)</b>					
Maximum	0.0130	0.0199	0.0096	0.0291	0.0123
Minimum	0.0006	0.0076	0.0008	0.0068	0.0009
Average	0.00905	0.01060	0.00616	0.01042	0.00395
SD ( )	±0.00434	±0.00339	±0.00380	±0.00631	±0.00374
<b>Chromium values (mg/l)</b>					
Maximum	0.0007	0.0004	0.0007	0.0007	0.1460
Minimum	0.0005	0.0004	0.0004	0.0005	0.0142
Average	0.00063	0.00040	0.00061	0.00057	0.05200
SD ( )	ND	ND	±0.00011	ND	±0.00554

Continued...

Values/Sampling Stations	SS-1	SS-2	SS-3	SS-4	SS-5
<b>Manganese values of (mg/l)</b>					
<b>Maximum</b>	0.4620	0.0125	0.0024	0.0146	0.2300
<b>Minimum</b>	0.0055	0.0012	0.0007	0.0014	0.0154
<b>Average</b>	0.1315	0.0033	0.0020	0.0057	0.0391
<b>SD ( )</b>	±0.1595	±0.0038	±0.00051	±0.004	±0.0601
<b>Nickel values of (mg/l)</b>					
<b>Maximum</b>	0.0121	0.0115	0.0185	0.0100	0.0148
<b>Minimum</b>	0.0010	0.0038	0.0010	0.0022	0.0115
<b>Average</b>	0.0102	0.0054	0.0054	0.0039	0.0133
<b>SD ( )</b>	±0.00341	±0.00240	±0.00480	±0.00220	±0.00080
<b>Zinc values of (mg/l)</b>					
<b>Maximum</b>	0.0184	0.0385	0.3490	0.0135	0.0458
<b>Minimum</b>	0.0002	0.0331	0.0035	0.0075	0.0116
<b>Average</b>	0.1240	0.0367	0.0957	0.0118	0.0397
<b>SD ( )</b>	±0.0074	±0.0017	±0.1299	±0.0024	±0.0100
<b>Mercury values of (mg/l)</b>					
<b>Maximum</b>	0.0003	0.0001	0.0009	0.0001	0.0009
<b>Minimum</b>	0.0003	0.0001	0.0002	0.0001	0.0001
<b>Average</b>	0.0003	0.0001	0.0005	0.0001	0.0004
<b>SD ( )</b>	±0	ND	±0.00033	±0	±0.00033

BDL – Below Detection Limit; SD – Standard Deviation; SS-1 - First Sampling Station (Khab, Kinnaur, Himachal Pradesh); SS-2 - Second Sampling Station (Wangtoo, Kinnaur, Himachal Pradesh); SS-3 - Third Sampling Station (Bayal, Rampur city, Shimla, Himachal Pradesh); SS-4 - Fourth Sampling Station (Kol dam, Bilaspur, Himachal Pradesh); SS-5 - Fifth Sampling Station (Wajipur Kalan, Ludhiana, Punjab).

**DISCUSSION**

Water qualities provide the primary assessment of the pollution status and it can be determined through the assessment of various parameters as Heavy Metals.

**Copper:** The copper is essential nutrient and also drinking water contaminant. Copper is mainly used in

making pipes, valves and also present in alloys and coatings therefore copper is a widely distributed trace element because most copper minerals are relatively insoluble and is sorbed to solid phases hence only low concentrations are normally present in natural waters.

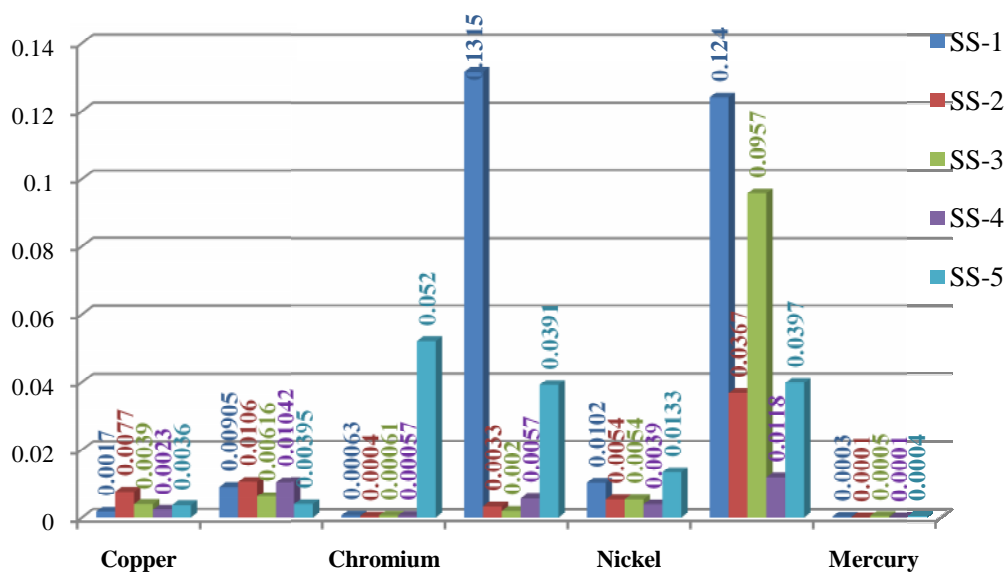


Fig. 2. Comparison of Average Values of Heavy Metals at different Sampling Stations.

Average value of copper in Satluj river varies from 0.0007 to 0.0380 mg/l at all sampling stations with minimum at SS-1 and maximum at SS-2. The results show that copper value in Satluj river is below the maximum permissible limit prescribed by BIS, 2012 and WHO, 2011 standards.

**Cadmium:** The cadmium related compounds are widely used in batteries industry and plastics. The pollution of water with cadmium mainly as a consequence of mining, electroplating plants, pigment works, textile and chemical industries. The average value of Cadmium was higher than the prescribed limit of 0.003 mg/l by WHO, 2011, and BIS, 2012 at all sampling stations. Average value of cadmium in Satluj river varies from 0.0006 to 0.0291 mg/l with minimum at SS-1 and maximum at SS-4.

**Chromium:** The concentration of chromium in natural waters is usually very low but high concentrations of chromium can result from mining and industrial processes. Average value of chromium in Satluj river varies from 0.0004 to 0.1460 mg/l with minimum at SS-2 & SS-3 and maximum at SS-5. Increased level of chromium was observed at SS-5 showing the population load and activities caused industrial discharges.

**Manganese:** Manganese is an essential element and required in small amount by all living organisms. The average value of manganese in Satluj river varies from 0.0007 to 0.4620 mg/l with minimum at SS-3 and maximum at SS-1. The results show that manganese concentration in water is above the maximum permissible limit only at SS-1 while in other sampling stations value of manganese Satluj river is below the maximum permissible limit prescribed by BIS, 2012, CPCB, 2014 and WHO, 2011 standards. Higher manganese value at SS-1 is supposed due to weathering of manganese bearing minerals, rocks landfill and leachate.

**Nickel:** The average value of nickel in Satluj river varies from 0.001 to 0.018 mg/l with minimum at SS-3 and maximum at SS-3 & SS-5. The results show that the nickel value in Satluj river is below the maximum permissible limit prescribed by BIS, 2012 and WHO, 2011 standards.

**Zinc:** The average value of zinc in Satluj river varies from 0.0002 to 0.3490 mg/l with minimum at SS-1 and maximum at SS-3. The results show that the average zinc value in Satluj river is below the maximum permissible limit prescribed by BIS, 2012 and WHO, 2011 standards.

**Mercury:** The average value of mercury in Satluj river varies from 0.0001 to 0.0009 mg/l with minimum at SS-2, SS-4 & SS-5 and maximum at SS-3. The results show that the nickel value in Satluj river is below the

maximum permissible limit prescribed by BIS, 2012 and WHO, 2011 standards.

## CONCLUSION

This study provides an informative data and helps to understand the contamination of Satluj river. The major sources of pollutants are local anthropogenic activities, agricultural runoff, industrial effluent and siltation. In the present study it was found that Heavy Metals Copper (Cu), Nickel (Ni), Zinc (Zn) and Mercury (Hg) were under prescribed limits at all sampling stations but Cadmium (Cd), Chromium (Cr) and Manganese (Mn) crossed the maximum permissible limit, due to heavy mixing of effluents, domestic sewage and siltation. This study concluded that the water quality of Satluj river has been severely deteriorated.

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