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# INVESTIGATION OF HEAVY METAL CONTAMINATION IN RIVERINE OF BADDI, HIMACHAL PRADESH

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## ABSTRACT

**The management of water resources is one of the essential factors as in the absence of water; life on the earth is not possible. The present study highlights the Heavy Metal contamination of different rivers of Baddi (H.P). The rising unplanned industrialization and their weak governance system adding toxic pollutants, therefore the rivers and riverine of Baddi area are degrading gradually. Heavy metals in riverine environment represent an abiding treat to human health. These heavy metals are not easily degradable in nature and accumulate in plants, animals and human bodies leading to toxic effects. This study includes the six heavy metals namely Iron, Copper, Chromium, Lead, Zinc and Cadmium found in range of 0.19-2.3, 0.01-0.15, 0-0.09, 0.01-0.12, 0.01-0.12 and 0-0.001 mg/l, respectively. The investigation of heavy metals can be done by using Flame Atomic Absorption Spectrometry (APHA). The overall mean concentration of heavy metals was observed in the following order Fe > Zn > Cu > Cr > Pd > Cd. The enhanced concentration of certain metals in the riverine ecosystem may be attributed due to anthropogenic contribution from industrial activities of the area. So it's important to design strategies to control mismanagement of valuable water resources.**

**KEY WORDS:** Riverine, Baddi, Heavy Metals, Industrialization, Water pollution.

## INTRODUCTION

Water is the basic necessity to sustain various forms of life. However, the cumulative effect of population, urbanization and industrialization lead to deterioration of water quality, mainly the impairment of surface water has been rising in the past few decades.

In surface water, rivers are extremely susceptible to pollution which is the result of anthropogenic activities. Heavy metal contamination in the aquatic system is the major threat and main concern of our rivers. Urbanization leads to degradation of our water resources by adding many harmful heavy metals in it (Aiyesanmi *et al.,* 2004; Amajor, 1986; Gupta *et al.,* 2009; Haritash *et al.,* 2008; Khawaja *et al.,* 2017; Rout *et al.,* 2017; Sharma and Walia, 2016). Both natural and anthropogenic activities are responsible for abundance of heavy metals in the environment (Wilson and Pyatt, 2007; Khan *et al.,* 2008). Being the civilized species on the earth, humans should take care of environment as it has also specific tolerance limit.

Contamination by heavy metals in water resources is due to the effect of unplanned urbanization and haphazard industrialization (Zhang *et al.,* 2011; Bai, *et al.,* 2011; Grigoratos *et al.,* 2014; Martin *et al.,* 2015; Bhuyan and Islam, 2017; Chung *et al.,* 2018). Heavy metal investigation in riverine water help us to accesses the degree of anthropogenic activities. Therefore, it is important to measure the concentration heavy metals in water and sediments of any contaminated riverine ecosystem, (Ali *et al.,* 2016).

Baddi of Himachal Pradesh is rapidly growing industrial area, known as Asia's leading industrial hub. As per the BBN development authority report in 2007, the 72% of industries in the study areas operating without effluent treatment plant (ETPs) have raised the pollution of Sirsa river (Herojeet *et al.,* 2015). Majority of heavy metal studies has been done on Sirsa river of the Baddi area. However, in our study we have included four different riverine of Industrial areas at discrete sampling stations.

## MATERIALS AND METHODS

**Study area:** The study was conducted for the evaluation of heavy metal concentration in different riverine ecosystems of Baddi of Himachal Pradesh. It is situated between the latitude of $30^0 55' 53.41''$ to $31^0 01' 30.63''$ N and longitude of $76^0 49' 25.45''$ to $76^0 82' 50.11''$ E. Surface water samples were collected from four sampling sites which receives waste from different sources. Sampling stations were selected on the basis of water pollution and water quality was accessed as per APHA and BIS guidelines. SRB-SS1 was first sampling station of Balad Khadd, SRR-SS2 was second sampling station of Ratta Khadd, SRM-SS3 was third sampling station around Manpura Khadd and SRBB-SS4 was forth sampling station of Bagbania Khadd. The collected water sample was subjected to analysis in ECO Laboratories & Consultants Pvt. Ltd. Mohali (Punjab) for detection of Heavy Metals like copper, iron, zinc, cadmium, lead and chròmium. Heavy metals in riverine environment represent an abiding threat to human health (Dipak Paul, 2017).

**Methodology:** Water samples were collected from March 2021 to June 2021. Two litre of surface water sample was collected and its temperature was noted at the sampling sites. After that water samples were acidified with 2N conc. $HNO_3$ per litre of the sample to avoid precipitations of heavy metals. The bottles were tightly closed and stored at $4^0$C to prevent evaporation (Singh *et al.,* 2005; Sehgal *et al.,* 2012). Samples were transferred to ECO Laboratories situated in Mohali (Punjab). For the testing, Standard Methods (APHA 2012) were followed. Atomic Absorption Spectrometry (AAS) of model: 240 FS version 5.1 PRO. was used for identification of heavy metals in the surface water of riverine system. The results obtained were evaluated by comparing them with standard values of Bureau of Indian standards (BIS), WHO and ICMR guidelines as shown in Table 5.

## RESULTS

Area around the Baddi is densely populated and highly industrialized, cause the rise in heavy metal concentration in the surface water resources. The results of heavy metal contamination at four different riverine viz. Balad Khadd, Ratta Khadd, Manpura Khadd and Bagbania Khadd are shown in Table 1, Table 2, Table 3 and Table 4 respectively. The average concentration of heavy metals in water followed the decreasing order of: Fe > Zn > Cu > Cr > Pd > Cd. Results were anlysed with mean value of readings at three positions of each riverine for the month of March, April, May, June and July and their standard deviations (±SD) has been also displayed.

## DISCUSSION

**Copper:** It is an essential trace element important in

**Table 1.** Heavy metal analysis of SRB-SS1 during March, 2021 to July, 2021.

| Parameters | Mar-21 | (±)(S.D) | Apr-21 | (±)(S.D) | May-21 | (±)(S.D) | Jun-21 | (±)(S.D) | Jul-21 | (±)(S.D) |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper (Cu)-(mg/l) | 0.0403 | 0.0359 | 0.0327 | 0.0155 | 0.0267 | 0.0289 | 0.03 | 0.0265 | 0.0267 | 0.0208 |
| Iron(Fe)-(mg/l) | 0.56 | 0.2884 | 0.5067 | 0.1877 | 0.52 | 0.3559 | 0.507 | 0.2122 | 0.4767 | 0.1674 |
| Zinc(Zn)-(mg/l) | 0.0733 | 0.0929 | 0.0933 | 0.085 | 0.0633 | 0.0681 | 0.107 | 0.0833 | 0.09 | 0.0794 |
| Cadmium(Cd)-(mg/l) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0003 | 0.0006 |
| Lead(Pb)-(mg/l) | 0.0253 | 0.015 | 0.029 | 0.0201 | 0.0243 | 0.015 | 0.033 | 0.0153 | 0.03 | 0.0173 |
| Chromium (Cr)-(mg/l) | 0.0467 | 0.0153 | 0.025 | 0.025 | 0.0367 | 0.0252 | 0.034 | 0.0051 | 0.0333 | 0.0058 |

**Table 2.** Heavy metal analysis of SRR-SS2 during March, 2021 to July, 2021.

| Parameters | Mar-21 | (±)(S.D) | Apr-21 | (±)(S.D) | May-21 | (±)(S.D) | Jun-21 | (±)(S.D) | Jul-21 | (±)(S.D) |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper (Cu)-(mg/l) | 0.0767 | 0.0643 | 0.0733 | 0.0493 | 0.0767 | 0.0987 | 0.0767 | 0.0814 | 0.0803 | 0.0868 |
| Iron(Fe)-(mg/l) | 0.6 | 0.1353 | 0.7467 | 0.0666 | 0.5933 | 0.165 | 0.5833 | 0.2454 | 0.5867 | 0.2136 |
| Zinc(Zn)-(mg/l) | 0.0767 | 0.0723 | 0.0867 | 0.0603 | 0.05 | 0.0265 | 0.0933 | 0.085 | 0.0833 | 0.0709 |
| Cadmium(Cd)-(mg/l) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lead(Pb)-(mg/l) | 0.0347 | 0.0139 | 0.032 | 0.008 | 0.0213 | 0.0103 | 0.034 | 0.008 | 0.0303 | 0.01 |
| Chromium (Cr)-(mg/l) | 0.04 | 0.02 | 0.06 | 0.03 | 0.0333 | 0.0321 | 0.0433 | 0.0153 | 0.0433 | 0.0058 |

**Table 3.** Heavy metal analysis of SRM-SS3 during March, 2021 to July, 2021.

| Parameters | Mar-21 | (±)(S.D) | Apr-21 | (±)(S.D) | May-21 | (±)(S.D) | Jun-21 | (±)(S.D) | Jul-21 | (±)(S.D) |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper (Cu)-(mg/l) | 0.0867 | 0.0737 | 0.1 | 0.0819 | 0.0267 | 0.0153 | 0.0733 | 0.0929 | 0.0733 | 0.1012 |
| Iron(Fe)-(mg/l) | 1.15 | 0.8246 | 1.033 | 0.8021 | 0.3067 | 0.1457 | 0.9767 | 1.1518 | 0.82 | 0.8571 |
| Zinc(Zn)-(mg/l) | 0.1133 | 0.0666 | 0.113 | 0.0586 | 0.0533 | 0.0321 | 0.1267 | 0.0833 | 0.15 | 0.1153 |
| Cadmium(Cd)-(mg/l) | 0 | 0 | 0 | 0 | 0 | 0 | 0.0003 | 0.0006 | 0 | 0 |
| Lead(Pb)-(mg/l) | 0.0173 | 0.0255 | 0.032 | 0.0204 | 0.029 | 0.0276 | 0.0357 | 0.025 | 0.0333 | 0.0208 |
| Chromium (Cr)-(mg/l) | 0.0567 | 0.0153 | 0.037 | 0.0289 | 0.0167 | 0.0153 | 0.0567 | 0.0208 | 0.0433 | 0.0153 |

**Table 4.** Heavy metal analysis of SRBB-SS4 during March, 2021 to July, 2021.

| Parameters | Mar-21 | (±)(S.D) | Apr-21 | (±)(S.D) | May-21 | (±)(S.D) | Jun-21 | (±)(S.D) | Jul-21 | (±)(S.D) |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper (Cu)-(mg/l) | 0.11 | 0.0346 | 0.0767 | 0.0503 | 0.08 | 0.0265 | 0.0867 | 0.0451 | 0.0867 | 0.0603 |
| Iron(Fe)-(mg/l) | 0.8767 | 0.5514 | 0.7267 | 0.4508 | 0.47 | 0.2287 | 0.4667 | 0.2409 | 0.44 | 0.2787 |
| Zinc(Zn)-(mg/l) | 0.1333 | 0.1079 | 0.1467 | 0.1193 | 0.1367 | 0.0306 | 0.177 | 0.1441 | 0.18 | 0.0985 |
| Cadmium(Cd)-(mg/l) | 0 | 0 | 0 | 0 | 0 | 0 | 0.0003 | 0.0006 | 0.0007 | 0.0006 |
| Lead(Pb)-(mg/l) | 0.0673 | 0.0498 | 0.0697 | 0.0535 | 0.0633 | 0.0551 | 0.07 | 0.0557 | 0.06 | 0.0458 |
| Chromium (Cr)-(mg/l) | 0.0367 | 0.0351 | 0.06 | 0.02 | 0.03 | 0.03 | 0.0557 | 0.0367 | 0.0407 | 0.0253 |

**Table 5.** Comparative values of heavy metals analyzed BIS 2012, WHO and ICMR.

| Parameters | SRB-SS1 | SRR-SS2 | SRM-SS3 | SRBB-SS4 | Permissible limit | | |
|---|---|---|---|---|---|---|---|
| | | | | | ISI | WHO | ICMR |
| Copper (Cu)-(mg/l) | 0.0313 | 0.0767 | 0.072 | 0.088 | 0.05 | 1 | 1.5 |
| Iron(Fe)-(mg/l) | 0.514 | 0.622 | 0.85733 | 0.596 | 0.3 | 0.1 | 1 |
| Zinc(Zn)-(mg/l) | 0.0853 | 0.078 | 0.11133 | 0.15473 | 5 | 5 | 0.1 |
| Cadmium(Cd)-(mg/l) | 0 | 0 | 0 | 0.0002 | 0.003 | 0.005 | 0.01 |
| Lead(Pb)-(mg/l) | 0.0283 | 0.0305 | 0.02953 | 0.06607 | 0.1 | 0.05 | 0.05 |
| Chromium (Cr)-(mg/l) | 0.0352 | 0.044 | 0.042 | 0.0446 | 0.05 | 0.1 | - |

different metabolic pathways of living organisms. However, too much copper can cause stomach cramps, diarrhoea, vomiting and even liver and kidney damage (Rana and Walia, 2019). During the course of study it has been observed that out of four riverine, three of them have copper above the permissible limits of 0.05 mg/l for all the months from March 2021 to July 2021.

**Chromium:** Exposure of chromium has been found to cause dermitis, perforation of nasal septa and kidney disorder (Ayodele and Gaya, 1998; Vincoli, 1995). Different industries such as electroplating, paint and pigment manufacturing, textile, fertilizer and leather tanning discharge Cr (Bhardwaj *et al.,* 2019). The study revealed that three of the sampling sites have chromium concentration above the acceptance limit of 0.05 mg/l.

**Iron:** It is vital element of human diet having its ability to form fundamental component of many enzymes. But its excessive intake results in hemochromatosis affecting the normal metabolism (Hussain *et al.,* 2017; Mesias *et al.,* 2013). Maximum sampling sites of the study area have Fe concentration above the permissible limit of ISI and this may be due to anthropogenic activities including leaching and corrosion of iron pipes.

**Lead:** All the sampling stations, SRB-SS1, SRR-SS2, SRM-SS3 and SRBB-SS4were shown to have significant concentration of lead which is more than the acceptance limit of 0.01 mg/l. Lead is a toxic heavy metal and its poisoning has been reported to cause teratogenic effect, inhibits haemoglobin synthesis and nervous system disorders (Ogwuegbu and Muhanga, 2005).

**Cadmium:** It is regarded as most hazardous trace element and its poisoning may cause damage to kidney and heart (Udoessien, 2003). However, the heavy metal analysis of surface water samples in this study showed that all the sampling sites have Cd concentration below the permissible limit.

**Zinc:** Zinc being an essential trace element in low concentration but toxic in high concentration (Oborn *et al.,* 2005). High level of Zinc in drinking water can lead to alimentary disorder and lung disturbance

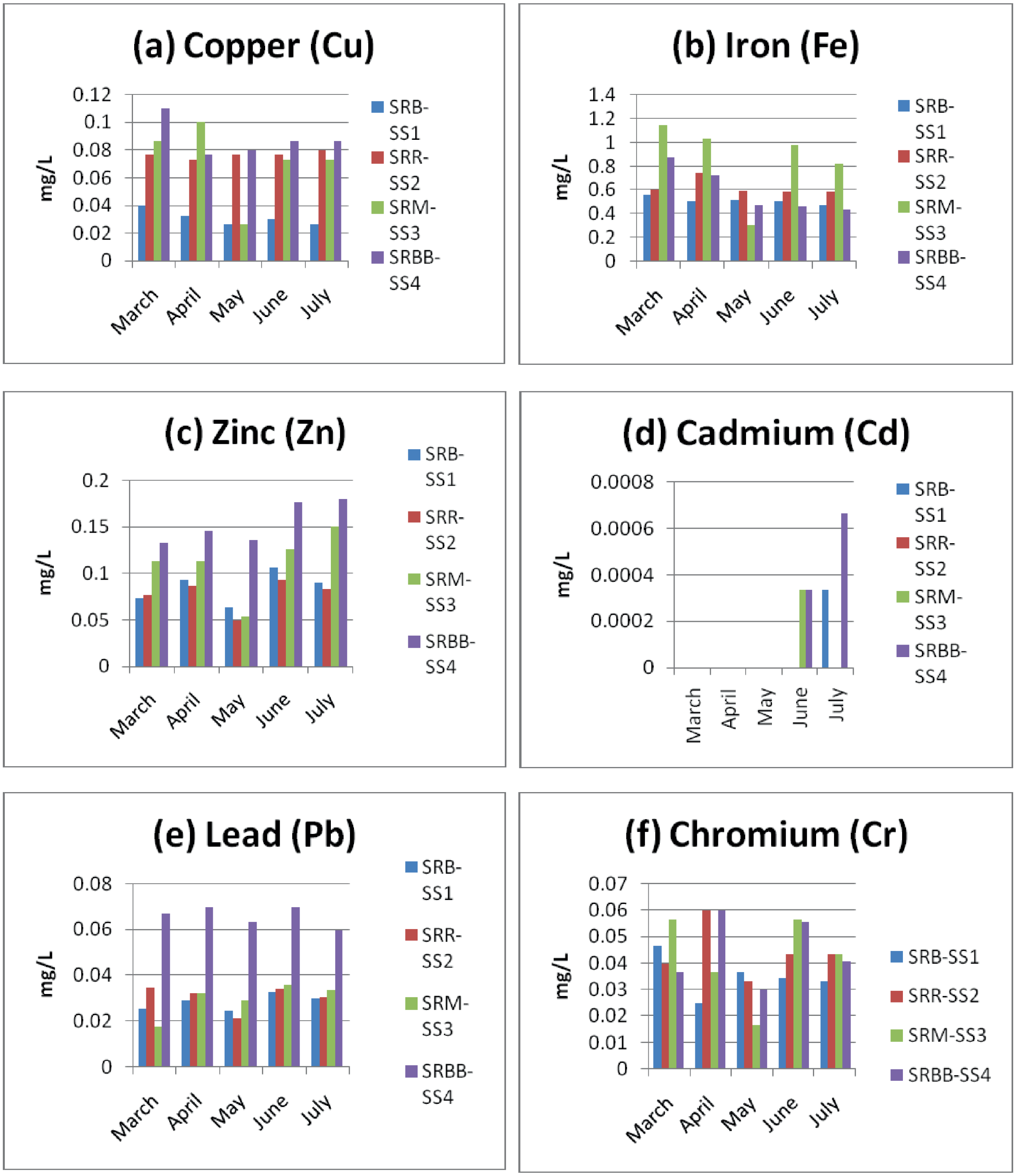


**Fig. 1.** Monthly variation of heavy metals from March 2021 to July 2021. (a) Copper, (b) Iron, (c) Zinc, (d) Cadmium, (e) Lead, (f) Chromium.

(Eka *et al.*, 2003). Results obtained for Zinc from the study area shown that its concentration is within the acceptance limits in all the sampling sites.

Industrialization has its adverse effect on agriculture and human health. This may leads to disorders like blood pressure, asthma, lungs problem, chest pain etc. (Sharma *et al.*, 2016). So rising pollution should be monitored and checked regularly to sustain our environment and life as well.

## CONCLUSION

This research article indicates the presence of heavy metals in the riverine of Industrial area of Baddi, Himachal Pradesh. The surface water of the study area contains toxic elements viz. copper, iron, zinc, cadmium, lead & chromium. Many of Heavy metals were not found within the acceptance limits except cadmium & zinc. It has been shown in Fig. 1, copper, zinc, cadmium and lead are found in high concentration in the Bagbania Khadd, iron if found more in Manpura Khadd where as chromium is high in Ratta khadd of Baddi. The study suggested that heavy metals contained in the surface water should be monitored regularly. More industrial effluent treatment plants should be installed and domestic sewage should be properly channelized so that our natural resources could be saved.

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## CONFLICT OF INTEREST

There is no conflict of interest for this manuscript.

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