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# Assessment of Heavy Metals and Environmental Monitoring in Surface Sediments and water at Someshwari River, North-Eastern Bangladesh

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**Abstract:** Studying surface sediment properties is crucial to understanding biological dynamics, environmental pollutants and sedimentary processes in aquatic systems. The Purpose of this research was to evaluate the level of heavy metal contamination in the surface sediment and water of Someshwari river. Six sediment samples and six water samples were analyzed by ICP-MS. The mean concentrations ($\mu g\ g^{-1}$) of As, Cd, Co, Cu, Cr, Ni, Fe, Mn, Pd, Se, V, Zn from the Someshwari river sediment were 9.215, 0.441, 11.45, 10.58, 80.26, 87.26, 25166.67, 420.5, 11.47, 15.52, 56.53, 34.25 respectively. In order of heavy metals, Fe>Mn>Zn>Cu>Ni>V>Se>Cr>Co>As>Cd were found in the Someshwari river water with mean values of 1291.17 $\mu g\ L^{-1}$, 891.93 $\mu g\ L^{-1}$, 14.18 $\mu g\ L^{-1}$, 3.36 $\mu g\ L^{-1}$, 3.31 $\mu g\ L^{-1}$, 2.5 $\mu g\ L^{-1}$, 1.49 $\mu g\ L^{-1}$, 1.40 $\mu g\ L^{-1}$, 1.07 $\mu g\ L^{-1}$, 0.45 $\mu g\ L^{-1}$, and 1.07 $\mu g\ L^{-1}$ respectively. Significant correlations were found between the contaminants of As and Cr ($r = 0.91$), As and Fe ($r = 0.97$), Ni and V ($r=0.91$), Se and V (0.99) in sediment and As and Mn ($r = 0.83$), Cd and Cu ($r=0.80$), Co and Fe ($r=0.95$), Co and Mn ($r=0.97$) in river water. In surface sediments As, Cr and Cu exceeds the lowest effect level (LEL) and Ni exceed the severe effect level (SEL). The Someshwari River's water is contaminated with Fe, Mn, and V. The main sources of metals in this river water are the weathering of rocks, sediments and sand extraction. This research suggests the regular monitoring of sediments and water for maintaining ecological balance.

## 1. Introduction

One of the main sources of heavy metals in the aquatic environment is river sediments. Sediments are the final sink for heavy metals released into the environment. They are a mixture of various mineral species and organic waste (Islam *et al.,* 2020). Heavy metals are potentially accumulated in sediments and aquatic organisms in the fresh water environment and subsequently transferred to man through the food chain. As a result, the concentration of heavy metals in aquatic ecosystems is usually scrutinized by measuring their concentrations in sediments (Ekeanyanwu *et al*., 2010). The major risks to plant, animal, and human health are caused by an excess of hazardous metals in the environment (Rahman *et al.,* 2020). One of the primary environmental elements that is vital to all aspects of human existence is water (Rahman *et al.,* 2016). Water quality deteriorates and becomes contaminated due to chemical or biological pollution. Both humans and other living things are negatively impacted by this water (Hanif *et al.,* 2020; Brahimi *et al.,* 2015).

Quality of water is affected by human-induced or natural activities in the upstream watershed (Sany *et al.,* 2013). Because of the natural flow of the water, most pollutants are drained into a one-point collection site, such as reservoirs that can serve as a sink for different pollutants (Nowrouzi and Pourkhabbaz, 2014). Due to its potential and toxic environmental and public health effects and the ability to accumulate, heavy metal contamination of the aquatic ecosystems is becoming a potential global problem (Sharma *et al*., 2015), (Karim *et al*., 2016). As a result, sediment may include heavy metals that will eventually leak into the water column.

The distribution of heavy metals through complex processes of material exchange within these aquatic environments can also be affected by anthropogenic inputs (Venkatramanan *et al*., 2015). Anthropogenic activities, such as industrial and agricultural discharges, inappropriate disposal of industrial wastes, dumping of domestic and municipal wastes, faulty drainage systems are some of the causes for heavy metal contamination of aquatic ecosystems (Hahladakis *et al*., 2013), (Islam *et al.,* 2015), (El abdouni *et al*., 2021), (Hahladakis *et al*., 2013). The health of many aquatic creatures depends on the quality of the sediment, which is a crucial component of fine sediment particle matter (Saroop and Tamchos, (2021).

Bottom stream sediments are sensitive indicators for monitoring contaminants as they can act as a sink and a carrier for pollutants in the aquatic environment (Benson and Etesin, 2008), (Asefa and Beranu, 2015). Heavy metal pollution of aquatic ecosystems is becoming a potential global problem. Trace elements may be immobilized within the stream sediments and thus could be involved in the absorption, precipitation and complex formation (Mohiuddin *et al*., 2010). Analysis of pollutants in sediments is vital as they were adsorbed by material in suspension and by fine-grained particles (Rainey *et al.,* 2003). Pekey (2006) demonstrated that the heavy metals tend to be trapped in aquatic environments and accumulate in sediments. Understanding the extent of heavy metal contamination in sediments and the possible ecological consequences associated with it requires research. Researchers try to minimize the heavy metal's levels in waters by proposing several chemical, biological… processes (Deghles *et al.,* 2019; Errich *et al.,* 2021; El Hammari *et al.,* 2022; Nairat *et al.,* 2022;)

The Someshwari River links the Konghso river, which is one of the largest rivers in northeastern area of Bangladesh, and The Someshwari River is composed of Atrakhali Channel. Recent years have seen increasing population density, as well as rapid expansion in mining and agriculture. On the other hand, barely is known about the geographical distribution of metal concentrations in river sediments along streams in urban and semi-urban areas. Therefore, this study fills in research gaps and offers useful data on specific heavy metals found in the Someshwari rivers near the Durgapur Upazila. The purpose of the study was to determine the level of major heavy metal contamination in surface sediment and water of Someshwari river.

## 2. Materials and methods:

### 2.1 Study area

Durgapur Upazila (small city) of Netrokona district, having an area of 293.42 square kilometers and consists of 7 unions (BBS, 2022). The study area is located in the most north-eastern part of Durgapur **Figure 1**. The Someshwari River sand deposit, which is studied in this research, is located in the north-eastern part of Bangladesh. Someshwari river known as Simsang river in the Indian state of Meghalaya is a major river in the Garo Hills of Meghalaya and Netrokona District of Bangladesh. It divides the Garo Hills into two parts (Kabir *et al*., 2021). According to west Garo Hills district, profile by State Government of Meghalaya (DCMSME, 2012) the Tura range is the source of the river, one of the major rivers of Meghalaya. The Someshwari river is the largest and the second longest river in West Garo Hills District, India. The river is locally known as Simsang. The Someshwari river of Bangladesh is mainly sand bedded rivers, the quantity of sediments carried by these rivers is tremendous, and the sediments contain large quantity of sandy materials, which are generally laid down in the beds of the river, forming sand bars.

**Table 1.** Sampling stations and their code, GPS coordinates, and major anthropogenic activities in the Someshwari river.

| Sample ID | Sampling Point | Latitude | Longitude | Major anthropogenic Activities |
|---|---|---|---|---|
| S1W1 | Birishiri | 25.112282 | 90.676028 | Bath, Wash |
| S2W2 | Birishiri-Shibganj Ghat | 25.11715278 | 90.66954722 | Human movement, bath, transport |
| S3W3 | Teri bazar | 25.124659 | 90.668055 | Human movement, sand mining |
| S4W4 | Shoshan Ghat | 25.12867 | 90.671903 | Sand mining, Coal Collecting, Bath |
| S5W5 | Atrakhali | 25.13334722 | 90.669525 | Sand mining |
| S6W6 | Kullagora | 25.14035 | 90.66824444 | Sand mining, Human movement, transport |

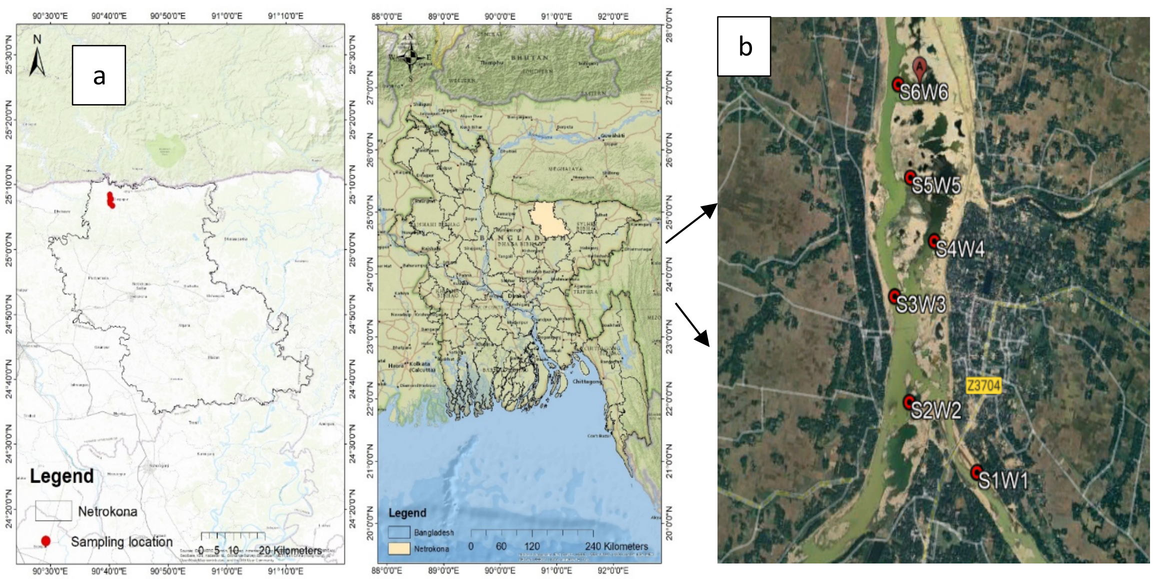


**Figure 1.** Location of the study area (a) ArcGIS 10.8; (b) Google earth pro.

## 2.2 Sample collection procedure

### *2.3 Sample collection*

Sediment and water samples were collected from 6 locations at Someshwari River in post monsoon season (December), 2023. Surface sediment samples were taken at a depth of 10 cm. Sampling sites located between 1~2 km from each other. Approximately, 300-500 g sediment samples were from each sampling site. Water samples collected in the depth range of 10~20 cm. water samples were acidified with 10% $HNO_3$. After sampling water, sample bottles were properly sealed and labeled with sampling Id, date and name.

### *2.4 Sample preparation procedure*

To begin with, Sediment samples were sun- dried for 48 hours. After that, Samples were transported to the laboratory. Samples were oven dried at 70 °C for 48 hours and ground using mortar and pestle. Then sieved (0.63 to .75 mm) the samples. The lower particle size fraction was homogenized by grinding again in the mortar and stored in plastic bag until chemical analyses were carried out and marked well. Precautions were taken to avoid contamination during drying, grinding, sieving and storage. At a time acidify water samples were stored in ice box.

### 2.4 *Digestion of sediment and water sample*

For metal analysis, powdered sediment sample weighing 0.2g was digested using 7 ml 70% Nitric acid ($HNO_3$) and 3 ml $H_2O_2$. Both chemicals were used of analytical grade. Sample and both reagents were mixed in vessel tube. After that, all of vessels were sealed properly and kept in Microwave Digestion system (Ethos Easy Milestone) for 40 minutes where temperature rising up to 200 °C. After cooling this digested samples filtered by using Whatman grade 42 filter paper. There after filtered paper kept in separate places to avoid contamination. After filtered mixer pour into 50 ml plastic bottle and filled it by deionized water.

For heavy metal identification from water, 50 ml Acidify water samples were filtered by using 125 mm filter paper (Whatman grade 42) and pour into plastic bottle. Samples were again filtered by syringe filter (0.45 µm hpPTFE) then set into ICP-MS sampling point by using test tube. Filtered sediment and water samples were ready for Inductively Coupled Plasma Mass Spectrometry (ICP-MS) (SHIMADZU-2030LF) analysis.

### 2.6 *Data analysis*

Microsoft excel 2016, Correlation analysis were used to perform and all of the statistical data in this study were analyzed. Pearson's correlation coefficient matrix (r) was used to assess the relationship between the heavy metal of the white clay and groundwater. ArcGIS 10.8 and google earth pro software was used to prepare for study area map.

## 3. Results and discussion

### *3.1. Abundance of heavy metals in sediments*

#### *3.1.1 Major Heavy metal analysis*

Considerable amount of metals accumulate in sediment and ultimately enter into the food chain through water, plants or leaching into groundwater. Heavy metals are responsible for brain damage or the reduction of mental processes (Garza *et al.,* 2006). The analysis of results showed that the average heavy metal concentrations in the surface sediment of Someshwari river were in the order of:

$$Fe > Mn > Ni > Cr > V > Zn > Se > Co > Pd > Cu > As > Cd.$$

The mean value **Table 2** of As, Cd, Co, Cu, Cr, Ni, Fe, Mn, Pd, Se, V, Zn from someshwari river sediment were found 9.215 µg $g^{-1}$, 0.441 µg $g^{-1}$, 11.45 µg $g^{-1}$, 10.58 µg $g^{-1}$, 80.26 µg $g^{-1}$, 87.26 µg $g^{-1}$, 25166.67 µg $g^{-1}$, 420.5 µg $g^{-1}$, 11.47 µg $g^{-1}$, 15.52 µg $g^{-1}$, 56.53 µg $g^{-1}$, 34.25 µg $g^{-1}$, respectively. Mohiuddun *et al.,* (2015) studied Buriganga river sediment of heavy metal and he found that Cr, Pd, Cd, Zn, Cu, Ni concentration were 173.4 µg $g^{-1}$, 31.4 µg $g^{-1}$, 1.5 µg $g^{-1}$, 481.8 µg $g^{-1}$, 344.2 µg $g^{-1}$, 153.3 µg $g^{-1}$, respectively.

**Table 2.** Heavy metal concentrations of s Someshwari river sediment (μg $g^{-1}$)

| Sam-ple No | As | Cd | Co | Cu | Cr | Ni | Fe | Mn | Pd | Se | V | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 7.89 | 0.42 | 7.56 | 6.92 | 62.6 | 65.7 | 17700 | 509 | 8.91 | 8.63 | 37.6 | 28.9 |
| S2 | 8.33 | 0.46 | 12.8 | 14.2 | 75.4 | 79.5 | 23200 | 364 | 15.3 | 13.9 | 49.2 | 40.1 |
| S3 | 9.88 | 0.426 | 15.8 | 12.3 | 96.6 | 96.2 | 27900 | 544 | 10.2 | 11.9 | 53.2 | 39.6 |
| S4 | 14.5 | 0.44 | 14 | 9.67 | 108 | 133 | 43700 | 497 | 16.7 | 35.1 | 107 | 34.9 |
| S5 | 6.82 | 0.43 | 11.8 | 10.5 | 68.7 | 89.7 | 20800 | 357 | 10.8 | 11.3 | 46.5 | 40.4 |
| S6 | 7.87 | 0.45 | 6.75 | 9.92 | 70.3 | 59.5 | 17700 | 252 | 6.96 | 12.3 | 45.7 | 21.6 |
| Mean | 9.215 | 0.44 | 11.4 | 10.585 | 80.26 | 87.26 | 25166.6 | 420.5 | 11.478 | 15.52167 | 56.53333 | 34.25 |
| Range | 6.82-14.5 | 0.426-0.464 | 6.75-15.8 | 6.92-14.2 | 62.6-108 | 59.5-133 | 17700-43700 | 252-544 | 6.96-16.7 | 8.63-35.1 | 37.6-107 | 21.6-40.4 |

Datta and Subramaniam (1998) showed the Padma river sediment of heavy metals such as Cr, Pd, Zn, Cu, Ni concentration were 97 μg $g^{-1}$, 17 μg $g^{-1}$, 76 μg g-1, 25 μg $g^{-1}$, 28 μg $g^{-1}$ respectively. A recent study conducted by Mohiuddin *et al.,* (2016) in Turag river has shown that the concentrations of Cr, Pb, Cd, Ni, Zn, Cu, Fe and Mn were 178.0, 18.3, 0.8, 155.4, 194.1, 54.8, 13679 and 5501.6 μg $g^{-1}$, respectively.

The concentration of As ranged from 6.82 to 14.5 μg $g^{-1}$ with a mean value of 9.215 μg $g^{-1}$. Maximum concentration of As was found in sample No. 4 near at Durgapur shoshan ghat. The mean value of As is partially higher than Lowest effect level (6) and not exceed Severe effect level. The concentration of Cr ranged from 62.6 to 108 μg $g^{-1}$ with a mean value of 80.26 μg $g^{-1}$. Maximum concentration of Cr was found in sample No. 4 near at Durgapur shoshan ghat. Anthropogenic sources of emission of Cr in the surface waters are from municipal wastes, laundry chemicals, paints, leather, road run off due to tire wear, brake wires, radiators (Dixit and Tiwari, 2008). Chromium concentration is medium on the basis of SEL (Rudnik and Gao., 2003). Compare to other river such as near to concentration of Padma river (Datta and Subrama-niam. 1998). Cr is commercially used in various products and Cr exposure in workers and the general population can occur via various routes (Lou *et al.,* (2021).

Cr is a well-known carcinogen in the respiratory tract and can cause lung cancer in occupational workers (Shin *et al.,* 2023). In the aquatic environment, trace elements are distributed between the dissolved phase, colloids, suspended matter and sedimentary phases. Sediments and soils have a high storage capacity for contaminants. In the hydrological cycle, less than 0.1% of the metals are actually dissolved in the water and more than 99.9% are stored in sediments and soils (Salomons, (1998).

The status of Cd in the present study ranged from 0.426-0.464 μg $g^{-1}$ having an average value of 0.441 μg $g^{-1}$. The concentration of Cd in the Turag river water ranged from 0.09 to 0.13 and 0.15 to 0.20 μg $g^{-1}$ during post-monsoon and pre-monsoon season (Meghla *et al.,* 2013). Cadmium concentration of the Someshwari river is lower than Turag river and lowest effect level.

The status of Fe (Iron) in sediments ranged from 17700 to 43700 µg $g^{-1}$, having an average value of 25166.66 µg $g^{-1}$. Iron comes into the water from natural geological sources, industrial wastes, domestic discharge and also from by-products. Excess Fe may be attributed to runoff from agricultural processes such as the application of fertilizers to the soil during land preparation and the spraying of pesticides (Kortei *et al.*, 2020). The high Fe concentrations detected in the river water pose a severe threat to the aquatic biota of the hydrological systems in the sub-basin and to humans reliant on this water for drinking (Bianchi *et al.,* 2019). Fe concentrations in aquatic ecosystems, particularly freshwater systems, have increased significantly in recent years, highlighting a serious environmental concern (Bjorneras *et al.,* 2017, Chandrapalan and Kwong, 2020).

This study reveals that manganese concentration range is 252-544 µg $g^{-1}$. This indicates that there had partially anthropogenic contact on the Someshwari river. According to Mohiuddin *et al.,* (2016) Buriganga river sediment Mn concentration is 5501.6 µg $g^{-1}$. There are much difference between two rivers and the study area is practically unpolluted by the range of Mn concentration **Table 3**. According to Ghani *et al.,* (2013) Mn Concentration of Abu-Qir Bay, Egypt range was 115.03–479.60 µg $g^{-1}$; Ünlü *et al.,* (2008) was found in the range of 300–1,560 µg $g^{-1}$ in the area of Gulf of Gemlik. In this study, Nickel has exceeded **Table 3** the severe effect level (Rudnik and Gao., 2003) and the maximum concentration was found in sample 4 here sand mining rate is higher than in others zones. Distribution of elevated Ni concentrations mostly revealed an impact of long-range transport influenced by the flow of the main tributary. Ni spatial pattern was mainly influenced by mineral com-pounds of Fe, Mn, and Al and to a lesser degree by organic matter content and silt and clay (Gwiazda *et al.,* 2011).

**Table 3.** Comparison of heavy metal concentrations (µg $g^{-1}$) in the Someshwari river sediments with different standard values and Bangladeshi rivers

| Heavy Metals | Geochemical Background and standard values | | | Report on the other Bangladeshi River | | | | This study (Average) |
|---|---|---|---|---|---|---|---|---|
| | CUC[a] | LEL[b] | SEL[b] | Buriganga[c] | Turag[d] | Padma[e] | Korotoa[e] | |
| As | 17.5 | 6 | 33 | | | | | 9.215 |
| Cr | 92 | 26 | 110 | 173.4 | 178 | 97 | 109 | 80.2667 |
| Pd | 17 | 31 | 250 | 31.4 | 18.3 | 17 | 58 | 11.4783 |
| Cd | 0.09 | 0.6 | 10 | 1.5 | 0.8 | | 1.2 | 0.441 |
| Zn | 67 | 120 | 820 | 481.8 | 194.1 | 76 | | 34.25 |
| Cu | 28 | 16 | 110 | 344.2 | 54.8 | 25 | 76 | 10.585 |
| Ni | 47 | 16 | 75 | 153.3 | 155.4 | 28 | 95 | 87.2667 |
| Mn | | 460 | 1100 | | 5501.6 | | | 420.5 |

CUC= Continental upper crust; LEL= Lowest effect level; SEL= Severe effect level. ([a]Rudnick and Gao, 2003; [b]Persuad *et al*., 1993; [c]Mohiuddin *et al*., 2015; [d]Mohiuddin *et al*., 2016; [e]Datta and Subramaniam, 1998)

### 3.1.2 *Pearson's correlation matrix of different Heavy metals*

The correlation coefficient matrix (r) was calculated considering the significance level to find out the inter-relationship and coherence pattern between chosen variables, presented in **Table 4**. A very strong correlation indicate the ranged from 0.7 to 0.9. Significant correlations between the contaminants of As and Cr (r = 0.91), As and Fe (r = 0.97), As and Ni (r =0.86), As and Se (r=0.93), As and V (r=0.96), Co and Zn (r=0.84), Cr and Fe (r=0.93), Cr and Ni (r=0.88), Cr and Se (r=0.80), Cr and v (r=0.86), Fe and Ni (r=0.96), Fe and Se (r=0.94), Fe and (r=0.97), Ni and Se (r=0.86), Ni and V (r=0.91), Se and V (0.99) could indicate the same or similar source input. The elemental association may signify that each paired element has an identical source or common sink in the stream sediments (Singh *et al.,* 2002; Nyangababo *et al.*, 2005). In most cases; however, there are significant correlations among most of these heavy metals, suggesting that these metals are associated with each other. On the other hand, some heavy metals did not have significant correlations among these HMs. Furthermore, these metals might have different anthropogenic and natural sources in the sediments of the area of study.

**Table 4.** Pearson's correlation matrix of different important heavy metals in sediment in Someshwari River

| | As | Cd | Co | Cr | Cu | Fe | Mn | Ni | Pd | Se | V | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| As | 1 | | | | | | | | | | | |
| Cd | 0.07 | 1 | | | | | | | | | | |
| Co | 0.52* | -0.07 | 1 | | | | | | | | | |
| Cr | 0.91** | 0.00 | 0.77** | 1 | | | | | | | | |
| Cu | -0.03 | 0.54* | 0.61* | 0.26 | 1 | | | | | | | |
| Fe | 0.97** | 0.07 | 0.67* | 0.93** | 0.11 | 1 | | | | | | |
| Mn | 0.51* | -0.63 | 0.53* | 0.52 | 0.19 | 0.49 | 1 | | | | | |
| Ni | 0.86** | -0.06 | 0.76** | 0.88** | 0.13 | 0.96** | 0.51 | 1 | | | | |
| Pd | 0.66* | 0.42 | 0.65* | 0.60* | 0.41 | 0.76** | 0.28 | 0.76** | 1 | | | |
| Se | 0.93** | 0.26 | 0.41 | 0.80** | 0.02 | 0.94** | 0.24 | 0.86** | 0.74** | 1 | | |
| V | 0.96** | 0.17 | 0.50 | 0.86** | 0.00 | 0.97** | 0.32 | 0.91** | 0.72 | 0.99** | 1 | |
| Zn | 0.11 | -0.09 | 0.84** | 0.33 | 0.61 | 0.33 | 0.38 | 0.51 | 0.60 | 0.10 | 0.15 | 1 |

**Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed)

### *3.2 Abundance of Heavy metals in River water*

#### *3.2.1 Major Heavy metals analysis*

The analysis of results showed that the average heavy metal concentrations **Table 5** in the surface water of Someshwari river were in the order of Fe>Mn>Zn>Cu>Ni>V>Se>Cr>Co>As>Cd and their value is 1291.17 µg $L^{-1}$, 891.93 µg $L^{-1}$, 14.18 µg $L^{-1}$, 3.36 µg $L^{-1}$, 3.31 µg $L^{-1}$, 2.5 µg $L^{-1}$, 1.49 µg $L^{-1}$, 1.40 µg $L^{-1}$, 1.30 µg $L^{-1}$, 1.07 µg $L^{-1}$, 0.45 µg $L^{-1}$, respectively. Hassan *et al.,* (2015) studied heavy metal pollution in the Meghna river and found that Zn (36.4 µg $L^{-1}$), Cd (3 µg $L^{-1}$) Fe (1022 µg $L^{-1}$), Mn (µg $L^{-1),}$ Cr (34.6 µg $L^{-1}$). Furthermore, Toma *et al.,* (2024) studied Padma river water and recorded values was Zn (7.71 µg $L^{-1}$), Cu (17.45 µg $L^{-1}$), Cd (1.62 µg $L^{-1}$), Fe (150.6 µg $L^{-1}$), Cr (2.61 µg $L^{-1}$), Ni (8.78 µg $L^{-1}$). According to those studies, the comparison among Someshwari river water Fe and Mn Concentration were much higher than Meghna river but Zn, Cd and Cr are less than Meghna river. On the other hand, Zn and Fe are higher than the Padma river but Cu, Cd, Cr and Ni concentrations are lower than Padma river.

According to Bhuyan *et al.,* (2015) identified the heavy metal from Buriganga river and found that Zn (332 µg $L^{-1}$), Cu (µg $L^{-1}$), Cd (59 µg $L^{-1}$), Fe (512 µg $L^{-1}$), Cr 934.6 µg $L^{-1}$), Mn (157 µg $L^{-1}$), Ni (150 µg $L^{-1}$). In this study, only Fe and Mn are higher than Buriganga HMs content but all of the HMs are much lower than Buriganga river **Table 6**.

**Table 5.** Heavy metal concentrations of Someshwari river water (µg $L^{-1}$)

| Sample No | As | Cd | Co | Cr | Cu | Fe | Mn | Ni | Zn | Se | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 0.835 | 0.409 | 0.512 | 1.4 | 1.91 | 710 | 83.8 | 7.37 | 12.4 | 2.13 | 2.59 |
| S2 | 1.02 | 0.494 | 1.67 | 1.26 | 3 | 1430 | 1230 | 2.33 | 10.6 | 0.99 | 2.11 |
| S3 | 1.05 | 0.436 | 2.11 | 1.89 | 2.51 | 1860 | 1370 | 3.79 | 19.6 | 1.62 | 3.2 |
| S4 | 1.54 | 0.415 | 2.14 | 1.36 | 2.15 | 2400 | 1920 | 2.81 | 14.6 | 1.12 | 2.53 |
| S5 | 1.21 | 0.51 | 0.881 | 1.07 | 8.48 | 727 | 662 | -0.35 | 18.6 | 1.42 | 2.06 |
| S6 | 0.779 | 0.416 | 0.486 | 1.41 | 2.13 | 620 | 85.8 | 3.89 | 9.25 | 1.67 | 2.63 |
| Mean | 1.07 | 0.45 | 1.30 | 1.40 | 3.36 | 1291.17 | 891.93 | 3.31 | 14.18 | 1.49 | 2.52 |

**Table 6.** Comparison of heavy metal concentrations (µg $L^{-1}$ in the Someshwari river water with different Bangladeshi rivers

| River | As | Zn | Cu | Cd | Fe | Cr | Mn | Ni | References |
|---|---|---|---|---|---|---|---|---|---|
| Someshwari | 1.07 | 14.18 | 3.36 | 0.45 | 1291.17 | 1.4 | 891.93 | 3.31 | This study |
| Meghna | | 36.4 | | 3 | 1022 | 34.6 | 8.8 | | (Hasan *et al.*, 2015) |
| Buriganga | | 332 | 239 | 59 | 512 | 34.6 | 157 | 150 | (Bhuiyan *et al.*, 2015) |
| Padma | | 7.71 | 17.45 | 1.62 | 150.46 | 2.61 | | 8.78 | (Toma *et al.*, 2024) |
| Old Brahmaputra | | 10 | 120 | 1 | | 10 | | 440 | (Bhuyan *et al.*, 2019) |
| Karnofully | | 280 | 50 | 10 | 2060 | 250 | | | (Islam *et al.*, 2013) |
| Japanese water supply act standard | 10 | 1000 | 1000 | 3 | 300 | 20 | 50 | 10 | (SHIMADZU, 2021) |
| WHO | 10 | 5000 | 2000 | 3 | 300 | 50 | 80 | 70 | (WHO, 2011) |

Iron (Fe) concentration at 300 µg $L^{-1}$ is essential in drinking water (WHO, 2011) whereas elevated concentration causes adverse impacts on aesthetic quality. In this study, found that Fe concentration was 1291.17 µg $L^{-1}$ which is much higher than the standard limit. Fe Concentration order from the analyzed sample is S4>S3>S2>S5>S1>S6. In this study, found Mn concentration was 891.93 µg $L^{-1}$ which is much higher than standard. The chemical composition of water is the result of complex multistage processes occurring both in catchment areas and in streams or reservoirs (Golovina, 2017; Culp *et al.,* 2020). Manganese concentration from this study in order of S4>S3>S2>S5>S1>S6. The lithological conditions of the catchment area, i.e., the chemical composition of rocks, the ratio of their types, and resistance to chemical weathering are the key factors that determine the natural elemental composition of water (Kuznestov and Petro, 2017; Mello *et al.,* 2020). The dissolved V concentration in rivers is typically low (<0.8 µg $L^{-1}$) (Gustafsson, 2019; Huang *et al.,* 2015). The main sources of Vanadium in river water are the weathering of rocks and the type of source rock (Schuth *et al.,* 2019). In this study, found mean concentration is 2.52 µg $L^{-1}$ and the lowest concentration is 2.06 µg $L^{-1}$. That means the entire sample exceeds the normal value of vanadium.

### *3.2.3 Pearson's correlation matrix of different Heavy metals*

The correlation coefficient matrix (r) is calculated considering the significance level to find out the inter-relationship and coherence pattern between chosen variables, presented in **Table 7**. A very strong correlation indicate the ranged from 0.7 to 0.9. Significant correlations between the contaminants of As and Fe (r = 0.75), As and Mn (r =0.83), Cd and Cu (r=0.80), Co and Fe (r=0.95), Co and Mn (r=0.97) could indicate the same or similar source input. The elemental association may signify that each paired element has an identical source or common sink in the stream sediments (Singh *et al.,* 2002; Nyangababo *et al.,* 2005). In most cases; however, there are no significant correlations among most of these heavy metals, suggesting that these metals are not associated with each other. Furthermore, these metals might have different anthropogenic and natural sources in the sediments of the area of study.

**Table 7.** Pearson's correlation matrix of different heavy metal in Shomeshari river water

| | As | Cd | Co | Cr | Cu | Fe | Mn | Ni | Zn | Se | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| As | 1 | | | | | | | | | | |
| Cd | 0.16 | 1 | | | | | | | | | |
| Co | 0.68* | 0.06 | 1 | | | | | | | | |
| Cr | -0.19 | -0.53 | 0.42 | 1 | | | | | | | |
| Cu | 0.25 | 0.80** | -0.19 | -0.59 | 1 | | | | | | |
| Fe | 0.75** | -0.17 | 0.95** | 0.40 | -0.33 | 1 | | | | | |
| Mn | 0.83** | 0.12 | 0.97** | 0.21 | -0.08 | 0.96** | 1 | | | | |
| Ni | -0.53 | -0.79 | -0.26 | 0.47 | -0.78 | -0.12 | -0.38 | 1 | | | |
| Zn | 0.47 | 0.28 | 0.43 | 0.28 | 0.51 | 0.32 | 0.40 | -0.38 | 1 | | |
| Se | -0.64 | -0.52 | -0.64 | 0.31 | -0.19 | -0.57 | -0.74 | 0.71 | 0.00 | 1 | |
| V | -0.18 | -0.68* | 0.29 | 0.96** | -0.58 | 0.32 | 0.10 | 0.53* | 0.28 | 0.45 | 1 |

**Correlation is significant at the 0.01 level (2-tailed);

*. Correlation is significant at the 0.05 level (2-tailed).

## Conclusion:

The investigation of heavy metals in sediments and water, which represents that this emerging pollutant is widely present in Someshwari river. In this study, the range of heavy metal concentrations in the surface sediment of Someshwari river were in the order of As (6.82-14.5 μg $g^{-1}$ ), Cd (0.426-0.464 μg $g^{-1}$), Co (6.75-15.8 μg $g^{-1}$ ), Cu (6.92-14.2 μg $g^{-1}$), Cr (62.6-108 μg $g^{-1}$), Ni (59.5-133 μg $g^{-1}$ ), Fe (17700-43700 μg $g^{-1}$), Mn (252-544 μg $g^{-1}$), Pd (6.96-16.7 μg $g^{-1}$ ), Se (8.63-35.1 μg $g^{-1}$ ), V (37.6-107 μg $g^{-1}$), Zn (21.6-40.4 μg $g^{-1}$). Nickel exceeded the severe effect level (SEL) and Cr, Cu above the lowest effect level (LEL). Shoshan ghat area was exceeded the Arsenic and Nickel concentration of SEL and close to Chromium value. However, Nickel concentration was crossed the four areas instead of six. On the other hand, Fe (620-2400 μg $L^{-1}$), Mn (83.8-1920 μg $L^{-1}$), and V (2.06-3.2 μg $L^{-1}$) contamination of Someshwari river water was found in this study those were exceeded the WHO guidelines. The contamination of river water and sediment could be due to sand mining, coal extraction, river bank erosion, various anthropogenic activities such as urban runoff, wastewater disposal, and transportation. Government should take to step for bring to stop sand mining and continuous monitoring of heavy metals of both sediment and water for protect the riverine ecosystem.

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