A Seminar Paper
on
Assessment of heavy metal contamination in sediment, water and aquatic biota in the southwestern coastal region of Bangladesh

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Assessment of Heavy Metal Contamination in Sediment, Water and Aquatic Biota in the Southwestern Coastal Region of Bangladesh[1]

by

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ABSTRACT

Coastal region is related to our export income shrimp and frozen fish industry, largest mangrove forest the Sundarban in south-western part, fish and aquatic animals nursing ground. Heavy metal contamination in this vital place can causes a great damage to our economy as well as biodiversity. Though, this review paper is based on the assessment of heavy metal in sediment, water and animal body to understand the extent of heavy metal contamination in this region. Secondary data, research papers, newsletters, books, journals etc are used for collecting information. It was found that Rupsha river sediment is contaminated by Pb and for Pasur river and Paira river sediment As, Pb, Cd and Cr. Consequently, Rupsha, Pasur and Paira river water is contaminated by Pb. In term of bioaccumulation, it was assessed for Rupsha and Paira river ten fishes and found Cr is in risk level for human health and *T. hilsha* and *C. soborna* shows higher bioaccumulation, as they are bottom feeder. There was no study for other rivers in this coastal part, bioaccumulation for Pasurriver was absent and heavy metal accumulation in salt plug area of Pasur river was not assessed yet. In all, this review provides a quantitative identification of the As, Pb, Cd, and Cr contamination in south-western part of Bangladesh based on the literature. which may be useful for researchers to formulate treatment schemes environmental and restorationists and local policy makers to implement for save this unique ecosystem of Bangladesh.

Keywords: Heavy metal, sediment, water, biota, Sundarban, Pasur, RupshaBangladesh

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[1]Title of the seminar paper presented as a part of course FMG 598 during Summer 2020

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LIST OF ABRREVIATIONS

As: Arsenic

Pb: Lead

Cr: Cromium

Pb: Lead

ASV: Average Standard Value

et al.: and others (at elli)

CHAPTER I

INTRODUCTION

In this era of civilization, heavy metal contamination is a global concern for our aquatic ecosystem. Heavy metals are accumulated in environment through food chain and persistent in nature. Heavy metals such as Pd, Zn, Cd, Cr, Asetc. are potentially gathered in aquatic environments including water, sediments, fish and shrimp. These are later transmitted into human body through the food chain (Maceda-Veiga et al., 2013) and causes serious physiological disorders like hypertension, sporadic fever, nausea, renal damage, cramps etc. (Bhattacharya et al., 2008). For examples, prolonged exposure to lead can result in coma, mental retardation and even death (Al-Busaidi et al., 2011). Cadmium injures the kidneys and causes symptoms of chronic toxicity including impaired kidney function, infertility, hypertension, tumours and hepatic dysfunction (M. Rahman et al., 2010). Likewise, Chromium could attack proteins and membrane lipids, thereby disrupt cellular integrity and functions (Mattia et al., 2004) (Brien et al., 2003).

Heavy metal contamination in the environment has been occurring for centuries, and in the last decade it has increased rapidly due to technological developments (Vrhovnik et al. 2013). In most circumstances, the major part of the anthropogenic metal load in the sea and seabed sediments has a terrestrial source, from mining and industrial developments along major rivers and estuaries (Purushothaman et al. 2007;Tang et al. 2014) .The hot spots of heavy metal concentration are often near industrial plants (Zarei et al. 2014) .

The world’s largest mangrove forest and a Ramsar site the Sundarban, is located in this south-western coastal part of Bangladesh (IUCN 1987).The southern part of Bangladesh, has a unique estuarine ecosystem. This region is under tidal fluctuation and depends on the freshwater supply of upstream. The Sundarban is an integral part of this estuarine ecosystem. This estuarine system supporting a large groups of fish, shrimp, edible crab, fish breeding ground, fish nursery ground and also supplies food and cash to the coastal communities (Hoq, 2003). Moreover, 8.5 million people’s livelihood directly or indirectly depend on the estuaries and sundarban, It causing shrinkage of the forest day by day (Shah, Huq, &Rahman, 2010).

The sundarban river system comes from GangesBrahmaputra river system. Freshwater flow from the Gorai River, a major distributary of the Ganges River in the Rupsa-Pasur River near Khulna (Figure:1). Commissioning of the Farakka Barrage on the Ganges River in India in 1975 has reduced the fresh water inflows to the region (Mondal et al., 2012). Moreover, effluent discharging rate has increased to about 10 million gallons day^{-1} in the Pasur River system from the third largest industrial city (Khulna). Nowadays, Pasur river water is not suitable for drinking and cooking because of high concentration of heavy metals (Ali et al., 2018). In 2016, Sarkar reported that, heavy metals such as Pb, Cd, Cr are found higher in concentration in PL of shrimp in the southern part of Bangladesh (Sarkar et al. 2016).

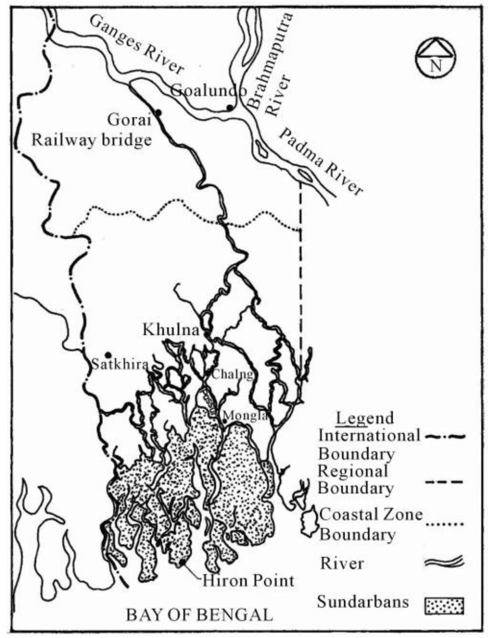

Figure 1.The southwest region of Bangladesh showing the coastal region. (Ref: Mondal et al. 2012).

The Paira River is another major river in south western zone. It has been considered as the main flow of polluted water from the peripheral rivers of the capital Dhaka City, Bangladesh to the Bay of Bengal. The inhabitants of Patuakhali district largely depend on this river for drinking and other household purposes, irrigation for agriculture and aquaculture, and for carrying merchandise. The unpleasant odor of the polluted water of Paira River can be sensed from a short distance (Islam et al. 2014). Nowadays, it is polluting with time through dumping of various industrial effluents, oil splitting from boats, fertilizers. (Islam et al. 2017)

The toxic heavy metals in aquatic environment could be found to both natural and anthropogenic sources for changes arising from man made activities that affecting on aquatic ecosystem and habitat (Olomukoro and Ezemonye, 2011; Mason, 1996; Ezemonye and Kadiri, 2000).Fish and shellfish can absorb heavy metals through epithelial or mucosal surface of their skin, gills and gastrointestinal tract (Jovanovic*et a*l., 2011), since heavy metals and organic compounds can bioaccumulated in aquatic biota (USEPA, 1991) and biomagnifying in food chains. Eventually the second largest export, shrimp industry of Bangladesh is in great danger of heavy metal pollution. It can causes a disaster in our economy as well as in the ecosystem.

Objectives of the Study

There are two specific objectives for this review paper, are as follows:

1. To review the present status of heavy metal pollution assessment in sediment, water and aquatic biota in south-western part of Bangladesh.
2. To investigate possible sources of these heavy metal in water, sediment and aquatic biota.

CHAPTER II

MATERIALS AND METHODS

Scientific paper is a written report describing research results. Scientific approach requires a close understanding of the subject matter. This paper mainly depends on the secondary data. Different published reports of different journals, books, proceedings and websites mainly supported in providing data in this paper. This paper is completely a review paper. Therefore, no specific method has been followed in preparing this paper. It has been prepared by browsing internet, studying comprehensively various articles published in different journals, books, proceedings, dissertation available in the internet.

The author would like to express her deepest sense of gratitude to her major professor and course instructors for their efficient and scholastic guidance, precious suggestions to write this manuscript. All the information collected from the secondary sources have been compiled systematically and chronologically to enrich this paper.

CHAPTER III

REVIEW OF FINDINGS AND DISCUSSION

In this review paper, major findings of different literature on assigned topic is presented with appropriate discussion.

3.1Heavy metal contamination in Southwestern coastal region

Soil and water near the industrial areas of the big cities in Bangladesh, such as Dhaka, Gazipur, Chittagong, and Khulna, displayed excess heavy metals and metalloids (Rahman et al. 2012). Rakib et al., 2014 mentioned that High traffic loads are also responsible for high heavy metal and metalloid pollution in water and soil.Toxicity of these metals stems are biologically non-degradable and have the tendency to accumulate in water, sediment and fish body (Gale et *al*. 2004). Heavy metals are accumulated and biologically magnified in fish tissues (Ayas et *al*. 2007).

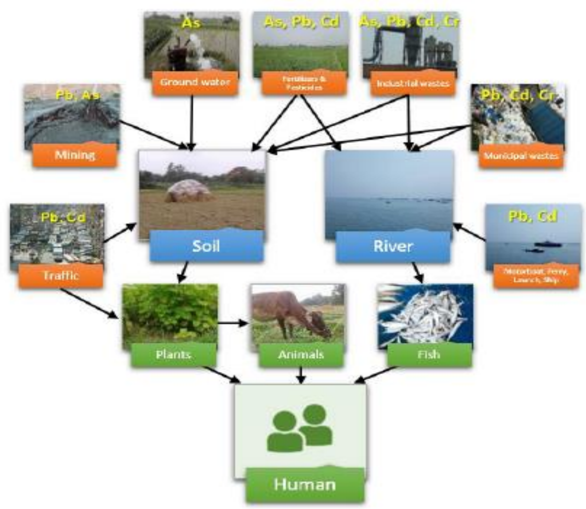

Figure 2.Major pathways of heavy metal and metalloid dispersion and human exposure in Bangladesh (Rahman et al. 2018).

Rupsha-Pasur river is the second large river after Meghna in size, a major freshwater flow river and connected with other rivers in southwestern part of Bangladesh (Banglapedia, 2015). Besides, a considerable amount of toxic elements enriched suspended solids is coming down from neighboring country like India through the Teesta and the Brahmaputra Rivers (Islam et al.

2015) and have been accumulated in the riverine environment. Consequently, it poses severe threats to fish and other aquatic biota. Paira river is another major river of Patuakhali district. The main industries located surrounding these river system are Tanneries, textile mills, oil refineries, TSP plants, DDT plants, fish processing plants, toxic metals manufacturing plants, cement factories etc. There is a possibility of coming out heavy metals from the effluents of those industries into the water of the river system and there is also likely to contaminate the aquatic organisms such as various species of fish and shellfish and other invertebrates. In this review paper, assessment of heavy metals of these major rivers are presented with relevant scientific documents.

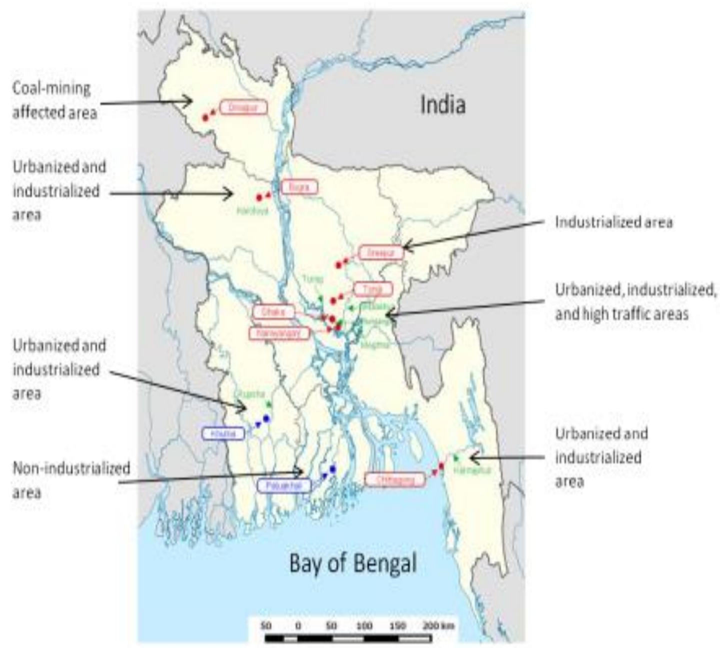

Figure 3.Pb, Cd and Cr pollution hotspots in Bangladesh. (Red=Hot spot, Blue=in danger, Green=safe range) (Islam et al, 2018).

3.2 Present status of heavy metal contamination assessment in sediment of Southwestern coastal region

Major sources of soil heavy metal and metalloid pollute on include municipal wastes, industrial effluents, chemical fertilizers, and pesticides (Chen et al.2005). In Bangladesh, cultivation in the dry season mostly depends on irrigation by deep shallow tube wells (STWs). Bangladesh has the highest percentage of As-contaminated STWs, and yearly increases of up to 0.1 mg of As per kg of soil can occur as a result of irrigation, especially in paddy fields (Meharg et al. 2003). Duxbury et al. (2003) stated that paddy fields irrigated with As-contaminated water for ten years wouldadd 5–10 mg/kg As into soil.

A previous study on metal assessment of sediments of the Pashur river reported that concentration of Fe (1.65-3.19%), Cr (2.8-31.9 μg/g) and Zn (26.3-71.9 μg/g) respectively by Rahman et al. 2011. In recent years, Hossain et al. (2016) reported Cr (64.03-82.35 μg/g), Mn (505-737μg/g), Fe (3.59-4.90%), Co (14.6-15.2 μg/g), Zn (46.8-88.8μg/g) in Sediments of the Poshur River NearbyMongla Port. This study indicates that concentration levels of these elements in the Poshurriver increased accordingly.

Table 1: Heavy metal and metalloid pollution in river sediments (mg/kg). (Modified from Islam et al. 2018)

River (Location)	Sampling period	As	Pb	Cd	Cr	Reference
Rupsha	June-August (2016)	1.56±0.07	4.03±0.31	2.26±0.21	3.65±0.37	Sabbir et al. 2018
Rupsha		2.22	62.40	0.56	67.72	Rahman and Hassan. 2020
Pasur (Mongla port)	Jan-June (2013)	NA	6.919	NA	19.369	Shil et al. 2017
Pasur (Mongla)	Sep (2014)- March (2015)	3.15-19.97	7.34-55.35	0.39-3.17	20.67-83.7	Ali et al. 2018
Pasur (Mongla port)		6.73±1.76	NA	NA	72.5± 8.1	Hossain et al. 2016
Paira	Mar-September 2012	12	25	0.72	45	Islam et al. 2014
Paira		19±3	49±11	1.2±0.73	67±27	Islam et al. 2017
Standards		4.8	17	0.09	92	Rudnick et al. 2014
Standards		NA	31	0.6	26	USEPA. 1999

Notes: NA, not applicable/reported. For metal and metalloid concentrations, some values were reported with standard errors, and some were reported with the concentration rangein brackets.

Sabbir et al. (2018) found in Rupshariver that all the metals attained their maximum values near Khulna Ship Yard may be due to ship breaking activities and direct toxic chemical discharged into the river. Cr was in acceptable range (USEPA 1999). The high level of Cd in sediments of Rupshariver at Khulna Ship Yard could be attributed to the ship breaking activities, industrial and agricultural discharge as well as from spill of petrol from fishing boats which were distributed in the River (Giguere*et al*. 2004).Moreover,higher Led (Pb) concentration in sediment was found due to the effect from point and non-point sources; such as gasoline, petroleum, municipal runoffs and atmospheric deposition (Mohiuddin*et al*. 2012).

In case of, Pasur river metals concentrations in sediment were higher in winter than summer due to the lower water flow during winter which could assistance to accumulate the toxic metals in sediment (Islam et al. 2015a, 2015c; Ali et al. 2016; Hossain et al. 2016; Shil et al. 2017).Besides, they did not found downstream pattern which might be due to the metal input in sediments from site specific characteristics such as flow of the rivers, pollution sources and waste disposal from the urban system (Ahmad et al. 2010; Islam et al. 2014).

Islam et al. (2014) found As (12 mg/kg), Pb (25 mg/Kg) and Cr (45 mg/Kg)was in higher than standard value. Islam et al. (2017) reported higher than previous value for As (19mg/Kg), Pb (49 mg/Kg), Cd (1.2 g/Kg) and Cr (67 mg/Kg) respectively in Paira river. It is increasing alarmingly in this coastal river.

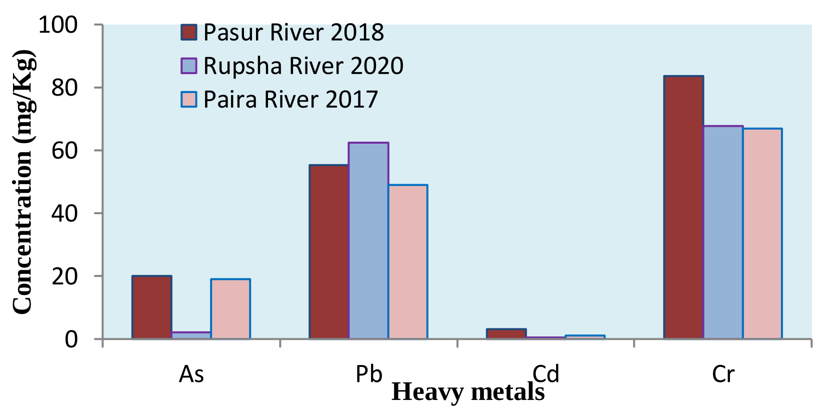

Figure 4. A comparative view of Pasur, Rupsha and Paira river heavy metal concentration.

Chromium concentration in sediment was higher than other metals in Both Rupsha, Pasur and Paira river, as a consequence of direct discharging untreated wastes from petroleum, fertilizers and textile industries (Facetti et al. 1998; Islam et al. 2015a).

Pasur and Paira river showed high As concentration, might be attributed to the anthropogenic activities such as treatment from the fertilizers and arsenical pesticides industries (Fu et al.

2014), treating of wood by exhausting copper arsenate (Pravin et al. 2012) and tanning in relation to some chemicals especially arsenic sulfide (Bhuiyan et al. 2011).

The average concentration of Cd in sediment of Pasur River was slightly higher than Paira and Rupsha river, mean: 0.53 mg/kg (Rahman and Hassan. 2020), Bangshi River, Bangladesh, mean: 0.61 mg/kg (Rahman et al. 2014); Korotoa River, Bangladesh, mean: 1.2 mg/kg (Islam et al. 2015c); River Ganges in India, range: 0.12–1.2 mg/kg (Gupta et al. 2009 and the Toxicity reference value 0.6 mg/kg (USEPA 1999) indicated that Cd might pose risk to the surrounding ecosystems. Elevated level of Cd in sediment of Pasur River might be due to the effect from industrial activity, atmospheric emission, leachates from defused Ni-Cd batteries and Cd plated items (Islam et al. 2014, 2015c).

Average concentration of Pb was higher than ASV value (20 mg/kg) in Pasur, Paira and Rupsha river, which could be due to the effect from point and non-point sources; such as leaded gasoline, petroleum, municipal runoffs and atmospheric deposition (Mohiuddin et al. 2012; Shikazono et al. 2012), chemicals and electronics manufacturing, cables, oils, tire and cement factory, and steel works nearby the study river of Khulna district.

3.2.1 Assessment of ecological risk of Pasur River

Ali et al. (2018) calculated pollution load index (PLI) for Pasurriver to to assess the ecological risk. As they have already found that Cr, Cd, Pb and Aswere in exceeding value of standard (USEPA 1999). The PLI can provide some understanding to the populations about the quality of the sediment. In addition, it also delivers essential information to the decision makers on the pollution status of the study area (Suresh et al. 2012).To assess the sediment quality, an integrated approach of PLI of the four metals was calculated according to Islam et al. (2015c).The PLI is used to determine the comprehensive pollution effect at different stations by the metals. For both seasons, higher PLI values were observed in sampling sites.

Figure 5.PLI value of sediment collected from Pasurriver(Ali et al. 2018).

Therefore, PLI value of zero indicates perfection, a value of one indicates the presence of only baseline level of pollutants and values above one would indicate progressive deterioration of the site and estuarine quality (Tomilson et al. 1980; Islam et al.2015b). The PLI gave an assessment of the overall toxicity status of the sample and also it is a result of the contribution of the four metals.

Hossain et al. (2018) calculated PLI values at different sampling stations at Mongla port in Pasur river are shown in Fig. 5.(Right) The range of literature data (Kumar et al. 2016) for PLI values (PLI = 0.90-1.16) of the Pashur river (shaded area) are also shown in Fig. 5. Values of PLI = 1 indicate metal loads close to background, and values above 1 indicate progressive pollution of the sediments (Tomlinson et al. 1980). In this study, the calculated PLI values among the sampling points varied from 1.20-1.30 indicating the progressive deterioration of the sediment quality of the river.

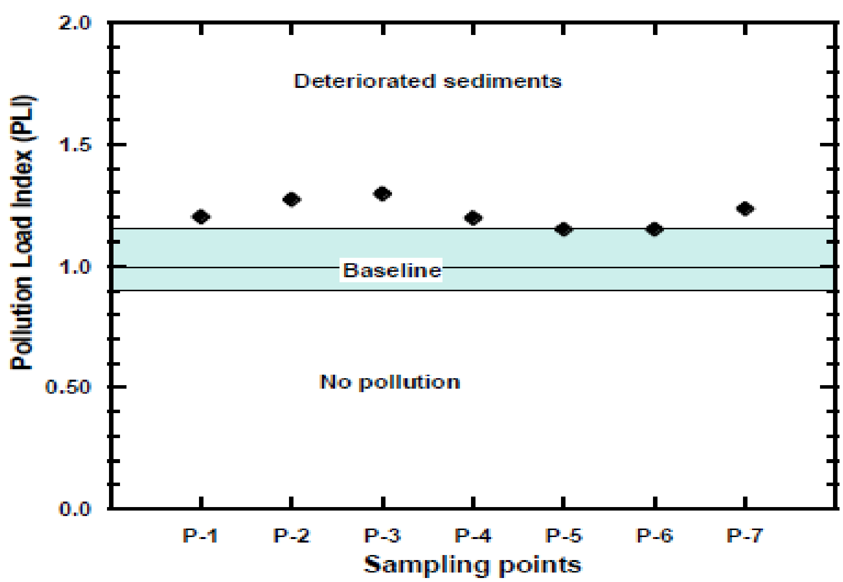

Figure 6. PLI value for surface sediment at the Mongla port in Pasur river (Hossain et al. 2016).

3.2.2Assessment of ecological risk of Rupsha River

As we have already found that Rupshariver sediment has lower amount of heavy metal such as As, Cr, Cd and Pb from the standard lebel (USEPA. 1999; Rudnick et al. 2014). Therefore, there was no study for assessment of ecological risk for this river. This river was in safe range in terms of heavy metal pollution.

3.2.3 Assessment of ecological risk of Paira River

As per before mentioned grade, Paira river sediments were polluted considerably, since PLI of three sites (P3, P7 and P8) were higher than one. The PLI values for winter ranged from0.63 to 1.75 with an average 1.03 and during summer ranged from 0.34 to 1.22 with an average of 0.66 (Fig. 7),which confirmed the progressive deterioration of sediments by selected heavy metals. The PLI can provide some understanding to the public about the quality of an aquatic environment (Suresh et al. 2012).

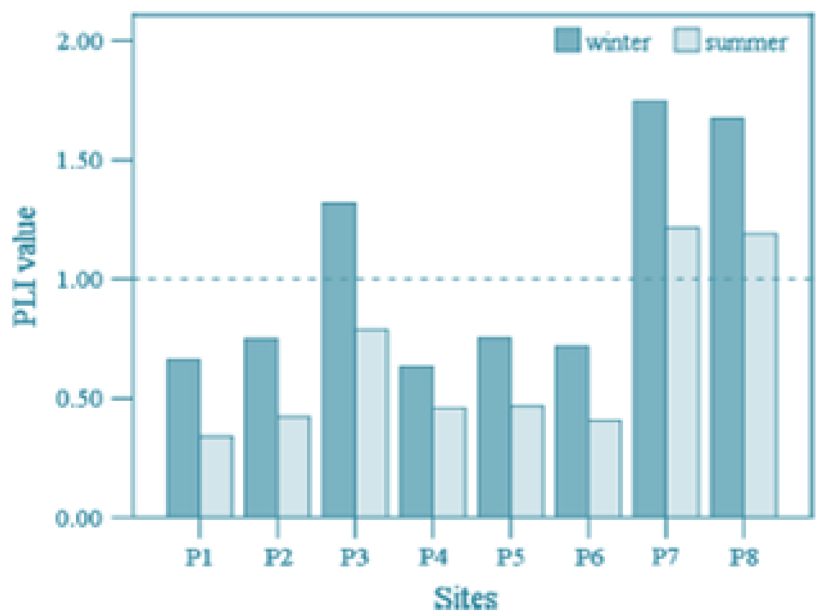

Figure 7.Pollution load index (PLI) of heavy metals in sediment at different sites of Paira River (Islam et al. 2017).

3.2.4 Identification of possible sources for heavy metal pollution in sediment of Pasur river

Possible sources of pollution need to be identified to solve out the problem. Researchers have some assumption on the sources of heavy metal pollution. Statistical analysis can make the sense of Ali et al. (2018) performed PCA to identify the source of heavy metals in sediment of different sites, which has been considered to be an effective tool for source identification (Bai et al. 2011; Anju & Banerjee 2012; Cai et al. 2012).

Ali et al. (2018) performed PCA on the dimensionless standardized form of the data set. In the current study, three principal components were extracted from the values of toxic metal concentrations in water and sediments. In the PCA, the first two PCs were 41.1 and 30.6% in sediment. Among two groups, one group revealed Cr, Cd, As and Pb in sediments, indicating that these were mostly contributed by anthropogenic activities (Renner 2004; Manzoor et al. 2006; Shah &Shaheen2007).

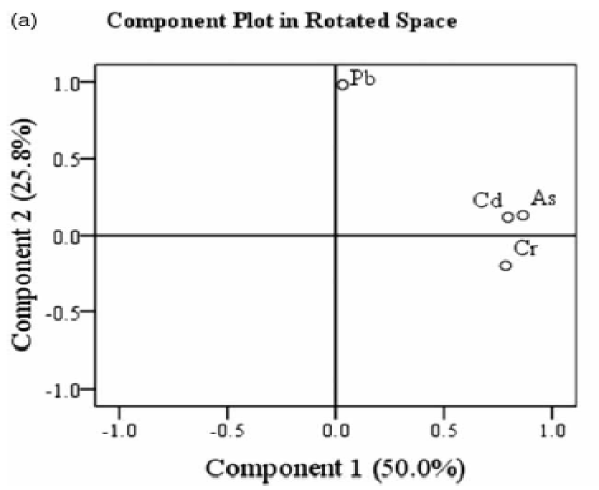

Figure8. Principal Component Analysis (PCA) of heavy metal in sediment of Pasur river (Ali et al. 2018)

The depositions of atmospheric particulates released by automobile releases were believed to contribute these metals in the urban areas, from where the sediment samples were composed (Manzoor et al. 2006; Pandey et al. 2012). PCA exposed thatthe apportionment of the same kind of heavy metals inwater and sediments were not alike, which might be due to the emission of toxic metals to the environment and addition by the water.

3.3Present status of heavy metal contamination assessment in water of Southwestern coastal region

The polluting industries of Khulna such as chemical complexes, fish processing plants, steel mills, paper mills, rayon mill complexes, cement factories, paint and dye manufacturing plants, several soap and detergent factories and a number of light industrial units directly discharge untreated toxic effluent in to the river (Chowdhury*et al.* 2010). Besides, releases of untreated toxic effluents are the major sources of heavy metals in any aquatic ecosystem.

According to Sabbir et al. (2018), in Rupsha river water As and Hg was absent and Cr (0.00495 mg/L), Cd (0.00273 mg/L), Pb (0.00453 mg/L) respectively.

On the other hand, for Pasur river Ali et al. (2018) documented As (0.0276–0.01673 mg/L), Pb (0.01269–0.04267 mg/L), Cd (0.0042–0.0198 mg/l) and Cr (0.0276–0.07739 mg/L) respectively. Shil et al. reported only Pb (0.02 mg/L) for Pausur river.

Table 2: Heavy metal and metalloid pollution in river water (mg/L). (Modified from Islam et al. 2018)

River (Location)	Sampling period	As	Pb	Cd	Cr	Reference
Rupsha	July-Sep (2013)	NA	0.011	0.001	0.021	Sarkar et al. 2016
Rupsha	June-August (2016)	NA	0.00453	0.00273	0.00495	Sabbir et al. 2018
Rupsha		0.027	0.136	0.008	0.058	Rahman and Hassan. 2020
Pasur (Mongla port)	Jan-June (2013)	NA	NA	NA	0.02	Shil et al. 2017
Pasur (Mongla)	Sep (2014)- March (2015)	0.0276-0.0967	0.0126-0.0426	0.0042-0.0198	0.0276-0.0773	Ali et al. 2018
Standards		NA	0.037	NA	NA	Rudnick et al. 2014
Standards		0.1	0.01	5.0	0.1	USEPA. 1999

Notes: NA, not applicable/reported

In Pasur river Ali et al. (2018) found the average concentration of studied metals in water followed a decreasing order of Cr>Pb>As > Cd. Interestingly the highest value of Cd was observed at S7 site (2.98 μg/L during winter) which might be attributed to the domestic sewage and effluents from the port area (Islam et al. 2015a). Considering the toxicity reference values proposed by USEPA (1999) almost all the heavy metals especially Cr and Cd greatly exceeded the limit for safe water, indicated that water from this river is not safe for drinking and/or cooking. The metals in water were seasonally varied, where winter season exhibited higher than summer in their study. The lower concentration of toxic metals during summer might be due to the dilution effect of water (Mohiuddin et al. 2012; Islam et al. 2015a).

On the basis of heavy metal concentration in water both of the Pasur and Shibsha rivers were below danger level except Pb (Table 2). Although, Pasur river is in high risk of contamination in near future if the present situation goes on.

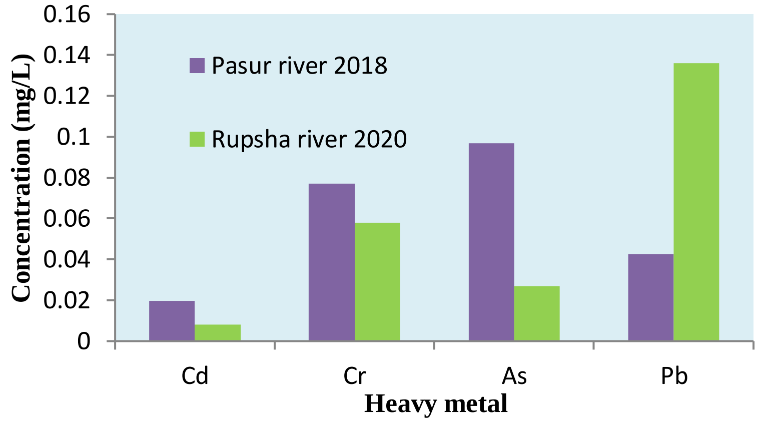

Figure 9.A comparative view of Rupsha and Pasur river heavy metal concentration in water.

In Pasur river Cd is in higher state rather than other metal, which might be attributed to the domestic sewage and effluents from the port area (Islam et al. 2015a). Comparatively, in Rupshariver Cr is higher than other metal, may be attributed to the huge amounts of raw sewage, ship breaking activities, agricultural and industrial waste water discharged into the river (Abdel-Moati and El-Sammak, 1997). There was no data for heavy metal assessment in water of Paira river.

3.3.2Identification of possible sources for heavy metal pollution in water

PCA was performed by Ali et al. (2018) to identify the source of heavy metal pollution in water. Researchers computed and the variance explained by them was 50.0 and 25.8% in water. Among two groups, one group revealed similar loadings of Cd, As and Cr in water.indicating that these were mostly contributed by anthropogenic activities (Renner 2004; Manzoor et al. 2006; Shah &Shaheen2007).

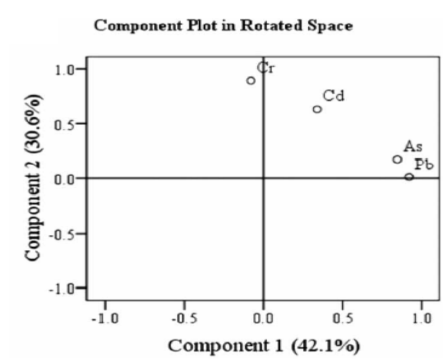

Figure 10. Principal Component Analysis of heavy metal in water of Pasur river (Ali et al. 2018).

3.4 Correlation of heavy metal between water and sediment

In the riverine aquatic environment, sediments have been widely used as environmental indicators for the assessment of metal pollution in the natural water (Islam et al. 2015c). The principal comportment of metals is a function of the suspended sediment composition and water chemistry in the natural water body (Mohiuddin et al. 2012). Sediment is an essential part of the river basin, with the variation of habitats and environments (Morillo et al. 2004). The investigation of heavy metals in water and sediments could be used to assess the anthropogenic impacts and risks posed by waste discharges to the riverine ecosystems (Yi et al. 2011; Saleem et al. 2015). Therefore, it is important to assess the concentrations of heavy metals in water and sediments and correlation between these in any contaminated riverine ecosystem.

A correlation of toxic heavy metal between water and sediment was studied by Ali et al. (2018). This study revealed that not all the toxic metal strongly correlated with water.

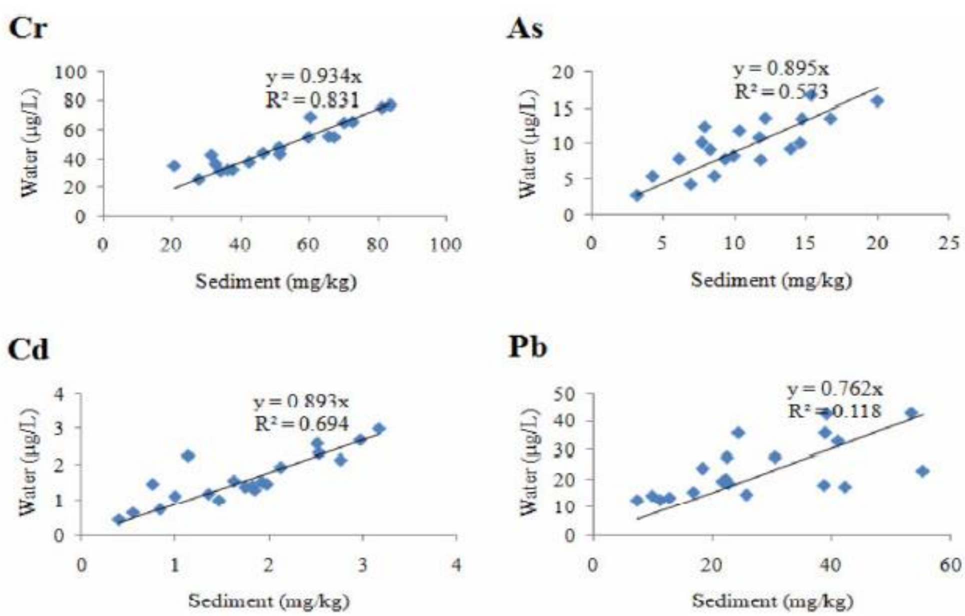

Figure 11.Correlation of heavy metal between water and sediment (Ali et al. 2018).

Researchers found strong correlation (R^2=0.831) of Cr of sediment with the Cr of water and moderate correlation (R^2=0.573) of Cd of sediment with the As of water in Pasur river. In case of As and Pb there is very poor correlation between heavy metal sediment concentration and water concentration.

3.5 Present status of heavy metal pollution in aquatic biota

Heavy metal concentration in an organism is mainly maintained by the balance between uptake and elimination (Luoma and Rainbow, 2008; Wang and Rainbow, 2008).

There is very scanty data for heavy metal accumulation in biota (plankton, fish and other aquatic organism) of southwestern part of Bangladesh. There are two orks on Rupshariver (Sarkar et al. 2016; Rahman and Hassan. 2020)and one for Paira river (Islam et al. 2017)

Table 3.Heavy metal and metalloid pollution in biota (mg/kg). (Modified from Islam et al. 2018)

River (Location)	Fish Name	As	Pb	Cd	Cr	Reference
Rupsha	Bagda*(Penaeusmonodon)*	NA	0.46	0.05	0.15	Sarkar et al. 2016
Rupsha	*Mastacem belusarmatus*(Baim), *Gudusia chapra*(Chaplin), *Puntius ticto*(Puti), *Notopterus notopterus*(Foli), *Corica soborna*(Kachki), *Setipinna phasa*(Fhassa), *Amblypharyngodo nmola*(Mola), *Mystus vittatus*(Tangra), *Heterponeustes fossilis*(Singh), and *Clupisoma pseudeutropius*(Batashi))	0.78	0.92	0.05	0.26	Rahman and Hassan. 2020
Paira	*Cyprinus carpio (Koi)*	0.25	0.81	0.025	0.78	Islam et al. 2017
	Heteropneustes fossilis (Shing)	0.27	0.92	0.016	0.97	
	Colisa fasciata (Kholisha)	0.18	0.52	0.019	0.70	
	Channa striata (Shoil)	0.25	0.78	0.020	0.69	
	Notopterus notopterus (Foli)	0.24	0.82	0.022	1.1	
	Tenualosa ilisha (Hilsha)	0.51	0.49	0.17	0.48	
	Corica soborna (Kachki)	0.37	0.58	0.20	0.44	
Standards		1.14	2.0	2.0	NA	Bebbington et al.1977
Standards		0.1	0.5	0.1	0.1	WHO. 2002

Notes: NA, not applicable/reported

Accumulation of heavy metal in the tissues of organism depends primarily on ambient water concentrations, levels in prey or commercial feed, and chemical uptake and elimination kinetics. Other factors such as chemical speciation/ bioavailability as well as fish growth cycle, age and trophic position, also can influence the extent of trace metal accumulation in organism (Kelly et al., 2008). Both laboratory and field investigations have confirmed that food can be a major source of trace metals bioaccumulated in fish (Spry et al., 1988; Mount et al., 1994; Wang et al., 2012).

Paude l*et al*. (2016) found that the levels of Cr in commercial fish were slightly above the permissible limits, suggesting that predators or scavengers would be at risk from chromium if they ate them in the wild. The liver is reported to be the primary organ for bioaccumulation and thus, has been extensively studied in regards to the toxic effects of xenobiotics (Hinton &Laurén, 1990; De Boeck*etal*., 2003; Yilmaz*et al*., 2007; Van dyk*et al*., 2007;Simonato*et al*., 2008; Madureira*et al*., 2012; Nunes*et al*.,2015)

Lead (Pb) is a neurotoxin that causes behavioral deficits in vertebrates (Weber and Dingel, 1997) and can cause decreases in survival, growth rates, learning, and metabolism (Eisler, 1988; Burger and Gochfeld, 2002).

According to Rahman and Hassan 2020, The mean metal concentrations in fish samples studied were decreased within the sequence of Pb> As> Cr> Cd, respectively. The variability of these heavy metals level in several species depends on feeding habits, ecological demands, metabolism, age, size and length of fish, and their habitats (Dalman et al. 2006). The studied values were compared with the suggested limits of metals in fishes, suggested by different authorities (Table 3). Table 3 displays that the mean metal concentrations in fish samples are below the prescribed limits. However, the extent of Pb in *C. Soborna* among the ten species was above the proposed acceptable limit for human consumption. From the literature survey, it had been apparent that the fish samples of *C. Soborna* were bottom-living and thus sediments could be the most sources of Pb contamination therein fish because the mentioned fish was nearly always in-tuned with sediment. Additionally, the quantity of lead may be a ubiquitous pollutant that finds its way into the Rupsha River dues to the discharge of commercial effluents from fish process plants, steel mills, paper mills, rayon mill complexes, cement factories, paint and also dye producing plants, soap and detergent factories and variety of sunshine industrial units etc.

Islam et al. 2017 reported, heavy metal for the studied elements in *C. soborna* and *T. ilisha* were slightly higher than the values obtained for other fish species (Table 3). This can be explained by the sediment ingesting as well as bottom feeding behavior of *C. soborna* and *T. ilisha* which may lead to the much greater bioaccumulation in this study (Debasish et al. 2013). Therefore, the fish species investigated in this study, *C. soborna* and *T. ilisha* can be used as a potential bio-indicator for the contamination of trace elements in the riverine environment. This study revealed that slightly higher accumulations of trace elements were observed in two species (*C. soborna* and *T. ilisha*). From the literature survey, it was noticed that these species are bottom feeder and therefore, sediments could be the major sources of trace elements in these fish species (Yaun et al. 2012; Debasish et al. 2013; Islam et al. 2015).

Metal bioaccumulation is influenced by multiple routes of exposure (diet and solution) and geochemical effects on bioavailability (Luoma*et al*., 2005). As metals are not metabolized, moreover the bioaccumulation of metals and metalloids is of particular value as an biological indicator. Similarly, bioaccumulation is often a good integrative exposure of the chemical accumulated in the estuarine organisms in polluted water bodies. All trace metals are toxic at some bioavailability (Luoma*et al.,* 2008).

3.6 Research gap

Researchers have done some works for assessment of heavy metal in sediment, water and fish of southern-estern region , these works are based on major river Rupsha (Ali et al. 2018; Rahman and Hassan; Sarkar et al. 2018; Sabbir et al. 2016) and Pasur (Hossain et al. 2016; Shil et al. 2017 and Ali et al. 2018) .

But as the south-western part connected with Sundarban with many canals , we need to analyse the canals connected with river to understand the actual heavy metal transmission from source to aquatic environment.

We already found in the study of Ali et al. 2018, that in dry season pollutants concentration was high in Pasur river. Pollutants can exist for long periods during the dry season due to negligible post-barrage river discharge and a salt plug area that found in the Pasurriver (Shaha and Cho 2016). There is no study on the effect of salt plug area on heavy metal concentration in Pasur river.

Unfortunately, there is no study on bioaccumulation of heavy metal in the Pasur river. Though, this river is polluted than Rupsha river and Paira river (Ali et al. 2018)

As heavy metals settled to sediments from various source through water, assessment of heavy metal concentration in water is also needed. It was lacking of the study in Paira river (Islam et al. 2017)

There was no guideline for diminishing or controlling the pollution. Although, corrective measures is need to be taken urgently for controlling Pb contamination in Rupsha river (Rahman and Hassan 2020), Pasur river (Shil et al. 2017; Ali et al. 2018) and Paira river (Islam et al. 2014; 2017).

CHAPTER IV
CONCLUSIONS

At the end of this review paper concluding remarks based on objectives are discussed here. According to first objectives, we found the present scenario of heavy metal pollution in the the Rupsha Pasur river system and Paira river. All these three rivers are situated near port and close to many anthropogenic activities such as various industries. As a result, we found from literature heavy metal concentration is in increasing state. Researchers have many scopes to study here, study in other rivers and canals to understand the actual heavy metal transmission pathway and mechanism.

Based on second objectives, Various heavy metal pollution point and non-point sources; such as leaded gasoline, petroleum, municipal runoffs and atmospheric deposition, petroleum, fertilizers and textile industries, arsenical pesticides industries, treating of wood by exhausting copper arsenate, leachates from defused Ni-Cd batteries and Cd plated items etc, are identified. Now policy maker should focus on these industries and anthropogenic activities to control the pollution. Otherwise, many river will be contaminated hazardously near future and we have to suffer a long run. The riverine country Bangladesh will lose her biodiversity, and people around these rivers will lose their livelihood.

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