Seasonal Investigation of Trace Metals in Water, Sediment, Some Commercial Fish and Seafood in the Coastal Area of Bangladesh and Health Risk Assessment

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バングラデシュの沿岸地域における水、土壌、魚類の微量金属汚染の季節変動とそのリスク評価 ○Mohammad Raknuzzaman[*, **], Md Kawser Ahmed[**], Md Saiful Islam[***], Md. Habibullah-Al-Mamun[*, **], 徳村 雅弘[*], 関根 真[*], 益永 茂樹[*] ([*]横浜国立大学, [**]ダッカ大学, [***]パトゥアカリ科学技術大学)

1. Introduction

Metallic elements are pervasive and potentially accumulated in the marine environment. Trace metal contamination in coastal ecosystem has become a severe problem in Bangladesh (Gupta et al., 2009). Sediment contamination by trace metals are a critical problem of marine ecosystem due to their toxicity and bioaccumulation (Chapman et al., 1998). In recent, the trace metals contamination in fish and sea foods have also become an important and severe issue to human health risk (Cid et al., 2001). The substantial economic development, unplanned industrialization & overall trans-boundary rivers issue accelerate the coastal pollution in Bangladesh. Factors such as TOC, suspended solid (SS), temperature, rainfall, anthropogenic inputs and geomorphological setup are influenced by seasonal vagaries which alter the variation of metal distribution. The concerned authorities and general people have not been aware that might be vital public health problem in near future. Thus, the aim of the study is to determine the seasonal variation of certain trace metals and their distribution in surface water, sediment, some fishes and sea foods in relation to health risk issue in the Bangladeshi Coastal area.

2. Methods

Four coastal sampling sites; Cox's Bazar (St1), Chittagong (St2), Meghna Estuary (St3) and Sundarbans (St4) with three different stations of each were investigated **Figure 1**. The water, sediment, fish and sea foods composite samples were collected in August, 2013 for summer and February 2014 for winter. The surface water samples were collected in acid washed 100 ml polyethylene bottles. Coastal bed sediment (top to 5 cm) was collected by Ekman grab sampler. Sub-samples were oven dried at 105°C for 24 hour. Fish and crustaceans samples were rinsed in deionized water to remove surface adherents. A composite of at least 9 samples of each fish and crabs, and 18 for shrimps was prepared and homogenized in a food processor. About 100 g of fish muscle were taken for freeze drying and stored in polypropylene Ziploc bag at −20 °C. Trace metals were analyzed by ICP-MS (Agilent 7700, USA).

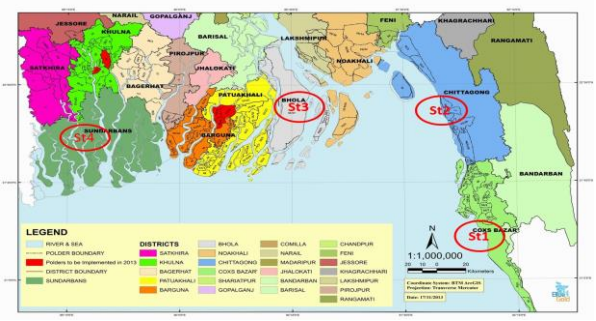

Figure. 1- Map showing sampling sites in the coastal area of Bangladesh.

3. Results

Water of Cox's Bazar hatchery site showed the highest levels of Zn (1390), Cu (510) and Pb (109 µg/L) in summer while As (19.7 µg/L) showed highest in Cox's Bazar Bakkhali estuary in winter **(Figure 2 a, b).** Fish of Cox's Bazar site showed the highest levels of Zn (138), As (13), Cd (0.075) and Pb (0.63 mg/kg ww) in summer season. The elevated concentration of Cu (400), Zn (1480), As (53) and Cd (8.27 mg/kg ww) was observed in crabs of Cox's Bazar in summer. Some metals in water, fish and crustaceans exceeded the international quality guidelines. Sediment samples of Chittagong ship breaking area showed the highest level of Cr (55.8 mg/kg dw) in summer and Ni (37.5), Cu (32) and Pb (48.9 mg/kg dw) in winter which exceeded the Canadian Sediment Quality Guidelines. Estimated daily intake (EDI) and target cancer risk (TR) revealed the high dietary intake of As and Pb, in fish and crustaceans.

4. Discussion

In Bangladesh context, seasonal vagaries play vital role in controlling the anthropogenic inputs like fisheries, agriculture expansion, and industrial activities which might regulate the variation of metal distribution in coastal ecosystem. Water of Cox's Bazar hatchery site showed the highest levels of Zn, Cu and Pb in summer. During summer, fish processing, aquafarm operation, hatcheries, crop cultivation and ship dismantling activities are vigorously increased. It might be due to huge discharge of different salts and chemicals from hatcheries, aquafarms and other industries containing those trace metals. Sediment samples of Chittagong ship breaking area showed the highest level of Cr and Ni in summer and Cu and Pb in winter which exceeded the Canadian Sediment Quality Guidelines. It might be due to influence of, ship scrapping, cement factories, agrochemicals etc. near the studied areas.

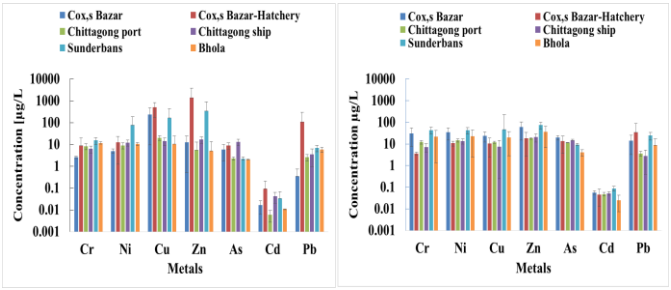

Figure. 2 (a, b) – Seasonal distribution of trace metals concentration (µg/L) in water samples (a = summer, b = winter; n = 3).

Besides, variation in water distribution of the river to the sea, less rainfall effect, less input of water, stability of weather and geomorphological effect resulting in the precipitation of pollutants in the sediment. Metals concentration were remarkably high in fish and crabs in summer at Cox's Bazar site due to interference of uncontrolled huge hatcheries and industrial activities during summer. Metal accumulation in fish has been evidenced to be pretentious by metabolic activities, swimming patterns and living environments. During the summer, the metabolic and swimming activities are increased vigorously which lead to more bioaccumulation and biotransformation of trace metals in fish.

Table 1 Estimated Daily Intake (EDI) and Target Cancer Risk (TR) of trace elements due to consumption of some commercial fishes and crustaceans collected from Bangladeshi coast.

Metals	Mean conc. (µg/g-ww)		Estimated daily intake (EDI) (µg/kg-bw/day)			RfD (USEPA 2008) (µg/kg-bw/day)	Target Cancer Risk(TR)
	Fish	Crustaceans	Fish	Crustaceans	Total (EDI)		Sea foods
Cr	0.75	6.40	0.88	2.28	3.16	3	
Ni	0.35	11.18	0.40	3.98	4.38	20	
Cu	4.18	159.75	5.00	56.86	61.86	40	
Zn	41.28	431.41	50.74	153.55	204.29	300	
As	3.10	16.14	3.71	5.75	9.46	0.3	2.E-02
Cd	0.08	2.59	0.08	0.92	1.01	1	
Pb	0.28	18.84	0.33	6.71	7.04	3.5	6.E-05

The elevated concentration was observed in crabs than those of fish which was considered as an absolutely discrepant aquatic species. Estimated daily intake (EDI) (**Table 1)** and target cancer risk (TR) revealed the high dietary intake of As and Pb through commercial fish and seafood consumption, which was obviously a matter of severe public health issue of Bangladeshi coastal people.

5. Conclusions

The elevated level of season based trace metals are highly affecting and increasing the potential health risk of Bangladeshi coastal people that should not be ignored and continuous monitoring of these toxic trace elements are needed to evaluate with an integrated approaches if any impending risks of the study area do exist.

References

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