Assessment of trace metals in water, sediment and fish species of some urban rivers in Bangladesh

Md. Saiful Islam* and Shigeki Masunaga

Faculty and Graduate School of Environment and Information Sciences, Yokohama National University, Japan

Introduction: The present study observed at the situation of three urban rivers (Turag, Buriganga and Shitalakha) around Dhaka city, Bangladesh. The greater Dhaka city is one of the most densely populated area in the world with approximately 12 million people of which less than 25% are served by sewage treatment facilities. Trace metals from natural and anthropogenic sources pose serious threats to the environment. Hence, trace metals are vital indicators for monitoring the change of aquatic environment. The consumption of fish has increased notably in recent decades to satisfy high protein demand. However, trace metals in fish has become an important worldwide concern, not only threat to fish but also due to the human health risk.

Objectives: To assess the contamination of trace metals in the aquatic environment

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Study area and methods

Eighteen pairs of water and sediment and three species of fifty four fish samples were collected in March 2012 (winter) and September 2012 (summer).

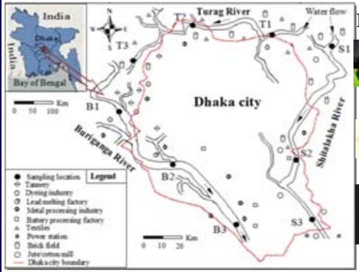
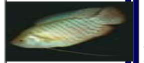


Fig. 1. Map of study area in Bangladesh

Fish species:

Spotted snakehead

Stinging catfish



Banded gourami

Analytical procedure:

0.2 g sediment / 0.3 g fish / 20 ml water sample

⇩

5 ml 69% HNO_3 (Kanto chemical Co, Japan)
+ 2 ml 30% H_2O_2 (Wako chemical Co, Japan)

⇩

Digestion by using microwave digestion system

⇩

Filtration by DISMIC® -25HP PTTF (0.45 µm) syringe filter

⇩

Metal analysis by using ICP-MS (Agilent 7700 x)

Reference: Joint FAO/WHO Expert Committee on Food Additives (JECFA), 2004. Safety evaluation of certain food additives and contaminants. WHO Food Additives Series No. 52. World Health Organization, Geneva.

Results and Discussions

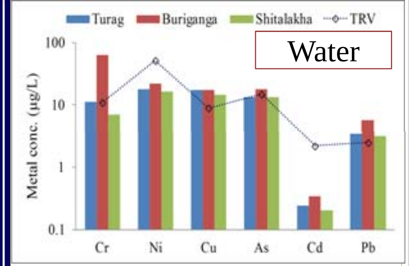


Fig. 2. Metals in water and comparison with TRV values

➢Among three studied rivers, Buriganga River exhibited higher than other two rivers.

➢Some of the metals exceeded the Toxicity Reference Value (TRV) for safe fresh water.

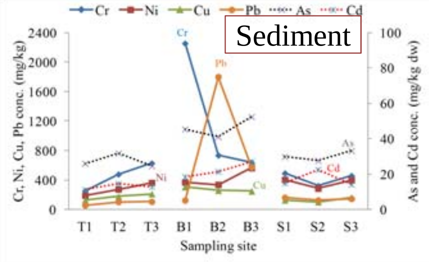


Fig. 3. Metals in sediment of three different rivers

➢Waste from tanneries was the most probably responsible for the highest Cr concentration in Buriganga River.

➢Higher Ni, Cd and Pb in sediment of Buriganga River might be due to industrial activities, atmospheric emission, leachates from defused Ni-Cd batteries and Cd plated items.

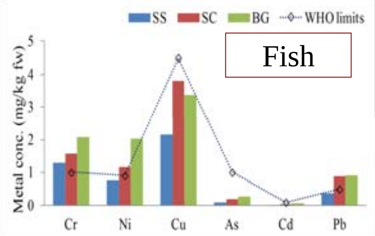


Fig. 4. Metals content in fish species and comparison with WHO permissible limits

➢Stinging catfish (SC) and banded gourami (BG) are bottom living and therefore, sediments could be the major sources of high metals in these fish species.

➢Most of the studied metals were higher than the WHO recommended permissible limits in fish for human consumption.

Sediment quality assessment

$$I_{geo} = \log_2[C_n/1.5B_n] \quad ....(1)$$

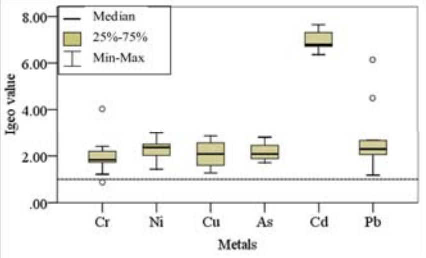


Fig. 5. *I*geo values of metals in sediment

➢Geo-accumulation index (*I*geo) was used to assess metal accumulation in sediment and measure the degree of metal pollution.

➢The frequency of *I*geo value of metals; Cd > Pb > Cr > Ni > Cu > As.

➢The highest *I*geo values for Cd (6.4 - 7.7) indicated extreme contamination. For other metals, moderately to extremely polluted.

Calculation of target carcinogenic risk:

$$TR = \frac{EFr \times ED \times FIR \times C \times CSFo}{BW \times AT} \times 10^{-3}$$

Where, *EFr* is the exposure frequency (365 days/year), *ED* is the exposure duration (70 years) equivalent to the average human life time, *FIR* is the fish ingestion rate (87.16 g/person/day), *C* is the metal concentration in fish (mg/kg, fresh weight), *BW* is the body weight (60 kg for adult), *AT* is the averaging time for non-carcinogens and *CSFo* is the oral carcinogenic slope factor.

Table 1. Carcinogenic risk due to fish consumption

Fish species	Target Carcinogenic Risk (TR) Ni	As	Pb
SS	2.6×10^{-3}	4.1×10^{-4}	7.8×10^{-6}
SC	3.7×10^{-3}	5.8×10^{-4}	1.3×10^{-5}
BG	5.5×10^{-3}	6.5×10^{-4}	1.7×10^{-5}

➢Carcinogenic risk of Ni, As and Cd were higher than the threshold risk level (10^{-6}) set by USEPA

➢Ni and As have a residual cancer risk as exceeding USEPA recommended value of 10^{-4}.

Conclusion: This study has shown that the water and sediment of the rivers was heavily polluted with metals. As some of the selected metals exceeded the safe levels, therefore, it suggested that the water from contaminated sites should not be used without treatment. Target carcinogenic risk values were larger than the threshold risk level set by USEPA (10^{-6}), indicating carcinogenic risks for all adult people of the study area.

islam-md.saiful-nj@ynu.ac.jp