Assessment of Heavy Metals in Sediments of Iloilo Batiano River, Philippines

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***Abstract*—No study have existed on heavy metals present in the river of Iloilo Batiano, Philippines. Thus, this study was conducted to determine the presence and quantities of heavy metals specifically cadmium, chromium and lead in the sediments of Iloilo Batiano River. Furthermore, water physicochemical parameters were determined such as pH and temperature, *in situ*. Three sampling stations were identified adjacent to (1) Batiano Bridge of Oton, Iloilo; (2) Sto. Niño Bridge of Villa, Iloilo City and (3) Calumpang Bridge of Molo, Iloilo City, respectively. Three (two sides and at the center perpendicular to the river) 500 g surface sediments were collected in each of the sampling station for a total of nine sediment samples stored in a sterile ziplock and were immediately transported at the CAS-ASL of UPV, Miag-ao, Iloilo for the quantification of metals through flame atomic absorption spectrophotometry (FAAS). Available cadmium was below detection limit and it appeared that available Pb > Cr in the three points of the river in the three sampling stations. Available chromium and lead have high accumulation in station three (Calumpang Bridge). This study provides information on the heavy metal status of the river, awareness to the public and for further conservation of the river.**

***Index Terms*—Cadmium, chromium, heavy metals, Iloilo Batiano River, lead.**

I. Introduction

Heavy metal contamination of soil is a natural process but it occurs as rare elements [1]. Production of heavy metals is due to agricultural, industrial [2] and other anthropogenic activities [3] as well as natural events such as rock corrosion and weathering.

Lead is considered as one of the industrial hazards and is considered as one of the dangerous environmental pollutants [4]. Cadmium, on the other hand, is a non-essential heavy metal resulting from agricultural, mining, industrial and even from the exhaust smoke emitted by vehicles [5]. Chromium is also a toxic environmental pollutant which can cause detrimental effects to plants and animals [6], [7].

Heavy metals include cadmium, chromium and lead in water, sediment and green algae (*Ulva lactuca)*. The abundance of heavy metals in sediment was Cd > Cr > Pb among the six different stations at Pulicat Lake, South East India [8]. The concentration of cadmium and chromium was 64.21 μg/g and 28.51 μg/g, respectively. Similarly, in an assessment of heavy metals in the sediment of the Second Songhua River in China, it was found out that the concentrations of chromium and lead in surface sediment (0-10 cm depth) were 2.4 – 75.4 mg/kg, correspondingly [9].

On the other hand, the presence of heavy metals such as cadmium, lead, mercury and chromium in water, sediment, plankton and fish from Lake Beysehir of Turkey through atomic absorption spectrophotometry was conducted [10]. Results showed that heavy metals found in sediment were Pb > Cd > Cr > Hg. Based on Turkish regulations, cadmium and lead in Lake Beysehir were above the permissible levels for drinking water. Similarly, an assessment of heavy metals in Almendares River sediments in Havana City, Cuba showed that lead concentration was 39.3 – 189 μg/g, 84.9 – 209.7 μg/g for chromium and 1.0 – 4.3 μg/g for cadmium dry weight of sediment [11].

In a study on the potential ecological risk assessment of heavy metals in sediment of Baiyangdian Lake, it was found out that cadmium and lead were very high [12]. Heavy metals in the sediments of Ravi River, Pakistan showed that cadmium concentration ranged from 0.99 – 3.17 μg/g, while chromium concentration ranged from 4.60 – 57.40 μg/g dry weight basis [13]. Furthermore, investigations on the heavy metals in the sediments of Kaohsiung Harbor, Taiwan revealed that cadmium concentration ranged from 0.1 – 6.8 mg/kg, 9.5 – 470 mg/kg for lead and 0.2 – 900 mg/kg for chromium and the river sediment was classified as concentrated with metals [14]. Evidently, the concentrations of heavy metals in the water, sediment and fish in the middle and lower portions of Yangtze River, China [15] revealed that sediments posed moderate and considerable ecological risk. This was due to or derived from metal processing, electroplating industries, industrial wastewater and domestic sewage. In contrast, heavy metals in the sediments of Danube River such as As, Cr, Cv, Pb, Mg, Ni, and Zn were low except for Cd that was high in the lower stretch of the river [16].

Moreover, studies on the heavy metal cations in the sediments of Shing Mun River, Hong Kong showed that lead concentration was 0.345 mg/g, 0.047 mg/g for chromium and 0.047 mg/g for cadmium [17].

Conversely, conducted assessments of metal contaminants in the sediments of Kubanni Zaria, Nigeria explained that 11 metals including chromium were polluting the river out of the 29 metals examined [18].

In this study, the presence and quantities of heavy metals such as cadmium, chromium and lead was conducted in the sediments of Iloilo Batiano River to determine the level of heavy metal contamination based on the Philippine standard value. Since there is no data on the presence of these heavy

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metals in Iloilo Batiano River, this study serves as a baseline study.

II. Materials and Methods

A. Study Area

Station 1 is found adjacent at the Batiano Bridge of Oton, Iloilo (10º41'36"N, 122º28'48"E), Station 2, adjacent at the Sto. Niño Bridge of Yulo Drive, Villa, Iloilo City (10º40'53"N, 122º31'02"E) and Station 3, adjacent at the Calumpang Bridge of Molo, Iloilo City (10º41'17"N, 122º32'19"E).

Fig. 1. Sampling stations.

B. Materials

Materials used were sterile ziplocks, cork borer, pH paper, thermometer, measuring tape and the flame atomic absorption spectrophotometer (Varian Model 55B) for analysis of sediment samples owned by the CAS-ASL of the University of the Philippines Visayas, Miag-ao, Iloilo.

C. Data Collection

Sub-surface soil samples with a depth of 0-5 cm were collected with the use of cork borer and were placed in sterile ziplock. A total of nine sediment samples in three sampling stations were collected weighing 500 grams each. These sediment samples were immediately transported at the CAS-ASL of University of the Philippines Visayas for analysis of heavy metals.

III. Results and Discussion

Table I presents the water physicochemical characteristics and GPS coordinates of Iloilo-Batiano River. In Station 1, pH value is 8 and the temperature is 27^0C. On other hand, in Station 2, the pH value is 7.67 and the temperature is 28.67^0C. Lastly, in Station 3, the pH value is 7.67 and the temperature is 28^0C.

Table 2 presents the quantities of dissolved heavy metals in Iloilo Batiano River. All total cadmium in all stations showed less than detection value (< dv). In Station 1, the mean concentration of available chromium is 9.68 mg/kg, 12.93 mg/kg in Station 2 and 16.34 mg/kg dry weight in Station 3. Lead, on the other hand, is 13.68 mg/kg for Station 1, 12.73 mg/kg for Station 2 and 28.06 mg/kg for Station 3. The sediments found in the three sampling areas are polluted because it exceeds the standard Philippine value [19].

TABLE I: Water Physicochemical Characteristics and GPS Coordinates of Iloilo Batiano River

Sampling Stations	GPS Coordinates	pH	Temperature
Batiano Bridge	10º41'36"N 122º28'48"E	8	27
Sto. Niño Bridge	10º40'53"N 122º31'02"E	7.67	28.67
Calumpang Bridge	10º41'17"N 122º32'19"E	7.67	28

IV. Conclusions

Available cadmium is less than detectable value in all sampling stations while available chromium and lead exceeds the standard value. This indicates that the river is contaminated with heavy metals. If the sediment will be disturbed, these heavy metals will spread in the water column and will pose hazards to animal, plant life and human health. The results of this baseline study will give awareness to the public not to fish and swim in the area and finally, provide policies for further conservation of the river by the government agencies.

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TABLE II: QUANTITIES OF AVAILABLE CD, CR AND PB AS COMPARED TO THE PHILIPPINE STANDARD VALUE

Metal (mg/kg)	Station 1 (Batiano Bridge)				Station 2 (Sto. Niño Bridge)				Station 3 (Calumpang Bridge)				Philippine Standard Value
	Left	Middle	Right	Mean	Left	Middle	Right	Mean	Left	Middle	Right	Mean	
Cd	< dv	< dv	< dv		< dv	< dv	< dv		< dv	< dv	< dv		.005
Cr	9.64	8.51	10.9	**9.68**	11.07	18.27	9.47	**12.93**	18.61	12.91	17.51	**16.34**	.01
Pb	13.21	10.20	17.64	**13.68**	10.28	16.73	11.18	**12.73**	24.18	12.82	47.20	**28.06**	.01

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