CONCENTRATION OF HEAVY METALS IN WASTEWATER, SOIL AND RICE SAMPLES FROM TAUNG IN LAKE NEAR MANDALAY INDUSTRIAL ZONE II

Hnin Hnin Aye[1], Win Win Aye[2], Nay Win Oo[3]

Abstract

To estimate the heavy metals concentration presence in the water, soils and the rice grown on the soil, the samples are collected from Min Ywa (MY), Nyaung Ni Bin (NNB), Nyaung Bin Zauk (NBZ) and Inn Gone (IG) villages. Theses villages are located in Mandalay Industrial Zone II and are assigned as study areas in our research work. The collected samples are analyzed by using Atomic Absorption Spectrophotometer (AAS). The results showed the 5 elements (Fe, Cu, Zn, Pb and Cd) exist in soil and rice samples. Mn, Fe, Cu, Zn and As concentrations in wastewater exceeded the permissible limit by WHO. Transfer values of soil to rice ranged from 0.001-0.004 for Fe, 0.282-0.577 for Cu, 0.371-0.658 for Zn. But Pb and Cd are not listed because they are below the detectable limit.

Keywords: wastewater, heavy metals, Atomic Absorption Spectrophotometer (AAS).

Introduction

The presence of heavy metals in plant**s** and soil are one of the major issues to be faced throughout the world requires attention because heavy metals which include more than their normal ranges are extremely threatened to both plant**s** and human life. Soil is capable of supporting plant life and is vital to life on earth. Accumulation of heavy metals in plants is of great concern because of the probability of food contamination through the soil root interface.

Water is the most used for industrial, municipal and agricultural purpose. Thus water plays a major role in virtually every aspect of human life. The industrial wastewater can result in the heavy metal contamination of agricultural soils. Heavy metal content**s** in wastewater are very dangerous because water pollution occurs in the agricultural areas, lakes, oceans, streams, rivers, underground water. There are some essential elements for human and animal health but they occur in small amounts naturally. Some minerals like Zn, Cu and Fe which are useful and can increase the water quality. Some elements like Pb, As, Hg, Cr, Ni, Cd, Co which are very harmful, toxic and poisonous and can decrease the water quality . Therefore the investigation of heavy metals is necessary for agricultural soils and wastewater. The main objective of this study is to estimate the concentration of heavy metals exist in the wastewater, soils as well as rice grown on the soil.

Materials and Methods

Studied Area

Industrial waste of local factory passes from Taung In Lake to Myitnge river through the canals. Hence, the Lake has been contaminated with these industrial wastewater. Almost every rainy season when the river level is high, the river Myitnge overflow**s** down the lake. Then, wastewater flow**s** into the villages (Min Ywa (MY), Nyaung Ni Bin (NNB), Nyaung Bin Zauk

[1] Dr, Assistant Lecturer, Department of Physics, Sagaing University.
[2] Dr, Assistant Lecturer, Department of Physics, Hakha College.
[3] Dr, Professor, Department of Physics, Magway University.

(NBZ) and Inn Gone (IG)) surrounded Taung In Lake. Taung In Lake is located in Amarapura region near Mandalay Industrial Zone IIand lying along 21.52° N latitude and 96.03° E longitude. The present study is carried out in the agricultural fields of Min Ywa (MY), Nyaung Ni Bin (NNB), Nyaung Bin Zauk (NBZ) and Inn Gone (IG) villages.The rice, soil and wastewater samples were collected from these villages.

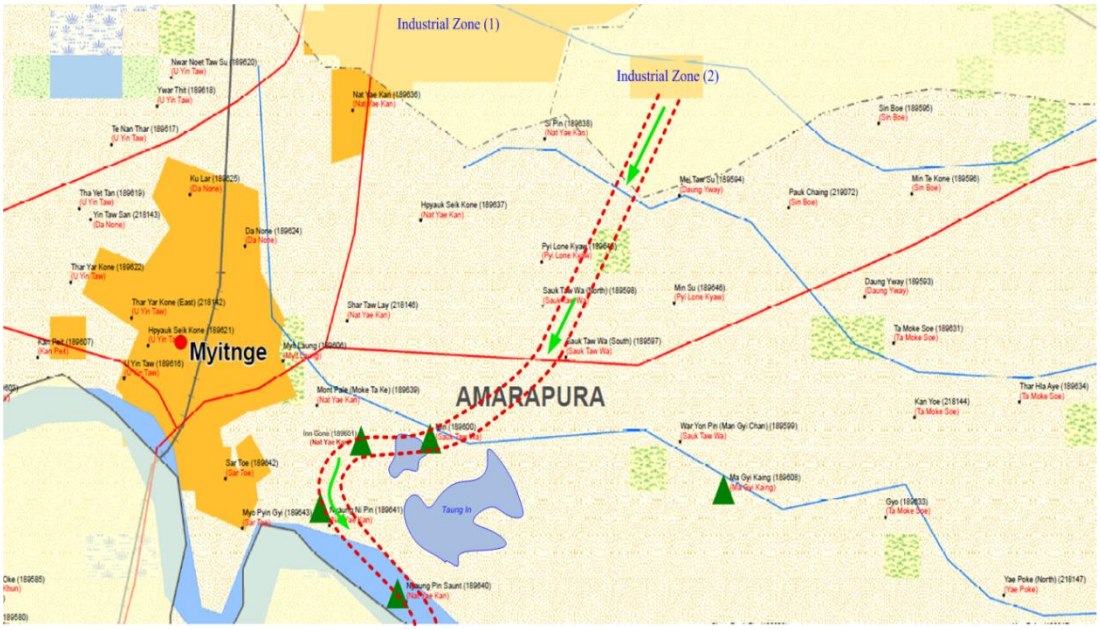

Figure 1 The Geological Map of Sampling Sites in Taung-In

Sampling and Preparing

Wastewater samples (site-1, site-2, site-3, site-4) were collected from flume flowing into the fields of rice in villages (Min Ywa (MY), Nyaung Ni Bin (NNB), Nyaung Bin Zauk(NBZ), Inn Gone (IG)) surrounded Taung In Lake in April, 2018. 500 mL of wastewater was filtered with filter paper. After filtering, sample was placed at room temperature about 5 hr.

Each soil samples were collected to a depth of 15 cm from surface level in respective fields. The rice samples were collected from these villages. The collected soil and rice samples were dried at room temperature for two weeks. The dried samples were ground manually with a ceramic-triturator and sieved to pass through 200 mesh to get fine powder. And then 1 g of rice powders were placed inside muffle furnace. After heating at 500°C for 2 hr, the ashes were obtained. Then the ashes were mixed with 5 ml of HCl at 50 °C for 10 min. The mixed solution was cooled and filtered with filter paper. After filtering, 1 ml of sample and 49 ml of de-ionized water (DI) were diluted into the 50 ml volume metric flask and then placed at room temperature about 24 hr.

5 g of soil powder were mixed with 30 ml of DI and 5 ml of HCl. The mixed solution was stirred at 100 °C for 10 min. The solution was cooled at RT and filtered with filter paper. After filtering soil solution was placed at room temperature about 24 hr. All samples were performed by Atomic Absorption Spectrometer at Universities' Research Centre (URC), Yangon University.

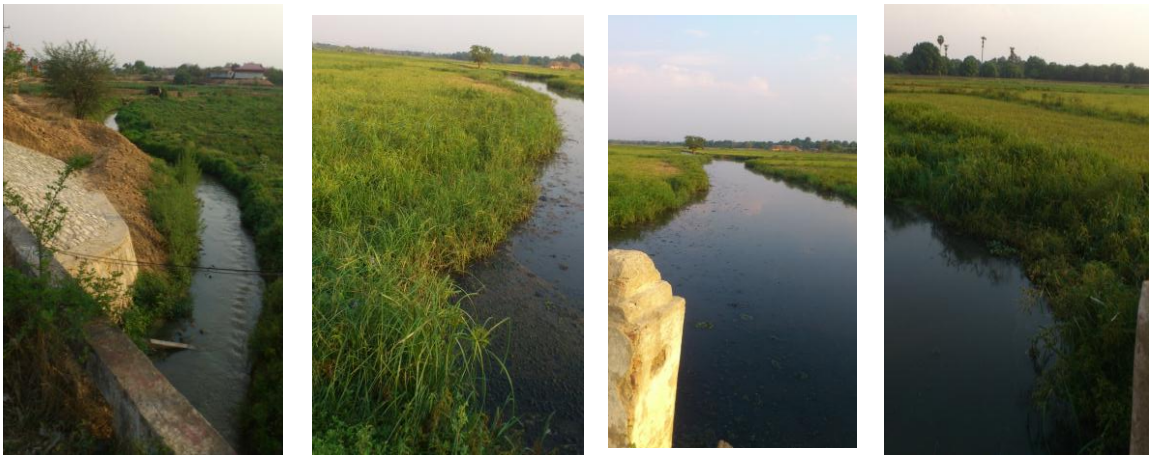

Figure 2 Site-1, site-2, site-3, site-4 at villages surrounded TaungIn Lake

Analysis of Samples

Atomic Absorption Spectroscopy (AAS) was performed to detect and measure concentration of metals in the soil, rice and wastewater samples. Almost every metallic element can be determined quantitatively by using the spectral absorption characteristics of atoms. It was found 7 (Cr, Cu, Cd, Fe, Mn, Asand Zn) elements in the measured samples.

Results and Discussion

AAS results

The presence of Fe, Cu, Zn, Cd and Pb metals in rice and soil samples were found. Comparative heavy metals concentration for rice samples (IG, NBZ, MY and NNB villages) with the recommended limit by FAO were shown in the Table (1). The observed concentrations ranged from 0.17-0.41 for Fe, 10.14-20.47 for Cu, 11.48-192.3 for Zn in rice samples (Table (2)). Zn concentrations were above the recommended limit by FAO for human consumption. Cd and Pb were toxic elements even at low concentrations. But, Cd and Pb concentrations cannot be detected. The concentrations of Fe, Cu, Zn and Pb elements in soil samples (IG, NBZ, MY and NNB villages) were enriched. Pb concentration was above the permissible value of FAO. The presence of Cr, Mn, Fe, Cu, Zn, As and Cd in wastewater sample presented in the Table (3). Fe and As concentrations were above the recommended limit by WHO.

Table1 Heavy Metal Concentrations of rice samples

Element	IG (ppm)	NBZ (ppm)	MY (ppm)	NNB (ppm)	FAO (ppm)
Fe	0.41	0.17	0.38	0.28	5
Cu	15.84	10.14	19.99	20.47	40
Zn	63.01	11.48	192.3	72.34	60
Cd	ND	ND	ND	ND	0.3
Pb	ND	ND	ND	ND	5

(Date of collected samples : April, 2018)

ND=Not Detected

Table 2 Heavy Metal Concentrations of soil samples

Element	IG (ppm)	NBZ (ppm)	MY (ppm)	NNB (ppm)	FAO (ppm)
Fe	102.6	118.8	107.3	123.2	ND
Cu	34.61	31.75	70.85	35.45	70
Zn	169.9	17.44	354.5	162.2	80
Cd	0.67	1.00	0.70	0.89	3
Pb	160.6	148.9	30.76	221.3	16

(Date of collected samples : April, 2018)

Table 3 Heavy Metal Concentrations of wastewater

Element	Taung In (ppm)	WHO (ppm)
Cr	LDL	0.10
Mn	1.334	0.20
Fe	29.53	5
Cu	1.512	0.20
Zn	3.576	2
As	5.426	0.10
Cd	LDL	0.01

(Date of collected samples : April, 2018)
LDL=Low detection limit

Since heavy metals can transfer to plant from soil, the transfer values were determined. The transfer coefficient was calculated by dividing the concentration of heavy metals in vegetables by the total heavy metal concentration in the soil.

$$TF = \text{conc. of metal in edible part} / \text{conc. of metal in soil} \quad (1)$$

The estimated results for transfer factors (TF) were shown in Fig. 3. The TF values for Cd and Pb are not detectable in all samples. It was found that TF value was less 1 for samples of Min Ywa (MY), Nyaung Ni Bin (NNB), Nyaung Bin Zauk(NBZ), and Inn Gone(IG) villages.

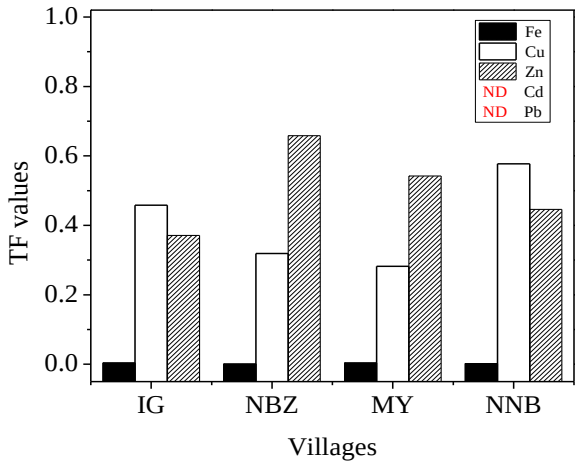

Figure 3 Transfer values from soil to rice

Conclusion

The quantitative analysis of heavy metals contained in wastewater, soil and rice samples are carried out by AAS spectrometer. The toxicity of the heavy metal in paddy fields of Min Ywa (MY), Nyaung Ni Bin (NNB), Nyaung Bin Zauk (NBZ) and Inn Gone (IG) villages around Taung In Lake in Mandalay Industrial Zone II depends on the influence of contaminated wastewater.

Fe, Cu, Zn, Cd and Pb metals are found in soil and rice samples. The concentrations of Fe, and Cu in rice sample are lower than the values of FAO(5 ppm for Fe, 40 ppm for Cu) but Zn concentration is high. Heavy metals in soil sample were greater than in rice samples. This indicates that the capability to transport metals from soil to plants. Cd was not found in AAS results for rice sample. Thus, Cd may not be reliable in heavy metal concentration measurement for rice sample.

Heavy metals of Cr, Mn, Fe, Cu, Zn, As and Cd are found in wastewater of Taung In Lake. Fe and As have the maximum concentrations compared to other heavy metals. It is due to an influence of the increasing of contaminated wastewater even flow through the plastic pipe from Industrial Zone II to directly Myitnge river.

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