# ASSESSMENT OF HEAVY METALS CONCENTRATION IN WATER SAMPLES FROM MANDALAY CITY

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## Abstract

The objective of this paper is to investigate heavy metal concentration and water quality parameters of different water stations in Mandalay city. Water samples were collected from six different townships in Mandalay City. The selected water samples are currently used for human consumption at the Mandalay region of Myanmar. The study provides an assessment of the present status of the concentration of heavy metals (Cu, Fe, Mn, Pb and Zn) of the Mandalay urban area. The concentration of Cu, Fe, Mn, Pb and Zn were determined using Inductively Couple Plasma Optical Emission Spectroscopy (ICP-OES) techniques for heavy metal evaluation index (HEI). Concentration of heavy metals in the water samples from the study area were Fe>Mn>Zn>Pb>Cu. In order to risk levels of Heavy Metal Evaluation Index (HEI) was evaluated. According to the pollution index, 67% of water samples were good as reported by heavy metal evaluation index (HEI).

**Keywords:** heavy metal, heavy meal evaluation index, drinking water

## Introduction

Water is the most important, abundant and useful resources on the earth because no life is possible without water. It is the most essential basic component to all living being as most of the biochemical reactions that takes place through the metabolism and growth of living organisms involve water. Contamination of the environment with toxic heavy metals has become one of the major causes of concern for human kind. Heavy metals in surface water bodies, groundwater and soils can be either form natural or anthropogenic sources. The two basis categories of pollution are organic and inorganic. Inorganic pollution is basically from heavy metals. Chemical substances such as heavy metals are one of the factors which contribute to environmental pollution and it was believed that it can disrupt living ecosystem. Currently, anthropogenic inputs of metals exceed natural inputs due to increased urbanization and industrialization. Healthy drinking water is the basic need of the human health. Contaminated drinking water is a significant risk to human health. The high concentration of heavy metal intensively effects on health, no. of disease increase day by day like cancers that are associated with heavy metal. The heavy metals can enter into the environment through anthropogenic activates and natural process.

The purpose of this research is to increase the awareness about heavy metal and its high concentration effect on living things.

## Materials and Methods

Mandalay is the second largest city in Myanmar and the economic centre of Upper Myanmar. In this research, the samples were collected from 6 BPS which based on the municipal water supply system at different townships in Mandalay urban area. In this research, the samples were collected from 6 BPS which based on the municipal water supply system at different townships in Mandalay urban area. The samples were collected 6 polyethylene bottles in ice boxes and the bottles were rinsed with the target water before sampling. And then, the concentrations of heavy metals (Cu, Fe, Mn, Pb and Zn) were analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Perkin Elmer Optima 3000 at the Environmental Science Research Center, Chiang Mai University, Thailand. After analyzing, the risk level of heavy metal concentrations in the samples were investigated the quantitative methods: Heavy Metal Evaluation Index (HEI).

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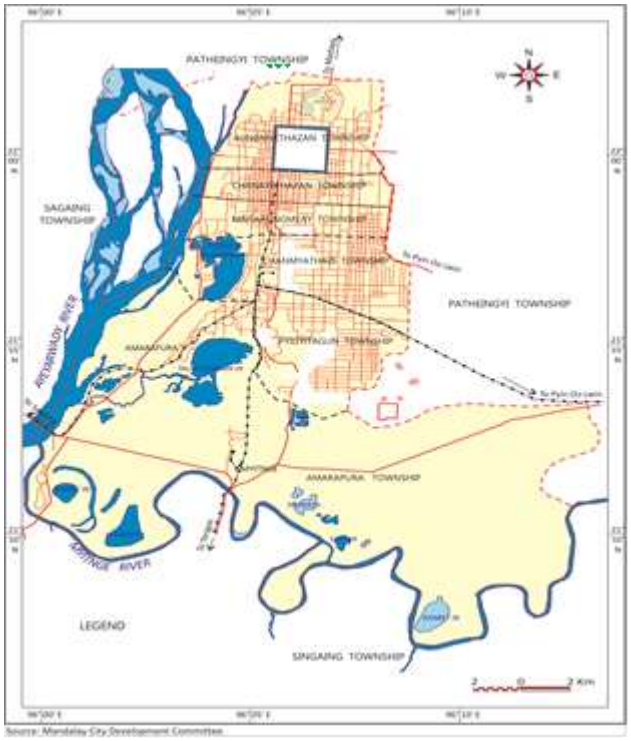


**Figure 1.** Geographical Map of Mandalay showing the study area

**Table 1 Samples Descriptions of Study Area**

| Samples Code | Study Area | Water Characteristics | Townships |
|---|---|---|---|
| W-1 | BPS-1 | Groundwater | Chanayethazan |
| W-2 | BPS-2 | Groundwater | Chanmyathazi |
| W-3 | BPS-3 | Groundwater | Aungmyaethazan |
| W-4 | BPS-5 | Groundwater | Mahaaungmyae |
| W-5 | BPS-10 | Groundwater | Amarapura |
| W-6 | BPS-15 | Groundwater | Pyigyidagun |

**Heavy Metal Evaluation Index (HEI)**

Heavy metal evaluation index provided an overall quality of water for heavy metals and can be calculated as follows:

$$HEI = \sum_{i=1}^{n} \frac{H_c}{H_{MAC}}$$

Where, $H_c$ is the monitored value and $H_{MAC}$ is the maximum admissible concentration (MAC) of the $i^{th}$ parameter.

**Table 2 Classification for Heavy Metal Evaluation Index (HEI) [Mohan *et al*., 1996]**

| HEI Value | Pollution Level |
|---|---|
| <10 | Low |
| 10-20 | Medium |
| >20 | High |

## Results and Discussion

Heavy metals concentration in water samples were measured by using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The mean concentration of Cu, Fe, Mn, Pb and Zn in water samples were LOD, 3.362, 0.296, 0.022 and 0.128 mg/L. Heavy metal concentration of analyzed water samples and compare the guidelines value as specified by the World Health Organization (WHO) for drinking water quality are in Table (3). The variations of heavy metal concentration in water samples are demonstrated in Figure (2) to Figure (5).

**Table 3 Heavy Metal Concentration in Water Samples**

| Study Area | Heavy Metal (mg/L) | | | | |
|---|---|---|---|---|---|
| | **Cu** | **Fe** | **Mn** | **Pb** | **Zn** |
| W-1 | LOD | 4.707 | 0.445 | LOD | 0.161 |
| W-2 | LOD | 4.704 | 0.443 | LOD | 0.162 |
| W-3 | LOD | 0.681 | LOD | 0.066 | 0.056 |
| W-4 | LOD | 0.672 | LOD | 0.068 | 0.055 |
| W-5 | LOD | 4.703 | 0.446 | LOD | 0.174 |
| W-6 | LOD | 4.706 | 0.444 | LOD | 0.161 |
| Average | - | 3.362 | 0.296 | 0.022 | 0.128 |
| WHO | 2 | 0.3 | 0.4 | 0.01 | 3 |

LOW: Lower Limited of Detection
WHO:World Health Organization

### Copper

Copper is an essential element and is contained in many foods. In this research, the concentration of Cu in all samples were estimated as zero by the detection instrument that means either there was no Cu present in water or the levels of Cu were lower than the detection limit of the instrument.

### Iron

Iron (Fe) is an essential element for human health that performs various function in our body, the most well-known of them is production of protein hemoglobin, which carry oxygen from our lungs to transfer it throughout the body. In this study, the concentration of iron in water samples ranged from 0.672 to 4.707 mg/L with an average value 3.362 mg/L. All of the water samples are higher than the range of WHO Standard.

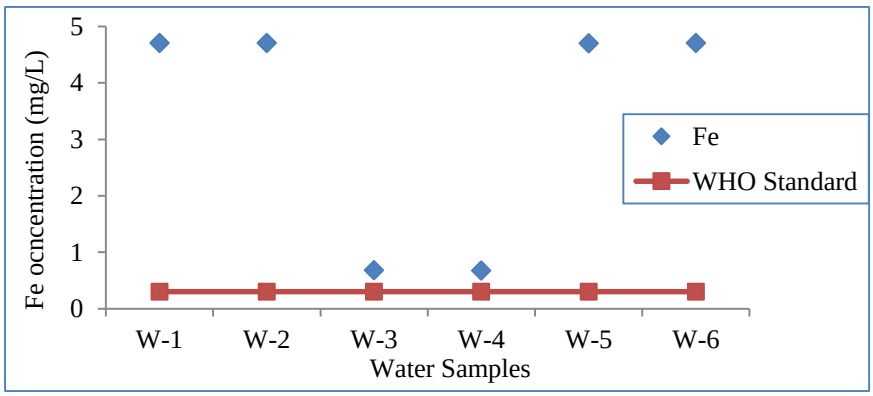


**Figure 2** Fe concentration in water samples

## Manganese

Manganese is an important trace mineral that is needed by our body in little amounts for the production of digestive enzymes, absorption of nutrients, wound healing, bone development and immune-system defenses. In the present investigation, the value of manganese ranged from 0 to 0.446 mg/L with an average value 0.296 mg/L. The concentrations of manganese are slightly larger than the WHO standard at W-1, W-2, W-5, W-6.

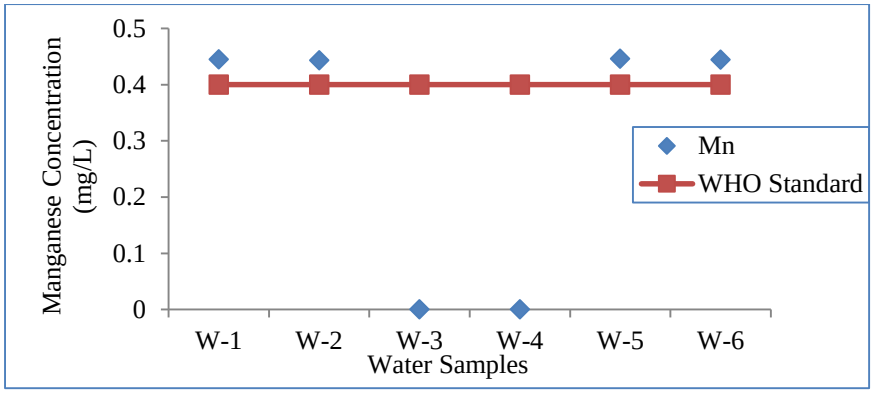


**Figure 3** Mn concentration in water samples

## Lead

Lead is toxic heavy metal and it is found in the earth crust. The excess amount of lead creates harmful effect on health and it can directly destroy the major organs and system of body. In the present study, the concentrations of lead were found below the permissible limit of WHO standard except water samples of W-3 and W-4.

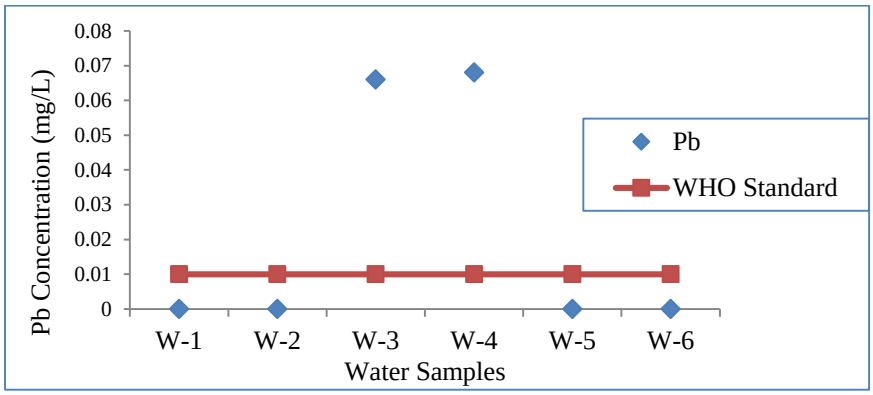


**Figure 4** Pb concentration in water samples

## Zinc

Zinc is an essential trace element, which is required in small quantity to maintain human health. Zinc helps in production of hormones, growths, improvement of immune and digestive system. In the present investigation, all of the water samples were found below the permissible limit of WHO standard.

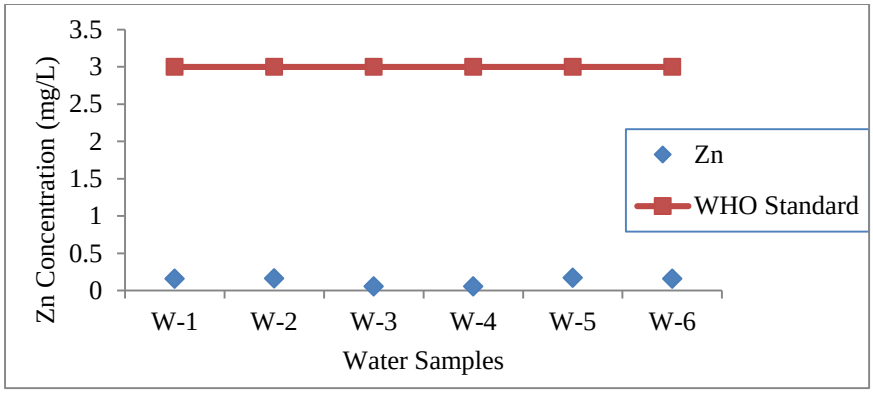


**Figure 5** Zn concentration in water samples

## Pearson Correlation Analysis of Water Samples

Pearson correlation analysis coefficient was applied to determine the relationship between heavy metals (Cu, Fe, Mn, Pb and Zn). Pearson correlation analysis of heavy metals in water samples from Mandalay urban area is shown in Table (4). According to the obtained data, Fe showed a significant positive correlation with Mn and Zn. Mn has positively correlated with Zn. The correlations between the concentrations of different heavy metals in the study area have been illustrated using a scatter plot in Figure (6).

**Table 4 Pearson Correlation Analysis of Heavy Metals in Mandalay Urban Area**

| | *Fe* | *Mn* | *Pb* | *Zn* |
|---|---|---|---|---|
| *Fe* | 1 | | | |
| *Mn* | 0.999989 | 1 | | |
| *Pb* | -0.99985 | -0.99982 | 1 | |
| *Zn* | 0.995885 | 0.996203 | -0.99586 | 1 |

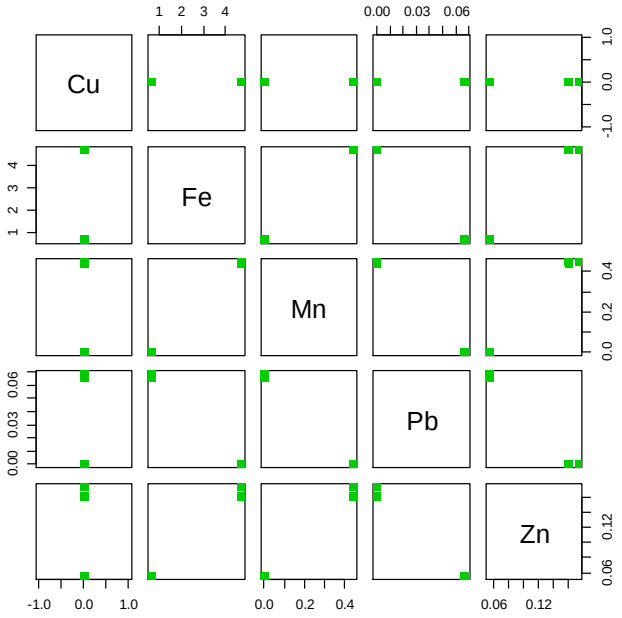


**Figure 6** Scatter plot of heavy metal concentration in water samples

## Assessment of Metal Contamination

Metals contaminations of heavy metals (Cu, Fe, Mn, Pb and Zn) were calculated for the study area. In the present investigation, Heavy Metal Evaluation Index (HEI) values were found in the range of 8.89 to 16.85 respectively. The observed HEI values of all the water samples are found within the medium pollution level and this indicates that the water is not critically polluted with respect to studied heavy metals. The observed data of HEI are presented in Figure (8).

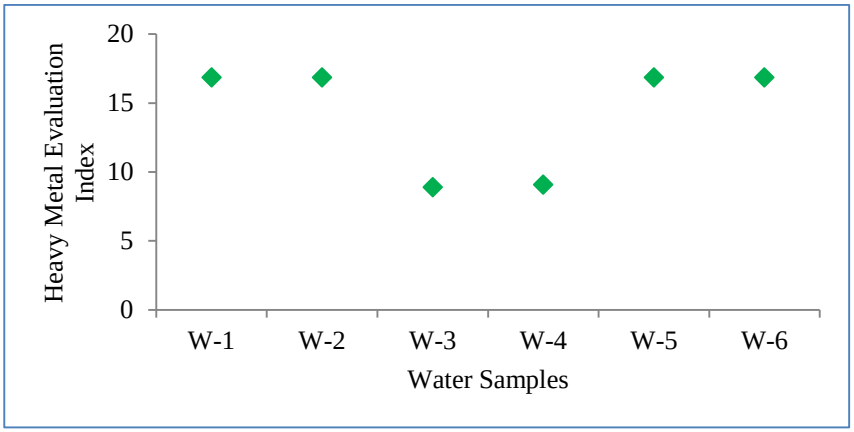


**Figure 8** Variations of Heavy Metal Evaluation Index of Water Samples

## Conclusion

Health water is a basic need for life. The excess amount of heavy metal present as pollutant in unhealthy water. In some area of present study, the concentrations of heavy metals are higher than the permissible limit of WHO standard. Fe, Mn and Zn are essential for health but in limited concentration, high concentration creates harmful effect on health. According to the obtained results, water used for human consumption in all sites had the correlation of Iron followed by Mn, Zn and Pb. We are able to control these serious diseases by removing excess amount of heavy metal in drinking water. If the people of Mandalay are going to use this water as drinking water, they should use it after treatment. Conducting this research helps to prevent the pollution of the water used by the people of Mandalay.

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