DETERMINATION OF HEAVY METALS CONTAMINATION IN THE RIVER WATER OF SUNGAI MAONG AND ENVIRONMENTAL AWARENESS AMONG THE VILLAGERS OF KAMPUNG SUNGAI MAONG

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DETERMINATION OF HEAVY METALS CONTAMINATION IN THE RIVER WATER OF SUNGAI MAONG AND ENVIRONMENTAL AWARENESS AMONG THE VILLAGERS OF KAMPUNG SUNGAI MAONG

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A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Environmental Science in Land Use and Water Resource Management

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DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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DETERMINATION OF HEAVY METALS CONTAMINATION IN THE RIVER WATER OF SUNGAI MAONG AND ENVIRONMENTAL AWARENESS AMONG THE VILLAGERS OF KAMPUNG SUNGAI MAONG

ABSTRACT

Anthropogenic activities have given great pressures on the environment including the river and therefore public awareness is important in order to sustain our natural resources. This study was carried out to analyze the heavy metals concentrations of the surface water of four stations within Sg. Maong catchment and also to investigate the environmental awareness of the villagers in Kpg Sg. Maong with regard to solid waste management and recycling. Elemental concentrations of Zn, Fe, Pb, Cu, As and Al were measured using atomic absorption spectroscopy (AAS). The mean values of the heavy metals are; Zn 0.91 mg/L; Fe 0.61 mg/L; Pb 0.018 mg/L; As 0.033 mg/L; Al 1.85 mg/L; whereas Cu was not detected in all water samples. The average trend of heavy metals in Sg. Maong was observed in the order: Al>Zn>Fe>As >Pb. Pearson correlation analysis was done to determine the degree of association between the heavy metals and pH. Fe and As showed high correlation with pH whereas between metals, Zn/Fe, Zn/Al, Fe/As and Fe/Al showed a positive correlation. It was observed that the surface water of Sg. Maong was not heavily contaminated with Fe, Zn, Al and Cu as these concentrations were below the standard limit of Interim National Water Quality Standard (INWQS). At the same time, a convenience sampling method was conducted in Kpg. Sg. Maong to investigate the villages’ awareness through scheduled interviews. The questions were categorized into five sections which are environmental awareness, water awareness, solid waste management, recycling awareness and demography. The finding shows that most of the respondents exhibited positive answers towards different awareness. Thirty households were interviewed in this study and the chi-square test was conducted to examine the significant difference between the independent variables with the dependent variables. Results indicate that there are significant differences between age, gender and education of the respondents.

Key words: surface water; heavy metals; Interim National Water Quality Standard (INWQS), environmental awareness, recycling, solid waste.
Aktiviti antropogenik telah member tekanan terhadap alam sekitar termasuk sungai. Oleh itu, kesedaran orang awam terhadap alam sekitar adalah penting untuk mengekalkan sumber alam semula jadi. Kajian telah dijalankan untuk menganalisis kepekatan logam berat di permukaan air bagi empat stesen yang terdapat di kawasan tadahan Sg. Maong. Selain itu, kajian telah dilakukan untuk menyiasat kesedaran alam sekitar penduduk Kampung Sg. Maong dengan mengambil kira pengurusan sisa pepejal dan kitar semula. Kepekatan unsur Zn, Fe, Pb, As, Cu dan Al telah ditentukan dengan menggunakan Spektroskopi Serapan Atom (AAS). Nilai purata bagi logam berat pada permukaan air Sg. Maong adalah; Zn 0.91 mg/L; Fe 0.61 mg/L; Pb 0.018 mg/L; As 0.033 mg/L; Al 1.85 mg/L; manakala Cu tidak dikesan dalam semua sampel air. Trend purata logam berat di Sg. Maong adalah mengikut urutan seperti berikut: Al>Zn>Fe>As >Pb. Korelasi Pearson juga telah dijalankan untuk menentukan hubungan antara logam berat dan pH. Fe dan As telah menunjukkan korelasi yang tinggi dengan pH manakala hubungan antara logam berat menunjukkan Zn/Fe, Zn/Al, Fe/As and Fe/Al telah menunjukkan korelasi yang positif. Kajian ini menunjukkan permukaan air Sg. Maong tidak dicemari oleh Fe, Zn, Al dan Cu kerana kepekatannya adalah di bawah had standard Piawai Interim Kualiti Air Kebangsaan (INWQS). Pada masa yang sama, kaedah persampelan mudah telah dijalankan di Kampung Sg. Maong untuk menyiasat kesedaran alam sekitar dikalangan penduduk melalui jadual temu bual. Soalan-soalan mengandungi lima kategori iaitu kesedaran alam sekitar, kesedaran kualiti air, pengurusan sisa pepejal, kesedaran terhadap kitar semula dan juga demografi. Keputusan menunjukkan bahawa kebanyakan responden memberikan jawapan yang positif bagi setiap kategori kesedaran.Tiga puluh isi rumah telah ditemu bual dan ujian Khi-kuasa dua juga telah dijalankan untuk mengkaji perbezaan yang signifikan antara beberapa pemboleh ubah yang bebas dengan pembolehubah bersandar. Keputusan ini menunjukkan bahawa terdapat perbezaan yang signifikan antara umur, jantina dan pendidikan responden.

Kata kunci: permukaan air, logam berat, Piawai Interim Kualiti Air Kebangsaan (INWQS), kesedaran alam sekitar, kitar semula, sisa pepejal.
CHAPTER ONE

INTRODUCTION

1.1 Background

Environmental issues such as air pollution, water pollution and waste disposal have become the major problems in our country (Global Environmental Forum, 2000). It gives significant impacts to our environment such as haze and loss of aquatic biodiversity. However, Malaysia has developed series of strategic plan to overcome these problems by including the environmental protection program in the Malaysian Plan to compete internationally in terms of economics and at the same time maintaining the 'green image' of the country (TEPO, 2010). In water treatment and sewerage, the government has reconstructed water industry as to improve the water quality, technical standard and its service to the society (Hua, 2009). At the same time, Malaysia also has established wastes recycle program to reduce the polluted environment (Mohamed, n.d). This program has been started since ten years ago and still continue to promote the 3Rs concept which are reduce, recycling and reuse in solid waste management system. Nevertheless, some of these strategic plans are still lacking somewhere as the environmental quality in our country does not seem to be improved. For example, in year 2000, there were 12 out of 120 rivers were categorized as polluted, across the country. In year 2010, the number of polluted rivers increased to 74 out of 750 rivers across the country (DOE, 2006; DOE, 2010). According to Interim National Water Quality Standard (INWQS), Malaysia Rivers are classified from Class I to V, with Class I being the cleanest and Class V is heavily polluted. The class V River has poor condition in term of chemical and physical appearances compared to a Class I River. Figure 1.1
shows the examples of clean rivers in Malaysia under class I whereas Figure 1.2 shows the example of the Class V River.
Figure 1.1: The examples of Class I river in Malaysia according to INWQS (DOE, 2010) (a) Sg. Wariu, Sabah (b) Sg. Jeram, Pahang (c) Sg. Tembeling, Pahang

Figure 1.2: Sg. Ara, Penang, Class V River in Malaysia according to INWQS (DOE, 2010)
Lack of environmental awareness among the public is one of the factors that influence the increase in the number polluted river across Malaysia. This can be proved as untreated domestic sewage; wastes from livestock and industrial are still directly discharged into the river (Farah Naemah et al., 2006). Besides, it was estimated that 20% of organic wastes were disposed into rivers or at illegal dumping areas (Abdul Jalil, 2010). Therefore, it is important for Malaysian government and non-government association to undertake many campaigns related to the environment and at the same time monitoring the environmental quality status in order to make the public aware of our changing environment.
1.2 Problem Statement

River pollution is one of the environmental problems faced by most of the developing nations as the wastes from various sources are discharges in the water without proper treatment (Azumi & Bichi, 2010). Sarawak River is polluted by various contaminants from industrial and residential areas. These sources contribute to the deposition of heavy metals in the sediment and cause severe environmental degradation. Sediments contained inorganic and organic matters that deposited heterogeneously in the water bodies (Gaine, 2005).

Heavy metals are one of the inorganic contaminants that are non-degradable in nature and will accumulate in the food chain causing health problems (Jain, 1978). Mercury (Hg), lead (Pb) and cadmium (Cd) for instances, are elements that cannot be broken down into simpler substances and thus give a serious threat to the environment (Notter, 1993). Large consumption of heavy metals by aquatic life will interfere with aquatic ecosystems (Santschi et al., 1984) and also affects the mankind when the heavy metals flow into the food chain.

Water quality status in Malaysia is currently based on National Water Quality Index (NWQI). Parameters that are used including pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and ammonia nitrogen and suspended solid (Global Environmental Forum, 2000). Discharged of wastewater into the river without treated will cause different degree of concern in water quality such as high level of BOD, suspended solid and high number of pathogens (Ling et al., 2010).
Apart from that, volume of solid waste generated in Malaysia increase every year where the major contributors are particularly from household, industrial and market. Waste generation varies with level of communities and degree of urbanization (Zaini, 2011). The area with high income and more urbanized will generate high levels of solid waste per capita (Omran et al., 2009). Thus, solid waste management is needed to overcome this situation. The disposal of solid wastes is mainly to landfill. Thus, handling and separation of waste are important prior to disposal. Solid waste is also directly discharged into the rivers which contribute to high concentrations of heavy metals in the surface water and sediments (Kassenga & Mbuligwe, 2009; Akan et al., 2010).

In our country, different bins are distributed for waste storage which is a small bin (household), medium bin (communal bin) and large bin (hauled bin) (Zaini, 2011). Most of residential area in the cities is given the small bin where it has been used to store different type of waste such as kitchen waste, metals, plastics and rubber (Zaini et al., 2002). So this led to waste disposal problem apart from insufficient provision, financial and technological resources to treat the waste (Omran et al., 2009).

Therefore, recycling concept has been launched in 1993 but it was not fully practiced by public. Then, the government re-launched the recycling campaign in 2001 and the feedback from the society remained the same (Omran et al., 2009). Hence, it is important to investigate the resident’s awareness towards environmental issue in order to understand the current problems and approaches that should be taken to overcome the issues.
1.3 Research Objectives

In order to investigate the change in the river water of Sg. Maong, four stations along Sg. Maong catchment was studied to evaluate the heavy metal contamination. At the same time, one of the areas in Sg. Maong catchment was studied in term of their awareness of environmental issues.

1.3.1 Specific Objectives

1. To analyze the surface water of Sg. Maong based on the selected heavy metals (Cu, Zn, Fe, Pb, As and Al).

2. To observe the trend of heavy metal concentration in Sg. Maong.

3. To investigate the environmental awareness with regard to water quality, solid waste management and recycling among the villagers in Kpg. Sg. Maong.
CHAPTER TWO

LITERATURE REVIEW

2.1 Sg. Maong Catchment

Sg. Maong is one of the tributaries of Sarawak River where it covers an area about 47 km$^2$ with a total population of 73000 (Jenny et al., 2006). It has two tributaries which are Sg. Maong Kanan and Sg. Maong Kiri (Figure 2.1).

![Figure 2.1: Map of Sg. Maong Catchment](source: Google Earth, 2012)