HEAVY METAL CONCENTRATION IN SEDIMENT DURING DRY AND WET SEASONS AT SUNGAI JARUM MAS, MATANG MANGROVES FOREST, PERAK

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HEAVY METAL CONCENTRATION IN SEDIMENT DURING DRY AND WET SEASONS AT SUNGAI JARUM MAS, MATANG MANGROVES FOREST, PERAK

By

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ABSTRACT

Concentration of heavy metals varied depending on different seasons and sediment depths. The objectives of this study were to determine the physiochemical properties of sediment and compared the physiochemical properties in Sungai Jarum Mas by different seasons and sediment depths. Seasonal variation of sediment; EC, pH and heavy metals iron (Fe), lead (Pb), zinc (Zn), copper (Cu) and cadmium (Cd) were measured in sediment sampled along Sungai Jarum Mas, Perak. The dry and wet season samples were collected in June and December 2015 respectively. Heavy metal elements were analyzed using Atomic Absorption Spectrometer (AAS) machine. Data obtained were analyzed using Statistical Analysis System (SAS) version 9.4. The result showed that the sediment in Sungai Jarum Mas was acidic. The sediment EC, pH water and pH 1 M KCl were higher in dry season with a mean 16.28(±0.502), 3.48(±0.027) and 3.28(±0.024), respectively. Iron(Fe) was obtained at a higher concentration in the sediment during dry season with a mean 8.908(±1.140) Cmol/Kg. Both lead (Pb) and cadmium (Cd) had a mean concentration of 0.018(±0.00) and 0.001(±0.00) Cmol/Kg, respectively in both seasons. While copper (Cu) and zinc (Zn) were found to be the highest in wet season with a mean 0.185(±0.048) and 0.029(±0.008) Cmol/Kg, respectively. Fe, Pb and Zn were recorded within the permissible limit of heavy metals concentraton in soil set by the WHO (2008), while Cu and Cd exceeded the standards. In term of EPA (2002) guidelines, Sungai Jarum Mas was moderately polluted by Cu. Heavy metals present in sediment due to environmental and human-induced factors. The knowledge of heavy metal concentrations in marine sediment is very important with respect to environmental management, aquatic ecology and human health.

ABSTRAK

Kepekatan logam berat berbeza-beza bergantung pada musim dan kedalaman mendapan. Objektif kajian ini adalah untuk menentukan sifat fisiokimia mendapan dan membandingkan sifat fisiokimia di Sungai Jarum Mas mengikut musim dan kedalaman mendapan yang berbeza. Variasi bermusim terhadap EC, pH dan logam berat besi (Fe), plumbum (Pb), zink (Zn), tembaga (Cu) dan kadmium (Cd) diukur dalam sampel mendapan di sepanjang Sungai Jarum Mas, Perak. Sampel mendapan musim kering dan hujan masing-masing diambil pada bulan Jun dan Disember 2015. Unsur-unsur logam berat dianalisa menggunakan mesin Spektrometer Atom (AAS). Data yang diperoleh dianalisis menggunakan Sistem Analisis Statistik (SAS) versi 9.4. Keputusan menunjukkan bahawa mendapan di Sungai Jarum Mas adalah berasid. EC, pH air dan pH 1 M KCl dalam mendapan adalah lebih tinggi pada musim kering dengan nilai min masing-masing 16.28(±0.502), 3.48(±0.027) dan 3.28(±0.024). Besi (Fe) memperoleh kepekatan yang lebih tinggi dalam mendapan semasa musim kering dengan min 8.908(±1.140) Cmol/Kg. Kedua-dua plumbum (Pb) dan kadmium (Cd) mempunyai kepekatan dengan purata masing-masing 0.018(±0.00) dan 0.001(±0.00) Cmol/Kg dalam kedua-dua musim. Selain itu, tembaga (Cu) dan zink (Zn) didapati tertinggi pada musim hujan dengan purata masing-masing 0.185(±0.048) dan 0.029(±0.008) Cmol/Kg. Fe, Pb dan Zn direkodkan dalam had kepekatan logam dalam tanah yang dibenarkan oleh WHO (2008), manakala Cu dan Cd melebihi standard. Dari segi garis panduan EPA (2002), Sungai Jarum Mas telah dicatat dalam pencemaran yang sederhana oleh elemen Cu. Logam berat hadir dalam mendapan berpunca dari faktor alam sekitar dan manusia. Pengetahuan tentang kepekatan logam berat di mendapan laut sangat penting dalam aspek pengurusan alam sekitar, ekologi akuatik dan kesihatan manusia.

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LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectrometer
ANOVA	Analysis of Variance
C	Celcius
CCME	Canadian Council of Ministers of the Environment
Cd	Cadmium
cm	centimeter
Cmol/Kg	Centimol Per Kilogram
Co	Cobalt
CO_2	Carbon Dioxide
Cu	Copper
CWT	Clean Water Team
E	East
EC	Electrical conductivity
ERL	Effect range low
ERM	Effect range medium
FAO	Food Agriculture Organization
Fe	Iron
g	gram
H^+	Hydrogen ions
KCl	Potassium Chloride
LEL	Lowest effect level
M	Molar
mL	mililitre
mm	milimeter
Mn	Manganese
N	North
NSCEP	National Service Center for Environmental Publications
NOAA	National Oceanic and Atmospheric Administration
Pb	Lead
PEL	Probable effect level

ppm	part per million
SAS	Statistical Analysis System
Se	Selenium
SEL	Severe effect level
TDS	Total Dissolved Salts
TEL	Threshold effect level
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency
USFDA	United States Food and Drug Administration
WHO	World Health Organization
Zn	Zinc

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CHAPTER 1

INTRODUCTION

1.1 Mangrove Forest

Mangroves are a group of trees and shrubs that live in the coastal intertidal zone. The trees are easily recognizable by their dense mats of thick, stick-like roots that rise out of the mud and water. These roots are called “prop roots” which slow the movement of water as the tides flow in and out, allowing sediments to settle onto the muddy bottom. The dense root systems of mangrove forests trap sediments flowing down rivers and off the land. This helps stabilizes the coastline and prevents erosion from waves and storms. Cornforth *et al.* (2013) stated that mangroves act as a protection for coastal areas from tidal waves, tsunamis and cyclones. Arising of heavy metals pollution from human activities, industrialization and urbanization may affect the health of mangrove ecosystem.

Malaysia is currently the 6th largest mangrove and ranks second in the world after Indonesia in terms of the diversity of the true mangrove species found in the country (Hamdan *et al.*, 2014). Hamdan *et al.* (2012) also identify that the total area of mangrove forest in Perak is about 43,292 ha where the largest area is in district of Larut & Matang and in Kerian. Matang Mangroves is known as the best mangrove management in the world (Okamura *et al.*, 2010).

According to Nawaz and Zakaria (2015), Malaysian mangroves act as a habitat for a large diversity of fauna species including 22 aquatic invertebrate species (encompassing 11 crustacean species, six mollusk species and four worm species), 36 fish species, 74 bird species, four reptile species, and four mammal species. Mangroves not only providing wood, but it also act as a feeding and nursery grounds for fisheries as well as the habitats of several important commercial fishes and prawns (Manokaran, 1992).

1.2 Important of Mangrove

Mangrove forests are extremely productive ecosystems that provide numerous good and services both to the marine environment and people. They serve as natural coastal protection, soil stabilization, erosion protection, nutrient retention, aquatic life habitat, water quality improvement, flood mitigation and sequestration of carbon dioxide. Other than that, mangroves also play an important role in global climate regulation where it serve as global carbon store and sink with largest average carbon stock per unit area than other marine ecosystem (UNEP, 2014).

1.3 Sediment

Sediments are weathered rock materials that are transported, suspended or deposited by flowing water. Sediment can consist of rocks and minerals, as well as the remains of plants and animals. According to Ellison (1999), sediment is the accumulation of residue such as rock, sand in a stream, lake or other marine environment. Sedimentation occur when they erode from the site of weathering and are transported by wind, water, ice, and mass wasting, all operating under the influence of gravity.

Sediment contamination can occur in numerous ways. Heavy metals are one of the factors of contaminated sediment. Sources of heavy metals are from the pesticide, directly flow from industrial and municipal waste dischargers, as well as from polluted runoff in urban and agricultural areas (NSCEP, 1999). Rajeshwari and Namburu (2014) identify that common sources of heavy metal are from mining and industrial wastes, vehicle emissions, lead-acid batteries, fertilisers, and paints and treated woods. Greaney (2005) also amphasise that human activities such as agriculture and industrial make the sediment contaminated and give negative impact to the stream.

1.4 Heavy metal

Heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of the heavy metals include iron (Fe), cadmium (Cd), copper (Cu), zinc (Zn) and lead (Pb). The metals can be transported along waterways from urban environments and accumulate in estuarine and coastal sediments. Natural waters are the main pathway for heavy metal as it is not biodegradable and undergo a global ecological cycle (Tam & Wong, 2005).

According to Ikem *et al.* (2003), sediment can be used to trace contamination sources as they act as a sink of contaminants and also play an important roles in the assessment of metal contamination in natural waters. Namburu and Rajeswari (2014) claim that metal pollution has harmful effect on biological systems and does not undergo biodegradation but can be accumulated in living organisms, thus causing various diseases and disorders even in relatively lower concentrations. These pollutants affect the mangrove ecosystem species, with potential impact on populations and biodiversity.

1.5 Problem Statement

Mangrove muds have an extraordinary capacity to accumulate materials discharged to the near shore marine environment because of their inherent physical and chemical properties (Harbison, 1986). Therefore, mangrove sediment favour the retention of water-bourne heavy metal as they are anaerobic and have rich in sulphide and organis matter (Silva *et al*., 1990; Tam & Wong, 2000). Contaminated sediment in mangroves area are caused by anthropogenic activities such as agriculture and industrial waste. From Rahimah (2012) researched, arising of contaminants are due to releasing of solid and liquid wastes from the industrial activities which contain toxic chemicals such as chromium salt, sulphides and other subtances including heavy toxic trace metal.

Seasonal variation such as wet and dry season may influences the heavy metal concentration in sediment. It was stated in Hanif *et al*. (2014) study that the distribution of heavy metals in river sediment were affected by monsoon seasons. Besides that, Alfreda *et al.* (2014) researched stated the mean concentrations of heavy metal in dry season were higher when compared to the mean concentrations of the heavy metals in wet season. This is in agreement with the studies of Ebah *et al.* (2016).

As in Matang Mangrove Forest, there are more activities that happen along Sungai Jarum Mas such as agricultural, industrial and villagers activities that may influences the sediment quality as the mangrove forest in Sungai Jarum Mas contribute many services to the locals. Since environmental factor influences the concentrations of heavy metal in sediment, thus the aim of this study is to determine the physiochemical properties of sediment by different seasons and sediment depths in Sungai Jarum Mas.

1.6 Objectives

The objectives of this study were:

1) To determine the sediment physiochemical properties at two different seasons at Sungai Jarum Mas.
2) To compare the sediment physiochemical properties between seasons
3) To compare the sediment physiochemical properties between sediment depths.

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