ASSESSMENT OF THE SEDIMENT QUALITY ALONG DARAU RIVER ESTUARY, KOTA KINABALU SABAH.

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I affirmed that this dissertation is the result of my own work, except for quotations and summaries, each of which has been fully acknowledged.

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-Mark Twain-

ABSTRACT

This research was conducted to observe the distribution of particle sizes, the concentration of nutrients, such as Total Organic Carbon (%), Total Inorganic Carbon (%), Total Phosphorus (mg of P/100g) and Total Nitrogen (%) and heavy metal concentration in sediment along the Darau river estuary. Six stations were selected and located near the source of nutrients. The six stations started with the upper stream of the estuary, the construction site, Ko-Nelayan shrimp farm, housing area, mixing point between Darau and Likas River and control station that located 1.5 kilometers from the river estuary. Along the Darau river estuary, the dominant type of sediment particles is silt (61.31%), followed by sand (37.42%) and mud (1.27%). Total Organic Carbon in sediment was range from 0.11%-3.33%, while the Total Inorganic Carbon (0.16%-4.52%), Total Phosphorus (0.22 mg of P/100g – 0.77 mg of P/100g) and Total Nitrogen (0.01%-0.18%). The significant different was observed between the sediment nutrients with Total Organic Carbon and Total Inorganic Carbon ($F=3.141$, $P<0.05$), Total Nitrogen ($F=24.03$, $P<0.05$) and Total Phosphorus ($F=13.03$, $P<0.05$) within stations. In conclusion, the sediment from Darau river estuary is mainly comprised of silt. While the nutrient content differs among the stations and related to the sources of origin along the river estuary. The highest percentage of heavy metal element along Darau River estuary is Iron (Fe) with (365.31 ppm) and lowest percentage was Arsenic (As) with (0.12 ppm). The sequence of heavy metal elements are as follow; Iron (Fe) > Aluminium (Al) > Magnesium (Mg) > Mangane (Mn) > Zinc (Zn) > Lead (Pb) > Nickel (Ni) > Copper (Cu) > Chromium (Cr) >Arsenic (As).

ABSTRAK

Penyelidikan ini mengkaji jenis saiz partikel, kepekatan nutrisi, seperti Jumlah Karbon Organik (%), Jumlah Karbon Inorganik (%), Jumlah Fosforus (mg/L daripada P/100g) dan Jumlah Nitrogen (%) dan tahap logam berat didalam tanah sepanjang persisiran Sungai Darau. Enam stesen telah dipilih dan setiap satu stesen terletak berhampiran sumber nutrisi. Enam stesen tersebut bermula dengan hulu sungai, kawasan pembinaan, lading udang Ko-Nelayan, kawasan perumahan, titik pertemuan diantara Sungai Darau dan Likas dan stesen kawasan dimana ianya terletak 1.5 kiloeter dari muara sungai. Sepanjang Sungai Darau, taburan kekerapan jenis partikel tanah adalah lumpur (61.31%), di ikuti pasir (37.42%) dan lumpur (1.27%). Julat Jumlah Karbon Organik yang terdapat di dalam tanah adalah sebanyak (0.11%-3.33%), manakala Jumlah Karbon Inorganik (0.16%-4.52%), Jumlah Fosforus (0.22 mg dari P/100g – 0.77 mg dari P/100g) dan Jumlah Nitrogen (0.01%-0.18%). Perbezaan yang signifikan ditunjukkan diantara tanah nutrisi adalah Jumlah Karbon Organik dan Jumlah Karbon Inorganik ($F=3.141$, $P<0.05$), Jumlah Nitrogen ($F=24.03$, $P<0.05$) dan Jumlah Fosforus ($F=13.03$, $P<0.05$) bagi setiap stesen. Sebagai konklusi, tanah di sepanjang Sungai Darau didominasi oleh lumpur. Sementara itu, kandungan nutrisi berbeza diantara setiap stesen dan saling berhubung kait dengan sumber asal nutrisi disepanjang muara sungai. Peratus tertinggi bagi logam berat di sepanjang Sungai Darau adalah Iron (Fe) dengan (365.31 ppm) dan peratus terrendah adalah Arsenik dengan (0.12 ppm). Susunan logam berat tersebut adalah seperti berikut; Iron (Fe) > Aluminium (Al) > Magnesium (Mg) > Mangane (Mn) > Zinc (Zn) > Lead (Pb) > Nickel (Ni) > Copper (Cu) > Chromium (Cr) >Arsenic (As).

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LIST OF SYMBOL

%	percentage
°C	degree celcius
Φ	phi
ΔS	different in salinity

LIST OF UNIT

g	gram
kg	kilogram
mg	milligram
mL	milliliter
N	normality
ppt	part per thousand

LIST OF FORMULA

LIST OF ABBREVIATION

TOC	Total Organic Carbon
TIC	Total Inorganic Carbon
TN	Total Nitrogen
TP	Total Phosphorus
Al	Aluminium
Cd	Cadmium
Cr	Chromium
Cu	Copper
Fe	Iron
Hg	Mercury
Mn	Manganese
Ni	Nickel
Pb	Lead
Ti	Titanium
Zn	Zinc

CHAPTER 1

INTRODUCTION

1.1 Estuary Sediment

Sediment is a particle of organic and inorganic substance that builds up in a loose, unconsolidated form. The particles derive from; the weathering and erosion of rocks, from the activity of living organisms, from the volcanic eruption, from the chemical processes in the water column, and even from the atmosphere (Garrison, 2010).

Estuaries are the meeting place of land drainage with the sea. They contain many differences habitats; shallow open water, salt marshes, sandy beaches, mud and sand flats, rocky shore, mangrove forests, sea grass beds, river deltas and tidal pool (Green *et. al.,* 2000). These habitats form the most productive area on the Earth, creating more organic material each year than comparable areas of forest or farmland (Green *et. al.,* 1997).

The detail scope in looking the estuary sediment can be according to; intertidal flats, fringes and headwaters (Dyer, 1973). The intertidal flat is the area where the tidal currents are weaker and the water on the incoming tide gently floods adjacent shallow intertidal flats, except when waves resuspend it. As the water deepens the waves have less and less effect on the sediment. Some fine silt and muds may be carried out to sea on the outgoing tide through the drainage channels (Dyer, 1973).

While the along the intertidal margins, the incoming tide can move turbid plumes (originating from intertidal flats or catchment run-off) up to small, sheltered, tidal creeks or side arms. If the conditions are calm then fine sediments settle out

Green *et al.,* 1973). These fringes are where mangroves love to grow, further enhancing sedimentation by slowing water movement (Dyer, 1973).

On the other hands, the sediment carried by the streams and rivers increase enormously following heavy rainfall. Some of this load is discharge directly into the ocean, but most settles down on intertidal banks and in shallow tidal creeks. Any sediment deposited in channels is soon scoured and re-deposited on intertidal flats and around the fringes of the estuary (Green *et al.,* 2000).

Sediment at estuary plays a vital role in cycling the element in the environment. Sediment is responsible for transport the significant proportion of many nutrients and also contaminants. Sediment in surface water derived from the erosion and comprises a mineral component. An additional organic component may be added by biological activity within the water body (Ongley, 1992).

Sediment also can carry pathogens, pollutants and nutrients downstream and excessively high sediment loads can give negative impact. Gravel and cobble-sized sediment are very important as habitat for benthic macro invertebrates (Ongley, 1992). Besides, coarser sediment like silt and clay are cohesive. Their grains hold each other by chemical attraction and increase their resistance to erosion.

Types of the sediment along the Darau River Estuary maybe vary due to the morphological of the location. Different types of sediment have different particle size. Furthermore, different types of sediment may content diverse types of nutrients. While the nutrients content may be influence by the activities surround the area and the in situ parameters like bottom temperature and oxygen.

1.1.1 Total Nitrogen (TN), Total Phosphorus (TP), Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC) in sediment.

Most of the nutrients; TN, TP, TOC and TIC in sediment come from the land activities. For instant, the fecal input and metabolic wastes and organic carbon originating from the feed lead to higher organic carbon concentration at the aquaculture site (Chou *et. al.,* 2004). Not only that the other nutrient also being introduced by the aquaculture activity. The fish farm at Greece found the amount of nitrogen element and phosphorus high due to the accumulation of feeding and fecal from the marine organism (Mantzavrakos *et. al.,* 2007).

There is not only one point source of the nutrients being introduce towards the estuary, but also including; housing area with sewage system and also the grain size (Shengrui *et. al.,* 2006). Near the human settlement, the nitrogen requirement for decomposition of organic matter under anaerobic conditions is about one-third of required under aerobic conditions (William *et al., 1968).* This is due to lower energetic efficiency of anaerobic metabolism. While, for the phosphorus accumulates in the sediment by sedimentation of algae or other organisms and by precipitation of calcium phosphate (Avnimelech, 1983).

On the other hands, the particle size particle also contributes in determination of the nutrients in the sediment. The TOC, TN and TP contain increasing as particle size decreasing (Shengrui *et. al.,* 2006). This is probably due to the clay fraction and the larger specific area for the fine fractions (Zhou *et al.,* 2004). As fractions with different sizes had different specific surface areas and weight, they had different effects on the exchange of phosphorus between sediments and the overlying water. Finer grain fractions had larger pollutant sorption capacity and high suspension potential (Shengrui *et. al.,* 2006). Therefore, sediments with higher proportion of clay and silt fractions were more heavily polluted.

1.1.2 Heavy metal

The origin of the heavy metal in marine sediment can come from natural and anthropogenic resource; distribution and accumulation are influence by sediment texture, mineralogical compositions, reduction/oxidation state, adsorption and desorption process and physical transport. Moreover, metal can be absorbed from the water column onto fine particles surface and move thereafter towards sediment.

On the other hands, metal may exist in several different forms, including soluble and exchangeable, as an amorphous material (Fe/Mn oxides) bound to organic matter and sulfides, or bound to mineral lattices. Determination of metal concentration in sediment is important to fully understand about the bioavailability, mobility and toxicity of metals but is generally useful as an indicator of contamination in aquatic environments (Alessandro *et al.,* 2006).

Heavy metal also give it own impact towards human being. The potential effects of heavy metal on human health were obtained through their different toxicological profiles, (IRIS, 2007; RAIS, 2009 and ATSDR, 2011). The profile confirmed that the human may have high level of heavy metal may expose to the carcinogenic susceptibility of some heavy metal (Olawoyin, 2012).

Heavy metal that induce the carcinogenic risk are Cadmium (Cd) and Chromium (Cr), while Copper (Cu), Magnesium (Mg) and zinc (Zn) are known to induce non-carcinogenic effect. Furthermore, Lead (Pb) classified as probable cancer causing in human body. No fact and study can confirm it to human body but the strong proof established in animal (USEPA, 2011a).

Darau river estuary will be selected due to the characteristics that have; aquaculture activities, housing area and human settlement and mixing of two estuary. This Darau river estuary has such abundance factors that influence the concentration of nutrients and the heavy metal.

1.2 Significance of study

There is a few detail study done in sediment quality of Inanam river estuary and not covering all part of the Darau river estuary. The data collection will more concern about the quality level of the estuary. Thus, the data provided will assist in observer and monitoring the level of Darau river estuary sediments quality.

1.3 Objectives

The objectives of the study are:

i. To identify the types of sediment based on particle size along Darau River Estuary.
ii. To determine the variability of Total Nitrogen (TN), Total Phosphate (TP), Total Organic Carbon (TOC) and Total Inorganic compound (TIC) in Darau River Estuary.
iii. To determine the concentration of heavy metal in sediment of Darau River Estuary.

1.4 Hypotheses

The hypotheses of the study are:

i. Based on the type and origin of sediment, the particle size may differ in each station along the Darau River Estuary.
ii. Concentration of TN, TP, TOC and TIC in the sediment in each station will vary in Darau River Estuary.
iii. There will be variation in the concentration of heavy metal along the Darau River Estuary.

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