TOTAL HEAVY METALS (Cd, Cr AND Pb) IN THE LAGOON WATER OF TELUK SALUT AND TELUK MENGKABONG, SABAH.

LEE KHAI ERN

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OF THE REQUIREMENTS FOR THE
BACHELOR OF SCIENCE WITH HONOURS

ENVIRONMENTAL SCIENCE PROGRAM
SCHOOL OF SCIENCE AND TECHNOLOGY
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Total Heavy Metals (Cd, Cr, Pb) in Lagoon Water Telut Salut and Telut Mengkabong, Sabah

: BSc. Environmental Science

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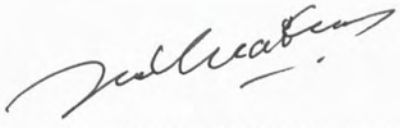

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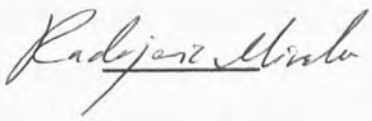

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ACKNOWLEDGEMENTS

Completion of this thesis was due to the help by many individuals. First of all, I would like to convey my sincere gratitude to my supervisor, Assoc. Prof. Dr. Mohd. Harun Abdullah for his time, patience and guidance throughout my study. His unfailing helpfulness has brought me to a better stage. Apart of this, I would like to thank my parents, Mr. Lee Jin Kong and Mrs. Kung Poe Tin for their support, blessing and believing throughout this journey.

I would like to thank UMS lecturers Assoc. Prof. Dr. Miroslav Radojevic, Dr. Anja Gassner and Mr. Justin Sentian for their help in guiding me to carry out this study. Their contribution was particularly helpful, and I am feeling grateful for their guidance. I feel appreciate the co-operation given by Universiti Kebangsaan Malaysia, Universiti Malaya, EiMAS (Environment Institute of Malaysia) , DOE (Department Of Environment) of Sabah State for allowing me to obtain information from them. To the people in Marine Borneo Institute; Mr. Asri, Mr. Ajahar, Mr. Josli for their contributions and co-operations during my study. I am also feeling grateful for help from Mr. Webster Wong and Mr Khairun from Jabatan Mineral dan Geosains Sabah.

To all my colleagues, I would like say thank you for advice and support in making this study a success. Finally, to all unmentioned individuals who offered their help and advice, I sincerely offer my appreciation.

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ABSTRACT

Teluk Salut and Teluk Mengkabong are saline lagoons those receive seawater input. A study was carried out to determine the concentration and distribution of total heavy metals (Cd, Cr and Pb) in both lagoons. The temperature, pH, salinity, conductivity, turbidity and TSS of the lagoons water of Teluk Salut and Teluk Mengkabong were measured during the sampling event on 14th October 2005 as water quality indicators. It was found that the Cd concentration were 0.01 ± 0.008 mg/L in Teluk Salut and 0.007 ± 0.001 mg/L in Teluk Mengkabong, Cr concentrations of 0.34 ± 0.06 mg/L in Teluk Salut and 0.36 ± 0.05 mg/L in Teluk Mengkabong, Pb concentrations of 0.19 ± 0.04 mg/L in Teluk Salut and 0.18 ± 0.01 mg/L in Teluk Mengkabong based on 0.7 to 1.8 m tidal ranges. There was no significant difference ($p>0.05$) for Cd, Cr and Pb concentration between Teluk Salut and Teluk Mengkabong.

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KEPEKATAN JUMLAH LOGAM BERAT (Cd, Cr dan Pb) DALAM AIR LAGOON TELUK SALUT DAN TELUK MENGKABONG, SABAH.

ABSTRAK

Teluk Salut dan Teluk Mengkabong merupakan laguna yang terdiri daripda air laut sahaja. Kajian ini telah dijalankan untuk menentukan kepekatan dan taburan logam berat jumlah (Cd, Cr dan Pb) dalam kedua-dua laguna. Bacaan suhu, pH, kemasinan, konduksian, kekeruhan dan TSS air permukaan Teluk Salut dan Teluk Mengkabong juga diambil semasa persampelan pada 14hb Oktober 2005 sebagai parameter rujukan kualiti air. Hasil kajian menunjukkan kepekatan Cd adalah 0.01 ± 0.008 mg/L di Teluk Salut dan 0.007 ± 0.001 mg/L di Teluk Mengkabong, kepekatan Cr 0.34 ± 0.06 mg/L di Teluk Salut dan 0.36 ± 0.05 mg/L di Teluk Mengkabong, kepekatan Pb 0.19 ± 0.04 mg/L di Teluk Salut dan 0.18 ± 0.01 mg/L di Teluk Mengkabong berdasarkan julat air pasang-surut 0.7 – 1.8m. Tiada perbezaan signifikan ($p>0.05$) untuk kepekatan Cd, Cr dan Pb di antara Teluk Salut dan Teluk Mengkabong.

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LIST OF SYMBOLS AND UNITS

^{o}C	degree Celcius
mg/L	milligram per liter
g/cm^3	gram per centimeter cube
µg/L	microgram per liter
mg/kg	milligram per kilogram
µg/g	microgram per gram
%	percent
m	meter
mS/cm	milliSiemens per centimeter
ppt	part per thousand
NTU^+	nephelometric turbidity unit
Cd	Cadmium
Cr	Chromium
Pb	Lead
HNO_3	Nitric acid
$KMnO_4$	Potassium Permanganate
Na_2SO_4	Sodium Sulfate

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LIST OF ABBREVIATIONS

DOE	Department of Environmental (Malaysia)
UMS	Universiti Malaysia Sabah
APHA	American Public Health Association
TSS	Total Suspended Solid
AAS	Atomic Absorption Spectrophotometer
MIBK	Methyl Isobuthyl Ketone
APDC	Ammonium Pyrrolidine Dithiocarbamate

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CHAPTER 1

INTRODUCTION

1.1. Identification of Research

"Water quality" is a term used to express the suitability of water to sustain various uses of processes; it can be determined by carrying out measurements on parameters and testing water samples on site and in the laboratory. From the reading that is obtained for each parameter, quality of water can be determined. Therefore, water quality monitoring becomes crucial in our environment because of its functions as pollution control and as tools to assess the long-term trends and environmental impacts (Bartram & Balance, 1996).

Several researches have been carried out by scientists to evaluate the level of heavy metals in water body since heavy metals are the significant parameters in assessing the water quality. However, there have been very few studies carried out concerning heavy metals pollution level in the lagoon water (Vazquez, 1999). Thus, this study concentrates on the level of heavy metals (cadmium, chromium and lead) in lagoon water of Teluk Salut and Teluk Mengkabong. The heavy metals in water analysis of this study

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becomes significant because water is the direct media that may transfer heavy metals to aquatic organisms via the food chains in the lagoons.

A lagoon is the extension of coastal water that enters inland, in other words, it can defined as the reservoir that links to the marine water. Lagoon water is totally different from fresh water because it only contains saline water. From a biotic perspective, lagoons always provide space for tremendous ecosystem biodiversity; commonly, mangrove forests (Alexander & Fairbridge, 1999).

1.2 Study Background

Input of heavy metals into the lagoon is a potentially serious problem because these contaminants are toxic to the organisms above threshold availability and at elevated concentrations can adversely affect the structure and functions of biotic communities. The high level of heavy metals in the lagoon which have rich ecosystems may affect the health of humans and organisms. However, heavy metals always appear in our environment such as in water, suspended materials, sediments and organisms from ecosystem but its content in such environments varies from one place to another according to the geological nature of catchments area (Sabri, 1992).

Heavy metals entering the lagoon water naturally are caused by the chemical weathering of rocks and suspended sediment into water body. Sedimentation caused by erosion and runoff from surface may contribute heavy metals into the lagoon water as

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well. Despite the natural source of heavy metals to the water, anthropogenic source also become an essential contributor of heavy metals. The wastes from agricultural irrigation and runoff, domestic sewage, and industrial effluents are the main anthropogenic sources that are mainly known (Kronfeld & Navrot, 1974).

Apart from high toxicity of heavy metals to the organisms and environment, heavy metals are extremely persistent in aquatic environments and organisms' body. Heavy metals tend to accumulate in sediments which usually have direct interactions with water in the lagoon (Fuhrer, *et al.*, 1997). Organisms take health risk if taking the water contains heavy metals which may bioaccumulate in their body and eventually cause acute and chronic health effects.

Water may become the vector of the pollution; it is able to carry all suspended and dissolved materials. Therefore, the quality of water may be described in terms of the concentration of pollutant that is present in the water. The level of heavy metals carried by water may indicate the pollution and the toxicity level of the water. The heavy metals level in water became public interest in last few decades since their presence in water may contribute significantly to health problems to water consumer.

Heavy metals that we are interested in this study are cadmium, chromium and lead which is high toxicity. Cadmium poisoning will cause serious acute effects to humans such as high blood pressure, kidney damage, destruction of testicular tissue, and destruction of blood cells. In Interim National Water Quality Standards for Malaysia, the

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concentration of cadmium should not exceed 0.01 mg/L. Chromium has several roles in our daily lives, because it is considered to be an essential micronutrient in human and animal nutrition. However, high concentration of chromium present as chromate is known to be carcinogenic which may cause cancer. Maximum tolerable concentration for lead is 50μg/L in Standards for Drinking Water recommended by World Health Organization. According to Manaham (2000), lead will cause acute poisoning and dysfunction in the kidneys, reproductive system, liver, and the brain and the central nervous system. Since it is difficult to excrete from human's body once it enters organ system, it may result in mortality if it accumulates in body.

1.3. Objectives of Study

Objectives have been set to achieve the main purpose of this study. Fieldwork and laboratory analysis were carried out to fulfill these objectives.

1. To determine the total concentration of heavy metals (cadmium, chromium and lead) in lagoon water of Teluk Salut and Teluk Mengkabong.
2. To compare the level of heavy metals (cadmium, chromium and lead) in lagoon water between Teluk Salut and Teluk Mengkabong.

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1.4. Scope of Study

a. The heavy metals that are taken into account in this study are cadmium, chromium and lead only.

b. The total heavy metals (Cd, Cr and Pb) concentration were be measure.

c. The samples that were taken for analysis are the lagoon water only.

d. The locations of the study are Teluk Salut and Teluk Mengkabong only.

1.5. Significance of Study

Through this study, the level of heavy metals (cadmium, chromium and lead) pollution will be known. Resort, industrial park and fish farms are features that can be found in Teluk Salut. Study on heavy metals in lagoon water become significant since there are seafood restaurants within Teluk Salut that carry out aquaculture and fish farming near their restaurant area. Aquaculture activities such as fish farming may produce waste loads from discharge solid and dissolved matter which may cause water quality changes. If there were heavy metals pollution near this study site, it is possible for aquatic organisms within these aquaculture farms to uptake the heavy metals and eventually cause toxicity to those aquatic organisms. In addition, the aquacultures activities that carried out here are purposely supply seafood for the seafood restaurants. Thus, the study becomes significant since concerns are focused on the heavy metals level here because the high heavy metals level may directly poison the seafood which may be consumed by humans later.

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In Teluk Mengkabong, mangrove forest (Mengkabong Conservation Forest) and water villages are predominant. Fishing activities are the main activities that are carried out in this huge lagoon. Heavy metals study in this area become crucial because the living of residents and fishing activities here are depending on the water (Hisham, 2005). Thus, if there are any heavy metal pollution occurs may directly influence the health of residents and aquatic organisms here.

Total metal analysis that included distribution of dissolved and particulate metal was measured to construct total database on metal variability. Data on total metals are presented to include the influence of solid on the heavy metal concentration in water. Apart from this, the heavy metals study becomes significant when come to compare their level in both lagoons. Since both lagoons comprise of different features which are combination of developed and pre-developed making this study interesting.

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CHAPTER 2

LITERATURE REVIEW

2.1. Heavy Metals

Heavy metals can be defined as metals with specific gravity that is more that $4.5g/cm^3$ (Alexander, 1999). It always related to the toxicity effects because of its ability to cause pollution to the environment due to its characteristic that tend to be accumulating in the environment and organisms' body. However, there are several of trace metals such as Fe, Cu, Mn, Zn, Co, Mo, Se, I, and V have been proved to be essential to life and there are also some metals such as Cr, Sn, and Ni may essential for animals and plants. These trace metals that show their importance for life may cause toxicity and lethal eventually also like other highly toxic heavy metals such as Ag, As, Au, Cd, Hg and Pb if excess threshold concentration been taken.

However, in this study will concentrate on cadmium, chromium and lead. The existence of cadmium and lead which are highly toxic metals is so undesirable in the environment so in the Interim Standards for marine water quality provided by DOE of Malaysia, the standard for the cadmium is 0.01 mg/L, whereas lead is 0.1 mg/L.

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Meanwhile, the standard of trace metals chromium is 0.5 mg/L. Chromium have a higher concentration compare to cadmium and lead in the standard because tolerance can be make towards chromium since it may play role as an essential micronutrient to the organisms.

2.1.1. Cadmium

Cadmium is a relatively volatile element; however, it is not essential for plants, animals and human beings. However, taking high concentration of cadmium may lead to toxics effects. Basically, pollution cadmium in water may arise from industrial discharges and mining wastes. Cadmium is very similar to zinc chemically, these two metals frequently undergo geochemical processes since cadmium production depends on the production of zinc; therefore, cadmium and zinc must be separated (Stoeppler & Julich, 1991)..

Basically, cadmium is relatively soft, silver-white, lustrous and ductile metal. Cadmium with atomic number 48 and atomic mass 112.4 and has a density of 8.64 g/cm^3 at 20°C. It is found in water in the +2 oxidation state. There are eight naturally occurring isotopes (listed in order of abundance): ^{114}Cd (29%), ^{112}Cd (24%), ^{111}Cd (13%), ^{110}Cd, ^{113}Cd, ^{116}Cd, ^{106}Cd and ^{108}Cd. The melting point and boiling point of cadmium are 320.9°C and 767°C, respectively.

The input of cadmium into waters is due to contributions from waste water and precipitation from the atmosphere, and indirectly from washout resulting from the

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weathering of minerals, soils sewage sludge deposits, waste dumps, etc. along with the drain water and ground water streams (Stoeppler & Julich, 1991).Cadmium compounds commonly using for nickel/cadmium batteries industries, metal plating, anticorrosive coatings of metals, pigments and stabilizers for plastics. Therefore, pollution from cadmium in water may arise from those industrial discharges and mining wastes. Coal burning is a significant source of cadmium as well, it occurs through transportation in atmosphere and precipitate into water and finally deposit in water. Natural occurrence such as weathering of mineral that contain cadmium usually take place in isomorphic form zinc minerals such as zinc blende (ZnS) and galmei ($ZnCO_3$) into water. However, pure cadmium minerals such as greenockite (hexagonal CdS), hawleyite (cubic CdS), otavite ($CdCO_3$), monteponite (CdO), and cadmoselite (CdSe) occur very rarely.

Cadmium appears as toxic heavy metals in our environment. Therefore, cadmium poisoning will cause serious acute effects to humans such as high blood pressure, kidney damage, destruction of testicular tissue, and destruction of blood cells (Manaham, 2000). Heavy long-term cadmium exposure might produce irreversible adverse renal effects. In particular, cases of vitamin and protein deficiency and bone disease have been observed (Stoeppler & Julich, 1991). Recently, experiments show that cadmium also has the potential to cause cancer as well.

In interim national water quality standards for Malaysia, the concentration of cadmium should not exceed 0.01 mg/L. Practically, according to Stoeppler, M. & Julich, 1991, the large excess of cadmium significantly increase cadmium concentration ranging

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