HEAVY METAL CONCENTRATION OF SEDIMENT IN SUNGAI TIRAM LAUT AT MATANG MANGROVE FOREST, PERAK

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HEAVY METAL CONCENTRATION OF SEDIMENT IN SUNGAI TIRAM LAUT AT MATANG MANGROVE FOREST, PERAK.

By

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DEDICATION

To my beloved family

W. Zainy bin Omar

Zaid bin Mohamad

Narma binti Ramli

Rose Hayati binti Patehkhan

To my fellow friends

Nor Haslinda binti Sulaiman

Noor Hurriyah binti Abd. Rashid

Azlin bin Hassan

To my guider

Ahmad Mustapha bin Mohamad Pazi

To my supervisor

Assoc. Prof. Dr. Seca Gandaseca

Thank you for your encouragements supports

and the helpful

Thank you for everything. May Allah Bless All of us

ABSTRACT

Mangrove forests thrive near the mouths of large rivers where river deltas provide lots of sediment (sand and mud). Mangrove roots collect sediments and slow the water's flow, helping to protect the coastline and preventing erosion. Over time, the roots can collect enough debris and mud to extend the edge of the coastline further out. The objective of this study was to compare physiochemical properties in Sungai Tiram Laut and compared heavy metal concentration between selected stations and sediment depths. The selected properties in this study were sediment texture using hydrometer method, electrical conductivity using EC meter, sediment pH was identified using pH water and pH KCl, and heavy metal concentration (Fe, Cu, Cd, Pb, Zn) using Aqua Regia method. Data obtained by using statistical analysis system (SAS) version 9.4. Heavy metal contamination was less concentrated except Cu due to maximum permissible addition (MPA) for sediment. The quality standard for Cu was not less than 0.116 cmol/kg. However there was a significant difference concentration by station, but not by depths. The percentage of the sand was higher than silt and clay and had significant difference by stations and depths. Electrical conductivity was higher at location that was nearby to the seawater as caused by the ions in the runoff to the Sungai Tiram Laut. Physiochemical properties concentrated were caused by natural and anthropogenic resources.

ABSTRAK

Hutan bakau berkembang pesat melalui sungai-sungai besar di mana delta sungai menghasilkan banyak sedimen (pasir dan lumpur). Akar pokok di hutan bakau bertindak untuk mengumpul sedimen dan melambatkan aliran air, membantu melindungi pantai dan menghalang hakisan. Dari masa ke masa, akar dapat mengumpulkan serpihan dan lumpur yang cukup untuk memanjangkan pinggir pantai. Objektif kajian ini adalah untuk membandingkan sifat-sifat fisiokimia di Sungai Tiram Laut dan perbandingan kepekatan logam berat antara stesen yang dipilih dan kedalaman tanah.Ciri-ciri yang dipilih dalam kajian ini adalah tekstur tanah yang dikaji dengan menggunakan kaedah hidrometer, kekonduksian elektrik menggunakan EC mete, pH tanah dikaji melalui pH air dan pH KCl, dan kepekatan logam berat (Fe, Cu, Cd, Pb, Zn) diuji dengan menggunakan kaedah Aqua Regia. Data diperoleh dengan menggunakan system analisis statistik (SAS) versi 9.4. Pencemaran logam berat dalam kajian ini tidak terlalu tertumpu kecuali Cu kerana mengikut kadar tambahan yang dibenarkan untuk sedimen adalah tidak lebih daripada 0.116 cmol/kg, tetapi terdapat perbezaan yang ketara dalam kepekatan di setiap stesen namun begitu tiada perbezaan dalam setiap kedalaman. Peratusan pasir lebih tinggi daripada lumpur dan tanah liat mengikut perbezaan antara stesen dan kedalaman. Konduktiviti elektrik lebih tinggi disebabkan lokasi stesen berdekatan dengan air laut yang disebabkan oleh ion-ion yang mengalir ke Sungai Tiram Laut

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APPROVAL SHEET

I certify that this research project entitled “Heavy Metal Contamination of sediment in Sungai Tiram Laut at Matang Mangrove Forest, Perak” by Wan Norsuriana Binti W. Zainy has been examined and approved as a fulfillment of the requirements for the degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
AAS	Atomic Absorption Spectrometer
Cd	Cadmium
cm	Centimeter
CL	Clay
Cu	Copper
Cmol/Kg	Centimol Per Kilogram
Cr	Chromium
CSIRO	Commonwealth Scientific and Industrial Research Organization
D	Depth
E	East
EC	Electrical conductivity
EPA	Environmental Protection Agency
Fe	Iron
FAO	Food Agriculture Organization
g	Gram
GWRTAC	Ground-Water Remediation Technologies Analysis Center
h	hour
ha	Hectar
HNO_3	Nitrate acid
HCl	Hydrochloric acid
HM. Concent.	Heavy metal concentration
IAEA	International Atomic Energy Agency
ITTO	International Tropical Timber Organization
KCl	Potasium Chloride

L	Litre
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
mL	Mililitre
M	Molar
mcg	Microgram
mg	miligram
MPA	Maximum Permissible Addition
N	North
Ni	Nickel
ppm	Part per million
Pb	Lead
Se	Selenium
Si	Silt
s	second
SD	Sand
SAS	Statistical Analysis System
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USDHHS	United States Department of Health and Human Services
WHO	World Health Organization
Zn	Zinc

CHAPTER 1

INTRODUCTION

1.1 Background

Mangroves are among the most productive ecosystem on earth and occupy brackish water zones along tropical and subtropical coasts (ITTO, 2006). Mangrove systems had the capacity to act as a sink or buffer and remove or restrain heavy metals before they reach nearby aquatic ecosystem. Because Mangrove sediments had a large proportion of fine particles, high organic anaerobic sediments either by adsorption on ion exchange sites on the surface of sediments particles, incorporation into mesh structures of the clay particles, or precipitation as insoluble sulfides (Harbison, 1986).

Mangrove forest is also distributed in the inter-tidal region between the sea and the land in the tropical and subtropical regions of the world (Alongi, 2009). Mangrove representatives such as *Rhizophora* spp. also function as a physical barrier against tidal and ocean influences by means of their large above-ground aerial root systems and standing crop. (Alongi , 2002).

In Malaysia, Mangrove forests form one of the major wetland types in Peninsular Malaysia, which had been identified as one of the life support systems on earth. The importance of mangrove forests goes beyond their status as the habitat of many endangered flora and fauna species. Mangrove forest is a valuable natural resource with distinctive diversity, high intrinsic natural productivity and unique habitat value. Mangrove forests provide

invaluable goods and services both in economics and environmental terms. Apart from the production of poles, charcoal and fuelwood, the mangrove ecosystem supports a wide range of functions such as coastline production, assimilation of waste, source of food, shelter and sanctuary for fauna, spawning and breeding ground for marine life and also recently proven as a barrier to significantly reduce the height and force of the waves of the tsunami (Kamaruzaman, 2008).

Heavy metals are defined as metallic elements that had a relatively high density compared to water (Fergusson, 1990). Heavy metals basically come from environment include geologic, industrial, agricultural, pharmaceutical, domestic effluents and atmospheric sources (He *et al.,* 2005). Heavy metals concentration can also occur through metals corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment resuspension, and metal evaporation from water resources to soil and groundwater (Nriagu, 1989).

WHO/FAO/IAEA, 1996 reported that metals such as cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni) selenium (Se), and Zinc (Zn) are essential nutrients that are required for various biochemical and physiological function. Heavy metals are efficient generators of active oxygen species and thus an important factor in these heavy metal, toxicities are the generation of oxidative stress (Aust *et al.,* 1985).

Soil consists of weathered minerals and organic matter. They are product of interaction among parent material, climate, and biological activity. It is well known that soils differ from place to place on the earth's surface, and beneath a given site the soil profile consists of horizontal layers that change in characteristics with depth below and the land surface (Munsiri *et al.,* 1995)

The differences in sediment composition such as its grain-size distribution and mineralogy would affect the natural heavy metal concentration (Loring, 1991). Their geological material shows a high heavy metal concentration rather than concentration (White and Tittlebaum, 1985; Murray 1996).

1.2 Problem Statement

Heavy metals are toxic to the living organisms and also considered as essential can be toxic if present in excess. The heavy metals can impair important biochemical processes posing a threat to human health, plant growth and animal life (Khan R *et. al.,* 2005).Soils may become contaminated by the accretion of heavy metals and metalloids through emissions from the quickly expanding industrial areas, harvesting areas, disposal of high metal waste, leaded gasoline, animal manures, sewage sludge, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition (Khan *et al.,* 2008).

In recent years, Sungai Tiram Laut was exposed to human activities but less disturbed area (Nursyafiqah, 2016). Some of the villagers used to fishing and harvesting in a few compartments but this area was considered as fewer disturbances rather than another site. This study needs to investigate the source of heavy metals concentration in Sungai Tiram Laut and to protect living organisms such as aquatic life and residents in the vicinity. Individuals in the vicinity will carry out with the activities related with the sediment. Other than that, this study needs to ensure the level of heavy metals concentration in the region is below than maximum permissible addition (MPA) in sediment and does not affect the health of people and aquatic habitat. As the area is Forest Reserve, it monitoring whether the heavy metals content is still control based on the comparison with other areas nearby.

This result can be made as baseline data for future research to compare with another site that gives more impact on heavy metals concentration. In addition, these results can be used as documentation in the Forest Reserve to improve their management towards a much better.

1.3 Hypothesis

The hypothesis of this study can determine by;

- Ho: There are no significant difference physiochemical properties at three stations by soil depths along Sungai Tiram Laut.
- H_1: There are significant difference physiochemical properties at three stations by soil depths along Sungai Tiram Laut.

1.4 Objective

The objectives of this study were;

1. To determine of sediment physiochemical properties at three stations by soil depths along Sungai Tiram Laut.
2. To compare of sediment physiochemical properties between three stations and five different depths along Sungai Tiram Laut.

REFERENCES

Alongi, D.M. (2002). Present state and future of the world's mangrove forest. *Environment Conservation*, 29, 331-349.

Alongi, D. M. (2009) *Introduction in the energetics of mangrove forest.* Springer Science and Business Media BV, New York.

Aust, S. D., Marehouse C. E. and Thomas C. E. (1985) Role of metals in oxygen radical reactions. *Journal of Free Radical and Biological Medicine,* 1, 3-25.

Andersson, A. (1979). Distribution of heavy metals as compared to some other elements between grain size fractions in soils. *Swedish Journal of Agricultural Researched,* 9, 7-13.

Akoto, O., Ephraim, J.H., Darko, G., (2008). Heavy metals pollution in surface soils in the vicinity of abundant railway servicing workshop in Kumasi, Ghana. *International Journal Environment Research*, 2,359-364.

Clough, B.F., Robertson, A.I., Alongi D.M., (1992) Primary productivity and growth of mangrove forest.In Tropical Mangrove Ecosystem, eds. *Coastal and Estuarine Studies*, 41, (pp. 225-249) Washington: American Geophysical Union

Chaney R.L., Susan B.F., Howard W.M., (1984). The potential for heavy metal exposure from urban gardens and soils. In: *Journal Preer ed. Proceedings of the symposium on heavy metals in urban gardens*. Agricultural Experiment Station, (pp. 37-84) Washington: University of the District of Columbia,

Chan H.T., (1996) Mangrove reforestation in peninsular Malaysia: a case study of Matang. *In Field C (ed.) Restoration of Mangrove Ecosystem, International timber Trade Organization and International Society for Mangrove Ecosystem*, (pp.64-76). Okinawa, Japan.

Martinez C. E. and Motto H. L., (2000). "Solubility of lead, zinc and copper added to mineral soils," *Environmental Pollution*, 107, 153-158.

Centre for Ecological Sciences, IISc, (2001) Environmental Hand Book – *Documentation on Monitoring and Evaluating Environmental Impacts, Compendium of Environmental Standards*,(3rd ed.). Bangalore: Indian Institute of Science,.

Baldwin D.R. and Marshall W.J., (1999). "Heavy metal poisoning and its laboratory investigation," *Annals of Clinical Biochemistry*, 36, 267-300.

Eriksson, J.E., (1989). The influence of pH, soil type and time on adsorption and uptake by plants of Cd added to the soil. *Water, Air and Soil Pollution,* 48, 317-335.

Evans, L.J. (1989). Chemistry of metal retention by soils. *Environmental Science and Technology,* 23, 1046-1056.

Environmental Protection Agency, (1986). Air quality criteria for lead, June 1986 and Addendum, September 1986. Research Triangle Park, N.C., EPA 600/8-83-018F.

Fergusson J.E., (1990). The heavy elements: chemistry, environmental impact and health effects. Pergamon, *Journal Trace Elem Medification Biolological*, 19,125-140.

Galfati I., Bilal E., Beji Sassi A., Abdallah H., Zaier A.,(2011). Accumulation of heavy metals in native plants growing near the phosphate treatment industry, Tunisia. Carpath *Journal Earth Environment*, 6, 85-100.

GWRTAC, (1997). "Remediation of metals-contaminated soils and groundwater," Tech. Rep. TE-97-01, GWRTAC, Pittsburgh, Pa, USA, GWRTAC-E Series.

Harbison, P. (1986) Mangrove muds – a sink or source for trace metals. *Marine Pollution Buletin,* 17, 246-250.

Hazelton P.A., Murphy B.W. (2007) Interpreting Soil Test Results: *What Do All The Numbers Mean?.*(3rd ed.). Melbourne: CSIRO Publishing.

ITTO Mangrove Workplan (2006). International Tropical Timber Organization, Yokohama, Japan.

FAO, (2002). International Soil Reference and Information Centre Procedure for soil analysis. Wageningen: International Soil Reference Centre.

Bjuhr J.,(2007). Trace Metals in Soils Irrigated with Waste Water in a Periurban Area Downstream Hanoi City, Vietnam, Seminar Paper. Sweden: Institution for markevenstap, Sveriges Iantbruks universitet (SLU), Uppsala,

Kamaruzaman, J., (2008). Managing Sustainability Mangrove Forest in Peninsular Malaysia. *Journal of Sustainable Development.* 1(1), 88-96

Khan R., Israd S.H., Ahmad H., Mohan A., (2005) Heavy metal pollution Assessment in surface water bodies and its suitability for irrigation around the Neyevli Lignite mines and associated industrial complex, Tamil Nadu, India. *Mine Water and the environment,* 24, 151-161.

Greany K. M., (2005). *An assessment of heavy metal concentration in the marine sediments of Las Perlas Archipelago*, Gulf of Panama, Master Science Thesis, Scotland: School of Life Sciences Heriot-Watt University, Edinburgh,

Lacerda, L. D., Carvalho, C. E. V., Tanizaki, K. F., Ovalle, A. R. C. &Rezende, C. E. (1993) The biogeochemistry and trace metals distribution of mangrove Rhizophores. *Biotropica,* 25, 252-257.

Smith L. A., Means J. L., Chen A., (1995). "Remedial Options for Metals-Contaminated Sites", Boca Raton: Lewis Publishers, , Fla, USA.

Langmuir, D. (1997). Aqueous Environmental Chemistry. Prentice-Hall, Inc., New Jersey.

McLaughlin, M. J., Zarcinas, B. A., Stevens, D. P., and Cook, N. (2000). "Soil testing for heavy metals," *Communications in Soil Science and Plant Analysis*, 31,(11-14), 1661-1700.

Miller, W.H., Schipper, H.M., Lee, J.S., Singer, J., Waxman, S., (2002). Mechanisms of action of arsenic trioxide review. *Cancer Research*, 62,3893-3903. [Publish Medline: 12124315.]

Morse J.W, Presley B.J., Taylor R.J., (1993). Trace metal chemistry of Galveston Bay: *water, sediments and biota. Marine Environment Research*, 361,1-37.

Moore, J.W. and Ramamoorthy, S., (1984). Heavy Metals in Natural Waters: Applied Monitoring and Impact Assessment, 28–246, Springer-Verlag, New York.

Nursyafiqah, A. (2016). "*Major macro and micro nutrients present on sediment along Sungai Tiram Laut, Perak*. Unpublished Final Year Project. Serdang,Universiti Putra Malaysia.

Nriagu, J.O., (1989). A global assessment of natural sources of atmospheric trace metals. *Nature,* 338,47-49.

National Research Council. (1980). Lead in the human environment. Washington: *National Academy of Sciences*.

Peech, M. (1965). Hydrogen-ion Activity. In: Methods of Soil Analysis Chemical and Microbiological Properties, Black, C.A., D.D. Evans, J.L. White, L.E.

Campbell, P. G. C. (2006). Cadmium-A priority pollutant, *Environmental Chemistry*, 3(6), 387-388.

Pritchard, D. W. (1967). What is an estuary: physical view stations. In *Estuaries* (Lauff, G., ed.). Washington: American Association for the Advanced of Science.

Perlman, H. (2016). *pH: Water Properties.* Retrieved from https://water.usgs.gov/edu/ph.html.

Klaassen, P. (2017). Electrical Conductivity, why it matters. Retrieved from; http://www.cannagardening.com.

Tchounwou, P.B., Yedjou, C.G., Patlolla, A.K., Sutton, D.J. (2012). "*Heavy metal toxicity and the environment*" *Experientia Supplementum*.1, 101, 134-152

Munsiri, P., Boyd, C.E., Hajek, B.F. (1995). Physical and chemical characteristics of bottom soil profiles in ponds at Auburn, Alabama, USA, and a proposed method for describing pond soil horizons *Journal World Aquatic Society*, 26, 346-377.

Singare, P.U. (2011). Distribution behaviour of trace and toxic metals in soil and sediments along the Thane Creek near Mumbai, India". *Interdisciplinary Environmental Review*, 12(4), 298-312.

Qian, J., Shan, X.Q., Wang, Z.J., and Tu, Q. (1996). Distribution and plant availability of heavy metals in different particle size fractions of soil. *The Science of the Total Environment,* 187, 131-141.

Harter, R. D. (1983). Effect of soil pH on adsorption of lead, copper, zinc, and nickel, *Soil Science Society of America Journal,* 47(1), 47-51.

Khan, S., Cao Q., Zheng Y. M., Huang Y. Z., and Zhu Y. G. (2008). Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China, *Environmental Pollution*, 152(3), 686-692.

Scokart, P.O., Meeus-Verdinne, K. and de Borger, R. (1983). Mobility of heavy metals in polluted soils near zinc smelters. *Water, Air and Soil Pollution,* 20, 451-463.

Seifi, M.R., Alimardani, R. and Sharifi, A. (2010). How can soil electrical conductivity measurements control soil pollution? *Research Journal of Environment and Earth Sciences,* 2(4), 235-238,

Sasekumar, A., Chong, V.C., Singh, H. (1994). The physical and chemical characteristics of the Matang mangrove waters. In: Sudara, S., Wilkison, C.R., Ming, C.I., (Eds.), Proceedings, Third ASEAN-Australia Symposium on Living Coastal Resources, Bangkok: Chulalongkorn University,

Teas, H.J. (1977). Ecology and restoration of mangrove shorelines in Florida. *Environmental Conservation,* 4,51-58.

Tam, N. F. Y. and Wong, Y. S. (1993). Mangrove soils as sinks for wastewater-borne pollutants. *Hydrobiological,* 295, 231-241.

Tiwana, N.S., Jerath, N., Singh, G. and Ravleen, (Eds.) (2005). Heavy metal pollution in Punjab rivers. *Newsletter Environmental Information System (ENVIS)*, 3(1), 3–7,

Tam, N. F. Y. & Wong, Y. S. (1996) Retention and distribution of heavy metals in mangrove soils receiving wastewater. *Environmental Environment,* 216, 33-39.

Crommentuijn, T., Sijm, D., Bruijn, J., Van den Hoop, M., Van Leeuwen, K. and Van de Plassche, E. (2000). Maximum permissible and negligible concentrations for metals and metalloids in the Netherlands, taking into account background concentrations. *Journal of Environmental Management*, 60, 121–143

Kirpichtchikova, T. A., Manceau, A., Spadini, L., Panfili, F., Marcus, M. A., and Jacquest T. (2006). Speciation and solubility of heavy metals in contaminated soil using X-ray micro fluorescence, EXAFS spectroscopy, chemical extraction, and thermodynamic modelling,. *Geochimicaet Cosmochimica Acta*, 70, 2163-2190.

Thompson, K., Hodgson, J.G., Grime, J.P., Burke, M.J.W. (2001). Plant trait sand temporal scale: evidence from a 5-year invasion experiment using native species. *Journal of Ecology,* 89, 1054–1060.

United State Environmental Protection Agency, USEPA, (1994). A plain English guide to the EPA part 503 bio solids rule. Washington: USEPA

United States Department of Health and Human Services, (1999). Toxicological profile for lead,. Atlanta: USDHHS.

Yedjou, G.C., Moore, P., Tchounwou, P.B. (2006). Dose- and Time- dependent response of human leukemia. (HL-60) cells to arsenic tic trioxide treatment. *International Journal Environment Research Public Health,* 3(2),136-140.

WHO/FAO/AIEA. (1996). *Trace elements in human nutrition and health*. Geneva: World Health Organization