ANALYSIS AND ASSESSMENT OF SEDIMENT QUALITY IN A TYPICAL MALAYSIAN RIVER

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To Mother Nature and my beloved parents

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ABSTRACT

Sediment quality receives little concern in aquatic monitoring programs due to its expensive analytical procedures. However, sediment contaminations can influence the overall quality of aquatic environment. Sediment provides habitats to benthic organisms, which some of them are the food sources to human. Due to the acidic condition in digestion track, sediment contaminants can become soluble to the organisms and lead to the occurrence of bioaccumulations. It also serves as diffuse sources of contamination to the overlying water body; slowly releasing the contaminant back into the water column (Marcus, 1991). Therefore, ensuring a good sediment quality is crucial to maintain a healthy aquatic ecosystem, which ensuring good protection of human health and aquatic life. The aim of this study was to analyse and assess the riverbed sediment quality in a typical Malaysian river. Sungai Linggi river basin at Negeri Sembilan had been chosen as the study area because of the multiple developments (commercial, indrustrial, agricultural etc.) within its basin boundary. Metals (Cd, Cr, Co, Fe, Pb, Mn, Hg, Zn, As and Al), nutrients (TKN and TP) and carbon content (loss of ignition) were selected to be the analysis parameters. The result was then being compared with the effect levels in published SQGs. In addition, sediment enrichment factors (SEFs) were calculated to assess the metal contaminants in collected sediment samples with relative to the Al content. SQGs and SEFs provided different conclusions of the major contaminants in the sediment samples. The SQGs approach indicated Hg and As were two major contaminants in this basin because many samples exceeded the severe effect level (SEL) (Hg = 80%; As = 26%). Conversely, Zn and As were the critical contaminants signified by SEFs approach. Percentages of samples with SEFs more than 2 for Zn and As were 56.52% and 43.48% respectively. These differences were expected because using SQGs in sediment quality assessment can be subjective due to the origin of SQGs; while SEFs provide more tailored approach because they were calculated based on the background concentrations of each sample.

ABSTRAK

Kuality enapan sering diabaikan dalam program pemantauan kualiti alam akuatik. Hal ini berlaku kerana perbelanjaan yang mahal bagi langkah-langkah analisis enapan. Walau bagaimanapun, pencemaran enapan boleh mempengaruhi kualiti alam akuatik secara keseluruhanya. Ia membekalkan habitat kepada pelbagain hidupan aquatik yang juga merupakan sumber makan kepada manusia. Keadaan asid dalam salur pencernaan hidupan boleh menyebakan bahan cemar dalam enapan menjadi mudah larut. Akibat daripadanya, bio-akumulasi berlaku di dalam badan hidupan akuatik. Selain itu, enapan dalam air juga menjadi sumber pencemaran pelbagai punca kepada lapisan air di atasnya (Marcus, 1991). Maka, kualiti enapan yang baik amat penting untuk memastikan eko-sistem akuatik yang selamat. Tujuan kajian ini adalah untuk menganalisis dan mengkaji enapan dasar sungai di kawasan legeh Malaysia yang tipical. Sungai Linggi di Negeri Sembilan dipilih sebagai kawasan kajian kerana keadaan guna-tanah yang pelbagai dalam kawasan legehnya. Bahan camar dalam enapan yang dikaji ialah logam (Cd, Cr, Co, Fe, Pb, Mn, Hg, Zn, As dan Al), nutrient (TKN dan TP) serta kandungan karbon (LoI). Dua cara penilaian kualiti enapan digunakan dalam kajian ini, iaitu perbandingan data dengan merujuk kepada panduan kualiti enapan (SQGs) dan pengiraan faktor kesuburan enapan (SEFs). Rujukan kepada SQGs memutuskan Hg dan As adalah bahan cemar dalam enapan yang utama. Manakalan pengiraan SEFs menunjukkan Zn dan As sebagai bahan cemar yang critical dalam enapan. Penilaian kualiti enapan berdasarkan SQGs lebih subjektif kerana keaadaan asal SQGs yang diterbitkan mungkin berbeza daripada kawasan kajian ini. Penilaian kualiti enapan menggunakan SEFs dianggap lebih spesifik bagi kajian ini kerana penggiraannya berdasarkan kandungan latar belakang bahan cemar dan Al dalam setiap sampel.

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AAS	-	Atomic Absorption Spectrometer
Al	-	Aluminum
As	-	Arsenic
Cd	-	Cadmium
Cu	-	Copper
Cr	-	Chromium
Cs	-	Cesium
DID	-	Department of Irrigation and Drainange
ER-L	-	Effect-Range Low
ER-M	-	Effect-Range Median
Fe	-	Ferrum (Iron)
GPS	-	Global Positioning System
Hg	-	Hydrargentum/Hydrargyrion (Mercury)
ISQV-High	-	Interim Sediment Quality Value - High
ISQV-Low	-	Interim Sediment Quality Value - Low
ISQVs	-	Interim Sediment Quality Values
LEL	-	Lower Effect Level
Li	-	Lithium
Mn	-	Manganese
N/A	-	Non-Applicable
N/D	-	Non-detectable
NOAA	-	National Oceanic & Atmospheric Administration (US)
OC	-	Organic Carbon
PAHs	-	Polycyclic Aromatic Hydrocarbons

Pb	-	Plumbum (Lead)
PCB	-	Polychlorinated Biphenyls
Rb	-	Rubidium
SEFs	-	Sediment Enrichment Factors
SEL	-	Severe Effect Level
Si	-	Silicon
SQGs	-	Sediment Quality Guidelines
TKN	-	Total Kjeldahl Nitrogen
TP	-	Total Phosphorus
USEPA	-	United States Environmental Protection Agency
Zn	-	Zinc

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CHAPTER 1

INTRODUCTION

Sediments are one of the possible media in aquatic monitoring. Apart from water, sediments are also responsible of nutrients and pollutant transportation in aquatic environment. Sediments are known to capture hydrophobic chemicals pollutants entering water bodies (McCready, 2006). River sediment is the potential pollution source of toxicity to aquatic organisms and water quality.

According to Marcus (1991), sediment serves as diffuse sources of contamination to the overlying water body; slowly releasing the contaminant back into the water column. Therefore, ensuring a good sediment quality is crucial to maintain a healthy aquatic ecosystem, which ensuring good protection of human health and aquatic life. This can be achieved by establishing a specific level of protection: criterion.

A sediment criterion is described as a specific protection level from adverse contamination effects in sediment (USEPA, 1992). Department of Environment of New York State identified five levels of sediment protection regarding to the human health, aquatic life and wildlife (New York Sediment Screening Criteria, 1991). Numerous sediment quality guidelines (SQGs) were developed to assist in assessing potential adverse effect of sediment contaminants.

1.1 Problem Statement

River is a dynamic hydraulic system; the contamination mechanism in the water column could be ever-changing. However, it can take months, or even a few years to observe changes in the quality of deposited sediments (Meybeck, 1996). Disturbance event such as violent storm and dredging activities can result in re-suspension of pollutant into water column, thus affect the water quality. Four major categories of sediment pollutants are particulate organic matters, nutrients, toxic organic pollutants and toxic inorganic pollutants (Thomas & Meybeck, 1996).

1.2 Aim of Study

The aim of this study is to analyse and assess the sediment quality based on selected parameters for a typical river in Malaysia.

1.3 Objectives

1.3.1 Analyse and access trace elements aand nutrient level from sampled riverbed sediment.
1.3.2 Elaborate the existing sediment quality guidelines and make interpretation.
1.3.3 Evaluate the trend of sediment quality in the selected river based on the result of study.

1.4 Scope of Work

1.4.1 Selection of Study Area

The selected study area must at least be a model of typical Malaysian river basin, which main river and its tributaries run through lands with vary activities such as industries, commercials, agricultures and townships.

1.4.2 Case Study Based on Selected River Basin.

A case study was conducted on a selected river basin. The focus of this case study was to analyse and assess the riverbed sediment samples collected from the selected river basin.

1.4.3 Riverbed Sediment Sampling and Laboratory Analysis

Riverbed sediment samples were collected and preserved according to the standard operation procedures recommended by USEPA. Collected samples underwent pre-treatment processes before being analysed with standard laboratory methods.

1.4.4 Elaboration of Published Sediment Quality Criteria and Guidelines

Varies sediment quality criteria and guidelines were elaborated. References were made on previous sediment quality study.

1.4.5 Result and Discussions

Result of this study was discussed in detail. Determinations of the sediment contaminants will be made based on two approaches: Sediment Quality Guidelines (SQGs) and Sediment Enrichment Factors (SEFs).