SEDIMENTATION ANALYSIS AT SARAWAK KANAN RIVER

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To my beloved family, friends, lecturers and students

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ABSTRACT

River is important to humans and other organisms on earth as they are essential resources for living. Erosion, transport and deposition are among the number of processes that influence the sedimentary content and quality of river water.This research discusses the sediment transport of Sarawak Kanan River. It describes a total of 16 sediment data obtained from October 2014 until December 2014 at Sarawak Kanan River Catchment in the river sediment collection and analysis project. The objective of the study are to determine the sediment yields throughout the period, the factors and correlation that influencing the sediment mobility and to identify and evaluate sediment equations that best predict sediment transport rate for Sarawak Kanan River. Data collection including suspended load, bed load, bed material and flow discharge have been carried out at the selected site. The correlation value,R^2 of flow discharge with suspended sediment concentration, water level, bed load, suspended sediment load are varies between 0.6387 to 0.9642 which indicates that they are each most directly proportional with each other. The sediment transport equation assessments have been carried out using Einstein,Einsten-Brown, Meyer-Peter-Muller,Shields,Yang, Engelund & Hansen, Ackers & White and Graf equations. In this study, Engelund & Hansen equation gives the highest value of accuracy which is 87.5% and followed by Yang and Graf equation with accuracy of 12.5% from the total data. Therefore, it is necessary to establish effective sediment and river management strategies that are economically, environmentally, and socially sustainable without compromising the needs of future generations.

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ABSTRAK

Sungai adalah penting kepada manusia dan organisma lain di bumi kerana ia adalah sumber penting untuk kehidupan. Hakisan, pengangkutan dan pemendapan adalah termasuk dalam proses yang mempengaruhi kandungan sedimen dan kualiti air. Penyelidikan ini membincangkan tentang pengangkutan sedimen Sarawak Sungai Kanan. Ia menerangkan mengenai 16 data sedimen yang diperolehi dari Oktober 2014 sehingga Disember 2014 pada tadahan Sungai Sarawak Kanan dalam pengumpulan dan analisis sedimen sungai projek. Objektif kajian ini adalah untuk menentukan hasil sedimen sepanjang tempoh tersebut, faktor-faktor dan perhubungan yang mempengaruhi pergerakan sedimen dan untuk mengenal pasti dan menilai persamaan sedimen yang terbaik bagi meramalkan kadar pengangkutan sedimen untuk Sungai Sarawak Kanan. Pengumpulan data termasuk beban terampai, beban dasar, bahan dasar dan kadar alir sungai telah dilakukan di tapak yang dipilih. Nilai perhubungan korelasi, R2, kadar alir sungai dengan kepekatan sedimen terampai, paras air, beban dasar, beban terampai adalah berbeza-beza antara 0.6387-0.9642 yang menunjukkan bahawa setiap parameter berkadar langsung antara satu sama lain. Penilaian persamaan pengangkutan sedimen telah dijalankan menggunakan persamaan Einstein, Einsten-Brown, Meyer-Peter-Muller, Shields, Yang, Engelund & Hansen, Ackers & White dan persamaan Graf. Dalam kajian ini, persamaan Engelund & Hansen memberikan nilai ketepatan tertinggi iaitu 87.5% dan diikuti oleh persamaan Yang dan Graf dengan ketepatan 12.5% daripada semua jumlah data. Oleh itu, adalah perlu untuk menubuhkan strategi pengurusan sedimen dan sungai yang berkesan dari segi ekonomi, alam sekitar, dan sosial tanpa menjejaskan keperluan generasi akan datang.

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LIST OF SYMBOLS/ ABBREVIATIONS/ TERMINOLOGY

DID	=	Department of Drainage and Irrigation
ASCE	=	American Society of Civil Engineers
FISWRG	=	Federal Interagency Stream Restoration Working Group
Q	=	Flow discharge (m^3/s)
B	=	Channel bottom width (m)
C	=	Chezy coefficient
A	=	Flow area (m^2)
V	=	Average velocity (m/s)
V_c	=	Critical velocity (m/s)
R	=	Hydraulic radius
y_o	=	Flow depth (m)
S_o	=	Energy slope (m/m)
d_{50}	=	Sediment diameter where 50% of bed material are finer (mm)
g	=	Acceleration of gravity
ω_s	=	Fall velocity (m/s)
S_s	=	Specific gravity of sediment (2.65)
υ	=	Kinematic viscocity
h_s	=	Conveyance shape
n	=	Manning's roughness coefficient
C_v	=	Volumetric concentration of sediment (ppm)
C_T	=	Sediment concentration in parts per million by weight
T_b	=	Bed load rate (kg/s)
T_t	=	Suspended load rate (kg/s)
T_j	=	Total bed load of sediment (kg/s)
t	=	Time(s)

U_*	=	Shear velocity
τ	=	Shear stress
τ_c	=	Critical shear stress
τ_o	=	Average shear stress
φ	=	Transport parameter
ψ	=	Flow parameter
λ	=	Darcy-Wiesbach friction factor

CHAPTER 1

INTRODUCTION

1.1 Introduction

Water is the lifeblood of the life on earth. It can be in many forms and can be find in various sources; rain fall, seas, lakes, rivers, water catchments, underground water and many more. Part of it, river are important to humans and other organisms on earth as they are essential resources for living. Erosion, transport and deposition are among the number of processes that influence the sedimentary content and quality of river water. These processes mutually interact along the river, from the ridges up to the mouth of the river (Townsend *et al*., 1980).

Sediments are known as the organic and inorganic materials or solid fragments derived from the weathering process, and as for underwater, sediments can also be define as silt and deposits from the material deposited at the bottom of the river. Sedimentation process is eroded and transported material through the water regime to get to the place of deposition. Suspended solids typically have colloidal substance micro-sized and require only a low velocity stream for transport of a point to point. The speed and the flow of the water in rivers are important in determining its capacity to carry away sediments. The slow moving river will have a lower rate of sediment movement (Toriman *et al*.,2009).A higher discharge and water velocity value will produce higher sedimentation rate.

Sediment carriage processes are important for the measurement of various aspects in a stream including the integrated water resources management. The purpose of the water resource management works is to maximise the utilisation of water resources so as to stimulate economic activities and enhance the standard of living.

The amount of sediment can affect to the water use in the local community, recreational activities for the purpose of tourism, which eventually lead to the river getting shallow through deposition of sediment and eventually flooding (Toriman *et al.*,2012).Generally, sediments play an important role in the cycle associated with the elements in the aquatic environment. Therefore, the sediments are responsible for the transport of nutrients and pollutants that are important in a system stream / river which is the main reason for the causes of the problems of water resources management. This study was conducted to estimate the production of suspended sediment load in the watershed and its impact on water resources in Sungai Sarawak.

Changes in water quality can be seen in the health of the river basin. This can be seen in the water discoloration becomes cloudy and smells from its original state once clear and safe for domestic use. This condition occurs as a result of rainfall runoff ditches and drains the most earthed directly into the river. Solid waste from residential and tourist area directly into the river causing the river filled with debris. As a result, rivers are severely polluted (Detwyler *et al.*,1972)

1.2 Problem statement

There are three physical processes that influence the content of the sediment and water quality. All three of these processes interact with each other along the groove until the mouth of the river, the process is like erosion, transport and deposition. However, most of the sediment in the water is caused by surface erosion and mineral components, the erosion of the bedrock and organic components during

the process of soil formation occurs (Toriman *et al.*, 2005) . Sedimentation can also occur outside the river banks, especially in the aftermath of the floods. This is because, during the flood, the water will bring with sediment load and when the tide is low, this burden will be left as a pile of sediment (Toriman, 2007). Therefore, water quality and quantity of sediment in the river will be affected by these factors. In fact, too much sediment collected in lakes and rivers will lead to lack the requisite on the lake and river. Consequently during the rainy season, the area will be more susceptible to flooding.

The increasing of volume and velocity of surface run-offs will increase the erosion rate. This increases the amount of suspended sediments and water turbidity in stream channels, thus reducing the water quality (Toriman *et al.*,2009). River quality is assured when it is sufficiently maintained. However, river quality may be adversely affected by sudden severe flooding or drought. Therefore the characteristics of the river discharge are important in terms of its geomorphology, hydraulics, flood control, navigation, stabilisation or development, depending on the purpose of the water resource for aquatic organisms, domestic use and many more (Simon *et al.*, 1969).

The Sarawak River is one of the main rivers in state of Sarawak. Located in along the city of Kuching, the river was the second important medium of transportation after land transportation, because it connects the Kuching city, and the residential area in Petra Jaya, also industrial area, Kuching Port, Sejingkat and many more. Due to the rapid development from time to time nowadays, the Sarawak River encountered flood problem. Flooding could be due to a variety of causes and circumstances or combination of factors which aggravated the situation and sedimentation is part of it. Sarawak river has a combination of two tributaries, that is Sarawak Kiri River and Sarawak Kanan River.

Sungai Sarawak Kanan, located south-west of Kuching city which flow north-ward into South China Sea. The whole basin of Sungai Sarawak Kanan is 630 km^2. The upstream subcatchment of Buan Bidi is about 225 km^2. Sungai Sarawak

Kanan springs from Bungoh Range of Sarawak-Kalimantan border and flows 65 km downstream before confluences with Sungai Sarawak at Batu Kitang. Sungai Sarawak Kanan drains the upper catchment of Sungai Sarawak of mountainous region and passes through the rural townships of Bau, Siniawan and surrounding villages. Due to the presence of the urban town of Bau in the middle valley and Siniawan at the lower reach, flood risk is significant. Sungai Sarawak Kanan is one of the rivers frequently affected by flood (Darrien *et al.*,2007).

1.3 Objectives of the study

The objectives of this study are;

i. To determine the sediment yields of Sarawak Kanan River for dry season (October 2014) and wet season (November-December 2014).
ii. To determine the relationship between various parameters that influencing sediment mobility at Sarawak Kanan River.
iii. To evaluate sediment transport formulations that best predict sediment transport rate for Sarawak Kanan River.

1.4 Scope of the study

The study site is located at Sarawak Kanan River, a right hand side principal tributary to Sarawak River Basin. The sampling stations are located near Buan Bidi water level gauging station of Department of Irrigation and Drainage (DID) Sarawak. The gauging station at Buan Bidi is sited upstream of the tidal limit of Sungai Sarawak.

The field measurement that were done are bed load, suspended load and velocity measurement and for the laboratory measuring are sieving analysis,

suspended sediment analysis, turbidity, pH and temperature will be taken into account throughout the research study. Evaluation of sediment equations are including Einstein, Einsten-Brown, Meyer-Peter-Muller,Shields,Yang, Engelund & Hansen, Ackers & White and Graf equations.

1.5 Significance of Research

The increase in suspended sediment load can cause turbidity in water bodies, the water situation is not neutral, odour and colour surprises on the river, the lack of sunshine and the next entry disrupt photosynthesis by aquatic plants in the water and aquatic organisms or dead due to lack of enough clean air and water or water that is not suitable pH and contamination. The discharge (Q) in Sarawak River is among the main factors that influence the mobility of sediments in the area. Thus, the increased rate of water flow can cause an increase in the concentration of suspended sediment. Thus, the concentration of suspended sediment is correlated with rainfall events increase the discharge of the river.

The input from this analysis is important in the management of rivers and water resources, particularly in the context of integrated water resources for domestic use, ecotourism, biodiversity of rivers, hydrology and hydraulics. This analysis will also help to learn the trend and transporting of sedimentation in Sarawak River, during wet and dry season, and its significance with discharge rate or the river.

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