STUDY ON CHARACTERISTIC OF SEDIMENT AND BED LOAD TRANSPORT IN SUNGAI JEMBERAU AT TASIK CHINI

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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kajian ini dijalankan di Sungai Jemberau, Tasik Chini. Objektif utama kajian ini adalah mengenalpasti ciri-ciri sedimen dan pengangkutan beban dasar di Sungai Jemberau. Pengangkutan beban dasar dianalisis dengan menggunakan kaedah ramalan melalui formula DuBoys dan Schoklitsch dan pengukuran terus melalui alat Helley-Smith. Oleh itu, kedua-dua kaedah ini dibandingkan dengan mendapatkan ramalan terbaik pengangkutan beban dasar di Sungai Jemberau. Untuk mengenal pasti ciri-ciri sedimen iaitu saiz dan ketumpatan sedimen, Analisis Saringan/Ayak dan Analisis Ketumpatan Zarah telah dijalankan di Makmal Geoteknik, UMP. Klasifikasi sedimen daripada hasil analisis ayak dikelaskan menggunakan Skala Udden-Wentworth. Analisis taburan saiz zarah menunjukkan saiz median sedimen tertinggi (d_{50}) adalah 4.30mm untuk Sampel 3 pada 5 Mac 2017 (cuaca hujan) diikuti oleh 3.80mm untuk Sampel 2 pada 1 Disember 2016 (cuaca cerah), 3.20mm untuk Sampel 5 pada 12 November 2017 (cuaca hujan) dan Sampel 6 pada 30 Januari 2018 (cuaca hujan), 2.70mm untuk Sampel 1 pada 24 September 2016 (cuaca cerah) dan terakhir ialah 1.20mm untuk Sampel 4 pada 17 Mei 2017 (cuaca hujan). Kebanyakannya, sampel sedimen dikelaskan sebagai jenis kerikil. Sementara itu, hasil analisis ketumpatan sedimen di Sungai Jemberau berada antara 2.34g/cm3 hingga 2.97g/cm3. Saiz dan ketumpatan sedimen ini mempengaruhi pengangkutan sedimen di Sungai Jemberau. Aktiviti perlombongan yang tidak terkawal meluas berhampiran Sungai Jemberau menyebabkan proses hakisan berlaku. Hasilnya, ia meningkatkan arus sedimen mengalir ke Sungai Jemberau dan keadaan bertambah teruk semasa ribut atau hujan. Jumlah sedimen yang banyak akan termendap di dalam dasar sungai dan membuat kedalaman sungai menjadi cetek jika pemendapan berlaku. Sekaligus, kawasan Sungai Jemberau akan menghadapi banjir kerana air sungai akan melimpah kesan daripada proses pemendapan. Dengan itu, menggunakan formula DuBoys dan Shoklitsch, pengangkutan beban dasar di Sungai Jemberau boleh diramal. Daripada perbandingan hasil pengangkutan beban dasar melaui kaedah ramalan dan pengukuran terus, DuBoys telah dipilih sebagai ramalan terbaik untuk pengangkutan beban dasar di Sungai Jemberau kerana pengangkutan beban dasar yang diramalkan oleh DuBoys lebih dekat dengan pengangkutan beban dasar yang diukur terus menggunakan alat Helley-Smith berbanding dengan pengangkutan beban dasar yang diramalkan oleh Schoklitsch. Walau bagaimanapun, hasil perbandingan menunjukkan pengangkutan beban dasar yang diramalkan menggunakan persamaan DuBoys dan Schoklitsch adalah terlebih anggaran banyak kerana kedua-dua persamaan yang digunakan berasal dari luar negara dan tidak begitu sesuai untuk digunakan di sungai di Malaysia.

ABSTRACT

This study conducted in Sungai Jemberau at Tasik Chini. The objectives of this research was to identify the sediment characteristic and bed load transport in Sungai Jemberau. The bed load transport are analyzed using predicted by DuBoys and Schoklitsch equation, and measured method by Helley-Smith Sampler. Thus, these two methods was compare to obtain the best prediction of bed load transport in Sungai Jemberau. As to identify the sediment characteristics which are particle size and density, the Sieve Analysis and Particle Density Analysis were carried out in the Geotechnical Laboratory, UMP. The classification of sediment from sieving test results was classified using Udden-Wentworth Scale. Analysis for particle size distribution shown the highest median grain size (d_{50}) was 4.30mm for Sample 3 on 5th March 2017 (Rainy) followed by 3.80mm for Sample 2 on 1st December 2016 (Sunny), 3.20mm for Sample 5 on 12th November 2017 (Rainy) and Sample 6 on 30th January 2018 (Rainy), 2.70mm for Sample 1 on 24th September 2016 (Sunny) and lastly 1.20mm for Sample 4 on 17th May 2017 (Rainy). Mostly, the sediment samples was classified as gravel type. Meanwhile, the density of sediment in Sungai Jemberau were range from 2.34g/cm^3 to 2.97g/cm^3. These particle size and density of sediment were influence the sediment transport in Sungai Jemberau. Extensive uncontrolled mining activities nearby the Sungai Jemberau were lead to erosion process to occur. In result, it increase the sediment flows into Sungai Jemberau and it becomes worsen during storm or rainfall event. High amount of sediment will settle down in stream bed and make the depth of river become shallow if the sedimentation occurred. At once, the area will face flooding because the river become overflow due to sedimentation process. Then, using DuBoys and Shoklitsch equation, the bed load transport in Sungai Jemberau can be predicted. From the comparison of predicted and measured bed load transport result, DuBoys were selected as the best prediction of bed load transport in Sungai Jemberau because the bed load transport predicted by DuBoys equation were more closest to measured bed transport using Helley-Smith Sampler compared to bed load transport predicted by Schoklitsch equation. However, shown that the predicted bed load transport using DuBoys and Schoklitsch equation were over-estimate because the both equations was develop from abroad and not really suitable to use in river at Malaysia.

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LIST OF SYMBOLS

N	North
E	East
mm	Milimeter
%	Percent
ϕ	Phi
in	Inch
D	Diameter
ρ_s	Mass per unit volume (g/cm^3)
R	Hydraulic radius (m)
n	Total manning roughness
lb	Pound
ft	Feet
G_s	Bed load discharge (lb/sec)
g_s	$G_s / _{Tw,}$ Bed load discharge per unit width (lb/sec/ft)
b	Width (m)
d	Depth (m)
V	Flow velocity (m/s)
A	Area (m^2)
$\boldsymbol{\tau}_o$	γdS, Bed shear stress (lbs/ft^2)
$\boldsymbol{\tau}_c$	Critical bed shear stress (lb/ft^2)
ψ	Coef. depending on mean size of bed material ($ft^3/lb/sec$)
γ	Specific weight of water (lb/ft^3)
S	Slope (m/m)
Q	Flow rate or discharge (m^3/s)
D_{si}	Mean grain size (ft)
q	Discharge per unit width
D_{50}	50 percent finer by weight in the size distribution curve
mg/L	Weight per volume, TSS
°C	Temperature in celcius

LIST OF ABBREVIATIONS

UMP	Universiti Malaysia Pahang
UNESCO	United Nations Educational, Scientific and Cultural Organizations
DMS	Degree, Minutes and Seconds
GPS	Global Positioning System
TSS	Total Suspended Solids
Dec	December
Sept	September
Jan	January

CHAPTER 1

INTRODUCTION

1.1 Background

Sediments are the fragments of rocks and minerals that comes from the weathering of rock and are carried and deposited by wind, water or ice. When the rainfall occur, the materials are dislodged and transported on the land surfaces. Rivers and streams will act as a passage for the movement of sediments and deposition will occur when there is no enough energy to transport the sediments. These passages will carry the sediment as they flow depending on the sediment supply along their course.

Sediment transport or sediment load deals with the interrelationship between flowing water and sediment particles which means the material in suspension and or in transport. Typically, the greater the flow, the more sediment will be transported. During transport in water body, the total sediment load are divided into two categories which are wash load and bed-material load. While in term of movement, the sediment can be identified as bed load transport and suspended load. The several factors affecting the sediment transport are velocity, depth of flow, particle sediment size, geometry cross section and course of river flow.

A river or stream can be considered stable when its water flow and sediment flux are in balance over time. The sediments is natural component in a river but if the sediment present in excess, it can be damaging. For example, it can disrupt ecosystem, water quality, increase water level and then causing flood. The sediment production are from the weathering of rocks, erosion by the flow of water over soil surfaces, channel bed erosion and bank caving (Habibi, 1994).

In addition, catchment clearing and “river training schemes” result in the indirect mobilisation of sediments into stream systems. Sediments may also enter stream or river as result of other human activities such as the construction of dams and mining activity within a catchment. Also, the construction of roads is known to be a major contributor of sediment to waterways (Till & Trayler, 2000).

Once the sediment has entered waterways, it is difficult and expensive tasks to remove where engineering solutions and heavy equipment are required. A question on how much sediment would be carried by a river under a given hydraulic condition makes the study of sediment transport is one of great engineering importance using the suitable methods or functions.

1.2 Background of Study

Tasik Chini is a lake in Pekan District, Pahang, Malaysia which locate at coordinates of 3 26’N 102 55’E. The 12,565 acres or 5,085 hectares Tasik Chini is the second largest fresh water lake in Malaysia and is made up of a series of 12 water bodies, referred to as ‘sea’ by the local inhabitants which are fed by the tributaries surrounding the water catchment areas of Chini forest before flowing into the Pahang River via the Sungai Chini. Tasik Chini is one of the UNESCO Biosphere Reserve status sites in Malaysia. Sungai Jemberau and Sungai Chini is the river that connect with Tasik Chini. In addition, Sungai Jemberau is one of the seven feeder river of Tasik Chini. While, Sungai Chini is the river that drains Tasik Chini into Pahang River for about 4.8 km.

While sediment movement is a natural part of a functioning freshwater ecosystem, human activities around waterways such as dam or road construction or land use change from native forest to pasture can greatly increase the amount of sediment that enters the system. This situation can have considerable effects on water quality, plant and animal live there, and water level. The addition of sediment to rivers and streams above normal levels is a serious issue. This means, the study of sedimentation rate is quite important since the problem related to our human society such as floods and water quality can be avoid. For example, the depth of river become shallow if the sedimentation occurred. It will make the quantity of aquatic life will reduced and the area will face flooding because the river become overflow due to sedimentation process (Ahmad Abdul Ghani, Othman, & Baharuddin, 2013).

At the same time, when the sediments in river system are high and it is still behind a dam, the sediments will sink to the bottom of the reservoir. This situation refers to reservoir sedimentation. Then, as the sediment are accumulated in the reservoir, the dam will rapidly reduce its usefulness or lifespan to store water. This accumulation of sediment in reservoirs may have several effects such as reduce the useful storage volume, change water quality, increase flooding level upstream and influence stability of the stream at downstream of dam.

As to maintain its Biosphere Reserve status by UNESCO, Tasik Chini faced many threats of uncontrolled logging, mining, plantation activities and small barrage that bring negative impacts to the ecosystem and water quality. The uncontrolled activities around the lake also contributes to the sedimentation problem in the river that flows into Tasik Chini. Indirectly, it also can affect the lake too.

1.3 Problem Statement

After the sluice was built in 1995, the water level of Tasik Chini has changed while blocking the flow of the water. Since 2000, the lotus flower garden scene has disappeared. Lotus flowers usually blossomed from August to January but since the water level was raised, it is difficult for lotus flowers to grow and even if they are able to grow, the rising water in rainy season is unable to flow out and thus, the flowers are drowned. Then now, the number of tourists have significantly reduced because they are coming for flower viewing. Originally, the sluice was built to improve the water level to facilitate the boatmen, but has unexpectedly destroyed the ecology of the lake instead. It blocks the natural flushing of Tasik Chini when Sungai Pahang has high water levels twice a year. The natural flushing used to remove pollutants and safeguard water quality. That is negative hydrological impact. The Orang Asli want the sluice to be removed and they said that was the start of their problem.

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