MODELLING OF TIDAL EFFECT ON SUSPENDED SEDIMENT DISPERSION AT SUNGAI BATU PAHAT, JOHOR

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DEDICATION

Special to my Mother and Father

Qameriah Khanan Bte Fateh Mohamed
Ismail Bin Daud

My beloved Brother and Sister

Muhammad NorFarhan and Faqiza Jan

My Beloved wife

Nurul Asyikin

My Beloved Daughter

Nurul Nargiss Najwa

No word can describe the gratitude for all of you

Thank for the past or present sustain

And

Shoulder to shoulder support

.....

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ABSTRACT

As part of an effort to understand and predict the nutrients dynamics in Sungai Batu Pahat, the transport of sediment has been studied by combining numerical model with an extensive fields program. Oversupply of sediment loads from multiple sources will cause unstable conditions to rivers, lakes, and shallow coastal and estuarine areas. Sediment transport also brought together sorbs chemical that will distract ecosystem in the water and human daily activity such as recreation and water supply. For this research, applications of Water Quality Simulation Program 5 or WASP5 have been used to simulate suspended sediment dispersion at Sungai Batu Pahat. TOXI5 is a WAPS5's kinetic model that has been specialized for toxic pollutants including sediment. TOXI5 is link to hydrodynamic model DYNHYD5. In this study, several analyses were conducted to determine magnitude and spatial distribution of suspended sediment in Sungai Batu Pahat due to real observation data. Results showed that there is a significant changes to sediment concentration due to tidal effect in this study.

ABSTRAK

Sebagai satu usaha untuk memahami dan meramal pergerakan nutrien di Sungai Batu Pahat, pengangkutan sedimen telah dikaji dengan menggabungkan bersama model numerikal dan program ekstensif lapangan. Pelepasan berlebihan muatan sedimen dari pelbagai sumber akan menyebabkan ketidakstabilan terhadap sungai, tasik, pesisir pantai dan kawasan muara. Pengangkutan sedimen turut membawa bersama bahan kimia terserap yang akan mengganggu ekosistem dalam sumber air dan aktiviti harian manusia seperti rekreasi dan pembekalan air. Untuk kajian ini, aplikasi perisian Water Quality Simulation Program 5 atau WASP5 telah digunakan untuk mensimulasi taburan sedimen terampai di Sungai Batu Pahat. TOXI5 merupakan model sub kinetik dalam WASP5 yang telah dikhususkan untuk pencemaran bertoksik termasuk sedimen. TOXI5 telah dihubungkan dengan model hidrodinamik DYNHYD5. Dalam kajian ini, beberapa analisis telah dilakukan untuk menentukan magnitud dan taburan sedimen dalam Sungai Batu Pahat berdasarkan nilai cerapan data sebenar. Keputusan menunjukkan terdapat perubahan ketara terhadap taburan kepekatan sedimen kesan daripada pasang surut dalam kajian ini.

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LIST OF SYMBOLS

V	-	velocity
t	-	time
m	-	mass
M	-	momentum
F	-	force acting on the mass
A	-	area
Q	-	Flow rate
P	-	Cross Section "Wetted Perimeter"
$\bar{\tau}_b$	-	Average Bed Shear Stress
B	-	weir base width (m)
H	-	head above weir crest excluding velocity head (m)
C_d	-	orifice discharge coefficient (0.40 – 0.62)
A_0	-	area of orifice (m^2)
D_o	-	orifice diameter (m)
H_o	-	effective head on the orifice measured from the centre of the opening (m)
g	-	acceleration due to gravity (9.81 m/s^2)
Z	-	vertical direction
Z_b	-	bed elevation
Z_w	-	$zb + H$ = water surface elevation
q_1	-	UH = unit flow rate in the x direction
q_2	-	VH = unit flow rate in the y direction
q_m	-	mass inflow rate (positive) or outflow rate (negative) per unit area
β	-	isotropic momentum flux correction coefficient that accounts for the variation of velocity in the vertical direction
g	-	gravitational acceleration

ρ - water mass density

pa - Atmospheric pressure at the water surface

Ώ - Coriolis parameter

n - Manning's coefficient

τ_{bx}&τ_{by} - bed shear stresses acting in the *x* and *y* directions, respectively

τ_{sx} &τ_{sy} - surface shear stresses acting in the x and y directions,respectively

$\tau_{xx},$ $\tau_{xy},$ τ_{yx} &τ_{yy} -shear stresses caused by turbulence where, for example, τ_{xy} is the shear stress acting in the *x* direction on a plane that is perpendicular to the y direction

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CHAPTER I

INTRODUCTION

1.0 GENERAL

Suspended sediments are usually silt and clay particles that are between 2 and 60 micrometers in diameter. Suspended sediments can be directly measured as total suspended sediment (TSS) in milligrams per litre (mg/L) but are frequently measured indirectly as turbidity. Turbidity is the optical property of water resulting in a loss of light transmission caused by absorption and scattering. Turbidity is typically measured in Nephlometric Turbidity Units (NTUs). While suspended sediments are often the main contributors to turbidity, other non-sediment sources that affect light transmission (that is, natural tannins and algae) can also influence turbidity.

Sediment is one of the most significant pollutants transferred by storm water. Sediments consist largely of soil materials eroded from uplands as a result of natural processes and human activities.

Four interactive factors that have substantially affected the suspended-sediment regime over this same period of time include increases in agriculture, commerce and industry, transportation networks and population and urbanization.

Development activities dramatically alter the hydrologic cycle of a site and ultimately of the entire watershed. The initial clearing and grading of the site removes vegetation which intercepted and absorbed rainfall and removes natural depressions which stored rainfall which would then infiltrate into the ground or evaporate back into the atmosphere. The construction activity will compact the soil, which further reduces the ability of the soil to infiltrate the rainfall and further increases the volume and rate of storm water runoff from the site.

1.1 PROBLEM STATEMENT

The greatest sediment loads are exported during the construction phase of a development site or any land clearing activities. Unless adequate erosion controls are installed and maintained at the site, enormous quantities of sediment may be delivered to the stream channel, along with attached soil nutrients and organic matter.

High concentrations of suspended sediment in streams and lakes caused many adverse consequences including increased turbidity, reduced light penetration, reduced prey capture for sight-feeding predators, clogging of gills/filters of fish and reduced angling success. Additional impacts can result after sediment is deposited in slower moving waters including the smothering of benthic communities, alterations in the composition of the bottom substrate, the rapid filling-in of small impoundments which create the need for costly dredging and reductions in the overall aesthetic value of the water resource. Sediment is also an efficient carrier of toxins and trace metals. Once deposited, pollutants in these enriched sediments can be remobilised under suitable environmental conditions posing a risk to benthic life.

Fine-grained suspended sediment and pollutant transport and the impact of these processes on the local habitat are some of the main concerns in current issues within the freshwater fluvial environment. Many anthropogenic inputs to fluvial systems have pathways that are preferentially associated with suspended particulate matter (SPM) and their deposition along rivers can create adverse environmental conditions. None the less, only little is known of the specific physical and biogeochemical processes that govern transport, deposition and entrainment of fine cohesive sediment in river systems. By now, it is well recognized that much of the suspended sediment load in rivers exists in the form of composite particles or aggregates.

The concentration, discharge, load, and yield of suspended sediments in a stream are important because of the relation between sediments and some water quality constituents that have a strong association to sediments. Trace metals, pesticides, and polychlorinated biphenyls (PCBs) have a strong affinity for and sorbs to soils, sediments, and other particulate matter present in the environment. The movement and distribution of these constituents in a river results from a continuous process of sorption to fine-grained sediments and other particulate matter, movement downstream (primarily in suspension), deposition, resuspension, movement, redeposition, and so on, in response to variations in stream flow.

1.2 OBJECTIVE

The main objective of the study is to determine tidal effect on suspended sediment concentration dispersion of the study area, which is near the Sungai Batu Pahat estuary.

1.3 SCOPE OF STUDY

The following is the scope of work for the study:

i. The study will be done at Sungai Batu Pahat. A part of Sungai Simpang Kiri and Sungai Simpang Kanan are involved where the constant inflow are taken for Sungai Batu Pahat modelling.

ii. Currents, water levels and sediment data collection will be collected during the study. The current tidal data is obtained from Port of Johor and the bathymetry data is from Geoinformation Faculty University Technology Malaysia.

iii. Using WASP5 software as modelling tool to set up one-dimensional numerical model to model the changes in flow, water levels and sediment concentration. The simulation period is eleven day due to the capability of computer available. Only the high accuracy data of simulation data will be used by neglected the data during model stabilizing period and spoil data.

1.4 STUDY AREA

Sungai Batu Pahat is situated in the southwest of Peninsular Malaysia in the vicinity of 1º48'00" to 1º48'54" N latitude and 102º56'00" to 102º56'30" E longitude. Sungai Batu Pahat is located between Muar and Batu Pahat. (Appendix A) The river opens into an estuary that joins the open sea, this being part of the Straits of Malacca. (Figure 1.1)

The dominant flow in Sungai Batu Pahat near Batu Pahat town are driven by the astronomical tides, with intermittent freshwater inflows causing some additional flow, principally in the more shallow upstream areas and where tidal currents are low or tidal flow does not penetrate other than on spring tides. From time-to-time there are likely to be some very high freshwater flows in the estuary. Typical spring tide ranges are in the order of 3m with neap tides in the range of 1m being common. However, spring tide ranges of nearly 3.7m may occur. Therefore, there is a significant range of tidal regime. Sungai Batu Pahat can be described as a sandy/muddy area, but the sediments delivered to the estuary in suspension from the catchments will be predominantly fine silts. The movement and resuspension of sediment particles commences when the fluid force on a particle is just larger than the resisting force related to the submerged particle weight and friction coefficient. In the case of fine silts, cohesive forces are also important. Thus settled mud particles remain in a stable state on the seabed until forces that exceed those needed to initiate sediment motion disturb them. These forces are caused by tidal and wind driven currents, as well as by wave action. There is little wave caused water particle motion near the seabed in the Sungai Batu Pahat area and so sediment movement is dominated by flood flows, which may cause significant sediment re-suspension in the upstream reaches and, subsequent transport to the entrance in Sungai Batu Pahat. Once suspended, fine particles may be transported throughout the estuary, ultimately settling in a more tranquil environment, in typically deeper areas. Therefore, apart from protected areas and muddy coasts, long-term retention of silts in shallow areas beyond the local equilibrium depth is unlikely. (Uni-Technologies Sdn. Bhd., 2006)

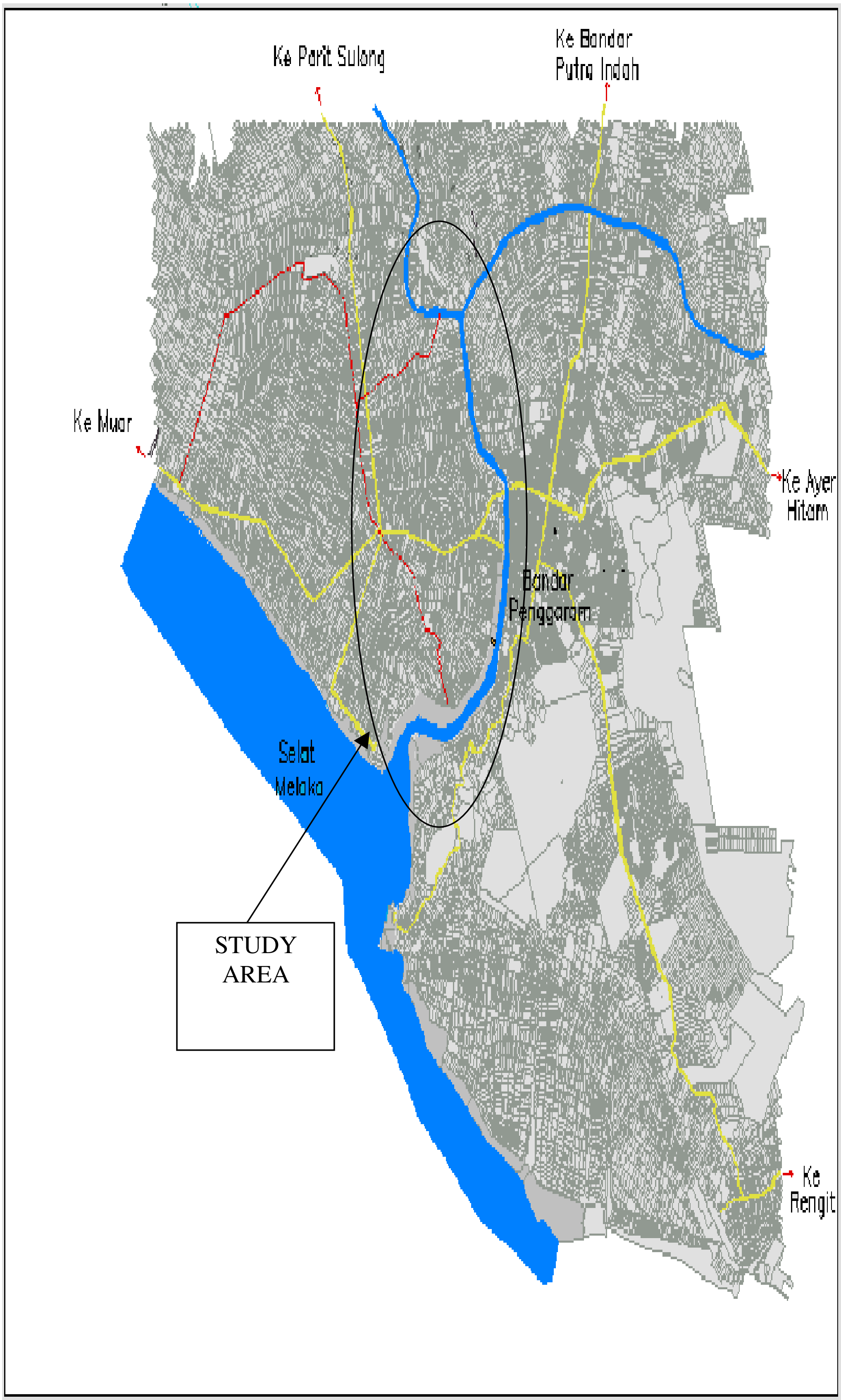

Figure 1.1: Location of study area

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