EFFECTS OF TIDES AND SURFACE RUNOFF ON CHANNEL GEOMETRY

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To my beloved family ;

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Muhd Nabel Aiman,

Muhd Luqmanul Hakim,

Aness Natasya,

&

Mak & Ma..

Thanks for your pray, attention and spiritual…….

ACKNOWLEDEMENTS

It is great pleasure to address those people who helped me throughout this project to enhance my knowledge and practical skills especially in research area. My deepest and most heartfelt gratitude goes to my supervisors, Tn Hj Tarmizi bin Ismail and En. Abu Bakar bin Fadzil. The continuous guidance and support from both of them have enabled me to approach work positively.

My gratitude also been extended to all personnel of the Laboratory of Hydraulics and to all staff especially in the Department of Hydraulics and Hydrology for their support, cooperation and constructive criticisms during the research period.

Many thanks to Universiti Teknologi Malaysia and generally to Government of Malaysia for giving me chance to pursue my study. Also thanks to Mohd Kamarul Huda, Aznan, Azreen, Shah, Amzari, Hood Tendot, Norasman, Hakim, Juwita, Liew Kuet Fah and other classmates for their helped and support.

Finally, I wish to express my special thanks to my beloved parents and family especially my wife, Laila Nazura Nawi who gives me spirit, support and encouragement to me in completion this project. I would also like to thank everyone who has contributed directly or indirectly to this project. This project would have been impossible without your guidance, advice and support.

ABSTRACT

Hydraulics of the river mouth with a tidal effect intrusion is sometimes quite different from that of the river without them. Upstream and downstream interactions of any hydrological and hydraulic system or watershed are complex and elusive. The type of land use and land cover of the area would largely determine the magnitude and extent between upstream and downstream interactions and accordingly the degree of degradation to the environment. Because of these, it is usually difficult to measure the flow field in the river mouth by using the ordinary methods. In this study, Sungai Sengkuang is a re-aligned and straightened channel is under tidal influence. The hydrologic and hydraulic analysis has been carried out for the existing system to investigate whether it is still able to accommodate the volume of water comprises the discharge from upstream and high tide from downstream. The actual data such as rainfall data, velocity, water level, tide level has been collected for the analysis. HEC-HMS is used to carry out the hydrologic model calibration and validation. By using HEC-RAS, hydraulic model calibration and validation is carried out for the channel. The discharge from flow simulation and tide level from frequency analysis with different ARI are used as the upstream and downstream boundary condition during the steady flow analysis. The result show that the existing channel is still able to accommodate the flow from upstream and downstream but the cross section of channel needs to be improving because of inadequate freeboard. From the Energy Grade Line of the channel, it can be concluded that the energy from downstream is more dominant than the energy from upstream.

ABSTRAK

Kajian hidraulik di kawasan muara sungai yang mengalami kesan gangguan air pasang surut kadangkala agak berbeza dengan kawasan yang tidak mengalami kejadian tersebut. Interaksi di antara hulu sungai dan hiliran dalam konteks sistem hidrologi dan hidraulik atau titik perubahan adalah kompleks dan elusif. Biasanya, jenis guna tanah dan litupan tanah di kawasan tersebut yang akan menentukan magnitud dan takat interaksi antara huluan dan hiliran. Lantaran itu, biasanya adalah sukar untuk mengukur aliran permukaan yang menuruni ke muara sungai yang mengalami kesan air pasang dengan menggunakan kaedah-kaedah biasa. Dalam kajian ini, Sungai Sengkuang telah dijajar dan diluruskan untuk memenuhi kehendak pembangunan dan disamping itu mengalami kesan pasang surut dari hiliran. Dalam kajian lepas, didapati kawasan di sekitar Sungai Sengkuang telah mengalami banjir akibat daripada pembinaan pembentung sementara di CH 600 kesan air balik yang berpunca daripada air pasang di hiliran. Maka dalam kajian ini, analisis hidrologi dan hidraulik dengan menggunakan HEC-HMS dan HEC-RAS telah dibina untuk mengkaji samada Sungai Sengkuang masih dapat menampung kadaralir dari hulu dan hiliran sungai selepas pembentung sementara dikeluarkan. Data dari kawasan kajian seperti data hujan, halaju, paras air, aras air pasang surut telah dikutip untuk dianalisis. Hasil kajian menunjukkan bahawa saluran yang sedia ada masih mampu untuk menampung kadaralir dari hulu dan hilir sungai. Bagaimanapun untuk memenuhi piawaian ruang bebas (freeboard) bagi saluran terbuka, keratan rentas saluran yang baru telah dicadangkan bersama dengan ban untuk menampung aliran sehingga 100 ARI. Dari analisis Garis Cerun Tenaga saluran pula, ia dapat disimpulkan bahawa tenaga daripada hiliran adalah lebih berpengaruh daripada tenaga dari air larian permukaan.

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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)
RL	-	Reduced level (m)
LSD	-	Land Survey Datum (m)
R	-	Storage Coefficient
y_c	-	Critical depth
y_o	-	Normal depth
S	-	Slope of stream flow path, m/km
E	-	Specific Energy
$V^2/2g$	-	Specific velocity (m)
t_c	-	Time of concentration, hr
Q_{peak}	-	Peak discharge, m^3/s
P	-	Rainfall depth, mm
S_o	-	Slope of channel bed
ARI	-	Average recurrence interval (year)
L	-	Length of flow path catchment divide to outlet (km)
C_d	-	orifice discharge coefficient (0.40 – 0.62)

A_0	-	area of orifice (m^2)
D_o	-	orifice diametre (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
p_a	-	Atmospheric pressure at the water surface
Ω	-	Coriolis parameter
n	-	manning's

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CHAPTER I

INTRODUCTION

1.1 Introduction

Human actions have drastically altered hydro geomorphic processes such as the volume of tidal exchange, extent of area under tidal influence, speed of tidal currents, amount of sediment in the main channel, and inputs of freshwater and sediment from the watershed. As a consequence, the distribution of tidal habitat types has changed dramatically over the past century.

> Floods also become the most severe hazard in Malaysia, a country that experiencing a wet equatorial climate with heavy seasonal monsoon rains in the period of November to February. Recently, it is reported that flood had occur in Sungai Damansara. Two hours of unusually heavy rainfall since 3:30am on Sunday 26 Feb 2006 has resulted in Sungai Damansara overflowing its banks and waters flooded 3,000 houses in Shah Alam. 9,015 people were evacuated. In many places, flood water hovered around 1m high. It rose to about 2.3m in a few areas, almost reaching the roof of single storey houses. (The Star, 27 Feb 2006)

Flood frequently occurred in our country since few years ago. The flood problem is more serious especially at the downstream part of the channel which having a low topographic profile. The condition becomes worse if the existing channel is under influence tide. Flood might occur at upstream part of the channel due to the creation of back water from tide. Therefore, the impacts of urbanization to the surrounding area need to be studied in order to avoid any flood problem.

Figure 1.1 : Sungai Damansara overflowing its banks and waters flooded 3, 000 houses in Shah Alam, Selangor.


BANJIR akibat kenaikan air laut yang tiba-tiba mengakibatkan kesesakan lalu lintas yang teruk di sepanjang jejantas di Pelabuhan Klang, semalam.

Penduduk kelam-kabut dilanda air pasang

Figure 1.2: Flood occur due to the creation of back water from tide at Pelabuhan Klang, Selangor.

Mathematical models have been developed to resolve many problems for water profile evaluation. A mathematical model consists of a set of differential equations that are known to govern the flow of surface water. Usually, the assumptions necessary to solve a mathematical model analytical are fairly restrictive. To deal with more realistic situations, it is usually necessary to solve the mathematical model approximately using numerical technique.

Figure 1.3: Flooded area at Shah Alam, Selangor due to high tide.

1.2 Problem Statement

Sungai Sengkuang is situated in the Mukim of Plentong, Johor Bahru District, Johor Darul Takzim. Surface water runoff flow from the catchment area to Sungai Sengkuang and it act as the main water channel of the cathment. There was a low lying, swampy area before it was developed into the housing area today. The Sungai Sengkuang with the catchment area of 4 km^2 is a tributary of the Tebrau River and drains portions of the heavily populated of Kg Bakar Batu areas. The area affected by

flood lies along the downstream portion of the river and also influenced by tide fluctuation. Due to the development and urbanization process, Sungai Sengkuang which is under the influence of tide has been straightened up started from CH 0 at the downstream to CH 1350 at upstream.

After straightening up the channel and reclamation work done, the water level of the channel becomes drastically higher than before. The condition of the channel becomes worse when a temporary culvert had been built at CH 600 of Sungai Sengkuang as a temporary access to the left hand side of the channel. According to the previous analysis to the channel, the temporary culvert had brought significant effect to the flow of channel and causes flooding to the nearby residential area. When the flow of the channel comes across the high tide from the downstream, back water will be created. From the previous analysis, the backwater reaches 1000 m from the discharge point. Flood occurred because the channel cannot accommodate the volume of back water due to the tide and the insufficient design of temporary culvert. After removing the temporary culvert, the flood problem seems to be reduced. But the capacity of the existing channel is still have not been determined whether able to accommodate the flow from upstream and downstream. Therefore, hydraulic and hydrology model analysis will be carry out in order to determine whether flood will occur or not.

1.3 Objectives

The objectives of the study are as follows:

i. To investigate the hydraulic characteristic of channel that experiences flood problem due to heavy rainfall and tide influence. The energy line along the channel reach shall be evaluated to determine the dominant energy from either upstream boundary condition or downstream boundary condition. Therefore, this study is conducted to investigate the optimum channel geometry.

1.4 Scope of Study

To carry out the hydraulic and hydrology model analysis, the scopes of study are as stated below:

i. Delineation of catchment's boundary and schematization of channel section of the study area.
ii. Data collection that include rainfall, stream flow, water level and tide fluctuation in order to evaluate the fundamental understanding of hydraulic and hydrologic principles.
iii. Hydraulic and hydrologic model calibration.
iv. Evaluate the causes of flood in terms of hydraulic principles.
v. Evaluate and analyze channel hydraulic characteristics for the system under tidal influence.