Faculty of Engineering

MODELING OPERATION OF FLOOD DIVERSION BARRAGE IN CONJUNCTION WITH KUCHING BARRAGE FOR FLOOD MITIGATION

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MODELING OPERATION OF FLOOD DIVERSION BARRAGE IN CONJUNCTION WITH KUCHING BARRAGE FOR FLOOD MITIGATION

JONG SWEE LEK

This subject is submitted in partial fulfillment of

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Dedicate To My Beloved Family And Friends

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ABSTRAK

Sejak 50 tahun yang lepas, Sungai Sarawak telah mengalami beberapa bencana banjir bermula dengan yang berlaku pada tahun 1963, diikuti pada Februari 2003, seterusnya pada Januari 2004 dan yang terbaru pada bulan Januari 2009. Selepas kejadian tersebut, Satu terusan banjir buatan sepanjang 8 km dengan kelebaran dasar 250 m bermula dari Kampong Paroh ke Batang Salak telah dicadangkan untuk menghala keluar air dari Sungai Sarawak daripada mengalir ke kawasan Bandar Raya Kuching. Tujuan utama kajian ini dijalankan ialah untuk mengkaji semula masalah di kawasan-kawasan kerap banjir di sekitar Sungai Sarawak dan untuk menjalankan analisis tentang operasi terusan banjir buatan yang bakal dibina dengan benteng hilir kuching semasa musim banjir. Model Sungai Sarawak telah dihasilkan menggunakan permodelan hidrodinamik 1-Dimensi dengan mengaplikasikan dua perisian kejuruteraan iaitu *InfoWorks River Simulation (RS)* dan juga *GIS* menggunakan data daripada banjir yang berlaku pada Januari 2009 bagi mendapatkan profil banjir di sepanjang Sungai Sarawak. Hasil simulasi menunjukkan bahawa terusan banjir tersebut telah mengurangkan kadar banjir di Sungai Sarawak. Keputusan yang diambil dari kawasan Kuala Maong menunjukkan pengurangan paras air sebanyak 6.5%. Dengan ini, operasi terusan banjir buatan yang bakal dibina dengan benteng hilir kuching berupaya mengurangkan kejadian banjir di sungai Sarawak.

ABSTRACT

Sarawak River had experienced several terrible flood events over the past 50 years, with the worst being in 1963, followed by February 2003, January 2004 and January 2009 flood. After the incident, a flood bypass channel proposed as a flood mitigation measure to reduce the flooding condition along the Sarawak River. The proposed flood bypass channel is 8 km long with 250 m base width man-made channel starting from Kampong Paroh to divert flood waters from Sarawak River away from Kuching city to Batang Salak. The main purpose of this project was to review the flooding problems in flood-prone areas of Sarawak River basin and analysis the operation flood diversion barrage in conjunction with the downstream barrage during the king tidal event. Sarawak River and its floodplains were modeled using one-dimensional hydrodynamic modeling approach, by develop the Wallingford Software model - InfoWorks River Simulation (RS), with the GIS applications, to obtain the flood hydrographs of the river and its floodplains in extreme flooding condition of flood event of 2009. The simulated results of January 2009 flood obtained showed that the operation of flood diversion barrage and downstream barrage had been diverting significant portion of flood waters from Sarawak River. Results taken from Kuala Maong showed a total average water level reduction of 6.5%. It is showed that the operation of flood diversion change in conjunction with downstream barrage be able to reduce the flood condition of Sarawak river.

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A	-	cross sectional flow area
U	-	Average velocity of water
x	-	distance along channel
B	-	water surface width
h	-	depth of water
t	-	time
S_t	-	friction slope
S_e	-	channel bed slope
S_e	-	friction slope/energy slope
S_r	-	bed slope
g	-	gravitational acceleration
km	-	kilometer
mm	-	milimetre
m	-	metre
n	-	Manning's roughness coefficient
P	-	Wetted perimeter
Q	-	Flow
q	-	Lateral inflow per unit length of channel
R	-	Hydraulic radius
S_e	-	Friction slope
S_r	-	Channel bed slope
t	-	Time

H	-	water surface elevation above datum (m)
ß	-	momentum correction coefficient
g	-	gravitational acceleration (m/s2)
α	-	angle of inflow
K	-	channel conveyance
K2	-	A2 R4/3 / n2

LIST OF ABBREVIATION

DID	-	Department of Drainage and Irrigation
DTM	-	Digital terrain Model
ESRI	-	Envinronmental Systems Research Institute
LSD	-	Land Survey Datum
GIS	-	Geographical information system
RS	-	River Simulation
TIN	-	Triangulated Irregular Network

CHAPTER 1

INTRODUCTION

1.1 Historical background

1.1.1 Sarawak River

Sarawak River is the important river in Kuching which play roles such as it is important source of water and transportation for the inhabitants in southwestern Sarawak. Total Length of Sarawak River is 120km long and the Sarawak River Basin Area is 2459 km^2.and its exits are toward the South China Sea. According to the Sarawak topography map, there were two major tributaries in Sarawak River which are Sarawak Kanan River and Sarawak Kiri River. From the topography, the two tributaries meet at the Batu Kitang area. Sarawak River (Sg. Sarawak) flows through the City of Kuching dividing it approximately into two equal halves (figure 1.1). Kuching City is located in tidal influence zone with a tidal range of approximately 6 meters. Sarawak river average annual rainfall of 3830mm and the total annual surface water runoff is about 306 billion cubic metres (m^3).

1.1.2 Flood problem in Sarawak River

The topography of the Sarawak state is the main cause of flood problems occurred in Sarawak River. The topography of Sarawak is the high grounds in the interior along a northest-southwest direction bordering with Kalimantan Indonesia. The river courses are relatively short with steep gradients in upper stretches and comparatively flat and meandering stretches in the lower reaches. Flood flows are passing in upper reaches but increase in duration and intensity towards the plain area. Bulk of population is concentrated in towns and villages in river valleys and coastal plains and hence prone to flood damages. Thus, the flooding phenomena is typically occurs in town area which is coastal plain.

The construction of Sarawak River Barrage in 1998(figure 1.2), the most significant flood events in the history of Sarawak occurred in January and February 1963. During this period, the state experienced an abnormal heavy rainfall, recorded as 2500mm for the two months. Spring tides from the sea coincided with heavy precipitation from the upstream catchments. Therefore the excess of runoff had given rise to the water levels and causing the low-lying areas to be flooded, as high as 7 meters. Even after the barrage is in operation, hitherto major flood events still occur although in a minor magnitude. Examples are the flood events in February 2003 and January 2004 which saw a rise in the water levels, up to 3 meters. These issues still affects citizens who stay around the floodplain area such as Maong River where still facing flood during the wet season.

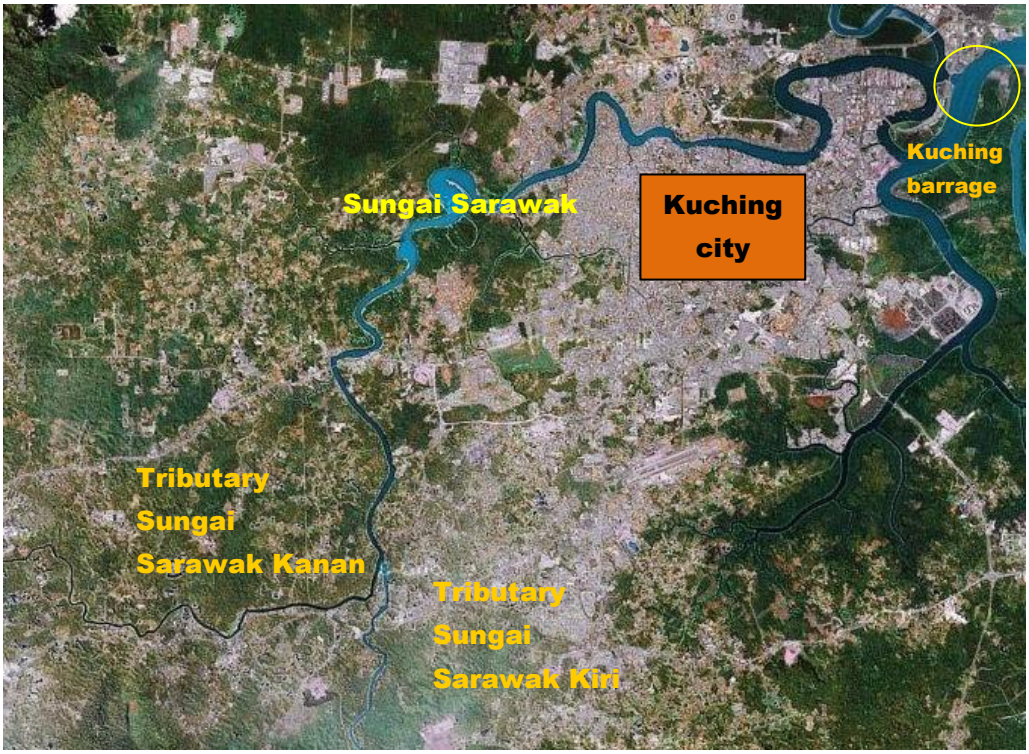

Figure1.1: Sungai Sarawak river basin (http://maps.google.com)

Figure 1.2: Kuching barrage and ship lock (http://www.cmsb.com.my)

1.2 Introduction of Diversion Channel

Diversion channels are constructed to divert waters from the main channel for purposes such as flood control, municipal and water supply. A type of diversion channel used for flood control is a flood by pass channel or called floodway. It is a separate channel into which flood waters are directly to lessen the impact of flooding on the main river system. The control structures maybe located at the head of the diversion channel to divert flows during period of high water and return flows during low water. Diversion channels are often used in urban areas where it is not possible to widen the existing channel due to development. Diversion channels may be used to provide a means of diverting flood water across the neck of a meander or series of meanders (Acheson, 1968).

Major design consideration for diversion channels include:

(a) Determinacy if the channel should convey partial or all flows

(b) Design of appropriate controls and sizing of the channel to convey the design discharge.

(c) Design to reduce maintenance

1.3 Objectives

In order to prevent the flooding problem in Sarawak river area, the main objectives is to studies the flood mitigation option by using the by-pass channel during the high tidal event. The operation of this by-pass channel with the Kuching barrage will definitely affect the flood phenomena in the Sarawak River. The by-pass channel will operate during the high tides from the South China Sea and also during the heavy rain season especially January. The main objective is to studies modeling operation of the Flood diversion barrage in conjunction with the existing Kuching barrage during the heavy rain season o f Sarawak River.

1.4 Scope of work

The Inforworks River Stimulation(RS) version 9.0, a Wallingford software model will be applied to studies of the by-pass channel as an alternative way to prevent the flood occurs in the kuching town area especially to the batu tiga, batu kawa, and matang area. Inserting flood events data the software and run the river stimulation for the by-pass channel together in conjunction with the kuching barrage during the high tides events.

CHAPTER 2

LITERATURE REVIEW

2.1 Flooding

A flood is an overflow or accumulation of an expanse of water that submerges land. In the sense of "flowing water", the word may also be applied to the inflow of the tide. Flooding is the primary hazard that occurred in all over the universe especially to our country. This may result from the volume of water within a body of water, such as a river or lake, which overflows or breaks levees, with the result that some of the water escapes its normal boundaries. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, it is not a significant flood unless such escapes of water endanger land areas used by man like a village, city or other inhabited area.

In the case, the kuching city experience where the city area is situated in the middle of the river and the sea, the flood will occurred when the high tide phenomena happen and it will causing the surrounding area where the river is not be able to carry the huge amount of water flows and the water will overflowing its bank.