

**PHYSICAL FLOOD MODELLING EVALUATION
OF RIVER MEANDERING CHANNEL IN
TIDAL EFFECTED REACH**

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ABSTRACT

Flood is one of the disasters in this country where around 29,000 km² or 9% of the country was exposed to it. Understanding the flood phenomena along the river and flood plain would be able to help in the assessment of the impact of human activity in the river basin. Modelling of river and flood plain will form as a basis for this understanding. The objectives of this study are to develop a physical model of river meandering channel in tidal affected reach and to assess the flood plain and water level for various flow under existing conditions and flood mitigation measures using cut off system. Scope of this study includes the development of physical model and the assessment of flood plain and water level. It includes gathering the available data and construction of physical model for parts of Selangor River at NAHRIM laboratory. The model was tested for different flows with various conditions. In the first part, the test was carried out at low water, mean sea and high water for existing alignment. In the second part of the study, cut off was introduced at one stretch of the channel section and similar test cases were carried out. Readings for velocity and water levels were taken at eight stations along the river channel and another eight locations in the flood plain area. The results of the experiments shows that the water levels increases as the flow increases and causes the flood. The recorded velocity was inconsistent and fluctuates but reduces in value as the flow increases. The introduction of cut off to the channel reduces the water levels and proved to be effective to solve flood problem on meandering rivers to certain discharge. The experiment also shows flood does not occur near the rivermouth under all conditions.

ABSTRAK

Banjir merupakan salah satu masalah di negara ini di mana 29,000 km² atau 9% dari keluasan negara terdedah kepadanya. Memahami fenomena banjir di sepanjang sungai dan dataran banjir membolehkan penilaian kepada kesan aktiviti manusia di lembangan sungai. Pemodelan sungai dan dataran banjir merupakan asas kepada pemahaman ini. Objektif kajian adalah untuk membina model fizikal sungai berlaku di kawasan yang di pengaruhi air pasang surut dan menilai dataran banjir dan aras air dengan kuantiti luahan yang berbeza dalam keadaan asal dan likuan sungai sebagai langkah tebatan banjir. Skop kajian merangkumi pengumpulan data, pembinaan model fizikal bagi sebahagian Sungai Selangor di Makmal NAHRIM. Model ini diuji dalam keadaan yang berbeza dengan nilai luahan yang berlainan. Bahagian pertama, ujian dijalankan pada aras air rendah, aras air minima dan aras air tinggi untuk keadaan asal. Pada bahagian kedua, ujian dijalankan dalam situasi yang sama seperti bahagian pertama tetapi satu potongan dibuat kepada liku sungai. Lapan bacaan untuk halaju dan aras air diambil dalam alur sungai dan dataran banjir. Keputusan ujian menunjukkan aras air bertambah seiring dengan kuantiti luahan seterusnya menyebabkan banjir. Bagi nilai halaju ianya tidak konsisten dan berubah-ubah namun halaju berkurangan apabila nilai luahan bertambah. Potongan kepada liku sungai telah mengurangkan aras air dan mungkin menjadi kaedah penyelesaian kepada masalah banjir yang berkesan pada nilai luahan yang tertentu. Hasil kajian juga menunjukkan banjir tidak berlaku di kawasan berhampiran muara dalam semua keadaan kajian.

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CHAPTER I

INTRODUCTION

1.1 Introduction

River is a gift from God to mankind. All land is part of river basin and all is shaped by the water it flows over it and through it. Rivers derive their water from precipitation, in the form of rain either directly from surface runoff, or indirectly from springs and marshes. The roles of rivers are very wide to the earth and its mankind. It has played an important role in the economic, social, cultural and religious life of people.

The main function of river is as a source of water supply to the lives on the planet earth. It is also serve as a source of food, transportation and irrigation. The great milestones of human history took place by the banks of rivers. The first civilizations emerged in the third millennium B.C. along the Euphrates, Tigris, Nile and Indus, and a little later along the Yellow. In Malaysia, it can be clearly observed that the main townships and early settlements are located either at the river banks or estuaries. The Kampong Laut Mosque which is more than 400 year old was founded at the banks of Kelantan River is another evidence of early settlement by the rivers.

Water flows through the river is a blessing as long as it maintains within the banks. Problems only arise when water overflows the banks and encroaches into the river basins.

In the United States only 5% of the total land area are flood plains and coastlines but are inhabited by 25% of its populations (Krimm, 1996). In Malaysia, the estimated area exposed to the flood disaster is estimated around 29,000 km² or 9% of the entire country which affects 2.7 million people or approximately 15% of the total population of Malaysia (Hiew, 1996).

Flood is one of the main disasters in this country. Major floods recorded are in 1926, 1931, 1947, 1957, 1967, 1971, 1973, 1979, 1983, 1995, 1998, 2003 and 2005 (Abdullah, 2006) and most recently in December 2006 and January 2007 which occurred in Johor. The January 1971 flood that hit Kuala Lumpur and many other states had resulted in a loss of more than RM 200 million then and the death of 61 persons. In fact, during the recent Johor 2006-2007 flood due to a couple of “abnormally” heavy rainfall events which caused massive floods, the estimated total cost of these flood disasters is RM 1.5 billion, considered as the most costly flood events in Malaysian history. In the United States, Federal Emergency Management Agency (FEMA) spends 1 billion USD for the flood mapping (Krimm, 1996).

Flood can be categorized as:

- Flash flood (very high intensity rain at very short period)
- Monsoon flood (prolong rain during monsoon season)
- Coastal flood (Due to High Tide effect)

In facing the flood problem in tidal affected reach, construction of tidal control gates are commonly being used. In London, Thames Barrier which was built in 1982 is one of the approaches in controlling flood due to spring tide. Whilst in Malaysia, the construction of barrage in some of the rivers such as Sg. Muda, Sg. Kerian and Sg. Besut is to control the effect of high tide.

However, it is crucial to have a clear understanding of the overall effect of this type of structure as a solution to flood problems in order to provide the best solution to the problems along the rivers.

Basically flood can occur at any reach of a river due to different factors. In the upstream area it usually caused by the discharge which exceed bankfull flow and that discharge cannot be sustained by river cross section and river bed. Whereas flood occur in estuary area is caused by the tidal influences. However, at the middle stretch of the open channel the occurrence of flood is more complex to explain because of the combination of both factors.

Presently there are still lack of research on open channel hydraulics under the tidal influence, one of the main reasons is the limited data available such as water level and flow along the river bed. The difficulty to produce rating curve in the tidal influence area also influence the calibration process. Therefore, only one value is normally used in hydraulic analysis, such as highest spring tide which will result in very high water level and is inaccurate.

1.2 Importance of Study

Modelling of river and flood plain are required as a basis for the understanding of flood phenomena along the river and flood plain. Understanding of this phenomena would be able to help in the assessment of the impact of human activity in the river basin. Outcome of this study may also be benefited in the process of reducing the damages to the properties and lost of life as well as safe guarding the environment due to flood.

The understanding of flood behaviour especially in tidal influence areas still requires a thorough study. Results from this research will also be able to benefit in

the effort to overcome flood problem in tidal influence areas and thus shall produce a more accurate design.

This research is expected to be able to help the relevant implementation agencies responsible to river and river basin management to apply more efficient approach for the purpose of analysing and producing the best design practise in overcoming flood problems.

1.3 Objectives of the Study

The objectives of the study can be describe as follows:

- To develop a physical model of river meandering channel in tidal effected reach.
- To assess the flood plain and water level for various flow under existing conditions and flood mitigation measures for cut off system in tidal effected reach.

1.4 Scopes of the Study

The scopes of the study includes develop a physical model using the data gathered for sections of Selangor River at National Hydraulic Research Institute of Malaysia Physical Laboratory. Development of physical model including choosing the model scale for construction, evaluating and setting up the instruments and construction of physical model.

Run the physical model experiment covering flow from low to high under fixed water level at low tide, mean sea level and high tide and flows in tidal effected reach. Two phase of experiment were carried out, firstly the test was carried out at fixed low water, mean sea and high water and with tidal effect simulated by the computer controlled tidal gate. In the second part of the study, cut off was intruduce at one stretch of the channel section and test cases similar to first part was carried out. Readings for velocity and water levels were taken at 8 stations along the river channel and another 8 locations in the flood plain area.

1.5 Problem Statement

Water flows through the river is a bless as long as it maintain within the banks. Problems only arise when flows overflow the banks and encroach into the river basins. Flood is one of the main disasters in this country it basically occurs at any reach of a river due to different factors. In the upstream area it usually caused by the discharge which exceed bankfull flow and that discharge cannot be sustained by river cross section and river bed. Whereas flood occur in estuary area is caused by the tidal influences. However, at the middle stretch of the open channel the occurence of flood is more complex to explain because of the combination of both factors. Flow scenarios changes when water overflow the bank into the flood plain. Flows in the flood plain will change drastically to various types such as from subcritical to supercritical or vice versa or calm condition. The water also flow in various directions to find the lowest level. The flow in flood plain will contribute or give a great impact to the overall flood behaviour in aspect of maximum flow or volume and thus directly influence the water level. Chow et. al. (1988) listed a few difficulties in the analysis of flood plain. They are the major changes in obstacles, river cross sections and flood plain. Cross (short cut) flow within the river meandering, bank overflow of flood water to the sides causes the reduction of waves and changes in flow time between flood plain and main channel. The present lack of research on open channel hydraulics under at tidal effected reach mainly due to the

limited data available such as water level and flow along the river bed and the difficulty to produce rating curve in this area which influence the calibration process.

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