DIGITAL MODELING EVALUATION ON TIDAL EFFECT OF THE GALING RIVER.

AMIRUL JUWAIDY BIN OMAR

A thesis submitted in fulfillment of the
requirements for the award of the degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering & Earth Resources
Universiti Malaysia PAHANG

NOVEMBER, 2010

ABSTRACT

Galing River has been spotted by the Drainage and Irrigation of Department of Pahang as one of the high potential area to be effected by flood. This river was chosen by the state government for the "1 State 1 River" program. 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 bank full flow and that discharge cannot be sustained by river cross section and river bed. Whereas flood occurs in estuary area is caused by the tidal influences. Analysis of the Galing River was conducted using the InfoWorks RS (river simulation) program software. The analysis is based on the rainfall and tidal data taken from the Drainage and Irrigation of Department for Kuantan area and the cross section of the river. Scope of this study included the location area, data input for each event and water level simulation of the river. The simulation were analysed in three conditions. In the first analysis, the simulation is carried out at high and low tidal. In the second analysis, the simulation is carried out at high tidal with 50 ARI and 100 ARI rainfall events. In the third analysis, the simulation was carried out at high tidal with existing bridge. The results of the simulation showed that flood occured at the downstream of the river during high tidal. The recorded data at each chainage showed that the water levels increase as the flow increases.

ABSTRAK

Sungai Galing telah dikenal pasti sebagai sungai yg berisiko tinggi untuk mengalami masalah banjir oleh Jabatan Pengairan dan Saliran Negeri Pahang (JPS). Sungai ini juga telah dipilih oleh kerajaan negeri untuk program "Satu Negeri Satu Sungai" yang telah dijalankan di seluruh Malaysia. Banjir merupakan salah satu bencana utama di negara kita dan bencana ini seringkali terjadi pada setiap bahagian sungai disebabkan oleh faktor-faktor yang berbeza. Pada bahagian hulu sungai, bencana banjir selalu terjadi disebabkan oleh limpahan air yang terlalu besar sehingga melebihi kapasiti sungai. Manakala pada bahagian hilir dan muara pula adalah disebabkan oleh kejadian pasang surut laut. Permodelan Sungai Galing dianalisa menggunakan aplikasi perisian InfoWorks RS. Analisa dijalankan berdasarkan maklumat data hujan dan pasang surut air laut yang diambil dari JPS dan Angkatan Tentera Laut Diraja. Skop kajian merangkumi lokasi sungai, data maklumat dan simulasi aras air sungai. Analisa sungai dikaji berdasarkan tiga keadaan yang berbeza. Analisis yang pertama melibatkan permodelan sungai ketika aras laut pasang dan ketika aras laut surut. Analisis yang kedua melibatkan permodelan sungai ketika aras laut pasang untuk purata kelebatan hujan selama 50 tahun dan purata kelebatan hujan selama 100 tahun. Analisis yang ketiga pula melibatkan permodelan sungai ketika aras laut pasang serta kewujudan jambatan sungai yang asal. Keputusan simulasi permodelan sungai menunjukkan banjir berlaku pada kawasan hilir sungai ketika kejadian air laut pasang. Hasil daripada pemerhatian data yang direkodkan pada setiap rantai keratan rentas sungai menunjukkan aras air sungai bertambah seiring dengan air limpahan.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

NO	ABBREVIATION	
1	**DID**	Department of Irrigation and Drainage
2	**MPK**	Kuantan Municipal Council
3	**DSM**	Department of Survey and Mapping
4	**MACRES**	Department of Remote Sensing Malaysia
5	**DOA**	Department of Agriculture
6	**GIS**	Geographic Information System
7	**CN**	Curve Number
8	**1-D**	One Dimensional
9	**2-D**	Two Dimensional
10	**3-D**	Three Dimensional
11	**MSMA**	Manual Saliran Mesra Alam
12	**ARI**	Average Reoccurrences Intensity
13	**CH**	Chainage
14	**Q**	Flow Rate of Water (m^3/s)
15	t_c	Time of Concentration
16	F_c	Conversion Factor
17	**L**	Length of Flow Path from Catchment devided to outlet (km)
18	**A**	Area of the Catchment
19	**S**	Slope of Stream Flow
20	**I**	Rainfall Intensity (mm/hr)
21	**P**	Rainfall Depth (mm)
22	$^{R}I_t$	Average Rainfall Intensity for ARI
23	**t**	Duration, time (hr, min, sec)
24	**a, b, c, d**	Fitting Constant from IDF curve

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Introduction

Kuantan River is the main river that flow in the middle of Kuantan town. Its runs from Lembing River through Kuantan city before flowing out to South China Sea. Galing River is one of major contributor to Kuantan River and covers the area from Semambu, Bukit Sekilau and flowing out to Kuantan River at the end of Kampung Tok Keramat.

Galing River has been spotted by the Drainage and Irrigation of Department of Pahang as one of the high potential area to be effected by flood. This river was chosen by the state government for the "1 State 1 River" program. This river also being classified as class IV for its pollution level. This is due to the rapid development in the basin area which is lead to many unfortunate events such as flooding, poor water quality, lack of clean water resources and erosion.

Galing River located near the shore at the east coast of peninsular Malaysia. Similar to the other places within this area, Galing River is also effected by the monsoon season. This area receives a heavy rainfall during the monsoon season at the end of November until December each year. Heavy rainfall causes the increasing of water level at a low ground level surface along Galing river area. Figure 1.1 shown the water level station monitored by the Department of Drainage and Irrigation Kuantan (DID) at Galing River.

Base on the study conducted by the DID, there were three factors that contribute to the flood event:

- Heavy rainfall (monsoon season)
- Tide (due to the location of Galing River which is near to South China Sea)
- River estuary

Analysis of the Galing River was conducted using the InfoWorks RS (river simulation) program software. The analysis was based on the rainfall data taken from the DID for Kuantan area and the cross section of the river. Other geographical factors of the river were also taken into consideration. At the end of the analysis, the best solution in conducting the river management and flood mitigation were produced.

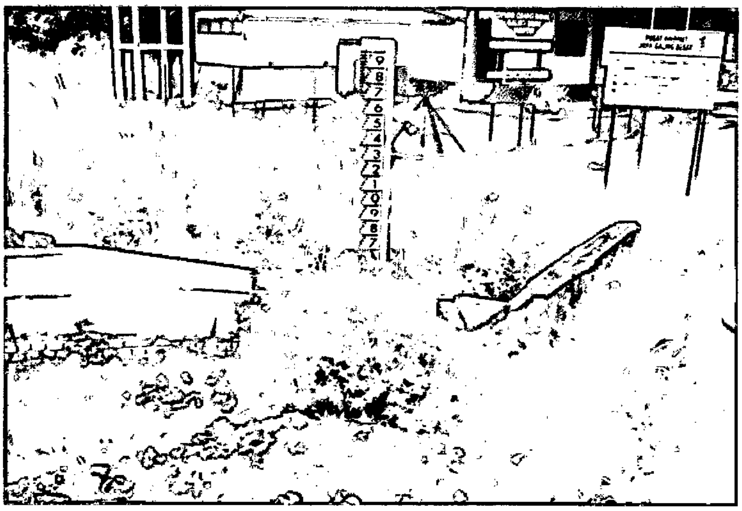

Figure 1.1 Water Level Station

1.2 Project Objectives

The objectives of this study are:

i. To develop a 2 dimensional model of the Galing River using the cross section and the longitudinal section of the river
ii. To investigate the effect of rainfall and tidal to the flow of the river by using river simulation software (InfoWorks RS)
iii. To propose the suitable solution for future development of Galing River.

1.3 Significant of Study

The importance of the study are:

i. The analysis of the Galing river using the real rainfall event can be used for future river construction and mitigation program.
ii. The result will determine the cause of overflow for Galing river.
iii. Designation for flood mitigation can be determined in order to prevent future flooding.

1.4 Scope of the Study

In oder to fulfill the objective of this study, there are three scopes of work that need to be conducted:

I. Location

This study was carried out along the Galing River and at the river bank of Kuantan River. Information about the status of Galing River is being carried out by the DID Kuantan. Interview session with local residents at the area along the Galing River were be conducted to get more information about the recent flood event.

II. Data

All the data required for the study and analysis were from the DID, Malaysian Meteorological Department, Royal Malaysian Navy and Department of Survey and Mapping (JUPEM).

III. Software

The analysis of the river was conducted using a very integrated software solution for simulating flows in rivers, in channels and on floodplains. The InfoWorks RS software is very sophisticated program that allowed planners and engineers to carry out fast and accurate modeling

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 where 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 bank full flow and that discharge cannot be sustained by river cross section and river bed. Whereas flood occurs 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. 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 flows in various directions to find the lowest level. The flow in flood plain will contribute or give a great impact to the overall flood behavior in aspect of maximum flow or volume and thus directly influence the water level. The present lack of research on open channel hydraulics under the influence of tidal may due to the limited data available such as water level and flow along the river bed.

CHAPTER II

LITERATURE REVIEWS

2.1 Introduction

The hydrological analysis had become a must in a development area. One of the main objectives in the hydrological analysis is to make sure that the development does not give any bad influence to the catchment area.

Based on the information given by the Department of Social Welfare (JKM) Pahang state, the total victim from recent flood event in Pahang which is during (the end of 2007 until the early of 2008) was about 4000 people and during (the end of 2008 until the early of 2009) the total of the victim was about 3200 people. From these information, the flood has causes serious damaged to the people and property in Pahang, especially at Kuantan area.

Flood is one in many ways which human population interact with hydrological system. Water is one of the basic needs for human to survive. People need water for drinking, washing and preparing meals every day, farmers need water to plant vegetation, development and industry need water as a raw material and for cooling agent, and river are use as a transportation network and transferring waste to the sea. (Nigel Arnell,2002)

Flooding in Pahang, especially at Kuantan River catchment are generally caused by extreme precipitation during monsoon season, tidal backwater generate from the South China Sea, high initial soil moisture and vegetation at the bottom of the river bases. Politician, the public and journalists have speculated that human activity may also contribute to the severe of flood event in Kuantan river. The activity including rapid development within catchment area, rubbish dumping and domestic waste from commercial areas, housing, village, squatters and other placements, waste poisons or chemicals from industrial and sewage is not treated properly, waste oil from the workshop, waste from wet markets, restaurants and food premises and lastly, the invasion reserves river with many activity contribute to the flooding phenomenon (R. Singh, M.J. Helmers, W.G. Crumpton, D.W. Lemke, 2007).

For the purpose of the study, Galing River which is one of tributaries for Kuantan River were chosen. The river is situated near the river bank of Kuantan River and have a frequent flood event within its area. Figure 2.1 shown the location of the Galing River. The estimate size of the river basin is 22.65km^2 and the length of the river is 7.2 km.(DID). This river also located at the core of development area in Kuantan city. A flood forecasting system may include all or some parts of the following three basic elements: (Yen-Ming Chiang , Kuo-Lin Hsu , Fi-John Chang , Yang Hong ,Soroosh Sorooshian, 2007).

(i) A rainfall forecasting model

(ii) A rainfall-runoff forecasting model

(iii) A flood routing model

The principle cause of flooding in most circumstances is prolonged or inten rainfall. A proportion of the rainfall on a natural catchment will soak into the grou raising the water table whilst the remainder finds its way into the streams and river, c be defined as runoff. Normally, the percentage runoff in a storm will be range of 20% 45% of the incident rainfall but under exceptional circumstances this can rise to 70% more (Peter Pollard, Michael Devlin, David Holloway, 2001). Thus the river flc occurring immediately after a heavy rain will vary according to the recent rainfi pattern and there may not be a direct correspondence between the frequency of tl rainfall and the frequency of the flooding.

Flood takes time to flow along the river with water building up rapidly in tl headwaters of the catchment but slowly in the downstream area. The speed of the flo depend upon the river gradient, the shallower the gradient, the lower speed of the wat For the downstream reaches of a major catchment, the arrival of the flood peak may l takes several days after the rainfall which caused the flood.

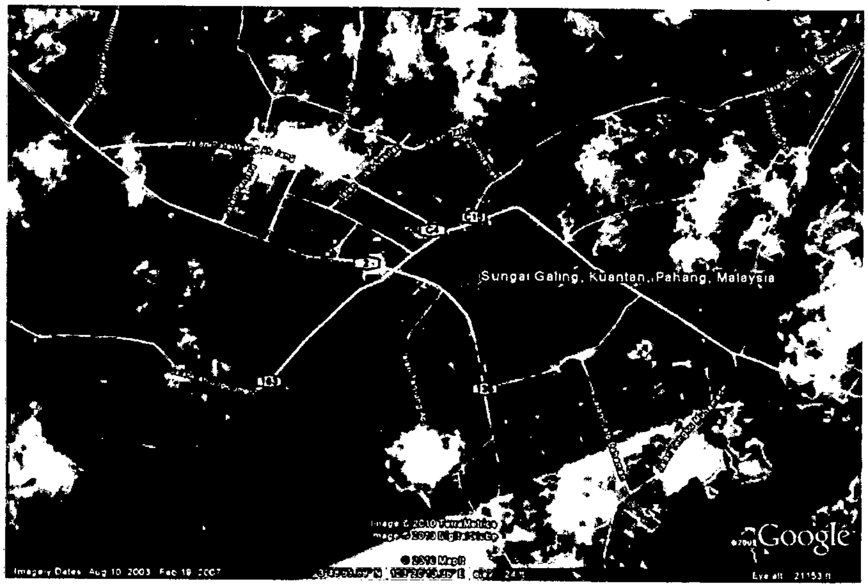

Figure 2.1 The Location of Galing River, Kuantan (Google Earth, 2005)

2.2 Conceptual Study

2.2.1 Hydrological Cycle

Hydrology is an earth science. It is a combination of occurrence, distributio movement, and properties of water. A knowledge on hydrology is the key item i manipulating and making decision in any problem where water involve. (Warre Viessman, Jr, Gary L. Lewis, 2003)

A process where water is driven from the sea to the air to the land and back th sea is call hydrological cycle. As most of the water are in the ocean, it is best to assum that the cycle is started with the ocean. Then, water evaporate at the surface of th ocean. The amount of water evaporate varies, being greatest at near the equator, whe solar radiation is more intense. Evaporated water is pure, because when it is carried o from the ocean, the salt is left behind. The water vapor move to the atmosphere an when the condition is suitable, water droplets is forming. These droplets then fall to th land and becoming precipitation or may revaporize.(C.W Fetter, 2001). Figure 2. shows the hydrologic cycles described in terms of six major elements, precipitatio infiltration, evaporation, transpiration, surface runoff and groundwater flow.

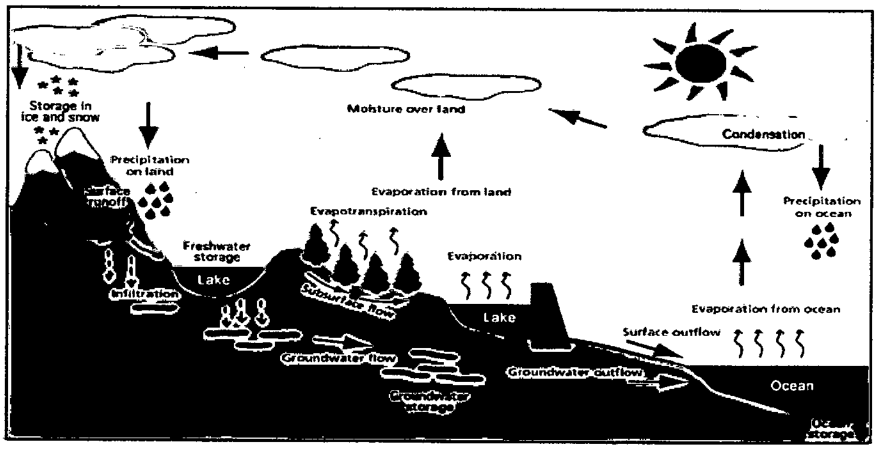

Figure 2.2 The Hydrological Cycle (C.W Fetter, 2001)

2.2.2 Rainfall – runoff Relationship

Rainfall is precipitation consisting of water drops larger than 0.5 mm. It can be classified as light rain when the intensity is smaller than 2.5 mm/h, moderate when it is between 2.5 and 7.5 mm/h, and heavy when it exceeds 7.5 mm/h. (Wilfried Brutsaert,2005)

After raining, the catchment surface area will be flowing with runoff. Runoff is described as a water flow over a surface, where then it will become stream flow when it reaches a defined channel. Rain falling on the watershed in an amount exceeding the soil or vegetation uptake becomes surface runoff. During rainfall, water is continually being absorb by the upper level of the soil after being intercept by vegetation within evaporate at the same time.

Many elements that involve during the rainfall event making it very difficult to predict the amount of runoff that will occur on the area involve. There are many structures that involve in the carrying surface runoff is design basis from the peak runoff. So, the method on predicting the runoff is important to carry out the best simulation and analysis. According to C.W. Fetter, the most simple way on predicting the runoff is by applying the rational equation. This equation assumes that both the rainfall rate and the rate of infiltration are constant. The rational method is very suitable when used in analysis of small drainage basin of 200 ac (100 ha) or less. The equation is

$$\boxed{Q = CIA}$$

Where,

Q = Peak runoff rate (L^3/T; ft^3/s or m^3/s)

I = Average rainfall intensity (L/T; ft/s or m/s)

A = Drainage area (L^2; ft^2 or m^2)

C = Runoff coefficient

Table 2.1 Runoff Factor for Rational equation (DID).

Description of Area	C
Business	
Downtown	0.70-0.95
Neighborhood	0.50-0.70
Residential	
Single-family	0.30-0.50
Multiunits, detached	0.40-0.60
Multiunits, attached	0.60-0.75
Residential suburban	0.25-0.40
Apartment	0.50-0.70
Industrial	
Light	0.50-0.80
Heavy	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard	0.20-0.35
Unimproved	0.10-0.30
Character of surface	
Pavement	
Asphalt and concrete	0.70-0.95
Bricks	0.70-0.85
Roof	0.75-0.95
Lawns, sandy soil	
Flat, up to 2% grade	0.05-0.10
Average, 2%-7% grade	0.10-0.15
Steep, over 7%	0.15-0.20
Lawns, heavy soil	
Flat, up to 2% grade	0.13-0.17
Average, 2%-7% grade	0.18-0.22
Steep, over 7%	0.25-0.35

Table 2.1 depicted the list of C value for different rate of infiltration. For each type of land for the area, a range of the value of C is given. The lower number is used for storms of a low intensity, storms with greater intensity will have proportionally more runoff, justifying the use of a higher C factor. (DID)