FLOOD ESTIMATION AND RIVER ANALYSIS OF SUNGAI ISAP, KUANTAN

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ABSTRACT

The purpose of this paper was to expose the people about the flood occurrences in Kuantan in the past few years and to analyse the rainfall and river cross section data to estimate the next flood event as well as studying the river behaviours and properties. This study was carried out due to the flood event that occurred in the Kuantan city during the monsoon period. Heavy rainfall occurres every year and often causes flooding problem in Kuantan city due to the overflow from Sungai Lembing and Kampung Panching. Although flood is difficult to avoid, we still can forecast the flood and take some precautions. Infoworks ™ by Wallingford Software was used in order to estimate the flood events by analysing the design rainfall produced from actual rainfall data for the past few years (2009) during September to March which acquired from Department of Irrigation Drainage (DID) and the current river cross-section data, which acquired from private company, site survey and Google Earth. This study gave the results of flood occurrence on 100 years ARI and the suitable solution was proposed.

ABSTRAK

Kajian kertas kerja ini adalah bertujuan untuk mendedahkan pada orang ramai mengenai kejadian-kejadian banjir yang melanda negeri Pahang terutamanya di Kuantan pada beberapa tahun yang lepas dan juga untuk menganalisa hujan dan keratan rentas sungai bagi tujuan menganggar kejadian banjir di masa akan datang disamping mempelajari sifat-sifat dan ciri-ciri sungai itu sendiri. Kajian ini telah dijalankan kerana masalah banjir yang berlaku di Kuantan pada musim tengkujuh beberapa tahun yang lepas. Hujan lebat yang turun mencurah-curah pada setiap tahun dan limpahan air sungai dari Sungai Lembing dan Kampung Panching biasanya dikaitkan dengan kejadian banjir di Kuantan. Walaupun banjir amatlah sukar untuk di elakkan, ianya masih boleh di ramal dan kita seharusnya akan menjadi lebih bersedia dalam mengambil langkah-langkah peringatan sebelum menghadapi banjir. Perisian Infoworks ™ oleh Wallingford Software telah digunakan bagi tujuan simulasi sungai untuk meramal kejadian banjir dengan cara menganalisi data hujan rekaan berdasarkan data hujan sebenar bagi tempoh kritikal dalam tahun 2009 yang diperoleh daripada Jabatan Pengairan dan Saliran (JPS) dan juga menganalisa bentuk keratan rentas sungai terkini yang diperoleh daripada syarikat persendirian, kerja lapangan dan juga perisian Google Earth. Kajian ini menunjukkan kejadian banjir berlaku pada ulangan 100 tahun dan penyelesaian yang sesuai telah dicadangkan untuk kemudahan masa hadapan.

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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

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CHAPTER I

INTRODUCTION

1.1 Introduction

Flood is an overflow or an accumulation of an expense of water that submerges land. It is also can be refer to the inflow of the tide or the backflow of the river; which occurs at the location where the rivers meet. From a geological perspective, floods are natural consequences of stream flow in a continually changing environment. The streams receive most of their water input from precipitation and the amount that falling in drainage basin varies from day to day. Based on the role of precipitation, the amount and time which precipitation takes places is not constant for any given area. Overall, the water cycle is a balanced system and the reason for the flood to occur is a large amount of precipitation, causing the river/ basin to overflow due to not efficient cross section of the river itself. As the amount of water is increase, the stream must adjust its velocity and cross section in order to form a balance. The discharge increase as more water is added through rainfall, tributary streams, or from the groundwater seeping into the stream resulting in floods due to increase of width, depth and velocity of streams (Ismail, DID).

Most town in Pahang state received heavy rainfall in monsoon period which results in flood in low area especially near the flood plain area. Heavy rainfall in such high area (Sungai Lembing and Kampung Panching) results in increasing water level in the river below their level such as Sg. Isap and Sg. Kuantan. According to the report released by Department of Irrigation and Drainage (DID) Pahang, the factors that affecting this phenomenon are heavy rainfall in Sungai Kuantan valley along with heavy tides and the shallow section of Kuantan's river estuary and poor drainage systems.

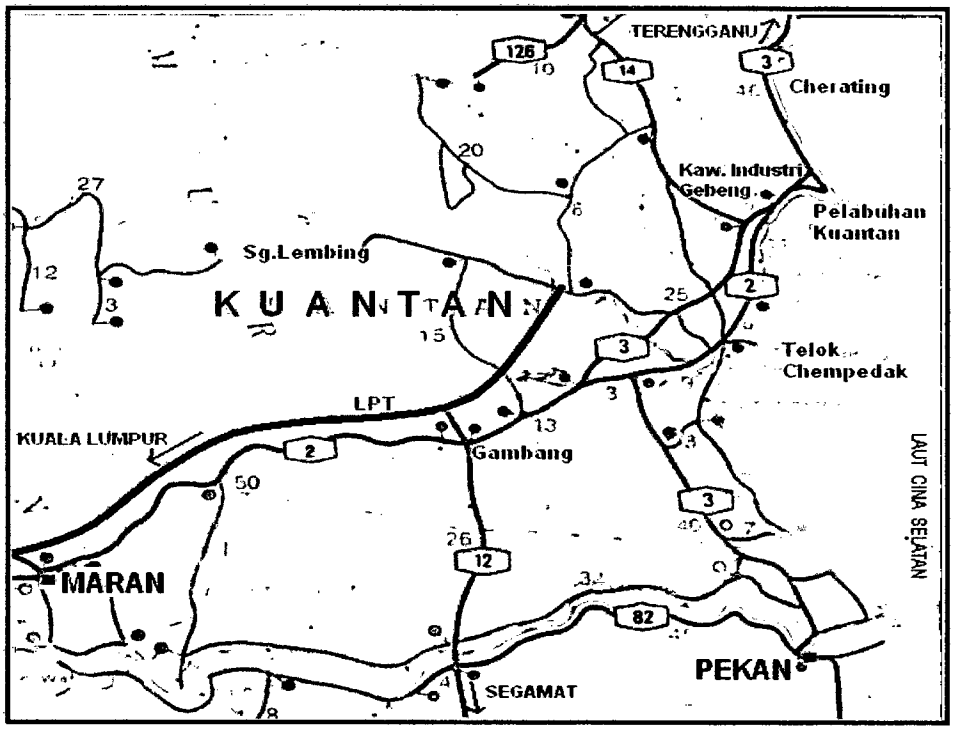

Figure 1.1 Location of Kuantan Towns (Google Maps)

The location of Kuantan town (Figure 1.1) which is surrounded by several rivers and their tributaries make the town widely open to the flood event in addition with the factors mentioned above. In addition with shallowness of the Kuantan River valley due to the sedimentation from various human activities resulting in the capability of river to hold the huge amount of water is low, hence, causing the flood occurrence.

1.2 Problems Statement

Kuantan, the capital city of Pahang state is located in the east of Malaysia, known as 'gateway to east coast', is a fast growing commercial city in the east coast of peninsular Malaysia with the population of more than 400 000 peoples. However, since its location is in the centre among Sungai Lembing, Sungai Isap, and the estuary of Kuantan river, the Kuantan city is clearly exposed to the worst world disaster; flood. For the past few years, Kuantan has faced with a worst flood which results in evil destruction and loses. The Municipal Council of Kuantan (MPK) have carried out many solutions to cope with this problem especially to the famous area such as Sungai Isap including the construction of embankment and a man made lake as a catchment during heavy rainfall or monsoon period but the scenario became even worst from year to year (Mat Ropi, MPK).

Every year during the monsoon periods (September- February), Kuantan town encountered a flood that can be predicted. The heavy rainfall causes the low area to be flooded. Normally, the flood reached two metres and the worst was recorded in 2001 (approaching four metres). When the flood stroke, residential area in Kuantan town suffers from lack of food and human resources and after the flood disappears, this town is covered with mud and waste. This phenomenon has become a norm every year (Mat Ropi, MPK).

The main factors that cause the authorities failed to give a warning to the residents are lack of flood estimation equipment and data regarding previous flood and river channel. The residents cannot make a connection of the water level from the river's valley with the flood level that will occur. Thus the early warning that have been released is useless without knowledge (Arkib Berita Harian).

The DID, has come out with several methods to cope with this problem including installation of device that can give an early warning such as sign board and siren. In addition, online flood warning system also has been set up. Flood mitigation project is also under construction at Sungai Isap (Ismail, DID).

1.3 Objectives

In order to make this study successful, three objectives have been determined. It works as a guide line so that the outcomes of this study can be easily achieved. The objectives are:

- To determine the river cross section.
- To analyse hydrological data for critical river sections.
- To propose the possible solution.

1.4 Scope of Study

The scope of study includes simulating the river using Infoworks ™ software using gathered data from local authorities. This study involved in the catchment area of Sungai Isap. In this study, a river network was established using the Google satellite images data and the analysis were carried out using river modelling and simulation.

The river simulation was carried after all the data were inserted and the networks were created. The river flow from upstream to downstream was marked in the model. Two experiments were carried out; the first, using the 50 years of design rainfall (50 years ARI) and the second one is 100 years of design rainfall (100 years ARI). The simulating process was conducted by mean of steady flow and different rainfall events to get various results.

1.5 Significant of Study

River simulating is the best option to study the behaviours of flood and what are the influenced factors. By creating the river model based on the actual data and GIS image, the true phenomenon of what is really happened can be understood.

The limitation of human activities along the flood plain area could be established after a river simulating was conducted and the hazard risk map was produced. Through this study, the effect of rainfall to the flood occurrences and behaviours could be determined. Thus, for the future, the appropriate early solution could be implemented for a certain types of rainfall. This increase the public awareness of the next flood event by predicting based on the rainfall behaviours. This study is also expected to be able to help the responsible agencies and authorities to river and river basin management to apply more efficient approach for the purpose of analysing and producing the best design practise in overcoming the flood problems.

CHAPTER II

LITERATURE REVIEWS

2.1 Introduction

Malaysia is an equatorial climate country with having wet and dry seasons every year. There are two types of wet seasons occurs in the peninsular Malaysia; Southwest Monsoon that affect west coast of peninsular Malaysia and Northeast monsoon that affected east coast of peninsular Malaysia (also known as "musim tengkujuh"). Kuantan town, located in Pahang state was one of the developed towns in east coast of peninsular Malaysia and has been experiencing this phenomenon for a few decades. Each year, Malaysia have received 3500mm of annual rainfall (average) which indirectly placed Malaysia as one of the riches country with water source. In Malaysia, river play an important role since its usage approaching 98% compare to ground water, 2% in daily activities (Ismail, DID).

2.2 Water Cycle

Theoretically, flood is caused by an excess amount of rainfall in a long direction. The ideal percentage of a water cycle balance in order to balance the eco-system to avoid flood is clearly highlighted and as long as Malaysia is on the line, the flood can be avoided. However, there are several factors that causing the water balance system is disturbed. Since Malaysia received a few numbers of rainfalls annually, the water source condition is usually affected by weather conditions and natural water cycle (Strathler, 1997). The water in the earth surface is evaporated to the atmosphere as a vapour and the group of water vapour in the atmosphere produced clouds which finally condensed and precipitate to the earth as rainfall. This process is known as precipitation (Syukri, 2009). Figure 2.1 and 2.2 indicate the illustration and percentages of water cycle on the earth surface.

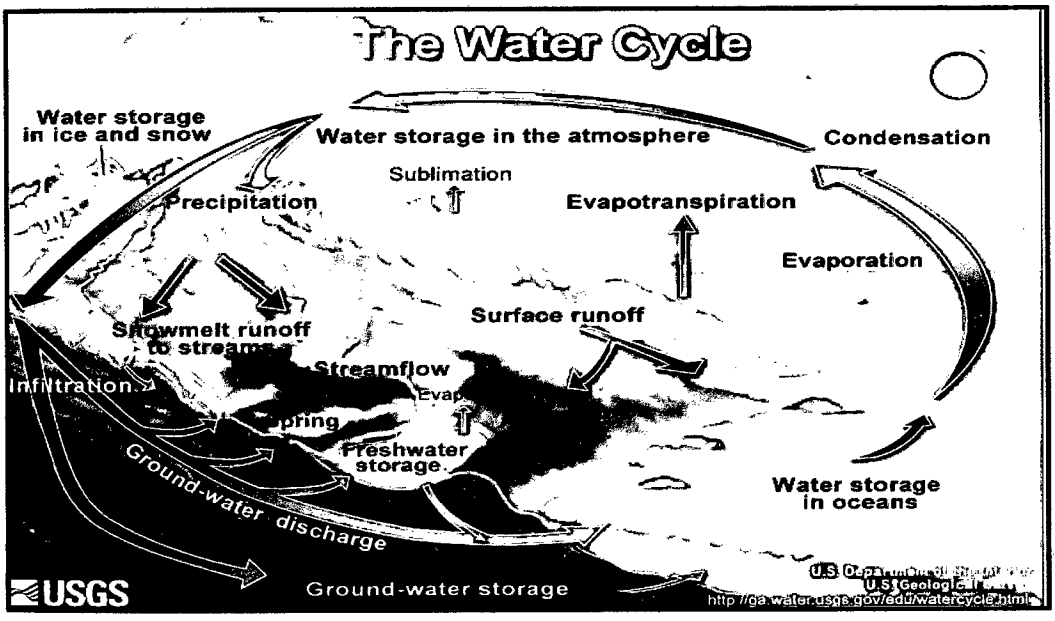

Figure 2.1 Natural Water Cycles (Strathler, 1997)

2.3 Factors Affecting Flood

Floods are natural consequences of stream flow in a continually changing environment. The streams receive most of their water input from precipitation and the amount that falling in drainage basin varies from day to day. Based on the role of precipitation, the amount and time which precipitation takes places is not constant for any given area. In Malaysia, river is known as a number one water resource and there are several town and residential area widely developed in the flood plain area which is known as a hazardous area because of its potential to be flood by water.

2.3.1 Rainfall (Precipitation)

Several factors have been listed down for affecting flood. The main factor that caused flood is precipitation. For a short duration of rainfall in a small watershed, flood also can be occurred and the danger accompanying is a high-water velocity which can results in extremely large flood. From the rainfall (precipitation) results, the runoff can be identified using available evaporation data as a catalyzer (Walter and Francis, 2005). The spatial patterns of different between two rainfalls with same average rainfall in one catchment can results in different runoff patterns. When the stream flow for a catchment is combined with the precipitation, flood event will occur. The evapotranspiration and evaporation has little influence of water balance at daily time scale compare to rainfall (L.Siriwardena, 2005).

2.3.2 Geomorphic Effects

Geographical change also influence flood to occur. The geographical change and mobilization of a flood plain area for human activities such as agricultural and building dikes is known as a factor that results in residential are or city flooded with water from the river during heavy rainfall (Erich J. Plate, 2002). Geomorphic effects controls several factor such as magnitude, frequency, rate of sediment movement, flood power, duration of effective flows, sequence of events and the channel geometry. Changes in the channel bed configuration and bank erosion have been considered as a measure of the geomorphic effectiveness of flows. For an example, in the river bank of Tapi River, India, the condition along several location with alluvial bank are steep but stable compared to the other section with gravely sandy units which occurs to response for high flood. The velocity of the river's flow is influenced by sediment load. The higher the ratio, the more increase in discharge (Vishwas, 2002).

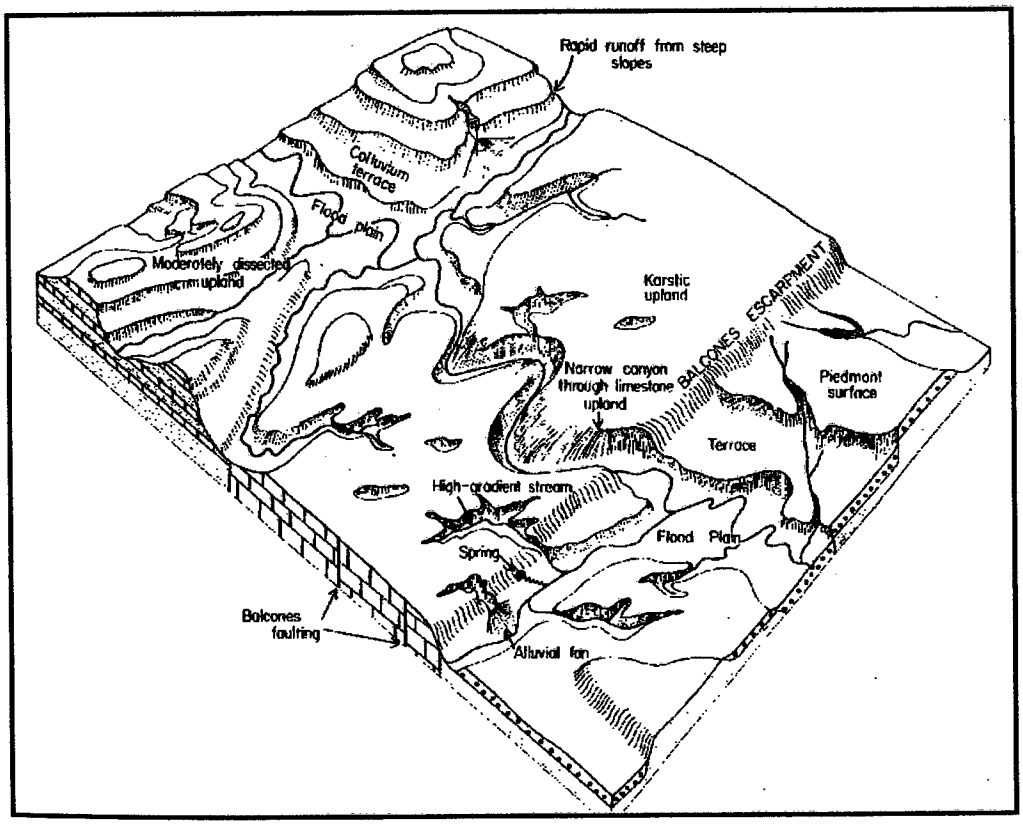

Figure 2.2 Geomorphic Effects on Flood Potential (Erich J. Plate, 2002)

2.3.3 Channel Section/ River Cross-Section

Others factor that affect the flood is river cross-section or channel section. The value of discharge is varying with channel width, depth and gradient. Flows get deeper and faster as a discharge increase. In the other words, the flood power is depended on the river section. During heavy rainfall, the stage and discharge increase and the depth of flow are assumed to be negligible since the width-depth ratio is too small. The rates of change in mean depth and velocity are greater than change in width. Thus, the increase in discharge is directly proportional to the depth which influences the river to flow in high velocity and causing overflow or in the other words, flood. The fact is, the river is more effective with depth compare to the width (Vishwas, 2002).

2.3.4 Urbanization

Urbanization also listed as one of the factors that affecting flood. Theoretically, the percentage rate of runoff increase due to urbanization because of the rate of infiltration is limited when certain section is covered with concrete. CN, also called as a curve number, is a percentage of constant runoff coefficients (value from 0-100%). The more CN value means the more urbanization in that area and the less number of infiltration which results in increasing surface runoff. The CN value also provides an indication of the watershed's water retention capacity (Gaume, 2003).

2.3.5 Land Used

The effect of land used in flood event is extremely remarkable. The early study reported that the hydrologic responses related to slow, consistent change in land used and increase in forest cover. Just like the urbanization, the change in land used for human activities decrease the rate of infiltration and results in excess runoff. For an example, the study for small catchment with vegetation and plant, similar to Comet river catchment (L.Siriwardena, 2005), they found that annual runoff is increased after the establishment of pasture and conversion to cropping. The results suggest clearing the forest and crop in order to increase the runoff, so that the water can easily flow to the river without floating the area within (L.Siriwardena, 2005).

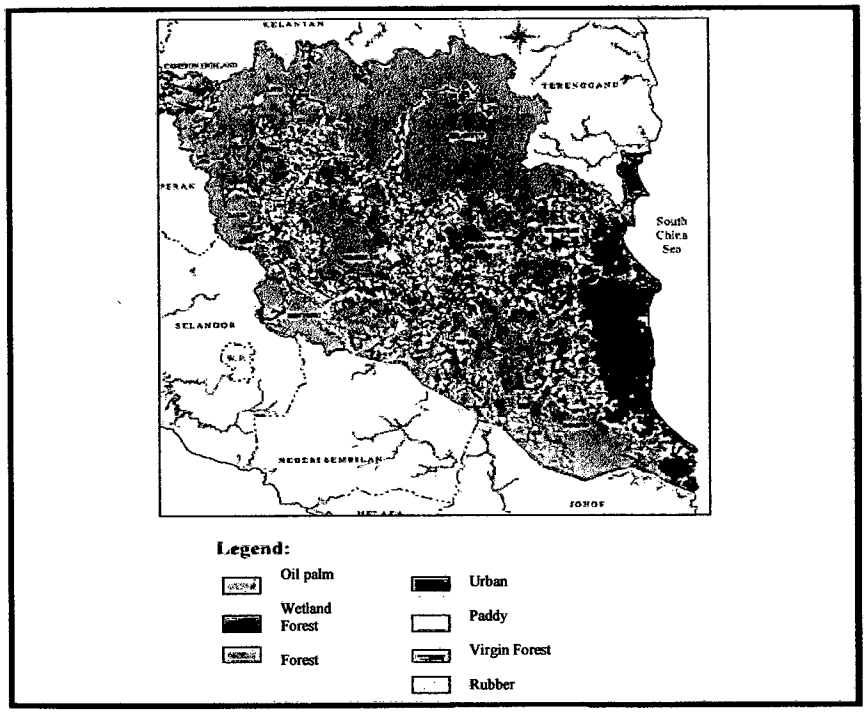

Figure 2.3 Land Used of Pahang State (JUPEM)