HYDROLOGICAL RIVER MODELING FOR SUNGAI LEMBING AREA BUKIT KENAU USING INFOWORKS RS

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ABSTRACT

Flood is an overflow or accumulation of an expanse of water that submerges land. It may result from the volume of water within a body of water, which overflows, resulting that some of the water escapes its usual boundaries. Floodplain and near river area nowadays are at risk of flood. Bukit Kenau area is also included. Whenever there are high precipitations, the water level will increase and could cause flood. Mitigation could be technical and nontechnical, structural and nonstructural. Structural mitigation such as constructing channels and sewers were the main method of flood mitigation. Infoworks software is chose to estimate the critical water level where flood could happen. This study can be used to help to prevent flood problem for the people especially at Pahang River. The objective of this study is to develop and validate 1-Dimensional hydrological modeling of Sungai Lembing on area Bukit Kenau using Infoworks RS. Hydrological data are collected from JPS and Map area obtained from JUPEM. Infoworks RS are used to simulate the flood event on Bukit Kenau. Steady and unsteady flow simulations were run for 20 and 50 ARI. Rational method is used based on Manual Saliran Mesra Alam (MASMA) for the design rainfall calculation. The results shows that at some area, the water level is higher that left or right bank of the river, so that area will have risk of flood. The simulation water level on JPS station is 1.8m and actual level is 1.811m, so the error calculated is 0.61%, which is allowable. Some methods can be taken for flood mitigation such as increasing the section area of the river or increasing height of bank so that the flow will have more space. The ability of Infoworks RS to run flood simulation on Sungai Lembing area Bukit Kenau is acceptable as the error calculated from validation process are small.

ABSTRAK

Banjir adalah lebihan aliran atau permukaan air terkumpul yang melimpah ke permukaan tanah. Banjir boleh disebabkan kuantiti air yang melebihi aliran, menyebabkan sebahagian darinya terkeluar dari kawasan yang sepatutnya. Kawasan yang berhampiran sungai berdepan dengan risiko banjir. Kawasan Bukit Kenau juga terbabit. Bilamana terdapat kadar hujan yang tinggi, paras air akan meningkat dan boleh menyebabkan banjir. Kawalan banjir boleh secara teknikal atau tidak, berstruktur ataupun tidak. Kawalan berstruktur seperti membina terusan dan saluran adalah kaedah utama kawalan banjir. Perisian Infoworks digunakan untuk menganggar paras air kritikal dimana banjir boleh berlaku. Kajian ini boleh digunakan untuk membantu mengawal masalah banjir terutamanya di kawasan Sungai Pahang. Objektif kajian ini adalah untuk membina dan mengesahkan model hidrologi 1-dimensi di Sungai Lembing kawasan Bukit Kenau menggunakan Infoworks RS. Data hidrologi diperolehi dari JPS dan peta kawasan dari JUPEM. Infoworks RS digunakan untuk simulasi kejadian banjir di Bukit Kenau. Simulasi aliran mantap dan tidak mantap dijalankan untuk 20 dan 50 ARI. Kaedah rasional diguna berpandukan Manual Saliran Mesra Alam (MASMA) untuk kiraan rekabentuk hujan. Keputusan menunjukkan sesetengah kawasan mempunyai risiko banjir. Paras air simulasi di stesen adalah 1.8m dan paras sebenar adalah 1.811, dan ralat yang dikira adalah 0.61%, maka boleh diterima. Antara kaedah yang boleh digunakan untuk mengawal banjir seperti memperluas keratan rentas sungai atau meninggikan tebing sungai supaya mempunyai lebih ruang untuk aliran. Keupayaan Infoworks RS untuk melakukan simulasi banjir di Sungai Lembing kawasan Bukit Kenau boleh diterima pakai kerana kesalahan yang dikira dari proses pengesahan adalah sangat kecil.

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LIST OF SYMBOLS

A	-	Area of the crossection (m^2)
a, b, c, d	-	Coefficients for the IDF polynomial equations
D	-	Depth
I	-	intensity
n	-	Manning's coefficient
Q	-	maximum flow (m^3/s)
R	-	hydraulic radius (m)
S_o	-	watercourse slope
t	-	time
tc	-	Storm duration
tp	-	Peak Hydrograph
V	-	Velocity
W	-	Width

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CHAPTER 1

INTRODUCTION

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 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 usual 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. Flood also could cause by soils, geology, floras, and non-natural impoundments in the upper basin.

Floods can also occur in rivers, when the strength of the river is so high it flows out of the river channel, particularly at bends or meanders and causes damage to homes and businesses along such rivers. While flood damage can be virtually eliminated by moving away from rivers and other bodies of water, since time out of mind, people have lived and worked by the water to seek sustenance and capitalize on the gains of cheap and easy travel and commerce by being near water. That humans continue to inhabit areas threatened by flood damage is evidence that the perceived value of living near the water exceeds the cost of repeated periodic flooding.

Flood estimation on flood plain and near river area is important for many hydrological applications as they are difficult and could be use on many purposes. Estimation of flood is required from various return periods for planning measures and purpose of flood mitigation and reduces or prevents flood damage. One of the main points in flood estimation is precipitation. Flood increases rapidly because high precipitation exceeds the infiltration capacity of the soil, and thus causing high runoff rate. Uncontrollable uses of land have made flood forecasting difficult because impermeable surfaces reduce infiltration and accelerate runoff. Mitigation could be technical and nontechnical, structural and nonstructural. Structural mitigation such as constructing channels and sewers were the main method of flood mitigation. Nowadays, ponding and nonstructural technique, mainly real-time process, has become practical alternatives. Other flood mitigation methods are warning system, stormwater channel management, storage pool, deepen and widen river, and so on.

1.1. Problem Statement

Floodplain and near river area in this day and age are at risk of flood. It seems to happen often. Bukit Kenau area is also included. Whenever there are high precipitations, the water level will increase and could cause flood. A flood is an overflow of an expanse of water that submerges land. If flood occur at this area now, more people will be affected by it. The flooding effects in that region will be a lot more severe. For that reason, this study is created to minimize these effects.

Flood risk also occurs at area Bukit Kenau where it is close to Pahang River. This is one of the factors that causes flood in that area. It becomes poorer if there is a storm. While there are many ways in flood mitigation, such as increasing river depth and cross section, Infoworks software is choosed to estimate the critical water level where flood could happens. This study can be used to help to prevent flood problem for the people especially at Pahang River. It is expected to be able to help the people in the future and also help Department of Irrigation and Drainage, Malaysia (JPS) to solve the flood problem.

1.2. Objective :

The objectives of this study are:

i) To develop and validate 1-Dimensional hydrological modeling of Sungai Lembing on area Bukit Kenau using Infoworks RS.
ii) To obtain water depth, flow and velocity data of Sungai Lembing on area Bukit Kenau for flood problem solving purpose.

1.3. Scope of Study

The scopes of study are as listed below:

i) Obtain the data needed such as rainfall data, crossection of the river, the geometry of structure, perimeter watershed, water level and other data required.
ii) Understand and analyze more on Infoworks software in theory and practical.
iii) Site survey at Bukit Kenau to obtain data and information needed.

1.4. Location of Study

The study of study is Sungai Lembing on area Bukit Kenau. This area is low level land and risk of flood when heavy rain. Human history shows that residential areas are built near the river as the river will supply water for human life. The economy will grow up on that area and many people will come. However, in this day and age, low land level near the river is not suitable for inhabitant area as the flood will cause damage. The study need to be made on Bukit Kenau area to reduce the damage.

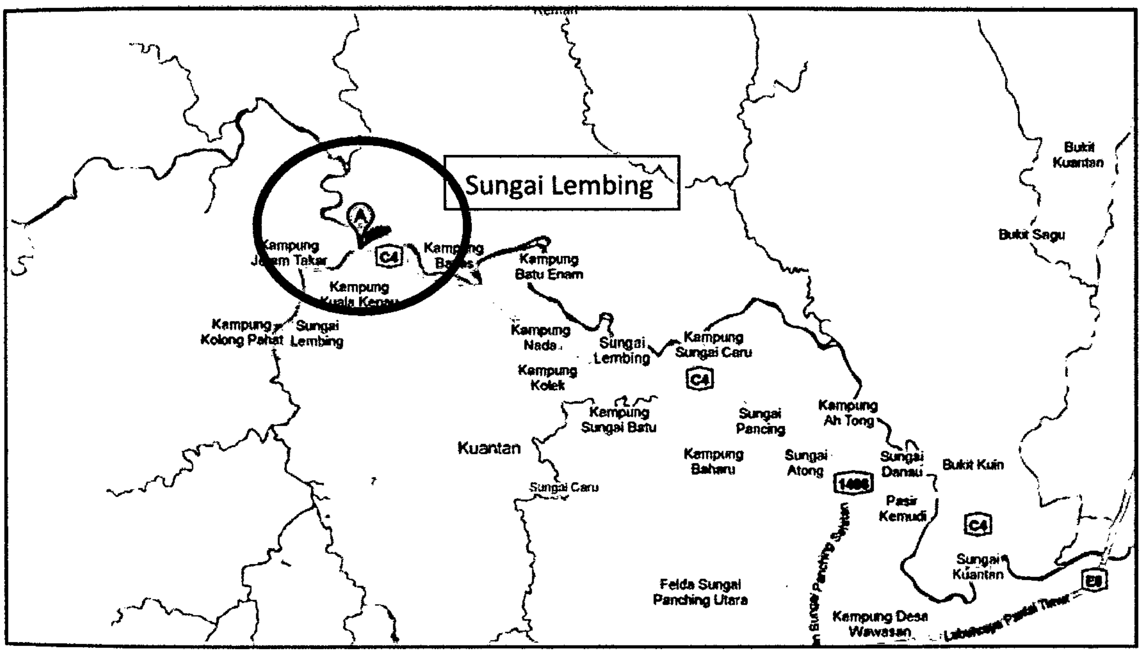

Figure 1.1 : Map shows the location of Bukit Kenau. (Source : http://maps.google.com.my/)

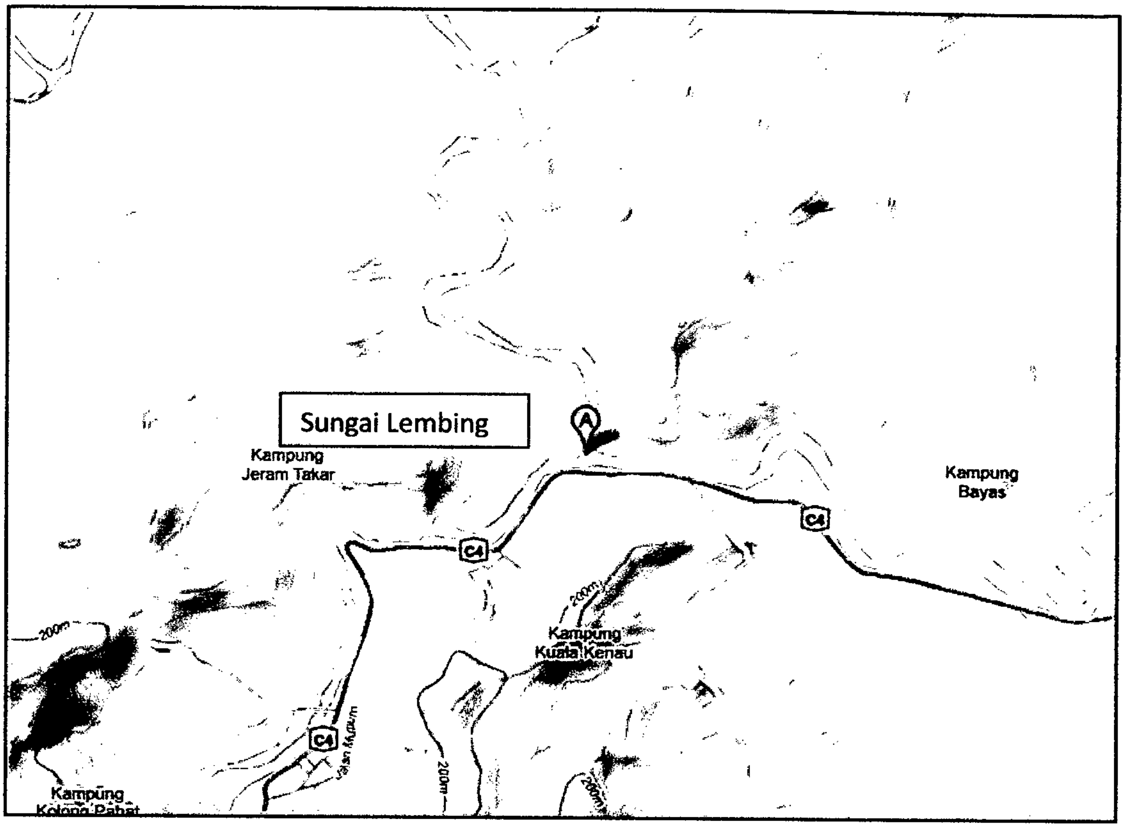

Figure 1.2 : Close-up map of Bukit Kenau. (Source : http://maps.google.com.my/)

Figure 1.1 and Figure 1.2 clearly shows the location of residential areas alongside the Sungai Lembing. Bukit Kenau is one of them. It is located on low level land area, plus near the river. Along the Sungai Lembing, there are many villages and residential area built on the left and right. This is very dangerous because if heavy rain happens, many people along the river will experience the effect of flood.

1.5. Significance of Study

The result from this study can be used to upgrade and update the river management system at Sungai Lembing. Scheduled maintenance can be made to the river so as to reduce the risk of flood to minimum. This could provide optimum effect against flood in the future.

From this Infoworks software, the hydrodynamic river modeling can be developed to obtain the water depth, flow and velocity. These data can be used to predict flood and water contamination treatment device design purpose. From the study, the suggestion of solution can be made such as to increase the width or depth or the river to mitigate flood.

The study also can prove the validation of Infoworks software in providing data for flood estimation.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

Water is essential in the life of any living things. Scientifically water are made of two molecule of Hydrogen and one molecule of Oxygen. Roughly water covers around 70% of the Earth's surface. It is found mostly in oceans and other large water bodies. Water in oceans forms 97% of surface water, 2.4% on glaciers and polar ice caps, 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds, and precipitation, and other land surface water such as rivers, lakes and ponds 0.6%. A very small amount of the Earth's water is contained within biological bodies and manufactured products (UNEP, 1995).

Fresh and clean water is essential to human and other living things. However, as large water body such as river forms most of the surface water, too much of excess water are not required because it can cause many problem in the future.

2.2. Flood

Flooding in general is caused by the inability of water to flow away rapidly from an area due to certain factors, causing a build-up of volume and thus creating floods. As an earth disaster, flood has caused many problems. Some of the effects of flood are destroyed crops, severe losses and damage in property, disease and illness, and death. Continuous flood also could affect a country's economy growth. Rebuilding a city after flood will need a big amount of expenses. This, however, does not promise that everything will be back like the time before flood. People will suffer of mental pressure and trauma, faith and confidence in government will decrease, and the spirit to wake up again will be hard to find.

In the case of Sungai Lembing, these flood contributing factors includes the area that near to the river and probably the condition of the current drainage system which is no longer suitable in handling the advent of torrential rains. The effect of flood can be seen on Figure 2.1.

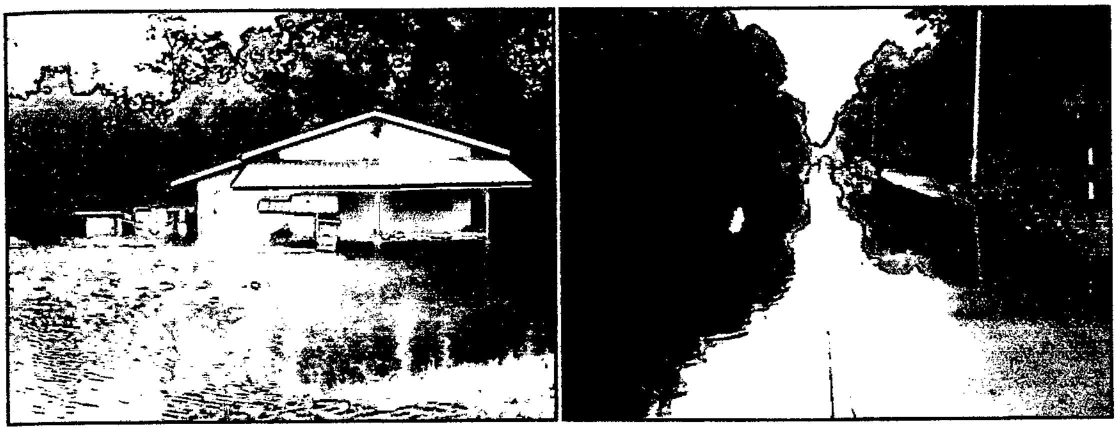

Figure 2.1. Image shows the effect of flood on 2007 on the way to Paloh Hinai.

Source : http://pekanroyaltown.blogspot.com/2007/12/jalan-ke-paloh-hinai.html

Flood planning, forecasting, and emergency management can be greatly enhanced through the use of models which have the ability to estimate the timing and location of flooding. Until recently, flood modeling has been dominated by one-dimensional models since these models are relatively simple and computationally quick. However, these models do not represent any of the complex physical processes present in floodplains and urban environments, and are therefore being discouraged by the National Research Council for use in floodplain inundation studies. Two-dimensional models based on the complete shallow water equations have a superior ability to resolve flow velocity and direction when compared to one-dimensional models. However, the limitation of using two-dimensional models for flood planning, forecasting, and emergency management is the increased computation cost. This dissertation presents the development and validation of a two-dimensional model based on the complete shallow water equations. For computational stability, the advective terms are resolved using an upwind differencing scheme, with the scale and velocity vectors located on a staggered grid. The model has been validated with laboratory experiments and has shown the ability to accurately estimate both velocities and depths. In addition, simulation results compared well to high water mark data collected from the Taum Sauk dam failure.

For years, researchers around the world have been trying to apply computer models to stimulate flood impact. Since the first applications, numerous computer models have been developed to assist in flood mitigation planning and flood control design. These models range in complexity and also in predictive capacity. Most flood estimation models are one-dimensional and perform dynamic wave simulations or solve the full Saint Venant equations consisting of a continuity and momentum equation (Judi, 2009).

Flood Modelling by using Computer Software become an integral part of flood risk assessment in both urban and rural areas, providing a means of converting catchment discharge into inundation extent, depth and in some cases flow velocity. These models vary in complexity from solutions of the two-dimensional shallow water to storage cell models based on Manning's equation. Common to all these models, however, is the computational expense (or burden) for many real world applications. Recently, developments in computer hardware have moved away from increasing clock speed towards providing many computational cores that operate in parallel. For example, desktop computers are now routinely sold with dual-core _86 general purpose central processing units (CPU's) and this trend towards larger multi-core machines is expected to continue in the future (Jeffrey et al.).

In this case, Infoworks RS is used to create the Hydrodynamic River Modeling. To decrease the computational cost, the two-dimensional model has been developed to take advantage of now prevalent multicore computers through Java multithreading to provide parallel computing on desktop computers. This desktop parallel computing capability coupled with an efficient domain tracking algorithm is shown to decrease computation time by as much as 200 times. Aside from an ability to provide more real-time flood forecasting, this reduction in computation time makes the incorporation of risk and uncertainty/ensemble forecasting more feasible for flood inundation modeling. However, as the scale of the simulation is increased (urban to region), and with the increasing availability and use of high resolution data, computation times will increase (Judi, 2009).

2.3. Types of Flood

2.3.1. Flash Floods

In areas with steep slopes, heavy rain can cause a riverbed that held very little or no water at first, to suddenly brim with fast flowing water. The rain water is collected on the slopes, then flows downhill gathering speed and all the water comes together in the river bed. The water level rises fast. The water flows over the river banks and floods the area. Speed is the keyword. It all happens fast, it rains heavily. The water flows at high speed. Because of this speed it has the strength to carry away heavy objects as you can see in the videos of Boscastle in 2004, Vaison la Romaine in 1992, and the area of Alicante in Spain in 2007. The flood stops as suddenly as it starts.

A flash flood is a very direct response to rainfall with a very high intensity or sudden massive melting of snow. The area covered by water in a flash flood is relatively small compared to other types of floods. The amount of water that covers the land is usually not very large, but is so concentrated on a small area that it can rise very high.

Because of the sudden onset and the high travelling speed of the water, flash floods can be very dangerous. The water can transport large objects like rocks, trees and cars. Never drive through a flash flood, even if it doesn't seem to be very deep: the car may be swept away by the sheer speed of the water.

When a dyke breaks along the sea or along a river, the water may flow in so suddenly and with such speed that could be compared with a flash flood. (Floodsite Project, 2008)

2.3.2. Urban Flooding

Flooding in urban areas can be caused by flash floods, or coastal floods, or river floods, but there is also a specific flood type that is called urban flooding.

Urban flooding is specific in the fact that the cause is a lack of drainage in an urban area. As there is little open soil that can be used for water storage nearly all the precipitation needs to be transport to surface water or the sewage system. High intensity rainfall can cause flooding when the city sewage system and draining canals do not have the necessary capacity to drain away the amounts of rain that are falling. Water may even enter the sewage system in one place and then get deposited somewhere else in the city on the streets. Sometimes you see dancing drain covers.

Throughout Europe urban flooding happens fairly frequently. The virtual tour shows two examples, Hull in England in 2007 and Mestre in Italy in 2007. The same sort of thing can happen in rural areas and is then called ponding.

Urban floods are a great disturbance of daily life in the city. Roads can be blocked, people can't go to work or to schools. The economic damages are high but the number of casualties is usually very limited, because of the nature of the flood. The