FLOODPLAIN MODELING DUE TO DAM BREAK USING CCHE2D_FLOOD

NURUL ATIQAH BINTI OMAR

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To my beloved family:

Father, Omar Bin Othman

Mother, Shakinah Bt. Ya'acob

Siblings; Nurul Aswa, Muhammad Syafiq, Nurul Athirah,

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ABSTRACT

The prediction of floodplains caused by dam break is very important to discuss for future planning and decision making concerning to dam safety, controlling downstream developments, contingency evacuation planning and real time flood forecasting. The objectives of this study are (1) to determine the propagation of flood in the study area, in terms of water depth and velocity magnitude, and (2) to identify the potential area of high risk of flooding. The comparison of results using one point source input flood discharge (total discharge) and flood hydrograph have been carried out. The floodplain simulation in this study using software is called as CCHE2D_FLOOD model. The study area is at Durian Tunggal Dam, located in Melaka. The dam has been classified as a significant hazard dam with a catchment area of 41.4 km^2, impounded area of 5.8 km^2 and a storage volume of 32.6 Mm^3. A flood hydrograph due to dam break, observed by Rahimah (2009) is used as a model parameters input to simulate the propagation of flood in the surrounding areas of Durian Tunggal river. The results of water depth, velocity distribution, and time required to flooding are the parameters that needed to be analysed.

ABSTRAK

Ramalan dataran banjir yang disebabkan oleh pecahan empangan adalah sangat penting untuk membincangkan bagi perancangan masa depan dan membuat keputusan mengenai keselamatan empangan, mengawal perkembangan hiliran, perancangan pemindahan di luaar jangkaan dan ramalan masa sebenar berlakunya banjir. Objektif kajian ini adalah (1) untuk menentukan penyebaran banjir di kawasan kajian, dari segi kedalaman air dan halaju magnitud, dan (2) untuk mengenal pasti kawasan yang berpotensi menghadapi banjir yang berisiko tinggi. Perbandingan keputusan dengan menggunakan input satu titik sumber pelepasan banjir (jumlah pelepasan) dan hidrograf banjir telah dijalankan. Simulasi dataran banjir dalam kajian ini menggunakan perisian yang dikenali sebagai CCHE2D_FLOOD model. Kawasan kajian adalah di Empangan Durian Tunggal, yang terletak di Melaka. Empangan telah diklasifikasikan sebagai empangan bahaya yang ketara dengan kawasan tadahan 41.4 km^2, kawasan takungan sebanyak 5.8 km^2 dan jumlah penyimpanan sebanyak 32.6 Mm^3. Satu hidrograf banjir yang disebabkan kepada pecahan empangan, diperhatikan oleh Rahimah (2009) digunakan sebagai input parameter model untuk simulasi penyebaran banjir di sekitar kawasan sungai Tunggal Durian. Keputusan kedalaman air, pengagihan halaju, dan masa yang diperlukan untuk banjir adalah parameter yang diperlukan untuk dianalisis.

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LIST OF ABBREVIATIONS

USACE	-	U.S. Army Corp of Engineers
FEMA	-	Federal Emergency Management Agency
GIS	-	Geographic Information system
NPDP	-	National Performance of Dams Programs
EFDC	-	Environmental Fluid Dynamics Code
PMF	-	Probable Maximum Flood
HEC-RAS	-	Hydrologic Engineering Centers River Analysis System

LIST OF SYMBOL

h	-	Water depth
σ	-	Sigma
τ	-	Stress
κ	-	Karman constant
ε	-	Turbulent energy
A_{xy}	-	Adjustable coefficient of eddy viscosity
C	-	Chezy's channel resistance coefficient
c_f	-	Friction coefficient
f_{cor}	-	Coriolis parameter
g	-	Gravitational acceleration
k	-	Turbulent kinetic energy
Q	-	Discharge (m^3/s)
u	-	Velocity component in direction x
U^*	-	Shear velocity
v	-	Velocity component in direction y
Z	-	Water level
ρ	-	Water density
∂	-	Partial differential

CHAPTER 1

INTRODUCTION

1.1 Introduction

Flood is a natural and recurring event for a river or stream. It is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers, stream, and coastal areas. This causes a watercourse to overflow its banks onto adjacent lands. Based on Southwest Florida Water Management District the flood occurs when natural or man-made bodies cannot sufficiently transport or hold excess water generated by storm or other source. It is important to note that flooding is a natural occurrence. Rivers, lakes, ditches, ocean and other water bodies have always overflowed their normal beds to flood the nearby land. Thus, flooding is a natural phenomenon due to improper planning and need to be easily prevented.

The lands adjacent to these bodies of water, as well as low-lying areas that cannot transport excess rainfall are called floodplains. A floodplain product of a larger number of water which is inter-related processes that change over time in response to external factors. These allocyclic factors such as climate change cause variation in, for example runoff, biological communities, weathering rate and sediment flux (Marriot and Alexander, 1999).

The probable flooding damage which may occur due to a dam failure is of concern to many civil engineers and planners. Not only to provide a source of information for insurance and flood control studies, but the actual planning process for the construction of a dam site can be modified by the result of such a predictive analysis. Dam break studies can be completed by either scaled hydraulic models or by use computer simulation (Hromadka et al., 1985).

By definition, dams are water storage, control, or diversion structures that impound water upstream in reservoir. Dam failure can take several forms, including a collapse of, or breach in, the structures. Dam provide many benefits for our society but floods resulting from the failure of dams also have produced some of most devastating disasters of the last two centuries. When dam fails, property damage is certain, but loss of life can vary dramatically with the extent of the inundation area, the size of the population at risk, and the amount of warning time available (Wahl, 1998). In order to reduce the potential damage owing to dam breaches, several hydraulic modeling programs have been developed so that simulate downstream water levels can be simulated in response to a dam breach (Hoogestraat, 2011).

1.2 Problem Statement

The 4th January 2012, Brazilian authorities are trying to evacuate at least 20,000 people after a dam break in northern Rio de Janeiro state. This indicates an estimated 66 towns and cities in Minas Gerais state have declared a state of emergency which is on red alert. Heavy rains caused the dam to burst in Campos dos Goytacazes, Brazil. Water broke through the dam protecting the town of Campos dos Goytacazes, opening up a big crater in a highway. Rio and other part of south-eastern Brazil have been battered by floods and landslides, with several people killed. A dam protecting Campos dos Goytacazes ruptured, sending floodwater from the River Muriae toward the small community of Tres Vendas some 30 km away. Many roads have been blocked, making it difficult to get help and supplies to affected areas. Last year more than 800 people died due to serve flooding in Rio de Janerio. Figure 1.1 shows the town of Campos dos Goytacazes due to the dam failure.

In Malaysia, there is about seventy four dam and most of the dam areas are located at the upstream of residential areas (Hassan, 2002). When dam break is occurred, it will contribute to affect the economic activities and surrounding environment. Based on USACE criteria, the Durian Tunggal Dam has been classified as a significant hazard dam. The consequences of a failure resulted on potential loss of life, damage and destruction of property, forcing evacuation people and vital resources. It is also caused the interruption of traffic by bridge and highway inundation, damage or destruction.

To be noted, a dam failure may involve the volume of water release to downstream, particularly where a large dam is involved. The amount of washout is so great that it overwhelms existing flood control or river control structures downstream of dam. The mere presence of floodwaters will certainly cause water related to damage in many area, and the high velocity of flow that will likely

accompany such a flood event may also cause structural or erosion related damage (Jeff et al., 2006).

Figure 1.1: Flooding at town of Campos dos Goytacazes due tothe dam failure.

1.3 Objectives of Study

The main objectives of this study are:

1. to determine the propagation of flood in terms of water depth and velocity flow.
2. to compare the floodplain results using (a) total discharge input (b) flood hydrograph.
3. to identify the potential area of high risk flood.

1.4 Scope of Study

The scopes of this study are:

1. The study area covers the downstream of Durian Tunggal dam, including Sungai Durian Tunggal and its surrounding areas.
2. The simulation is carried out using CCHE2D_FLOOD model to predict profile of hydrodynamic flow and floodplain inundation.
3. The length of the Durian Tunggal river is about 5 km
4. The turbulence model used to simulate unsteady flow is k-ε model.
5. The maximum simulation time to predict the flood is within 6 hours (total discharge input) and 17 hours (flood hydrograph) of simulation.

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