FLOOD DAMAGE ASSESSMENT MODEL USING COST-BENEFIT ANALYSIS

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ABSTRACT

Flood is a problem caused by precipitation and runoff particularly during periods of excessively high rainfall. Nowadays in Malaysia, flood becomes a serious problem to the extent of imposing impact to the environment. This problem may cause damages to properties, loss of life, loss of utility services, loss of trading and others. However, with sophisticated technologies, some flood mitigation measures have been designed by engineers. Every year, the government allocates huge amount of money for flood control projects. A study on flood damage assessment is necessary to identify, predict and evaluate the benefits of flood control projects. Thus, a model on flood damage assessment was developed by using Visual Basic 6.0 (VB6.0) language and the data which is used in this calculation is hypothetical data. The analysis was carried out in real time such that user may put the inventory data taken from various places and the result will be displayed in a graphical form. Besides, this study is important to ensure that floods are controlled by constructing flood control measures and to minimise damages to the environment. Indeed, an economic analysis plays an important role in deciding between various alternative projects available. From the analysis, more combinations of flood control schemes used may reduce more damages but it also increases the cost of flood control projects. The best approach to establish the most economical flood control system was selected based on which system gives the largest benefit-cost ratio or the maximum net benefit. The model is able to assist engineers to make the best decision in the planning of flood control projects before the design can be implemented.

ABSTRAK

Banjir merupakan suatu masalah yang disebabkan oleh hujan dan air larian yang berlebihan. Di Malaysia,keadaan banjir menjadi masalah yang serius di mana memberikan kesan buruk kepada alam sekitar. Masalah ini telah menyebabkan kerosakan kepada harta benda, kehilangan nyawa, kehilangan kemudahan awam, kerugian perniagaan dan sebagainya. Walaubagaimanapun, dengan teknologi yang canggih, jurutera telah mencipta sistem kawalan banjir. Setiap tahun, sejumlah besar wang telah diperuntukkan oleh kerajaan untuk tujuan kawalan banjir. Satu kajian tentang penilaian kerosakan akibat banjir dijalankan untuk mengenalpasti, menjangka dan menilai faedah-faedah sistem kawalan banjir. Dengan ini, sebuah model telah dicipta dengan menggunakan bahasa Visual Basic 6.0 dan data yang digunakan dalam pengiraan adalah berdasarkan data andaian. Penilaian mestilah dibuat pada keadaan sebenar di mana pengguna hanya perlu memasukkan data-data yang diambil daripada pelbagai tempat dan keputusannya akan dipaparkan dalam bentuk grafik. Selain itu, kajian ini juga penting untuk memastikan supaya banjir dapat dikawal dengan membina sistem kawalan banjir dan pada masa yang sama dapat mengurangkan kerosakan terhadap alam sekitar. Analisa ekonomi juga memainkan peranan penting dalam membuat pemilihan di antara projek kawalan banjir. Daripada analisa yang dijalankan, didapati bahawa kombinasi sistem kawalan banjir yang dibina dapat mengurangkan lebih banyak kerosakan banjir tetapi meningkatkan kos sistem kawalan banjir. Kaedah terbaik untuk menentukan sesuatu system kawalan banjir itu ekonomi adalah berdasarkan kepada sistem yang memberikan nilai kadar faedah-kos yang terbesar atau faedah bersih yang paling maksima. Oleh itu, model ini dapat membantu jurutera membuat keputusan yang terbaik dalam perancangan sebelum projek kawalan banjir ini dijalankan.

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LIST OF SYMBOLS

a	-	Coefficient
b	-	Coefficient
e	-	The base of Natural logarithms
h	-	Gauge height of the water surface (m)
i	-	Interest rate
m	-	The ranking
n	-	The number of year record
P	-	Probability
Q	-	Flow (m^3/s)
T	-	Return period
U	-	Useful life
V	-	Variance
x	-	The flood magnitude with the probability P
$\bar{x}$	-	The mean of all floods in the series
y_i	-	Reduced variate
z	-	Gauge height of zero flow (m)
σ	-	Standard deviation
$\sum$	-	Summation

LIST OF ABBREVIATIONS

Ann.	-	Annual
B/C	-	Benefit-cost
CBA	-	Cost-benefit analysis
GUI	-	Graphical user interface
Max.	-	Maximum
VB6.0	-	Visual Basic 6.0

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CHAPTER 1

INTRODUCTION

1.1 Background of the research

Flood is a simple natural phenomenon occurs in the hydrological cycle. Flood may be defined as a great flow of water, considered to be a usually high stage of the river at which a stream channel becomes filled and above which it overflows its banks and floods the near-by land (Gupta, 1979). All floods are due to surface runoff. Flood occurs when precipitation over small hilly catchments and heavy precipitation of several days duration over large catchments. The seriousness of flood is depending on the intensity and duration of precipitation, surface slope of the region and nature of the surface soil and covering vegetation. Flood may cause damages to humans, crops, properties and others. There are some measures of flood control needed to protect, reduce or mitigate of flood damages.

With sophisticated development, water resources engineers can build anything to eliminate the hazard of flooding. A simple and new approach is needed in order to state the benefits produce by each flood control system. Flood control systems can be divided into structural measures and non-structural measures. In this study, it emphasised on structural measures. Basically, structural measures attempt to reduce flood damage by restricting the movement of flood water into the floodplain. There are four (4) principal engineering measures to control floods which are dikes, diversion, reservoir, channel improvement and all combination of these alternatives also incorporated in cost-benefit analysis.

In designing of flood control structures, knowledge on flood hydrology becomes necessity in order to predict the extreme peak flow to annual flood event. The frequency of flood occurrence of flood peaks is important to mitigate flood. So, the Gumbel EVI method is used to describe the analysis of flood frequency. However, structural measures can reduce flood damages immediately but the costs of the flood control projects are very expensive. Hence, a model on flood damage assessment using cost-benefit analysis (CBA) was developed in this study.

In addition to it, this program is written in the Visual Basic 6.0 (VB6.0) language and based on data required such as the probability-discharge curve, rating curve and stage-damage curve. These data are used to obtain the total annual damages through calculating the area under probability-damage curve. The benefits from each alternative can be obtained by the difference of area before and after the alternative is installed. The total annual cost of flood control system is determined by considering cost parameters such as capital costs, maintenance and operation costs, interest rate and project life. Cost-benefit analysis (CBA) is used to make a comparison between costs and benefits of projects. The economic feasibility of a mitigating project can be evaluated on the reduction of expected annual damage, representing the gained benefit (Oliveri and

Santoro, 2000). The function for comparing alternative plans for flood control is to maximize net benefit and minimize cost required for structures and maintenance.

Moreover, the economic desirability of a project indicates by B/C ratio and net benefit parameters. It was also seen that these parameters will indicate the same alternative project as being most desirable. Moreover, with a change in interest rate, the parameters may change their preference. Therefore, cost-benefit analysis (CBA) is important in decision making for planning and design of flood control structures.

1.2 Problem statement

In Malaysia, floods are caused by a combination of natural and human factors. Malaysia covers 300,000 km^2 land area and 9 % of this area are floodplain areas. According to Department of Irrigation and Drainage, it has been estimated that more than 2.7 million people live in flood prone areas. When a flood occurs, it becomes a serious problem because flood may cause damages to crops, properties, public facilities and others. Besides, loss of life may happen if extreme flood occurs. Furthermore, flood damages have been estimated to be within the range of RM 200 to RM300 million per year. Therefore, an assessment of flood damage needs in order to reduce flood hazards.

According to the daily newspaper, Utusan Malaysia dated on 27 February 2006, the latest flood occurred at Shah Alam on 26 February 2006 where water inundated 4000 houses and 1240 people had been evacuated to relief centers. Unfortunately, this problem caused damages to properties, loss of utility services, loss of trading and others.

The damages were estimated around RM15,000 per house. However, with evolution technologies, some flood mitigation measures have been designed by engineers to solve this problem. In year 2001, the Selangor Government allocated RM23 million for flood mitigation measures and after this extreme event occurred, the state government had also approved another RM10 million for flood mitigation measures. Therefore, the government needs to allocate huge amount of money to for this purposes.

We know that engineers can build anything to control floods. However, finance is one of the major problems to implement flood control project. Without sufficient funds, the flood control project could not be constructed although the design had already done. Hence, an economic analysis plays an important role in order to balance the relationship between benefits and project costs after flood control systems were installed.

Besides, economic analysis is one of the important processes in water resources planning and development. On the other hand, a model was developed to determine the optimum alternative which gives the greatest economical advantages by using cost-benefit analysis (CBA). Therefore, a study on flood damage assessment using cost-benefit analysis (CBA) is necessary to solve various flood problems occur in Malaysia.

1.3 Objectives of the study

The objectives of the study are:

i. To determine the damages due to flood occurrence.
ii. To study on flood assessment using cost-benefit analysis (CBA).
    - To develop a model on flood assessment for user.
    - To make decision for planning and design of flood control by considering cost economic.

1.4 Scope and limitation of study

i. The study focuses on the direct tangible damages due to flood occurrence using hypothetical data.
ii. The study only consider the structural measures of flood mitigating measures.
iii. The modeling for flood damage assessment using cost benefit analysis (CBA) was developed using Visual Basic 6.0 (VB6.0) Language.