FLOOD ANALYSIS OF SG. GALAS AT DABONG, KELANTAN BY USING THE HEC-HMS SOFTWARE

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ABSTRACT

Extreme flood cause disasters such as loss of life, property and resources. In Malaysia, the occurrence of floods is due to a lot of factors. One of the major factors is because of the rapid development especially in floodplain area in Lembah Klang and Kuala Lumpur. The increase in the development will automatically increase the impervious area and as the result, the runoff will also increase. This increase will produce more water from the rainfall in the river and this is why flooding happens so often in these areas. If flood can be predicted, control and managed systematically, the losses due to flood can always be prevented or at least minimized.

This study focused on the utilization of a computer program called HEC-HMS to estimate the flood discharges for various return periods. The Sungai Galas catchment at Dabong, Kelantan was used as a case study. The total catchment area of Sungai Galas is 3970 km². Recorded hydrologic data from Sungai Galas basin was used in evaluation and testing of the model. Model evaluation involved calibration and verification.

The rainfall and discharge data were obtained from Hydrology and Water Resources Division, the Department of Irrigation and Drainage. Records are available since 1980. Simulation was performed using data from a selected event for calibrating the model parameters.
For verification, the model was tested by running the simulation on another storm event. The final output from this model were flood hydrograph for standards storms of return period of 2, 5, 10, 25 and 50 years.

The results obtained in this study show that the hydrologic modeling software HEC-HMS can be used to predict flood from the large catchment at Sungai Galas, Dabong.
ABSTRAK


Data-data ini diperolehi dari tahun 1980 sehingga kini. Simulasi dijalankan keatas data-data dari satu kejadian banjir yang dipilih untuk tujuan kalibrasi model. Manakala pengesahan pula dijalankan dengan menggunakan data dari kejadian banjir
yang lain. Keputusan akhir model ini adalah hidrograf bagi kejadian banjir untuk tempoh ulangan 2, 5, 10, 25 dan 50 tahun.

Secara keseluruhan, dapat disimpulkan bahawa dengan penggunaan perisian HEC-HMS dalam memodelkan kawasan tadahan Sungai Galas, kejadian banjir dapat diramalkan untuk kawasan tadahan yang begitu besar.
ACKNOWLEDGEMENT

First I would like to thank my supervisor, Associate Professor Dr. Abdul Halim Ghazali for his guidance and support rendered throughout the period of this study. I also would like extend my gratitude to supervisory committee members, Associate Professor Dr. Thamer Ahmed Mohammed and Pn. Badronnisa Mohd Yusuf for their guidance and suggestions.

My special thanks to Pn Norhayati and Tn Haji Azmi Md. Jafri from Unit Pengurusan Maklumat Bahagian Hidrologi dan Sumber Air, Jabatan Pengairan dan Saliran, Ampang for their help rendered during the data acquisition stage of this study. Thank you also to my colleague, Pn Roslina Yusuf to give some advise and suggestion to completed my project.

Lastly, thank you to my family, to give support and motivation throughout the preparation of this project.
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CHAPTER 1

INTRODUCTION

1.1 General

Flood can be defined as an excess of water in a place that is normally dry. There are several different types of floods. The most common is where a river overflows its banks due to a large input of rainfall. Another definition of flood is an overflow or inundation that comes from a river or other body of water and causes or threatens damage (Varsney, 1974).

Saul (1992) stated that a flood commonly is considered to be unusually high stage of the river. It is often described as that stage at which the stream channel becomes filled and above which it overflows its banks. Floods affect many of the engineering structures such as bridges, embankments, tanks and reservoirs etc. In order to reduce the effect caused by flooding, proper safeguards must be made for the safe passage of the maximum flood expected such as by implementing the structural and non-structural measures in flood protection and mitigation. To implement the measures requires the studies on the hydrological characteristics of a river catchment, shape and size of the catchment, topography, types of soil, channel configuration, stream flow data and rainfall data are necessary.
Malaysia is a tropical country, receiving more than 2,500mm of rain annually. The flooding of Malaysian rivers is mainly due to the high amount of rainfall in river basins. The worst flood in Malaysia was recorded in 1926 which has been described as having caused the most extensive damage to the natural environment. Subsequent major floods were recorded in 1931, 1947, 1954, 1957, 1967 and 1971. Floods of lesser magnitude also occurred in 1973, 1979 and 1983 (Ann, 1994).

The development of rainfall-runoff models can be fully attributed to the rising awareness to tackle crucial environmental issues such as water resources assessment, flood estimation, designed of engineered channels, assessing the impacts of effluents on water and many others. Living in an era where proper preservation and the integrated management of our watersheds and catchments are prioritised, it is obvious that rainfall-runoff modeling, which is associated with stream flow is deemed as important. A good example is the current effort by the government to undertake a comprehensive study to develop a master plan for flood mitigation, river management and water resource management at Sg.Langat river basin and Sg. Klang.
In this study, the hydrologic models are used to analysis and estimated the flood of Sg.Galas at Dabong, Kelantan. This computer simulation model for rainfall-runoff model are known as HEC-HMS and will be used to simulate flood hydrographs.

1.2 Need of study

To obtain a better understanding on the importance of the study, the need for this study has to be identified first before the commencement of the study. Among the needs that have been identified are as follows:

a. To achieve higher accuracy in terms of data representation through effective rainfall-runoff modeling.
b. To overcome the issue of missing data in stream flow gauging stations and rainfall-runoff data.
c. To cater for increasing awareness in the government and private sectors on proper management of our catchments.
1.3 Objectives of study

The main objectives of the study are as follows:

a. Application of the HEC-HMS model on a selected river catchment in Kelantan (Sg.Galas at Dabong).

b. To predict the flood of various return periods from rainfall data.

1.4 Scope of study

The scope of the study are as following:

a. Data collection

This will include the overall data and information required such as hydrological characteristics of river catchment, size of catchment, soil type, topography, channel configuration, rainfall and flow data. Most of the data and information can be acquired from Hydrology Division, Drainage and Irrigation Department (JPS Ampang).
b. Calibration of model

Calibration of the model is required to derive values for the set of model parameters that can capture the characteristics of the catchment or river system. For example, the predicted hydrograph may be adjusted to agree with the measured hydrograph. During the calibration process, care must be taken to make sure that physical parameters are not adjusted outside the reasonable range.

c. Validation

Testing the calibrated model using a set of data that has not been used in model calibration is required to verify the adequacy of the model when used for predicting future events.
d. Frequency analysis

Frequency analysis on partial duration series data from rainfall station R3 was performed to determine rainfall depth duration for various recurrence intervals. The frequency analysis was carried out by using the HYFA program, a FORTRAN software, developed by International Institute for Hydraulic and Environmental Engineering (IHE).

e. Results

The results from HEC-HMS model calibration and verification will be presented in Chapter 4.
CHAPTER 2

LITERATURE REVIEW

2.1 Hydrology in practice

Hydrology is broadly defined as the study of the occurrence, distribution, circulation and properties of water on the earth and the hydrological cycle in schematic form (Figure 2.1) lies at the heart of hydrological science. All the water that falls as precipitation has evaporated from the land and the oceans. Rivers transport some of the precipitated water across the land surface, to be evaporated elsewhere—from the sea or a lake, for example—and much is transported from one place to another as water vapour in the atmosphere (Ward & Robinson, 2000). Water is being continuously recycled through the ocean, atmosphere, lithosphere, cryosphere (ice sheets and glaciers) and biosphere (vegetation). Hydrology is therefore central to any understanding of the way the earth system works (Gupta, 1998).
Our country Malaysia, especially in Peninsular Malaysia, total water resources are dominated by the amount of water that flows in surface streams after rainfall. The source of all water is rainfall, which falls on the peninsular in response to two monsoonal seasons, the south-west monsoon in April to June and the north-east monsoon in November to February. Of the total average annual rainfall of about 2,470mm (324.2 billion m$^3$/year), some 46% (152.3 billion m$^3$/year) runs off as surface flow, some 46% (152.3 billion m$^3$/year) is evapotranspired back to the atmosphere and the balance of 8% (20.0 billion m$^3$/year) enters groundwater storage and eventually finds its way to the oceans without entering surface streams (JICA,2000). A state by state summary of the hydrological balance including the estimated 2000 annual demand is presented in Table 2.1.
Table 2.1: Hydrological Balance for Peninsular Malaysia (billion m³/year)

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<td>1.07</td>
<td>0.41</td>
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<td>795</td>
<td>0.03</td>
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<td>0.69</td>
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<td>N.Sembilan</td>
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<td>0.09</td>
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<td>Johor</td>
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<td>131,344</td>
<td>3.48</td>
<td>7.36</td>
<td>10.85</td>
</tr>
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</table>

(Source: JICA, 2000)

Literature which was published around the world and are related to the models of this study are numerous. The existence of several hundred published models and a larger number of unpublished ones made it impossible and impractical to be mentioned in this chapter. The advantages of studying selected literature is to have a good understanding of the research methodologies practiced by researchers and to acknowledge their findings. In this chapter, only selected models are presented and the model is called hydrologic models.
2.2 Rainfall

Precipitation can take many forms including rain, snow, sleet, hail and mist (McCuen, 1998). Rainfall is the liquid form of precipitation; snowfall and hail are the solids forms. Rain consists of water drops greater than 0.5 mm in diameter. The upper size of drop is 6 mm as drops bigger than this size tends to break up as they fall through the air (Varsney, 1974). In common usage, the world rainfall is often used to refer to precipitation. Exceptions are the cases where a distinction between liquid and solid precipitation is warranted (Ponce, 1989).

A rainfall event or storm describes a period of time having measurable and significant rainfall. The time elapsed from start to the end of the rainfall event is the rainfall duration. Typically rainfall duration is measured in hours. However, for very small catchments it may be measured in minutes, while for very large catchments it may be measured in days. Rainfall duration of 1, 2, 3, 6, 12 and 24 hours are common in hydrologic analysis and design. For small catchment, rainfall durations can be as short as 5 minutes. Conversely, for large river basins, durations of 2 days and longer may be applicable. Rainfall depth is measured in mm, cm or inch and it considered to be uniformly distributed over the catchment area. For instance, a 60 mm, 6 hour event produces 60 mm of depth over a 6 hour period (Ponce, 1989).