STUDY OF RAINFALL-RUNOFF RELATIONSHIP USING HYDROLOGICAL MODELLING SYSTEM (HEC-HMS) FOR LIPIS RIVER BASIN, PAHANG

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Thesis submitted in fulfillment of the requirements
for the award of degree of
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Faculty of Civil Engineering and Earth Resources
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JUNE 2016

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LIST OF ABBREVIATIONS

HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System
IDF	Intensity Duration Frequency
JPS	Jabatan Pengairan dan Saliran
SCS	Soil Conservation Service
Sg.	Sungai
UH	Unit Hydrograph
UNESCO	United Nations Educational, Scientific, and Cultural Organization

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ABSTRACT

In this study, Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) is used to determine the rainfall-runoff relationship of Lipis River, Pahang. HEC-HMS is software use in analyzing, planning, and simulating the process of rainfall and runoff. HEC-HMS 4.0 is used in this study to simulate discharge for Lipis River. This study uses rainfall data and stream flow data from January 2008 to December 2014. The data needed is from eleven rainfall stations and one stream flow station in Lipis River catchment area. The analysis result of the data is depends on the parameter used in HEC-HMS. Snyder Unit Hydrograph and SCS Unit Hydrograph are the method use in this study. The parameters include standard lag, peaking coefficient and lag time. The results of simulation can be generated in form of hydrograph, summary table, and time series table. Root Mean Square Error, RMSE is used to show the relationship of the observed and the simulated flow. If the RMSE value is lesser, it would indicate that the variables are positively linear related. During evaluation of model, the best value RMSE for Snyder UH method is 11.63m^3/s while for SCS UH method is 13.148m^3/s. It shows that the simulated models were fit with the observed data and proves that the HEC-HMS is suitable to predict and analyze rainfall-runoff relationship in Lipis River.

ABSTRAK

Dalam kajian ini, Hydrological Modeling System (HEC-HMS) digunakan untuk menentukan hubungan hujan dan proses larian air di Sungai Lipis, Pahang. HEC-HMS merupakan satu perisian yang digunakan untuk menganalisis, merancang, dan mensimulasi proses hujan dan larian air. HEC-HMS 4.0 digunakan dalam kajian ini untuk menjalankan simulasi pergerakan air untuk Sungai Lipis. Kajian ini menggunakan data air hujan dan aliran sungai dari Januari 2008 hingga Disember 2014. Data yang diperlukan adalah dari sebelas stesen air hujan dan satu stesen aliran sungai di kawasan tadahan Sungai Lipis. Keputusan analisis data bergantung kepada parameter yang digunakan dalam HEC-HMS. Snyder Unit Hidrograf dan SCS Unit Hidrograf adalah kaedah yang digunakan dalam kajian ini. Parameter tersebut termasuklah standard lag, peaking coefficient dan lag time. Keputusan simulasi boleh dihasilkan dalam bentuk hidrograf, jadual ringkasan, dan jadual siri masa. Root Mean Square Error, RMSE digunakan untuk menunjukkan hubungan aliran tersimulasi dan aliran diperhatikan. Jika nilai RMSE lebih rendah, ianya menunjukkan bahawa pembolehubah yang berkaitan adalah positif linear. Semasa penilaian model Sungai Lipis ini, nilai RMSE yang terbaik untuk kaedah Snyder UH adalah 11.63m^3/s manakala bagi kaedah SCS UH adalah 13.148m^3/s. Ianya menunjukkan bahawa model tersimulasi hampir selari dengan data diperhatikan. Ianya juga membuktikan bahawa HEC-HMS ialah perisian yang sesuai untuk meramal analisis hubungan proses hujan dan larian air di Sungai Lipis.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Water is essential to life and is the defining characteristic of Earth, the blue planet. Hydrology is the study of the global water cycle and the physical, chemical, and biological processes involved in the different reservoirs and fluxes of water within this cycle. This includes water vapour, liquid water, snow, and ice; indeed, one of the things that make our planet unique is the fact that water can be found in all three phases at Earth surface temperatures and pressures. It encompasses the occurrence, distribution, movement and properties of the water of the earth. Knowledge of hydrology is one of the key ingredients in decision-making processes where water is involved.

The Earth is a watery place. About 71 per cent of the Earth's surface is water-covered, and the oceans hold about 97.22 per cent of all Earth's water. Water also exists in the air as water vapour, in rivers and lakes, in icecaps and glaciers, in the ground as soil moisture and in aquifers shown in **Figure 1.1**.

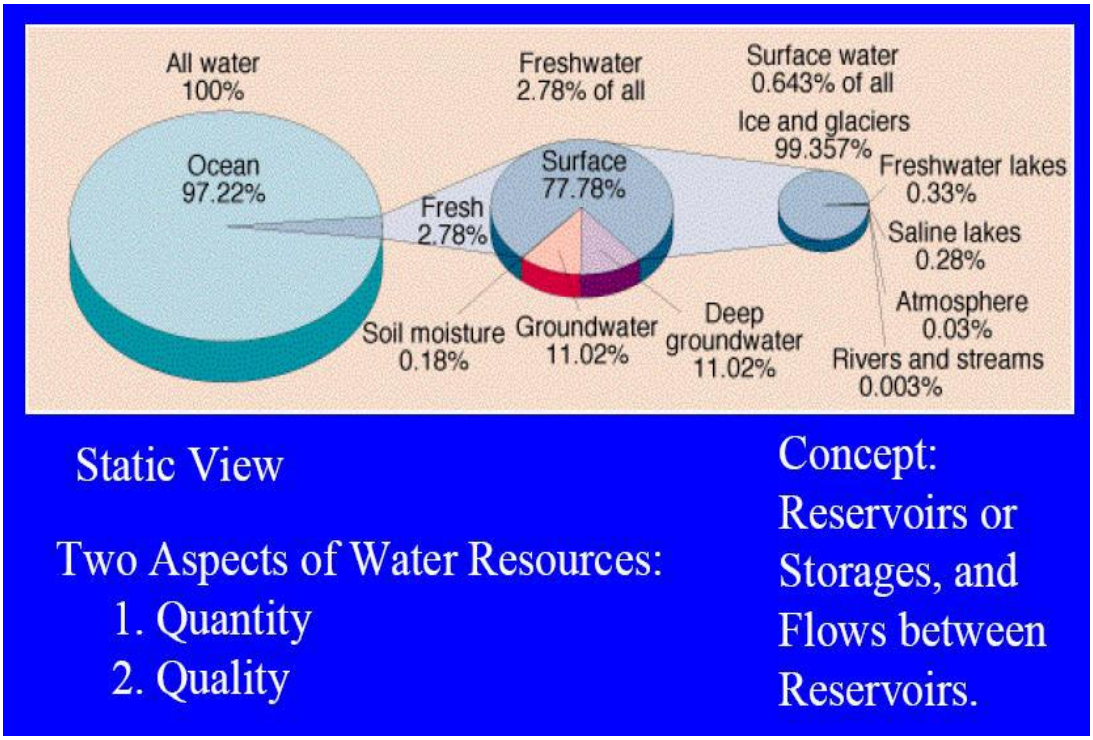

Figure 1.1: Distribution of earth's water

Source: Slide share, 2014

Hydrology Engineering Centre-Hydrologic Modelling System (HEC-HMS) had been used as tool for the hydrologic modelling of Lipis River basin. HEC-HMS is a popularly used watershed model to simulate rainfall runoff process.

HEC-HMS is hydrologic modelling software developed by the US Army Corps of Engineers-Hydrologic Engineering Centre (HEC), it is the physically based and conceptual semi distributed model designed to simulate the rainfall-runoff processes in a wide range of geographic areas such as large river basin water supply and flood hydrology to small urban and natural watershed runoff. The system encompasses losses, runoff transform, open channel, routing, and analysis of meteorological data, rainfall-runoff simulation and parameter estimation. HEC-HMS uses separate models to represent each component of the runoff process, including models that compute runoff

volume, models of direct runoff, and models of base flow. Each model run combines a basin model, meteorological model and control specifications with run options to obtain results.

1.2 PROBLEM STATEMENT

Nowadays, flood is the most significant disaster in Malaysia that effect to the social and economic of the population. Lipis River has been identified as one of the river that contributes flood problem. Heavy rainfall can cause the excess of runoff rise to the high water levels and causing the area to be flooded. Flood occurs in Kuala Lipis due to the drainage problem which the drainage capacity cannot cattle the quantity of water when the capacity of runoff increases (Amanina, 2014). When the quantity of the runoff is increasing and filled all the drainage and river, then the flood will occur (Laporan Banjir Pahang, Daerah Kuala Lipis, 2014). Thousands of money are spent every year in flood control and flood forecasting. Lipis River which is located in Kuala Lipis, Pahang is one of the rivers which can contribute to this problem.

This research is carried out to analyse the relationship between rainfall and runoff in order to prevent this disaster. Hydrological Engineering Centre-Hydrologic Modelling System (HEC-HMS) is one of the computer programs that can be used to simplify the data and assist to understand the hydrological characteristics. HEC-HMS is used to develop rainfall-runoff from a design rainfall or historic rainfall event for Lipis River basin. In this software, hydrology parameter such as rainfall data and stream flow data are important to simulate rainfall-runoff data. By analyse the data using HEC-HMS, it can assist to recognise the rainfall-runoff relationship in a certain period.

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