UNIVERSITI TEKNOLOGI MARA

FLOOD ESTIMATION USING RADAR-BASED QUANTITATIVE PRECIPITATION CONSIDERING IMPACT OF URBAN GROWTH

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ABSTRACT

Flooding problems also had been exacerbated by the increased growth and rapid development especially in the Klang Valley. The urban growth has resulted in the need of more commercial spaces and housing demands. Radar-based QPE offer high temporal and spatial distribution of rainfall data over the watershed. Therefore, with the advantage of weather radar data in spatial and temporal scales, flood estimation could be enhanced by integrating the radar-based QPE with the flood estimation model. The purpose of the study is to estimate flood using radar-based quantitative precipitation considering impact of urban growth. RAINRATE AUTO V2 was developed to extract radar-based QPE data for specific catchment areas. The system simplify the tedious works of raw weather radar data processing and QPE derivation. From the analysis, correlation of radar-rainfall data and gauge-rain data gives R^2 value of 0.7738. It is thus concluded that the radar-rainfall data can be used for radar-based QPE. A flood estimation model is developed by integrating the use of GIS and HEC-HMS in a novel HEC-GeoHMS model for Upper Klang Ampang catchment. ArcGIS software was used to process the GIS data and develop the basin model and extract the hydrologic parameters of the river basin to be used in the rainfall-runoff model. Using the radar-based QPE as input the flood estimation for significant heavy rainfall event on 27th April 2015 was carried out. The rainfall-runoff model successful computed the flood estimation with Nash-Sutcliffe of 0.655 with peak discharge of 139.3m^3/s. This computed peak discharge is relatively low compare to observed peak flow 210.4m^3/s. However, the result is in line with others findings which acknowledged the lower value of peak discharge for radar-based QPE input rainfall data. An urban growth model is developed using SLEUTH model which uses historical satellite images data as input data for urban growth analysis. The model considers increased urbanization from year 2020 to 2050 but with decreasing growth rate. Integration of the rainfall-runoff model and urban growth model is proposed as a decision making tools to estimate and simulate future flood risks for design and development planning purposes.

Keywords: Flood Estimation, Radar-based QPE, Doppler radar, Radar adjustment factor, Rainfall-runoff model, Urban Growth Model

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Quantitative measurement of discharge is vital for preparation of flood solution. Good understanding on meteorological and hydrological behaviour of the catchment is essential. Flood estimation uses rainfall data as an input in a rainfall-runoff model to forecast flow and water level in the river. However, weather radar could be used as Quantitative Precipitation Estimation (QPE) input to the flood estimation system. This method is getting more attention as the potential of weather radar increases with the improvement in temporal and spatial resolution of QPE (Berne and Krajewski, 2013; Knebl et al., 2005; Sun et al., 2000).

Convective rainfall is typical to tropics and is caused by heating of the air at the the ground resulting in locally strong vertical air motion occur (Ward & Robinson, 2000). When the air is thermally unstable, it continues to rise and creates towering cloud that may lead to locally intense rainfall but sometimes with limited duration (Figure 1.1). Malaysia is located in tropic region and experiences risk of flash flood due to intense convectional rainfall.

The study and use of weather radar in QPE is widespread in most developed countries such as the United States, European countries, Japan and Korea. However, there are limited studies in Malaysia to utilize the weather radar products for hydrological purposes. This study focuses on deploying S-band weather radar derived rainfall to simulate rainfall-runoff processes for Upper Klang Ampang River watersheds during tropical storm events. In addition, the model will consider the effect of land use and land cover change on accurate flood estimation.