UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF RAINFALL MODEL FOR FLOOD LEVEL SIMULATION INCORPORATING TIDAL EFFECTS

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ABSTRACT

Flood simulation models that have been developed in these decades are mostly influenced by local factors. Building a good flood model begins with determining the amount of rainfall that is influenced by local meteorology; and this model can estimate the rainfall pattern in the next catchment area, in which the runoff will flow to the ocean. However, most of the developed models are not capable of merging the whole hydrologic cycle, where the models should incorporate rainfall models with meteorological parameters. This step is very important as to first, project the amount of rainfall in a particular catchment area, considering the overall hydrologic model and second, to identify the areas with flood risks, considering the tidal effect. In order to fix the shortcoming, this study introduces a rainfall model that has been developed using selected rainfall parameters with the aim to recognize rainfall depth in a catchment area. In order to examine its ability, the rainfall model will be integrated with selected hydrologic models after the development phase. The result will influence quantity of flood in the catchment area, if a flood simulation model that considers every factor in hydrologic cycle were to be developed. This study proposes a rainfall model that utilizes the amount of rainfall, temperature, humidity and pressure records taken from selected stations in Peninsular Malaysia and they are analyzed using SPSS multiple regression model. The analysis shows that the selected meteorological parameters influence the rainfall development. As a result, the rainfall model developed for Senai proves that it can be used in Kota Tinggi catchment area within the limit boundaries, as the two stations are close from one another. Then, the amounts of rainfall at the Senai and Kota Tinggi stations are compared and the calibration analysis shows that the proposed rainfall model can be used in both areas. Kota Tinggi, Johor is chosen as the study area because of its flood records in 2006 and 2007. The amount of rainfall collected from selected stations in Kota Tinggi catchment has been processed using hydrologic model, HEC-HMS to identify the ability of Kota Tinggi as a catchment area in order to accommodate a huge amount of runoff that can cause flooding. During calibration process, the tests demonstrate that the simulation data and the data from previous floods are almost similar. This result suggests that the damaging floods in 2006 and 2007 were caused by Sungai Johor's incapability to accommodate the increased amount of rainfall and tidal effect at that time. In addition, flood inundation model is then developed for Kota Tinggi's catchment area, which includes Sungai Johor and the lowland areas in Kota Tinggi, using InfoWork RS and SURF7. The flood inundation model integrated with hydrologic and rainfall models produce data that resembles the data collected during flooding. In conclusion, the calibration analysis and validation for each suggested model show that the combination of rainfall, hydrologic and simulation models enhance the overall result and could be developed using selected parameters for each catchment area of interest.

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INTRODUCTION

1.1 BACKGROUND OF STUDY

Rain is abundant in Malaysia, contributing to an average of 2000 mm to 3000 mm per year. The annual average rainfall may exceed the above average level when extreme events occur, which consequently causes flooding in several areas during the monsoon periods (Suhaila and Jemain, 2007).

Seasonal floods normally occur during the northeast monsoon season between November to March and during the southwest monsoon season from May to September. Meanwhile, the two inter-monsoon periods, which occur in April and October, are generally characterized by wind and thunderstorm in the afternoon (Lawal et al., 2004). Historically, serious flood events occur every three years. Flooding in Malaysia is due to the incidences of heavy rainfall and large concentration of runoffs. In the past years, Malaysia has adopted various flood forecasting and warning systems using advanced hydraulic and hydrological models. However, these systems were proven inadequate in terms of their ability to predict impending floods (Chan, 1997).

In coastal areas, flooding is attributed to high tides and is irregularly forced by heavy rains or strong wind. The tidal effects on flood levels can be significant especially for areas near the sea. In addition, high tide may induce reverse flow toward estuaries and rivers. Scarlatos et al., (1996) stated that tides in rivers can spread far beyond the estuarine limits to a substantial reserve upstream, citing the Amazon river as example, where tides exhibit effects to as far as 800 km from the river mouth. In the absence of reverse flow, that is, when river water level is higher than tide level, high tide may cause stagnation to the flow, thus, creating a backwater effect. In such conditions, tidal effects are seen to have substantial effects on flooding.

Peninsular Malaysia is surrounded by the Straits of Malacca and the South China Sea; hence, tides may have several influences on the flooding problems in the country (Figure 1.1).