Hydrological Modelling using HEC-HMS for Flood Risk Assessment of Segamat town, Malaysia

Noor Suraya Romali[1], *Zulkifli* Yusop[2,3,*], and *Ahmad Zuhdi* Ismail[3]

[1]Faculty of Civil Engineering and Earth Resources, Universiti Malaysia Pahang, Gambang, Malaysia
[2]Centre for Environmental Sustainability and Water Security, Universiti Teknologi Malaysia, Skudai, Malaysia
[3]Faculty of Civil Engineering, Universiti Teknologi Malaysia, Skudai, Malaysia

Abstract. This paper presents an assessment of the applicability of using Hydrologic Modelling System developed by the Hydrologic Engineering Center (HEC-HMS) for hydrological modelling of Segamat River. The objective of the model application is to assist in the assessment of flood risk by providing the peak flows of 2011 Segamat flood for the generation of flood mapping of Segamat town. The capability of the model was evaluated by comparing the historical observed data with the simulation results of the selected flood events. The model calibration and validation efficiency was verified using Nash-Sutcliffe model efficiency coefficient. The results demonstrate the interest to implement the hydrological model for assessing flood risk where the simulated peak flow result is in agreement with historical observed data. The model efficiency of the calibrated and validated exercises is 0.90 and 0.76 respectively, which is acceptable.

1 Introduction

In consideration of the effects it causes, flood is known as a deadliest natural disaster in the world [1, 2]. Flooding pose a serious threat to people and cause major damage to properties, infrastructures, agricultural production and may also give serious impact to socio-economic activities [3, 4]. Even worse, flood may also lead to the loss of human life and decrease the quality of human health [5]. The consequences of natural disaster may lead to a great monetary loss to the economy of a region. Furthermore, on economic perspectives, natural disasters are also known as economic disaster [6]. In Europe, river flooding had caused about 100 billion euros of damage over 20 years' period from 1986 to 2006 [7]. Whereas according to the Emergency Disasters Database (EM-DAT) [8], flood in Malaysia had caused an approximate loss of RM 41.9 million within the years of 1995 to 2005.

Flood risk management is a non-structural flood mitigation measures that could be significantly reduce the impact of flooding [9]. This risk-based approach is contradicting to the conventional flood control approach which focusing on structural flood mitigation measures. Flood risk assessment is the initial step in flood risk management [10]. Flood risk assessment consist of two main elements i.e. flood hazard and flood vulnerability [7, 11, 12, 13]. Flood hazard assess the probability of a flood event to take place i.e. the extent or magnitude of flood while flood vulnerability assesses the potential flooding impacts to community and assets (flood damage) [14, 15].

Flood hazard normally represented by flood mapping. Generation of flood mapping needs the information of peak flood as it is the necessary input to hydraulics model [16]. Besides that, the estimation of flood damage for flood risk vulnerability assessment requires the combination of four main elements i.e. flood characteristics, exposure, value of elements at risk, and the susceptibility of the elements at risk to particular hydrologic conditions [17, 18]. The characteristics of flood such as flood depth and the information of affected area may be obtained from flood modelling.

Numerous flood modelling studies had been done by researchers worldwide (for example [16, 19, 20, 21]). Ullah et al. [19] applied the combination of remote sensing, geographical information system (GIS), HEC-RAS (1D) and HEC-Geo RAS to model a flood inundation forecasting of Kalpani River. River modelling using HEC-RAS requires two types of data, i.e., geometric data and hydrological data. Similarly, Khattak et al. [16] also utilised the application of HEC-RAS and ArcGIS to develop floodplain maps for the the part of Kabul that lies in Pakistan. Peak flows from selected flood event and various return periods were the input into the HEC-RAS model to find the corresponding flood level expected along the study area. The information of the hydrologic condition needed in the hydraulic modelling can be generated from hydrologic modelling. For example, Oleyiblo and Li [22] had applied HEC-HMS to obtain simulated peak discharge for the purpose of flood forecasting in Misai and Wan'an cathments in China. The application of HEC-HMS also can be observed in the study by Bhuiyan et al. [23]. In the study, the HEC-HMS was applied to simulate the

* Corresponding author: zulyusop@utm.my