Enhancing a Distributed Rainfall Intensity for Flood Analysis within a GIS Framework in an Urban Area (Kajang Flood)

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Abstract. The town of Kajang has experienced major flood events in previous decades since 1970s. Due to Eastern and Western Monsoon seasons in Malaysia, Kajang has potential to face with number of flood events. One of the critical elements in flood analysis is rainfall distribution. Therefore, flood studies need to have an optimum cognition of rainfall distribution as main input. In this study, HEC GeoHMS model was used in GIS (Geographic Information System) for Sungai Jeluh catchment (Kajang) due to estimation (visualization) of distributed rainfall in Kajang. In comparison with conventional methods, which they produced rainfall in lumped mode (e.g. Thiessen’s polygon), HEC GeoHMS visualized and tabulate a full distribution of rainfall for each small part (pixel of map) in a case study. HEC GeoHMS model for Sungai Jeluh has been set up by feeding high resolution of spatial and temporal resolution data (precipitation). Result of this study shows that rainfall by high intensity is distributed near urban area (downtown) in comparison with upstream which involved with less rainfall intensity.

1. Introduction
The United Nations had commissioned a report for the Coordination of Humanitarian Affairs (OCHA) where Malaysia is identified as ‘Extreme Flood Hazard’ for the coastal area of Peninsular Malaysia and ‘Significant Flood Hazard’ for mountainous area (Titiwangsa Range) which main state of Selangor and Wilayah Persekutuan Kuala Lumpur were reported as ‘Projected Increased Extreme Precipitation’ (Jabatan Pengairan dan Saliran Malaysia, 2003). In 2002, the Annual Average Damage (AAD) of whole Malaysia total up to approximately RM 915 million due to flood barely using year 2000 pricing value (Jabatan Pengairan dan Saliran Malaysia, 2003). Usually, flash floods cause the greatest damage and loss of life associated with intense rainfalls in urban areas. Sungai Jeluh is a potential river in Kajang Town which frequently has heavy rainfall and consequently flood. This study presents development of a distributed rainfall system via HEC-RAS Geospatial Hydrologic Modeling Extension (HEC GeoHMS) for Kajang to have contribution of rainfall for each part of catchment in visualization and tabulated form which is suitable for hydrological model as input data.

2. Methodology
2.1 Case study
Sungai Jeluh is one of the main rivers in Kajang town (Figure 1). The sub-watershed drains about 17.65 km². Kajang is extensively flooded during heavy rainfall in both eastern and western monsoon of the Peninsular Malaysia. This flood is due to frequent and unknown distribution of rainfall with contribution of other factors such as high urbanization, soil characteristics, and flat plain. Also, insufficient capacity of local drainage system will deteriorate the events. Therefore, there is a need to study the rainfall characteristic in this study.
2.2 HEC GeoHMS

There are various classes of hydrological models that are classified as lumped or distributed (Jajarmizadeh et al., 2012). In this research, the physically-based distributed model namely HEC GeoHMS is chosen to derive the fully distribution of rainfall in a distributed system. HEC GeoHMS needs digital terrain data and typical topographical maps as required database. Moreover, HEC GeoHMS provides main catchment, sub-catchments, main river alignment and main urban drainage (Figure 1).

2.3 Preparation of distributed rainfall and land use with HEC GeoHMS

The selection of rainfall duration is based on conservative technique, or namely typical lumped model. From this method, 180 minutes rainfall duration is identified as a critical rainfall storm for Sungai Jeluh catchment. The other issue, which is important for prediction of flood or recognition of flood prone area, is development of land use for urban region besides having distributed rainfall. Especially, HEC GeoHMS integrated with USDA Soil Conservation Services (SCS) curve number technique that needs primary information of land use and rainfall. Therefore, it has prepared a land use map for Kajang area beside derivation of distributed rainfall in first phase. Finally, it is feasible to visualize flood prone area by having distributed rainfall intensity and land use types identification via HEC GeoHMS (Figure 2 and Figure 3).

3. Result and discussion

Figure 3 shows that delineation of land cover of Kajang catchment is involved with residential area (32%) which is potential for flood production. Also, distributed rainfall intensity (Figure 4) shows that intense rainfall (darker blue colour) happened near urban area which is downstream. Visualization shows that the distribution of rainfall is gradually increasing from upstream to downstream in Kajang. Therefore, downstream area is a place with more contribution of high intensity of rainfall which leads to have proper drainage system for mitigation of unmanaged fresh waters on urban region. Distributed rainfall analysis provides an optimal information to conclude exact locations of the area which has a high contribution to intense rainfall. This is due to the distributed rainfall system has more logical meaning by real pattern of rainfall in comparison with lumped concept such as Thiessen’s polygon.
Figure 2: Landuse of Sungai Jeluh catchment for curve number map development

Figure 3: Distributed rainfall intensity of Kajang area
4. Conclusion
One of the critical topics in flood subject is a pattern verification of rainfall in urban regions. In this study, Kajang (Malaysia) has been identified as a flood prone area by development of distributed rainfall system and land use map via HEC GeoHMS. Results show that pattern of rainfall is lower at upstream than downstream based on intensity. It has been suggested to use distributed rainfall for input data in hydrological model to have improved hydrological analyses.

Acknowledgements
The authors wish to acknowledge and express our gratitude to Water Resources Management and Hydrology Division, Department of Irrigation and Drainage of Malaysia (DID) and ZHL-Engineers Sdn. Bhd. for collaborating in this study of “Enhancing Distributed Rainfall Intensity for Flood Analysis within a GIS Framework in an Urban Area (Kajang Flood)” project.

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