Regionalisation of rainfall runoff modelling for flood forecasting in Indonesia

Project Background Information/Introduction:

Flooding is the most frequent disaster in Indonesia, causing significant damage. Almost all areas in Indonesia experience flooding and more than 1 million households are affected on an annual basis. In order to prevent flooding, some approaches have been applied such as flood mitigation dikes and flood detention basins but these cost a lot of time and money. On the other hand, the development of flood warning systems can be implemented relatively fast with relatively low cost, and it can minimize flood-induced economic damage and also avoid fatality.

The development of reliable flood warning systems require lots of historical hydrology data. Such data is needed to calibrate hydrological models for flood forecasting. Unfortunately, not all of the catchments in Indonesia have historical flow records and most catchments in Indonesia are ungauged. However, statistical techniques, known as regionalisation methods, can be used to relate ungauged catchments to hydrologically similar gauged catchments. This enables simulation of historical and future flow data from ungauged areas.

Most of the previous regionalisation research has been done in the developed countries which usually have good data quality from reference catchments, and it is supported by relatively good hydrological and catchment properties data. Several previous studies have attempted to apply methodologies derived from developed countries to developing countries, and it has led to unacceptable levels of uncertainty for flood analysis in the developing country (Visessri and McIntyre, 2016). Regionalisation methods are less known in Indonesia and may be not as successful as those reported for other regions. My study will address this great challenge, in order to develop a regionalisation method for flood forecasting in Indonesia.

Research Aim/Objectives/Questions/Hypotheses:

This work seeks to contribute to understanding of regionalisation methods that can be applied for developing countries with limited hydrological data for flood forecasting analysis. The aim of this study is to assess applicability of regionalisation methods for flood forecasting in Indonesia.

Data/Methods/Analysis:

A rainfall-runoff model is a simplified representation of real-world hydrological processes and will be used to estimate streamflow with the rainfall and catchment properties as an input. One of the conceptual rainfall-runoff models that has a small number of parameters is the Probability Distribution Model (PDM) which has structural simplicity that is thought appropriate

given the imposed data limitations (Mathias et al., 2016). PDM will be applied to modelling the streamflow in donor catchments and ungauged catchments for developing a regionalisation method. Regionalisation methods to be evaluated in this study include: (a) spatial proximity method based on geographical distance; (b) physical similarity method based on catchment characteristics similarity; and (c) regression method. These functions will be applied in ungauged locations to estimate the model parameters, which will be used in the PDM to predict the streamflow. To maintain data prediction quality, this study will also analyse the uncertainty. Every model has a degree of uncertainty and hydrological models are no exception. Uncertainty in streamflow forecasting can be present from observed streamflow, input climate data, and also arises from simplification in the hydrological models and the regionalisation methods adopted. Therefore, maintaining data and model uncertainty of streamflow prediction in ungauged catchments is an important component of evaluating suitability of regionalisation schemes.

Contributions to the SDGs:

This study will lead to improved flood warning systems to provide critical information for flood response teams and communities which can protect property and save lives. This will lead to equitable disaster relief infrastructure, building towards Sustainable Cities and Communities (SDG 11). Developed flood warning tools will provide specific warnings about likely health impacts enabling better avoidance of flood-related water diseases including mental health. This will build towards Good Health and Well-Being (SDG 3). Such system will also provide specific warnings about infrastructure vulnerability including flood contamination of water supplies, enabling more secure water and sanitation that related to Clean Water and Sanitation (SDG 6).

Lessons learnt and key takes/reflections:

This study provides new frameworks for predicting river flows during flooding events in ungauged tropical catchments.

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