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SWAT AND ANN MODEL HYDROLOGICAL ASSESSMENT USING MALAYSIA SOIL DATA

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Flood is a primary hazard affecting Malaysia, often responsible for loss of lives and a severe threat to infrastructure and environment. Activities in flood plain and catchment such as land clearing for other developments effort may increase the magnitude of a flood. The problem of flood management cannot be solved simply by providing more construction of dams and reservoirs. The adoption of a strategic approach is needed for planning and managing that flood management in any watershed. The evolution of distributed watershed models has been established for more accurate representation of the hydrological system by considering the spatial variability of model parameters and inputs. The research aims to evaluate the performance and hydrological response of the Soil Water Assessment Tool (SWAT) process-based model in tropical river basin using Malaysia soil data. This study was specific to the upper part of Langat River Basin (UPLRB) in the context of Greater Kuala Lumpur Plan in the southern region. The research also provides a streamflow prediction using the Artificial Neural Network (ANN) method as another tool for assessment. ArcSWAT2009.93.b, which is embedded in ArcGIS10, has been selected for this study, and the model requires comprehensive data on topography, soils, land use and daily weather data within a watershed. SWAT-CUP, which links SUFI-2 algorithm to SWAT models, has been utilized in the study for the calibration of SWAT models. There were two sets of algorithms in developing the UPLRB ANN model and every algorithm set consisted of model inputs data preparation, neural network script and neural network error checking measures. All the processes for ANN model were conducted in MATLAB software. The study found that five SWAT input parameters were required to show the most stable and sensitive outcome using both local and global sensitivities analysis techniques, inclusive of CN2.mgt, GW_Delay.gw, SLOPE.hru, SOL_AWC.sol and SOL_K.sol. SWAT model performed better during the validation period compared to the calibration period in simulating streamflow at UPLRB. The runoff values were low at the upstream, and the evaluated value was increased from upstream sub-basin towards downstream sub-basin of the river basin with the exception of sub-basin 4 and sub-basin 10. The grand average of the surface runoff output for the period of the study ranged from 18.621 mm to 113.293 mm. The month of November experienced the highest monthly runoffs for all three different settings. The study also successfully produced two distinct sets of Neural Network Scripts to predict streamflow at UPLRB. Both models produced good results in predicting streamflow, and the existing AWC soil data in the ANN model did not significantly change the value of the simulation output. A comparison between the simulated streamflow by ANN model and SWAT model proved that the coupling of the outputs improved the results of the streamflow, mostly at the peak value of the monthly streamflow. It is hoped that the study can contribute to the improvement of integrated river basin management in tropical river basins.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Water quantity has been part of growing nationwide environmental concerns in Malaysia. Governments have developed a substantial range of policies, regulations, strategies, and frameworks to protect and conserve water quantity, and the aquatic ecosystems. To accomplish a holistic approach in managing river basin in the country, the Department of Irrigation and Drainage took the responsibility of starting an Integrated River Basin Management (IRBM) programme at the watershed basis. The objective of IRBM comprises of to ensure clean and sufficient water, reduce flood risk and enhance environmental conservation. Two river basins were selected for this project under river category wholly within states. In the central part of Peninsular Malaysia, the Selangor River was chosen to start this project, which was managed by Selangor Water Management Authority. In the northern region of Peninsular Malaysia, the Kedah River was selected and supervised by the Department of Irrigation and Drainage, and the State Economic Planning Unit. A main criterion for the program includes planning and upgrading management practices in the river basin.

Watershed models are useful tools for water resources assessment, development, and management. The models are able to quantify the impact of watershed management strategies, linking human activities within the watershed to water quantity of the receiving stream or lake for environmental and water resources protection (Singh and Woolhiser, 2002). Numerous operational, lumped or conceptual models have been developed since the development of the Stanford Watershed Model in the 1960s. With the evolution of watershed modeling, distributed models have been developed for more accurate representation of the hydrologic system by considering the spatial variability of model parameters and inputs. In recent years, with the development of Geographical Information System (GIS) knowledge, the use of spatial databases and GIS interface distributed hydrologic models have led to remarkable progress in detailed spatial analysis of hydrologic and water resources systems.