UNIVERSITI TEKNOLOGI MARA

SATELLITE BASED QUANTITATIVE RAINFALL ESTIMATION FOR FLASH FLOOD FORECASTING

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Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of Philosophy

Faculty of Civil Engineering

January 2008

ABSTRACT

The nature of flash flood which can be dreadfully torrential in a very short time requires an improvement in its flood forecasting-and-warning system (FFWS) to further mitigate flood damages and loss of life. The use of geostationary meteorological satellite images in estimating rainfall has become an attractive option in improving the performance of FFWS. Although the estimates are indirect, meteorological satellites with fine temporal and spatial resolution cover broader areas that may be inaccessible or that may cause difficulties with the traditional rainfall measurement such as the oceans or rigid mountains, therefore should be taken as complementary to radar and rain gage measurements. In this study, a rainfall estimation algorithm using the information from the geostationary meteorological satellite infrared (IR) images is developed for potential input to a flood forecasting system.

Data from the records of Geostationary Meteorological Satellite-5 (GMS-5) IR images have been retrieved for selected convective cells to be trained with the radar rain rate in a back-propagation Artificial Neural Network (ANN). The selected data as inputs to the neural network, are five parameters having a significant correlation with the radar rain rate: namely, the cloud top brightness-temperature of the pixel of interest, the mean and the standard deviation of the temperatures of the surrounding five by five pixels, the rate of temperature change, and the sobel operator that indicates the temperature gradient. In addition, three Numerical Weather Prediction (NWP) products namely the precipitable water content, relative humidity and vertical wind are also included as inputs; to provide some considerations on the meteorological factors that physically contribute to rain formation.

The algorithm is applied for areal-averaged rainfall estimation in the upper Klang River Basin and compared with another technique, which uses power law regression between the IR cloud top brightness temperature and radar rain-rate. Results from both techniques are validated against recorded Thiessan areal-averaged rainfall with coefficient correlation values of 0.77 and 0.91 for the power-law regression and the ANN-based technique, respectively

This satellite-based quantitative rainfall estimation using the ANN technique is then transformed to a satellite-based quantitative precipitation forecast (QPF) by using the cross correlation technique to track the direction of movement of the convective cloud cells. In addition, an example rainfall-runoff model is developed, namely the unit hydrograph technique to be linked with the satellite-based QPF to become a coupled hydro-meteorological FFWS. An extra lead time of around two hours is gained when the coupled hydro-meteorological model is applied to forecast several flash-flood events in the upper Klang River Basin.

ACKNOWLEDGEMENTS

All praises be to the Al-Mighty Allah S.W.T for the guidance, strength and blessings; only with His will that the work is able to be completed.

Deep appreciation is to my main supervisor, Dato' Prof. Ir. Dr. Sahol Hamid Abu Bakar for all the ideas, support and motivation provided throughout my study period. Appreciation also goes to my co-supervisor Prof. Dr. rer. nat. Dr.-Ing. András Bárdossy from Institut fur Wasserbau, Universitat Stuttgart, Germany, for the clarification and thoughts contributed.

Deep gratitude to Prof. Dr. Eeichi Nakakita, a professor of Hydro-Meteorology from the Disaster Prevention Research Institute, Kyoto University for filling in the voids in the overall picture of my work and the abundant of materials supplied. Many thanks also to Prof. Dr. Ruslan Hassan as my research progress evaluator for the excellent criticism and comments from all angles which had driven me to be alert of my research scope and limitation.

Many gratitude to Puan Maznorizan Mohamed, the Head of Satellite Divison of Malaysian Meteorological Department, Encik Razak, the Head of Radar Divison of Malaysian Meteorological Department and Encik Wahab from the same divison. Without their helps, I would not be able to acquire my primary data. Also to Encik Azmi Jaffri and Encik Azlan Abas from the Drainage and Irrigation Department for the rainfall-runoff data, and Encik Zaki from the Malaysian Mapping Department for the case study catchment materials.

Many thanks to the Deans (Dr. Yusof and Dr. Zainab) of the Faculty of Civil Engineering for all the supports and concerns, to Dr. Hamidah, Datin Dr. Hanizah, Dr. Amin and also to many other individuals in the faculty for their worthy contributions. Thanks also to the Institute of Research, Development and Commercialization for some funds provided.

Last but not least, my heartiest thanks to my husband Ahmad Shukri, my beautiful children, Abdullah Azzam, Fatin Mardhiyyah, Maryam Nadzifah and Imran Hakeem for their loves and indirect supplies of courage and strength; and to my dearest mother and everyone in the family who never fail to make *doa* for my success.

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July 2, 2007

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