1) QUANTITATIVE PRECIPITATION FORECAST USING NUMERICAL WEATHER PREDICTION (NWP) AND METEOROLOGICAL SATELLITE FOR FLOOD FORECASTING

The unusual heavy rainfall episodes at Kelantan River Basin in 2014 had caused massive destruction and several deaths. The unprecedented storm events at the northeastern Peninsular Malaysia and many other places indicated the need for enhanced storm forecasting to improve disaster preparedness among the civilian. Quantitative precipitation forecast (QPF) from atmospheric model, combined with geostationary meteorological satellite information as input to hydrodynamic model for flood forecasting system can potentially provide improved lead-time for warning. In this study, a QPF model was developed using the multilayer neural network with data inputs from the numerical weather prediction (NWP) model products (WRF model) combined with the geostationary meteorological satellite (FY-2C) infrared and visible image features to forecast precipitation for a flood-prone area in a tropical region. The results show that the model can satisfactorily produce 1-hour rainfall forecast with improved accuracy for larger forecast area.

Figure 1 (a) WRF output display (dated 21st November, 2009) covering Peninsular Malaysia  (b) Sample of 24-hour accumulated rainfall data
Figure 2 (a) FY-2C Infrared Image (b) MTSAT Visible Image

Figure 3 Multi-layer ANN model of QPF
Floods have been the most common natural disaster in the east coast Peninsular Malaysia especially during the monsoon season; generally due to the prolonged heavy rainfall occurrences. The nature of rainfall distribution which can be significantly non-uniform over a river basin requires the use of more advanced rainfall measuring techniques other than the telemetric rain gauges, especially for inputs to flood forecasting and warning system (FFWS). Weather radar can provide reliable and promising alternatives in rainfall estimation. Weather radar has been used to provide rainfall inputs to flood forecasting operation for many river basins around the world. The main advantage of the radar rainfall over point gauge rainfall is its ability to provide good spatial and temporal resolution rainfall information with a continuous detailed view of the rainstorm over a large area. However, the indirect estimation of rainfall using radar reflectivity factor is associated with various sources of error such as ground clutter, partial beam occultation, beam blockage and attenuation effects. In this study, the radar rainfall estimates were improved by climatological calibration of reflectivity-rain (Z-R) relationships for Pahang river basin. The reflectivity data for period of one year from Kuantan radar station and the hourly rainfall depths at 67 rainfall stations located in the basin for the same periods were used. Correlation analysis between radar and gauged rainfall indicates that the further the distance from the radar, the weaker the $R^2$ coefficient value. Two Z-R equations were derived using optimization method for distance (1) 0-100 km and (2) above 100 km from Kuantan radar. The results in the form of $Z = 24R^{1.7}$ and $Z = 5R^{1.6}$ represents the average relationship for Kuantan radar for distance (1) and (2). To further improve the accuracy of radar rainfall estimation, further calibration using gauged-radar rainfall ratio is recommended. The improved radar rainfall estimates can then be used as the input data for the FFWS for Pahang river basin.
Figure 1 (a) The Kuantan Doppler Radar (KN Radar) (b) Comparison between gauged rainfall with radar QPE

Figure 2. Display from KN Radar for events dated 26.12.2014 at 12:00 (a) using the Marshall Palmer (b) using the two new Z-R equations for distance 0-100 and above than 100 km

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