UNIVERSITI TEKNOLOGI MARA

THE DOCTORAL RESEARCH ABSTRACTS

Volume: 11, Issue 11 April 2017

ELEVENTH ISSUE

INSTITUTE of GRADUATE STUDIES

IGS Biannual Publication

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Name : SITI NORATIQAH MOHAMAD DEROS

Title : MODELING SEASONAL WIND PATTERN FROM IMAGING AND NON-IMAGING DATA

Supervisor : ASSOC. PROF. DR. ARNIS ASMAT **(MS)**
PROF. DR. SHATTRI MANSOR **(CS)**

Wind speed in Malaysia is categorized as low with annual mean of 3-5 m/s and influenced primarily by four monsoon season; Northeast and Southwest monsoon with two transition period; April and October inter monsoon. Monsoon seasons were classified based on the origin of wind blows that brings unique character of wind speed and direction. Current wind study utilized limited wind data to projects wind behavior in wind pattern model generation. Short-term wind data insufficient to explain wind criteria by neglects the seasonality behavior of wind caused by different monsoon season. Wind observation using ground measurement devices such as anemometer and wind vane produced limited spatial resolution data that initiated the used of imagery data with 100-150 km_2 swath width. Wind direction extraction using wavelet transform (WT) technique is an example of wind study using imagery data. However, the study focused on high wind speed area due to the limitations of wavelet coefficient derivation that requires minimum 7 m/s wind speed and underestimates streak produced by lower speed. This study attempts to develop wind pattern model by forecasting the seasonal wind speed, determine the seasonal wind speed distribution model and extract wind direction from SAR images acquired at low wind speed area. The study site represents the seasonal and low wind speed condition in Pulau Langkawi, Malaysia. The timely wind speed data used for year 2000-2010. The imagery data used is Standard-2 (100 km_2) and Wide-3 (150 km_2) RADARSAT-1 SAR images to picture high spatial resolution wind direction in Langkawi. Autoregressive and Moving Average (ARMA) model was used to combine the seasonal and non-seasonal component of wind speed that will be used in wind speed forecast. The seasonal wind speed distribution model was determined among Lognormal, Weibull and Gamma distribution model; evaluated using goodness-of-fit test with the lowest error value is the most fit distribution model. Introduction of new WT technique to extract low wind speed wind direction was performed on Standard-2 and Wide-3 RADARSAT-1 SAR images. Enhancement involved the derivation of wavelet coefficient of low wind-induced streak on SAR data that then was transformed by using Fast Fourier Transform (FFT), Short Time Fourier Transform (STFT) and Mexican-Hat wavelet transform technique. Finally, the wind pattern model used is the Multi-Layer Conveyor (MLC) model simulated from wind speed, direction and the day in monsoon as the time unit, and the wind speed distribution as wind capacity measure. SARIMA $(1,1,1)\times(1,1,3)$ model is the ARMA model that best represents the seasonal wind speed with high r-squared value (>0.9) in each monsoon season. This showed that the coefficient of determination between sample data and forecasted data is relatively high. Lognormal distribution model is the best model used to describe the seasonal distribution of wind with goodness-of-fit test showed lowest error (0.07-0.14) between the model performance and data. The introduction of new wavelet transform technique using FFT domain spectrum is the most suitable technique to extract wind direction at low wind speed area with r-squared value of 0.71 for Standard-2 and 0.99 for Wide-3 image. Wind pattern model developed showed high r_2 (0.94) and correlation (0.97) with actual wind data. As a conclusion, the seasonal wind pattern model developed using MLC model by using derived parameters successfully described the wind behavior of distinct monsoon season and able to projects the long-term scenario of low wind.

* (MS) = Main Supervisor (CS) = Co Supervisor