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【論文の内容の要旨】

Rainfall is one of the key variables that sustain many ecotourism sites in tropical region. Good rainfall maps would be helpful for the related tourism authorities in preparing a suitable facilities and activities that would meet the satisfaction of the tourists. For example, certain ecotourism activities for instance water sports are not suitable during dry season due to low water level. Another example is a good wildlife sighting condition may hindered if heavy torrential rainfall occurred. Indirectly the availability of effective rainfall data at both spatial and temporal basis would make the assessment of health and condition of the ecotourism sites possible. In particular, information on condition ecotourism site is vital in determining the sustainability of the ecotourism products in humid tropical region. Moreover, as the related elements that is affecting the ecotourism site and human health are also plausible. Torrential heavy rain is one of the most serious risks in property and personal accidents. However, various limitations of rain gauge measurement such as inadequate quantity, insufficient coverage and inefficient management has urged for alternative rainfall data support in humid tropics. Utilizing satellite precipitation is considered useful option due to its public data access and effective spatio-temporal characteristics. However, but, the accuracy of satellite precipitation data in humid tropical region particularly in small-sized region is hindered by several factors including coarse grid size and large

quantitative error. Therefore, The effectiveness of satellite precipitation data namely Tropical Rainfall Measurement Mission (TRMM) as an alternative rainfall measurement in humid tropical region was evaluated and improved in this thesis.

The accuracy of the Tropical Rainfall Measuring Mission (TRMM) satellite precipitation data is intensively evaluated at local climate region and seasonal monsoon scale in Peninsular Malaysia. Dense number of rain gauges (> 900) were employed to conduct the assessment from 1998-2010. The intensive validation indicated that spatio-temporal accuracy of TRMM data were varied during different monsoon seasons and rainfall intensity. The ability to depict local spatial rainfall pattern was hindered by coarse pixel grid size and varied via local climate regions. Difference of precipitation mechanism between rain gauge which quantified the rain on the ground and satellite that estimate the rain rate in the atmosphere was identified as one plausible affecting factor. Measures to improve the quantitative and spatial quality of TRMM data for small-sized humid tropical region were discussed.

The effort to minimize the large errors from TRMM rainfall data during the heavy thunderstorm monsoon without presence of rain gauge using principal component analysis was tested. 728 rain rate images during heavy thunderstorm from November to December were examined in three different years (2003, 2005, 2008). The output was positive where the bias was reduced at average of 62%. Approximately 70% of the samples were showed bias ratio reduction. PCA threshold values during different rain rate intensity were critical to determine the effectiveness of the approach. Using threshold value higher than 1.0 was effective for low intensity rainfall (< 12mm/day). For medium (13-29 mm/day) and high intensity rainfall (> 30mm/day), threshold value of 1.0 showed the most consistent performance.

Refining the coarse TRMM data grid size from 0.25 degrees to 0.06 degrees using high resolution seasonal co-efficient (HRC) was examined. Alternative environmental variables was needed to drive the spatial downscaling of satellite precipitation data in humid tropical region since other suggested variables from previous literatures were not suitable. The HRC was derived based on historical bias records for 10 consecutive years (1998-2007) and its applicability was tested using an independent datasets from 2008-2010. Despite the improved output, there was lacked of evidence to support the low variance of historical satellite-bias ratio and the effectiveness of HRC products. It was clarified that the HRC robustly minimized the large present error by the TRMM data. The HRC based technique, nevertheless was capable to produce high resolution satellite precipitation product with good accuracy (bias ratio: 28%). No negative impact was found from the spatial downscaling using the derived HRC.

The output of this study has significant implication in sustaining the tourism sector

direct and indirectly. Directly, the high accuracy of satellite precipitation data during heavy rainfall season would enable the effective disaster and risk management over the ecotourism locations that having poor on site rainfall measurement. Sites that are prone and highly exposed to flood can be identified. This tourism places may include the upper stream water fall, downstream river, and river banks. For the responsible authorities, that information was useful for necessary measures of disaster prevention, mitigation and post-event assessment. Acknowledging tourist with such information is useful for tourist in planning their journey and trips to prevent unprecedented casualties.