Assessment of Flowering Pattern using Climatic Remote Sensing Data in Peninsular Malaysia

Mohamad Hanif Bin Abdullah[1] and Noordyana Binti Hassan [1]
[1] Department of Geoinformatics, Universiti Teknologi Malaysia, Johor Bahru, Malaysia.
Email: hanifabdullah193@gmail.com , noordyana@utm.my

KEY WORDS: General flowering, climatic data, Digital Elevation Model (DEM), Peninsular Malaysia, Wind speed

ABSTRACT: In South-East Asian dipterocarp forests, phenological patterns are usually associated with clear seasonality of the climatic season. In Peninsular Malaysia, general flowering (GF) occurs at irregular intervals. However, seasonality in GF is poorly developed using only prologue drought and land surface temperature (LST). We advocate including the wind speed parameter to optimize the GF score along with SRTM satellite's digital elevation model (DEM). It will display the affected area because of the wind speed. Throughout this paper, we seek to enhance the GF pattern of Peninsular Malaysia by using climatic data and wind speed to identify the affected areas that were indirectly involved in GF in 2010. To improve the GF score in Peninsular Malaysia, we examine the precipitation value and Land surface temperature (LST) from the Moderate resolution Imaging Spectroradiometer (MODIS) and Tropical Rainfall Measuring Mission (TRMM) satellites as climatic data, as well as wind speed near the surface from the Global Land Data Assimilation System (GLDAS) Noah Land Surface Model.

INTRODUCTION

The general flowering (GF) events of Southeast Asian forests are among the most spectacular phenomena in tropical biology. GF events occur in multiyear cycles. Synchronization of reproduction among individuals occurs in seasonal environments, in part because a particular season is most favourable for reproduction and offspring survival. The reproduction of trees in the forest is critical for maintaining the global balance of ecosystems, but the researchers were unable to find a set of parameters to model the general flowering to a specific extent. Most of the flowering pattern research required a very long temporal data observation, which was costly.

Several ecologists have analysed these phenomena to discover the underlying causes of synchronisation. Many studies on plants had already focused on high year-to-year variation in seed production known as 'masting' or 'mast seeding' (Kelly, 1994). For some plant species, especially wind pollinated trees in temperate forests, high annual variability of crops perfectly aligned among individuals of single or closely related species has been reported.

Recently, the hypothesis and concepts of flowering phenology have been studied using remote sensing data in order to utilise the remote sensing data in the forestry division, (Appanah, 1985; Numata, Yasuda, Okuda, Kachi, & Noor, 2003; Numata et al., 2013) shows that by using rainfall and land surface temperature, we can predict the time of flowering event in south east forest, (Azmy et al., 2016 Previous research (Hanif, n.d.) also used MODIS NDVI to investigate flowering phenology this study area.

We try to find the relationship between wind speed and elevation in this paper to improve the small-scale area seeing as wind is an important climatic factor, especially in coastal and mountain environments, where it can explain the observed patterns of distribution of some species (Griggs 1983). Wind has both damaging (stem and branch breakage, leaf injury, growth inhibition) and beneficial (pollen, seeds, and other propagules distribution, increased supply of CO2) effects on plants. Different wind effects predominate in various environments. The dominant effects in coastal environments are direct physical damage or material damage (sand or salt), desiccation effects in arid environments, ice crystal damage in tundra, and decreased leaf temperature and thus decreased metabolic rate in alpine environments.

Wind's complex effects on vegetation are mediated by changes in water, food, and hormone relationships, as well as by turbulent transfer of heat, water vapour, CO2, spores, pollen, and seeds (Kozlowski et al. 1991). With the help of windspeed, we can now investigate the consistency of lowland rainforest tree partition forest clearing as an establishment site for offspring.

MATERIAL AND RESULT

The main findings of the results focusing on the time series graph for the entire year 2010. Figures 2, 3, and 4 illustrate the intensity of general flowering from 2001 to 2010. We attempt to investigate the relationship between wind speed and the general flowering effect using the elevation explanation. The results show that the GF is associated with low rainfall rates and high precipitation. The NDVI value in Figures 2, 3, and 4 is low, indicating the GF season in Peninsular Malaysia, as the tree is covered by flowers, revealing a low green value.

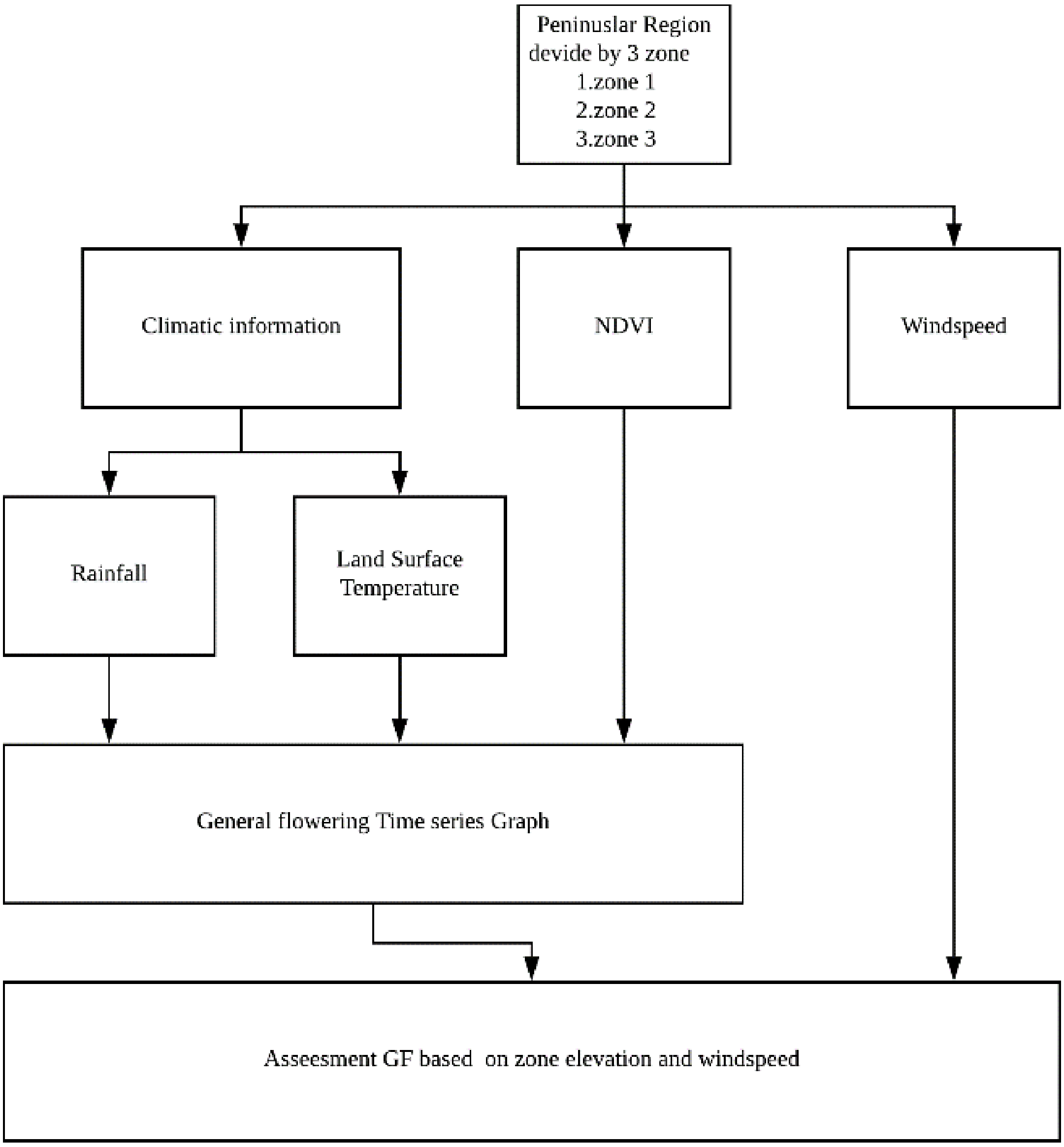

Figure 1: Flowchart of the Methodology

As shown in Figure 1, the research methodology of this study began with the selection of a forest location in Peninsular Malaysia, and the location was divided into three zones with varying elevations. The location's elevation was calculated using the Mean Sea Level (MSL). The location is then used for rainfall data extraction and land surface temperature data as the constant parameter for studying the GF pattern. The wind speed is also extracted to study the GF relationship. Following the completion of the data extraction, the information was displayed in the graph as figures 2, 3, and 4.

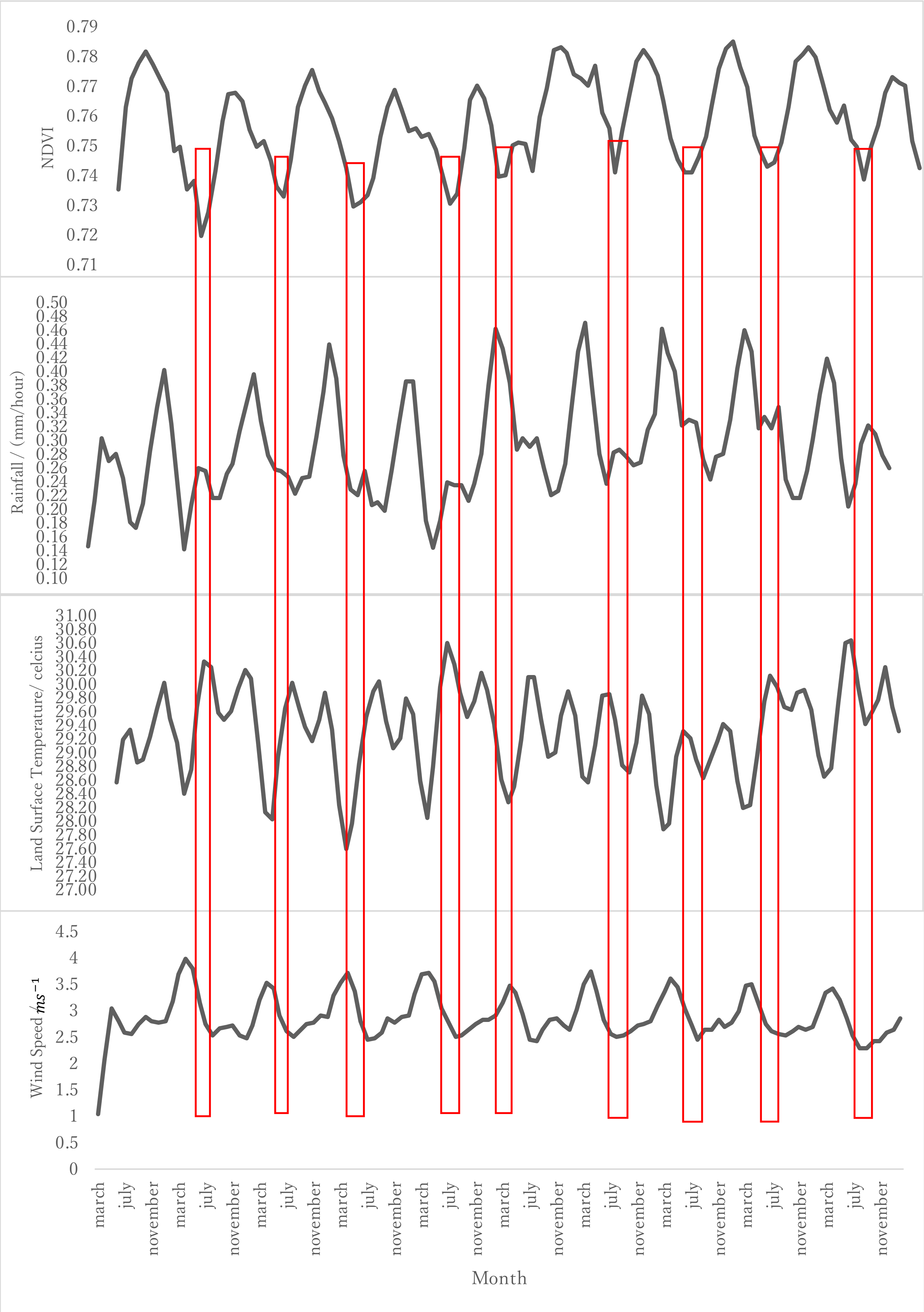

Figure 2: Results for zone 1

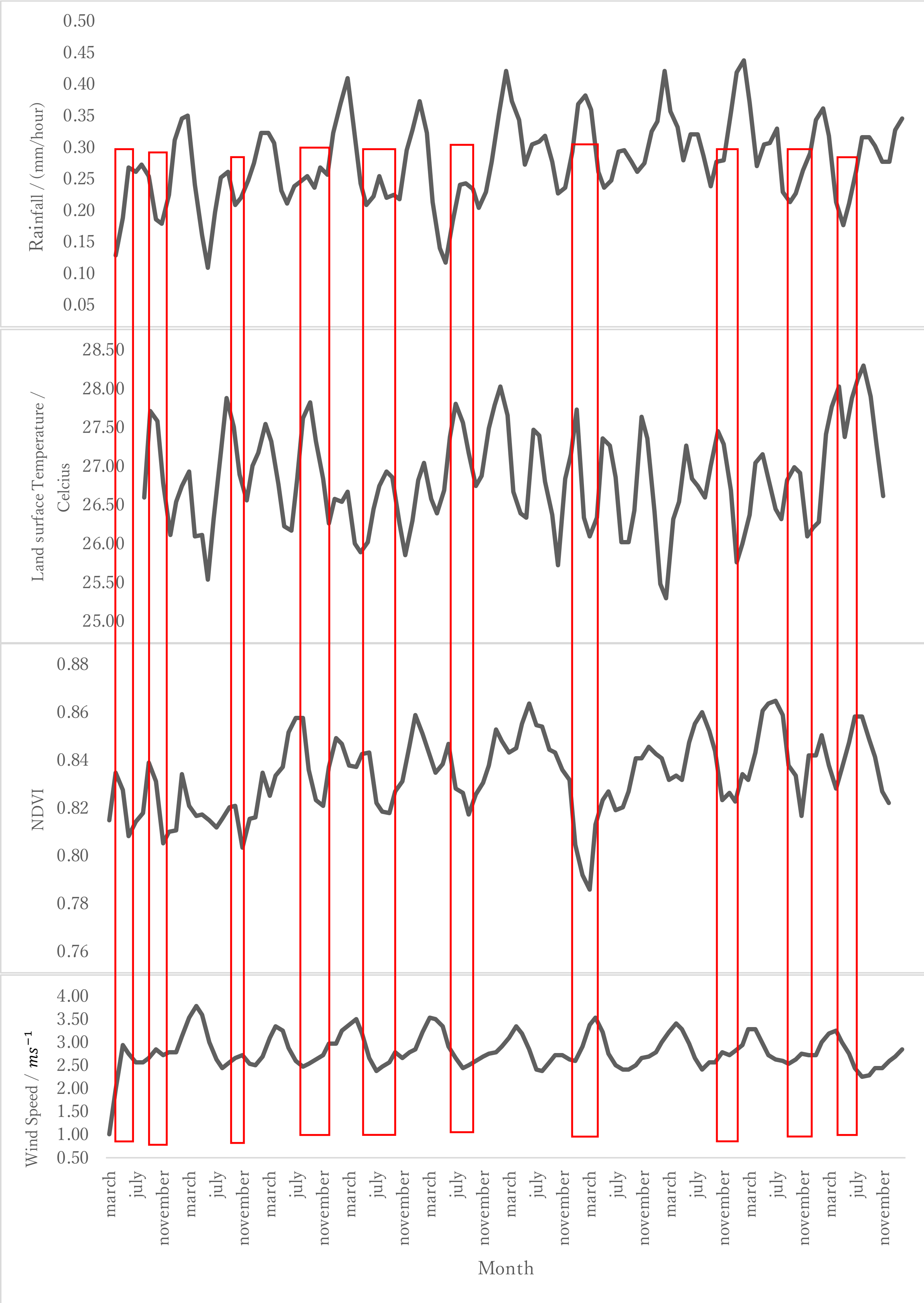

Figure 3: Results for zone 2

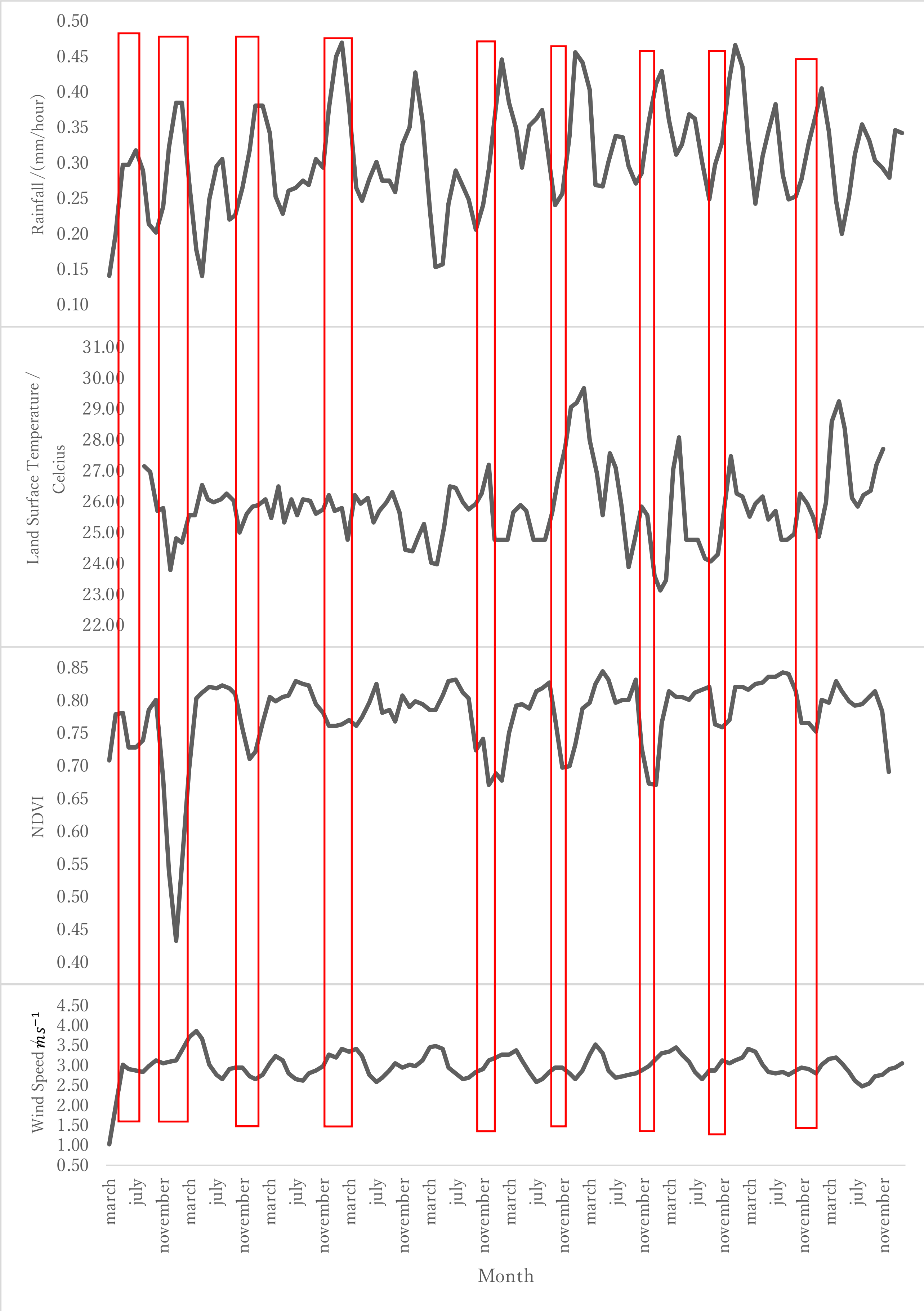

Figure 4: Results for zone 3

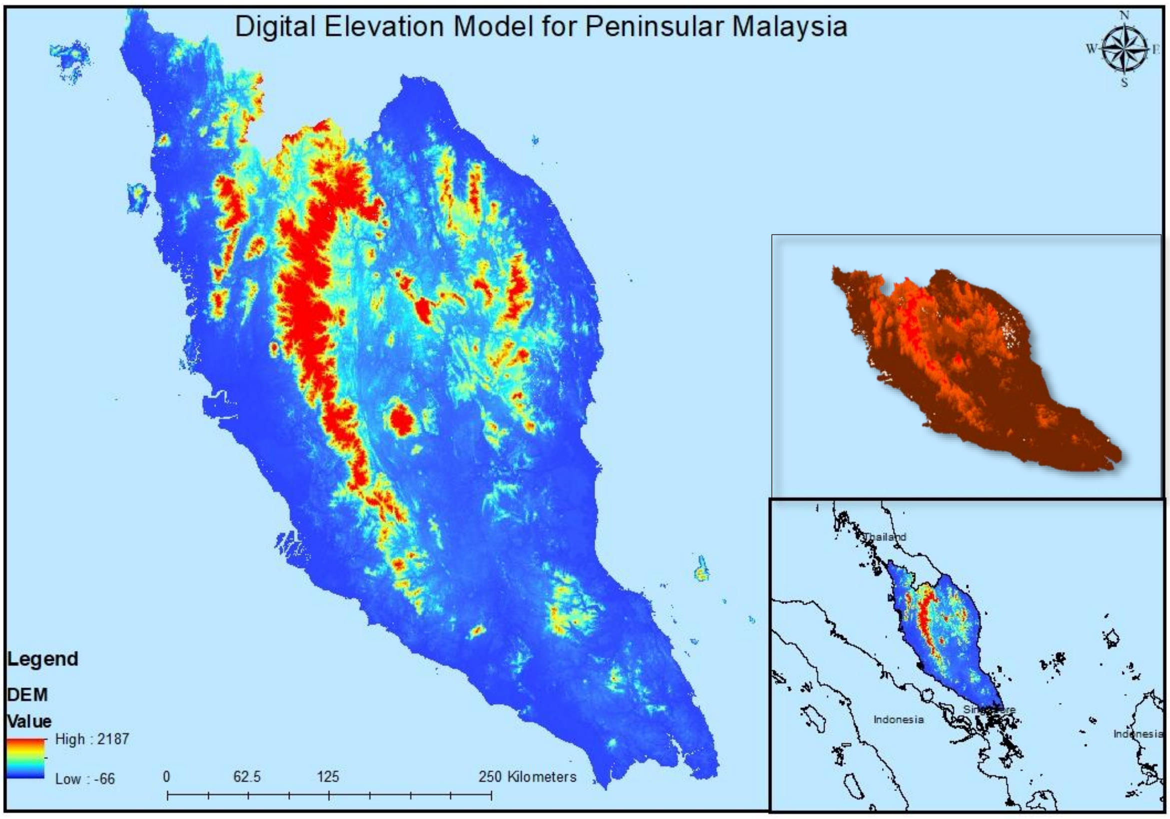

Figure 5:

The results show that there are nine GF flowering in the ten-year study, as evidenced by NVDI and climatic data. The results were obtained by plotting a three-month moving average graph from March 2001 to December 2010. Zones one and three show nine GF, but zone two shows ten GF, indicating that the elevation of the area has a significant impact on the GF season on Peninsular Malaysia, implying that elevations of 150m to 300m interact strongly with the climatic condition effect. The GF also effect by the medium speed of the wind as the figure shows the range of wind speed is 2.5 ms^{-1} to 3.5 ms^{-1}. From the results, the GF pattern can be improved with the elevation of the study area and moderate wind speed from the satellite data. The result can be distinguished for the true GF event or common side effect on the ENSO in large spatial scale. The strong wind can give huge damage on the high elevation area which can reduce of the flowering intensity due to tree need to recovery from the damage but for the small spatial scale study, the wind speed needs to compare with ground data.

CONCLUSION

The results show that windspeed at higher elevations produces a higher percentage of reproductive seed due to the size of the opening of the microclimatic gap, giving the species a better chance of survival in extreme conditions. The windspeed and elevation support the hypothesis that if we want to study the large-scale area, we must consider the climatic (rainfall, land surface temperature, and windspeed) and environmental factors (elevation), because these two parameters are the primary reasons for the irregular interval of general flowering. In some cases, ground data is required for wind speed in a small-scale area.

ACKNOWLEDGMENT

We gratefully acknowledge a Fundamental Research Grant Scheme (FRGS)- Spectral Characterisation of Triggering Biophysical Properties of General Flowering using Satellite Remote Sensing Data -R. J130000.7827.4F902, Ministry of Higher Education Malaysia, Universiti Teknologi Malaysia (UTM) and Tokyo Metropolitan University (TMU) for providing the data for this study.

REFERENCES

Allison TD. 1990. Pollen production and plant density affect pollination and seed production in Taxus canadensis. Ecology 71: 516–522.

Appanah S. 1985. General flowering in the climax rain forest of southeast Asia. Journal of Tropical Ecology 1: 225–240.

Appanah S. 1990. Plant–pollinator interactions in Malaysian rain forests. In: Bawa KS, Hadley M, eds. Reproductive ecology of tropical forest plants. Lancs: Unesco, Paris and The Parthenon Publishing Group, 85–101.

Appanah S. 1993. Mass flowering of dipterocarp forests in the aseasonal tropics. Journal of Bioscience 18: 457–474.

Appanah S, Chan HT. 1981. Thrips: the pollinators of some dipterocarps. Malaysian Forester 44: 234–252.

Ashton PS. 1982. Dipterocarpaceae. Flora Malesiana Series 1. Spermatophyta 9: 251–552.

Ashton PS. 1989. Dipterocarp reproductive ecology. In: Leigh

H, Werger MJA, eds. Ecosystems of the world 14B: tropical rain forest. Amsterdam: Elsevier Scientific, 219–240.

Ashton PS, Givnish TJ, Appanah S. 1988. Staggered flowering in the Dipterocarpaceae: new insights into floral induction and the evolution of mast fruiting in the seasonal tropics. American Naturalist 132: 44–66.

Augspurger CK. 1981. Reproductive synchrony of a tropical shrub: experimental studies on effects of pollinator and seed predators on Hybanthus prunifolius (Vioraceae). Ecology 62: 775–788.

Appanah, S. (1985). General flowering in the climax rain forests of South-east Asia. *Journal of Tropical Ecology*, *1*(3), 225. https://doi.org/10.1017/S0266467400000304

Azmy, M. M., Hashim, M., Numata, S., Hosaka, T., Noor, N. S. M., & Fletcher, C. (2016). Satellite-based characterization of climatic conditions before large-scale general flowering events in Peninsular Malaysia. *Scientific Reports*, *6*. https://doi.org/10.1038/srep32329

Hanif, M. (n.d.). IDENTIFICATION OF DIPTEROCARPACEA FLOWERING PHENOLOGY USING. *Acrs 2018*, (1).

Kobayashi, H., Nagai, S., Kim, Y., Yang, W., Ikeda, K., Ikawa, H., … Suzuki, R. (2018). In situ observations reveal how spectral reflectance responds to growing season phenology of an open evergreen forest in Alaska. *Remote Sensing*, *10*(7). https://doi.org/10.3390/rs10071071

Numata, S., Yasuda, M., Okuda, T., Kachi, N., & Noor, N. S. M. (2003). Temporal and spatial patterns of mass flowerings on the Malay Peninsula. *American Journal of Botany*, *90*(7), 1025–1031. https://doi.org/10.3732/ajb.90.7.1025

Numata, S., Yasuda, M., Suzuki, R. O., Hosaka, T., Noor, N. S. M., Fletcher, C. D., & Hashim, M. (2013). Geographical pattern and environmental correlates of regional-scale general flowering in Peninsular Malaysia. *PLoS ONE*, *8*(11). https://doi.org/10.1371/journal.pone.0079095