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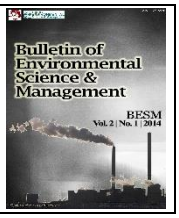

Spatial Temporal Analysis of Forest Fire in Malaysia Using ATSR Satellite Measurement

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Abstract

Over the last few decades, Malaysia experienced several severe forest fire episodes in history due to dry season and El-Niño events. In fact, research on fire event has become an important as its strongly responsive to climatic drivers, provide impacts on biogeochemical cycles and it tremendously affects ecosystems life. Therefore, this study aimed to collect and process Along Track Scanning Radiometer (ATSR) fire count data and to assess the distribution of fire occurrences in Malaysia. This study specifically used ATSR World Fire Atlas (WFA) product (Algorithm 2 data) from ATSR satellite data covering years 1997-2008. Preliminary results of this study show that there are 3 minor El-Niño events (June-December, July-November and September-October), and the large El-Niño event (January-April) had occurred as followed by an equally important La-Niña episode. Month of April and state of Sabah show the month and region with the highest fire events. There are several factors that can contribute to the forest fire events such as fire locations in Indonesia, anthropogenic activities, geographical and meteorological conditions and natural phenomenon such as lightning and El-Niño events. Findings from this study can be utilized to increase the understanding of spatial and temporal distribution of forest fire in Malaysia. ATSR Satellite measurements also found to be significantly helpful in providing a valuable fire data count.

INTRODUCTION

Forests are a natural, complex ecosystem, made up of a wide variety of trees which support a massive range of life forms and the greatest contributors of carbon on Earth. It plays an important role in global carbon cycle. Apart from trees, forests also include various types of soils that support trees and water bodies that run through them and even the atmosphere around them. It also acts as a climate control, as well as supplying oxygen, food and shelter for human and organisms' sustenance.

Forest fire is one of the events that completely destroyed the functions of forests towards ecosystem. It is defined as any fire which uncontrollable in combustible vegetation or forest cover that occurs in the rural or a wilderness area. Common sources of the forest fire are anthropogenic activities and natural phenomenon such as lightning and drought season. In Malaysia, increasing of land demands, which are caused by population growth, urbanization, civilization, economic benefits and technological advancement put a great stress on the natural forestry cycle and thus contributing to the forest fire events. Fire is used as the management tool in order to do the land clearing for development, industrial and agricultural area. Besides, the condition of the weather including temperature, humidity, precipitation and wind, proportion of the fuel and its distribution, physical and topography of the forest also affect the ignition of the forest fire to being spread faster than usual.

Nevertheless, the smokes and emissions from the forest fire events give hugely impact to human health and ecosystem condition. Forest fire episodes emit various trace gases such as carbon monoxide, carbon dioxide, methane and other trace pollutants which become the major sources of atmospheric pollution in Malaysia and these various types of greenhouse gases affect the climate change and global warming on earth [1-3]. Biomass burning events, particularly in Indonesia (Malaysia's neighbour), occur every year and become excessive during the prolonged dry season and thus the probability of haze is high across this region throughout the year. In 1997, this region experienced one of the world's worst pollution incidents in terms of its intensity, extent and duration, and the numbers of people affected. Smoke-haze episodes of unprecedented magnitude from large-scale biomass burning, which covered 3 million km² to 8 million km², an area approximating the size of Western Europe, were recorded in this episode [4]. Thus, this study aims to use ATSR World Fire Atlas measurements to assess the distribution of fire occurrences in Malaysia. Preliminary results of this study show that there are 3 minor El-Niño events (June-December, July-November and September-October), and the large El-Niño event (January-April) had occurred as followed by an equally important La-Niña episode. In fact, there are several factors that can contribute to the forest fire events such as fire locations in Indonesia, anthropogenic activities, geographical and meteorological conditions and natural phenomenon such as lightning and El-Niño events.

MATERIAL AND METHODS

The ATSR World Fire Atlas (ATSR WFA) is the longest global and consistent fire distribution series which consists of a global collection of hot spots detected using data acquired at night by the ATSR-2 nadir view camera of ERS-2 from November 1995 to December 2002 and extended using the Advanced ATSR since the beginning of 2003 to present [5-6]. In fact, almost 13 years the WFA's data being produce as consistently, thus it could be used as valid support to studies on long term analysis of climate parameters and potential trends in fire distribution. In this study, full dataset of Malaysia fire data product develop from algorithm 2 (308K threshold) aggregate monthly from year 1997 until 2008 was used for this study.

ANALYSIS PROCEDURE

In this research, a first attempt to collect and process the ATSR satellite data and study the occurrences hot spot potential trends is described by adopting the following strategy method. Firstly, the dataset of Malaysia forest fire monthly aggregate for period 1997 until 2008 was collected from ATSR World Fire Atlas data product that can be found at (http://dup.esrin.esa.int/ionia/wfa/index.asp). The algorithm 2 product (ALGO2) was selected because of ALGO2 more approach towards high surface temperature (308K) which highly detected all the possible fire events occurred. The monthly record generated by the ATSR WFA processing provides the detection date and time, and the pixel's coordinates with a±1 km geolocation accuracy for each hot spot. Secondly, The WFA monthly products then being retrieve and underpass a preliminary analysis process which aiming at the screening and classification of pixels according to state geographic information in Malaysia and to Glob Cover classification. In order to achieved accurate assess of the potential distribution of forest fire in Malaysia, it was decided to limit the period of interest analysed which was for monthly (January-December) and year range (1997-2008) for each state in Malaysia. In addition, due to the extracted time series and state region in order to retrieve statistical information and potential trend values for each selected category will be undergo the multivariate analysis such as Cluster Analysis and Principal Component Analysis. These analyses will give the overall observation of the pattern of forest fire events in Malaysia and the qualities data provided by ATSR measurements. Finally, the potential of occurrences in distribution of forest fire in Malaysia has been considered.

RESULTS AND DISCUSSION

Based on observation obtain from mapping the hot spot of forest fire count in Malaysia by monthly covered from 1997 until 2008 (Figure 2), there are 3 minor El-Niño events (June-December, July-November and September-October), and the large El-Niño event (January-April) had occurred as followed by an equally important La-Niña episode (October-December). In fact, the highest fire counts are on April due to the most contribution of fire events which is El-Niño events episode. In details, on January until April and August to September, the fire counts events become increasing in number as well as the hotspot whereas on May until July and November to December the fire counts started to slightly decrease due to another factors such as anthropogenic activities, geographical and meteorological condition.

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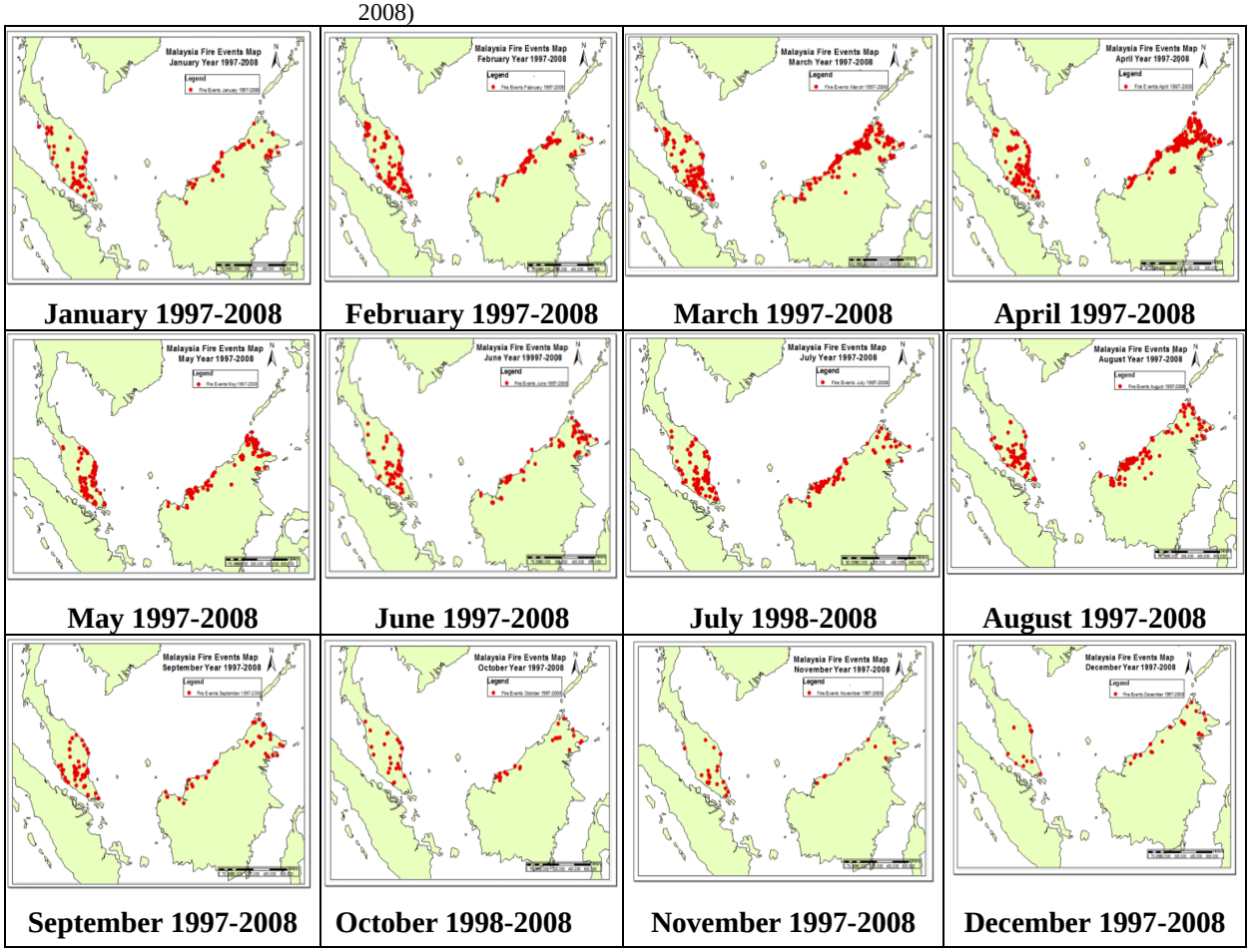
Based on Cluster Analysis result obtain (Table 1), in Cluster 1, those state region are the lowest fire counts event of all clusters and located at the West of Malaysia. In details, the wind from northeast will cause the moisture depletion in those state regions and this condition will be one of contributors in spreading as well as initiating the fire events and caused subsequently high count of forest fire events. In Cluster 2, Pahang is the state region with the bigger number in development activities which the forest was converted to other sector. Furthermore, Cluster 3 consist of the state region that located at the East of Malaysia and the factor such as wind from southwest will cause the precipitation depletion and increase the temperature in those state region. Thus, the fire activity become increasing in the number. For Cluster 4, Negeri Sembilan is the state region which has the most dry placed in Malaysia such as Kuala Pilah, Negeri Sembilan. In addition, Cluster 5 contains of Sarawak region which the state that has numerous of economies activities and development as well as the biomass number. In Cluster 6, Sabah is the state region that has the highest number of fire counts events due to bigger number of the biomass burning and located near the Indonesia. In fact, due to El-Niño events, the condition of the atmospheric also give effect to the fire events in Malaysia. Once the fire started because of several factors, it may spread continuously over the time.

Table 1. Cluster Analysis Class Spatially

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Perlis Kedah Pulau Pinang Perak Selangor Melaka	Pahang	Kelantan Terengganu Johor	Negeri Sembilan	Sarawak	Sabah

Figure 2: Malaysia Forest Fire Events Map Monthly (1997-2008)



CONCLUSION

ATSR Satellite measurements can significantly helpful in providing a valuable fire data count by increasing availability of data especially through improvement on satellite measurement sensors and their availability over longer periods and non-missing data. There are several factors contribute to the most common sources to ignite the forest fire events in Malaysia which are anthropogenic activities and natural phenomenon such as El-Niño events, monsoon winds, lightning and drought season.

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