Forest and Land Fire Prevention Through the Hotspot Movement Pattern Approach

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Abstract. Indonesia has experienced a great forest fire disaster in 2015. The losses incurred were enormous. But actually the incidence of forest and land fires occurs almost every year. Various efforts were made to cope with the fire disaster. The appearance of a hotspot becomes an early indication of the fire incident both location and time. By studying the location and time of the hotspot's appearance indicates that the hotspot has certain movement patterns from year to year. This study aims to show the pattern of movement of hotspots from year to year that can be used for the prevention of forest and land fires. The method used is time series analysis of land cover and hotspot distribution. The data used were land cover data from 2005 to 2016, hotspot data from 2005 to 2016. The location of this study is the territory of Meranti Kepulauan District. The results show that the highest hotspot is 425 hotspots occurs in the shrubs and bushes. From year to year, the pattern of hotspot movement occurs in the shrubs and bushes cover. The hotspot pattern follows the direction of unused land for cultivation and is dominated by shrubs. From these results, we need to pay more attention for the land with the cover of shrubs adjacent to the cultivated land.

Keywords: Hotspot, Landcover, Fire, Land and Forest, Time Series Analysis

1. Introduction

Indonesia has experienced a great forest fire disaster in 2015. The losses incurred were enormous. But actually the incidence of forest and land fires occur almost every year. Various efforts were made to cope with the fire disaster. The impact of these fires is smoke haze that blanketed the region known as the ASEAN Transboundary Haze Pollution. Losses caused by the huge smog covering the transport of water, sea, and land; health, education, economy, environment. As a result of peat fires in Sumatra accounts for the loss 2,8 billion dollar [1].

The identification of fires is obtained through hot spot data. A hot spot is indicated as the location of a fire [2]. Hot spot data is obtained through NOAA, MODIS. Hot spot data can also be downloaded from USGS and SIPONGI. In this activity the hotspot data used is hot spot data from MODIS image (Moderate Resolution Imaging Spectroradiometer) with spatial resolution 250 meters. Considering that at MODIS highest resolution, one pixel covers 250 m² [3].

Forest fires can occur because of the three elements of heat, oxygen, and fuel. Fire begins with combustion, which requires the mixture of heat, fuel, and oxygen in the right proportions or known as
the fire triangle. In the broader dimension of the actual conditions in the field of fire incident is triggered by three factors: vegetation, landform, and climatology [4].

![Figure 1. Triangel fire](image)

According to Saharjo [5,6] the opportunities for forest and land fires are caused by factors: political will, law enforcement, coordination, human resources, knowledge about forest fire, early warning and early detection, human approach. In relation to this study, the focus of the study is more on early warning and early detection factors. Signs for fire occurrence based on the concept fire triangle, among them are the fuel in the broad scale is vegetation. The question is which vegetation is the most potential as fuel. This is important to understand, so we can be alert from the beginning of the possibility of forest and land fires.

Fire data were obtained through hotspot distribution data. Hot spot data is taken from year to year i.e. year 2005 until 2016. This is done so that pattern of movement of hotspot can be known. It is also important to know about the location of hot spots. Where hot spots happen and associated with what type of land cover. This study aims to show the pattern of movement of hotspots from year to year that can be used for the prevention of forest and land fires.

2. Methods

2.1 Study Area and Data

Regency of Kepulauan Meranti consists of 9 (nine) sub-districts are Riau Province (BPS.2017). Meranti Islands Regency is located face to face with Malaysia and Singapore State separated by Malacca Strait. Geographically Meranti islands Regency is located at coordinates between 0° 42'30" - 1° 28'0" N and 102° 12'0" - 103° 10'0" E The total area of Meranti Islands Regency is 3,707.84 km2 or 4.26% of the area of Riau Province. Meranti Islands District, became interesting from the side of the fire disaster, because at the end of January 2014 re-occur forest and land fires in Riau starting from the region of Meranti Islands [5,7]. The data used are land cover data from 2005 to 2016, hotspot data from 2005 to 2016 as figure 3.
The study was conducted with the stages of such activities on the flowchart (figure 4). Several stages are described in section below. Hotspots data for 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015 and 2016 were plotted on a 50 K RBI map, into a 50 K spatial hot spot data. The hot spot data were obtained from MODIS image with 250 m spatial resolution. Thus each pixel in the MODIS image represents an area of 250 m² which means each hotspot point represents a total area of 250 meters². Confidence value of each hotspot selected is 85%.
2.2 Hot spot data time series analysis

Analysis of hot spot time series data derived from several series (hot spot year: 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016. Hot spot distribution is from year to year changing position as well as extents. The fact is used to analyze the pattern of hot spot distribution movement [8]. The direction of hot spot movement leads to land with high fuel potential [5]. Based on triangle fire fuel for the occurrence of fire is vegetation. In this case, what is meant by vegetation is land cover.

To determine the area of effective fire, spatially, buffering of each hotspot [9]. Buffering was done at a distance of 250 meters from the hotspot. The distance between hotspots one with other hotspots is not the same, the fire area indicated by this buffering between hotspots is unified, but some are stand-alone.

2.3 Time series land cover analysis

Time series analysis on land cover was done to obtain information on hotspot occurrence in a land cover type. Based on triangle fire, vegetation is fuel. Through this analysis was obtained what type of land cover is most potential as a fuel for the incidence of forest and land fires.

Figure 5a. Distribution of hot spot

Figure 5b. Hotspot after buffering

Figure 6. Map of distribution of hot spots in the District of Kepulauan Meranti in 2005-2016
2.4 Fire Prone Indication

Fire prone indication obtained through analysis of the pattern of movement of hotspots on land cover multi year ie from 2005 to 2016. Indication of this fire hazard can be: a. The first step to mitigate the fire disaster. b. Awareness of areas with potential fire; c. Preparation of an activity plan that includes the budget, equipment, and quantity and quality of human resources required [10]. Fire prone indication is indicated by map of the distribution of hotspots in the district of the Meranti Islands in 2005-2016. The spread of hotspots clumps a lot in shrubs and bushes and borders on plantations. Through fire prone indication can be known which administrative areas need to increase alertness to the possibility of fire that will come.

3. Results

The results show that the hotspot pattern follows the direction of unused land for cultivation and is dominated by shrubs and bushes. The highest hotspot is 425 hotspots occurs in the shrubs and bushes. From year to year, the pattern of hotspot movement occurs in the bush and bushes cover. In the 12-year time span (2005 up to 2016) the highest number of hotspots is always present in the type of land cover shrubs and bushes. This shows that trend the pattern of movement of forest fires always follows the lands of the shrubs and bushes. (See figure 7, and table 1).

In terms of location, it shows that the type of shrubs cover and bushes indicate adjacent or close to the plantation area. When referring to the fire practices caused by land clearing for new plantations / farms. The practice of clearing the land by burning, because of the consideration that the activity: a. easy to do; b. does not require expensive cost ; c. faster process; d. simple equipment; and it is assumed that the former land of fire is considered more fertile. (Saharjo. B H. 2016). Land clearing for plantation land also contributes to the occurrence of forest fires [11].

Table 1. Number of Hotspot in Kepulauan Meranti District

| Land Cover Type   | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Shrubs and bushes | 8    | 18   | 4    | 28   | 158  | 16   | 8    | 18   | 29   | 425  | 33   | 71   |
| Open land         | 3    | 1    | 0    | 0    | 31   | 1    | 0    | 1    | 0    | 277  | 13   | 3    |
| Swamp forest      | 5    | 2    | 0    | 2    | 36   | 7    | 5    | 3    | 12   | 114  | 41   | 6    |

Source: Data MODIS YEAR 2005 UP TO 2016

Figure 7. Chart Number of Hotspot events on a land cover 2005 up to 2016 in Kepulauan Meranti District
4. Conclusions

The existence of land cover in the form of shrubs and bushes, especially those adjacent to plantation land, need to be wary of as a potentially high area of fire occurrence. From these results, we need to pay more attention for the land with the cover of shrubs and bushes adjacent to the cultivated land. Based on this, it is necessary to always update the landcover data, especially shrubs and bushes every year.

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