INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 11, No. 5, p. 12-19, 2017
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Frequency and intensity of forest and land fire incidents in the banjar district in 2015

Abdi Fithria*[1], Syam'ani[2]

[1,2]*Department of Forest Science, Forestry Faculty, Lambung Mangkurat University, South Kalimantan, Indonesia*

[1,2]*Spatial Data Infrastructure Development Center, Lambung Mangkurat University, South Kalimantan, Indonesia*

[1,2]*Centre of Excellence Research Consortium for Sustainable Tropical Forest Management, Lambung Mangkurat University, South Kalimantan, Indonesia*

Article published on November 08, 2017

Key words: NASA FIRMS, MODIS Imagery, Geostatistical Interpolation, Inverse Distance Weight (IDW)

Abstract

Data showcased by NASA (US Space Agency) MODIS (Space Observer Imports Spectroradiometer) published in 2009 and 2015 show that the location of land fires in Banjar Regency mostly occurs in lowland areas, which are generally cultivated areas (outside forest areas and not forested areas), such as agricultural land, plantation land, even settlements. So serious the impacts caused by forest and land fires, efforts are needed to mitigate them. One form of technology that can be applied to support forest and land fire prevention activities is satellite remote sensing technology (spatial analysis). Spatial analysis method of intensity of forest and land fire incident is overlay between hotspot spots with administration area of Kabupaten Banjar. Mapping of land fires temperature using geostatistical interpolation method. The algorithm used is Inverse Distance Weighted (IDW). The result of the research shows that Both maps and tabular data of the fire incidents shows that the area with the largest number of forest fires are Simpang Empat Sub-District, with a total of 124 fires during 2015. Following Karang Intan and Sungai Pinang. Meanwhile, if viewed from the map and the temperature intensity of fire incidents data, it appears that the most dangerous fires occurred in the area around the Aranio, Pengaron, Sungai Pinang, and Paramasan sub-districts. The satellite had detected fires with high temperatures in these sub-districts in 2015. Especially in Paramasan Sub-District, where recorded a forest fire with temperatures over 170°C.

***Corresponding Author:** Abdi Fithria ✉ mksfabdi@unlam.ac.id

Introduction

According to 2015, Banjar District suffered from forest and land fires which were quite severe. It might even be the worst in the last 15 years. The 2015 circumstances as if serve as a reminiscent of the long drought circumstances in 1997. Indeed, between the long drought in 1997 and the 2015 circumstances, the cause has been identified as the same, i.e. El Nino. El Nino is a symptom of discrepancy in sea conditions that are marked with rising sea-surface temperature in the Pacific Ocean around the equator, especially in the Central and Eastern parts (around the coast of Peru). The increase in the sea-surface temperature significantly increases the Earth's atmosphere temperature. Hence, a kind of hot air storm hit tropical regions, including Indonesia.

In general, long drought circumstances always followed by severe forest and land fires, including fires in settlement areas and other public facilities, such as markets or shops. Even the field condition precisely shows that the largest land fires, particularly in Banjar District, happened to the land outside the forest, like rice fields, plantations, scrubs, and so on. The data shown by the MODIS (Moderate Resolution Imaging Spectroradiometer) image published by NASA (United States Space Agency) (sourced fromhttp://earthobservatory.nasa.gov) in 2009 and 2014 shows that the location of the fire lands in Banjar District area, mostly occur in the lowlands, which generally is a cultivation area (outside the forest area and not the wooded area), such as agricultural lands, plantations, even neighborhoods.

A variety of information from the media, whether prints, televisions, radios, and online, all of them preach that the fire incidents in Indonesia are already so severe. Even the intensity of the incidents has increased from year to year. Even NASA scientists believe, the situation that year is similar to that recorded in 1997 as the most severe smog disaster in history. "Conditions in the Southeastern Sumatra and Singapore are similar to 1997," said Robert Field, Columbia University scientist who also worked for NASA. Center for International Forestry Research (CIFOR) researcher, Herry Purnomo, agrees with NASA estimates. "I am sure that the impact of the forest fires this year will be the same as 1997, in terms of financial losses." (http://www.dw.com). Even land and forest fires that occurred in Gambut Sub-District on Thursday, October 01, 2015, rated as the largest in South Kalimantan, so all of the combined units of firefighters, police, and the TNI had to be mobilized to put out the fire. Because of such serious impacts caused by land and forest fires, efforts are needed to countermeasure them. Efforts to cope with the impact of the natural disaster include the handling of prior incidents, at the time of the incidents and post incidents of forest and land fires. Various efforts have been undertaken by various elements, whether Government, privates, and non-governmental organizations in tackling this natural disaster. In this case, the role of research and technology is needed to support the activities of such countermeasures. One form of technology that can be applied to support forest and land fires prevention activities is remote sensing satellite technology. There have been a lot of researches related to the application of remote sensing technology to combat forest and land fires, such as the utilization of satellite data to detect fire hotspots, the detection of fires spread, smog and fire emissions calculations (Suwarsono, 2009).

The hotspots are hot dots on the surface of the Earth, where the dots are the indication of forest and land fires (Ratnasari, 2000). According to the LAPAN (2004), hotspots or hot dots are a parameter derived from satellite data and indicated as the location of land and forest fires. This parameter is already being widely used in Indonesia as well as other countries to monitor forest and land fires from the satellite. Hotspot indicates the location of the fires as seen on the computer screen or the map, or when the coordinate verified into the field.

Hotspot data that comes from the Terra/Aqua MODIS image can be downloaded for free from the internet. The hotspot data is the NASA's FIRMS (Fire Information for Resource Management System).

NASA's FIRMS give the global fire locations (hotspots) easily with varieties of data formats. NASA's FIRMS is an active fire locations data which represents the midpoint pixel measuring 1 km x 1 km which extracts from the MODIS Image using the Thermal Anomalies algorithms. FIRMS are part of NASA's Earth Observing System Data and Information System (EOSDIS). EOSDIS together with twelve Distributed Active Archive Centers (DAACs) provides access to data from NASA's Earth Science Missions.

FIRMS developed by the Maryland University, with funding from NASA's Applied Sciences Program and the UN Food and Agriculture Organization, to provide active fire locations which are near the time of the original incident (near real-time) for natural resource managers who face difficulties in obtaining fire information from the satellite on time. MODIS active hotspot data that are distributed by FIRMS comes from two sources: 1) near real-time data (MCD14DL) that are processed by LANCE-MODIS, and 2) data extracted from the standard data files produced by the Maryland University (MCD14ML). Both types of data are bundled into 2 data formats, namely ASCII and Shape file. In general, data for near real-time data (MCD14DL) must not be used for time series analysis or long-term studies, for the use of this kind, standard MCD14ML products are more appropriate (Giglio, 2015).

Fire incidents data from time to time are indeed available quite comprehensively, one of it is NASA's FIRMS data mentioned above. However, it is still just data of the fire dots at the time of the incident. By simply downloading the data as it is, we cannot measure and define how severe the fire incident intensity which occurred in a region. For the purposes of this kind, further spatial analysis is required. The intensity of the forest and land fire incidents that feels increasing from year to year, accompanied with all its negative impacts that also felt increasingly large, demanding us to figure out how big the actual intensity of forest and land fire incidents, particularly in Banjar District. The purposes of this study are knowing the frequency of land and forest fire incidents in Banjar District in 2015 based on specific administrative area, knowing the intensity of land and forest fire incidents in Banjar District in 2015 based on the temperatures.

Materials and methods

Material

The tools that were used in this study are computer and internet network for data download and data analysis; GIS software, ArcGIS for Desktop 10.3.1, that were provided by Environmental Systems Research Institute (ESRI) for data spatial analysis; GPS Receiver for data field verification; digital camera for field documentation; Banjar District administrative data; and NASA's FIRMS MODIS Thermal Anomalies/Fire Locations data.

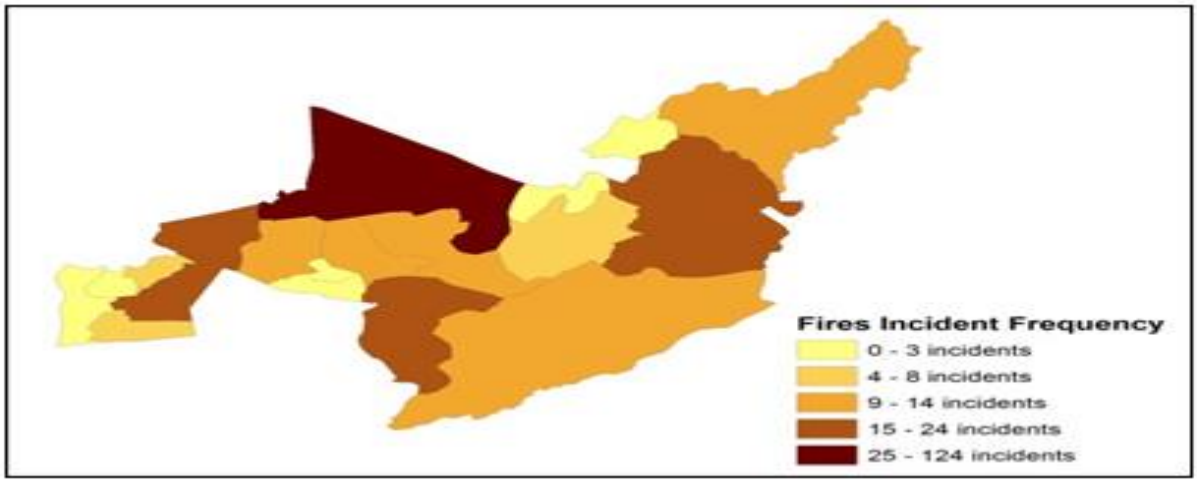

Fig. 1. The Land Incidents Frequency in Banjar District based on its Sub-Districts in 2015

This research will be conducted in Banjar District area. The time required to do the research were 2 months, from November 2015 until December 2015. Which included the literature studies, drafting the research proposal, data collections, field verifications, analysis, and writing a final report.

The research procedures were as follows: download the nasa's firms modis thermal anomalies/fire locations datafrom NASA's server (https://earthdata.nasa.gov/) according to Banjar District administrative boundaries.

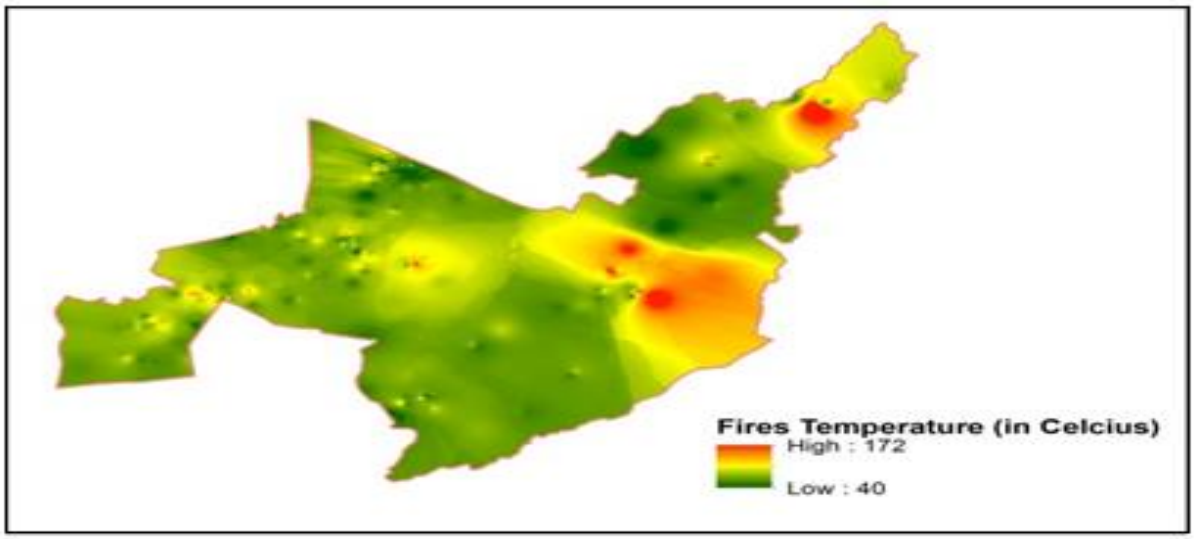

Fig. 2. The Land Incidents Temperature Intensity in Banjar District in 2015.

The data that will be used is the data that is extracted from the standard data files produced by the Maryland University (MCD14ML); forest and land fire locations data analysis on NASA's FIRMS MODIS thermal anomalies/fire locations data, which have confidence level of 80% or more; the spatial analysis of forest and land fire incidents intensities was by overlapping between hotspot points with the administrative area of Banjar District; and land fire temperatures mapping using geostatistical interpolation method.

The algorithm

The algorithm used was the Inverse Distance Weighted (IDW). Geostatistical interpolation is the estimation process of the quantitative geographical phenomenon of unknown value at some place, based on a quantitative geographical phenomenon which value was already known at some point which was closest to the value being estimated.

The basic idea of the geostatistical interpolation begins from limited geographical data, while we are required to present a comprehensive geographic information on a region, for example, rainfall. Of course, it is not possible to measure precipitation at any "span" of the Earth's surface, or placing BMKG station in every village.

The cost needed will be too large. In the geostatistical interpolation, we only need a certain amount of sample measurement points where the coordinates are known with certainty.

IDW determines the value of a point that has unknown value by using a combination of linear weights from a set of sample points. What is mean by sample points is the points that the value are already known and by spatial lying closest to the point which will be determined. While the weight means is an inverse distance function of the sample points towards the point which value will be determined.

If the fire temperature value of each hotspot points is z, thus z_1, z_2, z_3, z_4, and z_5. And the distance of each sample point to point X are d, thus d_1, d_3, d_2, d_4, and d_5. Therefore the unknown temperature value of a point, i.e. point X (z_x) can be specified with the following functions:

$$F(z_x) = \sum_{i=1}^{n} w_i z_i$$

Where:

$$w_i = \frac{\left[\frac{1}{d_i}\right]^p}{\sum_{j=1}^{n}\left[\frac{1}{d_j}\right]^p}$$

Subject to:

$$\sum_{i=1}^{n} w_i = 1, \quad p > 1$$

Description: n is the sum of sample points, the i and j are the numbers of sample points, w is the weight, and p is the power.

The amount of the value of the weight must equal to 1, and the p-value must greater than 1, generally the p-value used is 2.

Results

Hotspot data presented in this study was already the result of a query (selection) of > 80% confidence interval. So it really is believed to be the location of the fires. Of course, the likely of error persists.

Among them was undetected fire locations due to thick clouds. Or one fire location which lasted quite long (persistent hotspot) and recorded more than once by satellite, so it read as more than one hotspot. However, if we just want to see a practical distribution of overview of fires, mistakes like this can be ignored or assumed not to exist. Given the fire broke out in the dry season, where the potential presence of thick clouds is quite rare. And fire is a dynamic phenomenon that appears and move in a relatively short time.

Table 1. The Fire incidents frequency number in 2015.

Sub-Districts	Fire Incidents Frequency Number in 2015
Aluh-aluh	1
Aranio	12
Astambul	14
Beruntung Baru	8
Gambut	21
Karang Intan	24
Kertak Hanyar	5
Martapura	0
Martapura Barat	12
Martapura Timur	0
Mataraman	12
Paramasan	12
Pengaron	6
Sambung Makmur	0
Simpang Empat	124
Sungai Pinang	23
Sungai Tabuk	22
Tatah Makmur	3
Telaga Bauntung	1

In this study, the frequency of fire incidents is the sum of fire location points in 2015 according to a specific area. Which is in this research are set according to the districts.

Fire frequency spatial data like this effectively to determine which areas are most prone to experiencing forest and land fire.

While the intensity of fire incidents referred to in this research is the high and low of fires volume that occurs based on temperature. Indirectly, the fire temperature distribution is associated with the level of danger or risk of fire. Because a lot of fire points are not always dangerous, it could be just small fires.

According to Table 1, it is clear that the area with the largest number of forest and land fires is Simpang Empat Sub-District, with a total of 124 fire incidents during 2015.

Following Karang Intan Sub-District and Sungai Pinang Sub-District. For Simpang Empat Sub-District, most of the area are a swamp, and some are peat land. The area is also mostly used for agricultural purposes. So that the fire that occurred in this region is the agricultural land and peat land fires. For Karang Intan and Sungai Pinang Sub-Districts, which is a highland area, most of their territory consists of shrubs, forests, and plantation fields.

Table 2. The fire incidents temperature intensity.

Sub-Districts	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
Aluh-aluh	59,10	67,25	63,86
Aranio	53,42	148,12	68,23
Astambul	41,74	86,53	66,83
Beruntung Baru	54,25	76,36	62,05
Gambut	41,95	130,64	67,10
Karang Intan	41,62	83,38	61,80
Kertak Hanyar	55,72	95,34	69,34
Martapura	54,49	66,71	61,78
Martapura Barat	54,55	93,62	64,93
Martapura Timur	61,14	64,10	62,55
Mataraman	57,71	113,89	72,95
Paramasan	51,19	172,41	74,92
Pengaron	54,49	121,81	75,51
Sambung Makmur	60,49	84,10	74,60
Simpang Empat	40,11	109,25	65,29
Sungai Pinang	42,21	170,37	73,82
Sungai Tabuk	42,81	115,34	66,76
Tatah Makmur	60,41	73,83	65,07
Telaga Bauntung	41,90	62,92	52,78

According to Table 2 below clearly shows that the most dangerous fires, if measured from the temperature, took place in the area surrounding Aranio, Pengaron, Sungai Pinang, and Paramasan Sub-Districts. Because in these sub-districts, fires with the highest temperatures were detected by satellite in 2015. Especially in Paramasan Sub-District recorded land and forest fire with a temperature of more than 170 degrees Celsius.

All of the regions that experienced major fires were highland are, so the fires could be a forest fire, or at least bushes or plantation belonging to the community.

If we compare between the incidents frequency of fires with the of the fire incident intensity data, the contrast is quite visible that the Simpang Emp at Sub-District experienced the most fires, but the intensities are very low (small fires).

By contrast, Paramasan Sub-District only experienced 12 times of fires incidents and Pengaron Sub-Districts only experienced 6 times of fire incidents, thus having a very big fire intensity. It is important to confirm, that the temperature distribution data that presented in this study is also the temperatures that were detected by the satellite sensor. In the world of remote sensing, the temperature detected by the satellite sensor known as the emissions temperature. Not the measured temperature data in the field or the surface temperature of. In general, the surface temperature data is always higher than the emission temperature. In other words, the fires that occur in the field could be indeed bigger.

Conclusion

Areas which experienced the largest number of forest and land fire incidents in Banjar District during 2015 were the Simpang Empat, Karang Intan, and Sungai Pinang, are as which experienced the highest temperature intensity of forest and land fire incidents and the most at risk in Banjar District during 2015 were Aranio, Sungai Pinang, and Paramasan, and the number of fire incidents was not always correlated with the fire temperature intensity. From the results of this research, we provide recommendations so in the future the number as well as the temperatures intensity of the fire incidents tested and calibrated using the field data. So, the results retrieved can describe the actual conditions in the field.

Acknowledgement

We thank the Provincial Government of South Kalimantan, who funded this research activity. Spatial analysis in this research was carriedout by using the ArcGIS for Desktop software. Therefore, we also like to thank the Environmental Systems Research Institute (ESRI) and PT. ESRI Indonesia, which had donated the ArcGIS platform software.

References

NASA Earth Observatory. Home. Climate change, global climate change, global warming, natural hazards, Earth, environment, remote sensing. http://earthobservatory.nasa.gov

Deutsche W. 2015. How 'El Niño' affects Indonesian forest fires. 30.07.2015. www.dw.com/en/how-el-ni%C3%B1o-affects-indonesian-forest-fires/a-18618153

Giglio L. 2015. MODIS Collection 6 Active Fire Product User's Guide Revision A. Department of Geographical Sciences, University of Maryland.

Lembaga Antariksa dan Penerbangan Nasional (LAPAN). 2004. Kebakaran Hutan/Lahan Dan Sebaran Asap di Sumatera dari Data Satelit Lingkungan dan Cuaca. Bidang Pemantauan Sumberdaya Alam dan Lingkungan Pusat Pengembangan Pemanfaatan dan Teknologi Penginderaan Jauh Lembaga Penerbangan dan Antariksa Nasional.

Schepers L, Haest B, Veraverbeke S, Spanhove T, Vanden Borre J, Goossens R. 2014. Burned Area Detection and Burn Severity Assessment of a Heathland Fire in Belgium Using Airborne Imaging Spectroscopy (APEX). Remote Sens. **6(3),** 1803-1826 p. http://dx.doi.org/10.3390/rs6031803

Maral Moeini, Hassan Ahmadi, Baharak Motamed Vaziri, Ehsan Zandi Esfahan. 2013, Effect of fault network on zoning of mass movement using GIS Case Study: Science and Research Branch, Islamic Azad University. Journal of Biodiversity and Environmental Sciences (JBES). **3(11),** 48-53, 2013. www.innspub.net/wp-content/uploads/2013/10/JBES-Vol3No11-p48-53.pdf

Ratnasari E. 2000.Pemantauan Kebakaran Hutan dengan Menggunakan Data Citra NOAA-AVHRR dan Citra Landsat TM: Studi Kasus di Daerah Kalimantan Timur, Skripsi Fakultas Kehutanan Institut Pertanian Bogor, Bogor.

Suwarsono, Yulianto F, Parwati, Suprapto T. 2009, Pemanfaatan Data Modis untuk Identifikasi Daerah Bekas Terbakar (Burned Area) Berdasarkan Perubahan Nilai NDVI di Provinsi Kalimantan Tengah Tahun 2009. Jurnal Penginderaan Jauh **6,** 54-64.

Vali Abbas Ali, Erahimi Khusfi zohre, Khosroshahi Mohammah, Ghazavi Reza. 2016. Land use change detection using GIS and RS techniques casestudy: The South east of Zayanderood Basin, Esfahan, Iran. Journal of Biodiversity and Environmental Sciences (JBES) **8(6),** 87-100. www.innspub.net/jbes/land-use-change-detection-using-gis-and-rs-techniques-casestudy-the-south-east-of-zayanderood-basin-esfahan-iran/

Nyatwere D, Mgang, Herbert V, Lyaruu, Feetham Banyikwa. 2017. Above-ground carbon stock in a forest subjected to decadal frequent fires in western Tanzania. Journal of Biodiversity and Environmental Sciences (JBES) **10(2),** 25-34. www.innspub.net/jbes/above-ground-carbon-stock-in-a-forest-subjected-to-decadal-frequent-fires-in-western-tanzania/