p-ISSN 2460-0768 e-ISSN 2597-6044
https://doi.org/10.20961/ge.v9i1.61379

GeoEco, Vol. 9, No 1. January 2023 Page. 101-113
https://jurnal.uns.ac.id/GeoEco/article/view/61379

SPATIAL DISTRIBUTION OF HOTSPOTS USING S-NPP VIIRS FOR EARLY DETECTION OF POTENTIAL FIRE

Rosalina Kumalawati[1]* , Avela Dewi[1], Astinana Yuliarti[1], Rizky Nurita Anggraeni[1], Karnanto Hendra Murliawan[2]

[1]Faculty of Social and Political Science, Lambung Mangkurat University, Indonesia

[2] Ministry of Agrarian and Spatial Planning/National Land Agency, South Kalimantan, Indonesia

*E-mail: rosalina.kumalawati@ulm.ac.id

ARTICLE INFO

Article History
Received : 21/05/22
Revised : 01/02/23
Accepted : 20/02/23

Citation:
Kumalawati, R., Dewi, A., Yuliarti, A., Anggraeni, R. N., & Murliawan, K. H., (2023) Spatial Distribution Of Hotspots Using S-Npp Viirs For Early Detection Of Potential Fire. GeoEco. Vol. 9, No. 1.

ABSTRACT

Fire is a disaster and its frequency is increasing every year. Seeing this, it is very important to know the spatial distribution of hotspots to determine the potential for fires in each area. Based on this, it is necessary to conduct research with the title "Spatial Distribution of Hotspots Using S-NPP VIIRS for Early Detection of Potential Fires". This research includes the type of descriptive research. The population in the study were all hotspots in Banjar Regency, South Kalimantan Province. Hotspots were taken from the results of the S-NPP VIIRS satellite imagery recording from 2012-2021. The number of samples is equal to the number of populations. The data analysis technique uses nearest neighbor analysis and descriptive analysis which is processed using Arc GIS software. The research results show that fires occur during the dry season, namely in July, August, September and October. Spatial distribution of hotspots from the results of S-NPP VIIRS satellite imagery based on the accuracy of the most confidence level in July, August, September and October. If the spatial distribution of hotspots is known, it can be used as an early detection effort. Early detection is carried out as an effort to prevent and control fires with a greater negative impact. In addition, with the existence of an early warning system, the community is better prepared to deal with fires so that the negative impacts that may arise due to fires can be minimized, including loss of life and property.

Keywords: *Early Detection; S-NPP VIIRS; Spatial Distribution*

INTRODUCTION

Fires often occur, especially during the dry season in both developing and developed countries, including Indonesia. Large-scale forest and land fires in Indonesia occurred in 1982-1983, 1991, 1994, 1997-1998, 2006 and 2015 (Endrawati & Yusnita, 2015). If low rainfall is accompanied by high temperatures and supported by a long dry season, fire incidents will easily occur (Muliono & Sembiring, 2019). Fires that occur during the dry season are generally more difficult to control and therefore require serious attention. Fires can cause land damage that disrupts the surrounding land (Maliki., 2022).

Fire is a disaster that can destroy anything, both flora, fauna, property and life (Arisandi et al., 2020). Fire incidents, including in Indonesia, had seized the world's attention (Arifudin et al., 2019). Fires will have an even greater negative impact when they occur on peatlands (Novitasari., 2018). Most of the fire disasters are caused by human intent (Meiwanda., 2016; Siregar & Lestari., 2019) such as burning land to clear land. Clearing land by burning is much cheaper as a result of smoke haze and will have a negative impact on health, especially causing respiratory problems (Syamsuadi et al., 2020; Herawati & Santoso., 2011).

Land clearing is one form of land use which is a human effort in order to meet their needs (Utoyo., 2012). Land use is increasing along with the increasing population, causing population pressure on land. The increase in population will indirectly increase fires because the habit of people clearing land by burning is one of the triggers for fires. Other impacts of fires besides causing smoke haze are causing enormous environmental damage, economic losses, social problems (Yusuf et al., 2019) and land degradation including deforestation, loss of biodiversity, ozone depletion, and water scarcity (Yurdayanti & Nurjanah., 2022). Fires if not handled properly can trigger more serious environmental problems such as having an impact on economic and social conditions including pollution, water availability, and energy (Vardoulakis & Kinney, 2019; Nurani et al., 2022).

Forest and land fires that occur have resulted in decreased air quality which has an impact on air transportation, health, education, and economic activity (Adiputra, et al, 2018). Health problems, especially in at-risk individuals, including patients with heart and respiratory disorders, the elderly, pregnant and lactating women and toddlers (Susanto et al., 2019). Another impact of fires is that it causes economic losses in Indonesia reaching more than 200 trillion, especially those that occurred in 2015 (Purnomo et al., 2017). The negative impact of fires is quite large so it is necessary to carry out early detection of potential fires that will occur in each area. Early detection is carried out as an effort to prevent and control fires with a greater impact. Early detection of fires can be done by knowing the spatial distribution of existing hotspots. It is very important to know the spatial distribution of hotspots because knowing the spatial distribution of hotspots can determine the potential for fires that may occur in each area so as to minimize the negative impacts of fires such as loss of property and life (Rizki et al., 2022).

Humans are very dependent on the environment so that if the environment is damaged it is feared that it can no longer support life (Yurdayanti & Nurjanah., 2022), therefore proper handling of the environment is needed, including the problem of fire. Fires can occur on peatlands, both inside and outside forest areas (Saharjo, 1997; Page et al., 2016; Syaufina 2008). Fires on peatlands are more difficult to control and difficult to detect. Dry peat, especially in the dry season, is more flammable and difficult to extinguish. Fires usually occur during the dry season, namely in July, August and September (Anastasia., 2020; Yusuf et al., 2019). These land fires can be identified using remote sensing technology (Handayani et al, 2014). One of remote sensing technology is using S-NPP VIIRS satellite imagery.

Fires can be identified through hotspot data. Hotspot by definition can be defined as an area that has a relatively higher surface temperature than the surrounding area based on a certain temperature threshold monitored by remote sensing satellites (Asyowi et al., 2021). Hotspot is a term for a pixel that has a temperature value above a certain threshold from the interpretation of satellite imagery, which can be used as an indication of forest and land fires (KLHK, 2016). The satellite images used for hotspot detection include S-NPP VIIRS.

Hotspots can be accessed through the SiPongi Karhutla Monitoring System website. Data on hotspots or forest fire area is still limited, namely the data provided in the form of reports per province and has not explained specifically per district or city. Data information on hotspots or forest fires is needed so that it can be seen which districts/cities have hotspots in each area (Mustamin et al., 2021). The SiPongi Karhutla Monitoring System website contains daily data on hotspots throughout Indonesia, including South Kalimantan. Hotspots or groups of hotspots in large numbers and occur continuously are indicators for detecting the occurrence of fires (Almegi et al., 2022).

Fires can be detected by knowing the spatial distribution of hotspots. Hotspots can be identified from the results of the

S-NPP VIIRS satellite image recording Hotspots are indicators of the occurrence of land fires in a location that has a relatively higher temperature than the surrounding temperature (Putra et al., 2019). An area can be partially or completely burned, but a hotspot cannot show exactly how big the burned area is (Januarisky, 2012) so field observations are still needed. The hotspot obtained from the S-NPP VIIRS satellite contains information on the location of the coordinates in units of number per day so that it will be easier to check directly in the field. Field checks are carried out to find out whether the existing hotspots have really become hotspots and cause fires.

Giglio et al, (2009) have developed hotspot data to estimate the burned area. According to Csiszar et al (2006) hotspots can be validated by direct and indirect observations. Direct observation can be done by checking the field/survey while indirect observation can be done by means of visual interpretation of hotspots and comparing them with other data references. The higher the accuracy of the hotspot, the higher the potential for the hotspot to become fire and fire. Hotspots are known to be able to become an early warning system so that early information related to fires or potential fires can be quickly identified so that negative impacts that may arise due to fires can be minimized. Based on the above background, it is very necessary to do research with the aim of knowing " Hotspot Spasial Distribution Using S-NPP VIIRS for Early Detection of Potential Fires" **(Figure 1)**.

The spatial distribution of hotspots is known in addition to early detection of potential fires as well as efforts to prevent and control fires with a larger impact (see Figure 1), which is a novelty in this study. Efforts to prevent and control fires also maintain local wisdom. Local wisdom is understood as a way of life and knowledge and life strategies in several activities carried out by local communities to answer various problems in meeting daily needs (Dahliani et al., 2015; Marlina et al., 2020; Susanthi et al., 2022). Local wisdom is an effort to reduce the impact of disasters by establishing a good relationship between nature and humans (Hairumini et al., 2017).

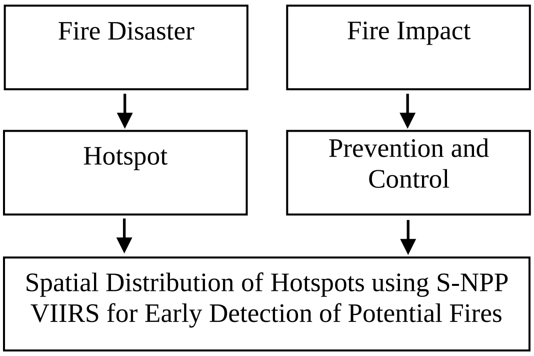

Figure 1. Spatial Distribution of Hotspots using S-NPP VIIRS for Early Detection of Potential Fires

MATERIALS AND METHODS

The research location is in Banjar Regency, South Kalimantan Province with the consideration that the number of hotspots in Banjar Regency is quite high and the research location is close to Syamsudin Noor Airport. This research is descriptive research with a research approach using secondary data. The secondary data taken is hotspot data from the recording of the S-NPP VIIRS satellite imagery. This type of research is used for generalization and interpretation based on the results of statistical data analysis (Khairani, 2016).

The population in this study are all hotspots located in Banjar Regency, South Kalimantan Province. The hotspot was taken from the results of the S-NPP VIIRS satellite image recording from 2012-2021. The data taken are monthly data and daily data. The sample of this research is all hotspots located in Banjar Regency, South Kalimantan Province. The number of samples is the same as the total population, namely the total sampling (Nur., 2020; Asyowi et al., 2021).

The technique used in this research is to map the spatial distribution of hotspots. The data analysis technique uses nearest neighbor analysis and descriptive analysis which is processed using Arc GIS software. This research is carried out by processing identity data hotspots with administrative boundaries. Hotspots are processed and analyzed daily and monthly so that the highest spatial distribution of hotspots can be found in what month. Giglio (2015) divides the confidence level into three classes. The hotspots taken in this study are all hotspots that have high, medium, and low accuracy. The higher the level of confidence, the higher the potential that the hotspot will become a land or forest fire (Asyowi et al., 2021).

RESULTS AND DISCUSSION

The potential for fires in each area can be seen from the grouping and distribution of existing hotspots (Pramesti., 2017; Athifaturrofifah et al., 2020). Hotspots in Banjar Regency from 2012-2021 are spread unevenly in each sub-district and every month (**see Table 1 and Table 2**). The number of hotspots every year always increases and decreases from January to December and fluctuates. The increase in hotspots starts every July as many as 384, continues to increase in August by 1654 and September by 8532. In October the number of hotspots is still large but has started to decline, namely as much as 8532. November continues to decline until December **(Figure 2 and Figure 3)**.

Based on **Table 1 and 2**, it can be seen that the months with the highest number of hotspots are July, August and September because they are in the dry season. Fires usually occur during the dry season, namely in July, August and September (Anastasia., 2020; Yusuf et al., 2019). The highest number of hotspots each year from 2012-2021 was found also in July, August, and September. So, in these months you have to be more alert and careful because the potential for fires is much greater when compared to other months.

Table 1. Number of Hotspots per Month based on Recording Results of S-NPP VIIRS Satellite Imagery, Banjar Regency, South Kalimantan Province

Month	Number of Hotspots
January	20
February	10
March	12
April	11
May	52
June	71
July	384
August	1654
September	8532
October	5487
November	756
December	18
Number of Hotspots	17007

Source: Secondary Data Processing Results, 2021 and Analysis Results, 2022

Hotspots that are detected annually in each region with a pattern that tends to clump together are a strong indication that the area has a high level of potential for fires. In addition, hotspots with high accuracy or confidence level will have a higher fire potential **(see Table 3)**. The potential for fires based on accuracy or level of confidence in Banjar Regency, South Kalimantan Province from

January to December is the most at the nominal accuracy level of 15048, Low of 1291 and High of 668 **(Figure 4)**.

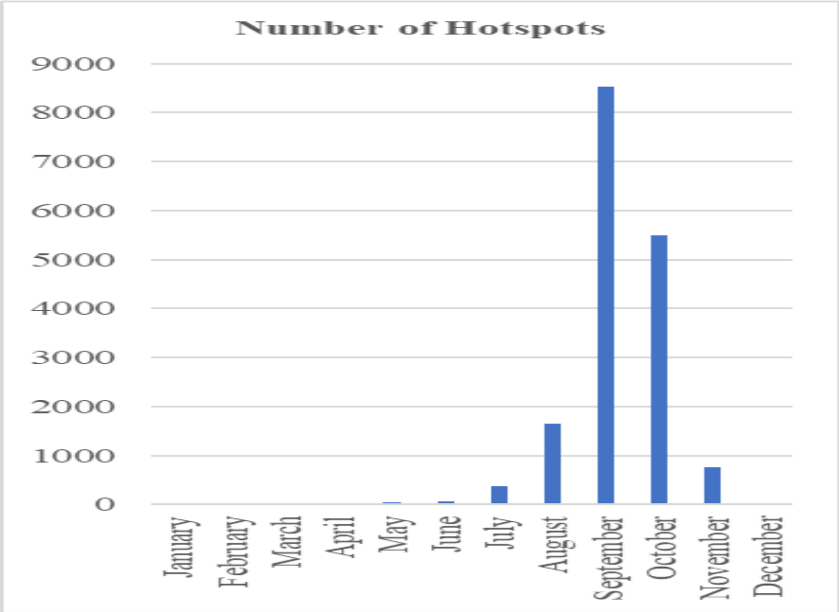

Figure 2. Number of Hotspots per Month based on Recording Results of S-NPP VIIRS Satellite Imagery, Banjar Regency, South Kalimantan Province

Nominal and High Accuracy has the potential to become a bigger fire when compared to Low. The months with the most hotspots found based on accuracy or confidence level are August, September, and October. November is still a lot but it starts to decline until December. Seeing this, it can be seen the distribution of hotspots and what months have a high potential for fires so that people are expected to be much more prepared in dealing with fires. Hotspot distribution is a form of early warning system that aims to prevent fires from occurring and the spread of fires which can be implemented through monitoring activities to detect

Early symptoms of fires on an ongoing basis (Sukmawati., 2006). Early detection is carried out as an effort to prevent and control fires with a greater negative impact. In addition, with an early warning system, the community is better prepared to deal with fires so that the negative impacts that may arise from fires can be minimized, including loss of life and property.

Table 2. Number of Hotspots each year based on the results of satellite image recording of S-NPP VIIRS Banjar Regency 2012-2021

Month	Years									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	0	3	0	0	13	1	1	2	0	0
February	0	1	1	0	1	1	3	2	1	0
March	0	0	2	0	1	4	2	2	0	1
April	3	1	2	1	0	2	2	0	0	0
May	18	5	8	4	2	3	9	3	0	0
June	8	14	2	7	4	10	18	4	4	0
July	27	13	38	97	7	24	91	80	7	0
August	184	56	238	554	23	48	206	293	52	0
September	807	303	1200	3374	58	248	918	1560	64	0
October	437	321	1666	1854	66	79	538	486	40	0
November	12	14	241	146	5	3	20	310	5	0
December	6	0	0	10	0	1	0	1	0	0
Number of Hotspots	**1502**	**731**	**3398**	**6047**	**180**	**424**	**1808**	**2743**	**173**	**1**

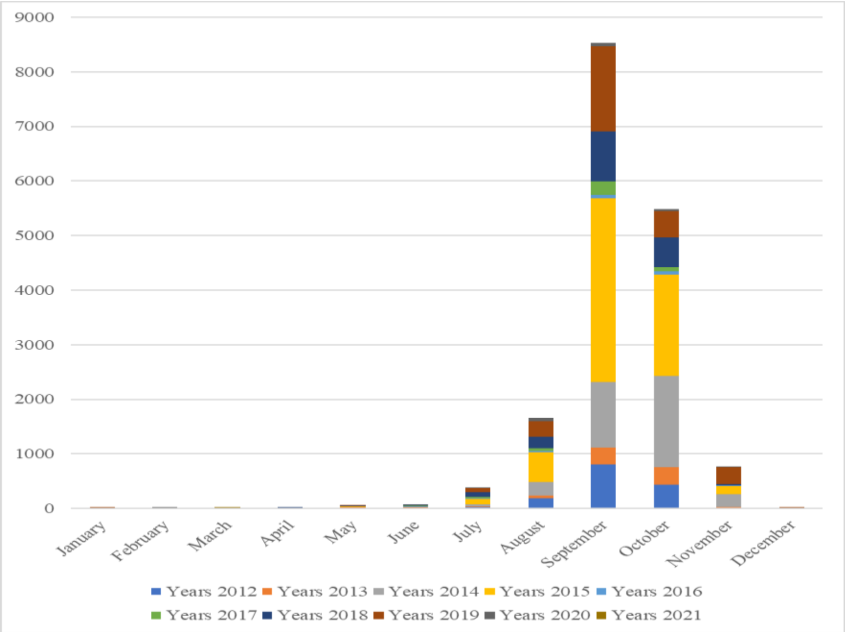

Figure 3. Number of Hotspots each year based on the results of satellite image recording of S-NPP VIIRS Banjar Regency 2012-2021

Table 3. Number of Hotspots based on Confidence from Satellite Image Recording Results of S-NPP VIIRS Banjar Regency 2012-2021

Month	**Confidence**		
	Low	**Nominal**	**High**
January	0	20	0
February	0	10	0
March	0	12	0
April	0	11	0
May	0	50	2
June	1	70	0
July	6	368	10
August	68	1509	77
September	753	7367	412
October	405	4925	157
November	57	689	10
December	1	17	0
Number of Hotspots	1291	15048	668

Source: Secondary Data Processing Results, 2021 and Analysis Results, 2022

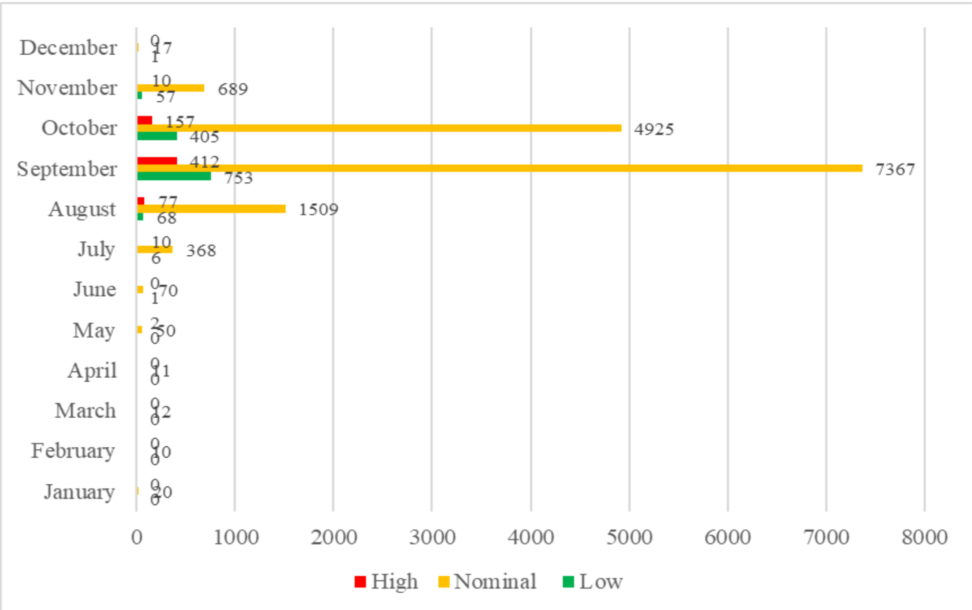

Figure 4. Number of Hotspots based on Confidence from Satellite Image Recording Results of S-NPP VIIRS Banjar Regency 2012-2021

CONCLUSIONS

The number of hotspots every year from 2012-2021 is mostly found in July, August, and September so in these months one must be more alert and careful because the potential for fires is much greater when compared to other months.

The potential for fires based on accuracy or level of confidence in Banjar Regency, South Kalimantan Province from January to December is at most at the Nominal Accuracy level of 15048, Low of 1291, and High of 668.

Hotspot distribution is a form of early warning system aimed at preventing fires from occurring and the spread of fires as well as minimizing negative impacts such as the number of casualties and property.

ACKNOWLEDGMENTS

The authors would like to thank the University of Lambung Mangkurat, especially the Institute for Research and Community Service (LPPM) for their support and support for this research. This article is part of the research results of the Compulsory Research Lecturer (PDWM).

REFERENCES

Adiputra, Agung, Baba Barus. 2018. Analisis Risiko Bencana Kebakaran Hutan dan Lahan di Pulau Bengkalis. Jurnal Geografi Edukasi dan Lingkungan. Volume 1, Nomor 2.

Athifaturrofifah, A., Goejantoro, R., & Yuniarti, D. (2020). Perbandingan Pengelompokan K-Means dan K-Medoids Pada Data Potensi Kebakaran Hutan/Lahan Berdasarkan Persebaran Titik Panas. EKSPONENSIAL, 10(2), 143-152.

Almegi, A., Akmal, A., Alfiah, A., Nelvawita, N., & Novita, Y., (2022). Sebaran Spasial Titik Panas (Hotspot) Berdasarkan Penutupan Lahan di Kabupaten Pesisir Selatan. EL-JUGHRAFIYAH, 2(1), 16-21.

Anastasia, A., Putra, Y. S., & Adriat, R. Studi Distribusi Tingkat Bahaya Kebakaran Menggunakan Fire Weather Index (FWI) di Kalimantan Barat. PRISMA FISIKA, 9(2), 179-182.

Arifudin, A., Syahza, A., Kozan, O., Mizuno, K., Mizuno, K., Isnaini, Z. L., ... & Hasrullah, H. (2019, January). Dinamika Penggunaan, Kebakaran, dan Upaya Restorasi Lahan Gambut: Studi Kasus di Desa Tanjung Leban, Bengkalis. In Unri Conference Series: Agriculture and Food Security (Vol. 1, pp. 40-45).

Arisandi, D., Syamsuadi, A., Gafar, T. F., Hartati, S., & Anugerah, M. F. (2020). Pembinaan Masyarakat Peduli Api Sebagai Bentuk Partisipasi Warga Desa Dayun Dalam Menangani Bencana Kebakaran Lahan. IKRA-ITH ABDIMAS, 3(3), 34-37.

Asyrowi, H., Saharjo, B. H., & Putra, E. I. (2021). Analisis Pola Sebaran Hotspot di Taman Hutan Raya Raden Soerjo. Jurnal Penelitian Hutan dan Konservasi Alam, 18(2), 151-165.

Csiszar, I. A., J.T. Morisette, and L. Giglio. (2006). Validation of Active Fire Detection from Moderate-Resolution Satellite Sensors: The MODIS Example in Northern Eurasia. IEEE Transactions on Geoscience and Remote Sensing, Vol. 44, No. 7, July.

Dahliani, Soemarno, I., & Setijanti, P. (2015). Local Wisdom In Built Environment In Globalization Era.

International Journal of Education and Research, 3(6), 157–166.

Endrawati, & Yusnita, R. (2015). Analisis Data Titik Panas (hotspot) dan Kebakaran Hutan dan Lahan 2015.

Giglio, L., T. Loboda, D.P. Roy, B. Quayle, C. O. Justice. (2009). An active-fire based burned area mapping algorithm for the MODIS sensor. Remote Sensing of Environment 113, 408–420.

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

Hairumini, Setyowati, D. L., & Sanjoto, T. B. (2017). Kearifan Lokal Rumah Tradisional Aceh sebagai Warisan Budaya untuk Mitigasi Bencana Gempa dan Tsunami. Journal of Educational Social Studies, 6(1), 37–44.

Handayani, T., Santoso, A. J., Dwiandiyanta, Y. (2014). Pemanfaatan Data Terra Modis Untuk Identifikasi Titik Api Pada Kebakaran Hutan Gambut (Studi Kasus Kota Dumai Provinsi Riau). Seminar Nasional Teknologi Informasi Dan Komunikasi 2014 (Sentika 2014).

Herawati H, Santoso H. 2011. Tropical forest susceptibility to and risk of fire under changing climate: A review of fire nature, Policy and Institutions in Indonesia. Forest Policy and Economics, 227 - 233.

Januarisky, H. A. (2012). Pola Sebaran Titik Panas (Hotspot) Dan Keterkaitannya Dengan Perubahan Penggunaan Lahan (Studi Kasus: Provinsi Kalimantan Barat). Skripsi. Program Studi Manajemen Sumberdaya Lahan Departemen Ilmu Tanah Dan Sumberdaya Lahan Fakultas Pertanian Institut Pertanian Bogor.

Khairani. 2016. Penelitian Geografi Terapan. Padang: UNP PRESS

KLHK. (2016). Peraturan Menteri Lingkungan Hidup dan Kehutanan No P.32/MenLHK/Setjen/Kum.1/ 3/2016.

Maliki, R. Z., (2022). Riverbank Erosion in Part of Tibo Village, Donggala Regency. GeoEco, 8(1), 12-24.

Marlina, Sumarmi, & Astina, I. K. (2020). Sustainable marine ecotourism management: A case of marine resource conservation based on local wisdom of bajo mola community in wakatobi national park. Geojournal of Tourism and Geosites, 32(4), 1317–1323. https://doi.org/10.30892/GTG.324 1 9-575

Meiwanda, G. (2016). Kapabilitas Pemerintah Daerah Provinsi Riau: Hambatan dan Tantangan Pengendalian Kebakaran Hutan dan Lahan. Jurnal Ilmu Sosial Dan Ilmu Politik, 19(3), 251. https://doi.org/10.22146/jsp.15686

Mustamin, N. F., Zulkarnain, A. F., & Ramadhan, M. R. B. (2021). Sistem Informasi Geografis untuk Sebaran Titik Panas (Hotspot) di Kalimantan Selatan Menggunakan Metode Clustering. In Prosiding Seminar Nasional Lingkungan Lahan Basah (Vol. 6, No. 3).

Muliono, R., & Sembiring, Z. (2019). Data Mining Clustering Menggunakan Algoritma K-Means Untuk Klasterisasi Tingkat Tridarma Pengajaran Dosen. Computer Engineering, Science and System Journal, 4(2), 272–279.

Nurani, I. W., Wibowo, S. B., & Anggraeni, R. D., (2022). Spatial Distribution of Eco-Friendly Coffee Shops in Malang City. GeoEco, 8(1), 98-112.

Nur, I. L. (2020). Analisa Spasial Hotspot di Kabupaten Bengkalis Provinsi Riau (Doctoral dissertation, STKIP PGRI Sumatera Barat).

Novitasari, N. (2018, October). Pengaruh karakteristik gambut terdegradasi terhadap kebakaran lahan gambut (Studi kasus lahan gambut PLG Blok A di Kalimantan Tengah). In Prosiding Seminar Nasional Lingkungan Lahan Basah (Vol. 3, No. 2).

Page S.E., Hooijer, A. 2016. In the line of fire: the peatlands of Southeast Asia. Philosophical Transaction Royal B. 371, p. 1-9.

Putra, I. D. G. A., Heryanto, E., Sopaheluwakan, A., Pradana, R. P., & Haryoko, U. (2019, February). Sebaran Spasial dan Temporal Titik Panas (Hotspot) di Indonesia dari Satelit Modis dengan Metode Gridding. In Seminar Nasional Geomatika (Vol. 3, pp. 1123-1128).

Purnomo, H., Shantiko, B., Sitorus, S., Gunawan, H., Achdiawan, R., Kartodihardjo, H., & Dewayani, A. (2017). Fire economy and actor network of forest and land fires in Indonesia Forest Policy and Economics, 78.

Rizki, I. A., Bintoro, H., Rahman, P., Realita, A., & Deta, U. A. Profile of Community Understanding and Literacy About Disaster Risk Mitigation: The Responses of Java South Coast Community Against Megathrust Earthquake and Tsunami Prediction. GeoEco, 8(1), 62-76.

Sahardjo BH. 1999. Study on Forest Fire Prevention for Fast Growing Tree Species Acacia Mangium Plantation in South Sumatera, Indonesia. Kyoto University, Graduate School of Agriculture. p. 33-39.

Sahardjo BH. 1999. H. Watanabe, E.A. Husaeni and Kasno. 1998. The management of fuel and fire in land preparation for forest plantation and shifting cultivation. Workshop on Fires and Sustainable Agricultural and Forestry Development in Easter Indonesia and Northen Australia. ACIAR Proc. No. 91, p.39-44.

Sukmawati, A. (2006). Hubungan Antara Curah Hujan Dengan Titik Panas (Hotspot) Sebagai Indikator Terjadinya Kebakaran Hutan Dan Lahan Di Kabupaten Pontianak Provinsi Kalimantan Barat.

Susanthi, Y., Meisandy, R. R., & Nisa., (2022). A. Earthquake Mitigation Based on Local Wisdom: The Vernacular Architecture Concept of Dasan Beleq Traditional House in North Lombok-Indonesia. GeoEco, 8(1), 48-61.

Susanto, A., Arifin, N., Erlang, S., Zaini, J., Yunus, F., Fitriani, F., Isbaniah, F., Ikhsan, M., Ginanjar, A., & Prasenohadi. (2019). Pencegahan dan Penanganan Dampak Akibat Asap Kebakaran Hutan. UI Press.

SIREGAR, A. A., & Lestari, M. (2019). Analisis Faktor Manusia Terhadap Kejadian Kebakaran Lahan Basah Di Kabupaten Ogan Ilir, Sumatera Selatan (Doctoral dissertation, Sriwijaya University).

Syamsuadi, A., Arisandi, D., Gafar, T. F., Trisnawati, L., Hartati, S., & Anugerah, M. F. (2020). Peningkatan Kewaspadaan Bencana Asap Di Kecamatan Dayun Kabupaten Siak. Community Development Journal: Jurnal Pengabdian Masyarakat, 1(2), 48–51.

Syaufina, L. 2008. Kebakaran Hutan dan Lahan di Indonesia. Pola, penyebab dan Dampak kebakaran. Bayumedia Publishing, Malang.

Utoyo, B. 2012. Dinamika Penggunaan Lahan di Wilayah Perkotaan (Studi di Kota Bandar Lampung). Seminar Hasil Penelitian dan Pengabdian Kepada Masyarakat–Dies Natalis FISIP Universitas Lampung.

Vardoulakis, S., & Kinney, P. (2019). Grand Challenges in Sustainable Cities and Health. Frontiers in Sustainable Cities, 0, 7. https://doi.org/10.3389/FRSC.2019.00007

Yurdayanti, Y., & Nurjanah, N., (2022). Development of Geographic Booklets Learning Media Based on Environmental Care on Natural Resources Materials in Senior High School. GeoEco, 8(1), 113-127.

Yusuf, A., Hapsoh, H., Siregar, S. H., & Nurrochmat, D. R. (2019). Analisis Kebakaran Hutan Dan Lahan Di Provinsi Riau. Dinamika Lingkungan Indonesia, 6(2), 67-84.