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Adaptation management to minimize land fires in peatland hydrological unit Bengkalis Island

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Abstract. Peatland fires are an annual phenomenon in Bengkalis Island. One of the factors causing peatland fire is wrong land management. Not much research on peatland fires due to land management can provide new evidence that land management models can minimize peatland fires. This study aimed to find a comprehensive management adaptation to minimize land fires on peatland. This study draws on spatial, qualitative, and quantitative data from the literature, project and policy documents, observations from the field, and interviews with key persons and other stakeholders in Peatland Hydrological Unit (PHU) Bengkalis Island. Adaptation of communities around peatland based on sustainable management has a good result in an economic and social aspect. One of the community adaptations to minimize land fires is management without burning. Land management without burning will be beneficial if it is carried out in conjunction with soil amendments such as F1-embio on peat soil that will remain rich in soil fertility bacteria. The result of the study stated adaptive management of communities around peatlands could minimize land fires.

1. Introduction

Peatlands are identical lands in tropical regions, especially Indonesia. Peat in Indonesia is 14.9 million ha [1], and Riau Province has the most considerable peatland degradation rate in Sumatra of 1.3 million ha [2]. Riau Province is an administrative area of $\pm 9,024,816.5$ Ha where $\pm 3,563,871.06$ Ha is peatland [3].

Peatlands are marginal lands that are prone to burning. Cases of forest and land fires are driven by natural factors, namely the El Nino phenomenon, and anthropogenic factors, namely human activities, in meeting their basic needs that depend on nature [4]. Economic development, land use, and natural climate phenomena are driving factors for forest and land fires. Changes in landscape, climate, and socioeconomic factors as causes of land fires [5]. This shows that forest fires in each region are caused by the same primary factors: climate, landscape, and socioeconomic community [6].

Many causes of fires are caused by deliberate burning in the context of land clearing/preparation. Due to carelessness due to carelessness or willfulness, do not do water management, the early warning does not work, conflicts/land disputes with the community, and human resources who do not have the minimum ability to control land fires [7]. Land clearing by burning in ancient times was carried out traditionally, and the perpetrators of burning can be responsible for the fire used to burn. When compared with current conditions, peatland fires occur due to land burning efforts carried out by irresponsible people and environmental conditions that exacerbate peatland fires that occur because land clearing by burning is part of the religious activities of indigenous peoples.



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Humans play an essential role in forest sustainability [8]. This is because the anthropogenic part is enormous in forest and land management. As human activity increases, anthropogenic activity is related to the number of large-scale fires [9]. The community has its reasons for clearing land by burning. Many factors cause land clearing by burning. Land clearing by burning to increase nutrients and help grow crops to be cultivated. Communities learn from nature in land management [9]. There are driving factors that cause the community to choose the wrong land management. These driving factors continue to pressure the environment, which will impact ecosystem function and human well-being and lead to changes in community conditions and responses [10].

This study aimed to find a comprehensive management adaptation to minimize land fires on peatland from the possible factors causing land fires in the 2014-2020 period in PHU Bengkalis Island, Riau Province. For understanding the distribution and spatial variation of thematic data in Riau Province to mitigate peatland fires. Measurement of social, economic, and environmental aspects that are very complex to understand land management systems.

2. Methodology

2.1. Study area

The research study area was located in PHU Bengkalis Island on Desa Peduli Gambut Peatland Restoration Agency. Desa Peduli Gambut Peatland Restoration Agency provides non-burning land management methods (PLTB) and environmentally friendly natural agriculture to communities on the peatlands of PHU Bengkalis Island. Desa Peduli Gambut, assisted by the Peatland Restoration Agency, is shown in table 1.

Table 1. List of “Desa Peduli Gambut” peatland restoration agency of PHU Bengkalis Island.

No	Village Name	Intervention Period
1	Padekik	2019
2	Penampi	2019
3	Kelemantan	2019
4	Air Putih	2019
5	Temeran	2019
6	Kelebuk	2020
7	Pasiran	2020
8	Resam Lapis	2020
9	Damai	2020

2.2. Data source

The historical land fires were collected from NASA FIRM data consisting of the Moderate Resolution Imaging Spectroradiometer (MODIS) Satellite of Riau Province in the 2014-2020 period. MODIS Satellite is a choice with a relatively large amount and has fairly complete data for Indonesia, precisely in Riau Province [11].

This study uses analysis of peatland fires with MODIS satellites and analysis of spatial variations to evaluate possible causes of land fires (figure. 1). Peat fires followed this at many points. Many hotspots with > 80% confidence were on community land.

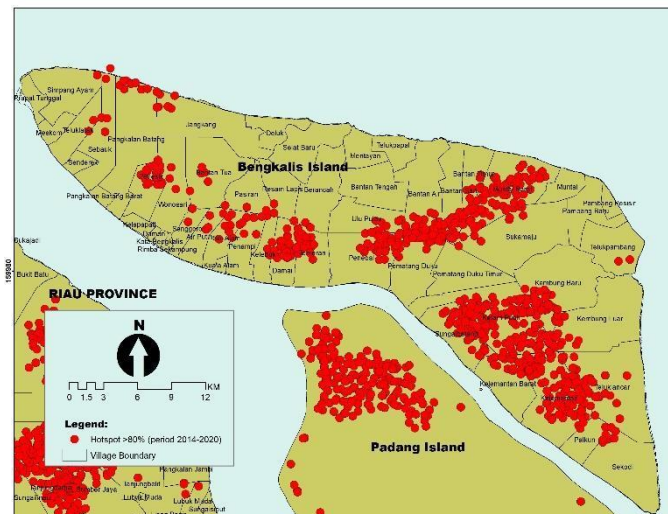


Figure 1. Hotspot in PHU Bengkalis Island, Riau Province 2014-2020.

We see the distribution pattern of hotspots temporally and spatially using Hierarchy Cluster Analysis (HCA) by looking at the hotspot cluster using a grid [12]. This was done for the overall spatial analysis of land cover in Bengkalis Island with fires from available MODIS imagery hotspot data.

The sampling technique used to support research is the purposive cluster sampling method for Desa Peduli Gambut 2019 and 2020. Sampling was carried out on respondents related to PLTB in the village by comparing changes before and after land management. The data source from project and policy documents, observations from the field, and interviews with key persons and other stakeholders in PHU Bengkalis Island. The questioner measurement of social, economic, and environmental aspects. The social elements including several family members, land tenure status, farmer institutions. The environmental aspects including land types, types of cultivated plants. The economic aspects including the number of agricultural products and living conditions. Quantitative descriptive methods describe the land preparation system applied by the community in clearing peatlands for agriculture [9].

Land preparation carried out by farmers determines the occurrence of land fires that occur in Riau Province. The analysis is also carried out for the relationship between land preparation and fire events in analyzing the causes of land fires. Analysis of the results of land fires associated with the characteristics of peatlands and climate in Riau Province.

3. Results and discussion

3.1. An adaptation management for the environment

Adaptation management carried out by farmers in Bengkalis Island proves that it can reduce fire incidence in Bengkalis Island. This is indicated by the agglomeration of hotspots that gets smaller every year. The fire phenomenon is caused by many factors affecting land cover characteristics and human activities [13][14]. Fires that occur due to land cover and land use [14]. The fire that can be done from a hotspot is one of the efforts to fire an early warning system that can be done to prevent fire incidents in Indonesia [15]. In addition to the rainfall factor, land management is a significant trigger for fires [16].

NASA FIRM Active Fire Data for 2014-2019 shows many hotspots each year (figure. 2). Many factors can cause a difference in the number of hotspots. When linked to land use, factors that cause fire events produce a picture that shrubland use initiates fire events.

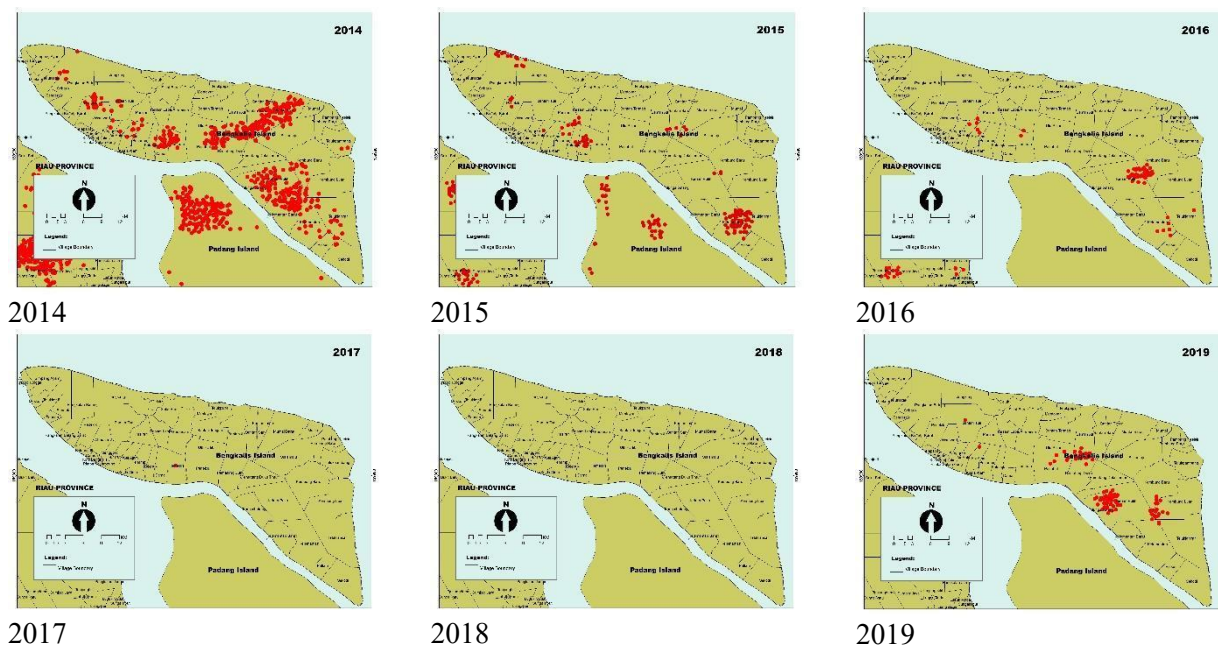


Figure 2. Hotspot Agglomeration in PHU Bengkalis Island per years (2014-2019).

3.2. The economic and social aspect

The community island management carries out the land preparation system in a minimum manner by the available land management budget. The level of the economy plays a vital role in the selection of agricultural land preparation systems. And the land has a role in community survival [17]. Peatlands managed by the community have hopes and are the foundation of community life [18]. Apart from being a growing medium, peatlands must also help the community's economy to survive. The habit of clearing land by burning, which is often done, makes the community accustomed to minimize expenditures. At the same time, the results obtained are maximum because there is no need to incur high costs to get nutrients and minerals for plants. The existence of forests and land adjacent to the community drives the sense of ownership of the forests and land around their homes. Various aspects that can be concluded to be the beginning of land clearing by burning are economic activities, civilization, resources, anatomy, behavior, politics, and knowledge [19].

The factors that cause fires are not easy to control are the facilities and infrastructure of fire control that are minimal in both quantity and specifications, the location of the fire is difficult to reach, fires occur in several areas in one day. Still, the facilities and infrastructure are limited [7], the weather condition is not conducive to wind fast and change the direction of dry and unusual daily temperatures brutal to get rainy time, fires occur in locations with high potential fuel potential, woody logs or rotting natural forest logs, unavailability of good water sources, and unavailability of transportation facilities adequate.

Careful management of canals according to the peatland water balance as a whole [20] because peat is a hydrological entity that cannot be managed partially. Careful calculations need to be made to obtain canal management techniques that ensure water in peat areas suitable for plant growth and domestic needs while also not susceptible to peat fires [20].

Intensive socialization and active participation of communities and surrounding villages on peat are always encouraged, related to the future of the region that continues to experience subsidence and fire-prone. Lessons learned by the people of Bengkalis Island, who were initially been land burners, have now started practicing organic farming on their land. This is felt by marketing their garden products to traditional markets in Bengkalis.

PLTB methods and environmentally friendly natural agriculture provide farmers and farmer groups with knowledge to practice making organic fertilizers, soil amendments (F1-embio), and making organic

pesticides. Many soil amendments (F1-embio) on peat soils will help accelerate the breakdown of the peat soil from bacteria, increasing soil fertility. This method has been applied to the demonstration plot created by the Peatland Restoration Agency and is ready to be applied to the broader community in Bengkalis Island.

4. Conclusion

In conclusion, this paper's results show that adaptive management of communities around peatlands can minimize the occurrence of land fires. The key to all of this is that these fires are detrimental, damage the environment, and so on. Therefore fires must be controlled and prevented because human actions must be extinguished and controlled, and the perpetrators must be prosecuted. And the problem is sometimes the implementation in the field, where many problems arise. For example, every time we hear about prevention when a fire has occurred, no more comprehensive prevention has entered the point of extinction. Prevention is carried out long before the fire occurs with the term early warning system or using early detection. Fire incidents must be prevented, and implementation in the field must be carried out so that there are not many problems. Early warning system efforts are carried out for prevention. When a fire occurs, prevention is carried out before the fire occurs (early warning system), but no one is competing with the equipment and infrastructure for preventing land fires that have been provided.

This paper suggests that it is possible to build on integrating the strengths to anticipate and do the best peatland management. Clear benefits to both bottom-up and top-down approaches to sustainability monitoring will produce the more accurate and relevant result.

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