Succession Post Land Fire in Mare Island Tidore Islands City

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Abstract. *The forest and land fires on Mare Island, Tidore Islands City, were quite large due to the area's existing conditions, most of which were covered with flammable vegetation. Forest and land fires in this area have occurred repeatedly from 2016, 2019 to 2023. Fires cause losses in the form of loss of initial vegetation and various nutrients in the soil and also disrupt people's health. The island city of Tidore, in this case, Mare Island, is one of the areas included in the forest and land restoration priority by the North Maluku Provincial Forestry Service. This research aims to determine the form of fire, factors causing fire, and post-fire succession. The research method uses a direct survey of land-using farmers to obtain an overview of post-fire succession, and data collection uses a questionnaire filled out by people whose land experienced fire, totaling 124 respondents. The results of filling out the questionnaire were then analyzed using the percentage test (%), presented in table form, and narrated. The research results showed the answers from 124 respondents regarding the characteristics of fires on Mare Island, where all respondents answered that the fire forms were surface and canopy fires. Factors that influence fires include lack of water vapor in the air, lack of rainwater and water content in forests and land, and minimal water availability in the soil. This condition results in the land becoming dry and flammable. The impact of forest and land fires is the occurrence of secondary succession, where the initial plant types are largely replaced by new plant types that are different from the initial plants.*

Keywords: *Secondary Succession, Land Fire, Mare Island*

1. INTRODUCTION

Indonesia is a developing country. Industrial and agricultural development will continue to increase in line with development in Indonesia. This impacts increasing the need to clear new land to support the sustainability of life in the agricultural and plantation sectors. Clearing land by burning forests is the choice of farmers because it is considered easy and cheap; the impact of clearing land by burning forests is on a large scale and, simultaneously results in fires that impact smoke haze.

The haze in Indonesia is caused by fires that always occur in the dry season, from August to October, or during the transition period from the rainy to the dry season (Rasyid F, 2014). We often see that an event is only a disaster if casualties exist. Man. Disasters are events or series of events caused by nature, humans, and both, which result in human casualties and suffering, loss of property, environmental damage, damage to facilities, infrastructure, and public facilities, and disruption to people's livelihoods (Sudibyakto, 2011).

Syaufina (2008) said that forest fires are events where dry vegetated fuel is then engulfed in flames in forest areas that spread freely and uncontrolled, while land fires are fire events that occur outside forest areas. Usually, fire spreads from land areas to forest areas and vice versa. Therefore, fire incidents in Indonesia are known as forest and land fires. Darwiati and Tuhuteru (2010) also explained that forest and land fires occur when the three elements of the fire triangle are met. These three elements are oxygen (O), fuel, and a heat source. The fuel here is vegetation and litter or dry leaves ready to burn.

The process of forest and land fires is where fire is used in clearing and preparing agricultural land by local communities. The use of fire to prepare land for cultivation has been carried out for a long time

and passed down from generation to generation by the community. This is because fire is cheaper, easier, and more effective (Aryadi, 2017). The method of using fire in land preparation activities is carried out because it is cheap in terms of costs and effective in terms of time, and the results achieved are pretty satisfactory (Rasyid F, 2014).

Fire is a collection of uncontrolled fires, meaning they are beyond human ability and desire, but there are also fires caused by human activity, whether intentional or unintentional (Ramli, 2010). The cause of fires is due to processing/clearing land by burning; this condition still dominates a group of people who cultivate/clear land by burning. This is done because burning is much cheaper than fertilizer (Kumalawati et al., 2019).

The forest and land fires that occurred on Mare Island, Tidore Islands City, were quite large because the existing conditions of the area, most of which were forest areas, were always overgrown with flammable vegetation. Forest and land fires in this area can cause losses in the form of loss of vegetation and various nutrients in the soil, disrupt public health, and cause infectious diseases of the respiratory tract (ARI). The island city of Tidore, in this case, Mare Island, is one of the areas included in the forest and land restoration priority by the North Maluku Provincial Forestry Service in 2016, 2019 to 2023. Mare Island is one of the islands Isidore that often experiences forest fires and land (Tolangara, 2022).

The forests and land on Mare Island are forests covered with trees and dominated by reeds, which are flammable, so it is feared that the impacts and losses due to fires will be more significant. Forest and land fires occur due to 2 (two) primary factors: natural and uncontrolled anthropogenic factors. Natural factors include the influence of El-Nino, which causes long dry seasons that result in plants drying out. Dry plants are potential fuel if the leaves of the reed plants rub against each other and sparks arise, as do fires that occur due to farmers cutting down trees and then burning them to clear the land of grass. This condition can cause surface fires and crown fires. This research aims to determine the form of fire, the factors that cause fires, and the succession after forest and land fires on Mare Island.

2. RESEARCH METHODS

This research was carried out on Mare Island and lasted for four years from 2019 to 2023; during this research, direct observations were made of fires that occurred and post-fires in forests and land on Mare Island, Tidore Islands City. The research location can be shown in Figure 1 below.

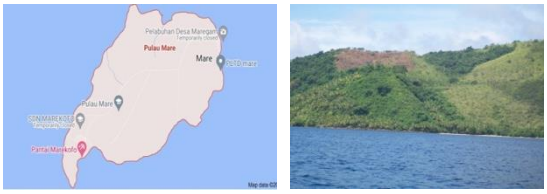

Figure 1. Map of Mare Island

following images are presented as evidence of forest and land fires on Mare Island from 2019 to 2023.

Figure 2. Fires in 2019

Figure 3. Fires in 2021

Figure 4. Fires in 2023

The data collection technique uses a questionnaire as quantitative data, filled in by people whose agricultural land has experienced a fire. The material in the questionnaire consisted of characteristics of land fires and factors that influence fires, with respondents totaling 124 heads of families who were victims of forest and land fires.

After the questionnaire has been filled out, it is then withdrawn for analysis using the percentage test (%) with the following formula:

$$P = \frac{f}{N} \, x \, 100\%$$

Information :
P = Percentage (%)
f = Number of respondents who filled out the questionnaire
N = Total Number of respondents
100 = Fixed value

In addition to gathering data via questionnaires, we conducted direct field observations (field research) to understand the plant species that emerge from forest and land fires, thereby identifying the succession process on the burned land. We also conducted a literature review (library research) to gather additional supporting information. We then present the data analysis results in tables and narratives.

3. RESULTS AND DISCUSSION

Based on the results of the research on land reconstruction after the fire and the secondary succession formed, where the data are obtained through direct observation in the field accompanied by the layout of the lift by respondents whose lift

contains the characteristics of the land fire occurring on the island of Mare, the filling results of such lifts have been analyzed and presented in Table 1 below.

Table 1. Forest and land characteristics on Mare Island

Characteristics of forest and land fires	Answers	Total Respondent	Percentage (%)
Surface fire	Yes	124	100
	No	0	
Header fire	Yes	124	100
	No	0	

(Source: Primary Data Processing, 2024)

Based on the data presented in Table 1, it is evident that all 124 respondents, when asked about the characteristics of fires on Mare Island, answered in the affirmative for both surface and canopy fires. Several factors influence the characteristics of forest and land fires, as shown in Table 2 below.

Table 2. Factors influencing forest and land fires on Mare Island

Factors influencing forest and land fires	Answers	Total Respondent	Percentage (%)
Water content in forests and land is lacking.	Ya	114	91.94
	Tidak	10	8.06
Availability of water in the soil	Ya	95	76.61
	Tidak	19	23.39
Lack of Rainwater	Ya	114	91.94
	Tidak	10	8.06
Water vapor in the air	Ya	118	95.16
	Tidak	6	4.84

(Source: Primary Data Processing, 2024)

Table 2 provides information regarding the factors that influence land fires according to 124 respondents. The lack of water vapor in the air was answered yes by 95.16% of respondents, respondents answered the lack of rainwater at 91.94%, and the water content in forests and land was answered yes by respondents at 91.94. In comparison, water availability in the soil had a percentage of 76.61%: 23.39% for yes or no answers from all respondents. Therefore, lack of water vapor in the air, lack of rainwater, and water content in forests and land will make forests and land lack water, resulting in the land becoming dry and easy to dry. Burnt.

The fire process (combustion) is the opposite of the result of the photosynthesis reaction carried out by plants, where the fire will only occur if the elements of fuel, oxygen, and heat as elements of the fire triangle unite. Based on the type of fuel and the nature of the burning, forest and land fires in the mountains (Kumalawati R. et al., 2019) are divided into two types, namely:

1. Surface fire, a crucial part of the ecosystem, is a type of fire that consumes surface fuel in the form of litter, shrubs, saplings, stakes and logging waste, underscoring the importance of understanding different fire types.
2. Crown fire is a type of fire that burns the tree crown (the top of the tree).

According to Aditiea L. (2015), forest and land fires in mountainous areas usually start with igniting fire on the ground surface. The fire will move along the top surface of the ground and is influenced by the speed and direction of the wind. As a surface fire, if it reaches the tree canopy, it will become a crown fire. Burning parts of trees/twigs/shrubs can be blown by the wind and fall to new places, thus causing new fires such as spot fires (spotting). These three processes can be seen in Figure 5 below.

(a) Surface Fire

(b) Heading Fire

(c) Jump Fire

Figure 5. Forest and land fires in 3 types, namely surface, crown, and jump fires

The impact of this fire is in the form of greenhouse gas emissions resulting from a land fire process. This is influenced by the environmental conditions where the burning is carried out, including fuel and weather. Gas emissions from forest and land fires depend on the ecosystem, such as fuel potential, water content in the fuel, natural conditions, fire behavior, and the characteristics of the fire that occurs (Nurhayati, A.D, 2010).

Forest and land fire events will have a huge impact on vegetation, both underground and trees. Syaufina and Ainuddin (2011) said that forest fires have a direct and indirect impact on vegetation. Fire can directly kill plants and cause injury. Meanwhile, fire can indirectly cause open wounds on trees and undergrowth, thereby triggering attacks by pests and disease.

Furthermore, Syaufina and Ainuddin (2011) explained that forest and land fires will change vegetation's structure and composition by increasing species' diversity under the forest floor. In addition, soil macrofauna diversity decreases after fires; in some cases, new macrofauna communities will appear after fires. Fire can reduce certain bacteria, such as Lactobacillus and Rhizobium, and

phosphate-solubilizing bacteria will increase. The magnitude of the effect of fire on tropical forest biodiversity is influenced by several factors: high fire intensity, fire severity, low rainfall, and vast burned areas. This condition will give rise to succession in areas of former forest and land fires, which we call secondary succession in plants, as shown in Figure 6 below.

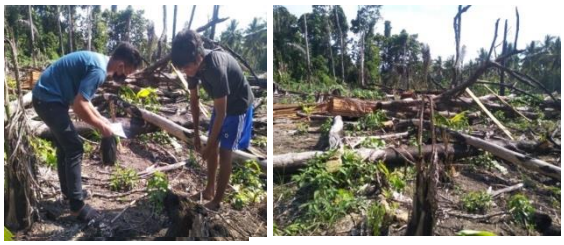

Figure 6. Plants growing after the fire on Mare Island

Plant succession is the replacement of a plant community by other plants, most of which will be different from the original plants. This can occur at a slow integration stage when the initial growing site is very hard, so that few plants can grow on it, or succession can occur very quickly when a community is damaged by a factor such as forest and land fires or due to flooding or because of replacement by other plants. For instance, pioneer species like fireweed and aspen may quickly colonize the area in a recently burned forest, followed by a succession of other species as the soil conditions and microclimate change (Tolangara, 2022).

They were also explained by Onrizal et al. (2005) that succession is a process that occurs continuously and is characterized by changes in vegetation, soil, and climate during this process. Two factors cause succession: climatic factors and topographic/edaphic (soil) factors. The climatic conditions in question include fluctuating inconsistent climatic conditions, drought, intense solar radiation, etc., which can damage vegetation, giving rise to succession. The population growth rate and species composition occur very quickly in the initial phase of succession, then decrease in subsequent developments. Conditions that limit the rate of population growth and species composition, especially undergrowth, in the next stage, are environmental factors that strongly support the survival of natural regeneration for certain species (EK. Rahmasari, 2011).

Masyrafina (2014) explains that undergrowth communities are often used as bioindicators of soil fertility and produce litter to increase soil fertility. So, the more diverse types of plants that grow, the better the soil quality will be. Meanwhile, using understory plants as indicator plants for various conditions that can minimize disturbances, such as forest and land fires, is essential because only a few particular areas have several types of undergrowth like that.

It is certain that areas that have been burned, both forest and land, will experience succession, both primary and secondary succession. Primary succession occurs when the original community is disturbed, resulting in the total loss of the original community and the formation of a new habitat. Secondary succession, on the other hand, occurs when a community or natural ecosystem is disturbed, either naturally or artificially. However, the disturbance does not completely destroy the place where the original organisms grew, allowing the old substrate and life to persist (Akhiarni, 2008). Akhiarni (2008) further said that environmental factors limit the number of species that live at a succession stage, which can be classified into two categories, including;

1. environmental factors that make it difficult for plants to adapt due to phenomena that limit the results of photosynthesis, for example, sunlight, availability of sufficient water, adequacy of nutrients in the soil, and temperature,
2. factors related to damage, whether partial or complete damage to vegetation biomass, a term used to describe the total mass of living plants in a given area, such as pest attacks, pathogens, or human influence.

According to Saharjo and Cornelio (2011). The speed at which the succession process can quickly recover in each habitat is influenced by various factors, including the following:

1. The extent of the initial community damaged by disturbances. The more extensive the initial community is damaged, the slower the succession process will be.
2. The types of plants found around where succession occurs play a significant role. The more types of plants that exist, the faster the succession process will be because the presence of these types of plants will be a source of plant material (seeds and spores). It is important to note that the types of plants in this place are local types with relatively high adaptability compared to foreign or exotic plant types, emphasizing the relevance of local research in understanding succession processes.
3. The characteristics of each plant species where succession occurs. The characteristics of the type of plant in question include, among other things, the speed of the plant, the period of the flowering and fruiting season, fruit productivity, and whether or not the seeds germinate quickly.
4. The presence of potential new individuals which include (seeds, fruit, spores, etc.) is

a critical factor. The presence of potential new individuals in an area undergoing a succession process is very important, and depends on the presence of the types of organisms around the place where succession occurs and also depends on the method of dispersal of the new individuals. This highlights the urgency of conservation efforts to ensure the presence of these potential new individuals for a successful succession process.

5. A new type of substrate is formed. A new substrate rich in organic material will be a suitable growing medium for certain types of plants, thereby accelerating plant growth and development.
6. Climatic conditions, especially the direction and speed of the wind that carries potential new individuals, and rainfall will influence the germination of seeds or spores and the development of subsequent seedlings.

4. CONCLUSION

Based on the results of research conducted on Mare Island and Tidore Islands, it can be concluded that all 124 respondents said that the characteristics of fires on Mare Island include the form of fires that occur on the surface and canopy. Factors that influence fires include lack of water vapor in the air, lack of rainwater and water content in forests and land, and minimal water availability in the soil. This condition results in the land becoming dry and flammable. The impact of forest and land fires is the formation of secondary succession, where the initial plant types are largely replaced by new plant types that differ from the initial plants.

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