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Forest Fire Disaster Mitigation Through Social Policy Implementation in Peat Ecosystem Management

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Abstract

Forest fires are a problem that often hit Riau Province. Therefore, there is a need for mitigation efforts to deal with this forest fire disaster. One of the steps that can be taken is by implementing peat ecosystems. This research then aims to see how the implementation of peat ecosystems can mitigate forest fires, especially in Riau Province. This research will be conducted using a descriptive qualitative approach. The data used in this research comes from various previous research results that are still relevant to this research. The results of this study found that in implementing peat ecosystems, there are still challenges that need to be faced, such as climate change and land use. To overcome this, various opportunities such as technological developments and stakeholder collaboration can be implemented. In mitigating forest fires, conservation and restoration of peat ecosystems are important steps to strengthen the resilience of the ecosystem.

Keywords: Peat Ecosystem, Disaster Mitigation, Forest Fire.

Abstrak

Kebakaran hutan merupakan permasalahan yang sering melanda Provinsi Riau. Oleh karena itu, perlu adanya upaya mitigasi untuk menghadapi bencana kebakaran hutan ini. Salah satu langkah yang bisa dilakukan adalah dengan penerapan ekosistem gambut. Penelitian ini kemudian bertujuan untuk melihat bagaimana penerapan ekosistem gambut dapat melakukan mitigasi kebakaran hutan khususnya di Provinsi Riau. Penelitian ini akan dilakukan dengan menggunakan pendekatan deskriptif kualitatif. Data yang digunakan dalam penelitian ini berasal dari berbagai hasil penelitian terdahulu yang masih relevan dengan penelitian ini. Hasil penelitian ini menemukan bahwa dalam penerapan ekosistem gambut masih terdapat tantangan yang perlu dihadapi seperti perubahan iklim dan tata guna lahan. Untuk mengatasi hal tersebut, berbagai peluang seperti perkembangan teknologi dan kolaborasi pemangku kepentingan dapat dilaksanakan. Dalam mitigasi kebakaran hutan, konservasi dan restorasi ekosistem gambut merupakan langkah penting untuk memperkuat ketahanan ekosistem.

Kata Kunci: Ekosistem Gambut, Mitigasi Bencana, Kebakaran Hutan.

INTRODUCTION

Riau Province, located on Sumatra Island, Indonesia, has abundant natural resources, including vast peat forests. However, over the past few decades, Riau has faced serious problems in the form of recurring catastrophic forest fires. Riau's forest fires not only threaten the natural environment but also cause significant economic and social losses. Peat ecosystems in Riau play an important role in regulating climate, storing carbon, and providing habitat for various species of flora and fauna (Adrianto et al., 2019). However, these ecosystems are highly susceptible to fires, especially during long dry seasons and dry weather conditions. Factors such as land clearing for agriculture, forest encroachment, and unsustainable

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management have led to the degradation of peat ecosystems, increasing the risk of forest fires (Dako et al., 2019).

The implementation of peat ecosystems in forest fire disaster mitigation involves a series of conservation and restoration efforts aimed at maintaining and strengthening the hydrological functions and resilience of the ecosystem. Some of the measures that have been taken include the restoration of peat vegetation, the construction of irrigation canals, integrated fire management, and sustainable land management (Nugroho et al., 2023). One important aspect to consider in peat ecosystem implementation is a thorough understanding of the condition of peat ecosystems in Riau. Through careful mapping and monitoring, we can identify locations prone to forest fires and develop appropriate mitigation strategies (Hidir, 2021).

It is also important to involve various stakeholders in peat ecosystem implementation. The government, local communities, companies, and research institutions need to work together in formulating policies, developing action plans, and implementing programs that support forest fire disaster mitigation (Nizam & Yasir, 2022). Over the past few years, several efforts have been made to implement peat ecosystems in forest fire disaster mitigation in Riau. However, a thorough evaluation of the success and impact of these efforts is still needed to identify lessons learned and recommendations that can be used to improve and expand mitigation activities (Setiawan, 2019).

Currently, there are complex challenges in implementing peat ecosystems in mitigating forest fire disasters in Riau. Factors such as climate change, economic interests, and social dynamics affect the ability and effectiveness of mitigation efforts (Robertua et al., 2022). Research that focuses on the implementation of peat ecosystems in mitigating forest fire disasters in Riau is very relevant and urgent. The information gathered from this research can provide a strong scientific basis to inform more effective mitigation policies and actions. This research is expected to provide a better understanding of the role of peat ecosystems in forest fire mitigation and provide recommendations that can be used to improve the effectiveness of future mitigation programs.

This research aims to identify and evaluate the role of social policy in mitigating forest fire disasters, especially in peat ecosystems. This research focuses on how social policy can be implemented effectively in managing peat ecosystems to prevent and reduce the impact of forest fires. This research aims to explore the relationship between social policy, peat ecosystem conditions, and the frequency and intensity of forest fires. It is hoped that this research can provide evidence-based policy recommendations for better peat ecosystem management and more effective forest fire mitigation through an in-depth understanding of this dynamic.

LITERATURE REVIEW

Peat Ecosystem

Peat forests grow in waterlogged areas that have a pH between 3.5 and 4.0, making the soil nutrient-deficient. In forests, peat is formed when fallen trees sink into the mud, which contains little oxygen, preventing soil microorganisms from continuing the complete decomposition of plant material. Eventually, the materials that do not decompose slowly turn into peat, which can reach a thickness of up to 20 meters (Darmanto & Setiawan, 2021).

Peat refers to a pile of plant remains buried for hundreds to thousands of years. In epistemology, peat is organic matter that is naturally buried in excess water or a water-saturated state, has a non-dense nature and is partially or completely decomposed (Grove et al., 2020). In the pedological concept, peat is

an area of soil that is significantly affected by organic matter content. In ecological terms, peat functions as a source and sink of carbon, which can result in greenhouse gas emissions that contribute to climate change and global warming (Abakumov et al., 2023). Two forms of peat classification can be identified:

1. Ombrogenous Peat
   This type of peat is generally found in coastal areas with a thickness of up to 20 meters. This peat water is highly acidic and has few nutrients (oligotrophic), especially calcium, as there is no supply of nutrients from external sources. Therefore, plants growing in homogenous peat soils obtain nutrients from the peat itself and rainwater (Cantonati et al., 2020).
2. Topogen Peat
   This type of peat is rare and usually forms in areas with indented topography, either on the coast or inland with obstructed drainage. The water is acidic and contains more nutrients than ombrogenous peat (Morgenstern et al., 2021).

Peat soil is a type of soil formed from organic matter or the remains of past plants. Based on the USDA (2006) classification, peat soils belong to the order histosol. To be categorized as peat soil, the soil must meet certain requirements, namely having a minimum organic matter content of 12-18% Organic (depending on the mineral fraction) and a minimum thickness of 40 cm. In Indonesia, tropical peat organic matter is formed under anaerobic conditions (Jarmain et al., 2023). This condition occurs due to continuous waterlogging of the organic material, resulting in the formation of a layer of organic material. This layer gets thicker over time until it reaches or exceeds a thickness of 40 cm, which is then referred to as peat soil. Peat organic matter comes from the vegetation that grows on it, and the nature and characteristics of peat soil are influenced by the type of originating vegetation, topography, formation process, and the age of the peat soil itself (Kleber et al., 2021).

Foret Fire

There is a difference between forest fires and land fires. Forest fires refer to fires that occur within forest areas, while land fires are fires that occur outside forest areas. Both forest fires and land fires can occur either intentionally or unintentionally (Wulandari & Fitriasari, 2022).

A forest fire is an event where a fire occurs that causes harm or disaster. Fires can occur due to a variety of factors, including uncontrolled burning, spontaneous natural processes, or deliberate actions. Natural processes are one example of a cause of forest fires, such as when lightning strikes a tree or building, a volcanic eruption releases a plume of embers, or friction between dry branches of plants containing oil, which can be triggered by shifting winds and produce heat or sparks. In addition, forest fires can also occur due to deliberate human actions. Examples of human activities that can cause fires include burning agricultural land, plantations, Industrial Plantation Forests (HTI), land preparation for raising cattle, and so on (Wahyudi, 2021).

According to Darwiati and Tuheteru, almost 99% of forest and land fires in Indonesia are caused by human activities, whether intentional or negligent. In that percentage, land conversion activities contributed 34%, illegal cultivation 25%, agriculture 17%, social jealousy 14%, and transmigration projects 8%. Only about 1% of fires are caused by natural factors. In addition, other factors exacerbate forest and land fires and trigger them. These factors include climate extremes, and the use of energy sources such as wood, coal deposits and peat (Wahid & Baidawi, 2022).

Every year, forest fires occur in Indonesia. Most of these forest fires are caused by negligence or deliberate human actions to clear land on a large scale. Usually, this action is carried out by plantation and forestry companies illegally, either for agricultural, forestry or plantation activities. Only a small

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proportion of forest fires are caused by natural factors, such as lightning or lava from volcanoes (Nisa, 2020).

Forest fires often occur as a result of land clearing and conversion of forests to plantations using the method of burning debris, leaves and plant residues. This method of burning is considered cheap, easy and efficient in the process. However, due to the lack of control over such burning, fires can easily spread and cause widespread fires. The burning method is usually used to clear land of existing vegetation before planting new crops. However, without proper supervision and control, fires can quickly spread to unwanted areas and cause fires that are difficult to control (Marlina & Rahmaniati, 2022).

Weather factors play an important role in causing forest fires. Some of the weather factors that affect forest fires include wind speed and direction, air temperature, rainfall, groundwater conditions, and relative humidity. Weather conditions can affect the degree of vegetation dryness, the ability of fire to spread, and the speed of fire spread. In addition, time also plays a role in forest fires. Time is closely related to the weather conditions present at the time. Time is differentiated between daytime and nighttime. Time conditions can affect the potential for forest and land fires (Frakusya et al., 2022).

Forest fires have become a serious problem every year in Indonesia, especially during the dry season. The impact of forest and land fires is not only limited to the area of the incident itself, but also extends to neighbouring countries. The haze produced by forest and land fires can spread widely, reaching areas in ASEAN countries such as Singapore, Malaysia and Brunei Darussalam. The impact of this spreading smoke concentration is significant (Maranatha & Kusmayadi, 2020). Visibility is reduced, air and land transportation is disrupted, and people experience an increased risk of upper respiratory tract infections. Social and economic problems also arise from these fires. The impact of smoke from forest fires causes health problems such as acute respiratory infections (ARI), bronchial asthma, bronchitis, pneumonia, and eye and skin irritation. Dust levels in the air that exceed the threshold are the main cause of these health impacts (Nurhayati & Ambari, 2021).

In addition to the smoke disrupting public health and land, water and air transportation facilities, forest fires also have other significant negative impacts, including ecological damage, decreased biodiversity, decreased economic value and productivity of forests, and micro and global climate change (Leu, 2021). Forest fires have a direct impact on the mortality of populations and soil organisms and damage their habitats. Changes in soil temperature and loss of litter layer can alter habitat characteristics and microclimate. Forest fires reduce the availability of food for soil organisms, and most soil organisms are susceptible to fire, resulting in rapid changes in habitat and possibly a significant decrease in the number of microorganisms. However, these negative impacts are generally temporary, and populations of soil organisms eventually recover within a few years (Certini et al., 2021).

Social Policy for Peat Ecosystem Management

Social policy in the context of environmental management refers to a series of policies, regulations and programs designed to manage human interactions with the natural environment sustainably and fairly. This policy aims to address environmental issues such as ecosystem degradation, pollution and climate change, by combining social, economic and environmental approaches. Social policy involves efforts to involve local communities in sustainable management practices, provide economic incentives for environmental conservation, and regulate land use to prevent further damage in the management of peat ecosystems. This concept also includes community empowerment through education and training, as well as the formation of collaboration between government, communities and non-governmental organizations to achieve common goals in maintaining ecosystem sustainability, and it is hoped that

solutions will be created that are not only effective in conservation but also fair and inclusive for all stakeholders By integrating social perspectives in environmental policy (Adrianto et al., 2019).

Existing social policies related to peat ecosystem management include various initiatives aimed at preserving the ecosystem while improving the welfare of local communities. One prominent policy is the Peat Restoration Program which is being implemented in several countries, including Indonesia, which has a significant area of peatland. This program involves efforts to restore damaged peatlands through rewetting (rewetting) and revegetation (replanting) as well as involving local communities in the restoration process. Policies such as a moratorium on clearing new peatlands have been implemented to prevent further damage. These policies are often complemented by economic incentives for farmers and landowners to switch to more sustainable farming practices, as well as education and training programs to raise awareness of the importance of peat ecosystems (Dako et al., 2019).

Various initiatives at the global level such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation) also support the conservation of peat ecosystems by providing financial compensation for developing countries that succeed in reducing carbon emissions through better forest protection and management. The implementation of these policies often faces challenges, including a lack of coordination between government agencies, limited resources, and resistance from parties with short-term economic interests. The success of managing peat ecosystems through social policy is highly dependent on a holistic and inclusive approach, as well as strong collaboration between all stakeholders (Frakusya et al., 2022).

Forest Fire Disaster Mitigation

Commonly used forest fire mitigation strategies and techniques include a variety of approaches aimed at preventing fires, detecting fires early, and extinguishing fires quickly and effectively. One primary strategy is fuel management, which involves reducing dry vegetation and combustible materials through controlled burning or mechanical removal. This technique aims to reduce the potential for large fires by removing fuel that can speed up the spread of fire. In addition, the construction and maintenance of firebreaks is an important step that creates a physical barrier to prevent the spread of fire to a wider area..

Fire monitoring and early detection systems are also very important in mitigation. The use of technology such as satellites, drones and smoke detection sensors allows real-time monitoring of forest areas so that fires can be detected early and a quick response can be carried out. Implementation of an early warning system integrated with the fire control centre helps more effective response coordination. Education and training of local communities regarding forest fire prevention plays a key role. Community awareness programs, volunteer firefighting training, and community involvement in forest monitoring can improve early detection capabilities and local response to fires (Grove et al., 2020).

Other techniques used include direct fire extinguishing with fire extinguishers and fire vehicles, as well as the use of firefighting aircraft to drop water or chemical extinguishers from the air onto the burning area. Innovative techniques such as the use of fire retardant gels and chemical fire retardants are also applied to protect vulnerable areas in some regions. Forest fire mitigation requires a comprehensive and coordinated approach, involving a variety of techniques and strategies adapted to local conditions and the fire risk faced, and collaboration between government, communities and non-governmental organizations is critical to the success of these mitigation efforts (Jarmain et al., 2023).

The role of technology and innovation in mitigating forest fires is increasingly important and diverse as time goes by. Satellite and drone technology enables real-time monitoring of large areas of forest, providing accurate data on hot spots and areas at high risk of fire. This information is invaluable for

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early detection and rapid response to fires. The use of smoke detection sensors and surveillance cameras connected to the internet network helps in more efficient monitoring and increases the ability to detect fires at an early stage.

Innovations in analytical software and geographic information systems (GIS) also play an important role in forest fire mitigation. This technology enables the modelling and simulation of forest fires, aiding in strategic planning and more informed decision-making. An information technology-based early warning system, which integrates data from various sources, can provide notifications to firefighters and local communities about potential fires so that preventative steps can be taken immediately (Certini et al., 2021).

Firefighting technologies such as firefighting aircraft, helicopters with water buckets, and firefighting vehicles equipped with modern extinguishers increase the effectiveness of extinguishing efforts. The use of fire retardant chemicals and fire retardant gels are also important innovations that help protect areas vulnerable to fire. No less important, communication technology and mobile applications enable better coordination between firefighting teams and the community. Special applications can be used to report fires quickly and accurately, as well as provide evacuation guidance and other important information to affected communities. Technology and innovation have changed the way we respond to wildfires, making responses faster, more efficient and more effective. By continuing to invest in advanced technology and innovations, we can improve our forest fire mitigation capabilities and protect ecosystems and the human lives that depend on them (Hidir, 2021).

Role of Stakeholders

Several main stakeholders play an important role and must work together to achieve success in peat ecosystem management, including::

1) The government is a key stakeholder responsible for formulating policies, and regulations and monitoring the implementation of pest management programs. The government also plays a role in providing funds and resources for the restoration and conservation of peat ecosystems.
2) Local communities living around peat ecosystems are important actors because they have local knowledge and direct ties to peatlands. Their active participation in management and restoration programs is essential for long-term sustainability. They are also often the first responders to detect and respond to fires.
3) Non-governmental organizations (NGOs) and research institutions also play an important role in providing technical support, research and advocacy. They help develop and implement best practices in peat ecosystem management, as well as raise awareness about the importance of peat conservation.
4) The private sector, especially companies operating in or near peat ecosystems such as plantation and forestry companies, have a big responsibility to ensure that their business activities do not damage peat ecosystems. They can also contribute through corporate social responsibility (CSR) programs that support restoration and conservation efforts.
5) The international community, including UN agencies and other global organizations, is often involved in providing financial, technical and policy support through various international initiatives and programs that focus on climate change and environmental conservation.
6) Cooperation and coordination between all these stakeholders is very important for the success of sustainable and effective management of peat ecosystems. Through close collaboration, they can overcome the complex challenges faced in conserving peat ecosystems and mitigating forest fires.

Each stakeholder has a crucial and complementary role and contribution to mitigating forest fires. The government, as a policy maker and regulator, plays a major role in formulating and enforcing regulations as well as providing funds and resources for forest fire prevention and control programs. The government is also responsible for building necessary infrastructure, such as watch towers and early warning systems, as well as coordinating inter-agency responses in the event of a fire (Nizam, 2020).

Local communities are the front line in forest fire mitigation. They are often the first to detect a fire and can provide a quick initial response. Their participation in forest fire education and training programs increases their capacity to take preventative action, such as clearing flammable fuel around their villages. The local wisdom they have can also be used in more sustainable land management strategies. Non-governmental organizations (NGOs) and research institutions play a role in providing the technical and scientific support necessary for effective forest fire management. They develop and promote best practices, and conduct research to understand the causes and impacts of forest fires. NGOs also often engage in advocacy, raising public awareness about forest fire issues, and mobilizing resources for restoration projects (Nisa, 2020).

The private sector, especially companies operating in or near forest areas, has a big responsibility in implementing environmentally friendly business practices to prevent forest fires. They can contribute through corporate social responsibility (CSR) initiatives, fund forest restoration projects, and participate in public-private partnerships focused on fire prevention. Companies can also innovate in technology and forest management methods that are safer and more sustainable. The international community, including UN agencies and other global organizations, provides financial and technical support through various international programs that support forest fire mitigation and climate change. They also play a role in facilitating cross-border cooperation and sharing knowledge and technology. Each of these stakeholders can make their unique contribution to creating a comprehensive and sustainable approach to forest fire mitigation, ensuring better protection of ecosystems and the communities that depend on them through effective collaboration (Kleber et al., 2021).

Literature Gaps

The gaps in the existing literature that this research aims to address include:

1) Limited Focus on Social Policy Implementation: Existing literature often emphasizes technical aspects of peat ecosystem management and forest fire mitigation, but there is a gap in understanding how social policies can effectively support these efforts. This research intends to explore how social policies can be integrated to enhance sustainable management practices and mitigate forest fire risks in peat ecosystems.
2) Insufficient Coverage of Recent Studies: Many studies in the literature review may not sufficiently cover recent developments in peat ecosystem management and forest fire mitigation strategies. This research aims to expand the literature review to include more recent studies and innovations in technology, stakeholder collaboration, and policy frameworks relevant to mitigating forest fires in peatlands.
3) Lack of Comprehensive Frameworks: There is a need for a more detailed theoretical framework that explicitly connects social policies, peat ecosystem management practices, and effective forest fire mitigation strategies. The research aims to develop or refine such a framework to guide future research and policy development in this area.
4) Limited Examination of Stakeholder Contributions: Existing literature may not fully explore the roles and contributions of different stakeholders, including local communities, governmental

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agencies, NGOs, and private sectors, in mitigating forest fires in peat ecosystems. This research intends to analyze and highlight the varied contributions and challenges faced by these stakeholders.

5) Incomplete Understanding of Technological Advancements: Although some studies touch upon technological solutions for detecting and managing forest fires, there is often a lack of in-depth analysis of the effectiveness and integration of these technologies in peat ecosystems. This research aims to explore the opportunities and challenges associated with technological advancements in mitigating forest fires in peatlands.

The research seeks to contribute to a more holistic understanding of how social policies, technological innovations, stakeholder collaborations, and management practices can collectively contribute to effective forest fire mitigation in peat ecosystems by addressing these gaps.

RESEARCH METHOD

This research uses a qualitative descriptive approach and literature study methods to explore relevant information about the role of peat ecosystems in fire mitigation. The qualitative descriptive approach allows researchers to describe in detail the characteristics and role of peat ecosystems in the context of fires, while the literature study method allows collecting data from various reliable sources such as scientific journals, reference books and research reports. The collected research data will be processed by researchers with the hope that conclusions from this research can be found (Jaya, 2020). A qualitative descriptive approach was chosen because it allows an in-depth exploration of the complexity of peat ecosystems and their interactions with forest fires, while the literature study method supports this approach by providing the necessary theoretical foundation and empirical data. (Jaya, 2020).

Key concepts in the context of this research need to be clearly defined to ensure clarity and reliability of the research. The following are the definitions and measurements of the main concepts relevant in this research:

1) Peat Ecosystem

The peat ecosystem is an environmental system consisting of wetlands with a thick layer of organic material called peat. These ecosystems are important because they have the unique ability to store large amounts of carbon and influence the global climate.

Measurement: Measurement of peat ecosystems can involve parameters such as peat depth, carbon content, soil moisture, and the type and diversity of flora and fauna. Measurement methods include field techniques such as soil sampling, laboratory analysis for carbon content, and biodiversity surveys.

2) Disaster Mitigation

Disaster mitigation is a series of actions taken to reduce the risk, impact and vulnerability to natural or human disasters, such as forest fires. The goal is to protect human life, property, and the environment.

Measurement: Disaster mitigation can be measured by identifying and evaluating implemented prevention and response strategies. This measurement involves analyzing the effectiveness of mitigation strategies that have been implemented in reducing the frequency, intensity and damage caused by forest fires.

3) Forest Fires

Forest fires are events where vegetation burns in forest or peatland areas. These fires can be triggered by natural factors such as lightning or human activities such as clearing agricultural land. Measurement: Forest fires can be measured by identifying fire characteristics such as scale (area burned), intensity (strength of the fire), and duration of the fire. Measurement methods include field observations,

satellite image analysis to map burned areas, and weather data recording to understand meteorological conditions that influence fires.

RESULTS AND DISCUSSION

Contribution of Peat Ecosystems in Forest Fire Disaster Mitigation

Peat ecosystems have a unique ability to store water, which plays an important role in mitigating forest fires. The thick peat layer can absorb and store large amounts of water, forming a sustainable water source to maintain the surrounding moisture. In addition to storing water, peat ecosystems are also able to resist burning. The dense and compact structure of peat slows down fire propagation, allowing more time for fire intervention and suppression, thus minimizing the impact. The role of peat ecosystems as "natural fire barriers" is crucial in reducing the risk of forest fires. Peat has a high water content and tends to be less flammable, which can significantly inhibit the spread of fire.

The peat ecosystem is known as a very large carbon store (see table 1). The organic material that accumulates in peat can contain large amounts of carbon that is released into the atmosphere in the event of a fire. According to research by Smith et al. (2021), peat ecosystems can store up to 10 times more carbon than other tropical forests. This shows that preserving peat ecosystems can significantly reduce carbon emissions and the impact of global climate change (see figure 1).

Table 1. Peat Ecosystem Carbon Storage Capacity

Ecosystem Type	Carbon Storage Capacity (ton CO_2/ha)
Peat Ecosystem	1.000 – 5.000
Tropical forest	100 – 500
Savanna	50 – 200

Source: data proceed

The peat ecosystem also plays a role in maintaining water balance and soil moisture. The thick peat layer and its hydrophobic properties are able to store water well, prevent drought and stabilize hydrological conditions in the area it surrounds. This reduces the risk of forest fires due to the more humid conditions and lack of flammable organic material. The physical structure of peat ecosystems, such as thick and high layers of peat, also functions as a natural barrier against fire shock. According to a study conducted by Mulyadi et al. (2020), the thickness and density of the peat layer has a significant impact in reducing the intensity and rate of spread of forest fires in peat ecosystem areas.

The hydrological function of peat ecosystems also plays a role in maintaining moisture and regulating regional climate. Peat ecosystems serve as important water storage areas for rivers and groundwater sources. By maintaining the availability of water, peat ecosystems can maintain the surrounding humidity, reduce the potential for drought, and create conditions that are less favourable for fire. In addition to the ability to store water, peat ecosystems also play a role in maintaining water quality. Peat can settle dissolved substances and drain water with a cleaner content. This has a positive impact on ecosystem sustainability and environmental health. Peat ecosystems also contribute to reducing greenhouse gas emissions and controlling climate change. When peat ecosystems burn, the carbon stored

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in the peat is released into the atmosphere as a gas. By maintaining the sustainability of peat ecosystems, greenhouse gas emissions can be reduced and the impact of climate change can be slowed down.

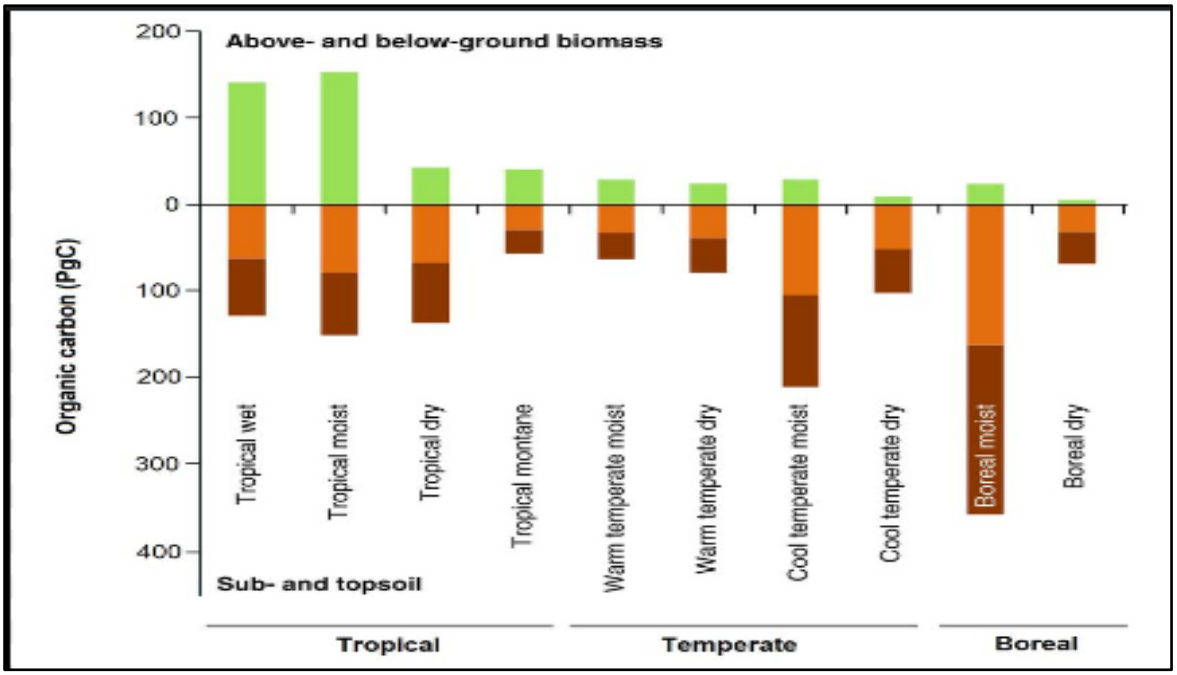

Figure 1. Comparison of Carbon Storage in Various Ecosystem Types

The sustainability of peat ecosystems also impacts biodiversity. A healthy peat ecosystem provides an important habitat for many species of flora and fauna, including endangered species. By protecting peat ecosystems, we are also protecting the biodiversity within them. The implementation of conservation and restoration practices for peat ecosystems is key to improving their contribution to mitigating forest fires. Efforts to restore peat vegetation and sustainable management will strengthen the hydrological function and fire resistance of peat ecosystems (Nugroho & Yasir, 2022).

The importance of strengthening the role of peat ecosystems in forest fire mitigation underscores the need for protection and sustainable management. In this context, there needs to be cooperation between the government, local communities, companies and research institutions to maintain the sustainability of peat ecosystems. Awareness of the importance of peat ecosystem conservation and restoration in mitigating forest fires needs to be widely disseminated. Education and socialization to the community about the benefits of peat ecosystems as an effective mitigation tool will increase participation and support in maintaining and restoring peat ecosystems in Riau.

Implementation of Peat Ecosystem Conservation and Restoration Efforts

Restoring peat vegetation is an important step in strengthening the resilience of peat ecosystems. Through replanting and rehabilitating degraded peatlands, it can increase the sustainability of the peat ecosystem and strengthen its ability to store water, resist burning, and maintain moisture. In addition to vegetation restoration, the construction of irrigation canals is also an important effort in maintaining water availability in peat ecosystems. Well-designed irrigation canals can help maintain optimal water levels in the peat, prevent drought, and retain the moisture needed to reduce fire risk. Integrated fire management is key in preventing and reducing forest fires in peat areas. This approach includes fire prevention through

regular patrols, strict surveillance, and early detection using advanced technology and monitoring systems.

Infrastructure development that supports fire mitigation also needs to be considered. This includes the construction of road networks, effective fire suppression, and improved accessibility to fire locations to speed up firefighting response. The implementation of peat ecosystem conservation and restoration efforts requires strong collaboration between the government, communities and the private sector. Through sustainable partnerships, coordination in peatland management, law enforcement against illegal burning, and better monitoring of activities that damage peat ecosystems can be achieved. In this context, the importance of counseling and educating local communities on the importance of peat ecosystem conservation should not be overlooked. Communities need to be given a good understanding of the benefits of peat ecosystems and their role in maintaining and restoring them.

Skilled human resources trained in peat ecosystem management are also needed. Training and education on sustainable management practices and fire mitigation methods need to be provided to experts, land managers and firefighters. In implementing peat ecosystem conservation and restoration efforts, it is important to consider social justice aspects. Active participation of local communities, including indigenous groups, in decision-making and benefit sharing from conservation and restoration efforts is essential.

Regular evaluation and monitoring of the results of the implementation of peat ecosystem conservation and restoration efforts is necessary. By monitoring and evaluating progress, gaps and opportunities for further improvement and refinement in fire mitigation strategies can be found. The sustainability of peat ecosystem conservation and restoration efforts requires strong policy support. The government needs to encourage policies that support the sustainable management of peat ecosystems, including incentives for parties involved in conservation efforts, strict supervision of destructive activities, and strict law enforcement against illegal burning.

Collaboration between Stakeholders

The role of the government is crucial in formulating policies and implementing forest fire disaster mitigation programs that focus on peat ecosystems. The government can create regulations governing peatland management, involve various related institutions, and provide a budget to support peat ecosystem conservation and restoration efforts. Collaboration with local communities is a key element in conserving and managing peat ecosystems. Local communities have valuable traditional knowledge of peat ecosystems and can act as natural watchdogs and partners in vegetation restoration, fire monitoring and prevention of illegal burning. Through participatory approaches, local communities can be involved in decision-making regarding peatland management. By involving them in the planning and implementation process, there will be a shared understanding and greater responsibility for the sustainability of the peat ecosystem.

Company involvement is also important in implementing sustainable land management practices. Companies have a role as significant land users and can contribute to the restoration and maintenance of peat ecosystems through responsible practices, such as suppressing new land clearing, conducting restoration, and reducing greenhouse gas emissions. The importance of collaboration between government, local communities and companies in supporting peat ecosystem conservation and restoration efforts. Through dialog and strong partnerships, there can be a clear division of roles, exchange of knowledge and technology, and strict monitoring of activities that have the potential to damage peat ecosystems. In addition, coordination between stakeholders is needed to address conflicts of interest that

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may arise in peatland management. With open dialog and joint solutions, an agreement can be reached that benefits all parties and maintains the sustainability of the peat ecosystem.

The involvement of research institutions and academics can also strengthen collaboration between stakeholders. These institutions can provide an in-depth understanding of peat ecosystems, provide data and information needed for decision-making, and support the development of research and innovation in peat ecosystem management. Transparency and accountability in stakeholder collaboration is essential. Disclosure of information on peatland management activities, commitment to sustainable practices, and structured reporting will increase trust and strengthen cooperation between stakeholders.

Formal dialog forums and coordination mechanisms between stakeholders are needed. This can take the form of coordination meetings, working groups, or specialized institutions that aim to facilitate collaboration, share information, and monitor progress in implementing peatland ecosystem conservation and restoration efforts. Collaboration between stakeholders in peat ecosystem implementation requires long-term commitment and sustainability. Continuous cooperation, periodic evaluation, and strategy adjustments are needed to achieve common goals in maintaining the sustainability of peat ecosystems.

Challenges and Opportunities in Peat Ecosystem Implementation

The challenge of climate change is one of the obstacles in maintaining the sustainability of peat ecosystems in Riau. Changing rainfall patterns, increasing temperatures and fluctuating water levels can disrupt sensitive peat conditions. In the face of these challenges, effective adaptation strategies are needed to maintain the moisture and sustainability of peat ecosystems. Socio-economic challenges also have a significant impact on peat ecosystem mitigation implementation. Population growth, urbanization, and land use change increase the pressure on peatlands. The need for agriculture, plantations and infrastructure can threaten ecosystem sustainability. Mitigation efforts must address these challenges through sustainable and community-based approaches. Land use change is a serious challenge in maintaining the sustainability of peat ecosystems. Converting peatlands to agriculture or plantations increases the risk of fire and damages the hydrological function of peat. Sustainable land management and control of land use change are key to maintaining the sustainability of peat ecosystems.

Even though there are challenges, there are opportunities for developing technology and innovation that can strengthen forest fire mitigation in peat ecosystems. The use of remote monitoring systems and satellite technology can help detect early fires and speed up emergency response. In addition, the use of innovative fire control methods, such as drip torches or water transport helicopters, can increase the effectiveness of fire extinguishing. Another opportunity is the development of restoration and rehabilitation programs for degraded peat ecosystems. By involving local communities and related parties, efforts to restore peat vegetation and hydrological reconstruction can strengthen the ecosystem's resilience to fires and climate change. A community-based approach is an important opportunity in implementing peat ecosystem mitigation. By involving local communities as partners in managing and maintaining ecosystems, long-term sustainability can be created. Strengthening community capacity in understanding and active participation will help overcome socio-economic challenges that affect mitigation implementation.

Another opportunity is collaboration between institutions and stakeholders in supporting the implementation of peat ecosystem mitigation. Synergy between government, society, companies and non-governmental organizations can create joint strength in overcoming challenges and exploiting existing opportunities. Developing educational programs and public awareness about the importance of peat ecosystems is also an opportunity that needs to be exploited. By increasing understanding of the benefits

of peat ecosystems and their contribution to mitigating forest fire disasters, communities will play a more active role in conservation and sustainable management.

Utilizing available funds and resources is an opportunity that can strengthen mitigation implementation. Through appropriate funding allocation and efficient use of resources, mitigation programs can be implemented effectively and sustainably. The final opportunity is international support and regional cooperation in implementing peat ecosystem mitigation. Collaboration with other countries that have similar peat ecosystems can provide learning and knowledge exchange, as well as financial and technical support that can strengthen mitigation efforts.

Challenges in Implementation

The implementation of peat ecosystem management is faced with various complex challenges, such as climate change which supports increasing temperatures and decreasing rainfall, as well as changes in land use which can increase pressure on the ecosystem. Climate change causes extreme conditions that exacerbate the risk of forest fires and affect water availability in peat ecosystems. Global warming can also accelerate the decomposition of organic material in peat, which in turn releases more carbon into the atmosphere. On the other hand, changes in land use such as the conversion of peat to agricultural land or plantations increase the risk of fire because they increase the accumulation of flammable materials and reduce soil moisture.

There are still opportunities to overcome these challenges through technological advances and collaboration between stakeholders. Remote sensing technology and geographic information systems (GIS) can be used for better monitoring of peat ecosystem conditions and early detection of fires. The development of prediction systems based on mathematical models can also help in estimating fire risks and designing more effective mitigation strategies. In addition, close collaboration between government, local communities, companies and non-governmental organizations is needed to develop sustainable and effective policies in managing peat ecosystems. Through this initiative, awareness can be built of the importance of peat ecosystems, as well as encouraging the adoption of management practices that are sustainable and adaptive to global environmental changes.

CONCLUSION

The implementation of peat ecosystems in mitigating forest fire disasters in Riau has several challenges that need to be overcome. Climate change, socio-economic challenges, changes in land use, and other inhibiting factors are factors that influence the success of mitigation programs. However, in facing these challenges, some opportunities can be exploited, such as technology development, collaboration between stakeholders, and peat ecosystem restoration programs. The importance of conservation and restoration of peat ecosystems as an important step in strengthening ecosystem resilience is the main point in implementing mitigation. Restoring peat vegetation, building irrigation channels and integrated fire control are relevant strategies in maintaining moisture and reducing the risk of fire in peat areas. In addition, collaboration between stakeholders, including the role of government, local communities and companies, is key in implementing sustainable land management practices.

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