# The Synergy of Local Government and Academia in Addressing Peatland Fires in Siak Regency with a Technology-Based Approach

**Diki Arisandi[1], Amir Syamsuadi[2], Iiza Trisnawati[2]**
[1,2,3]Abdurrab University, Pekanbaru, Indonesia
Email: diki@univrab.ac.id

**Abstract**

This study aims to explore the synergy between the local government and academia in mitigating peatland fires in Siak Regency. In the fields of social humanities, science, and technology, this study uses an exploratory qualitative method. The study reveals the important role of the local government in disaster mitigation through regional regulations, policies, and synergy between related departments. Through the regional regulation on forest fire prevention and handling, the local government has involved the Regional Disaster Management Agency (BPBD) and other supporting units in mitigation efforts. In addition, academics have also contributed by developing a technology-based peatland fire detection system. The main results of this study show that collaboration between the local government and academia is very significant in peatland fire mitigation efforts. The role of the local government through Governor's Decree No. 9 of 2020 and Regent's Decree No. 4 of 2022, as well as synergy between departments, encourages more effective steps in preventing and handling peatland fires. In addition, the contribution of academics to producing a technology-based peatland fire mitigation technology design opens up the potential for innovative and sustainable solutions. These findings have significant implications, as they highlight the importance of collaboration between the local government and academia in facing the challenges of peatland fire mitigation in Siak Regency. This synergy allows a better understanding of the problem, the development of more effective policies, and the application of advanced technology in preventing and handling peatland fires.

**Keywords:** *Local Government; Academia; Peatland Fires; synergy; Technology.*

– – – – – – – – – – ◆ – – – – – – – – – –

## A. INTRODUCTION

Forest fires in the Province of Riau, especially in Siak Regency, have had a number of serious impacts on the social life of the people in the region. There are many negative impacts felt by the community resulting from this disaster (Muzaki, Pratiwi, & Az Zahro, 2021). First, the haze contains harmful particles such as PM10, PM2.5, C0, and $NO_2$ that have a negative impact on public health, especially on children, the elderly, pregnant women, and individuals with respiratory disorders (Utami & Primawardani, 2021). Secondly, the impact of forest fires has the potential to cause population displacement and relocation, resulting in social instability. Changes in community patterns of population displacement and relocation due to forest fires can cause social instability in the area. Residents who are forced to leave their homes and neighborhoods may experience stress and trauma stemming from being forced to leave their homes and neighborhoods and may lose their sources of

livelihood and income (Atmaja, 2023). Third, the food crisis caused by forest fires has an impact on food production. Forest fires can reduce the production output of economic sectors, including the agricultural sector. The burned agricultural land decreases the availability of agricultural land and disrupts food production (Okka, Pandjaitan, & Sumarti, 2019). Fourth, the accumulation of the three negative impacts mentioned above can lead to a reduction in employment in sectors that rely on forests or land, causing an increase in the unemployment rate and social inequality in society (Nugraha, Fauzi, & Ekayani, 2019).

Riau Province, including Siak District, has a geographically significant amount of peatland. The organic soil layer with inorganic conditions is a peat soil, with a thickness of more than 50 cm, and an organic carbon content of about 18%. The peat layer also has a high-water content and a low nutrient content, which sets it apart from other land types. In addition, it is important to recognize that peatlands in Siak District have a significant influence on the environment (Notohadiprawiro et al., 2022). More than 50% of Siak District is peatland. Most of the peatland is used for agriculture, such as oil palm and acacia cultivation (Naufal, Waluyati, & Darwanto, 2019). However, the utilization of these peatlands can also cause various environmental problems. Peatland fires, which can cause significant environmental damage, are one such problem. Peatland fires not only lead to habitat and biodiversity loss but also cause air and water pollution, which negatively impacts ecosystems and human health. As mentioned earlier, smoke from peatland fires contains harmful particles that can cause respiratory and other health problems in people (Yusuf, Hapsoh, Siregar, & Nurrochmat, 2019). Peatland fires can affect peat soil properties. For example, the high temperatures that occur during fires can result in a decrease in the water table of peat soils. This causes the peat soil to become more arid and increases the risk of fire. In addition, fires can also alter the porosity of peat soils, reducing their ability to absorb water and causing drainage problems that impact flooding and the ability of the land to store water during the dry season (Gunawan et al., 2020).

There are a number of internal factors that cause peatland fires in Siak District. Peatlands in Siak District are widely used for the cultivation of plantation crops such as acacia and oil palm (Amady, 2020). These plants have flammable properties, especially during dry weather situations. Plantation crops such as oil palm have a lot of flammable organic material, such as plant debris, litter, and dried oil palm fruit bunches. When fires occur, this organic material becomes highly flammable, causing fires to quickly spread to dry peatlands and ignite more extensive fires (Virmanto, Sa'ad, Arsyad, & Ermadani, 2022). The factor of improper land management is also another trigger in terms of peatland fires in Siak District. Human factors, such as inadequate land management, also play an important role in increasing the risk of peatland fires. The practice of intentionally draining peatlands to clear new land or remove crop residues causes a decrease in the water content in the peat soil. Dry peat soil becomes flammable and can trigger fires quickly (Aulia, Hamid, & Budhi, 2022). The habit of residents and corporations to clear new land

through burning is also a common practice to clear the land of plant debris or brush. However, if not properly supervised, the fire from this burning can easily spread to the surrounding peatlands and cause wider peatland fires (Rahayu, Lutfillah, Sari, Rahayu, & Yudi, 2021). In the real world, many practices of new land clearing and land clearing are performed without proper supervision. This is worsened by the existence of overlapping regulations between work units and local governments related to the handling of peatland fires, resulting in conflicting responsibilities (Syamsuadi et al., 2022).

Besides internal factors, peatland fires can also be influenced by external factors, such as wind that carries hot air from land fires in areas surrounding Siak Regency. When the wind spreads smoke and fire from fires in neighboring areas such as Rokan Hilir, Dumai, Bengkalis, Meranti, Kampar, and Pekanbaru City, the fires may quickly spread to peatlands in Siak District and ignite more wildfires (Nurhayati & Aulia, 2022). Peatland fire statistics for 2020 and 2022 show how these fires can cause extensive peatland loss. There are several notable events related to peatland fires in Siak District, including: In 2020, since January, 166.39 hectares of peatland have burned in Siak District (Anhar, Mardiana, & Sita, 2022). In addition, during the first dry season in 2022, 12 hotspots were recorded in Siak District, burning 20.5 hectares of land (Amanda, Ananda, & Madan, 2022). The impact of peatland fires in Siak Regency has proven to be significant. The causes of peatland fires in this region are the result of complex interactions between natural, human, and policy factors. Therefore, the efforts to prevent and suppress peatland fires in Siak Regency must be based on a holistic scientific understanding and involve active participation from the Siak local government and academia from universities.

In addressing peatland fires in Siak Regency, the role of technology is becoming more important as it can deliver various benefits and solutions in fire prevention, detection, and suppression efforts. Technology is crucial in handling peatland fires in Siak District because it can provide various benefits and solutions in fire prevention, detection, and suppression efforts. Technology can be used to detect and estimate burned areas (Hafni, 2017). This allows authorities to take quick action to handle fires before they spread and cause more damage (Amanda et al., 2022). Technology can also be used to monitor peatland conditions in real-time. A monitoring system for early detection of forest fires is an example (Diki Arisandi, Trisnawati, & Syamsuadi, 2022). With effective monitoring, authorities can identify hotspots or temperature changes that could be early signs of a fire. In addition to detection and monitoring, technology can also be used in firefighting attempts. Using fire-fighting equipment for peat restoration, for example, can help extinguish fires more efficiently and effectively. The estimation of fire area, carbon emissions, and severity of peatland fires can also be done with the help of technology (Afina, 2022). The data obtained through this technology can help in better planning and decision-making in fire management. Finally, technology can also be used in fire prevention efforts. Technology can also be used in fire prevention efforts; for example, the use of technology in peatland management is synergized with various

aspects, such as the economy, tourism, and emission reduction policies (Pradipta, 2023).

The purpose of this research is to study and explain how the Siak Regency government, particularly the BPBD (Regional Disaster Management Agency), handles and copes with forest and land fires on peatlands from 2019 to 2023. One of the critical issues that threaten the environment, health, and people's lives is the phenomenon of forest and land fires, mainly in areas with peat ecosystems. In addition, this research will document the Siak Regency government's collaborative efforts with academics from regional universities. The aim of this collaboration is to improve understanding of the underlying problem of forest and land fires and find innovative solutions to tackle it. It is hoped that by involving academia, there will be an exchange of knowledge, technology, and resources that can help prevent, suppress, and mitigate forest and land fires more effectively.

This research, conducted in collaboration between the government and academia, will look at how universities are involved in creating and implementing forest and land fire prevention and mitigation programs. The development and research of Internet of Things-based technologies, the training of experts in forest and land fire management, and the provision of relevant scientific data and information to help the government make strategic decisions are some examples of this involvement. This research is expected to provide a better understanding of how the Siak Regency government handles forest and land fires on peatlands. It is also hoped that this research will show how valuable collaboration between government and academia is in addressing complex environmental issues such as forest and land fires. It is hoped that the information and findings from this research can serve as a reference for other regions facing similar problems to develop more effective and sustainable strategies to counter forest and land fires.

## B. METHOD

This research employs an exploratory qualitative method. The exploratory qualitative research method is a research approach that is used to understand and describe phenomena in depth and comprehensively (Anggito & Setiawan, 2018). This research uses exploratory qualitative research methods that allow the author to explore a deep understanding of a topic (Priadana & Sunarsi, 2021), particularly related to synergy aspect, as well as the important role of academia and local governments in handling fire disasters. The steps of the exploratory qualitative research method in the context of this research include:

1. Determination of Research Focus: The author must clearly identify the research objectives and questions, which in this context are to understand the synergy between local government and academics in handling peatland fires in Siak District.
2. Data Collection: The author may gather data from various sources, such as mass media, national journals, international journals, and sources of local regulations on fire disaster management. Data from mass media can provide

an overview of the issue of peatland fires in Siak Regency and the role of the local government through BPBD and academics exposed in the media. National and international journals can provide insights from previous research on similar topics elsewhere or views from experts. Local regulation sources will provide an overview of how local government is involved in fire management.

3. Data Processing: Data obtained from various sources will be organized systematically. This involves the process of organizing, grouping, and classifying data relevant to the research focus. This data processing aims to find patterns, themes, and relationships that emerge from the information collected.
4. Data Analysis: Qualitative data analysis is conducted using an inductive approach to identify patterns or themes that emerge from the data that has been processed. The author will look for new relationships and patterns in the collected data, as well as connect the findings with existing concepts in theory or previous research.
5. Interpretation and confirmation: After analyzing the data, the author will interpret the findings using existing knowledge about the synergy between local government and academics in handling peatland fires. This interpretation will help illustrate how the synergy works, the factors that influence it, and the implications of the findings. Meanwhile, confirmation is intended to visit the Siak government directly regarding what strategies have been implemented based on collaboration with academics from universities.
6. Conclusion: The activity will be completed by compiling a conclusion based on the findings of this exploratory qualitative research. The conclusions will include a summary of the findings relevant to the research focus and their implications for peatland fire management in Siak Regency.

## C. RESULT AND DISCUSSION

According to information from the BPBD (Regional Disaster Management Agency) of Riau Province, this province is located on the equatorial equator, which has an equatorial-type climate and experiences two peak seasons, namely the rainy and dry seasons. The first peak of the dry season is estimated from February to March, and the second is estimated from June to September. During the dry season, most areas of Riau Province have the potential for forest and land fires. To address the forest and land fires that occur every year, an integrated and coordinated mechanism for handling forest and land fires is required in Riau Province.

To optimize the implementation by the Command of the Forest and Land Fire Control Task Force at the provincial, district/city, sub-district, and village levels, it is necessary to establish a Standing Procedure for the Forest and Land Fire Control Task Force in Riau Province. The Governor of Riau responded by issuing Riau Governor Regulation (Pergub) number 9 of 2020, which contains fixed procedures for criteria for determining the status of a disaster emergency and the command of

the forest and land fire control task force in Riau Province. The procedures in this Governor's Regulation are intended to provide an explanation of the criteria for determining the status of an emergency and the establishment of the Land and Forest Fire Control Task Force Command in Riau Province. In addition, the standard procedure in this Governor Regulation aims to serve as a guideline for the Regional Government to determine the status of a disaster emergency and the establishment of the Forest and Land Fire Control Task Force Command in Riau Province during a disaster emergency.

BPBD Riau province, as the authorized body to plan, implement, coordinate, and supervise disaster management efforts in its region as outlined in Riau Governor Regulation Number 9 of 2020, actually has a technology-based information system, namely the Riau Forest and Land Fire Control Information System (SIPAKAR), which was launched in 2021. The SIPAKAR application contains various features such as map identification of the Riau region, adding fire point coordinates, reporting fire incidents, and others. The SIPAKAR application can be used on mobile and web-based devices, as shown in Figure 1. However, this application can only be used in the internal circles of the Land and Forest Fire Control Task Force Command in Riau Province, including BPBD Riau Province itself.


**Figure 1. Login Page of SIPAKAR Application**

The Siak Government itself already has a Regional Regulation (Perda) of Siak District Number 4 of 2022 concerning "Siak Green Area" that states that everyone has the right to live in physical and mental prosperity, have a place to live, and obtain a safe and healthy environment as part of human rights. In addition, the Siak government is also aware that the threat of ecological disasters, such as floods,

landslides, droughts, forest and land fires, and the potential for pollution and damage to the quality of land, water, and air ecosystems are quite obvious, so it is necessary to manage natural resources sustainably and improve and maintain the quality of the environment in Siak District.

Siak Regional Regulation Number 4 of 2022 also describes the prevention and handling of forest and land fires (karhutla) in each zone in Siak, such as plantation zones, forest zones, conservation zones, and so forth. This is stated in articles 22 to 28 regarding the prevention and handling of forest and land fires, including peat. This regulation also emphasizes that preventive efforts in the context of controlling environmental impacts need to be implemented by maximally utilizing supervision and licensing instruments. In the event that environmental pollution and damage have already occurred, repressive efforts need to be made in the form of effective, consequential, and consistent law enforcement against environmental pollution and damage that have already occurred. In connection with this, it is necessary to develop a clear, firm, and comprehensive system of environmental protection and management to ensure the protection and management of natural resources and other development activities.

BPBD of Siak Regency has a very crucial role in maintaining and monitoring the condition of peatlands in its area. In this task, BPBD of Siak performs in close collaboration with various related stakeholders. This coordination involves village authorities to ensure local participation and support, Manggala Agni and Fire Brigade for rapid response to fires, Fire Awareness Communities (MPA) for awareness campaigns, security agencies to ensure order and security, health agencies to treat casualties and address health impacts, NGOs to observe implementation and transparency, volunteers who are ready to provide direct assistance, the private sector for resource donations, as well as academics who provide scientific insights for a more holistic approach.

Through this synergy, BPBD of Siak is not only improves monitoring and management of peat disasters but also strengthens capacity in various aspects needed to effectively protect the environment and communities. The synergy between BPBD Siak and academia has been shown, namely in the form of socialization held at BPBD Siak in June 2020, where a number of academics from various disciplines conducted socialization activities for the prevention of smoke disasters in the 4.0 era by involving technology such as the internet of things (IoT) in monitoring the state of peatlands (Figure 2). This activity was attended by the Secretary of BPBD, Mr. Arief Hamidi, and all implementing elements under the coordination of BPBD, such as Fire brigade, Manggala Agni, representatives from villages, and MPA. In this activity, the academia delivered aspects of information technology based on the Internet of Things (IoT), namely detecting anomalies on land using sensor-based tools. In addition, the policy aspect, namely redirecting the community to comply with related regulations such as village regulations, regional regulations, and laws regarding disasters, also needs to be socialized so that public awareness and vigilance against smoke disasters can increase. Meanwhile, the

Secretary of BPBD said in his remarks that the haze disaster caused by burning forest land was indicated by the large number of hotspots originating from plantation land, industrial forest, and also abandoned lands (Riau pos, 2020).


**Figure 2. Socialization of Haze Disaster Prevention in the 4.0 Era**

MPA, in coordination with the local village administration and BPBD, is at the forefront of efforts to prevent and manage peatland fires in Siak. MPA is a community group formed voluntarily to support the local administration in the prevention and handling of forest and land fires. MPAs have a very important role in forest and land fire control efforts because they have in-depth knowledge and experience of local conditions. There are several roles for MPA in the prevention and handling of forest and land fires, including conducting community counseling on the dangers of forest and land fires, monitoring and patrolling potentially burned land areas, conducting early extinguishing of fires, assisting firefighters in extinguishing fires, evacuating people affected by fires, and restoring burned land. Since MPA has a very important role, it is necessary to develop MPA so that they can optimize their duties. Some of the activities done by academics involve strengthening organizational management, starting with the planning function, organizing function, staffing function, and directing function. These activities are given so that the MPA organization can achieve what is desired in the most efficient way possible. The next activity given to MPA members is learning effective communication techniques in teams when completing a job. Some discussions about effective communication include how to be a good listener, how to convey messages clearly when in the field, the use of non-verbal language, and how to respond to criticism and feedback from teammates, as shown in Figure 3 (Diki Arisandi, Syamsuadi, Gafar, Hartati, & Fajar, 2020a).

**Figure 3. Activities With MPA Personnel**

Not only socialization and training for MPA, but the synergy between BPBD and academia in terms of technology-based forest and land fire prevention and mitigation needs to be followed up so that mitigation and prevention can be done as early as possible. The activity continued with an FGD (focus group discussion) between BPBD Siak District and several cross-disciplinary academic institutions (Figure 4). During the FGD session, Mr. Kamaruzzaman, as the head of the BPBD Siak District, explained the description of the forest and land fire situation in the Siak area and the supporting factors that caused the fire. Meanwhile, the Fire Department and MPA explained in more detail several cases of forest and land fires that commonly occur on peatlands in Siak District. Moreover, the firefighters and MPA also explained what obstacles often occur when handling and preventing forest and land fires. Based on the narrative of the parties under the auspices of BPBD Siak, it can be concluded that early prevention is needed so that the forest and land fire disaster will not spread widely and can be resolved immediately.

**Figure 4. FGD Session Between BPBD and Academia**

The academics responded to the explanation from BPBD Siak by making a prototype of an early detection system for forest and land fire prevention based on IoT. The idea for the IoT-based prototype has actually been published by several researchers, some of them are from Riau itself. There are several research results, both at the national and international levels, from researchers from Riau that are the

source of reference for this early detection system prototype. A research pioneer published at an international seminar by Kadir et al. explained that the use of temperature, gas, humidity, and CO2 sensors has a role in detecting the presence of hotspots (Kadir, Othman, & Rosa, 2021). In line with this research, Arisandi et al. (Diki Arisandi, Syamsuadi, Gafar, Hartati, & Fajar, 2020b) and Irawan et al. (Irawan, Muzawi, & Alamsyah, 2022) developed prototypes of land fire detection tools using sensors but with the development of different foundation structures for different land terrain conditions. Because the monitoring system must be accessible anywhere and anytime with a mobile device, a model and mechanism are needed to deliver information from the sensor device to the mobile device of each officer. This research has been published by Fatayat et al. regarding the mechanism for delivering information based on mobile devices (Fatayat & Risanto, 2020). The data collected from the device also needs to be processed so as to generate usable information for decision-makers or field officers to determine prevention and handling moves. Some research on processing data collected from conditions in the field. Pratiwi et al. explained the results of their research related to how observation data is processed into information using the Bayes probability method to be classified(Pratiwi, Irsyad, & Kurniawan, 2021). Another study by Karo et al. compared several probability methods to find out which method is effective for classifying fire occurrence data on land and concluded that the ID3 method is the method with the highest precision outcome (Karo, Nadia, & Dian, 2022). As a compilation of the previously mentioned research results, researchers built a forest and land fire early detection system that is integrated and connected to mobile devices so as to produce real-time information and can be used for early prevention of forest and land fires (D Arisandi, Syamsuadi, Trisnawati, & Hartati, 2022).

As an implementation of the FGD results and publications from academia, peat areas that are at risk of fire will be deployed with sensor-based detection devices (Figure 5). Each detector consists of a temperature sensor, an air humidity sensor, a soil moisture sensor, and a groundwater discharge sensor. A number of devices will be deployed to several locations, and each device will be connected via an internet connection and send land condition data periodically to the cloud server. The data stored on the cloud server can be accessed through mobile devices (Figure 6a) and desktop devices (Figure 6b) so that BPBD, as a user, can monitor the status of peatlands that have been installed with sensors. The information from the sensors can be a reference to the early actions that can be taken by BPBD, firefighters, MPA, and related stakeholders before a fire occurs in the surrounding area.

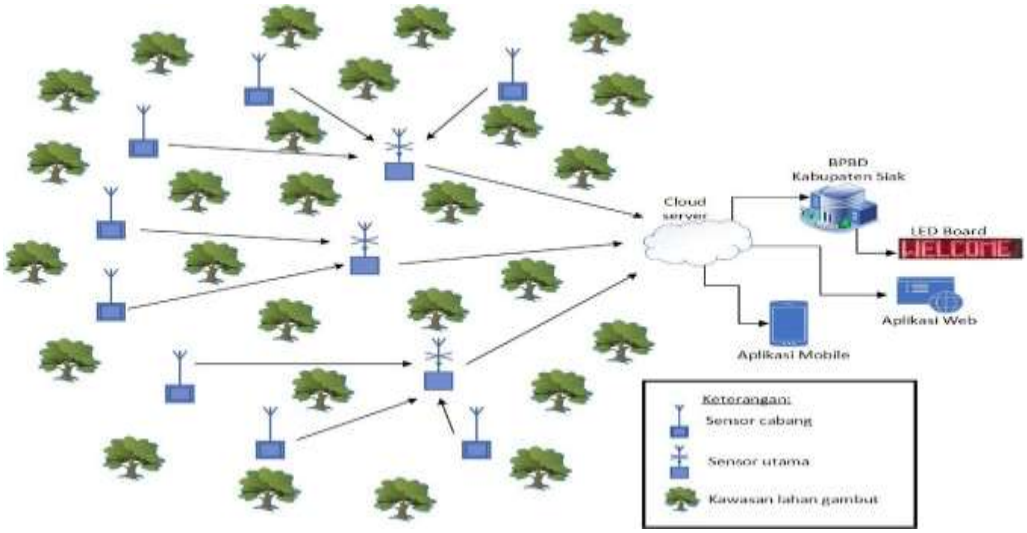


**Figure 5. Detection Devices Deployment Scenario**


**Figure 6a. Mobile Application**


**Figure 6b. Desktop Application**

Based on the implementation and synergy conducted, the Regional Government, through BPBD, considers that this effort needs to be supported and its sustainability needs to be considered. BPBD Siak expressed readiness to contribute to efforts to prevent forest and land fires, especially in peatlands, by involving academics and also utilizing technology. On the same occasion, Mr. Kamaruzzaman, as the head of BPBD Siak, proposed an integrated dashboard between the monitoring system built with several monitoring satellites, such as SiPongi and Himawari. But on the other hand, he also realizes that there are shortcomings that are on the legal basis of references such as Pergub number 9 of 2020 and Perbup number 4 of 2022 that do not contain handling and prevention using technology, as well as collaboration with academia. These shortcomings will be conveyed by Mr. Kamaruzzaman when there are hearing activities with the Parliament and the local government regarding the prevention and control of forest and land fires. The hope is that there will be technical guidelines or regulations related to collaboration with academia and the use of technology.

Besides formal regulations, local governments need to encourage elements from other sectors to perform a role in the prevention and handling of forest and land fires. The first recommendation is the initiation of a consortium of forums for

forest and land fire prevention. The consortium of forums will accommodates the involvement of various stakeholders such as academics and researchers, local governments, community groups, business owners, and the media. This is done to ensure that all interested and potential stakeholders in forest and land fire prevention efforts have the same views, awareness, and acceptance of the dangers of forest and land fires and their solutions. The forum should be followed by a regular meeting agenda that discusses progress, challenges, best practice, and lessons learned on forest and land fire prevention from inside and outside Siak as a reference. This will provide equal opportunities for all stakeholders to learn and gain experience. In addition, mapping the scope of activities and possible contributions from other stakeholders can be done through this consortium. The second is the establishment and maintenance of a science center for the forest and land fire mitigation center. It is important to establish and maintain this knowledge channel so that it can be accessed by various people who need accurate information on forest and land fire prevention. Forest fire mitigation is a set of actions taken by the government and communities to prevent and reduce forest fires so that their impact on society and the environment is minimized. In addition, this science hub and forest fire mitigation center can be used as evidence-based education and reporting tools. Moreover, the use of social media platforms as a medium of knowledge that follows technological advances also needs to be maximally utilized in order to accelerate the penetration of education and information relating to forest and land fires.

## D. CONCLUSIONS

Geographically, Siak Regency has a large stretch of peatland and the potential for natural resources that can be utilized for the benefit of the local community. The occurrence of forest and land fires, particularly on peatlands, has caused losses both socially and materially. BPBD Siak Regency has synergized with academia to address this forest and land fire issue with the assistance of technology. The result of this synergy is an integrated system that can assist in monitoring land conditions. But on the one hand, the existing regulations do not include collaboration with academia or the use of technology. This needs to be done on an ongoing basis for more effective prevention and handling of forest and land fires. In addition to collaboration and technology utilization, the regional government also needs to encourage the formation of a consortium for forest and land fire prevention and mitigation studies. This is important because the forest and land fire disaster in Siak Region is a common issue that must be resolved together as well.

## ACKNOWLEDGEMENT

The authors would like to acknowledge the support of the Abdurrab University Research and Service Board, particularly for the support and direction provided during this research. In addition, gratitude is also addressed to BPBD Siak Regency and its staff for the collaboration that has been given. We are also grateful to the

Ministry of Research, Technology, Education, and Culture for providing grant funding for this research.

## REFERENCES


1. Afina, F. S. (2022). *Estimasi Tingkat Keparahan Kebakaran Lahan Gambut di Kabupaten Siak, Provinsi Riau*. IPB University.
2. Amady, M. R. El. (2020). Kearifan Lokal Masyarakat Desa Gambut Di Provinsi Riau. *Jurnal Penelitian Sejarah Dan Budaya*, *6*(2), 145–170.
3. Amanda, N., Ananda, F., & Madan, H. (2022). *Revitalisasi degradasi lahan gambut pasca kebakaran hutan di provinsi riau*. *Quo vadis restorasi gambut di indonesia*.
4. Anggito, A., & Setiawan, J. (2018). *Metodologi penelitian kualitatif*. CV Jejak (Jejak Publisher).
5. Anhar, I. P., Mardiana, R., & Sita, R. (2022). Dampak Kebakaran Hutan dan Lahan Gambut terhadap Manusia dan Lingkungan Hidup (Studi Kasus: Desa Bunsur, Kecamatan Sungai Apit, Kabupaten Siak, Provinsi Riau). *Jurnal Sains Komunikasi dan Pengembangan Masyarakat [JSKPM]*, *6*(1), 75–85.
6. Arisandi, D, Syamsuadi, A., Trisnawati, L., & Hartati, S. (2022). A Development of Multi-Platform Based Forestry Wildfire Prevention System Using Incremental Model: Case study: a peatland area in Siak Regency. *2022 International Conference on Electrical and information Technology (IEIT)*. Malang: ieeexplore.ieee.org. Retrieved from https://ieeexplore.ieee.org/abstract/document/9967894
7. Arisandi, Diki, Syamsuadi, A., Gafar, T. F., Hartati, S., & Fajar, M. (2020a). Pembinaan Masyarakat Peduli Api Sebagai Bentuk Partisipasi Warga Desa Dayun Dalam Menangani Bencana Kebakaran Lahan. *Ikraith-Abdimas*, *3*(3), 34–37.
8. Arisandi, Diki, Syamsuadi, A., Gafar, T. F., Hartati, S., & Fajar, M. (2020b). Rancang Bangun Perangkat Telemetri Sebagai Deteksi Dini Kebakaran Hutan Di Desa Dayun Kabupaten Siak. *Ikraith-Abdimas*, *3*(3), 7–11.
9. Arisandi, Diki, Trisnawati, L., & Syamsuadi, A. (2022). Sistem Monitoring Deteksi Dini Kebakaran Hutan Berbasis Multiplatform Di Kabupaten Siak Menggunakan SDLC Prototyping. *Jurnal Sistem Komputer dan Informatika (JSON)*, *3*(4), 410–416.
10. Atmaja, D. S. (2023). *Efektivitas Implementasi Program Penanggulangan Bencana Kebakaran Hutan dan Lahan Di Kabupaten Kubu Raya*. IAIN Pontianak. Retrieved from https://digilib.iainptk.ac.id/xmlui/handle/123456789/2709
11. Aulia, S., Hamid, I., & Budhi, S. (2022). Ecocentrism Ethic Masyarakat Lokal Dalam Pengelolaan Lahan Gambut Di Kecamatan Mantangai Kabupaten Kapuas. *PADARINGAN (Jurnal Pendidikan Sosiologi Antropologi)*, *4*(1), 41.
12. Fatayat, F., & Risanto, J. (2020). Model Sistem Deteksi Dini Kebakaran Hutan Dan Lahan (Karhutla) Berbasis Android Di Kabupaten Pelalawan. *Simtika*, *3*(3), 19–25. Retrieved from http://lppm.undhari.ac.id/ejournal/index.php/simtika/article/view/99
13. Gunawan, H., Afriyanti, D., Humam, I. A., Nugraha, F. C., Wetadewi, R. I., Surayah, L., Nugroho, A., et al. (2020). Pengelolaan Lahan Gambut Tanpa Bakar: Upaya Alternatif Restorasi pada Lahan Gambut Basah. *Jurnal Pengelolaan*

*Sumberdaya Alam dan Lingkungan (Journal of Natural Resources and Environmental Management)*, *10*(4), 668–678.

14. Hafni, D. A. F. (2017). *Estimasi Luas Kebakaran dan Emisi Karbon Akibat Kebakaran Hutan dan Lahan Gambut di Kabupaten Siak, Provinsi Riau*. Institut Pertanian Bogor. Retrieved from https://www.researchgate.net/profile/Dinda-Fadhillah-Hafni/publication/327136565_Estimasi_Luas_Kebakaran_dan_Emisi_Karbon_akibat_Kebakaran_Hutan_dan_Lahan_Gambut_di_Kabupaten_Siak_Provinsi_Riau/links/5b7bcd70299bf1d5a71910e6/Estimasi-Luas-Kebakaran-dan-Em
15. Irawan, Y., Muzawi, R., & Alamsyah, A. (2022). SISTEM REAL TIME MONITORING PENDETEKSI KEBAKARAN HUTAN DAN LAHAN DI PROVINSI RIAU REAL TIME MONITORING SYSTEM FOR FOREST AND LAND FIRE DETECTION IN RIAU PROVINCE Universitas Hang Tuah Pekanbaru , STMIK Amik Riau PENDAHULUAN Kebakaran hutan dan lahan benca. *Journal of Information Technology and Computer Science (INTECOMS)*, *5*(2).
16. Kadir, E. A., Othman, M., & Rosa, S. L. (2021). Smart Sensor System for Detection and Forecasting Forest Fire Hotspot in Riau Province Indonesia. *2021 International Congress of Advanced Technology and Engineering, ICOTEN 2021* (pp. 1–6). IEEE.
17. Karo, I. M. K., Nadia, A. S., & Dian, S. (2022). Wildfires Classification Using Feature Selection with K-NN, Naïve Bayes, and ID3 Algorithms. *Journal of Software Engineering, Information and Communication Technology (SEICT)*, *3*(1), 15–24.
18. Muzaki, A., Pratiwi, R., & Az Zahro, S. R. (2021). Pengendalian Kebakaran Hutan Melalui Penguatan Peran Polisi Kehutanan Untuk Mewujudkan Sustainable Development Goals. *LITRA: Jurnal Hukum Lingkungan, Tata Ruang, dan Agraria*, *1*(1), 22–44.
19. Naufal, M., Waluyati, L. R., & Darwanto, D. H. (2019). Kinerja Usahatani Kelapa Sawit Lahan Gambut di Desa Dayun Kabupaten Siak. *Jurnal Teknosains*, *9*(1), 77.
20. Notohadiprawiro, I. T., Maas, I. A., Amron, I. M., Karolioneritas, V., Utami, I. S. N. H., Devangsari, I. M., Purwanto, I. B. H., et al. (2022). *Tantangan Pengembangan Sumberdaya Lahan Rawa Dan Gambut*. Deepublish.
21. Nugraha, R. P., Fauzi, A., & Ekayani, M. (2019). Analisis Pendapatan Usaha Pertanian Dan Peternakan. *JURNAL EKONOMI PERTANIAN , SUMBERDAYA DAN LINGKUNGAN ( Journal of Agriculture , Resource , and Environmental Economics )*, *2*(2), 1–11.
22. Nurhayati, A. D., & Aulia, W. (2022). Analisis Kebakaran Hutan dan Lahan Berdasarkan Hotspot dan Area Terbakar di Kabupaten Pelalawan, Provinsi Riau. *Journal of Tropical Silviculture*, *13*(03), 225–231.
23. Okka, O., Pandjaitan, N. K., & Sumarti, T. (2019). Power Of Resources And Capacity Of Community Adaptation In Forest Fire Disaster. *Sodality: Jurnal Sosiologi Pedesaan*, *7*(1), 17–24.
24. Pradipta, P. (2023). Inisiatif Masyarakat Dayun dan Penyengat Cegah Kebakaran Lahan Terulang. *Kompas.com*. Siak. Retrieved from

https://www.kompas.id/baca/humaniora/2023/03/14/inisiatif-masyarakat-dayun-dan-penyengat-cegah-kebakaran-lahan-terulang
25. Pratiwi, T. A., Irsyad, M., & Kurniawan, R. (2021). Klasifikasi Kebakaran Hutan dan Lahan Menggunakan Algoritma Naïve Bayes (Studi Kasus: Provinsi Riau). *Jurnal Sistem dan Teknologi Informasi (Justin)*, *9*(2), 101.
26. Priadana, M. S., & Sunarsi, D. (2021). *Metode Penelitian Kuantitatif*. Pascal Books.
27. Rahayu, S., Lutfillah, N. Q., Sari, D. P., Rahayu, R., & Yudi, Y. (2021). Cost [in]Efficiency Di Balik Kebakaran Hutan Dan Lahan. *Jurnal Akuntansi Multiparadigma*, *12*(2), 351–369.
28. Riau pos. (2020, June 27). Univrab dan BPBD Siak Gelar Sosialisasi Pencegahan Bencana asap era 4.0. *Riau pos*, 2020. Pekanbaru. Retrieved from https://riaupos.jawapos.com/pendidikan/27/06/2020/233970/univrab-dan-bpbd-siak-gelar-sosialisasi-pencegahan-bencana-asap-era-40.html
29. Syamsuadi, A., Arisandi, D., Trisnawati, L., Hartati, S., Elvitaria, L., & Putra, A. A. (2022). A Model of Development Mitigation Disaster Based on Digital Eco-Tourism as a Prevention Effort of Forest and Land Fire Disaster Management. *Journal of International Conference Proceedings (JICP)* (Vol. 5). ejournal.aibpmjournals.com.
30. Utami, P. N., & Primawardani, Y. (2021). Upaya Pemenuhan Hak Atas Lingkungan Hidup Terhadap Kebakaran Hutan bagi Masyarakat Riau. *Jurnal HAM*, *12*(3), 367.
31. Virmanto, D., Sa'ad, A., Arsyad, A. R., & Ermadani, E. (2022). Kajian Beberapa Karakteristik Tanah Gambut Pada Lahan Terbakar Dan Tidak Terbakar Di Perkebunan Kelapa Sawit. *Jurnal Solum*, *XIX*(2), 43–52. Retrieved from http://jurnalsolum.faperta.unand.ac.id/index.php/solum/article/view/256%0Ahttp://jurnalsolum.faperta.unand.ac.id/index.php/solum/article/download/256/209
32. 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.