

# Utilization of Remote Sensing Technology in Mitigating Forest Fire Threats and Their Implications for National Security

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## Article Info

Received: 17-June-2026

Revised: 06-Sept-2026

Accepted: 07-Sept-2026

## Keywords

Disaster Mitigation; Early Detection;  
Forest Fire; National Security; Remote  
Sensing

## Abstract

Indonesia's tropical forests are vital to both ecological balance and national security. However, increasing forest fires exacerbated by climate change and human activities pose multifaceted threats, including environmental degradation, public health crises, and geopolitical instability. Remote sensing technologies offer strategic capabilities for early detection and management of such fires. This study employed a qualitative literature review approach supported by a structured brainstorming process to examine how remote sensing data contribute to forest fire mitigation. Key dimensions explored include technology classifications, early warning mechanisms, risk assessment, and post-disaster recovery strategies. Findings reveal that remote sensing—via satellite imagery, thermal sensors, and UAVs—enhances early fire detection, enables real-time monitoring, supports effective fire risk mapping, and informs rehabilitation planning. The study also highlights how forest fires can escalate into national security issues through economic disruption, social dislocation, and cross-border haze diplomacy. Remote sensing constitutes a strategic asset in Indonesia's environmental security infrastructure. Its integration into national policy, combined with inter-agency collaboration and public education, can significantly improve fire mitigation outcomes and safeguard national interests. This article links remote sensing not only to environmental management but also to national security responses, offering an interdisciplinary framework for future policy formulation.

## 1. Introduction

Forests have a very vital role in maintaining the balance of ecosystems and human life. Forests function as carbon dioxide absorbers, oxygen providers, and homes for various species of flora and fauna (Gao, 2020). Forests as carbon dioxide absorbers function to reduce the greenhouse effect that contributes to climate change. In addition, forests also function as oxygen providers which are very important for human life and other living things and play an important role in mitigating climate change. Indonesia, which has tropical forests with rich biodiversity, really needs the existence of forests to maintain the balance of the ecosystem. Indonesia's tropical forests support more than 10% of the world's biodiversity, including various species of flora and fauna that are not found anywhere else. Forests also provide various ecosystem services, such as regulating the water cycle, protecting soil from erosion, and providing raw materials for industry and the daily lives of the community. Indigenous communities often depend on forests for food, medicine, and building materials (Guimarães, 2020). In the event of a forest fire, all of these aspects are threatened and the impact can be felt by future generations.

In addition, forests also contribute to the local and national economy. Many communities depend on forests for their livelihoods, whether through agriculture, fisheries, or tourism. Therefore, preserving forests is not only important for the environment, but also for the economic well-being of communities. With this in mind, it is important for us to realize that forests are not just a collection of trees, but are an integral part of human life and the ecosystem. Efforts to protect and preserve forests must be a priority, especially in the context of the increasing threat of forest fires.

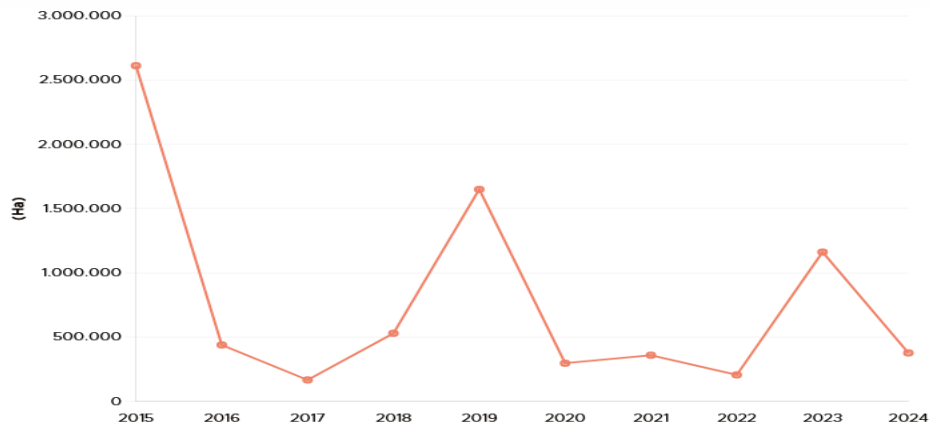


Figure 1. Area of Forest and Land Fires 2015-2024 (Source: Ministry of Forestry)

Forest fires are a significant environmental threat, not only to ecosystems, but also to communities and national security. In a global context, forest fires are becoming an increasingly urgent issue especially with the increasing frequency and intensity in various parts of the world. Throughout the world, forest fires cause huge losses, both in economic, social and environmental terms (Gale, 2021). Forest fires can be caused by a variety of factors, both natural and human induced. One of the main causes of forest fires is climate change, which has increased the frequency and intensity of fires in many parts of the world. Increasing ambient temperatures and erratic rainfall patterns contribute to the high risk of forest fires. In Indonesia, forest fires often occur during the dry season, when conditions become very dry and flammable.

Human activities are also the main cause of forest fires. Land clearing for agriculture, illegal logging, and careless waste disposal can trigger fires. Many cases of forest fires are caused by land burning to open agricultural or plantation areas, such as oil palm (Kalantar, 2020). This not only damages forests, but also threatens biodiversity and public health. In addition, extreme weather conditions such as strong winds and high temperatures can also exacerbate the risk of forest fires. The BMKG report states that changing weather patterns due to climate change can lead to longer and more intense dry seasons, increasing the likelihood of forest fires. Therefore, it is important to understand the various factors that cause forest fires in order to develop effective mitigation strategies. By understanding the causes of forest fires, we can better plan the prevention and mitigation measures needed to protect forests and the communities that depend on them. In this regard, it is important to develop a holistic approach to forest fire management, which considers social, economic and environmental impacts.

The impact of forest fires is very broad, not only limited to habitat and biodiversity damage, but also threatens public health. Smoke from forest fires can cause respiratory problems, eye irritation, and long-term health impacts. Forest fires also have broader implications for national security. The impact of forest fires can threaten natural resources, disrupt people's lives, and cause significant economic losses. Forest fires can trigger social and political conflicts, especially in areas that depend on forest resources for their livelihoods. Bushfires cause huge economic losses. The bushfires in Australia in 2019-2020 caused economic losses estimated at billions of dollars, as well as affecting air quality and public health. In the context of Indonesia, bushfires often result in losses for farmers and communities that depend on non-timber forest products. This shows that bushfires are not just a local problem, but a global issue that requires international collaboration to overcome.

In addition, forest fires can disrupt food security and water availability. Burning forests can result in decreased soil quality and reduce the soil's ability to store water. This has an impact on agricultural productivity and food availability for the community. Decreased agricultural productivity due to forest

fires can cause increased food prices and increase food insecurity in the community. The social impacts of forest fires also cannot be ignored. Forest fires can trigger community migration, especially in areas that are highly dependent on forest resources for their livelihoods. When fires destroy agricultural lands and other natural resources, communities are forced to seek new homes and livelihoods, which can lead to social tensions and conflicts in new areas. Therefore, it is important to develop effective mitigation strategies to reduce the risk of forest fires and their impact on national security. Collaborative efforts between the government, communities, and the private sector are essential to create sustainable and responsive policies to the threat of forest fires.

With the increasing frequency and intensity of forest fires, there is an urgent need to use more sophisticated technologies in forest fire management. Remote sensing is one of the most promising technologies in forest fire management. By utilizing sensors installed on satellites or aircraft, remote sensing can collect data about the earth's surface accurately and in real time. Data obtained from remote sensing can provide important information about forest conditions, fire potential, and the impact of fires on the environment and communities.

One of the applications of remote sensing in forest fire management is monitoring high-risk areas. By using satellite imagery, authorities can identify areas prone to fire and take appropriate preventive measures. This technology allows mapping of areas with flammable fuels, so that more effective preventive measures can be taken (Barmpoutis, 2020). In addition, remote sensing can also be used to monitor ongoing fires. With real-time data, authorities can obtain information about the location, size, and intensity of the fire, which is very important for planning an effective extinguishing strategy (Meng, 2018). The use of remote sensing technology has been shown to increase efficiency in extinguishing forest fires and reduce losses incurred. Remote sensing can also contribute to post-fire recovery. By utilizing the data obtained, authorities can monitor the ecosystem recovery process and identify areas that require further intervention. This technology can be used to map post-fire vegetation growth and assess the success of rehabilitation efforts. However, to make the most of remote sensing technology, adequate capacity and infrastructure development is needed. Investment in technology and training for field officers is essential to ensure that the data obtained can be used effectively in forest fire management.

In an in-depth analysis of forest fires, it is important to highlight the various interrelated aspects. Forests play a crucial role in maintaining the balance of the ecosystem, providing natural resources, and supporting the lives of communities. However, with the increasing threat of forest fires, we must consider their broader impacts. Forest fires not only damage the environment, but also affect public health, the economy, and social stability. Therefore, it is important to develop a comprehensive approach to forest fire management, which includes collaboration between the government, communities, and the private sector. Raising public awareness of the risks and impacts of fires is also crucial in forest fire management. Education on the importance of protecting forests and ways to prevent fires should be an integral part of mitigation strategies (Bhattacharjee, 2023). Educational campaigns involving local communities can help raise awareness of the importance of protecting forests and preventing fires (Rodríguez, 2023). In addition, training on firefighting techniques and fire prevention can also be provided to communities, so that they are better prepared for emergency situations (Djabri, 2023).

In addition, the development of infrastructure that supports forest fire monitoring and mitigation is also very important. The development of remote sensing technology infrastructure and effective monitoring systems can help authorities identify potential fires and respond quickly (Yu, 2024). By utilizing data obtained from remote sensing, authorities can make faster and more accurate decisions in forest fire management, including determining the location of resources needed to extinguish the forest fire. The importance of international collaboration in forest fire management cannot be ignored. Forest fires often do not recognize national borders, so cross-border cooperation is needed to address this problem. Sharing information, technology, and resources between countries affected by forest fires can increase the effectiveness of mitigation efforts. Countries with experience in forest fire management can provide training and technical support to countries struggling with forest fires. Forest fires are a serious threat that affects ecosystems, communities, and national security. The importance of forests in human life and ecosystems cannot be underestimated, and the impact of forest fires can be felt widely. Therefore, a joint effort is needed to develop effective mitigation strategies, including the use of remote sensing technology for forest fire management. With a holistic and collaborative approach, it is hoped that it can prevent the threat of forest fire risks and their impacts on national security.

## 2. Method

The method of writing this essay uses a literature review with a qualitative descriptive approach, which focuses on the collection, review, and analysis of secondary data from various written sources. The literature study was conducted to explore theories, concepts, and empirical findings regarding remote sensing technology and its application in forest fire mitigation and its impact on national security. The literature sources reviewed include scientific journal articles, books, research reports, government policy reports, publications of international institutions, and other relevant documents discussing the topics of remote sensing, forest fires, and security issues. Literature searches were conducted using keywords such as "remote sensing", "forest fire", "early detection", "forest fire mitigation", and "national security", in online databases such as Scopus and internationally reputable journals, to ensure the relevance and up-to-dateness of the data analyzed.

This approach is used to develop a comprehensive conceptual framework on how remote sensing technology contributes to early detection, risk assessment, management, and post-forest fire recovery. The analysis is carried out by identifying the advantages, challenges, and strategic impacts of implementing this technology on the environment, socio-economy, and national security. Data are analyzed thematically to produce a systematic, critical, and contextual narrative.

The descriptive qualitative approach was chosen to emphasize a comprehensive understanding of complex phenomena through in-depth interpretation of available secondary data, without direct intervention in the field. Thus, this method allows the author to present evidence-based arguments regarding the importance of remote sensing data-based policies in maintaining national security from the threat of forest fires. The research brainstorming used can be seen in figure 2.

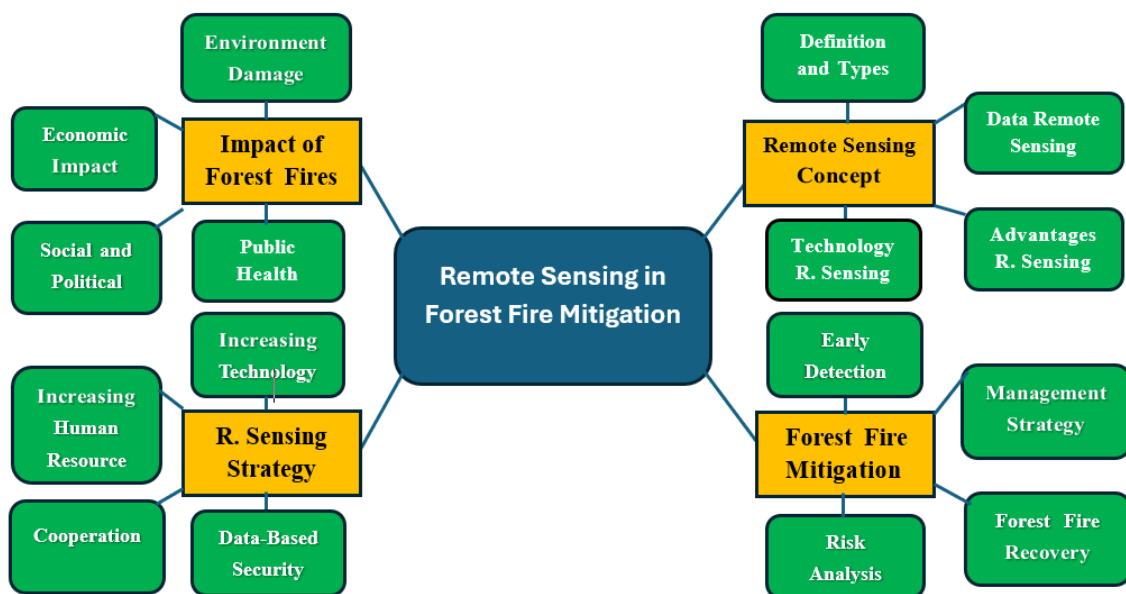


Figure 2. Brainstorming

## 3. Results and Discussion

### 3.1. Remote Sensing Concept

Remote sensing is a technique for collecting data from a distance, utilizing sensors mounted on various platforms such as satellites, airplanes, and drones (Guimarães, 2020). This technique allows observation and analysis of phenomena occurring on the earth's surface without the need to be physically present at the location. Data obtained from remote sensing includes visual imagery, spectral data, and other information that can be used for various purposes, from environmental monitoring to natural resource management.

Remote sensing can be divided into two categories: active remote sensing and passive remote sensing. Active remote sensing uses its own energy source to collect data, such as radar that emits electromagnetic waves and measures their reflection. Synthetic Aperture Radar (SAR) provides information about changes in the Earth's surface, including ground movement and vegetation changes due to forest fires. Passive remote sensing, on the other hand, relies on sunlight or other light sources to collect data. Optical sensors on satellites, such as those used by Landsat and Sentinel, produce images that depict vegetation conditions and land changes over time. With the advancement of technology, remote sensing is able to provide accurate and detailed data. Images or pictures produced by modern satellites can show small differences in vegetation health that were previously undetectable by older technologies (Mohajane, 2021). This allows for deeper analysis of phenomena occurring on the earth's surface, such as climate change and its impact on ecosystems (Soubry, 2021).

The development of remote sensing technology from year to year shows an increase. Satellites such as Landsat and Sentinel have provided high-resolution images that can be used to monitor vegetation changes and detect forest fires more accurately. The Sentinel-2 satellite can produce images with a resolution of 10 meters, allowing detailed analysis of vegetation conditions and detecting areas at high risk of fire.

Drone technology is gaining popularity in forest fire monitoring. Drones' ability to fly low and provide more detailed data in areas that are difficult for satellites to reach makes them a valuable tool. By using drones, researchers can conduct direct monitoring and obtain more specific images of forest conditions, as well as detect hotspots more quickly. A study shows that the use of drones in forest fire monitoring can reduce response time in detecting hotspots, which is very important in forest fire extinguishing efforts. Airborne sensors such as aircraft equipped with optical and infrared sensors are also used to collect data on atmospheric conditions and vegetation around the fire area (Sannigrahi, 2020). This technology allows for more comprehensive and real-time data collection, which is critical in forest fire management. By combining data from multiple sources, researchers can build more accurate models to predict fire risk and plan more effective mitigation strategies (Parajuli, 2020).

Data generated from remote sensing includes various types of information, such as satellite imagery, radar data, and other spectral information. Satellite imagery can provide a broad overview of the area affected by fire, while radar data can be used to detect hotspots without being affected by the weather. The use of radar data can help in detecting fires that occur in cloudy areas, where optical imagery cannot provide accurate information (Gibson, 2020).

In addition, spectral data generated from remote sensing can be used to analyze vegetation conditions and detect changes that may increase fire risk. Using vegetation indices such as the Normalized Difference Vegetation Index (NDVI), researchers can monitor plant health and identify areas that may be at risk of fire experiencing stress due to drought or disease. This data is crucial for formulating more effective mitigation strategies and for predicting future forest fire risks. Concrete use of remote sensing data can be seen in forest fire monitoring projects in Indonesia, where satellite data is used to monitor land changes and detect fires in peatlands. By utilizing spectral data, researchers can identify patterns of change that may contribute to fire risk, so that authorities can take quick and appropriate action to anticipate the threat of fire.

One of the main advantages of remote sensing is its ability to provide extensive and comprehensive data in a short time (Barmpoutis, 2020). By using this technology, we can monitor forest conditions in real time, detect hotspots, and analyze fire risks based on historical data and current weather conditions. Satellite-based monitoring systems can provide information on surface temperature and soil moisture, which are important factors in assessing forest fire risk. Remote sensing also allows for deeper analysis of changes occurring in forest ecosystems. By utilizing historical data, researchers can identify patterns of change that could potentially lead to fires, such as increased temperatures and decreased humidity. This allows authorities to take quick and appropriate action in dealing with forest fires (Yebra, 2018).

Remote sensing technology can be used to plan sustainable forest resource management. By monitoring the health of forest ecosystems in real time, forest managers can make better decisions about logging, reforestation, and protection of endangered species. Thus, remote sensing serves as a detection tool as well as a tool for more effective forest resource planning and management. Remote sensing is a very valuable tool in monitoring and managing natural resources, especially forests. By understanding the

definition and types of remote sensing, as well as the technology and data produced, it can be seen the importance of remote sensing techniques in maintaining the sustainability of ecosystems and reducing the risk of forest fires. The advantages offered by remote sensing allow authorities to take faster and more precise action in dealing with the threat of forest fires. With the advancement of technology, the potential of remote sensing will be even greater and provide new opportunities to protect and manage forests with their natural resources sustainably.

### 3.2. Remote Sensing in Forest Fire Mitigation

The use of satellite imagery to detect fire hotspots is one of the important innovations in forest fire mitigation. Satellite imagery, produced by various satellites orbiting the Earth, provides invaluable data for researchers and authorities. Various studies have shown that satellite imagery can detect fire hotspots with high accuracy, even in unfavorable weather conditions. Monitoring systems such as MODIS (Moderate Resolution Imaging Spectroradiometer) have the ability to provide information about the location and intensity of fires in real time. MODIS is able to detect hotspots with fairly good resolution, allowing for a quick response from firefighting teams. In this context, the use of satellite imagery not only helps in detecting fires, but also provides important information for planning a more effective response.

Temporal analysis using remote sensing data also plays an important role in monitoring vegetation changes that can increase fire risk. By utilizing historical data, researchers can identify patterns of change that have the potential to cause fires. Increased temperature and decreased humidity can be strong indicators of the possibility of fire. With this analysis, authorities can formulate more effective mitigation strategies and target areas that are most vulnerable to fire (Adolf, 2018). In some areas which have a history of fires, observations of climate and vegetation changes can help in predicting when and where fires might occur, so that preventive measures can be taken early.

Research shows that remote sensing can improve the effectiveness of fire detection. Satellite imagery-based detection systems are able to detect fires earlier than conventional methods, allowing for a faster response. In this context, the use of advanced image processing algorithms can improve the accuracy of fire detection, even in difficult conditions. With the ever-evolving technology, such as the use of artificial intelligence in image analysis, the opportunities to improve the accuracy of fire detection are increasing. This is important, considering that every second in a fire situation can determine the extent of the damage that occurs. Remote sensing is not only used to detect fires, but also to monitor the overall condition of the forest. By analyzing vegetation data and weather conditions, scientists can predict the potential for fires and formulate effective mitigation strategies (Fadlullah, 2021).

The use of predictive models that combine remote sensing data with meteorological data can provide a better picture of fire risk. With this approach, authorities can make more timely and targeted interventions, which can ultimately reduce the impact of forest fires. The use of remote sensing technology in forest fire detection can improve the accuracy and speed of response to fires (D'este, 2021). In the context of forest fire mitigation, this is very important where every second can determine the extent of the damage that occurs (Bo, 2022). Remote sensing plays a key role in more effective forest fire management, by enabling authorities to make better and faster decisions based on accurate and up-to-date data. This technology also supports hotspot monitoring, fire pattern analysis, and prediction of potential future fires, so that prevention and emergency response efforts can be carried out more optimally.

Satellite data can be used to assess forest fire risk by analyzing factors such as vegetation type, soil moisture, and air temperature. With this information, authorities can identify areas that are most vulnerable to fire. Areas with dry vegetation and high temperatures are at higher risk of fire, requiring special attention in management. Risk assessments conducted using remote sensing data can provide a clearer picture of fire potential, which is very important in forest resource planning and management. Climate change has a major impact on forest fire patterns (Tadese, 2021). Rising global temperatures and changing rainfall patterns can increase the frequency and intensity of forest fires. Remote sensing can help in analyzing these relationships and formulating appropriate mitigation measures.

With accurate information about climate change, authorities can plan more effective actions to reduce the risk of fires. If data shows that an area is experiencing significant increases in temperature, authorities can take preventive measures, such as increasing monitoring or conducting controlled burns to reduce available fuels. By using historical data and current weather conditions, remote sensing can provide a

clearer picture of the fire risk in an area (Huot, 2022). Predictive models that use remote sensing data can improve the accuracy of forest fire risk estimates.

Thus, comprehensive analysis can help in formulating more effective mitigation strategies. If the prediction model shows that an area has a high risk of fire, authorities can plan more focused interventions, such as increased surveillance or vegetation management (Gómez, 2019). These models can provide valuable information for decision makers in formulating forest fire mitigation strategies. The use of remote sensing data in predictive models can help in better forecasting fire risks. This helps authorities to take necessary preventive measures before a fire occurs. By having access to accurate and up-to-date data, decision makers can formulate more strategic and targeted plans, which can ultimately reduce the impact of forest fires.

The success of using remote sensing to reduce fire risk is highly dependent on proper resource planning and management (Gale, 2021). Integration of remote sensing data is essential in forest management planning to reduce fire risk. With accurate and up-to-date information, authorities can formulate more effective and efficient management plans if the information obtained is accurate and up-to-date. By understanding past fire patterns and current conditions, authorities can determine which areas need the most attention and resources (Adolf, 2018). Remote sensing data can be used as a basis for decision-making related to forest fire management. The use of accurate and timely data can improve the effectiveness of the response to fires. Thus, data-driven decision-making can reduce losses caused by fires (Piralilou, 2022). If data shows that an area is at high risk of fire, authorities can prioritize resource allocation for fire suppression or vegetation management.

Continuous monitoring with use technology remote sensing enables authorities to respond to fires more quickly (Thyagarajan, 2019). An effective monitoring system can reduce response time and minimize damage caused by fires. With continuous monitoring, authorities can take necessary actions before the fire spreads. If the monitoring system detects a hotspot, the fire team Firefighters can be immediately deployed to the location to prevent the fire from spreading further. Monitoring forest health after a fire is essential for planning effective recovery (Meng, 2018). Remote sensing can be used to assess damage and determine necessary recovery measures. Post-fire vegetation monitoring can help identify areas in need of immediate rehabilitation. With this information, authorities can plan appropriate actions to restore the ecosystem affected by the forest fire.

Recovery plans based on remote sensing data can help in assessing post-fire ecosystem damage. The use of remote sensing data in forest restoration can increase the effectiveness of rehabilitation programs (Mohajane, 2021). With accurate information on forest conditions, authorities can plan more precise and efficient recovery steps. If data shows that an area is severely damaged, authorities can prioritize rehabilitation of that area to accelerate ecosystem recovery (Gibson, 2020). Remote sensing has become a very important tool in forest fire mitigation. With the ability to detect fires early, analyze risks, and plan effective management strategies, this technology provides significant benefits in efforts to protect forests and ecosystems. From early detection of fire hotspots to post-fire recovery, remote sensing allows authorities to take faster and more precise actions in dealing with the threat of forest fires. By continuing to develop and apply this technology, it is hoped that it can reduce the impact of forest fires on national security.

### **3.3. Impact of Forest Fires on National Security**

Forest fires are a phenomenon that not only impacts the environment, but also has serious implications for national security. In the context of increasingly pressing climate change and increasing frequency of fires, the link between forest fires and security threats is becoming increasingly clear. The impacts caused by forest fires include losses to species and habitats, ecosystem damage, threats to public health, economic losses, and social and political impacts that can trigger tensions at home and abroad. Forest fires can cause significant losses to species and habitats. Extensive fires can destroy natural habitats and threaten the existence of species that depend on those ecosystems. Endemic species that are only found in certain forests, such as orangutans in Borneo, can experience drastic population declines due to fires. This habitat loss not only threatens the species, but also disrupts the balance of the ecosystem as a whole. When keystone species are lost, a domino effect can occur, affecting other species that depend on them for survival (Bhattacharjee, 2023).

Forest destruction caused by fires also causes loss of biodiversity. Fires can result in the loss of endemic species and disrupt the balance of the ecosystem. Biodiversity loss not only impacts threatened species, but also the ecosystem as a whole, which can reduce the carrying capacity of the environment. The loss of pollinator species such as bees can have a direct impact on food production, given that many plants depend on pollination to reproduce.

Forest fires can also cause environmental crises that have the potential to cause tensions between countries. Air pollution and other environmental impacts can trigger conflicts between countries that share borders. Smoke from forest fires in Indonesia can spread to neighboring countries such as Malaysia and Singapore, causing health problems and public discontent in those countries. These tensions can worsen diplomatic relations and add burden to regional cooperation efforts in addressing environmental issues (Rodríguez, 2023). Forest fires also disrupt important ecosystem services, such as clean water supply and climate regulation. Damage to ecosystem services can impact people's well-being. Forest loss can reduce the soil's ability to store water, which in turn can lead to drought in surrounding areas. The decline in the quality of these ecosystem services can result in a decline in people's quality of life and increase their vulnerability to climate change (Sirin, 2022).

The impact of wildfires on public health is also significant. Wildfires can cause serious air pollution, which has an impact on public health. Smoke from wildfires can cause respiratory problems and other diseases. Long-term exposure to air pollution can increase the risk of lung and cardiovascular diseases (Verma, 2022). In areas that experience frequent fires, such as California, the increase in the number of patients with respiratory disorders during the fire season has become a pressing public health problem (Stockwell, 2022). Forest fires can also increase the risk of disease spread. The smoke and fine particles produced can cause long-term health problems for exposed communities. Increased cases of asthma and respiratory infections can occur in areas affected by fires. In addition, unhealthy conditions caused by fires can create a conducive situation for the spread of infectious diseases, especially in areas with limited access to health services (Gong, 2022).

Economically, bushfires can have a major impact on the agriculture and tourism sectors, causing significant economic losses. Fires can damage agricultural land and reduce crop yields, which impacts food security and local economies (Vieira, 2021). The fires that occurred in Australia in 2020 caused billions of dollars in losses to the agriculture and tourism sectors. The decline in the number of tourists to fire-affected areas also contributed to greater economic losses, as many areas depend on tourism revenue. The costs of forest restoration and rehabilitation after fires are also very high. States and local governments must allocate significant resources to restore damaged ecosystems (Guimarães, 2020). Recovery costs can include reforestation, land rehabilitation, and restoration of ecosystem services, all of which require long-term investments. Furthermore, these costs are often unexpected and can disrupt government budgets, diverting resources from other important programs.

The social and political impacts of forest fires also cannot be ignored. Forest fires can cause displacement due to loss of shelter and resources (Hassan, 2022). Widespread fires can force people to move to safer areas. This phenomenon can cause greater social and economic pressure on areas receiving refugees. When the population increases suddenly, infrastructure and public services in the area can be stressed, causing dissatisfaction among local residents (Majdalani, 2022). Social instability due to loss of land and resources can also trigger conflict (Daiyoub, 2023). Tensions between communities competing for limited resources can increase the risk of conflict. In some cases, population shifts due to fires can lead to prolonged social tensions. In areas experiencing major fires, potential conflicts between local residents and displaced people can increase, creating an unstable and potentially dangerous environment.

Forest fires that cause environmental damage can trigger population migration and resource conflicts (Jiao, 2023). Resource conflicts can increase due to increasing population pressure (Hendel, 2020). These tensions can worsen the social and political situation in affected areas. In the long term, conflicts triggered by forest fires can disrupt development processes and create new challenges for governments in maintaining stability. The impacts of wildfires on national security are broad and complex. From species and habitat loss to public health, economic, and social and political instability, wildfires pose significant challenges to countries around the world. In the face of ongoing climate change and increasing fire frequency, it is critical that governments and communities work together to develop effective mitigation strategies. Efforts to protect forests and ecosystems, raise public awareness of health risks, and strengthen

social and economic infrastructure can help mitigate the negative impacts of wildfires and safeguard national security.

### **3.4. Remote Sensing Strategy in National Security**

Sustainable resource management requires accurate, up-to-date data. Remote sensing provides critical spatial information to support efficient decision-making. Lechner et al. (2020) highlighted the role of remote sensing in mapping land use, monitoring changes, and identifying disaster-prone areas. Dossa and Miassi (2024) emphasized integrating remote sensing with GIS for sustainable land-use planning, particularly for carbon sequestration. Evidence-based mitigation strategies, supported by robust data, enable effective interventions and efficient land-use planning (Gürsoy & Atun, 2019).

Practical applications of remote sensing in policy include flood risk prediction (Zhu et al., 2022) and air pollution analysis (Tikader et al., 2024). Collaborative approaches involving governments, researchers, and communities enhance mitigation effectiveness. Maharani et al. (2023) stressed the importance of clear governance models and stakeholder trust to ensure successful collaboration. Data-driven policies, supported by multisectoral cooperation, are key to reducing fire risks and promoting ecological and social resilience.

Widespread forest fires are one of the serious threats that can affect national and regional security policies. In this context, it is important to understand how remote sensing data can play a role in formulating more responsive policies. Integration of remote sensing data into security planning is not just an option, but an urgent need. With accurate and up to date data, authorities can formulate more effective strategic steps in dealing with the risk of forest fires. Countries that have implemented satellite-based monitoring systems can identify hotspots forest fires faster, so that preventive measures can be taken before the fire spreads further. The implementation of policies has been carried out in many countries, where governments have adopted remote sensing technology to monitor forest conditions and predict potential fires. Using satellite imagery and meteorological data, they can identify high-risk areas and mobilize resources earlier. This shows that policies based on remote sensing data not only improve response to fires, but also assist in long-term planning for risk mitigation.

Integrating remote sensing data into security planning can improve response to wildfire threats. With accurate and timely information, response teams can be directed to locations where assistance is most needed. This is critical in emergency situations, where every second counts. Fire monitoring systems that rely on remote sensing data enable firefighters to respond to wildfires more quickly and efficiently. By leveraging this information, they can prioritize the most threatened areas and allocate resources more effectively. However, to improve the effectiveness of using this data, the government and related institutions should consider appropriate recommendations. These recommendations include increasing investment in remote sensing technology and training personnel in data analysis (Wang, 2018). In addition, it is important to build infrastructure that supports sustainable data collection and analysis. Thus, policies based on remote sensing data will not only improve fire response but also strengthen national resilience to broader environmental threats.

Investment in research and development of new infrastructure and technologies is essential to improving forest fire monitoring capacity. In this context, innovations in monitoring technology and methodology can help address the challenges faced in forest fire management. The development of advanced algorithms is essential for image analysis, which can significantly improve fire detection and monitoring capabilities. The use of drone technology equipped with infrared sensors can provide more accurate information on temperature and soil conditions in hard to reach areas (Li, 2024). With this data, authorities can better assess fire risks and plan more effective preventive measures. In addition, the development of an artificial intelligence-based monitoring system (Artificial Intelligence) can also help in analyzing fire patterns and predicting potential future risks (Zulfiqar, 2021). Thus, increasing technological capacity will not only improve monitoring efficiency but will also provide a stronger foundation for data-based decision making.

Training and education in the use of remote sensing technology cannot be ignored. In order to improve the effectiveness of fire response, a comprehensive training program must be designed to improve the skills of the workforce in using this technology effectively. With such training and education, it is expected that increasing the capacity of human resources will contribute to the success of forest fire

mitigation strategies. These training programs can cover a variety of aspects, from a basic understanding of remote sensing technology to more complex data analysis skills. Training in the use of image analysis software can help professionals interpret data more accurately (Hao, 2024). In addition, training should also include emergency situation simulations, where participants can learn how to respond effectively to fires. By increasing human resource capacity, we can ensure that remote sensing technology is optimally used to address the threat of forest fires (Guo, 2024).

Collaboration between various parties, including governments, scientists, and communities, is essential in monitoring and responding quickly to forest fires (Rodríguez, 2023). International collaboration can increase the capacity of countries to deal with the threat of forest fires. In this context, sharing data and experiences between countries can help in developing more effective strategies to address forest fires and their impact on national security. An information exchange program between fire-prone countries can help strengthen the global monitoring network (Hassan, 2022). Countries can share remote sensing data, monitoring techniques, and proven mitigation strategies. In this way, each country can learn from the experiences of other countries, thereby improving their ability to respond to forest fires. In addition, this cooperation can also create a platform for joint research, where scientists from different countries can collaborate in developing innovative solutions to address the problem of forest fires (Zhang, 2023).

Remote sensing plays a very important role in national and regional security policies, especially in the context of widespread forest fires. With policies based on remote sensing data, technological capacity building, human resource development, and cooperation between institutions and countries, we can formulate more effective strategies in dealing with the threat of forest fires. Therefore, it is important for the government and related institutions to continue to invest in technology and training, and build strong collaboration networks to improve the response to forest fires and maintain overall national security.

#### **4. Conclusion**

Forest fires are a phenomenon that not only damages the ecosystem, but also has a wide impact that is felt by the community and the country as a whole. With the increasing frequency and intensity of forest fires, especially in vulnerable areas, it is important to understand how remote sensing technology can be a very valuable tool in forest fire mitigation efforts. The use of remote sensing data in such mitigation has great potential to reduce the impact of fires on the environment, health, economy, and national security. Remote sensing technology, which includes the use of satellites and airborne sensors, makes it possible to detect and monitor fires in real time. Satellites can provide accurate data on the area burned, surface temperatures, and even the type of vegetation affected. With this information, researchers and decision-makers can conduct better risk analyses. With remote sensing data, it can be shown that an area has a higher temperature than usual and there are indications of a fire so that preventive measures can be taken immediately, such as deploying a firefighting team or announcing an evacuation for local residents.

Risk analysis conducted with the help of remote sensing can also include predictive modeling that identifies areas that are most likely to burn. Using historical data and current weather conditions, scientists can predict fire patterns and formulate more effective management strategies. In an area that shows a consistent pattern of fires during the dry season, the government can plan to plant more fire-resistant vegetation or conduct controlled burns to reduce the fuel available for uncontrolled fires.

However, to maximize the benefits of remote sensing, investment in technology and human resource training is needed. Adequate technological infrastructure is essential to ensure that the data obtained can be accessed and analyzed efficiently. In addition, training for field officers and decision makers is also key to ensuring that they can understand and use the data produced appropriately. Training on how to read satellite imagery and interpret meteorological data can help firefighting teams respond more quickly and effectively to fires.

Forest fires are a complex threat, which must be addressed with an integrated approach. This approach includes not only technology and data, but also the involvement of all parties in forest fire mitigation efforts. Community involvement in monitoring and reporting fires can also improve faster responses. Cooperation between institutions is also an important aspect in forest fire mitigation efforts. Forest fires do not recognize administrative boundaries, so collaboration between local, national, and

international governments is essential. In this context, remote sensing can serve as a tool to share important data and information between countries, so that each party can take appropriate preventive measures.

The use of remote sensing data in forest fire mitigation not only offers technological solutions, but also opens up opportunities for broader collaboration between various parties. By utilizing this technology effectively, it can reduce the impact of forest fires on national security. However, to achieve this goal, investment in technology, human resource training, and inter-agency cooperation is needed. In facing the increasingly complex threat of forest fires, an integrated and participatory approach is essential to realizing sustainable national security.

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