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Full Length Research Article

Effectiveness of Forest and Land Fire Mitigation in South Sumatra: An Analytical Approach using Analytical Hierarchy Process and Importance Performance Analysis

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ABSTRACT

In Indonesia, forest and land fires remain a major environmental issue. In 2022, South Sumatra recorded 51,972 ha of burned land, accounting for 25% of the nationwide total. These incidents resulted in severe air pollution, health risks, economic losses, and environmental degradation, underscoring the urgency of mitigation. This research employs a mixed-methods approach, combining Kernel density analysis, the Analytical Hierarchy Process (AHP), and Importance Performance Analysis (IPA) to assess fire mitigation in South Sumatra. The results indicate that Ogan Komering Ilir, Ogan Ilir, Penukal Abab Lematang Ilir, Musi Rawas, and Prabumulih are the most fire-prone districts. Human activity was the dominant factor (0.80), particularly land clearing. The AHP analysis indicated that prevention is the highest priority (0.77), reflecting its cost-effectiveness and sustainability compared to suppression. The IPA emphasized three preventive measures as most effective: hotspot monitoring, water reservoirs, and canal blocks. Hotspot monitoring enables early detection and rapid response, reservoirs maintain soil moisture to reduce fire risk, and canal blocks restore peatland hydrology to limit large-scale burning. Suppression (0.14) ranked second, highlighting its necessity for a rapid response despite its lower effectiveness and higher cost. Management (0.09), although the lowest weighted, remains important for land rehabilitation and ecosystem restoration, despite requiring time and resources. Overall, these findings demonstrate that effective mitigation depends on prioritizing prevention through technology-driven monitoring and water management infrastructure, supported by regulatory enforcement. Suppression and management serve as complementary strategies to strengthen ecosystem resilience. This research provides a foundation for integrating fire prevention into governance frameworks, supporting sustainable forest management in South Sumatra and other fire-prone districts.

1. Introduction

Indonesia, one of the most forested countries in the world after Congo and Brazil, possesses exceptional biodiversity that underpins ecosystem functions and sustains the livelihoods of more than 65 million rural people (Gatto and Sadik-Zada 2024). However, this ecological and socio-economic potential is increasingly threatened by human-induced forest and land fires, primarily

caused by land clearing through combustion for agriculture and plantations (Kalfas et al. 2024; Sarmiasih and Pratama 2019). These fires damage ecosystems, reduce biodiversity, and intensify the effects of climate change.

In 2022, forest and land fires in Indonesia affected a total of 204,894 ha (BNPB 2023). South Sumatra experienced the largest impact, with 51,972 ha burned, representing 25% of the total affected area nationwide. Riau, Jambi, and South Sumatra are among the most vulnerable provinces due to the high number of hotspots and the extensive peatland areas compared to other regions (Tarmizi and Sirozi 2020). Furthermore, the South Sumatra and Jambi regions exhibited a progressive decrease in rainfall, as reported by BRIN (2022) during the period from January to May 2022. This reduction in rainfall, particularly during the dry season, elevates the likelihood of fire outbreaks. Taufik et al. (2023) further validate this assumption by showing that the continuous drainage of peatlands resulting from land use changes significantly elevates the frequency of tropical forest fires.

These worsening fire conditions have also led to visible and widespread consequences. The haze resulting from forest and land fires in South Sumatra is among the most visible impacts, spreading to Bengkulu, Jambi, Bangka Belitung, and Riau while also severely affecting local areas, including the capital of South Sumatra (Palembang). As a result, 12,288 cases of acute respiratory infection (ARI) were recorded, particularly in Palembang and some areas in South Sumatra (Ogan Ilir Regency), where air quality was the most severely affected (South Sumatra Provincial Health Office 2023). In September 2023, the haze that enveloped Palembang led to a surge in ARI cases, with 3,633 cases reported within a month (Greenpeace 2023). The haze contains deleterious compounds such as formaldehyde, carbon monoxide, and carbon dioxide, whose significant inhalation may cause respiratory system injury (Reid and Maestas 2019). Due to the significant environmental and health impacts of forest and land fires, implementing effective mitigation measures is essential to minimize fire frequency and severity. Mitigation strategies generally involve prevention, suppression, and management, and their effectiveness depends on resource allocation, governance, and adaptive management (Anggarwal and Dwivedi 2022). However, limited coordination among agencies and low community engagement may reduce the effectiveness of these strategies, suggesting the need for systematic evaluation. Therefore, this research aims to assess the effectiveness of mitigating and managing forest and land fires in South Sumatra.

2. Materials and Methods

2.1. Research Methods and Analytical Tools

The research methods applied consist of four main techniques: (1) Distribution of questionnaires to experts (academics), community leaders, field officers, and key stakeholders, with respondents selected using purposive sampling; (2) Utilization of ArcGIS software for spatial data analysis based on secondary data in SHP format obtained from the Regional Disaster Management Agency of South Sumatra (*BPBD Sumatera Selatan*) and Indo Geospatial; (3) Application of the Analytical Hierarchy Process (AHP) method using expert choice to determine the priority of fire-triggering factors; and (4) Use of Importance Performance Analysis (IPA) through SPSS to measure the level of importance and effectiveness of mitigation efforts.

2.2. Research Approach and Data Collection

This research employs a mixed-methods approach, integrating both qualitative and quantitative research methods. According to Oranga (2025), this method produces more comprehensive, accurate, consistent, and objective data. To support this methodology, data were collected from both primary and secondary sources, as detailed in the following subsections.

2.2.1. Primary data

This research collected quantitative and qualitative primary data through questionnaires and in-depth interviews with various stakeholders. Respondents were selected intentionally, including academic experts, community leaders, field officers, and representatives from the local government agencies of South Sumatra Province. The sample determination was carried out using a non-probability, purposive sampling method to ensure the involvement of respondents with relevant expertise and responsibilities. Academics were selected based on their scientific expertise related to forest fires, community leaders were selected based on their local influence and experience, field officers were selected for their direct involvement in fire control efforts, and representatives from regional apparatus organizations were selected for their role in disaster mitigation policies and implementation. To collect representative and thorough data, the research was conducted in five districts/cities with the highest hotspot intensity in South Sumatra, specifically Ogan Komering Ilir, Ogan Ilir, Penukal Abab Lematang Ilir, Musi Rawas, and Prabumulih, involving 25 respondents in each district proportionally drawn from the stakeholder groups.

2.2.2. Secondary data

Secondary data for this research were obtained from documents and relevant archives provided by authorized institutions. These included the Forest Area Designation Bureau (*Balai Pemantapan Kawasan Hutan*), the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG), Statistics Indonesia (BPS), and the Regional Disaster Management Agency of South Sumatra (*BPBD Sumatera Selatan*). The dataset, covering the period from 2000 to 2023, includes information on regional boundaries, peatland areas, land cover, rainfall, wind speed, temperature, air pressure, water bombing points, forest and land fire monitoring operations, and hotspot distribution.

2.3. Data Analysis Technique

This research method includes a series of analysis stages to support the study of forest and land fires in South Sumatra. Initially, areas with the highest concentrations of hotspots were identified using hotspot data from the National Institute of Aeronautics and Space of Indonesia (LAPAN) for the period 2000–2023. The LAPAN hotspot dataset was derived from MODIS and VIIRS satellite sensors. Preprocessing included filtering for a confidence level of 80% or higher, clipping to the South Sumatra boundary, removing duplicate points, and projecting to the WGS84 coordinate system. The data was analyzed through two main steps:

(a) Time series analysis is applied to describe the picture and dynamics of hotspot changes in a temporal context, and

(b) Kernel density analysis was used to map the spatial distribution of hotspot density using ArcGIS software. Furthermore, the AHP method was applied to compile a priority ranking of factors that trigger forest and land fires in South Sumatra. This analysis uses expert choice software to compare the weights between criteria and produce priority-based recommendations systematically. Thereafter, the IPA method was used to assess the level of significance and effectiveness of efforts to mitigate forest fires. The priority and performance of mitigation-related aspects were evaluated by analyzing questionnaire data using SPSS software, thus ensuring that the recommendations produced are data-based and on target.

3. Results and Discussion

3.1. Hotspot Analysis and Water Bombing in South Sumatra

Recurrent forest and land fires pose a persistent challenge in South Sumatra, with adverse consequences for air quality, ecosystems, economic activities, and public health (Kala 2023). Several mitigation measures have been implemented, including mapping hotspots to identify fire-prone regions and utilizing helicopter water bombing to prevent the spread of fires. Thus, a map depicting the hotspots and sites for the most intensive water bombing in South Sumatra is presented in **Fig. 1**.

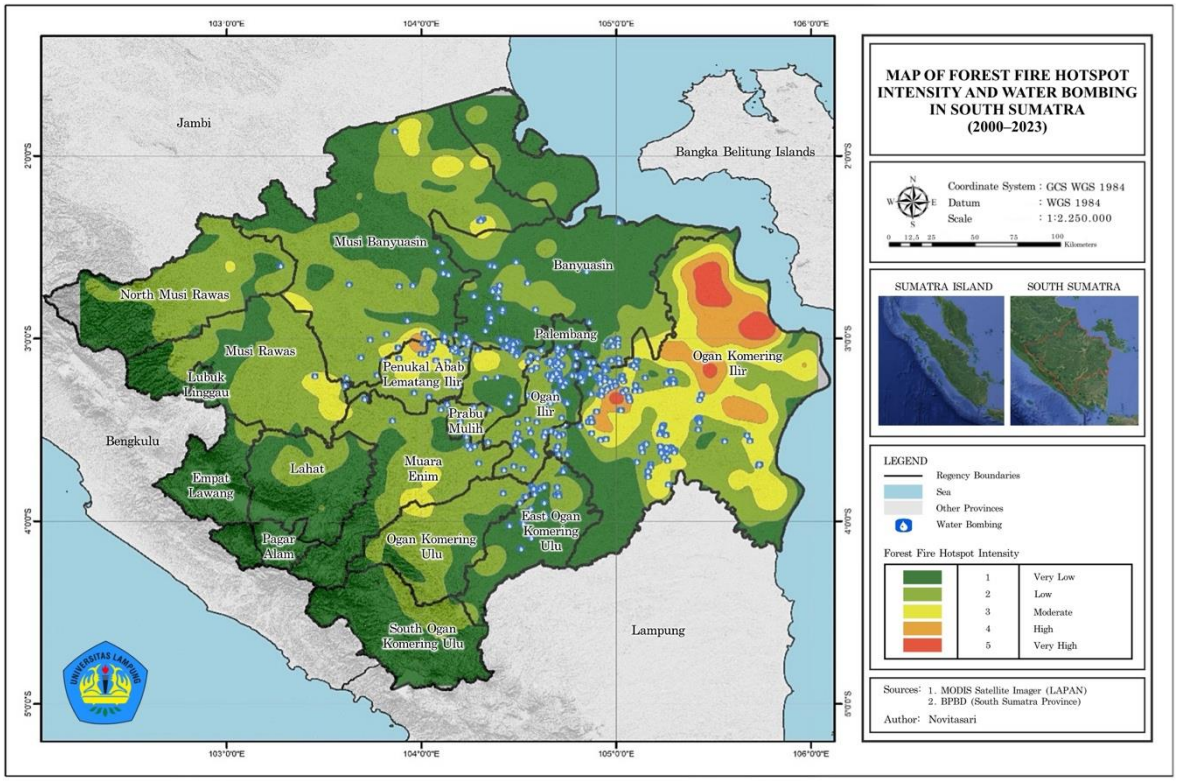

Fig. 1. Map of the highest hotspot intensity with water bombing in South Sumatra.

Based on (**Fig. 1**), mapping of water bombing operations in 2023 identified five priority districts/cities: Ogan Komering Ilir, Ogan Ilir, Penukal Abab Lematang Ilir, Musi Rawas, and Prabumulih. The concentration suggests that the districts with the highest fire risk were the focus of suppression efforts. Among these districts, OKI has the highest number of interventions, with 3,973 water-bombing operations releasing a total of 16,485,000 liters of water. This district was

followed by Ogan Ilir, with 2,520 operations releasing 10,080,000 liters of water. In comparison, PALI recorded 784 operations (3,136,000 liters), Musi Rawas 159 operations (636,000 liters), and Prabumulih 69 operations (276,000 liters). Overall, the results indicate that OKI and Ogan Ilir represent the most critical areas for water bombing operations, reflecting their high vulnerability to forest and land fires.

Nevertheless, aerial water bombing efforts are more frequently conducted in areas located outside the primary hotspot clusters. This condition indicates that forest and land fires in South Sumatra frequently expand beyond the spatially identified zones, predominantly driven by anthropogenic factors such as deliberate land clearing and unintentional negligence. Consequently, suppression efforts are required not only within the main hotspot clusters but also across wider surrounding areas. This result is consistent with the research of Nurhayati et al. (2021), who emphasize that most fires in the Sumatra region are anthropogenic in origin, particularly those caused by land clearing for agriculture and plantations. However, the current spatial monitoring system does not always track these incidents within designated critical hotspots, leading to a mismatch between actual fire locations and suppression efforts. Water bombing remains a key firefighting strategy, but several factors, including the insufficient number of helicopters and the inaccessibility of fire-prone areas, limit its effectiveness. These logistical constraints caused delays in a prompt and focused response.

Additionally, water bombing is highly expensive and becomes even less effective under severe weather conditions, such as strong winds or dense smoke, which explains its limited use. According to the Head of the National Agency for Disaster Management, the operational cost of water bombing using Fixed-Wing Aircraft is approximately IDR 200 million per hour. In contrast, helicopter operations cost around IDR 250 million per hour (Gautama et al. 2023). Although ground crews are less costly, aerial suppression remains indispensable for controlling rapidly spreading fires in remote areas, highlighting the importance of a mixed-method approach. Therefore, a comprehensive evaluation is essential to determine the optimal deployment and operational efficiency of water bombing in forest and land fire suppression in South Sumatra.

3.2. Prioritization of Factors Causing Forest and Land Fires in South Sumatra

The causes of forest and land fires in South Sumatra were identified using the AHP method. This approach takes into consideration three crucial factors: (1) Human factors, such as the widespread practice of farmers and corporations burning land for clearing; (2) Climate factors, such as low rainfall, high temperatures, low air pressure, and wind speeds that accelerate vegetation drying and fire spread; and (3) Land condition factors, such as highly flammable peat and dry vegetated land cover, that increase the likelihood of fires. The significance of a holistic approach in preventing and controlling forest and land fires is emphasized by these three factors. This research involved stakeholders and experts from five districts with the highest hotspot intensity in South Sumatra: Ogan Komering Ilir, Ogan Ilir, Penukal Abab Lematang Ilir, Musi Rawas, and Prabumulih. The results of the analysis are presented in **Figs. 2** and **3**.

Based on (**Fig. 2**), the main causes of forest and land fires in South Sumatra show that the human factor has the highest weight (0.801), with an inconsistency value of 0.03 (< 0.1), so priority mitigation efforts should focus on this factor. Human factors, which account for 99% of forest and land fires in Indonesia, include careless cigarette disposal and intentional land burning for economic gain. This result is supported by Suhardono et al. (2024), which indicates that nearly

80% of forest and land fires in Indonesia are the result of human activities, including both intentional and negligent ones. To overcome these issues, a focused mitigation strategy is necessary, including strengthening law enforcement, optimizing forest and land fire patrols, and conducting intensive community outreach to increase awareness and compliance with applicable regulations (Nurlia et al. 2021).

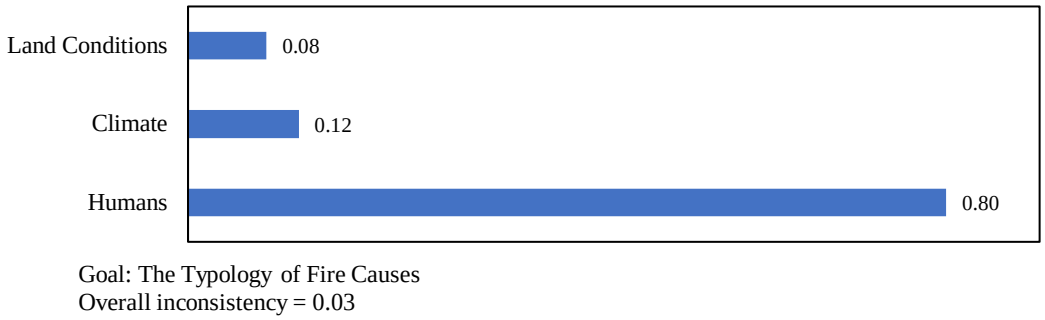

Fig. 2. AHP-based weighting of main factors causing forest and land fires in South Sumatra.

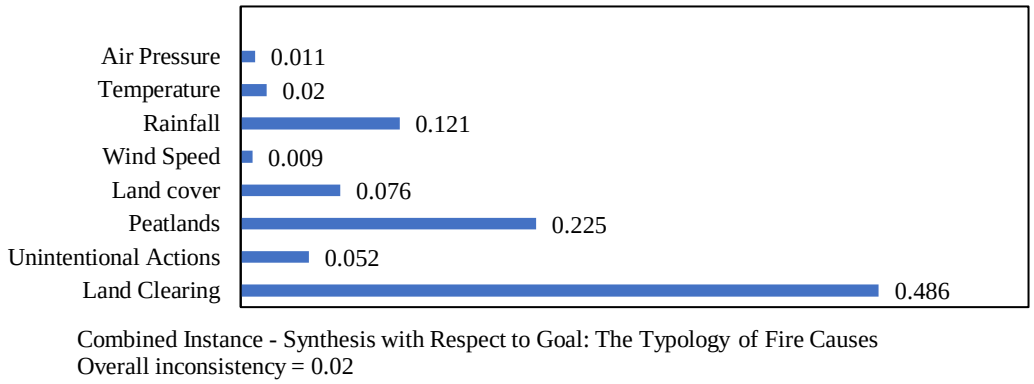

Fig. 3. AHP weighting of sub-criteria under main factors causing forest and land fires in South Sumatra.

Climate factors, weighted at 0.117, are significant in conjunction with human factors. Severe weather conditions, such as prolonged dry seasons leading to soil and vegetation desiccation, significantly increase the risk of fire. Research conducted by Nurdiati et al. (2022) demonstrates that forest and land fires in Southeast Asia have significantly escalated due to extreme meteorological events, including the Indian Ocean Dipole (IOD) and the El Niño–Southern Oscillation (ENSO). Topographical features can significantly impact the likelihood of wildfires, particularly during the dry season. Additionally, land conditions, particularly peatlands, weigh 0.083 and play a substantial role in the occurrence of fires, particularly during the dry season. Peat ignites due to insufficient moisture, with over 90% of fire-related carbon emissions in Indonesia originating from peatland fires (Kiely et al. 2019; Rozaki et al. 2020).

Furthermore, (**Fig. 3**) shows that intentional land clearing, such as plantation development, has a significant weight of 0.486, making it the dominant factor causing forest and land fires. Land-clearing activities often employ burning techniques considered more efficient and economical; however, this practice frequently develops into uncontrolled fires (Ayuningrum and Nurhayati 2022; Prasetia and Syaufina 2020). Although the contribution of non-human causes to fires is

relatively smaller, these factors remain relevant and should not be ignored in mitigation efforts. In addition, the spread of fires is accelerated by rainfall (0.121), high temperatures (0.020), and wind (0.009–0.011), which increase the intensity of the fire and dry out natural fuels. The occurrence of forest and land fires is also substantially influenced by other factors, including the presence of peatland (0.225) and deforested land cover (0.076). This conclusion is consistent with the findings of Silviana et al. (2020), who observed that the water table in peatlands is reduced due to the extensive drainage of peatlands. As a result, the peat layer loses moisture, making it more vulnerable to fire. Fires are also triggered by human negligence (0.052), which involves unintentional actions such as leaving fires unattended or carelessly discarding cigarette stubs. A comprehensive mitigation strategy is necessary to address these factors, which should encompass public education, stringent law enforcement, prevention efforts, and adaptation to climate change, thereby reducing the risk of future fires.

Based on the existing data, a Kernel density analysis was conducted to validate the compatibility with the AHP results that identified land clearing as a priority for forest and land fire mitigation in South Sumatra. This analysis revealed five districts with the highest hotspot intensity: Ogan Komering Ilir, Ogan Ilir, Penukal Abab Lematang Ilir, Musi Rawas, and Prabumulih (**Fig. 4** and **Table 1**). Additionally, other districts not classified as the highest hotspots remain at risk of fire due to variations in temperature, climate, and rainfall.

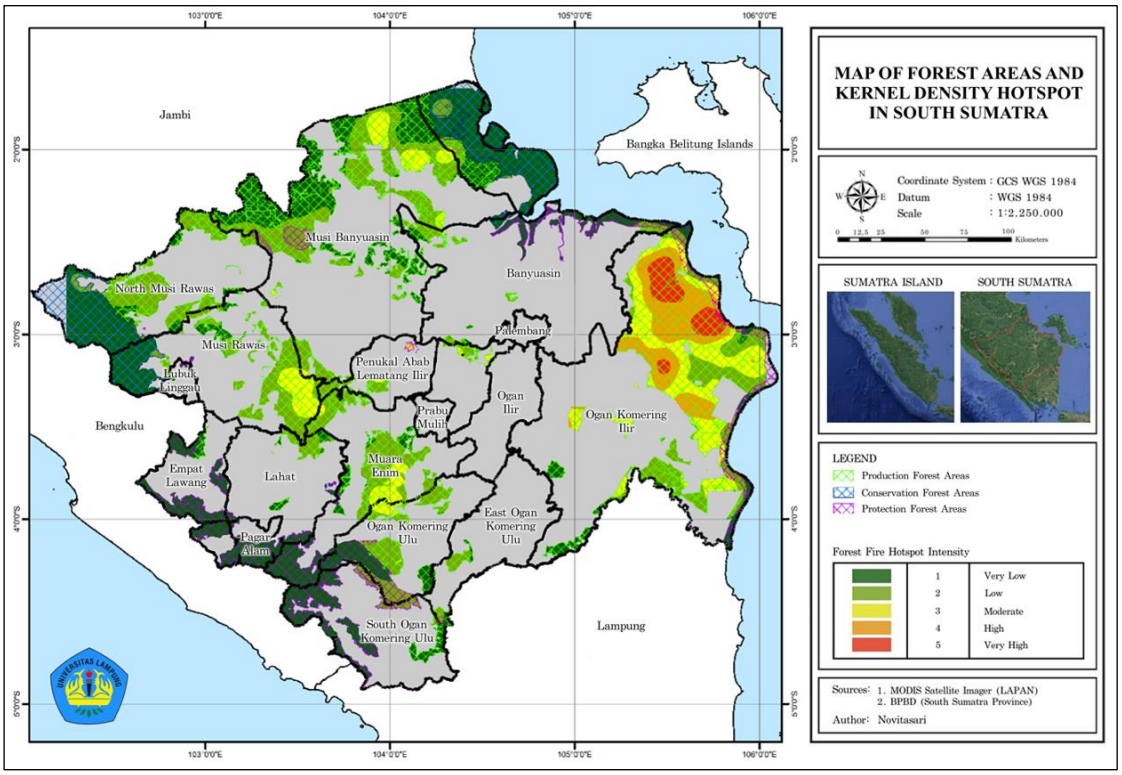

Fig. 4. Kernel density map of hotspots in South Sumatra.

Among the three classifications of forest types in South Sumatra, production forests have the highest level of vulnerability to forest fires. These cover a total of 2,082,463.77 ha, followed by protection forest areas of 562,444.11 ha, and conservation forest areas of 423,795.47 ha. The tradition of sonor and land burning by local communities in the vicinity of lebak-lebung (fish pond) areas is the primary cause of forest and land fires in South Sumatra. During the dry season, local communities frequently observe the sonor tradition, which involves using fire to cleanse the land

for agricultural preparation. In the Lebak-Lebung areas, burning is also commonly used to locate fish or create new land. Despite its perceived economy and effectiveness, this method has a significant environmental degradation. It has been demonstrated that sonor systems degrade ecosystems, cause significant smoke emissions, deplete land resources, and accelerate peat subsidence (Wildayana et al. 2017). These negative consequences are widespread and include biological, physical, chemical, social, economic, cultural, and political aspects (Wildayana et al. 2017). Sustainable solutions are necessary to mitigate these risks, including implementing eco-friendly practices, enhancing law enforcement, and educating the public about the dangers associated with burning. Communities, environmental organizations, and the government must work together to preserve South Sumatra's ecosystems.

Table 1. Area prone to forest and land fires using Kernel density by forest function classification

Forest function classification	Kernel density	Area (ha)	Total area (ha)
Production Forest	Low	920,025.49	2,082,463.77
	Very low	472,051.52	
	Very high	75,598.98	
	Moderate	415,778.55	
	High	199,009.23	
Conservation Forest	Low	27,033.84	423,795.47
	Very low	396,761.63	
Protection Forest	Low	115,050.48	562,444.11
	Very low	425,832.97	
	Very high	1,827.80	
	Moderate	15,720.85	
	High	4,012.02	

3.3. Evaluation of the Effectiveness of Forest and Land Fire Mitigation and Management

3.3.1. Effectiveness of forest and land fire mitigation and management using the AHP method

The efficiency of South Sumatra's forest and land fire mitigation and management can be evaluated using the AHP method. Three main factors can be evaluated as determining criteria and levels for this assessment: prevention, suppression, and post-fire management. In light of this, data analysis using AHP and Expert Choice Version 11 software produced the following outcomes (**Fig. 5** and **Fig. 6**).

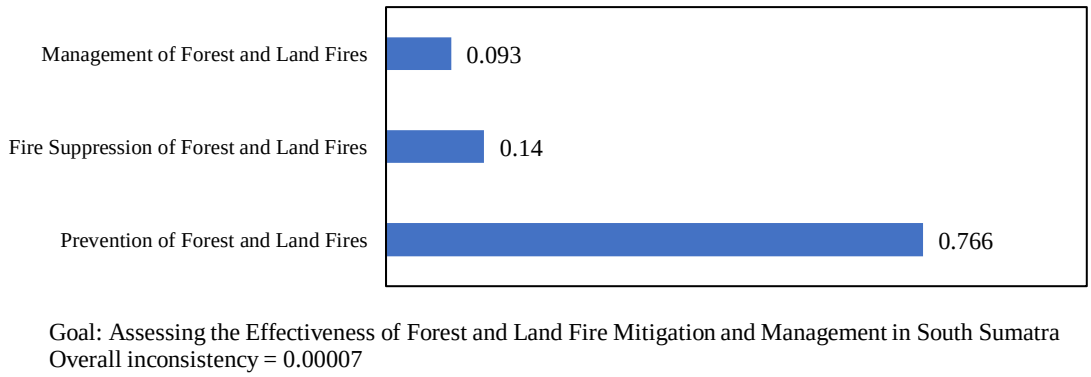

Fig. 5. AHP-based weighting of main factors in forest and land fire mitigation and management in South Sumatra.

According to the AHP results, prevention has the highest weight (0.766). It is a priority strategy for mitigating and managing land and forest fires in South Sumatra. Preventing fires is more effective than suppressing them, as it reduces the cost of suppression and the negative effects on the environment and society. Monitoring hotspots using modern technologies, such as satellite photography and Geographic Information Systems (GIS), is an essential preventive strategy, assigned a weight of 0.406. Research by Kumalawati et al. (2023) in East Kalimantan demonstrated that risk-based zoning significantly reduced fire incidents, facilitating the swift identification of hotspots. To facilitate peatland rewetting initiatives, the construction of water reservoirs (0.168) is essential. Research on water management in Tebing Tinggi Island, Riau, indicates that water reservoirs can mitigate fire danger by sustaining steady soil moisture levels during the dry season (Sutikno et al. 2023).

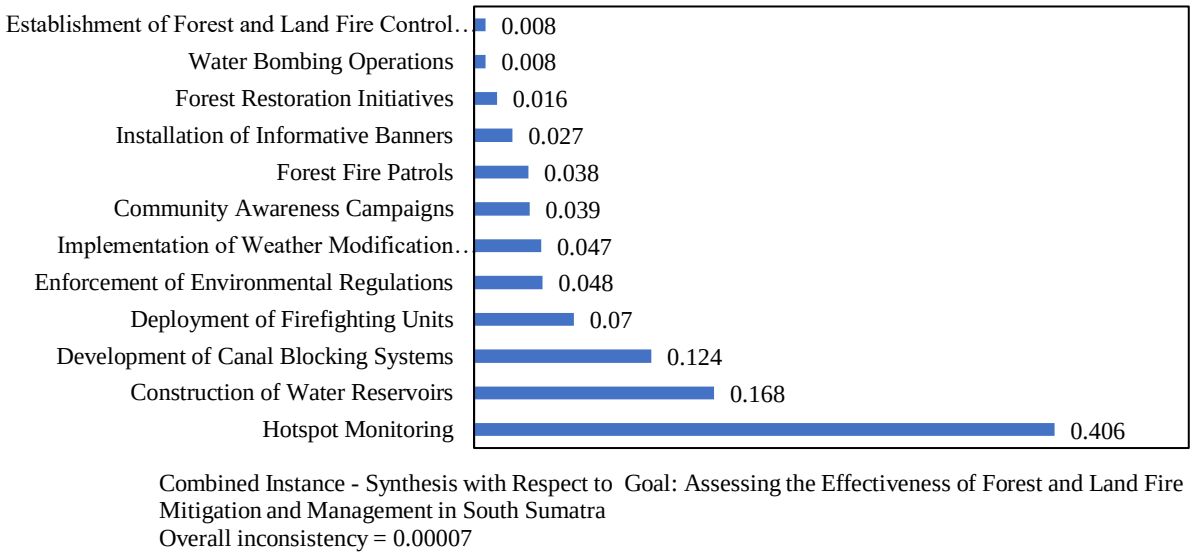

Fig. 6. AHP weighting of sub-criteria under main factors in forest and land fire mitigation and management in South Sumatra.

Installing block canals (0.124) is also very beneficial for keeping the land from drying out and raising the water table in the peat. These measures can reduce the likelihood of a fire. Building canal blocks is a smart idea, as confirmed by Herawati et al. (2018), which demonstrates that doing so can increase the moisture content of peat soil by 250%. However, areas without canal obstructions are only 60% wet. In South Sumatra, the risk of forest and land fires can be significantly reduced if a holistic approach is taken, incorporating improvements to water infrastructure, the use of monitoring technology, and effective management of local water resources. Additionally, to raise public awareness and detect potential fires early, it is essential to engage with the community and regularly monitor their activities.

Additionally, fire suppression (0.14) is necessary for the timely response to fires that have already begun, with technology such as water bombing and firefighting teams playing a major role. It is crucial, but after fires have spread, it is not very effective. The last component, fire management (0.093), is expensive and includes land rehabilitation and ecosystem restoration. In general terms, the primary goal of fire risk mitigation is to prevent fires through the use of hotspot monitoring technology, enhanced coordination among relevant agencies, and the development of supportive infrastructure.

3.3.2. Effectiveness of forest and land fire mitigation and management using the IPA method

An analysis using the IPA approach was conducted to assess the significance and effectiveness of forest and land fire mitigation in South Sumatra. This method produces a Cartesian diagram categorizing indications into four quadrants: qualities requiring significant improvement, attributes to be sustained, attributes deemed superfluous, and attributes of little priority. This diagram guides the prioritization of more effective mitigation. The following are the results of the IPA, presented in **Table 2** and **Fig. 7**.

Table 2. Importance and effectiveness assessment of forest and land fire mitigation based on eight indicators

No	Indicator	Importance		Effectiveness	
		Score	Percentage (%)	Score	Percentage (%)
1	Socialization	2.84	57	2.32	46
2	Banners	1.96	39	1.92	38
3	Patrolling	3.56	71	2.92	58
4	Weather modification	3.08	62	2.92	58
5	Canal block construction	3.92	78	3.32	66
6	Water reservoir (construction)	4.04	81	3.68	74
7	Hotspot monitoring	4.64	93	3.16	63
8	Security post	3.76	75	2.56	51

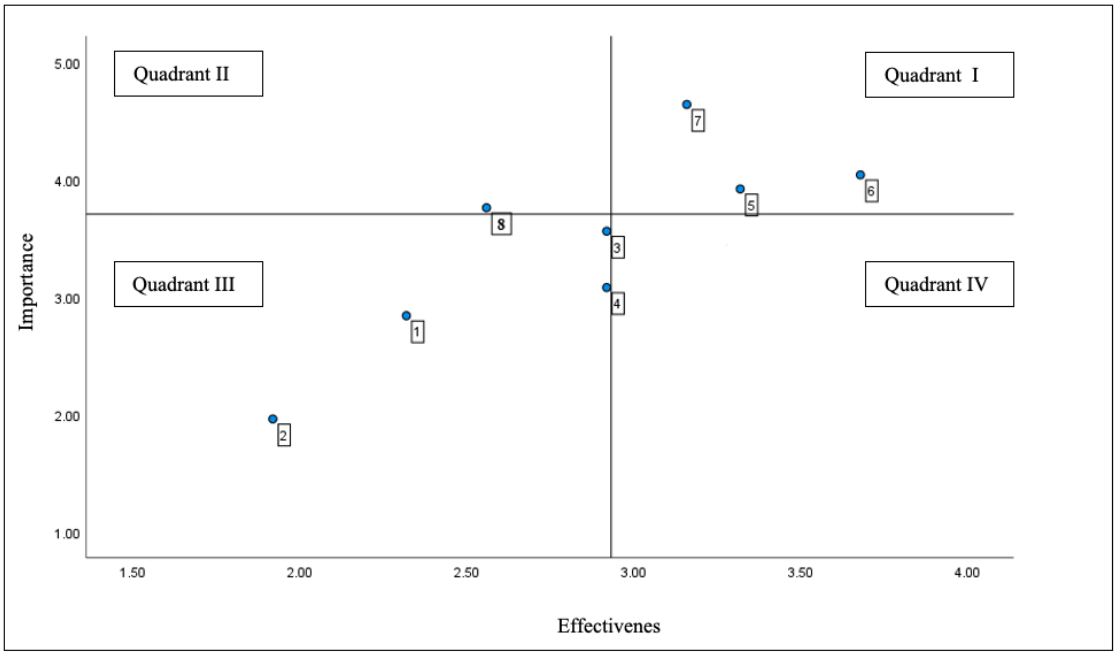

Fig. 7. IPA-based Cartesian diagram of eight mitigation indicators.

The results of the analysis show that the importance and effectiveness of various forest and land fire mitigation measures in South Sumatra vary. The top priorities are indicators that score high in both importance and effectiveness, specifically hotspot monitoring (93% and 63%), water reservoir construction (81% and 74%), and canal block construction (78% and 66%). These

indicators should be maintained as they contribute significantly to fire mitigation. Meanwhile, the security post indicator demonstrates relatively high importance (75%) but only moderate effectiveness (51%). The result suggests that, although it is considered important, there is still room for improvement in its practical implementation.

In contrast, the implementation effectiveness of other indicators, such as patrolling (71% and 58%) and weather modification (62% and 58%), is limited by operational and cost constraints. The importance and effectiveness of socialization (57% and 46%) and banner use (39% and 38%) remain low. Therefore, their effectiveness must be evaluated, particularly in terms of their ability to alter individuals' behavior substantially. Passive communication strategies, such as banners, are less effective than contextualized direct actions. In contrast, technology-based hotspot monitoring measures, including the use of satellite imagery and Geographic Information Systems (GIS), have proven to be more effective. Research by Ramadan et al. (2024) demonstrated that hotspot monitoring can detect potential fires early, enabling more precise resource allocation and faster intervention. Thus, mitigation strategies based on direct action, such as hotspot surveillance, should be prioritized over informative approaches that have a less substantial impact on community behavior change. Generally, hotspot monitoring, canal block construction, and water reservoirs are the primary focus of fire mitigation. However, indicators with low efficacy necessitate a more comprehensive evaluation to identify more strategic interventions. Furthermore, **Table 3** and **Fig. 8** illustrate the significance and effectiveness of forest and land fire mitigation related to other indicators.

Table 3. Importance and effectiveness assessment of forest and land fire mitigation based on four indicators

No	Indicator	Importance		Effectiveness	
		Score	Percentage (%)	Score	Percentage (%)
1	Firefighters	4.60	92	3.84	77
2	Water bombing	3.40	68	3.28	66
3	Law enforcement	4.76	95	2.68	54
4	Forest rehabilitation	3.92	78	2.60	52

The Cartesian diagram analysis reveals the distribution of forest and land fire mitigation indicators in South Sumatra across four quadrants. Quadrant I includes important indicators with high levels of effectiveness that need to be maintained, such as the role of firefighters (92% importance, 77% effectiveness), who are effective in rapid response, suppression, and mitigation education. Quadrant II contains important but less effective indicators, such as law enforcement (95% importance, 54% effectiveness) and forest rehabilitation (78% importance, 52% effectiveness). Although law enforcement holds the highest level of importance, its effectiveness remains relatively low due to resource and regulatory constraints. Improvements could be achieved through strengthened interagency coordination and the allocation of more adequate resources. Similarly, forest rehabilitation requires increased funding and collaborative efforts to achieve long-term impact. This research does not include Quadrant III, while Quadrant IV contains indicators with high efficacy but low significance, such as water bombing (68% importance, 66% effectiveness). Resource constraints and stakeholder relevance may result in a decrease in these indicators. Therefore, the most critical indicator that must be preserved is the function of

firefighters, as determined by the findings of this Cartesian diagram analysis. This conclusion aligns with the findings of Alit et al. (2024), who suggested that the presence of a rapidly responsive fire department can substantially mitigate the effects of fires. Furthermore, mitigation education by firefighters also plays a role in preventing subsequent fire incidents.

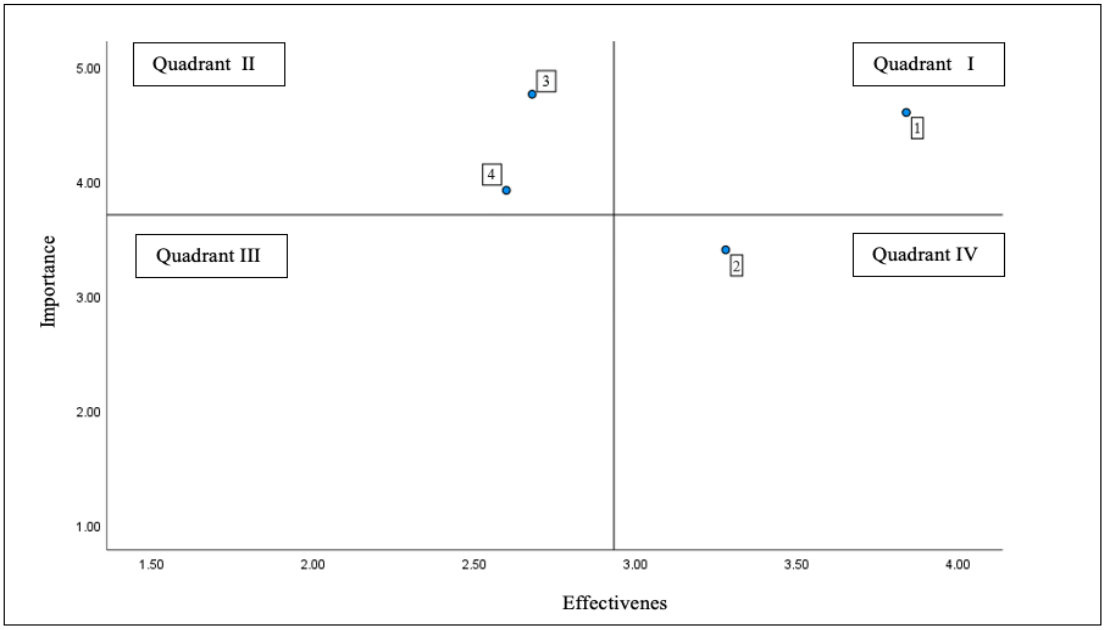

Fig. 8. IPA-based Cartesian diagram of four mitigation indicators.

4. Conclusions

This research demonstrates that forest and land fires in South Sumatra are predominantly caused by human activities, particularly the careless disposal of cigarettes and intentional land burning for economic purposes. Ogan Komering Ilir, Ogan Ilir, Penukal Abab Lematang Ilir, Musi Rawas, and Prabumulih are identified as the most vulnerable districts. The Analytical Hierarchy Process (AHP) confirmed that prevention is the most effective strategy, as it is more cost-efficient and environmentally sustainable compared to suppression and management. The Importance Performance Analysis (IPA) further emphasized the role of technology-based hotspot monitoring, water reservoir construction, and canal block construction as the foundation of preventive measures. Although suppression and management hold lower weights, both remain indispensable, with suppression serving for rapid emergency response and management for long-term rehabilitation and ecosystem recovery. Collectively, these findings underscore the importance of prioritizing prevention through technological innovation, effective water management infrastructure, and stringent regulatory enforcement, while maintaining sufficient resources for suppression and long-term rehabilitation. This research offers policymakers actionable insights to integrate data-driven prevention into broader forest governance frameworks, thereby enhancing ecosystem resilience and promoting sustainable forest management in South Sumatra and other fire-prone regions.

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Author Contributions

N: Conceptualization, Data Curation, Formal Analysis, Writing – Original Draft Preparation, Visualization, Writing – Review and Editing; D.T.M.: Data Curation, Writing – Original Draft Preparation, Visualization, Writing – Review and Editing.

Conflict of Interest

The authors declare no conflict of interest.

Declaration of Generative AI and AI-Assisted Technologies in the Manuscript Preparation

During the preparation of this research, the authors used Quillbot.com, a paraphrasing tool, and Grammarly.com, a grammar and spell-checking tool, to smartly enhance the clarity and readability of the writing, making it easier for readers to understand and helping to avoid plagiarism. After using these tools/services, the authors carefully reviewed and edited the content as needed and took full responsibility for the publication's final content.

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