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Research Paper

Spatial Data Integration and Validation for Peatland Fire Risk Mapping in Ogan Ilir District, South Sumatra Province

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Abstract

This study aims to map peatland fire vulnerability in Ogan Ilir District, South Sumatra, using a GIS-based spatial data integration approach. The analysis integrates biophysical factors, including soil type, land cover, topography, and rainfall, with anthropogenic variables such as accessibility to roads, settlements, and rivers. A multi-criteria scoring and weighting method was applied to generate the vulnerability map, which was validated using hotspot data from 2019 to 2024. Previous studies in Ogan Ilir primarily focused on fire-potential mapping using simple scoring and overlay techniques without standardized validation. To address this limitation, this study adopts the official methodology outlined in Technical Guidelines No. P.6/PSKL/SET/KUM.1/5/2020 issued by the Ministry of Environment and Forestry and incorporates fire spot data from the Regional Disaster Management Agency (BPBD) for validation. Results show that high-vulnerability areas (Score 3–4) dominate the district, covering 222,855.3 hectares or 90.7% of the total mapped area. Validation indicates that 83.8% of actual hotspots occur within these zones, supported by a kappa accuracy value of 0.8628, reflecting strong model reliability. Key factors influencing vulnerability include land cover dominated by shrubs, swamps, and plantations such as oil palm and rubber; the predominance of Hemic Organosol soils; and low rainfall, especially in southern areas. These findings align with studies across Sumatra highlighting the influence of drained vegetation, accessibility, and human activities on peatland fire susceptibility. Overall, this study provides essential spatial information to support targeted peatland fire mitigation, including enhanced monitoring, strict no-burn policies, and improved water-management practices to maintain sustainable peat moisture.

Keywords

Forest and Land Fires, Fire Vulnerability, Ogan Ilir, Geographic Information System, Spatial Validation

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1. INTRODUCTION

Tropical peatlands are unique ecosystems formed through the accumulation of semi-decayed organic matter in water-saturated conditions over thousands of years. This uniqueness makes peatlands one of the world's largest carbon stores and plays an important role in global climate regulation (Page and Hooijer, 2016). However, peatlands in Southeast Asia, particularly in Indonesia, are currently under intense pressure from human activities, especially land use change for oil palm plantations, industrial timber estates, and infrastructure development (Thorburn and Kull, 2015). These areas are also highly susceptible to fires, particularly in Southeast Asia, including Indonesia (Page and Hooijer, 2016). Peatland fires not only cause extensive ecological damage, but also release significant carbon emissions that contribute to global climate change.

Peatland fires not only cause huge ecological and economic losses, but also impact public health due to smoke that can spread to neighbouring countries (Koplitz et al., 2016; Glauber and Gunawan, 2015). The 2015 haze crisis in Southeast Asia was the worst since 1997, with massive carbon emissions released into the atmosphere (Huijnen et al., 2016).

Ecologically, peatlands that are drained for plantations or agricultural activities are highly susceptible to fire because draining lowers the water table and increases oxygen availability, which supports burning. Research by Marlier et al. (2015) confirms that hydrological restoration is essential to reduce fire potential in peatlands. In addition, the study by Marlier et al. (2015) shows that over the past two decades, deforestation and land conversion in Southeast Asia have resulted in severe peatland degradation and increased fire risk.

Land use change, especially conversion to oil palm plantations, is one of the main drivers of peatland fires in Indonesia

(Sloan et al., 2017). Research by Marlier et al. (2015) also demonstrates that fires occurring in plantations, timber concessions, and illegally cleared areas contribute significantly to carbon emissions and regional air quality degradation. This situation is exacerbated by the El Niño phenomenon, which triggers prolonged dry seasons and increases fire vulnerability (Sloan et al., 2017).

Peatland fire risk assessment is increasingly relevant amid the complexity of land use change and the high market demand for plantation commodities such as palm oil (Thorburn and Kull, 2015). Furthermore, spatial monitoring using remote sensing technology such as the Normalized Difference Vegetation Index (NDVI) is an effective method for detecting vegetation degradation and potential fire risk (Bharathkumar and Mohammed-Aslam, 2015). The use of satellite imagery can help identify priority areas for fire mitigation in Ogan Ilir District.

According to Koplitz et al. (2016), land use change in Indonesia has occurred massively since the 1980, driven by aggressive development policies that have disrupted ecosystem balance. As a result, peat ecosystems have become increasingly vulnerable to fires and release high amounts of carbon emissions. Miettinen et al. (2016) also showed that between 1990 and 2015, peatland cover in Sumatra and Kalimantan experienced significant land conversion, posing major challenges for fire risk management.

Peatland fires not only affect the local environment but also pose serious public health risks. Koplitz et al. (2016) reported that peat fires emit fine particulate matter (PM2.5), which can cause respiratory and cardiovascular diseases and even increase mortality rates. Furthermore, Glauber and Gunawan (2015) found that the economic losses caused by the 2015 fires in Indonesia amounted to billions of dollars.

Ogan Ilir Regency in South Sumatra Province is one of the regions with extensive peatland areas, making it highly susceptible to forest and land fires (Putra et al., 2019; Nurhayati et al., 2021). Previous studies indicate that forest and land fires occur almost annually in this region, driven by land conversion and unsustainable land management practices (Miettinen et al., 2016; Nurhayati et al., 2021; Syaufina and Fitriana, 2021). These fires also cause economic losses and raise public health concerns due to air pollution from the resulting haze (Utomo et al., 2022; Asteriniah and Hestiriniah, 2023).

Therefore, assessing peatland fire risk in Ogan Ilir District is essential to support disaster mitigation policies, climate change adaptation strategies, and sustainable land management. This study integrates spatial analysis, biophysical and hydrological factors, and land use changes that influence fire risk. The findings are expected to provide a scientific foundation for local governments to develop effective and sustainable peatland fire management strategies.

2. EXPERIMENTAL SECTION

2.1 Study Area

This study was conducted in the Ogan Ilir District, South Sumatra Province, which is known as one of the areas with a high level of forest and land fire vulnerability (Utomo et al., 2022; Hapsoro, 2025). The district is geographically located between 3°02'-3°48'S and 104°20'-104°48'E with an area of 2,463.40 km^2 or 246,340 hectares, as shown in Figure 1 (RTRW Ogan Ilir 2024-2048). The relatively flat topography of the region with an average elevation of 8 meters above sea level makes this area vulnerable to the accumulation of fire fuels such as shrubs and peatlands (Sukarman and Haryati, 2021).

Table 1. Types and Sources of Data

Data Type	Source
Soil Type	Ogan Ilir District RTRW 2024-2048
Elevation	Fabdem 30-meters resolution
Land Cover	Ogan Ilir District Environment Office
Rainfall	CHIRPS
Settlement Distribution	Ogan Ilir District RTRW 2024–2048
Road Network	Ogan Ilir District RTRW 2024–2048
River Network	Ogan Ilir District RTRW 2024–2048
Hotspots Validation	Field Survey 2015–2024

2.2 Data

This study utilizes computer hardware with spatial data processing software, namely ArcGIS (https://www.arcgis.com/home/) and Microsoft Office for tabular data processing (Beck et al., 2018; Vetrita and Cochrane, 2020). The data used included vector and raster thematic data collected from various sources. The Landsat 8 satellite has two sensors, the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). Both sensors provide global medium-resolution multispectral imagery data for mapping and monitoring environmental change. OLI provides image data with a spatial resolution of 30 meters for bands 1-7 and 9-11, and a spatial resolution of 15 meters for band 8 (panchromatic). Meanwhile, TIRS provides image data with a resolution of 100 meters. The use of Landsat satellite data is immensely helpful in monitoring land cover and detecting fires (Field et al., 2016). This study also used field validation data obtained through surveys to the locations of fires detected during the 2015-2024 period. Details of the data and their sources are provided in Table 1.

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Figure 1. Map of the Research Location in Ogan Ilir Regency, South Sumatra

Table 2. Weight of Each Variable

Variables	Weight
Soil Type	0.238
Elevation	0.210
Land Cover	0.180
Rainfall	0.148
Settlement Distance	0.087
Distance from Road	0.079
Distance from River	0.057
Total	1.000

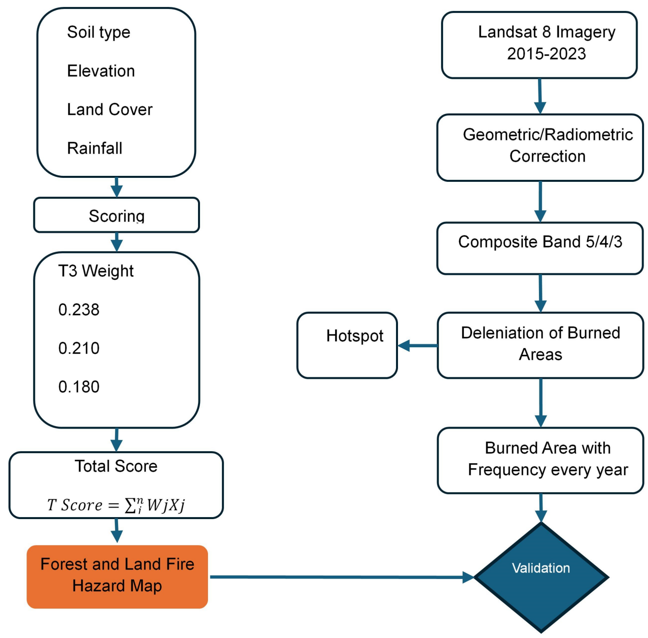

Figure 2. Research Method Flowchart

2.3 Methods

This research refers to the Technical Guidelines for the Preparation of Forest and Land Fire Prone Maps issued by KLHK (Perdirjen PPI, 2020). Validation was carried out by comparing the modeled map with actual fire data (fire spot) in Ogan Ilir District (2015-2020).

2.3.1 Determination of Parameters and Variables

The research parameters include fire frequency, fire area, and annual variability of fires (Achmad and Alfan, 2018). The variables used are categorized into biophysical (soil type, elevation, land cover), climatological (rainfall), and anthropogenic (distance to settlements, roads, rivers) (Niko-novas et al., 2022; Kasin and Papastathopoulos, 2020). The weight values for each variable were determined through a verification analysis using fire occurrence data between 2015 and 2020.

2.3.2 Determination of Weight and Score

The weight of each variable was calculated through verification analysis based on 2015-2020 fire data (Perdirjen PPI, 2020). The determination of the 1-5 score follows the methodology widely used in fire risk mapping (Rendana et al., 2023). Table 2 presents the weights of each variable used in this study. Meanwhile, the score values of each variable are presented in Table 3 to Table 7.

2.3.3 Total Score Calculation

The total score is calculated using a multivariable linear combination formula as shown in Equation (1):

$$\text{Total Score} = \sum_{j=1}^{n} W_j X_j \quad (1)$$

where W_j indicates the weight of the jth variable, and X_j indicates the score of the jth variable (Achmad and Alfan, 2018). Scores range from 1 (not vulnerable) to 5 (highly vulnerable).

2.3.4 Determination of Regional Typology

The research area is categorized in typology 3 (Perdirjen PPI, 2020), according to the results of cluster analysis based on the biophysical homogeneity of the area. This approach is important to improve the accuracy of fire-prone predictions (Budiningsih et al., 2022).

2.3.5 Validation of Fire Prone Map

Validation was conducted by comparing the modeling results with BPBD Ogan Ilir District firespot data (Utomo et al., 2022). Spatial overlay between vulnerability zones and hotspots is used

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Table 3. Scores for Soil Type Classes

Soil Type Class	Score
Peat	5
Non-Peat	1

to measure the accuracy of the model (Niko-novas et al., 2022). The flowchart of the research method is shown in Figure 2.

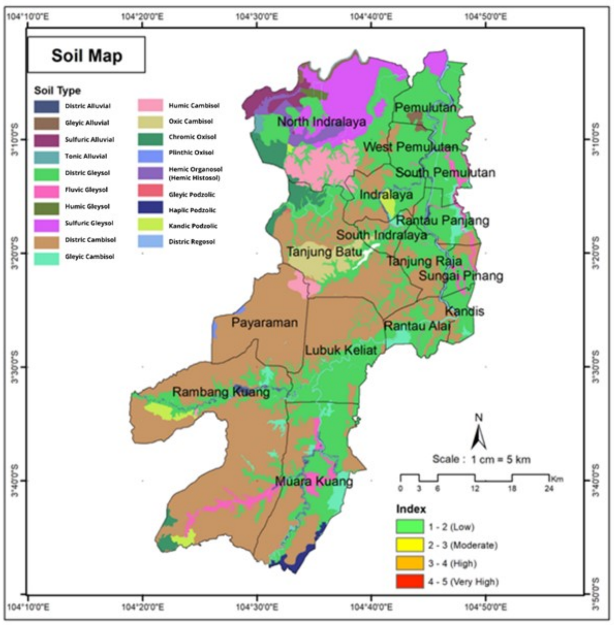

Figure 3. Map of Soil Type Distributed in the Ogan Ilir Regency

3. RESULT AND DISCUSSIONS

3.1 Soil Types and Their Implications for Land Fire Risk

Ogan Ilir Regency, South Sumatra, is geomorphologically located in a lowland area formed from a relatively young alluvial sedimentation process (flood and river deposits). Flat topographic conditions, variable drainage (ranging from fairly good to very poor), and repeated sedimentation processes cause the development of young mineral soils (cambisols) and soils that are always wet or flooded (gleisols). Most of Ogan Ilir is a floodplain formed by active alluvial sedimentation. This area is influenced by seasonal flooding of major rivers such as the Ogan River and its tributaries (Sukarman and Haryati, 2021).

Areas with very poor drainage (swamps or along rivers) favor the formation of gleisols (periodically or permanently water-saturated soils), while slightly higher areas (not always flooded) favour the formation of cambisols. Soils in these areas are generally young or still in the early stages of development due to repeated sedimentation. As a result, Ogan Ilir District is dominated by soils classified by WRB (World Reference Base)

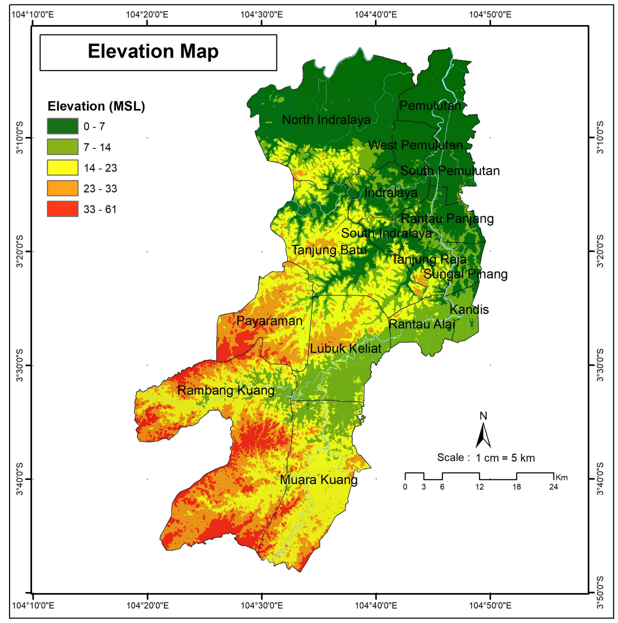

Figure 4. Elevation Map

as District Cambisols (young mineral soils) and District Gleisols (water-saturated soils). The District Cambisol soil type is spread in Kecamatan Rambang Kapak Tengah, Kecamatan Lubuk Keliat, Kecamatan Payaraman, parts of Kecamatan Tanjung Batu and Kecamatan Muara Kuang (Figure 4).

Table 4. Scores for Elevation Class

Elevation Class	Score
0 to < 250 meters above sea level	5
250 to < 500 meters above sea level	4
500 to < 750 meters above sea level	3
750 to < 1000 meters above sea level	2
≥ 1000 meters above sea level	1

In Ogan Ilir Regency, there are also soil types composed of organic matter, namely Hemic Organosols and Humic Cambisols (Sukarman and Haryati, 2021). The level of decomposition of organic matter in Hemic Organosol soils is moderate, not raw like Fibric and not very decomposed like Sapric. These soils are formed from the accumulation of organic matter in water-saturated environments such as swamps, and are a key indicator of peatlands.

The analysis shows that Hemic Organosols, although only covering about 4.5% of the total area, have a high susceptibility to land fires, especially during the dry season and when the water table drops. This is consistent with Field et al. (2016), who highlighted that shallow peat dries quickly and becomes a flammable fuel. Meanwhile, the Humic Cambisol soil type is not classified as peat, but mineral soil that has a high organic

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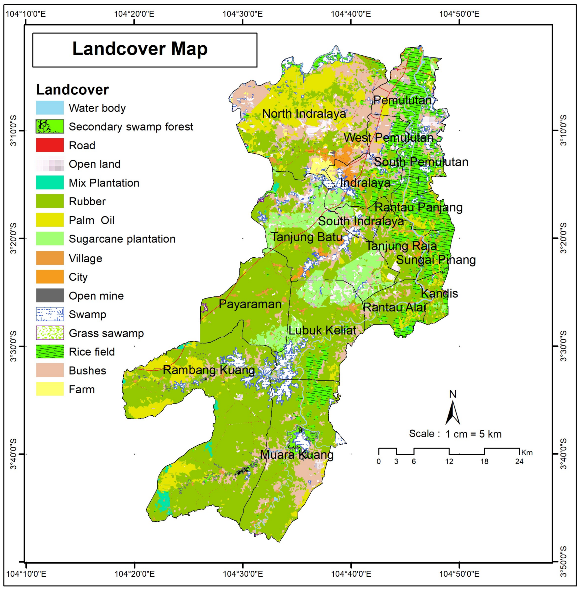

Figure 5. Landcover Map

matter content (humus) in the upper layers. This feature distinguishes it from Organosols (peat soils), where all or most of the soil profile is composed of organic matter (Darsiti et al., 2024). The map of soil types in Ogan Ilir Regency is shown in Figure 3.

Table 5. Scores for Land Cover

Land Cover Class	Score	Land Cover Class	Score
Swampy Scrub	5	Settlements	2
Plantation	5	Mining	2
Rice Field	5	Secondary Mangrove Forest	2
Swamp	5	Transmigration	2
Dryland Farming and Shrubs	4	Water Body	1
Dryland Agriculture	4	Pond	1
Savanna/Grassland	4	Air/sea port	1
Shrubs	4	Primary Dryland Forest	1
Forest Plantation	3	Primary Mangrove Forest	1
Secondary Swamp Forest	3	Open Land	1
Secondary Dryland Forest	3	Primary Swamp Forest	1

The classification results based on the soil type map (Figure 3) show that Ogan Ilir Regency is dominated by mineral soil covering 231,395.7 ha or 94% of the total area. Organic and peaty soil types cover 11,062.98 ha or only 4.5%. Water bodies

Table 6. Scores for Rainfall

Rainfall Class	Score
1000 to < 1500 mm/yr	5
1500 to < 2000 mm/yr	4
2000 to < 2500 mm/yr	3
2500 to < 3000 mm/yr	2
> 3000 mm/yr	1

in the form of rivers and lakes cover 3,694.86 ha (1.5%). The area and score of each soil type are presented in Table 8.

3.2 Topography and its Relationship to Fire Potential

The area of Ogan Ilir Regency is generally flat topography with an elevation of 0-61 meters above sea level (asl), as shown in Figure 4. In the eastern and northern parts, the elevation ranges from 0-14 meters asl, which includes Indralaya, Pemulutan, West Pemulutan, South Pemulutan, and North Indralaya subdistricts. In the south and west, the elevation ranges from 15-61 meters asl, covering Rambang Kuang, Payaraman, and Muara Kuang sub-districts.

The highest risk score, 5, on the fire-prone map is attributed to the low variation in topography, which causes a more even accumulation of fuel (dry biomass). Research by Budiningsih et al. (2022) showed that flat topography increases the accumulation of light fuels, thus supporting the spread of fire.

3.3 Land Cover and its Relationship to Land Fire Risk

The results of the land cover analysis in Ogan Ilir District show that the region is dominated by rubber plantations with a total area of around 114,804 Ha. This cover is the main component of the landscape in the region. Other significant cover types include shrubs (30,804 Ha), rice fields (24,939 Ha), and oil palm plantations (22,865 Ha) (Niko-novas et al., 2022).

In addition, there are various other types of land cover such as sugarcane plantations, swamps, settlements, open land, secondary swamp forest, moor/field, mixed plantations, swamp grass, roads, water bodies, and open mining (Table 9).

In the context of land fire risk, the relationship between land cover type and fire potential is very important, especially during dry seasons or periods of drought. Based on research, land cover types with low and easily draining vegetation such as shrubs, open land and swamps have a very high fire risk (Yokelson et al., 2022; Rendana et al., 2023). This vegetation provides light, flammable fuels, especially during hot weather, strong winds, and human activities such as land clearing by fire.

Plantation land (especially oil palm and rubber) also has high fire potential. Improper management of crop residues such as leaves, twigs, or litter increases this risk. Burning practices for land preparation further contribute to high fire potential (Wijayanti et al., 2023).

Several other land covers such as moor/field, mixed plantations, and secondary swamp forest also have medium to high fire risk due to dense vegetation, fuel availability, and frequent

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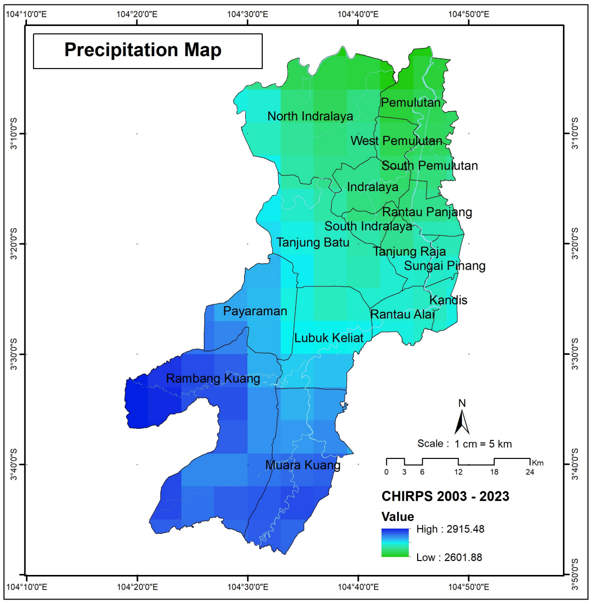

Figure 6. Map of Annual Rainfall Distribution in Ogan Ilir Regency

human intervention. In contrast, water bodies, roads, and settlements have lower fire risk scores (1-2). Water bodies have high moisture levels that prevent ignition, while roads and settlements have hard surfaces and lower association with fire use (Vetrita and Cochrane, 2020). The land cover map of Ogan Ilir District is shown in Figure 5.

3.4 Rainfall and its Implications for Peatland Fire Risk

The spatial distribution of rainfall in Ogan Ilir Regency was analyzed using CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) data with high spatial resolution and analysis time span for the last 10 years. Based on the results of the analysis, annual rainfall in this region ranges from 2,601 mm/year to 2,915 mm/year. Spatially, the northern and northeastern regions of Ogan Ilir Regency, including North Indralaya, Pemulutan and Rantau Panjang sub-districts, tend to have higher rainfall. This is indicated by the bright green color on the annual rainfall map (Figure 6). In contrast, the southern and southwestern regions, such as Muara Kuang, Rambang Kuang, and Payaraman sub-districts, tend to have lower rainfall, indicated by the dark blue color on the map. This variation in rainfall between regions reflects the influence of orographic factors and microclimate dynamics that cause a decrease in rainfall intensity towards the south (Rendana et al., 2023).

According to Fick and Hijmans (2017), the distribution of rainfall in a region is strongly influenced by topography, dominant wind patterns, and the direction of local hills. This phenomenon is relevant to explain the significant difference in rainfall between the northern region (which tends to have higher rainfall intensity) and the southern region of Ogan Ilir Regency (which is relatively lower).

Table 7. Distance from Settlements, Roads and Rivers

Distance	Score
0 to < 2 km	5
2 to < 4 km	4
4 to < 6 km	3
6 to < 8 km	2
≥ 8 km	1

Table 8. Soil Type Class

Soil Type Class	Area (Ha)	Score
Peat (Hemic Organosol, Humic Cambisol)	11,062.98	5
Mineral Soil	231,395.7	1
Water Body	3,694.86	0

Based on the scoring results of the rainfall data, Ogan Ilir District is generally in the annual rainfall class of 2500 mm to less than 3000 mm, which is given a fire vulnerability score of 2. Climatologically, the region is classified as climate type B or C (wet to slightly wet) according to the Schmidt & Ferguson classification, with the dominant rainy season occurring between November and April (Schmidt and Ferguson, 1951).

Although rainfall rates in the region are generally high, decreases in annual rainfall in the south can increase the duration and frequency of seasonal droughts, especially during the dry season (June-September) (Beck et al., 2018). These drought conditions can reduce the moisture of surface fuels, such as low vegetation (shrubs and reeds) and dry peat layers, making them highly flammable (Field et al., 2016). This is an important factor in increasing the vulnerability of peatland fires in Ogan Ilir District.

3.5 Accessibility to Settlements, Roads, and Rivers in the Context of Land Fire Vulnerability

Accessibility from residential areas, roads and rivers is one of the significant indirect factors in influencing the level of forest and land fire vulnerability. This factor is an indicator of the intensity of human activities that have the potential to trigger fires, whether through agricultural activities, land clearing, or other economic activities.

Spatial analysis was conducted by measuring the distance to the settlement area, which was calculated from the centroid or from the outermost boundary of the settlement area if it was in the form of a polygon (Budiningsih et al., 2022). The closer an area is to a residential area, the higher the intensity of human activity that can contribute to increased fire risk.

Apart from settlements, distance to rivers is also an important variable in mapping fire vulnerability. Rivers often serve as the main transportation route used by communities for various activities, such as agriculture, trade, crop distribution, and daily mobility. This is in line with the findings of Achmad and

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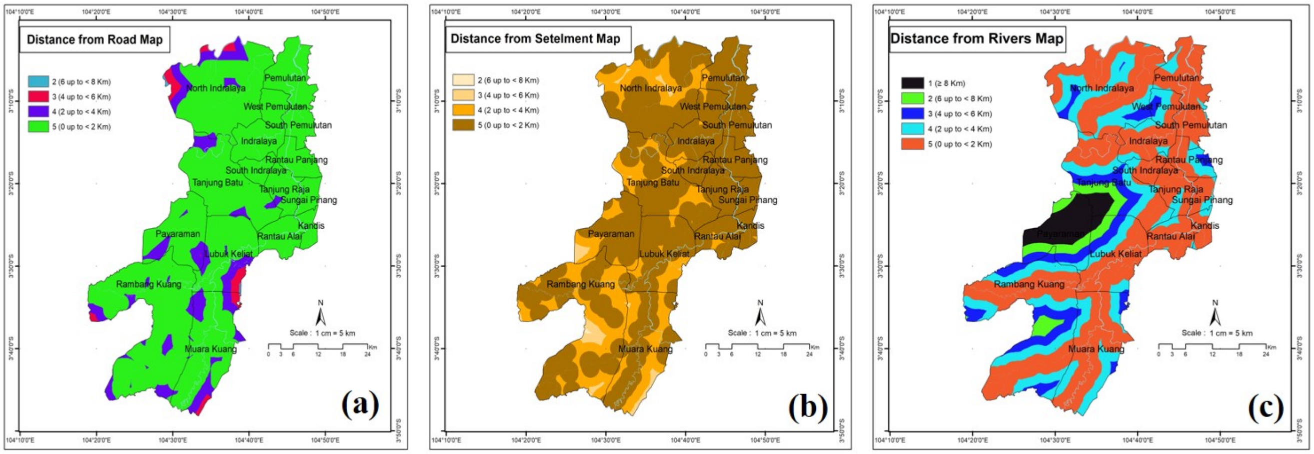

Figure 7. Distribution Map of Distance to Infrastructure (a) Distance from Road, (b) Distance from Settlement, (c) Distance from River

Table 9. Types of Land Cover

Land Cover Type	Total Area (Ha)	Score
Rubber plantation	114,804.64	5
Shrubs	30,804.31	4
Rice Field	24,939.49	5
Oil palm plantation	22,865.35	5
Sugarcane plantation	14,692.14	5
Swamp	12,248.62	5
Settlements	7,793.92	2
Open land	7,334.47	1
Water Body	3,382.01	1
Secondary swamp forest	2,206.78	3
Road	1,977.35	1
Farm/field	1,490.57	4
Mixed plantation	1,330.84	5
Swamp Grass	156.41	4
Open pit mining	131.70	2

Alfan (2018), which showed a strong correlation between the location of fires and their proximity to rivers. Areas around rivers tend to have more intensive human activities and are therefore given a higher vulnerability score, while areas further away from rivers generally have a lower risk of fire.

The variable of distance to roads is also important to consider because roads function as land transportation infrastructure that facilitates human access to forest and land areas. According to Kasin and Papastathopoulos (2020), the closer an area is to a road, the higher the potential for fire due to human activities, including land clearing and agricultural waste disposal. Therefore, areas adjacent to roads were given a maximum score of 5 in the fire vulnerability analysis.

Technically, spatial modeling of the variable distance from roads, rivers and settlements was carried out using buffering techniques in Geographic Information System (GIS) software. This technique produces concentric maps that represent levels of distance, making it easier to score fire vulnerability based on proximity to human activity. The resulting maps of distance from roads, settlements and rivers are shown in Figures 7a-c to illustrate the spatial distribution of accessibility to potential land fires in Ogan Ilir District.

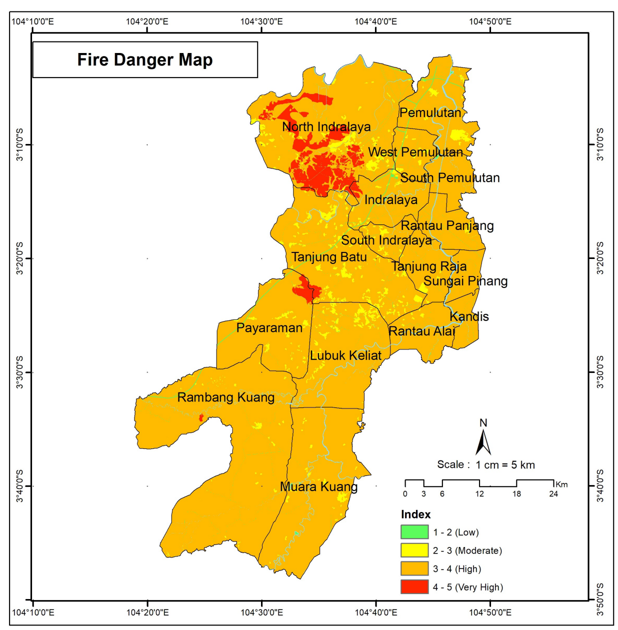

Figure 8. Map of Land and Forest Fire Vulnerability in Ogan Ilir District

3.6 Land and Forest Fire Vulnerability Map

The analysis of forest and land fire vulnerability mapping in Ogan Ilir District was conducted through a process of scoring each variable (parameter) affecting vulnerability, followed by weighting using a multi-criteria equation (Equation 1). This process combines biophysical factors (soil type, land cover, rainfall, topography) and anthropogenic factors (accessibility to roads, settlements and rivers). The final calculation results in a forest and land fire vulnerability map with a vulnerability index range from 1 to 5.

The analysis map shows that areas with a very high level of vulnerability (index 4–5, marked in dark red and red) are concentrated in the northern part of Ogan Ilir District (Figure 8). The sub-districts of North Indralaya, Indralaya, parts of Pemulutan and Payaraman fall into this category. These areas are characterized by extensive land cover in the form of shrubs, open land, swamps and plantations. The presence of road networks and dense settlements increases human activity, which is often a trigger factor for fires, both intentionally (land clearing with fire) and unintentionally (daily activities that cause sparks).

Table 10. Distribution of Area And Percentage of Forest and Land Fire Vulnerability Classes in Ogan Ilir District

Prone Class	Score Range	Area (Ha)	Percentage (%)
Low	1 - 2	5,202.36	2.1
Medium	2 - 3	8,238.87	3.4
High	3 - 4	222,855.3	90.7
Very High	4 - 5	9,466.02	3.9

Table 11. Distribution of the Number of Fire Spots by Forest and Land Fire Vulnerability Class

Prone Class	Score Range	Number of Hotspots	Percentage (%)
Low	1 - 2	44	5.6
Medium	2 - 3	46	4.6
High	3 - 4	653	83.8
Very High	4 - 5	46	5.9
Total		779	100

In areas with moderate to high vulnerability (index 2-4, yellow to orange color), the spatial distribution extends to the central to southern part of the district, covering the sub-districts of Tanjung Batu, Lubuk Keliat, Rambang Kuang, and Muara Kuang. Although rainfall in this area is relatively higher than in the north, the presence of dry vegetation such as shrubs, reeds, and shallow peat still contributes significantly to fire potential, especially during the dry season (June-September).

Areas of low vulnerability (index 1-2, green colour) were identified sporadically, mainly in areas with wet land cover such as water bodies or well-managed active agricultural land. This reflects that intensive land management and the presence of water resources play an important role in reducing fire risk.

Furthermore, based on the overlay with the land cover map, areas that dominate the high to very high vulnerability class generally have extensive cover of shrubs, open land, swamps, and oil palm and rubber plantations. These areas are mainly located in the northern and southwestern parts of the district, such as North Indralaya, Pemulutan, Rambang Kuang, and Muara Kuang sub-districts. These land cover types generally have surface fuels in the form of dry vegetation, twigs and litter that can easily catch fire, especially during the dry season. This is reinforced by the results of the study by Rendana et al. (2023), which showed that low and open vegetation cover has a high potential to be the initial trigger for fires in the Sumatra region.

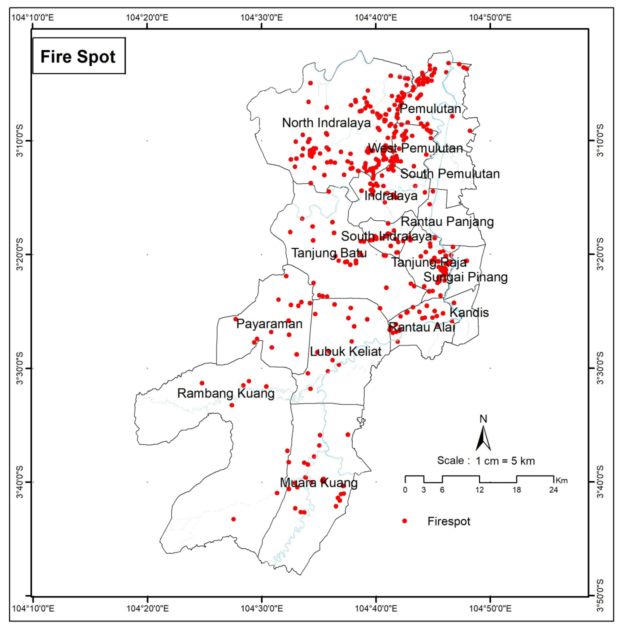

Figure 9. Fire Spot Distribution Map 2019-2024 (BPPD Ogan Ilir Regency)

In addition, the scattered oil palm and rubber plantations in this area are also a factor that increases the potential for fires, especially if land clearing practices still use burning methods (Wijayanti et al., 2023). The presence of secondary swamp forests that dry out during the dry season also increases the vulnerability of peatland fires in this district. Conversely, areas with relatively high rainfall, wetland cover, and low accessibility (far from main roads and settlements) tend to have a lower fire risk. However, these factors need to be monitored on an ongoing basis as changes in land cover and human activities could increase fire vulnerability in the future.

The results of this spatial analysis confirm the importance of prioritizing fire mitigation in zones with low rainfall, high accessibility, and dominance of fire-prone land cover, such as in North Indralaya sub-district and its surroundings. Spatially-

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based mitigation strategies are needed to support effective land fire management efforts. The area for each class of forest and land fire vulnerability is presented in Table 10.

The findings show that more than 90% of Ogan Ilir district falls into the high vulnerability category. This indicates the urgency of spatial data-based fire management interventions and land use policy adaptations, including restrictions on open burning and strengthened monitoring in vulnerable areas.

3.7 Validation of Land and Forest Fire Vulnerability Map

Validation of the forest and land fire vulnerability map was conducted to assess the spatial accuracy of the modeling results using actual fire data (hotspot) from 2019 to 2024 (Figure 9). Hotspot data was obtained from the Regional Disaster Management Agency (BPBD) of Ogan Ilir District, which records forest and land fires based on reports and field hotspot detection.

Validation was conducted by extracting pixel values from the forest and land fire vulnerability map at each mapped hotspot point. From the results of the spatial overlay of 779 hotspot points, the distribution of fire occurrence according to the vulnerability class generated from the modeling was obtained (Table 11). The majority of the fires (653 points or 83.8% of the total) were identified as being in the high vulnerability class with a score of 3-4. This indicates a good level of accuracy in detecting fire risk areas.

Based on the results of this validation, it is known that the high vulnerability class covers an area of 222,855.3 hectares or about 90.7% of the total mapped area. This finding is in line with the distribution of fire spot points, which shows that 653 events (83.8%) are within the high vulnerability zone. According to the classification of vulnerability levels issued by Perdirjen PPI (2020), the high vulnerability class is interpreted as having a 50–75% chance of forest and land fire occurrence with moderate fire intensity.

This high level of accuracy indicates that the fire vulnerability model developed has good reliability in predicting high-risk areas. Therefore, the resulting vulnerability map can be used as a basis for land and forest fire mitigation planning, including prioritizing the handling, monitoring and sustainable land management in Ogan Ilir District.

When compared with previous research, the results of this study are consistent with the findings of Utomo et al. (2022) who mapped fire risk in Ogan Ilir District and found that areas dominated by shrubs, open land, and intensive plantations tend to have a high fire risk. Rendana et al. (2023) in a fire risk mapping study in Sumatra also emphasized that low vegetation such as shrubs and reeds have a high vulnerability to fire, especially during the dry season. The results of this study are also in line with the study of Budiningsih et al. (2022) who found that accessibility to roads, settlements and rivers increases fire risk because it facilitates human activities that trigger fires, such as land clearing with fire.

In addition, compared to the fire model developed by Nikonovas et al. (2022) in South Sumatra, the results of this study show similar validation accuracy, with more than 80% of the actual fire hotspots found in high vulnerability zones. This corroborates that the use of multi-criteria approaches based on spatial data is effective in mapping fire vulnerability in tropi

4. CONCLUSIONS

This research has successfully produced a map of peatland fire vulnerability in Ogan Ilir District by utilizing a Geographic Information System (GIS)-based spatial data integration approach. The results of the analysis show that areas with high vulnerability classes (scores 3-4) dominate most of the study area, with a total area of 222,855.3 hectares or 90.7% of the total mapped area. The very high vulnerability class (score 4-5) recorded 9,466.02 hectares or 3.9%, while the medium vulnerability class (score 2-3) covered 8,238.87 hectares or 3.4%. Meanwhile, the low vulnerability class (score 1-2) occupies only 5,202.36 hectares or about 2.1% of the total area. Validation of the vulnerability map using 779 firespot points (2019-2024 period) obtained from the BPBD of Ogan Ilir District showed excellent results. A total of 653 fire spots (83.8%) were detected in the high vulnerability zone (score 3-4), indicating a high level of modelling accuracy. Only a small proportion of firespots were found in the low (5.6%) and medium (5.9%) vulnerability classes. This finding indicates that the vulnerability model developed closely matches the actual distribution of fires in the field.

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