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Mapping Of Spatial And Temporal Characteristics Of Land Fires For Disaster Mitigation In The New National Capital Location

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Abstract— *Fires occur every year and will be a serious problem if they occur at the location of the new capital city in East Kalimantan Province. Fire distribution can be known using remote sensing technology. Seeing this, it is very important to conduct a study entitled " Mapping of Spatial and Temporal Characteristics of Land Fires for Disaster Mitigation in the New National Capital Location". The purpose of the study was to analyze the results of Mapping of Spatial and Temporal Characteristics of Land Fires for Disaster Mitigation in the future. The quantitative descriptive research method. The data used are primary data (mitigation), secondary (hotspots from SNPP-VIIRS Imagery), while the analysis techniques are spatial, statistical and descriptive. The results of the study show that the spatial and temporal characteristics of fires in each region vary in terms of the number of hotspots. The result of mitigation is high (Good), meaning that if a disaster occurs, the number of casualties and property can be minimized. The findings of the study in the form of mapping results can be used as an early warning system and a basis for determining fire disaster management policies.*

Keywords— *Characteristics, Disaster Mitigation, Land Fires, Mapping, Temporal*

I. INTRODUCTION

The National Capital (IKN) will be moved from Jakarta to East Kalimantan in 2019 [1;2;3;4]. Jakarta, as Indonesia's capital and economic hub, often faces flooding during the rainy season due to poor land and water management [5]. The relocation of the IKN has several negative impacts so special attention is needed to minimize these negative impacts [6]. The relocation was carried out after considering several factors including equal distribution of development, overcoming problems in Jakarta, and realizing better governance [7;8]. The relocation of the IKN is expected to reduce the burden on Jakarta, encourage economic growth in eastern Indonesia, and create new jobs [9;10;11]. The relocation of the nation's capital will form new urban communications in society, However, this also poses some daunting challenges, most of which are in the social aspects of human life such as air pollution and disaster [12].

The selection of the location in East Kalimantan as the location of the IKN was partly due to considering the disaster aspect [13;14]. Disasters in East Kalimantan are seen as having a lower risk of disaster when compared to other areas, although it does not rule out the potential for disaster. One of the potential disasters in East Kalimantan as the location of the IKN is fire [15;16] (see Table 1). The potential for fires at the IKN location can be seen from the number of hotspots recorded from SNPP-VIIRS satellite imagery. The number of hotspots in Kalimantan Province varies in each district/city with different levels of confidence [4;17] The highest number of hotspots was found in the core location of the IKN, namely Kutai Kartanegara Regency (48635). The high number of hotspots in each district/city in East Kalimantan Province can be an indicator of fires so that the characteristics of land fires are very important to know for disaster mitigation. The characteristics of land fires can be known through mapping.

Mapping of land fire characteristics is carried out spatially and temporally [18;19;20]. Spatial analysis in this study is an analysis related to the distribution of hotspots using SNPP VIIRS satellite imagery. A high number of hotspots with high accuracy has a high potential for fire occurrences [21;22]. Meanwhile, temporal analysis can be interpreted as a frequency of re-recording of hotspot data based on a predetermined period of time, namely from 2000-2025. So that various trends of fire incident periods are obtained based on the number of hotspots recorded within a period of 25 years with high, medium and low confidence levels.Fire disasters tend to occur every year and have the potential to increase [23;24]. If this is left unchecked, it will be very dangerous if it occurs at the IKN location, so it needs serious attention from the government. Based on this, it is very important to conduct a study entitled "Mapping of Spatial and Temporal Characteristics of Land Fires for Disaster Mitigation in the New National Capital Location". The purpose of this study is to analyze the results of the Mapping of Spatial and Temporal Characteristics of Land Fires for Future Disaster Mitigation at the IKN location. The study was conducted in order to assist in the study of environmental change detection over time [25], to support the future development of the IKN.

TABLE 1. NUMBER OF HOTSPOTS FROM SNPP-VIIRS IMAGE RECORDING RESULTS IN EAST KALIMANTAN

No.	District/City	Amount
1	Paser	28204
2	Kutai Kartanegara	48635
3	Berau	26065
4	Kutai Barat	22968
5	Kutai Timur	43403
6	Penajam Paser Utara	4737
7	Mahakam Ulu	5765
8	Kota Balikpapan	863
9	Kota Samarinda	805
10	Kota Bontang	3443
	Total	184888

Source: https://firms.modaps.eosdis.nasa.gov/map/#d:24hrs;@0.0,0.0,3.0z

This spatial and temporal mapping has research findings that are expected to provide references that can explain the characteristics of land fires, including the frequency of fires, the number of hotspots that have high potential to become fire points each year and their mitigation. This is the reason that fire mitigation is something that must be done correctly, quickly and in a planned manner in order to minimize the number of casualties and property. Recommendations for mitigation efforts should take lessons and the history of fires that occur almost every year, so that the incident does not happen again so that it can minimize the negative impacts that may occur.

II. MATERIALS AND METHODES

A. Research Approach

The study used quantitative and descriptive methods [26;27]. The quantitative descriptive method is a research method that describes the characteristics of a variable numerically (with numbers) [28;29;30]. This study does not aim to test a particular hypothesis, but rather to provide an overview or summary of the data collected. The data collected in this method is usually quantitative data, which can be measured or calculated using numbers, such as fire characteristics seen from the frequency of hotspots, the number of hotspots can be classified as high, medium, low as well as for the level of accuracy at the IKN location and disaster mitigation.

B. Research Time and Location

The study was conducted in 2024 on mapping the spatial and temporal characteristics of land fires for disaster mitigation. The study was conducted at the location of the national capital (IKN) in East Kalimantan Province. East Kalimantan Province consists of 10 districts/cities (see Figure 1).

C. Data Collection Method

Data collection uses primary and secondary data [31,32,33]. Secondary data includes fire frequency, and the number of hotspots to determine the spatial and temporal characteristics of fires. Hotspot data was obtained from the results of SNPP-VIIR satellite imagery recording from 2000-2025 online (https://firms.modaps.eosdis.nasa.gov/map/#d:24hrs;@0.0,0.0,3.0z). While primary data is land fire mitigation (see Table 2). Primary data was obtained through the results of FGD (Focus Group Discussion) attended by related agencies, officials and community leaders.

D. Data Analysis Method

Data analysis was conducted after collecting primary and secondary data. The analysis process involves several stages, namely spatial, temporal, statistical and descriptive analysis. Spatial analysis to analyze the frequency of fires, and the number of hotspots, namely to determine the spatial and temporal characteristics of fires from 2000-2025. Statistical analysis to determine disaster mitigation, both structural and non-structural mitigation. While descriptive analysis to analyze the results of spatial, temporal and statistical analysis.

TABLE 2. SECONDARY DATA AND PRIMARY DATA

No.	Data Type	Data Source
1.	a. Frequency of Fires b. Number of Hotspots	Secondary
2.	a. Structural Mitigation b. Non-Structural Mitigation	Primary

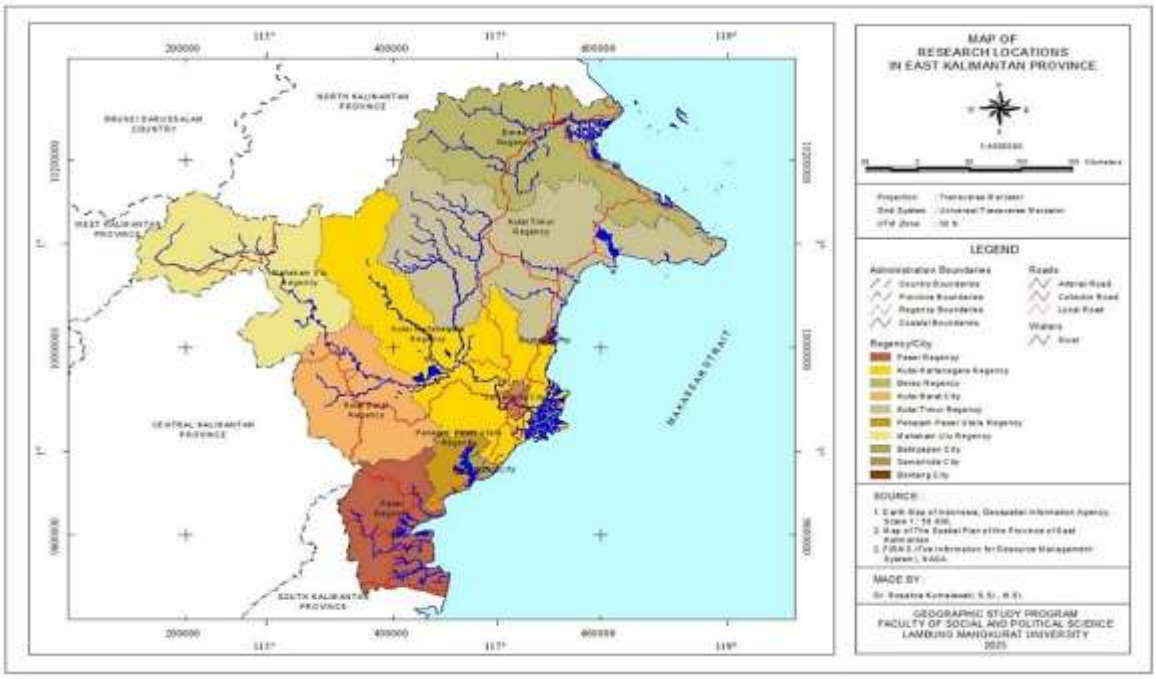

Fig. 1 Map of Research Locations in East Kalimantan Province

III. RESULT AND DISCUSSION

A. Characteristics of Land Fires

The potential for land fires is very important to know, especially at the IKN location. The potential for land fires can be seen from its characteristics through the number of hotspots based on the level of confidence and the number of each month. The characteristics of land fires at the IKN location seen from the level of confidence and the number of each month are:

1) Number of Hotspots based on Confidence Level: The hotspot confidence level is information that shows how likely it is that the hotspots detected by the satellite are actually forest and land fires in the field [34; 35;36] Hotspots are indicators of forest and land fires, not the number of fires themselves [37;38].

This confidence level helps in interpreting hotspot data and ensuring that appropriate fire prevention or mitigation measures can be taken (see Table 3 dan Figure 2). Appropriate mitigation can minimize greater negative impacts.

TABLE 3. NUMBER OF HOTSPOTS BASED ON THE LEVEL OF CONFIDENCE IN THE IKN LOCATION

No.	District/City	Confidence		
		Low	Nominal	High
1	Paser	1434	26082	688
2	Kutai Kartanegara	1975	45408	1252
3	Berau	1083	24370	612
4	Kutai Barat	1108	21230	630
5	Kutai Timur	1422	41144	837
6	Penajam Paser Utara	205	4408	124
7	Mahakam Ulu	234	5320	211
8	Kota Balikpapan	11	844	8
9	Kota Samarinda	23	779	3
10	Kota Bontang	49	3367	27
	Total	7544	172952	4392

Source: https://firms.modaps.eosdis.nasa.gov/map/#d:24hrs;@0.0,0.0,3.0z

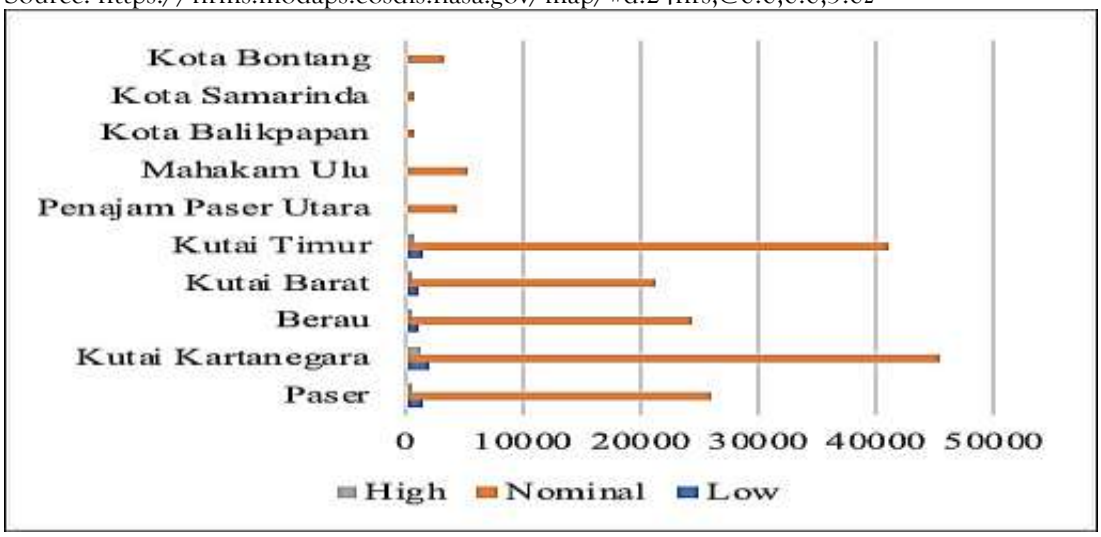

Fig. 2 Number of Hotspots based on the Level of Confidence in the IKN Location

No	District/ City	Month											
		January	February	March	April	May	June	July	August	September	October	November	December
1	Paser	335	290	233	268	422	422	693	1715	8409	13569	1459	389
2	Kutai Kartanegara	2026	2592	2140	1775	1220	1113	1929	4863	13050	14270	2558	1099
3	Berau	136	307	666	595	407	661	1483	6825	9695	4588	485	217

No	District/ City	Month											
		January	February	March	April	May	June	July	August	September	October	November	December
4	Kutai Barat	188	204	165	268	183	272	580	2226	8322	9308	1084	168
5	Kutai Timur	2007	2777	3148	2469	1569	1198	1771	5706	10005	8275	2827	1651
6	Penajam Paser Utara	91	43	38	46	31	30	55	155	837	3072	285	54
7	Mahakam Ulu	10	23	6	15	9	12	184	1996	2723	716	65	6
8	Kota Balikpapan	48	34	19	61	61	32	39	96	118	233	70	52
9	Kota Samarinda	89	64	50	23	24	35	38	62	137	181	73	29
10	Kota Bontang	192	289	333	269	300	227	233	317	380	405	321	177
	Total	5122	6623	6798	5789	4226	4002	7005	23961	53676	54617	9227	3842

2) Number of Hotspots based on Month: The characteristics of land fires can also be seen from the number of hotspots each month in each Regency/city at the IKN location. The number of hotspots each month from January to December is quite varied and relatively increases each month. The most significant increase in the number of hotspots occurred starting in August, September and October (see Table 4 and Figure 3). The highest number of hotspots occurs in September and October due to the ongoing dry season in the region. In these months, rainfall tends to be low, so that soil moisture and vegetation decrease, triggering an increased risk of forest and land fires. This causes September and October to often be the peak of the dry season in many areas, including Kalimantan. The increase in the number of hotspots will also be followed by an increase in the frequency of land fires so that the community must be more alert and prepared if a fire disaster occurs.

TABLE 4. NUMBER OF HOTSPOTS EACH MONTH AT IKN LOCATIONS
Source: https://firms.modaps.eosdis.nasa.gov/map/#d:24hrs;@0.0,0.0,3.0z

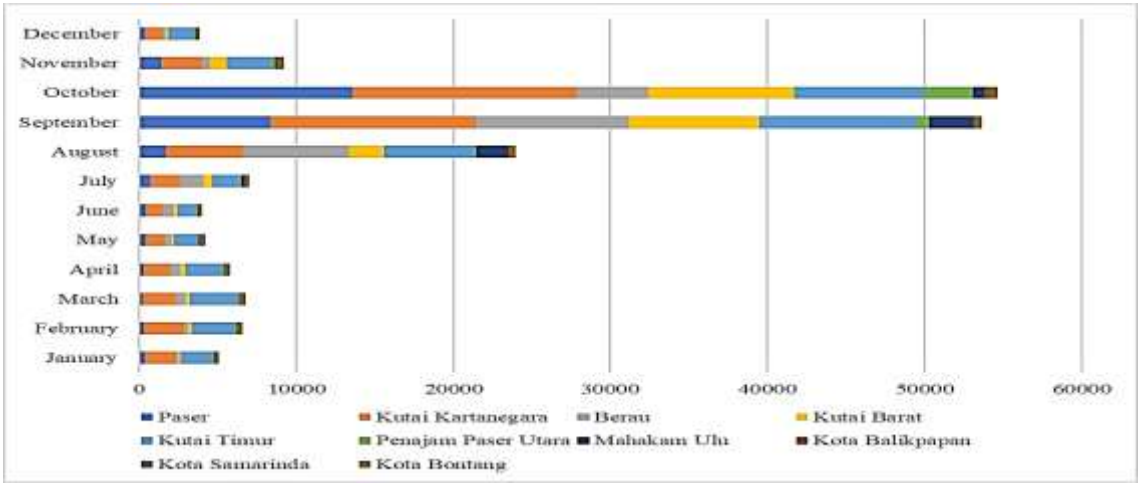

Fig. 3 Number of Hotspots Each Month at IKN Locations

B. Disaster Mitigation

In recent years, the frequency and intensity of disasters have increased, driven by climate change, urbanization, and environmental degradation [39]. Mitigation is any effort made to reduce or minimize the negative impacts caused by a disaster, both natural disasters and non-natural disasters [40,41]. Mitigation aims to reduce the risks, losses, and damage caused by disasters, so that the impact of the disaster can be minimized [42,43]. If disasters are allowed to continue, they can trigger climate change. Negative impacts of climate change include rising temperatures, water scarcity, and decreased rainfall, which dramatically impact the water quality of swamps and rivers, as well as the drying up of wells, springs, and irrigation channels [44]. Decreased rainfall can trigger water scarcity, drought, and fires. Mitigation is very important because as we know the wider the area of fire and the increasing frequency of fires, the greater the negative impact [45]. Disaster mitigation in this study is structural and non-structural mitigation (see Table 5). And also, Climate change and increasing urbanization have contributed greatly to the potential future disasters that could occur in a newly formed city [46].

TABLE 5. LAND FIRE MITIGATION AT IKN LOCATIONS

No.	Mitigation		Answer	Total	Percentage (%)
1	Structural	Fire Car	Yes	92	92
			No	8	8
		Hydrant	Yes	81	81
			No	19	19
		Fire Station	Yes	88	88
			No	12	12
		Road Infrastructure	Yes	85	85
			No	15	15
		Nozzle/Hose	Yes	89	89
			No	11	11
		Alkon/Water Suction Machine	Yes	87	87
			No	13	13
		Fire Suit	Yes	90	90
			No	10	10
		Fire Helmet	Yes	90	90
			No	10	10
		HT Communication Tools	Yes	94	94
			No	6	6
		APAR (Light Fire Extinguisher)	Yes	84	84
			No	16	16
		Head Flashlight	Yes	87	87
			No	13	13
		Relocation	Yes	95	95
			No	5	5
2	Non-Structural	Disaster Information	Yes	89	89
			No	11	11
		Socialization	Yes	85	85
			No	15	15
		Training	Yes	86	86
			No	14	14

No.	Mitigation		Answer	Total	Percentage (%)
		Counseling	Yes	86	86
			No	14	14

Source: Primary Data Processing and Analysis, 2025

Structural mitigation is a mitigation that focuses on facilities and infrastructure to support the process of preventing disasters and to reduce the risk of land fires [47]. Structural mitigation in this study involves physical development or infrastructure. While non-structural mitigation is an effort to reduce disaster risks that do not involve physical development or infrastructure. The focus is on policies, regulations, spatial planning, training, socialization, and increasing public awareness.

Disaster mitigation in the research area based on interview results is quite high. Most people stated that land fire mitigation is very effective in minimizing the negative impacts of fires from getting bigger, both structural and non-structural mitigation (>80%) and only 20% stated no (see Table 5). Mitigation is said to be very effective because more people answered "Yes" where the structural mitigation that answered "Yes" the most is relocation. The relocation policy is considered the most effective form of disaster mitigation. So that with relocation, it can increase the community's ability to deal with potential disasters in the future.

C. Mapping of Spatial and Temporal Characteristics of Land Fires for Disaster Mitigation

Spatial temporal mapping is mapping that combines location information (spatial) with time information (temporal) to track changes or trends in an area over time [48; 49; 50; 51; 52]. This information can be used for various purposes, such as analyzing the characteristics of natural disasters in this case land fires. Spatial temporal mapping of land fire characteristics at the IKN location is seen from the number of hotspots each month and based on the level of confidence. The results of mapping the characteristics of land fires at the IKN location are quite varied, some are high, medium and low (see Table 6 and Figure 4). The mapping results can be an important basis for developing and implementing an early warning system. This mapping helps identify areas that have high characteristics of fire disasters so that they can be used as a reference to determine the right early warning strategy. High fire characteristics mean that they have the potential for greater damage, significant environmental impacts, and causes that are often related to human activities. The location of the IKN that has high fire characteristics is located in Kutai Kartanegara Regency which is the core location of the IKN development so that it requires quite serious attention. Mitigation of land fires in areas that have high fire characteristics needs to be improved and maintained so that the negative impacts of fires can be minimized and do not increase.

TABLE 6. CHARACTERISTICS OF LAND FIRES AT THE IKN LOCATION

No	District/City	Fire Characteristics
1	Paser	Moderate
2	Kutai Kartanegara	High
3	Berau	Moderate
4	Kutai Barat	Moderate
5	Kutai Timur	High
6	Penajam Paser Utara	Low
7	Mahakam Ulu	Low
8	Kota Balikpapan	Low
9	Kota Samarinda	Low
10	Kota Bontang	Low

Source: https://firms.modaps.eosdis.nasa.gov/map/#d:24hrs;@0.0,0.0,3.0z

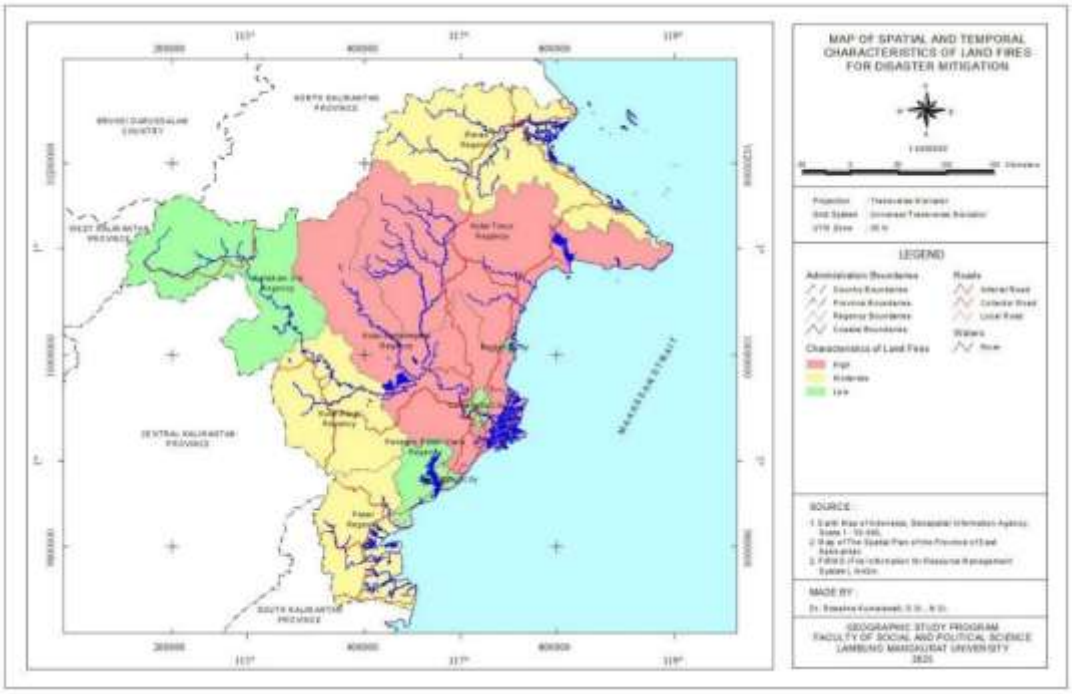

Fig. 4 Mapping of Spatial and Temporal Characteristics of Land Fires for Disaster Mitigation

Mitigation is very important because it helps reduce the risk and impact of disasters, both for individuals and society as a whole. Mitigation includes efforts to prevent disasters, reduce material losses, increase public awareness, and prepare for effective disaster responses. Seeing this, mitigation is an important thing that must get attention from the government.

IV. CONCLUSIONS

The potential for land fires can be seen from its characteristics through the number of hotspots based on the level of confidence and the number of each month,

Most people stated that land fire mitigation is very effective in minimizing the negative impacts of fires from getting bigger, both structural and non-structural mitigation (>80%) and only 20% stated no,

The location of the IKN that has high fire characteristics is located in Kutai Kartanegara Regency which is the core location of the IKN development so that it requires quite serious attention.

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