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| Research Article |

Spatial Analysis of Land Use and Land Utilization Based on Suitability Spatial Planning on Food Estate Planning Site in Kapuas Regency, Central Kalimantan

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Abstract: The limited space on land increases the importance of spatial planning that is transparent, accountable, and effective, which involves multi-stakeholders in its conception. Such planning is intended to create a spatial arrangement that supports security, productivity, and sustainability. In an attempt to secure food supply in the future, the government of Indonesia initiated a Food Estate program in 2020. This study analyzes land use and land utilization in regions planned for a food estate project in Kapuas Regency, Central Kalimantan, and evaluates their suitability with the designated spatial planning. The method used land surveying and spatial analysis to answer the research objective. The result explained that 85,492.58 Ha (49.20%) of land use is suitable for spatial planning. The area of 88,786.43 Ha (51.09%) of land utilization is suitable for its spatial planning. The survey was carried out at the early stage of spatial planning implementation throughout spatial development is ongoing. Development results that are in accordance with the spatial planning have not yet been seen, this happens because the determination of the spatial planning and the spatial suitability analysis are too close together. The food estate program has not been included in the Kapuas Regency spatial planning. The results of the research concluded that there was a large mismatch gap, it was necessary to revise the spatial planning by including the food estate program in the regional spatial planning.

Keywords: Land use, land utilization, spatial planning, suitability, food estate

INTRODUCTION

Land use planning and spatial planning are distinct yet related concepts. Historically, spatial planning has its roots in land use planning and transportation planning (Baja, 2012). Land use planning involves the organization of land use within a natural space, either naturally or through deliberate planning. According to the Food and Agriculture Organization (FAO), land use planning is defined as the systematic assessment of land and water potential, alternatives for land use, and economic and social conditions to select and adopt the best land use option (FAO, 1993). The primary goal is to choose and implement land uses that best meet the needs of the people while preserving resources for the future.

Law No. 26 Year 2007 defines space as the area on and below the sea and earth, including the airspace, inhabited by humans and other living organisms for their activities (Iskandar et al., 2016). Spatial planning deals with the spatial arrangement influencing the distribution of human activities in this space, manifesting in spatial structure and spatial patterns (Mokodongan et al., 2019). Understanding the latest research on land use change modeling and prediction is crucial for fundamental knowledge in spatial planning and regional development policies (Arimjaya & Dimyati, 2022; Arimjaya & Wibowo, 2021). Spatial structure refers to the arrangement of human settlements and supporting facilities and infrastructures, primarily for socio-economic activities within a given area.

Spatial planning is integral to the spatial arrangement process, encompassing planning, utilizing, and controlling space (Mungkasa, 2020). Various definitions of spatial planning include the following. The Ministry of Agriculture and Land Affairs (2001) defines spatial planning as the allocation of various activities, land uses, and buildings interrelated in terms of distance, proximity, and spatial aspects,

influenced by environmental, infrastructure, political, and socio-economic factors. Cullingworth et al. (2006) describe spatial planning as coordinating or integrating the spatial dimensions of sector policies through area-based strategies, enhancing coordination between various sectors and levels of government. According to Law No. 26 Year 2007, spatial planning is a process for determining spatial structure and patterns, including the preparation and determination of spatial plans.

To streamline spatial planning implementation, zoning regulations serve as operational tools. To implement harmonious development and anticipate its effects, the government has established zoning regulations (Lubis et al., 2013). Human activities form functional hierarchical relationships, shaping activity patterns. Spatial patterns are perceived as the distribution of land uses and human activities in space, categorized into conservation/protection functions and cultivation functions (Mokodongan et al., 2019). The growing human population, juxtaposed with limited space, demands accountable and transparent spatial planning involving multi-stakeholders to create a safe, productive, appropriate, and sustainable environment (Iskandar et al., 2016). Competing demands for space, such as housing, facilities, food, and goods production, necessitate careful spatial policy considerations to ensure adequate allocation and maximum yield/benefit (Firman & Soegijoko, 2005).

To address the increasing food demand due to population growth and anticipate climate change, the Government of Indonesia initiated a food estate program in several areas (FAO, 2020). This program aims to boost domestic food production. Previous presidential administrations have undertaken similar projects, such as the Mega Rice Project during the Soeharto era, the Merauke Integrated Rice Estate during the SBY era, and the Merauke Special Economic Zone during Jokowi's first tenure (Lasminingrat & Efriza, 2020). In the current administration, food estate development in Central Kalimantan involves intensifying existing agricultural land by increasing the cropping index (Mukti, 2020). Decades ago, this area was designated for the "one million hectares peatland" project for horticulture development (Mawardi, 2007). The expectation is to redesign and reestablish these old locations under the food estate program, reserving them as a national center for future food production.

Land and spatial thematic mapping visualize land use and land utilization availability in an area at an appropriate scale. Parcel-based maps provide information on land use and utilization, enabling authorities to verify that current conditions align with designated spatial planning. According to Government Regulation No. 16 Year 2004 on Land Use Arrangement, land use is the physical cover on the land surface formed naturally or artificially. Land utilization involves activities that add value without altering the physical appearance of land use. These terms are categorized differently for mapping purposes. This study aims to explain land use and utilization in the planned food estate area in Kapuas Regency, Central Kalimantan, and evaluate their suitability with the designated spatial planning.

METHOD

Study Area

This study was conducted in the planned area for the food estate program in Kapuas Regency, Central Kalimantan Province (Figure 1). The program encompasses 12 subdistricts: Basarang, Bataguh, Dadahup, Kapuas Barat, Kapuas Hilir, Kapuas Kuala, Kapuas Murung, Kapuas Timur, Mantangai, Pulau Petak, Selat, and Tamban Catur.

The technique used in this research is a field survey process carried out by census based on land parcels, focusing on the themes of land use and land utilization. The equipment used includes a SIPETIK mobile-based application. The final product of this field survey will be a Land and Spatial Thematic Map. The thematic land and spatial parcel-based survey aimed to identify land use and land utilization in the study area and collect all related information. The survey was conducted in 2020 and resulted in two types of maps: a land-use map and a land-utilization map.

Spatial data analysis was performed using a map overlay process to answer the research questions through a mapping application. The process was as follows: clip processing was conducted on the spatial planning map of Kapuas Regency for the respective area of interest (AOI). The conformity matrix is based on the Regulation of the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency No. 17 of 2017 concerning Spatial Planning Audit Guidelines. The map overlay and suitability analysis process employed a gradual inspection approach, analyzing the overlap between the existing land-use map and the existing land-utilization map with the spatial planning map. The results of this analysis produced a suitability map of land use with spatial planning and a suitability map of land utilization with spatial planning. This workflow is depicted in Figure 2.

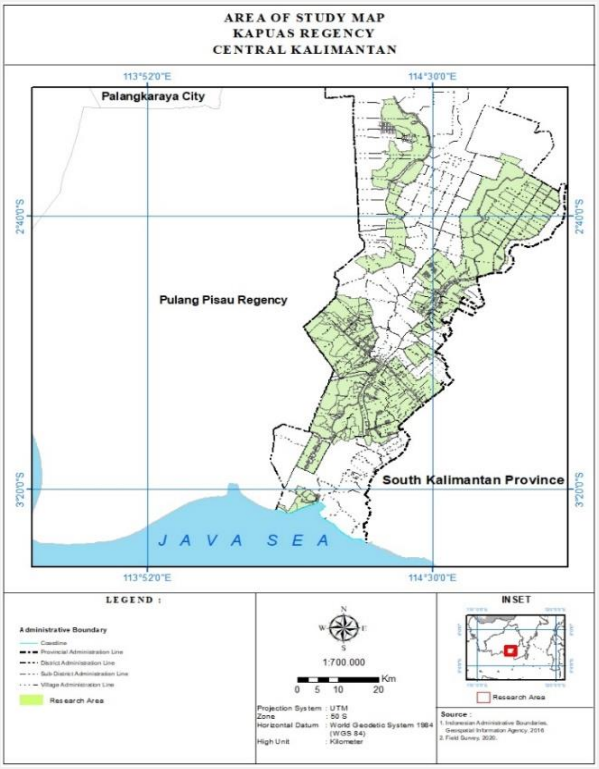

Figure 1. Area of study (map resulting from data processing).

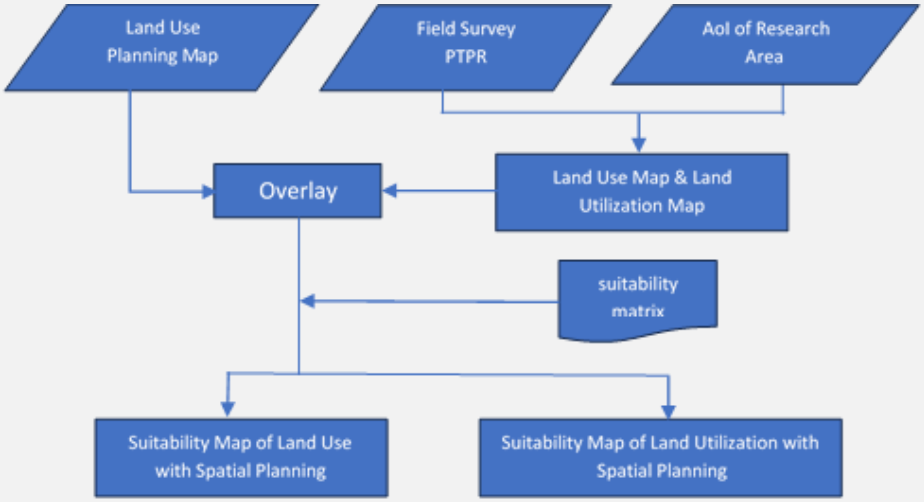

Figure 2. The workflow of the study.

Data Processing and Analysis

The method used to collect and produce the latest land use and land utilization data involved field surveys. These surveys were carried out using working maps of satellite imagery at the research location and a mobile app called Sipetik. The field survey process was conducted by census based on land parcels depicted on satellite imagery working maps. The resulting plot maps included information on land possession, land tenure, land use, land utilization, and other thematic information.

Data from the field survey were processed using a mapping application, with data attributes filled in according to the themes of land use and land utilization. The results of this data processing produced land use and land utilization maps in SHP file format, complete with data attributes and classifications. The study classified land use and land utilization types following the Technical Guideline

on Thematic Land and Spatial Mapping (2020) published by the Directorate of Survey and Thematic Mapping, Ministry of Agrarian and Spatial Planning/National Land Agency (ATR/BPN) (2020). This guideline is a mandatory reference in regular parcel mapping surveys within the agency.

Nineteen different types of land use were classified according to the guidelines, including public facilities, forest/woodland, industry, streets/roads, gardens/farmyards, grass fields, housing/dwellings, aquatic environments, plantations, agriculture, animal farms, irrigation canals, paddy fields, shrub fields, rivers, service lands, bare lands, crop fields, and water bodies. These types and their definitions were also contained in the Norm, Standard, Procedure, and Criteria (NSPK) of Thematic Survey and Mapping 2012, which classifies land use differently for various map scales. For this study, the classification for a 1:50,000 scale was chosen based on survey findings and the required level of detail.

Ten classes of land utilization were used from the guideline, including road/street utilization, economic utilization, social/public facility utilization, trade activities utilization, agricultural production utilization, non-economic utilization, housing utilization, irrigation canal utilization, river utilization, and no utilization. The guideline provides definitions and delimitations for every type applied in the mapping, with the classes chosen based on the required level of detail.

Spatial planning data were obtained from the Local Government Regulation of Kapuas Regency No. 5 of 2019 on Spatial Planning for Kapuas Regency and supporting data from the Directorate General of Spatial Planning, Ministry of Agrarian and Spatial Planning/National Land Agency. The data were processed using the same application to obtain a spatial planning map. The spatial pattern classification was based on the Minister of Agrarian and Spatial Planning/National Land Agency Regulation No. 14 of 2021, which provides guidelines for database and mapping spatial planning and details of spatial planning at the provincial, regency/city level, with information designed for a mapping scale of 1:50,000.

Table 1. Suitability Matrix for Land Use to Spatial Planning

LAND USE	River	Protected Forest	Horticulture	Limited Production Forest	Industry	Aquaculture	Plantation	Rural Settlement	Urban Settlement	Crops	Coastal Banks	River Bank
Public Facility	U	U	U	U	U	U	U	S	S	U	U	U
Forest	U	S	U	S	U	U	U	U	U	U	S	S
Industry	U	U	U	U	S	U	U	U	U	U	U	U
Road/Street	U	U	S	U	S	S	S	S	S	S	U	U
Garden/Farmyard	U	U	S	U	U	S	S	U	U	S	U	U
Grassland	U	U	U	U	U	U	U	U	U	U	U	U
Housing/Dwelling	U	U	U	U	U	U	U	S	S	U	U	U
Aquatic Environment	U	U	U	U	U	S	U	U	U	U	U	U
Plantation	U	U	S	U	U	U	S	U	U	S	U	U
Agriculture	U	U	S	U	U	U	S	U	U	S	U	U
Animal Farm	U	U	S	U	U	U	S	S	U	S	U	U
Irrigation Canal	S	U	S	U	U	S	S	U	U	S	U	U
Paddy Field	U	U	S	U	U	U	U	U	U	S	U	U
Shrub	U	S	U	S	U	U	U	U	U	U	S	S
River	S	U	U	U	U	S	U	U	U	U	U	U
Service Land	U	U	U	U	S	U	U	S	S	U	U	U
Bare Land	U	U	S	U	S	U	S	S	S	S	U	U
Crops Field	U	U	S	U	U	U	S	U	U	S	U	U
Waterbody	S	U	U	U	U	S	U	U	U	U	U	U

Source: Data processing and analysis (U: Unsuitable; S: Suitable)

Table 2. Suitability Matrix for Land Utilization to Spatial Planning

LAND UTILIZATION	River	Protected Forest	Horticulture	Limited Production Forest	Industry	Aquaculture	Plantation	Rural Settlement	Urban Settlement	Crops	Coastal Banks	River Bank
Road/Street	U	U	S	U	S	S	S	S	S	S	U	U
Economy Utilization	U	U	S	U	S	S	S	U	U	S	U	U
Public Facility Utilization	U	U	S	U	S	S	U	S	S	U	U	U
Trade Activities Utilization	U	U	U	U	S	S	S	U	U	S	U	U
Agricultural Production Utilization	U	U	S	U	U	U	S	U	U	S	U	U
Non-Economy Utilization	U	U	U	U	U	U	U	U	U	U	S	S
Housing/Dwelling Utilization	U	U	U	U	U	U	U	S	S	U	U	U
Irrigation Canal	S	U	U	U	U	U	U	U	U	U	U	S
River	S	U	U	U	U	S	U	U	U	U	U	S
No Utilization	U	S	U	S	U	U	U	U	U	U	S	S

Source: Data processing and analysis (U: Unsuitable; S: Suitable)

The resulting land-use and land-utilization maps were overlaid separately onto the spatial pattern map using the intersect method. Suitability analysis used a matrix correlating the function of spatial patterns in spatial planning with land use and utilization data separately (Tables 1 & 2). The suitability matrix is based on the Minister of Agrarian and Spatial Planning/National Land Agency Regulation No. 17 of 2017, applied in the intersect process to produce a suitability map of land use and land utilization to spatial planning.

Data processing methods and analysis of the level of suitability of land use and land utilization were calculated using a spatial data overlay analysis process between existing land use and land utilization maps with spatial planning maps. The first step was to equalize the scale of the existing land use and land utilization map with the spatial planning map. If it was not possible to equate the map scale, the next step was to group land use and land utilization at a more general map scale.

Next, the existing land use and land utilization maps were overlaid with the spatial planning map. This overlay process highlighted similarities and differences between land use and land utilization with spatial planning. The subsequent step involved checking and analyzing zoning regulations to determine whether land use was permitted or not in the relevant zones. This analysis provided the basis for creating a suitability matrix, despite not conducting a detailed zoning regulation analysis due to the close timing between the spatial planning determination and the land use and utilization surveys. The suitability matrix (Tables 1 & 2) shows the relationships between land use, land utilization, and spatial planning, forming the foundation for the suitability map generation.

RESULTS

Existing Land Use

The survey produced a comprehensive land-use map for the food estate planning area in Kapuas Regency, covering 12 villages (Figure 3). The results in Table 3 indicate a diverse range of land use types with varying degrees of coverage. Garden/farmyard dominates the landscape, covering 42,732.84 hectares, which constitutes 24.59% of the total area. This high percentage reflects the significant agricultural activities in the region, emphasizing the local reliance on garden and farmyard-based farming practices for food production and livelihood. Woodland and forest land uses represent the second largest category, occupying 29,988.89 hectares or 17.26% of the area. This indicates a substantial presence of natural or semi-natural forest areas, which are crucial for biodiversity conservation, climate regulation, and providing ecosystem services.

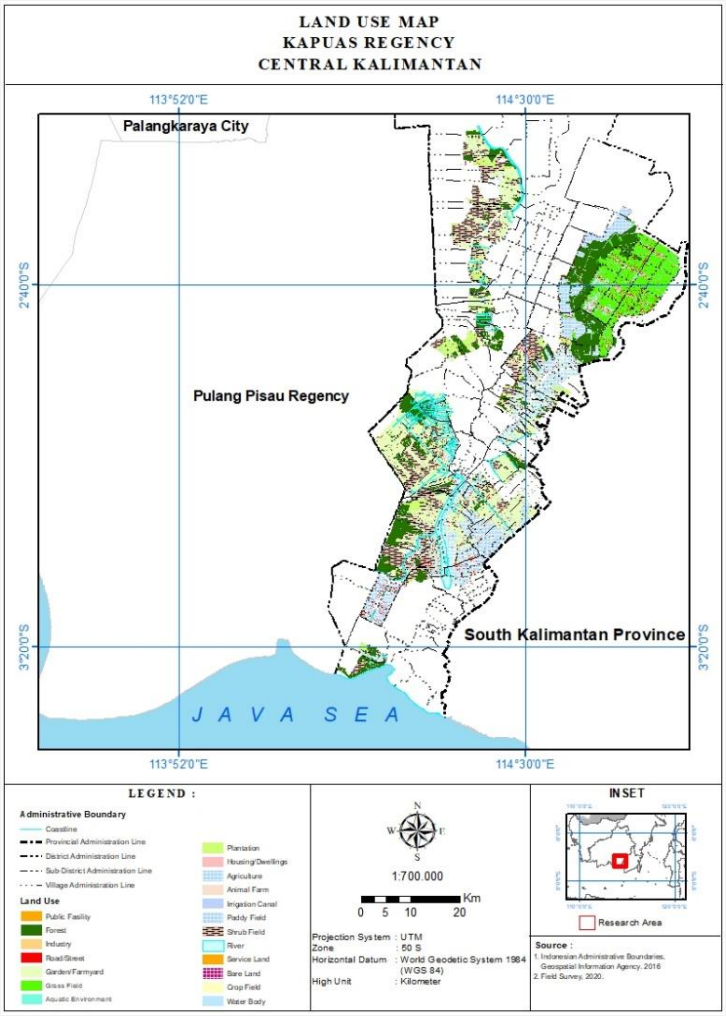

Figure 3. Land-use map in the food estate planning area in Kapuas Regency.

Table 3. Summary of land-use area and its percentage from 12 villages in Kapuas Regency

Land use Type	Area (Ha)	%
Garden/Farmyard	42,732.84	24.59
Woodland/forest	29,988.89	17.26
Shrub	27,743.70	15.97
Paddy field	27,098.84	15.59
Grass field	19,061.72	10.97
Agriculture	8,243.13	4.74
Plantation	4,940.19	2.84
River	3,852.21	2.22
Street/road	2,411.63	1.39
Housing/dwelling	2,129.01	1.23
Waterbody	2,495.12	1.44
Irrigation canal	2,053.92	1.18
Crop field	349.16	0.20
Public facility	215.68	0.12
Aquatic environment	151.82	0.09
Bare land	124.48	0.07
Service land	85.41	0.05
Animal farm	78.83	0.05
Industry	14.73	0.01

Source: Data processing and analysis

Shrubland covers 27,743.70 hectares, accounting for 15.97% of the total area. Shrublands typically represent areas of secondary succession, degraded lands, or transitional zones between forested and open areas. Paddy fields make up 27,098.84 hectares or 15.59% of the area, underscoring the importance of rice cultivation in the region and reflecting its status as a staple food and a critical component of local agriculture. Grasslands cover 19,061.72 hectares, which is 10.97% of the total area. These areas are often used for grazing livestock, indicating the presence of pastoral activities and livestock farming.

General agricultural land, excluding specialized categories like paddy fields and plantations, covers 8,243.13 hectares (4.74%). This includes diverse crops and farming practices contributing to the region's agricultural productivity. Plantation areas cover 4,940.19 hectares, accounting for 2.84% of the total land use. Plantations typically involve monoculture crops such as oil palm or rubber, which are significant for commercial agriculture. River areas account for 3,852.21 hectares or 2.22% of the total area, vital for irrigation, transportation, and supporting aquatic ecosystems. Infrastructure such as streets and roads cover 2,411.63 hectares, which is 1.39% of the area, highlighting the extent of developed transportation networks within the region.

Residential areas cover 2,129.01 hectares, making up 1.23% of the total land use, reflecting the spatial distribution of human settlements within the region. Water bodies, including lakes and ponds, cover 2,495.12 hectares or 1.44%, essential for water supply, recreation, and supporting biodiversity. Irrigation canals cover 2,053.92 hectares, which is 1.18% of the total area, critical for supporting agricultural activities, particularly paddy fields. Crop fields cover 349.16 hectares, making up 0.20% of the land use, including various non-paddy crops. Public facilities occupy 215.68 hectares or 0.12% of the area, indicating spaces allocated for public services and infrastructure.

Aquatic environments, such as wetlands, cover 151.82 hectares or 0.09%, vital for maintaining hydrological balance and supporting aquatic life. Bare land, which includes areas with minimal vegetation or development, covers 124.48 hectares or 0.07%. Land designated for service activities covers 85.41 hectares, accounting for 0.05% of the area. Animal farms cover 78.83 hectares or 0.05%, indicating the presence of dedicated livestock farming areas. Industrial areas are the least extensive, covering 14.73 hectares or 0.01%, reflecting limited industrial activity within the area of interest (AOI).

These findings, illustrated in Figure 3 and summarized in Table 3, are critical for understanding the existing land use patterns and planning future land use to enhance food production, conserve natural resources, and ensure sustainable development in the region. The detailed land-use map and classification provide a valuable tool for policymakers, planners, and stakeholders involved in the food estate program, enabling them to make informed decisions regarding land allocation and management.

Current Land Utilization

The land utilization map produced for the food estate planning area in Kapuas Regency, depicted in Figure 4, reveals distinct patterns of land utilization across the region. Agricultural production utilization emerges as the dominant category, covering a substantial area of 75,993.15 hectares, which accounts for 43.73% of the total surveyed area. This highlights the area's primary focus on agricultural activities, emphasizing its role in food production within the region. Conversely, significant portions of land, totaling 74,075.09 hectares (42.63%), exhibit no current utilization, indicating areas that are either undeveloped or underutilized.

Economy utilization, covering 10,465.51 hectares (6.02%), represents areas where economic activities are concentrated, likely including commercial and industrial zones. This category underscores the region's economic diversity beyond agriculture, contributing to local employment and economic growth. The distribution of other utilization categories, such as non-economical utilization (2.53%), river utilization (2.22%), and irrigation canal utilization (1.18%), reflects the diverse functional roles of different land areas within the surveyed region.

Detailed statistics for each land utilization category across the surveyed villages are provided in Table 4, offering a comprehensive view of how land is currently utilized in Kapuas Regency. These findings are instrumental in guiding future land-use planning strategies, ensuring sustainable development that balances agricultural productivity, environmental conservation, and socio-economic needs within the region.

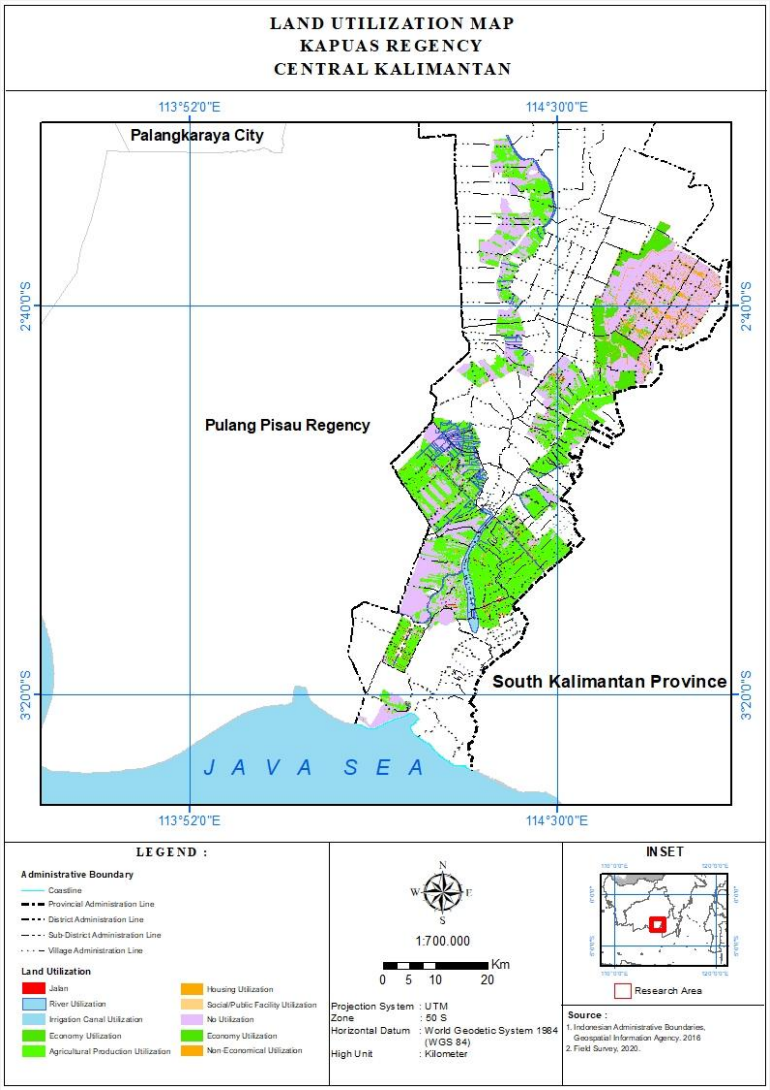

Figure 4. Land-utilization map in the food estate planning area in Kapuas Regency.

Table 4. Summary of Land Utilization in Food Estate Area in Kapuas Regency

Land utilization category	Area (Ha)	%
Agricultural production utilization	75,993.15	43.73
No utilization	74,075.09	42.63
Economy utilization	10,465.51	6.02
Non-economical utilization	4,400.09	2.53
River utilization	3,852.21	2.22
Irrigation canal utilization	2,053.92	1.18
Housing utilization	1,486.01	0.86
Road/street utilization	1,220.20	0.70
Social/public facility utilization	214.35	0.12
Trade activities utilization	10.78	0.01

Source: Data processing and analysis

Spatial Planning of Kapuas Regency

The spatial planning map for the food estate planning area in Kapuas Regency, depicted in Figure 5, illustrates the distribution of 12 distinct spatial patterns across the region's 12 villages. This map serves as a critical tool for guiding future development and land-use decisions within the area. The dominant spatial patterns identified include plantation, covering a significant area of 74,215.03 hectares (42.71%),

and crop field areas spanning 41,086.07 hectares (23.64%). These patterns underscore the region's agricultural focus and highlight areas designated for extensive cultivation and food production.

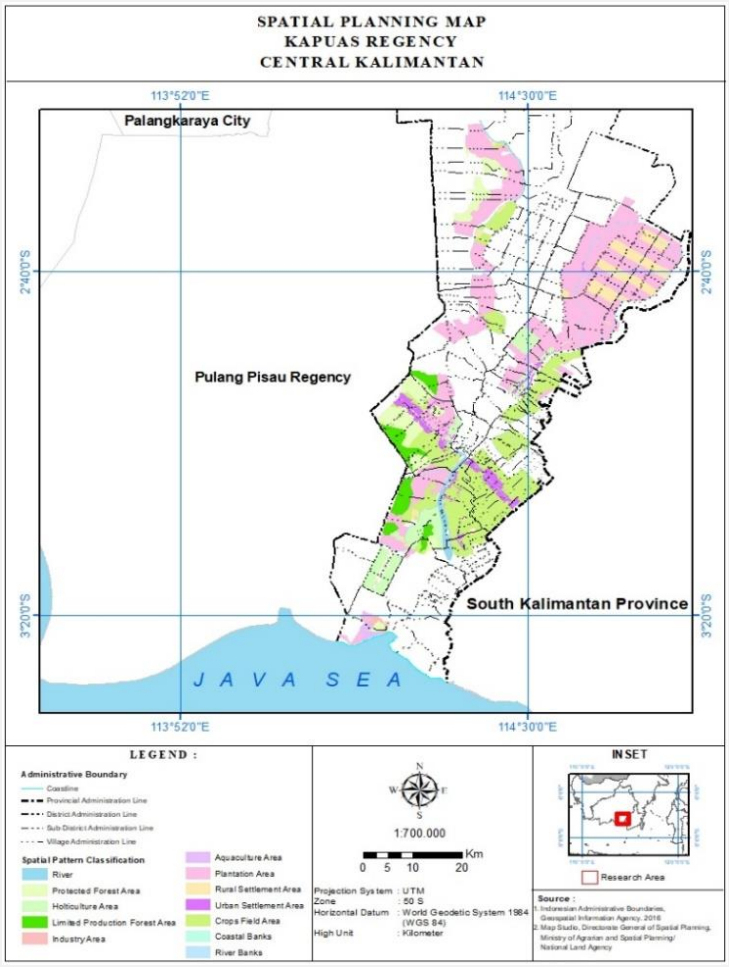

Figure 5. Spatial planning map in the food estate planning area in Kapuas Regency.

Table 5. Summary of spatial pattern distribution in spatial planning.

Spatial pattern classification	Village	Area (Ha)	%
Plantation	9	74,215.03	42.71
Crops field area	11	41,086.07	23.64
Protected forest area	7	12,865.70	7,40
Horticulture area	5	11,652.94	6,71
Rural settlement	12	11,401.72	6.56
Limited production forest	3	7,469.91	4,30
Urban settlement	11	6,475.98	3.73
River	12	4,166.46	2,40
Aquaculture area	3	982.78	0,57
Industry area	3	521.29	0.30
Coastal banks	2	9.89	0.01
River banks	12	2,923.73	1.68

Source: Data processing and analysis

Other prominent spatial patterns include protected forest areas (7.40%), horticulture areas (6.71%), and rural settlements (6.56%), each contributing uniquely to the region's landscape and socio-economic fabric. Urban settlements are also prevalent across most subdistricts, covering 6,475.98 hectares (3.73%), indicating areas of concentrated residential and commercial development. Rivers and

riverbanks are uniformly distributed throughout all subdistricts, serving as critical natural features within the landscape.

Table 5 provides a detailed summary of the distribution of spatial patterns across the 12 villages, offering insights into the specific areas allocated for each pattern within the region. These findings are instrumental in spatially organizing development initiatives, ensuring that future growth aligns with environmental conservation goals, community needs, and economic objectives. Detailed statistics by village further elucidate the localized distribution of spatial patterns, aiding stakeholders in making informed decisions regarding land-use planning and management strategies in Kapuas Regency.

Suitability of Land Use with the Spatial Planning

Based on the suitability matrix of land use with spatial patterns in Kapuas Regency's spatial planning, the study reveals that 85,492.58 hectares (49.20%) of the total area are deemed suitable for the designated land uses, while 88,278.73 hectares (50.80%) are considered unsuitable (Figure 6). This distribution underscores the complexities in aligning existing land use with planned spatial patterns across the region. Detailed analysis by subdistricts, as shown in Table 6, highlights varying degrees of suitability and unsuitability.

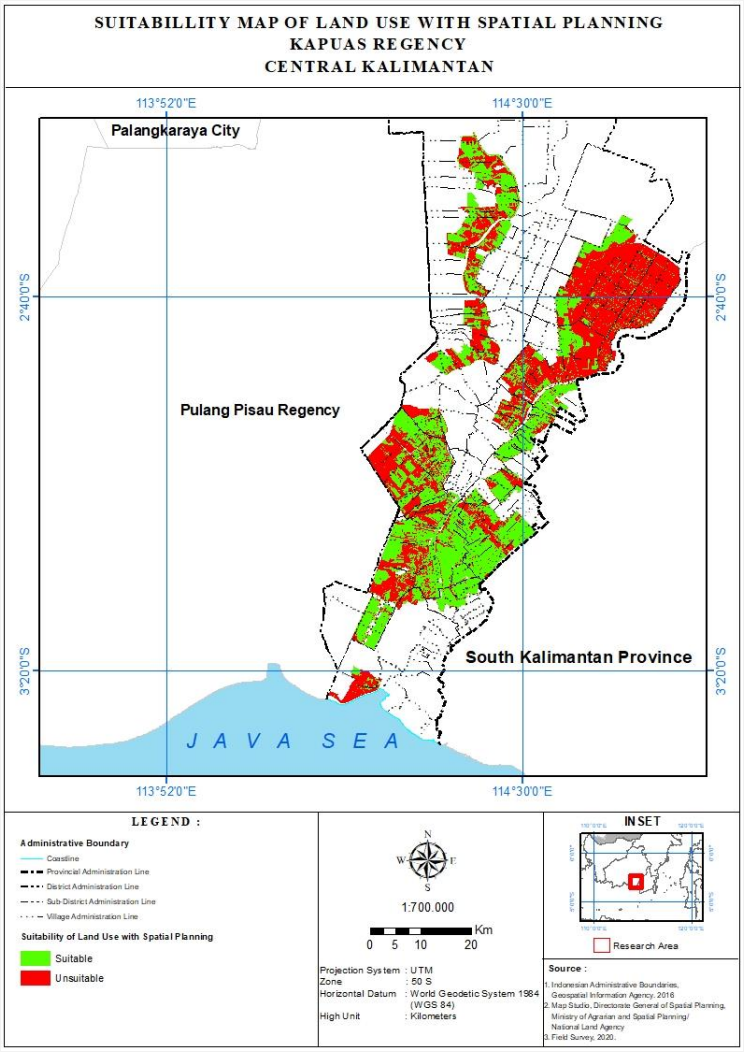

Figure 6. Suitability map of land use to spatial planning in the food estate planning area in Kapuas Regency.

The suitability map (Figure 6) illustrates spatially where agricultural development and other land uses can harmoniously integrate with the planned spatial patterns. Notably, areas such as Bataguh, Mantangai, and Dadahup exhibit relatively higher suitability percentages, ranging from 6.82% to

12.79%, indicating favorable conditions for implementing planned land uses. In contrast, areas like Kapuas Hilir and Selat show lower suitability percentages, reflecting challenges in aligning existing land uses with planned spatial patterns due to factors such as existing urban settlements or environmental constraints.

Table 6. Distribution of suitability of land use with spatial planning in the food estate area in Kapuas Regency

No	Village	Suitability of land use with spatial planning			
		Suitable (Ha)	Percentage (%)	Unsuitable (Ha)	Percentage (%)
1	Basarang	9,068.54	5.22	9,965.62	5.73
2	Bataguh	22,217.44	12.79	12,366.70	7.12
3	Dadahup	5,774.42	3.32	19,062.32	10.97
4	Kapuas Barat	6,945.96	4.00	6,047.54	3.48
5	Kapuas Hilir	3,193.61	1.84	1,190.59	0.69
6	Kapuas Kuala	271.91	0.16	714.47	0.41
7	Kapuas Murung	7,508.76	4.32	23,315.95	13.42
8	Kapuas Timur	9,550.20	5.50	2,930.57	1.69
9	Mantangai	11,848.91	6.82	9,507.43	5.47
10	Pulau Petak	5,136.07	2.96	2,588.89	1.49
11	Selat	767.64	0.44	286.08	0.16
12	Tamban Catur	3,209.11	1.85	302.58	0.17
	Total	85,492.58	49.20	88,278.73	50.80

Source: Data processing and analysis

A significant focus on agriculture, covering 66.35% of the total planned area, underscores the region's agricultural potential and supports initiatives like the food estate program. Despite discrepancies between existing land use data and spatial planning maps, attributed to differences in survey scales and timing of data collection, the study anticipates increasing alignment as spatial planning matures and developments progress.

These findings provide critical insights for policymakers and stakeholders to refine spatial planning strategies, optimize land utilization, and mitigate challenges in integrating existing and planned land uses effectively within Kapuas Regency's developmental framework.

Suitability of Land Utilization with the Spatial Planning

Based on the suitability matrix for land utilization with spatial patterns in Kapuas Regency's spatial planning, the study reveals that 88,786.43 hectares (51.09%) of the total area are deemed suitable, while 84,984.88 hectares (48.91%) are considered unsuitable (Figure 7). This distribution highlights a slight majority of land being utilized in alignment with the planned spatial patterns, yet a significant portion remains misaligned. Detailed analysis by subdistricts, as shown in Table 7, provides insights into the specific areas where land utilization aligns or diverges from spatial planning.

The suitability map (Figure 7) visually illustrates the alignment between current land utilization and planned spatial patterns, indicating areas where adjustments are needed to achieve better conformity. For instance, subdistricts like Bataguh and Mantangai exhibit higher suitability percentages, suggesting effective land utilization practices that align well with spatial planning. Conversely, areas like Kapuas Kuala and Selat display lower suitability percentages, reflecting challenges in aligning existing land uses with planned patterns due to factors like entrenched land use practices or specific environmental conditions.

The analysis identifies notable gaps in suitability, especially in subdistricts such as Kapuas Murung, where a gap of 3,405.13 hectares (1.96%) exists between land use and land utilization suitability (Table 8). These gaps often arise from mismatches in land utilization categories and their designated spatial patterns. For example, agricultural or economic activities occurring in riverbank areas intended for protection or urban settlement zones still being used for farming contribute to these discrepancies.

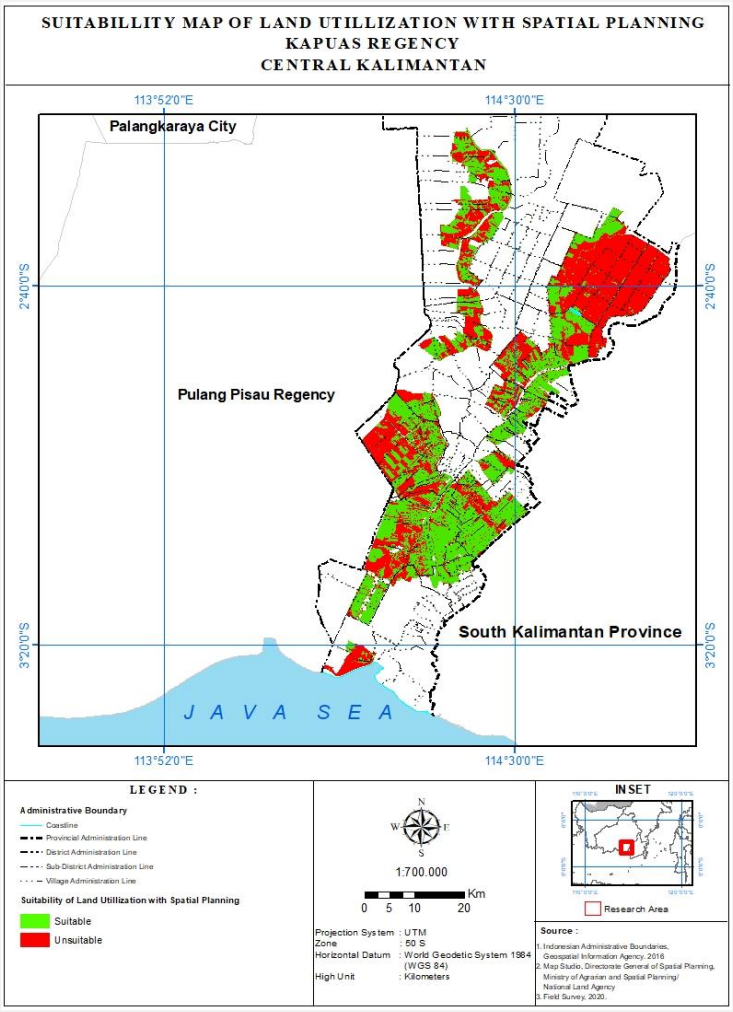

Figure 7. Suitability map of land utilization to spatial planning in the food estate planning area in Kapuas Regency.

Table 7. Distribution of suitability of land utilization with spatial planning in the food estate area in Kapuas Regency

No	Subdistricts	Suitability of land utilization with spatial planning			
		Suitable area (Ha)	Suitable percentage (%)	Unsuitable area (Ha)	Unsuitable percentage (%)
1	Basarang	8,908.25	5.13	101,25.90	5.83
2	Bataguh	21,973.37	12.64	12,610.78	7.26
3	Dadahup	5,908.45	3.40	18,928.29	10.89
4	Kapuas Barat	7,092.56	4.08	5,900.94	3.40
5	Kapuas Hilir	3,138.15	1.81	1,246.06	0.72
6	Kapuas Kuala	261.20	0.15	725.18	0.42
7	Kapuas Murung	10,913.90	6.28	19,910.82	11.46
8	Kapuas Timur	9,455.72	5.44	3,025.05	1.74
9	Mantangai	11,673.45	6.72	9,682.89	5.57
10	Pulau Petak	5,510.28	3.17	2,214.68	1.27
11	Selat	769.28	0.44	284.45	0.16
12	Tamban Catur	3,181.83	1.83	329.86	0.19
	Total	88, 786.43	51.09	84,984.88	48.91

Source: Data processing and analysis

Table 8. A gap in the suitability of land use to spatial planning and a group of suitable land utilization to spatial planning by Villages

Villages	Area (Ha)	%
Basarang	160.29	0.09
Bataguh	244.07	0.15
Dadahup	134.03	0.08
Kapuas Barat	146.6	0.08
Kapuas Hilir	55.46	0.03
Kapuas Kuala	10.71	0.01
Kapuas Murung	3,405.14	1.96
Kapuas Timur	94.48	0.06
Mantangai	175.46	0.10
Pulau Petak	374.21	0.21
Selat	1.64	0.00
Tamban Catur	27.28	0.02

Source: Data processing and analysis

Addressing these mismatches requires strategic interventions by local government and policymakers to realign land use practices with spatial planning. This may involve transitioning agricultural areas to their designated urban settlement roles or relocating economic activities from protected zones. Such adjustments are crucial for achieving the intended outcomes of spatial planning and supporting sustainable regional development.

By closely monitoring these gaps and implementing targeted measures to optimize land utilization, stakeholders can enhance the overall development and sustainability of Kapuas Regency. Ensuring that land utilization aligns with spatial planning will contribute to the region's long-term growth and the successful implementation of regional development strategies.

DISCUSSION

The research in Kapuas Regency reveals a significant gap between land use and spatial planning, highlighting the need for continuous assessment and revisions to align with evolving regional needs. Similar studies across various regions emphasize the critical role of timely and inclusive spatial planning, especially for food estate programs. Here, we compare findings from the Kapuas Regency study with other research to draw broader conclusions.

Similar to Kapuas Regency, other regions also face challenges due to temporal gaps between planning and implementation. In Pulang Pisau Regency, a study highlighted that spatial land resource data management is crucial for achieving sustainable land use. The need for land use planning becomes apparent since the lands have the opportunity to be developed. Appropriate land use planning based on spatial land resource data management is then required to achieve sustainable land use. The objective of this study was to design and allocate appropriate agricultural land regions for land use policy through extensification and intensification programs to support sustainable food crops development areas. The use of geographic information system (GIS) technology was also employed for spatial data management and decision-making within land use planning (Bhermana et al., 2021).

The exclusion of food estate areas in initial spatial plans is a common issue. Research in Central Kalimantan has shown that food estate programs must be integrated into spatial plans to ensure their success and sustainability. The combination of land resource evaluation and GIS application can provide final results on rational land allocation and utilization based on land capability and suitability. A study conducted in Central Kalimantan determined prime commodities at developed areas on the basis of information on land resources at a regional scale, supporting policy for agricultural development, especially for spatial agricultural land use planning (Bhermana et al., 2013).

Studies consistently emphasize the importance of food estate programs for food security, particularly in the face of climate change and pandemics. For instance, the development of food estates to support food security in Pulang Pisau and Kapuas Districts continues to be implemented. The clearing of food estate land is complete, but the processing of peat agricultural land ready for planting and the construction of irrigation channels are targeted to be completed soon. Not all peatlands are suitable for agricultural land due to potential fires and past project failures due to poor management. Converting forest land for agriculture can disrupt the hydrological cycle and ecosystems (Rakuasa & Latue, 2023).

Sustainable land use is a recurring theme. Research indicates that regions with proactive spatial planning that includes food estate programs can better balance agricultural productivity with environmental conservation. This approach fosters sustainable development and economic growth, aligning with the recommendations from the Kapuas Regency study. For example, in Tuban Regency, land suitability was evaluated using spatial multicriteria analysis, integrating various factors like soil order, elevation, and climate. The results indicated that suitable land for agriculture corresponds to 91% of the total study area, confirming high soil fertility and the importance of looking for land allocated for agriculture outside Java Island to anticipate the country's food needs (Widiatmaka et al., 2016).

The findings of this study suggest that the initial spatial planning did not fully anticipate the needs and impacts of food estate development. Therefore, it is essential to revisit and update the spatial plan to reflect the current and future needs of the region. This proactive approach will not only enhance the alignment between land use, land utilization, and spatial planning but also support the sustainable development of the food estate program in Kapuas Regency. Such efforts will ensure that land resources are utilized optimally, fostering economic growth and food security while adhering to the principles of sustainable development.

CONCLUSION

The research identified a nearly balanced gap between suitable and unsuitable existing land use at 49% and 51%, respectively. For land utilization suitability, the comparison was 51% suitable to 49% unsuitable. These percentages indicate a significant mismatch between current land activities and the spatial pattern classifications outlined in the spatial planning.

Several factors contribute to this discrepancy. Firstly, the food estate program was not included in the spatial planning that had been established. Additionally, the proximity in timing between the establishment of the spatial plan and the survey data collection meant that there had been insufficient time for the development to align with the spatial planning directives.

To address these issues, it is imperative to revise the spatial planning to incorporate the food estate program. Such revisions will help align land use and utilization with the designated spatial patterns, facilitating the achievement of the program's objectives. As the food estate program progresses, it is expected that the percentage of land use and utilization suitability will increase, ultimately leading to the successful production of food supplies and the realization of sustainable development goals.

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REFERENCES

Arimjaya, I. W. G. K., & Dimyati, M. (2022). Remote sensing and geographic information systems technics for spatial-based development planning and policy. *International Journal of Electrical and Computer Engineering*, *12*(5), 5073. https://doi.org/10.11591/ijece.v12i5.pp5073-5083

Arimjaya, I. W. G. K., & Wibowo, A. (2021). Klasifikasi Tutupan Lahan Peta Rupabumi Indonesia dalam Identifikasi Kesesuaian Kawasan Permukiman di Kalimantan Tengah [Land Cover Classification of the Indonesian Land Cover Map in Identifying Suitability of Residential Areas in Central Kalimantan]. *Indonesian Journal of Earth Sciences*, *1*(2), 63–73. https://doi.org/10.52562/injoes.v1i2.232

Baja, I. S. (2012). *Perencanaan tata guna lahan dalam pengembangan wilayah [Land use planning in regional development].* Penerbit Andi.

Bhermana, A., Agustini, S., Irwandi, D., & Firmansyah, M. A. (2021). Spatial landuse planning for developing sustainable food crop areas using land evaluation approach and GIS application (a case study of Pulang Pisau Regency, Central Kalimantan). In *IOP Conference Series: Earth and Environmental Science* (Vol. 648, No. 1, p. 012011). IOP Publishing. https://doi.org/10.1088/1755-1315/648/1/012011

Bhermana, A., Sunarminto, B. H., Utami, S. N. H., & Gunawan, T. (2013). The combination of land resource evaluation approach and gis application to determine prime commodities for agricultural land use planning at developed area (a case study of Central Kalimantan province, Indonesia). *Journal of Agricultural and Biological Science*, *8*, 771-784.

Cullingworth, J. B., Nadin, V., Hart, T., Davoudi, S., Pendlebury, J., Vigar, G., Webb, D., & Townshend, T. (2015). *Town and Country Planning in the UK (15th edition).* London: Routledge.

Direktorat Survei dan Pemetaan Tematik, Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional. (2020). *Petunjuk Teknis Pemetaan Tematik Pertanahan dan Ruang* [Technical Guidelines for Thematic Mapping of Land and Spatial, Directorate of Survey and Thematic Mapping, Ministry of Agrarian and Spatial Planning/National Land Agency].

Firman, T., & Soegijoko, B. T. S. (2005). Urbanisasi dan pembangunan perkotaan di Indonesia. [Urbanization and urban development in Indonesia]. In *Bunga rampai pembangunan kota Indonesia dalam abad 21, konsep dan pendekatan pembangunan perkotaan di Indonesia (1st ed.)*. Lembaga Penerbit Fakultas Ekonomi, Universitas Indonesia.

Food and Agriculture Organization (FAO). (1993). *Guidelines for Land Use Planning*. Rome, Italy.

Food and Agriculture Organization (FAO). (2020). *Global Report on Food Crises*. New York: Food Security Information Network. Retrieved from https://www.wfp.org/publications/2020-global-report-food-crises

Indonesia, Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional. (2021). *Peraturan Menteri Agraria dan Tata Ruang/Kepala Badan Pertanahan Nasional Republik Indonesia Nomor 14 Tahun 2021 tentang Pedoman Penyusunan Basis Data dan Penyajian Peta Rencana Tata Ruang Wilayah Provinsi, Kabupaten, dan Kota, Serta Peta Rencana Detail Tata Ruang Kabupaten/Kota [Regulation of the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency of the Republic of Indonesia Number 14 of 2021 concerning Guidelines for the Preparation of Databases and Presentation of Spatial Planning Maps for Provinces, Regencies, and Cities, as well as Detailed Spatial Planning Maps for Regencies/Cities]*. BN.2021/No.326. https://jdih.atrbpn.go.id: 18 HLM. https://peraturan.bpk.go.id/Details/209801/permen-agrariakepala-bpn-no-14-tahun-2021

Indonesia, Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional. (2017). *Peraturan Menteri Agraria dan Tata Ruang/Kepala Badan Pertanahan Nasional Republik Indonesia Nomor 17 Tahun 2017 tentang Pedoman Audit Tata Ruang [Regulation of the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency of the Republic of Indonesia Number 17 of 2017 concerning Spatial Planning Audit Guidelines]*. BN 2017/No. 1513. atrbpn.go.id: 29 HLM.

Indonesia, Pemerintah Pusat. (2004). *Peraturan Pemerintah Nomor 16 Tahun 2004 tentang Penatagunaan Tanah [Government Regulation Number 16 of 2004 concerning Land Use Management]*. LN. 2004 No. 45, TLN No. 4385, LL SETNEG: 15 HLM. https://peraturan.bpk.go.id/Details/51840/pp-no-16-tahun-2004

Indonesia, Pemerintah Pusat. (2007). *Undang-Undang Nomor 26 Tahun 2007 tentang Penataan Ruang [Law Number 26 of 2007 concerning Spatial Planning]*. LN.2007/NO.68, TLN NO.4725, LL SETNEG: 50 HLM. https://peraturan.bpk.go.id/Details/39908/uu-no-26-tahun-2007

Iskandar, F., Awaluddin, M., & Yuwono, B. (2016). Analisis Kesesuaian Penggunaan Lahan Terhadap Rencana Tata Ruang/Wilayah di Kecamatan Kutoarjo Menggunakan Sistem Informasi Geografis [Analysis of Land Use Suitability for Spatial/Regional Planning in Kutoarjo District Using Geographic Information Systems]. *Jurnal Geodesi Undip*, *5*(1), 1–7.

Kabupaten Kapuas. (2019). *Peraturan Daerah (PERDA) Kabupaten Kapuas Nomor 5 Tahun 2019 tentang Rencana Tata Ruang Wilayah Kabupaten Kapuas [Regional Regulation (PERDA) of Kapuas Regency Number 5 of 2019 concerning Spatial Planning of Kapuas Regency]*. LD.2019/No.5. https://peraturan.bpk.go.id/Details/191491/perda-kab-kapuas-no-5-tahun-2019

Lasminingrat, L., & Efriza, E. (2020). The Development of National Food Estate: The Indonesian Food Crisis Anticipation Strategy. *Jurnal Pertahanan & Bela Negara*, *10*(3), 229. https://doi.org/10.33172/jpbh.v10i3.1110

Lubis, S., Suprayogi, A., & Hani'ah. (2013). Kesesuaian Rencana Tata Ruang Wilayah (RTRW) Dengan Penggunaan Lahan Kecamatan Gayamsari dan Kecamatan Semarang Timur [Compatibility of Regional Spatial Planning (RTRW) with Land Use in Gayamsari District and East Semarang District]. *Jurnal Geodesi Undip*, *2*(2), 13-22.

Marwanto, S., & Pangestu, F. (2021, July). Food estate program in Central Kalimantan Province as an integrated and sustainable solution for food security in Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 794, No. 1, p. 012068). IOP Publishing. https://doi.org/10.1088/1755-1315/794/1/012068

Mawardi, I. (2007). Rehabilitasi dan Revitalisasi Eks Proyek Pengembangan Lahan Gambut di Kalimantan Tengah [Rehabilitation and Revitalization of Ex-Peatland Development Projects in Central Kalimantan]. *Jurnal Teknologi Lingkungan*, *8*(3), 287–297.

Mokodongan, R. P., Rondonuwu, D. M., & Moniaga, I. L. (2019). Evaluasi Rencana Tata Ruang Wilayah Kotamobagu Tahun 2014 – 2034 [Evaluation of the Kotamobagu Regional Spatial Plan for 2014 - 2034]. *SPASIAL*, *6*(1), 68–77.

Mukti, A. (2020). Pemberdayaan Pertanian Lokal Dalam Menopang Keberhasilan Program Food Estate di Kalimantan Tengah [Empowering Local Agriculture in Supporting the Success of the Food Estate Program in Central Kalimantan]. *Journal Socio Economics Agricultural*, *15*(2), 97–107. https://doi.org/10.52850/jsea.v15i2.3375

Mungkasa, O. (2020). *Perencanaan Tata Ruang Sebuah Pengantar [Spatial Planning An Introduction]*. BAPPENAS.

Prihatin, R. B. (2015). Alih fungsi lahan di perkotaan (Studi kasus di Kota Bandung dan Yogyakarta) [Land conversion in urban areas (Case studies in the cities of Bandung and Yogyakarta)]. *Jurnal Aspirasi*, *6*(2), 105–118.

Rakuasa, H., & Latue, P. (2023). Spatial Planning and Policy Study of Food Estate Development on Peatland in Pulang Pisau and Kapuas Districts, Kalimantan Tengah, Indonesia. *Nusantara Journal of Behavioral and Social Sciences, 2*(2), 49-54. https://doi.org/10.47679/202329

Rantau, M. (2022). Impact of a Spatial and Regional Planning Policy for Sustainable Food Agricultural Land Protection in Banten Province. *KnE Social Sciences, 7*(5), 296-305. https://doi.org/10.18502/kss.v7i5.10558

Widiatmaka, W., Ambarwulan, W., Setiawan, Y., & Walter, C. (2016). Assessing the suitability and availability of land for agriculture in Tuban Regency, East Java, Indonesia. Applied and Environmental Soil Science, 2016(1), 7302148. https://doi.org/10.1155/2016/7302148