

Original Research Article

Spatial Multi Criteria Analysis for Evaluation of Residential Land in South Jambi, Jambi City

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ARTICLE INFO	ABSTRACT
<i>Keywords:</i> Land, distance, settlement	The land is a landscape on the earth's surface, dynamic to changes, such as converting to settlements. Settlement is driven by changes in population; the greater the population, the greater the need for land to be converted into housing. Based on data from 2018 to 2022, there has been an increasing population in the South Jambi sub-district, which is a strong indication of residential development. This research aims to evaluate the suitability of settlements in the South Jambi sub-district in 2022, using five variables: distance from the road, distance from the river, slope, soil type, and flood hazard index. The method of analysis uses the Spatial Multi-Criteria Analysis (SMCA) method. The research results show that the South Jambi sub-district is dominated by suitable criteria, covering 568.0 hectares or 86.4%; very suitable criteria cover 5.8 hectares or 0.9%; and somewhat suitable areas cover 80.8 hectares or 12.3%. This means that the South Jambi area has a relatively high level of suitability for settlement. It is hoped that these results can provide information for various stakeholders in determining areas that are suitable for residential development, especially those that are at risk of flooding.

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1. INTRODUCTION

A city is an entity that is constantly changing, whether shrinking or increasing in size (Gutierrez Garzon et al., 2022). Indonesia is a country with a relatively high level of population growth (United Nations, 2022), which encourages the conversion of land into built-up land, including settlements in the lowlands (He et al., 2023), especially in the eastern region of Sumatra. Jambi City is a city in the lowlands, with a large river that divides the city (Badan Pusat Statistik, 2022), making it quite suitable for urban development (Wang et al., 2023), even though it has a fairly high risk of flood disasters because it is located facing the Batanghari River (Zabihi et al., 2023).

The increase in demand for residential areas is caused by two factors namely population growth by birth and urbanization, which attracts people from other areas to settle there (Bagheri & Soltani, 2023). Jambi City is the provincial capital, and the South Jambi sub-district plays a significant role in the circulation of land change in the city. It is the center of population activities, including social, trade, tourism, and industry (Badan Pusat Statistik, 2022).

Economics is a strong reason for encouraging people to convert land into settlements (Yufeng, 2022). The higher population growth in Jambi City, especially in South Jambi, drives the demand for land, while the nature of land is fixed and cannot be increased (Buitrago-Mora & Garcia-López, 2023). Open land and forests are being transformed little by little to meet residential needs, which can have both positive and negative impacts, such as increased vulnerability to natural and social disasters (Chelariu et al., 2023).

Jambi City is a government and economic area that experienced economic growth of 4.7% from 2018 to 2022, and the South Jambi sub-district saw residential growth increase by 302.42 hectares (Badan Pusat Statistik, 2018, 2022). This indicates a strong demand for land for settlement, which allows the conversion of productive land for food into residential areas (Woyessa & Welderufael, 2021). The geographical position of Jambi City and South Jambi is close to the Batanghari River and its tributaries (Badan Pusat Statistik, 2022). It is important to identify areas of vulnerability and evaluate settlements to mitigate future losses.

With the development of technology, various methods have emerged, including Spatial Multi-Criteria Analysis (SMCA), which is considered effective for evaluating residential, industrial, and disaster-prone locations (Rana et al., 2023). SMCA is an efficient Geographic Information System (GIS) method that reduces the time and costs required (Kosamia et al., 2023), and is relevant for analyzing disasters and evaluating settlements (Dinas et al., n.d.). This method has proven to be more effective than traditional methods (Guan et al., 2022). SMCA improves policymakers' decision-making in disaster mitigation that they can reduce risks that may occur in the future (Islam et al., 2022).

2. METHODS

The location for this research is South Jambi District, Jambi City, which has an area of 759.53 hectares (Figure 1) (BIG, 2022). This research was carried out by collecting both primary and secondary data from various agencies and relevant literature to strengthen the analysis using the SMCA method (Thomas et al., 2021). The data includes a map of the Indonesian Earth's appearance from the Geospatial Information Agency, a slope map from DEMNAS BIG, soil type data from the UN GeoNetwork, built-up area data from Google Earth, and flood-prone area data from INARISK BNPB.

Spatial Multi-Criteria Analysis (SMCA) allows land planners and managers to analyze the interaction of independent spatial factors and provide results in the form of a spatial suitability map for determining suitable locations for certain land uses. The analysis in this study used ArcGIS Pro 3.1 with the Supervised Classification and Weighted Overlay tools. Supervised Classification uses maximum

likelihood, a method of manually classifying colors and pixel classes, followed by detecting randomly generated samples to achieve a high level of accuracy.



Figure 1. Research Location

In this study, the Supervised Classification tool was used to obtain residential land use in the South Jambi sub-district using satellite imagery from Google Earth Pro, which has a high spatial resolution for the research area. Meanwhile, Weighted Overlay is a tool that uses a raster data format, allowing the value of each raster pixel in each variable to be added, with the results depending on the evaluation scale and importance value. The criteria for each variable used in this research can be seen in Table 1.

Variable Research	Classification	Criteria	References
Distance from River	0 – 100m	1	Kimpraswil Department in Public Works, 2007
	101 – 750 m	3	
	>750 m	5	
Distance from Road	0 – 100m	5	Tunjung et al., 2021
	101 – 750 m	3	
	>750 m	1	
Type of soil	Alluvial, Glei Soil, Planosol, Gray Hydromorphic, Soil	1	PP Number 38 of 2011, Tunjung et al., 2021
	Laterite.	2	
	Latosol.	3	
	Brown Forest Soil, Cambisol, Non Celtic Brown, Meditenan.	4	
	Andosol, Laterite, Grumosol, Podsol, Podzolic.	5	
	Regosol, Litosol, Organosol, Renzina.		
Land Slope	Flat (0 – 8%)	5	Deris et al., 2019
	Slope (8 – 15%)	4	
	Slightly Steep (15 – 25%)	3	
	Steep (25 – 45%)	2	
	Very Steep (>45%)	1	

Variable Research	Classification	Criteria	References
Landslide Prone Index	< 0 (No Risk)	3	Tunjung et al., 2021
	0 – 0.3 (Low Risk)	2	
	0.3 – 0.6 (Medium Risk)	1	
	0.6 – 1 (High Risk)	0	

Table 1. Research Variables

3. RESULTS AND DISCUSSIONS

Based on five variables, scoring has been carried out based on literature studies (Rana et al., 2023). The selection of this literature is based on the availability of data and existing conditions in the research area. The processing results can be seen in Figure 2. In Figure 2, there are variables such as distance from the road, distance from the river, soil type, land slope, and landslide-prone index. The distance from the river functions as a measure of risk, meaning that if the built-up land is close to the river, it will have a greater risk. The scores range from 1 to 5, with 5 indicating a significant impact (Cerbelaud et al., 2023). The South Jambi region has varied distances from the river, with a dominant score of 3 (Figure 2).

Distance from the road describes the ease of accessibility and mobility of the population, meaning that the closer the land is to the road, the more suitable it is for built-up areas, especially residential areas (Islam et al., 2022). Economically, residents near the road can meet more strategic needs compared to those far from the road. Soil types in the South Jambi sub-district consist of four types: Alluvial Glesik, District Kambisol, Hemic Organosol, and Haplik Podzolic (Figure 2). Most of the land is of the Podzolic type, which is fertile, good for agricultural land, and has low erodibility, making it resistant to erosion and suitable for residential areas (USDA, 1999).

Land slope data was obtained from DEMNAS using the Slope tool in ArcGIS Pro 3.1, and the slope classification was determined. The South Jambi region is dominated by flat areas, which are suitable for residential development. A flat area is considered highly suitable with a weight of 5; the flatter the area, the higher the level of suitability. South Jambi has a flat area covering 517.30 hectares or 68.11%, sloping areas covering 196.63 hectares or 25.89%, and rather steep areas covering 41.95 hectares or 5.52%. Lastly, the flood hazard index was obtained from INARISK BNPB and reclassified to provide a classification divided into not vulnerable, low, medium, and high. The South Jambi region is dominated by areas that are not vulnerable, with a percentage of 87% or 661.15 hectares, and areas with a high flood vulnerability index make up 7% or 50.85 hectares.

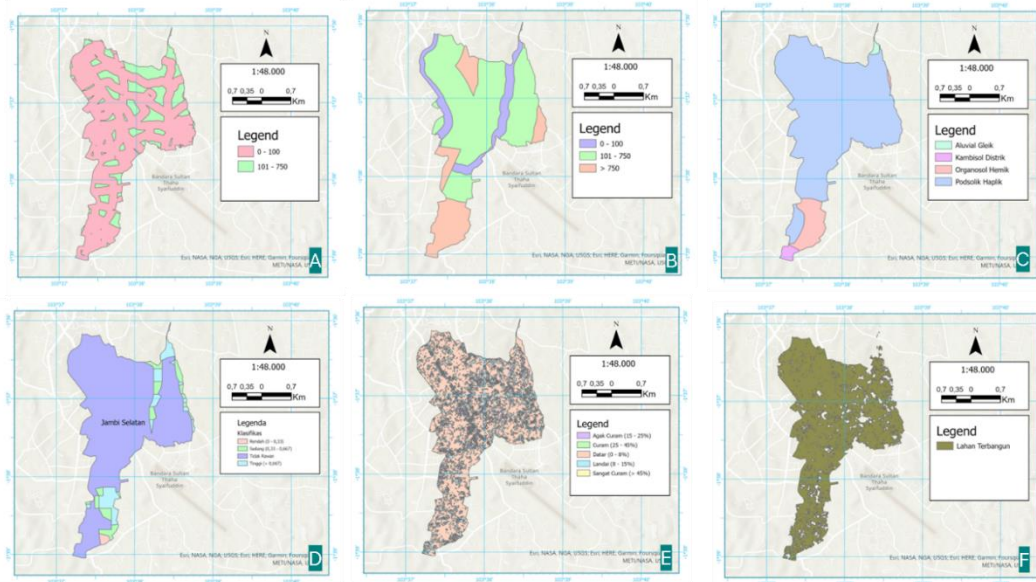


Figure 2. (A) Distance from River, (B) Distance from Road, (C) Soil Types, (D) Flood Prone Index, (E) Slope, (F) Built up Areas

Suitability of Residential Land

The suitability of residential land affects the housing conditions of residents in a city and their vulnerability to the threat of natural disasters, such as floods (Li et al., 2024). Land suitability in this study used the SMCA method and was classified into 4 classes, namely very suitable, suitable, somewhat suitable, and conditionally not suitable (Figure 3).

The area with the most suitable criteria is in the Thenhok sub-district with an area of 7.12 hectares, this sub-district has a flat area, good soil type, and is far from rivers and close to roads. Areas with suitable criteria are spread across Pakuan Baru (59.98 hectares), Pasir Putih (172.43 hectares), Tambak Sari (86.63 hectares), Thenhok (241.58 hectares), and Wijaya Pura (71.45 hectares), with a total area of 632.07 hectares. Areas with somewhat appropriate criteria are Pakuan Baru (3.06 hectares), Pasir Putih (54.57 hectares), Tambak Sari (4.39 hectares), Thehok (36.83 hectares), Wijaya Pura (17.88 hectares) with total 116.72 Hectares. The last ones that do not comply with the conditions consist of the two areas of Pasir Putih (2.38 hectares) and Wiajaya Pura (1.41 hectares) with a total of 3.80 hectares (Figure 4).

The area with high suitability is Thenhok, which has the most suitable, somewhat suitable, and very suitable areas, located in the south of the South Jambi sub-district (Figure 4). Apart from that, Thenhok is the sub-district with the largest area in Jambi City. The sub-district with a high level of non-conformity is Pasir Putih, with a total of 54.94 hectares of slightly conforming and non-conforming areas. This district has an area of 229.38 hectares. This research found that the South Jambi District has a majority of suitable areas with a total of 632.07 hectares and somewhat suitable areas covering 116.72 hectares. This means that most of this area meets the appropriate criteria for residential development, suggesting the possibility of land changes in the future.

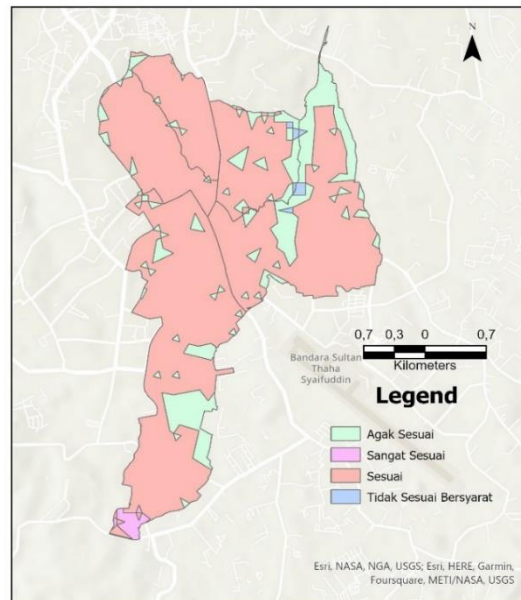


Figure 3. Suitable Settlement Map

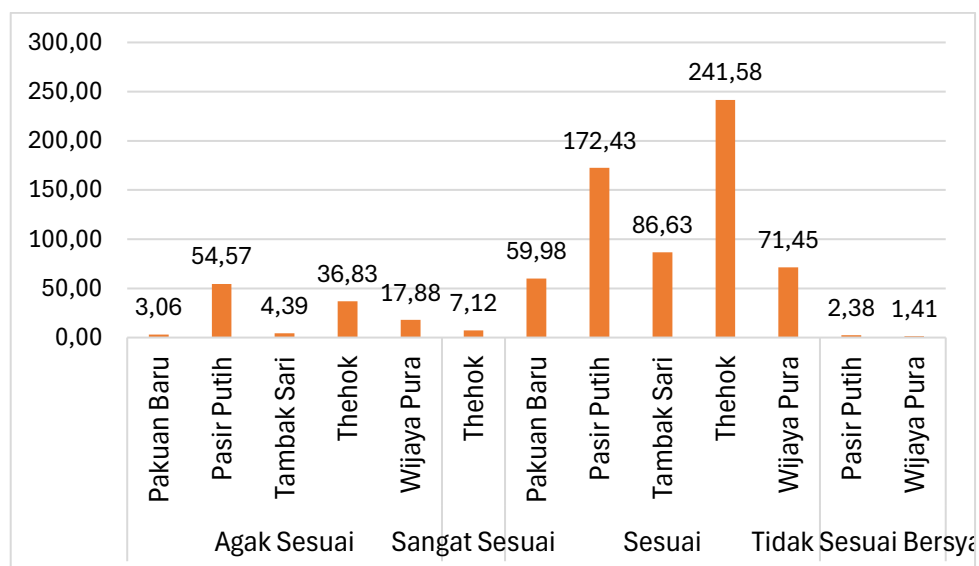


Figure 4. Settlement Suitability Graph for South Jambi City

Evaluation of Residential Land

Settlement evaluation is used to assess the distribution of settlements in areas that are conditionally unsuitable, somewhat suitable, suitable, and very suitable (Figure 5) (Rana et al., 2023). This analysis helps predict potential future impacts. Settlement data was obtained from Google Earth Pro using supervised classification, then mapped according to settlement suitability. The results of the settlement evaluation can be seen on the map.

Based on Figure 6, the built-up land area in the South Jambi sub-district is 657.1 hectares. This area is divided into very suitable, suitable, somewhat suitable, and conditionally suitable categories. The area with very suitable criteria is 5.8 hectares, located only in the Thehok sub-district. The area with suitable criteria is 568.0 hectares, the largest in the South Jambi sub-district, spread across Pakuan Baru (59.1 hectares), Pasir Putih (146.4 hectares), Tambak Sari (82.8 hectares), Thehok (214.0 hectares), and Wijaya Pura (65.7 hectares). The somewhat suitable area is 80.8 hectares, distributed in Pakuan Baru (2.9 hectares), Pasir Putih (32.4 hectares), Tambak Sari (3.4 hectares), Thehok (27.4 hectares), and Wijaya Pura (14.6 hectares). Areas that do not comply with conditions cover 2.5 hectares, spread over two sub-district areas, with 1.4 hectares and 1.1 hectares.

Based on this explanation, the biggest criteria are suitable and somewhat suitable, with the rest being very suitable or not suitable. Meanwhile, the potential area for residential expansion with very suitable criteria is in Thehok sub-district with an area of 1.3 hectares, which is relatively small. This is because this area is topographically lowland with a high level of flood vulnerability. Suitable areas cover 63.9 hectares, with the largest sub-districts being Thehok (27.6 hectares) and Pasir Putih (25.9 hectares), comprising about one-third of the South Jambi sub-district

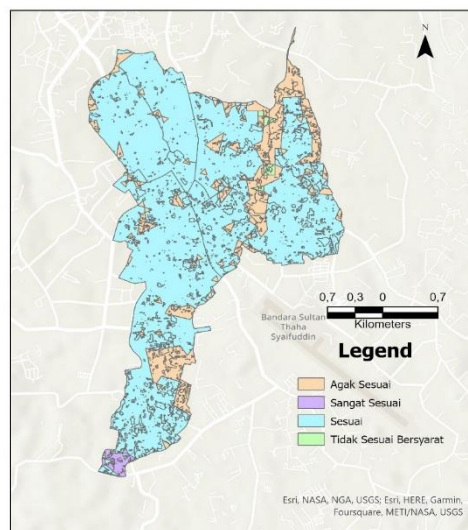


Figure 5. Evaluating Settlement

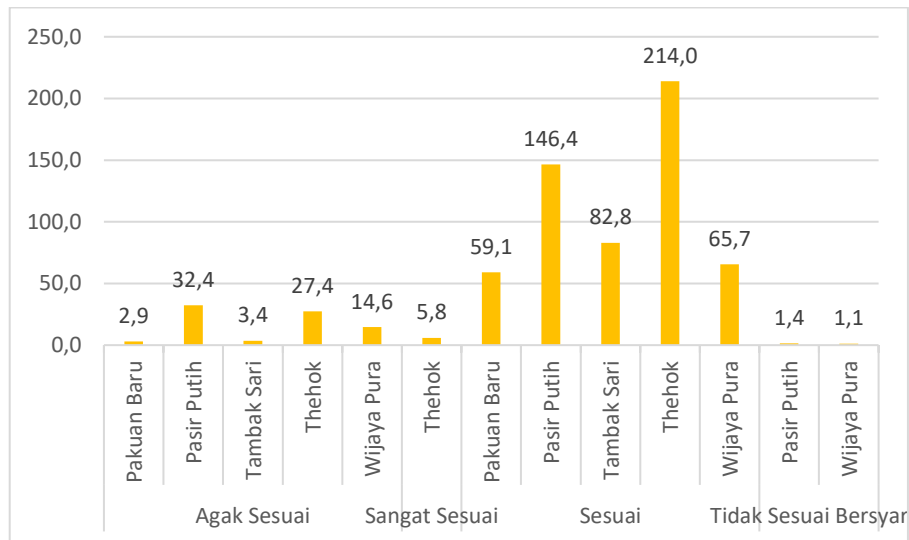


Figure 6. Distribution graph of residential land evaluation

This evaluation shows that there are still residential areas that do not meet the requirements, which could experience vulnerability and loss, both physical and social, in the future (Kristini et al., 2022; Madurika & Hemakumara, 2017). Although the South Jambi sub-district has a large area suitable for residential development, attention must be given to vulnerable zones, particularly those prone to flood disasters from river overflows or unfavorable surface water run-off conditions (Paul et al., 2019). Potential residential areas can be optimized in the future, aligning with population growth.

4. CONCLUSION

Urban conditions, characterized by population and economic growth, can trigger the expansion of residential areas. However, the land in the city is finite, which poses a threat to residential areas due to their vulnerability to flood disasters. South Jambi District in Jambi City has 5.8 hectares of settlements in Thehok District and 568.0 hectares, primarily spread across Pasir Putih sub-district (146.4 hectares) and Thehok (214.0 hectares). Suitable areas dominate the district, making up 86% of the total land, which is considered favorable. This research can be further developed by incorporating additional variables and overlaying the findings with detailed spatial planning for the South Jambi area to enhance the effectiveness of the evaluation.

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