THE JOURNAL OF INDONESIA SUSTAINABLE DEVELOPMENT PLANNING

VOL. 7 NO. 2 - AUGUST 2026

E-ISSN: 2722-0842 | P-ISSN: 2721-8309

Available online at
http://journal.pusbindiklatren.bappenas.go.id/

Research Paper

Land Price Variation in the Urban Fringe of Banda Aceh

A Hedonic Analysis of Syiah Kuala District

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Abstract

Land price modeling plays a key role in supporting spatial planning and sustainable development. This study focuses on Syiah Kuala District, Banda Aceh, where post-2004 tsunami residential growth has transformed land-use patterns and prices that have not yet been systematically mapped or analyzed. This study used a quantitative deductive approach, employing the Hedonic Pricing Model (HPM) and multiple linear regression to examine the influence of 14 predictor variables on land prices based on 61 observation points from the 2025 NJOP dataset. Spatial network analysis measured distances between sample points and facilities. The results indicate that the regression model is statistically significant, with moderate explanatory power and an Adjusted R-square of 0.375. Distance to supermarkets (X4) and hospitals (X10) emerged as the most significant determinants, both with negative coefficients, indicating that land closer to these facilities commands higher prices because of access to essential services. Public facility variables and disaster risk (X14) were not statistically significant. These findings suggest that accessibility and hazard exposure alone cannot fully explain land price variation in post-tsunami Banda Aceh. Future research should consider risk perception, institutional trust, and adaptive capacity.

Keywords: Hedonic Pricing Model; land price modeling; urban fringe development; spatial planning; disaster-affected area.

ARTICLE INFO
Received: January 15, 2026
Received in revised form: April 12, 2026
Accepted: August 30, 2026

doi: 10.46456/jisdep.v7i2.971

THE JOURNAL OF INDONESIA SUSTAINABLE DEVELOPMENT PLANNING
Published by Centre for Planners' Development, Education, and Training (Pusbindiklatren), Ministry of National Development Planning/National Development Planning Agency (Bappenas), Republic of Indonesia

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Supported by Indonesian Development Planners Association (PPPI)

Please cite this article in APA Style as:
Arafah, Y., Hanifah, W., Sabila, F., Asra, H., & Djamaluddin, M. (2026). Land price variation in the urban fringe of Banda Aceh: A hedonic analysis of Syiah Kuala District. *The Journal of Indonesia Sustainable Development Planning, Vol 7(2),* 290-304.
https://doi.org/10.46456/jisdep.v7i2.971

1. Introduction

The approach of land development built through market mechanisms in Indonesia has caused a significant increase in land prices, especially in urban and peri-urban areas (Pratomo, Samsura, & van der Krabben, 2020; Rondhi, Pratiwi, Handini, Sunartomo, & Budiman, 2018). The most evident impact is the continuous expansion of housing development, which in turn supports rising land prices (Hasanawi & Winarso, 2018). Property prices in Indonesia's major cities indicate a sustained increase supported by the urbanization process (Nurkhayati & Fitrady, 2024; Vitriana, 2017), where economic growth is more stable (Kurniawan & Purwono, 2017; Pratami, Marwa, Andaiyani, & Abukosim, 2024) with large-scale infrastructure development. In Jakarta, which has strategic areas, for example, the Central Business District (CBD) and transportation corridors, have developed into urban corridors that can increase land demand in the surrounding areas so that they can support a significant surge in land prices (Gamal, Khoirunisa, & Muhtadi, 2024). This happened with similar conditions in the city of Surabaya, showing that land prices have increased by shooting up to 41.09% in the period from 2007 to 2017 (Subroto, Pamungkas, & Santoso, 2018). Furthermore, the city of Bandung indicated an annual increase that showed a moderate category, which reached 4.18% (Petriella, 2022), while the city of Semarang indicated that there was an increase in land price that was quite stable, although it could not be measured with certainty related to infrastructure development, for example, toll roads and railways (Rakhmatulloh, Buchori, Pradoto, & Riyanto, 2018; Saputra, Ariyanto, Ghiffari, & Fahmi, 2021). Meanwhile, in satellite cities, Depok City and Bekasi City have experienced fairly rapid growth in property prices, especially due to infrastructure development and the rapid expansion of residential areas in peri-metropolitan areas (Anggara & Wijaya, 2024; Cindar Hari Prabowo & Joko Adianto, 2022).

Although economic growth in Indonesia has indicated a good trend, which is shown by the average GDP growth reaching up to 5% per year, which has been happening since 2015 (Badan Pusat Statistik Indonesia, 2025), the spatial and social disparities that arise due to land ownership and utilization have become a big problem in realizing fair and sustainable development (Lestari, Hasibuan, & Ardiwijaya, 2024; Putri, Sarmilah, Velda, & Zschock, 2024). Heavy reliance on market mechanisms to manage land has triggered a surge in uncontrolled prices, especially in strategic areas with new growth centers (Rahmawati, Samsura, & Krabben, 2025). The neoliberal tendency towards spatial planning has encouraged a reduction in the role of the state in regulating the market on land (Olesen, 2014), so that investors have gained more space to use and capitalize on urban space (Herlambang, Leitner, Tjung, Sheppard, & Anguelov, 2019) This results in spatial planning that should have an orientation to social justice can actually increase the risk of social exclusion in urban areas (Arifin, Muhafidin, & Pancasilawan, 2024; Herlambang et al., 2019; Hidayati, Yamu, & Tan, 2019; K. Kim, 2022; Muñoz Unceta & Hausleitner, 2020). Various initiatives, such as inclusionary zoning, have been introduced to ensure housing affordability, especially for low-income groups, but in implementation, it is still limited due to weak coordination and institutional support, especially in the involvement of the private sector (Indradjati, 2020). Although some policies and reform changes have been launched, most of them still have a broad scope and have not been strongly supported by the institutional structure. Furthermore, housing finance policies continue to face various regulatory and institutional challenges, limiting their effectiveness in providing affordable housing, particularly for low-income households.

The factors influencing land prices have been the subject of numerous studies. of illustrate how drivers differ across metropolitan zones, Malaitham, Fukuda, Vichiensan, & Wasuntarasook (2020) used the Hedonic Pricing Model (HPM) to compare estimated land prices with market values in the Bangkok Metropolitan Region. To address spatial instability, they used Geographically Weighted Regression (GWR), emphasizing how factors such as access to public amenities, business centers, and transportation networks affect land values. Similarly, Choi, Park, & Uribe (2023) investigated the impact of Light Rail Transit (LRT) station construction on residential property values in Calgary, Canada, and found that land-use diversity and commercial activity opportunities had varying effects depending on neighborhood characteristics. Interestingly, they found that land-use diversity does not always have a positive link with property values, challenging the widely held ideas that favor transit-oriented development (TOD). Recent research conducted by reveals how important climate in urban micro areas is in property valuation using HPM, which is based on spatial data. The results of this study indicate that thermal comfort, with the existence of green infrastructure, can have an influence on the difference in property value. The results

of the study indicate the increasing role of landscape, environmental sustainability, and climatic conditions in shaping the dynamics of the property market.

In the context of Indonesia where the method has been used in several studies, for example is the research conducted by Tufail & Dirgahayani (2018)where the research conducted an analysis of the potential of Land Value Capture at Gedebage Station, Syabri (2011) analyzed the influence of the Serpong railway station on property value, and Berawi et al. (2018) conducted research on the determining factors in land prices around Duren Kalibata station in South Jakarta. While these studies provide valuable insights, most focus on urban settings and transportation corridors in major Indonesian cities and draw heavily on cases from developed countries. Research on peri-urban land price projections in Banda Aceh using HPM remains scarce. Existing works largely emphasize housing markets and urban infrastructure rather than peri-urban land-use transitions or speculative land dynamics. This study focuses on Syiah Kuala District in Banda Aceh, an area severely affected by the 2004 tsunami that has subsequently experienced rapid residential expansion driven by both private developers and self-built community housing initiatives. The rapid expansion of residential development has likely reshaped land use patterns and land prices in the area; however, these dynamics remain insufficiently documented. Accordingly, this study aims to identify the key determinants of land prices in the peri-urban area of Syiah Kuala District and to examine their spatial distribution.

Therefore, this research is important to understand the factors that contribute to the land prices in peri-urban areas such as Syiah Kuala. The Hedonic Pricing Model (HPM) provides a particularly relevant framework for this purpose, as it enables the analysis of land prices based on physical, spatial, and socioeconomic attributes. The findings provide important implications for policymakers seeking to mitigate speculative land price escalation, while also supporting spatial planning initiatives designed to foster more equitable and sustainable urban development in the face of accelerating urbanization and increasing land market pressures.

2. Methods

The study area is located in Syiah Kuala District, one of the administrative districts of Banda Aceh City, Aceh Province. Geographically, Syiah Kuala District is located in the eastern part of Banda Aceh and shares a direct administrative boundary with Aceh Besar Regency. The location of the study area is shown in Figure 1. As a peri-urban area, Syiah Kuala functions as a transitional zone between urban and rural environments and has undergone rapid development over the past two decades, particularly in the housing, education, and infrastructure sectors (Irwansyah, Achmad, Manaf, & Hanifah, 2025).

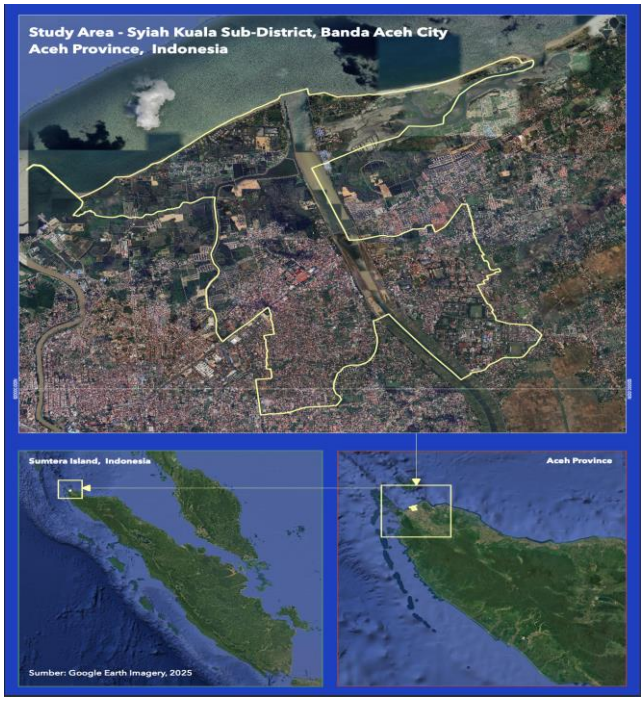

Figure 1. Location Study of Syiah Kuala Sub-district, Banda Aceh, Indonesia

Syiah Kuala holds strategic significance in the post-2004 tsunami context, having evolved into a new growth center (Irwansyah et al., 2025). The existence of Syiah Kuala University, the largest higher education institution in Aceh, has contributed to the expansion of residential areas, commercial activities, and supporting infrastructure within the district (Sania, 2024). Infrastructure development, including improvements in road networks and public facilities (AlMismary & Wahyono, 2020), has contributed to economic growth and accelerated residential expansion in response to rising population demand (Akbar & Ma'rif, 2014; Nazamuddin, Masri, & Fitriyani, 2022). These conditions make Syiah Kuala a particularly relevant case study for examining the determinants of land prices using the Hedonic Pricing Model (HPM).

This study uses a quantitative approach with a deductive orientation, applying the well-established theory of the Hedonic Pricing Model (HPM) to explain how the physical, spatial, and environmental attributes of land or property affect its market value. In quantitative research, theories are applied deductively to research or validate existing theoretical premises (Creswell & Creswell, 2018). This study prepares theoretical assumptions, collects empirical data for examination, and subsequently assesses whether the findings confirm or refute the theoretical framework. The variables based on the Hedonic Pricing Model theory and employed in this research can be seen in Table 1.

Table 1. Hedonic Model Variables

Category	Variable	Index
Dependent Variable		
Land Price	Land Price	Y
Independent Variable		
Distance to CBD	Central Business District	X1
Distance to the private transportation	Toll Road	X2
Distance to the public transportation	Bus Stop	X3
Distance to the economic activity and basic services	Supermarket	X4
	Traditional Market	X5
	Government Office	X6
	Junior High School	X7
	Senior High School	X8
	University / Higher Education Institution	X9
	Hospital	X10
	Community Health Center (Puskesmas)	X11
Distance to the recreational	Sport Facility	X12
Distance to the social services	Mosque	X13
Environmental conditions	Disaster risk	X14
	Slum Category	X15

This study presumes that land prices in Syiah Kuala District are influenced by a range of spatial and physical characteristics. First, distance to the Central Business District (CBD), or economic core, is a critical factor, measured from the urban center to the specific land parcel (J. Chen & Hao, 2008; Jordaan, Drost, & Makgata, 2004; Yudha, Deliar, & Handayani, 2016). Secondly, the availability of infrastructure significantly affects land price, encompassing proximity to toll roads (private transport) and bus stops (public transport) (Efthymiou & Antoniou, 2013; Pavón & Rizzi, 2019), commercial hubs (e.g., supermarkets and traditional markets), as well as public amenities such as schools, hospitals, mosques, and sports facilities. Thirdly, environmental factors play a critical role, including exposure to disaster risks (Samarasinghe & Sharp, 2010; Wei & Zhao, 2022) and settlement characteristics such as population density and the prevalence of informal settlements (Hussain & Wei, 2021; Nakamura, 2017).

Network analysis is a type of GIS analysis that models network conditions realistically and dynamically to solve routing problems by treating spatial data in the form of points and lines integrated

into a network. Network analysis revolves around three main components: origin locations, destination locations, and travel paths. It encompasses a variety of analytical techniques, including shortest path analysis, closest facility analysis, service area analysis, Origin-Destination (OD) cost matrix, route optimization/vehicle routing problem (VRP), and network allocation/location-allocation analysis(Vasanthi, Vanaraju, Baskaran, & Anbazhagan, 2012). The network analysis process in this study is shown in Figure 2. In this study, closest facility analysis was used to identify the nearest facilities from one or more road-connected locations. The tool considers two entities: incidents (points of interest, e.g., land price points) and facilities (destinations), iteratively searching until it identifies all network facilities (Strzalka, Malicki, & Blachowski, 2024). In this study, 13 facility locations (as shown in Table 1, indicated by the variable notation X1–X13) were calculated with the closest distance measured from each facility to land price points. The distance of each land price point is calculated on the basis of the cumulative length of the facility that is assumed to be able to affect the land price at each point.

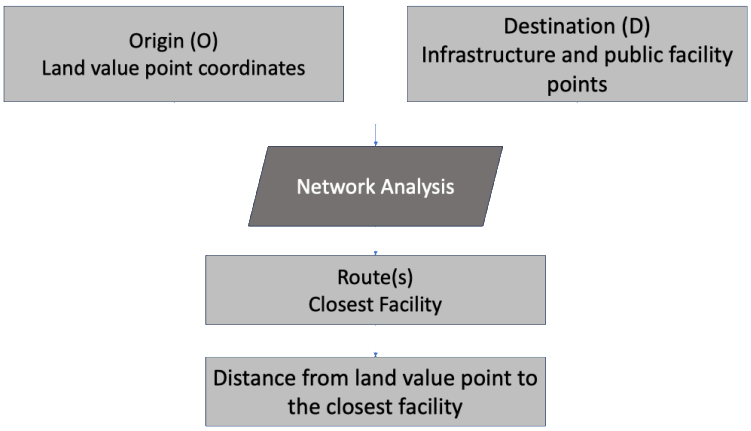

Figure 2. Stages of Network Analysis

Meanwhile, the Environmental Conditions variable (as shown in Table 1, indicated by the variable notation X14–X15) was measured using the category score shown in Table 2.

Table 2. Environmental Conditions Variables

Environment conditions	Classification	Score
Disaster risk	No risk	1
	Low risk	2
	Moderate risk	3
	High risk	4
Slum Category	Non-slum area	1
	Light slum category	2
	Moderate slum category	3
	Severe slum category	4

This study falls into the causal-association category with the aim of identifying the relationship as well as the causal effect among several variables. Causal analysis focuses on independent variables or the determination of land price and dependent variables or land prices. Methodologically, this study uses a quantitative approach by applying multiple linear regression (MLR) analysis in the framework of the Hedonic Pricing Model. MLR is a parametric statistical method used to analyze the relationship between one dependent variable and two or more independent variables. This method aims to determine the simultaneous influence of predictor variables on the response variable and to predict the value of the dependent variable based on the combination of independent variables used. According to Gujarati & Porter (2009), multiple linear regression is capable of explaining the average change in the dependent variable caused by changes in independent variables while assuming that other variables remain constant. In addition, Gujarati & Porter(Wooldridge, 2019) (2009) state that this method is widely applied in economic, social, and spatial studies because it can identify both the direction and magnitude of relationships among variables.

Before conducting regression analysis, a classical assumption test was carried out on 15 independent variables using a total of 94 samples. However, this sample size remains below the commonly accepted rule of thumb suggesting that the number of observations should be at least 10 EPP in a regression model (Riley et al., 2019). Given the inclusion of 15 independent variables, the recommended sample size would range from 150 to 300 observations. Consequently, the sample size employed in this study does not satisfy the ideal recommendation. This limitation was not attributable to deficiencies in the research design but rather resulted from constraints related to data availability and the limited timeframe for field data collection. Accordingly, this issue should be acknowledged as one of the study's limitations, as it may affect both the stability of the estimated parameters and the model's ability to generalize its findings to a broader population.

3. Results and Discussions

3.1 Spatial Patterns in Land Prices Across the Urban Fringe of Banda Aceh

This section provides a spatial overview of the distribution of land prices in the suburbs of Banda Aceh by focusing on Syiah Kuala District as a study area. A total of 94 land price points were analyzed to be able to see the spatial variation in land prices in the peri-urban context. The dataset originated from the Tax Object Selling Value (NJOP) Year 2025 published by the Banda Aceh City Financial Management Agency (Badan Pengelolaan Keuangan Kota Banda Aceh) and was classified into seven categories ranging from less than IDR 235,183/m² to more than IDR 931,990/m².

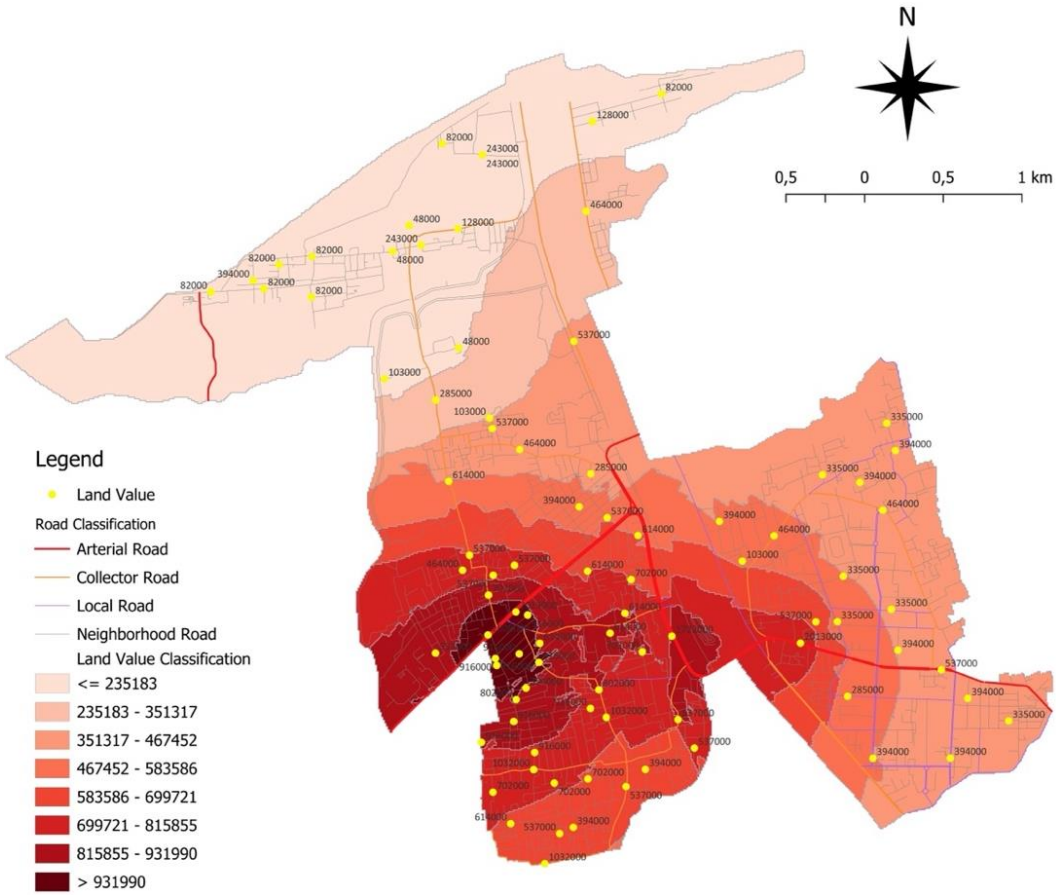

Figure 3. The spatial distribution of land prices in the Syiah Kuala Sub-district, Banda Aceh, Indonesia

Based on the Figure 3, the spatial distribution of land prices in the suburbs of Banda Aceh, more specifically in the Syiah Kuala District, indicates the presence of a clear gradient pattern from north to south. The high-value zones are marked in red and dark black on the map, which are mostly concentrated in the southern and central parts of Syiah Kuala. The area is linked to key urban facilities, including universities, markets, and administrative centers. In contrast, land prices are lower in the northern areas

closer to the coast. These zones are characterized by lighter colors, lower accessibility, limited infrastructure, and higher environmental risks related to coastal flooding and previous tsunami impacts. According to a study conducted by Akbar & Ma'rif (2014), housing developments in Banda Aceh predominantly expanding toward the coastal and northern areas exhibit lower land prices, as central urban land is scarce and costly, while the remaining parcels in coastal zones are subject to elevated tsunami risk. The contrast between high- and low-value areas illustrates a spatial polarization driven by market-oriented land development, where infrastructure expansion and locational advantages fuel property value appreciation.

3.2 Determinants of Land Price in Peri-Urban Banda Aceh: A Hedonic Pricing Perspective

The initial dataset of 94 observations violated the normality assumption during the classical assumption testing stage. Several data treatment procedures were undertaken; first, observations identified as outliers were removed using the Z-score method, reducing the sample size from 94 to 61 observations. Although this reduction resulted in a smaller analytical sample, the procedure was necessary to improve the distributional characteristics of the data and to address violations of the normality assumption detected during the preliminary diagnostic tests. Second, we refined the model by excluding variable X15 (Slum Category) from the regression model due to severe multicollinearity. Initial diagnostic testing indicated that the variable exhibited a Variance Inflation Factor (VIF) exceeding the commonly accepted threshold of 10, suggesting a high degree of linear dependence with other explanatory variables. Such a condition may inflate standard errors, reduce the precision of coefficient estimates, and compromise the stability of the regression model. Therefore, X15 was removed to improve the overall reliability and interpretability of the model.

Table 3. Collinearity Statistics

		Tolerance	VIF
1	(Constant)		
	X1	.183	5.452
	X2	.331	3.019
	X3	.357	2.803
	X4	.304	3.285
	X5	.121	8.279
	X6	.495	2.021
	X7	.202	4.961
	X8	.242	4.136
	X9	.449	2.225
	X10	.163	6.151
	X11	.409	2.446
	X12	.304	3.293
	X13	.694	1.442
	X14	.179	5.589

In addition, appropriate data transformations were applied to further enhance compliance with the assumptions underlying multiple linear regression. Following these procedures, the dataset satisfied the classical regression assumptions, thereby providing a more robust basis for model estimation. Consequently, the final regression analysis used 61 observations and 14 explanatory variables.

Overall, all VIF values remained below the critical threshold of 10 (as shown in Table 3); the model can be considered free of severe multicollinearity. Nevertheless, several variables exhibited VIF values exceeding 5, suggesting the presence of moderate to relatively strong correlations among certain independent variables. This condition may partially explain the notable reduction in Adjusted R^2 relative to R^2 and may also affect the stability and precision of the estimated regression coefficients. Therefore, the findings of this study should be interpreted with caution, particularly with respect to the individual effects of the independent variables included in the model.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.722[a]	.521	.375	.45898

a. Predictors: (Constant), X14, X7, X13, X3, X4, X9, X11, X6, X12, X8, X2, X10, X1, X5

Table 4 presents the overall performance of the multiple regression model after the data screening and model refinement procedures were completed. The model produced a multiple correlation coefficient (R) of 0.722, indicating a relatively strong relationship between the set of independent variables and the dependent variable. Furthermore, the coefficient of determination (R-squared) was 0.521, suggesting that approximately 52.1% of the variation in the dependent variable can be explained collectively by the 14 explanatory variables included in the model. However, the Adjusted R-square value decreased to 0.375, indicating that after adjusting for the number of predictors and the sample size, the model effectively explains only 37.5% of the variance in the dependent variable. The difference of approximately 14.6 percentage points between R-squared and Adjusted R-squared is relatively substantial and may indicate that some explanatory variables contribute limited additional explanatory power. This finding is consistent with the methodological concerns discussed earlier regarding the relatively large number of predictors compared to the available sample size.

The observed discrepancy between R-squared and Adjusted R-squared should be interpreted in light of the study's data limitations. Although the final dataset satisfied the classical regression assumptions after outlier removal and variable refinement, the final sample size of 61 observations remains below the commonly recommended threshold for a regression model containing 14 predictors. Consequently, the model was more sensitive to sampling variation, and the explanatory power reflected by the unadjusted R-squared may somewhat overstate the model's performance in other samples. Nevertheless, the model still demonstrates moderate explanatory capability, after adjustment for model complexity.

Table 5. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.532	14	.752	3.571	<.001[b]
	Residual	9.690	46	.211		
	Total	20.223	60			

a. Dependent Variable: Y
b. Predictors: (Constant), X14, X7, X13, X3, X4, X9, X11, X6, X12, X8, X2, X10, X1, X5

Table 5, the ANOVA table, provides an overview of the overall significance of the regression model. The value of F = 3.571 with p < 0.001 indicates that the regression model is statistically significant in explaining the variation in land price (Y). The comparison of the Sum of Squares for regression (10.532) with the residual (9.690) suggests that the model explains a substantial portion of the variability in the data. With 14 degrees of freedom for regression and 46 for residuals, the Mean Square for regression (0.752) is greater than the Residual Mean Square (0.211), supporting the conclusion that the model has significant predictive power. In summary, the ANOVA results confirm that the combination of 14 independent variables has a statistically significant joint influence on land price. However, only 2 of the 14 predictors, distance to supermarkets (X4) and distance to hospitals (X10), were individually significant at p < 0.05. This discrepancy between overall model significance and limited individual significance likely reflects two factors. First, the relatively small sample size (n = 61) relative to the number of predictors (14) reduces the statistical power to detect individual effects. Second, moderate-to-high multicollinearity is present among several predictors, as indicated by VIF values exceeding 5 for X1 (VIF = 5.452), X5 (VIF = 8.279), X10 (VIF = 6.151), and X14 (VIF = 5.589). Such multicollinearity inflates standard errors and makes it difficult to isolate the unique contribution of each correlated variable, even when the overall model fit remains strong.

Table 6. Results of regression analysis of land price in the Urban Fringe of Banda Aceh

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	21.158	3.925		5.391	<.001
	X1	-.465	.271	-.408	-1.714	.093
	X2	.291	.235	.220	1.241	.221
	X3	-.049	.115	-.073	-.429	.670
	X4	-.384	.151	-.468	-2.532	.015
	X5	.197	.277	.208	.709	.482
	X6	-.084	.090	-.135	-.928	.358
	X7	-.150	.177	-.192	-.844	.403
	X8	.240	.173	.288	1.385	.173
	X9	-.051	.126	-.061	-.403	.689
	X10	-.898	.390	-.583	-2.303	.026
	X11	-.066	.145	-.073	-.455	.651
	X12	.261	.152	.319	1.720	.092
	X13	-.086	.104	-.101	-.824	.414
	X14	.662	.338	.472	1.956	.057

a. Dependent Variable: Y

$$Y = 21.158 - 0.465X1 + 0.291X2 - 0.049X3 - 0.384X4 + 0.197X5 - 0.084X6 - 0.150X7 + 0.240X8 - 0.051X9 - 0.898X10 - 0.066X11 + 0.261X12 - 0.086X13 + 0.662X14 + \varepsilon$$

Based on Table 6, the regression results provide clues to various factors of accessibility, services, and environment affecting land price (Y) in peri-urban areas. The constant of 21.158 ($p < 0.001$) reflects the base land price when all predictors are zero. Among the predictors, proximity to supermarkets (X4) had a significant negative influence on land prices (B = -0.384, p = 0.015), indicating that land located closer to supermarkets tends to command higher prices, while land farther away tends to be cheaper. This finding is consistent with standard accessibility theory, where proximity to commercial facilities enhances convenience and reduces transportation costs, thereby increasing land value (Rakhmatulloh et al., 2018; Rey-Blanco, Zofío, & González-Arias, 2024). Based on the regression results, the proximity-to-supermarket variable shows that shorter distance is associated with higher land prices. In suburban areas such as Syiah Kuala district, land closer to supermarkets appears to be more in demand and commands higher prices, likely because of the convenience of easy access to shopping and daily necessities. The distance to the hospital variable (X10) had a significant negative influence on the land price (B = -0.898, p = 0.026). This phenomenon is in accordance with the conditions in Banda Aceh, where hospitals are highly concentrated and can cause negative impacts such as noise, traffic congestion, and environmental effects from medical facilities. As a result, the price of land around the hospital tends to be lower while land that is further away generally has a higher price.

Distance to toll roads (X2), bus stops (X3), traditional markets (X5), government offices (X6), schools (X7-X9), health centers (X11), sports facilities (X12), mosques (X13), and disaster risk (X14) did not reach conventional significance levels although disaster risk (X14, B=0.662, p=0.057) and sports facilities (X12, B=0.261, p=0.092) were close to significance. The standardized coefficients provide an indication of the distance to the hospital (Beta = -0.583) and the distance to the supermarket (Beta = -0.468) are the strongest predictors. Overall, this model shows that access to major health and commercial facilities plays a very important role in determining land prices in these peri-urban areas, while other services have a weaker or less significant influence. These findings are somewhat at odds with the theory that proximity to public facilities tends to increase land prices due to ease of access and greater benefits (Okamoto & Sato, 2021). However, in the suburbs of Banda Aceh, these factors seem to have a limited role in the effort to determine land prices. These differences focus on the importance of taking context-specific factors into

consideration in land valuation because perceived benefits of public facilities can differ depending on local urban dynamics and cultural preferences.

The disaster risk variable (X14) did not show a statistically significant influence on land prices in Banda Aceh. This finding may appear counterintuitive given the city's history of natural disasters, particularly the 2004 tsunami. Conventional urban economic theory and land valuation literature suggest that areas with higher exposure to environmental hazards typically have lower land prices, owing to perceived risk and associated mitigation or insurance costs (Harrison, T. Smersh, & Schwartz, 2001). However, in the context of Banda Aceh, several factors may explain why the influence is not significant. Several studies suggest that objectively assessed hazard exposure does not necessarily align with communities' risk perception. Risk perception is a social construct that evolves over time as communities adapt to disaster experiences, develop trust in institutions, and gain a deeper understanding of the mitigation measures that have been implemented (Adomah Bempah & Olav Øyhus, 2017; T. L. Chen, Chao, & Cheng, 2020; Rogers, 1997). The literature understands it as a social construct that evolves as communities adapt to disaster experience, develop institutional trust, and gain confidence in mitigation systems (Adomah Bempah & Olav Øyhus, 2017; T. L. Chen et al., 2020; Rogers, 1997). Prior studies suggest that, in post-disaster contexts, communities may gradually come to regard environmental risk as part of everyday life when mitigation infrastructure is perceived as effective (Staro minski-Uehara, 2021).

In the context of Banda Aceh, the post-tsunami reconstruction process has been internationally recognized as one of the largest urban recovery programs in modern history (Benazir et al., 2026). Following the 2004 tsunami, substantial investments were directed toward rebuilding transportation networks, housing, public facilities, coastal protection structures, evacuation routes, and disaster preparedness systems (Adamy, 2021). These interventions not only transformed the physical landscape but also strengthened community resilience and institutional preparedness. As a result, areas that were previously perceived as highly vulnerable are no longer necessarily viewed negatively by households, investors, or property developers.

However, factors such as community risk perception, institutional trust, and adaptive capacity were not directly measured as variables in this model; X14 was the only environmental variable tested, and its non-significant result should not be interpreted as evidence about these broader psychosocial constructs. Given these limitations, the non-significant effect of disaster risk on land prices should be interpreted with caution rather than as evidence that disaster risk is irrelevant to land price formation. We recommend that future research directly incorporate measures of community risk perception, institutional trust, and adaptive capacity to clarify how more than two decades of post-tsunami recovery may have reshaped the relationship between hazard exposure and land values in Banda Aceh, and whether land markets in post-disaster cities are increasingly shaped by perceptions of resilience rather than objective hazard exposure alone.

Conclusion

Using the Hedonic Pricing Model (HPM), this study examined the determinants of land prices in Syiah Kuala District, Banda Aceh, across 14 predictor variables. The model exhibited moderate explanatory power, with an Adjusted R^2 of 0.375, and the overall regression was statistically significant ($F = 3.571$, $p < 0.001$), indicating that the variables collectively help explain land value formation, while a substantial share of variation remains attributable to unobserved factors. Among the 14 predictors, only distance to supermarkets (X4) and distance to hospitals (X10) were individually significant at $p < 0.05$, both showing negative coefficients. This indicates that land located closer to these facilities tends to command higher prices, consistent with accessibility theory, where proximity to commercial and healthcare services enhances convenience and reduces the cost of accessing essential daily and emergency needs. The remaining predictors, including proximity to public facilities (schools, mosques, government offices) and disaster risk, did not show statistically significant individual effects. A particularly noteworthy finding concerns the disaster risk variable (X14), which did not exhibit a statistically significant effect on land prices despite Banda Aceh's history of tsunami events. This finding suggests that objectively measured hazard exposure, as captured in this study, does not necessarily translate into lower land prices. While this study did not directly measure community risk perception, institutional trust, or adaptive capacity, these unmeasured factors offer plausible explanations worth pursuing in future research. Banda Aceh's

post-tsunami recovery, marked by large-scale investment in transportation networks, housing, public facilities, coastal protection infrastructure, evacuation systems, and disaster preparedness programs, has substantially transformed the city's physical landscape over more than two decades. It is plausible that such transformation has, over time, influenced how households and investors evaluate hazard-prone areas; however, this explanation remains speculative and was not directly tested within the scope of this study. Overall, these findings underscore the importance of considering local socio-spatial and methodological contexts when examining land market dynamics in post-disaster cities such as Banda Aceh. Beyond conventional accessibility and location factors, land values may also be shaped by community perceptions, institutional trust, and the long-term legacy of reconstruction processes—dimensions that warrant direct empirical investigation in future studies. This research contributes to the growing literature on post-disaster urban development by highlighting that the role of disaster risk in land price formation may not be straightforward and may evolve as cities recover and adapt. Future research should incorporate direct measures of risk perception, institutional trust, and adaptive capacity, alongside strategies to address sample size and multicollinearity limitations (e.g., variable reduction or regularized regression techniques), to develop a more robust understanding of land price formation in post-disaster urban settings.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the final analytical sample consisted of 61 observations after the removal of 33 outliers identified using the Z-score method. Although this procedure was necessary to satisfy the assumptions of multiple linear regression and improve the validity of the statistical estimates, the resulting sample size remains relatively small given the inclusion of 14 explanatory variables in the model. Consequently, the model was susceptible to a degree of overfitting, as reflected in the relatively large difference between the R-squared (0.521) and Adjusted R-squared (0.375) values. In addition, this study employs a cross-sectional design that captures land price variation at a single point in time. Therefore, while the analysis identifies factors associated with spatial differences in land values, it does not fully capture temporal changes in land prices. As a result, the findings should be interpreted as evidence of cross-sectional variation rather than a comprehensive representation of land price dynamics over time.

A further limitation arises from the use of Nilai Jual Objek Pajak (NJOP) as a proxy for land prices. Although NJOP is an official and readily accessible dataset, it may not accurately reflect actual market transaction values because its assessments are primarily intended for administrative and taxation purposes. Consequently, NJOP may not fully capture market mechanisms such as bargaining processes, speculative behavior, investor expectations, developer pricing strategies, or short-term supply and demand fluctuations. The estimated land prices used in this study may therefore differ from actual market prices, potentially affecting the accuracy of the estimated relationships and the interpretation of the findings. Future research is encouraged to employ larger sample sizes, longitudinal datasets, and actual transaction-based land price data to improve model stability, reduce the risk of overfitting, and provide a more comprehensive understanding of land price formation and dynamics.

Acknowledgments

The authors sincerely thank the Banda Aceh City Development Planning Agency (BAPPEDA), the Public Works and Spatial Planning Office of Banda Aceh City, the Public Housing and Residential Areas Office of Banda Aceh City, the Banda Aceh City Disaster Management Agency, and the Banda Aceh City Financial Management Agency for their valuable support and collaboration. The authors also gratefully acknowledge Raja-Al-Fath for his assistance in preparing the map visualizations.

Declaration of Generative AI Use

During the preparation of this work, the authors used ChatGPT to assist with language editing and to check grammar and clarity of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Author Contributions

Yunita Arafah: conceptualization and supervision; writing original draft. Winda Hanifah: methodology; data analysis; writing. Farisa Sabila: data analysis; writing. Hirsali Asra: writing – review and editing. Masdar Djamaluddin: data collection. All authors have read and agreed to the published version of the manuscript.

Funding Statement

This research was funded by Universitas Syiah Kuala through the Ministry of Higher Education, Science, and Technology, under the Research Assignment Agreement of the PL (Penelitian Lektor/Lecturer Research) Scheme for the 2025 Fiscal Year (Agreement No. 568/UN11.L1/PG.01.03/14264-PTNBH/2025, dated July 15, 2025).

Conflict of Interest

The authors declare no conflict of interest.

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