Research paper

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Housing Backlog Analysis in Hilly Areas of Malalayang District

Windy Anatasya Tambuwun
Loudy Moody Barce Kalalo
Mutiara Lisa Allokendek

Department of Urban and Regional Planning, Faculty of Engineering, Sam Ratulangi University, Manado, Indonesia

Abstract

Population growth in Manado City has significantly increased housing demand, while the limited availability of flat land has pushed housing development toward hilly areas, including Malalayang District. This condition has given rise to a housing backlog that requires spatial analysis, given that hilly areas are vulnerable to hydrometeorological hazards, particularly landslides. This study aims to analyze the distribution of built-up land in sloped areas and to calculate the housing backlog in Malalayang District for the 2025–2035 period. A quantitative-spatial approach was applied using a Geographic Information System (GIS) to map slope classification, built-up land distribution, and backlog per kelurahan (sub-district), combined with a quantitative comparison between the number of households (KK) and existing housing units. The results show that safe-slope areas (<25%) cover 1,411.45 km², yet the highest backlog occurs in Batu Kota (+1,327 units) and Winangun Dua (+1,284 units), both located on moderately steep terrain (15–25%), while gently sloping kelurahan such as Bahu, Kleak, and Malalayang Satu show a surplus/safe condition but with high housing density. The study recommends directing new housing development toward safe land, strictly controlling construction on slopes >25%, and applying an adaptive settlement concept grounded in disaster mitigation.

Keywords: Geographic information system, Hilly area, housing backlog, landslide mitigation, Malalayang

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Correspondence address:
Windy Anatasya Tambuwun, Department of Urban and Regional Planning, Faculty of Engineering, Sam Ratulangi University, UNSRAT Campus Road, Manado City Indonesia
Email: windytambuwun@unsrat.ac.id

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Introduction

Population growth in Manado City has directly increased housing demand. As the availability of flat land for residential development becomes increasingly limited, housing development has expanded more extensively into hilly areas, including Malalayang District. This phenomenon has given rise to housing backlog issues, referring to the gap between housing demand and the available housing stock. In the context of Manado City, this issue was previously examined by Marjorie Tindas, A. J. Rumagit, and G. Jocom (2023), who demonstrated that the city's housing backlog continues to increase alongside population growth. Similar challenges are also widespread in cities throughout Indonesia and other developing countries, as emphasized in studies on housing affordability by Galster and Lee (2020) and in discussions of the causes of housing shortages by McClure and Schwartz (2024) and Quercia (2024).

Housing backlogs are not merely quantitative problems; they also involve housing quality, financing, and socioeconomic sustainability. Various studies in Indonesia have identified this issue as a threat to national resilience (Mubarrak, Pertiwi, and Carnadi 2025). These studies have also encouraged the development of strategies to accelerate housing provision for low-income communities, ranging from vertical housing (Revayati 2026) and land optimization (Aribowo, Fitriani, and Hadinata 2024) to financing schemes based on productive waqf (Fawwaz and Hanif 2025), the protection of the right to adequate housing during crises (Asnar 2023), and institutional strategies implemented in other Indonesian urban areas (Margaretha Siagian, Mahulae, and Simanjuntak 2021). Housing backlogs also occur in various developing countries, as described by Ameyaw et al. (2025) in the context of Ghana's housing deficit. Their findings underscore the cross-regional nature of this problem and the need for contextual approaches that account for the physical characteristics of individual regions.

The problem becomes increasingly complex when residential expansion occurs in areas that are physically vulnerable to disasters, such as hilly terrain with steep slopes. Residential development undertaken without an adequate assessment of slope-bearing capacity may increase the risk of hydrometeorological disasters, particularly landslides, while simultaneously diminishing residents' quality of life. Several studies have demonstrated that inadequate and unsafe housing conditions are associated with deteriorating residents' physical and mental health (Pevalin et al. 2017; Singh et al. 2019; Alidoust and Huang 2021). Meanwhile, inappropriate locations and building quality also contribute to long-term housing deterioration (Robinson and Swanstrom 2024). Therefore, housing backlogs in sloping areas must be understood not only in terms of the difference between housing demand and supply but also in relation to the suitability and safety of the land on which housing is constructed (Bates and Collins 2023; Tayefi Nasrabadi et al. 2024; Mrani et al. 2025).

The state of the art of this study lies in integrating a housing backlog calculation model with spatial slope analysis using a Geographic Information System (GIS), reflecting a target-based program approach also applied to construction backlog management by Zilberova, Tomashuk, and Bobkina (2019). Previous research in Manado (Marjorie Tindas, A. J. Rumagit, and G. Jocom 2023) has generally calculated housing backlogs quantitatively by determining the difference between the number of households and the number of completed housing units, without explicitly linking the results to spatial safety parameters such as slope gradients. The proposed novelty of this study is the mapping of housing backlog conditions in relation to slope classifications in Malalayang District. This approach provides a comprehensive picture of housing deficits while simultaneously considering land-bearing capacity and safety.

Based on this discussion, the research questions are as follows: (1) How is built-up land distributed across sloping areas in Malalayang District? and (2) What are the housing backlog conditions in the hilly areas of Malalayang District during the 2025–2035 period? In accordance with these questions, this study aims to analyze the distribution of built-up land across sloping terrain in Malalayang District and examine the housing backlog in its hilly areas during the 2025–2035 period. The findings are expected to provide an empirical basis for safer and more sustainable housing development planning while supporting landslide mitigation efforts in urban hilly areas.

Methods

This study was conducted in Malalayang District, Manado City, focusing on areas with slope gradients exceeding 15%. Administratively, the study area comprises nine urban villages (kelurahan): Malalayang Dua, Malalayang Satu Barat, Malalayang Satu, Malalayang Satu Timur, Batu Kota, Batu, Kleak, Winangun Dua, and Winangun Satu. The research was conducted over six months, from May to November 2026.

Research approach and design

This study employed a quantitative-spatial approach with a descriptive-analytical design. The research process was divided into three main phases: data collection, data analysis, and the formulation of policy recommendations.

Data collection methods

The data consisted of secondary and primary data. Secondary data included household counts and data on existing housing units obtained from Statistics Indonesia (Badan Pusat Statistik, BPS) and the Department of Housing, as well as topographic maps showing slope gradients obtained from the Geospatial Information Agency (Badan Informasi Geospasial, BIG). Primary data were collected through field observations of the physical conditions of buildings and interviews with relevant stakeholders in the study area.

Data analysis methods

The housing backlog was analyzed by quantitatively comparing the number of households with the number of existing housing units in each urban village. Spatial analysis was conducted using a Geographic Information System (GIS) to map landslide risk levels by scoring slope gradients, rainfall, and soil types. Subsequently, the housing backlog analysis and slope analysis results were overlaid to identify priority zones for safe residential development.

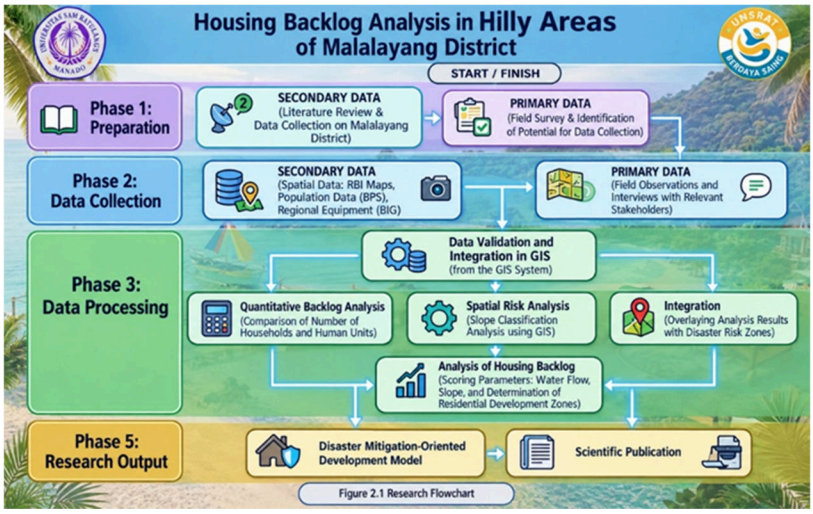


Figure 1
Research flowchart

Results and discussion

Overview of the study area

Malalayang District is an administrative district in Manado City characterized by diverse physical landscapes, ranging from coastal areas to inland areas with hilly terrain. Based on the administrative map derived from the Manado City Spatial Plan (RTRW) for 2023–2043, Malalayang District is located in the southern part of Manado City. It borders Manado Bay to the north and the Minahasa Regency area to the south. These geographical characteristics make Malalayang District a strategically located area whose residential development is nevertheless spatially complex.

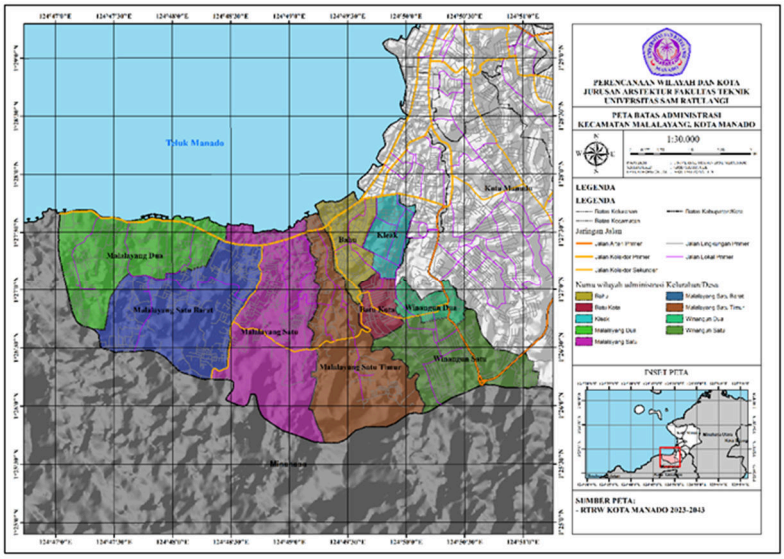


Figure 2
Administrative map of Malalayang Disctrict

Administratively, the study area in Malalayang District comprises nine urban villages: Malalayang Dua, Malalayang Satu Barat, Malalayang Satu, Malalayang Satu Timur, Batu Kota, Batu, Kleak, Winangun Dua, and Winangun Satu. Areas closer to the coastline and major road networks tend to exhibit more intensive built-up development, whereas areas farther south have increasingly hilly terrain and greater surface relief. These physical characteristics are important to this study because the analysis focuses on areas with slopes exceeding 15%, indicating that parts of Malalayang have hilly characteristics that require particular consideration in residential development.

Physical conditions and topography

Based on the slope-gradient mapping results, Malalayang District exhibits considerable topographic variation, ranging from flat terrain to extremely steep slopes. The terrain is divided into five slope classes: 0–8% (flat), 8–15% (gentle), 15–25% (moderately steep), 25–45% (steep), and >45% (very steep).

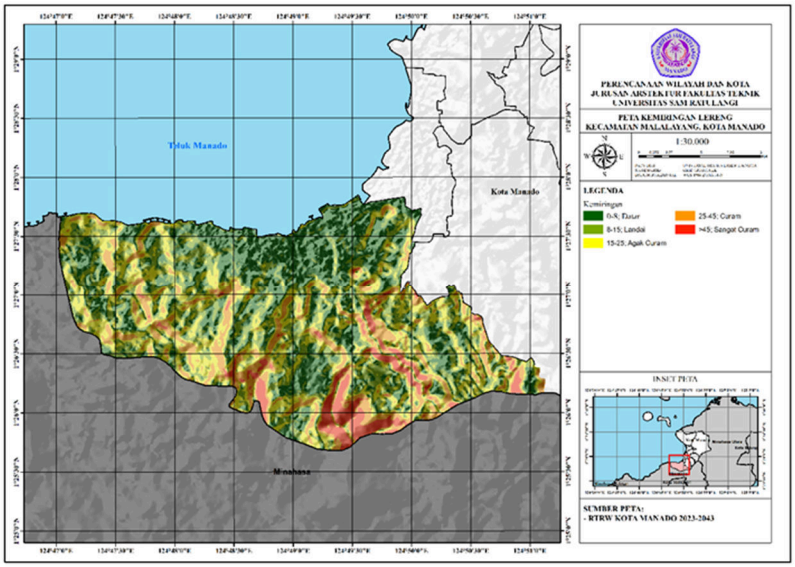


Figure 3
Slope classification map of Malayang District

Areas with slopes of 0–8% are concentrated primarily in the northern part of the district and in several central areas. Their relatively flat topography makes them more suitable for built-up development. The 8–15% slope class (gentle slopes) is relatively widespread and remains comparatively easy to develop. The 15–25% class (moderately steep slopes) is prominent across the central and southern parts of Malalayang District. This class is particularly important to the analysis because the study specifically focuses on areas with slope gradients exceeding 15%. Areas with slopes of 25–45% (steep slopes) are concentrated mainly in the central and southern parts of the district, whereas slopes exceeding 45% (very steep slopes) occur in certain central and southern locations. These areas have extremely rugged terrain, requiring substantially greater attention to potential disaster risks when considering their use for residential development.

Table 1
Area of each slope class in Malayang District

Slope gradient (%)	Category	Area (km²)
0–8	Flat	550,04
8–15	Gentle	460,40
15–25	Moderately steep	401,01
25–45	Steep	253,17
>45	Very steep	96,79

Residential development patterns

Residential development in Malalayang District exhibits an expansion pattern that generally extends from coastal areas and locations with high accessibility toward the central and southern parts of the district, which are characterized by hilly terrain. Based on the map of built-up and non-built-up land, built-up areas are relatively concentrated in the northern and central parts of the district, whereas the southern part still contains substantial areas of undeveloped land interspersed with clusters of built-up areas. This pattern indicates that residential development is beginning to extend into areas with more varied physical land characteristics, in response to the limited availability of flat land and increasing housing

demand in Manado City.

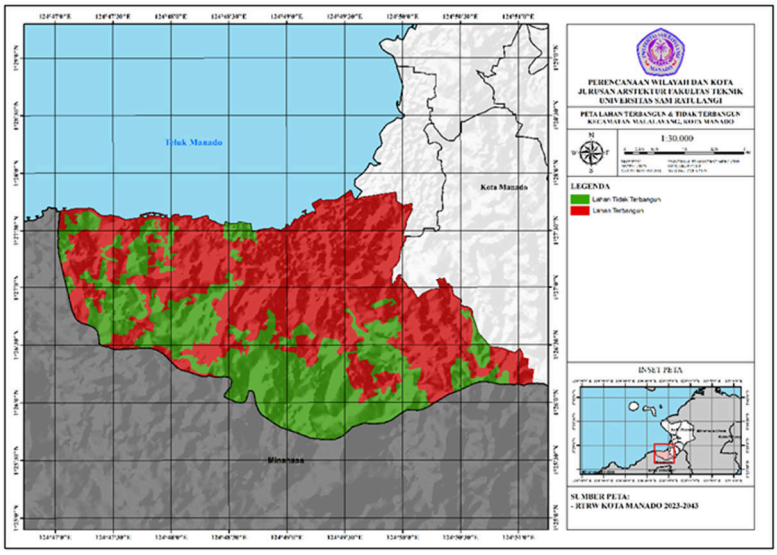


Figure 4
Map of built-up and no-built-up land

Residential expansion in the southern part of Malalayang District warrants particular attention because the area is characterized by hilly terrain with slopes exceeding 15%. Field surveys of existing conditions identified residential development on slopes exceeding 25%, which, under spatial planning regulations, are classified as unsuitable for residential construction. This finding reinforces the urgency of analyzing residential backlogs in ways that account for safe slope thresholds for housing development.

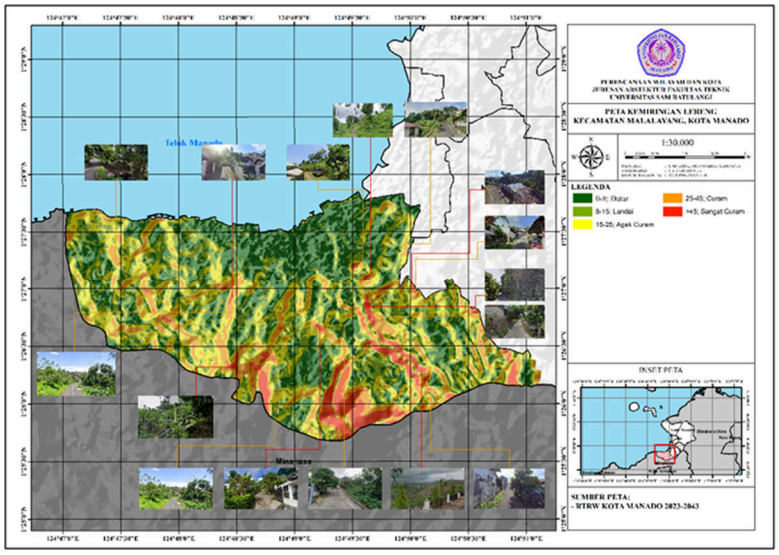


Figure 5
Map of existing residential conditions by slope gradient

Housing backlog analysis in sloping areas

The housing backlog analysis for areas classified as safe (slope gradients below 25%) considers geographical characteristics, slope conditions, and the imbalance between housing demand and supply in Malalayang District. Spatial planning regulations and disaster mitigation principles classify areas with slopes below 25% as suitable for residential development. These areas comprise the 0–8% slope class, covering 550.04 km², which dominates the northern area near the coast and represents the most suitable zone for residential development; the 8–15% slope class, covering 460.40 km², which lies within a transitional zone and is relatively easy to develop; and the 15–25% slope class, covering 401.01 km², which is prominent in the central and southern areas and remains classified as a safe zone, subject to the limits of adaptive residential development. The total area classified as safe (<25%) reaches 1,411.45 km². Meanwhile, areas classified as unsafe (>25%) comprise the 25–45% slope class, covering 253.17 km², and the >45% slope class, covering 96.79 km². These areas are categorized as landslide-prone zones and have already experienced land-use conversion, as evidenced by the presence of existing residential development within them.

Table 2
Housing backlog analysis by urban village in Malalayang

Urban Village	Existing housing units	Number of households	Backlog (Unit)	Status	Predominant slope conditions
Batu Kota	2.322	995	+1.327	Excessive deficit (>300)	Aman–Transisi (<25%)
Winangun Dua	2.116	832	+1.284	Excessive deficit (>300)	Safe–Moderately steep (<25%)
Kleak	1.237	1.552	-315	Safe (≤0)	Flat–gentle (<15%)
Bahu	643	2.276	-1.633	Safe (≤0)	Flat–gentle (<15%)
Winangun Satu	695	2.131	-1.436	Safe (≤0)	Moderately steep –Steep (<25% & >25%)
Malalayang Satu Timur	586	2.214	-1.628	Safe (≤0)	Gentle – Moderately steep (<25%)
Malalayang Satu	1.312	3.396	-2.084	Safe (≤0)	Gentle – Moderately steep (<25%)
Malalayang Satu Barat	864	2.174	-1.310	Safe (≤0)	Gentle – Moderately steep (<25%)
Malalayang Dua	431	2.879	-2.448	Safe (≤0)	Flat, gentle, to steep

Positive backlog values (+) in the table indicate a housing deficit, or a shortage of housing units relative to the number of households, whereas negative values (−) indicate a housing surplus relative to the number of households in the respective urban village.

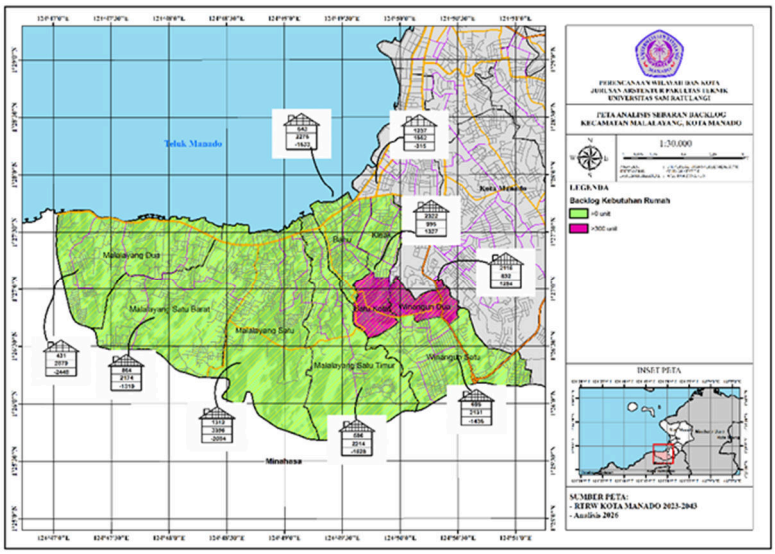


Figure 6
Map of housing backlog distribution in Malalayang District

Spatial relationships between slope gradients and housing backlogs

Winangun Dua (+1,284 units). Both areas are situated in the central-to-southern hilly zone, where the predominant terrain has slopes of 15–25% (moderately steep). The high backlog figures in these two urban villages are consistent with the general pattern described by Marjorie Tindas, A. J. Rumagit, and G. Jocom (2023), namely, increasing pressure for residential expansion as flat land becomes increasingly limited in the northern part of Manado City.

Conversely, urban villages characterized by flat-to-gentle terrain (<15%), such as Bahu, Kleak, and Malalayang Satu, exhibit high residential density. Despite their substantial household populations for example, Malalayang Satu, with 3,396 households the recorded housing availability in these urban villages is represented by negative backlog values, indicating a housing surplus under the study's calculation, although housing availability is also described as limited relative to the existing household population. This finding suggests pressure for dense development on the remaining available flat land. These conditions reinforce the arguments of Adabre, Chan, and Darko (2021) and Tayefi Nasrabadi et al. (2024) that housing backlogs and housing inequalities are not determined solely by land availability but are also associated with residential density patterns and housing affordability in already developed areas.

Although the total area classified as safe (<25%) reaches 1,411.45 km², the substantial housing demand in Batu Kota and Winangun Dua may encourage development spillover into steep areas (>25%) if left uncontrolled. This finding is consistent with the field survey results, which identified residential buildings on steep to very steep slopes. It further underscores the importance of an approach that integrates quantitative housing demand with spatial safety considerations, as emphasized by Zilberova, Tomashuk, and Bobkina (2019) in their target-based program approach to construction backlog management.

Planning recommendations and policy implications

Based on the analysis above, this study formulates three main recommendations. First, direct residential development through zoning. New housing units intended to address the backlogs in Batu Kota and Winangun Dua should be prioritized on remaining undeveloped land with slope gradients below 25%. Second, strictly control development on slopes exceeding 25%. Given that existing residential buildings have already been identified on steep to very steep slopes, local governments should cease issuing building permits for residential construction in these areas to minimize the risk of hydrometeorological disasters. Third, implement an adaptive settlement concept for areas with slopes of 15–25%. This approach requires supporting infrastructure, including slope drainage systems and retaining walls. These recommendations are consistent with the strategies for accelerating housing backlog reduction through spatial policy proposed by Margaretha Siagian, Mahulae, and Simanjuntak (2021) and Revayati (2026), which emphasize the importance of integrating spatial planning controls with housing provision for communities.

Conclusion

This study demonstrates that built-up land in Malalayang District is concentrated in the northern and central areas, which are relatively flat to gently sloping. Meanwhile, the southern part of the district, characterized by hilly terrain, still contains extensive undeveloped land but is increasingly experiencing residential expansion pressures, including development on slopes exceeding 25%, where construction should not take place. Regarding the housing backlog during the 2025–2035 period, the highest figures were identified in urban villages with moderately steep terrain: Batu Kota (+1,327 units) and Winangun Dua (+1,284 units). In contrast, urban villages with gentle slopes, such as Bahu, Kleak, and Malalayang Satu, are reported as having a housing surplus despite their high residential density. These findings confirm that housing backlogs in hilly areas cannot be separated from considerations of land suitability and safety. Accordingly, housing development planning must integrate the quantitative fulfillment of housing needs with landslide risk mitigation. This can be achieved by directing residential development toward safe land, strictly controlling construction on steep slopes, and implementing adaptive settlement concepts.

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