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# Assessment of Land Capability for Urban Building Height Planning in Bukittinggi, Indonesia

**Fajar Agung Mulia[1], Wiwandari Handayani[2]**
[1,2,] Departemen Perencanaan Wilayah dan Kota, Universitas Diponegoro
E-mail Korespondensi : fajaragungmulia@students.undip.ac.id

***ABSTRACT***

*With urban development and rapid growth, the challenge of land capability to accommodate urbanization is becoming increasingly complex. Therefore, the concept of a "vertical city" has surfaced, indicating the importance of integrating sustainable development with spatial and building height restrictions. This study aimed to analyze the land capability of Bukittinggi City in relation to building height control. The methodology adopted adhered to the Ministry of Public Works Regulation Number 20/PRT/M.200 and relevant literature, using the scoring and overlay method with ArcGIS tools. The analysis results showed that the majority of Bukittinggi's area had a relatively high level of land capability, with a significant portion covering 71.3% of the total territory. Moreover, most buildings adhered to the land capability, even though seven unsuitable buildings were identified. These results served as a crucial basis for making informed decisions regarding land use and fostering sustainable urban development.*

*Keywords: Building height, Land Capability, GIS*

**ABSTRAK**

Dengan perkembangan perkotaan dan pertumbuhan yang pesat, tantangan kemampuan lahan untuk menampung urbanisasi menjadi semakin kompleks. Oleh karena itu, muncullah konsep “kota vertikal” yang menunjukkan pentingnya mengintegrasikan pembangunan berkelanjutan dengan pembatasan tata ruang dan ketinggian bangunan. Penelitian ini bertujuan untuk menganalisis kemampuan lahan Kota Bukittinggi dalam kaitannya dengan pengendalian ketinggian bangunan. Metodologi yang diadopsi mengacu pada Peraturan Menteri Pekerjaan Umum Nomor 20/PRT/M.200 dan literatur terkait, dengan menggunakan metode scoring dan overlay dengan tools ArcGIS. Hasil analisis menunjukkan bahwa sebagian besar wilayah Bukittinggi mempunyai tingkat kemampuan lahan yang relatif tinggi, dengan porsi yang signifikan mencakup 71,3% dari total wilayah. Selain itu, sebagian besar bangunan masih mematuhi kemampuan lahan, meskipun teridentifikasi tujuh bangunan yang tidak sesuai. Hasil-hasil ini menjadi dasar penting dalam pengambilan keputusan terkait penggunaan lahan dan mendorong pembangunan perkotaan berkelanjutan.

*Kata Kunci : Ketinggian Bangunan, Kemampuan Lahan, GIS*

## 1. INTRODUCTION

The land is a fundamental non-renewable asset, necessitating proper use and management. Therefore, comprehensive information regarding its potential capability is crucial for effective decision-making (Girma & Moges, 2015; Yohannes & Soromessa, 2019). Land capability refers to its inherent physical ability to sustain various land use and management practices without resource degradation over the long term (Yohannes & Soromessa, 2019). With urban development and rapid growth, the challenge of land capability to accommodate urbanization is becoming increasingly complex (Ding, 2013). The concept of a "vertical city" is gaining traction, as evidenced in modern cities comprising New York, Los Angeles, Tokyo, Chicago, Hong Kong, Singapore, Kuala Lumpur, Shanghai, Taipei, and others (Ding, 2013). Using space vertically necessitates consideration of physical and environmental aspects appropriate to land capability (Pigawati, 2023). Establishing zones for high-rise buildings and those with restricted height is a step toward integrating sustainable spatial development (Pigawati, 2023).

Bukittinggi is a major city connecting the Central Sumatra and East Sumatra Lines and functions as a Regional Activity Center (PKW) for numerous Local Activity Centers (PKL) across West Sumatra, as well as other areas, including North Sumatra and Riau (Bukittinggi City Government, 2017). With its strategic position, the city holds considerable potential for economic growth, which in turn affects both economic and spatial aspects of land resources. However, the land area of Bukittinggi City is limited to only 25,239 km2, covering about 0.06% of the total area of West Sumatra Province, making it the smallest region with the highest population density (BPS, 2023). Given this constraint, horizontal urban development options are limited. Vertical urban development offers promising economic and environmental benefits in densely populated areas, facilitating interaction, fostering urban density economies, and enhancing access to health facilities, trade, services, and others (Kohlhase & Ju, 2007; Mansouri Daneshvar et al., 2017; Rosenthal & Strange, 2003).

Prior to this study, an investigation on land capability and building height direction had not been conducted in Bukittinggi City. Existing literature in the city has predominantly focused on tourism (Arianti, 2017; Ghafur Wibowo & Yusuf Khoiruddin, 2020) and disaster management (Firmansyah et al., 2019; Imanda, 2013). Pigawati (2023) conducted a study on building height suitability in Semarang City using Light Detection and Ranging (LIDAR) data to assess the height of existing buildings. In contrast, this investigation used field survey data

from the 2021 Bukittinggi City Spatial Detail Plan (RDTR) to gather information on existing building height.

## 2. DATA AND METHODS

This study was carried out in Bukittinggi City, located in West Sumatra Province, with astronomical coordinates between 100 0 20' - 100 0 25' East Longitude and 00 0 16' - 00 0 20 South Latitude (Figure 1).

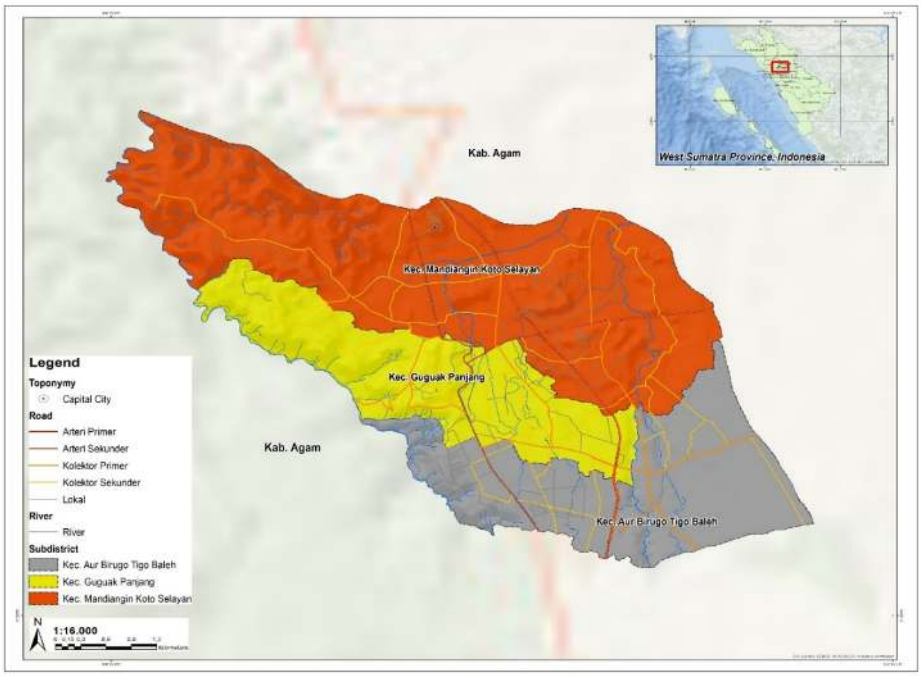


**Figure 1.** Administrative map of Bukittinggi City
*Source: Analysis, 2023*

The data used were various types of physical and environmental information, including slope, morphology, topography, hydrogeology, rainfall, potential disasters, land use, and building, extracted from thematic information sources within the Detailed Spatial Planning Plan for Bukittinggi City spanning the 2021-2041 period.

The initial phase of this analysis was to conduct a Land Capability Unit Analysis, covering assessments, such as Morphology, Ease of Work, Slope Stability, Foundation Stability, Water Availability, Resistance to Erosion, Drainage, Waste Disposal, and Vulnerability to Natural Disasters. The assessments were conducted using scoring criteria outlined in Minister of Public Works Regulation Number 20/PRT/M.200 and relevant literature. The overlay process was facilitated through ArcGIS software. This analysis adhered to the

Technical Guidelines for Physical and Environmental, Economic, and Socio-Cultural Analysis as stipulated by the Minister of Public Works Regulation Number 20/PRT/M.2007.

**Table1.** Land Capability Unit of Morphology

| Slope (%) | Score | Morphology | Score | Land Capability Unit of Morphology | Score |
|---|---|---|---|---|---|
| >40 | 1 | Mountainous | 1 | Low (1-2) | 1 |
| 15-40 | 2 | Hilly | 2 | Less (3-4) | 2 |
| 5-15 | 3 | Bumpy | 3 | Medium (5-6) | 3 |
| 2-5 | 4 | Wavy | 4 | Sufficient (7-8) | 4 |
| 0-2 | 5 | Flat | 5 | High (9-10) | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

**Table 2.** Land Capability Unit of Ease of Work

| Altitude | Score | Slope | Score | Soil Type | Score | Land Capability Unit of Ease of Work | Score |
|---|---|---|---|---|---|---|---|
| 1500-2500 | 3 | >40 | 1 | Alfisol, Histosol | 1 | Low (1-2) | 2 |
| | | 15-40 | 2 | Vertisol | 2 | | |
| 500-1500 | 4 | 5-15 | 3 | Andisol | 3 | Less (3-6) | 3 |
| <500 | 5 | 2-5 | 4 | Inceptisol, Oxisol, Ultisol | 4 | Medium (7-10) | 4 |
| | | 0-2 | 5 | Entisol | 5 | High (11-15) | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pertiwi, 2021; Pigawati, 2023)*

**Table 3.** Land Capability Unit of Slope Stability

| Morphology | Score | Slope (%) | Score | Altitude (m) | Score | Land Capability Unit of Slope Stability | Score |
|---|---|---|---|---|---|---|---|
| Mountainous | 1 | >40 | 1 | 1500-2500 | 3 | Low (4-5) | 1 |
| Hilly | 2 | 15-40 | 2 | | | Less (6-8) | 2 |
| Bumpy | 3 | 5-15 | 3 | 500-1500 | 4 | Medium (9-11) | 3 |
| Wavy | 4 | 2-5 | 4 | <500 | 5 | Sufficient (12-13) | 4 |
| Flat | 5 | 0-2 | 5 | | | High (14-15) | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

**Table 4.** Land Capability Unit of Foundation Stability

| Morphology | Score | Slope | Score | Altitude | Score | Soil Type | Score | Land Capability Unit of Foundation Stability | Score |
|---|---|---|---|---|---|---|---|---|---|
| Mountainous | 1 | >40 | 1 | 1500-2500 | 3 | Alfisol, Histosol | 1 | Low (5-7) | 1 |
| Hilly | 2 | 15-40 | 2 | | | Vertisol | 2 | Less (8-10) | 2 |
| Bumpy | 3 | 5-15 | 3 | 500-1500 | 4 | Andisol | 3 | Medium (11-14) | 3 |
| Wavy | 4 | 2-5 | 4 | <500 | 5 | Inceptisol, Oxisol, Ultisol | 4 | Sufficient (15-17) | 4 |
| Flat | 5 | 0-2 | 5 | | | Entisol | 5 | High (18-19 | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

**Table 5.** Land Capacity Unit of Water Availability

| Hydrogeology | Score | Rainfall (mm/year) | Score | Land Use | Score | Land Capacity Unit of Water Availability | Score |
|---|---|---|---|---|---|---|---|
| Rare groundwater areas | 2 | >4.000 | 5 | Non-built | 1 | Low (4-5) | 1 |
| Local productive aquifer | 3 | 3500-4000 | 4 | | | Less (5-6) | 2 |
| Medium aquifer | 4 | 3000-3500 | 3 | | | Medium (7-8) | 3 |
| Widely crossed | 5 | 2500-3000 | 2 | Built-up | 2 | Sufficient (9-10) | 4 |
| | | | | | | High (11-12) | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

**Table 6.** Land Capability Unit Against Erosion

| Morphology | Score | Slope (%) | Score | Rainfall (mm/year) | Score | Soil Type | Score | Land Capability Unit Against Erosion | Score |
|---|---|---|---|---|---|---|---|---|---|
| Mountainous | 1 | >40 | 1 | >4.000 | 5 | Alfisol, Histosol | 1 | Low (21-24) | 2 |
| Hilly | 2 | 15-40 | 2 | 3500-4000 | 4 | Vertisol | 2 | | |
| Bumpy | 3 | 5-15 | 3 | 3000-3500 | 3 | Andisol | 3 | Less (16-20) | 3 |
| Wavy | 4 | 2-5 | 4 | 2500-3000 | 2 | Inceptisol, Oxisol, Ultisol | 4 | Sufficient (11-15) | 4 |
| Flat | 5 | 0-2 | 5 | | | Entisol | 5 | High (7-10) | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pertiwi, 2021; Pigawati, 2023)*

**Table 7.** Land Capability Unit for Drainage

| Rainfall (mm/year) | Score | Slope (%) | Score | Altitude (m) | Score | Land Capability Unit for Drainage | Score |
|---|---|---|---|---|---|---|---|
| >4.000 | 5 | >40 | 1 | 1500-2500 | 3 | Less (3-5) | 1 |
| 3500-4000 | 4 | 15-40 | 2 | | | | |
| 3000-3500 | 3 | 5-15 | 3 | 500-1500 | 4 | Sufficient (6-11) | 2 |
| 2500-3000 | 2 | 2-5 | 4 | <500 | 5 | High (12-14) | 3 |
| | | 0-2 | 5 | | | | |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

**Table 8.** Land Capability Unit of Waste Disposal

| Altitude (m) | Score | Slope (%) | Score | Rainfall (mm/year) | Score | Land Use | Score | Land Capability Unit of Waste Disposal | Score |
|---|---|---|---|---|---|---|---|---|---|
| 1500-2500 | 3 | >40 | 1 | >4.000 | 5 | Non-built | 1 | Low (13-14) | 1 |
| | | 15-40 | 2 | 3500-4000 | 4 | | | Less (11-12) | 2 |
| 500-1500 | 4 | 5-15 | 3 | 3000-3500 | 3 | | | Medium (9-10) | 3 |
| <500 | 5 | 2-5 | 4 | 2500-3000 | 2 | Built-up | 2 | Sufficient (7-8) | 4 |
| | | 0-2 | 5 | | | | | High (4-6) | 5 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

**Table 9.** Land Capability Unit against Natural Disaster

| Land Movement | Score | Earthquake Prone | Value | Land Capability Unit against Natural Disaster | Score |
|---|---|---|---|---|---|
| Very Low | 2 | Low Zone | 3 | Low (5-6) | 5 |
| Low | 3 | | | | |
| Medium | 4 | Medium Zone | 4 | Medium (8-7) | 4 |
| High | 5 | High Zone | 5 | High (9-10) | 3 |

*Source: (Kementerian Pekerjaan Umum, 2007; Pertiwi, 2021; Pigawati, 2023)*

To assess the potential for land development, a comprehensive process comprising the calculation of value (assessment), weighting, and combination of nine Land Capability Unit Maps was conducted. Each unit was assigned a weight corresponding to its impact on urban development (Table 10).

**Table 10.** Land Capability Unit weights

| No | Land Capability Unit | Weight |
|---|---|---|
| 1 | Morphology | 5 |
| 2 | Ease of Work | 1 |
| 3 | Slope Stability | 5 |
| 4 | Foundation Stability | 3 |
| 5 | Water Availability | 5 |
| 6 | Against Erosion | 3 |
| 7 | For Drainage | 5 |
| 8 | Waste Disposal | 0 |
| 9 | Against Natural Disasters | 5 |

*Source: (Ministry of Public Works, 2007; Pigawati, 2023)*

The weighted values were combined to form various classes, determined by calculating minimum and maximum possible scores. Based on the data, the lowest possible score was 32, while the highest was 160. Therefore, the total score classification included Class A, Class B, Class C, Class D, and Class E with a score range of 32-58, 59-83, 84-109, 110-134, and 135-160, respectively. These classifications showed diverse characteristics of land ( Table 11 ).

**Table 11.** Land Capability Class

| Total Score | Land Capability Class | Development Classification | Building Height Directive |
|---|---|---|---|
| 32-58 | Class a | Very Low Development Capability | Non-Building |
| 59-83 | Class b | Low Development Capability | |
| 84-109 | Class b | Medium Development Capability | Building < 4 Floors |
| 110-134 | Class d | Moderately High Development Capability | |
| 135-160 | Class e | Very High Development Ability | Building > 4 Floors |

*Source: (Kementerian Pekerjaan Umum, 2007; Pigawati, 2023)*

The final phase comprised integrating the land capability classification results with existing building maps to assess the compatibility between existing buildings and identified land capability classes.

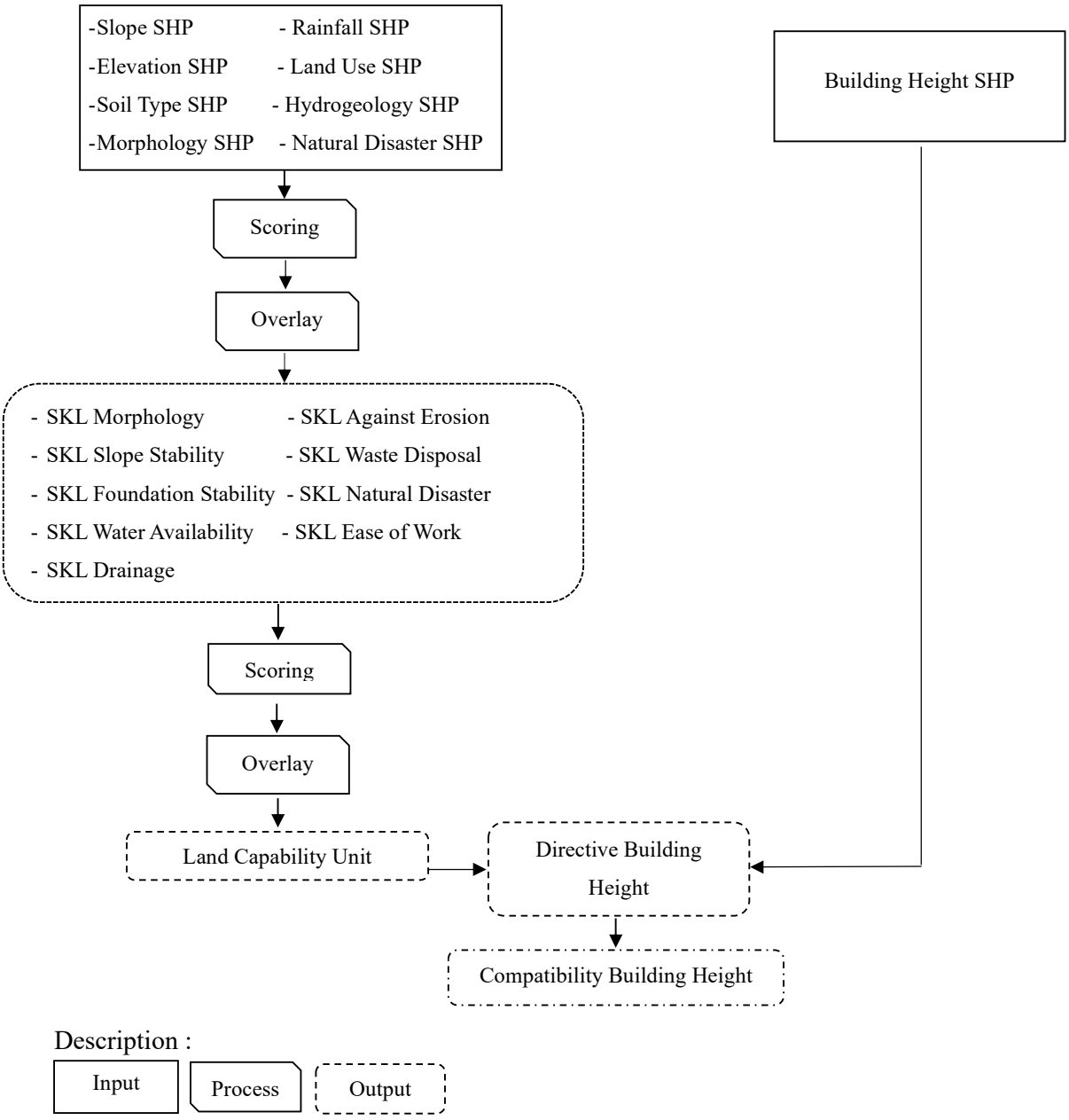


**Figure 2.** Analysis process

## 3. RESULTS AND DISCUSSION

### 3.1 Land Capability Unit (SKL)

The Land Capability Unit of Morphology characterized an area's shape and geographical features, assessing its potential for development based on predefined objectives. In Bukittinggi City, the unit had a range of capability from low to high, with the medium classification covering the largest area, accounting for 40.4% of the total area.

**Table 11.** Bukittinggi City Land Capability Unit of Morphology

| No | Land Capability Unit of Morphology | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Low | 272,23 | 11,0% |
| 2 | Less | 280,87 | 11,3% |
| 3 | Medium | 295,49 | 11,9% |
| 4 | Sufficient | 1.003,68 | 40,4% |
| 5 | High | 631,70 | 25,4% |
| Total | | 2.483,96 | 100,0% |

*Source: Analysis result 2023*

The Land Capability Unit of Ease of Work evaluated the ease with which a specific area could be utilized or developed within the context of regional construction or development. In Bukittinggi City, the unit showed predominantly low and medium capability, with the medium classification covering the largest area, constituting 89% of the total area.

**Table 12.** Land Capability Unit of Ease of Work for Bukittinggi City

| No | Land Capability Unit of Ease of Work | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Less | 272.23 | 11.0% |
| 2 | Medium | 2,211.74 | 89.0% |
| Total | | 2,483.97 | 100.0% |

*Source: Analysis results, 2023*

The Land Capability Unit of Slope Stability assessed the slope's ability in a development area to withstand the load it carried while maintaining stability. In Bukittinggi City, the unit had a range of capability from low to high, with sufficient classification covering the largest area, accounting for 40.4% of the total area.

**Table 13.** Land Capability Unit for Slope Stability of Bukittinggi City

| No | Land Capability Unit of Slope Stability | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Less | 553.10 | 22.3% |
| 2 | Medium | 295.49 | 11.9% |
| 3 | Sufficient | 1,003.68 | 40.4% |
| 4 | High | 631.70 | 25.4% |
| Total | | 2,483.97 | 100.0% |

*Source: Analysis results, 2023*

The evaluation of the Land Capability Unit of Foundation Stability assessed the ability of the land to support heavy building structures and determined the suitable foundation types for urban development needs. In Bukittinggi City, the unit ranged from low to medium capability, with the medium category covering the largest area, accounting for 52.3% of the total area.

**Table 14.** Land Capability Unit of Foundation Stability for Bukittinggi City

| No | Land Capability Unit of Foundation Stability | Area | Percentage |
|---|---|---|---|
| 1 | Low | 272.23 | 11.0% |
| 2 | Less | 280.87 | 11.3% |
| 3 | Medium | 1,299.17 | 52.3% |
| 4 | Sufficient | 631.70 | 25.4% |
| Total | | 2,483.97 | 100.0% |

*Source: Analysis results, 2023*

The Land Capability Unit of Water Availability evaluated the availability and capacity of water supply, crucial for regional development. In Bukittinggi City, the unit ranged from sufficient to high capability, with the high classification covering the largest area, accounting for 58.6% of the total area.

**Table 15.** SKL for Bukittinggi City Water Availability

| No | Water Availability SKL | Wide | Percentage |
|---|---|---|---|
| 1 | Sufficient | 1,029.52 | 41.4% |
| 2 | High | 1,454.44 | 58.6% |
| Total | | 2,483.96 | 100.0% |

*Source: Analysis results, 2023*

The Land Capability Unit against Erosion assessed the land's resistance to erosion and its mitigation strategies. In Bukittinggi City, the unit ranged from medium to high capability, with the high classification covering the largest area, accounting for 58.6% of the total area.

**Table 16.** Land Capability Unit against Erosion in Bukittinggi City

| No | Land Capability Unit Against Erosion | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Sufficient | 1,299.17 | 52.3% |
| 2 | Less | 631.70 | 25.4% |
| 3 | High | 553.10 | 22.3% |
| Total | | 2,483.96 | 100.0% |

*Source: Analysis results, 2023*

The Land Capability Unit for Drainage assessed the land's natural ability to drain rainwater effectively, thereby preventing waterlogging. In Bukittinggi City, the unit varied from medium to high capability, with the high classification covering the largest area, accounting for 77.7% of the total area.

**Table 17.** Land Capability Unit of Drainage for Bukittinggi City

| No | Land Capability Unit of Drainage | Wide | Percentage |
|---|---|---|---|
| 1 | Sufficient | 553.10 | 22.3% |
| 2 | High | 1,930.87 | 77.7% |
| Total | | 2,483.97 | 100.0% |

*Source: Analysis results, 2023*

The Land Capability Unit of Waste Disposal assessed areas suitable for waste storage and processing, including solid and liquid waste. In Bukittinggi City, this unit had predominantly low land capability, with the majority falling under the low classification, covering 79.3% of the total area.

**Table 18.** Land Capability Unit of City Waste Disposal for Bukittinggi

| No | Land Capability Unit of Waste Disposal | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Low | 1969.0197 | 79.3% |
| 2 | Less | 514.94188 | 20.7% |
| Total | | 2483.9615 | 100.0% |

*Source: Analysis results, 2023*

The Land Capability Unit for Natural Disasters evaluated land resilience to geological disasters to reduce losses. In Bukittinggi City, the unit had varying levels of capability, with the majority classified as low, reaching 58.9% of the total area.

**Table 19.** Land Capability Unit for Natural Disasters in Bukittinggi City

| No | Land Capability Unit of Disaster | Area | Percentage |
|---|---|---|---|
| 1 | Low | 1,462.33 | 58.9% |
| 2 | Medium | 637.35 | 25.7% |
| 3 | High | 384.28 | 15.5% |
| Total | | 2,483.97 | 100.0% |

*Source: Analysis results, 2023*

### 3.2 Land Development Capability of Bukittinggi City

The Land development Capability in Bukittinggi City was categorized into four levels, with moderately high development having the largest coverage, accounting for 71.3% of the total area (Figure 3).

**Table 20.** Bukittinggi City Land Development Capability

| No | Development Classification | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Low | 6.55 | 0.3% |
| 2 | Medium | 563.04 | 22.7% |
| 3 | Moderately High | 1,772.31 | 71.3% |
| 4 | Very high | 142.33 | 5.7% |
| Total | | 2,484.23 | 100% |

*Source: Analysis results, 2023*

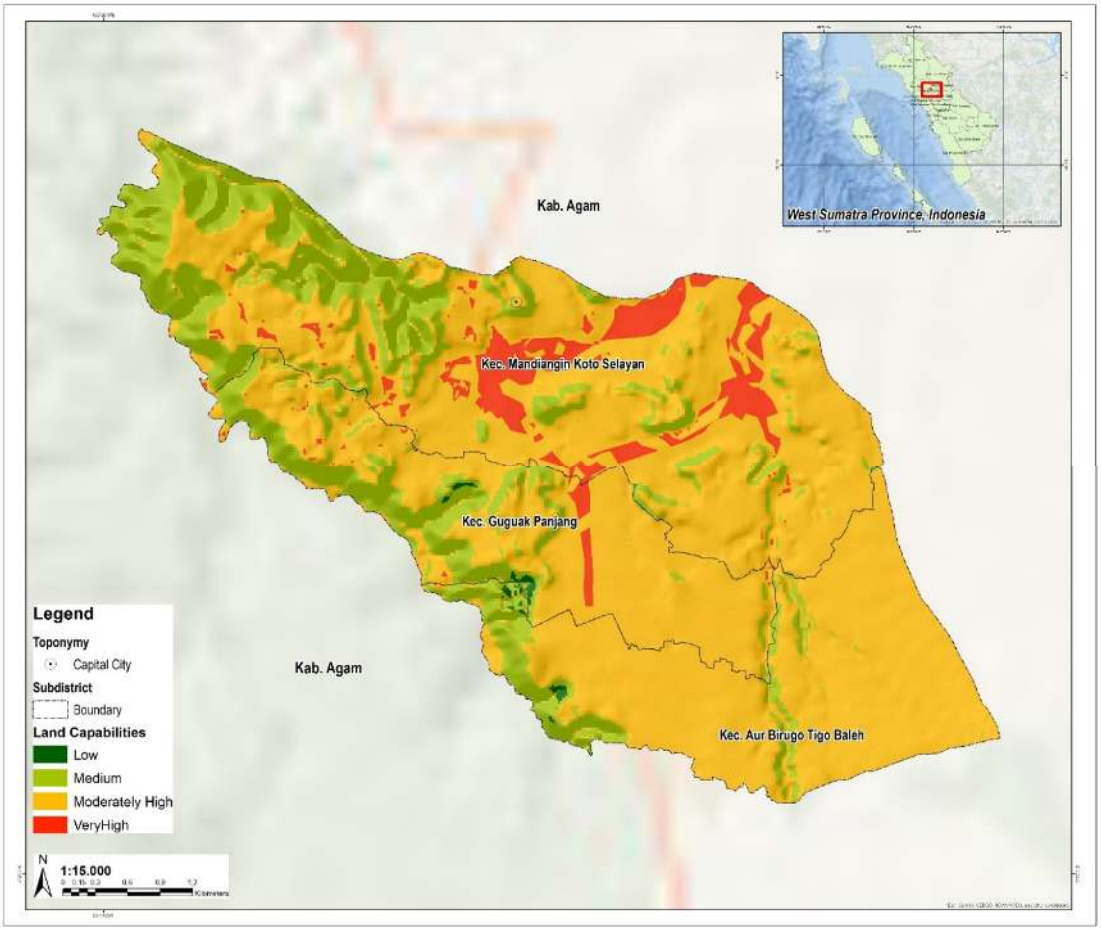


**Figure 3.** Land Development Capability Map of Bukittinggi City
*Source: Analysis results, 2023*

### 3.3 Building Height Directive of Bukittinggi City

The building height directive indicated the maximum allowable height for buildings. Therefore, buildings that fell within or below the specified limits were permitted. This directive was determined based on the analysis of land capability. In Bukittinggi City, there were three development directions for building height, including non-building structures, buildings with less than four floors, and buildings with more than four floors (Figure 4). Specifically, the majority of development was directed toward buildings with less than four floors, covering 94% of the total area.

**Table 21.** Building Height Directive of Bukittinggi City

| No | Building Height Directive | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Non-Building | 6.55 | 0.3% |
| 2 | Building <4 Floors | 2,335.35 | 94.0% |
| 3 | Building >4 Floors | 142.33 | 5.7% |
| Total | | 2,484.23 | 100.0% |

*Source: Analysis results, 2023*

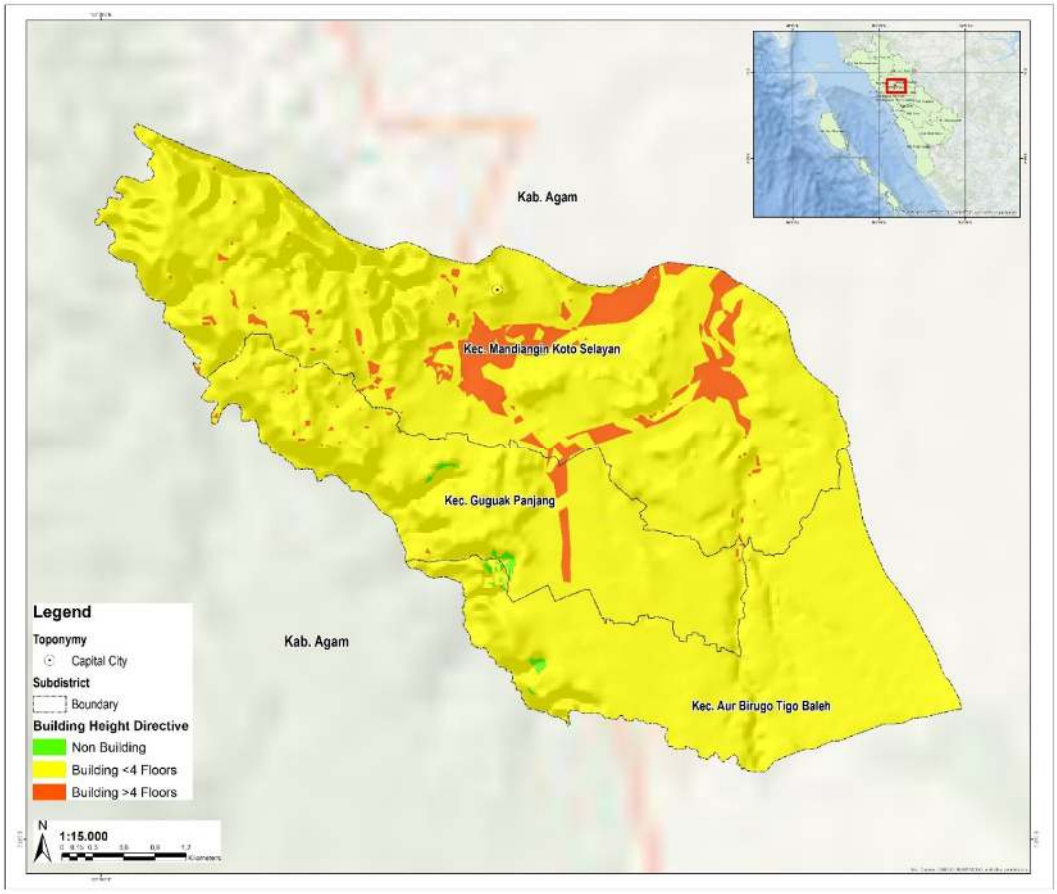


**Figure 4.** Building Height Directive Map of Bukittinggi City
*Source: Analysis results, 2023*

### 3.4 Suitability of Building Height

The existing buildings in Bukittinggi City had varying numbers of floors, including 1, 2, 3, 4, and 7. Buildings with 1 to 4 floors served residential, commercial, and service purposes, while those with 7 floors were primarily hotels and Clock Tower buildings.

**Table 22.** Building Heights Suitability in Bukittinggi City

| Building Height Instructions | Existing Building Floor | | | | | | Suitability of Building Height | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Appropriate | | Not Appropriate | |
| | 1 | 2 | 3 | 4 | 7 | Total | Building | % | Building | % |
| Building <4 Floors | 2.9370 | 1,889 | 175 | 15 | 3 | 3.1452 | 3.1449 | 92.19 % | 3 | 0.01% |
| Building >4 Floors | 2,500 | 141 | 15 | 2 | - | 2,658 | 2,658 | 7.79% | 0 | 0.00% |
| Non-Building | 4 | - | - | - | - | 4 | 0 | 0.00% | 4 | 0.01% |
| Total | | | | | | 34,114 | 34,107 | 99.98 % | 7 | 0.02% |

*Source: Analysis results, 2023*

The analysis showed that 99.98% of the total floors of buildings in Bukittinggi City were in line with land capability. However, there were still seven buildings that did not comply with the capability regulations, consisting of both buildings with less than four floors and non-building structures.

## 4. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study showed the significance of understanding land capability amidst rapid urban growth, with a focus on Bukittinggi City in West Sumatra Province. Land, being a non-renewable resource, necessitated appropriate management to foster sustainable development. The results showed that the majority of Bukittinggi City had relatively high land capability, with the moderately high zone covering 71.3% of the total area. While most buildings adhered to land capability standards, seven buildings deviated from these standards. Therefore, the analysis results offered an important basis for enhanced decision-making regarding land use and sustainable urban development. Through a comprehensive understanding of land capability, Bukittinggi City could streamline development and regulate building height more effectively, fostering sustainable urban growth and optimal land use.

## 5. ACKNOWLEDGEMENT

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