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COMPARISON OF URBAN DEVELOPMENT PATTERNS BASED ON LAND CAPABILITY UNITS (LCU's) IN THE TALIWANG URBAN AREA

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ABSTRACT

Taliwang Urban Area, the capital of West Sumbawa Regency, functions as the administrative and socio-economic center of the region and has experienced rapid urban growth over the past decade. Data from the Regional Development Planning Agency (Bappeda) indicate that built-up land expanded by nearly 35% between 2014 and 2024. While this growth reflects dynamic development processes and the implementation of spatial planning policies, expansion into areas with low environmental carrying capacity increases the risk of environmental degradation and disaster vulnerability. This study examines the relationship between land capability and urban development patterns using the Land Capability Unit (LCU) approach. A descriptive analytical method with a spatial framework was applied, employing overlay analysis and thematic map interpretation. The findings reveal that although 51% of Taliwang District is situated within zones of relatively high land capability, significant urban expansion has occurred in areas with low land capability. This spatial inconsistency may lead to inefficient land use and heightened environmental risks. The study emphasizes the importance of land suitability–based planning that prioritizes biophysical characteristics to support sustainable urban development and disaster risk reduction.

Keywords: *land capability; land capability unit (LCU); spatial analysis; urban development*

INTRODUCTION

Urban development patterns not only reflect the dynamics of growth but also serve as an indicator of the effectiveness of spatial planning. Taliwang Urban Area, as the capital of West Sumbawa Regency (KSB) in West Nusa Tenggara Province (NTB), serves as the primary hub of socio-economic activities within the mining influence area of PT. Amman Mineral International. Over the past decade, Taliwang has undergone rapid urban expansion, largely driven by spillover effects from intensive mining activities in adjacent districts, including Jereweh, Sekongkang, and Maluk. Based on 2024 data from the Provincial Office of Manpower and Transmigration (Disnakertrans) of NTB, mining

operations by PT Amman Mineral Nusa Tenggara (AMNT), together with the development of a copper smelter in KSB, have generated employment for approximately 37,000 workers. This labor absorption has stimulated significant population inflows into the Taliwang Urban Area. Moreover, Statistics Indonesia (BPS) reported in 2024 that Taliwang accounts for 37.46% of the total population of KSB, indicating a pronounced concentration of population and urban activities within the area. This phenomenon inevitably drives urban expansion, consequently escalating the demand for urban land and spatial resources (Setyaningsih et al. 2015), availability of land within city limits remains constrained, often resulting in a significant disparity between limited supply and the burgeoning demand for urban space (Cahyani & Giyarsih, 2024).

The expansion and intensification of mining activities in West Sumbawa Regency (KSB) have generated substantial implications for regional development in the Taliwang Urban Area, in response to society's increasing need for land as living space to fulfill basic human needs (Atsamari & Pigawati, 2024). These implications are manifested through accelerated infrastructure provision, housing expansion, the development of public facilities, and broader physical transformation of the urban environment. Among the most pronounced impacts is land-use change and land conversion in areas within and adjacent to the mining influence zone. As highlighted by Dahlia et al. (2020) mineral extraction activities can significantly alter land-cover patterns and landform morphology. Such transformations affect both forested landscapes and built-up residential areas in mining-affected regions. Collectively, these processes may operate as multiplier mechanisms, catalyzing rapid economic growth and socio-spatial transformation.

Recent transformations have inevitably intensified land-use pressures (Prihatin, 2015), particularly in Taliwang, contributing to the expansion of spatially integrated areas increasingly shaped by urban characteristics (Hirsan, 2022). Previous studies have documented multiple impacts of mining activities, including the conversion of residential and agricultural land into mining areas, environmental degradation, various forms of pollution (air, water, and noise), and shifts in local livelihood structures

(Salsabilla & Murlianti, 2023). Moreover, Environmental Quality Index (EQI) data for West Sumbawa Regency (KSB) in 2024 show that the Water Quality Index (WQI) reached only 58.62%, while the Land Quality Index (LQI) stood at 93.48% (Anonim 1, 2016). These indicators suggest that environmental quality particularly water resources remains below established sustainability benchmarks in KSB.

Despite the environmental pressures associated with large-scale mining activities in West Sumbawa Regency (KSB), regional development has continued to intensify. Data from the Regional Development Planning Agency (Bappeda) of KSB in 2024 indicate that the built-up area of Taliwang expanded by nearly 45% over the past decade. This rapid urban expansion has reconfigured both the physical and socio-spatial structure of the city, while simultaneously exacerbating spatial planning challenges, including extensive land-use conversion, declining environmental quality, and growing inconsistencies between observed land-use patterns and underlying biophysical land capacity (Lasaiba, 2024). As a result, risks of environmental degradation and land-use vulnerability have become increasingly systemic (Ippolito et al., 2021) within the urban development process.

The urgency of this study lies in examining the extent to which urban development in Taliwang has been influenced by mining activities in West Sumbawa Regency (KSB). To assess urban expansion in relation to land carrying capacity and land capability, this study employs the Land Capability Unit (LCU) approach as a key analytical framework. The LCU framework provides a scientific basis for development planning that is aligned with the natural capacity of a region by identifying biophysical constraints, including slope, soil type, erodibility, and drainage (Gad, 2015). These parameters are used to delineate areas suitable for development while also indicating the land's capacity to support population activities and urban growth (Gumano et al. 2023). Such considerations are particularly important in the Taliwang Urban Area, where heterogeneous land characteristics coexist with its dual function as the primary service center for the population of West Sumbawa Regency and as part of the regional mining influence area.

This study examines the extent to which urban development in Taliwang particularly the expansion of built-up areas aligns with existing land carrying capacity and land capability (Auliya et al. 2025). This assessment is critical given that urban growth in Taliwang is strongly driven by its function as a supporting area for mining activities. Spatial variations in land characteristics between the Taliwang Urban Area and other mining-intensive parts of West Sumbawa Regency (KSB) indicate heterogeneous levels of land capability and carrying capacity across the region. Accordingly, integrating land carrying capacity considerations into land-use planning is essential to optimize land utilization and mitigate potential environmental impacts (Pratiwi et al. 2023). Within this context, Land Capability Unit (LCU) analysis provides an analytical framework for evaluating whether development in the Taliwang Urban Area, as a mining-influenced region, is consistent with biophysical constraints and the spatial patterns that emerge.

Urban development, particularly in small and medium sized cities, is strongly influenced by locational factors (Mardiansjah et al. 2020). Location plays a critical role in shaping urban growth dynamics, as rapid expansion of built-up areas tends to concentrate in areas traversed by major transportation corridors or primary development axes (Baga, 2015). These growth dynamics highlight the need for effective land management to support sustainable urban development (Sakti, 2016). Accordingly, this study aims to examine how land capability conditions influence the patterns and directions of urban expansion, with the objective of formulating recommendations for more integrated and sustainable urban planning. Nevertheless, empirical studies that explicitly link physical urban development patterns with land capability remain limited, thereby underscoring the relevance and contribution of this research.

MATERIALS AND METHODS

This study employed a mixed-methods (Pratiwi et al., 2023) qualitative data within a descriptive–analytical framework from a spatial perspective. Spatial analysis was applied to examine the dynamics of urban development and land capability in Taliwang District, utilizing overlay techniques and the spatial interpretation of multiple

thematic maps. The research area is located within the Taliwang Urban Area, as delineated in the Detailed Spatial Plan (RDTRK) for the 2015–2035 period. Taliwang, located in West Sumbawa Regency, West Nusa Tenggara (NTB) Province, is designated as an urban area under the NTB Provincial Spatial Plan (RTRW) 2024–2044, as Local Activity Center (PKL) Tier-1, with a primary role in supporting urban activities at the regency/municipal scale as well as across multiple sub-districts. Accordingly, the urban center serves as a key node for the provision of social, cultural, economic, and administrative services to communities throughout the regency (Anonim 2, 2024). Given that the concentration of built-up areas is not exclusively confined to specific zones within the formal urban boundary, the scope of the analysis was therefore expanded to encompass the entire administrative area of Taliwang District, as part of West Sumbawa Regency, is presented in **Figure 1** for further reference.

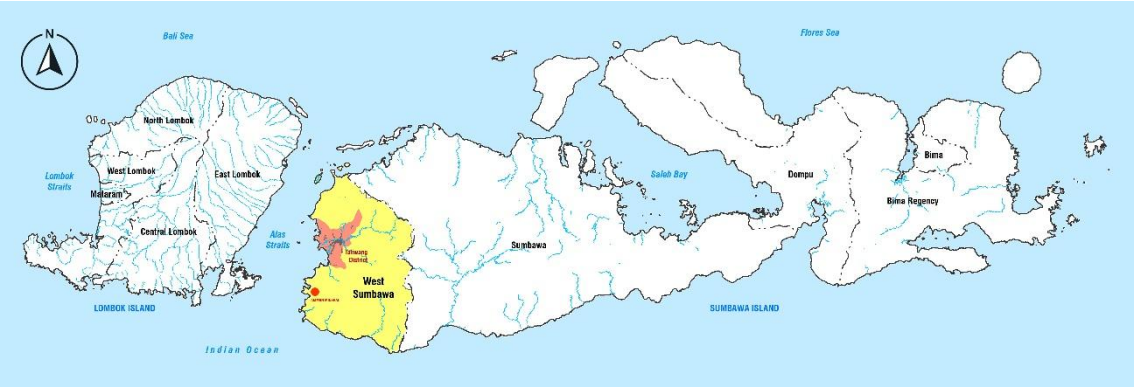

Figure 1. Taliwang's Position in the Constellation of West Sumbawa Regency and West Nusa Tenggara Province
Source: Regional Spatial Plan of West Sumbawa

Primary spatial data comprised thematic maps, including topographic maps, land-use maps, and satellite imagery, which were processed using Geographic Information System (GIS) software. Primary spatial data comprise thematic maps, including topographic maps, land use maps, and satellite imagery, processed using Geographic Information System (GIS) software. Physical land and land use maps, particularly built-up areas, are in vector format and were obtained from base maps provided by the Regional Development Planning

Agency (Bappeda) of West Sumbawa Regency, using data from 2015 and 2024 corresponding to the initial and final stages of the Taliwang Detailed Spatial Plan (RDTR), respectively, and verified by the Geospatial Information Agency of the Republic of Indonesia.

The analysis focused on nine key parameters of Land Capability Units (LCU), namely: (1) morphological conditions, (2) workability or ease of development, (3) slope stability, (4) foundation stability, (5) water availability, (6) waste management capacity, (7) drainage conditions, (8) erosion susceptibility, and (9) disaster risk.

The integration of these factors within a land unit results in distinctive characteristics that distinguish it from other land units (Primadi et al. 2022). Each parameter was assigned a specific weight and subsequently integrated to produce a composite land capability map, following the guidelines stipulated in the Regulation of the Minister of Public Works No. 20/PRT/M/2007. Land capability classification represents a systematic assessment of land components and their grouping into several categories based on inherent characteristics that reflect both the potential and constraints for sustainable land use. Accordingly, land capability is defined as the intrinsic capacity of land to support a particular type or level of general land use (Wirawan et al. 2019).

Following the application of the weighting process to each land capability unit, a land development classification was produced. This classification was derived from the total composite scores, which were subsequently grouped into several classes based on the minimum and maximum values of the aggregated scores. The class intervals were determined using the equation 1 proposed by Pratiwi et al. (2023):

$$I = R/N \quad (1)$$

I = Interval width

R = Range (maximum score – minimum score)

N = Number of intervals

Based on the weighting process and land capability assessment, the resulting land classifications are categorized as follows shown in **Table 1**:

Table 1. Land Capability Classification

Land Capability Class	Development Capability
Class I	High Development Capability
Class II	Moderately High Development Capability
Class III	Moderate Development Capability
Class IV	Low to Very Low Development Capability

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 1 presents the classification of land capability classes from which the results are derived results of the land capability analysis were compared with urban development capability, as reflected in the growth and spatial expansion of built-up areas. This comparison was conducted through a time-series analysis of built-up land-use maps (Kartikakirana, 2021) for the Taliwang Urban Area covering the period from 2014 to 2024, which was then overlay with the final LCU map. The analysis was based on observations derived from aerial photograph maps, complemented by information on urban development trends obtained from relevant spatial planning documents. Through this approach, spatial patterns of urban growth over time were systematically identified and evaluated. The overall stages of the analytical process employed in this study are illustrated in the following flowchart, shown in **Figure 2**:

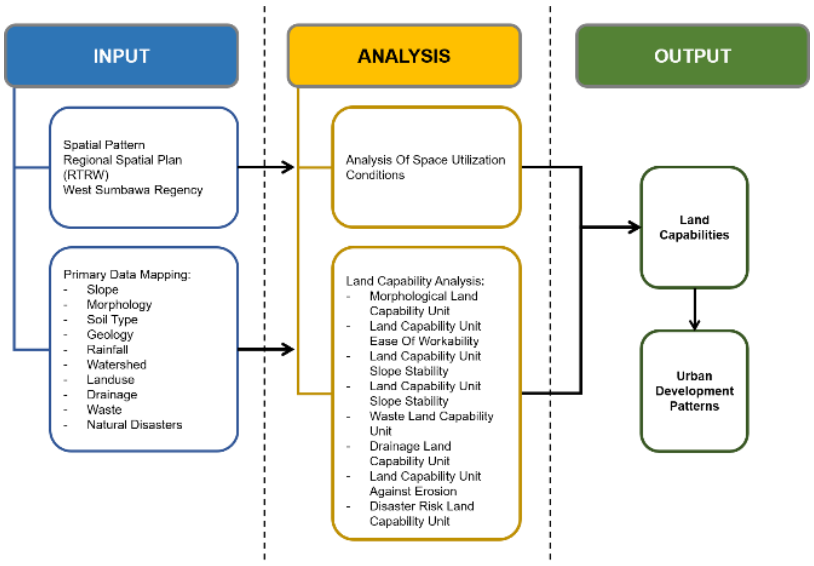

Figure 2. Flowchart of the Analytical Stages

Source: Processed by the Authors, 2025

The score classification applied in the analysis of each Land Capability Unit (LCU) includes morphology (**Table 2**), workability (**Table 3**), slope stability (**Table 4**), foundation stability land capability (**Table 5**), water availability land capability (**Table 6**), drainage land capability (**Table 7**), waste disposal land capability (**Table 8**), erosion susceptibility land capability (**Table 9**), natural hazard land capability (**Table 10**).

Table 2. Parameters and Scores of Morphological Land Capability (LCU Morphology)

Slope (%)	Score	Morphology	Score	Morphological Class	Score
0–2	5	Plain	5	High (9–10)	5
3–5	4	Gently Undulating Hills	4	Moderately High (7–8)	4
6–15	3	Moderately Hilly	3	Moderate (5–6)	3
15–40	2	Steep Hills	2	Low (3–4)	2
>40	1	Very Steep Hills	1	Very Low (1–2)	1

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 3. Parameters and Scores of Workability Land Capability (LCU Workability)

Elevation (m-asl)	Score	Slope (%)	Score	Soil Type	Score	Workability Class	Score
<500	5	0–2	5	Alluvial	5	High (11–15)	5
500–1500	4	3–5	4	Latosol	4	Moderate (7–10)	4
		6–15	3	Brown Forest Soil	3	Low (3–6)	3
1501–2500	3	15–40	2	Mediterranean Soil	2	Very Low (0–3)	2
		>40	1	Red-Yellow Podzolic			

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 4. Parameters and Scores of Slope Stability

Elevation (m-asl)	Score	Slope (%)	Score	Landform Type	Score	Workability Class	Score
<500	5	0–2	5	Plain	5	High (14–15)	5
		3–5	4	Gently Sloping	4	Moderately High (12–13)	4
500–1500	4	6–15	3	Moderately Hilly	3	Moderate (9–11)	3
		15–40	2	Steep Hills	2	Low (6–8)	2
1501–2500	3	>40	1	Very Steep Hills	1	Very Low (4–5)	1

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 5. Parameters and Scores of Foundation Stability Land Capability

Elevation (m-asl)	Score	Morphology	Score	Soil Type	Score	Foundation Stability Class	Score
<500	5	Plain	5	Alluvial	5	High (18–20)	5
	4	Gently Sloping	4	Latosol	4	Moderately High (15–17)	4
500–1500	3	Moderately Hilly	3	Brown Forest Soil	3	Moderate (11–14)	3
	2	Steep Hills	2	Mediterranean Soil	2	Low (8–10)	2
1501–2500	1	Very Steep Hills	1	Red-Yellow Podzolic	2	Very Low (5–7)	1

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 6. Parameters and Scores of Water Availability Land Capability

Watershed Condition	Score	Annual Rainfall (mm)	Score	Land Use	Score	Water Availability Class	Score
Evenly Distributed	5	4001–4500	5	Built-up Area	2	High (11–12)	5
Uneven Distribution	4	3501–4000	4	–	–	Moderate (9–10)	4
Locally Limited	3	3001–3500	3	–	–	Moderate (7–8)	3
–	–	2500–3000	2	Non-built Area	1	Low (5–6)	2

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 7. Parameters and Scores of Drainage Land Capability (SKL Drainage)

Elevation (m-asl)	Score	Slope (%)	Score	Rainfall (mm)	Score	Drainage Class	Class
<500	5	0–2	5	2500–3000	2	High	3
500–1500	4	3–5	4	3001–3500	3	Moderate	2
1501–2500	3	6–15	3	3501–4000	4	Low	1
–	–	>40	1	4001–4500	5	–	–

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 8. Parameters and Scores of Waste Disposal Land Capability

Elevation (m-asl)	Score	Slope (%)	Score	Rainfall (mm)	Score	Land Use	Score	Waste Disposal Class
<500	5	0–2	5	2500–3000	2	Built-up Area	2	High
500–1500	4	3–5	4	3001–3500	3	–	–	Moderate
1501–2500	3	6–15	3	3501–4000	4	–	–	Low
–	–	>40	1	4001–4500	5	Non-built Area	1	Very Low

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 9. Parameters and Scores of Erosion Susceptibility Land Capability

Elevation (m-asl)	Soil Type	Morphology	Slope (%)	Erosion Class
<500	Red-Yellow Podzolic	Very Steep Hills	0–2	High
500–1500	Mediterranean	Steep Hills	3–5	Moderate
1501–2500	Latosol	Moderately Hilly	6–15	Low
–	Alluvial	Plain	>40	Very Low

Source: Ministry of Public Works of the Republic of Indonesia, 2007

Table 10. Parameters and Scores of Natural Hazard Land Capability

Landslide Susceptibility	Score	Seismic Zone	Score	Natural Hazard Class
High	5	High (>0.4 g)	5	High
Moderate	4	Moderate (0.3 g)	4	Moderate
Low	3	Low (0.1–0.2 g)	3	Low
Very Low	2	–	–	Very Low

Source: Ministry of Public Works of the Republic of Indonesia, 2007

RESULTS AND DISCUSSION

Urban development patterns based on the Land Capability Unit (LCU) approach constitute an important framework in spatial planning and urban development, as this approach explicitly accounts for the capacity of land to support diverse functions, including residential, industrial, agricultural, and conservation uses. This framework is particularly relevant in the context of the study area, which exhibits heterogeneous land characteristics in terms of topography, soil conditions, natural resource availability, and mining potential, especially within West Sumbawa Regency (KSB).

Several findings derived from a literature synthesis indicate that the results of this research are consistent with Lasaiba (2024), who highlights the uncontrolled transformation of physical landscapes. Such transformations lead to a significant misalignment between actual land use and biophysical land capacity. In Taliwang, urban expansion continues to encroach upon areas characterized by low land capability, despite the fact that 51% of the region possesses relatively high capability. Furthermore, this study aligns with the findings of Baga (2015), demonstrating that the expansion of built-up areas is predominantly concentrated along major transportation corridors. In the case of Taliwang, the initial linear growth trajectory has evolved into a more fragmented or sprawling pattern often characterized as "octopus" while remaining fundamentally oriented toward the

primary road network. Consistent with Rahma Wati et al. (2024), this study confirms that urban growth in small and medium-sized cities is frequently hampered by inadequate spatial planning control mechanisms. This institutional gap is evidenced by the encroachment of residential zones into protected conservation areas in Taliwang, suggesting that land capability assessments have not been effectively integrated into formal planning processes. Consequently, these findings reinforce the argument advanced by Pratiwi et al. (2023) regarding the critical necessity of evaluating land characteristics and carrying capacity to ensure sustainable land use and mitigate future environmental degradation. Specifically, the analysis of Taliwang underscores the urgency of implementing strategic mitigation measures to address the heightened risks of pluvial flooding in lowland areas and landslides in hilly terrains.

These findings indicate that the parameters assessed in this study operate within a dynamic process shaped by multiple interacting factors, including physical land characteristics, population growth, and spatial planning policies. Collectively, these factors influence the formation of urban development patterns. Such patterns may manifest in several forms, including:

- radial development, in which urban growth expands outward from the city center following economic and social flows;
- linear development, where urban expansion occurs along transportation corridors or river systems;
- planned or clustered development, guided by spatial planning frameworks that concentrate activities within designated zones; and,
- urban sprawl, characterized by irregular and uncontrolled expansion of urban areas.

Within the framework of Land Capability Units (LCUs), urban development patterns are strongly influenced by the land's capacity to support urban functions. Areas with low land capability tend to constrain intensive infrastructure development, whereas areas with high land capability are generally more suitable and offer greater flexibility for urban expansion.

1. Land Capability Units (LCU)

Land Capability Unit (LCU) analysis is an evaluative approach used to assess the suitability of land for specific uses, including residential development, transportation infrastructure, and other spatial functions associated with built-up areas. This approach involves the systematic assessment of physical and biophysical land characteristics to determine the extent to which land can support its intended functions (Girmay et al. 2018). The results of LCU analysis are commonly expressed through numerical indices, graphical representations, or spatial maps that depict varying levels of land capability, thereby illustrating both the potential and limitations of land for different uses.

Within the context of the Taliwang Urban Area, LCU considerations provide a fundamental framework for interpreting urban development dynamics. These considerations encompass several key components, beginning with morphological land capability.

a. LCU Morphological LCU

Based on the weighted calculations and scoring of morphological land capability units, the results are presented in **Table 11**:

Table 11. Classification and Area of Morphological Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Morphological Capability Class	Area (ha)
2	5	10	Low	2,626.5
3–4	5	15–20	Moderately Low	4,417.2
5–6	5	25–30	Moderate	2,038.0
7–9	5	35–45	Moderately High	5,561.5
10	5	50	High	728.0

Source: analyzed by author, 2025

Based on **Table 11**, the morphological Land Capability Unit (LCU) of the Taliwang Urban Area is predominantly classified within the moderate category, covering approximately 5,561.5 hectares. This classification indicates that the prevailing land characteristics primarily flat to gently sloping terrain are generally suitable for supporting urban development in Taliwang. Spatially, areas classified within this category include the villages of Banjar, Batu Putih, Labuhan Kertasari, Labuhan Lalar, Lalar Liang, Seloto, Sermong, and Temekan, as well as the urban villages (*kelurahan*) of Arab

Kenangan, Bugis, Dalam, Kuang, Menala, Sampir, and Telaga Bertong. The spatial distribution of morphological Land Capability Units (LCUs) within the Taliwang Urban Area is presented in **Figure 3**.

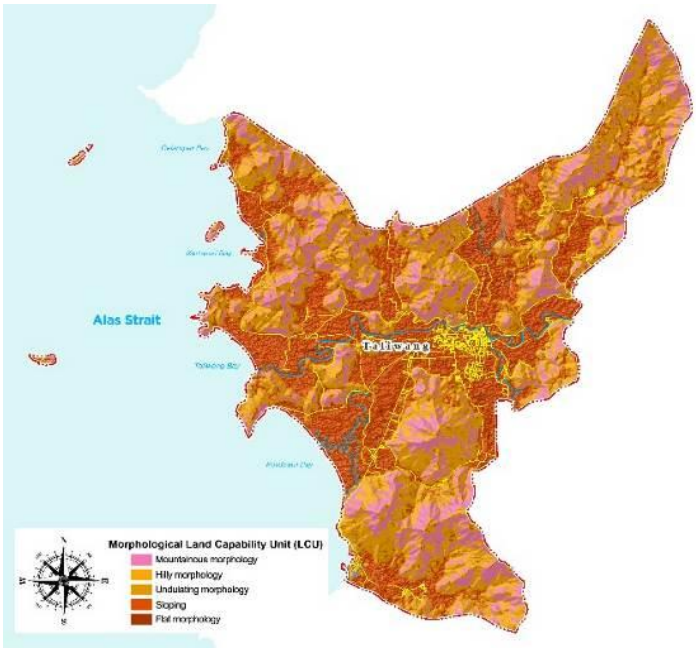

Figure 3. LCU – Morphology

Source: analyzed by author, 2025

Based on the land capability map for the morphological aspect shown in **Figure 3**, the central and northern parts of the district are predominantly characterized by flat to gently sloping topography, which is physically suitable for the development of residential areas and public facilities. In contrast, the hilly areas in the southern and southeastern parts of the district exhibit greater development constraints due to steeper slopes and increased susceptibility to landslides.

b. LCU Ease of Development

The results of the weighted calculation and scoring for the Ease of Development LCU are presented in **Table 12**:

Table 12. Classification and Area of Workability Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Workability Capability Class	Area (ha)
8–10	1	8–10	Moderate	5,714.0
11–15	1	11–15	High	9,657.2

Source: analyzed by author, 2025

The ease of land development constitutes a critical indicator in spatial planning. Areas with high ease of development values are predominantly concentrated in flat zones surrounding the urban core. This spatial pattern corresponds closely with the distribution of existing built-up areas, which tend to develop in zones characterized by the highest levels of development feasibility. However, several newly developed residential areas have expanded into land with moderate to low ease of development values, indicating increasing development pressure that exceeds optimal physical capacity. In general, the simulation results presented in the land development ease map indicate the dominance of land classified as having a high ease of development, covering an area of 9,657.2 hectares. The spatial distribution of the Ease of Development Land Capability Unit (LCU) is illustrated in **Figure 4**.

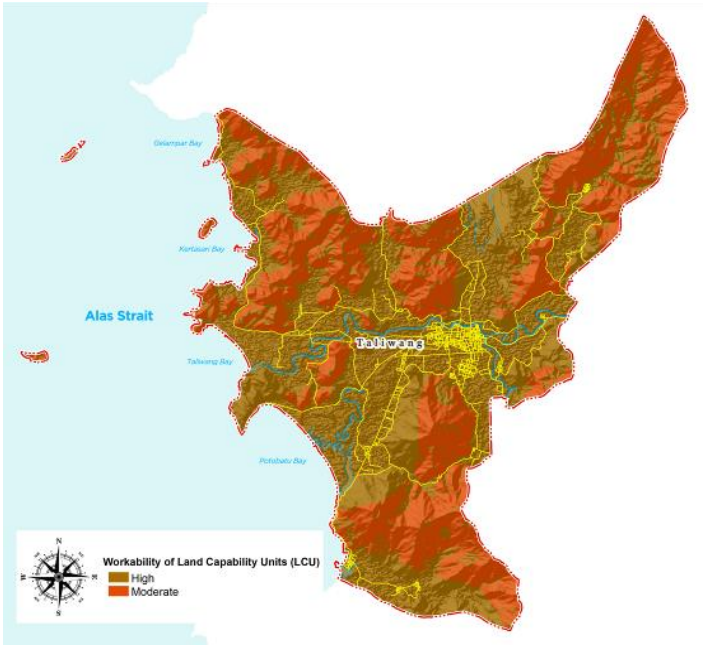

Figure 4. LCU – Ease of Development
Source: analyzed by author, 2025

c. LCU Slope Stability

Based on the weighted calculations and scoring of the Slope Stability Land Capability Unit (LCU), the results are presented as follows:

Table 13. Classification and Area of Slope Stability Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Slope Stability Class	Area (ha)
6–8	5	30–40	Low	3,803.7
9–11	5	45–55	Moderate	5,283.2
12–13	5	60–65	Moderately High	3,284.3
14–15	5	70–75	High	3,000.0

Source: analyzed by author, 2025

According to the data presented in **Table 13**, slope stability index is predominantly classified within the moderate category, covering an area of approximately 5,283.2 hectares characterized by moderately hilly terrain. This level of slope stability indicates that the Taliwang Urban Area is generally stable and relatively safe for urban development, with a low risk of land mass movement hazards such as landslides. The spatial distribution of LCU slope stability is shown in **Figure 5**.

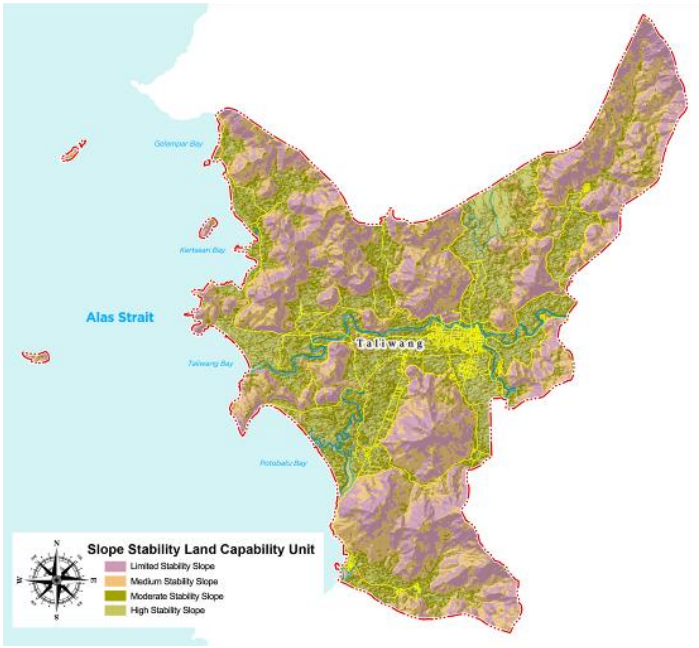

Figure 5. LCU – Slope Stability

Source: analyzed by author, 2025

d. LCU Foundation Stability

Based on the weight calculation and assessment of the Foundation Stability Land Capability Unit (LCU), the results are shown in **Table 14**:

Table 14. Classification & Area of Foundation Stability Land Capability

Total Score	Weight	Weighted Score	Foundation Stability Class	Area (ha)
9–10	3	27–30	Low	2,190.9
11–14	3	33–42	Moderate	6,354.8
15–17	3	45–51	Moderately High	3,995.0
18–20	3	54–60	High	2,830.5

Source: analyzed by author, 2025

Base on foundation stability aspect, the analysis indicates that the Taliwang Urban Area is predominantly classified within the moderate category, covering approximately 6,354.8 hectares. Areas included in this classification encompass the villages of Banjar, Batu Putih, Labuhan Kertasari, Labuhan Lalar, Lalar Liang, Seloto, Sermong, and Temekan, as well as the urban villages (kelurahan) of Bugis, Dalam, Kuang, Menala, Sampir, and Telaga Bertong. These areas exhibit relatively stable foundation characteristics, rendering them generally suitable for high-intensity development. However, in areas with relatively steep slopes, uneven foundation conditions have been identified, which may adversely affect building construction. Therefore, a geological assessment is required prior to the issuance of building permits in these areas. **Figure 6** presents the foundation stability LCU map of the Taliwang Urban Area.

e. LCU Water Availability

The results of the weighted calculations and scoring of the Land Capability Units for Water Availability (LCU) are presented in **Table 15**:

Table 15. Classification and Area of Water Availability Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Water Availability Class	Area (ha)
5–6	5	25–30	Low	3,024.1
7–8	5	35–40	Moderate	4,709.2
9–10	5	45–50	Moderately High	2,020.7
11–15	5	55–75	High	5,617.2

Source: analyzed by author, 2025

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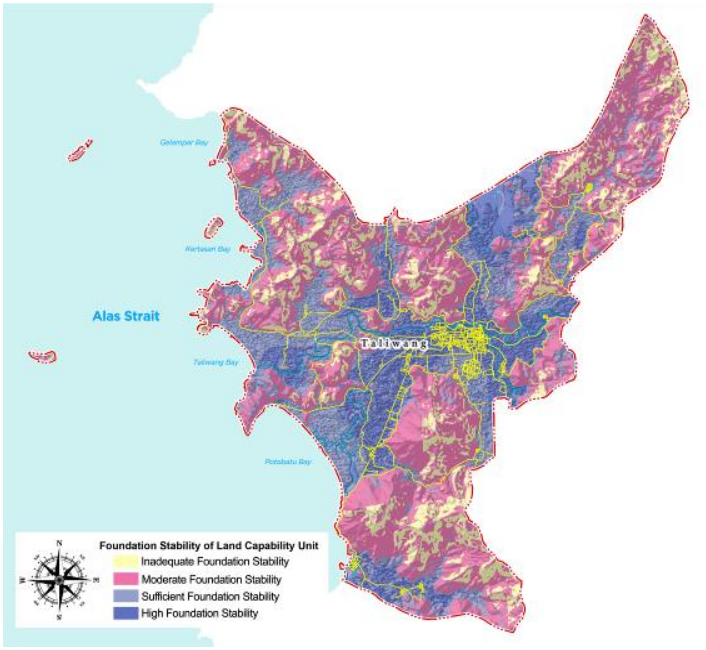

Figure 6. LCU – Foundation Stability
Source: analyzed by author, 2025

In terms of water availability parameters, the analysis indicates that the Taliwang Urban Area is predominantly characterized by a very high-water availability classification, covering approximately 5,617.2 hectares. These areas are mainly located in close proximity to the Brang Rea River, which provides a reliable water supply throughout the year. This condition constitutes a significant advantage for the development of new residential areas as well as for intensive agricultural activities.

Conversely, as built-up areas expand, the potential for reduced groundwater recharge becomes increasingly evident, particularly in the city center, where the proliferation of impervious surfaces is intensifying. The spatial distribution of water availability across Land Capability Units (LCUs) in the Taliwang Urban Area is illustrated in **Figure 7**.

f. LCU Drainage

Based on the weighted calculations and scoring of the Drainage Land Capability Unit (LCU), the results are presented as follows:

Table 16. Classification and Area of Drainage Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Drainage Capability Class	Area (ha)
7–11	5	35–55	Moderately High	9,785.0
12–13	5	60–65	High	5,586.0

Source: analyzed by author, 2025

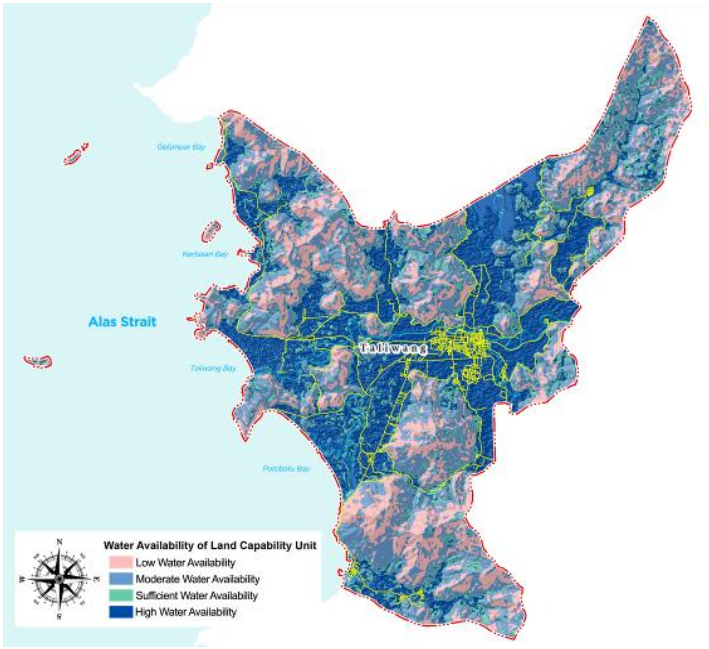

Figure 7. LCU – Water Availability

Source: analyzed by author, 2025

The results presented in **Table 16**, indicate that drainage capacity in the Taliwang Urban Area is predominantly classified as moderate, covering approximately 9,785 hectares, while areas with high drainage capacity account for about 5,586 hectares. These areas are primarily located in the lowland zones of the central and eastern parts of the city, indicating a considerable potential for surface water inundation due to limited natural drainage capacity. This condition is further exacerbated by the rapid expansion of residential areas that has not been accompanied by the development of adequate artificial drainage systems. If left unmanaged, the risk of urban flooding is likely to increase substantially, particularly during the rainy season. The spatial distribution of the drainage Land Capability Unit (LCU) in the Taliwang Urban Area is illustrated in **Figure 8**.

g. LCU Erosion Susceptibility

Based on the weighted calculations and scoring of the Erosion Susceptibility Land Capability Unit (LCU), the results are presented as follows:

Table 17. Classification and Area of Erosion Susceptibility Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Erosion Susceptibility Class	Area (ha)
7–10	3	21–30	High	6,784.0
11–18	3	33–54	Low	2,292.0

Source: analyzed by author, 2025

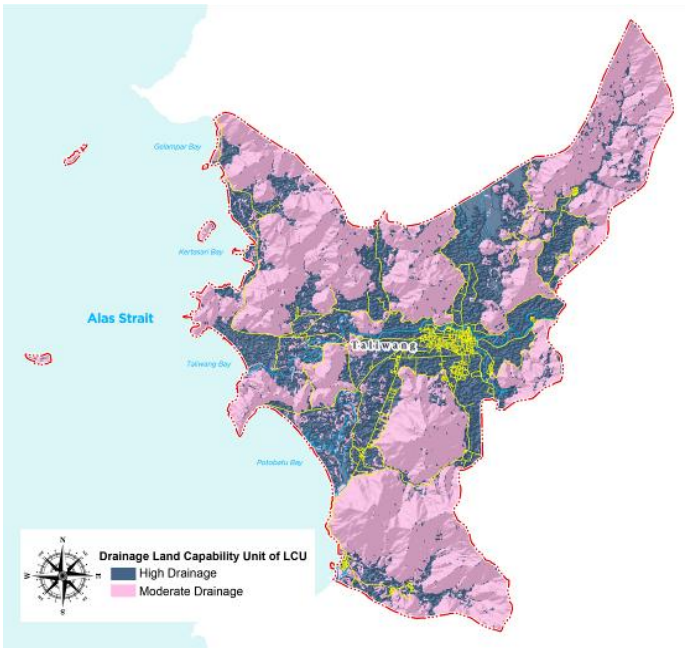

Figure 8. LCU – Drainage

Source: analyzed by author, 2025

Erosion vulnerability constitutes a critical concern in this study. As shown in **Table 17**, approximately 6,784 hectares of the study area fall within the high erosion vulnerability category. These areas are predominantly located in the southwestern hilly zone of Taliwang, which is characterized by steep slopes and limited vegetation cover. Such physical conditions substantially increase the risk of soil loss and land degradation if development activities are not properly managed.

Consequently, these areas should be designated as protected zones, with priority given to the implementation of sustainable soil and vegetation conservation measures. This approach is essential for mitigating erosion

hazards, maintaining environmental stability, and supporting long-term land sustainability. **Figure 9** illustrates the spatial distribution of erosion susceptibility within the Taliwang Urban Area.

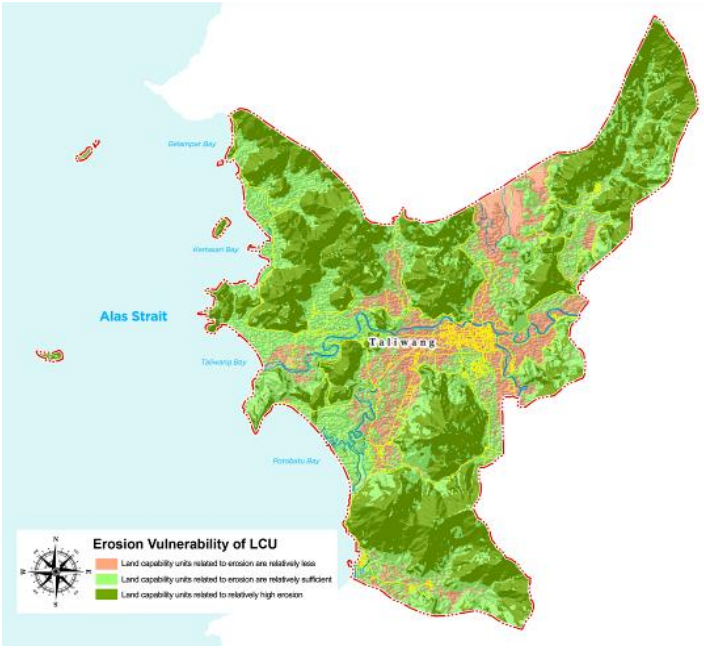

Figure 9. LCU – Erosion Susceptibility

Source: analyzed by author, 2025

h. LCU Waste Disposal

Based on the weighted calculation and scoring of the Waste Disposal Land Capability Unit (LCU), the Taliwang Urban Area is predominantly characterized by moderate land capability for waste disposal, covering approximately 4,709 hectares. This classification indicates that the prevailing physical land conditions are reasonably supportive of waste disposal activities and capable of accommodating waste containment and management functions. The results of the weighted calculation and assessment of the Waste Disposal Land Capability Unit (LCU) are presented in **Table 18**:

Table 18. Classification and Area of Waste Disposal Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Waste Disposal Capability Class	Area (ha)
5–6	0	0	High	3,024.0
7–8	0	0	Moderately High	4,709.0
9–10	0	0	Moderate	2,627.0
11–12	0	0	Low	3,310.0
13–15	0	0	Very Low	2,307.0

Source: analyzed by author, 2025

Certain parts of the study area exhibit moderate waste disposal capacity, indicating their potential suitability for accommodating waste management infrastructure. However, the development of such facilities must be supported by an integrated planning approach and the implementation of environmentally friendly management practices to ensure long-term ecological sustainability. In the absence of an effective waste management system supported by adequate regulatory implementation, the expansion of waste disposal activities in these areas may exacerbate environmental degradation and pose risks to public health. **Figure 10** illustrates the spatial distribution of waste disposal land capability within the Taliwang Urban Area.

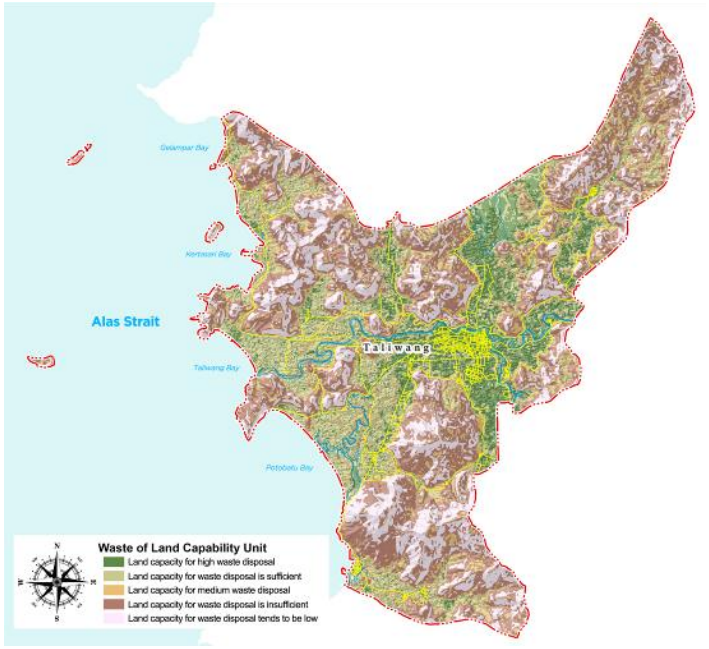

Figure 10. LCU – Waste Disposal
Source: analyzed by author, 2025

i. Disaster Risk Land Capability Unit (LCU)

The weighting and assessment calculations of the Disaster Risk Land Capability Unit (LCU) in **Table 19**, show various levels of land capability in relation to the potential for natural disasters in the Taliwang Urban Area.

Table 19. Classification and Area of Natural Hazard Land Capability in Taliwang Urban Area

Total Score	Weight	Weighted Score	Natural Hazard Risk Class	Area (ha)
3–6	5	15–30	Low Risk	10,368.8
7–8	5	35–40	Moderate Risk	4,954.5

Source: analyzed by author, 2025

Disaster risk in Taliwang is predominantly classified as low, with approximately 10,368 hectares falling within this category. This condition underscores the importance of implementing effective development control strategies to ensure that urban expansion remains aligned with land capability constraints. Although most of the Taliwang Urban Area is relatively safe from tectonic hazards, hydrometeorological risks especially flooding and landslides remain significant in areas with unstable landforms and inadequate drainage. Therefore, future spatial development should be directed toward safe and stable zones, as identified through the composite land capability classification, in order to minimize disaster risk and support sustainable urban growth. The spatial distribution of Disaster Risk Land Capability Unit (LCU) in the Taliwang Urban Area is illustrated in **Figure 11**.

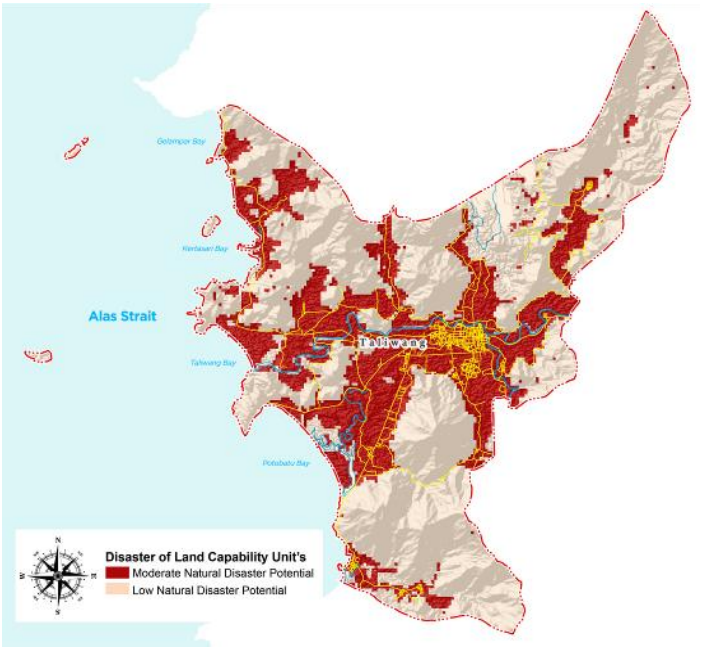

Figure 11. LCU – Disaster Risk

Source: analyzed by author, 2025

Data analysis was performed using spatial analysis techniques to produce spatial (geographic) data and information through the application of Geographic Information Systems (GIS) (Natalia et al. 2024). Based on the results of the overlay analysis applied to the weighted evaluation of each Land Capability Unit (LCU) criterion, as outlined in the analytical workflow in **Figure 2**, A total score was calculated for each spatial unit and used to classify urban areas into development capability classes based on established score ranges. Overall scores range from 59 to 134. On the basis of this range, urban land development capability can be classified into (3) three categories:

1) Low development capability, with scores ranging from 59 to 83;
2) Moderate development capability, with scores ranging from 84 to 109;
3) Relatively high development capability, with scores ranging from 110 to 134.

As the capital of West Sumbawa Regency, Taliwang District exhibits land development capability that is predominantly classified as moderate to relatively high. Approximately 51% of the district area falls within the relatively high development capability category, while 42% is classified as having moderate development capability. Areas with low development capability account for only 7% of the total district area.

A more detailed examination indicates that current land development patterns in Taliwang generally comply with several land capability criteria. However, the scoring results reveal that certain aspects remain insufficient to support higher development intensity in the future. These limitations are particularly evident in urban development capacity, infrastructure provision, and the adequacy of residential facilities and services. Accordingly, targeted interventions are required to enhance overall land capability and to ensure sustainable urban growth.

To provide a comprehensive overview of the overlay results derived from nine (9) Land Capability Units (LCUs), a spatial synthesis is presented in the LCU Analysis Summary Map, is presented in **Figure 12**.

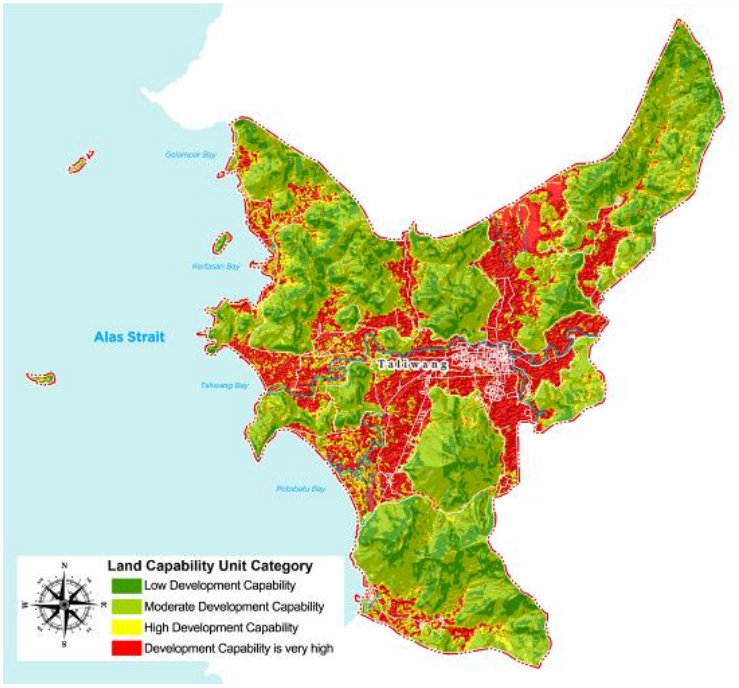

Figure 12. LCU of Taliwang District

(Source: analyzed by author, 2025)

2. Urban Development Pattern of Taliwang

The pattern of urban development in Taliwang District exhibits dynamic changes shaped by the interplay of geographical conditions, economic drivers, and regional development policies. As the administrative center of West Sumbawa Regency, Taliwang serves as a primary hub for economic and social activities, a role that has significantly accelerated urban growth and spatial transformation. As emphasized by Astuti et al. (2024), demographic dynamics, along with social, economic, political, and cultural processes, significantly influence the configuration and structure of urban areas.

An analysis of land use change patterns was conducted through a comparative assessment of historical land use and existing land use conditions, with the aim of identifying spatial dynamics during the 2014–2024 period. This approach allows for a comprehensive evaluation of land use changes over a ten-year timeframe and facilitates the identification of dominant trends in land conversion processes.

The observed land use changes over this decade are expected to reveal systematic patterns of urban expansion, including the direction, intensity, and form of land

development. These patterns provide a critical basis for understanding the trajectory of urban growth in Taliwang and for evaluating the extent to which such development aligns with land capability characteristics and established spatial planning objectives, as illustrated by the simulation shown in **Figure 13**.

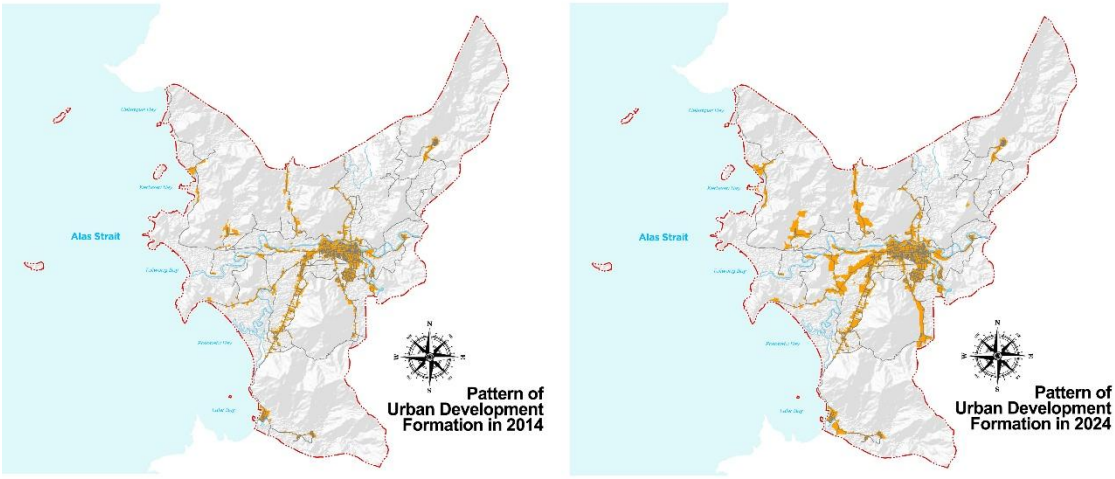

Figure 13. Urban Development Pattern

Source: Authors' Analysis

Based on the analysis of urban growth directions and development trends, the urban development pattern of Taliwang has undergone a notable transformation. Initially characterized by a linear growth pattern, urban expansion has progressively shifted toward a dispersed, multi-directional form, commonly described as an octopus-like growth pattern, as shown in **Figure 14**.

Primary growth centers remain concentrated along the main road network, indicating the persistent influence of transportation infrastructure on urban expansion. However, this outward growth has increasingly encroached upon areas with moderate to low land capability, suggesting a growing mismatch between spatial land use patterns and the physical carrying capacity of the land. This misalignment highlights emerging land management challenges and underscores the need for stronger integration of land capability assessments into urban spatial planning to promote sustainable development.

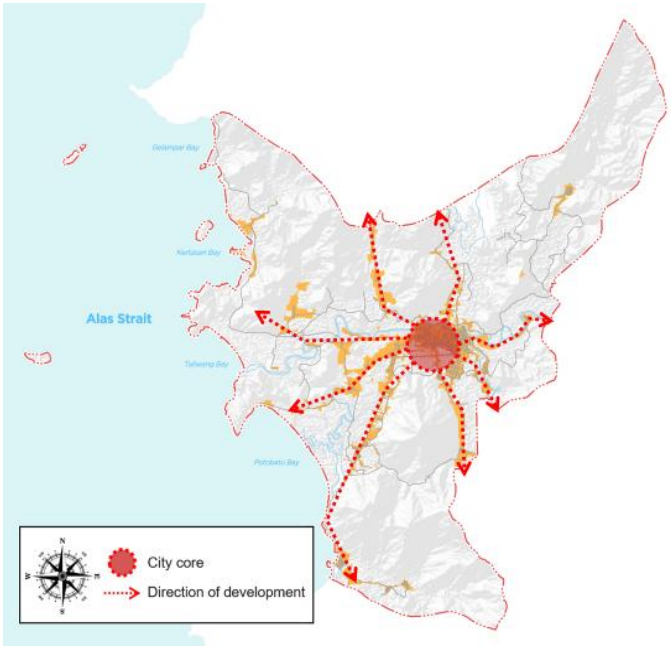

Figure 14. Urban Spatial Expansion Trends

Source: Authors' Analysis

Based on observed trends in urban development pattern formation, the findings indicate that spatial changes in Taliwang District are strongly influenced by land use classification, which comprises five principal components:

- Urban/Residential Areas, including residential settlements, government and administrative offices, educational institutions, religious facilities, healthcare
- facilities, urban green open spaces, vacant land, and commercial and service areas;
- Industrial Areas, consisting of designated industrial zones;
- Agricultural Land, primarily dryland agriculture;
- Plantation Areas, encompassing plantation land uses; and
- Water Bodies, including rivers, reservoirs, and lakes.

Overall, the urban development pattern in Taliwang District reflects the outcome of interactions among multiple interrelated factors. The combined effects of infrastructure expansion, increasing local economic activity, spatial planning interventions, and adaptation to geographic conditions have collectively shaped the current urban form and structure. Although this growth has generated positive economic impacts, inadequate implementation of spatial governance grounded in geospatial data may result in land

fragmentation, spatial conflicts, and infrastructure inefficiencies.

The GIS-based analysis integrating urban expansion dynamics with land capability characteristics indicates that urban development in Taliwang District, West Sumbawa Regency, retains substantial potential for sustainable management in the medium to long term. However, a careful examination of the overlay between the land capability map and the 2024 built-up area map, shown in **Figure 15**, reveals several areas where the direction of development is inconsistent with land capability. Notably, areas designated for conservation purposes have begun to undergo conversion into residential uses. This pattern suggests that current spatial planning and development control mechanisms have not yet been fully aligned with land capability considerations. Although the extent of these inconsistencies remains relatively limited, their emergence highlights the need for stronger integration of land capability evaluations into spatial planning frameworks to prevent more extensive land-use conflicts in the future.

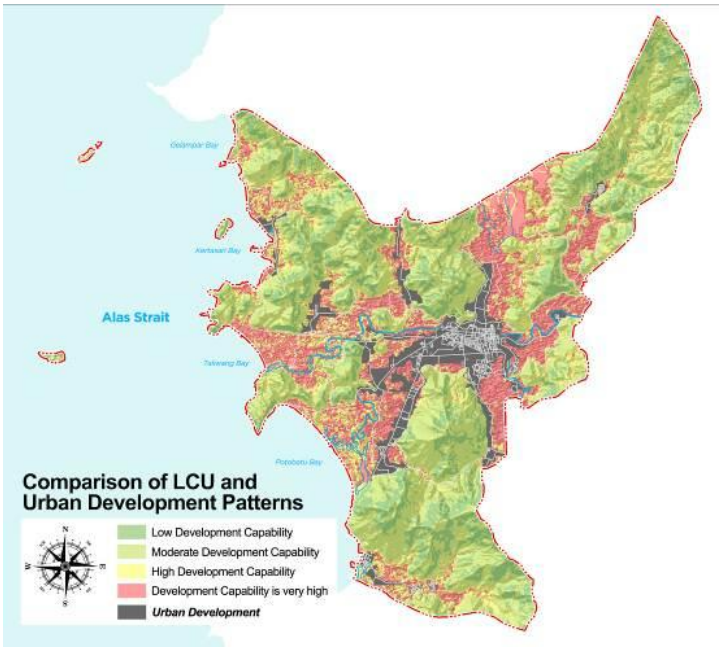

Figure 15. Comparison between Land Capability Units (LCU) and Urban Development Patterns

Source: Analysis Results

CONCLUSIONS

The majority of Taliwang District exhibits land capability conditions that are generally suitable for development; however, this potential must be supported by careful, evidence-based spatial planning. The findings reveal that 51% of the area falls within zones of moderately high land capability, while current development trends have also encroached upon areas characterized by low land capability. This spatial mismatch presents substantial risks of environmental degradation and spatial inefficiency.

These findings highlight the necessity for future development in Taliwang to adopt a land suitability–based planning approach, in which biophysical land characteristics constitute a primary consideration in spatial decision-making processes. Such an approach is essential to ensure environmental sustainability and to mitigate disaster-related risks. In the absence of systematic integration of land capability assessments into urban development control, ecological pressures and the risk of environmental degradation are likely to intensify alongside uncontrolled physical urban expansion.

For future research, it is recommended that more in-depth analyses be conducted on land use dynamics in mining-influenced areas, particularly by incorporating land price escalation as a key variable in the context of West Sumbawa Regency. This perspective would enable a more comprehensive understanding of the socio-economic drivers underlying land conversion processes and urban expansion in mining-oriented regions.

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