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THE ANALYSIS OF LAND SUITABILITY FOR SUSTAINABLE SETTLEMENT DEVELOPMENT IN KABUPATEN MANOKWARI, PROVINSI PAPUA BARAT

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Abstract: The imbalance between population growth and residential land use by the Spatial Plan and land characteristics has given rise to various problems in Kabupaten Manokwari, including changes in land use and environmental degradation. This study analyzes land suitability as a basis for sustainable settlement development in Kabupaten Manokwari. The research method uses weighting analysis, LCU (Land Capability Unit) overlay, and settlement carrying capacity analysis. The results of the study indicate that (a) Based on the land capability analysis, land development in Kabupaten Manokwari that can be used as a settlement development area is class d and e because it has a flat topography contour and can be developed with a maximum land cover of 70% of the area with an area of 103,053.42 Ha and 44,736.64 Ha respectively; (b) The land carrying capacity of the settlement development area in Kabupaten Manokwari is 3,662.02 Ha; and (c) Sustainable settlement development in Kabupaten Manokwari based on physical components that the direction of raw water utilization in Kabupaten Manokwari is very good with an area of 147,790.06 ha, this shows that for Kabupaten Manokwari there are no obstacles in the utilization of raw water because it has water sources that can be utilized as raw water sources. These findings provide strategic recommendations for the development of residential areas by considering environmental and socio-economic sustainability aspects and supporting the achievement of SDGs goals, especially related to the availability of clean water and sanitation.

Keywords: settlement, land suitability, land capability

INTRODUCTION

Settlement is an activity that dominates land use both in cities and suburbs. The irregular development of settlements on the city's outskirts results in urban sprawl, which is called urban sprawl (Andari et al., 2022). Settlement is one of the basic human needs that must be fulfilled so humans can prosper and live decently according to their human dignity (Sasongko et al., 2022).

Land suitability is the level of suitability of a type of land for a particular use, which is assessed based on an analysis of land quality related to the requirements of a particular type of use so that suitable quality will provide a high land value or class for a particular type of use (Djohan et al., 2024). Land suitability has several purposes including identifying, comparing various land uses to be developed, and determining the potential value of land (Dwi et al., 2022).

Land management and planning are very important to pay attention to land suitability, in addition to referring to the detailed spatial plan in the area. Land with characteristics and quality that are appropriate for its use will have a high value, compared to land that has characteristics and quality that are lacking or even unsuitable for its use. Along with the increasing population every year, analyzing the suitability of residential land is very urgent. The provision of these settlements is the responsibility of the government, private sector, and community, therefore settlement development must be supported by various

policies that concern various aspects and must be accompanied by a good approach (Mendiyani, 2023).

Kabupaten Manokwari Regency is the capital of Provinsi Papua Barat which has the potential for rapid development in recent years. In the Draft Spatial Plan for Kabupaten Manokwari Regency 2024-2024, Kabupaten Manokwari is directed to develop industrial areas, agricultural areas, plantation areas, and tourism areas that directly impact economic growth that will cause population migration to Kabupaten Manokwari resulting in significant population growth that directly impacts the need for residential land.

Based on data from the Central Statistics Agency of Kabupaten Manokwari, population growth from 2018-2022 was 27,765 people or 13.8% with a population in 2022 of 200,785 people (Manokwari in Figures, 2022), the high population growth in Kabupaten Manokwari is one of the main problems in settlement development. In the Decree of the Regent of Manokwari Number: 653.2 / 135 / VII / 2019 there are 21 slum areas with an area of 166.81 Ha, population growth that is not balanced with many residents who use land for settlements that are not according to the City Spatial Plan and the characteristics of the designated residential land so that changes in land use occur which will affect spatial patterns and create various city problems such as dense housing, slums and illegal housing, land deviations and declining environmental quality, especially in coastal areas.

Several factors that need to be considered in determining the location of residential development include slope, drainage, erosion, topography, water availability, accessibility and the availability of other supporting infrastructure. This is appropriate to the research (Prabandari & Wibowo, 2024) and (Prasetya & Wibowo, 2024) that the analysis of the suitability of residential land takes into account the slope factor. Furthermore, according to research (Dien et al., 2018) the suitability of land for the development of residential areas uses the variables of the slope, rainfall intensity, vulnerability to erosion, landslide-prone, and soil type. Kabupaten Manokwari as a geographically diverse area and has a coastal area, requires in-depth analysis to understand the characteristics of each potential location for residential development.

This study discusses morphology, slope gradient, slope stability, water availability, foundation stability, drainage, erosion, waste disposal, and natural disasters analyzed through land development capability, land suitability, and land carrying capacity. Thus, this study aims to conduct a land suitability analysis as a basis for determining the location of sustainable settlement development in Kabupaten Manokwari. Land suitability analysis is important to minimize negative impacts on the environment and ensure the sustainability of settlement development in the long term. The results of this study are expected to provide recommendations that can be used as a reference in decision-making related to settlement development in Kabupaten Manokwari by paying attention to aspects of sustainability and environmental impacts.

LITERATURE REVIEW

Land suitability is an evaluation to determine whether a land use is appropriate to the designated designation and follows applicable directives. Meanwhile, land suitability classification is the process of matching land quality with the needs or requirements for a particular type of land use (Salsabila et al., 2023).

Land suitability classes are subdivisions of an Ordo that indicate the level of suitability within an Ordo. These suitability levels are identified by a sequential number added after the Ordo symbol. The number indicates a class hierarchy, where higher values indicate lower levels of suitability. In general, it is recommended to use two class levels in an S Ordo, namely S1 and S2, and two class levels in an N Ordo, namely N1 and N2 (Salsabila et al., 2023). Land capability classification aims to group land into certain units based on its potential for

optimal use and the treatment required for sustainable use (Ahmadi, 2023).

Based on the Regulation of the Minister of Spatial Planning No. 20 of 2007 concerning Guidelines for Analysis of Physical & Environmental, Economic and Socio-Cultural Aspects in the Preparation of Spatial Planning, it is explained that the Land Capability Unit (SKL) consists of several SKLs, including (Pertiwi et. al, 2021):

a) Land Capability Unit Morphology

Analysis of Morphological Land Capability Units (LCU) is the process of sorting out the natural landscape/ morphology forms in a region and/or planning area that are capable of being developed according to their function.

Table 1. Morphology SKL Weighting

Slope (%)	Mark	Morphology	Mark	LCU Morphology	Mark
0-2	5	Plains	5	Low (9-10)	5
2-5	4	Sloping	4	Less (7-8)	4
5-15	3	Medium Hills	3	Medium (5-6)	3
15-40	2	Steep Mountains/Hills	2	Enough (3-4)	2
>40	1	Very Steep Mountains/Hills	1	Height (1-2)	1

Source : (Pertiwi et. al, 2021)

b) Land Capability Unit Ease of Work

The Land Capability Unit (LCU) Ease of Work analysis aims to determine the level of ease of land in a region or area to be excavated/developed in the process of building and developing the area.

Table 2. The weighting of Land Capability Unit (LCU) Ease of Work

Height	Mark	Slope (%)	Mark	Soil Type	Mark	LCU Ease of Work	Mark
<500	5	0-2	5	Alluvial	5	Height (11-15)	5
		2-5	4	Latosol	4	Enough (7-10)	4
500-1500	4	5-15	3	Brown Forest, Mediterranean	3	Less (3-6)	3
		15-40	2				
1500-2500	3	>40	1	Red Yellow Podsol	2	Low (0-3)	2

Source : (Pertiwi et. al, 2021)

c) Land Capability Unit Slope Stability

Land Capability Unit (LCU) Slope Stability Analysis aims to determine the level of slope stability in the development area in receiving loads. This analysis is carried out by combining data from topographic maps, slope maps, and morphological maps.

Table 3. The weighting of Land Capability Unit (LCU) Slope Stability

Height	Mark	Slope (%)	Mark	Morphology	Mark	LCU Slope Stability	Mark
<500	5	0-2	5	Plains	5	Height (14-15)	5
		2-5	4	Sloping	4	Enough (12-13)	4
500-1500	4	5-15	3	Medium Hills	3	Medium (9-11)	3
		15-40	2	Steep Mountains/Hills	2	Less (6-8)	2
1500-2500	3	>40	1	Very Steep Mountains/Hills	1	Low (4-5)	1

Source : (Pertiwi et. al, 2021)

d) Land Capability Unit Foundation Stability.

The LCU analysis of foundation stability aims to determine the level of land capacity to support heavy buildings in urban development, as well as the types of foundations that are suitable for each level.

Table 4. Land Capability Unit (LCU) Weighting of Foundation Stability

Height	Mark	Slope	Mark	Morphology	Mark	Type Land	Mark	SKL Foundation Stability	Mark
<500	5	0-2	5	Plains	5	Alluvial	5	Height (18-19)	5
		2-5	4	Sloping	4	Latosol	4	Enough (15-17)	4
500-1500	4	5-15	3	Medium Hills	3	Mediterranean, Brown Forest	3	Medium (11-14)	3
		15-40	2	Mountains/ Steep Hills	2			Less (8-10)	2
1500-2500	3	>40	1	Mountains/ Very Steep Hills	1	Red Yellow Podsol	2	Low (5-7)	1

Source : (Pertiwi et. al, 2021)

e) Land Capability Unit Water Availability.

The Land Capability Unit (LCU) Water Availability Analysis aims to determine the level of water availability and water supply capacity at each level, for regional development.

Table 5. Weighting of Land Capability Unit (LCU) Water Availability

Watershed Map	Mark	Rainfall Map	Mark	Land Use Map	Mark	SKL Availability Water	Mark
Good evenly	5	4000-4500 mm	5	Awake	2	Height (11-12)	5
		3500-4000 mm	4			Enough (9-10)	4
Good not evenly distributed	4	3000-3500 mm	3	Non Awake	1	Medium (7-8)	3
Limited local	3	2500-3000 mm	2			Less (5-6)	2

Source : (Pertiwi et. al, 2021)

f) Land Capability Unit (LCU) Drainage

Land Capability Unit (LCU) analysis for drainage aims to determine the level of land capacity to drain rainwater naturally so that the possibility of local or widespread puddles can be avoided.

Table 6. Drainage Land Capability Unit (LCU) Weighting

Height	Mark	Slope	Mark	Rainfall	Mark	SKL Drainage	Mark
<500	5	0-2%	5	4000-4500 mm	5	Low (12-14)	5
		2-5%	4	3500-4000 mm	4	Enough (6-11)	3
500-1500	4	5-15%	3	3000-3500 mm	3		
		15-40%	2			Height (3-5)	1
1500-2500	3	>40%	1	2500-3000 mm	2		

Source : (Pertiwi et. al, 2021)

g) Land capability unit against erosion

LCU Analysis Against Erosion aims to identify areas experiencing soil erosion so that the level of land resistance to erosion can be determined and its impact on downstream areas can be anticipated.

Table 7. Weighting of Land Capability Unit (LCU) Erosion

Rainfall	Mark	Soil Type	Mark	Morphology	Mark	Slope	Mark	SKL Erosion	Mark
4000-4500 mm	5	Alluvial	5	Plains	5	0-2%	5	There isn't any (16-20)	5
3500-4000 mm	4	Latosol	4	Sloping	4	2-5%	4	Low (12-15)	4
3000-3500 mm	3	Mediterranea, Brown Forest	3	The Hills Currently	3	5-15%	3	Currently (8-11)	
				Mountains/ Steep Hills	2	15-40%	2	Enough (4-7)	3
2500-3000 mm	2	Red Yellow Podsol	2	Very Steep Mountains/ Hills	1	> 40%	1	Height (0-3)	2

Source : (Pertiwi et. al, 2021)

h) Land Capability Unit for waste disposal

The purpose of the LCU Waste Disposal Analysis is to identify areas that can be used as final storage and waste processing locations, both solid and liquid waste.

Table 8. Weighting of Land Capability Unit (LCU) Waste Disposal

Height	Mark	Slope	Mark	Rainfall	Mark	Land Use	Mark	SKL Waste Disposal	Mark
<500	5	0-2%	5	4000-4500 mm	5	Awake	2	Height (13-15)	5
500-1500	4	2-5%	4	3500-4000 mm	4			Enough (11-12)	4
1500-2500	3	5-15%	3	3000-3500 mm	3	Not awake	1	Medium (9-10)	3
		15-40%	2	2500-3000 mm	2			Less (7-8)	2
		>40%	1					Low (4-6)	1

Source : (Pertiwi et. al, 2021)

i) Land Capability Unit (LCU) Against Natural Disasters. LCU analysis of natural disasters aims to determine the level of land capacity to receive natural disasters, especially from a geological perspective, to avoid/reduce losses from victims of the disaster.

Table 9. Land Capability Unit (LCU) Weighting of Natural Disasters

Land Movement	Mark	Earthquake Prone	Mark	SKL Natural Disasters	Mark
Tall	5	High Zone > 0.4 g	5	Height (9-10)	5
Intermediate	4	Moderate Zone 0.3-0.4 g	4	Medium (7-8)	4
Low	3	Low Zone 0.1-0.2 g	3	Low (5-6)	3
Very low	2				

Source : (Pertiwi et. al, 2021)

j) Land Development Capability

This analysis is carried out to obtain an overview of the level of land capability to be developed as an illustration of sustainable city development. Land capability analysis is also used as a reference for land suitability directions in the next analysis stage.

Table 10. Land Development Capability

Total Value	Land Capability Classification	Development Classification
32 - 58	Class A	Very Low Development Ability
59 - 83	Class B	Low Development Ability
84 - 109	Class C	Medium Development Ability
110 -134	Class D	Somewhat High Development Ability
135 -160	Class E	Very High Development Ability

Source : (Pertiwi et. al, 2021)

Settlements are part of the living environment outside protected areas in the form of urban or rural areas which function as residential environments and places for activities that support life and livelihood, which are equipped with facilities and infrastructure so that the function of the settlement can be effective and beneficial (Risnawati, 2020). Residential areas have several basic physical requirements, namely (Ayat & Jonizar, 2020) :

1. Accessibility, namely the possibility of reaching and from the residential area.
2. Compatibility, suitability, and integration between the areas that constitute its environment.
3. Flexibility, the possibility of physical growth or expansion of residential areas is linked to the physical conditions of the environment and the integration of facilities.
4. Ecology, namely the integration between the natural activity system and the environment that contains it.

Demographic factors, especially population, play a major role in assessing the carrying capacity of settlements. In addition to population, another important variable is population growth. Population growth is used to project the population in the future (Ramadan, 2021). So that it can be known how much land is needed for settlements later. The assessment of settlement carrying capacity uses simple calculations. The calculation is done by comparing the area of land suitable for settlement with the number of residents. So that the area of existing movement space per person is obtained. The value of the existing movement space area is then compared with the minimum standard needs for settlement. If the resulting value is greater than one (> 1,000), then it describes the existing movement space area as greater than the minimum standard needed and this can be called the settlement carrying capacity is still good or "still supportive" (Tanie et al., 2023).

The carrying capacity of a region for settlements can be interpreted as the ability of a region to provide residential land to accommodate a certain number of residents to live properly. In formulating the carrying capacity of a region for settlements, in addition to the required size of land that is suitable and feasible for settlements, standards, and criteria for land needs for each resident are also needed (Tanie et al., 2023). Determining the suitability of settlements can be seen from the criteria of locations that cannot be built on, such as protected areas, areas prone to natural disasters, and areas prone to landslides (Prasetia et al., 2022).

An ideal settlement must meet the principles of sustainability that include environmental, social, and economic aspects. The environmental aspect relates to the creation of comfortable and healthy settlement conditions. The social aspect involves community interaction in the settlement environment and the availability of various community services.

The economic aspect focuses on the progress and economic growth of the local community, which not only meets the needs of residents but also creates job opportunities for the surrounding population (Lapenangga et al., 2023)

RESEARCH METHODS

This research was conducted in Kabupaten Manokwari, Provinsi Papua Barat. This research was conducted during 2024 to collect data, analyze, and compile a research report.

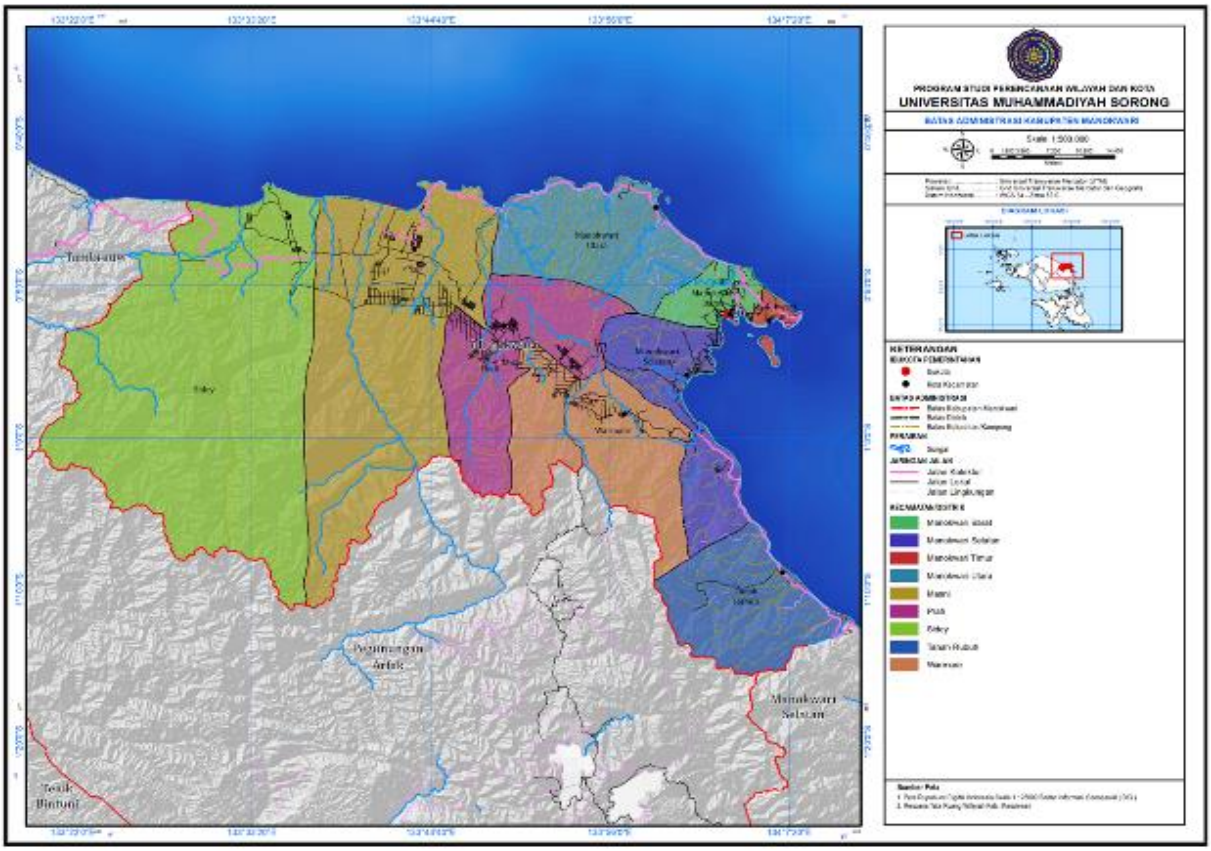

Figure 1. Research Location

The data in this study are Morphological Map data, Rainfall Map, Topographic Map, Existing Land Use Map, Disaster Prone Map, and Elevation Map.

a. Land suitability analysis for residential development

Land Suitability Analysis for Settlement Development using Land Capability Unit analysis. Land capability analysis is carried out to evaluate the extent to which a land can be developed, by considering physical aspect variables based on the Land Capability Unit (LCU). LCU data is then processed using an analysis method in the form of scoring, weighting, and overlay, with the score calculation using the formula: Score = Final value × Weight (Aldian & Pigawati, 2024).

Figure 2. Land Capability Unit Analysis Framework

b. Analysis of residential land carrying capacity

Analysis of Carrying Capacity of Settlement Land To find out and calculate the carrying capacity of settlements using three variables, population, standard area of space requirements per capita, and area of settlement land.

The three variables are then calculated using the formula (Nurfatimah, 2023):

Carrying Capacity of Residential Land

$$DDPm = \frac{\text{LPm}/JP}{a} \quad \text{..... (1)}$$

Information :

DPPm : Housing Carrying Capacity
JP : Total population
a : Area coefficient of space requirements (m^2/capita)
In this case, according to the Indonesian National Standard 03-1773-2004 is 26 m2/capita
LPm : Land area suitable for settlement (m^2).

The Limitations Are

- Outside protected areas and disaster-prone areas (floods and landslides)
- Has land capability class I – IV

Optimal Population

JPo = DDPm x JP ..... *(2)*

Information :

JPo : Optimal Population Size
DPPm : Housing Carrying Capacity
JP : Total population

Overlay Analysis

This spatial analysis aims to understand the distribution of the area and number of units of aspects studied geographically. The analysis process is carried out by utilizing the Geographic Information System (GIS), ArcMap 10.8 software, and Geoprocessing tools (Overlay-Unions) to identify the location of residential area development. In general, Overlay analysis with the merging function (Unions) involves the integration of two themes, which is basically the application of the intersection concept of set theory in algebraic mathematics (Laia & Geniusmaniat, 2023).

RESULTS AND DISCUSSION

1. Land suitability analysis for residential development

Morphological Land Capability Unit.

Based on the results of the analysis, it can be seen that the LCU Morphology spread across Kabupaten Manokwari has very diverse geographical conditions consisting of high morphology with an area of 94,729.43 Ha, sufficient morphology with an area of 70,643.57 Ha, moderate morphology with an area of 50,628.83 Ha, poor morphology with an area of 52,666 Ha and low morphology with an area of 44,518.63 Ha.

Table 11. Land Capability Unit (LCU) Morphology of Kabupaten Manokwari

No	LCU Morphology	Area (ha)	Percentage (%)
1	Tall	94,729.43	30
2	Enough	70,643.57	23
3	Currently	50,628.83	16
4	Not enough	52,666	17
5	Low	44,518.63	14
Total		**313,186.47**	**100**

Source: LCU Analysis Results, 2024

Land capability from low morphology with an area of 44,518.63 Ha has a slope of 0-2% and land capability from less morphology with an area of 50,628.83 Ha with a slope of 2-5% is a morphological land capability that has flat land conditions and is easy to develop so that it can be used as a cultivation area in the form of residential development.

Land Capability Unit Ease of Workability.

Kabupaten Manokwari has a high land capacity with an area of 212,713.24 Ha and sufficient land capacity with an area of 100,42 Ha, according to the analysis and scoring calculations' results. As a result, land development is simple and there are few barriers, such as those related to infrastructure development or other activities that follow the rules.

Table 12. Land Capability Unit (LCU) Ease of Employment Kabupaten Manokwari

No	LCU Ease of Workability	Area (ha)	Percentage (%)
1	Land Ease of Work High	212,713.24	68
2	Land Ease to be worked on Sufficient	100,425	32
	Total	**313,138.23**	**100**

Source: LCU Analysis Results, 2024

Land Capability Unit (LCU) Slope Stability

Based on the results of the analysis and scoring calculations, in Kabupaten Manokwari there is an area of 97,183.80 Ha that has high slope stability and an area of 50,628.72 Ha that has sufficient slope stability, where the condition of this area is a flat area and stable moderate hills so that it is safe for development because the threat of landslides is very minimal so that it can be developed for settlements and other buildings.

Table 13. LCU Slope Stability of Kabupaten Manokwari

No	SKL Slope Stability	Area (ha)	Percentage (%)
1	High Slope Stability	97,183.80	31
2	Slope Stability Sufficient	50,628.72	16
3	Poor Slope Stability	164,209.43	52
4	Low Slope Stability	1,161.13	0.4
	Total	**313,183.08**	**100**

Source: LCU Analysis Results, 2024

Land Capability Unit Foundation Stability

From the results of the analysis and scoring calculations, an area of 87,518.33 Ha is an area with high foundation support and stability, high foundation stability means that the area will be stable for any building foundation so that people can build buildings with good and sturdy foundations and an area of 60,271.70 Ha in the planning area is an area with sufficient foundation stability. And there is also an area of 152,607.40 Ha in the planning area is an area with moderate foundation stability and an area of 12,740.81 Ha in the planning area is an area with less foundation stability which means that the area is less stable so a strong building foundation is needed and by the conditions of the area to build a building.

Table 14. LCU Foundation Stability of Kabupaten Manokwari

No	LCU Foundation Stability Facility	Area (ha)	Percentage (%)
1	Tall	87,518.33	28
2	Enough	60,271.70	19
3	Currently	152,607.40	49
4	Not enough	12,740.81	4
	Total	**313,138.23**	**100**

Source: LCU Analysis Results, 2024

Drainage Land Capability Unit

From the results of the analysis and calculation of the Drainage Land Capability Unit scoring, it can be seen that Manokwari Regency has a high, sufficient, and insufficient drainage level. Based on the results of this analysis in Kabupaten Manokwari, there is a high drainage land

capacity that can drain water well with an area of 44,498.37 Ha and there is also sufficient and insufficient drainage land capacity with an area of 267,481,45 and 1,158.41 Ha, where the water is difficult to flow sufficiently and is easily inundated. Drainage that does not function properly where during the dry or rainy season it is more dominantly dry and there is also drainage that can overflow during high rainfall due to the condition of the drainage that is not functioning properly, thus increasing the obstacles to water flow to the primary drainage and there is an overflow of water in the drainage.

Table 15. LCU Drainage

No	SKL Drainage	Area (ha)	Percentage (%)
1	Tall	1,158.41	0.4
2	Enough	267,481.45	85.4
3	Low	44,498.37	14.2
Total		**313,138.23**	**100**

Source: LCU Analysis Results, 2024

Erosion Land Capability Unit

From the results of the analysis and scoring calculations, Kabupaten Manokwari has an area of 69,371.04 Ha and 78,419.46 Ha which have a low level of erosion land capability and none, which means that soil erosion in the planning area almost does not occur because it has a flat morphological condition and a slope of 2-15%.

So that the planning area is suitable if it is designated as a residential area. In addition, an area of 165,349.17 Ha of the planning area has a sufficient level of erosion land capability, which means that it has the potential for erosion or soil erosion because it has a steep morphological condition with a slope of 15-40% and >40%.

Table 16. LCU Erosion

No	SKL Erosion	Area (ha)	Percentage (%)
1	Enough	165,349.17	53
2	Low	78,419.46	25
3	No Erosion	69,371.04	22
Total		**313,139.66**	**100**

Source: LCU Analysis Results, 2024

Waste Disposal Land Capability Unit

From the results of the analysis and scoring calculations, it can be seen that the planning area has a high and sufficient land capacity for waste disposal, which means that the conditions in the area are very supportive as a waste disposal site and are capable of being a place for storing and managing waste.

In addition, the planning area also has a moderate waste development capacity, which means it can be supported as a waste disposal site, but good and appropriate management is still needed to maintain environmental sustainability.

Table 17. Land Capability Unit (LCU) Waste Disposal

No	SKL Waste Disposal	Area (ha)	Percentage (%)
1	High Waste Disposal	46,513.22	14.9
2	Sufficient Waste Disposal	101,278.18	32.3
3	Medium Waste Disposal	70,637.79	22.6
4	Insufficient Waste Disposal	93,552.01	29.9
5	Low Waste Disposal	1,158.41	0.4
Total		**313139.61**	**100**

Source: LCU Analysis Results, 2024

Disaster Prone Land Capability Unit

From the results of the analysis and scoring calculations, it can be seen that Kabupaten Manokwari has sufficient disaster potential, which means it has the potential for moderate disasters with an area of 148,365.07 Ha, in addition to areas that have high natural disaster potential in the form of moderate and high erosion disaster potential with slopes of 15-40% and <40%.

This can be seen from the morphological conditions of the planning area and from the analysis of erosion land capability units.

Table 18. LCU Disaster Prone

No	Natural Disaster LCU	Area (ha)	Percentage (%)
1	Tall	164,821.40	53
2	Currently	148,365.07	47
	Total	**313186.47**	**100**

Source: SKL Analysis Results, 2024

Land Development Capability

Land capability classification for Manokwari Regency is obtained by overlaying (intersecting) each land capability unit that has been obtained from the results of multiplying the final value (land capability level in each LCU) with its weight one by one so that a map of the total final value is obtained multiplied by the weight of all LCUs cumulatively. The result of multiplying the final value by the weight of each unit, in this analysis is called the score (Score = final value x Weight)

Table 19. Land Development Capability

Total Value	Land Capability Class	Development Classification	Area (ha)	Presentation (%)
59 - 83	Class b	Low Development Ability	1,158.41	0.4
84 - 109	Class c	Medium Development Ability	164,189.80	52
110 - 134	Class d	Somewhat High Development Ability	103,053.42	33
135 - 160	Class e	Very High Development Ability	44,736.64	14
		Total	**313138.27**	**100**

Source: LCU Analysis Results, 2024

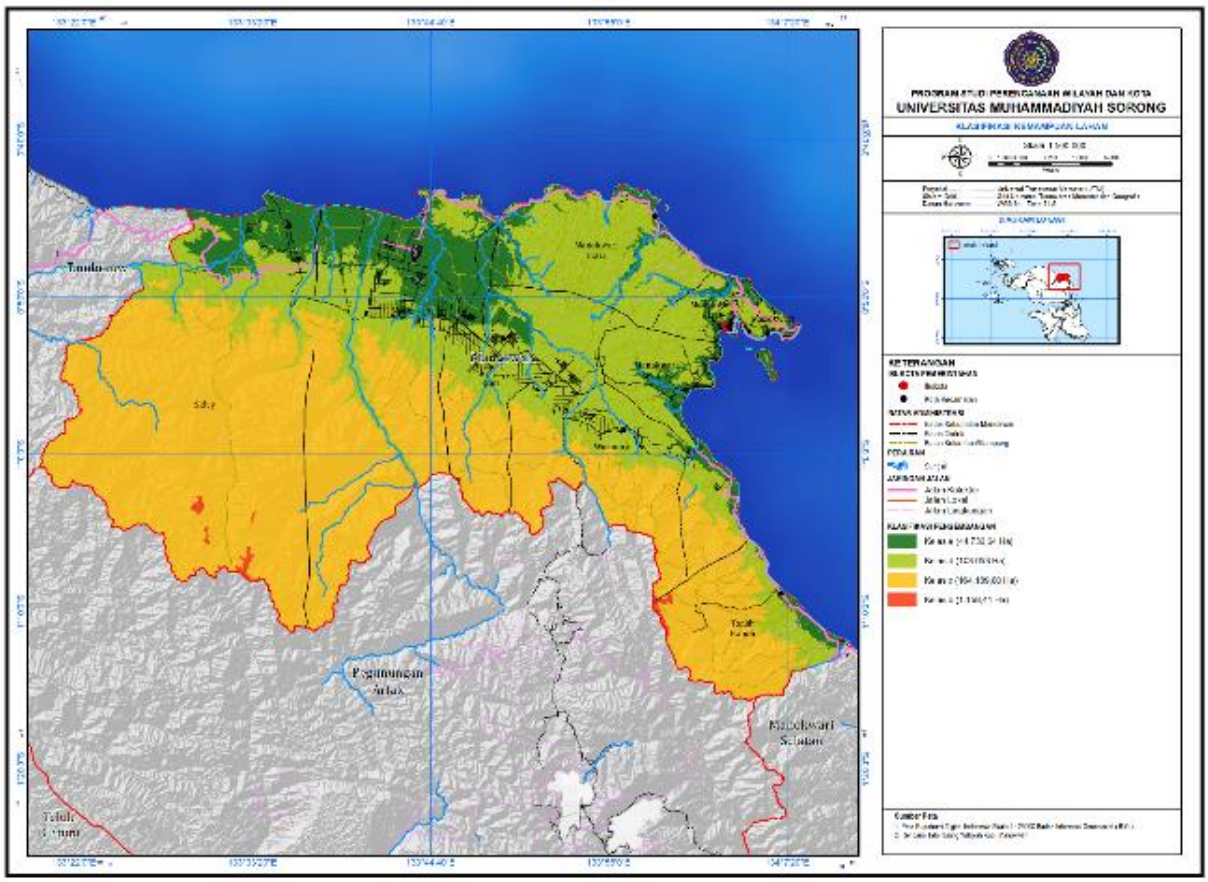

Figure 2. Land Capability Map of Kabupaten Manokwari

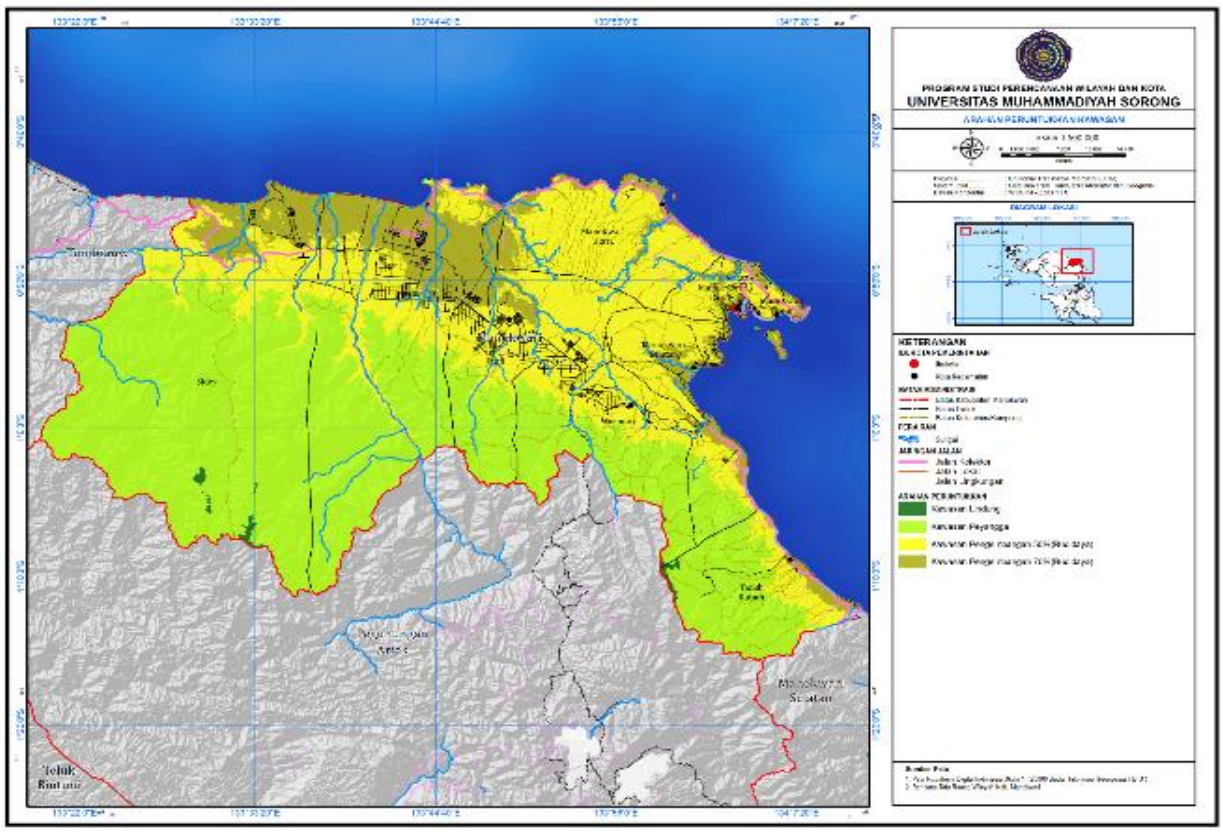

Figure 3. Map of Directions for Area Allocation of Kabupaten Manokwari
Source: 2024 Analysis Results

According to the findings of Kabupaten Manokwari's land capability analysis, Manokwari Regency's land capability is separated into four classes: class B is low development capability, class C is medium development capability, class D is rather high land capability, and class E is very high development capability.

These four classes can serve as a guide for the Kabupaten Manokwari area's allocation direction. The classification of area allocation is separated into three categories: development areas, buffer areas, and protected areas.

a. Land capability class B is included in the protected area because the maximum land cover in this land capability class is 0%.
b. Land capability class C is included in the buffer zone because this land capability class has a maximum land cover of 20% but has terms and conditions for its use.
c. Land capability classes D and E are included in the development area, this land capability class is suitable for development because the maximum land cover is 50% and 70% of the area.

From the results of the land development classification in Kabupaten Manokwari, it is known that the areas that can be used as residential development areas are classes D and E because they have flat topographic contours and can be developed with a maximum land cover of 70% of the area with an area of 103,053.42 Ha and 44,736.64 Ha respectively.

2. Analysis of settlement carrying capacity *Land Carrying Capacity*

Based on the calculation of land carrying capacity analysis that has been carried out in Manokwari Regency, the results obtained are that for Class E Land Capability, the built-up area is still far from the land cover ratio, namely 8%, while for class b it is up to the specified standard or does not exceed it because it is still 0% - 11%.

Table 20. Land Carrying Capacity of Kabupaten Manokwari

Classification Class	Coverage Ratio Standard (%)	Existing (%)	Information
Class b	0	0	In accordance
Class c	20	0	In accordance
Class d	50	2	In accordance
Class e	70	8	In accordance

Source: LCU Analysis Results, 2024

It can be concluded that the residential development area in Manokwari Regency is still very large and the land carrying capacity is still by the land cover ratio standard, where for class e land capacity, the existing built-up area is only 3,662.02 Ha out of 44,736.64 Ha or only 8% of the area and is still far below the standard cover ratio in class e, which is 70% of the area.

Carrying capacity of residential development areas

Calculating the carrying capacity of settlements using 3 calculation variables, namely population, standard area of space requirements per capita, and area of residential land. The population of Kabupaten Manokwari in 2022 is 200,785 people. Then, the area of residential land based on the analysis of land capability units is obtained as 1,477,900,584.76 m2.

JPo = DDPm x JP
JPo = 283 x 200,785
JPo = 56,822,155 people

Then, from the results above, the following calculations can be made if the population increases 283 times the current population.

$$DDPm \frac{\text{LPm}/JP}{a}$$

DDPm = 1,477,900,584.76 / 56,822,155
26
DDPm = 26
26
DDPm = 1

Based on the calculation results above, it can be seen that the population has increased 283 times, or 56,822,155 people from the current population obtained by 1 DDP. This means that the land available for settlement is still able to accommodate the existing population. Thus, with sufficient settlement carrying capacity figures, the problem of residential buildings on the coastal border can be resolved. This is because there is still a large area that can be developed as a settlement that is not designated as a protected area or buffer.

Guidelines for Utilization of Raw Water

The analysis of raw water utilization guidelines is intended to determine water sources that can be utilized as raw water sources in spatial planning. The data needed to conduct this analysis include the LCU Map of Water Availability and Current Land Use. Based on the results of the analysis of raw water utilization guidelines for all districts in Kabupaten Manokwari, it is known that raw water utilization for Kabupaten Manokwari is in the very good raw water utilization guidelines class with an area of 147,790.06 ha.

Table 21. Kabupaten Manokwari Raw Water Utilization Guidelines

No	Guidelines for Utilization of Raw Water	Area (ha)
1	Low	1,158.41
2	Enough	16,4189.80
3	Good	103,053.42
4	Very good	44,736.64
	Total	**313138.27**

Source: LCU Analysis Results, 2024

It can be concluded that the direction for the use of raw water in Kabupaten Manokwari is very good with an area of 147,790.06 ha, this shows that there are no obstacles in the use of raw water because it has water sources that can be used as sources of raw water.

Figure 4. Existing Condition of Clean Water Network

Building Height Guidelines

The analysis of building height directions is intended to determine the description of areas that are suitable for development with heavy/tall buildings in the area's development. Based on the results of the data analysis, it is known that most of the areas in Kabupaten Manokwari are Buffer areas of 52% with an area 164189.80 which is not intended for development above the area of more than 20% of the area.

In the analysis results for building height guidelines in the Regency are divided into three, namely building height guidelines >4 floors with an area of 44,736 ha, building guidelines <4 floors with an area of 267,243.22 ha and non-buildings or protected areas with an area of 1,158.41 ha.

Table 22. Building Height Guidelines for Kabupaten Manokwari

No	Building Height Guidelines	Area (ha)
1	Building >4 Floors	44736.64
2	Building <4 Floors	267243.22
3	Non-Building (Protected Area)	1158.41
	Total	**313138.27**

Source: LCU Analysis Results, 2024

Figure 5. Existing Condition of Building Height

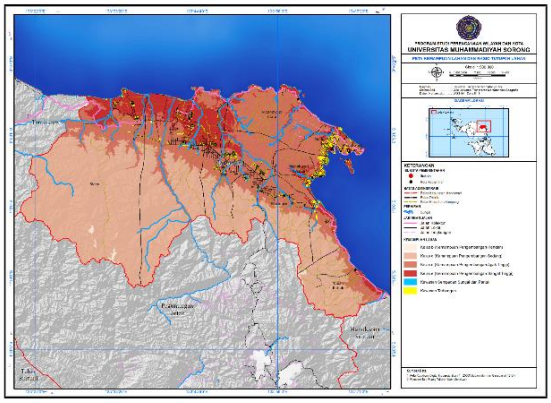

Figure 6. Land Capability Map and Cover Ratio of Kabupaten Manokwari

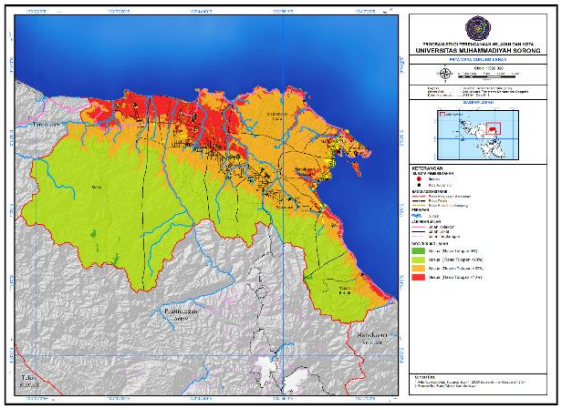

Figure 7. Land Carrying Capacity of Kabupaten Manokwari

Eco-friendly settlements have three components that are used as settlement indicators: physical, economic, and social. The development of settlements in Kabupaten Manokwari is still very extensive and the carrying capacity of the land is suitable with the standard land cover ratio with an area of 44,736.64 Ha. Based on this carrying capacity, sustainable settlement development is certainly the right solution. Sustainable settlement development refers to deliberate and planned efforts to improve the quality of life by utilizing and managing

resources wisely.Land conditions must be stable, there must be sufficient sources of clean water, easy to reach or have good accessibility, and must be free from flooding and other environmental hazards. Based on the results of the analysis of the direction of raw water utilization in Kabupaten Manokwari, it is very good with an area of 147,790.06 ha, this shows that there are no obstacles in the use of raw water because it has water sources that can be used as sources of raw water. Therefore, the development of sustainable settlements in Kabupaten Manokawari is a benchmark for achieving the 6th SDGs, namely ensuring the availability of water and sanitation.

CONCLUSION

The conclusion of this study is

A. Based on the land capability analysis, land development in Kabupaten Manokwari that can be used as a residential development area is class D and E because it has a flat topographic contour and can be developed with a maximum land cover of 70% of the area with an area of 103,053.42 Ha and 44,736.64 Ha respectively.
B. The carrying capacity of the land for residential development areas in Kabupaten Manokwari is still very large and the carrying capacity of the land is also still suitable with the standard land cover ratio, whereas for the land capacity of class E, the existing built-up area is only 3,662.02 Ha out of 44,736.64 Ha or only 8% of the area and is still far below the standard cover ratio in class e, which is 70% of the area. The carrying capacity of the residential environment is still able to accommodate residents 283 times the current population because it has a larger area to accommodate the existing population.
C. The development of sustainable settlements in Kabupaten Manokwari is based on physical components that indicate the use of raw water in Kabupaten Manokwari is very good with an area of 147,790.06 ha, this shows that for Kabupaten Manokwari there are no obstacles in the use of raw water because it has water sources that can be used as sources of raw water.

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