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Spatial Analysis of Landscape Suitability of Ambon City for Settlement Using Geographic Information System

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ABSTRACT

This study analyzes the suitability of Ambon city landscape for settlement development purposes. This research utilizes spatial analysis to evaluate the characteristics of the terrain shape and Land Use Territory (WTU) in the context of settlement suitability. This research uses DEM (Digital Elevation Model) to generate slope and elevation or altitude which is later used to create terrain shape map and business land area map . these studies involve the collection and integration of landscape data, such as topography, land use, vegetation, and other environmental factors. Then, spatial analysis methods are used to assess the suitability of the landscape for settlement by considering factors such as accessibility, availability of essential services, and potential environmental impacts.Making landscape suitability using the weighted sum overlay method. The results showed that the landscape in Ambon City that is suitable for settlement development is 30,456.94 ha and the unsuitable one has an area of 16,890.38 ha. The results of this study provide insight into the most suitable locations for settlements based on physical and environmental factors. The results of this study are expected to support sustainable urban planning in Ambon by considering aspects of landscape suitability.

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1. INTRODUCTION

Sustainable urban development is an important challenge in the context of global development [1], [2]. Cities around the world are experiencing rapid population growth, which is often accompanied by unplanned land conversion and adverse environmental impacts [3], [4]. One approach needed to meet this challenge is spatial analysis of landscape suitability for settlements [5]. Ambon City is the capital city of Maluku Province, Indonesia. As one of the cities located in eastern Indonesia, Ambon has rich natural and cultural potential and offers significant development opportunities. However, unplanned and uncontrolled development can have a negative impact on the environment and quality of life [6]. Therefore, a spatial analysis of landscape suitability is needed as a foundation in planning and developing residential areas in Ambon City [7]. Population development and economic activities in Ambon City have led to irregular settlement growth [8]. Increased population density and unplanned land conversion have the potential to damage the natural environment, disrupt drainage, and increase the risk of natural disasters such as floods and landslides [9], [10], [11]. Therefore, it is necessary to comprehensively assess the suitability of landscapes for settlements in order to avoid potential negative impacts in the future.

Spatial analysis of landscape suitability is an approach that uses spatial data to evaluate the suitability of an area to support a specific purpose, such as human settlement [12], [13]. This method involves the integration of various factors such as

topography, geology, hydrology, vegetation and environmental sustainability. By conducting this analysis, we can identify the most suitable areas for settlement based on certain criteria, such as accessibility, potential natural hazards, availability of natural resources, and environmental impacts [14], [15]. In this research, the author uses a landscape suitability approach that is suitable for settlements, the author also uses the same concept of suitability as in the research conducted by Utami et al [16], which uses the concept of settlement suitability areas, using ecological landscape variables and using infrastructure elements, but this is different from the research conducted by Maimaiti et al [17], who used HEI (Human Settlements Environment Index), to evaluate the suitability of the environment for settlements in the boston lake basin, he divided the suitability class into 4 classes, namely; high suitability areas, medium suitability areas, low suitability areas, and unsuitable areas. In this research, the author uses suitability into 2 classes, namely, suitable and unsuitable.

The importance of finding areas of suitability for settlements is supported by Latue & Rakuasa [18], who state that humans will tend to look for locations that are already suitable for living, rather than modifying them to suit their needs. Based on the above research, this study uses the concept of suitability areas by using physical landscape variables in defining the concept of landscape suitability for settlement expansion. Previous research conducted by Pratami et al [19], regarding the simulation of urban growth with the integration of LEI (Landscape Expansion Index) with CA (Cellular Automata) resulted in a model that is good enough to know the evolution process of a city (in his research the city is defined as settlements and other activity centers).

Spatial analysis of landscape suitability for settlements is an important tool in meeting the challenges of sustainable urban development [20]. In the context of Ambon City, this approach can assist in better planning, more effective environmental management, and safer development. By considering various factors such as topography, disaster risk, and environmental impacts, this analysis can provide valuable guidance for policy makers and urban planners in directing responsible and sustainable urban growth. Based on the above description, this research aims to spatially analyze the suitability of Ambon City's landscape for settlements.

2. RESEARCH METHOD

This research was conducted in Ambon City, Maluku Province. This research used DEM (Digital Elevation Model) of Ambon City obtained from the Geospatial Information Agency to produce slopes and elevations or heights which were later used to create terrain shape maps and maps of business land areas. Making landscape suitability using the weighted sum overlay method to find areas of suitability for settlements, with landscape variables used including terrain shape and business land area. Terrain shape is a combined unit between the aspects of height and slope in an area which has a class between flat to very steep. The business land area is a pattern that exists on the earth's surface which is useful for implementing a planned land use system so that the utilization and results obtained are optimal.

Table 1. Suitability of Terrain Shape for Settlement Expansion

No	Slope (%)	Elevation (m)	Terrain shape	Suitability
1	<2	>5	Flat	Suitable
2	2-7	5-25	choppy	Suitable
3	7-13	25-75	Wavy	Suitable
4	13-20	75-200	Hilly	Not suitable
5	20-55	200-500	Mountains	Not suitable
6	55-140	500-1.000	Steep Mountains	Not suitable
7	>140	>1.000	Very steep mountains	Not suitable

Source: [21]

Based on Table 1, it can be seen that the shape of the Ambon City terrain is the result of combining the variables of slope and land elevation which are then classified into seven classes including flat, undulating, undulating, hilly, mountains, steep mountains and very steep mountains. The shape of the terrain in Ambon City is then analyzed for its suitability for future residential area development. The complete classification of terrain shapes and their level of suitability for residential area development can be seen in Table 1.

Table 2. Suitability of Business Land Areas for Settlement Expansion

No	Slope (%)	Elevation (m)	Business Land Area	Suitability
1	<3	0-2	Limited 1	Not suitable
2	<3	2-7	Primary 1a	Suitable
3	3-15	7-25	Primary 1b	Suitable
4	3-15	25-100	Primary 2a	Suitable
5	15-40	100-500	Primary 2b	Not suitable
6	>40	>500	Limited 2	Not suitable

Sumber: [21]

Table 3. Landscape Suitability for Settlements in Ambon City

No	Parameters	Variable Suitability Classes		Suitability
		Terrain shape	Business Land Area	
1	Landscape Suitability Area	Suitable	Suitable	Suitable
		Suitable	Not suitable	Suitable
		Not suitable	Suitable	Suitable
		Not suitable	Not suitable	Not suitable

Sumber: [21]

In Table 2, it can be seen that the Business Land Area (WTU) in Ambon City is the result of combining the variables of slope and land elevation which are then classified into six WTU classes including limited WTU 1, main 1a, main 1b, main 2a, main 2b and limited 2. The Business Land Area (WTU) in Ambon City is then analyzed for suitability for the development of future residential areas. The suitability of terrain and business land areas was then overlaid using the weighted sum overlay method to produce a landscape suitability for settlements in Ambon City. The classification of landscape suitability for settlements in Ambon City can be seen in Table 3.

3. RESULTS AND DISCUSSION

3.1. Conformity of Ambon City Terrain Shape

To see the landscape conditions in Ambon City, this research uses two parameters, namely terrain shape and business land area, which will ultimately produce a landscape suitability area for settlement expansion in Ambon City. Terrain shape analysis is an important step in settlement suitability planning. Diverse terrain, such as flat, hilly, or valley, has a significant impact on settlement design and development. The results showed that flat terrain has an area of 3,184.73 ha or 6.03%, undulating terrain has an area of 7,271.30 ha or 13.76%, undulating terrain has an area of 88,13.75 ha or 16.67%, hilly terrain has an area of 15,719.25 ha or 29.74%, and mountainous terrain has an area of 17,868.08 ha or 33.80%. Spatially, the terrain is dominated by hilly areas at 33.80%. The terrain of Ambon City is then classified into suitable and unsuitable areas for the development of residential areas. The shape of the Ambon City terrain that is suitable for the development of residential areas is 19,269.79 ha or 36.46% and the unsuitable area is 33,587.33 ha or 63.54%.

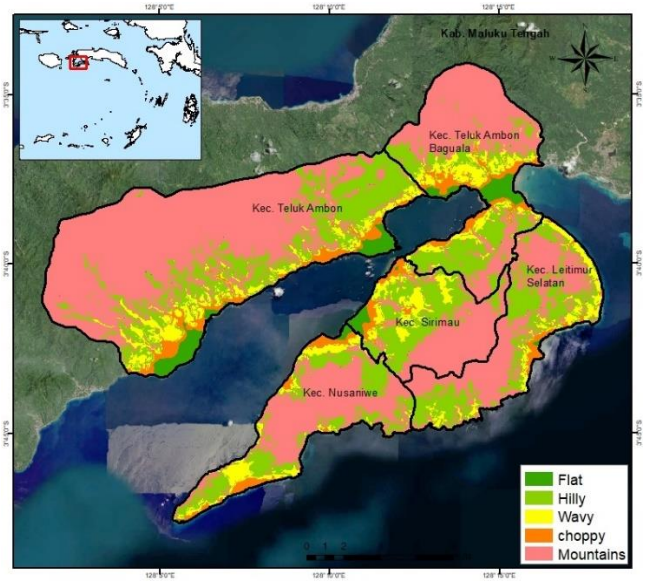

Figure 1. The shape of the Medan City of Ambon

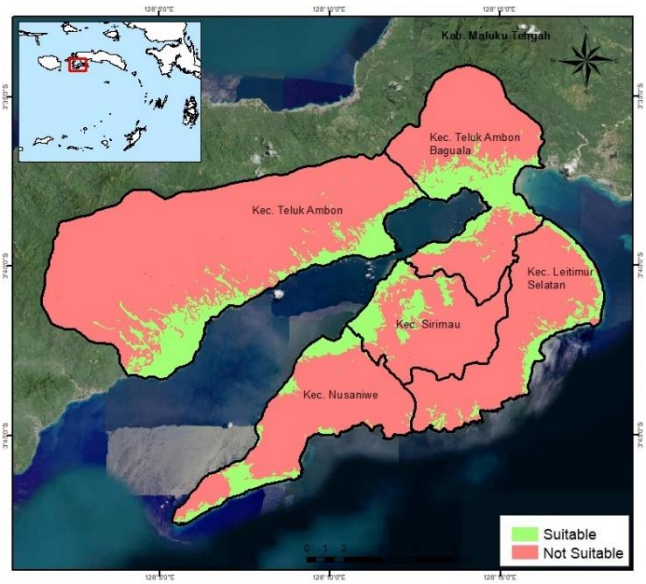

Figure 2. Ambon City terrain shape suitability area

The shape of the terrain consisting of slope and land elevation has a significant impact on various aspects of settlement suitability. First of all, topography affects the safety and stability aspects of buildings. Settlements planned on steep slopes may be prone to landslide and erosion risks. Therefore, an in-depth understanding of the topography and slope of the terrain is necessary to identify potentially high-risk zones and take appropriate mitigation measures. The spatial terrain of Ambon City can be seen in Figure 1 and the area of suitability of Ambon City's terrain can be seen in Figure 2.

3.2. Ambon City Business Land Area

Business land area is a pattern that exists on the earth's surface that is useful for implementing a planned land use system so that the utilization and results obtained are optimal. In the context of planned land use, the business land area can include various types of uses, such as settlement, agriculture, industry, conservation, tourism, and others. Each of these areas has different characteristics and needs, therefore, regulating land use patterns is essential to avoid unwanted use conflicts and maximize the yield generated from each area. The application of business land areas also considers aspects such as topography environmental sustainability, accessibility, and socio-economic factors. By identifying and mapping areas suitable for specific uses, the government and interested parties can work together to plan and manage these areas in a way that has a positive impact on society and the environment. In other words, the concept of enterprise land area is an important tool in spatial planning and sustainable development. It helps avoid mistakes in land use that could negatively impact the environment and society, and ensures that the potential of land and natural resources is utilized efficiently and sustainably.

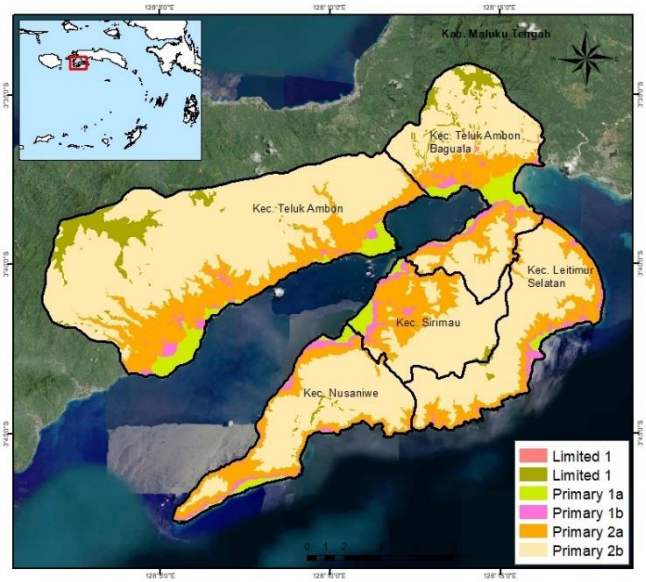

Figure 3. Business land area of Ambon City

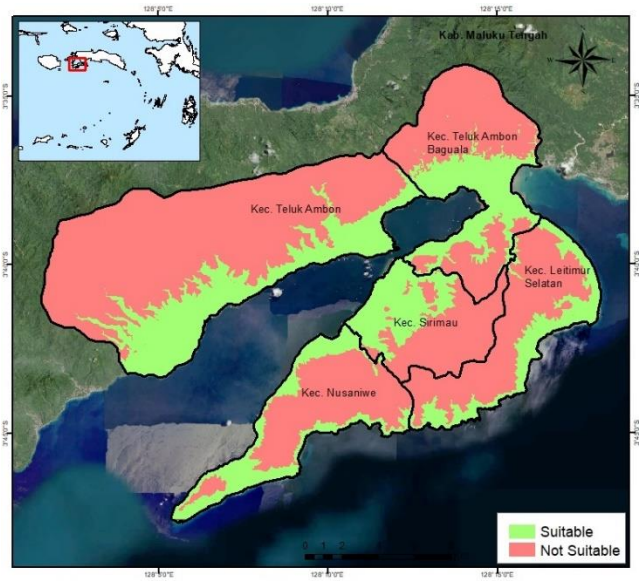

Figure 4. Area of Suitability for Business Land Area in Ambon City

The results of the study show that the Business Land Area (WTU) in Ambon City is divided into limited WTU 1, main 1a Limited WTU 1 has an area of 13,534.46 ha or 15.55%, Main WTU 1a has an area of 13,592.18 ha or 15.61%, Main WTU 1b has an area of 17. 899.75 ha or 20.56%, WTU Utama 2a, 19,650.66 ha or 22.57%, Utama 2b covering 20,986.42 ha or 24.11% and WTU Limited 2 covering 1,387.64 ha or 1.59%. Spatially, the Business Land Area (WTU) is dominated by Main 2b at 24.11%. The shape of the terrain of the Business Land Area (WTU) that is suitable for the development of residential areas is 51,142.60 ha and the unsuitable area is 35,908.51 ha. Spatially, the suitability area of the business land area of Ambon City can be seen in Figure 4.

3.3. Landscape Suitability Area for Settlement

Landscape Suitability Areas for Settlements is a spatial planning approach that considers physical landscape and environmental characteristics in determining the most suitable locations for settlement development [22],[23]. It recognizes that each part of the landscape has unique characteristics that affect the sustainability, beauty and functionality of settlements. In this approach, landscape analysis involves evaluating factors such as topography, drainage, accessibility, vegetation, water management, and potential natural disasters [24]. By considering these aspects, the most suitable areas for settlement development can be identified. Areas of landscape suitability for settlements in Ambon City, divided into two classes, namely suitable and unsuitable, in the search for areas of landscape suitability for settlement expansion, two parameters are used, namely terrain shape and Land Use Area (WTU). Landscape suitability for settlement expansion in Ambon City is classified into two, namely suitable areas with an area of 30,456.94 and unsuitable areas with an area of 16,890.38 ha. The complete landscape suitability for settlement expansion in Ambon City can be seen in Figure 5.

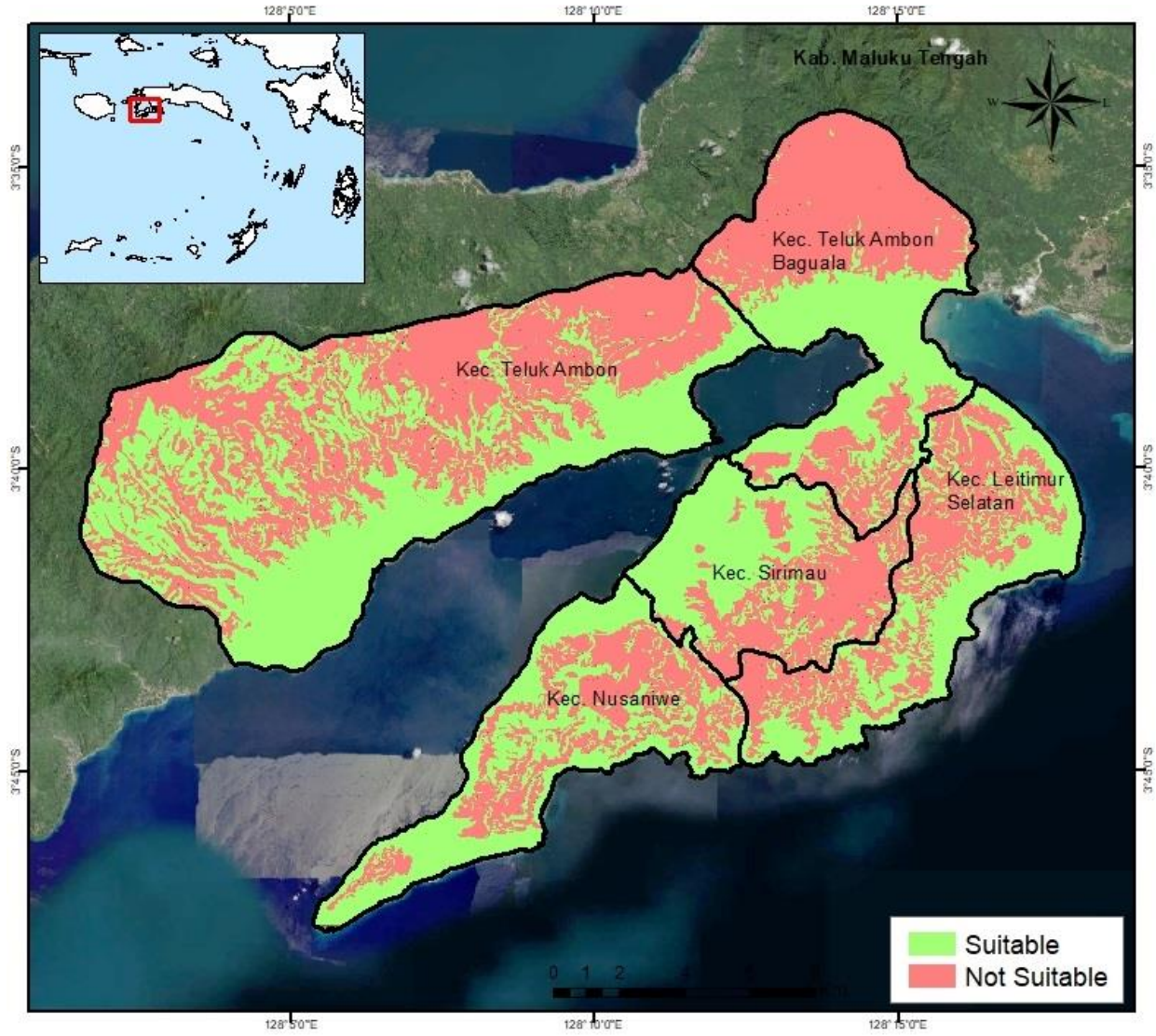

Figure 5. Landscape suitability for settlement expansion in Ambon City

The spatial analysis of Ambon City's landscape suitability for settlements has significant benefits in planning and developing sustainable, safe and functional settlements in the city. The following are some of the key benefits of the analysis: (a) Optimization of Land Use: Spatial analysis of landscape suitability helps identify the most suitable and optimal areas for settlement development [25]. This minimizes inappropriate land use and avoids undesirable use conflicts. (b) Natural Disaster Risk Reduction: By considering factors such as topography, flood potential, and landslide risk, this analysis can help reduce the risk of natural disasters for residents living in such settlements [26], [27]. (c) Improved Quality of Life: Choosing a location that takes into account aesthetic aspects and natural beauty can improve the quality of life of residents by providing beautiful scenery and a pleasant environment. (d) Infrastructure Efficiency and Accessibility: By selecting sites that consider accessibility and connectivity with key infrastructure, the cost and effort in building infrastructure such as roads and transportation can be reduced [28]. (e) Environmental Stewardship: Selecting ecologically appropriate sites helps in minimizing negative impacts on the natural environment such as forests, rivers, and other ecosystems [29]. (f) Sustainability Support: This analysis supports sustainable development by selecting sites that minimize environmental degradation, encourage the use of renewable energy, and promote environmentally friendly lifestyles [30]. (g) Resource Efficiency: By considering the availability of clean water, fertile land, and other natural resources, this analysis helps in managing and utilizing resources more efficiently. (8) Mapping and Monitoring: By generating landscape suitability maps, the government and relevant agencies can have a clear visual view of areas suitable for residential development. This facilitates supervision and control of urban development [31]. (h) Minimize Conflicts: The analysis can help avoid conflicts of interest between different sectors and activities within the city, such as agriculture, industry, and the environment. (i) Informed Decision Making: Based on objective analysis results, stakeholders, including government, developers, and local communities, can make more informed decisions in planning and managing settlement development [32]. Overall, the spatial analysis of landscape suitability for settlements in Ambon City has a positive impact on creating a sustainable, safe, and comfortable urban environment for its residents.

4. CONCLUSION

The results of this study indicate that the shape of the Ambon city terrain suitable for the development of residential areas is 19,269.79 ha or 36.46% and the unsuitable area is 33,587.33 ha or 63.54%. The suitable Land Use Unit (WTU) for residential development is 30,456.94 ha and the unsuitable area is 16,890.38 ha. Landscape suitability for settlement expansion in Ambon City is classified into two, namely suitable areas with an area of 30,456.94 and unsuitable areas of 16,890.38 ha. The results of this research are expected to be used to improve the sustainable planning of Ambon City, create a comfortable and functional residential environment, and guide urban development policies that are responsive to community needs and environmental preservation.

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