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Research article

Assessing Settlement Suitability Using Road Network Analysis for Sustainable Urban Planning in Ambon City, Indonesia

Heinrich Rakuasa*, Viktor Vladimirovich Budnikov

Department of Geography, Faculty of Geology and Geography, Tomsk State University, Tomsk Oblast, Russian Federation

*Correspondence: heinrich.rakuasa@yandex.ru

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Abstract: The availability of infrastructure, particularly the road network, is a critical factor influencing the spatial distribution and suitability of land for settlement development in Ambon City. This study aims to assess settlement suitability by analyzing the relationship between settlement areas and their proximity to the road network, with a focus on supporting sustainable urban planning. Using road network data and SPOT 6 satellite imagery, the research employs a buffer technique to categorize settlements into three zones based on their distance from the nearest road: less than 100 meters, between 100 and 750 meters, and more than 750 meters. The findings reveal that settlements located within 100 meters of the road network cover 8,538.43 hectares or 26.21% of the total settlement area. Settlements situated between 100 to 750 meters from roads account for 11,634.20 hectares (35.72%), while those farther than 750 meters from the road network occupy 12,401.05 hectares, representing 38.07% of the total settlement area. These results underscore the critical role that proximity to roads plays in determining land suitability for residential development, with a noticeable concentration of settlements closer to transportation infrastructure. The outcomes of this study provide valuable insights for urban planners and policymakers in Ambon City, offering a spatial understanding of settlement distribution that can guide future infrastructure development and land use policies.

Keywords: Ambon, buffer analysis, road network, infrastructure, urban planning

1. Introduction

Ambon City, as the capital of Maluku Province, has great potential for settlement development. With population growth continuing to increase, the need for suitable settlement land is critical [1], [2]. The availability of infrastructure, especially road networks, plays a crucial role in determining land suitability for settlements. Good roads not only facilitate population mobility but also support access to essential services such as education, health, and economy [3]. In the context of regional development, land suitability analysis is one of the strategic steps to plan sustainable settlement development [4]. This research aims to classify the level of settlement suitability in

Ambon City based on the existing road network. By using spatial analysis methods, accurate information about the distribution of land suitable for settlements is expected to be obtained.

A good road network can improve people's quality of life by providing better access to facilities [5]. However, not all areas in Ambon City have equal access to the road network. Therefore, it is important to conduct an in-depth analysis of the relationship between the road network and settlement land suitability [6]. This will assist in formulating appropriate policies for regional development. The method used in this study is buffer analysis, which allows researchers to measure the distance between settlements and the road network [7]. By classifying areas based on distance, this research can provide a clear picture of the distribution of land that is very good, good, and less good for settlements [8]. The results of this analysis are expected to serve as a reference for the local government in planning infrastructure and settlement development in Ambon City.

In addition, the use of satellite imagery and GIS software in this study provides greater accuracy in the analysis. Data obtained from satellite imagery can be used to validate existing settlement conditions in the field[9]. Thus, this research is not only theoretical but also empirical, reflecting the actual conditions in Ambon City. The results of this research are expected to contribute to the development of better regional planning policies in Ambon City. By understanding the level of land suitability of settlements based on the road network, it is expected to create a better and more sustainable environment for the community. This research can also be a reference for future studies related to settlement and infrastructure planning in other regions in Indonesia. Based on the above background, this research aims to determine the classification of the level of suitability of settlements in the city of Ambon, Indonesia, based on the road network.

2. Methods

This research was conducted in Ambon City, Maluku Province, Indonesia. The method used in this research consists of several systematic stages, from data collection to analysis and interpretation of results. The data used in this study include road network maps, Ambon City boundary maps, and SPOT 6 satellite imagery. The road network map includes various types of roads, such as arterial, collector, and local roads, which function as the main infrastructure in supporting population mobility. This data was obtained from relevant government agencies and accessible public sources. Once the data was collected, the next step was data processing using Geographic Information System (GIS) software, specifically ArcGIS 10.8. In this stage, the road network map and the boundary map were integrated to produce a thematic map showing the distribution of the road network in Ambon City. This process also involved the creation of layers to facilitate spatial analysis.

The analysis method used in this research is buffer analysis. This analysis aims to measure the distance between settlements and the road network. Buffers are formed with a certain radius, which is then classified into three categories: very good (0-100 m), good (101-750 m), and poor (>750 m) [7]. This classification is based on road accessibility distances that affect land suitability for settlements. Based on the results of the buffer analysis, settlement areas in Ambon City are classified into land suitability categories. The criteria used for this classification include factors such as accessibility, connectivity, and development potential [10]. Each category will provide an overview of how suitable an area is for settlement based on its proximity to the road network.

To ensure the accuracy of the analysis results, field validation was conducted by observing the real conditions in the analyzed locations. This observation aims to verify

the data obtained from satellite images and maps, as well as to understand more about the social and economic conditions of the community in the area. After all the data has been analyzed, the research results will be interpreted to provide recommendations related to settlement development in Ambon City. The results of the classification of land suitability levels will be presented in the form of thematic maps and reports that explain the implications of the research results for regional planning and development policies in Ambon City. By using this systematic research method, it is expected that the research can make a significant contribution to the understanding of land suitability of settlements in Ambon City and support better decision-making in regional planning.

3. Results and Discussion

The results of the suitability level of settlements in Ambon City based on the road network show significant variations in the settlement size distribution based on distance from roads. This analysis provides a clear picture of the accessibility of settlements to the existing road network. Based on the analysis, settlements less than 100 meters from the road have an area of 8,538.43 hectares, equivalent to 26.21% of the total settlement area in Ambon City. These areas are categorized as very good for settlements due to their proximity to the main road network, which facilitates accessibility and mobility of the population. The availability of good road infrastructure in these areas has the potential to support the economic and social growth of communities, as well as facilitate more efficient logistics flows [11]. Furthermore, settlements that are between 100 and 750 meters from the road have an area of 11,634.20 hectares or 35.72% of the total settlement area. This category is considered good, although accessibility is not as optimal as areas less than 100 meters away. Nonetheless, these areas still have good potential for settlement development, especially if road infrastructure is improved. Good connectivity between settlements in this category can support population mobility and improve quality of life [12]. Settlements that are more than 750 meters away from roads cover an area of 12,401.05 hectares, which is equivalent to 38.07% of the total settlement area. This category is classified as unfavorable, as greater distances from the road network can hinder the accessibility and mobility of residents. This could potentially lead to difficulties in meeting basic needs, such as transportation, education, and health services. Therefore, special attention should be given to infrastructure planning and development in these areas to improve connectivity and accessibility [13].

Based on the classification of settlement suitability levels in Ambon City, Indonesia, Figure 1 shows variations in accessibility to the main road network in different sub-districts. Areas closer to the road (<100 meters) such as in Sirimau sub-district and parts of Nusaniwe are more suitable for settlement development due to easier access to infrastructure. In contrast, areas further from roads (>750 meters), such as in Teluk Ambon and Teluk Baguala, face challenges in accessibility and require more intensive infrastructure development to improve settlement suitability. The distance factor from major roads strongly influences the development of areas, with less accessible areas likely to require more attention in urban planning to support sustainable growth [14].

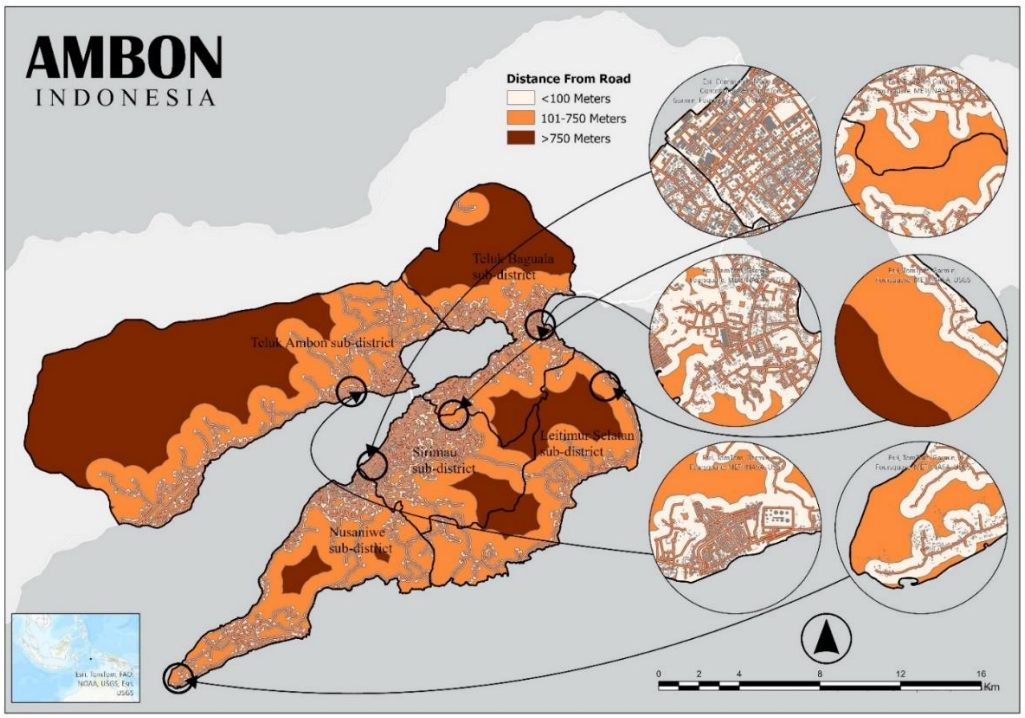

Figure 1. Map of road distance from Ambon city.

The analysis shows that most of the settlements in Ambon City are in the poor category with regard to distance from the road network. With 38.07% of the total settlement area located more than 750 meters from roads, this indicates a challenge in developing infrastructure that can support sustainable settlement growth [15]. This condition also reflects the need for intervention in spatial planning and road infrastructure development to improve accessibility in less favorable areas. Construction of new roads or upgrading the quality of existing roads in settlement areas that are farther from the road network can be a solution to improve connectivity and support local economic development. Table 1 shows the results of the classification of the suitability level of settlements per sub-district in Ambon City based on the road network. This data is divided into several sub-districts with different suitability categories: very good, good, and poor.

Table 1. Distribution of settlement suitability criteria for each sub-district in Ambon city.

Sub-district	Area (ha)		
	Very good (100 m)	Good (750 m)	Less Good (>750 m)
Leitimur Selatan	1,017.35	2,492.12	1,241.51
Nusaniwe	1,956.67	2,417.53	309.80
Sirimau	8,538.43	11,634.20	12,401.05
Teluk Ambon	2,253.03	3,663.14	7,444.96
Teluk Baguala	1,597.90	1,688.81	2,788.38

In Table 1, Kecamatan Sirimau shows a significant dominance in terms of excellent settlement area, with a total area of 8,538.43 hectares. This reflects that most areas in Sirimau have excellent accessibility, which can support more optimal social and economic development for its residents. In addition, the sub-district also has 11,634.20 hectares in the good category and 12,401.05 hectares in the poor category. While there are excellent areas, the proportion of poor areas indicates accessibility challenges in some parts of the sub-district, which need to be considered in urban planning. Nusaniwe sub-district also shows positive results, with 1,956.67 hectares in the excellent category and 2,417.53

hectares in the good category. The less favorable area in Nusaniwe is relatively small at 309.80 hectares, indicating that most of the area has adequate accessibility. This indicates good potential for sustainable settlement development in this sub-district.

On the other hand, Kecamatan Teluk Ambon has 2,253.03 hectares in the excellent category and 3,663.14 hectares in the good category. However, the unfavorable area reaches 7,444.96 hectares, which shows that despite the good areas, there are still significant challenges in terms of accessibility in this region. This is an important concern for infrastructure planning and settlement development. The sub-districts of Leitimur Selatan and Teluk Baguala show mixed results. Leitimur Selatan has 1,017.35 hectares in the excellent category, but the unfavorable area reaches 1,241.51 hectares, indicating the need for more attention to infrastructure development. Meanwhile, Teluk Baguala has 1,597.90 hectares in the excellent category and 2,788.38 hectares in the unfavorable category, indicating similar challenges in terms of accessibility.

To strengthen the results of data analysis, a validation process was carried out on the condition of settlements in the research location using Spot 6 Satellite Imagery. Figure 2 shows the variation of settlements in Ambon City based on their distance from the road network. In Figure 2 a), settlements that are less than 100 meters from the road look very dense. These areas are usually city centers or commercial areas where accessibility is a top priority. The density of buildings indicates high economic and social activity, with many buildings close together. Good road infrastructure around these areas facilitates mobility and daily activities of residents and supports local economic growth [11]. In Figure 2 b), we see settlements that are less than 750 meters from the road. These areas tend to be more balanced in terms of density and open space. The settlements here may be a transition between dense central areas and quieter peripheral areas. The greater distance from the main road infrastructure allows more space for larger sized residential developments, as well as the potential for more green space or parks. This creates a cooler and more comfortable environment to live in. Whereas in Figure 2 c), settlements that are more than 750 meters away from the road look sparser and more scattered. These areas are often peripheral or rural areas that have more limited road access. Remoteness from the main road network can cause challenges in accessibility, but it also provides the advantage of a more natural and tranquil environment. Residents in these areas may rely more on private transportation or simpler local transportation systems. In addition, these areas have the potential for more sustainable development by capitalizing on natural advantages and remoteness from the hustle and bustle of the city [16].

(a) **(b)** **(c)**

Figure 2. Settlements that are: **(a)** less than 100 m from the road; **(b)** between 100-750 m from the road; and **(c)** more than 750 m from the road.

The analysis shows that Kecamatan Sirimau has the highest level of settlement suitability, with more than half of the settlement area in the very good category. This reflects the successful development of road infrastructure that supports accessibility and population mobility. In contrast, Teluk Ambon and Teluk Baguala sub-districts show greater challenges in terms of accessibility, with a significant proportion in the poor

category. This suggests the need for intervention in infrastructure planning and development to improve connectivity in these areas [17]. Overall, this research highlights the importance of the road network in determining land suitability for settlements in Ambon City. Recommendations for better infrastructure development and planning policies can be made based on the results of this analysis so as to improve the quality of life of people in all sub-districts in Ambon City. Efforts to improve accessibility in less favorable areas will be critical to support the future growth and development of the city.

4. Conclusions

The results of this study show that the analysis of land suitability for settlements in Ambon City is strongly influenced by the existing road network. Using the buffer analysis method, this study successfully classified settlement areas based on distance from the road network into three categories: very good, good, and poor. The results of this analysis indicate that there is significant variation in the distribution of settlements in relation to road accessibility, which in turn affects the quality of life of the community. Therefore, this research provides important recommendations for local governments in planning more sustainable infrastructure and settlement development, as well as a reference for future studies in the field of regional planning in Indonesia.

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