

THE PHYSICAL SPATIAL DEVELOPMENT OF TIAKUR CITY, MOA ISLAND, MALUKU PROVINCE, INDONESIA

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ABSTRACT

This study aims to analyze the physical spatial development of Tiakur City, Moa Island, Maluku Province, Indonesia, through changes in land cover between 2015 and 2025 and to identify built-up area growth patterns influenced by population growth, economic activity, and regional development policies. The research method used is a quantitative approach based on remote sensing, utilizing 3-meter-resolution PlanetScope satellite imagery analyzed using the Maximum Likelihood Classification (MLC) supervised classification method to differentiate land cover into built-up and unbuilt areas. Then, spatial change analysis and field validation were conducted to ensure the accuracy of the classification results. The results show a significant increase in built-up land area from 171.29 hectares (7.31%) in 2015 to 395.66 hectares (16.89%) in 2025, with growth of 224.37 hectares dominated by development along main road corridors and urban activity centers. While unbuilt land decreased due to land conversion due to urbanization. The conclusion of this study is that Tiakur City is experiencing rapid spatial transformation due to its increasing administrative status and population growth. Therefore, more sustainable spatial planning is needed to control the expansion of built-up areas and maintain environmental balance.

Keywords: Spatial Development, Land Cover, Planetscope, Urbanization, Tiakur City

INTRODUCTION

Tiakur City, located on Moa Island, is the capital of Maluku Barat Daya Regency, Maluku Province, Indonesia. As the center of government established through Law No. 31 of 2008 on the Formation of Southwest Maluku Regency, Tiakur has undergone significant physical spatial development [1]. This development is closely linked to its role as the administrative center, which has driven the growth of various supporting facilities and urban infrastructure. As the regency capital, Tiakur City has experienced rapid population growth. Data from the Central Statistics Agency show that in 2015, the population of Tiakur was recorded at 897 people [2]. This growth has continued with an average population growth rate of 25.27% per year, and by 2024, the population in Tiakur Village reached 5,370 people [3]. This population increase places pressure on land requirements for housing and other supporting facilities.

In its development, Tiakur City has transformed into an educational hub for Southwest Maluku Regency. The presence of various educational facilities, from primary to secondary levels, as well as several higher education institutions, has made Tiakur the main destination for people in the surrounding areas seeking education [3]. This directly impacts the need for the development of educational infrastructure and its supporting facilities. In addition to being an educational center, Tiakur City has also evolved into the economic hub of Southwest Maluku Regency. Increasing trade and

service activities have driven the construction of various economic facilities, such as markets, shops, and offices [4]. According to Rakuasa, the development of the economic sector in Tiakur has significantly driven the transformation of land use from non-built-up areas to built-up areas [5].

In the context of physical spatial development, changes in land cover in Tiakur City between 2015 and 2025 are an important focus for research. The spatial transformation reflects the dynamics of urban growth influenced by various factors, including population growth and economic activities [6]. Understanding the patterns and intensity of these changes is crucial for sustainable urban planning. To analyze this physical spatial development, the use of remote sensing technology through PlanetScope satellite imagery is an appropriate choice. PlanetScope imagery, with a spatial resolution of 3 meters, is effective in identifying urban objects in detail [7]. Its high temporal resolution also enables regular and accurate monitoring of land cover changes. The advantages of PlanetScope imagery in urban studies have been demonstrated by various previous studies. According to Frazier et al., the 3-meter spatial resolution of PlanetScope imagery can accurately identify urban objects such as buildings, roads, and open spaces [8],[9]. This makes PlanetScope imagery an effective tool for monitoring urban physical spatial development [10].

High-resolution satellite imagery, such as PlanetScope, allows for a more detailed identification of urban development patterns [10]. This method can reveal the direction of urban growth, the intensity of development, and changes in land use over a specific period. This information is essential for evaluating development policies and urban planning in the future. Research on the physical spatial development of Tiakur City is particularly important given its position as the growing capital of the regency. According to Latue & Rakuasa, understanding the dynamics of urban development through land cover change analysis can provide valuable insights for local governments in formulating more targeted and sustainable development policies [11]. This study is expected to provide a comprehensive overview of the patterns and intensity of physical development in Tiakur City, as well as serve as a consideration in future urban development planning. The results of land cover change analysis using PlanetScope imagery can serve as a basis for evaluating spatial planning policies and improving infrastructure development planning.

RESEARCH METHODS

This study employs a quantitative approach utilizing remote sensing technology to analyze the physical spatial development of Tiakur City. The primary data used in this research includes PlanetScope satellite imagery from 2015, recorded on January 1, and from 2025, also recorded on January 1, covering the administrative area of Tiakur City. Additional supporting data includes administrative maps of Tiakur City, population statistics, and spatial planning documents obtained from relevant agencies such as the Regional Planning Agency (Bappeda) and the Central Statistics Agency (BPS) of Southwest Maluku Regency. The data collection process began with the acquisition of PlanetScope imagery, which has a spatial resolution of 3 meters. The selection of PlanetScope imagery was based on several advantages, including its high spatial resolution that allows for detailed identification of urban objects, good temporal coverage, and sufficient radiometric quality for urban land cover classification. The image data used underwent geometric and radiometric correction to minimize

interpretation errors.

PlanetScope satellite imagery is a product of a constellation of more than 130 small satellites known as "Doves," launched by Planet Labs. These images offer a spatial resolution typically ranging from 3 to 5 meters per pixel, with 3 meters being the standard resolution most commonly used. While its resolution is lower than some other satellites, PlanetScope has advantages in consistent monitoring and broad coverage, capable of covering more than 300 million square kilometers of Earth's surface daily. In addition, PlanetScope is equipped with optical sensors capable of capturing images in various light spectra, including near-infrared, making it highly useful for applications such as environmental monitoring, urban planning, and land change analysis [12]. The data processing was carried out in several stages. First, the imagery was clipped (cropping) according to the administrative boundaries of Tiakur City. Next, image enhancement was performed to improve the visual quality of the images, facilitating the interpretation process. Land cover classification was carried out using a supervised classification method with the Maximum Likelihood Classification (MLC) algorithm, which has proven to be effective for urban land cover classification [13].

The land cover classification in this study was divided into two main categories: built-up land and non-built-up land. This simple classification was chosen based on the research's focus on identifying the physical spatial development of the city through the expansion of built-up land. Built-up land includes all areas that have undergone physical changes due to human activities, such as buildings, roads, and other infrastructure, while non-built-up land includes areas that have not been developed, such as vegetation, vacant land, and bodies of water [14]. Data analysis was conducted by comparing the land cover classification results from 2015 and 2025 to identify changes that occurred. Change analysis includes calculating the area of built-up and non-built-up land for both periods, as well as determining the growth rate of built-up land. To validate the classification results, ground checks were conducted at several sample points chosen through stratified random sampling, with a minimum acceptable accuracy rate of 85%.

The analysis results were then integrated with supporting data such as population growth and city development directions in accordance with planning documents to gain a comprehensive understanding of the factors influencing the physical spatial development of Tiakur City. The results were visualized through the creation of thematic maps showing the spatial distribution of built-up land changes, as well as graphs and tables illustrating development trends quantitatively.

RESULTS AND DISCUSSION

The results of the land cover change analysis in Tiakur City show significant changes between 2015 and 2025. In 2015, the built-up land area was recorded at 171.29 hectares, or 7.31% of the total area, while non-built-up land dominated, covering 2,171.27 hectares, or 92.69%. Over the ten-year period, the built-up land area increased to 395.66 hectares, or 16.89%, in 2025, while non-built-up land decreased to 1,946.90 hectares, or 83.11%. This is consistent with Abebe's (2019) research, which found that small cities in developing countries experience significant built-up land expansion as their administrative roles increase. Spatially, the development of built-up land in 2015 can be seen in Figure 1, and in 2025 in Figure 2. The built-up and non-built-up land areas for 2015 and 2025 are shown in Table 1.

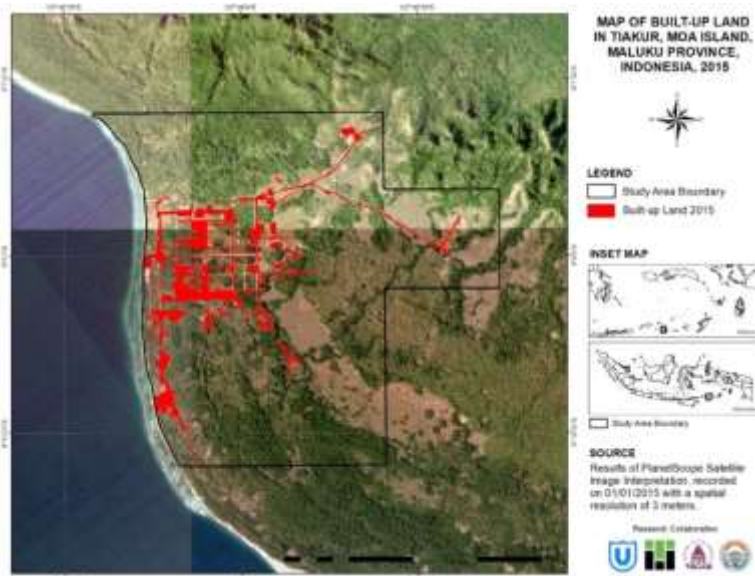


Figure 1. Map of Bult-up Land in Tiakur, Moa Island, Maluku Province, Indonesia 2015

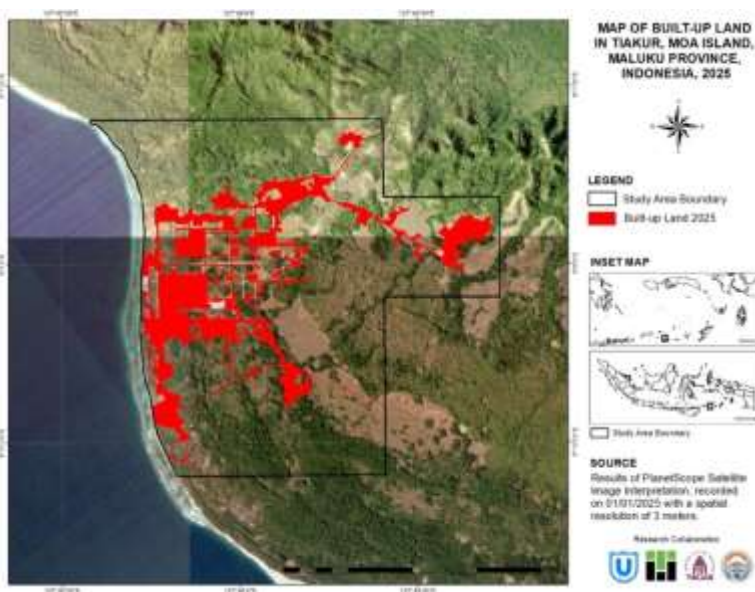


Figure 2. Map of Bult-up Land in Tiakur, Moa Island, Maluku Province, Indonesia 2025

The increase in the built-up land area by 224.37 hectares over the ten-year period indicates a relatively high rate of development in Tiakur City. This finding is consistent with Cohen's research, which identified that cities serving as new administrative centers tend to experience faster physical growth compared to surrounding cities [15]. This phenomenon is closely related to the need for urban infrastructure development to support the city's administrative functions.

Demographic data show a strong correlation between population growth and built-up land expansion in Tiakur City. The population increased from 897 people in 2015 to 5,370 people in 2024, with an average annual growth rate of 25.27%.

According to Sasongko et al., rapid population growth in small cities in Indonesia is generally followed by the conversion of non-built-up land into residential areas and other urban supporting facilities [16].

Table 1.
Area of Built-up Land and Non-Built-up Land

Land Use	Area (ha) - Year			
	2015	%	2025	%
Built-up Land	171,29	7,31	395,66	16,89
Non-Built-up Land	2.171,27	92,69	1.946,90	83,11
Total Area	2.342,56	100,00	2.342,56	100,00

Spatial analysis of built-up land growth patterns shows that expansion primarily occurred along main road corridors and urban activity centers. This pattern is in line with Hugo's findings in his study of developing cities in Asia, where accessibility and infrastructure availability are key factors influencing the direction of urban development [17]. In Tiakur, the concentration of built-up land growth in strategic areas reflects a development pattern oriented towards infrastructure efficiency. The land cover changes also reflect the transformation of Tiakur from a rural settlement to an urban center. The increase in the proportion of built-up land from 7.31% to 16.89% over ten years indicates a high intensity of development. This is consistent with Wilonoyudho's research, which identified that new cities in eastern Indonesia undergo rapid physical urbanization as a result of increased administrative status [18].

The pressure of development on non-built-up land in Tiakur requires special attention in the context of sustainable development. The decrease in non-built-up land by 224.37 hectares over ten years reflects a high intensity of land conversion. According to Bibri, in his research on developing cities, balancing development and environmental preservation is key to maintaining the sustainability of urban growth [19]. The identified physical spatial development pattern in Tiakur City shares characteristics similar to other small cities in eastern Indonesia. Research by Septory et al. in Ambon City, the capital of Maluku Province, showed that an increase in a city's administrative status is generally followed by a significant acceleration of physical development in the first decade [20]. This is reflected in the growth of built-up land in Tiakur, which more than doubled in the ten-year period.

The findings of this study have important implications for the future development planning of Tiakur City. The high rate of land conversion needs to be balanced with spatial planning policies that consider environmental carrying capacity. As Majewska et al. stated in their comparative study of the development of small cities, proper planning at the early stages of urban development will determine the sustainability of long-term development [21].

CONCLUSION

From the study of the physical spatial development of Tiakur City on Moa Island, it can be concluded that the city has undergone significant transformation influenced by various driving factors such as population growth, economic activities, and local government policies. The physical development of the city shows a pattern that tends to be linear, following main transportation routes and coastal areas, with growth centers

concentrated in trade and service areas. However, this development also faces challenges such as limited land suitable for development due to topographical conditions, as well as the need for more integrated planning to anticipate future urban growth. Therefore, development strategies that consider environmental sustainability and local wisdom are necessary to create a more planned and sustainable urban space.

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