BANJARESE
PACIFIC INDONESIA
Journal of International Multidisciplinary Research

The Physical Spatial Development of Tiakur City, Moa Island, Maluku Province, Indonesia

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Informasi Artikel
E-ISSN : 3026-6874
Vol: 3 No: 2 February 2025
Page : 49-55

Keywords:
Urban Physical Development, Remote Sensing, Spatial, Tiakur

Abstract
Tiakur City, the capital of Southwest Maluku Regency, has undergone significant physical development between 2015 and 2025, driven by population growth and economic activities. This study employs a quantitative approach using remote sensing technology with PlanetScope satellite imagery to analyze land cover changes. The analysis reveals an increase in built-up land area from 171.29 hectares (7.31%) in 2015 to 395.66 hectares (16.89%) in 2025, while non-built-up land experienced a decline. These findings indicate a rapid development rate and highlight the importance of sustainable spatial planning. In conclusion, understanding the patterns and intensity of land cover changes in Tiakur City is crucial for evaluating spatial planning policies and improving infrastructure development planning for the future.

Abstrak
Kota Tiakur, sebagai ibukota Kabupaten Maluku Barat Daya, mengalami perkembangan fisik yang signifikan antara tahun 2015 hingga 2025, yang dipengaruhi oleh pertumbuhan penduduk dan aktivitas ekonomi. Penelitian ini menggunakan pendekatan kuantitatif dengan memanfaatkan teknologi penginderaan jauh melalui citra satelit PlanetScope untuk menganalisis perubahan tutupan lahan. Hasil analisis menunjukkan peningkatan luas lahan terbangun dari 171,29 hektar (7,31%) pada tahun 2015 menjadi 395,66 hektar (16,89%) pada tahun 2025, sementara lahan tidak terbangun mengalami penurunan. Temuan ini mengindikasikan laju pembangunan yang tinggi dan pentingnya perencanaan tata ruang yang berkelanjutan. Kesimpulannya, pemahaman terhadap pola dan intensitas perubahan tutupan lahan di Kota Tiakur sangat penting untuk evaluasi kebijakan tata ruang dan perencanaan pembangunan infrastruktur yang lebih baik di masa mendatang.
Kata Kunci : Perkembangan Fisik kota, Penginderaan Jauh, Keruangan, Tiakur

INTRODUCTION

Tiakur City, located on Moa Island, is the capital of Southwest Maluku 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 (Indonesia, 2008). 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 (BPS Maluku Barat Daya, 2015). 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 (BPS Maluku Barat Daya, 2024). 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 (BPS Maluku Barat Daya, 2024). 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 (Rakuasa & Latue, 2023). 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 (Rakuasa, 2022). 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 (Wang et al., 2021). 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 (Matiza et al., 2024). 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 (Frazier & Hemingway, 2021; Salakory & Rakuasa, 2022). This makes PlanetScope imagery an effective tool for monitoring urban physical spatial development. High-resolution satellite imagery, such as PlanetScope, allows for a more detailed identification of urban development patterns (Lefulebe et al., 2022). 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 (Lefulebe et al., 2022). 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.

METHOD

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 (Basheer et al., 2024). 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 (Senamaw et al., 2022).

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 (Badan Standarisasi Nasional, 2010). 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.

RESULT 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.

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

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 (Cohen, 2004). 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 (Sasongko et al., 2024).

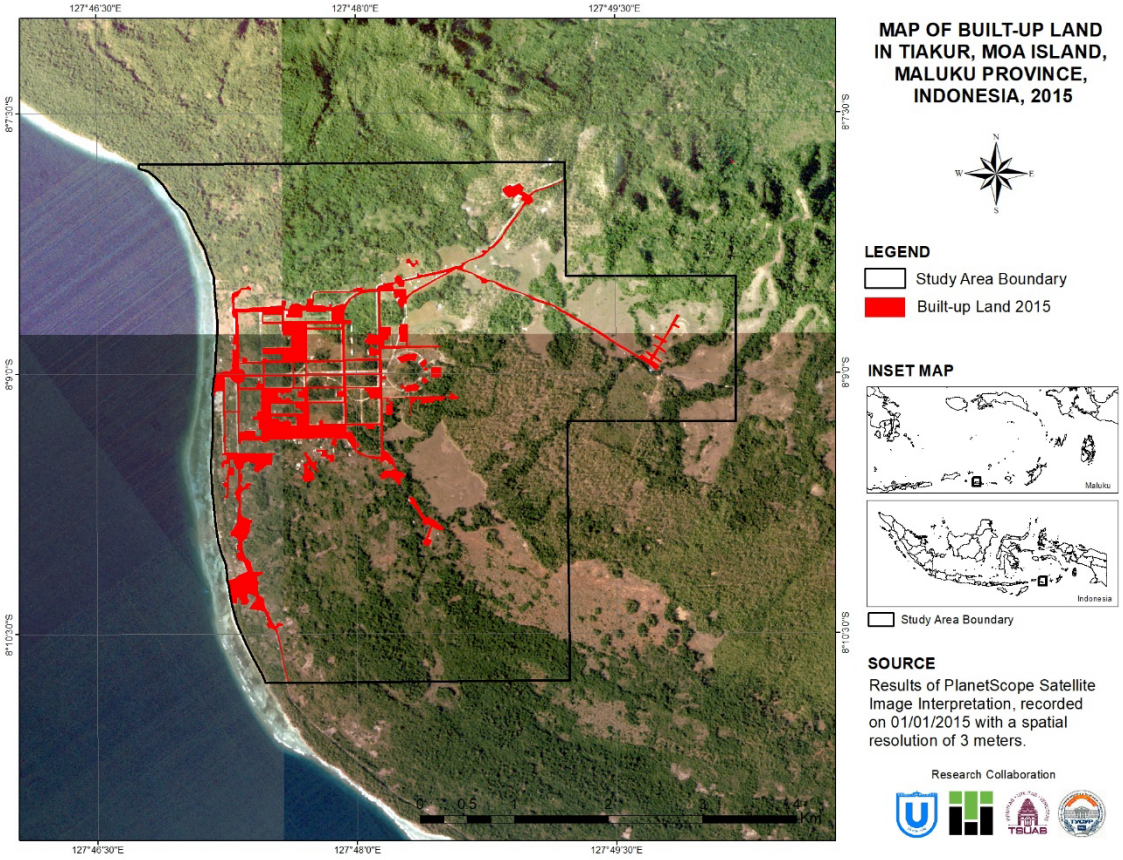

Image 1. Map of Bult-up Land in Tiakur, Moa Island, Maluku Province, Indonesia 2015

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 (Sasongko et al., 2024). 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 (Hugo, 2019). 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 (Wilonoyudho, 2017). 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 (Bibri, 2020).

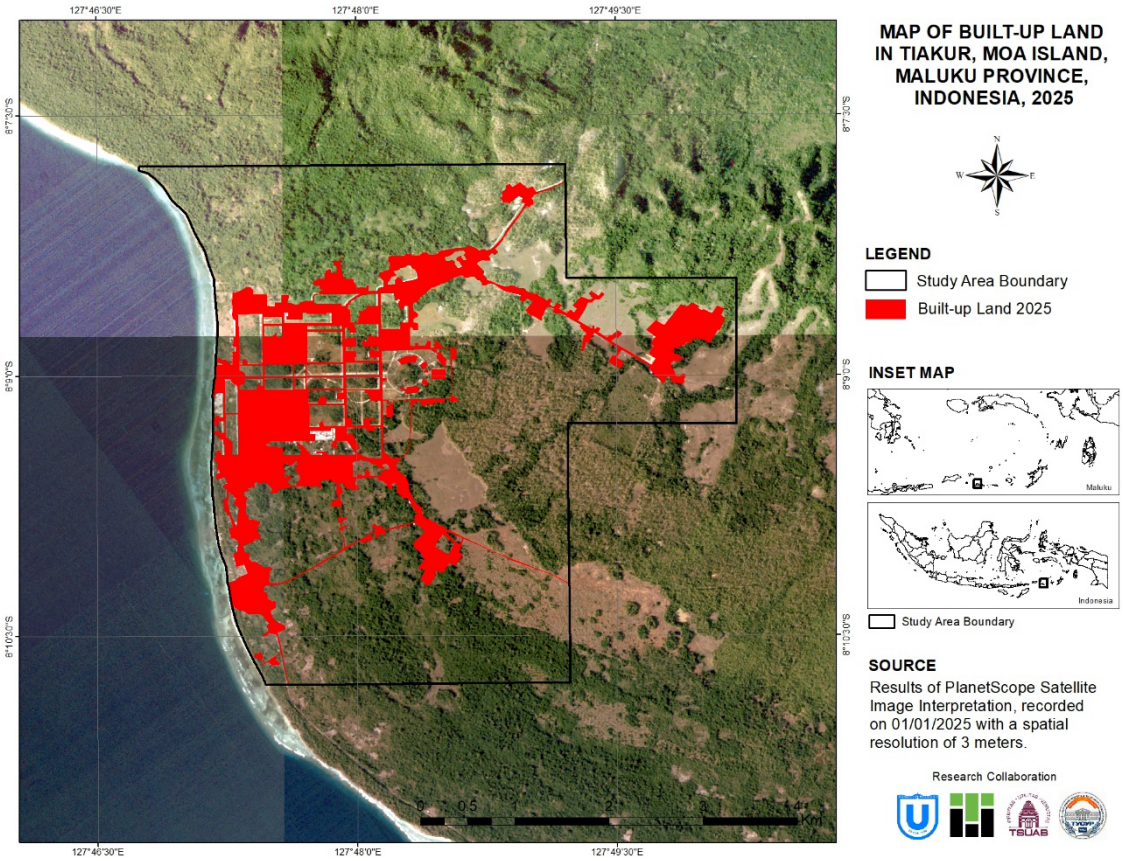

Image 2. Map of Bult-up Land in Tiakur, Moa Island, Maluku Province, Indonesia 2025

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 (Septory et al., 2023). 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 (Majewska et al., 2022).

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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