Research Article

Spatial Dynamics of Land Cover Change in Tidore Island, Indonesia 2015-2025

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Abstract.
This study aims to analyze the dynamics of land cover change on Tidore Island, North Maluku, over the period 2015-2025 using GIS technology and remote sensing data. The method used involved spatial and temporal analysis of PlanetScope satellite image data recorded in 2015, 2020 and 2025. The results showed that built-up land experienced a significant increase to 1,227.49 ha or 10.37% of the total area, reflecting the growing pressure of urbanization. Meanwhile, the vegetation area decreased to 89.37%, which could potentially threaten biodiversity and the stability of the local ecosystem. The remaining open space of 264.26 ha provides opportunities for further development, while also indicating the need for careful management to avoid negative impacts on the environment. These findings emphasize the importance of ongoing monitoring and effective spatial planning strategies to support environmental sustainability and adaptation to climate change on the islands.

Keywords: land cover, Tidore island, GIS

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1. Introduction

Land cover as a manifestation of the dynamic process of interaction between human activities and land resources, which is spatially distributed over the land surface and identifies the biophysical cover of the terrain; this includes inland water, bare land or human infrastructure Land cover and its limiting elements affect the processes that occur on the land surface (1). In Indonesia, land cover change has become a critical issue, especially in archipelagic regions that are vulnerable to development pressures and climate change (2). Tidore Island, as part of North Maluku, has experienced significant land cover transformation due to urbanization, agricultural expansion, and natural resource exploitation.

The increase in human needs is always related to the development and increase in population. The high increase in population can increase the need for land which is

realized in the form of physical development, economic facilities or social facilities (3). An increase in population will be accompanied by an increase in land requirements to meet the needs of the population, so that many forest areas are converted to agricultural land, plantations, settlements and other cultivated land. When the need for land increases and the availability of land decreases, the carrying capacity of the land will also decrease (4).

The study of the spatial dynamics of land cover change requires a comprehensive approach based on spatial-temporal data (5). The use of remote sensing data has become a key tool in monitoring land cover change accurately and efficiently (6). High-resolution satellite imagery such as PlanetScope has been widely used to identify land change patterns in various regions (7). In Tidore, the use of PlanetScope satellite data can provide a detailed picture of the spatial dynamics of land cover change over the period 2015-2025.

Land cover change on islands often results in ecosystem fragmentation and decreased biodiversity (8). In Tidore, human activities such as land clearing for agriculture and settlement have resulted in forest loss and land degradation. Regular monitoring of land cover change is necessary to identify critical areas that require policy intervention (9). Spatial analysis can help understand patterns of change and the factors driving them.

A spatial-temporal approach to land cover change studies allows the identification of long-term trends and future predictions. The period 2015-2025 was chosen because it covers a crucial phase of infrastructure development and population growth in Tidore. By analyzing satellite data during this period, this study aims to reveal the dynamics of land cover change and its environmental implications. The results of this study are expected to provide a basis for sustainable spatial planning.

This study uses an integrative approach that combines spatial, temporal and statistical analysis to understand land cover change in Tidore. By utilizing high-resolution satellite data, this study is expected to make a significant contribution to the literature on land change dynamics in the archipelago. The results of this study can also serve as a reference for policy makers in designing effective conservation and land management strategies.

2. Research Methodology

This research was conducted on Tidore Island, Central Halmaherea Regency, North Maluku Province, Indonesia (Figure 1). This research began with a preparatory phase containing literature studies from books, journals, or from the internet. The literature study was conducted to understand the basic theories related to land cover change. After the preparation stage, the next stage is data collection. The data used in this research is PlanetScope satellite image data recorded on August 02, 2015, February 14, 2020, and January 20, 2025. PlanetScope satellite imagery has a spatial resolution of 3 meters, while for spectral resolution, PlanetScope satellite imagery generated from recording the Dove Classic and Dove-R satellite instrument types has a total of 4 bands (Red, Green, Blue, and Near InfraRed), while for the SuperDove satellite instrument type has 8 bands (Red, Green, Blue, Near InfraRed, Yellow, Green I, Coastal Blue, and Red Edge).

PlanetScope satellite image data was then subjected to orthorhodification correction and RGB band compositing to facilitate the interpretation and digitization process. Land cover interpretation is carried out based on interpretation keys, namely hue or color, shape, size, texture, pattern, shadow, site, and association. In addition, interpretation is carried out based on a simple land use classification consisting of settlements, open land, agricultural land and water bodies. The entire data analysis process was conducted in Arc GIS 10.8 software. The results of the research were then analyzed spatially descriptively to provide an overview of land cover changes that occurred in the research location.

3. Research Result and Discussion

Land cover in Ternate City in 2015 showed that the built-up land area reached 791.31 ha, which contributed about 6.69% of the total area, indicating a relatively low growth of urbanization amidst the dominance of very extensive vegetation (10810.86 ha or 91.36%). This is in line with research showing that population growth and urbanization affect land cover change, especially in areas with high vegetation potential. Open land, which covers 224.50 ha or 1.90%, also shows room for further development, providing opportunities for better urban planning.

The presence of water bodies covering 6.14 ha and contributing about 0.05% of the land cover signifies the challenge of conserving water resources in urban areas.

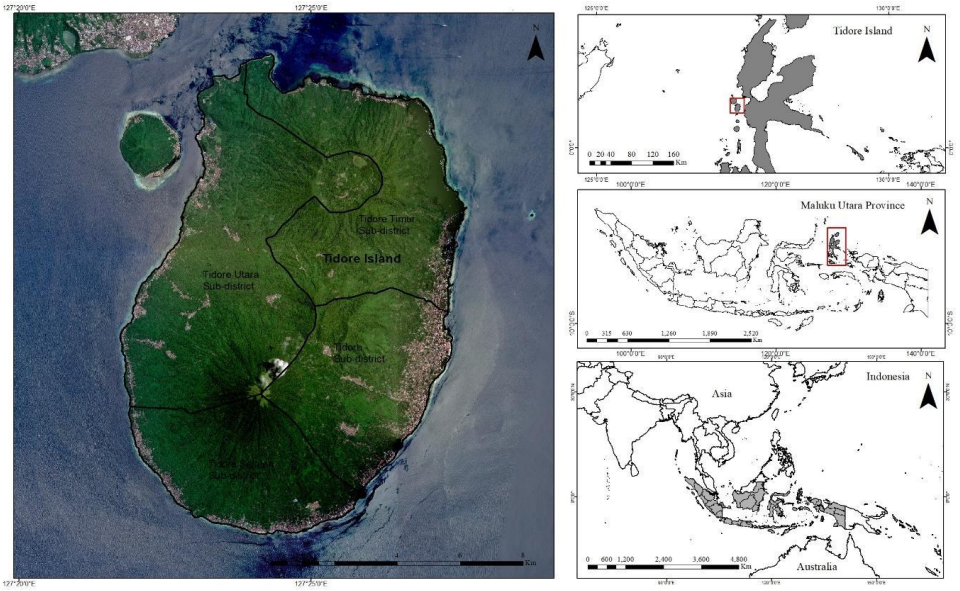

Figure 1: Research Location.

The high proportion of vegetation in Ternate City's land cover reflects the importance of maintaining local ecosystems, which can function as climate regulators and carbon stores. Unplanned development can negatively impact vegetation and water resources, so sustainable management is needed to address pressures from population growth and increasing urbanization (10). The spatial land cover of Tidore Island in 2015 can be seen in Figure 2.

Land cover in Ternate City in 2020 shows that built-up land reached 996.52 ha, which contributed about 8.42% of the total study area. Meanwhile, open land of 255.66 ha or 2.16% indicates that there is space that can still be utilized for sustainable infrastructure development. Vegetation dominates the area with an area of 10,574.49 ha or 89.37%, reflecting the importance of natural ecosystems in maintaining environmental balance and providing benefits to local communities. In land management, the presence of high vegetation is instrumental in climate change mitigation and protection against natural disasters.

Furthermore, water bodies in Ternate City only cover 6.14 ha or 0.05%, indicating challenges in water resources management in the area. A decrease in vegetated land area due to land conversion for different uses can have a significant impact on environmental quality and biodiversity. Therefore, further evaluation of land cover dynamics is essential to formulate planning strategies that can support environmental sustainability and socioeconomic development in Ternate. In 2025, land cover in Ternate City underwent a significant transformation, with built-up land reaching 1,227.49

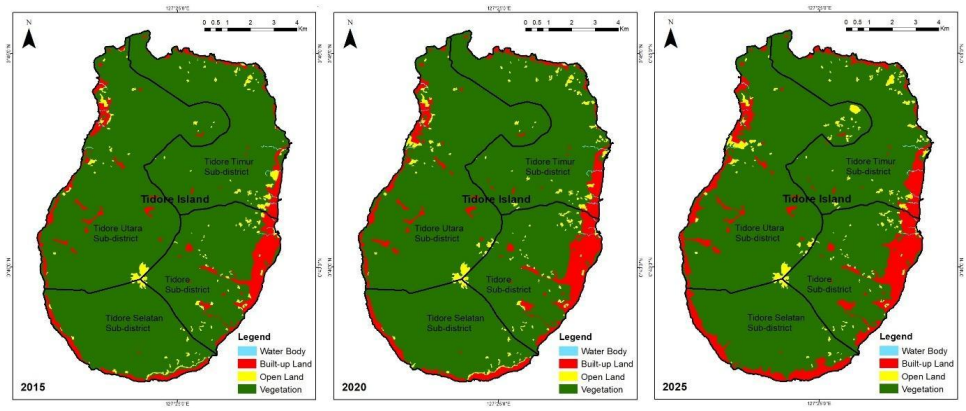

Figure 2: Land Cover Tidore Island 2015, 2020, 2025.

ha or 10.37% of the total area. This increase in built-up land use indicates growing urbanization due to rapid population growth and the need for better infrastructure. In addition, the 264.26 ha of open land indicates that there is space available for development, but there is a risk of losing green land that functions as a carbon sink and microclimate regulator.

The presence of vegetation, which still dominates, with an area of 264.26 ha or 87.34%, plays an important role in maintaining biodiversity and environmental stability in this area. This shows that there are still opportunities for conservation and sustainable use of natural resources, although challenges due to land conversion to built-up land are increasingly evident. Meanwhile, water bodies covering 6.14 ha or 0.05% reflect environmental conditions that, if not properly managed, could be threatened by land use change and the impacts of uncontrolled urbanization.

Analysis of the spatial dynamics of land cover change on Tidore Island over the period 2015-2025 shows a significant upward trend in built-up area, reflecting the impacts of rapid urbanization and population growth. While vegetation still dominates land cover, its decline due to land conversion for infrastructure and residential development indicates growing pressure on natural ecosystems. The relatively stable presence of water bodies, but with a very small area (0.05%), confirms the importance of sustainable water resources management to mitigate the negative impacts of uncontrolled urbanization. This finding is in line with previous studies that have shown that land cover change on islands often threatens biodiversity and ecosystem balance (11). Therefore, data-driven spatial planning that considers environmental aspects is crucial to ensure sustainable development on Tidore Island.

4. Conclusion

The results of this study show a significant trend in the expansion of built-up land due to population growth and rapid urbanization. The increase in built-up land to 1,227.49 ha or 10.37% of the total area reflects the urgent need for better infrastructure to support the welfare of local communities. However, this transformation is also accompanied by a decrease in vegetation area, potentially reducing biodiversity and increasing vulnerability to natural disasters such as floods and landslides. This research underscores the importance of regular monitoring of land cover change using remote sensing techniques to provide the necessary data for sustainable spatial planning. The results of this study are expected to serve as a reference for better policy development in natural resource management and environmental protection on Tidore Island.

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