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Spatial Analysis of Land Use Deviations in Sirimau Sub-district, Ambon City Based on Cultivation and Protected Areas, Ambon City Spatial Plan 2011-2031

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ABSTRACT
This study conducts a spatial analysis of land use deviations in the Sirimau Sub-district of Ambon City, focusing on the impacts of urbanization and population growth on the implementation of the Ambon City Spatial Plan (RTRW) 2011-2031. Utilizing remote sensing and GIS techniques, the research identifies significant discrepancies between planned and actual land use, driven by economic pressures and ineffective enforcement of land use regulations. The findings reveal that the conversion of agricultural land and protected forests into residential areas poses serious threats to environmental sustainability and biodiversity. The study emphasizes the need for enhanced community involvement, better inter-agency coordination, and stricter regulatory enforcement to address these challenges and promote sustainable land use practices in the region.

Keywords: *Environmental Sustainability, GIS Analysis, Spatial Planning*

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INTRODUCTION

Land use planning is a crucial aspect of urban development, as it determines the allocation of land resources for various activities, such as agriculture, housing, industry, and conservation (Mohamed & Worku, 2019; Latue et al., 2024). In Indonesia, the Spatial Planning Act No. 26 of 2007 mandates the creation of spatial plans at the national, provincial, and municipal levels to guide land use development (Rakuasa & Somae, 2022). The Ambon City Spatial Plan (RTRW) 2011-2031 is one such plan that aims to manage the city's land resources sustainably (BAPPEDA Kota Ambon, 2011)

However, the implementation of spatial plans often faces challenges, including land use deviations, which can lead to environmental degradation, social conflicts, and economic losses (Zhang et al., 2020; Rakuasa et al., 2024). Land use deviations occur

when actual land use differs from the planned land use, often due to factors such as population growth, urbanization, and economic development (Rakhmonov et al., 2021; Latue & Rakuasa, 2023). In Ambon City, the Sirimau Sub-district is a critical area that requires attention, as it is experiencing rapid urbanization and land use changes (Sugandhi et al., 2022)

The Sirimau Sub-district is a coastal area with a diverse range of ecosystems, including mangroves, coral reefs, and seagrass beds (Septory et al., 2023). These ecosystems provide essential ecosystem services, including shoreline protection, water filtration, and fisheries (Rakuasa et al., 2023). However, the area is also under pressure from human activities, such as coastal development, fishing, and agriculture, which can lead to environmental degradation and loss of ecosystem services (Madrigal-Martínez et al., 2022). To address these challenges, it is essential to analyze land use deviations in the Sirimau Sub-district and identify areas that require conservation and protection (Muin & Rakuasa, 2023). This study aims to conduct a spatial analysis of land use deviations in the Sirimau Sub-district, Ambon City, based on cultivation and protected areas, as outlined in the Ambon City Spatial Plan (RTRW) 2011-2031.

The study will use a combination of remote sensing and GIS techniques to analyze land use changes and deviations in the Sirimau Sub-district. The results of this study will provide insights into the extent and patterns of land use deviations in the area and inform policy and decision-making for sustainable land use management (Yunita et al., 2022). Previous studies have highlighted the importance of spatial planning and land use management in maintaining ecosystem services and promoting sustainable development (Akhtar et al., 2020). However, few studies have focused on the Sirimau Sub-district, Ambon City, and the specific challenges it faces in terms of land use deviations and environmental degradation.

This study will contribute to the existing literature on land use planning and management by providing a case study of the Sirimau Sub-district, Ambon City, and highlighting the importance of spatial analysis in identifying areas that require conservation and protection. The study will also provide recommendations for policymakers and stakeholders on how to address land use deviations and promote sustainable land use management in the Sirimau Sub-district, Ambon City. Overall, this study aims to provide a comprehensive analysis of land use deviations in the Sirimau Sub-district, Ambon City, and contribute to the development of sustainable land use management strategies in the area.

RESEARCH METHODOLOGY

This research was conducted in Sirimau Sub-district, Ambon City, with a geographical area of 8,681.32 hectares, in accordance with the provisions in the Regional Regulation (PERDA) of Ambon City Number 2 of 2006. The data used involved secondary data from various agencies, including Bappekot Kota Ambon and the Central Bureau of Statistics of Ambon City, as well as primary data obtained through field checks related to land use types. The tools and materials used include the Administrative Map of

Ambon City in 2020 with a scale of 1:150,000, the Spatial Pattern Map of Ambon City Spatial Plan (RTRW) 2011-2031 from Bappekot Kota Ambon, and the Existing Land Use Map of Ambon City in 2024 analyzed using Sentinel 2 Imagery in 2024. The tools used include Personal Computer, Scanner, ArcGIS 10.6 Software, and Garmin etrex 10 GPS.

The 2024 Existing Land Use Analysis was conducted with the aim of understanding land use patterns in that period, with data obtained from the 2020 land cover map and analyzed on the 2024 Landsat 8 image. This research also includes field checking activities to make improvements to the classification results.

RESULT AND DISCUSSION

Land Use in 2024

Based on the results of the Land Use research of Sirimau Sub-district, Ambon City in 2024. The table 1 presents the results of a research study on land use deviations in Sirimau Sub-district, Ambon City, based on the Ambon City Spatial Plan (RTRW) 2011-2031. The table shows the distribution of land use types in the study area, including residential areas, open spaces, agricultural areas, protected forests, and water bodies.

Table 1. Land Use, Sirimau District, Ambon City 2024

Type of Land Use/ Land Cover	Area (ha)
Settlements	443.925
Open Land	924.71
Field, Farm, Garden	1557.063
Protected Forest	11462.28
Water Body	176.53
	14.564.51

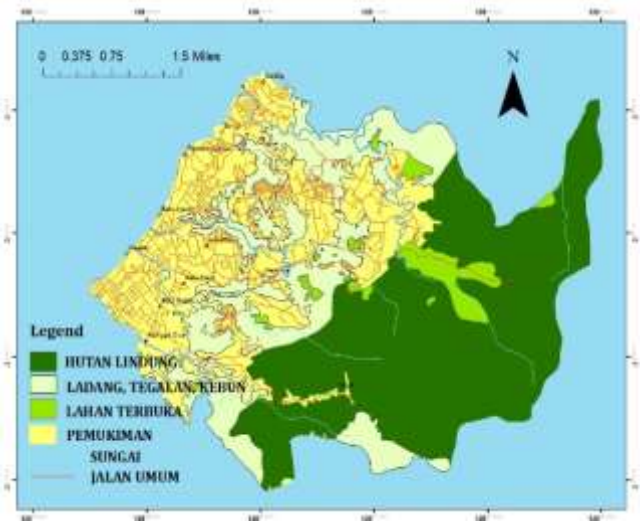

Figure 1. Land Use in Sirimau District, Ambon City

The results indicate that the largest proportion of land use is allocated for protected forests, covering an area of 11,462.28 hectares or approximately 7.87% of the total area. This is followed by agricultural areas, which account for 1,557.063 hectares or around

10.69% of the total area. Residential areas occupy 443.925 hectares or about 30.47% of the total area, while open spaces and water bodies cover relatively small areas of 924.71 hectares and 176.53 hectares, respectively. These findings suggest that the study area has a significant proportion of land allocated for conservation and environmental protection, which is in line with the Ambon City Spatial Plan's objectives. However, the results also highlight the need for more effective land use planning and management to ensure sustainable development and minimize land use conflicts in the area.

Cultivation and Protected Areas, Spatial Pattern of Ambon City Spatial Plan 2011-2031

The Spatial Pattern of the 2011-2031 Regional Spatial Plan (RTRW) includes the distribution of spatial designations within an area, involving protected and cultivated functions, in accordance with the provisions stipulated in the Republic of Indonesia's KBPN Number 37 of 2016. The Protected Area Plan is established with the main objective of protecting the preservation of the environment, including natural resources, artificial artifacts, as well as the nation's historical and cultural values, in an effort to support sustainable development. This area is maintained as a protected zone with main functions, such as maintaining the water system in the lower area, especially in the Gunung Sirimau Protected Forest.

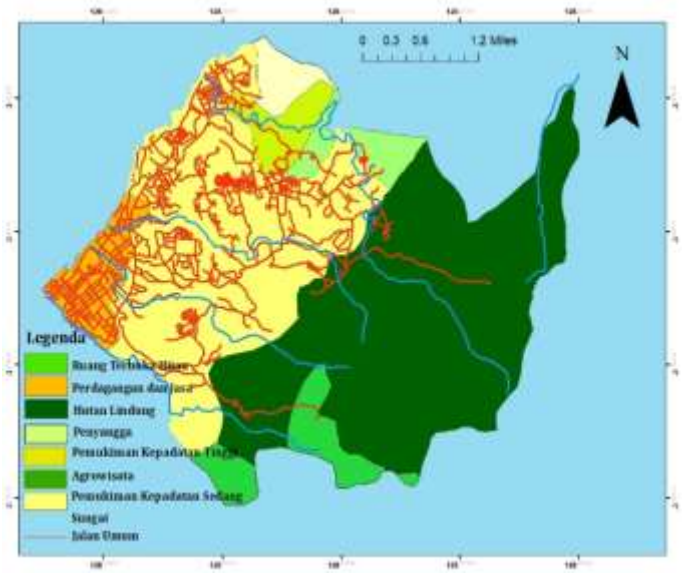

Figure 2. Spatial Pattern Map of the Regional Spatial Plan (RTRW) of Ambon City 2011-2031

It is important to recognize that regional development planning for Ambon City plays a crucial role in overall national development. In a formal sense, planning is defined as a process for determining the appropriate course of action. Ambon City often experiences significant new development and land clearing, and sometimes government planning is ignored, in line with the spatial plan for Ambon City 2011-2031. Tarigan (2005) states that regional spatial planning involves planning for the development and

utilization of regional space, which includes planning for land use and movement within that space. The Spatial Plan is a hierarchically organized regional spatial planning instrument, including national, provincial, and district/city spatial plans (RTRW). In line with this, based on Forestry Decree No. 415/KPTS-11/99, the plan for protected forest areas aims to maintain environmental balance, prevent erosion, and act as a catchment area and water reserve.

This protected forest area is spread across several locations, such as Mount Salahutu with an area of 8,300.22 Ha, Mount Nona with an area of 1,621.78 Ha, and Mount Sirimau with an area of 5,449 Ha. However, some of these areas, especially around the slopes of Mount Sirimau, have undergone functional changes into built-up areas for settlements and public buildings, as well as being converted into agricultural land in the form of plantations. Therefore, some of these areas have shifted from protected areas to areas with different land uses. Further information about the Spatial Pattern of the Sirimau District RTRW, Ambon City, can be seen in Table 2.

Table 1. Spatial Pattern Map of the Regional Spatial Plan (RTRW) of Ambon City 2011-2031

Area Type	Area (ha)
Cultivation Area	
Buffer Area	120.76
Agrotourism	178.29
Residential Area	
Medium Density Settlement	79.76
High Density Settlement	1327.08
Trade and Services	174.08
Medium Density Settlement	79.76
Protected Area	
Protected Forest	16386.66
Green Open Space	66.88

Table 2 dan Figure 2 Spatial pattern map of Sirimau District RTRW, has a cultivation area, Buffer area of 120.76 Ha (7.36%) and Agrotourism with an area of 178.29 Ha (10.86%), for built-up areas, namely medium-density settlements with an area of 79.76 Ha (4.86%), high-density settlements with an area of 1327.08 Ha (8.08%), and trade with an area of 174.08 Ha (10.61%). Protected Areas, namely an area of 16386.66 Ha (9.98% and Green Open Space with an area of 66.88 (4.07%). Land use is part of the factors that play a role in the level of vulnerability (Mohamed & Worku, 2019)

Land Use Deviation Based on Ambon City Spatial Plan 2011-2031

Land use deviation refers to land use change or conversion that is not in accordance with the regional spatial plan (RTRW). The deviation map was obtained through an overlay between the Existing Land Use Map of 2024 and the Spatial Pattern Map of the

2011-2031 RTRW. For more information on land use deviation in Sirimau Sub-district, Ambon City, can be found in Table 3.

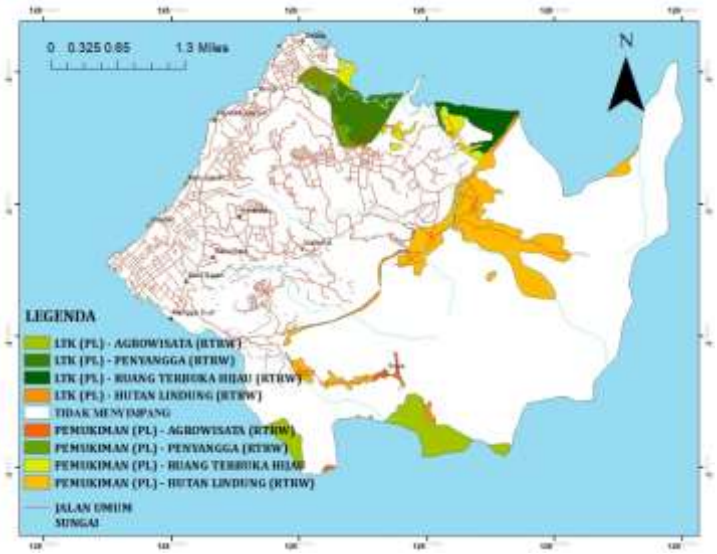

Figure 3. Map of Land Use Deviation Based on Cultivation and Protected Areas of Ambon City RTRW 2011-2031

Table 3. Deviations in Land Use Based on Cultivation and Protection Areas of Ambon City RTRW 2011-2031

Change Type	Area (ha)
Open Land (Land Use) - Protected Forest (RTRW)	102.44
Fields, Tegalan, Kebun LTK (Land Use) -Protected Forest (RTRW)	15.05
Fields, Tegalan, Kebun LTK (Land Use) -Agriculture (RTRW)	75.96
Fields, Tegalan, Kebun LTK (Land Use) - Green Open Space RTH (RTRW)	37.03
Field, Farm, Garden LTK (Land Use) - Buffer (RTRW)	59.66
Settlement (Land Use) - Protected Forest (RTRW)	78.182
Settlement (Land Use) - Green Open Space RTH ((RTRW)	33.07
Settlement (Land Use) - Agritourism (RTRW)	5.69
No Deviation	3049.2

In Table 3 and Figure 3, the highest Land Use Deviation is centered on Open Land against Protected Forest (RTRW) with an area of 102.44 Ha (29.63%), Settlement (PL) against Protected Forest (RTRW) with an area of 78.182 Ha (22.62%), LTK Land Use against 75.96 Ha (21.97), LTK (PL) against Buffer Area (RTRW) with an area of 59.66 Ha (17. 26%), LTK (PL) against Green Open Space (RTRW) with an area of 37.07 Ha (10.71%), settlements (PL) against Green Open Space (RTRW) with an area of 33.07 Ha (0.95), settlements (PL) against Agro-tourism with an area of 5.69 Ha (0.16), and land use that does not deviate from the Spatial Pattern (RTRW) of Sirimau District with an area of 3049.2 Ha (88.22). Changes in land use and cover are the result of dynamic interactions between human activities and natural resources. This is the core of the environmental changes that occur (Toure et al., 2018; Salakory & Rakuasa, 2022).

Causes of Land Use Deviations

One of the main causes is the rapid population growth and urbanization in the area. The increasing need for housing and infrastructure has led to the conversion of agricultural land and protected forests into residential areas, resulting in deviations from planned land use. Another cause of land use deviations is the lack of effective enforcement of land use regulations. The Ambon City Spatial Plan 2011-2031 has designated certain areas for specific land uses, but the lack of supervision and law enforcement allows for unauthorized land use changes. This has resulted in encroachment of residential areas into protected forest and agricultural land, leading to environmental degradation and loss of biodiversity. This research highlights the role of economic factors in driving land use deviance. The increasing demand for land for residential and commercial purposes has driven up land prices, making it more profitable for landowners to convert their land into residential or commercial areas rather than maintaining it for agricultural or conservation purposes. This has led to the conversion of agricultural land and protected forests to more profitable land uses, resulting in deviations from planned land uses (Tariq et al., 2023).

The results of this study noted that the lack of community involvement in the land use planning process has contributed to land use deviations. Local communities have not been adequately involved in the planning process, resulting in a lack of awareness and understanding of the land use plan and its objectives (Rakhmonov et al., 2021). This has led to unauthorized land use changes, as community members may not be aware of land use plans in their area (Fitriana et al., 2021; Achmadi et al., 2023). In addition, this study identified the limited availability of land for development as a cause of land use deviation. The hilly terrain and limited land in Sirimau sub-district has led to a lack of land for development, resulting in pressure to convert protected forest and agricultural land into residential and commercial areas. This leads to deviations from planned land use, as developers try to find ways to meet the demand for land (Stoian et al., 2019; (Latue et al., 2023). Finally, a lack of coordination between government agencies and stakeholders has contributed to land use deviations. The various government agencies and stakeholders involved in land use planning and management have not been adequately coordinated, resulting in conflicting policies and decisions that lead to deviations from planned land use. This highlights the need for improved coordination and collaboration between government agencies and stakeholders to ensure that land use planning and management is effective and sustainable.

CONCLUSION

The research on land use deviations in the Sirimau Sub-district of Ambon City reveals that rapid urbanization, population growth, and economic pressures significantly contribute to the divergence from the planned land use as outlined in the Ambon City Spatial Plan (RTRW) 2011-2031. The study highlights the critical role of ineffective enforcement of land use regulations and the lack of community involvement in the planning process, which exacerbate unauthorized land use changes and environmental degradation. To address these challenges, the research advocates for improved

coordination among government agencies, enhanced community engagement, and stricter enforcement of regulations to promote sustainable land use management and protect vital ecosystems in the region.

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