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Spatial Analysis Of Customary Forest Degradation In Sereh Village, Cycloop Mountains, Jayapura Regency

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Abstract
An occupation that can disrupt the ecosystem occurs in the customary forest of Kampung Sereh, part of the Cycloop Mountains Area of Papua, Indonesia. The occupation of customary forests in urban areas, especially Sentani District, the capital of Jayapura Regency, is the main topic of this study. This differentiates it from previous studies that focused on customary forest areas that are generally far from urban areas. Using field observation methods and spatial analysis, Landsat and Sentinel satellite imagery from 2008 to 2023, revealed a significant increase in residential and agricultural land and a decrease of around 37% in previously customary forests. This degradation increases the risk of ecological disasters, which endanger ecosystem services for biodiversity, soil erosion, and water supply. For the preservation of customary forests in urban areas. Referring to best practices in customary forest management in other areas, this study recommends strengthening customary institutions and local community economic development, community-based forest management, and the use of Automated Analysis Technology for Land Change Detection.
Keywords: Customary forests, Cycloop Mountains, urbanization, spatial analysis, sustainable forest management

INTRODUCTION

The customary forest in the Cycloop Mountains, especially in Sereh Village in Jayapura, Indonesia, has a significant ecological foundation and the customs of the local indigenous people. This place is very important because it plays a role in the formation of water resources that support fauna and flora and has high cultural and spiritual significance. However, in recent years, urban expansion and increasing demand for land have significantly encroached on the customary forest. This condition not only endangers the environment but also the livelihoods of city dwellers.

The Cycloop Mountains, which cover an area of around 31,479 hectares, have been designated as a conservation area to protect the ecosystem in the Jayapura Regency and Jayapura City areas of Papua Province, Indonesia. However, deforestation activities that occur in the area, especially in Sereh Village, have caused environmental damage that has an impact on the livelihood of indigenous peoples (24). The flash flood disaster in March 2019 in Jayapura Regency which claimed more than a hundred victims is a real example of the direct consequences of environmental degradation caused by uncontrolled occupation and deforestation activities (27).

Several protection efforts have been made to deal with this threat. For example, BBKSDA Papua and USAID Lestari involve local communities in the Cycloop Mountains ecosystem restoration plan through a customary forest protection and conservation program (25). In addition, WWF Indonesia collaborates with the Sereh Village indigenous community to plant trees and maintain local food security in customary forest areas (28). However, major challenges remain, especially related to weak law enforcement and increasing pressure on the need for residential and agricultural land. The local government, through the Acting Regent of Jayapura, Triwarno Purnomo, has called for a halt to new encroachment on the slopes of the Cycloop Mountains to prevent further damage (26).

With an emphasis on Sereh Village in Sentani District, this study seeks to produce comprehensive data and information on the extent of customary forest occupation in the Cycloop Mountains area. To find patterns of occupation and activities on occupied land, this method combines field observation and spatial analysis. It is hoped that the conclusions of this study will provide a strong scientific basis for better policy-making on customary forest management and practical recommendations for building a balance between development and environmental conservation.

METHODOLOGY

The purpose of this study is to generate statistics and information about the extensive use of customary forests in Sentani District, Jayapura Regency's Sereh Village, Cycloop Mountains. Using field observations and spatial data, the methodological approach combines quantitative and qualitative analysis.

Quantitative Approach: Spatial Analysis

Satellite Imagery: Landsat 7 ETM+ (2008) and Landsat 8 OLI/TIRS (2013, 2018, 2023) satellite imagery were used in this investigation. To ascertain changes in vegetation cover over the previous 15 years, these imagery data were analyzed using the Normalized Difference Vegetation Index (NDVI) (1). This index makes it possible to pinpoint the destruction of forests brought on by land occupation, such as the growth of settlements and the conversion of land for farming.

Spatial Data Processing

Spatial data analysis is done with GIS software such as ArcGIS or QGIS. This technique includes digitizing maps, overlays, and land use change analysis (15). This approach provides accurate visual information about land occupation patterns in Sereh Village's traditional wooded area.

Field Observations: Observations were made in order to validate the results of the spatial analysis. GPS technology was used to map new occupation zones and confirm the correctness of spatial data (18). Additionally, field photos were used to visually capture the social and physical characteristics of the research site.

Analysis Framework

Temporal and Spatial Analysis: This study examines the temporal and spatial dynamics of customary forest occupation in Sereh Village using data on changes in land cover from 2008 to 2023. To give a comprehensive picture of the changes that take place, the analysis's findings are combined with qualitative research.

When it comes to managing customary forest areas, a multi-criteria-based approach can offer a solid foundation for complicated decision-making, particularly when urbanization pressures are present. According to Elmahmoudi et al. (21), multi-criteria-based decision-making in spatial analysis might offer an organized method of land use management, particularly in regions with significant ecological stress, like the Sereh customary forest.

RESULTS AND DISCUSSION

The extent of customary forest occupation in Sereh Village, Sentani District, Jayapura Regency, is the subject of several important findings from this study. The findings of this study center on the extent of customary forest occupation, ecological impacts, and changes in land use.

Land Use Change in Sereh Village (2008-2023)

1. Map of satellite imagery from Landsat-7 (2008), Landsat-8 (2013) and Sentinel-2 (2018, 2023)

Maps from satellite imagery from Landsat-7 (2008), 2013) and Sentinel-2 (2018, 2023) show a significant pattern of changes in land cover in Sereh Village over the last 15 years. Map analysis reveals that customary forest land in this region continues to decline, while residential and agricultural areas increase consistently.

a. Landsat-7 Map of 2008

Figure 1 Landsat-7 Map of 2008 Sereh Village

Initial Condition Description: In 2008, the majority of Sereh Village was still covered by dense natural vegetation, as indicated by the dominant green color on the map. Human activities, including settlements, are concentrated in small areas near the main villages.
Key Findings: Dense vegetation cover dominates the northern and central areas of Sereh Village. However, early signs of land conversion are starting to be seen around residential areas.

b. Landsat-8 Map 2013

Figure 2 Landsat-8 Map of Sereh Village Year 2013

Changes Occurred: In 2013, communities expanded south westward and northward. Indicating a rise in human activity, natural vegetation regions in the south are starting to fragment.
Initial Impact: The decline in vegetation cover in the southern part leads to a reduction in the quality of local ecosystems, especially in the function of water runoff control.

c. Sentinel-2 Map 2018&2023

Figure 3 Sentinel-2 Map of 2018

Description of Land Change: In 2018, Conversion of land increased in frequency. While the natural forest area in the center has started to rapidly decline, the residential area has grown significantly.
Environmental Implications: The risk of soil erosion is increased by the reduction of vegetation, particularly in the slope areas surrounding Sereh Village.

Figure 4 Sentinel-2 Map of Sereh Village Year 2023

Final Condition: By 2023, natural vegetation cover has been almost completely replaced by residential and agricultural areas, especially in the southern part of Sereh Village.
Key Findings: The loss of most of the vegetation cover in the central and southern areas indicates the impact of extensive land use for agriculture and settlements.

d. Implications of the Results of the Analysis of Satellite Image Maps
Environmental Degradation Scale: According to map representations, there has been a notable decrease in the amount of natural vegetation between 2008 and 2023, with a decrease of over 37%.
Ecological Impacts: Degradation of vegetation reduces biodiversity and obstructs ecosystem services including erosion prevention and the supply of clean water.
Social Impact: Agricultural growth and settlement are frequently carried out without adequate planning, which may lead to disputes between governments or other outside parties and indigenous peoples.

2. Changes in Vegetation Cover in Sereh Village Based on NDVI

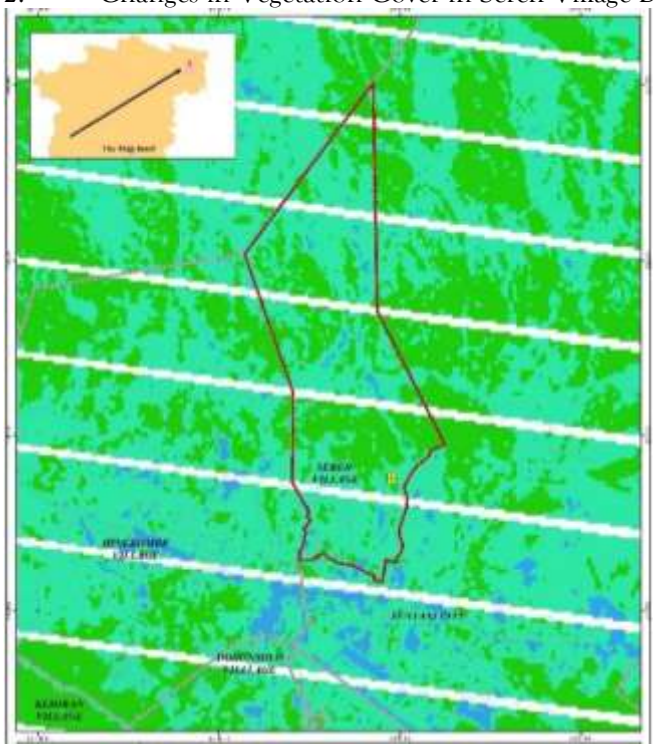

Figure 5 NDVI Map of Sereh Village in 2008

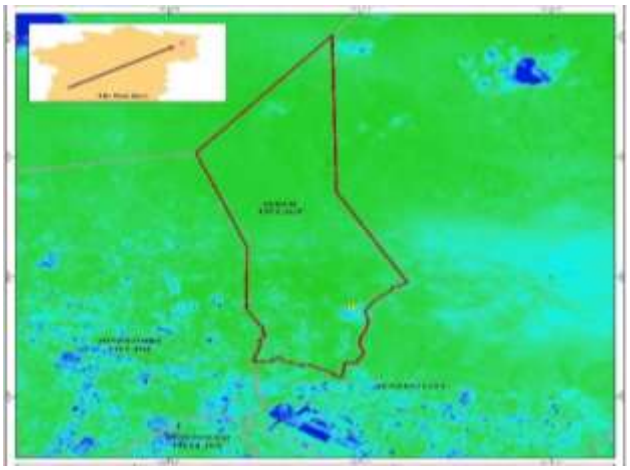

Figure 6 NDVI Map of Sereh Village in 2013

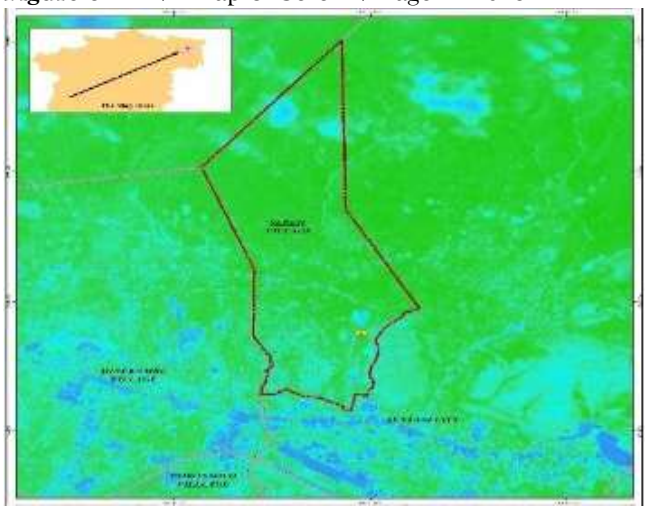

Figure 7 NDVI Map of Ampung Sereh in 2018

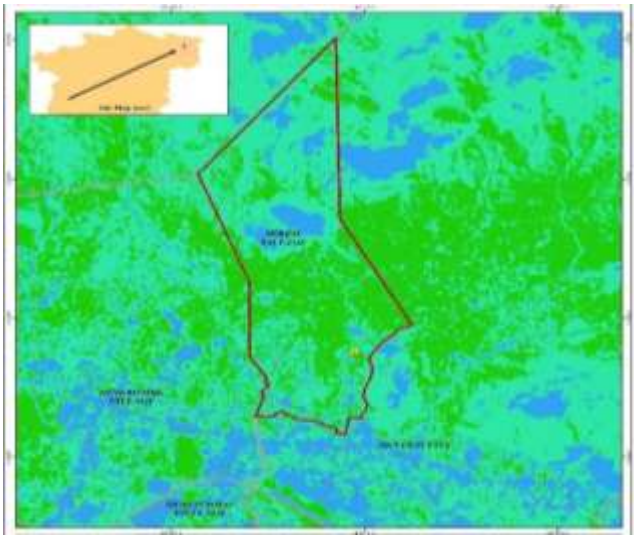

Figure 8 NDVI Map of Sereh Village in 2023

This NDVI map is an important tool to analyze the dynamics of customary forest occupation. by contrasting data from 2008 to 2023. We may observe a temporal comparison in Sereh Village from the NDVI map from 2008 to 2023 that was previously indicated. The 2008 NDVI map (Figure 5) shows the initial condition of vegetation in Sereh Village. If most areas have a high NDVI (light/dark green color), this indicates that the

vegetation is still dense. In 2013 (Figure 6), changes in NDVI can begin to be seen, especially if there is a decrease in green color in certain areas, indicating possible deforestation or occupation. The map presents an updated picture of vegetation conditions in 2023 (Figure 8), allowing analysis of vegetation degradation rates cumulatively over 15 years. In 2018, a further decline in NDVI values (more blue or brown areas) indicated an expansion of occupations, land conversion for settlements, or other human activities (Figure 7). Sereh Village's decreasing NDVI over time provides a graphic representation of how habitation affects traditional woodlands. The well-known NDVI technique is frequently used in international research to analyze changes in forest cover and occupation. In addition to offering valuable insights into the dynamics of forest ecosystems under human pressure, it has been demonstrated in multiple studies to be useful in recognizing land use change, deforestation, and degradation worldwide (1, 13). The method's ability to quantify vegetation change makes it a valuable tool for understanding the environmental consequences of land occupation. Occupation in Sereh Village includes land clearing for settlement, agriculture, or other activities. Areas showing the most significant decline in NDVI could be the focus of further research, identifying occupation patterns occurring in customary forests.
The table below shows data on land use change in Sereh Village from 2008 to 2023:

Table 1 Changes in Land Use in Sereh Village (2008-2023)

Years	**Forest Area (Hectares)**	**Settlement area (Hectares)**	**Agricultural Area (Hectares)**
2008	4500	200	300
2013	3900	600	700
2018	3400	900	1200
2023	2800	1200	2500

The data presented above indicates that the forest area has decreased by 1,700 hectares over the last 15 years, and there has been a notable increase in both residential and agricultural areas.
The following graph visually illustrates these land-use trends.

Figure 9 Graph of Forest Area Change in Sereh Village (2008-2023)

The graph above shows a significant decline in forest area from 4,500 hectares in 2008 to just 2,800 hectares in 2023. This decrease illustrates the scale of customary forest occupation that occurs in Sereh Village.

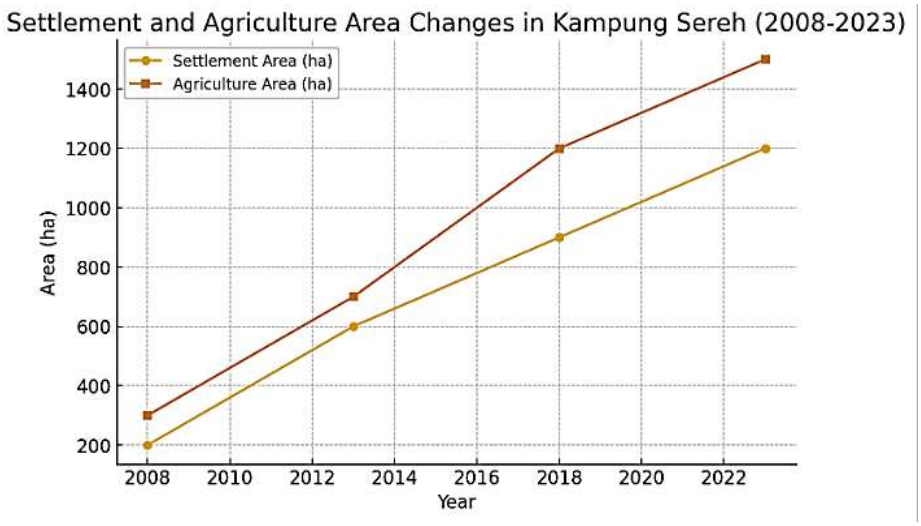

Figure 10 Graph of Changes in Residential and Agricultural Areas (2008-2023)

This graph illustrates how residential and agricultural areas grew steadily between 2008 and 2023. The growing demand for land was reflected in the 1,200-hectare rise in the agricultural area and the 1,000-hectare increase in the residential area.

Environmental Impact in Sereh Village

Customary forest occupation in Sereh Village has significant ecological impacts:

1. Ecosystem Degradation: As forest areas shrink, local biodiversity is lost and ecosystem functions are disrupted.

Many scientific studies have previously been conducted on the significant impacts of deforestation on ecology, such as in the indigenous forest area of the Cyclops Mountains. Many species lose their habitat due to deforestation, which endangers the biodiversity in the area. Populations of endemic species decline due to this habitat loss, and this may lead to extinction. Laurance (6) found that habitat fragmentation caused by deforestation in tropical areas isolates wildlife populations and reduces genetic diversity. By displacing native species and animals, forest encroachment activities in the Cyclops Mountains cause significant ecological damage, according to research by Nubatonis (12).

Furthermore, forests are essential for maintaining the balance of ecosystems, especially the water and nutrient cycles. These cycles are disrupted by deforestation, which hurts water availability and soil fertility. Research in the Cyclops Mountains shows that changes in land use have an impact on the degradation of the ecosystem function of clean water providers. Triono (17) found that land use changes in this area decreased in the quality and quantity of springs, which were previously the main source of clean water for local communities. Disruption of the nutrient cycle is also a concern, as expressed by Purbopuspito et al. (19), which shows that deforestation can reduce the organic matter content in the soil, thereby significantly reducing soil fertility. In the Cycloop Mountains area, this finding is in line with observations of increased soil erosion due to the loss of vegetation cover. These results make it more evident that the Cyclops Mountains' deforestation affects not just the local environment but also crucial ecological processes including the nutrient and water cycles. This emphasizes how urgent it is to implement conservation measures to preserve the natural equilibrium and the well-being of the surrounding communities.

2. Enhanced Disaster Risk: As demonstrated in Sentani in 2019, the loss of vegetative cover raises the possibility of flash floods.

Bradshaw et al. (2) found that deforestation increases the frequency and duration of floods in developing nations. According to their findings, a 10% decrease in the area of natural forests can lead to a 4%–28% increase in the frequency of floods and a 4%–8% increase in the total duration of floods. Jean-Louis et al. (5) demonstrated that urbanization and deforestation raise the risk of flooding in a case study in Cap-Haïtien, Haiti. Loss of forest cover reduces the soil's ability to absorb water, which exacerbates flooding by increasing surface runoff.

The significance of trees in the hydrological cycle is the mechanism underlying this phenomenon. By reducing the pace at which rainwater reaches the ground, trees and other plants decrease surface runoff and promote water penetration into the soil through their root systems. This function is eliminated by deforestation, which increases surface runoff and increases the risk of flash floods.
Thus, the loss of vegetation cover in areas such as Sentani significantly contributes to the increased risk of flash floods.
3. Disruption of the Water Source: Previously, the community's primary source of clean water came from the customary forest in Sereh Village. The quantity and quality of water sources are impacted by the loss of forest area.
Mapulanga and Naito's research indicates that deforestation is associated with a decrease in access to safe drinking water (10). This study found that every 1% increase in deforestation resulted in a 0.93% loss in access to safe drinking water. Growing soil erosion and sedimentation lead to compromised water supplies.
The impact of forests on the hydrological cycle is covered by Locatelli and Vignola (8) in Forest Ecology and Management. Forests contribute to both lowering surface runoff and enhancing water infiltration into the soil. River base flow and water availability may decrease during the dry season when deforestation disrupts this process. However, the relationship between deforestation and water quality in the Amazon was examined in Lima et al.'s study (7) in Environmental Monitoring and Assessment. The results showed that areas with high levels of deforestation had higher amounts of sediment and water nutrients, which is an indication of lower water quality.

CONCLUSION

This study shows that the customary forest in Sereh Village, Cycloop Mountains, has experienced significant occupation during the period 2008 to 2023. Spatial data reveals that the area of customary forest decreased from 4,500 hectares in 2008 to only 2,800 hectares in 2023. The decrease of 1,700 hectares or more than 37% in the 15 years is a strong indication of anthropogenic pressure due to the increasing need for land for settlements and agriculture.
In contrast, during the same period, the area of settlements increased from 200 hectares to 1,200 hectares, and the area of agriculture increased from 300 hectares to 2,500 hectares. These drastic changes illustrate uncontrolled development pressures, which threaten the sustainability of the customary forest ecosystem of Sereh Village.
In addition to contributing to environmental deterioration, this loss of vegetation cover interferes with vital ecosystem services like clean water supply, erosion prevention, and biodiversity preservation. As a result, Sereh Village's customary forest management needs to be addressed right away using a more organized and inclusive strategy.

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