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| Research Article

Mangrove Empowerment to Support the Ecosystem and Biodiversity of Mangrove Kampoeng Nipah Sei Nagalawan Village

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Abstract: Mangrove is a very important ecosystem for life as a whole and the geographical conditions in coastal areas. Geography plays a major role in the sustainability of the mangrove ecosystem. Lack of mangrove areas can result in coastal erosion, which can then reduce biodiversity in coastal areas. This study aims to evaluate the condition of the mangrove ecosystem on the Kampoeng Nipah coast in Sei Nagalawan Village, explore the potential of the mangrove ecosystem that can support sustainability, and study the various types of species in the ecosystem. The methods applied in this study include observation to collect primary data and literature studies to obtain supporting data. Furthermore, qualitative analysis is needed to help understand the results of this study. The findings of the study indicate that (1) the condition of the mangroves is generally not good due to the lack of routine maintenance. (2) There are four types of mangroves identified in the mangrove ecosystem on the Kampoeng Nipah coast, which live in two different types of habitats, namely sand and mud. (3) Biodiversity in the mangrove ecosystem is diverse, but there are some mangroves that have little biodiversity. The results of this study can be used to increase public awareness regarding the importance of maintaining the mangrove ecosystem.

Keywords: Mangrove Ecosystem; Biodiversity; Sustainable Ecosystem.

1. INTRODUCTION

The mangrove ecosystem plays a vital role in maintaining the balance of nature along the coastline, including at the Kampoeng Nipah mangrove beach location in Sei Nagalawan Village. The beauty of the beach will be lost if it is not managed correctly. Mangrove empowerment is crucial for ensuring the sustainability of biodiversity in the ecosystem, and this is a practical step to support the sustainability of the ecosystem on the Kampoeng Nipah mangrove beach in Sei Nagalawan Village. Mangrove empowerment efforts can enhance the quality of the mangrove ecosystem, thereby improving environmental resilience. As explained by Lestari and Susiana (2024), mangrove empowerment can help people become more aware of the importance of preserving this ecosystem. The mangrove ecosystem presents vital elements with financial value, including support for the fisheries sector, protection from disaster damage, carbon absorption and storage, and cultural benefits such as recreation and tourism (Husain et al., 2020).

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The unique feature of this study is the observation of the interactions between biodiversity within the mangrove ecosystem on the Kampoeng Nipah mangrove beach in Sei Nagalawan village. This will provide insights into the level of biodiversity within the mangrove ecosystem.

Currently, mangrove ecosystems face numerous challenges due to exploitation focusing solely on narrow economic aspects. Meanwhile, mangroves serve various complex ecological, social, and economic functions (Maryani et al., 2025). Various social and ecological factors, including climate change, natural disturbances, and human activities such as fish farming and agriculture, influence the decline in mangrove forests. Climate change and other related factors are the leading causes of mangrove forest loss (Bhowmik et al., 2022). The study by Wirabuana et al. (2025) reveals that Indonesia has implemented a substantial mangrove forest reforestation program to maintain the balance of coastal ecosystems and mitigate the impacts of climate change. The long-term impact of reforestation on mangrove recovery remains minimally studied, as most efforts are typically observed for only two years.n

Mangrove ecosystems are crucial in providing valuable resources for social, economic, and environmental aspects, including coastal resilience, carbon sequestration, and habitat for various marine species (Pamungkas et al., 2023). Additionally, rehabilitation planning should consider the type of coast, tree density, physical factors, and land use (Rahadian et al., 2022). The potential of mangrove forests encompasses biological, ecological, economic, and educational aspects, with various types of mangroves serving as sources of food, medicine, and creative economic products (Harefa et al., 2020). Community participation in mangrove planting is crucial for supporting ecotourism development and increasing residents' awareness and welfare (Murni et al., 2023).

Mangrove forest restoration demonstrated a positive cost-benefit analysis, ranging from 10.50 to 6.83, across various discount rates, indicating that mangrove restoration efforts are an economically efficient method in ecosystem management (Su et al., 2021). The services provided by mangrove ecosystems, including clustering, distribution, and use mapping, aim to understand the important relationship between mangrove services and their contribution to achieving or realizing the Sustainable Development Goals (Bimrah et al., 2022).

Mangroves have various benefits; these plants are essential for marine and terrestrial ecosystems. Good management can positively impact the economy in both primary and secondary sectors (Madyowati & Kusyairi, 2020). According to Hulopi et al. (2022), gastropods are one type of marine biota often found in shallow waters, so mangrove ecosystems must balance coastal environmental conditions. Based on an analysis of several factors, the mangrove area is highly suitable for ecotourism (Zakia, 2024). Mangrove forests are highly productive ecosystems with numerous benefits (Ely et al., 2021). The mangrove ecosystem is a unique coastal area providing numerous nutrients for biota, including fish, Shellfish, and crustaceans (Junaidi et al., 2024). Mangrove forests around river mouths increase access to mangrove areas more easily and affordably than mountainous areas (Naibaho et al., 2023).

The utilization of mangrove forests has been the subject of study in Indonesia over the last decade through various research efforts. In fact, mangroves have significant potential as a source of additional income for coastal communities (Ismawati et al., 2020). Mangrove conservation aims to maintain species diversity, preserve water and soil quality, and protect coastal areas from erosion and damage caused by natural disasters (Suriadi et al., 2024). Sustainable mangrove management is crucial for achieving various sustainable development targets and fostering the development of economically valuable and sustainable mangrove ecosystems through environmentally friendly planting and harvesting methods (Arfan et al., 2024). Assessment of problems in the Social-Ecological System (SES) using the DPSIR model reveals that management is influenced by the function of the mangrove ecosystem, population growth, land use, economic activities, and quality of life, as well as understanding related to sustainable ecosystem management (Mahardika et al., 2023).

2. RESEARCH METHODS

This research was conducted in the coastal mangrove area of Kampoeng Nipah, Sei Nagalawan Village, Perbaungan District, Serdang Bedagai Regency, North Sumatra Province, on Tuesday, June 5, 2025. In this study, researchers identified a population that included the entire mangrove ecosystem on the coast of Kampoeng Nipah, Sei Nagalawan Village, Perbaungan District, Serdang Bedagai Regency, North Sumatra

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Province. For this study, samples were collected using the Purposive Sampling method to assess the condition and potential of the mangrove ecosystem in relation to biodiversity in the study area.

Data collection was conducted to gather both primary and secondary data. Primary data were collected through direct observation in the field to understand the existing conditions and problems. In contrast, secondary data were obtained from relevant literature studies accessed online and well-known journals at national and international levels. The data analysis process was conducted using a qualitative approach, utilising information regarding the condition and potential of the mangrove ecosystem in terms of biodiversity at the research location. This analysis aims to provide a clear picture of the condition and potential of the mangrove ecosystem at the location being studied.

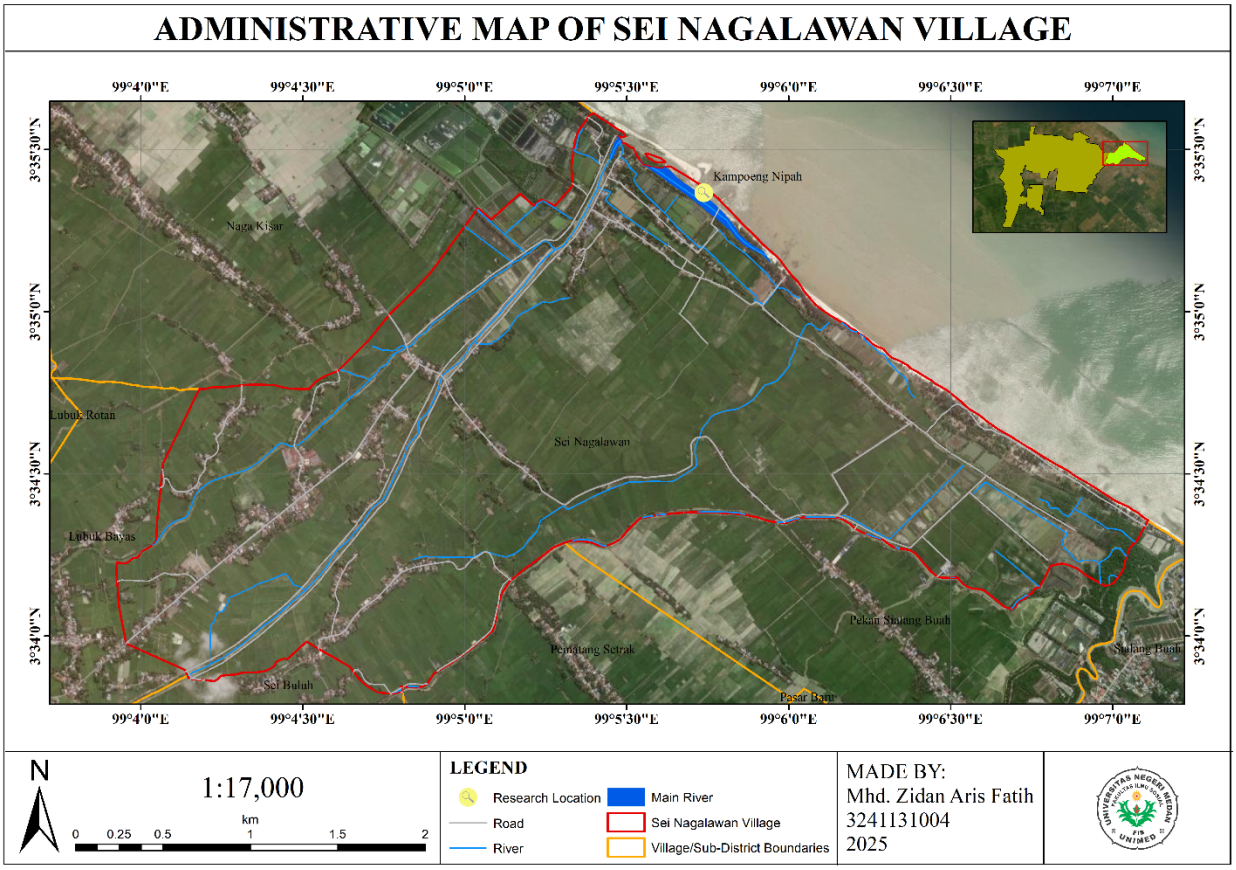

Figure 1 | Research Location Map (Source: ESRI Satellite Imagery processed with ArcMAP 10.8, 2025)

3. RESULTS AND DISCUSSION

Vegetation growing in the mangrove area on the coast of Kampoeng Nipah, Sei Nagalawan Village, can be considered dense and healthy, as supported by Harefa et al. (2020), which indicates that the mangrove ecosystem in Kampoeng Nipah covers an area of approximately 9 hectares. The environmental diversity in the mangrove ecosystem at the research location is relatively rich, encompassing both sandy and muddy areas, as well as tidal zones. These environmental differences result in significant variations in the biodiversity of the mangrove ecosystem.

According to Mahmudin et al. (2020), the level of biodiversity of a mangrove ecosystem is influenced by the location of empowerment activities in the area. Amri et al. (2021) added that the condition of the mangrove ecosystem can also be influenced by environmental resilience. Environmental conditions influence variations in the level of diversity in each mangrove ecosystem (Faisal et al., 2021). Part of the mangrove ecosystem on the coast of Kampoeng Nipah, Sei Nagalawan Village, has been damaged and can no longer sustain the coastal biodiversity.

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In the research of Harefa et al. (2020), it was found that the mangrove ecosystem in Kampoeng Nipah experienced significant damage in 1996 due to the land function being changed into shrimp ponds, which damaged around 300 m^2 of the mangrove ecosystem, as well as the decline that occurred in the North Sumatra ecosystem until 2009. The researchers identified four types of mangroves: Avicennia marina, Avicennia sp., Rhizophora mucronata, and Rhizophora sp. The diversity of these mangrove types shows that the condition of the mangrove ecosystem on the coast of Kampoeng Nipah, Sei Nagalawan Village, is quite good. However, the types of biodiversity in each type of environment in the mangrove ecosystem were recorded as low.

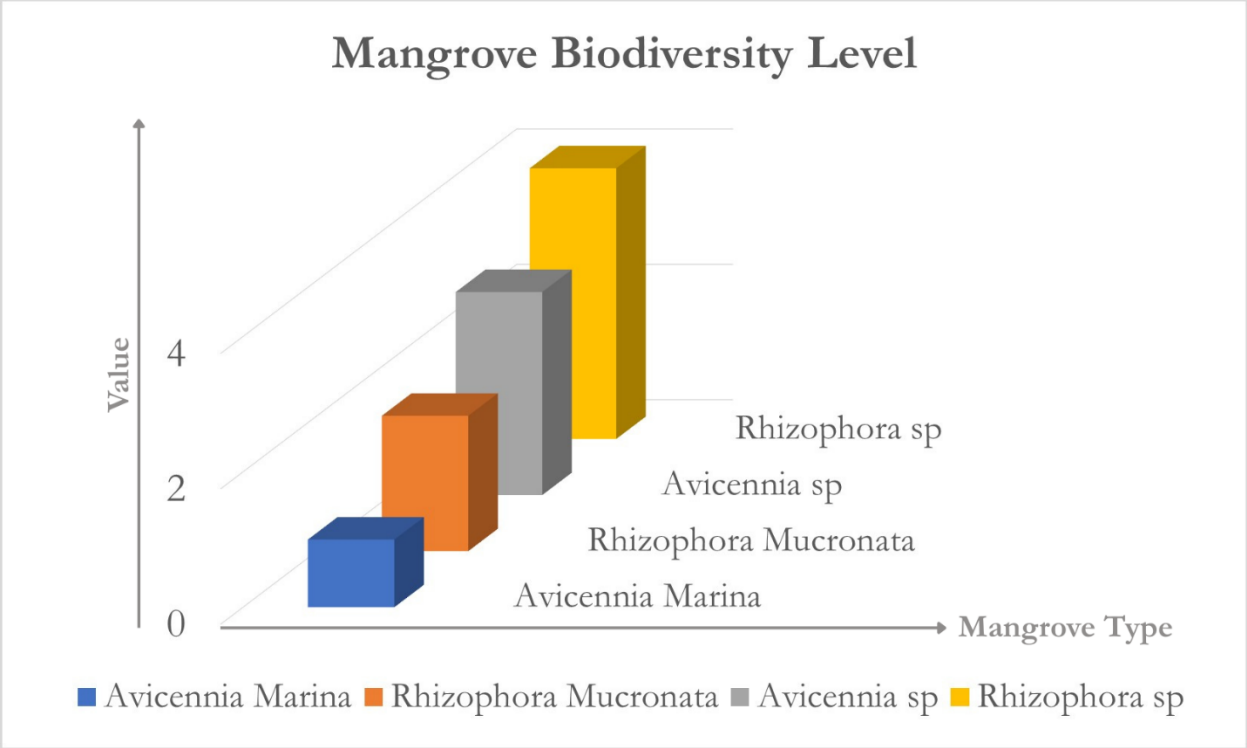

Figure 2| Mangrove Biodiversity Level (Source: Original Research, 2025)

Table 1 | Biodiversity in the Mangrove Ecosystem of Kampoeng Nipah

Mangrove Type	Biodiversity
Avicennia Marina	Nothing
Avicennia sp	Mudskipper Fish
Rhizophora Mucronata	Mudskipper Fish, Uca Crab, Mangrove Crab
Rhizophora sp	Mudskipper Fish, Uca Crab, Mangrove Crab, White Egret, Belitung Snail

(Source: Original Research Data, 2025)

The results of this study can be used to increase public awareness of the importance of maintaining the mangrove ecosystem, ensuring its biodiversity is sustained. This can be achieved by providing Education and developing environmental Education programs that enhance the skills of local communities in managing and utilizing natural resources wisely. The results of this study align with Supriatna's (2018: 102) Theory, which states that "Public Education and awareness are key in biodiversity conservation efforts, because only by understanding the importance of biodiversity can we take action to preserve it."

The Potential of Mangrove Ecosystems in Mitigating Climate Change

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The biodiversity in this ecosystem is relatively weak. Evitasari et al.'s (2023) research indicates that the decline in mangrove vegetation can compromise water quality and hinder ecological functions in disaster management efforts. As a result, this impacts the survival of coastal areas. This finding aligns with research by Sy et al. (2023), which revealed that damage to coastal ecosystems, including mangroves, can reduce fish catches by up to 40% within ten years and threaten the economic stability of people living in coastal areas.

Ecological Potential

In a study conducted by Rahman et al. (2024), it was revealed that mangrove forests can store carbon (blue carbon), with Indonesia contributing around 18% of the world's total blue carbon, and have the potential to reduce greenhouse gas emissions. However, this potential can be better utilized if the government, private sector, and community participate in optimal mangrove ecosystem management. (Kurniawansyah et al., 2023). The environmental potential analyzed from the physical side is the mangrove forests, which can reduce the impact of erosion (coastal thinning) in the coastal area of Kampoeng Nipah mangrove in Sei Nagalawan Village. In addition, the biological function of this forest also provides a refuge for marine creatures to shelter from various predators before they migrate to the open sea (Harefa et al., 2020).

Tourism and Economic Potential

The mangrove ecosystem can be utilized as a tourist attraction that attracts visitors from outside to learn how to manage the ecosystem. This will increase visitors' insight into the importance of mangrove management for the survival of coastal ecosystems. Visitors can contribute to mangrove management efforts by planting mangrove seedlings along the coast, thereby helping to increase the amount of mangrove vegetation and supporting the ecosystem's recovery.

On the other hand, this activity can improve the local economy by selling tourist tickets and providing support to residents who sell around the Kampoeng Nipah mangrove, Sei Nagalawan Village. Mangrove canopy cover is important in maintaining and protecting environmental stability in coastal areas. In addition, mangrove canopies make a significant contribution to protecting coastal areas from strong winds (Pietersz et al., 2024). The development of ecotourism in mangrove areas is crucial for enhancing the community's economy while minimizing the risk of further damage to the mangrove ecosystem (Haidawati et al., 2022).

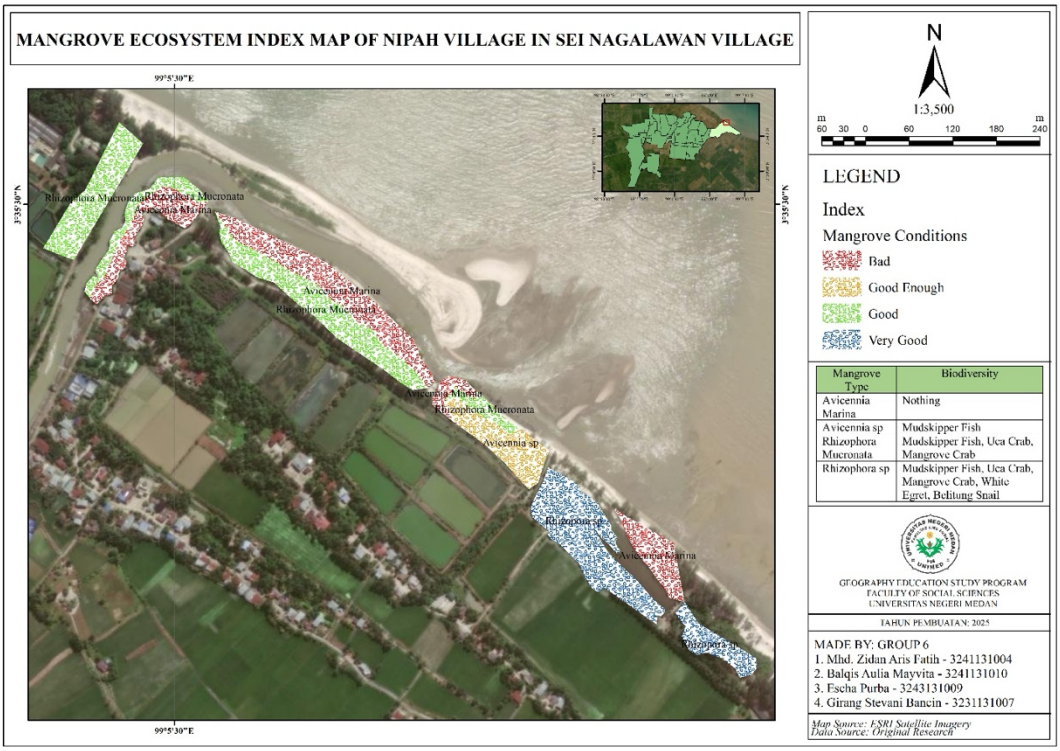

Figure 3 | Mangrove Index Map (Source: Original Research Processed with ArcMAP 10.8, 2025)

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4. CONCLUSION

Based on the study conducted, it can be concluded that the Plant cover in the mangrove land of the Kampoeng Nipah mangrove coastal area, Sei Nagalawan Village, falls into the dense and good category. However, several areas in the mangrove ecosystem on the Kampoeng Nipah coast, specifically in Sei Nagalawan Village, are damaged, so they cannot function as optimal habitats for coastal biodiversity. Researchers found four types of mangroves grew in that place: Avicennia Marina, Avicennia sp., Rhizophora Mucronata, and Rhizophora sp. The diversity of mangrove types suggests that the mangrove ecosystem in the Kampoeng Nipah coastal area, particularly in Sei Nagalawan Village, is in relatively good condition. However, the biodiversity variation level within each mangrove ecosystem environment is still considered low.

Researchers want to convey the following recommendations: Mangrove ecosystem management must be carried out correctly to protect all coastal biodiversity from the risk of extinction. The government should pay more attention to the sustainability of the mangrove ecosystem in the coastal area of Kampoeng Nipah, Sei Nagalawan Village, so that it is protected and reduces damage in the physical, ecological, biological, and economic fields.

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