

Optimizing Mangrove Conservation through Integrated Landscape Management in Kota Karang, Bandar Lampung

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ABSTRACT

Mangrove degradation in Bandar Lampung, specifically Kota Karang, Teluk Betung Timur, has left only 9,86% or 6 hectares, causing habitat loss and increased greenhouse gas emissions. This study identifies deficiencies in the government-led mangrove management system, emphasizing individual management leading to overlapping responsibilities and a lack of coordination. The research method employed is descriptive qualitative, incorporating primary data from observations, interviews, and documentation, alongside secondary data and literature studies. Observations encompass the assessment of biophysical elements, ecological indicators, and mangrove reduction due to land conversion. Literature studies focus on identifying soil types, water pH, dissolved oxygen levels, mangrove vegetation types, and principles of integrated landscape management. SWOT (Strength, Weakness, Opportunity, Threats) analysis considers stakeholders roles, disaster risks, land conversion, pollution, over-exploitation, and community participation. Findings prompt five strategies: community empowerment, eco-friendly tourism, cross-sector cooperation, enhanced monitoring, and mangrove rehabilitation. Recommendations, rooted in integrated landscape management, target all stakeholders, with a focus on government involvement. This holistic approach addresses identified issues, striving for enhanced mangrove ecosystem sustainability through collaborative efforts and strategic planning, emphasizing the need for coordinated stakeholders action in mangrove conservation.

Keywords: degradation, land conversion, stakeholders, SWOT analysis

INTRODUCTION

Indonesia dominates the world's mangrove ecosystems with an area of approximately 3.1 million hectares (Hanggara et al. 2021). However, Indonesia's mangrove ecosystems are facing significant threats to their long-term viability. Anthropogenic activities, such as land conversion to shrimp ponds and damage from oil spills and pollutants, have caused damage to Indonesia's mangrove ecosystems, which cover 71% of the total mangrove area. As a result, Indonesia has the highest rate of global mangrove ecosystem degradation (Campbell et al. 2016; Ginting et al. 2015). In addition, mangrove habitat loss accounts for approximately 42% of global greenhouse gas emissions (Murdiyarso et al. 2015).

Mangrove ecosystems support marine life despite occupying only 2% of the Earth's surface. Several animals, including fish, crabs

and shrimp, depend on mangrove ecosystems for survival. In addition, mangroves also contribute to nutrient cycling and act as coastal guards, protecting land from erosion (Eddy et al. 2017; Ginting et al. 2015; Indrayanti et al. 2015).

Bandar Lampung serves as a poignant illustration of the severe decline in mangrove ecosystems in Indonesia, experiencing an alarming 90.14% reduction. The natural mangrove areas in Bandar Lampung undergo an annual diminishment, with only 6 hectares remaining in Kelurahan Kota Karang since 2016. Notably, the mangrove area in Kelurahan Kota Karang is under critical threat due to the contamination of mangrove roots by waste, compounded by the conversion of a portion of the area into a settlement (Kurnia and Hasanah 2016; Iswandaru and Febryano 2021). This annual degradation underscores the urgency of the

issue, emphasizing the need for swift and strategic conservation interventions.

Integrated Landscape Management (ILM) is integral for effective mangrove management, harmonizing ecosystem sustainability with community well-being. ILM considers environmental, social, and economic factors, creating a balanced decision-making framework. This approach ensures that mangrove resources are conserved and utilized sustainably, fostering a holistic and adaptive strategy that preserves the environment and enhances community welfare (Mann *et al.* 2018).

Securing the sustainability of mangrove ecosystems in Bandar Lampung demands a comprehensive approach, as emphasized by Reed *et al.* (2015). This approach transcends conventional climate change techniques and strives to harmonize mangrove conservation with the unique needs of local communities. To materialize this approach, the focus narrows down to Kelurahan Kota Karang in Bandar Lampung, where the application of ILM principles becomes paramount.

ILM principles, ranging from adaptive management and continuous learning (P1) to stakeholder capacity building (P10), collectively provide a robust framework for collaboration and coordination among diverse stakeholders (Sayer *et al.* 2013). By applying these principles in mangrove management, an efficient and effective strategy unfolds. This involves the active involvement of all parties, resolution of conflicts of interest, integration of knowledge and resources, and the achievement of conservation and sustainable use goals for mangrove ecosystems.

In this specific locale, Kelurahan Kota Karang, recommendations informed by SWOT techniques will leverage ILM principles. This integration aims to strike a balance between effective mangrove utilization for community well-being and ecological preservation. ILM, therefore, emerges as a solid framework that not only maintains the sustainability of mangrove ecosystems but also aligns with the specific needs and goals of communities. In the realm of mangrove management, ILM provides a holistic, adaptive, and sustainable strategy, ensuring that all stakeholders actively participate in achieving common goals. This

seamless alignment of overarching ILM principles with the specific application in Bandar Lampung exemplifies a nuanced and sustainable mangrove management strategy.

MATERIALS AND METHODS

Study site

This research was conducted at Kelurahan Kota Karang, Teluk Betung Timur, Bandar Lampung (Figure 1). This location was chosen by the research plan to analyze the management of mangrove areas in Bandar Lampung.

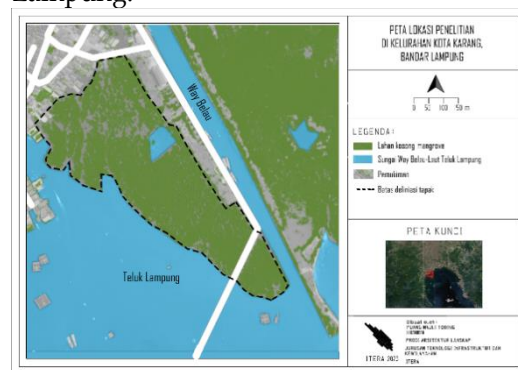


Figure 1. Research location map

Data Collection Methods

Primary data collection for this research involved conducting interviews with various stakeholders engaged in mangrove area management in Bandar Lampung. The participants included representatives from the government, NGO (Non-Governmental Organization), community leaders, and the general public within the research location. To ensure a focused and purposeful selection, a non-random sampling technique, specifically purposive sampling, was employed. This method targeted individuals and institutions directly associated with the management of the mangrove ecosystem in Kota Karang. The sample size, consisting of 9 resource persons, was determined based on these criteria, providing a representative snapshot of perspectives integral to the mangrove management dynamics in the area. Meanwhile, secondary data was obtained from several related agencies such as BMKG (Meteorology, Climatology, and Geophysics Agency), BNPB (National Disaster Management Agency), Lampung Geoportal, the Landsat 8 Collection 2 Level 1 imagery, utilized in the study period from July 18,

2020, with a Scene Cloud Cover L1 of 16.80% and a Land Cloud Cover of 25.60%, to August 9, 2022, with a Scene Cloud Cover L1 of 8.42% and a Land Cloud Cover of 14.48% as well as from literature studies taken from previous research. These literature studies were used to complement secondary data, specifically focusing on the identification of soil type, water pH, dissolved oxygen level, mangrove vegetation type, and studies on integrated landscape management principles.

Data Analysis Method

The SWOT analysis, as elucidated by Rangkuti (2005), is a foundational method in this study, offering a comprehensive examination of internal and external factors influencing mangrove area management in Bandar Lampung. This strategic analysis technique, known for its qualitative nature, stands distinct from quantitative methods that rely on specific measurements. Instead of predetermined weights or units, the SWOT analysis leverages expert judgment and a nuanced interpretation of multifaceted factors. The SWOT analysis will emphasize its fitting application to comprehend the complex dynamics of mangrove management in Kelurahan Kota Karang, Bandar Lampung. This qualitative approach, rooted in expert knowledge, contributes to a holistic understanding and informs the decision-making process regarding the most effective mangrove management strategy.

RESULT AND DISCUSSION

Biophysical Elements of The Area

Based on the observation results, it was identified that four mangrove species

naturally thrive in the Kota Karang, Bandar Lampung mangrove area: *Avicennia marina*, *Avicennia germinans*, *Rhizophora apiculata*, and *Bruguiera parviflora*. A shallow sea around the mangrove area is indicated by bathymetric research using satellite images. Additionally, according to findings from previous research conducted by Nugraha in 2015, the secondary data collected indicates favorable soil conditions and good water quality at the study site. However, based on the results of NDVI (Normalized Difference Vegetation Index) statistical analysis (Figure 2), a decrease in mangrove vegetation density from 2020-2022 was identified. NDVI was calculated using coding via Google Earth Engine to obtain statistical values. In 2020, the average NDVI value was 0.674 (Figure 3), but it dropped to 0.372 in 2022 (Figure 4). This decline in NDVI indicates environmental pressures and threats to the sustainability of the mangrove ecosystem in the study area. The chosen timeframe of 2020-2022 was based on interviews, revealing that during this period, the mangrove area experienced significant degradation, primarily due to the establishment of shrimp ponds and illegal logging. This has significant consequences for the biological function of mangrove areas and their ability to protect the coastline from erosion and flooding and maintain biodiversity. Therefore, practical conservation and management are required to conserve and restore the study site's mangrove ecosystem and mitigate the adverse impacts of anthropogenic influences and environmental change.

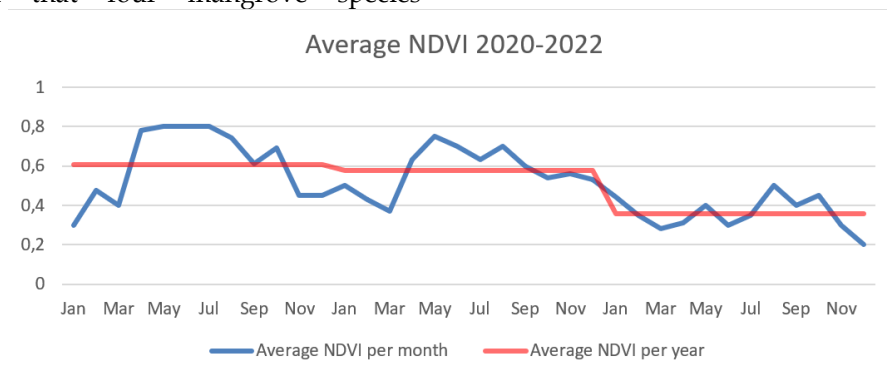


Figure 2. NDVI statistics for 2020-2022

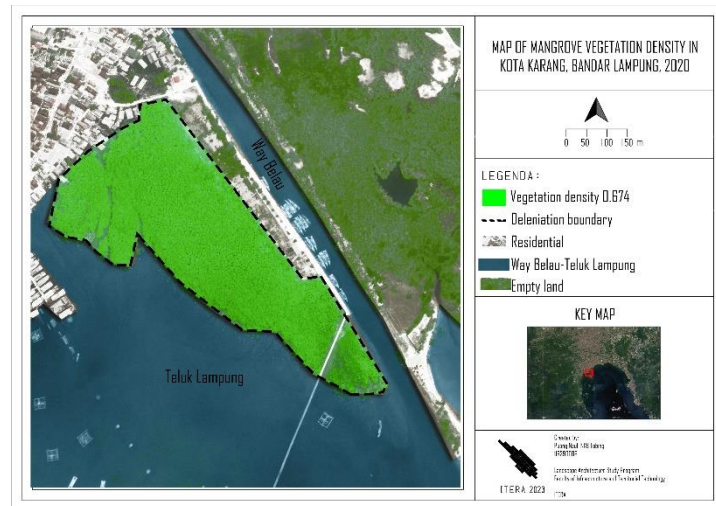


Figure 3. 2020 mangrove density map

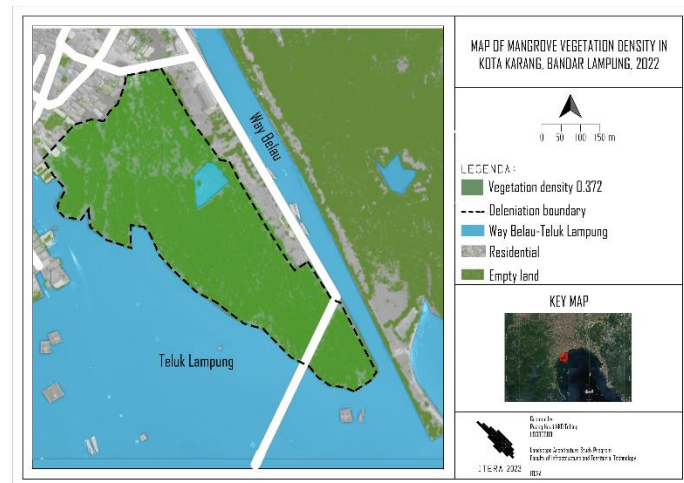


Figure 4. 2022 mangrove density map

Anthropogenic Elements of the Area

Based on insights gathered through interviews with key stakeholders, including representatives from the Bandar Lampung City Marine and Fisheries Service, the Head of Kelurahan Kota Karang, NGO, expert figures, and the community, significant anthropogenic factors impacting the research site were identified. The stakeholders pointed out concerning levels of trash and oil pollution along the coast of Bandar Lampung, underscoring the adverse consequences of human activities on mangrove ecosystems. Moreover, the encroachment of a 3000m² pond by the community since 2022 and illegal logging have exacerbated the situation. Currently, local mangrove area management, overseen by the urban village, has proven ineffective

due to a lack of clear division of rights and obligations among stakeholders, resulting in frequent overlaps. The role of stakeholders in mangrove management is crucial but remains unclear, leading to a lack of coordination, collaboration challenges, and conflicts of interest that impede efficient management efforts. Therefore, there is a pressing need to establish clarity and regulations defining the obligations and rights of each stakeholder, facilitating integrated and sustainable mangrove management.

Mangrove Management Recommendations for Kota Karang, Bandar Lampung

From Table 1 of the management strategy based on the SWOT analysis above, it can be

concluded that the strategies and directions that are suitable to be applied in the mangrove area in Kota Karang, Teluk Betung Timur, Bandar Lampung, by

applying the principles of integrated landscape management, which are as follows in Table 2.

Table 1. Management strategy based on SWOT analysis

	Opportunity (O)	Threat (T)
	1. Role of stakeholders; 2. Local-based management.	1. Exposure to natural disaster risk; 2. Land conversion; 3. Pollution and waste; 4. Over-exploitation of mangroves; 5. Community participation; 6. Collaborative management.
Strength (S)	SO Strategy	ST Strategy
1. High soil fertility and water quality; 2. Coastal protection; 3. Resource access and use.	1. Periodic socialization and counseling activities; 2. Developing environmentally friendly tourism.	1. Encourage collaboration across sectors and stakeholders to pool resources; 2. Develop relevant policies in mangrove management practices.
Weakness (W)	WO Strategy	WT Strategy
1. Vegetation density decreased; 2. Mangrove condition is severely damaged.	1. Development of an integrated monitoring and evaluation system.	1. Restoration and rehabilitation of mangroves; 2. Conduct training to increase the capacity of communities and stakeholders.

Table 1. Recommendations for mangrove area management in Kota Karang

Num.	Analysis	Strategies and Activities	Utilization Function	Related Parties
1.	Counseling and socialization related to disaster mitigation, the importance of mangrove ecosystems, and management.	a. Use more interactive and engaging but adaptive and sustainable extension methods, such as workshops, group discussions, or educational games (P1, P10); b. Involving community leaders to increase public awareness (P2); c. Conduct educational campaigns in schools and local communities on mangrove protection and management (P2); d. Form community groups that care about mangroves to increase mutual care and learn from each other (P2, P5); e. Conduct disaster mitigation simulations to improve community preparedness (P9); f. Create effective communication channels between stakeholders to	Ecology, social	Government, community, NGO, private sector, academia

Table 1. Recommendations for mangrove area management in Kota Karang

Num.	Analysis	Strategies and Activities	Utilization Function	Related Parties
		share information and experiences (P5, P10).		
2.	Development of environmentally friendly tourism industry	a. Create an tourism master plan (P1, P3); b. Form tourism awareness groups at the community level to manage tourism sustainably (P2, P7, P8); c. Develop tour packages that cover various scales from local to regional (P3); d. Building environmentally friendly tourism facilities and infrastructure, such as walking trails, rest areas, and information centers, designing multifunctional tourism objects e.g. educational zones, conservation zones, and recreational zones (P4); e. Empowering local communities in managing environmentally friendly tourism, such as through training, mentoring, and job creation (P10); f. Forming a team consisting of various stakeholders to manage mangroves (P5, P10); g. Establishing eco-tourism success indicators and a monitoring and evaluation system (P8).	Economic, social	Government, community, NGO, private sector, academia
3.	Establish integrated inter-sectoral cooperation	a. Establish a communication and coordination forum among stakeholders involving government, communities, NGO and academics (p5, P10); b. Establishment of integrated work teams from various sectors to coordinate mangrove area management activities (P2, P5, P7); c. Holding regular meetings for integrated and collaborative program evaluation and planning (P8); d. Negotiate rights and responsibilities between sectors in mangrove management (P5, P7); e. Implement an integrated monitoring and evaluation system to measure the effectiveness of inter-sector cooperation (P8); f. Development of an integrated action plan involving various relevant sectors (P3, P4).	Economic, social	Government, community, academia, NGO, private sector
4.	Improve legal monitoring and enforcement.	a. Training and capacity building for supervision and enforcement officers (P2, P10); b. Develop reporting and monitoring systems that are more accessible to the public (P8);	Social	Community, government, NGO

Table 1. Recommendations for mangrove area management in Kota Karang

Num.	Analysis	Strategies and Activities	Utilization Function	Related Parties
		<ul style="list-style-type: none"> c. Improved coordination and cooperation among law enforcement agencies and related institutions (P7); d. Improved integrated supervision and law enforcement (P6, P7); e. Creating incentive and disincentive programs for local communities (P6, P7); f. Establish a mangrove area supervisory group from the community (P2, P7). 		
5.	Mangrove rehabilitation and conservation	<ul style="list-style-type: none"> a. Design multifunctional rehabilitation and conservation activities, e.g. mangrove planting, animal habitat improvement, and mangrove-based product development (P4); b. Knowing mangrove rehabilitation techniques such as appropriate planting methods, mangrove tree species selection, and proper maintenance, using local mangrove species that are suitable for local conditions and consider genetic diversity (P1); c. Invite the community in conservation and rehabilitation activities, such as monitoring, planting, and environmental education (P2, P5); d. Develop mangrove rehabilitation and conservation programs covering various scales from local to regional (P3); e. Monitoring mangrove conditions and mapping areas that need to be rehabilitated and conserved as well as assessing the resilience and adaptability of mangrove ecosystems in the face of climate change and human pressures (P8, P9); f. Building networks with local communities, government, NGO, and the private sector to garner support and participation in mangrove rehabilitation and conservation programs (P5). 	Ecology, cultural, social	Government, community, NGO, private sector, academia

CONCLUSION

Based on SWOT analysis, mangrove areas in Kota Karang, Bandar Lampung have potential that can be realized by applying the concept of integrated landscape management. Mangrove areas have strengths in biodiversity and as coastal protection but also face threats such as environmental damage and conflicts of interest. To address

these challenges and capitalize on existing opportunities, five management strategies were identified: community empowerment through counseling, development of an environmentally friendly tourism industry, integrated cross-sector cooperation, increased monitoring and law enforcement, and mangrove rehabilitation based on the principles of integrated landscape

management. These strategies ensure ecosystem sustainability and provide an integrated and robust direction to conserve mangrove ecosystems while meeting community needs in a sustainable manner.

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