The Impact of Mangrove Land Use Conversion on Abrasion in Muara Gembong Using a Rationalistic Paradigm Approach

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Abstract. The conversion of mangrove land functions has significantly impacted the abrasion in the coastal community in Muara Gembong which bring environmental and socio-economic losses. The conversion was carried out by the locals for years. However, they have not been able to mitigate threats from land conversion. This research aims to analyze the effects of land use conversion and generate recommendations to mitigate abrasion impacts in the area by the community. This research is using qualitative descriptive methodology. The study's samples consist of members of the KEBAYA, POKDARWIS, and ALIBATA farmer groups. Data was collected through interviews with these groups and a review of relevant literature on mangroves in Muara Gembong. The data will be analyzed by comparing the ecological conditions in Muara Gembong with qualitative approaches. The research indicates that the leading cause of abrasion in Muara Gembong is converting mangrove land into shrimp ponds. This situation has led to the degradation of the mangrove ecosystem, significantly affecting the livelihoods of the local community. The mangrove area in Muara Gembong has steadily decreased from 213.37 m^2 in 2009 to 154.15 m^2 in 2014. Therefore, mangrove conservation programmes are crucial, including reforestation, community development, and education, to enhance understanding of the critical role of the mangrove ecosystem in maintaining coastal sustainability.

Keywords: Abrasion, Coastal Communities, Mangrove Land Conversion, Muara Gembong

1 Introduction

Abrasion is a common issue in coastal areas that is caused by coastal abrasion due to the forces of ocean waves and currents. Two primary factors that contribute to abrasion are natural factors such as tides, wind, waves, and ocean currents, which are inevitable due to their natural cycles [1] . Also, human factors or anthropogenic activities also play a role in abrasion, particularly through activities like sand mining, coastal development, and the land conversion of mangrove land into ponds, which disrupt coastal ecosystems and increase the potential of coastal abrasion. Protection efforts and

ICESDM 2023, November 02, Banjarmasin, Indonesia

DOI 10.4108/eai.2-11-2023.2348002

a better understanding of marine ecosystem balance are key to addressing this abrasion problem.

For instance, in the case of abrasion in the coastal area of Muara Gembong, the coastal region of Muara Gembong is situated in Pantai Sederhana Village, Muaragembong District, Bekasi Regency. This area has gone significantly due to land conversion of mangrove forests into shrimp ponds [2] . As a result, most areas of Muara Gembong are affected by abrasion.

Based on research, the predominant land conversion in the coastal areas is transforming mangrove areas into shrimp ponds. This occurred in Pantai Bahagia, Pantai Bakti, Pantai Sederhana, Pantai Mekar, and Pantai Harapanjaya. In 2000, the mangrove density changed, with a total density of 398.79 m^2. Subsequently, there was an increase in density in 2010, covering an area of 822.48 m^2, and this density continued to increase until 2020, reaching 1,028.64 m^2 [3] .

Prior research has explored the role of mangrove ecosystems in economic and social development, such as economic improvements through tourism activities, the development of mangrove products, and the application of digital marketing strategies[4] . However, there is no research that has identified the impact of mangrove conversion on abrasion in Muara Gembong. This study aims to fill this gap by analyzing the effects of mangrove land use conversion and generate strategies for mitigating the abrasion impacts. The novelty in this research lies in applying a rationalistic paradigm to reduce abrasion in Muara Gembong. This research can be an input into the mangrove ecosystem management system in Muara Gembong to prevent and mitigate the negative impacts of abrasion resulting from the conversion of mangrove land.

2 Introduction

2.1 Abrasion

Abrasion is the land (coast) decrement process due to the activities of waves, currents, and tides. Abrasion can reduce the total length of the coastline which can reduce coastal area. Activities such as mangrove deforestation, sand mining, and high waves and tidal fluctuations have significant consequences that lead to abrasion or coastal abrasion [5] . The abrasion in coastal land leads to sediment transport from its origin, following the direction of incoming waves, thereby influencing changes in the coastline [6] . In this context, land accretion results in the lowering of the land surface and coastal inundation, thus altering the coastline [7], and the sediment transport to a particular point is more significant than the amount of sediment transported out of that point [8] .

2.2 Mangroves

Mangroves are tropical coastal plant communities that can adapt to muddy or tidal areas. In generally, mangroves are a community plants that grow below the high tide level. Mangrove trees thrive in communities within a particular region which often referred to as mangrove forests. Mangroves are commonly found along the shoreline,

in shallow bays, estuaries, deltas, and protected coastal areas [9] . Mangroves are halophytic plants that grow in coastal areas influenced by the highest tides to areas near the average sea level, mainly in tropical and subtropical regions [10] . Mangrove forest can be defined as a type of forest that grows in tidal areas (especially in sheltered coastlines, lagoons, river deltas) that are inundated during high tide and free from flooding during low tide, with a plant community that tolerates saline waters.

2.3 Benefit of Mangroves

Mangroves offer several benefits to coastal and marine life, as outlined by:

1. Nursery Ground

The mangrove ecosystem is known for its organic material, which forms the basis of the food chain in coastal areas. Microorganisms, particularly crabs transform mangrove leaf litter that falls into the water and its surroundings, and decompose microorganisms into detritus, which eventually becomes zooplankton consumed by marine animals. Consequently, the mangrove environment is rich in nutrients for fish and shrimp.

2. Natural Habitat Fostering Ecological Balance

Various forms of biota interact with one another. In a natural state, the diversity of these biota contributes to an ecological balance, especially the balance between prey and predators. Maintaining this environmental balance is essential for the continuous natural progression of life. However, if one component is lost, it can disrupt this balance and ultimately damage the entire mangrove forest ecosystem.

3. Coastal Protection against Abrasion Hazards

The dense root system of mangroves serves as an anchor and buffer against oncoming waves. Additionally, the roots' grip in the soil can prevent the loss of soil particles. As a result, the risk of abrasion can be mitigated.

4. Absorption of Pollutants

Mangroves that grow in urban areas, residential centers, and transportation routes can act as absorbers of pollutants, including vehicle emissions and industrial waste. Industrial waste discharged into rivers can be carried to estuaries and filtered by the mangrove roots.

These are the essential benefits of mangrove ecosystems for both the environment and the communities living in coastal regions.

3 Methods

3.1 Research Approach

Fig. 1. Muara Gembong Maps

The research approach adopted in this study is descriptive qualitative. Data analysis is conducted following the rationalistic paradigm, which will summarize the perspectives of individuals or groups on the understanding and conditions of the knowledge concerning the situation or phenomenon in their environment

3.2 Research Location and Time

This research was conducted from April to July 2023. The research location is in Beting Village, Pantai Bahagia Village, Muara Gembong District, Bekasi Regency.

The selection of this location was guided by geographical factors and its appropriateness for gathering essential data related to the conversion of shrimp ponds and its implications on the mangrove ecosystem.

3.3 Population and Sample

The number of respondents was determined using the Quota Sampling method, which divides the population into small groups and selects samples based on specific

criteria in each group that represent their respective fields [11] . Based on this, the study selected four individuals as key informants, with the following criteria:

1) Respondents are residents living near the mangrove area.
2) Respondents have involvement in the management or are village officials around the mangrove area.
3) Respondents are willing to be interviewed, and the interview results can be stored as research data.

The population in this study consists of members of the KEBAYA, POKDARWIS, and ALIBATA farmer groups. Due to geographical and natural constraints, it is decided to collect data from all residents and mangrove farmers in the Muara Gembong region. Therefore, the researcher selected sample data to represent the existing population. The explanation of respondents is as follows:

1. Mr. Nurson is a mangrove farmer and environmental activist in the POKDARWIS community.
2. Mr. Basyid, a mangrove farmer and environmental activist in the ALIBATA community.
3. Ms. Alfiyah, the leader of the Kelompok Ibu Berkarya community, which processes mangrove products.

Mr. Ahmad Qurtubi, the secretary of Pantai Bahagia Village

3.4 Data Collection Method

Data was collected through structured interviews with respondents about the area's conditions, factors causing land use conversion, occurrences of abrasion, and the impacts of abrasion. Interviews were conducted using questionnaires as guidance, which were then answered by each respondent. Additionally, data on the ecosystem's conditions were collected through a literature review from relevant sources, such as scientific journals, proceedings, books, government reports, and other scientific articles.

3.5 Data Analysis Method

Impact of Mangrove Land Use Conversion on Abrasion in Muara Gembong. The impact of mangrove land use conversion was analyzed using qualitative analysis of literature study results, field surveys, secondary data collection, and interviews. The data were analyzed with a descriptive approach. Subsequently, all collected data was discussed to identify the relationship between land use conversion and its environmental and socio-economic impacts in the research area.

Efforts to Reduce the Abrasion Impact Due to Mangrove Land Use Conversion in Muara Gembong. Efforts to reduce the abrasion impact due to mangrove land use conversion in Muara Gembong were interpreted from the interviews. Information from respondents will be aligned with relevant literature studies to make appropriate recommendations.

4 Result and Discussion

4.1 The Impact of Mangrove Land Use Conversion on Abrasion

Natural factors and human activities cause abrasion. Human activities in coastal areas, such as excavation, land reclamation, and land use conversion, have led to an ecological imbalance in the mangrove ecosystem, resulting in issues like abrasion that increase the potential for tidal flooding [12] , explained that abrasion in Muara Gembong, particularly around the Citarum River, is caused by the reduction of mangrove forests in the surrounding areas, which have been converted into shrimp ponds, residential areas, agriculture, and industries by the local population. Muara Gembong District is a coastal region that has significant land use changes, particularly converting mangrove forests into shrimp ponds. Excessive and environmentally unbalanced transformation has led to environmental degradation, affecting the productivity of the area [13] . The land changes that do not consider ecological balance in Muara Gembong's coastal areas have resulted in high levels of abrasion.

A reduction in the area of mangrove ecosystems occurs in Muara Gembong. The reduction in mangrove areas has occurred in Pantai Harapan Jaya, Pantai Mekar, and Pantai Bahagia [14] . The same source mentions that from 2009 to 2014, the mangrove area continued to decrease from 213.37 m^2 to 154.15 m^2. In the same years, occurred. The mangrove area decreased in Pantai Mekar, decreasing from 145.7 m^2 to 134.55 m^2. A similar situation occurred in Pantai Bahagia, where the mangrove area was reduced from 312.93 m^2 to 245.35 m^2 in 2009-2014.

These findings align with interviews conducted with environmental community groups in the Muara Gembong area, including KEBAYA, POKDARWIS, and ALIBATA. Abrasion in the Muara Gembong area results from the land use conversion of mangroves carried out by residents. It happens because most of the population works as fishermen, and due to a lack of knowledge and economic demands to meet their daily needs, they convert mangrove land into shrimp ponds to sustain their livelihoods.

Nevertheless, the unintended consequences of land use conversion have had a negative impact on the coastal area of Muara Gembong. After the conversion of mangrove land, abrasion and tidal flooding began to affect the coastal areas in Muara Gembong. These disasters have adverse economic and health impacts. From an economic perspective, many residents have lost their shrimp ponds due to abrasion, resulting in the loss of livelihoods for the population in Muara Gembong [15] , stated that the number of impoverished residents in Muara Gembong District, as determined by recipients of Jamkesmas and Jamkesda cards, was 13,441 people in 2016.

In addition to its economic repercussions, abrasion also has a significant impact on community health conditions. The damage to sanitation facilities due to abrasion and tidal flooding has led to a high incidence of diarrhea in Muara Gembong. According to data from the Bekasi Regency Health Profile for 2022, there were 1,179 cases of diarrhea across all age groups in 2022 [16] .

4.2 Efforts of Reduce the Impact of Abrasion Due to Mangrove Land Use Conversionin Muara gembong

The density of mangroves in the area ranges from 1033 to 1425 individuals per hectare, which is categorized as moderate damage according to the mangrove damage scale. The condition of mangroves in Muara Gembong, classified as having a moderate risk to threats or disturbances [17] , indicates the need for appropriate measures to preserve the mangrove ecosystem in Muara Gembong. This condition is consistent with field observations conducted. Based on the field observations, many mangroves in the area have been converted into shrimp ponds and coastal residential areas. Additionally, the newly planted mangroves along the coastline often have relatively weak root systems to withstand the force of ocean waves. Consequently, these mangroves are damaged and carried away by wave currents.

The impacts of mangrove ecosystem degradation have triggered coastal flooding, inundating residential areas. This condition has led to structural damage to residents' homes and the surrounding environment (Figure 1). Additionally, many residences have been submerged and waterlogged (Figure 2). This is attributed to the high intensity of seawater intrusion into the settlements due to coastal flooding.

Fig. 2. Condition in Muara Gembong

Fig. 3. Settlements submerged due to abrasion

Furthermore, this situation has magnified into a more severe condition, where several regions and residences have ultimately suffered intensive destruction (Figure 3). The damage has resulted in comprehensive environmental losses, encompassing both physical and material aspects. The interaction among these factors has profound and lasting impacts on the entire ecosystem. This underscores the importance of addressing mangrove degradation for long-term environmental resilience and community well-being.

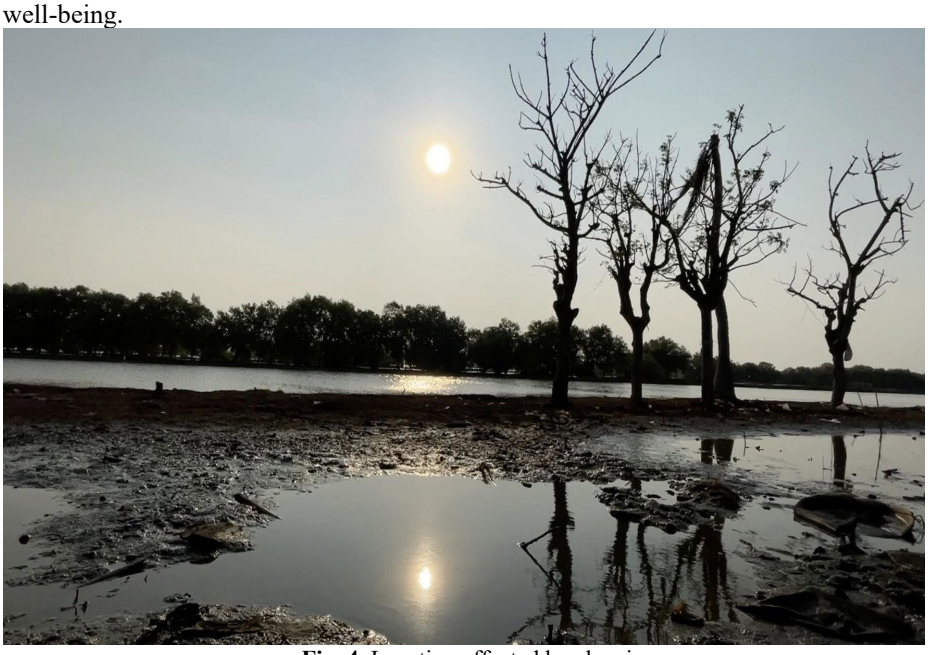

Fig. 4. Location affected by abrasion

Based on the described conditions, various efforts are formulated to reduce the impact, such as:

1) Mangrove Planting
   Mangrove planting serves as abrasion control in coastal areas. The dense root system of mangroves acts as an anchor and wave breaker, while the root structure can help prevent soil abrasion [18] . Also, mangroves can be utilized for value-added products such as mangrove syrup, dodol, and mangrove chips [19] .
2) Community Education
   Educating the community can raise awareness about the importance of the mangrove ecosystem. The role of education and recreation in conservation centers is to introduce and educate the community about mangrove forests [20] .
   POKDARWIS, ALIBATA, and KEBAYA are coastal community groups that are trying to build coastal community awareness about the importance of the mangrove ecosystem. Besides local coastal community groups, external organizations and various companies are also conducting training and community development programs for the Muara Gembong community.
3) Creating Mangrove-Based Tourism
   To ensure the sustainability of mangroves, the community should experience economic benefits. One approach to generating income from the mangrove ecosystem is by developing natural tourism based on mangroves, while still considering its carrying capacity and environmental sustainability [21] . Additionally, housewives in the Muara Gembong coastal area can process mangroves fruits into products, such as pedada fruit, into syrup, dodol, and chips [22] . This provides an additional income source while ensuring the sustainable preservation of mangroves.

5 Conclusion

Based on the conducted research, it can be concluded that the conversion of mangrove land use in Muara Gembong has indeed led to serious impacts, namely abrasion and tidal floods. Through the rationalistic paradigm approach, it is evident that the systematic conversion of mangrove land causes significant losses to the coastal community's economy and health. The extent of mangrove land in Muara Gembong has consistently decreased from 213.37 m^2 in 2009 to 154.15 m^2 in 2014. A similar reduction in mangrove land area occurred in the neighboring villages of Pantai Mekar and Pantai Bahagia during the same period. Consequently, the mangrove ecosystem in Muara Gembong is categorized as being at a moderate risk level against threats and disturbances. In 2018, it was documented that 13,441 impoverished residents in the Muara Gembong sub-district received the Jamkesmas and Jamkesda health insurance cards. Furthermore, in 2022, 1,179 cases of diarrhea were recorded across all age groups.

Efforts that both the community and the government can undertake include mangrove planting, which serves as a natural abrasion buffer along the coast. Educating the community to raise awareness about the importance of the mangrove ecosystem is also crucial. Furthermore, the development of mangrove-based tourism can serve as a means to preserve the mangrove ecosystem and generate sustainable income for coastal communities.

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