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Mangrove Planting as a Natural Protection Measure Coastal Environment Risk Vulnerability

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ABSTRACT
Mangroves are widely known for their role as natural protection against various environmental risks such as storms, tsunamis, waves and coastal erosion by being the first line of defense in protecting coastlines. Unfortunately, in many parts of the world, mangrove forests have been lost due to the pressures of urban development, the rapid expansion of aquaculture and agriculture, mining, overexploitation of timber, and increasing environmental risks. This activity aims to assess mangrove planting as a natural protection measure for the risk vulnerability of the coastal environment. The target of this service activity is the coastal area of Tongo Village. The results of service activities show that the mangroves planted on the coast of Tongo Village, namely *Rhizophora Sp* and *Ceriops Sp* grow well. It will take at least another five years to assess its effectiveness in mitigating coastal erosion. Planting mangroves in coastal areas is very important in an effort to protect the natural risk vulnerability of the coastal environment. This is important to do as soon as possible because the growth of mangrove plants requires a long time to get maximum benefits.

Keywords : environment risk; mangrove; rhizophoraceae; vulnerability; wetlands

ABSTRAK
Mangrove telah dikenal luas karena perannya sebagai proteksi alami terhadap berbagai risiko lingkungan seperti badai, tsunami, gelombang, dan erosi pantai dengan menjadi pertahanan pertama dalam melindungi garis pantai. Sayangnya, di banyak belahan dunia, hutan bakau telah hilang karena tekanan pembangunan perkotaan, pesatnya ekspansi budidaya perikanan dan pertanian, pertambangan, eksploitasi kayu yang berlebihan, dan meningkatnya risiko lingkungan. Penelitian ini bertujuan untuk menilai penanaman mangrove sebagai upaya proteksi alami kerentanan risiko lingkungan pesisir. Sasaran kegiatan pengabdian ini adalah wilayah pesisir pantai Desa Tongo. Hasil kegiatan pengabdian menunjukkan bahwa mangrove yang ditanam di pesisir pantai Desa Tongo yaitu Rhizophora Sp dan Ceriops Sp tumbuh dengan baik. Diperlukan waktu setidaknya lima tahun lagi untuk menilai efektfitasnya dalam mitigasi abrasi pantai. Penanaman mangrove di wilayah pesisir pantai sangat penting dilakukan dalam upaya proteksi alami kerentanan risiko lingkungan pesisir. Hal ini penting dilakukan sesegera mungkin karena pertumbuhan tanaman mangrove membutuhkan waktu yang panjang untuk mendapatkan manfaat yang maksimal.

Kata Kunci: *risiko lingkungan; mangrove; rhizophoraceae; kerentanan; lahan basah*

INTRODUCTION

Coastal environments play a critical role in the global ecosystem, especially as areas that are home to a variety of marine species and people. However, coastal areas often face environmental risks such as abrasion, sea level rise, and more frequent and intense storms due to climate change. Damage to the coastal environment can threaten the lives and well-being of the people living around it, as well as reduce biodiversity (Zhang et al., 2022).

Mangrove planting has proven to be an effective way to mitigate environmental risks in coastal areas. Mangroves serve as natural protection against coastal abrasion, reduce the impact of large waves and storms, and capture sediments that can improve water quality and improve marine habitats. Mangrove forests can sequester and store significant amounts of carbon, which contributes to mitigating global climate change (Strain et al., 2022).

In addition to their ecological functions, mangroves also provide economic benefits to coastal communities. They provide habitat for a variety of fish and other marine life that are important to local fisheries. Healthy mangrove areas increase fisheries yields and provide a source of livelihood for coastal communities (Weaver & Stehno, 2024).

However, in many places, mangrove ecosystems are threatened by human activities such as land conversion to aquaculture areas, residential development, and industrial activities. Mangrove loss leads to increased coastal vulnerability to environmental risks. For this reason, mangrove planting and rehabilitation programs are very important as an effort to protect the coastal environment while improving community welfare (van Hespen et al., 2023).

Many studies have highlighted the significant role of mangroves in reducing erosion and protecting shorelines from natural disasters such as hurricanes and storms (Pennings et al., 2021). The decline of mangrove forests has been associated with increased erosion in coastal regions, emphasizing the importance of preserving these ecosystems for coastal protection (Vieira et al., 2021). Geospatial analyses have been employed to assess changes in mangrove ecosystems, such as in the undarbans, to understand the impacts of natural and human-induced factors on mangrove loss and coastal stability (Jayanthi et al., 2022).

Research has demonstrated the global flood protection benefits of mangroves, showcasing their cost-effectiveness in mitigating natural hazards and serving as a form of coastal infrastructure for hazard mitigation and disaster recovery (Menéndez et al., 2020). The structure of mangrove forests has been found to promote sediment deposition and prevent surface erosion, highlighting their role in stabilizing coastal areas and preventing abrasion (Chen et al., 2022). Studies have also observed the accretion of mangroves in estuaries, contrasting with coastal erosion in other areas, underscoring the dynamic nature of coastal landscapes (Teixeira et al., 2021).

This service program aims to carry out mangrove planting as a natural protection effort against environmental risks in coastal areas. This activity will involve local communities in the process of planting and maintaining mangroves, as well as providing education about the importance of maintaining mangrove ecosystems. With this participatory approach, it is hoped that the community can have higher awareness and play an active role in coastal environmental conservation.

METHODS

The type of service described above is community service that focuses on environmental rehabilitation, specifically through mangrove planting in coastal areas. This activity aims to restore damaged coastal ecosystems, involving collaboration between various parties, including local communities, government, and private institutions.

Mangrove planting in Tongo Village, Bonepantai Sub-district, Bone Bolango Regency, Gorontalo Province, began with a site survey to determine the area's most in need of rehabilitation. The survey included an analysis of soil conditions, water quality, and the level of environmental damage. The results of this survey became the basis for determining the next steps in the mangrove rehabilitation program.

Coordination with various related parties, such as the local government, non-governmental organizations, and local communities, was carried out to obtain permission and support for the program. This step is important to ensure that the whole process runs smoothly and get active participation from the local community. After coordination, a work team was formed consisting of program implementers of PT Pertamina Patra Niaga Integrated Terminal Gorontalo and local communities who will be involved in all stages of the activity.

The selection of mangrove species that are suitable for local ecosystem conditions is the main focus in the procurement of seedlings. The selected mangrove species are Rhizophora Spatau black mangrove and Rhizophora apiculate. Seedling procurement is done through cooperation with mangrove seedling providers or by developing their own nurseries, to ensure the availability of healthy and ready-to-plant seedlings.

Implementation of mangrove planting begins with land preparation. The area to be planted is cleaned of garbage and nuisance plants, and arranged to be suitable for planting seedlings. The planting process is carried out by paying attention to the distance between seedlings, which is about 1-2 meters, to ensure optimal growth. Afterwards, seedling guards made of organic materials or nets are installed to protect the seedlings from animal disturbance or extreme environmental conditions.

Maintenance and monitoring are carried out regularly. This includes replanting dead seedlings, cleaning the planting area, and monitoring water and soil conditions. Monitoring of mangrove growth is done every three months to record progress and identify obstacles that may arise.

Figure 1. Tongo Mangrove Conservation Team and PT Pertamina

Figure 2. Mangrove Planting Activity Process

Finally, the program is evaluated after six months and one year to assess its success and identify areas that require improvement. A report on the results of the activities and their impact on the environment and the community is prepared and submitted to all parties involved as a form of transparency and accountability.

RESULTS AND DISCUSSION

Number of Seedlings Planted During the service activities, a total of 4,000 mangrove seedlings (2,000 Rhizopora mangrove seedlings and 2,000 Ceriops mangrove seedlings) were successfully planted in the coastal area of Tongo Village, Bonepantai District, Bone Bolango Regency, Gorontalo Province. The participation of the Tongo Village community in the process of planting and maintaining mangrove plants was 10 people and joined in one group, namely the Tongo Mangrove Conservation Group (see Figure 1). The land area used for mangrove planting is 2 hectares. Seedlings sown come from certified Pohuwato mangrove plant breeders who are taken in mature conditions. Characterized by the appearance of a kind of yellow ring located between the cotyledons and fruit. The number of leaves on the planted seedlings was 2-4 and roots had emerged in the polybags. The seedlings are healthy, fresh, and not attacked by pests and diseases. Seedlings are 2-5 months old. Planting is done in several stages over one year, with active participation from the local community and the village government.

Figure 2 illustrates seedling growth condition of the 4,000 seedlings planted, 85% showed good growth in the first three months. The seedlings that did not grow well (15%) were mostly due to disturbance from local fauna and unfavorable environmental conditions in some areas. Community Participation Community participation in this activity was very high.

Abrasion Reduction and Water Quality Initial monitoring showed a reduction in abrasion at several points of the coast that had been planted with mangroves. In addition, water quality around the planting area began to show improvement, characterized by better water clarity and reduced siltation.

Mangrove planting as a natural protection effort has proven effective in reducing coastal environmental risks. Mangroves function as a natural barrier that can reduce the

impact of abrasion and improve water quality. According to Lewis (2005), mangroves have a natural ability to stabilize sediments and improve soil conditions, which supports our initial findings in the field (Adame et al., 2021).

Although the mangrove planting program is going well, there are some challenges faced. Some areas showed soil conditions that were not optimal for mangrove growth. Solutions included the installation of seedling guards and the selection of more appropriate planting sites.

Community involvement in the program is critical to the sustainability of the project. The active participation of the community showed that the education and training provided was successful in increasing their awareness and commitment to mangrove conservation. The success of mangrove rehabilitation relies heavily on the support and participation of the local community.

In addition to ecological benefits, the program also provides positive social impacts. Communities gain new knowledge and skills in mangrove conservation, which can improve their livelihoods through sustainable natural resource management. Improved water quality also has the potential to increase local fisheries yields, which are critical to the economic well-being of coastal communities.Mangrove planting programs have been recognized for their ability to mitigate coastal erosion and enhance air quality in Indonesia. The choice of mangrove species plays a crucial role in the success of such initiatives. Rhizophora species, known for their effectiveness in protecting coastal areas from erosion, high waves, and storms, are often preferred for their resilience (Suwanto et al., 2021). These species not only contribute to stabilizing the coastline but also offer additional benefits such as providing habitats for various organisms and improving water quality through filtration processes (Pringgenies et al., 2021).

In line with the development of ecotourism activities, mangrove rehabilitation programs involving planting activities have been suggested as a means to enhance coastal areas for both environmental and economic purposes (Tjiong et al., 2021). By engaging local communities in mangrove planting and maintenance efforts, these programs not only contribute to the restoration of mangrove ecosystems but also provide livelihood opportunities and promote sustainability (Malik et al., 2021). The involvement of communities in the preservation of mangroves post-plantation is crucial for ensuring the long-term success of these initiatives and the protection of coastal areas from erosion (Yenni, 2023).

The success of mangrove planting initiatives is also influenced by factors such as the early performance of seedlings and the choice of suitable planting locations. Variations in morphometric ratios of mangrove seedlings can serve as indicators of the quality and condition of local mangrove vegetation, aiding in the selection of appropriate sites for rehabilitation efforts (Hidayati et al., 2022). Additionally, assessments of mangrove diversity and suitability for ecotourism purposes can guide decision-making processes regarding the allocation of resources and the implementation of planting programs in areas that can benefit both the environment and local communities (Tjiong et al., 2021).

Mangrove ecosystems not only play a crucial role in coastal protection but also offer various ecological, economic, and social benefits. These benefits include the provision of habitats for diverse species, the prevention of erosion and abrasion, and the support of fisheries and aquaculture activities (Nugraha et al., 2022). Furthermore, mangroves have been utilized for their medicinal properties, with local coastal communities in Indonesia incorporating mangrove plants into traditional medicine practices (Herningtyas, 2023). The

bioprospecting potential of mangrove fruits has also been explored, highlighting the nutritional, antioxidant, and elemental properties that can support the development of functional food materials for coastal communities (Basyuni et al., 2021).

The conservation and restoration of mangrove forests are essential for maintaining the ecological balance and supporting sustainable development in coastal regions. Mangroves act as natural buffers against coastal erosion, protecting shorelines from the impacts of waves and storms (Pringgenies et al., 2021). By planting mangroves in strategic locations and involving local communities in conservation efforts, it is possible to not only reduce abrasion but also improve water quality through the filtration and purification capabilities of mangrove ecosystems (Suwanto et al., 2021).

CONCLUSIONS

The 4,000 mangrove seedling planting program in Tongo Village was successful with an 85% seedling success rate in the first three months. The program not only reduced abrasion and improved water quality, but also increased community awareness and skills in mangrove conservation, which had a positive impact on their economic welfare. It is recommended to continue regular monitoring and maintenance, especially on areas that show less than optimal mangrove growth. This includes replanting seedlings and improving soil conditions in less favourable locations. In addition, it is necessary to further strengthen community participation, especially through training and capacity building in sustainable natural resource management. This way, the community can continue to maintain and develop the mangrove area, as well as gain economic benefits from fisheries and mangrove products. Closer cooperation with the government, non-governmental organizations and the private sector needs to be enhanced. This will ensure the sustainability of mangrove rehabilitation programs and allow for more effective resource allocation to support future conservation efforts.

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