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Sustainable Environmental Conservation through Planting of Mangrove Arboretum in Sungsang IV Village, Banyuasin, South Sumatera

Sarno[1*], Yuniar Harvianti[2], Yadi Oktariansyah[3], Guntur Pragustiandi[4], Ayu Safitri[5], Syafrina Lamin[6], Eva Musifa[7]
Fakultas Matematika & Ilmu Pengetahuan Alam, Universitas Sriwijaya
Corresponding Author: Sarno sarno@mipa.unsri.ac.id

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A B S T R A C T

Mangrove ecosystems play an important role in maintaining the balance of the coastal environment and supporting the sustainability of the community's economy. Sungsang IV Village, Banyuasin, South Sumatra, has experienced degradation of the mangrove ecosystem due to land conversion and excessive exploitation. This study aims to develop the Mangrove Arboretum as a conservation effort based on ecotourism, education, and research. The methods used include location surveys and replanting of mangroves at the arboretum location. The results of the activity are mangrove planting at the arboretum location using Rhizopus mucronata mangroves aged 150 Days After Planting (DAP) with a height of between 40-60 cm. Thus, the Mangrove Arboretum has the potential to become a sustainable conservation model that supports the achievement of the Sustainable Development Goals (SDGs).

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INTRODUCTION

Mangrove ecosystems in Indonesia, representing almost 1/5 of the world's mangroves, play an important role in biodiversity conservation, coastal protection, and the provision of ecosystem services. The diverse geographical conditions in this country contribute to one of the largest mangrove forests in the world. However, the mangrove ecosystem in this country has been damaged and reduced quite significantly in recent decades due to anthropogenic activities. To take steps in ecosystem conservation activities, it is important to understand the current status of population distribution, species diversity, and conservation strategies (Giri et al., 2011).

Sungsang IV Village, which covers an area of around 176,907 hectares, is mostly mangrove forest. Sungsang is a mangrove ecosystem area on the east coast of South Sumatra. For hundreds of years, Sungsang has been inhabited by a group of people who live as fishermen. However, in the last dozen years, the fish population in this area has decreased due to the destruction of mangroves. Mangroves that are opened for plantations and ponds are one of the causes of the decline in fish catches of Sungsang IV villagers, most of whom are fishermen. The mangrove ecosystem is one of the vital ecosystems in coastal areas that plays a strategic role in maintaining environmental balance, protecting coastal areas from erosion, absorbing carbon, and providing habitat for various species of biota. In addition, this ecosystem also offers economic benefits to the community, such as fisheries and ecotourism potential (Hadiyan, et al., 2014). However, in various regions, including the Sungsang coastal area, Banyuasin Regency, South Sumatra, the existence of mangroves is increasingly threatened by land conversion, excessive exploitation, and environmental pollution.

The mangrove arboretum covers an area of 9,158 m² with a circumference of 460 meters in Sungsang IV Village, which is designed as a strategic step for sustainable environmental conservation. This development is based on several aspects: (1) the condition of the mangrove ecosystem which is degraded due to human activities, (2) the importance of preserving biodiversity which is a habitat for various fauna, (3) the role of mangroves in maintaining ecosystem balance and mitigating climate change, (4) community dependence on coastal resources, (5) low public awareness of the importance of mangroves, and (6) great potential for developing ecotourism based on the environment and education. Based on the situation analysis above to preserve the mangrove ecosystem in Sungsang IV and increase community awareness and participation, this community service program proposes the establishment of a mangrove arboretum. This arboretum is designed as a conservation, education, and ecotourism area, aiming to preserve mangrove biodiversity, provide learning facilities for the community and students, and create economic opportunities through the development of environmentally based tourism (Napolion et al., 2015).

Through a participatory approach, this program will involve local communities in every phase of activities, from planning, construction, to management of the arboretum. It is hoped that the Sungsang community will not only act as beneficiaries, but also as the main actors in mangrove conservation. This arboretum is expected to be a model for sustainable coastal ecosystem management, support the development of village potential, and contribute to the achievement of sustainable development goals (SDGs), especially in the sustainable management of marine and terrestrial ecosystems.

IMPLEMENTATION AND METHODS

This activity is carried out through several methods, namely preparation, land preparation and planting. The stages of implementing the activity include the following: 1. Preparation a. Observation of the area that will be used as an arboretum. b. Coordination with the village government, community, and related institutions. c. Provision of facilities and infrastructure, such as mangrove seedlings and planting tools. 2. Planting and selecting types of mangroves in the arboretum area; a. Using mangrove seedlings aged between 150 Days After Planting (DAP) which have a height of between 40-60 cm. b. Planting at the arboretum location with a distance of 1 x 1 m2 to provide space for root growth between mangrove plants. The target of this activity is the local community in Sungsang IV Village, Banyuasin, South Sumatra, starting from the village head to the community, especially fishermen groups. The number of participants involved is around 10 people who will be directly involved in mangrove planting activities at this arboretum location.

RESULTS AND DISCUSSION

Sungsang IV Village is located on the east coast of South Sumatra, which has a wet tropical climate with two main seasons, namely the rainy season which generally lasts from October to March, with high rainfall that supports the growth of mangrove vegetation. While the dry season occurs from April to September, with lower rainfall but still supports coastal ecosystems. Sungsang IV Village has a lowland topography with most of the area consisting of river and sea waters. This area is the estuary of the Musi River, which makes it an abrasion-prone area and important for mangrove conservation. The density of mangrove vegetation in the Sungsang IV Village Forest is the basis for restoration activities which show that the diversity of this species has great potential for preserving the mangrove ecosystem (Kurniawan et al., 2024). With its geographical conditions and rich mangrove ecosystem, Sungsang IV Village has great potential for the development of mangrove conservation and community-based ecotourism. Conservation efforts through planting mangrove arboretums can be an effective solution to maintain the balance of coastal ecosystems and improve the welfare of local communities.

The activity location survey was carried out on February 19, 2025 with representatives from the team visiting Sungsang IV Village, Banyuasin, South Sumatra and discussing the mangrove planting activities that would be carried out and preparing various other administrative preparations such as submitting a letter of application for activities and making a letter of assignment. Coordination with the local village head has also been carried out and received a positive response regarding the activity.

The selection of seedlings for mangrove planting with an age of between 150 Days After Planting (DAP) and a height of around 40-60 cm was carried out with biological and ecological considerations so that the chances of plant survival were higher. At this age, mangrove seedlings generally enter a stable early vegetative growth phase, where the roots have begun to develop quite strongly and the leaves have been able to photosynthesize effectively. Seedlings of this size also have better resistance to environmental pressures, such as changes in salinity levels, tidal waterlogging, and pest or disease attacks. In addition, seedlings aged 150 DAP tend to be more adaptable to new planting media because they are not too big but are strong enough to support themselves and withstand minor physical disturbances such as water currents or wind (Kurniawan et al., 2024). Therefore, the selection of seedlings at this phase is considered optimal to increase the survival rate of plants and the efficiency of mangrove rehabilitation programs in coastal areas such as Sungsang IV Village. After that, planting was carried out at the arboretum location with a distance of 1 x 1 m^2 to provide space for root growth between mangrove plants. According to (Sarno & Ridho, 2017) with a distance of 1x1 m^2 allows roots to grow and develop optimally without pressing on each other, thus supporting plant growth and stability. This activity involved a group of local fishermen totaling 10 people who were directly involved in planting mangrove seedlings. With the assistance from the community of Sungsang IV Village, Banyuasin, it indicates enthusiasm and enthusiasm to be directly involved in the activity.

Manngrove planting is carried out using mangrove seedlings of the *Rhizopora mucronata* species which were previously planted in polybags. Nursery cultivation is carried out by residents of Sungsang IV starting with propagules and the second is through mangrove seeds. The first method is nursery cultivation using propagules. The propagules are taken and then sorted for good and healthy ones. The mechanism is to first prepare a polybag then put in the sandy mud found at the nursery location and then some of the propagules are inserted into the planting media (Septinar et al., 2023). There are 12 mangrove species in the mangrove nursery location including *Bruguiera gymnorrhiza, Sonneratia alba, Rhizhopora apiculata, Rhizophora mucronata, Kandelia candel, Avicennia marina, Sonneratia caseolaris, Bruguiera sexangula, Bruguiera parviflora, Excoecaria agallocha, Rhizophora stylosa and Xylocarpus granatum*.

Figure 1. Location of Mangrove Nurseries in Sungsang IV Village

In Sungsang IV Village, planting is carried out in two ways, namely planting on land and in the waters. For planting on land, the method is to dig a hole to insert some of the mangrove seedlings, while for waters, in addition to planting seedlings, bamboo is also used as a support and to hold them from currents and waves so that the seedlings can remain standing (Septinar et al., 2023). Planting of mangrove seedlings is carried out in land conditions with muddy soil with a clay-loam texture that is air-logged, high humidity (wet and flooded soil conditions), suitable for mangrove growth. In addition, planting is carried out in an open location, namely with optimal exposure to sunlight so that it greatly helps the photosynthesis process of mangroves which can support their growth. Soil salinity that is suitable for mangrove growth generally grows well with a soil salinity of 5–30 ppt for many species such as *Rhizophora spp.* and *Avicennia spp.* (Matatula, 2019).

Figure 2. Mangrove Planting Process at the Mangrove Arboretum in Sungsang IV Village

The type of mangrove planted in the mangrove conservation activity at the Sungsang IV Village arboretum is from the genus *Rhizopora*, namely the species *Rhizopora mucronata*. The mangrove group of the *Rhizopora* genus has a root form that is very effective in maintaining the stability of mud and beaches, absorbing pollutants, and is also able to withstand seawater infiltration into the mainland. Another adaptability is that several types of mangroves grow with fruits that germinate on their parent trees (viviparous), such as *Kandelia, Bruguiera, Ceriops and Rhizophora* (Karminarsih, 2007).*Rhizophora sp.* has weak supporting roots, so it is more suitable to be planted in areas protected from waves, so the location of the arboretum is ideal for the growth of the *Rhizopora* genus mangrove (Septinar et al., 2023). Several studies on mangrove species in Indonesia, namely *Rhizophora* and *Avicennia*, show that these species can provide food, wood-derived commodities, and local medicinal resources. The ability to thrive in extreme conditions results in the production of unique phytochemicals with therapeutic properties. These compounds include various phytochemicals such as steroids, triterpenes, saponins, flavonoids, alkaloids, fatty acids, quinones, and tannins, which have medicinal benefits such as antibacterial (Shelar et al., 2012).

Figure 3. Series of Mangrove Planting Activities in Sungsang IV Village

The planting of mangrove arboretum in Sungsang IV Village, Banyuasin, has made a significant contribution to the restoration of coastal ecosystems that were previously damaged by abrasion and human activities. Mangrove roots, especially of the *Rhizophora* and *Bruguiera* species, are able to withstand waves and ocean currents, making them effective in reducing coastal erosion which is a serious threat to this coastal area (Septinar et al., 2023). In addition, the mangrove root system also functions as a natural filter for sediment, heavy metals, and pollutants, thus helping to maintain water quality in the Musi River estuary area which is the center of local fishing activities (Kariada & Irsadi, 2014).

From an ecological perspective, the existence of mangroves can increase biodiversity. Mangrove vegetation can add new habitats for various types of coastal fauna, for example crabs, shrimp, fish, molluscs, and water birds that migrate back to this area. This has an impact not only on enriching the ecosystem but also on boosting the community's economy (Ministry of Environment and Forestry of the Republic of Indonesia, 2023). In addition, planting mangroves has an impact on soil stability and water quality, and also increases the stability of the microclimate in coastal areas. A well-growing mangrove ecosystem can reduce strong winds and tidal floods, and stabilize environmental humidity. Surprisingly, mangrove trees are also able to contribute to the absorption of carbon emissions in the surrounding environment, making them an important priority for future climate change mitigation efforts. For this reason, planting a mangrove arboretum in Sungsang IV Village provides great benefits in restoring the ecological function of coastal areas and maintaining environmental resilience in a sustainable manner (S.K. Handayani & Hewindati, 2019).

During the implementation of the mangrove arboretum planting program in Sungsang IV Village, several challenges both technically and socially had to be faced. One of the obstacles was the limited resources, supporting personnel, and adequate field equipment. Moreover, in the early stages of implementing the activity, the problem of low understanding and awareness of the community regarding the importance of preserving mangroves was a major obstacle. Some residents still think that the mangrove area is an unproductive and unproductive land. This is due to the lack of environmental education and the lack of direct community involvement which ultimately results in inconsistency in seedling maintenance activities (Putri et al., 2022).

The explanation above, a number of strategies should be carried out in order to create a sustainable program that runs well, including education and socialization to the local community which is carried out in stages through socialization activities, technical training, and field visits. This program also involves community leaders, the younger generation and farmer and fisherman groups so that they can become agents of change in the surrounding environment (Pakpahan, et al., 2023). On the other hand, collaboration with various external parties such as universities, non-governmental organizations, and environmental services also contributed in the form of technical assistance, provision of seeds, and logistical assistance. This cross-sector collaboration has proven to be able to accelerate planting and increase community ownership of the mangrove arboretum (Sumianto et al., 2019).

In addition, to maintain the sustainability of activities, community involvement is very important to continue to be improved. One recommendation that can be implemented in the future is to form structured forest farmer groups or mangrove management communities that receive regular training. A community-based approach like this not only strengthens the social and economic aspects of the community, but also expands the scope of sustainable mangrove ecosystem maintenance. Support from local governments and related institutions must continue to be strengthened, both in the form of regulations, funding, and incentive programs for villages that carry out conservation activities (E. A. Handayani et al., 2023) with the synergy between the community, government, and other stakeholders, the mangrove arboretum program in Sungsang IV Village can be maintained and preserved and have a greater impact on the environment.

CONCLUSIONS AND RECOMMENDATIONS

Sungsang IV Village, Banyuasin has a lowland topography with most of the area consisting of river and sea waters. This area is the estuary of the Musi River, which makes it an abrasion-prone area and important for mangrove conservation. The planting of mangrove arboretum can be an effective solution to maintain the balance of coastal ecosystems and improve the welfare of local communities. Mangrove planting in this study used the Rhizopus mucronata species aged 150 Days After Planting (DAP) with a height of between 40-60 cm with a distance of 1 x 1 m2 to provide space for root growth between mangrove plants. The number of participants involved was around 10 people who directly involved in mangrove planting activities at this arboretum location. In implementing the mangrove arboretum planting program in Sungsang IV Village, there were a number of challenges that must be faced, both from a technical and social perspective. One of the main obstacles is the limited resources, supporting personnel, and adequate field equipment. Education and socialization efforts to local communities are recommended to be carried out in stages through outreach activities, technical training, and field visits. In addition, support from local governments and related institutions must continue to be strengthened, both in the form of regulations, funding, and incentive programs for villages that carry out conservation activities.

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