

Education on the Role of Mangroves in Increasing the Potential of Muaragembong Community Ponds, West Java

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Abstract

This community service program was conducted by the PUI Mangrove USU and PKR Mangrove Ecology PREE BRIN teams in Muaragembong District, Bekasi Regency, West Java on October 26, 2024. The aim was to raise awareness and support the conservation of mangrove ecosystems to improve community pond productivity. Primary data were collected through field observations, interviews, and purposive sampling of 12 members of the KTH Sumber Makmur group. Activities included planting 10,000 *Rhizophora mucronata* and *Avicennia* sp. seedlings, educational outreach, and focus group discussions on mangrove functions in environmental protection and socio-economic development. The silviforestry approach, integrating fish, shrimp, and seaweed cultivation in mangrove ecosystems, has increased production while maintaining water quality. Planned mangrove ecotourism development offers further economic potential if supported by local regulations. These efforts are expected to improve ecosystem sustainability and local welfare.

Keywords: Mangroves; Ecosystem sustainability; Silviforestry.

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Introduction

Administratively, Muaragembong mangrove tourism includes Muaragembong District, Bekasi Regency, West Java with 5 villages, namely Pantai Bahagia Village, Harapan Jaya Village, Pantai Mekar Village, Pantai Sederhana Village, and Jakasakti Village, Bekasi Regency, West Java. Muaragembong District has a high level of suitability for seaweed cultivation because it is included in the category of areas with high salinity, currents, and sufficient substrate. The people of Muaragembong District use it as a place to cultivate seaweed of the *Gracilaria* sp species which is usually done together with milkfish in polyculture. This type of seaweed is the raw material for making agar. Of all the cultivation activities in Muaragembong District, Pantai Mekar Village and Pantai Sederhana Village have the largest production compared to other villages because of the unlimited supply of fresh water. In addition to seaweed cultivation, the potential of the mangrove ecosystem is quite extensive and can be used as a buffer zone to reduce the potential impacts of global warming, abrasion, tidal flooding, and land subsidence (Rohman et. al., 2018).

Mangrove ecosystems are among the most productive coastal habitats and provide critical ecological and economic services, such as shoreline protection, carbon sequestration, and support for fisheries productivity. However, extensive degradation has occurred in many parts of Java, including Muaragembong, mainly due to land conversion into ponds, settlements, and agriculture. The decline of mangroves has resulted in coastal erosion, seawater intrusion, and the loss of fish nursery grounds, which threatens local livelihoods. Despite several rehabilitation programs, most efforts have focused only on planting activities and have not been integrated with local livelihood systems. Previous studies show that integrating mangrove restoration with silvo-aquaculture systems can enhance water quality, reduce production costs, and increase fish and shrimp yields. Furthermore, community-based mangrove ecotourism has been reported to provide

alternative income while improving public awareness of. Nevertheless, in Muaragembong, educational interventions on the role and multifunctional value of mangroves remain very limited. Therefore, this community service program is designed to address that gap by combining mangrove rehabilitation, education, and silviforestry-based livelihood development to support the sustainability of coastal ecosystems and improve the welfare of local communities

The mangrove forest area in Muaragembong is relatively good and is currently designated as a protected forest area. The results of the mangrove biodiversity study show that there are 33 types of mangrove vegetation in Pantai Mekar Village. The dominant type is the black api-api type (*Rhizophora mucronata*). Nevertheless, efforts to preserve mangrove forests in Bekasi Regency are still being carried out considering the high potential for damage. Several things were identified in Muaragembong, including: the mangrove ecosystem in Muaragembong, Bekasi Regency has changed its function to become ponds, settlements, fields, and rice fields. Furthermore, the Muaragembong mangrove ecosystem has experienced a rate of degradation due to land conversion.

The mangrove ecosystem in Muaragembong, Bekasi Regency has been largely converted into ponds, settlements, fields, rice fields, and other uses. This has caused the function of the mangrove forest as an animal habitat to no longer be effective and fish catches have decreased. *The results of data processing showed that in Muara Gembong Subdistrict in 2009-2019 it was known that there was an increase in the area of mangrove land by 1017, 746 ha and reduction in mangrove area by 275.37 ha.* (Alin, et. al., 2021). Pond land in Muaragembong has been recorded as 1,582 ha over the past 10 years, the result of the conversion of existing mangrove land. The high conversion to ponds is triggered by the very promising economic potential in the pond sector with the highest net revenue of IDR 56.4 million/ha compared to conversion to other sectors.

The Muaragembong mangrove ecosystem has experienced a rate of degradation due to land conversion. The remaining area in 2020 only reached 1,028.64 hectares (9.81%). In fact, the initial area of mangrove forest area determination reached 10,481.15 hectares. The mangrove density level reached 1033-1425 individuals/hectare which is included in the moderate category based on the level of mangrove damage.

The impact is that seawater intrusion and abrasion cannot be controlled, environmental quality has decreased, economic activities of the community have been disrupted, several public facilities have been damaged, and several livelihoods of coastal communities have been lost. Unclear and overlapping authority have caused differences in the use of understanding and the purpose of use which have resulted in conflicts of interest so that the degradation of the mangrove ecosystem continues to occur to this day.

Then, Ditha et. al. (2014) reported potential carbon stored of mangrove stands in Muara Gembong is 55,35 tons ha, with the highest carbon stored in mangrove species *R.mucronata* is 17,60 tons/ha. Based on the potential of biomass and carbon being produced, showed that the ability of mangrove ecosystem to absorbing carbon in Muara Gembong is not too high. The potential carbon stored in the Muaragembong ecosystem is also considered to be relatively low, which is 55.35 tons of CO₂eq/ha. The highest carbon content is in the mangrove plant species *Rhizophora mucronata* with a total of 17.60 tons of CO₂eq/ha. Meanwhile, the biomass potential of the Muaragembong mangrove was found to be not too much. The high biomass potential is influenced by the level of soil fertility and the density of trees in the area. Therefore, more intensive conservation is still needed.

Research that has been conducted has found that abrasion and changes in the coastline in Muaragembong, Bekasi are covering an area of 252,071.71 m². This study was conducted by overlaying maps from 2012 to 2020. In addition, the study also stated that the highest tidal wave was 0.62 m. Mangroves have an Economic Value (EV) consisting of direct benefits from wood, charcoal, and marine fisheries as well as indirect benefits such as preventing abrasion, supplying oxygen, and preventing global warming.

In addition, the mangrove ecosystem also functions ecologically as a source of germplasm and as a spawning ground, nursery ground, and foraging ground for several fish, birds, and marine organisms. To create a sustainable mangrove ecosystem (mangrove ecosystem sustainability), Muaragembong District requires great collaboration from all parties, both local governments, academics, organizations, and the community. The mission to save the earth has also been carried out by several stakeholders. One of the villages that experienced land reduction in 2009-2014 due to the conversion of mangrove land into pond areas and abrasion was Pantai Bahagia Village. The village then experienced an increase in mangrove area again in 2014-2019 because mangrove planting and rehabilitation of mangrove areas began.

Team of Center of Excellence for Science and Technology (PUI Mangrove) USU with PKR Ecology Mangrove PREE BRIN were done community services in Pantai Bahagia Village, Muara Gembong to carried out of rehabilitate the concerning land conditions. Slowly, the conditions in Pantai Bahagia where predicted have become green again by collaborating with green partners, farmer partners, and others.

Implementation Method

The implementation of this community service activity was carried out on Saturday, October 26, 2024, from 10:00-04:00 pm. The community service mechanism was carried out through socialization, Discussion Group Forums (FGD), filling out questionnaires, checking the location of mangrove planting and fish and shrimp cultivation. Community Service Partners came from Forest Farmers Group (KTH) Sumber Makmur Muaragembong, Field Facilitators of the Bakau Manfaat Universal Foundation (MU), Community Service Teams (PUI Mangrove USU, PKR Ecology Mangrove FREE BRIN), Pantai Bahagia and Pantai Bakti communities. Primary data came from field observations, interviews with respondents and figures who understand the problems of the Muaragembong mangrove. Furthermore, using the purposive sampling method was done to 12 respondents were determined from members of KTH Sumber Makmur Muaragembong. While, secondary data was collected from several journal sources and research conducted in Muaragembong. Furthermore, the socialization process and Discussion Group Forum (FGD) were carried out by the PUI Mangrove Community Service Team of USU and PKR Mangrove Ecology of BRIN with 12 members of KTH Sumber Makmur, Muaragembong District, Bekasi Regency, West Java as described in Figure 1 below.



Figure 1. Socialization and Forum Group Discussion (FGD) KTH Makmur in Pantai Bahagia

Result and Discussion

Mangrove Planting Education

Socialization of mangrove seeds A total of 10,000 *R.mucronata* and *Avicennia* sp mangrove seedlings were prepared, then distributed to the planting area (Table 1) using boats to reach all designated locations. Planting was carried out at low tide to facilitate access to the location and seedling stability. All seedlings were successfully planted well and were given retaining stakes to protect them from waves.

Table 1. Description of mangrove planting

Stages	Number of seeds	Description
Picking and sowing	10.000	All seeds are well prepared
Distribution to location	10.000	Smooth distribution using boats
Planting	10.000	All seedlings are planted with support stakes

According to Mr. Dwi Kurniawan, the field facilitator of the Bakau MU Foundation, the planting, maintenance and monitoring of mangroves of the *R. mucronata* and *Avicennia* sp species as many as 10,000 were carried out together with the Sumber Makmur KTH at Bahagia Beach and Bakti Beach, Muaragembong. In addition, the mangrove planting locations in Muaragembong were grouped in Figure 2 below. Mangrove planting is expected to have a positive sustainable impact on the coastal environment of Muaragembong and increase public awareness of the importance of preserving the Muaragembong mangrove ecosystem.



Figure 2. Location of Mangrove Nursery and Planting in Muara Gembong, Bekasi, West Java

The socialization activities carried out by the PUI Mangrove USU and PKR BRIN Community Service teams support the very important role of mangroves according to [Oktaviani et al. \(2019\)](#) in the mangrove land in Muaragembong which is able to provide a crucial role for 113,256 people. In 2010, this capacity increased to 509,365 people. This shows an increase in the capacity of the mangrove ecosystem in supporting the economic, social and environmental needs of the local community, especially in terms of providing natural resources and protecting coastal areas from abrasion and other natural disasters.

Figure 3 below describes the FGD related to the planting of 10,000 mangroves on 10 ha in Muaragembong by Mr. Aang and Endang. According to [Arifin et al. \(2022\)](#) Mangrove forests are exploited on a large scale without reforestation by irresponsible individuals, therefore large-scale planting and seeding are carried out in the following manner: collecting and picking fruit conducted in the ponds of residents who have productive mangrove trees. The results of 10,000 mangrove seedlings were prepared from the picked and selected fruits. The picked seedlings were sown in 15 x 20 cm polybags, then stored in a nursery area with sufficient exposure to sunlight. A total of 10,000 were ere successfully sown and grew well.



Figure 3. Results of Education on the Socialization of the Role of Mangrove FGD

Silviforestry on Shrimp and Fish

The Discussion Group Forum (FGD) provided education on Silviforestry combining fish and shrimp cultivation in the mangrove ecosystem to increase sustainability and economic benefits, consisting of: vandame shrimp, kelong shrimp, milkfish, tilapia, white snapper, and mangrove crab (Table 2).

Table 2. Silviforestry Source (Asyiwati & Akliyah, 2014)

Komoditas	Peran Silviforestry
Shrimp	The nutrient-rich mangrove environment supports shrimp growth and increases their resistance to disease.
Milkfish	Milkfish adapt well to brackish water; mangroves promote natural growth and reduce dependence on supplementary feed.
Tilapia	The brackish and nutrient-rich water conditions of mangroves help tilapia grow in ponds, making them more efficient.
Mangrove Crab	Mangroves help maintain good water quality for mangrove crabs, while providing natural shelter.
White Snapper	White snapper thrive in mangrove areas with brackish water; mangroves provide a protected habitat that supports their growth.
Seaweed	The protected habitat of mangroves improves pond water quality, supporting optimal seaweed production.

According to [Asyiwati & Akliyah \(2012\)](#), the production results of each commodity are very large per year from one year can be per ton which produces high economic value pond commodities, natural nutrients from mangroves reduce the need for additional feed and maintain the quality of pond water,

minimize environmental impacts and increase the conservation of mangrove ecosystems in coastal areas. According to Rohman et al. (2018) The results show that the Muaragembong waters have great potential as a place to develop Gracilaria sp. seaweed cultivation. This potential can be maximized by considering several water quality parameters that are not yet ideal and play an important role, such as currents and basic materials.

Questionnaire of Members KTH Sumber Makmur

After education and FGD, the results were obtained from Table 3 below, it describes the benefits, development and preservation of mangroves in the Muaragembong area as follows:

Table 3. Benefits, development and preservation of mangroves in Muaragembong, Bekasi Regency, West Java

SA= Strongly agree; A=Agree; D=Disagree; and SD=Strongly disagree

No	A.Benefit mangrove	SA	A	D	SD
1	Community is involved in mangrove conservation program	7	4	1	0
2	Mangrove flora reduces coastal erosion	7	5	0	0
3	Mangrove fauna contributes to maintaining ecosystem balance	5	6	1	0
4	Community utilizes sustainable mangrove forest products	5	3	4	0
5	Mangrove conservation increases community income	4	7	1	0
6	There is a mangrove education program for the community	5	5	2	0
7	Illegal logging is a major problem	3	5	3	1
8	Mangrove fauna is a livelihood for the community	5	3	4	0
9	Mangrove reduces the impact of flooding	7	4	1	0
10	Community plays a role in planting mangroves sustainably	3	7	2	0
11	Local government must support mangrove conservation program	4	5	3	0
12	Fauana is vulnerable to environmental pollution	4	3	4	1
13	Mangrove flora is included in the category of plants that must be protected	3	8	1	0
14	Community understands the importance of maintaining mangrove ecosystems	8	5	0	0
15	Community must understand the importance of maintaining mangrove ecosystems	4	8	0	0
16	Utilization of mangrove flora for industrial raw materials must be environmentally friendly	5	4	3	0
17	Climate change has a negative impact on mangrove ecosystems	4	7	1	0
18	The role of women is important in mangrove empowerment	8	2	2	0
19	Youth play an active role in mangrove conservation activities	4	7	1	0
20	Training on mangrove forest management must be provided to the community	6	4	2	0
	B. Development and preservation of mangroves	SA	A	D	SD
1	Mangroves can pose a threat to development	8	1	3	0
2	Muaraembong has the potential to become a mangrove tourism	5	4	3	0
3	Mangrove fauna can be a source of food	4	5	3	0
4	Mangrove conservation can add economic value to the community	8	3	1	0
5	Mangroves play a role in storing and absorbing carbon	6	3	3	0
6	Mangrove cultivation can be done by the community	5	4	3	0
7	Mangrove flora acts as a filter for seawater pollutants	7	2	3	0
8	Mangrove fauna has economic value	7	4	1	0
9	The community plays a role in planting mangroves	6	2	4	0
10	The community patrols the mangrove ecosystem	8	2	2	0
11	Mangroves reduce the impact of pollution on the environment	5	4	3	0
12	The community plants mangroves traditionally	6	5	1	0
13	Ecotourism development will improve community welfare	8	3	1	0
14	The community knows the role and function of mangroves in the environment	8	1	3	0
15	The community plants mangroves regularly	8	3	1	0
16	Development of mangrove flora is beneficial for health	5	2	5	0

17	Mangrove fauna will be threatened with extinction if not preserved	4	4	4	0
18	The use of mangrove products is increased in the community	6	4	2	0
19	Mangrove planting program collaborates with the government	6	2	4	0
20	Threats of invasive species detected in mangroves	7	2	3	0

According to [Ahnanto et al \(2014\)](#), improving and preserving mangrove forests can be done in stages: community motivation and awareness about the role and benefits of mangrove forests; increasing knowledge and skills through local wisdom about conservation; effective communication; planting mangroves; regulating coastal spatial planning; law enforcement; and holistic coastal improvement. These supporting measures have been carried out by the community around Muaragembong by planting 10,000 mangrove seedlings accompanied by Bakau MU and BRIN, training in breeding white snapper and Vandame shrimp by KTH Sumber Makmur.

Building Mangrove Tourism

After planting 10,000 mangrove seedlings with 10 ha by Mr. Aang and Endang, then continued with Silviforstry from FGD, this service builds mangrove tourism with Silviforestry which will have a high impact on tourism and economic development in the coastal area of Muara Gembong. However, there must be government efforts to maintain the sustainability of mangroves, not only from residents and tourists ([Ahnanto et al., 2014](#)). And with this cleaning activity, it is hoped that participants, local communities, and tourists who come to Muara Gembong will participate in preserving the coastal environment from various types of waste. As a result, the level of awareness of participants, local communities and tourists to avoid littering ([Ritonga et al., 2022](#)).

The condition of the mangrove ecosystem in Muaragembong, as explained in the studies of [Asyiwati & Akliyah \(2012\)](#) and [Oktaviani et al. \(2019\)](#), shows that the conversion of mangrove land into ponds and settlements has resulted in serious degradation, leaving only 1,028.64 hectares of mangroves in 2020 from an initial area of 10,481.15 hectares. The community service program involving KTH Sumber Makmur seeks to rehabilitate this ecosystem through mangrove planting and collaboration with the community, especially in Pantai Bahagia Village, in order to restore the function of mangroves as a barrier to abrasion and a natural habitat.

In the cultivation sector, research results by [Rohman et al. \(2018\)](#) stated that Muaragembong has conditions that support the cultivation of *Gracilaria* sp. due to adequate salinity and water currents. Data from the community service program supports this, showing that seaweed cultivation in Pantai Mekar, Sederhana Villages and Pantai Bakti has grown rapidly and has been able to increase food security and community income ([Setio et al., 2019](#)).

Mangrove conservation efforts, as suggested by [Ahnanto et al. \(2014\)](#) and [Ritonga et al. \(2022\)](#), are a priority to maintain coastal ecosystems. The community service program carried out in Muaragembong has driven a mangrove planting campaign with the participation of more than 4,300 people, helping to restore land conditions while increasing community environmental awareness.

From an economic perspective, research by [Arifin et. al. \(2022\)](#) emphasizes the role of mangroves in supporting food security and the economy of coastal communities. The community service program shows that the people of Pantai Bahagia and Pantai Mekar Villages feel the benefits of mangrove rehabilitation for their economic stability, where the FGDs and education carried out have succeeded in increasing understanding of the importance of mangrove ecosystems for long-term welfare.

Conclusion

Mangrove management and conservation activities in Muaragembong show that collaborative efforts between KTH Sumber Makmur, the community, and village officials through education, planting, and silviforestry approaches have had a positive impact on the coastal environment and local livelihoods. The planting of 10,000 mangrove seedlings in a 10-hectare area was successfully carried out, accompanied by education on the importance of mangroves for the economy, society, and environment, as well as their benefits in protecting coastal areas from abrasion and natural disasters. The application of silviforestry with fish and shrimp cultivation in the mangrove ecosystem has been proven to support economic sustainability by increasing the production of various commodities, such as shrimp, milkfish, tilapia, white snapper, and seaweed. Silviforestry not only increases production but also reduces environmental impacts and maintains the quality of pond water. In addition, the plan to develop mangrove tourism in this area has the potential to positively impact the local economy, but requires government support and regulation to maintain the sustainability of the mangrove ecosystem. It is also hoped that the clean-up activities held can increase awareness of local communities and tourists about the importance of maintaining the cleanliness and sustainability of the coastal environment from waste.

However, this program had several limitations, such as its relatively short implementation time, limited number of respondents (12 members of KTH Sumber Makmur), and the absence of long-term monitoring to evaluate the survival rate of planted mangroves and the economic performance of silviforestry systems. Future activities should be designed to include multi-year monitoring, broader community participation, collaboration with local government and private sectors, and the development of training modules that can be adopted by other coastal villages. These steps are expected to strengthen the sustainability and scalability of mangrove-based livelihood programs in Muaragembong and similar coastal areas.

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