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Implementation of Environmental Awareness in the Legon Wetan Mangrove Area, Legon Kulon District, Subang Regency

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Abstract
Background. The mangrove ecosystem in Legon plays a vital role in maintaining the balance of the coastal ecosystem while preserving economic potential through the development of ecotourism and products based on local resources. However, challenges in the form of environmental degradation and low community participation are the main obstacles in the utilization of this potential.
Purpose. Increase awareness, capacity, and the active role of local communities in mangrove conservation through *a community-based conservation* (CBC) approach. The methods used include area mapping, environmental socialization and education, technical training on conservation and processing of mangrove-based products, coastal clean-up and replanting actions, and the formation of local driving communities.
Result. The results of the activity included increased community participation, the formation of the "Legon Mangrove Friends Community" as a sustainable conservation partner, the preparation of technical training modules, and the development of several strategic recommendations.
Conclusion. These recommendations include zoning-based management (rehabilitation, education/ecotourism, and core protection), periodic evaluations, the development of pilot products as regional icons, and the integration of green economic value chains to strengthen conservation behaviors. Analysis of 4A *(Attraction, Accessibility, Amenities, and Ancillary Services*) shows that the Legon mangrove area offers conservation-based ecotourism attractions, although there is still a need for improved accessibility, more facilities, and newly formed institutions.
Implementation. These results affirm the importance of collaboration among the community, government, and academia in achieving sustainable mangrove management, while opening opportunities to improve the welfare of coastal communities.

Keywords: mangroves, *community-based conservation*, ecotourism, green economy, community service

INTRODUCTION

Mangroves are coastal ecosystems that have essential ecological, social, and economic functions. Ecologically, mangroves act as natural fortresses that protect the coast from abrasion, waves, and storms, and serve as habitats for various marine life (Alongi, 2012). In terms of climate change mitigation, mangroves are known as effective blue *carbon* absorbers. Meanwhile, socio-economically, mangroves provide benefits to coastal communities through fisheries, derivative products (syrups, ecoprint batik, herbal soaps), and nature-based tourism services (Walters et al., 2008).

Legon District, one of the coastal areas in West Java, has a mangrove ecosystem with considerable potential but faces challenges, including damage from land conversion, pollution, and low public awareness of environmental protection. To address this challenge, the community-based conservation (CBC) approach is used, as it has proven effective at linking environmental conservation with community empowerment (Berkes, 2004).

This service activity aims to strengthen the local community's capacity to manage the Legon mangroves sustainably, while increasing economic value through the integration of ecotourism and green economy concepts.

LITERATURE REVIEW

Mangrove conservation in coastal areas has been the focus of international and national studies over the past two decades, mainly because of the important role of mangroves in coastal protection, climate change mitigation, blue carbon storage, as well as a source of nature-based economy (Alongi, 2012; Walters et al., 2008). Globally, *the community-based conservation* (CBC) approach is seen as an effective model for maintaining ecosystem sustainability while improving local community well-being. Berkes (2004) and Armitage (2005) show that the success of conservation is primarily determined by the adaptive capacity of communities and the integration between ecological, social, and economic interests.

In Indonesia, research on community-based mangrove management is growing rapidly as coastal degradation from land conversion, abrasion, and pollution intensifies. A study by LIPI & BPLHD (2015) recorded a significant decrease in mangrove area in Pantura, West Java, including Subang, due to the conversion of ponds and settlements. Some studies emphasize the importance of community empowerment, strengthening local

institutions, and developing ecotourism as a sustainable conservation strategy (Dahuri et al., 2004; Insafitri, 2017; Purnomo et al., 2019).

However, most previous studies have focused more on the biogeophysical aspects of mangroves, rehabilitation models, or macroecotourism strengthening, and few have combined awareness-building, green-economy empowerment, and local institutional formation simultaneously in the context of a specific region. In addition, research on the comprehensive application of the 4A tourism framework (Attraction, Accessibility, Amenities, Ancillary) to comprehensively assess the readiness of mangrove areas as a conservation-based ecotourism destination is also still limited.

This article presents a new contribution by integrating community-based conservation approaches, environmental education, mangrove-based product innovation, and ecotourism-readiness analysis into a single series of implementation. Unlike previous studies that tend to focus on one aspect (e.g., rehabilitation or economic empowerment), this study shows that strengthening environmental awareness, building a "Friends of Mangrove Legon" community, and developing green products can run as a sustainable intervention system at the local level.

In addition, the use of 4A analysis in the context of mangrove conservation is a contemporary approach that emphasizes mapping the potential and obstacles to ecology-based ecotourism development while providing a foundation for formulating regional development strategies. The integration of ecological conservation and the green economy through creative products such as mangrove syrup, herbal soaps, and ecoprints signals a new direction for green value chain development on a community scale.

Thus, this state-of-the-art research is at the intersection of three fields: ecological conservation, community empowerment, and sustainable ecotourism development, and provides an implementation model that has not been widely studied in an integrated manner in previous studies, especially in the coastal area of Subang. This article expands knowledge on how community-based interventions can shape long-term conservation behaviors while also creating environmentally friendly economic opportunities.

Research on mangrove conservation and community-based ecotourism development has been widely conducted at both the national and international levels. However, there are some important *gaps* that previous research has not addressed, which then constitute a contribution space for this article.

Gaps related to the integration of conservation, empowerment, and the green economy. Most research on mangrove management focuses on only one aspect: Ecosystem rehabilitation (planting and physical restoration), Community empowerment, or Ecotourism development. There have been few studies that integrate these three components into a single intervention model. This article fills that gap by designing a program that includes increasing public awareness, creating a local conservation community—Environmental Action —and developing mangrove-based products to build *a green economy*.

Gaps in *community-based conservation* (CBC) approaches at the local practice level. CBC studies are generally conceptual or at the macro case study level. There is not much research that shows how CBC is operational, what the stages are, how local communities are formed, and how the sustainability of the program is maintained from the *grassroots level*. This article provides an implementable *blueprint* documenting the CBC's step-by-step in Legon, including the establishment of the Legon Mangrove Friends Community. This practical aspect has not been extensively explained in previous research.

Gap in mangrove ecotourism study using a comprehensive 4A analysis. Ecotourism research typically addresses the attractiveness and potential of the area, but the overall analysis of Attraction, Accessibility, Amenities, and Ancillary (4A) factors in mangrove areas remains limited. Most studies use a descriptive approach without mapping the readiness of ecotourism destinations. This article fills this gap by applying a 4A analysis that provides a concrete picture of Legon's readiness as a conservation-based ecotourism destination, as well as the challenges that must be addressed for long-term development.

The gap is related to the development *of green value chains* in coastal communities. Although research on the use of mangroves for derivative products is rare, it is important to examine how the product is linked to conservation behavior, how the Green Economy can strengthen people's motivation to maintain the ecosystem, and how the product is used as a regional icon to strengthen ecotourism identity. This article fills this gap by developing products such as mangrove syrup, herbal soaps, and ecoprints, and linking them to increased ecological awareness.

Gap in community-based monitoring mechanisms. The conservation literature suggests the need for *community monitoring*. However, there has been little research: it

has focused on a simple surveillance mechanism, identified relevant indicators for grassroots communities, or documented its implementation. This article closes the gap by introducing community-based monitoring using practical indicators: *survival rate*, frequency of beach-cleaning activities, and level of citizen participation.

There is a gap in the local context of Subang, especially Legon Wetan. Although provincial-level research shows a decline in mangrove area in Subang, micro-studies in the Legon Wetan region examine ecological conditions, community behavior, ecotourism potential, and the Local Empowerment Strategy. It is still minimal. This article provides important empirical data to close the gap. There has been no comprehensive integration of conservation, environmental education, and the green economy in community-scale mangroves.

1. The implementation of CBC at the local operational level is still rarely described in the literature.
2. The 4A analysis on mangrove ecotourism has not been widely used as a tool to evaluate destination readiness.
3. The mangrove green value chain has not been studied as a strategy to strengthen community conservation behavior.
4. The monitoring model by the community for conservation sustainability is still lacking in previous research.
5. Micro-studies in Legon Wetan, Subang, are not yet available as an integrative scientific reference.

METHOD

The approach emphasizes the principle of community-based conservation (CBC), in which local communities are not only beneficiaries but also actively participate as planners, implementers, and managers of activities. Thus, the program's sustainability is more assured because it is supported by a strong sense of ownership among the community.

The implementation method is prepared in stages, starting with mapping actual conditions, raising awareness, providing technical training, undertaking field actions, and forming community institutions. This phased approach is expected to address short-term needs (rehabilitation and education) while laying the groundwork for long-term development through ecotourism and green economic value chains.

The activity is carried out in five main stages:

1. **Initial Observation and Mapping**
    a. Survey the actual condition of mangroves (damage rate, rehabilitation needs).
    b. Interviews with community leaders, fishermen, and village officials.
    c. Spatial and social mapping as the basis of intervention.
2. **Socialization and Education**
    a. Material: ecological function of mangroves, impact of damage, practice of protecting the environment.
    b. Methods: interactive talks, group discussions, educational video playbacks.
    c. Target: students, fishermen, the general public.
3. **Conservation Training and Workshops**
    a. Technical training: planting, maintenance, and selection of mangrove species.
    b. Product training: mangrove syrup, ecoprint batik, herbal soap.
    c. Ecotourism workshop: mangrove trail and *environmental storytelling*.
4. **Coastal Cleanup and Mangrove Planting Action**
    a. Gotong royong cleans the coastal area.
    b. Planting 50 mangrove seedlings according to the conditions of the substrate and wave energy.
5. **Community Building and Evaluation**
    a. Establishment of the Legon Mangrove Friends Community.
    b. Preparation of organizational structure and community-based monitoring mechanisms.
    c. The evaluation was carried out with simple indicators: seedling survival rate, net area, and citizen participation.

DISCUSSION

Based on the results of mapping conducted by P3O LIPI with BPLHD West Java, mangrove forest areas on the north coast of Subang Regency, including Legonkulon (Legon) District, are estimated to have a total area of around ±6,593 hectares. However, this condition has decreased compared to the past due to the conversion of land into ponds, agriculture, or settlements. Other data showed that the area of mangrove-planted ponds decreased from 3,402.6 ha to 2,384.9 ha between 1989 and 2013, while ponds without mangroves increased significantly over the same period.

The mangrove area in Legon District is a significant part of the coastal ecosystem. Based on the initial mapping, this area still supports natural mangrove stands, but some areas show signs of degradation from land conversion, logging, and pollution. This condition is the main reason for the need for rehabilitation and conservation-based interventions.

As a first step, this service activity carried out mangrove replanting in locations identified as experiencing light to moderate damage. The mangrove species selected are based on wave energy and substrate characteristics, primarily *Rhizophora* and *Bruguiera*, which are known to have good resistance to the dynamics of the coastal environment. This planting is not only aimed at increasing vegetation cover, but also serves as a means of practical education for the community about the importance of ecosystem sustainability.

Based on the ecological and social conditions described, community service activities in the Legon mangrove area focus not only on physical rehabilitation through mangrove planting but also on strengthening the community's capacity and its role as the leading actor in conservation. This aligns with the community-based conservation (CBC) approach, which emphasizes local community participation in maintaining ecosystem sustainability while generating economic benefits from sustainable resources. Thus, the results of activities can be reviewed from three main aspects.

Increased Participation and Awareness

The results show a significant increase in public awareness of the importance of maintaining mangrove ecosystems. Through environmental socialization and education, people begin to understand the relationship between ecosystem sustainability and long-term benefits for their well-being. Citizens' involvement in coastal clean-up actions is increasing, and some groups, such as the Ema-ema Rempong group, are actively carrying out routine clean-ups in their area, while other community groups are starting to serve as conservation volunteers.

The Formation of the Legon Mangrove Friends Community

This community serves as a conservation partner, ensuring the sustainability of the program through monitoring, mentoring, and driving the development of environment-based ecotourism. To strengthen this role, it is necessary to establish small,

environmentally friendly communities in every RT/RW in coastal areas. This group can serve as a planter of mangrove seedlings, a guardian of the coastal area, and an environmental steward who maintains the coastal ecosystem. With this community-based approach, conservation efforts are not only more coordinated but also firmly embedded in the community's local culture.

Green Economy Integration

Mangroves are a type of coastal plant with a variety of benefits, ranging from their roots, stems, and leaves, which not only help preserve the environment but also produce products with economic and social value. Through a sustainable utilization process, the community can turn mangroves into various creative products. Several pilot products, such as mangrove syrup and ecoprint batik, were developed as *pilot projects* that are expected to become leading icons of the region. This initiative strengthens community motivation to link conservation activities with economic well-being, thereby fostering a harmonious relationship between environmental conservation and local economic development.

This community service activity not only focuses on replanting *Rhizophora* and *Bruguiera mangroves* but also on strengthening the local community's social, economic, and institutional capacity. With *a community-based conservation* (CBC) approach, the service program is designed through several main stages, integrated with one another to ensure the sustainability of activities and increase the community's active involvement as a driver of conservation. The service is designed in several main stages.

Increased Participation and Awareness

The first stage of implementing the service program is carried out through field surveys in mangrove ecosystem areas, which serve as the basis for formulating activity interventions. This survey includes observation of mangrove biophysical conditions, vegetation density levels, identification of dominant species, assessment of area damage, and mapping of sources of environmental pressure, such as abrasion, coastal debris, and anthropogenic activities. In addition, social surveys were conducted to determine the level of community knowledge, perceptions of mangrove conservation, and their potential involvement in rehabilitation activities and environmentally based economic development. The results of this survey are an important foundation in determining the

strategy *of the community-based conservation* (CBC) approach that is relevant to the local socio-ecological characteristics.

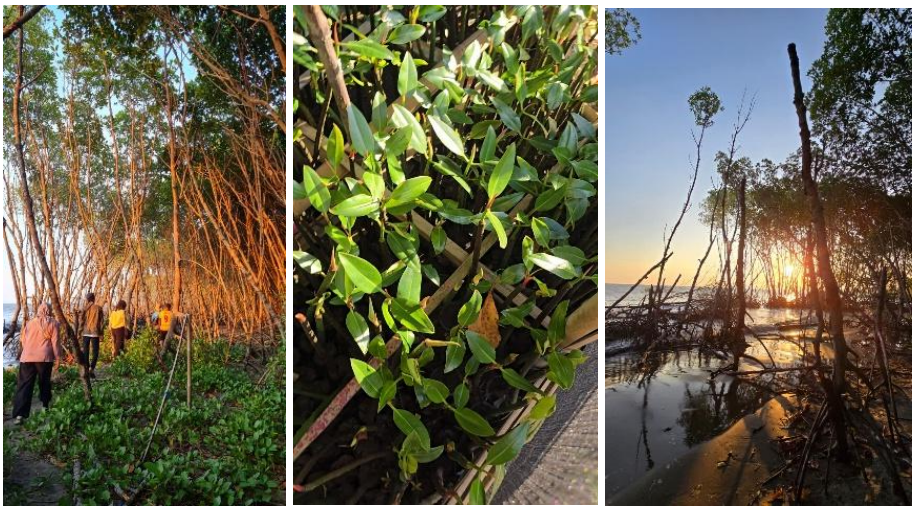

Figure 1. Mangrove Land
Source: researcher

The Formation of the Legon Mangrove Friends Community

The following socialization and environmental education for the community is carried out through community small-group discussions and the presentation of materials on the ecological functions of mangroves, the role of mangroves in coastal disaster mitigation, and opportunities to utilize mangroves for the development of the creative economy and ecotourism. An explanation of the relationship between environmental sustainability, tourism awareness, and the long-term improvement of coastal community welfare also strengthened this education.

In this process, local communities are formed and strengthened as sustainable conservation partners. The community is tasked with monitoring mangrove growth, maintaining coastal cleanliness, and ensuring the sustainability of planting activities. In addition, the community is the driving force in developing environment-based ecotourism, through the management of educational attractions, conservation-based tourism assistance, and the development of creative products that responsibly utilize mangrove resources. Thus, the existence of this community is key to maintaining the program's sustainability, strengthening local institutions, and encouraging community participation in building sustainable, productive coastal areas.

Figure 2. Environmental Awareness Activities
Source: Researcher

Green Economy Integration

The economic use of mangroves is one of the important strategies for diversifying conservation outcomes and providing added value to coastal communities. This effort is intended to show that environmental conservation can go hand in hand in hand with community welfare. Some pilot products, such as mangrove syrup, herbal soap, and ecoprint batik, utilize the color and shape of mangrove leaves. This product is expected to become an icon of the region and to motivate the community to connect conservation with improved welfare. Thus, diversification of mangrove utilization plays an important role in building the community's collective motivation to continue maintaining, caring for, and developing the mangrove ecosystem as an ecological asset and a source of welfare.

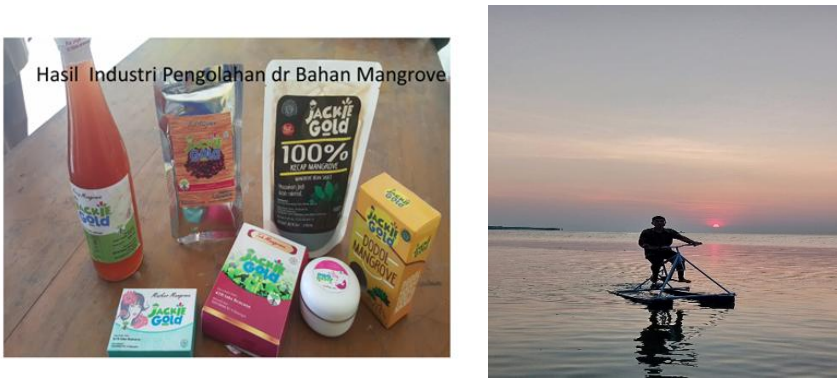

Figure 3. Mangrove Innovation Products
Source: Researcher

Preparation of Technical Modules and Strategic Recommendations

A technical training module is composed that emphasizes species selection according to location, planting techniques, and seed protection. In addition, strategic recommendations were prepared in the form of zoning (rehabilitation,

education/ecotourism, core protection), periodic evaluations, and the integration of the green economy value chain.

Table 1. Analysis of 4A Legon Mangrove Area

Components (4A)	Field Findings	Potential/Challenge
Attraction	- The beauty of natural mangrove forests.- Biodiversity (birds, marine life).- Mangrove trail activities have the potential to be developed.	The potential for educational ecotourism is high, but it has not been managed professionally.
Accessibility	- The location can be reached from the center of the sub-district. - Road access is still limited and inadequate.	Need to improve basic infrastructure (roads, small docks, signage).
Amenities	- Basic facilities are very minimal (toilets, garbage cans, parking areas). - There is no tourist information center yet.	The main challenge in attracting outside tourists is the need for investment in facilities.
Ancillary Services	- Initial support from the village government and schools. - Local communities are formed.	Institutions are beginning to be formed, but they need networks with tourism offices, NGOs, and universities.

By looking at the existing conditions of the area and the interventions that have been carried out, the results of service activities, and the discussion of the 4A analysis can comprehensively describe the potential, challenges, and direction of the development of the Legon mangrove as a conservation-based ecotourism destination.

Analysis 4A shows that the Legon mangroves are quite attractive as an ecotourism base, but accessibility, facilities, and supporting services need improvement. This aligns with findings from similar research (Feka & Ajonina, 2011), which emphasize that the development of mangrove ecotourism requires a combination of conservation, supporting infrastructure, and community empowerment. Based on the service stages completed and the results of the 4A analysis, the Legon mangrove area has excellent potential as a conservation-based ecotourism destination. However, the success of regional development depends heavily on the sustainability of community participation, institutional strengthening, and improvements in supporting infrastructure.

Integration of Three Approaches: Conservation – Education – Green Economy

This article presents an intervention model that integrates ecological conservation, environmental awareness enhancement, and green economy development into a single program. This multidimensional approach is rarely found in other mangrove studies, which typically focus only on rehabilitation or ecotourism.

Practical Implementation of *Structured Community-Based Conservation* (CBC)

This research not only discusses the concept of CBC, but also documents complete operational steps, starting from:

1. socio-ecological mapping,
2. public education,
3. Technical training,
4. Field Action,
5. to the formation of local institutions.

Details of practices like this are a new contribution to the community-scale coastal conservation literature.

Establishment of the Legon Mangrove Friends Community as a Local Institutional Model

This article introduces new local communities that serve as conservation drivers, area supervisors, and engines of ecotourism development. Documentation of its formation, function, and working mechanism is a novelty, as there is little research that explains the systematic formation of *grassroots institutions* in the context of Indonesian mangroves.

Development of Mangrove-Based Green Value Chain

This study shows a direct link between conservation and economic improvement through product innovation (mangrove syrup, herbal soap, ecoprint). The connection between local creativity and conservation behaviour is a novel aspect, as previous research has rarely examined the green economy as a long-term conservation booster.

5. Use of 4A Analysis to Assess Mangrove Ecotourism Readiness

This article is one of the first to conduct a comprehensive assessment of mangrove ecotourism readiness using the 4A framework:

1. Attraction,
2. Accessibility,
3. Amenities,
4. Ancillary services.

This approach provides strategic mapping that has not been widely applied to mangrove areas in West Java, including Subang.

Community-Based Monitoring Model with Simple Indicators

This research introduces conservation monitoring indices that communities can run without complex technology, namely:

1. the survival rate of seedlings,
2. area of clean area,
3. Levels of Citizen Participation.

The novelty lies in the focus on *practical monitoring tools* that align with the local community's capacity.

In-Depth Micro Study on the Legon Wetan Mangrove Area, Subang

To date, there has been no integrative research that analyzes ecological conditions, maps community participation, evaluates the potential of ecotourism, and simultaneously plans a green economy strategy in the Legon Wetan area. This article is the first scientific study to examine this region comprehensively. This article presents an innovative community-based conservation implementation model integrating environmental education, the formation of local institutions, the development of a mangrove-based green economy, and the evaluation of ecotourism readiness using the 4A analysis. This holistic approach is a new contribution that has not been widely found in the study of mangrove conservation in Indonesia, especially in the local context of Subang.

CONCLUSION

Community service activities in the Legon mangrove area have increased community participation in conservation, formed driving communities, and produced green-economy pilot products. The 4A analysis shows that although the area's attractiveness is very promising, accessibility, facilities, and supporting services remain challenging. Therefore, collaboration among the community, the government, and other stakeholders is needed to ensure the sustainable management of the Legon mangrove ecosystem while supporting the community's welfare.

Strategic Recommendations

1. Establish zoning: rehabilitation areas, education-ecotourism, and core protection.
2. Conduct periodic evaluations with simple community-based indicators.
3. Develop pilot products as an area icon.

4. Develop a species-based conservation technical module.
5. Integrating the green economic value chain with sustainability standards.
6. Implement a community-based monitoring system.

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