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Community-Based Mangroves Forest Management: Socio-Ecological Recovery Movement for Coastal Areas of Pasuruan-Indonesia

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Abstract

This study aims to determine the success of the Socio-Ecological Recovery movement on the CBMM approach as the management and utilization of mangrove forests in Penunggul Village, Nguling District, Pasuruan Regency. This research is descriptive qualitative using survey method with purposive technique. Collecting data using observation techniques through observation and measurement of objects in the field and semi-structured interviews were conducted with 34 respondents who had previously been determined (purposive) (age, education and livelihood). The data analysis technique in this study used a single tabulation with the stages of collecting, coding, editing, and visualization, which were then described. The results showed that: 1) Regional characteristics (ocean waves, abrasion level, salinity, tides, flora and fauna) determine mangrove forest recovery; 2) Recovery depends on the role of the community and institutions (formal and non-formal) in responding to mangrove forest management by regional conditions. The collective idea of a society in Socio-Ecological Recovery raises a new perspective on the ideal integrative relationship between humans and nature. This research is expected to be an illustration in decision making for stakeholders regarding sustainable area management.

Keywords:
community-based mangrove managements, socio-ecological recovery, sustainability, coastal area

Introduction

Regional management and development strategies are very influential on people's lives. Regional organization and proper regional planning can impact improving the socio-economic quality of the community (Fudge, Ogier, & Alexander, 2021). Acceleration of economic growth (Iqbal, Firdaus, Juanda, & Hakim, 2020) through welfare (Kurnia, Masbar, Sirojuzilam, & Zulham, 2021) and poverty alleviation (Liu, Liu, & Zhou, 2017) can be achieved through proper regional planning and development. In accordance. Therefore, spatial characteristics determine the success of regional development directions and programs (Tolstykh, Gamidullaeva, Shmeleva, & Lapygin, 2020), including the development of coastal areas.

Coastal areas have unique spatial characteristics. Coastal areas are identical to areas with complex non-physical interactions by humans through pressure on land and physical features in protected area geomorphic systems (de Oliveira & Bonetti, 2021). Such conditions have consequences for the emergence of disaster phenomena (Sajjad, Chan, & Kanwal, 2020), the carrying capacity of the area due to population pressure (Tian, Shao, & Wu, 2020), to the preservation of estuary and mangrove ecosystems (Ellis, Kelly, & Flannery, 2018; Sheng, Xu, Zhang, & Chen, 2019) become a challenge in developing coastal areas. Therefore, coastal areas require full attention in regional development (Brammer, 2014; Burt et al., 2017; Li, Sun, Zhu, & Cao, 2010) through appropriate approaches, one of which is Community-Based Mangrove Management (CBMM).

Community-Based Mangrove Management (CBMM) can be an alternative solution to the problems of coastal areas and estuary ecosystems in their implications for people's lives. This approach emphasizes complex integration with orientation to the socio-economic conditions of the community (Damastuti & de Groot, 2017) based on representations of ecological protection (Christian, Budiman, Purwanto, & Damar, 2021). Community participation as the primary goal in CBMM can be realized (Sreeranga, Takagi, & Shirai, 2021) considering that the community has lived side by side with the environment (de Oliveira & Bonetti, 2021), it can be an alternative solution for sustainable management through mangrove forest ecosystem management (Kongkeaw, Kittitornkool, Vandergeest, & Kittiwatanawong, 2019). However, the empirical review shows that there is no guarantee

that the implementation of CBMM by the community can fully apply the principles of sustainability (Garcia & Lescuyer, 2008). The implementation of community sustainability principles can shift with the demands of material needs (Peña, Flores, Buncag, Lubrico, & Pacañot, 2017). In addition, the community has an essential motivation that the ecosystem must meet the needs of the mass environment, making CBMM unable to run optimally (Aheto et al., 2016). Therefore, it is necessary to understand further the diversity of CBMM implementation patterns in local concepts, one of which is in Penunggul.

Penunggul Village is one of the thriving villages in the implementation of CBMM. Previously, the implementation of CBMM in Penunggul Village was motivated by efforts to restore the area's ecology as a result of pond activities that hampered reforestation with an area of up to 105 hectares (Sofian, Harahab, & Marsoedi, 2012) and the phenomenon of massive abrasion along the coast of Penunggul Village (Kristiyanto, A., & Armono, 2013).. The actualization of the principle of equality of harmonious relations between the social and ecological environment has made Penunggul Village successful in implementing CBMM through Socio-Ecological Recovery efforts.

Socio-Ecological Recovery can be a substantial effort to manage mangrove ecosystems based on CBMM. Socio-Ecological Recovery efforts to implement community-based mangrove conservation are very appropriate, considering the long-term achievements and orientation to complex adaptive systems (Phalkey, 2020). Then, the application of Socio-Ecological Recovery widely impacts the dissemination of knowledge and good environmental awareness (Ounvichit & Yoddumnern-Attig, 2018) through collaborative activities in society (Gevaña et al., 2021). Based on the above background, this study aims to determine the success of the Socio-Ecological Recovery movement on the CBMM approach as the management and utilization of mangrove forests Penunggul - Pasuruan Regency.

***Community-Based Mangrove Management* (CBMM)**

Community-based mangrove management (CBMM) is an approach to sustainably managing mangrove ecosystems. CBMM appears as a challenge for community-based mangrove management located in economic and conservation zones (Dat & Yoshino, 2013). Given that the community has historically lived side by side with the surrounding

environment, awareness is needed in sustainable resource management (de Oliveira & Bonetti, 2021). The empirical facts in the field show that CBMM has been applied in several areas in Indonesia.

The implementation of CBMM has been widely applied in various regions in Indonesia. The collaborative management of mangrove forests in Damas Beach, Trenggalek Regency, was initiated by the government, independently managed by the local community (Purwanti, Indrayani, & Fattah, 2018). Mangrove management is a sustainable environmental management strategy to improve the community's ecological, economic, and social dimensions (Basyuni et al., 2018). Then, the effectiveness of the Village CBMM approach in Central Java with variations in the results of the application of CBMM as efficient use of potential, optimal intensification and extensification of mangrove areas, and effectiveness of community resources and livelihoods (Damastuti & de Groot, 2017). This condition shows that CBMM provides various benefits to the community.

CBMM provides various benefits for both humans and the environment. The benefits of CBMM are based on community-centred processes and collaborative use of resources based on community capacities that trigger community motivation to obtain benefits generated by an ecosystem (Aheto et al., 2016). On the other hand, experts doubt that the CBMM approach directly impacts ecosystem sustainability (Rovai et al., 2012).

Socio-Ecological Recovery

A socio-Ecological Recovery is a form of collective activity related to the achievement of conservation program objectives. Socio-Ecological Recovery as a form of activity in the application of community-based mangrove conservation is ideal to be carried out. The broad application of Socio-Ecological Recovery impacts the dissemination of knowledge and good environmental awareness (Ounvichit & Yoddumnern-Attig, 2018) through collaborative activities in society (Gevaña et al., 2021). Integrating various elements in Socio-Ecological Recovery provides a shift in the value of the ideal integrative perspective on the relationship between humans and nature (Wang et al., 2021).

In its implementation, Socio-Ecological Recovery provides an overview of the relationship between the social context and the surrounding environment. In the context

of conservation, Socio-Ecological Recovery emphasizes population size in restoring environmental conditions (Donoso & Romero, 2020). The role of social and institutional capacities (Zazueta & Garcia, 2021) and the availability of processes and natural resources determine success (Itzkin et al., 2021). This condition shows the role of the Socio-Ecological Recovery components in contributing to the successful interaction of human relations with nature, CBMM.

Methods

This research is descriptive qualitative using survey method with purposive technique. The selection of these methods and techniques focuses on the representation of output data in field activities (Annisa, N., Prasetia, H., & Riduan, 2020). The sample in this study is communities who participate in the management and use of the Penunggul mangrove forest. The research instrument is in the form of observation sheets through field observations and semi-structured interviews that aim to obtain information openly without compromising the essence of the research (Sugiyono, 2018). The variables in the study consisted of the characteristics of mangrove forests with indicators: 1) Mangrove area habitat; 2) Physical characteristics of the sea (ocean waves, level of abrasion, salinity, tides); and 3) The presence of flora and fauna in the mangrove forest. Mangrove Forest Management consists of indicators: 1) Forest management consists of a nursery, planting, maintenance, utilization of mangrove plants; and 2) Marketing of mangrove products. The data analysis technique in this study used a single tabulation with the stages of collecting, coding, editing, and visualization, which were then described.

Results

The research location is Penunggul Beach, Penunggul Village – Pasuruan, Indonesia. Observation activities were divided into three location sections, based on the variable Characteristics of Mangrove Forests. The indicators used are 1) Mangrove habitat; 2) Physical characteristics of the sea (ocean waves, level of abrasion, salinity, tides); and 3) Types of flora and fauna of mangrove forests. Details of the characteristics of mangrove debt can be seen in table 1

Table 1.

Characteristics of the Mangrove Forest of Penunggul - Pasuruan, Indonesia

Parameter	**Informations**		
	Loc. A (7^{0}42′17,9″ South Latitude -113^{0}05′49,6″ East Longitude)	**Loc. B** (7^{0}42′10,8″ South Latitude -113^{0}05′32,4″ East Longitude)	**Loc. C** (7^0 42' 09.7″ South Latitude-113^0 05' 24,1″ East Longitude)
Mangrove Forest Habitat	Dusty Clay	Loamy Sand	Sea wave
Sea Wave	Tidal waves and beach forming (Constructive waves)		
Abrasi	High	High	Small
Salinity	(0,8%) *Oligohaline*	(1,9%) *Oligohaline*	(1,9%) *Oligihaline*
Tidal	High tide occurs at 10.00 am and begins to recede at 02.00 pm		
Flora	*Rhizophora apiculata, Rhizhophora mucronata, Avicennia alba,* dan *Avicennia marina*		
Fauna	Green Mussels, Oysters and Crab Species (*Rajungan*)		

Indicators of the Characteristics of Mangrove Forests consist of physical characteristics of mangrove habitat, ocean waves, abrasion, salinity, tides, and the presence of flora and fauna. Observation of the data was carried out teritrically at three research points adjusted to the age zoning of mangrove plants from points A, B and C. In the first indicator, the determination of soil texture used the texture by feel method and grain analysis. The table shows that the habitat of the mangrove forest area from research points A to C that dominates is clay soil texture and research point A is dusty clay textured because the distance is slightly far from the shoreline.

Then, on the sea wave indicator, it is observed that the sea waves at research points A, B, and C have similarities related to the period, length, and type. Judging from the forming

factors, the three research points have the equation of ocean waves formed by the tides, while in terms of their nature, they are included in the building waves or beach-forming (Constructive waves). This condition has implications for the level of abrasion indicator, which shows that there is minor abrasion at point C due to the high density of mangrove plants.

The salinity indicator was obtained by taking water samples in the field and measured using a Water Quality Checker (WQC) at each research point. The measurement results show that the salinity based on the estuary zone is included in the Oligohaline classification with points A (0.8%), B (1.9%), and C (1.9%). Such conditions are influenced by coastal structures, which impact the amount of material resulting from sedimentation of the river flow system. In addition, salinity is also influenced by the magnitude of the tidal period of the North Coast of Nguling, which occurs twice a day, at 10 am and 10 pm. The highest tide is 2.78 m at a full moon and 1.25 m at low tide. During field observations, high tide occurred at 10 am and receded at 2 pm.

The last indicator is related to the Characteristics of Flora and Fauna in the mangrove ecosystem of Penunggul Village. In general, two types are consisting of four species. The dominance of four species in the mangrove ecosystem of Penunggul are Rhizophora apiculata and Rhizophora mucronate. This type of flora distribution is due to the pattern of adaptation to the environment in the morphology of mangroves with the characteristics of having solid and large roots as a natural breakwater to overcome the problems of tidal flooding and coastal abrasion. Meanwhile, the fauna species identified in the mangrove forest of Penunggul include Pisces, molluscs, reptiles, aves, crustaceans and insects. The diversity of fauna in the mangrove forest of Penunggul has six types of fauna and fourteen species, direct observation in the field of fauna most commonly found in the species of green mussels, oysters and crabs.

Furthermore, Mangrove Forest Management consists of indicators: 1) Forest management consists of a nursery, planting, maintenance, utilization of mangrove plants; and 2) Marketing of mangrove products. Data were obtained through semi-structured interviews with 34 previously selected respondents based on purposive sampling techniques related to the active participation of respondents in managing and utilizing mangrove

forests. The identification of respondents is based on age, education, and livelihood criteria.

Based on the results of the entire study, the respondents belonged to the productive age group. Most respondents are in the range of 25-32 years, with 13 respondents (38.24%) of 34 respondents. These results indicate that the community managing the mangrove ecosystem has an ideal average age. Then, based on the level of formal education taken by the respondent, it can be classified into three levels (elementary school graduates, junior high school graduates, and high school graduates). The majority of respondents have completed high school education, with 17 respondents (50%). Furthermore, in the livelihood aspect, most respondents work seasonally as fishermen, with a total of 14 respondents (41.18%). Mangrove forest management sees table 2.

Table 2.

Mangrove Forest Management in Penunggul Village – Pasuruan, Indonesia

Indicator	Parameter	Information
Mangrove Nursery	Land status	Private (public property)
	Nursery area habitat	Outside the influence of tides (on land)
	Nursery type	Temporary nursery
	Selection of plant types	Abrasion and tidal flood resisting plants (4 types)
	Forms of seedling maintenance	Watering and pest control
Planting	Cultivation system	Banjar system
Maintenance	Protection against pests	Weeding, embroidery, and control of damaging factors
Utilization and Marketing	Types of product utilization and marketing	Non-wood
	Utilization and marketing of wood species	nothing done
	Utilization and marketing of non-timber species	Chips, syrup, and processed fishery products
	Utilization and marketing of types of environmental services	Research and ecotourism sites
	Forms of cooperation with institutions	Company, University, and Fisheries & Marine Service

The table above shows the management of mangrove forests in Penunggul Village,

Nguling District, Pasuruan Regency. The mangrove forest nursery shows the type of temporary nursery based on the need for the implementation of mangrove rehabilitation in Penunggul Village. The form of maintenance is watering mangrove seedlings with seawater once a week and controlling crab pests. Then, planting activities in the mangrove forest of Penunggul Village were planted using saplings, and the types of tillers used were from the nursery. The mangrove planting system uses a daily Banjar system with a distance of approximately 1x1 meters.

The maintenance of mangrove forests in Penunggul Village has three stages, namely weeding, replanting, and controlling destructive factors. Weeding activities are not carried out by the community, considering that pest attacks rarely occur in the mangrove forest of Penunggul. Then, on the aspect of the use of mangrove forests in the form of non-timber and environmental services developed towards research and education centres and ecotourism. Furthermore, marketing is in the form of processed mangrove chips and processed crabs. Based on the findings in the field, the promotion of processed mangrove resources has several limitations due to the low innovation of product dissemination strategies to the broader community.

Discussion

Characteristics of the Mangrove Forest in Penunggul

The Penunggul mangrove forest has different characteristics from mangrove forests in other areas. Physical review in the form of coastal morphology makes the optimization of the growth of the Penunggul mangrove forest (Sofian et al., 2012). The morphology of the sloping beach ground floor with a height of 2-8 meters above sea level (Subekti, 2012) provides an ideal growing medium for restoring mangrove ecosystems. At the research point, the mangrove ecosystem is in the coastal foreshore zone with nutrient sedimentation in the Lawean river. Such conditions have implications for the distribution of the density of the Penunggul mangrove vegetation with the Rhizophora type on the sandy loam soil texture and the Avicennia mangrove plant species with the clay soil texture (Tefarani, Tri Martuti, & Ngabekti, 2019). In addition, such coastal morphology has implications for the formation of sea waves in the form of tidal waves and constructive waves so that they do not interfere with the restoration process of the mangrove ecosystem.

Then, a chemical review of the suitability of the Penunggul mangrove ecosystem looked at the salinity of the Oligohaline criteria with a salinity level of 0.8%–1.9%. This is suitable for the growth and development of mangrove plants to adapt by adjusting salt levels in their habitat (Mathius, Lantang, & Maturbongs, 2018). The Penunggul Mangrove Forest is a mixed prevailing semi-diurnal tide, making it ideal as a medium for mangrove growth. The tidal conditions affect the condition of the mangroves, with changes in the cycle of seawater inundation in the mangrove area. Thus, it affects the distribution of the formation of the Penunggul mangrove species.

The Penunggul mangrove forest contains four species of mangrove plants. The species consisted of Rhizophora apiculata, Rhizophora mucronata, Avicennia alba, and Avicennia marina. The diversity of flora as a food source makes the formation of a symbiotic relationship with fauna. The distribution of fauna in the Penunggul mangrove ecosystem can be seen horizontally (land-sea) with terrestrial fauna, including egrets, grasshoppers, crabs, snails and similar reptiles such as lizards, monitor lizards. Meanwhile, the distribution of aquatic fauna in the waters includes milkfish, mullet, glodok, mangrove crabs, green mussels, oysters and white shrimp. In addition, in the Penunggul mangrove forest, many types of molluscs are found, namely green mussels and oysters, and even become suppliers of this type of fauna for the surrounding area.

Pengunggul Mangrove Forest Management

Management of the Penunggul mangrove forest ecosystem is an adaptive effort to overcome environmental problems through Socio-Ecological Recovery. The Penunggul mangrove forest ecosystem is a recovery area for fish ponds that have experienced abrasion, high tides and tidal flooding, which impact residents' settlements (Sofian et al., 2012). In Socio-Ecological Recovery, the community is faced with several complex pressures and raises the dissemination of knowledge and collective environmental awareness as an alternative to a problem (Ounvichit & Yoddumnern-Attig, 2018). One form of the implementation of Socio-Ecological Recovery is through the involvement of the Penunggul community in a farmer group in the management of the "Sumber Rejeki" mangrove forest.

Socio-Ecological Recovery as a form of collective activity related to achieving the goals of an ideal community-based conservation program to be implemented. The collaboration of

the Penunggul community farmer group can be an effective strategy for managing mangrove Socio-Ecological Recovery (Gevaña et al., 2021). The collective idea of the community in Socio-Ecological Recovery raises a new perspective on the ideal integrative relationship between humans and nature (Wang et al., 2021), thus giving rise to adaptive ideas in overcoming problems. Therefore, the role of social institutions (formal and non-formal) in supporting the achievement of mangrove ecosystem management.

Management of the Penunggul mangrove forest in collaboration with a State University in East Java. Institutional collaboration with local communities can increase the achievement of sustainable ecosystem management (Febryano, Suharjito, Darusman, Kusmana, & Hidayat, 2014). The role of social and institutional capacity is a success factor for Socio-Ecological Recovery efforts to manage mangrove ecosystems (Zazueta & Garcia, 2021). One of the things done by the Penunggul community is utilizing resources in the mangrove ecosystem through the use of non-timber products in the form of chips, crackers and syrup from mangrove fruit. In addition, community and government institutions increase the usefulness of mangrove forests through the functional value of the area to be used as a place of research and education, as well as a place for ecotourism (Pradana, O. Y., Soenardjo, N., & Suryono, 2013), which has implications for the economic condition of the community.

Management of the Penunggul mangrove ecosystem has an impact on the economic condition of the community. Mangrove forest management (nursery, planting, maintenance, and utilization of mangrove plants) and marketing of mangrove plant products are forms of feedback for harmonious relationships in CBMM. The ability of the community to collectively trigger community motivation to obtain benefits generated by an ecosystem (Aheto et al., 2016). The harmonious relationship between humans and nature Penunggul responds to the challenges of community-based mangrove management, through a basic understanding of management and utilization that does not become an obstacle to economic activities in conservation areas (Dat & Yoshino, 2013).

Conclusion

Socio-Ecological Recovery efforts in the CBMM approach are effective in managing the Penunggul Mangrove Forest, Nguling District, Pasuruan Regency. The physical and

chemical characteristics of the beach support the optimal restoration of the mangrove ecosystem. In addition, community participation through a shift in perception as a motivational basis for better environmental management has implications for the achievement of mangrove ecosystem recovery through efforts by emphasizing the harmonious relationship between humans and nature through Socio-Ecological Recovery in the CBMM approach. Thus, this research is expected to illustrate decision-making for stakeholders regarding sustainable management of the area.

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