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Community Perceptions and Participation in Mangrove and Coral Reef Conservation: Implications for Sustainable Coastal Ecosystem Management in Sendang Biru, Indonesia

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ABSTRACT

Purpose of the study: This study aimed to analyze community perceptions and participation in mangrove and coral reef conservation and to evaluate their implications for sustainable coastal ecosystem management in Sendang Biru, Malang Regency, Indonesia.

Methodology: A quantitative descriptive research design was employed using a structured questionnaire survey involving 97 respondents selected from a population of 2,841 coastal residents through proportionate random sampling. Data were analyzed using descriptive statistical techniques based on perception scores and percentage distributions.

Main Findings: The results indicated that community perceptions of mangrove and coral reef conservation were generally positive, particularly regarding environmental benefits. Approximately 76% of respondents were familiar with mangrove ecosystems, and 68% recognized their environmental benefits. Environmental perception scores for mangrove and coral reef conservation were 164 and 183, respectively, while economy perception scores reached 115 and 105. In contrast, perceptions of economic benefits differed between ecosystem types, with mangrove conservation receiving a negative score (T = 68) and coral reef conservation a positive score (T = 159). Community support for conservation initiatives was high (T = 180), but willingness to participate directly in conservation activities remained low (T = 82).

Novelty/Originality of this study: This study provides an integrated assessment of community perceptions and participation in both mangrove and coral reef conservation within a coastal ecosystem management framework. The findings reveal an awareness–participation gap, demonstrating that positive conservation perceptions and support do not necessarily translate into active participation, highlighting the need for more participatory and community-based conservation strategies.

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1. INTRODUCTION

Mangrove forests and coral reefs are among the most important coastal ecosystems due to their ecological, economic, and social functions [1], [2]. These ecosystems provide essential services, including

shoreline protection, carbon sequestration, biodiversity conservation, and support for fisheries productivity. The ecological connectivity between mangrove forests and coral reefs contributes significantly to the resilience of coastal landscapes and the sustainability of marine resources [3], [4]. Healthy mangrove and coral reef ecosystems can reduce the impacts of coastal erosion, storms, and other environmental disturbances while supporting local livelihoods [5], [6]. Consequently, the conservation of these ecosystems has become a global priority in efforts to achieve sustainable coastal development and environmental sustainability.

Despite their importance, mangrove forests and coral reefs are increasingly threatened by both natural and anthropogenic pressures. Coastal development, destructive fishing practices, pollution, tourism activities, and land-use changes have accelerated ecosystem degradation in many coastal regions worldwide [7], [8]. The loss of these ecosystems can reduce biodiversity, weaken coastal protection functions, and negatively affect the socio-economic well-being of coastal communities [9], [10]. In Indonesia, the degradation of mangrove forests and coral reefs remains a significant environmental challenge despite various conservation and rehabilitation initiatives [11], [12]. Therefore, effective conservation strategies are needed to ensure the long-term sustainability of coastal ecosystems and the services they provide.

The success of conservation programs is influenced not only by ecological factors but also by social dimensions, particularly community perceptions and participation [13], [14]. Local communities are often the primary users of coastal resources and directly experience the benefits and consequences associated with ecosystem changes. Positive perceptions toward conservation can encourage support for environmental protection efforts and foster responsible resource-use behavior [15], [16]. Conversely, negative perceptions or limited awareness may reduce community involvement and hinder conservation outcomes [17], [18]. For this reason, understanding community perceptions is considered an important component of sustainable ecosystem management and conservation planning.

Previous studies have demonstrated that community perceptions play a crucial role in shaping conservation attitudes and environmental behavior in coastal areas [19], [20]. However, most studies have focused on public awareness, environmental knowledge, or perceptions of a single ecosystem, such as mangrove forests or coral reefs [21], [22]. Limited attention has been given to examining community perceptions of mangrove and coral reef conservation simultaneously within an integrated coastal ecosystem context. Furthermore, studies investigating the relationship between positive conservation perceptions and willingness to participate in conservation activities remain relatively scarce, particularly in Indonesian coastal communities [23], [24]. This condition indicates a research gap regarding how conservation perceptions can support or constrain the implementation of sustainable coastal ecosystem management.

Sendang Biru Coastal Area in Malang Regency represents an important coastal landscape where mangrove forests and coral reefs provide ecological and economic benefits for local communities. The area has experienced conservation initiatives aimed at protecting coastal ecosystems while supporting sustainable livelihoods [25], [26]. Nevertheless, the effectiveness of these efforts depends largely on the extent to which local communities understand, support, and engage in conservation activities [27], [28]. Investigating community perceptions in this area is therefore important for evaluating the social foundations of ecosystem conservation and identifying opportunities for improving stakeholder participation [29], [30]. Moreover, the findings can provide evidence-based recommendations for strengthening community-based conservation approaches in coastal regions.

The novelty of this study lies in its integrated assessment of community perceptions toward both mangrove and coral reef conservation within a single coastal ecosystem management framework. Unlike previous studies that primarily focus on environmental awareness or individual ecosystem conservation, this research examines the potential gap between positive conservation perceptions and actual willingness to participate in conservation activities [31], [32]. This approach provides a broader understanding of the social factors that influence conservation effectiveness in interconnected coastal ecosystems. The study also contributes to the development of conservation strategies that incorporate community perceptions as a key element of ecosystem governance. Therefore, the findings are expected to enrich the literature on nature and landscape conservation while supporting evidence-based coastal management practices.

Based on the aforementioned background, this study aims to analyze community perceptions toward mangrove and coral reef conservation in Sendang Biru Coastal Area and to evaluate their implications for sustainable coastal ecosystem management. Specifically, the study investigates community perceptions regarding the ecological, economic, and socio-cultural benefits of conservation, as well as their willingness to participate in conservation activities [33], [34]. Understanding these aspects is essential for identifying opportunities and challenges in community-based conservation efforts. The results are expected to support policymakers, conservation practitioners, and local stakeholders in designing more inclusive and participatory conservation programs. Ultimately, strengthening the connection between conservation awareness and active community engagement can contribute to the long-term sustainability of coastal ecosystems and the well-being of coastal communities.

2. RESEARCH METHOD

2.1 Study Area

This study was conducted in Sendang Biru Coastal Area, Tambakrejo Village, Sumbermanjing Wetan District, Malang Regency, East Java, Indonesia. The area contains interconnected coastal ecosystems, particularly mangrove forests and coral reefs, that provide important ecological and socio-economic services for local communities. These ecosystems support fisheries production, biodiversity conservation, coastal protection, and tourism activities [35], [36]. However, increasing environmental pressures and unsustainable resource utilization have raised concerns regarding ecosystem degradation and long-term sustainability [37], [38]. Therefore, Sendang Biru represents an appropriate study area for examining community perceptions toward mangrove and coral reef conservation and their implications for sustainable coastal ecosystem management.

2.2 Research Design

This study employed a quantitative descriptive research design to assess community perceptions and participation in mangrove and coral reef conservation [39], [40]. The quantitative approach was selected because it enables the systematic measurement and description of perception patterns within a community. The study focused on evaluating respondents' perceptions of the environmental, economic, and socio-cultural benefits of mangrove and coral reef conservation, as well as their support for conservation initiatives and willingness to participate in conservation activities [41], [42]. Data were collected through a structured questionnaire survey administered to community members residing in the study area. The findings were subsequently interpreted to understand the potential contribution of community perceptions and participation to sustainable coastal ecosystem management.

2.3 Population and Sampling

The target population consisted of residents of Sendang Biru aged 17 years and above, totaling 2,841 individuals. The sample size was determined using the Slovin formula with a margin of error of 10%. Respondents were selected using proportionate random sampling to ensure that the sample adequately represented the characteristics of the coastal community [43], [44]. The selected respondents were considered capable of providing information regarding their perceptions of mangrove and coral reef conservation because of their direct interaction with coastal resources and environmental conditions in the study area. Based on the Slovin formula, a minimum sample size of 96.6 respondents was obtained and rounded to 97 respondents.

$$n = \frac{N}{1 + Ne^2} \quad \ldots(1)$$

where n is the sample size, N is the population size, and e is the margin of error.

Using a population size of 2,841 and a margin of error of 10% (e = 0.1), the sample size was calculated as follows:

$$n = \frac{2841}{1 + 2841\ (0.1)^2}$$

$$n = \frac{2841}{29.41}$$

$$n \approx 96.6$$

Thus, the survey involved 97 respondents representing the coastal community of Sendang Biru.

2.4 Data Collection

Primary data were collected using a structured questionnaire distributed directly to respondents. The questionnaire was designed to assess community perceptions regarding mangrove and coral reef conservation across environmental, economic, and socio-cultural dimensions [45], [46]. Additional items were included to evaluate respondents' support for conservation programs and their willingness to participate in conservation activities. Each statement was developed based on indicators relevant to coastal ecosystem conservation and community involvement. The questionnaire approach enabled the collection of standardized data and facilitated quantitative analysis of community perceptions and participation.

2.5 Research Variables and Indicators

The study examined community perceptions and participation as the primary variables. Perceptions of mangrove and coral reef conservation were assessed through three dimensions: environmental benefits,

economic benefits, and socio-cultural benefits. In addition, community support for conservation initiatives and willingness to participate in conservation activities were evaluated to understand the social factors influencing conservation effectiveness [13], [34]. These indicators were selected because they represent important components of community-based conservation and sustainable coastal ecosystem management.

2.6 Data Analysis

The data obtained from the questionnaire were analyzed using descriptive statistical techniques based on perception scores and percentage distribution [47], [48]. Community perceptions were measured using a three-point Likert-type scale consisting of agree (2), do not know (1), and disagree (0). The total perception score (T score) for each indicator was calculated and compared with the mean score (T mean) to determine perception categories. The T mean value was obtained by dividing the total possible score by the number of response categories, resulting in a threshold value of 97. Perceptions were categorized as positive when the obtained T score was greater than 97 and as negative when the T score was equal to or lower than 97. The resulting perception categories were subsequently interpreted to evaluate community support and participation in mangrove and coral reef conservation and their implications for sustainable coastal ecosystem management.

Table 1. Calculation of T score and T mean

Number of Respondents	Weight	Score
97	2	194
97	1	97
97	0	0
Total	3	291
T mean = 291 / 3 = 97		

From the table, we can see that the T score is 291, while the T mean is 97. This can be used as a reference for measuring perception. If the value is > 97, the perception can be said to be positive, while if the value is ≤ 97, the perception can be said to be negative.

3. RESULTS AND DISCUSSION

Knowledge is an important prerequisite for shaping environmental perceptions and conservation behavior. Therefore, respondents were first asked about their familiarity with mangrove ecosystems, coral reefs, and conservation activities in Sendang Biru. The results showed that 75% of respondents were familiar with mangrove ecosystems, while 68% recognized the benefits provided by mangroves. Most respondents referred to mangroves using the local term *tanjangan*, indicating that mangrove ecosystems are relatively well known within the community. These findings suggest that mangrove ecosystems have become part of local environmental knowledge and provide a foundation for conservation awareness.

3.1 Respondents' Knowledge About Mangroves

To determine public knowledge about mangroves, researchers asked respondents whether they had ever heard of or heard about them. The questionnaire results are shown in Figure 1.

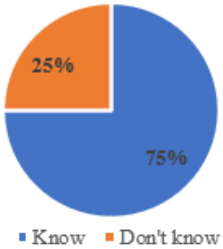


Figure 1. Whether or not respondents know about mangroves

From the graph, we can see that the majority of respondents (75%) knew about mangroves. If respondents knew what mangroves were, the researcher proceeded to the next question, asking whether mangroves were beneficial. The results of the questionnaire regarding this question can be seen in Figure 2.

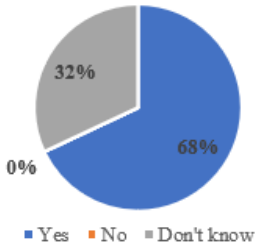


Figure 2. Respondents' knowledge about whether mangroves are beneficial

Of the 97 respondents, 68% knew about the benefits of mangroves. However, 76% of respondents reported knowing about mangroves, meaning 8% of the population knew about mangroves but didn't know their benefits. The graph also shows that no respondents said mangroves weren't beneficial, but 32% didn't know about their benefits. From all the respondents' answers, the benefits of mangroves are as follows: holding back waves, preventing abrasion, preventing landslides, bridge materials, buildings, firewood (but now prohibited because it is a protected forest), preventing erosion, protected forests, fish spawning grounds, preventing seashore erosion, woody plants (now prohibited because it is a protected forest), reducing air pollution, contributing/producing a lot of oxygen, and a breeding ground for crabs.

After asking about the general benefits of mangroves, the researcher tried to pose the question of whether there would be any harm to the community if the mangrove forest was damaged. This is important because if the community perceives there will be a loss to them if the mangrove forest is damaged, they will tend to be more concerned about it. The results of the questionnaire can be seen in Figure 3.

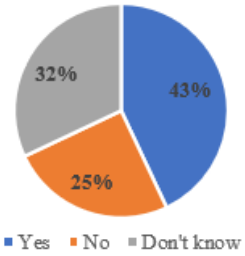


Figure 3. Respondents' knowledge about whether there are losses for the community if mangrove forests are damaged.

From the graph, we can see a more diverse range of answers than for the previous question. This question featured the response "it doesn't affect us; if there is an impact, it's on nature," and a similar response from 25% of respondents. This is quite concerning because if you already perceive that there are no harms to me, then your likelihood of caring about mangrove conservation is also very low. 32% of respondents answered "don't know," stating they didn't understand the issue because their education only reached elementary school. 43% of respondents answered "there are harms to the community if mangrove forests are damaged." Their reasons were as follows: the air becomes hotter, fish breeding grounds disappear, crab populations decrease, making it difficult for people looking for crabs, and landslides damage rice fields and can inundate nearby homes.

The researchers also asked respondents about the condition of the mangroves in Sendang Biru Hamlet. This was deemed necessary because knowledge of the condition can be an indicator of concern. The results of the questionnaire regarding this are shown in Figure 4.

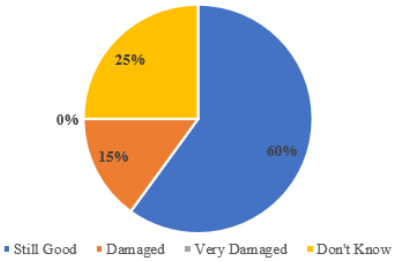


Figure 4. Respondents' knowledge about the condition of mangroves in Sendang Biru Hamlet

Of the 97 respondents, 60% said the mangroves in Sendang Biru Hamlet were in good condition. 25% said they didn't know, mostly because it wasn't their business. 15% said they were damaged, due to previous

illegal logging. Based on these findings, it can be estimated that more than 50% of the Sendang Biru Hamlet community tends to be indifferent to the mangroves.

3.2 Respondents' Knowledge of Coral Reefs

To determine public knowledge about coral reefs, researchers asked respondents whether they had ever heard of or heard about coral reefs. The questionnaire results are shown in Figure 5.

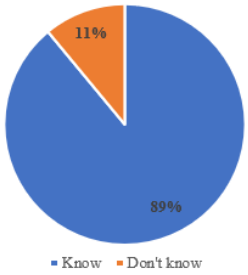


Figure 5. Whether or not people know about coral reefs

From the graph, we can see that the majority of Sendang Biru residents are familiar with coral reefs (89%). If respondents knew what mangroves were, the researcher proceeded to the next question about the benefits of coral reefs. Community knowledge of the benefits of coral reefs is expected to have positive implications for coral reef conservation in Sendang Biru Hamlet. The results of the questionnaire regarding this can be seen in Figure 6.

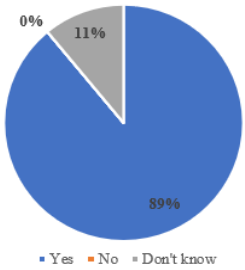


Figure 6. Community knowledge about whether coral reefs are beneficial

From the graph, we can see that the majority of the Sendang Biru community (89%) are aware of the benefits of coral reefs. Respondents' knowledge varied widely; they were considered knowledgeable if they successfully mentioned at least one benefit. Overall, the benefits of coral reefs were as follows: shelter for fish, breeding grounds, habitat for fish, spawning grounds, and underwater tourism.

After asking about the general benefits of coral reefs, the researcher posed the question of whether the community would suffer losses if the reefs were damaged. This is important because if the community perceives a loss to them if the coral reefs are damaged, they are more likely to be concerned about the situation. The results of the questionnaire are shown in Figure 7.

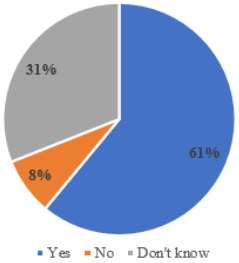


Figure 7. Respondents' knowledge of whether there are losses to the community if coral reefs are damaged.

This graph shows a more diverse range of answers than the previous question. This question featured the response "It doesn't affect us; if there is an impact, it's an impact on nature," and a similar response from 8% of respondents. 31% of respondents answered "I don't know," stating they didn't understand the issue because their education only reached elementary school and it wasn't their concern. 61% of respondents answered "There are losses to the community if coral reefs are damaged." Their reasons were as follows: the ecosystem becomes unstable, fish migrate to other areas, fish availability could be threatened, fish catches decline, fishermen have to

move further out to sea to fish, fishermen's incomes decline, and some fishermen believed there are losses to the community, but only limited to those who regularly fish.

The researchers also asked respondents about the condition of the coral reefs in Sendang Biru Hamlet. This was deemed necessary because knowledge of the condition can be an indicator of concern. The results of the questionnaire regarding this matter are shown in Figure 8.

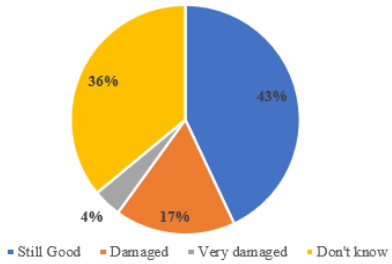


Figure 8. Respondents' knowledge about the condition of coral reefs in Sendang Biru Hamlet

From the graph we can see more diverse answers than the previous question. Of the 97 respondents, 43% answered that the condition of the coral reefs in Sendang Biru Hamlet is still good, Some of them said that the Sendang Biru area is used for coral reef tourism, and some respondents said there is coral reef planting. 36% of respondents answered they did not know, some of them said they did not understand about it because their education only reached elementary school, some said it was not their business. 17% of respondents said that the condition is much damaged, they said that the initial damage to the coral reefs in 1994 was due to the tsunami, damaged because some people catch coral fish using potassium, covered by shipping waste, there is sedimentation due to forest destruction. Meanwhile, 4% of respondents said that the condition is very damaged, the damage to the coral reefs is due to friction from ships when docked, exposed to oil from washing ships, some also dump unused oil into the sea.

3.3 Respondents' Knowledge About Conservation

To determine public knowledge about coral reefs, researchers asked respondents whether they had ever heard of or heard about coral reefs. The results of the questionnaire can be seen in Figure 9.

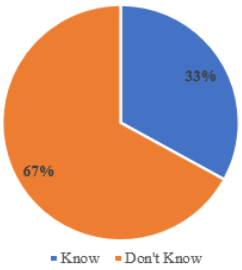


Figure 9. Public Awareness of Conservation

From this graph, we can see that the majority of respondents (67%) still don't know about conservation. Of those who do, 33% have a bachelor's degree, 14% have a high school education, and 16% have a junior high school education (32% of respondents with a junior high education, so 16% of respondents with a junior high education don't know about conservation). Formal education contributes significantly to conservation knowledge, but informal education also plays a role. If respondents know what conservation is, the researcher proceeds to the next question, asking whether conservation is beneficial. The results of the questionnaire regarding this question can be seen in Figure 10.

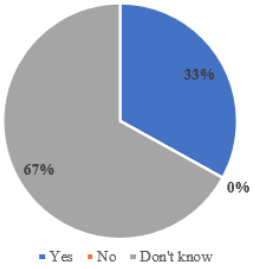


Figure 10. Respondents' Knowledge of the Benefits of Conservation

The graph shows that the majority of respondents (67%) are still unaware of conservation. Therefore, greater efforts should be made to educate the Sendang Biru community about conservation, which will hopefully have a positive impact on conservation development in Sendang Biru Hamlet. Furthermore, 33% of respondents cited the following benefits of conservation: preserving nature, restoring damaged nature, preserving nature, protecting, and maintaining natural sustainability.

After asking about the general benefits of conservation, the researcher posed the question of whether there would be any losses to the community if conservation activities were absent or less active. This is important because if the community perceives there will be losses if conservation activities are absent or less active, they will tend to be more concerned about it. The results of the questionnaire can be seen in Figure 11.

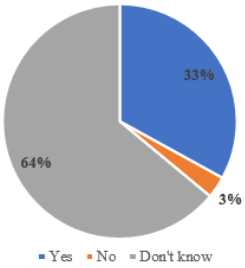


Figure 11. Respondents' knowledge of whether there are losses to the community if conservation activities are absent or less active.

This graph shows a more diverse range of answers than the previous question. This question featured the response "it doesn't affect us, because we're not involved in it. If there is an impact, it's an impact on nature," and a similar response came from 3% of respondents. 32% of respondents answered "don't know," stating they didn't understand the issue because their education only reached elementary school. 33% of respondents answered "there are losses to the community if conservation activities are absent or less active." Their reasons were as follows: if coral reefs aren't conserved, fish stocks will decrease; if mangrove forests are damaged, landslides will damage rice fields and the air will become hotter; those who manage them for tourism will naturally experience a decrease in income, and so on.

The researchers also asked respondents about the condition of the mangroves in Sendang Biru Hamlet. This was deemed necessary because knowledge of the condition can be an indicator of concern. The results of the questionnaire regarding this matter are shown in Figure 12.

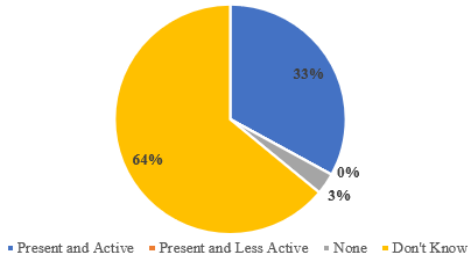


Figure 12. Respondents' Knowledge of Conservation Conditions

Of the 97 respondents, 64% said they were unaware of the conservation conditions in Sendang Biru Hamlet. 3% said there were none. 33% of respondents answered that there were and they were active. They stated that the natural restoration activities by planting mangroves in the Clungup area were quite active and growing due to tourism. Some respondents also stated that there had been mangrove planting during the time of Mr. Darsono's village head, but they were unaware of any subsequent planting. Others stated that there had not been any mangrove planting, but that coral reef planting had occurred, often by university students. Given the high level of community ignorance about conservation, greater efforts should be made to educate the Sendang Biru community about it, which will hopefully have a positive impact on conservation development in Sendang Biru Hamlet.

The researchers also asked respondents questions regarding conservation activities in Sendang Biru Hamlet. The results of the questionnaire are shown in Figure 13.

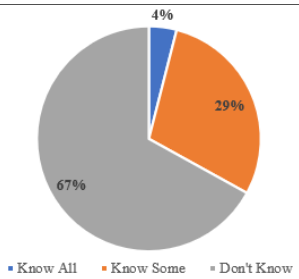


Figure 13. Respondents' knowledge of conservation activities in Sendang Biru Hamlet

Of the 97 respondents, 67% answered "don't know." 29% answered one or two activities, thus categorized as "partially aware." These included beach tourism, mangrove planting, and floating houses. The 4% of respondents who knew all about conservation activities in Sendang Biru Hamlet were tour guides.

Community knowledge regarding conservation activities was comparatively lower. A large proportion of respondents were unable to identify conservation programs that had been implemented in the area, while only a small number were able to mention specific activities such as mangrove planting, coral reef rehabilitation, and ecotourism initiatives. This finding indicates that although local communities are familiar with coastal ecosystems, information regarding conservation programs may not have been distributed evenly across the community [49], [50]. Limited knowledge of conservation initiatives can reduce opportunities for broader public engagement in conservation activities. Therefore, strengthening environmental communication remains important for enhancing community participation in ecosystem management.

The relatively high level of ecosystem knowledge observed in this study is consistent with the close interaction between coastal communities and natural resources. Communities that depend on coastal ecosystems for fisheries, tourism, and daily activities tend to develop greater awareness of environmental resources [51], [52]. However, awareness of ecosystem existence does not necessarily imply an understanding of conservation programs and management objectives. The gap between ecosystem knowledge and conservation knowledge suggests that environmental education efforts should focus not only on ecological functions but also on conservation processes and community involvement [53], [54]. Such efforts are essential for strengthening the social foundations of sustainable coastal ecosystem management.

3.4. Perceptions About the Impact of Conservation on Environmental Conditions or Natural Balance

The results of the calculation of respondents' perceptions regarding the positive impact of conservation on environmental conditions can be seen in Table 2.

Table 2. Calculation of respondents' perception measurements regarding conservation having a positive impact on environmental conditions

Object	Positive impact on environmental conditions	Total	Weight	Score	T Score	Perception
Mangrove Conservation	Agree	66	2	132	164	Positif
	Don't know	31	1	31		
	Disagree	0	0	0		
Coral Reef Conservation	Agree	86	2	172	183	Positif
	Don't know	11	1	11		
	Disagree	0	0	0		

- Mangrove forest conservation has a positive impact on environmental conditions or natural balance.

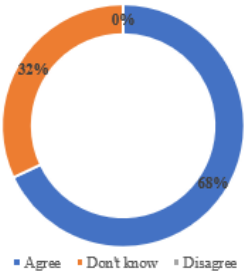


Figure 14. Perception of mangrove forest conservation as having a positive impact on environmental conditions and natural balance

Based on the results of the questionnaire, the majority of respondents (68%) agreed that mangrove conservation has a positive impact on environmental conditions and natural balance. Of these 68%, 33% were aware of the benefits of conservation and mangrove forests, agreeing with this understanding. The remaining 35% were unaware of conservation and its benefits but acknowledged that mangrove forests offer various benefits, particularly for natural balance, and therefore warrant their preservation.

- Conservation of beaches and coral reefs has a positive impact on environmental conditions or natural balance.

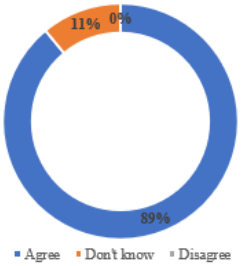


Figure 15. Perception of coastal and coral reef conservation as having a positive impact on environmental conditions and the balance of nature

Based on the results of the questionnaire, the majority of respondents (89%) agreed that coral reef conservation has a positive impact on environmental conditions and the balance of nature. Of these 89%, 33% were aware of the benefits of conservation and coral reefs, and therefore agreed because they were aware. Fifty-six percent of the 89% were unaware of conservation and its benefits but were aware that beaches and coral reefs offer various benefits, both direct and indirect.

Respondents generally perceived mangrove and coral reef conservation as beneficial for environmental quality and ecosystem sustainability. For mangrove conservation, 68% of respondents agreed that conservation activities positively affect environmental conditions and ecological balance. Many respondents associated mangrove conservation with environmental protection, coastal stability, and the maintenance of natural resources. Even among respondents who possessed limited knowledge of conservation concepts, mangroves were still perceived as important for preserving environmental balance. This indicates that ecological values of mangrove ecosystems are widely recognized within the study area [55], [56].

Similarly, perceptions regarding the environmental benefits of coral reef conservation were predominantly positive [57]. Respondents acknowledged the role of coral reefs in maintaining marine ecosystems and supporting fish habitats. Positive environmental perceptions were reflected in the perception scores, where mangrove conservation obtained a score of 164 and coral reef conservation achieved a score of 183, both categorized as positive perceptions. These results demonstrate strong public recognition of the ecological importance of coastal ecosystem conservation [58], [59]. Such recognition represents an important social asset for supporting conservation initiatives.

Positive perceptions of environmental benefits indicate that local communities understand the ecological functions of mangrove forests and coral reefs. Similar findings have been reported in coastal conservation studies where ecosystem services directly experienced by communities tend to generate stronger environmental awareness [60], [61]. In Sendang Biru, environmental experiences associated with coastal protection, fisheries productivity, and ecosystem health may contribute to positive perceptions toward conservation. These perceptions are valuable because they can encourage support for environmental protection measures and strengthen the legitimacy of conservation programs. Nevertheless, positive environmental perceptions alone do not automatically guarantee active participation in conservation activities.

3.5 The Perception That Conservation Has a Positive Non-Economic Impact on the Community

The results of the calculation of respondents' perceptions regarding the positive (non-economic) impacts of conservation on the community can be seen in Table 3.

Table 3. Calculation of respondents' perception measurement regarding the positive (non-economic) impact of conservation on the community

Object	Positive (non-economic) impact on the community	Total	Weight	Score	T Score	Perception
Mangrove Conservation	Agree	42	2	84	115	Positif
	Don't know	31	1	31		
	Disagree	24	0	0		
Coral Reef Conservation	Agree	14	2	28	105	Positif
	Don't know	77	1	77		

	Disagree	6	0	0

- Perception of non-economic impacts on the community from mangrove conservation.

The results of filling out the questionnaire related to this matter can be seen in the graph.

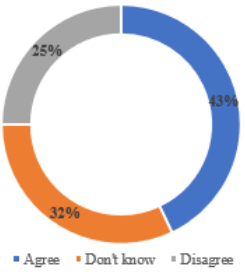


Figure 16. Perception that mangrove forest conservation has a positive non-economic impact on the community

From the results of the questionnaire, the majority of Sendang Biru residents (43%) agreed that mangrove forest conservation has a non-economic impact on the community, while 25% said it had no impact, and 32% said they didn't know. The 43% of respondents who agreed were aware of the benefits of conservation and mangrove forests. They also believed that if mangrove forests were damaged, it would not only impact the balance of nature but also impact humans. The reasons for those who agreed varied, with some citing multiple reasons and others citing a single reason. This was certainly influenced by the respondent's level of knowledge. Some of the reasons cited were as follows: if mangrove forests are damaged, the weather will also become hotter, which will affect the community; if mangrove forests are damaged, landslides can affect nearby residents.

32% of respondents said they didn't know; 23% were unaware of conservation but were aware of the benefits of mangroves. According to 23% of respondents, mangroves are only useful for maintaining the balance of nature, but whether they have an impact on society (non-economic), they are still hesitant to answer whether they agree or not because they admit they don't know. 9% who said they don't know are respondents who don't know about conservation and don't know about mangroves, so they answered they don't know. 25% of respondents who said there is no impact are people who don't know about conservation and don't know about mangroves. These respondents seem to be guessing (one of the principles of perception is guessing) that mangrove conservation has no impact on them.

- Perception of non-economic impacts on communities from coral reef conservation.

The results of filling out the questionnaire related to this matter can be seen in the graph

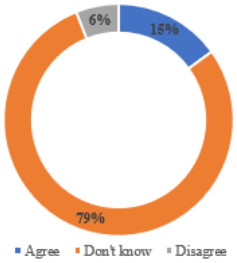


Figure 17. Perception that coral reef conservation has positive non-economic impacts on the community.

Based on the questionnaire, the majority of respondents (79%) were unaware of the non-economic impacts of coral reefs on the community. A majority of respondents were aware of the economic impacts. Respondents who disagreed (6%) stated that they believed coral reefs had no non-economic impacts on the community. Respondents who agreed (15%) argued that when coral reefs are damaged, fishermen have to travel farther to fish, requiring more effort.

3.6 The Perception That Conservation Has a Positive Impact on the Community Economy

The results of the calculation of respondents' perceptions regarding the positive impact of conservation on the community's economy are shown in Table 4.

Table 4. Calculation of respondents' perception measurement regarding conservation having a positive impact on the community's economy

Object	Positive impact on the community's economy	Total	Weight	Score	T Score	Perception
Mangrove Conservation	Agree	6	2	12	68	Negatif
	Don't know	56	1	56		
	Disagree	35	0	0		
Coral Reef Conservation	Agree	64	2	128	159	Positif
	Don't know	31	1	31		
	Disagree	2	0	0		

The respondents' answers regarding whether mangrove conservation has a positive impact on the community's economy can be seen in Figure 5.

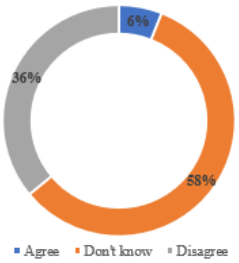


Figure 18. Perception that mangrove forest conservation has a positive impact on the community's economy

The majority of respondents (58%) stated they were unaware that mangrove forest conservation has a positive impact on the community's economy. They hesitated to answer yes or no. Most cited the reason that they were not involved in the matter. Some of those who were unaware said they simply didn't want to pretend to know. Thirty-six percent of respondents who disagreed stated that there was no economic impact from mangrove conservation (it only benefits the environment). Meanwhile, six percent of respondents who agreed stated that mangrove conservation has an indirect economic impact, primarily for fishermen, as mangroves also serve as a breeding ground for fish. In the future, it is possible for communities to supplement their income through crab hunting, but the results of mangrove restoration are currently small-scale, so they are only consumed locally and not yet sold.

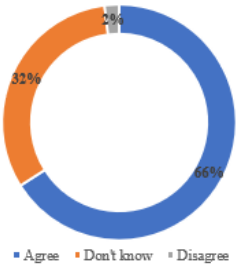


Figure 19. Perception that coastal and coral reef conservation has a positive impact on the community's economy

The majority of respondents (66%) agreed with the statement that coastal and coral reef conservation has a positive impact on the community's economy, particularly for fishermen. The majority of respondents believed that coral reefs are a breeding ground for fish, so the good or bad condition of coral reefs will impact fishermen's income, albeit indirectly. Some respondents also stated that direct economic impacts can be felt, especially by underwater tourism operators such as snorkeling and diving, and those involved in tourism management. The economic impact on the community is less noticeable. 32% of respondents who disagreed stated that they did not know the economic impact of coral reef conservation.

Community perceptions regarding the socio-economic impacts of conservation varied between ecosystem types. For mangrove conservation, only 43% of respondents agreed that conservation generates positive non-economic benefits for society, while 32% were uncertain and 25% disagreed. Respondents who agreed generally believed that environmental degradation would ultimately affect human well-being through increased temperatures, environmental instability, and greater vulnerability to natural hazards. Meanwhile, respondents who were uncertain often acknowledged the ecological benefits of mangroves but were unsure

whether these benefits directly influenced community welfare. This finding suggests that the indirect social benefits of mangrove conservation are not fully understood by all community members.

Perceptions regarding coral reef conservation showed a similar pattern. Most respondents were aware of the economic benefits associated with fisheries resources, yet many had limited understanding of broader non-economic benefits. Approximately 79% of respondents reported uncertainty regarding the non-economic benefits of coral reef conservation, while only 15% agreed that coral reef conservation provides positive social benefits. This result indicates that coral reefs are primarily perceived through their economic contribution rather than their wider ecological and social functions. Consequently, conservation messaging may need to emphasize both direct and indirect ecosystem services provided by coral reefs [62], [63].

The economic dimension also revealed contrasting perceptions between mangrove and coral reef conservation. Mangrove conservation received a negative perception score (T = 68), whereas coral reef conservation obtained a positive perception score (T = 159). This difference suggests that respondents perceived more immediate economic benefits from coral reef ecosystems, particularly through fisheries and marine-based livelihoods. In contrast, the economic value of mangroves may be less visible because many of their benefits are indirect and long-term. Therefore, increasing public understanding of mangrove ecosystem services could help strengthen support for mangrove conservation initiatives [40], [64].

The differing perceptions between mangrove and coral reef conservation highlight the importance of perceived ecosystem services in shaping public attitudes. Communities tend to value ecosystem components that provide visible and direct livelihood benefits. As a result, coral reefs are more readily associated with economic gains than mangrove forests. However, ecosystem services such as coastal protection, nursery habitats, and carbon sequestration also contribute substantially to community welfare, although their benefits are often less apparent [65], [66]. Conservation programs should therefore communicate these hidden benefits more effectively to improve public appreciation of mangrove ecosystems and strengthen long-term conservation support.

3.7 The Impact of Perception on Agreeing or Disagreeing with the Existence of Mangrove and Coral Reef Conservation

The results of the calculation of respondents' perception measurements regarding whether they agree or disagree with the existence of conservation are shown in Table 5.

Table 5. Calculation of respondents' perception measurement regarding whether they agree or disagree with the existence of conservation

Object	Agree with its existence	Total	Weight	Score	T Score	Perception
Mangrove Conservation	Agree	83	2	166		
	Reluctant to answer	14	1	14	180	Positif
	Disagree	0	0	0		
Coral Reef Conservation	Agree	83	2	166		
	Reluctant to answer	14	1	14	180	Positif
	Disagree	0	0	0		

Whether or not the community agrees with the existence of this conservation area will certainly have a significant impact on its sustainability. At the very least, even if they aren't yet willing to participate in conservation activities, they won't disrupt or threaten its continued existence.

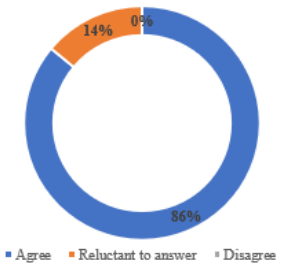


Figure 20. Impact of perception on agreement or disagreement regarding the existence of conservation

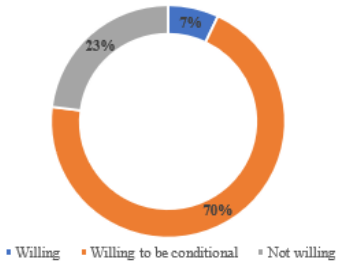
From this graph, we can see that 86% of respondents agree with nature restoration and conservation activities. As long as they have a positive impact and are not detrimental, the public will certainly agree. Although no respondents directly disagreed, 14% of respondents said "don't know," seemingly reluctant to answer the question.

3.8 The Impact of Perception on Willingness to Participate in Conservation Activities

The results of the calculation of respondents' perception measurements regarding their willingness to participate if there are conservation activities are shown in Table 6.

Table 6. Calculation of respondents' perception measurements regarding their willingness to participate if there are conservation activities.

Object	If there are conservation activities, I am willing to participate.	Total	Weight	Score	T Score	Perception
Conservation	Willing	7	2	14	82	Negatif
	Conditionally willing	68	1	68		
	Not willing	22	0	0		



Gambar 21. Kesediaan berpartisipasi jika ada kegiatan

From the graph, we can see that very few respondents, at 7%, answered that they were willing to participate. 23% of respondents openly answered that they were not willing. Meanwhile, the majority of respondents (70%) answered that they were willing if they had free time and were not busy, or could be said to be "conditionally willing." From the review above, we can see that public perception is generally positive towards conservation in Sendang Biru Hamlet, except for perceptions related to the economic impact of mangroves, which are negative. The majority of respondents agree with the existence of conservation in Sendang Biru Hamlet and the benefits of these activities. Willingness to participate in activities is greatly influenced by whether the activity has a direct economic impact on them or not.

The survey revealed strong public support for the existence of conservation programs in Sendang Biru. A total of 86% respondents agreed with the continuation of conservation initiatives, while the remaining respondents were hesitant to express an opinion, resulting in a positive perception score of 180. No respondents explicitly opposed the existence of conservation programs. These findings indicate that conservation activities have gained social acceptance within the community and are generally viewed as beneficial. Community support provides an important foundation for the long-term success of conservation efforts [27], [67].

Despite this strong support, willingness to participate directly in conservation activities remained relatively low. Only 7% respondents expressed unconditional willingness to participate, while most respondents indicated conditional participation and 23% respondents stated that they were unwilling to participate. The resulting perception score was 82, which was categorized as negative. This result demonstrates a discrepancy between positive attitudes toward conservation and actual willingness to engage in conservation activities [68], [69]. The gap between support and participation represents one of the most important findings of this study.

The findings reveal an awareness–participation gap within the study area. Although most respondents recognize the importance of conservation and support its continuation, relatively few are prepared to become actively involved in conservation activities. Similar patterns have been documented in environmental conservation studies where positive attitudes do not necessarily translate into conservation behavior [70], [71]. Several factors may explain this discrepancy, including limited time, economic priorities, insufficient incentives, and restricted access to conservation programs. Therefore, conservation strategies should move beyond awareness-building and focus on strengthening participatory mechanisms that encourage active community involvement [72], [73]. Enhancing environmental education, community empowerment, and collaborative governance may help transform positive perceptions into meaningful conservation actions.

3.9 Implications for Sustainable Coastal Ecosystem Management

The findings of this study have important implications for sustainable coastal ecosystem management in Sendang Biru. The generally positive perceptions of mangrove and coral reef conservation indicate that local communities already recognize the ecological significance of these ecosystems and support efforts to protect them [46], [74]. This favorable perception constitutes a valuable form of social capital that can facilitate the implementation of conservation programs and environmental management policies. However, the limited willingness of community members to actively participate in conservation activities suggests that conservation

awareness alone is insufficient to ensure effective ecosystem stewardship [75], [76]. Therefore, future coastal management strategies should focus not only on increasing environmental knowledge but also on creating opportunities that encourage meaningful community engagement in conservation practices.

The observed gap between conservation support and active participation highlights the need for more inclusive and participatory management approaches in Sendang Biru. Sustainable coastal ecosystem management requires collaboration among local communities, government agencies, conservation organizations, and other stakeholders to strengthen community involvement in conservation decision-making and implementation. Community-based conservation programs, environmental education initiatives, capacity-building activities, and incentive mechanisms could be developed to enhance public participation and foster a stronger sense of ownership toward coastal resources [77], [78]. Such approaches are particularly important because the long-term sustainability of mangrove forests and coral reefs depends not only on ecological interventions but also on the active commitment of local communities. By transforming positive conservation perceptions into concrete conservation actions, coastal management efforts in Sendang Biru can contribute more effectively to ecosystem resilience, biodiversity conservation, and the sustainable use of coastal resources.

4. CONCLUSION

This study shows that the coastal community of Sendang Biru has a positive perception of mangrove and coral reef conservation, particularly regarding their ecological functions and benefits for ecosystem sustainability. However, community participation in conservation activities remains relatively low, resulting in a gap between awareness and actual involvement. This situation suggests that sustainable conservation depends not only on increasing awareness but also on strengthening mechanisms that encourage active community participation. Further research is recommended to examine the social, economic, and institutional factors that specifically influence low community participation in conservation activities. Furthermore, future studies could evaluate the effectiveness of various participatory approaches or incentive programs in increasing direct community involvement in coastal ecosystem management.

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AUTHOR CONTRIBUTIONS

Conceptualization, R.H. and C.T.; Methodology, R.H.; Software, R.H.; Validation, R.H. and C.T.; Formal Analysis, R.H.; Investigation, R.H.; Resources, R.H.; Data Curation, R.H.; Writing – Original Draft Preparation, R.H.; Writing – Review & Editing, C.T.; Visualization, R.H.; Supervision, C.T.; Project Administration, R.H.; Funding Acquisition, C.T.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

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