Degradation of Mangrove Ecosystem in Karimunjawa Island Based on Public Perception and Management

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Degradation of Mangrove Ecosystem in Karimunjawa Island Based on Public Perception and Management

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Abstract

The condition of mangrove ecosystem in Karimunjawa island which is degrading arises the questions concerning its causes. This research aimed to study the perception of the society concerning the degradation of mangrove ecosystem in Karimunjawa island, its causes, as well as to formulate the management solution to support its sustainability. The research was conducted in August 2017 and March 2018 in Karimunjawa island. Data was collected by questionnaire involving local society as the respondents. The result showed that 59.40% of the respondents agreed that mangrove ecosystem in Karimunjawa island is degraded. The causing factors including fishing activities (48.12%), mangrove logging (59.40%), increasing population (60.90%), development of aquaculture facilities (48.87%), development of ponds (61.65%), aquaculture activities (51.13%), and development of tourism facilities (39.10%). Analysis of correlation showed weak relations, where the coefficient of correlations was less than 50%. The awareness of the local community and the tourist to the condition of mangrove ecosystem was poor. However, the tourist has better interest to participate in the mangrove conservation activity. The suggested management strategy to support mangrove conservation is by developing mangrove eco-tourism.

Keywords: degradation, mangrove, management, fisheries, perception, tourism

1. INTRODUCTION

Mangrove ecosystem as one of the coastal ecosystems has important role both ecologically and economically. Ecologically, mangrove plays a role in maintaining the stability of coastal environment [1]. Through the environmental services it provides, mangrove could control the erosion and sedimentation rate in the coastal area, thus the coastal plain don't get eroded by the wave [2]. Moreover, the function also has an impact on the cleaner coastal waters, ensure the nutrient supply which supports seagrass and coral ecosystems around it [3]. Mangrove forest also has important role as habitat of various organisms, both terrestrial and aquatic [4]. Thus, mangrove supports the biodiversity of coastal area.

Another important role which is related to human livelihood in the coastal area is in controlling sea water intrusion [5]. It has important implication in providing freshwater for the community which lives in the coastal area. Various resources which are produced directly or indirectly by mangrove ecosystem can not be neglected as well, such as fish resources [6,7], timber production [8] and fruit products [9] which can be utilized as food sources as well as to support the civilization of human in the coastal area.

Small island is vulnerable to ecosystem dynamics, especially in the inhabited islands [10–12]. Excessive exploitation of small islands could cause structured damage to the ecosystem. However, mangrove ecosystem has important role in maintaining the stability of coastal area [13]. Small islands which are surrounding by sea along with the tidal and wave dynamic tend to be vulnerable to high erosion rate [14,15].

The development of mangrove ecosystem in the small islands show the change of coastal sediment structure caused by the increasing concentration of clay. The rock in the coastal area

generally gets weathered and crumbled into sand, thus mangrove plays major role in protecting the coastal area. Unfortunately, mangrove ecosystem in the inhabited small island is generally degraded due to the irresponsible utilization [13].

Generally, mangrove ecosystem in the small island is threatened. This is caused by the high exploitation level, both to the mangrove land and vegetation [16]. In fact, as an ecosystem mangrove provides great supports to the community of small island [17–19]. A lot of mangrove forest has been deforested for the development of settlements, aquaculture and agriculture [20]. While mangrove woods are utilized as building materials, boats and firewood [21]. Thus, mangrove forests are destructed leading the decrease of its carrying capacity in maintaining the coastline and supporting the fisheries resources.

Karimunjawa is a small island in the territorial waters of Jepara Regency, Province of Central Java with intensive utilization level. The beauty of Karimunjawa waters become the tourism interest of domestic and international tourists. As the impact, land utilization for the development of tourism infrastructure was increased [22]. Moreover, mangrove ecosystem became the most affected area [23].

Even though Karimunjawa archipelago has become a popular tourism destination, but the perception of the local community and the tourists concerning the existing condition of natural resources remains unknown, especially regarding mangrove ecosystem. This research aimed to understand the perspective of the local community regarding the degradation of mangrove ecosystem in the Karimunjawa island, the cause of damage, to study the knowledge and willingness to participate of local community and tourists in the conservation of mangrove ecosystem and to formulate the management strategy of mangrove ecosystem.

2. METHODS

This research was conducted in two periods. The first period was conducted in August 2017 while the second period was conducted in March 2018. The research instrument utilized in this research was questionnaire. The respondents occupied in this research were the local community of Karimunjawa island and the tourists. Data collection was conducted through door to door interview for the local community and incidental interview to the tourists. The questionnaires included 11 questions related to the degradation of mangrove ecosystem and 5 questions related to the knowledge and willingness to participate of the respondents in mangrove conservation. The Likert scale was utilized in the data collection of community's perspective, including three agreement states: (1) disagree; (2) doubt; and (3) agree.

The collected data was then tabulated and presented descriptively to describe the proportion of community's perception of the degradation of mangrove ecosystem in Karimunjawa island. Statistical analysis used in this research was cross-tabulation with chi-square test and correlation test. Validity and reliability test was conducted to fulfill the statistical rule. Chi-square test was conducted to understand the distribution differences of respondent's perception. Cross-tabulation also provides the information about the domination of respondent's perspective. Further analysis was conducted through bivariate correlation test to prove the relationship of the mangrove degradation toward its causes. Literature study was conducted to formulate the management strategy in order to achieve sustainable and integrated management plan in Karimunjawa island.

3. RESULTS

Data collection obtained as many as 133 respondents in the first period, while in the second period there was 198 respondents, including 98 respondents from the local community and 100 respondents from the tourists. Detailed proportions of the respondent's perception on the mangrove condition and the cause of degradation obtained from the data collection in the first period is presented in Table 1.

Table 1. Proportions of respondents' perception on the mangrove condition and its degrading cause

No.	Variable	Statement	Proportion of Answers (%)		
			Disagree	Doubt	Agree
1.	Y	The mangrove ecosystem in Karimunjawa islan has been degraded?	19,55	21,05	59,40
2.	X1	Some of the fishermen does fishing activity in the mangrove area.	40,60	39,10	20,30
3.	X2	The increased fishing activity causes degradation of mangrove ecosystem.	27,82	24,06	48,12
4.	X3	Some of the fishermen gather mangrove wood for firewood.	41,35	21,05	37,59
5.	X4	Some of the fishermen cut mangrove trees for sale which cause disturbance on the function of mangrove forest.	15,04	25,56	59,40
6.	X5	Increasing population in the coastal area has caused the extention of settlements and ponds toward mangrove ecosystem, resulted the destruction of mangrove forest.	21,05	18,05	60,90
7.	X6	The development of infrastructure for aquaculture has caused the degradation of mangrove ecosystem.	20,30	30,83	48,87
8.	X7	The development of ponds in the coastal area has caused the decrease of mangrove coverage.	6,02	32,33	61,65
9.	X8	Aquaculture activity affected the ecological function of mangrove ecosystem due to increasing pollutant loads.	18,05	30,83	51,13
10.	X9	The development of offshore inns (guesthouses) contributes the degradation of mangrove ecosystem.	38,35	33,08	28,57
11.	X10	The development of tourism facilities has caused degradation of mangrove ecosystem.	28,57	32,33	39,10

According to the information obtained from the questionnaire, 59.4% of the respondents agreed that the condition of mangrove ecosystem in Karimunjawa has been degraded. Several activities contribute to the degradation were including: increased fishing activity (48.12%), mangrove logging (59.40%), increasing population (69.90%), development of infrastructure for aquaculture (48.87%), development of ponds (61.65%), aquaculture (51.13%), and development of tourism facilities (39.10%).

Validity test for the first observation data showed that there was one invalid item for item X7. The reliability test of the valid items showed that the items were reliable and could be used for further analysis. Thus, only 10 items could be used for bivariate correlation analysis. The analysis result is presented in Table 2.

Table 2. Correlation of activities in Karimunjawa island with degradation of mangrove ecosystem

No.	Items	Factor	Pearson Correlation
1.	X1	Fishing activity in the mangrove ecosystem.	,211*
2.	X2	Increased fishing activity.	,371**
3.	X3	Wood gathering for firewood.	,331**
4.	X4	Mangrove logging.	,403**
5.	X5	Increased human population.	,266**
6.	X6	Development of aquaculture infrastructure.	,241**

7.	X8	Aquaculture activities (fish farming).	,353**
8.	X9	Development of offshore inns (guesthouses)	,200*
9.	X10	Development of tourism facilities.	,376**

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Analysis of correlation showed there are several activities that have significant correlation with the degradation of mangrove ecosystem although the correlation levels were weak. Mangrove logging has the strongest correlation with mangrove degradation with 40.3%. The development of tourism facilities gets the second rank with the coefficient of 37.6%, followed by fishing activities with 37.1%. Aquaculture activity is the next correlated activity with 35.3%, followed by wood gathering for firewood with 33.1%. Other than the mentioned activities, the correlation coefficients were below 30%. However, among the observed activities, the increased community's activity and the development of tourism accessibility were not significantly correlated with the degradation of mangrove ecosystem.

The data obtained from the second observation was valid and reliable. Data includes the knowledge of local community and tourists regarding mangrove ecosystem. Detailed respondents' perception is presented in Table 3.

Table 3. Knowledge and willingness to participate in mangrove conservation of local community and tourists

No.	Item	Statement	Local Community			Tourists		
			No	Doubt	Yes	No	Doubt	Yes
1.	Z1	Know about mangrove ecosystem / vegetation.	17.35%	43.88%	38.78%	9%	50%	41%
2.	Z2	Know about mangrove specieses.	10.20%	40.82%	48.98%	18%	54%	28%
3.	Z3	Understand the advantages of mangrove ecosystem.	18.37%	46.94%	34.69%	13%	44%	43%
4.	Z4	Understand the impact of mangrove ecosystem degradation.	19.39%	60.20%	20.41%	14%	65%	21%
5.	Z5	Willing to participate in the conservation activity of mangrove ecosystem.	72.45%	18.37%	9.18%	43%	19%	38%

Analysis on the knowledge of local community and tourists showed that both groups of respondents has poor knowledge regarding mangrove ecosystem. Cummulatively, only 39.9% of the respondents knows about mangrove ecosystem. Statistically, there was no significant difference between the knowledge of the respondents of local community and tourists in Karimunjawa island regarding mangrove ecosystem.

Observation on the knowledge of mangrove species showed that local community has better knowledge than the tourists. The proportion of local community with appropriate knowledge of mangrove species was 49.0%, while only 28.0% of the tourists know the mangrove species properly. Statistical analysis proved that there was significant difference between the knowledge from the two groups of respondents.

The knowledge of the respondents on the advantages of mangrove ecosystem was generally low. Statistical analysis proved that there was no significant difference between the knowledge from the two groups of respondents. Cummulatively, only 38.9% of the respondents know about the advantages of mangrove ecosystem, while the partial proportions were 34.7% and 43.0% respectively for local community and tourists.

The knowledge of the respondents regarding the impact of mangrove degradation was very poor. The proportion of local community that know the impact was only 20.4%, while the tourist was

only a little higher with 21.0%. Chi-square analysis showed that the two groups of respondents did not have significant difference in knowledge regarding the impact of mangrove degradation.

Regarding the willingness to participate on the conservation of mangrove ecosystem, there was obvious differences, were the proportion of local community who wills to participate wa only 9.2%, while the tourists had the proportion of 38.0%. However, the proportion of the respondents who don't will to participate was still huge, including 72.4% of the local community and 43.0% of the tourists. This result is surprising since most of the respondents do not want to support the conservation of mangrove. Significant difference of the two groups of respondents was proven from the statistical analysis.

4. DISCUSSION

Degradation of mangrove ecosystem occurs almost in the whole world. The cause of the damage varies, due to natural phenomena as well as the impact of human activities. However, the degradation caused by human activities is generally dominant. Moreover, the natural phenomenas which are generally assumed as the cause of mangrove degradation are also resulted by human activities indirectly through the accumulated impact of human activities.

Based on the result of data analysis, according to the respondents' perspective the development of pond in the Karimunjawa island was the most dominant factor which affect the reduced coverage of mangrove forest. However, the coastal ponds are generally developed on mangrove forest through land conversion (mangrove clearance) [24,25]. In order to do that, mangrove forests were clear cut and excavated to build ponds. Preferred organism for the pond was tiger shrimp [26–28]. Unfortunately, the validity test showed that this item was not valid, thus it can not be proved wether it has significant correlation to the degradation of mangrove ecosystem.

Conversion of mangrove area for brackish water ponds contributed the most dominant cause of mangrove degradation in most regions in Indonesia, even in the world [25,27]. Mangrove forests provide suitable environment to support aquaculture activities due to its carrying capacity. Unfortunately, the extensive conversion of mangrove for ponds caused the significant reduction of mangrove forest. Indeed, the existence of mangrove is required to protect the coastal area and to provide environmental services which support pond productivity and neutralize pollutant from pond effluent [29]. The loss of mangrove ecosytem in the coastal area increases the rate of erosion and accumulation of pollutants which lead to the decrease of pond productivity [30]. As the impact, coastal ponds are abandoned while the fish resources are depleted [31].

The increasing population in Karimunjawa is acknowledged by the respondents. Most of the respondents agreed that the increasing population has altered the damage of mangrove ecosystem due to the expansion of settlements and ponds development [32]. Increasing population would lead to the increase of land, infrastructure, and building materials to develop the settlements. Land conversion for settlements is the only choice for the community. However, it may cause the degradation of mangrove ecosystem. Accessibility to sea as the main source of livelihood becomes the important consideration in the determination of settlement's location [33,34]. Thus, mangrove ecosystem becomes the potential area to be utilized.

Mangrove cutting has been conducted for various purposes, including for timber production and land provision for another utilization. According to the result, most of the respondents agreed that mangrove logging also occurred in Karimunjawa island. The distance of Karimunjawa island is pretty far from the main islands which caused limited supply of logistics and energy. However, the isolated community generally utilized traditional methods to fulfill their needs. Wood plays important role in the culture of traditional community, such as for house material, boat material, furnitures, as well as firewood [8]. To fulfill the needs, they prefer to obtain it from the nearby locations. In Karimunjawa island, most of the community lives in the coastal area in where mangrove ecosystem existed, thus the most potential source of wood is from mangrove trees. Thus, the utilization of mangrove woods is dominant.

Concerning the aquaculture activity, most of the respondents agreed that aquaculture has an impact on mangrove ecosystem. Aquaculture activity in the coastal area is always related to mangrove ecosystem for the whole processes, from land preparation to the maintenance. Preparation of land is generally conducted through mangrove clearing and the development of ponds [35]. Ecologically, the activity causes significant change on the coastal environment, including the ecological function of mangrove, biodiversity and increasing salt water intrusion [16,30]. The utilization of mangrove ecosystem in the small island causes more emphasized impact due to the limitation of land resources.

During the growing activity, fish/shrimp culture produces effluent from the food residues and faeces which is generally discarded to the coastal environment without any treatment [36]. Thus, the coastal ecosystem becomes more vulnerable to the increase of pollution. It also increases the vulnerability of coastal ecosystems degradation, including coral reefs and seagrass ecosystems which are more sensitive to pollutant accumulation [37].

To support the aquaculture activities, some infrastructures and facilities need to be developed such as roads, water canals and transportation. According to the respondents' perspective, the development of aquaculture infrastructures and facilities also has a contribution on the degradation of mangrove ecosystem. The development causes the change of land-use and hydrological pattern of coastal environment [29].

Even though fishing activity is not conducted in the mangrove area, but it appears to have some indirect impact on the degradation of mangrove ecosystem. It is shown by the respondents' perception. Some of the traditional fishing methods were known to utilize mangrove twigs in the fishing activity. Moreover, some mangrove plants also have good wood quality which is often used in boat making [38]. Thus, the fishing activity may contribute to the degradation of mangrove ecosystem.

Some respondents also considered that the development of tourism facilities also has som impacts on the degradation of mangrove ecosystem. Generally, the development of tourism facilities has similar impact as the development of settlements. Several facilities such as homestays, road, restaurants as well as transportation means both on land and at the sea are improved to fulfill the needs of the tourists [4,39]. The impact of this development is the change of land use in the coastal area.

Tourism activities in Karimunjawa archipelago have been lasted for a long time and has provided significant contribution in the regional development, both economically and ecologically. In order to maintain the sustainability and carrying capacity of Karimunjawa island, public awareness is required especially the local community and the tourists since both are the main stakeholders in the management of Karimunjawa island. Thus, the knowledge and interest of both groups concerning the sustainability of mangrove ecosystem in Karimunjawa island need to be known.

Generally, both local community and tourists do not really know about mangrove ecosystem. However, the knowledge of local community concerning the species of mangrove is better than the tourists. It could be due to the local community generally acknowledge mangrove as "bakau". In the meanwhile, the tourist's knowledge about mangrove is generally poor, since most of the come from the city where mangrove is not common scene.

Both local community and tourist have poor knowledge regarding the advantages of mangrove ecosystem as well as the impact of its degradation. It showed that both groups of respondents were unaware to mangrove ecosystem in Karimunjawa island. This could be due to the main tourism interest was dominant in the water area [40], while tourism interest on the land area, especially in the mangrove ecosystem is very limited.

Tourism activity in the archipelago is generally prioritized on the coral reef ecosystem or beaches of the surrounding islands [41]. As the impact, the main island only works as the transit area or tourism base. Thus, both local community and the tourists pay less attention to the condition of the main island. The local community also gets involved in the tourism activities more than the other typical activities, such as fishing, farming, fish culture or wood gathering [42].

The development of Karimunjawa island as tourism area has supported the acceleration of goods and services distribution. Thus, various logistic materials could be obtained trough trading activities. However, it has positive and negative impacts to the mangrove ecosystem [42]. The positive

impact is the decreased mangrove logging for building materials as well as for firewood. While the negative impact is the reduced interaction between the community and mangrove ecosystem, thus the changes that occur in the mangrove ecosystem are not well monitored.

The interest of local community and the tourist to participate in the mangrove conservation activity was different significantly. The willingness to participate in the mangrove conservation of the local community was poor. Meanwhile, the respondents of the tourist group have significantly better interest to participate.

The low participation interest of the local community in Karimunjawa island was caused by their poor knowledge about the advantages of mangrove ecosystem and the impacts of its degradation. Moreover, mangrove conservation doesn't provide direct economic advantage to the community, thus they are not interested to participate [43]. The reluctance to participate in the conservation activity is emphasized by the development of tourism activities in Karimunjawa. The development of tourism activity slowly shifts the employment of the local community, which is previously dominated by fishermen to the tourism related business, such as homestay, transportation, souvenir, food, etc [42].

The management of coastal and small island resources is dependent to the participation of the surrounding community [44], moreover on the small islands which are more vulnerable to degradation. Unfortunately, the awareness of the community regarding the vulnerability of small islands and its sustainability is poor. The increasing exploitation as the impact of economic oriented activities frequently disobeys the ecological sustainability [40].

In the Karimunjawa island, the economic growth is supported by the development of marine tourism activities [42]. As the impact, the land ecosystem is ignored. This is shown by the decreasing mangrove coverage. Moreover, the condition of existing mangrove coverage is disturbed. Ecological stress due to massive land conversion for various purposes along with active mangrove clearance becomes the main factors which contribute the degradation of mangrove ecosystem [17].

One of the general effort to recover the condition of mangrove ecosystem is through mangrove replanting [30]. However, this effort requires the awareness of the local community concerning the importance of mangrove ecosystem [43]. Thus, the participation of the community should be improved. Unfortunately, the community's interest to participate the mangrove conservation is poor. This could be a serious problem since the awareness and participation of the community is required in order to obtain successful conservation effort.

Local community has key role in the mangrove conservation activity [45], since they are the main user of the products and services provided by mangrove ecosystem. Low participation of local community may lead to the poor planting, maintenance, monitoring and evaluation effort in terms of mangrove conservation. Without the awareness of the community, the planting might be useless ever since the utilization activity keeps going.

Education concerning the importance of mangrove ecosystem needs to be provided for the community to improve their knowledge [46]. However, it is not easy to be done. However, since the interest of the tourist to participate in the mangrove conservation is pretty high, thus the conservation effort could be conducted through tourism approach [40]. Thus, local community would be forced to actively participate in the mangrove rehabilitation effort. Various activities, such as tracking, boating, canoeing, planting, and fishing could be developed as tourism interests [47].

Conservation activity which involves tourism approach has been conducted in many countries in the context of eco-tourism [39,48]. Especially for mangrove eco-tourism, the development of infrastructure and facilities could be conducted progressively considering the sustainability of mangrove ecosystem. In the other side, the involvement of tourist in the conservation activity might indirectly affect the maintenance effort of the existing mangrove forest. Through the utilization of mangrove as eco-tourism interest, monitoring activity could be conducted every time through the involvement of the mangrove visitors.

5. CONCLUSION

The local community of Karimunjawa island considered that the mangrove ecosystem has been degraded due to various human activities, including the development of ponds, increasing population, mangrove logging, aquaculture, development of aquaculture infrastructure, fishing and the development of tourism facilities. Local community and the tourist have poor knowledge about mangrove ecosystem, its advantages as well as its degradation impacts. Moreover, both local community and the tourist have poor interest to participate in the mangrove conservation effort, even though the tourist has better interest to participate than the local community. The proposed applicable solution to maintain the sustainability of mangrove ecosystem in Karimunjawa is through the utilization of mangrove as eco-tourism interest.

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