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Changes in the Coastal Ecosystem of Sabang Island, Indonesia

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Abstract

The research was conducted on the island of Sabang. The method used is a survey and study of literature by using a questionnaire and analyzed using content analysis. The results showed that changes in ecosystems in Sabang Island due to the exploitative use of coastal resources. Changes in ecosystems impact on the lives of fishermen. Changes in ecosystems seen from damage to mangroves and coral reefs. Changes in mangrove ecosystems caused by pollution of tourism industrial waste, the opening of Fish and shrimp ponds, logging for building materials, household waste disposal, diversion of freshwater inflow and disarrayed by a tsunami. Changes in coral reef ecosystems are caused by fish bombings, industrial waste disposal, fishing with toxic materials, ship anchor disposal, coral reef dredging and tsunami disasters. The socio-economic impacts of coastal ecosystem changes are the decline in the number and diversity of fisherman catches, the loss of wood supply, the difficulty of determining fishing areas, coastal pollution, disrupting the regeneration of fish and marine life, ecosystem degradation and changes in fish migration patterns.

Keywords: ecosystems; mangrove; coral reefs; Sabang Island.

1. Introduction

Indonesia is an archipelago country consist of 13,667 islands and has coastal area of 54,716 kilometers. Indonesia coastal ecosystem has a high level of threats.

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The highest threats come from human activities (anthropogenic), i.e. Overfishing and destructive fishing, drainage basin pollution, and infrastructure development. Damages and threats could incur losses up to billions of dollars [1]. The damage is caused by resource utilization pattern which tends to be very extractive and dominated by short-term economic interests and considerations [2]. Rapid exploitation of natural resources in fact continues to be developed towards economic utilization. It has an impact on the declining of environmental quality which impact on the deterioration of human life quality [3]. The society is the weakest party in terms of access and control over natural resources, thus almost always experiencing the process of marginalization as well as vulnerable to various forms of environmental degradation [4]. Population growth and economy have led the increasing of demand for coastal region's ecosystem. As a result, there are indications of overcapacity of coastal and marine ecosystems, such as pollution, overfishing, physical degradation of coastal habitats, and coastal abrasion [5]. The cause of coastal area damage is the uncontrolled economic activity and the low awareness of the importance of coastal natural resource conservation among the perpetrators [6]. Ecosystem change is change that occur in the entire biotic and abiotic components in the sea and coast as a direct or indirect result of human activity. These changes resulted in negative impacts on the resources contained and the physical aspects of the oceans [7]. Generally, coastal ecosystem change occurs due to natural disasters, such as floods, hot lava or cold lava, volcanic eruptions, earthquakes, tsunami waves, and others. Sabang Island is an island located in Aceh province, Indonesia. The island of Sabang is the zero point Kilometer Country of Indonesia located at 05° 46' 28" S - 05° 54' 28" S and 95° 13' 02" E - 95° 22' 36" E. Most people in Sabang are highly dependent on marine resources, especially those from the reef and mangrove ecosystems. Over-utilization has resulted in the decreasing of coral and mangrove ecosystems function, as well as socio-economic problems caused by low public awareness in Sabang. The damage affects both ecologically and economically. Economically, it affects on fishermen fish catch in Sabang. Ecologically, it affects ecosystem sustainability. Therefore, this study needed to be conducted to see the influence and impact of ecosystem change in coral reef and mangrove ecosystems toward the fishermen on Sabang Island. The purpose of this study was to analyze the impact and cause of coastal ecosystem damage in Sabang. This study was expected to provide recommendations for solving socio-economic and environmental problems of coastal communities and creating sustainable ecosystem management in the Sabang coastal area.

2. Methods

The research was conducted on April to June 2017 at Iboih Village, Sukakarya Sub-district, Sabang City, Aceh Province, Indonesia. Research was done using literature review and survey methods. Data are collected in the form of primary and secondary data. Primary data was collected by questioner-based interviews, focused group discussion (FGD) and in-depth interview. Questioner-based interview was conducted to 90 local fishermen. Accidental sampling and snowball sampling method was applied for selecting respondents. FGDs were conducted with local fishing groups.

In-depth interview was conducted by several local leaders. Secondary data were obtained from the relevant agencies and departments concerned with marine and fisheries Aceh, and research reports. Furthermore, the data were analyzed descriptively to give an overview of the ecosystem condition, the cause of ecosystem changes and the impact of ecosystem changes on fishermen in Sabang Island.

3. Results and Discussion

3.1 History Context of Ecosystems Change in Sabang

Coastal ecosystem change of Sabang have began since World War II, where Sabang became the most important port city in Southeast Asia. The Sabang port at that time was named Kolen Station, built by the Dutch since 1881. In 1887, the Dutch obtained authority through Delange Company, assisted by Sabang Haven to add and build port facilities and supporting tools. Sabang free port era started in 1895, managed by Maatschaappij Zeehaven en Kolen Station, later known as Sabang Maatschaappij. World War II affected Sabang condition, where in 1942 Sabang was occupied by Japanese troops, then Sabang coastal area was bombed by the Allied war so that most of the coastal area was damaged and the free port was forced to close. In the early days of Indonesian independence, Sabang became the center of navy defense of the United States of Indonesia (RIS) with full authority from the government through the decree of the Ministry of Defense RIS No 9/MP/50. All Sabang Maatschaappij port assets were purchased by Indonesia Government. Then in 1965, the government of Sabang Municipality was formed and the initial idea to reopen the Free Port and Free Trade Area was initiated. But it finally closed in 1986. After the free port status was revoked by central government around 1985. People's lives underwent drastic changes. The society lost their livelihood in trade and service sector, turning their professions into fishermen. Fishermen became a promising alternative to work because marine and coastal resources were available abundantly. Fishing conducted in an environmentally unfriendly manner such as bombing and using toxic materials which caused damage in marine ecosystem. The new era of Sabang, when the issuance of Government Regulation in lieu of Law no. 2 of 2000, September 1, 2000 and subsequently ratified as Law Number 37 Year 2000 on Sabang Free Trade Area and Free Port. Ecosystem change in Sabang region was continued by the entry of several ornamental fish producer companies in early 2000. People began to hunt ornamental fish for sale, and fishing in an environmentally unfriendly way made most of the coral reef became damaged. Not only coral reef, mangrove ecosystem also began to thin out due to the development around the coast. Continued in 2001, the society began to open cultivation of shrimp and fish on a large scale through the company. These activities, then destroyed hectares of mangrove in Sabang. After one year of running, it did not produce any result. Finally, in 2002 the ponds that originally became a breeding ground for milkfish and shrimp were abandoned by the owners. Sabang Free Port and Free Trade activities in 2002 started to operate with the entry of stuffs from abroad. But in 2003 this activity stopped because Aceh was designated as a Military Emergency Area. Then, at the end of 2004 Tsunami was occured which resulting Sabang east coastal area damaged severely. Most of mangrove ecosystems and coral ecosystem are damaged. Post tsunami, mining companies followed by the establishment of a special transport port were emerging. Sabang has several types of minerals such as geothermal (Jaboi area), copper, sand, gamping/limestone/marmar, granite and other materials. The existence of natural resources has triggered illegal miners without any environmental permit process. Mining activities have damaged most of the coastal environment. Environmental damage has caused negative impacts, in the form of production of hazardous waste for other environmental elements. These conditions have affected most of the fishing activities on Sabang Island.

3.2 Ecosystem change

Environmental change could not be understood separately from political and economic context in which the problem arises [4]. Coast and ocean are the areas that rich in natural resources which are very useful for human benefit. Coastal ecosystem change affected the society around. Ecosystem change is the effect of human and nature interactions, which taking place in exchange context. These processes involve energy, matter and information provided by both parties (both interacting systems). Nature and human systems give energy, materials and information to one another in different numbers and shapes [8]. The form of ecosystem change that occured in Sabang coastal area studied in this study were change in mangrove ecosystem and change in coral reef ecosystem.

3.2.1 Mangrove Ecosystem Change

The existence of mangrove in coastal area had a strategic role. This ecosystem has a role in ecological, socio-economic and socio-cultural which important in maintaining coastal stability from abrasion; fish, shrimp and other diversity; firewood and timber source; and had conservation, education, eco-tourism and Cultural identity function. Mangrove distribution in Sabang coastal could be found in Paya, Keuneukai, Beurawang, Jaboi, Balohan, Cot Abeuk, Cot Ba'u villages, as well as in several villages around coastal area such as Anoi Itam, Ujong Kareung and Ie Meulee and in Kecamatan Sukakarya such as Iboih, Batee Shok, Paya Seunara, Krueng Raya, Aneuk Laot, Kota Bawah Timur, Kota Bawah Barat, and Kota Atas. The damage of this mangrove ecosystem itself was also recognized by fishermen. A total of ninety respondents were interviewed, 48 respondents (53,3%) stated that the condition of mangrove ecosystem was currently in bad condition, 23 respondents (25,6%) stated it was in very bad condition, and 19 respondents (21,1%) stated it was in good condition.

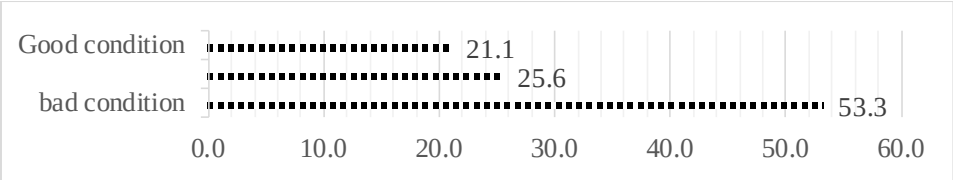

Figure 1: Perception of a respondent to a condition of the mangrove ecosystem.

A total of 71 fishermen respondents (78,8%) stated that the damage of mangrove ecosystem was poor and very bad, 12 respondents (16,90%) stated that ecosystem change caused by pollution of tourism industrial waste, 24 respondents (33,80%) stated it caused by the opening of Fish and shrimp ponds, 14 respondents (19,72%) stated that it caused by logging for building materials, 11 respondents (15,49%) stated that it caused by household waste disposal. A total of 7 respondents (9,86%) stated that it caused by the diversion of freshwater inflow and 3 respondents (4,23%) stated that it was in disarrayed by tsunami.

3.2.2 Coral Ecosystem Change

Coral reef ecosystem are part of marine ecosystem that serve as a place for a wide range marine biota. In coral reef ecosystem, there are more than 300 species of corals, 2000 species of fishes and dozens species of molluscs,

crustaceans, sponges, algae, seagrasses and other biota [5]. The condition of coral reef ecosystem in Sabang region based on monitoring result conducted by WCS-Marine institution in 2009 was averaged 56.04%). In 2011 the condition of coral reef decreased by 31.43%. This condition was due to the rising of sea level in 2010 [9]. Around 80% of coral species experienced death and it was one of the worst coral deaths ever recorded in Aceh [9]. A total of 45% of corals in Sabang suffered deaths, 94% of *Acropora* coral colonies and 87% of *Pocillopora* coral colonies died [10]. Coral bleaching has an impact on the composition of fish catch species on Sabang Island [11]. The damage of coral reef had an impact on the decreasing of the number of coral reef fish production per year. The average abundance of coral reef fish had decreased every year. In 2010 the average number of reef fish production reached ± 68,396 kg, decreased in 2011 to ± 35,906 kg. The decrease in average reef fish production continued to occur until 2013 to ± 15,497[12]. Currently, the condition of coral ecosystem has changed. Changes in coral reef ecosystems is still largely influenced by the movement of bleaching and strong currents, fishing activities, and violation of rules [13]. Coral reef ecosystem change was recognized by the fishermen in Sabang. A total of eighty respondents were interviewed, 42 respondents (46,7%) stated that coral ecosystem condition was currently in bad condition, 25 respondents (27,8%) stated it was in a very bad condition, 19 respondents (21,1%) stated it was in a good condition, and 4 respondents (4,4%) stated it was in a vary good condition.

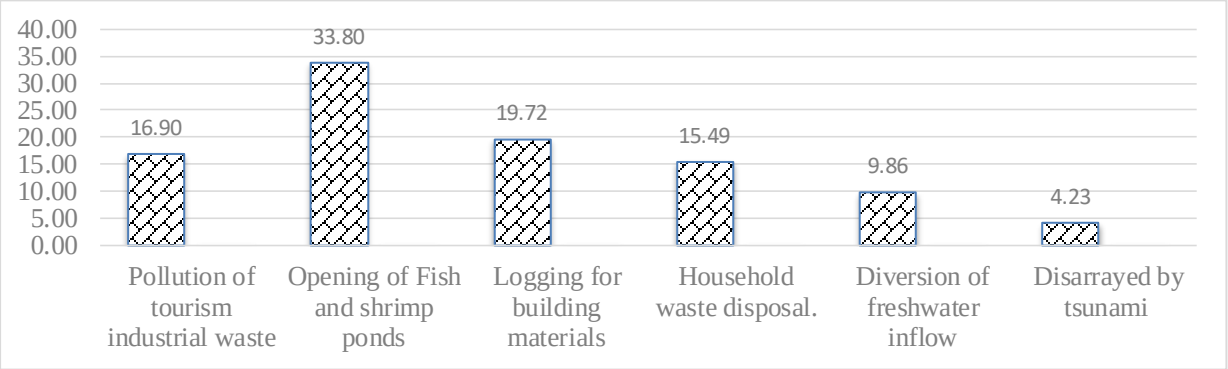

Figure 2: Perception of respondents to the cause of damage to the mangrove ecosystem

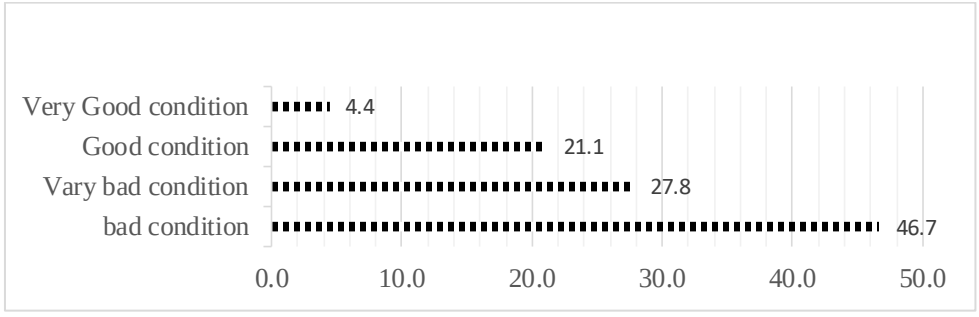

Figure 3: Respondents' perceptions of the condition of coral reefs.

A total of 67 (74,4%) fishermen respondents stated that the damage of coral ecosystem were poor and very bad, 21 respondents (31,3%) stated that ecosystem change caused by blast or dynamite fishing, 16 respondents (23,9%) stated it was caused by Tourism waste disposal, as many as 13 respondents (19,4%) stated that it was

caused by fishing with toxic materials, 9 respondents (13,4%) by ship anchor disposal, 4 respondents (6,6%) stated it was caused coral reef dredging and 4 respondents (6,6%) stated that it was caused by tsunami.

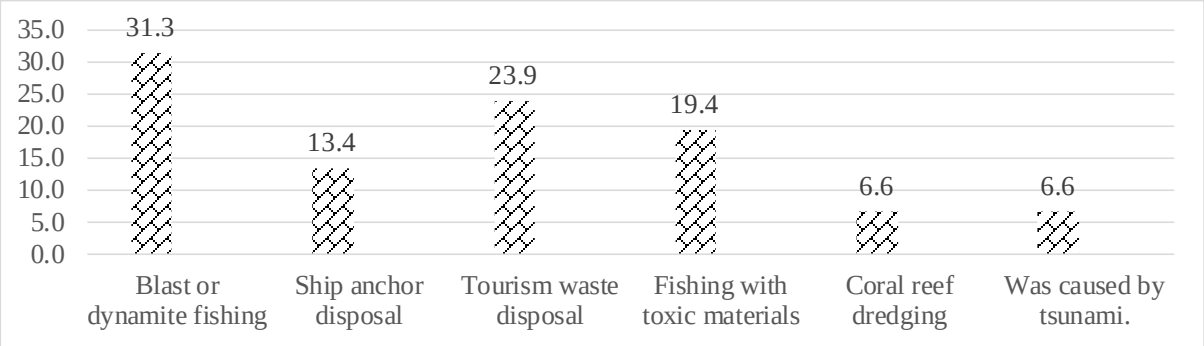

Figure 4: Respondents' perception of Causes of coral reef damage

3.3 The impact of ecosystem changes

Table 1: Matrix of the impact of Ecosystem Change due to Human Activity

Activity	Ecosystem changes	Social, Economic and Ecological Impacts
Mangrove Logging	Damage to mangrove ecosystem	The decrease in the number and diversity of fisherman catches. The reduced supply of firewood, Nipah and raw materials of medicines. Loss of breeding grounds for fish, crabs, and shrimp. So that disturbs the availability of fish stock, shrimp, and crab.
The opening of shrimp and fish ponds	Damage to mangrove ecosystem	Decreasing its area of mangrove Reduced diversity of fisherman catches. The reduced number of fishermen catches because the access of fishermen entering the mangrove forest area has been closed by fish ponds
Solid waste disposal	Damage to mangrove ecosystem and coral reefs	Pollution along the coast. Disrupt the regeneration of fish stocks. Disturbing the growing availability of seaweed and crabs
Freshwater diversion	Damage to mangrove ecosystem	The loss of substrates that are the source of fish feed. The loss of nurturing and rearing fish.
Fish bombing and fishing with toxic materials	Damage to coral ecosystems	The fisherman is difficult to determine fishing area. The decrease in the number and diversity of fisherman catches. The death of coral ecosystems.
Pollution of tourism industry waste	Damage to coral ecosystems	Pollution along the shoreline. Disturbing the regeneration of fish stocks. Damage to shelter for marine biota in coastal areas.
The release of the ship anchor	Damage to coral ecosystems	Damage to coral reefs. Loss of fishing areas and changes in fish migration patterns.

The island of Sabang has abundant marine and coastal resources in the form of mangrove and coral reef ecosystems. Mangrove and coral reef ecosystems have provided great benefits for the Sabang community. Coastal development activities and population growth have caused the mangrove ecosystem and coral reefs to decrease. Changes in mangrove ecosystems and coral reefs that occur in Sabang Island has affected the life of fishermen. The impacts of these changes do not only affect the fishermen's economic condition, but also affect the social life of the fishermen. Some areas show more arrests with bombings and toxic materials that cause ecosystem damage, so there is a tendency in one region to experience an increase in catch and in other declining areas. Here is a form of community activity that impacts on damage to mangrove ecosystems and coral reefs.

4. Conclusion

Changes in mangrove ecosystems and coral reefs that occur in Sabang Island has affected the life of fishermen. Changes in mangrove ecosystems caused by pollution of tourism industrial waste, the opening of Fish and shrimp ponds, logging for building materials, household waste disposal, diversion of freshwater inflow and disarrayed by a tsunami. Changes in coral reef ecosystems are caused by fish bombings, industrial waste disposal, fishing with toxic materials, ship anchor disposal, coral reef dredging and tsunami disasters. The socio-economic impacts of coastal ecosystem changes are the decline in the number and diversity of fisherman catches, the loss of wood supply, the difficulty of determining fishing areas, coastal pollution, disrupting the regeneration of fish and marine life, ecosystem degradation and changes in fish migration patterns. This study provides an overview of the changes in the ecosystems of Sabang Island that impact on the condition of the community, especially fishermen. It is recommended that the government reconstitute policies related to coastal resource management at local and national levels. Communities should be involved in management by enhancing human resource capacity, strengthening fisheries institutions, and other institutions to manage and utilize sustainable coastal resources.

Acknowledgement

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