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COASTAL ECOSYSTEM RESILIENCE: MANGROVE AND CORAL REFF ECOSYSTEM SYGNIFICANCE FOR HUMAN AND NATURE

Muhamad Soimin[1)]

[1)] Program Studi Kehutanan, Fakultas Pertanian, Universitas Nusa Cendana

*Email: muhammad.soimin01@gmail.com

ABSTRACT

Coastal ecosystem is one the most significant ecosystem on earth supporting numerous natural processes and human life. The two significant ecosystems which play that role are mangroves and coral reefs ecosystems. As earth is cover by water area where coral reefs occur and lands in between where mangroves occur possess a pivotal combination of supportive ecosystem functions including ecological and socio-economic values. However, apart from its' significances, they are being threatened by antropogenic activities and this is being worsened by cimate changes. Some emerging challanges have to be faced and tackled in order to create a sustainable coastal management and conservation. This has to involve many stakeholders, governments, local people, or non-governmental organizations to work together within beneficial collaborative works. Certain sustainable steps can be promoted within the context of management and conservation of coastal ecosystem for mangroves and reefs: 1) decide reefs are wanted and recognize their value; 2) adopt the precautionary principle in making management decisions; 3) reduce reef overexploitation; 4) use science for managing more effectively; 5) do new science to advance management; and 6) recognize and take advantages of synergy among impacts and among management actions. If we do not do these immediate actions, the extinction of mangroves and reefs are likely to happen, then resulting in worse impacts for people.

Keywords: coastal ecosystem, mangroves, coral reefs, sustainable conservation and management, collaborative works.

1. INTRODUCTION

In recent years the world human population increases day by day and it is predicted to increase in the next decades. As a part of an ecosystem, human always interact with other ecosystems components, both biotics and abiotics. Moreover, there are several forms of human interactions with natures, ranging from interacting positively or even making negative interactions. One prime example is those interactions between human and coastal ecosystems, including mangroves and coral reefs ecosystem. Specifically, the paper firstly outlines and describes certain issues related to the impact of human activities to the mangroves and coral reefs ecosystems; secondly, elaborates the ecological and socio-economic value of mangrove and coral reef ecosystem; lastly, discusses the challenges of coastal ecosystem conservation.

Coastal ecosystems that will be the discussion object are mangroves and coral reefs ecosystem. Both are the major example of coastal ecosystems that can be found in the coastal region. Moreover, both are close each other, where there is an upward mangroves and it is likely that coral reef ecosystems laid under the sea water. In the past before there were not too many environmental issues, the mangroves and reefs were in very good condition. However, today when the world is still facing numerous environmental problems, several problems are becoming the

threat for mangroves and reefs. This therefore needs to be addressed immediately for the sustainability of coastal communities.

2. METHODS

This study used a descirptive-exploratory approach to search all related scientific evidence and research to be analyzed and discussed. The resources are selected from reputable books and journals that available on the internet.

3. DISCUSSION

3.1. Coastal Ecosystems Nowadays

To begin, coral reefs ecosystem is categorized as the most endangered ecosystem (Steneck, et al. 2010). There are several causes of the coral reef damaged, ranging from local to global causes. The local triggers include agricultural runoff, fishing, algal blooming, diseases, nutrient runoff, tropical cyclone damage, and invasive species, meanwhile the causes which categorized as the global causes include ocean acidification, coral bleaching, sea level rise, and overfishing (Steneck, et al. 2010). The latest Global Coral Reef Monitoring Network (GCRMN) report from 2008 estimated that 19% of the world's reefs are totally lost (impossibly to recover), another 15% are at a critical stage and likely to be lost within 10 – 20 years, and a further 20% are endangered by local people pressures (already experiencing 20 – 50% loss of corals) (Hughes, et al. 2010).

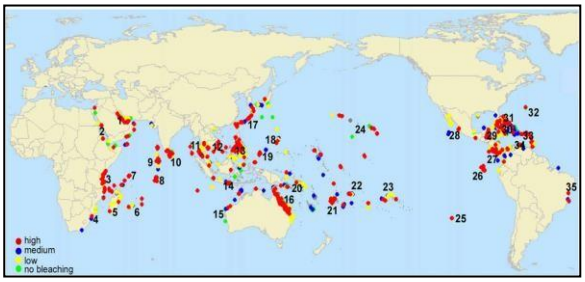

Figure 1. Coral reefs bleaching records 2008 (Andrew C. Baker, et al, 2008).

It is undeniable that some coral reefs devastation is caused by anthropogenic activities, such as agricultural runoff or overfishing. This condition is happening nowadays when the world is inhabited by many people. It is expected that the world population will increase from 6.7 billion to 9.2 billion by 2050 and the majority of these people will live in the coastal region developing countries (Sale, 2008). It is imaginable that if the enormous number of people lives in the coast, they demands for more food and ecosystem services offered by nature. In addition, the most appropriate way for them to gain food is by using terrestrial land or water as a food resources. Consequently, they will crop the land next to the coast and doing the fishing. It will not be a problem if they do such activities based on environmentally friendly techniques, but it will be disaster for the reefs if they do that without implements the environmentally friendly or sustainable principles. In addition, the coral reef degradation also occurred as an impact of coral bleaching due to climate change which caused by human activities, such as using a fossil fuel or doing illegal logging, etc. According to the figure 1, there are many more coral reefs ecosystems where the coral bleaching occurred rather than which do not experience coral bleaching, for example, the coral bleaching become a threat for coral reefs triangle in South East Asia region, great barrier reefs in Australia, and Caribbean region. Hence, it can be argued

that coral bleaching is an indirect impact of human activities. The coral reefs ecosystem which today is in endangered will be disappear in the future and could not be restored anymore.

Regarding to the phenomena experienced by the coral reef ecosystem, another type of coastal ecosystem, namely mangroves ecosystem is also still fighting against human destructive activities globally. Similar to a coral reef ecosystem, it can be argued that mangrove ecosystem ruin is mainly caused by human. 35% of the area of mangrove forests has been loss in the past two decades globally (Valiela, et al. 2001). One prime example is in China where population boom and economic development increase rapidly since 1980s, resulting in great reduction of mangrove area and only about 22,700 ha mangroves remains in 2001 (Cheng, et al. 2009). Furthermore, another research identified that mangrove destruction in Iranian coastline of Oman is caused by the lack of identity of mangroves ecosystem resource and lack of tools for mangrove economic evaluation (Ghasemi, et al. 2010). Within a larger scope, the world total mangrove area is decreasing.

Table 1. Current area of mangrove forest, total known losses, and percentage loss compared with initial value of acreage for Asia, Australia, Africa, and the Americas, as well as totals for the whole world (Valiela, et al. 2001).

Region	Present mangrove area (km^2)	Area of mangroves for countries with available multiyear data		Percentage of total present mangrove area represented in loss estimates	Percentage loss of mangrove forest area	Annual rate of loss ($km^2 y^{-1}$)[1]	Percentage of original area lost per year
		Present area (km^2)	Original area (km^2)				
Asia	77,169	26,193	41,208	34	36	628	1.52
Africa	36,259	14,903	21,847	41	32	274	1.25
Australia	10,287	10,000	11,617	97	14	231	1.99
Americas	43,161	38,472	62,242	89	38	2251	3.62
World total	166,876	89,568	136,914	54	35	2834	2.07

According to the table 1, it can be seen that each region has experienced mangrove forest loss annually with the total loss in the world of 2.07%. If this pattern is not restricted and it continuous year to year, it is predicted that in the next five or six decades the world mangrove area will be disappeared. Hence, it is clear that the deterioration which happens nowadays in mangroves and coral reefs ecosystem is mostly caused by anthropogenic activities.

3.2 Ecological and Socio-economic Values of Mangrove and Coral Reef Ecosystem

Ecosystem services are defined as the quantifiable services that an ecosystem provides to humans, including consumables and non-consumables (Steneck, et al. 2010). Both ecosystems, mangroves and coral reefs provide valuable benefits for people, especially for those who live next to the coastal environment. The ecosystem goods and services given by them are needed more than before by our growing coastal populations, while our growing impacts make reefs ever less able to provide them (Sale, 2008). In an ecosystem which consists of biotic and abiotic factors, mangroves have a crucial role as a producer and as a decomposer in the ecosystem (Gong, et al. 2013). Mangroves as an autotroph organism provide the energy resources for other biotic components, such as animals (herbivores). Furthermore, mangroves not only provide goods for people, for instance timber, fish and prawn, natural cockles, and floating cage aquaculture, but also provide services, such as maintenance of channel depth, sediment accretion and coastal protection, bird sanctuary/migratory stops, mangroves and adjacent coastal fisheries, sequestration of atmospheric carbon dioxide and ecotourism (Gong, et al. 2013). In socio-economic aspects, mangroves provide people valuable profits. For instance, in Serawak Malaysia mangroves support marine fisheries worth

US$21.1 million p.a. and more than 3000 jobs, timber products worth US$123,217 p.a., and a tourist industry worth US$3.7 million p.a. (Bennett, et al. 1992). It is estimated that the annual market value of capture fisheries supported by mangroves ecosystem ranges from US$750 to 16,750 per hectare, which illustrates the potential support value of mangroves (Ro¨nnba¨ck, 1999).

Regarding those positive values provided by mangroves ecosystem, coral reefs ecosystem also provide similar benefits. Research found that there are various advantages can people obtain from the reefs. Not only the people, but also the nature itself recognizes the importance of reefs. In an ecological perspective, the reefs provide physical structure services (the reefs have function as a shoreline protect, buildup of land, promoting growth of mangroves and seagrass beds and generation of coral sands); biotic services within and between ecosystem, including maintenance of habitat, biodiversity, resilience and genetic library, regulation of ecosystem process and functions, biological support through 'mobile links', and export organic production and plankton to pelagic food webs; biogeochemical services consists of N fixation, CO_2/Ca budget control, and waste assimilation; information services which the reefs can be an indicator for monitoring pollution and climate record; and social and cultural services, such as support recreation, aesthetic values and artistic inspiration, sustaining livelihood of communities, and support of cultural, religious, and spiritual values (Fredrik Moberg and Carl Folke, 1999). In addition, coral reefs provide goods as a renewable resource which consist of sea food products, raw materials for medicines or jewelry, and life fish and coral for aquarium trade (Fredrik Moberg and Carl Folke, 1999). Real evidence is shown in Indonesia where almost more than half of their land consists of the sea earns income from fishing about US$55 per crew per month and US$306,800 per km^2 of coral reefs in recent 20 years (C. Pet-Soede, et al. 1999).

According to the short description above, both are significant for human. In ecological aspects, both of them provide a crucial role in ecosystem, especially for other species which live and dependent to them. For the people who live in the coastal region obtain the physical advantage of the existence of mangrove and reefs, both provide natural physical protection for the land from abrasion, also for the people from the risk of huge wave or even tsunami, especially for the small islands. What is more, the combination of them as a tourist attraction in form of ecotourism benefits people socially and economically.

Figure 2. Mangroves and coral reefs as a tourist attraction in Bunaken, Indonesia. (Pictures were taken from Free picture sources)

3.3 Challenges

The benefits provided by mangroves and coral reefs ecosystem are priceless. It might be argued that the human cannot pay for the ecological and socio-economic services given. However, even though the destruction of mangroves and coral reefs ecosystem is such an emerging trend and has been occurring continuously, people are often struggles to restore the damaged ones and to conserve which left. It does not mean that we should be pessimistic, yet we have to be very optimistic. We have to remember that

those are not inherited by our ancestor, yet we just borrow it from our kids or future generation.

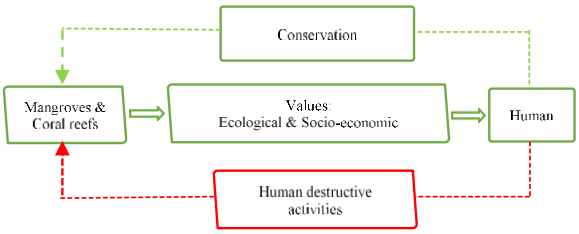

Figure 3. Schematic relation among human, mangroves and coral reef ecosystem.

Unrealizably, human activities alter the natural disturbance regimes of coral reefs by transforming pulse events into persistent disturbance or even chronic stress, by introducing new disturbance, or by suppressing or removing disturbance (Magnus Nystrom, et al. 2000), over fishing for instance. From figure 3, human are likely to produce the negative feedbacks to the mangroves and coral reefs ecosystem, such as destructive or over exploitative activities. It is reported that over half (55%) of the 49 island countries considered are exploiting their coral reef fisheries in an unsustainable way (Newton, et al. 2007). For mangrove forests in South East Asia region, 50 – 80% of them in that region has already destroyed (Clive Wilkinson, et al. 2006). As a result, mangroves and coral reefs are not able to accommodate and tolerate the human's need on fisheries.

There are several challenges to be faced in order to promote a sustainable coastal management and conservation; it must involve related stakeholders, governments, local people, or non-governmental organizations (NGOs). There is a statement that the coral reef crisis is a crisis of governance (Hughes, et al. 2010), so if we want to be succeeding in conserving mangroves and reefs it must be started from good governance. It is important to consider the plan before taking the action because there are several factors can be hitch for the coral reefs restoration and conservation. It is necessary to measure how much coral cover is lost, and which species are locally extirpated; the ability of remnant and recovering coral reefs ecosystem to adapt or acclimatize to higher temperatures and another climatic factor such as reductions in aragonite saturation state; the changing balance between reef accumulation and bio erosion; and people's ability to maintain ecosystem resilience by restoring healthy levels of herbivory, macro algal cover, and coral recruitment (Baker, et al. 2008).

Another future challenge is that the human population will go up rapidly and it needs more and more from mangroves and coral reefs. It is predicted that people require an extra 196,000 km^2 of coral reefs in 2050 to support the anticipated growth in human population (Newton, et al. 2007). Another possibility to deliver is keeping the balance in human population. It is because the large whole imbalance between current and sustainable catches implies that management methods to minimize social and economic dependence on reefs ecosystem fisheries are essential to prevent the collapse of coral reef ecosystems while sustaining the well-being of burgeoning coastal populations (Newton, et al. 2007). Hence, should the coastal ecosystem be protected totally and people are restricted to interact with them? This question also needs to consider because if people are banned to do activities in that ecosystems, then it will create another issue. In one side, the mangroves and coral reefs ecosystem remain save and stable without human disturbance, but on the other hand people's life will suffer because they are dependent on those ecosystems. In this case, the best solution is implementing the ecosystem approach in management and

conservation, meaning that people are the part of nature and they will keep the nature existence, also people can obtain benefits without disturb the nature itself.

Next, what should be done? In terms of management and conservation, the government their self cannot take the action and finish it successfully, but it requires the synergy from many stakeholders, including NGOs or local communities. There are certain sustainable steps that can be implemented in management and conservation of coastal ecosystem for mangroves and reefs: 1) decide reefs are wanted and recognize their value; 2) adopt the precautionary principle in making management decisions; 3) reduce reef overexploitation; 4) use science for managing more effectively; 5) do new science to advance management; and 6) recognize and take advantage of synergy among impacts and among management actions (Sale, 2008).

It is suggested that there are various approaches that could be implemented in restoring, managing, and conserving mangroves and coral reefs ecosystem. Firstly, conservation is not only a responsibility of government, but also it is a responsibility of all people, so working cooperatively among government, NGOs, local communities is obligatory. Secondly, prevention effort is required to save the remaining mangroves or reefs from the destruction. Thirdly, from law and policy aspect, governments have to create a sustainable policy about the management and conservation of mangroves and coral reef ecosystem and then implement it appropriately, for those who did the deterioration must be punished. Next, in social perspective it is important to deliver the campaign about conservation because there are few people do not know and understand about the importance of such ecosystems. Eventually, as an investment for future and long-term efforts, the education has a crucial role in constructing the young generation awareness about conservation, also education can broaden young generation's mind, thus they will not do such destructive activities which can threat nature.

4. CONCLUSION

It is realized that the mangroves and coral reefs ecosystem have crucial roles for the nature and for human. However, the recent condition of both ecosystems are being threatened by anthropogenic activities and worsened by climate changes. Even though people acknowledge about how importance the ecological and socio-economic values provided by them, the destruction is still continuing. Hence, the management, restoration, and conservation of mangroves and coral reefs ecosystem is a must because if people do not do it immediately, the extinction of mangroves and reefs are likely to happen, then resulting in worse impacts for people and nature.

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