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Fudjaja, L., Viantika, N.M., Rani, C., **Nurdin,**
N., Priosambodo, D., Tenriawaru, A.N

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Anthropogenic activity and the destruction of coral reefs in the waters of small islands

L Fudjaja¹, N M Viantika¹, C Rani², N Nurdin², D Priosambodo³ and A N Tenriawaru¹

¹Department of Socio Economic of Agriculture, Faculty of Agriculture, Universitas Hasanuddin, Makassar, Indonesia

²Department of Marine Science, Faculty of marine science and fisheries, Hasanuddin University, Makassar, Indonesia

³Department of Biology, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Makassar, Indonesia

Email: letty_fdj@agri.unhas.ac.id

Abstract. Coral reefs have a very important function in maintaining the balance of marine ecosystems, but the pressure of anthropogenic activity can damage the coral reef ecosystem. This research aims to analyse the activities and behaviors of communities that cause damage to the coral reefs of the small island waters of the Spermonde Islands. This study was conducted on 8 small islands of the Spermonde Islands using a qualitative descriptive approach. The results showed that anthropogenic activity conducted by the small islands, tends not to be environmentally friendly. As a result there is damage and reduced living coral reefs are quite large. It's been identified there are 13 island community activities that could damage the coral reef ecosystem. In order to support the sustainability and existence of coral reefs, it is a must that every stakeholders for having collaboration in the management of the community-based coral reefs.

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1. Introduction

Coastal areas are dynamic coastal ecosystems and have diverse habitat strength, both on land and in the sea, as well as interacting with each other. In addition for having great potential, coastal areas are also the easiest ecosystem to be impacted by human activities. Generally, by development activities, directly or indirectly, have a detrimental impact on coastal ecosystems.

The life of the coastal population depends largely on marine resources [1], but involuntary human activity can damage the Reef ecosystem. This human behavior is heavily influenced by Anthropocentrism ethics, which considers beings or other objects other than men to be human welfare enhancers or known as instrumentalist Principles [2]. This perception was became the driving factor of pollution and exploitation of nature, including coastal areas.

One of the coastal areas that is important from economically and ecological is the coastal area of South Sulawesi's Spermonde archipelago. The Spermonde archipelago has ± 121 islands, with a vast coral reef exposure to its waters. In this region there are economic activities based on natural



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resources such as fisheries, unfortunately these fishing activities are not environmentally friendly which affect the destruction of coastal ecosystems.

Based on data from the Ministry of Marine Affairs and Fisheries, currently about 70% of coral reefs in Indonesia's sea conditions are severely damaged, and only 30% are still relatively good. In South Sulawesi, the coral reefs have reached worse damage, reaching approximately 75% which is usually caused by fishing activities using explosives [3].

Degradation or damage at the ecosystem of corals can be caused by factors that come from nature as well as from human activities. Some causes of damage to coral ecosystems that are natural are hurricanes and tsunamis, climate change, and natural predators. Some influences factor of human activity includes: activities of destructive fisheries, mining and prevention of coral for building materials and lime production, tourism activities, and development at coastal areas without environmental wisdom, un-controlled logging of mangrove forests or reducing of mangrove forests.

According to Amri (2012) [4], human activities that pollute the environment (anthropogenic) on coastal areas especially in small islands are increasing so as the population. Pollution needs to be anticipated as early as possible because not only can damage coastal ecosystem; coral reefs, but also can harm human health and can extinguish living creatures that utilize the contaminated coastal resources. Coastal Ecosystem should be well-managed to be able to support human life sustainably, it is important to examine the causes of coastal resources degradation. One of the factors is caused by human activity so based on it, the research aims are to analyze the activities and behaviors with respects of the community towards damage of coral reefs in the island waters of small island, Spermonde islands.

2. Research methods

The study was conducted in February- November 2017 on 8 small islands of Spermonde islands, namely: Podang-Podang Caddi Island, Podang-Podang Lompo Island, Polewali Island, Kulambing Island, Bangko-Bangkoang Island, Satando Island, Saugi Island and Sabuton Island. The type of the research is a descriptive qualitative and the data collection were done through several methodological approaches, such as: (1) Surveys (*Rapid Assessment*); (2) Questionnaire; (3) *in depth Interview*, (4) discussion with local government apparatus, (5) triangulation.

3. Results and Discussion

3.1. Socio-economic conditions at the community of small islands

The survey showed that from the 8 islands that became the location of the research, there is one uninhabited island, namely Podang-Podang Caddi Island. Although there is no permanent resident, but the island is not lack for natural resources so the community of the surrounding islands use it for planting. This island is known as a stopover island because the people who come only stopover for rest or other activities, such as recreation, pilgrimage and become places for student field practice, held a research, gardening or livestock. Groundwater conditions in the small islands mostly already had sea water intrusion so it becomes salty especially during dry season. Among the 8 islands, there are 2 of them that still have a source of fresh water, namely Podang-Podang Caddi (having one well) and Satando (Two Wells). These two wells in Satando supplied freshwater continuously for the islands and located on the middle with the vegetation of breadfruit and banana trees. According to the Sultan, *et.al.* (2014), the central region of Satando Island is a thick alluvial area of the coast. Based on the geoelectric result interpretation, the it show that only in this alluvial layer contained freshwater in Satando Island area, so that the vegetation above this alluvial layer should be preserved, especially the

existence of breadfruit so that fresh water supply can be maintained. Clean freshwater trade at Mattiro Baji village comes from Satando Island.

Conditions of the resident housing is un-arranged, although there is a pathway. The technical/physical infrastructures identified in 8 islands are limited, such as: Clean water, embankment, jetty, electricity (PLN and non-PLN), Port (on Sabutung Island, which is prepared as a *Check Point* for ships which sailing at Makassar Strait). Social/nonphysical infrastructure in the form of residential environment facilities, among others: General MCK, Mosque, PAUD and TPA, elementary school, junior High School, high school, Non-Formal School for Women (in Kulambing Island), PP Marine silver (on Sabutung Island), Pustu, Poskesdes/Puskesmas, Posyandu and village office.

For accessibility between islands using ships as a mode of sea transport. There are generally small passenger vessels, but people who are mostly fishermen, often use their own boat for inter-island transportation. Fishing boats like *Jolloro* or fiber boats.

The livelihoods of people in small islands are mostly fishing rods, fishing nets/trawler, fisherman cages or crab seekers. There are also fishermen who catch fish and dive and take seaweed growing on the corals.

The education level of most people are still low, especially women. Although there is already a formal school to high school level, but many people are dropped out from school. Many assumptions in society that women do not need to study till high school, because eventually they have to take care of children and households resulted in many cases of dropouts in girls and early-childhood marriages on small islands.

The kinship of the inhabitants of the small islands is very close, because most are still in one lineage. Residents generally come from the ethnic Bugis Makassar and they still maintain the social strata that are determined by the value of the character of a person, wealth, lineage and position in social and governmental institutions. In terms of customs, the majority of the community ceded a complete problem resolution to community leaders who had high social strata.

3.2. Anthropogenic activity on small islands

Anthropogenic pressure on the environment increases with increasing population, especially in small islands, both inhabited and uninhabited. The results of identification of population activities that potentiates the environment and damage the coastal ecosystem on 8 islands that become research locations, presented in table 1.

3.2.1. *Traffic boat/boat*. Based on the observation results presented in table 1, the traffic activities of ships/boats of various types and sizes of the downstream homecoming occurred in 8 islands that became the object of research. It is inevitable because the ship/boat is the only inter-island transportation mode used by Archipelago society. According to Bengen (2002), marine transportation activities that utilize land area and allocation of space in the sea for shipping lines, ports and others are an economic activity prevalent for coastal communities, but the traffic of boats and vessels that come and go on the island can cause physical or mechanical damage to the ecosystem of the waters. The dangers posed by the boat traffic are mainly caused by a sting of the propeller (*propeller scarring*).

Large boats are mostly found on islands with steep topography, such as on Podang-Podang Lompo Island, Kulambing and Sabutung. Meanwhile, small boats are more anchored on sloping islands such as Podang-podang Caddi island, Polewali island, Bangko bangkoang island, Satando island and Saugi island. A large boat in the form of a fishing fleet that usually operates in the offshore waters and cement transporter ships derived from Tonasa cement factory in Pangkep district. Small boats such as *Jolloro*, *katinting* and *Lepa-Lepa* are commonly used by fishermen to capture fish and/or other marine commodities, for transportation from one island to another, or to bring catches to the market or fish auction place.

3.2.2. *Ship repairs and shipbuilding/boat.* Ship repair activities are carried out by fishermen while resting from the activities of the sea. Fishermen utilize leisure time by repairing damage to the vessel or boat. Although this activity is not very often done, but the elements and chemical compounds contained in the materials used such as antifouling paint, putty or other materials can lead to pollution that can inhibit growth or even deadly biota that exists around it. This harmful chemical substance is toxic and directly endangers seagrass and biota associated with it [5] and Hemminga and Duarte (2000) [6].

Table 1. Anthropogenic activity on the small islands of the Spermonde Islands

No	Activity type	Name of Islands							
		Caddi Podang-Podang	Podang-Podang Lompo	Polewali	Kulambing	Bangko-Bangko	Satando	Saugi	Sabutung
1.	Traffic boat/Boat	√	√	√	√	√	√	√	√
2.	Repairs and shipbuilding/boat	√	√	√	√	√	√	√	√
3.	Disposal of garbage (households, etc.)	√	√	√	√	√	√	√	√
4.	MCK (Bath, Wash, Latid)	√	√	√	√	√	√	√	√
5.	Sand mining	√							
6.	Arding/Beach Reclamation								
7.	Seaweed Collection						√		
8.	The installation of Bubu/Rakkang			√	√	√	√	√	√
9.	Fishing		√	√	√	√	√	√	√
10.	Research activities/practice of Students' field	√	√	√	√	√	√	√	√
11.	Domestic waste flow (drainage)		√	√	√	√	√	√	√
12.	Fishing boat Stopover	√					√		
13.	Aquaculture						√		

Shipbuilding/boat activities exist only on Kulambing Island and Podang-Podang Lompo Island, but the boat characteristics on both islands are different. On Kulambing Island, boat craftsmen generally make large boats for cement transport vessels, while on Podang-Podang Lompo Island makes small boats for fishermen fishing, choking, squid and other economical marine resources.

3.2.3. *The Garbage Disposal.* The garbage generated by the activity of the population is a thing that is a dilemmatic in small islands such as islands in the water area of Pangkep Regency. Some people already understood the importance of maintaining cleanliness, but on the other hand they have no choice on throwing garbage to the beach in hopes that garbage will be carried away from the island. In fact, the garbage is precisely stacking on the beach. Fahmi (2015) reported that the waste management system is still very lacking in the archipelago of Mattiro Uleng Village Pangkep District.

The phenomenon of garbage scattered on the coast was seen in 8 islands that become the research location. Garbage that is observed were consist of many pile on the beach such as plastic bags, plastic beverage bottles, food packaging plastics/instant drinks, cans, pieces of wood/trees, twigs, leaves,

coconut husk, plastic rope pieces, etc. According to Tait and Dipper (1998) [7], the garbage will be in the waters for a long time. The garbage that is not decomposed over time is increasingly stacked on the shore and reduce the intensity of sunlight obtained by seagrass plants, coral reefs and other biota to be well developed.

3.2.4. The Beach utilization activities for MCK (Bath, Wash, Kakus). At the research site, we still found the utilization of beaches for MCK. Conditions of home sanitation are still very concerning that caused the rapid growth of population and behavior of people who are not environmentally friendly. Since the year 2014, "MAMPU" which is an Australia-Indonesia partnership Agency for Gender Equality and women's empowerment, developed the women's School on Sabutung Island and actively educate the women of the island about the various things to improve their insight, knowledge and skills, including how to behave and manage the environment responsibly. The existence of the school for women is currently reach out 480 people as members and spread across several islands namely Sakuala Island, Salemo Island, Sabangko Island, Sagara Island, Sapuli Island, Saugi Island, Satando Island, Sabutung Island, Bangkobangkoang Island and Kulambing Island which help speed the transformation of the island community towards conscious for cleanliness and environmental sustainability.

3.2.5. The Sand mining. Sand mining took place in Podang-Podang Caddi Island. The activity of sand mining on Podang-Podang Caddi Island is lively done by fishermen originating from the surrounding islands, especially from Podang-Podang Lompo Island. The sand taken from the island is used as building material. This activity is free because there are no residents residing on the island. If the sand mining continues in the long term, it will derived to possibility of Podang-Podang Caddi Island will be get drowned and lost.

3.2.6. Hoarding/Beach Reclamation. As the population grows in small islands, the need for residential land is increasingly limited. One of the alternatives that residents have to get land to build a dwelling house is by stockpiling the Beach and creating foundations using rocks taken from the coral reefs around the island.

3.2.7. Seaweed Collection. Seaweed collection activities are found in Bangkobangkoang Island. Fishermen on the island not only hunt fish, crabs and squid, but also look for seaweed that grows on coral reefs. Seaweed pickup location around Bangobangkoang Island and Kulambing Island. This activity threatens the sustainability of the coral reef ecosystem around the island.

3.2.8. The installation of Bubu/Rakkang. Bubu/Rakkang is a fish/crab fishing tool. This appliance is made of wood, bamboo, rattan or wire and it is passive. Bubu/Rakkang is designed to facilitate fish/crab in and difficult to get out [8]. Bubu/Rakkang is an environmentally friendly capture tool because it only catches fish/crabs that are large enough, but the installation of this tool and the ballast at the bottom of the water can interfere even deadly seagrass he covers.

3.2.9. Catching Fish. Fishing activities by fishermen in small islands of Pangkep Regency are not environmentally friendly. It is seen from the location and on how fishing were applied by fishermen. The usual location of the fishing that visited by fishermen was a form of an area called Taka. It is an oral reef that lives in a relatively shallow water (*Reef patch*). To get a lot of catches, fishermen use a capture tool that highly on environmental destroyer effects such as bombs, pushers, Cantrang. All of these capture tools can result an extensive physical damage to the coral reefs and a high percentage of immature fish mortality. The production of capture fisheries in Pangkep district showed the symptoms of *over fishing* (excess catch) indicated by the decline in the production of catch fish.

3.2.10. *The Student field Research/Practice.* Podang-podang Caddi island, Podang –Podang Lompo island, Polewali island, Kulambing island, Bangkombangkoang island, Satando island, Saugi island and Sabutung island are the islands that received many visits from student, lecturers and researchers from various disciplines related to maritime fields (such as biology, physics, chemistry, geology, fisheries, socio-economics, and maritime anthropology). The student's field of practice is an activity that has been carried out frequently on these islands. Amri (2012) [4] mentions that this activity may affect seagrass land and its associated biota through the collection of samples for herbarium and the collection of ornamental biota for aquarium accessories. This activity can also cause physical damage to seagrass through foot valves (*trampling*).

3.2.11. *Flow (drainage) Waste domestic.* Activities that happened on the mainland can produce liquid waste that will flow into the beach. In addition, waste from the mainland can be carried to the shore through the rain water that falls on the mainland of the island and flows (*runoff*) to the beach. One of the effects of *runoff* is the increased nutrient content and sedimentation in the waters [9]. The most activity that produces liquid waste in the land comes from households and industries such as miniplant in Saugi Island and dry fish processing on Podang-Podang Lompo Island.

3.2.12. *Fishing boat Stopover.* Podang-Podang Caddi Island and Satando Island, these islands are commonly visited by fishermen who use *Jolloro* and *katinting* boats. On both, fishermen take a break and pick up clean fresh water before continuing the journey.

3.2.13. *Aquaculture Activity.* Aquaculture activity is found in Bangkombangkoang Island. Sizable expanse of pond in the middle of the island surrounded by mangrove forest. People utilize mangrove wood as firewood, fence, and Keramba. Pond business is potential to cause environmental pollution since the use of fertilizer and feeding fish can increase the organic as well as liquid pollutants or waste materials that can interfere with the surrounding ecosystem.

3.3. Coral reefs damages in Small Island waters

Coral reefs were found in shallow sea waters throughout the tropics. The dynamic conditions of coral reefs are characterized by changes occurring within the community as well as a strong interaction between coral biota and other biota of reef dwellers as well as environmental conditions. Changes in environmental conditions as a result of various human activities as well as by natural events have caused damage to the coral reefs in large scale. Rani (2017) [10] reported that in the last 26 years, there was a decrease in coral cover area of shallow water and increased coral change of life into algae overgrown corals, fragments of coral and sand and fragments of coral in Kulambing Island, Bangkombangkoang, Satando, Saugi, Sabutung and Polewali (table 2).

Table 2. The Changes of shallow water covering in small islands, Spermonde islands period year of 1990-2016

No.	Island Name	Living Coral Reduction Area (HA)
1.	Kulambing	31.48
2.	Bangkombangkoang	27.56
3.	Satando	15.14
4.	Saugi	12.42
5.	Sabutung	17.60
6.	Polewali	5.09

Along with the increasing number of population, more upon on small islands that have limited land, so the pressure caused by anthropogenic activity also rapidly increasing. As data shows in table 2, the largest reduction of living corals occurred in Kulambing Island, which is approximately 31, 48 Ha for the last 26 years. This shows that the greatest pressure on the environment occurs on the

island. As the center of village governance, this area is quite developed public facilities that become the center of Community activities. Dense residential conditions. The traffic intensity of large vessels and cement transporter ships is quite high, thereby worsening the destruction of coral reef ecosystem in the waters surrounding the island of Kulon. The pressure of anthropogenic activity in coastal areas is a major threat to the Seagrass ecosystem [11,12] and coral reefs.

According to Dahuri (2008) [13], in order to ensure the sustainability of resources and human activities of the future, the regional management approach should be concerned with comparing the aspects of availability and resource capacity to the number of populations and activities that are on it.

4. Conclusion and policy recommendation

There are 13 anthropogenic activities that gain by observed the communities in the small islands of the Spermonde Islands. Potentials Anthropogenic activities which affect the coral reef ecosystem on 8 islands were: the research location, the pressure of anthropogenic activity that continues to grow as the population increases causing coral reefs and the diminishing area of coral living in the waters of the small islands of the Spermonde archipelago. It takes efforts to minimize the negative impact caused by anthropogenic activity of the coral reef ecosystem. The collaboration of all stakeholders is obviously urgent needed, for the sustainability and existence of coral reefs. The role of government, especially the local government of Pangkep Regency as a facilitator and catalyst for the proactive and productive development in the management of coral reefs, also by supporting and giving chances for the community to participate in community-based management. Such as : The installation of garbage processors, the use of environmentally friendly fishing equipment, foster public awareness to conduct self- monitoring of sand mining activities and coral harvesting, replanting damage coral.

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