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The change of coral cover in Ujong Pancu waters, Peukan Bada Sub-District, Aceh Besar

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Abstract. Coral reef ecosystems are one of the most productive ecosystems on the earth, with large ecological functions. The disruption of coral reef ecosystems has a significant impact on the surrounding biota. This study aims to determine the condition of coral reefs for the last three years in Ujong Pancu waters, Peukan Bada sub-district, Aceh Besar district. This study uses data in 2017, 2018, and 2019 with three observation locations: Lhok Keeutapang, Lhok Mata Ie, and Tuan Island. The method used is Point Intercept Transect (PIT) with a transect length of 20 m with four repetitions. The results showed that the percentage of hard coral cover in the Ujong Pancu waters decreased from the good category (50.31%) in 2017 to moderate (47.81%) in 2019. The percentage with the highest coral cover was at the Lhok Keutapang location at 72, 81% in 2018, while the lowest coral cover at the Tuan Island location was 15.94% in 2017. The composition of the coral genus found also decreased from 12 coral genera (2017) to 9 coral genera (2019).

1. Introduction

Coral reef ecosystems are one of the most productive ecosystems on earth, with significant ecological functions as breeding, nurturing, and foraging for aquatic biota [1,2]. The existence of coral reef ecosystems serves as physical protection for coastal areas from strong waves and currents [3]. In addition, from the economic sector, this ecosystem can develop marine tourism [4], which can provide benefits for the incomes of coastal communities and the government if appropriately managed.

Ujong Pancu Waters is located in Peukan Bada subdistrict, Aceh Besar District. This area has potential for coral reef resources, but recently there has been the degradation of coral reefs caused by community waste and ponds since 2016 and an increase in coral-eating biota (*Acanthaster planci*) since 2018. Coral reef ecosystems are currently experiencing serious declines and threats that occur both naturally and as a result of human activities [5,6]. Human activities that often damage coral reefs include;



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bombing, dropping of ship anchors in any place, siltation, sedimentation, and natural factors such as drastic temperature increases and predation by other marine biotas [7].

Nevertheless, coral reef ecosystems are fragile and vulnerable to damage [8], threats of degradation, and even extinction [9]. The condition of coral reef ecosystems has changed globally, both caused by human factors and natural factors [10]. Damage to coral reefs on a small scale can impact decreasing reef fish populations, while on a large scale, it can affect the economy of coastal communities [11]. Environmental pressures due to human activities on land can affect the surrounding aquatic ecosystems, thereby reducing biodiversity, especially in coral reef ecosystems [12].

The real threat to coral reef ecosystems originating from human activities is ponds around the coastal area, including the Ujong Pancu coast. The ponds in Ujong Pancu coastal area have been built since 2017. For the past four years, ponds have been continuously built to dominate most of the coastal areas of Ujong Pancu. Unfortunately, the rapid development of ponds does not pay attention to environmental aspects. Pond waste is directly discharged into the sea through existing sewer pipes, which will undoubtedly impact eutrophication. Eutrophication in coastal areas can cause phase-shift, namely the change of reefs that corals initially dominated to reefs dominated by algae in a relatively long time [13].

In addition, the direct impact of eutrophication is the increasing number of predatory coral biota, *Acanthaster planci*. This biota is one of the causes of coral mortality in Indonesia [14]. The results of the initial survey in one of the waters of Ujong Pancu, Tuan Island, found up to > 100 ind *Acanthaster planci* in just one survey [7,14,15] states that if this environmental pressure occurs continuously, while the recovery is slow, it is feared that coral reefs will die. This condition is exacerbated by the lack of public awareness, limited monitoring efforts, and inadequate management. Therefore, it is suspected that there will be severe damage to the coral reef ecosystem of Ujong Pancu waters in the future.

Environmental conditions strongly influence the dominating coral population in a habitat. If the environmental conditions are following certain coral species, the coral species can be dominated in a habitat. The flat reef area is usually dominated by small coral reefs, which are generally massive and submassive. Reef slopes are usually overgrown with branching corals, while massive corals dominate in the outer reef with currents. Therefore, an inventory of coral reefs can be done by collecting data in the form of a percentage of live coral cover. The abundance of reef fish and the condition of the archipelagic waters that contain coral reef ecosystems can be the basis for supporting the suitability of an area to be used as an object of marine ecotourism.

The latest research on the condition of the coral reef ecosystem in Ujong Pancu was reported by Bahari [16], where live coral cover is still in the good category. However, there has been no research that examines the current condition of coral reef ecosystems after the construction of ponds around Ujong Pancu waters. Finally, this research to be carried out immediately to reference the appropriate management and policymaking related to preserving coral reef ecosystems in Ujong Pancu waters, Aceh Besar District.

2. Material and Methods

2.1. Study Site

This research was conducted from 2017 to 2019 in Ujong Pancu waters, Peukan Bada Sub-District, Aceh Besar District. Data was carried out at three stations, namely Tuan Island, Lhok Mata Ie, and Lhok Keutapang.

2.2. Sampling method

Observation of coral cover was carried out using the PIT (Point Intercept Transect) method. With a transect length of 20 meters and using 3 repetitions. The data taken in the form of the coral genus on transects and coral growth forms at a distance of 0.5 m (50 cm) were then carried out at every 50 cm

interval. Live coral cover data were collected at two depths, namely 3-5 meters (shallow) and 6-10 meters (deep). Identification of coral genus using identification book [17].

3. Data Analysis

3.1. Coral Cover

3.1.1. Analysis of live coral cover using the formula for the percentage of coral cover

Analysis of live coral cover using the formula for the percentage of coral cover based on English *et al.* [18]:

$$C_i = \frac{l_i}{L} \times 100\%$$

Information: C_i : Percentage of coral lifeform cover of the i th type; L_i : Lifeform length of the i th species (m); L : Total length of line transect (m)

Table 1. Categories of coral reef conditions

Coral cover (%)	Category
0 – 25	Poor
25 – 50	Medium
50 – 75	Good
75 – 100	Very good

3.2. Coral Mortality Rate

Coral mortality was calculated using the Mortality Index. This index provides information on the magnitude of the change from live coral to dead coral. A mortality index value close to 0.0 indicates almost no coral mortality, while a value close to 1.0 indicates a significant change from live coral to dead [18]:

$$IM = \frac{DC}{LC + DC}$$

Information: IM: Mortality Index; DC: Percentage of dead coral cover; LC: Percentage of live coral cover

4. Result and Discussion

4.1. Percentage of hard coral cover

The average percentage of hard coral cover for three years, 2017, 2018, and 2019, in Ujong Pancu waters is 50.9%, which according to the Ministry of Environment Regulation in 2014, is in a good category. The results of the study found that the percentage of hard coral cover from 2017 to 2019 experienced insignificant fluctuations. The percentage of hard coral cover in 2018 was the highest percentage of cover, namely 54.58, which was in the good category, an increase of 5% from 2017, which was only 50.31%. Whereas in 2019, it decreased by 10% from 2018, the value of coral cover only reached 47.81% (Figure 1).

The condition of coral cover at the Lhok Keutapang location changed from good to moderate coral cover. Unlike the Lhok Mata Ie location, where there is no significant change in coral cover, it is still in the good category for three years. Meanwhile, in Tuan Island, the percentage of coral cover has increased every year. However, the percentage of hard coral cover in the Tuan Island location was in the poor category in 2017 and 2018, then became the moderate category in 2019 with a cover value of 31.56% (Figure 3).

Overall, the percentage of hard coral cover in the Ujong Pancu waters area decreased from the good category (50.31%) in 2017 to moderate (47.81%) in 2019. During the three years of observation, the highest percentage of coral cover was found at Lhok Keutapang, which was 72.81% in 2018. In contrast, the lowest percentage of coral cover was at Tuan Island, which was 15.94% in 2017.

The decrease in the percentage of coral cover at the Lhok Keutapang location is due to the high fishing activity in these waters, so it is assumed to be the cause of the low hard coral cover in the area. According to [19], coral reefs are vulnerable to damage caused by human factors and natural factors. Environmental pressures that occur cumulatively will damage the coral reef ecosystem in the waters. Continuous human activity is a significant threat to coral reefs that can inhibit the growth of coral reefs [16].

In addition to human factors, coral reef ecosystems are also damaged due to natural factors. Damage to the coral reef ecosystem in the study area due to natural factors is caused by the high intensity of the waves. So, it can affect the coral reef ecosystem, resulting in fractures, especially at the tip of the coral. In addition, high wave intensity can cause more significant coral damage; even the corals will die. The low coral cover in 2019 at the Lhok Keutapang location was due to coral bleaching, which made the coral ecosystem fragile. Similar results were also reported by [15], where there was a drastic decline in coral cover in the 2015-2017 range in the Krueng Raya waters of Aceh Besar. Today's coral reef ecosystems are experiencing severe decline and threats that occur both naturally and as a result of human activities [5,6].

4.2. Coral Genus Composition

The composition of the coral genus in 2017 consisted of 11 genera of corals, namely: *Acanthastrea*, *Acropora*, *Euphyllia*, *Favites*, *Fungia*, *Heliopora*, *Millepora*, *Montipora*, *Pocillopora*, *Podabacia*, and *Porites*. Furthermore, in 2018 the composition of the coral genus increased to 14 genera. The genus found was the same as the genus in the previous year, but there were seven newly discovered genera, namely: *Alveopora*, *Ctenactis*, *Echinophyllia*, *Echinopora*, *Hydnophora*, *Psammocora*, and *Sandalolitha*. Whereas in 2019, the composition of the coral genus was reduced to 9 genera. The genus found was also the same as the previous year. However, there were two new coral genera discovered in 2019, namely *Montastrea* and *Pavona*. Overall, during the three years of observation, the dominant coral genus was *Acropora*.

Corals from the genus *Acropora* are easy to grow compared to other coral genera, even though the water conditions are current. [20] stated that the types of corals that live in currents are usually branched corals. Not much different from the research conducted by [21] in the waters of Krueng Raya, Aceh Besar, the number of coral genera found were eight main genera, with the genus *Porites* dominating in 2019.

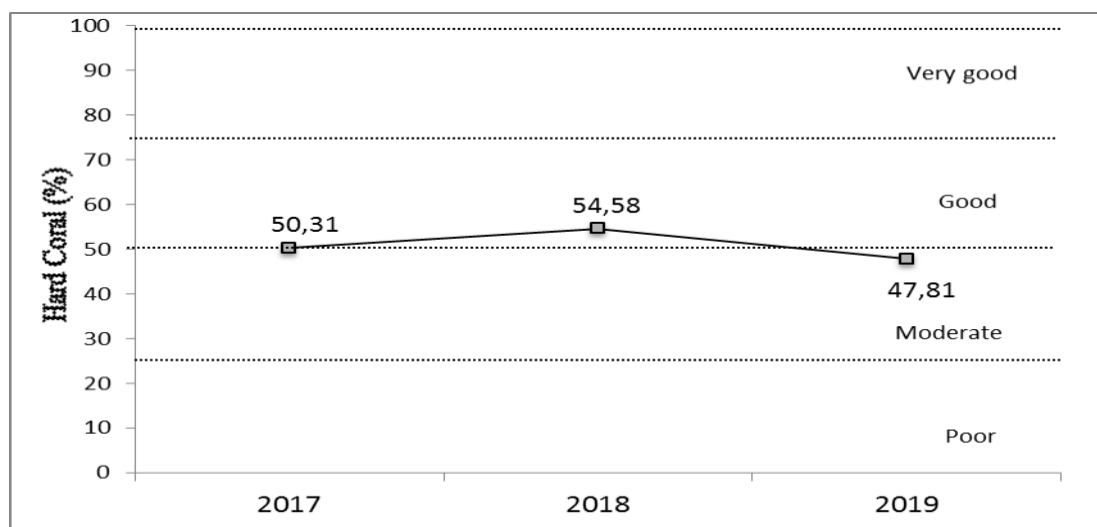


Figure 1. Changes in coral cover in Ujong Pancu waters

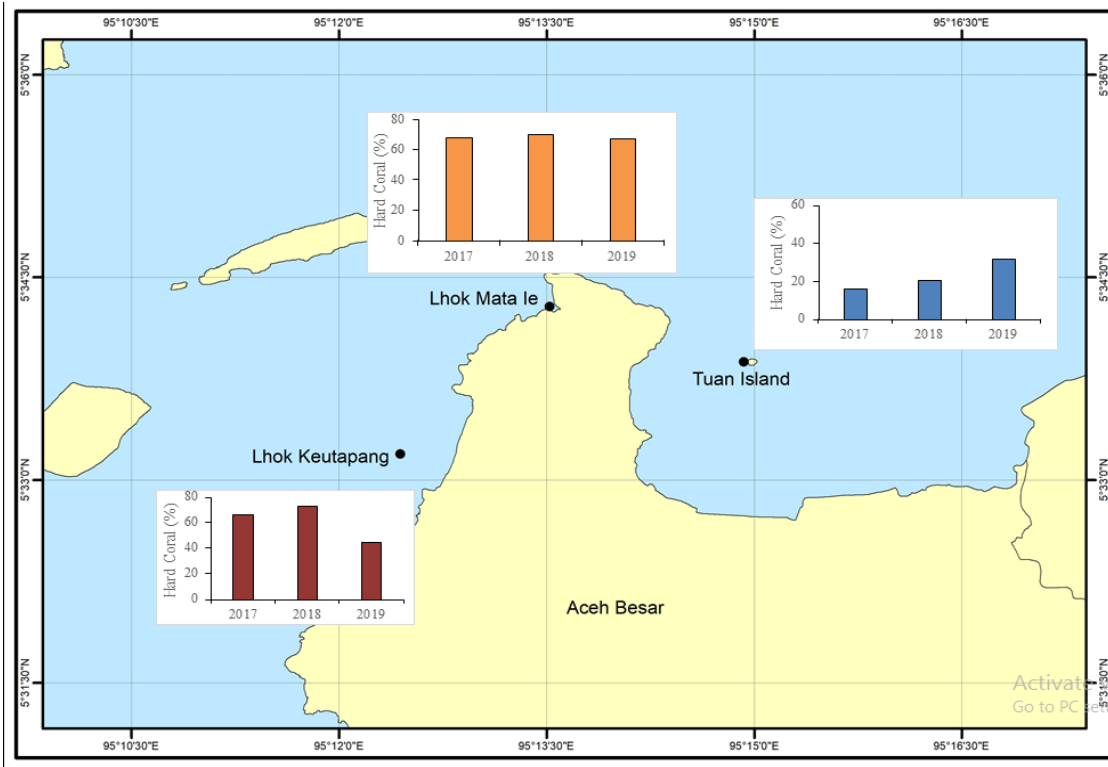


Figure 2. Percentage of hard coral cover at the locations of Lhok Keutapang, Lhok Mata Ie, and Tuan Island

Table 2. Composition of coral genera in Ujong Pancu waters

Genera	Tahun (%)		
	2017	2018	2019
<i>Acanthastrea</i>	0,42	0	0
<i>Acropora</i>	76,32	67,37	82,65
<i>Alveopora</i>	0	0,57	0
<i>Ctenactis</i>	0	0,19	0
<i>Echinophyllia</i>	0	2,48	0
<i>Echinopora</i>	0	7,44	0,65
<i>Euphyllia</i>	0,42	0	0
<i>Favia</i>	0	0	0,22
<i>Favites</i>	0,21	0,19	0
<i>Fungia</i>	0,63	0,38	0
<i>Heliopora</i>	10,78	7,06	0,22
<i>Hydnophora</i>	0	0,38	0
<i>Millepora</i>	0,42	0	0
<i>Montastrea</i>	0	0	0,22
<i>Montipora</i>	1,27	5,73	2,17

<i>Pavona</i>	0	0	0,65
<i>Pocillopora</i>	8,25	4,58	9,54
<i>Podabacia</i>	0,42	0	0
<i>Porites</i>	0,85	2,67	3,69
<i>Psammocora</i>	0	0,19	0
<i>Sandalolitha</i>	0	0,76	0
Total	100	100	100

4.3. Coral Mortality Rate

The calculation of the Mortality Index (IM) of coral reefs at the Lhok Keutapang and Lhok Mata Ie locations showed no significant change from live coral to dead coral. Both sites have a mortality index value ranging from 0.02-0.07 (low coral mortality). In contrast to the Tuan Island location, in 2017, the mortality index value was 0.393, then there was an increase in 2018 of 0.684. There was a significant change from live coral to dead coral in that year. However, in 2019 the mortality index value decreased again to 0.144, indicating the condition of coral reefs at that location has begun to recover (Table 2).

Table 3. Coral Mortality in Ujong Pancu waters

Location	Year		
	2017	2018	2019
Lhok Keutapang	0,074	0,021	0,053
Lhok Mata Ie	0,064	0,026	0,061
Pulau Tuan	0,393	0,684	0,144

The highest increase in coral mortality in 2018 was on Tuan Island due to the disposal of aquaculture pond waste, increasing *Acantaster planci*. *A. planci* is a coral polyp-eating organism and is a significant potential problem in coral reef management. Among the existing coral predators, these animals are the most dangerous coral predators when there is a population outbreak. Almost all living corals are preyed on by these animals. The waste is in the form of organic waste in metabolic products and leftover shrimp feed. Shrimp culture waste is organic waste, especially from feed, feces, and dissolved materials that will disrupt the ecosystem in these waters [22]. Shrimp pond waste contains organic material consisting of protein, carbohydrates, and other inorganic materials such as nitrogen, phosphorus, and ammonia. This waste will affect the coral reefs so that the corals in the waters of Tuan Island are damaged and die.

Meanwhile, Lhok Mata Ie and Lhok Keutapang, due to their geographical location, is more protected. The distribution of waste is not too significant, so it is suspected that it will not affect coral mortality too much. Lhok Mata Ie and Lhok Keutapang are located in the western part of Aceh Besar District. In contrast, the shrimp pond waste channel is located directly in Tuan Island, the eastern part of Aceh Besar District.

5. Conclusion

The percentage of hard coral cover in Ujong Pancu waters decreased from the good category (50.31%) in 2017 to moderate (47.81%) in 2019. The percentage with the highest coral cover was at the Lhok Keutapang location, which was 72.81 % in 2018, while the lowest coral cover was in Tuan Island, which was 15.94% in 2017. The composition of the coral genus found also decreased from 11 coral genera (2017) to 9 coral genus (2019). The coral mortality index in the Ujong Pancu area in 2017 was 0.177, increased in 2018 to 0.24, and subsequently decreased to 0.086 in 2019.

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