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Preliminary Study of Coral Reef Condition at the Embankment Construction Site of Pulau Harapan, Kepulauan Seribu National Park, DKI Jakarta

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Abstract

The construction of the embankment on Pulau Harapan aims to break the waves and protect the land from coastal abrasion. The construction of this embankment will provide many benefits for the community, but the implementation of its construction activities will, directly and indirectly, have an impact on the condition of the biota in the shallow sea waters of Pulau Harapan. To find out the impact of damage, it is necessary to conduct an initial study of the condition of coral reefs at the embankment construction site on Pulau Harapan. The purpose of this study is to obtain preliminary information on coral reef ecosystems. The method used in this research is the Underwater Photo Transect/UPT method which is then analyzed using CPCe 4.1 (Coral Point Count with Excel extension) software. The results of the physical and chemical measurements of the waters concluded that the quality of the waters at the observation site was still within the tolerance limits for coral life. The results of the analysis of the percentage of live coral cover are in the bad category with a percentage value of 17.1%. The composition of corals found were 5 families and 7 genera. The most commonly found coral genus is Porites. The dominance index value is 0.43 and is included in the low category and means that there is no dominant coral genus. The structure of the benthic community in the survey site area is dominated by sand and coral fragments that have been dead for a long time. The condition of the coral reef ecosystem in the observation area is classified as unstable.

Keyword: Coral Reef, Pulau Harapan Embankment, Underwater Photo Transect.

INTRODUCTION

Coral reefs are one of the most productive coastal ecosystems and are rich in biodiversity. Coral reefs are important massive deposits of calcium carbonate, mainly produced by the coral Scleractinia with little addition of calcareous algae and other organisms that secrete calcium carbonate (Nybakken, 1992). Coral reefs are marine resources that have various functions as breeding habitats, shelter for marine biological resources, are home to 25% of all marine biota, and are the most fragile and easily extinct ecosystems in the world. Therefore, the management of coral reef ecosystems for the preservation of their functions is very important (KEPMEN LH No. 4 Tahun 2001).

In Indonesia, it is known that increasing development activities in coastal areas have a direct impact on coral damage (physical damage) or indirectly (sedimentation), therefore various control efforts need to be carried out. In the context of implementing the coral reef damage control program, the Ministry of Environment issued ministerial decree number 4 of 2001 concerning standard criteria for coral reef damage, it is mandatory to monitor and evaluate the status of coral reef conditions and submit reports to the competent and responsible agencies. Status of coral reef condition is the level of condition of coral reefs at a certain location within a certain time which is assessed based on standard criteria for coral reef damage using the percentage of living coral reef cover area (KEPMEN LH No. 4 Tahun 2001).

Embankment construction on Pulau Harapan, Kepulauan Seribu, DKI Jakarta as a Regional Strategic Activity carried out by the Suku Dinas Tata Air Pemerintahan Kabupaten Administrasi Kepulauan Seribu DKI Jakarta to realize the construction and service of facilities, infrastructure in the field of reliable Water Management towards a new Jakarta that modern and organized. The purpose of the embankment construction is expected to function as a breakwater of the sea and protect it from coastal abrasion. The provision of supporting facilities and infrastructure that can be used by the community as a tourist area and access to the ring road as well as with the existence of a dike around the island is hoped that there will be no more coastal reclamation activities carried out by the community for settlement. The construction of the embankment is planned to have a width of 480 cm with a length of 320 m2 in the western region and the additional location has an area of 420 cm with a length of 130 m2 in the eastern area of the South Pier of Pulau Harapan.

The construction of the embankment will provide many benefits to the community, but the implementation of its development activities will, directly and indirectly, damage important resources in the shallow sea waters of Pulau Harapan, Kepulauan Seribu National Park, DKI Jakarta, including coral reef ecosystems.

To avoid the threat of damage, it is necessary to conduct an initial survey of the condition of coral reefs at the embankment construction site on Harapan Island to obtain data and analysis results to recommend coordinate points or safe locations for mooring barges, lower concrete cubes, and distribution lines of concrete cubes to the location. embankment installation or construction. The results of this survey data analysis are useful in minimizing the level of damage to coral reef ecosystems. In addition, the results of this survey data analysis will also be used as comparative data on the impact of activities on the condition of coral reefs before the embankment construction activities are carried out and after the construction activities are carried out.

METHOD

1. Survey Location

This survey activity was carried out on 22-24 August 2019 at the construction site embankment in the South Harbor Area of Pulau Harapan, Kepulauan Seribu National Park, DKI Jakarta (Figure 1). Location Coordinates where survey data were taken regarding the condition of coral reefs and recommendations for mooring points are shown in Table 1.

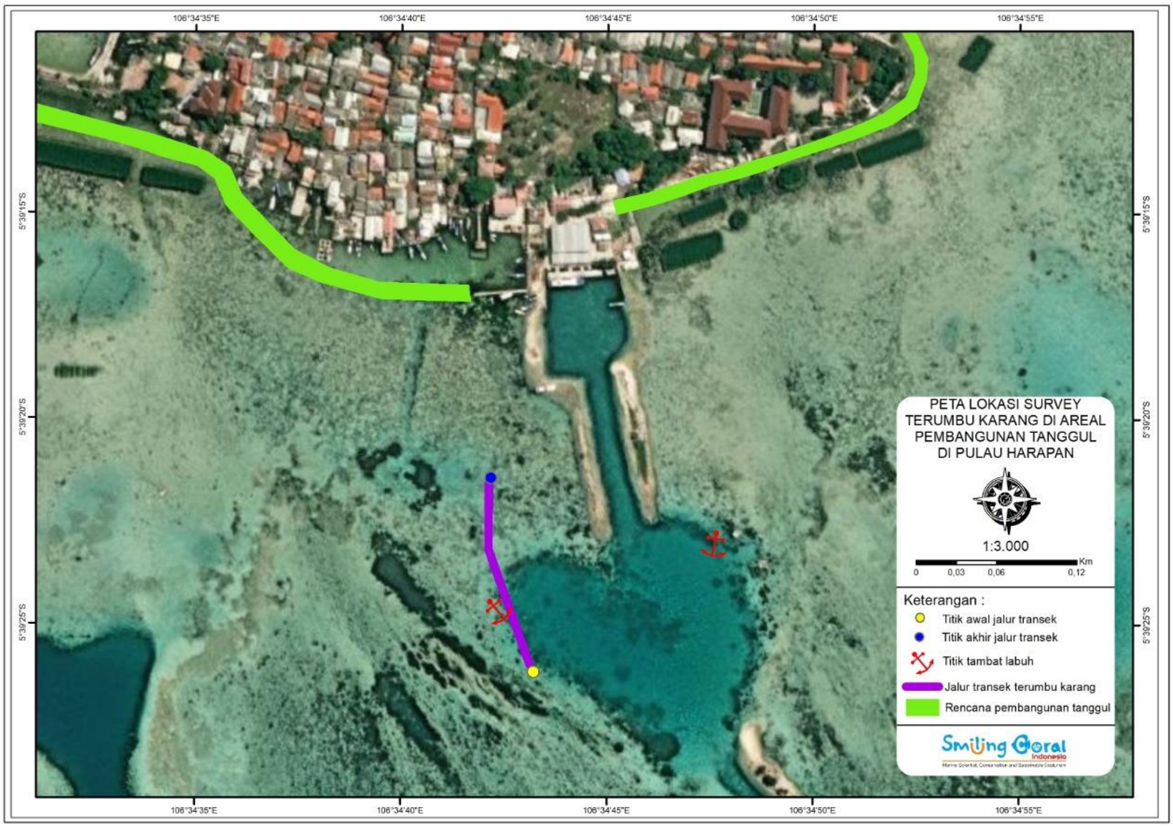

Table 1. Coordinates of survey data collection locations for coral reef conditions and recommendations for anchoring points

No	Coordinate point	Longitude	Latitude
1	Beginning of transect point	106.578611	-5.657222
2	The end transect point	106.578333	-5.656389
3	Recommended mooring point west location	106.578333	-5.6569444
4	Recommended mooring point east location	106.579745	-5.656432

2. Data Collection

Underwater Photo Trasect (UPT) is one of the sampling methods for coral reef health assessment that has been recognized by the Oceanographic Research Center of the Indonesian Institute of Sciences (P2O LIPI), where this method utilizes technological developments, both the development of digital camera technology. and computer software technology. Data collection in the field in the form of underwater photos was then analyzed using computer software called Coral Point Count with Excel extension version 4.1 (CPCe 4.1) which was developed by Kohler and Gill in 2006 from the National Coral Reef Institute (NCRI) to obtain data that quantitative (Giyanto et al, 2017).

A survey of the initial condition of coral reefs was carried out before the implementation of the embankment construction project in the Southern Area of Pulau Harapan Harbor. The researcher dives and draws transect lines/lines at a depth of 2 – 3 m along 100 m following the plan for the drop site and material distribution to the embankment construction site. Taking photos is adjusted to the size of the frame, namely 58 x 44 cm which is placed on the transect line starting at the 1st-meter point and every subsequent meter up to the 30th meter. Sampling in the 100 m transect is repeated 3 times, each replication has a length of 30 m and 5 m for the distance or interval between replicates, thus collected data as many as 90 photos (Figure 2). Taking photos of the installed frame is carried out perpendicularly with a distance of ± 60 cm from the frame and the base of the substrate. The frame is placed in a zigzag manner, i.e. the first point is placed closer to the mainland, then at the next point, the frame is placed further away from the mainland (Giyanto et al., 2010 and Giyanto, 2012).

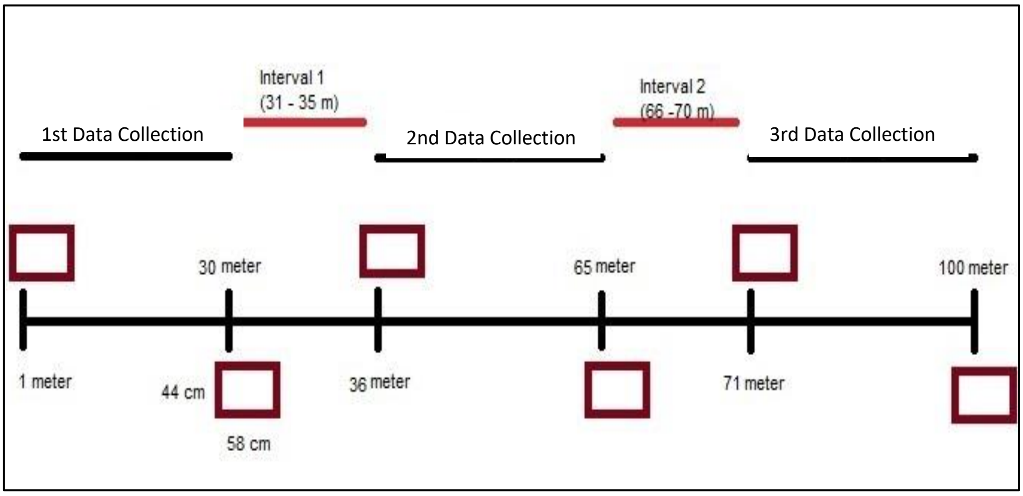

Figure 2. Illustration of transect line.

Data processing in the form of digital photos was analyzed using CPCe 4.1 software in the form of frequency of presence and percentage of cover from the base substrate. Each photo is identified in a limited frame given 30 points that are randomly distributed but still structured, where the results of the analysis consist of 2700 (30 x 90 frames) identified points. Calculation of the coral genus diversity index using these points, one point identified as a hard coral is indicated as an individual. The basic substrate category used in this CPCe has been modified from its initial default to the general category used by marine ecologists for benthic communities on coral reefs developed by English et al (1997) in their manual survey of tropical marine resources. Based on the taxonomic classification, identification of hard coral species was carried out up to the clan level using the Coral Reefs of the World identification book (Veron, 2000) and Coral Types in Indonesia (Suharsono 2008).

Assessment of a coral reef condition can be known through the calculation of the percentage of substrate cover by coral reefs, other biotic and abiotic factors. The percentage of live coral cover obtained is categorized based on the assessment criteria of the Minister of Environment Decree no. 04 of 2001 concerning the standard criteria for coral reef damage (Table 2).

Table 2. Criteria for assessing coral cover conditions

Percentage of Covering (%)	Assessment criteria
0 – 24,9	Bad
25 – 49,9	Moderat
50 – 74,9	Good
75 – 100	Very Good

3. Data Analysis

The processed data from the CPCe software obtained from the UPT method can be further analyzed with several indices that can describe the richness of genera diversity and the stability of the coral reef ecosystem.

a. Shannon-Wiener diversity index (H')

The diversity index is used to measure the community based on the number of hard coral genera in a location. The greater the number of genera, the more diverse the community. This index also assumes that the more species there are, the greater the role of these species in the community. Although in reality, this is not always the case.

The diversity index (H') that is commonly used is the Shannon-Wiener index which is suitable for random communities on a wide scale where the total number of species is known (Ludwig & Reynolds, 1988), with the formula:

$$H' = -\sum_{i=1}^{S} Pi \ln Pi$$

$$Pi = n/N$$

Where:

H' = Species diversity index
Pi = Proportion of the number of types i
n = Number of types i
N = Total number of all types

The criteria for the diversity index are as follows:

H' 2.0 : small diversity
2.0 < H' 3.0 : moderate diversity
H' > 3.0 : high diversity

b. Evenness index (E)

Evenness index (E) is used to see the balance of hard coral communities, by measuring the similarity of the total hard coral species in the community. The more evenly distributed hard coral species, the more balanced the ecosystem will be. The formula used is (Ludwig & Reynolds, 1988):

$$E = \frac{H'}{H'maks}$$

With:
H' max = maximum evenness index = $[(-1/S)][(N/N-1)]$
S = number of genera

The range used in the evenness index is as follows:

0.0 < E 0.5: population evenness is small
0.5 < E 0.75: moderate population evennes
0.75 < E 1: high population evenness

c. Dominance index (D)

The dominance index (D) based on the percentage of coral growth cover is used to see the level of dominance of certain biota groups. If D is high, then the evenness value (E) is low, indicating the dominance of one species over another species. The amount of domination will direct the condition of the community to be unstable or depressed. The formula used to determine the dominance index (Ludwig & Reynolds, 1988) is

$$D = -\sum_{i=1}^{S} (Pi)^2$$

With:
D = Dominance index Simpson

The Simpson dominance index has a range of:

$0,0 < D \leq 0,5$: low dominance
$0,5 < D \leq 0,75$: moderate dominance
$0,75 < D \leq 1$: high dominance

RESULT AND DISCUSSION

a) Condition of water physical and chemical parameters

The water quality at the survey site is still within the tolerance limits for coral life with the measured values of physical and chemical parameters of the waters, namely temperature 30ºC, Ph 8, salinity 39.5 psu, and brightness 8 meters (Table 3).
The temperature value that can affect the optimal growth of coral reefs is in the temperature range of 25 - 30ºC (Sukirno, 1994). According to Nybakken (1992), the temperature that can be tolerated by coral reefs is up to a minimum temperature of 20ºC and a maximum temperature in the range of 36 - 40ºC. According to the Decree of the Keputusan Menteri Lingkungan Hidup Nomor 51 Tahun 2004, the pH standard for seawater that can support marine life is in the range of 7 – 8.5. According to Sukarno (1995), good salinity levels for coral reef life range from 25-40 psu (Sukarno, 1995). According to the Keputusan Menteri Lingkungan Hidup Nomor 51 Tahun 2004, the value of brightness in waters is in good condition if it is more than 5 meters.

Table 3. Values of physical and chemical parameters of waters at the survey site.

Temperature (ºC)	pH	Brightness (m)	Salinity (psu)
30	8	8	39,5

b) Substrate cover by coral reef benthic communities

The results of data analysis on the percentage of hard coral cover at the survey location of the South Pier of Pulau Harapan as a whole are based on the assessment criteria of the Keputusan Menteri Lingkungan Hidup No. 04 Tahun 2001 is included in the low category, which is 17.11%. The low live coral cover was caused by the impact of the construction of the dock pond and at the survey site, it is an active port on Pulau Harapan as a mooring area for ships that move when entering and leaving the dock causing physical damage and high sedimentation in the water column which eventually covers and affects growth live coral at this location. In addition, the coral damage factor at the survey site was caused by solid and liquid waste pollution of the people of Pulau Harapan which had a direct impact on live coral. The activity of coral miners for coastal reclamation by the community is also a factor in the damage to living coral in that location.

The percentage of substrate cover occupies the highest value which is dominated by abiotic in the form of sand at 29.81% and coral fracture at 21.85%. High coral fractures are caused by natural factors such as strong waves and currents and factors from physical activity caused by human anthropogenic activities. From the results of observations, coral fractures are mostly caused by human physical activities such as building docks, mooring anchors, destructive fishing activities, and ship activities. Dead coral fractures that were found were in an old condition. Coral fractures have an impact on the decline in small coral colonies or recruitment. Coral and rock fractures can be used for coral recruitment as a substrate for the formation of new colonies, but because coral fractures are easy to move or unstable, recruit corals will die and cannot survive attached to coral fractures, especially if currents tend to be strong at a location. This is reinforced by the statement of Razak (2006) that the stretch of broken coral and sand is an unstable substrate because it is easily shifted by currents and waves, making it difficult for juvenile corals to stick.

The percentage value of low-level plants in the form of filamentous algae (turf algae) is 16.74%, then the dead coral cover which is almost entirely overgrown with filamentous algae (the age of coral death is long enough) is 5.59%, fine sediment is 5.11%, macroalgae 3.59%. Macroalgae as bioindicators of water quality and as competitors of corals in coral reef aquatic ecosystems. The high algal cover occurs due to an increase in water fertility which can be triggered by the entry of nutrients from 13 rivers that empty into the Jakarta Bay carried to the waters of the Thousand Islands and sourced from household liquid waste pollution from the Pulau Harapan community. Another factor that can also contribute to the increase in macroalgae is the decrease in the number of macroalgae predators, such as herbivorous fish and sea urchins. Jompa and McCook (2003) stated that all species in the macroalgae group are coral competitors that can threaten the existence of live coral if the growth of the macroalgae group is not controlled. Concern about the growth of macroalgae is something that needs special attention. In Caribbean waters, Veirmeij et al. (2010) found that filamentous algae changed the substrate from coral cover to algal cover due to increased nutrition. Herbivorous fish are not even able to control the population of these filamentous algae. As a result, filamentous algae are now the main benthic organisms in Caribbean waters.

The other identified coral reef benthic category is the marine sponge *Clathria* sp. and soft coral *Sarcophyton* sp. which was found to contribute as another category of biota by 0.18% covering the substrate (Figure 3). Sponges and soft corals are multicellular animals with soft bodies, very slow growth, sessile (attached to the bottom substrate of the water), and light in color. In ecosystems, sponges and soft corals have several ecological functions, including as one of the animals that make up the coral reef ecosystem, as a balancer for the ecosystem, and as a supplier of carbonate compounds that are useful for reef formation.

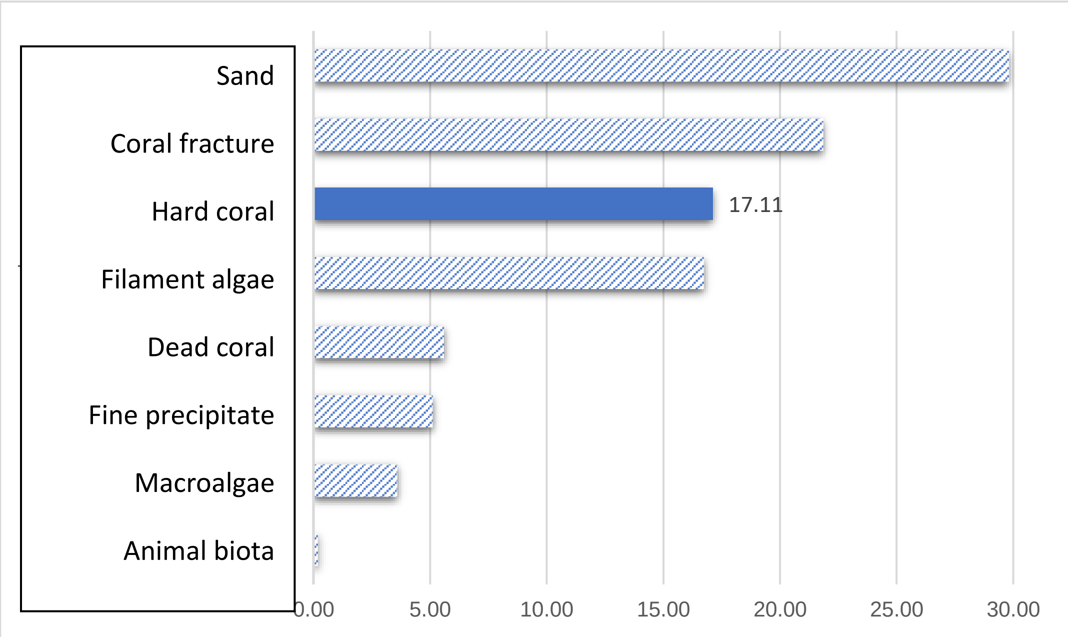

Figure 3. Substrate cover by coral reef benthic communities.

c) Genera composition and growth form of live hard corals

As many as 7 genera were identified which belonged to 5 hard coral families from 437 individuals (Table 4).

Table 4. Hard coral composition

Family	Genera	Total individu
Acroporidae	*Acropora*	69
Agariciidae	*Pavona*	98
Fungiidae	*Ctenactis*	1
Faviidae	*Cyphastrea*	1
	Favites	4
Poritidae	*Goniopora*	5
	Porites	259

The seven genera of hard corals are *Acropora, Ctenactis, Cyphastrea, Favites, Goniopora*, *Pavona*, and *Porites* with a low overall diversity index value of 1.05. The low diversity index is caused by solid and liquid waste pollution, high sedimentation, destructive human anthropogenic activities, space competition (habitat competition) with dominant macroalgae triggered by the entry of nutrients sourced from wastewater pollution from the people of Pulau Harapan. In addition, the type of substrate in the form of sand and high rubble becomes an unstable substrate for the life of young corals and will affect the low number of genera found.

The value of the dominance index ranges from 0-1, the higher the index value, the more visible a biota dominates the bottom substrate of the waters. If the dominance index value (D) is close to zero, then this indicates that there is no dominant biota in the waters and is usually followed by a high evenness value (E). On the other hand, if the dominance value (D) is close to one, this indicates that in the waters there is one biota that dominates and is usually followed by a low evenness value.

The results of the calculation of the dominance index at the survey location show a low value (0.43) indicating that there are almost no certain genera that dominates and a moderate evenness index value (0.54) indicates a moderate trend of genera dominating. It was concluded that the hard coral community at this location was classified as unstable.

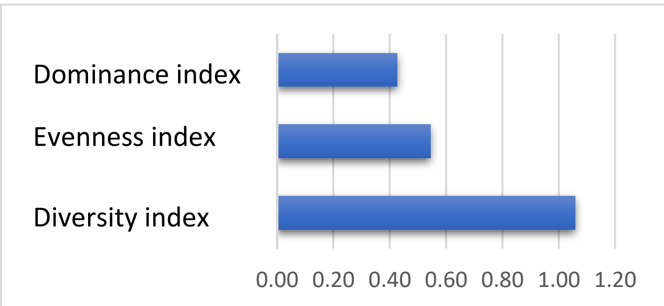

Figure 4. Dominance index (D), Evenness index (E), and Diversity index (H')

The *Porites* genera were the most common genera found compared to other genera with a cover of 9.59% (Figure 5). Hard corals of the Porites genus are a group of corals that can live in turbid waters with good adaptability and more active metabolism so that in turbid waters this genus can still form a broad and dominating unit (Tomascik et al., 1997b; Munasik et al., 2000; De Meesters et al., 2002).

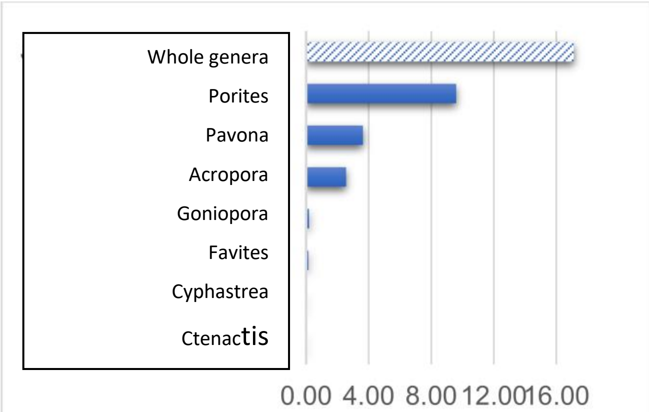

Figure 5. Percentage of hard coral genera cover

The growth form of the *Porites* genus at the survey location was found in 2 growth forms, namely branching coral and massive coral which became the dominant growth form at this location. The dominance of the *Porites* genera is due to a form of adjustment to water conditions that have high sedimentation. According to Cappell (1980), a high sedimentation rate means that the colony will tend to be massive, branching, and foliose. This is reinforced by the statement of De Meesters et al. (2002) that the Porites genus can adapt in turbid waters by carrying out a more active metabolism. so that in turbid waters and low salinity, the dominant coral genus is likely *Porites*. Other coral genera included in the form of massive coral growth are *Goniopora*, *Favites*, and *Cyphastrea.*

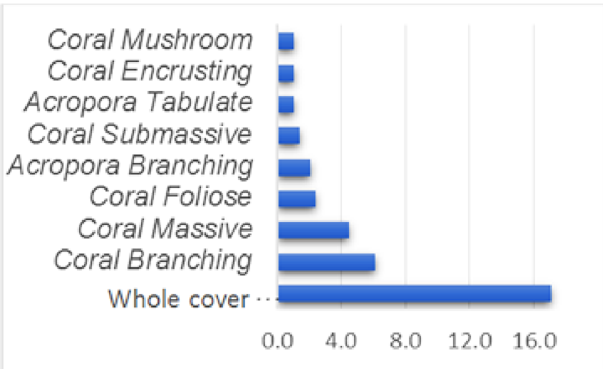

Figure 6. Percentage of hard coral growth

Based on the benthic community category developed by English et al (1997), the *Acropora* genus was separated in its growth form from other (non-Acropora) corals. Acropora branching (Acropora branching) and Acropora tabulate (Acropora table) (Fig. 9) are growth forms of the genus Acropora identified in the survey area. *Acropora* with branching colonies are fast-growing corals because they have relatively small polyp sizes so they have relatively faster growth, have very high recovery power, and are often seen as dominating in coral reef ecosystems. According to Suharsono (1984), Acropora corals have relatively small polyp sizes so that their growth is relatively faster, reaching

20 cm per year. This is reinforced by the statement of Tomascik et al. (1997) although Acropora corals are prone to fragmentation, *Acropora* has a high recovery capacity and fractures can develop into new individuals and can be found in waters with a depth of 3 – 20 m.

Other growth forms are submassive corals (almost massive or almost large) and foliose corals identified are growth forms of the *Pavona*. The growth form of coral mushroom (coral mushroom) generally describes corals from the Fungidae tribe (coral fungus) one of the genera belonging to this family is Ctenactis, this form is solitary and does not attach to the substrate or bottom of the waters

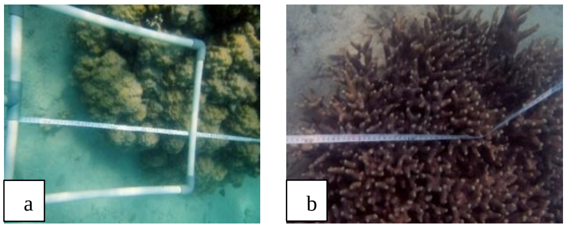

Figure 7. Hard corals of the *Porites* genera in the form of massive coral growth (a) and coral branching form (b).

CONCLUSION

Based on the results of a coral reef survey that has been carried out in the area of the South Pier of Harapan Island embankment construction at a depth of 2 - 3 m, the following conclusions are obtained: the percentage value of hard coral cover in the survey location area is low or poor, namely 17.1%; the hard corals found in the survey area consisted of 5 family and 7 genera; the structure of the benthic community in the survey site area is dominated by sand and coral fragments that have been dead for a long time; the condition of the coral reef ecosystem in the survey location area is classified as unstable.

From the survey results, several coordinate points are recommended for mooring barges, loading goods, and distribution lines of cube concrete to the location of the embankment construction activity so that the implementation does not damage the coral reef ecosystem.

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