Changes of Coral Reefs Condition in the Core Zones of Kapoposang Island MPA, Makassar Straits

T Arifin, R Rahmania, Yulius, D P Gunawan, N A Setyawidati, N Gusmawati and M Ramadhan

Marine Research Center, Ministry of Marine Affairs and Fisheries Republic of Indonesia

E-mail: a.taslimar@gmail.com

Abstract. Coral reefs in Kapoposang Islands have been degraded for years due to environmental pressures and human activities. After designated as marine protected area (MPA), coral reefs conditions (e.g. living coral coverage - both hard and soft corals) were monitored regularly since 2015 by several agencies. This study aims to evaluate the effectiveness of MPA management in Kapoposang by analyzing changes of coral reef coverage in its two core zones. The survey was conducted in July 2019 using Line Intercept Transect (LIT), video transect, and satellite imagery analysis, then compared to data from the previous assessment. Results of recent survey, i.e.: living coral reefs coverage ranged from 46.73% - 73.08%; 21 genera found with 10 dominant genera, which Porites sp., is a resistant coral genus and the most dominant genus in Kapoposang MPA; the highest coral recruitment was found in Suranti island at a depth of 10 meters, while the lowest is in Papandangan island; several genera in the form of recruitment (e.g. Acropora sp., Goniopora sp., Fungia sp., Favona sp., and Porites sp.); percentage of macroalgae is 2.95% of total coral reef substrate cover; the most densely macroalgae coverage is found in Suranti, while the lowest is in Kapoposang island.

1. Introduction

In the Makassar Strait lies many small islands including the Spermonde Islands which are located in the western part of South Sulawesi. Administratively, the islands are part of Maros Regency, Pangkep Regency, Makassar City and Barru Regency [1]. The Spermonde Islands are crossed by the Wallacea line (figure 1), and are characterized by a congregation of high marine biodiversity [2].

The condition of coral reefs in the region has been degraded, due to anthropogenic activity and domestic wastes. These were confirmed by Edinger et al. [3], that one of the causes of coral damage in the Spermonde Islands was an increase in the amount of domestic and industrial wastes in the form of organic material and sedimentation. Furthermore, environmental pressures due to onshore activities have reduced biodiversity in coral reef areas by 30-60% [4]. In addition, the increasing of sea surface temperatures due to global climate change may lead to mass coral bleaching [5].
Figure 1. Wallacea Region

Marine Protected Area of Kapoposang and its surrounding sea (MPA) in Spermonde Islands (figure 2) is one of the representatives of the fringing coral reef ecosystem, seagrass, and mangrove in Sulawesi. The coral reef ecosystem in the waters of the MPA has a high diversity of flora and fauna with a representation rate of around 55% and 70%. These water, coastal and small islands conservation areas are determined through Ministerial Decree KP No. 59/KEPMEN-KP/2014. MPA has an area of 50,000 hectares and a length of 103 km that covers waters on 6 islands, namely Kapoposang Island, Papandangan Island, Tambakhulu Island, Bali Gondong Island, Pamanggangan Island, and Suranti Island.

MPA management is carried out based on the zoning system: Core Zones/Sanctuaries, Sustainable Fisheries Zones, Utilization Zones, and other Zones according to their characteristics and designation. The core zone has a total area of approximately 1,084.6 Ha consisting of 2 (two) locations: Core Zone 1, located on Kapoposang Island with an area of 775.4 Ha; and Core Zone 2, located on Suranti Island with an area of 309.2 Ha. The Sustainable Fisheries Zone is located outside the waters of the islands with a total area of 39,340.3 Ha.

As an area that is vulnerable or sensitive to disturbance and areas that have a high diversity of flora and fauna, human activity in the Core Zone is very limited. The effectiveness of MPA management is the result of a collaboration between the government and the local government with the community in efforts to conserve fish resources and marine ecosystems. An assessment of changes in the condition of coral reefs in the core zone needs to be carried out in an effort to monitor the effectiveness of Kapoposang MPA management.
2. Materials and Methods

Technically, coral reef data collection uses two methods, namely the Line Intercept Transect (LIT) method [6] (figure 3) and the video transect method [7] (figure 4) at 6 observation stations on Kapoposang Island, Papandangan, Pamanggangan, and Suranti Islands.

![Figure 3. Illustration for collecting coral cover, other biotas, and coral reef substrate data using the LIT method](image-url)
Data collecting at each study site was divided into 2 (two) types of depth, namely: shallow (depth 5 m) and deep (depth 10 m) types.

### 2.1. Percentage of Coral Cover
Percentage of Coral Cover (%) is calculated using the following formula:

\[
\text{Percentage of Coral Cover} = \frac{\text{Total of coral cover per type}}{5000 \text{ (Transect length)}} \times 100\%
\]

Then by referring to Yap and Gomez [8], the condition of coral reefs was categorized based on the percentage of cover, namely: (a) Excellent: If the percentage of coral cover is 75-100%; (b) Good: If the percentage of coral cover is 50-74.9%; (c) Fair: If the percentage of coral cover is 25-49.9%; (d) Poor: If the percentage of coral cover is 0-24.9%.

### 2.2. Coral Recruitment and Class Distribution
According to Bachtiar [9], the colony size which is less than 10 cm is the size of the coral that can describe the recruitment process by looking at the increase in the number of classes. The class size distribution used in this study refers to the study of Grimsditch et al. [10].

### 3. Results and Discussion

#### 3.1. Coral Coverage
Based on analysis using the Line Intercept Transect (LIT) method at all observation stations, coral reef conditions were obtained as shown in Figure 5. The percentage of live coral ranged from 46.7 to 73.08% with the average coral condition category is Good. Nonetheless, the percentage of abiotic became the second-highest cover that dominated at all observation stations. The dominant type of abiotic is rubble or coral fragments. Based on the Institute of Manager of National Water Conservation Area (BKKPN) in Kupang reported in 2015, many rubbles were formed because of fishing incidents using explosives. The result is in line with the abiotic substrate coverage percentage which is dominated by coral fragments at each observation station.
Figure 5. Percentage of coral cover (live coral, dead coral, algae, other, and abiotic) in observation stations in 2019

Further, BKKPN Kupang revealed the trend of coral reef ecosystem conditions in the period of 2015 - 2018, during which time the condition of coral reef ecosystems has increased in growth. In 2015 the average of coral reef coverage was 48.21%, in 2017 it was 61.22% and in 2018 observations reached 66.92% (figure 6).

Figure 6. Percentage of coral cover in observation stations in 2015, 2016, and 2018

The condition of coral coverage in the period of 2015 and 2019 (figure 7) and (table 1), especially in the core zone of Kapoposang Island and Suranti Island have changed, where the condition of coral coverage on Kapoposang Island has increased by an average of 9.93%, while on Suranti Island there was a decrease of about 19.05%.
Figure 7. Percentage of coral cover in observation stations in 2015 and 2019

Table 1. Data of coral cover (live coral, dead coral, algae, other, and abiotic) in observation stations in 2015 and 2019

| Type Zona     | 2015  | 2019  |
|---------------|-------|-------|
|               | Live Coral | Dead Coral | Algae | Other | Abiotik | Live Coral | Dead Coral | Algae | Other | Abiotik |
| Kapoposang 1  | 49.27  | 3.00  | 21    | 20.40 | 6.53    | 53.5       | 15.65      | 1.27  | 0.55  | 28.83   |
| Kapoposang 2  | 61.47  | 12.27 | 6.33  | 11.40 | 8.53    | 73.08      | 7.72       | 0.23  | 1.11  | 17.86   |
| Papandangan   | 54.77  | 0.17  | 20    | 12.58 | 12.51   | 68.72      | 11.87      | 0.93  | 0     | 18.48   |
| Pamanggangan  | 33.40  | 1.43  | 25.80 | 23.14 | 16.53   | 45.68      | 5.91       | 2.8   | 0     | 45.61   |
| Suranti 1     | 69.06  | 3.6   | 14.8  | 8.40  | 4.94    | 50.01      | 32.11      | 8.13  | 2.95  | 6.8     |
| Suranti 2     | 32.53  | 0.47  | 37.9  | 28.86 | 0.4     | 46.73      | 13.53      | 4.39  | 1.92  | 33.43   |

Sources: Data 2015 (Coremap CTI, 2015) [11]; Data 2015 (Survey MPA Kapoposang, 2018) [12]

3.2. Frequency of coral size classes
Coral size class can describe the condition of coral reefs in an area. The frequency of hard corals based on their size is dominated by corals with a size of 41-80 cm which is distributed almost at each observation station (figure 8).
3.3. Coral Recruitment
Coral recruitment is a coral colony of \( \leq 10 \text{ cm} \) in size (figure 9) which shows the potential for coral regeneration in water. Overall, the highest coral recruitment is at Station 1 depth of 10 meters, and the lowest coral recruitment is at Station 3. Some genera found in the form of recruitment such as *Acropora* sp., *Goniopora* sp., *Fungia* sp., *Favona* sp., *Goniopora* sp., and *Porites* sp. *Porites cylindrica* corals develop rapidly and have the highest recruitment rate after the tsunami [13].

3.4. Macroalgae
Based on observations, the percentage of macroalgae was 2.95% (figure 10) of the total coral reef substrate cover. The most densely macroalgae cover is at station 1, while the lowest macroalgae cover is at station 6.

Coral reefs regularly have the ability to compete with macroalgae, but macroalgae density can
affect reef growth [14]. Macroalgae composition and biomass increases in spring and decreases in summer, with maximum macroalgae abundance corresponding to average temperatures between 22°C and 24°C [15].

![Figure 10](image1.jpg)

**Figure 10.** Percentage of macroalgae cover in observation stations

### 3.5. Resistant Coral Genus

The resistant coral genus is a type of coral that is more resistant to changes in temperature and other factors that cause coral death. In this study, several coral genera such as the genus *Psammocora* sp., *Pavona* sp., and *Goniopora* sp. is a genus that has high resistance compared to other genera. Overall the genus that is found in the genus *Porites* sp. According to Wilson, et al. [16], *Porites* sp. is a genus of moderate resistance.

![Figure 11](image2.jpg)

**Figure 11.** Percentage of resistant coral genus in observation stations
4. Conclusion
The live coral coverage in the MPA of the Kapoposang Islands and the surrounding sea is in good condition, with the genus that is mostly found is *Porites* sp., and dominated by coral measuring 41-80 cm. Suranti Island waters have the highest macroalgae and coral fragments coverage compared to other observation stations. *Acropora* sp., *Goniopora* sp., *Fungia* sp., *Favona* sp., *Goniopora* sp., and *Porites* sp. are genus of coral recruitment found in MPA.

There has been a change in the condition of coral reefs in the core zone (in 2015 and 2019), where on Kapoposang Island the increase ranged from 4.23 - 13.95%, and conversely there was a decline in Suranti Island around 19.05%. This indicates the lack of effective management and supervision in the Kapoposang MPA area, especially on Suranti Island.

The policy recommendations that need to be made are (a) Continuation of zoning socialization and its rules to increase knowledge and awareness of the community and stakeholders in the management of the Kapoposang MPA area, (b) Development of harvest control regulations in support of sustainable fisheries, such as fishing gear regulation, size regulation and the number of catches allowed, and (c) the installation of a boundary in the core zone.

5. Supplementary data
Photos of substrate in core zone

**Suranti Island**
Kapoposang Island

6. References

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