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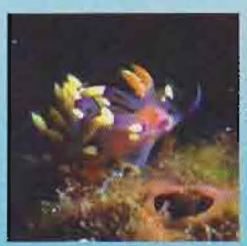


THE EFFECT OF SEDIMENT LOAD ON FRINGING REEF CORALS AT MEKKONGA GULF, SOUTHEAST SULAWESI, INDONESIA

By : Mahatma Lanuru[34] and Syafyudin Yusuf[35]

ABSTRACT

Mekongga Gulf is one of coastal water affected by mining activities in the land. These mining operation activities have been lasted for more than two last decades and were supposed to produce excessive sediments that may influence coastal ecosystem stability (e.g. coral reefs) in the coastal areas. The effect of sedimentation on coral reef at the Mekkonga Gulf (Southeast Sulawesi, Indonesia) was examined in November 2007 (dry season) and May 2008 (wet season). The coral reef conditions were determined using line intercept transect (LIT) method at seven stations were (i.e. CRS1, CRS2, CRS3, CRS4, CRS5, CRS6, and CRS7). Sediment deposition rate was measured with sediment traps at the river mouth of Huko-huko and Oko-oko and Tambea village. Results of this study showed that deposition rates were higher during wet monsoon (May 2008) compared to those in dry monsoon (November 2007). Sedimentation reduced live coral coverage at river mouth stations (Station CRS2 and CRS 6). The decrease of live coral coverage was attributed to be the results of increasing sediment load to the coastal area during wet season as indicated by increasing of deposition rate.

Key words: Sedimentation, corals, coral reef, Mekongga Gulf, Southeast Sulawesi

INTRODUCTION

Coral reefs are the most diverse marine ecosystems on earth and provide essential resources to millions of people living in tropical and subtropical coastal areas. Despite their importance and value, coral reefs have been declining at an alarming rate in the past few decades due to both natural and human impacts (Golbuu et al., 2008). Sedimentation is cited as one of the main destructive forces for coral reefs (Babcock & Davies 1991). Enhanced sediment loading of coastal waters generally results from terrestrial deforestation (McManus 1988) or marine construction works and dredging (Brown 1997).

Sedimentation is a natural part of coral reef dynamics, but changes in land-use patterns can alter the quantity and quality of sediment in the nearshore coastal ocean. Terrestrial sediment is likely to be the most dangerous to reef corals, since sediment runoff from urban and agricultural areas often contains harmful organic compounds, heavy metals, or nutrients (Fabricius, 2005). Grain size, organic content, and nutrient-related properties are primary factors in determining sedimentation stress in corals. Nutrient-rich terrestrial

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sediment can be biologically aggregated into marine snow, which can be detrimental or lethal to reef organisms after just a few hours' exposure (Fabricius and Wolanski, 2000).

Mekongga Gulf (Southeast Sulawesi, Indonesia) is one of the coastal water affected by mining activities in the land. These mining operation activities have been lasted for more than two decades and were supposed to produce excessive sediments that may influence coastal ecosystem stability in the coastal areas. Coral reef is one of the three main coastal ecosystems in Mekongga Gulf that may suffer from the high sedimentation rate.

There was relatively few research in Indonesia regarding effect of sedimentation on coral reefs, the present study, thus evaluates the effect of sediment load on fringing reef corals at Mekongga Gulf.

METHODS

Study Site

The field study was conducted in November 2007 (dry season) and May 2008 (wet season) at Mekongga Gulf, Southeast Sulawesi, Indonesia. At the study area, seven stations were chosen, i.e. CRS1, CRS2, CRS3, CRS4, CRS5, CRS6, and CRS7 to assess the effect of sedimentation on fringing reef corals. Station CRS2 and CRS6 are located at Huko-huko and Oko-oko river mouths, respectively. Station CRS4 is located close to Tambea village, while CRS7 is located at Maniang Island.

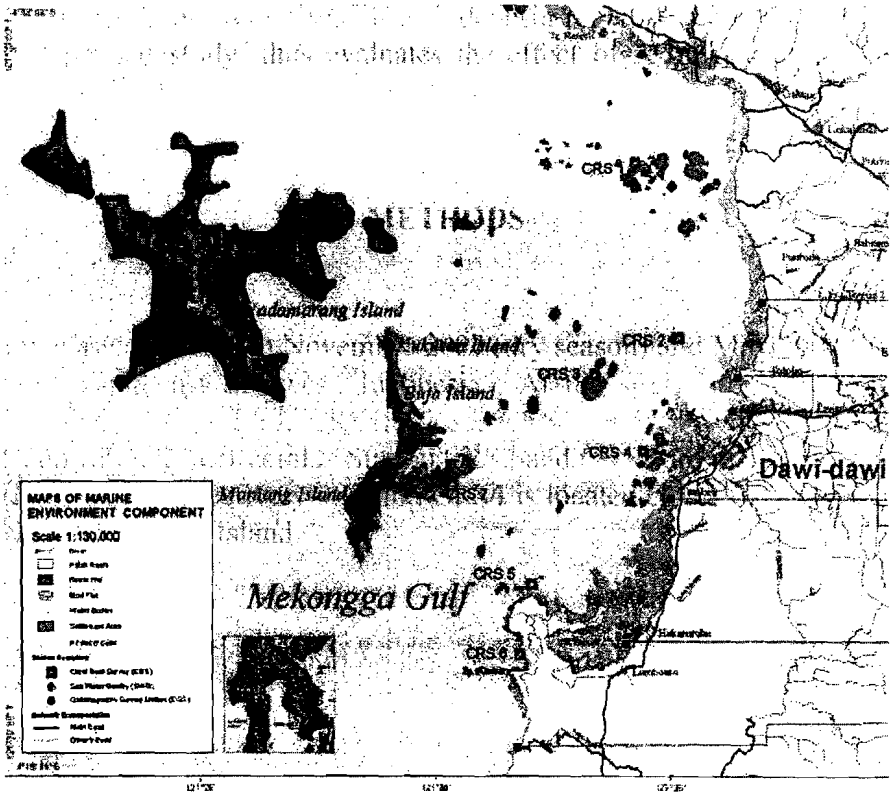

Figure1. Map Of Study Site Showing The Sampling Stations.

Sediment Deposition Rate

Sediment traps were deployed at 30 cm above the sea-bed at Huko-Huko river mouth (Stations OSS1), Tambea village (Station OSS4), and Oko-Oko river mouth (station OSS6) to measure the amounts of sediment deposition. The traps consist of PVC tubes closed at the lower end. The inner diameter of the tubes is 5.0 cm and the length of the tube is 25.0 cm giving an aspect ratio of 5 which is consider optimal for measuring sediment flux in horizontal flows, in which maximum speed infrequently reach 0.2 m s^{-1} (Gardner, 1980). All traps were mounted on an iron stick of 50 cm long, diameter 0.5 cm, driven into the 30 cm x 30 cm cement-concrete at each sampling stations. Sediment deposited at the traps was collected after a deployment period of 2 - 4 days to measure sediment flux.

Materials collected in the traps were filtered using preweighed Millipore GEM filter of 0.45 μm pore size. The filters were dried for 2 hours at 105 °C and weighed.

Coral Reef Conditions

Line Intercept Transect (LIT) method was used to estimate habitat coverage (life form) and benthic community of coral reefs following method described by English et al., (1997). Length of the transect was 30 meters and lay parallel to the shoreline following the coral reef contour. Transition of life form and substratum category of coral reef along the transect was noted. Colony shapes (life form), substratum type, organism species, live and dead corals were measured to the centimetre scale. Lifeform categories used in this study are live hard coral (acropora and non acropora), dead coral, other fauna, algae, and abiotic. Dead coral was grouped into dead coral covered by algae (DCA) and white (DC) that has not been covered by algae yet (English, et al., 1997).

RESULTS AND DISCUSSION

Sediment Deposition Rate

Sediment at the study site is dominated by terrigeneous sediments with grain diameters varied from very fine sand to coarse sand. Deposition rate at the study site is presented in Table 1. Deposition rates were higher during wet monsoon (May 2008) compared to those in dry monsoon (November 2007) at station OSS1 (Huko-huko river mouth) and Station OSS6 (Oko-oko river mouth). Higher deposition rate at Stations OSS1 and OSS6 observed in May 2008 was mainly caused by increasing sediment load to the coastal area at the study site through both Huko-Huko and Oko-Oko Rivers during rainy/wet monsoon. In addition, high deposition rate observed at Station OSS6 in May 2008 may also caused by directly input of eroded sediment from the land as a result of soil erosion due to land clearing and deforestation.

Table 1. Sediment Deposition Rate At Station OSS1, OSS4, And OSS6.

Station	Deposition Rate (g m^{-2} d^{-1})	
	Nov 2007	May 2008
OSS1 (Huko-huko river mouth)	6.9	76.0
OSS4 (Tambea village)	171.1	100
OSS6 (Oko-oko river mouth)	12.8	190.1

Deposition rates remain high at the Station OSS4 both in dry monsoon (November 2007) and wet monsoon (May 2008). High deposition rate at Station OSS4 is probably due to sediment input from "stockpile" that found close to Station OSS4 as shown in Figure 2.

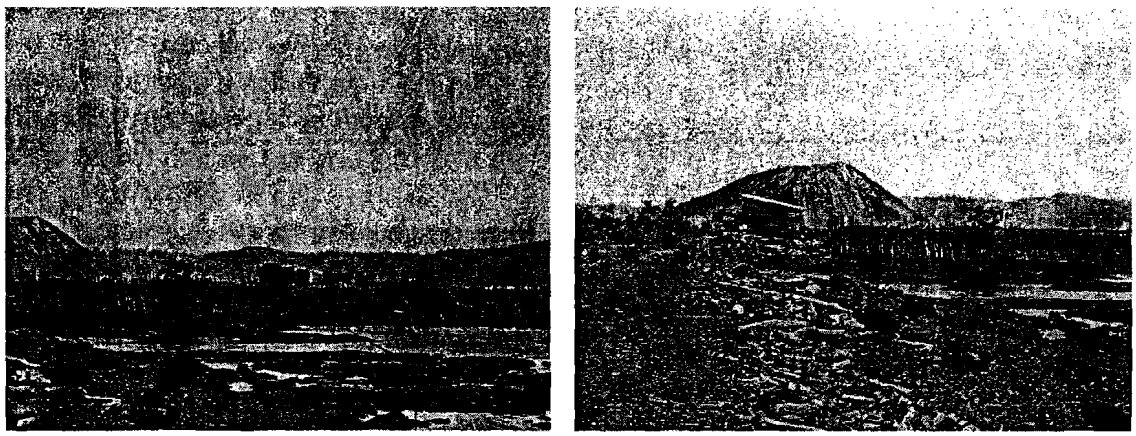

Figure 2. Stockpile/pile of sands that found close to Tambea village (Station OSS4).

Coral Reef Conditions

Coral reef condition was assessed based on the percentage of live coral coverage that obtained from average values of LIT. Coral reef that classified as in good condition with coral coverage above 50 percent was only found at station CRS1 and CRS2. Moreover, coral reef condition that categorized as in fair/moderate condition was observed at stations CRS3, CRS4, CRS6 and CRS7, while coral in bad/damaged condition was found at station CRS5 (Figure 3). This condition was strongly influenced by the station distance to the location of human activities in the land and distance to the estuary. According to Nuquest and Rober (2003), mortality rate of coral was higher at location close to the estuary rather than the further one, where sediments were deposited to the coral colonies. There were changes in live coral coverage from dry season (November 2007) to wet season (May 2008). As shown in Figure 4, coral degradation was occurred at stations CRS2, CRS3, CRS5, and CRS6. In contrast, the accretion or improvements of live coral coverage were observed at station CRS4 and station CRS7 (Figure 4). The highest decline of coral reef was found at stations CRS2 and CRS6.

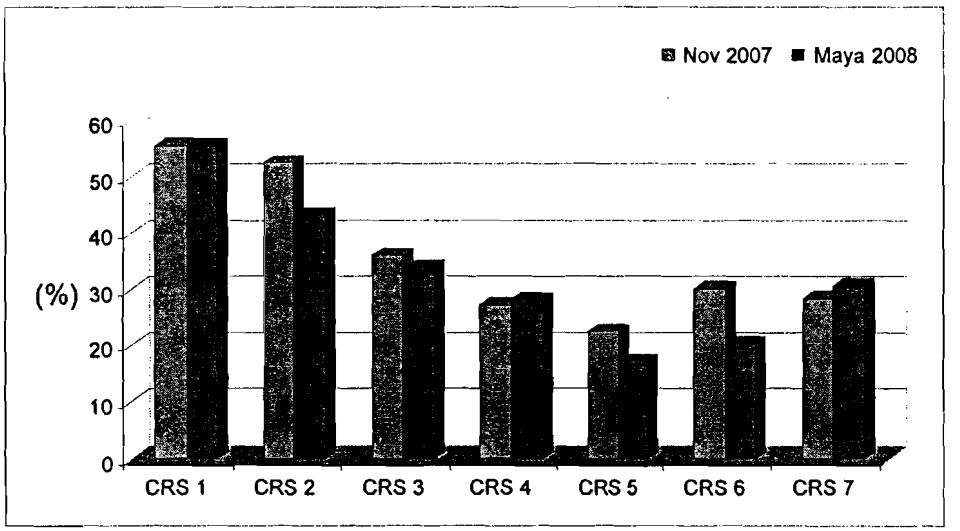

Figure 3. Live Coral Coverage At Makongga Gulf On November 2007 And May 2008

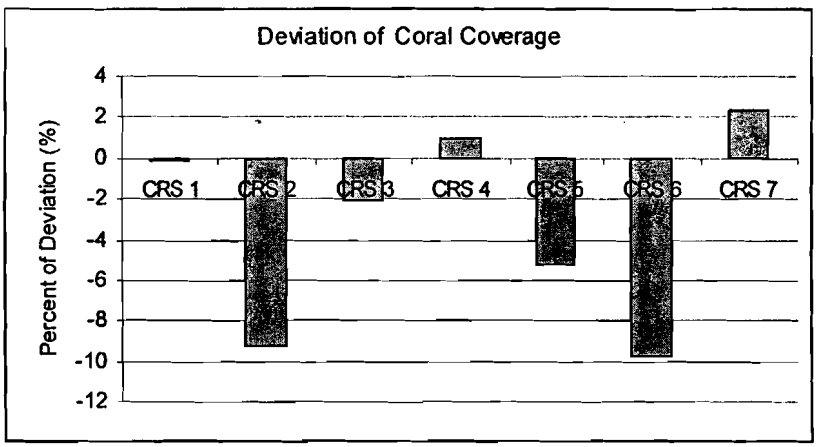

Figure 4. Deviation of coral coverage for six months (Nov 2007 – May 2008)

Detail examination conducted on dead coral component revealed that dead coral components at the study site consisted of coral debris (R), recent dead coral (DC) and dead coral covered by algae (DCA). Dead coral covered by algae (DCA) is a form of coral dead due to natural disturbance such as grazing by *Acathaster planci* and result of sedimentation, while coral debris (R) is an indication of coral broken by destructive fishing like blast fishing.

Coral degradation at the study site was not merely caused by sedimentation as observed at stations CRS4 and CRS6, but also by eutrophication. This was indicated by the presence of algae that growing between live corals and dead coral substrates. Moreover, degraded corals due to destructive fishing were observed at almost all stations where dead coral (DC) and rubble (R) were more dominant, except at station CRS6 where corals and other coral reef components were covered by 67.70 % of silt (Table 2).

Table 2. Indicators Of Coral Reef Degradation In Mekongga Gulf

Station	Damage Indicators				Possibly causes
	Dead Coral (%)	Rubble (%)	Silt (%)	Algae (%)	
CRS1	11.23	24.6	0.00	0.00	Destructive fishing (blasting and cyanide)
CRS2	7.57	46.62	0.00	0.00	Destructive fishing more than sedimentation effect
CRS3	13.72	40.13	0.00	0.00	Destructive fishing more than sedimentation effect
CRS4	44.68	0.00	4.53	0.47	Sedimentation and eutrophication
CRS5	32.55	21.33	0.00	0.63	Destructive fishing: blasting and cyanide
CRS6	0.00	0.00	67.70	0.08	Most sedimentation (siltation) directly from mining
CRS7	35.55	19.92	0.00	0.00	Destructive fishing

Effect Of Sediment Load On Coral Reef

Although sedimentation has long been known to affect corals, the ways in which it does so are complex (Nugues and Roberts, 2003). Sediments can cause coral mortality directly by increasing energy expenditure from removing sediment particles from coral tissue. However, they can also affect corals indirectly by decreasing the light available to photosynthesising symbiotic algae, or stimulating the growth of competitors of corals (reviewed by Rogers, 1990). In this study, there was correlation between coral degradation and sedimentation rates measured in traps. Live coral coverage decreased in May 2008 (wet monsoon) compare to those in November 2007 (dry monsoon) at station CRS 2 and CRS 6 as deposition rate increased in wet monsoon both at Huko-huko and Oko-oko river mouths (see Table 1).

Sedimentation reduced live coral coverage at the stations close to river mouth (CRS2 and CRS 6) during wet monsoon. However, station CRS7 was not affected by sedimentation due to location is far enough from the mainland/rivers. This result in line with the findings of Nuquest and Rober(2003). Riverine sediment discharge through Huko-huko and Oko-oko river mouths would have negatively effect on coral reef at the study site as the fine sediments may cover polyps of the corals and hence can cause coral damaged and coral mortality. This may explain why low live coral coverage was observed in wet monsoon at river mouth stations (CRS2 and CRS6).

In addition, high deposition/sedimentation at at Station CRS4 (close to Tambea village) had bad effect to coral reef health around station CRS4 as deposited sediment on the corals (Figure 5) will cover coral colonies and inhibit the photosynthesis of coral's zooxanthella (Philipp and Fabricus, 2003; Fabricus, 2005). As a result, many dead corals were found at the station (Table 2) and percent cover of corals at the station is relatively low (Figure 3).

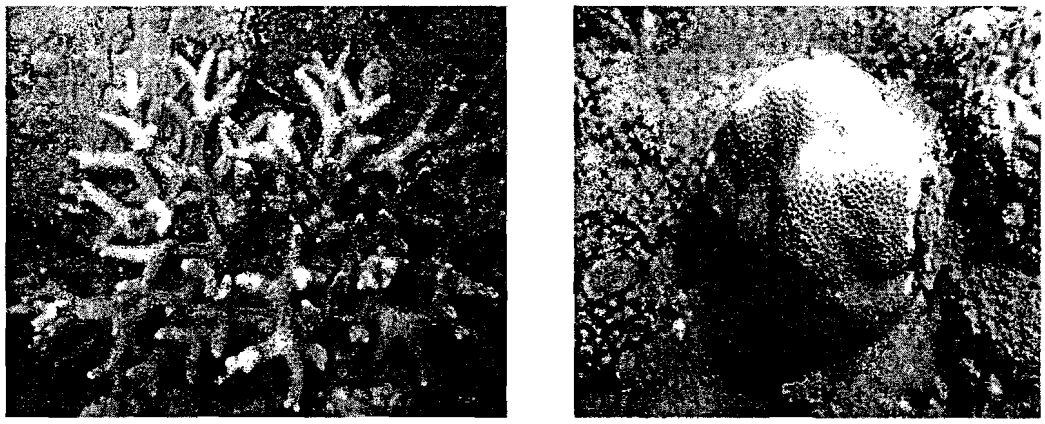

Figure 5. Deposited Sediment Over The Corals Found At Station CRS 4 (Close To Tambea Village).

CONCLUSION

Primary causes of the coral degradation at the study site were sedimentation and destructive fishing practices. Sedimentation reduced live coral coverage at river mouth stations (CRS2 and CRS 6) but not at the station "far" from the river mouth/estuary (CRS7). The decrease of live coral coverage was attributed to be the results of increasing sediment load to the coastal area during wet monsoon as indicated by increasing of deposition rate.

ACKNOWLEDGEMENT

This work was made possible through financial support by the PT International Nickel Indonesia. We thank Abd. Muiz and Ibrahim for help with the field works and Isyanita for laboratory works.

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