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THE PROBLEMS OF CONSERVATION OF CORAL REEFS IN NORTHWEST SABAH

by

NIGEL P.E. LANGHAM [1] and JACK A. MATHIAS [2]

ABSTRACT

In March 1974 a survey was made of the coral reefs of NW Sabah centered on three m areas (1) Kota Kinabalu, (2) Kudat and (3) Labuan. At various sites within these areas, the c reefs were assessed according to the extent of living coral, the damage resulting from fish blast mining and sedimentation, and the accessibility for tourism.

The coral reefs in this region support a significant fishery accounting for about 30 per of the fish landings both in weight and monetary value. Reef fish are caught by lines, gill r and illegal use of explosives. The latter method has seriously damaged a number of reef hab resulting in a marked drop in the fauna including valuable fish and invertebrates.

Coral mining for limestone used for foundations of buildings and roads has been ca out on accessible reefs near Labuan and Kota Kinabalu. The removal of coral heads has resu in extensive reef damage especially near Labuan.

Recent efforts have been made to preserve these reefs and has led to the establishment national park around Pulau Gaya. However, a number of other areas require protection bot safeguard the fishery and promote tourism.

INTRODUCTION

In March 1974, a team of scientists from Universiti Sains Malay visited Northwest Sabah with the object of defining coastal mai resources of the region and assessing environmental vulnerability of th resources to oil spills. Recently, offshore drilling has begun and seep or spillage from drilling or transport operations may threaten vari marine ecosystems and the livelihood of local people dependent u them. One part of this survey involved an inspection of the coral reef three main areas: Kota Kinabalu, Kudat Peninsula, and Labuan. T survey reported the general condition of the reefs in these ar (MATHIAS & LANGHAM 1975).

THE REEF FISHERY AND FISH BLASTING

The coral reef ecosystems in this region (Fig. 1) contains a num of important fish species *e.g.* snappers and fusiliers *(Lutjanidae)*, pigfa bream *(Lethrinidae)*, wrasses *(Labridae)*, parrot fishes *(Scaridae)*, ra fishes *(Siganidae)*, groupers *(Serranidae)*, and grunters *(Pomadasyidae)*.

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The reef fishery constitutes one of the most important fisheries on the west coast of Sabah, accounting for 2900 tons or about 30 percent

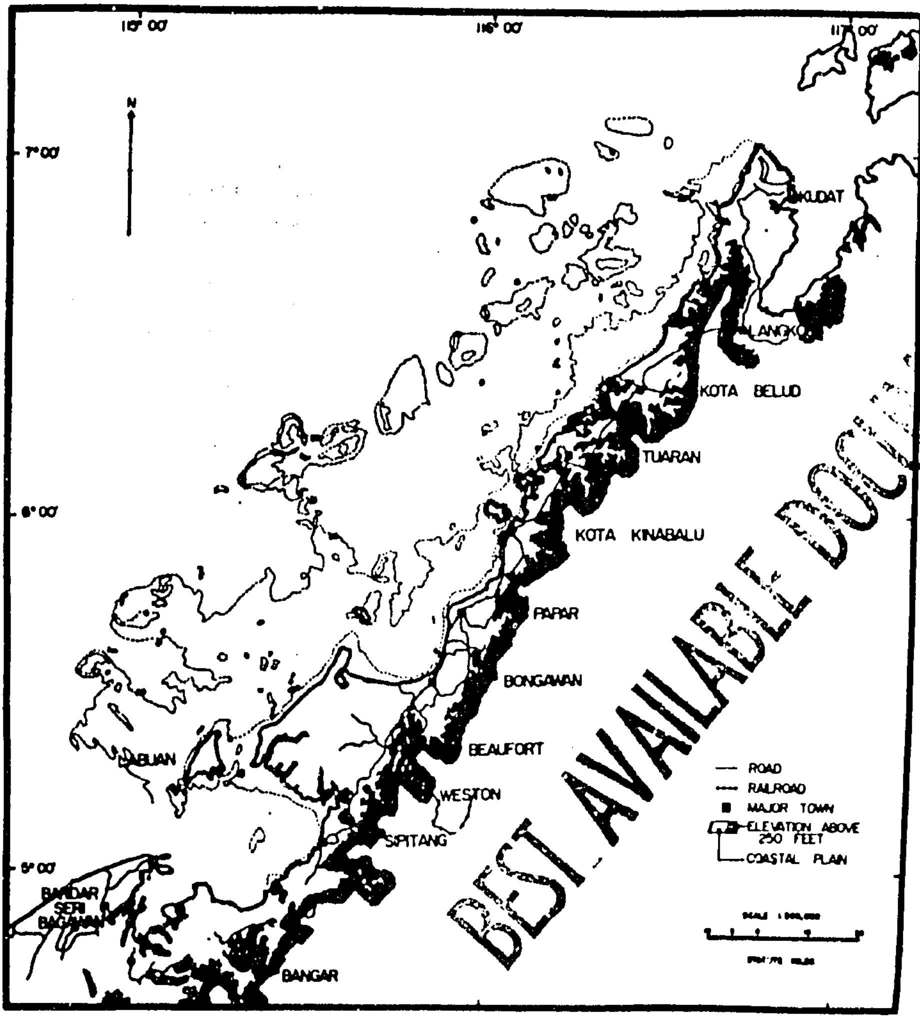

Figure 1. Map of Northwest Sabah.

f the total fish landed, with a market value of about M$ 3¼ million ıbout US$ 1¼ m) or 30 percent of the total earnings from fish. Reef sh are particularly important in the Kota Kinabalu area, but are :condary to the combined landings of mackerel *(Scombridae)* and omfret *(Stromateidae)* at Labuan (Fig. 2). The total combined landings f mackerel and pomfret is about 3100 tons. (Fisheries Department, abah, 1974 Annual Report).

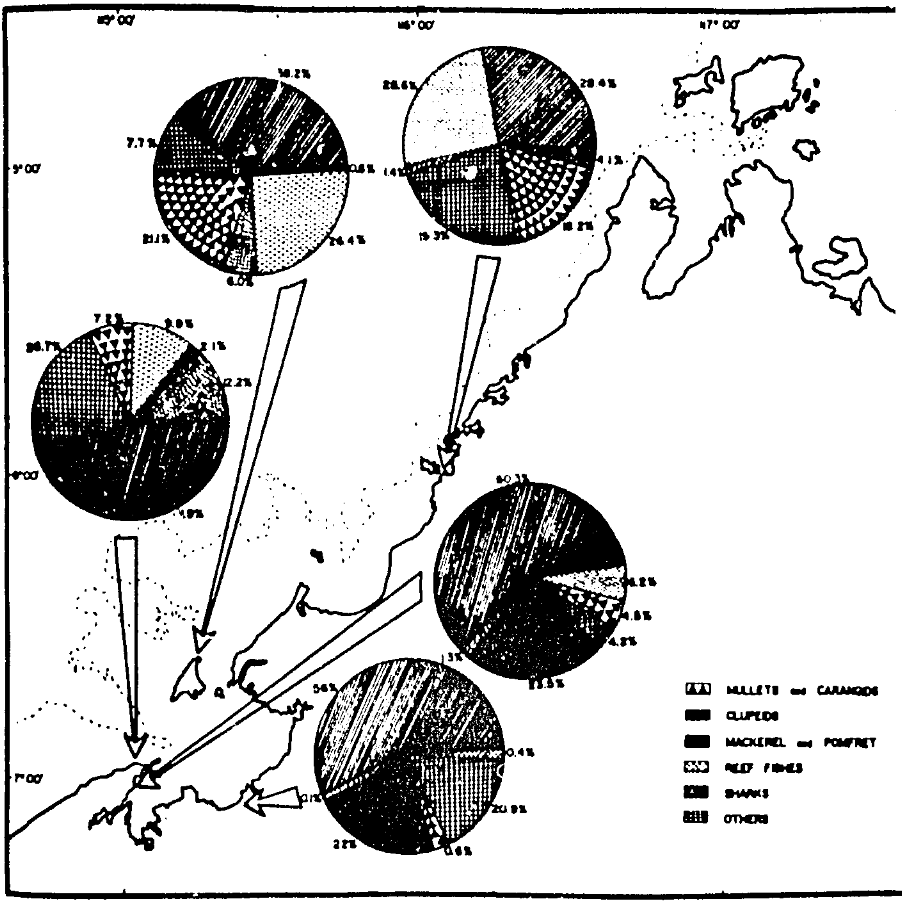

Figure 2. Map of Northwest Sabah showing the percentage composition of market landi of major groups of fish (after CHUA & MATHIAS 1975)

The coral reefs are not only important habitats for mai commercial fish species, but also contain a variety of invertebrates, mai of which are valuable sources of protein. For example, at least six speci of spiny lobsters (*Panulirus* spp.) occur on the coral reefs of Northwe Sabah. Usually they are caught by speargun or grapple and although relatively little commercial importance, they represent a considerab potential which the Sabah Fishery Department is currently explorin Also, various molluscs such as the giant clam, *Tridacna*, spider shell *Lambis*; top shells, *Trochus*; cowries, *Cypraeidae* and others - *Murex*, *To na*, *Strombus*, and *Cassis* are found on the reef and are taken by loc collectors.

Most of the reef fish landed are caught by hand-lines or floating gill-nets. However, it is apparent that carbide bombs are widely used. In these instances, fish are attracted to the area by bait and the bomb devised so that it explodes on reaching the reef surface. Although the use of explosives is illegal, this method of fishing is still widely practiced. For example, out of a total of 55 species recorded at a "tamu"* near Penumpang, 39 species were obtained by the use of explosives (CHUA & MATHIAS 1975). Fish caught by such means can be detected by the severe and extensive internal haemorrhaging, and in some cases fractured vertebral columns. Such methods are particularly used to catch shoaling fish such as fusiliers and carangids.

It would appear that many fish caught by unlicensed fishermen are taken by this means and are not shown on Fishery Department landing figures. Not only is this method unselective, killing fish of all size and life stages, both desirable and undesirable species, but it also produces craters of one to three metres diameter in the reef, knocking down table top and staghorn *Acropora* and similar branching corals.

The blasting can severely damage the reef resulting in the alteration or destruction of the reef community. When the habitat is altered in this manner, most of fish and many invertebrates disappear, and are replaced by a community dominated by corals of the genus *Fungia*, sea urchins of the genus *Diadema* and numerous species of Sea cumbers. In some cases, the coral rubble becomes covered with algae (*Cladophora* spp.) which prevents the establishment of coral larvae (Planula), this inhibiting coral recolonisation. A similar phenomenon of algal succession following the death of corals by sewerage, silt and freshwater has been well documented in Hawaii (WOOD & JOHANNES 1975)

CORAL MINING

In Sabah, especially in the Labuan and Kota Kinabalu areas, the coral skeleton provides a relatively easy accessible source of limestone ($CaCO_3$) for road building and land reclamation. Some of this coral is collected by small boats over shallow reefs, but the majority is collected by larger boats fitted with power winches. These boats search for large coral heads generally of the genera *Goniopora* or *Porites*. Divers fix cables to the base of the coral head which is then broken off and hauled to the boat. This process frequently involves dragging the coral heads over the reef until they can be hauled vertically into the boat and it is this dragging that causes extensive damage to the reef. As with fish blasting, associated with this destruction is the impoverishment of the area with the disappearance of most of the fish and associated

* Local fair where villagers sell locally obtained produce.

invertebrates. LULOFS (1973) has estimated that on average, a sing coral head extraction destroys an area of 10 feet wide and 25 feet lon Limestone contractors at Kota Kinabalu estimated that 450 tons we extracted on a good day. The average weight of a coral head is four ton this represents about 110 coral heads per day per boat. A full bo carries about 64 four-ton heads; so that 110 heads represents more th one trip per day.

In 1965, one contractor operated two boats, each of which broug two loads per day which represents 320 cu.yd. of limestone, b accessible heads became scarcer so that by 1969 extraction was reduc to one trip per day or 160 cu.yds. per day. In 1974, 100-120 cu.yd. p day was a representative extraction figure because of the increas distances involved and the boats not being able to operate in rou weather which were more likely offshore. It is estimated that in rece years about 20,000 cu.yd. of coral was mined per year (110 cu.yd. p day x 22 days per month x 8.5 months per year), valued at M$ 170,0 (M$ 8.00 per cu.yd.) or US$ 65.000 (US$ 3.20 per cu.yd.). Only persons are employed in this extraction of coral which is insignifica compared with the persons this possible fishery that these reefs cou have sustained.

If 100 coral heads are mined each day and each head extract damages an area of 250 sq.ft. (23 sq.m.per day) this would represent t destruction of 4.7 X 10^6 sq.ft. per year (43.7 ha. per year). If an avera reef slope is approximately 200 ft. wide, then the annual mining wou be equivalent to the destruction of about 4.2 miles (6.8 km) of re front. Although this is a rough approximation, it gives some idea of t destruction possible.

THE EXTENT OF MINING

Reef destruction by mining is most extensive around Labuan whe it has now extended to neighbouring islands. Near Kota Kinabalu, tv platform reefs off Pulau Gaya were examined by LULOFS in 1973, b nine months later these were found to be extensively damaged by bo blasting and mining (LULOFS 1973; LULOFS *et al.* 1974). It is hoped th with the gazetting of the Tunku Abdul Rahman National Park so as to e compass Pulau Gaya and its surrounding reefs, the two damaged platfor reefs will be allowed to regenerate. According to recent reports (D. JENKI pers. comm.) coral mining has decreased in the Kota Kinabalu area wi construction companies now using mainly sand and quarried rock.

PROTECTED AREAS

There are still a number of islands and their fringing reefs that should receive similar protection while their coral reefs are still in relatively good condition. This is particularly so for the islands of the Pulau Tega group and Pulau Balumbangan. In 1973, tourist income in Malaysia was M$ 230 million (US$ 90 million) or 4.5 percent of foreign exchange. Despite the world's present economic position, it is projected that by 1980, this will have reached about 7.6 percent of foreign exchange. In Sabah, in particular, tourism has increased with many tourists visiting the Mount Kinabalu National Park. It is hoped that the recently established marine park near Kota Kinabalu will encourage these tourists to spend a longer time in the area so as to justify the setting up of such a park and encourage the State to set aside further similar areas.

ACKNOWLEDGEMENTS

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OBSERVATION ON BEACH EROSION AND CORAL DESTRUCTION BY REMOTE SENSING TECHNIQUES

by

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ABSTRACT

Remote sensing techniques were used to observe beach erosion at Sengkidu Beach, Labuan Amuk, east coast of Bali. Erosion was caused by wave actions flowing over destructed coral reef. Aerial photography was found useful in obtaining first hand information of the destructed corals and its affects on the beach.

INTRODUCTION

Since the past, Indonesia has been collecting oceanographic data and informations from coastal areas, territorial waters, and adjacent seas. Lack of facilities, funds, and manpower, has limited the gathering of information about the sea, which covers 70% of the country's total territory.

The use of remote sensing techniques in oceanography in Indonesia started in 1973/74 when a project was set up by BAKOSURTANAL and USGS to test the possible applications of using multispectral photography for several disciplines, including oceanography (SZEKIELDA *et al* 1974). This was followed in 1975 by using satellite data (ERTS - 1) to study the pollution problems in the Jakarta Bay (PRASENO 1975).

In marine sciences the best results using remote sensing techniques were obtained for coastal areas (BROWN *et al* 1971, BOWKER *et al* 1973, ROSS 1973, WRIGHT *et al* 1973, ANDERSON *et al* 1973, HUNTER 1973, MASCARENHAS & TANAKA 1974, SZEKIELDA *et al* 1974, PRASENO 1975, YOST *et al* 1971). Satellite and aircraft became valuable because of the "abilities" to cover a wide area. It is, however, limited by the depth penetration capabilities of the spectral bands. The location of reefs, their distances from the coast, and their distributions can be mapped by using aerial photography. On some occasions the condition of reefs can also be studied.

This paper discusses one of the results obtained from Sengkidu Beach, Labuan Amuk, east of Bali during the 1974 project of remote sensing in Bali. The place is one of the sites where reefs are collected for lime and other construction materials.

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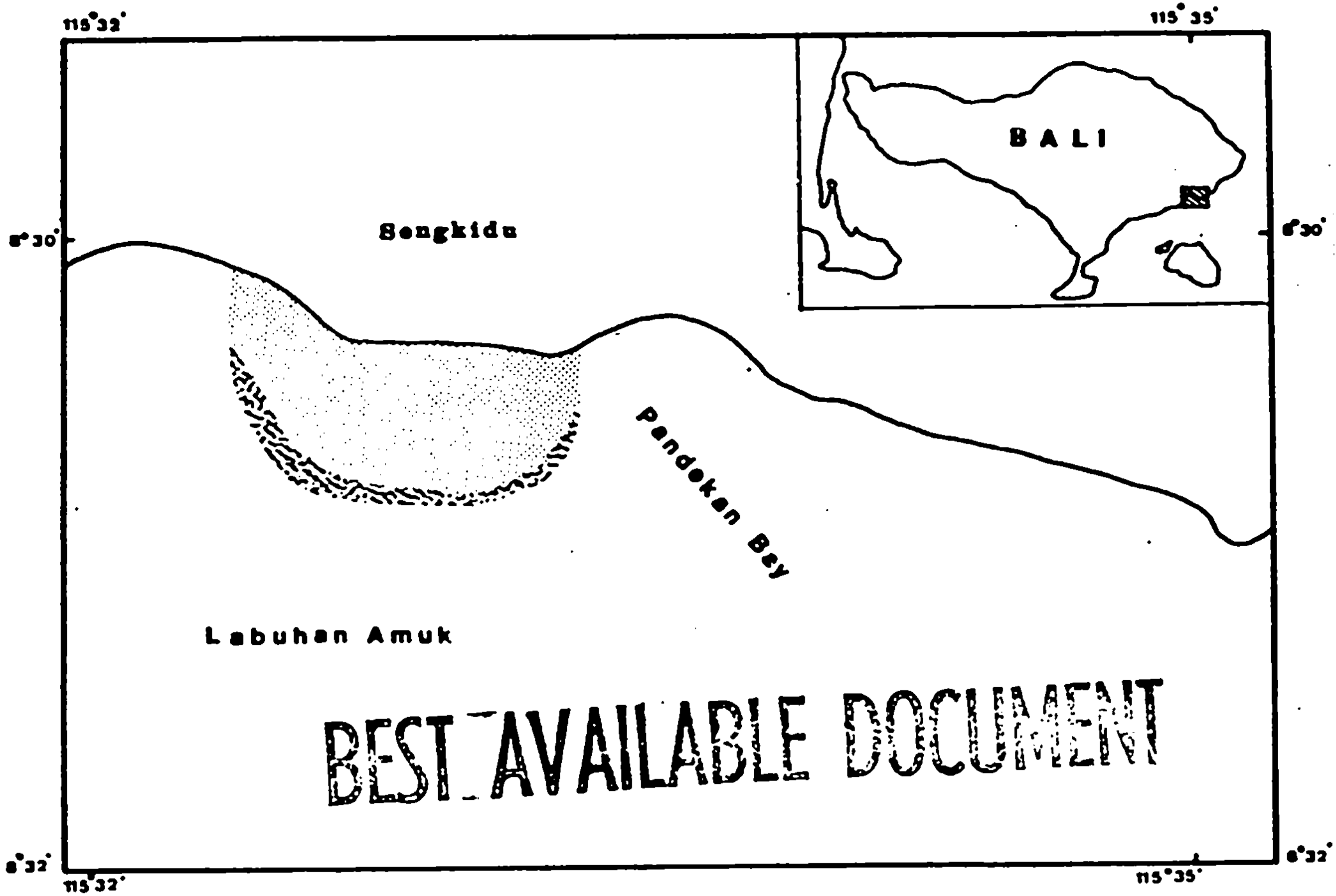


Figure 1. Sengkidu beach, Labuan Amuk, east coast of Bali.

THE INVESTIGATED AREA

Sengkidu is a small village near the coast on the eastern part c Bali Island (115° 33' 30" E – 08° 30' 20" S). The studied reef f streched in an east-west direction parallel to the shore-line bet Labuan Amuk and Pandekan Bay (Fig. 1). The reef flat is app mately 1 km long and forms a barrier at a distance of 150 m of coast. From the coast, the reef flat is rather horizontal and grad sloping toward the sea. Water depths varies between 1 to 3 n pending on the tide.

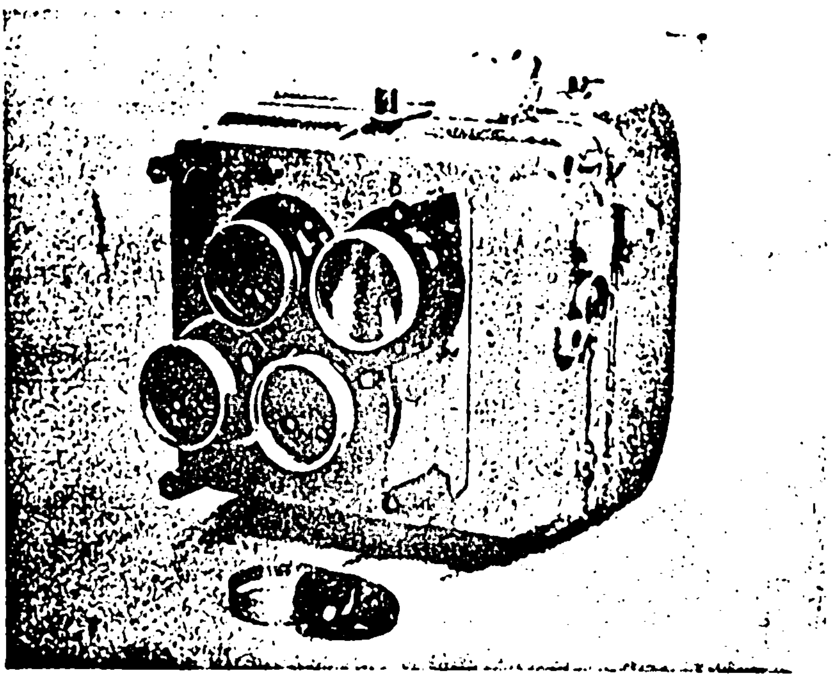
Living coral is limited to areas of hard rock which are not co by sand. The corals consist mainly of small colonies of *Acropora* number of colonies increases toward the sea. On the seaward slop colonies become bigger.

According to the local inhabitants, some decades ago a " (temple) was built on the coast of Sengkidu. Due to beach erosio temple is now about 100 m away from the shore (Fig. 2).

Figure 2. A "puri" (temple) originally built on the coast of Sengkidu is presently se distance of approximately 100 m off the shore.

MATERIALS AND METHODS

The aerial photographs were taken using a multispectral camera 'ig. 3). The camera consists of four lenses, each equipped with four fferent filters. Blue, green, red, and infra-red filters were used for our ırpose. The film used was a Black & White film which is also nsitive to infra-red spectrum.



ure 3. The multispectral camera. A camera with four lenses, each equipped with different filters.

Each of the four spectral negatives was taken at the same instant by ; four matched lenses. Four spatially identical negatives were pro- ced, since the optical axes of the lenses were normal to the film ıne. The obtained images were identical except for the densities ıich differ partly due to the selective spectral reflectance of ground jects.

The mission was flown at an altitude of 8,000 feet at 09.30. Low ıging clouds prevented flight to be carried out earlier and higher. rlier experiments showed that good results were obtained when the otographs were taken early in the morning between 07.00 - 08.00 al time (SZEKIELDA *et al* 1974).

At the same time ground truth was made by surveying the area. A ıgh map was drawn showing the distribution of coral and the ıditions of both coral and beach.

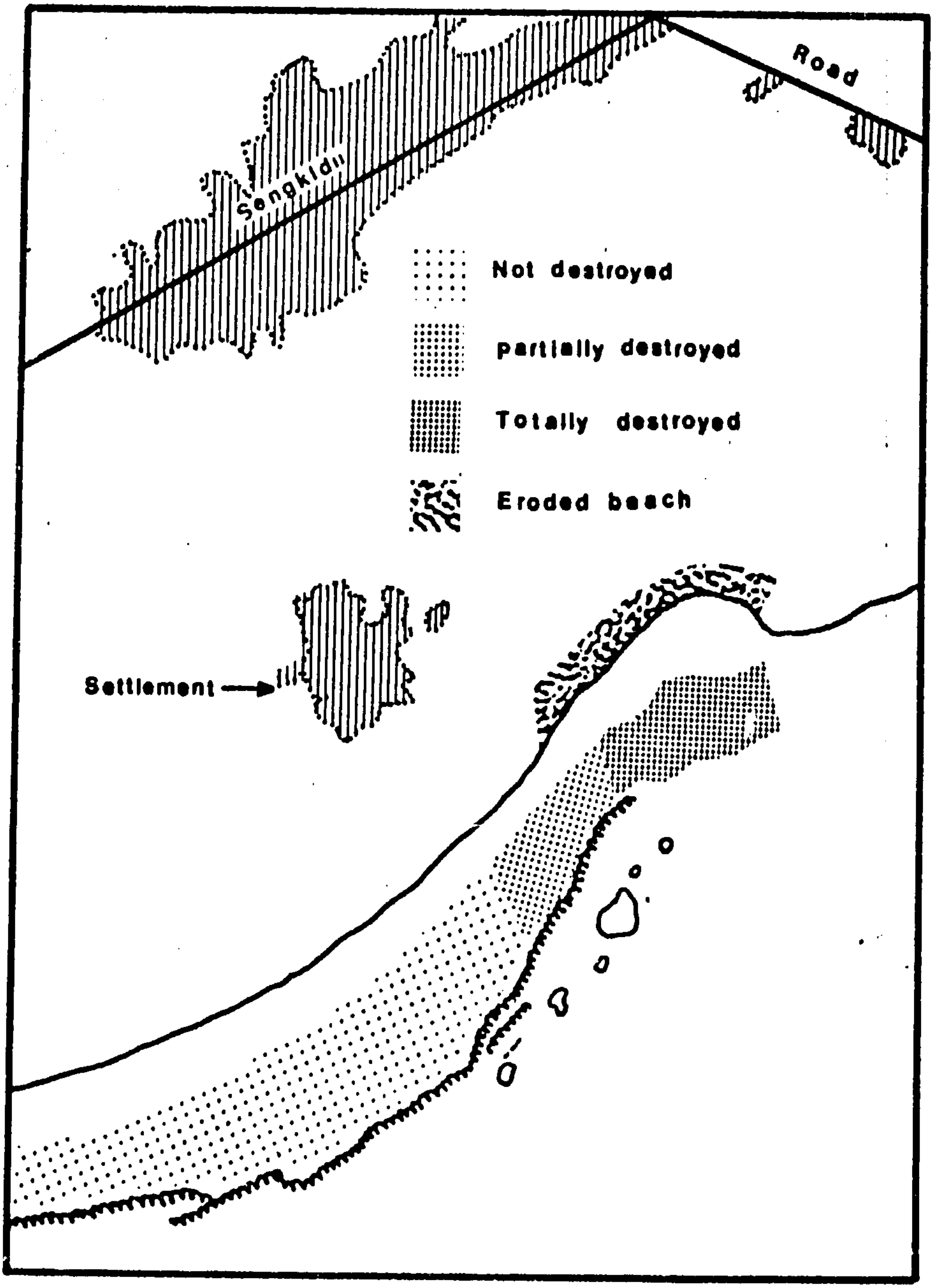


Figure 4. Coral destruction and beach erosion at Sengkidu analyzed from aerial photographs (see also figure 6)

RESULTS AND DISCUSSION

Images obtained through the infra-red filter shows the best results. 'eatures above sea level can be seen nicely. Reefs are usually studied ›y observing the breaking of waves on the reef. On some spots, .owever, this feature does not up. These may be interpreted as des-ructed coral reef. On those spots the waves are clearly seen passing ›ver destructed coral and acting their force on the beach. Figure 4 hows the area of totally destructed coral, partially destructed, and ›on-destructed areas. Figure 5 shows the eroded beach and piles of nined coral laying on the beach ready to be transported.

Images taken with the blue and green filters shows turbidity patterns ›f the sea water. The passing waves are not clearly seen due to signals eceived from the turbidity patterns. Turbidity is likely caused by the :roding effects. Bottom features are not visible on areas of destructed :orals. But on non-destructed areas some bottom features are still seen.

Eighteen species of stony corals are recorded from Sengkidu waters Table I). The most dominant genus is *Acropora*. Seven species of the ;enus are recorded, *i.e.* *Acropora latistella* (BROOK) *A. smithi*

Table I. List of stony coral found at Sengkidu Beach, Labuan Amuk, east coast of Bali.

1.	*Acropora latistella* (BROOK)
2.	*Acropora smithi* (BROOK)
3.	*Acropora symmetrica* (BROOK)
4.	*Acropora pruinosa* (BROOK)
5.	*Acropora samoensis* (BROOK)
6.	*Acropora vanderhorsti* HOFFMEISTER
7.	*Acropora pagoensis* HOFFMEISTER
8.	*Favites yamanarii* YABE et SUGIYAMA
9.	*Galaxea explanata* QUELCH
10.	*Hydnophora microconos* (LAMARCK)
11.	*Montipora auriculata* BERNARD
12.	*Montipora explanata* BERNARD
13.	*Platygyra lamellina* (EHRENBERG)
14.	*Pocillopora brevicornis* LAMARCK
15.	*Pocillopora elegans* DANA
16.	*Porites lobata* DANA
17.	*Porites lutea* MILNE, EDWARD & HAIME
18.	*Seriatopora hystrix* DANA

(BROOK), *A. symmetrica* (BROOK), *A. pruinosa* (BROOK), *A. samoensis* (BROOK), *A. vanderhosti* HOFFMEISTER, and *A. pagoensis* HOFFMEISTER. Next dominant corals are two species of *Montipora, i.e.* *Montipora auriculata* BERNARD and *M. explanata* BERNARD, *Porites lutea* MILNE EDWARD & HAIME and *P. lobata* DANA also form an important member of the stony corals of Sengkidu waters.

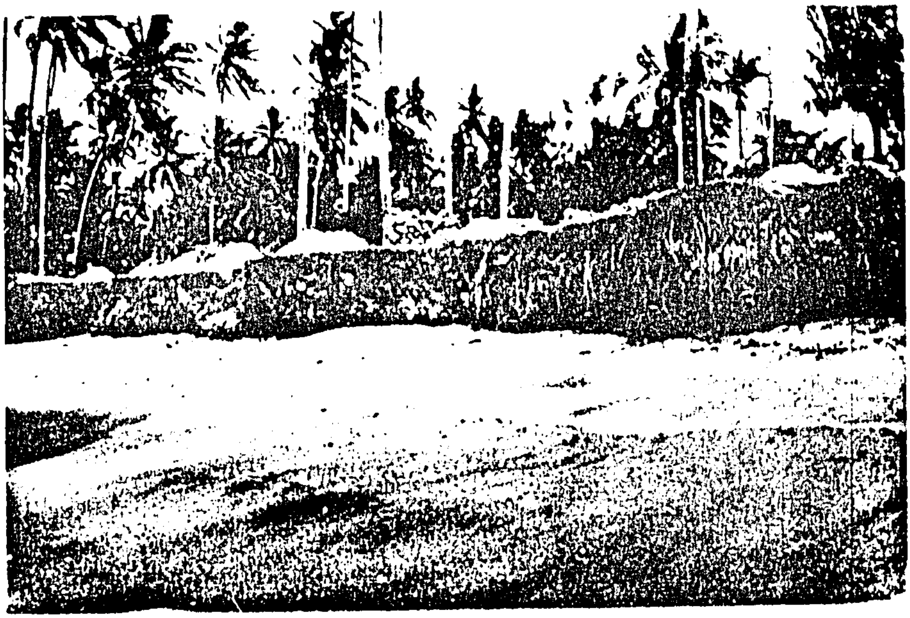


Figure 5. Eroded beach and piles of mined coral.

Ground truth observations shows that destruction of the reef occurs also due to other causes. One possible cause of earlier destruction is the drop in pH of the sea water. This is caused by the Gunung Agung eruption. The lava following eruption enters the sea near Sengkidu Beach. The drop in sea water pH due to the lava stream is not tolerated by the corals causing the destruction. After the eruption the corals starts to recover. This can be seen from the small sized colonies of stony coral scatters on the reef flat. On the seaward slope toward the sea, the colonies became bigger by depth. This suggests that only the upper layers are exposed to the low pH.

From the study made at Sengkidu Beach, it is proven that aerial photography forms a perfect tool for determining coral reefs. Even satellite imagery can be used to locate coral reefs (SZEKIELDA *et al* 1974). It is, indeed, true that sometimes it is difficult to interpret ERTS - 1 imagery (satellite imagery) for areas near river mouths. River discharge and mud in the near coastal areas do not allow sharp contrast in the reflective properties in the infra-red band. Generally, location of reefs and their distance from the coast are in agreement with common maps.

To locate reefs, infra-red spectrum is found best suitable, since it will record all features above sea level. The breaker's zone of the reef

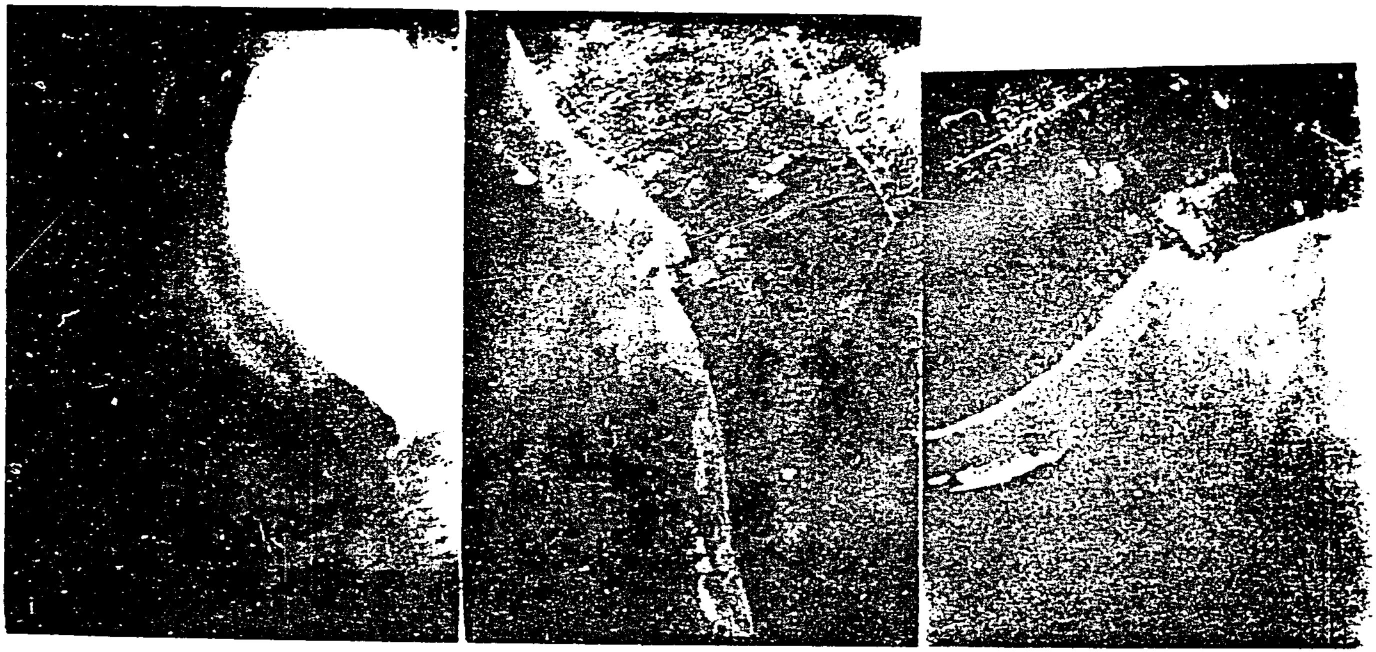


Figure 6. Aerial photographs of Sengkidu Beach taken through three different filters: blue (a), green (b), and infra-red (c). See test for explanation.

can then be located accurately. The red spectrum penetrates the water for a few centimeters which will also indicate coral distribution. However, suspended sediment near the surface will interfere the signals obtained from waves, and waves will show less sharp. The green and blue spectra may be used to study conditions of coral reef. Both spectra are able to penetrate sea water and so catch signals from the bottom of the sea. Both spectra are able to penetrate water to some meters, depending on water transparancies. On areas where beach erosion occurs, plumes of suspensions will interfere the reflections from the bottom, and bottom features will not be clearly seen.

Clouds may also form a problem in remote sensing. This is the case during the Bali project. The second part of the project was flown during the rainy season. Low hanging clouds prevented missions to be flown as was scheduled.

If coral collecting activities are continued, the beach will suffer heavier damage from eroding affects of waves and currents. A rapid change of coast line will happen that will destroy plantations near the coast. On the other hand, it will be difficult to prevent people from collecting corals, since the activity constitutes one of their major livelihood. The collecting activities should be localized to the inner side of the reef flat, saving those living on the breaker's zone. The collections should be limited to dead corals only.

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THE EFFECTS OF SOME PESTICIDES ON REEF CORALS

by

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ABSTRACT

While investigating a reef coral kill in Samoa it was speculated that this might have been du to contamination by some chemical. Subsequently, scleractinian reef corals were tested to asse their reactions to 12 commonly used pesticides and toxic substances. The chlorinated-hydroca bons such as DDT and Endrin produced stress effects in corals subjected to 2ppm for 24 hours i *in-vitro* studies although the corals continued to deposit skeletal calcium. *In-vivo* tank exper ments suggested that small amounts of these substances in seawater stimulated the corals to dep sit skeletal calcium. Other pesticides were much less toxic to the corals.

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