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 main areas (1) Kota Kinabalu, (2) Kudat and (3) Labuan. At various sites within these areas, the condition of the 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 cent of the fish landings both in weight and monetary value. Reef fish are caught by lines, gill nets and illegal use of explosives. The latter method has seriously damaged a number of reef habitats, 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 carried out on accessible reefs near Labuan and Kota Kinabalu. The removal of coral heads has resulted in extensive reef damage especially near Labuan.

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

INTRODUCTION

In March 1974, a team of scientists from Universiti Sains Malaysia visited Northwest Sabah with the object of defining coastal marine resources of the region and assessing environmental vulnerability of these 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 on them. One part of this survey involved an inspection of the coral reef in three main areas: Kota Kinabalu, Kudat Peninsula, and Labuan. The survey reported the general condition of the reefs in these areas (MATHIAS & LANGHAM 1975).

THE REEF FISHERY AND FISH BLASTING

The coral reef ecosystems in this region (Fig. 1) contain a num ber of important fish species e.g. snappers and fusiliers (Lutjanidae), pigfish (Lethrinidae), wrasses (Labridae), parrot fishes (Scaridae), rabbitfishes (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 of the total fish landed, with a market value of about M$ 3½ million (about US$ 1½ m) or 30 percent of the total earnings from fish. Reef fish are particularly important in the Kota Kinabalu area, but are secondary to the combined landings of mackerel (Scombridae) and pomfret (Stromateidae) at Labuan (Fig. 2). The total combined landings of mackerel and pomfret is about 3100 tons. (Fisheries Department, Sabah, 1974 Annual Report).
The coral reefs are not only important habitats for marine commercial fish species, but also contain a variety of invertebrates, many of which are valuable sources of protein. For example, at least six species of spiny lobsters (*Panulirus* spp.) occur on the coral reefs of Northwest Sabah. Usually they are caught by speargun or grapple and although of relatively little commercial importance, they represent a considerable potential which the Sabah Fishery Department is currently exploring. Also, various molluscs such as the giant clam, *Tridacna*, spider shell *Lambis*; top shells, *Trochus*; cowries, *Cypraeidae* and others - *Murex*, *Tonna*, *Strombus*, and *Cassis* are found on the reef and are taken by local collectors.
Most of the reef fish landed are caught by hand-line 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 sex stages, both desirable and undesirable species, but it also produces rates of one to three metres diameter in the reef, knocking down table coral 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 urchins. In some cases, the coral rubble becomes covered with algae (Cladophora spp.) which prevents the establishment of coral larvae (Planula), this inhibiting coral colonisation. A similar phenomenon of algal succession following the death of corals by sewage, 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 (CaCO₃) 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 lines 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 dragging that causes extensive damage to the reef. As with fishasting, associated with this destruction is the impoverishment of the sea with the disappearance of most of the fish and associated

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* Local fair where villagers sell locally obtained produce.
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LULOFS (1973) has estimated that on average, a single coral head extraction destroys an area of 10 feet wide and 25 feet long. Limestone contractors at Kota Kinabalu estimated that 450 tons were extracted on a good day. The average weight of a coral head is four tons, which represents about 110 coral heads per day per boat. A full boat carries about 64 four-ton heads; so that 110 heads represents more than one trip per day.

In 1965, one contractor operated two boats, each of which brought two loads per day which represents 320 cu.yd. of limestone, but accessible heads became scarcer so that by 1969 extraction was reduced to one trip per day or 160 cu.yds. per day. In 1974, 100-120 cu.yd. per day was a representative extraction figure because of the increased distances involved and the boats not being able to operate in rough weather which were more likely offshore. It is estimated that in recent years about 20,000 cu.yd. of coral was mined per year (110 cu.yd. per day x 22 days per month x 8.5 months per year), valued at M$ 170,000 (M$ 8.00 per cu.yd.) or US$ 65,000 (US$ 3.20 per cu.yd.). Only 2 persons are employed in this extraction of coral which is insignificant compared with the persons this possible fishery that these reefs could have sustained.

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

THE EXTENT OF MINING

Reef destruction by mining is most extensive around Labuan where it has now extended to neighbouring islands. Near Kota Kinabalu, two platform reefs off Pulau Gaya were examined by LULOFS in 1973, but nine months later these were found to be extensively damaged by blasting and mining (LULOFS 1973; LULOFS et al. 1974). It is hoped that with the gazetting of the Tunku Abdul Rahman National Park so as to compass Pulau Gaya and its surrounding reefs, the two damaged platform reefs will be allowed to regenerate. According to recent reports (D. JENKE pers. comm.) coral mining has decreased in the Kota Kinabalu area with construction companies now using mainly sand and quarried rock.
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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 at. I encourage the State to set aside further similar areas.

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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.
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THE INVESTIGATED AREA

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

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

According to the local inhabitants, some decades ago a "puri" (temple) was built on the coast of Sengkidu. Due to beach erosion the 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 some distance of approximately 100 m off the shore.
The aerial photographs were taken using a multispectral camera (Fig. 3). The camera consists of four lenses, each equipped with different filters. Blue, green, red, and infra-red filters were used for our purpose. The film used was a Black & White film which is also sensitive to infra-red spectrum.

Each of the four spectral negatives was taken at the same instant by four matched lenses. Four spatially identical negatives were procured, since the optical axes of the lenses were normal to the film plane. The obtained images were identical except for the densities which differ partly due to the selective spectral reflectance of ground objects.

The mission was flown at an altitude of 8,000 feet at 09.30. Low hanging clouds prevented flight to be carried out earlier and higher. Earlier experiments showed that good results were obtained when the photographs were taken early in the morning between 07.00 - 08.00 a.m. (Szekielda et al. 1974).

At the same time ground truth was made by surveying the area. A high map was drawn showing the distribution of coral and the conditions 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. Features above sea level can be seen nicely. Reefs are usually studied by observing the breaking of waves on the reef. On some spots, however, this feature does not up. These may be interpreted as destructed coral reef. On those spots the waves are clearly seen passing over destructed coral and acting their force on the beach. Figure 4 shows the area of totally destructed coral, partially destructed, and non-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 of the sea water. The passing waves are not clearly seen due to signals received from the turbidity patterns. Turbidity is likely caused by the eroding effects. Bottom features are not visible on areas of destructed corals. 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 genus are recorded, i.e. Acropora latistella (BROOK) A. smithi

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<thead>
<tr>
<th>Table I. List of stony coral found at Sengkidu Beach, Labuan Amuk, east coast of Bali</th>
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<tr>
<td>1. Acropora latistella (BROOK)</td>
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<td>2. Acropora smithi (BROOK)</td>
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<td>3. Acropora symmetrica (BROOK)</td>
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<td>4. Acropora pruinosa (BROOK)</td>
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<td>5. Acropora samoensis (BROOK)</td>
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<td>6. Acropora vanderhorsti HOFFMEISTER</td>
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<td>7. Acropora pagoensis HOFFMEISTER</td>
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<tr>
<td>8. Favites yamanarii YABE et SUGIYAMA</td>
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<td>9. Galaxea explanata QUELCH</td>
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<td>10. Hydnophora microconos (LAMARCK)</td>
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<td>11. Montipora auriculata BERNARD</td>
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<td>12. Montipora explanata BERNARD</td>
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<td>13. Platygyra lamelliina (EIHRENBERG)</td>
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<td>14. Pocillopora brevicornis LAMARCK</td>
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<td>15. Pocillopora elegans DANA</td>
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<td>16. Porites lobata DANA</td>
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<td>17. Porites lutea MILNE, EDWARD &amp; HAIME</td>
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<td>18. Seriatopora hystrix DANA</td>
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(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.
Ground truth observations show 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 start 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 (Szkie1da et al. 1974). It is, indeed, true that sometimes it is difficult to interpret ERIS-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 text for explanation.
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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 due to contamination by some chemical. Subsequently, scleractinian reef corals were tested to assess their reactions to 12 commonly used pesticides and toxic substances. The chlorinated-hydrocarbons such as DDT and Endrin produced stress effects in corals subjected to 2ppm for 24 hours in in-vitro studies although the corals continued to deposit skeletal calcium. In-vivo tank experiments suggested that small amounts of these substances in seawater stimulated the corals to deposit skeletal calcium. Other pesticides were much less toxic to the corals.

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