



Corals, fishermen and tourists

A. Kunzmann

Abstract

Two major anthropogenic activities that disturb coral reefs are fishing and tourism, even though coral reefs are important for both fishing and tourism. Already more than 60 per cent of all reefs worldwide are endangered. The use of explosives and poison by small-scale fishers, to supply the market for live fish for aquariums and for human consumption, cause irreversible damages to reefs. Similarly, rapid and unmanaged coastal development for marine tourism negatively affects coral reefs in many ways. Though marine parks and marine protected areas are being promoted all over the world, developing countries need assistance in establishing and assessing such reserves and for taking appropriate actions for rehabilitation of reefs. These can be accomplished through partnership projects.

Introduction

Coral reefs are one of the most productive ecosystems on earth, although they usually occur in waters that are relatively low in nutrients. Reef communities lying along tropical coasts are a rich and indispensable source of renewable goods. The importance of coastal environments as a source of protein and foreign exchange is steadily increasing, particularly for tropical countries. At the same time, these countries are confronted with exploding growth of coastal population as well as an alarming rate of coastal degradation. For these countries, the sustainable use of reefs and other tropical marine ecosystems will soon be a question of survival for the coastal population.

In recent years the press has frequently reported that reefs are endangered worldwide (e.g., Der Spiegel 1999; National Geographic 1999) due to natural and anthropogenic reasons. This paper concentrates on two manmade factors leading to reef destruction: fishermen and tourists. The issue has been neglected in the past and public awareness is still low. Furthermore, this paper concentrates

regionally on examples from Southeast Asia and the Red Sea.

Why do we need reefs

Coral reefs are a rich meadow for fishermen, while for the scuba divers they are a pleasure for the eyes. But reefs have several additional important functions. They are indispensable and invaluable. Indispensable, because they protect coasts from erosion by waves and currents and because they make them safe¹ for navigation, fishing and tourism. They are also invaluable as effective coastal protection, because they re-grow and repair damage to a certain extent². They also provide goods with a high value. Worldwide, reefs yielded a value of about US\$ 375 billion per year (Costanza et al. 1997), of which US\$ 100 billion was food from reefs or reef environments. In some developing countries, food from reefs provides for 25 per cent of the total food supply and 60 per cent of the total protein intake.

Reefs are known for an enormous diversity of species. There are about 4 000 species of fish and 800 species of coral identified. It is estimated that

about 9 million species occur in reefs, not counting the microbial species (Reaka-Kudla 1997). Therefore, reefs are a genetic treasure box. They host a number of bioactive substances that are increasingly used in pharmacology and medicine. They provide moulds for anti-cancer medication and raw material for implant surgery.

In spite of this global importance, reefs are endangered worldwide. According to a report by the World Resources Institute (Bryant et al. 1998), almost 60 per cent of all reefs are endangered through human disturbance or activities, such as coastal development, overexploitation, destructive fishing methods, increasing sedimentation and eutrophication, and pollution from domestic and industrial sewage. Climatic variations with abnormal high or low water temperatures (e.g., El Niño) and so-called "red-tides" (toxic phytoplankton blooms) are often the last straw for stressed reefs. For example, in 1997 (the International Year of the Reef) and in 1998 (the International Year of the Ocean), a worldwide bleaching of corals was observed (Wilkinson and Hodgson 1999). Almost 10 per cent of all reefs were destroyed beyond repair.

¹ Although reefs are usually known as obstacles for shipping, the leeward side of very long reefs, paralleling the coast, offers safe navigation because waves are broken and swell is minimized (e.g., in Indonesia).

² This capacity for self-repair has natural limits that are frequently overstepped by unwise exploitation.

The major negative effects on coral reefs can differ from area to area. In Southeast Asia, it is mainly sedimentation and destructive fishing practices that destroy reefs, while in the Red Sea and the Caribbean, tourism is the main factor. This paper presents the effects of fishing and tourism, with selected examples from Indonesia, the Philippines and the Red Sea.

Misuse of reefs

Coral reefs in Southeast Asia are known for their extraordinary species richness. As with rainforests, Southeast Asia represents the global centre for biodiversity, i.e., there are many species per unit area. For example, some 400 reef-building corals, more than 3 000 coral fish species and about 1 700 species of molluscs are known in the region. Coral reefs in Southeast Asia account for some 160 000 km², which corresponds to approximately 25 per cent of all reefs worldwide. Unfortunately the status of reefs in Southeast Asia is already critical. Thirty five per cent of Asian reefs are considered disturbed and less than five per cent are categorised as original or "excellent" (Cesar et al. 1997). The main reasons for this are overexploitation, unsustainable use, and rapidly increasing coastal development.

Fishing with destructive methods

The use of dynamite and various poisons for fishing has been banned in Indonesia since 1972. Nevertheless, up to 50 per cent of fishermen use explosives and poison from time to time, although they are aware of the ban and realise that this practice destroys corals (Kunzmann 1997).

Fishing with explosives is done in several ways. Large bombs target large areas in order to catch baitfish for the long liners that catch the highly sought after and expensive tuna. Smaller bombs, on the other hand, catch reef fish for supplying to local fish markets and tourist restaurants. Both methods severely destroy corals

and the reef structure. Only coral rubble remains and is soon overgrown by algae. The organisms in the vicinity of the explosion are killed or badly injured (Figs. 1-4). Human victims of self-made explosives can take months or even years to recover, while the recovery of reefs through resettlement with corals can take decades. In many cases the destruction is permanent (Cornish and McKellar 1998).

Cyanide and CN-insecticides are used in order to catch valuable ornamental fish for the lucrative aquarium trade. Expensive napoleon wrasses, groupers and crayfish are caught for live export to Hong Kong and Taiwan. These markets demand up to 25 000 t live reef fish annually, with a value of more than US\$ 1 billion (Johannes and Riepen 1995).



Fig. 1. Pulau Pandan, West Sumatra: destroyed reef crest in ca. 12 m depth. A big bomb has left a crater with a diameter 6 m in the middle of a healthy reef so that part of the reef has broken off and fallen down the slope.



Fig. 2. Pulau Pandan, West Sumatra: destroyed reef crest at ca. 7 m depth. Smaller, hand-made explosives have left craters of 1-2 m diameter. The resulting rubble of this Acropora formation moves back and forth with the swell and works like a caterpillar, destroying large areas of the reef over the next few days.

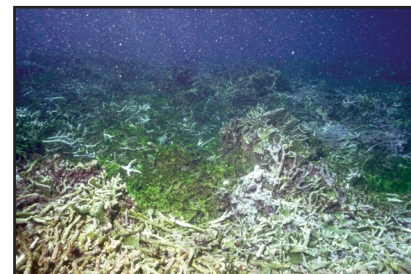


Fig. 3. Pulau Pandan, West Sumatra: destroyed reef crest at ca. 7 m depth. Photo taken seven days after Fig. 2. Green, slimy algae overgrow the Acropora fragments and prevent a resettlement by corals.



Fig. 4. Pulau Pandan, West Sumatra: destroyed reef immediately under the surface. These Pachyseris specimens have been destroyed by a bomb and look like they are cut with a sharp knife.

Groupers are traded for several hundred US\$ each and a napoleon wrasse can fetch several thousand US\$ (Lee and Sadovy 1998). For prestige reasons, rich Chinese businessmen are willing to pay up to US\$ 2 000 for a pair of napoleon wrasse lips! (Fig. 5).

The market share of the Philippines in the global export of ornamental fish is 80 per cent, with a value of more than US\$ 100 million per year. More than two-thirds of ornamental fish are caught with cyanide and up to 75 per cent of the poisoned fish die upon capture. Another 60 per cent of the survivors die during transport. The very same cyanide also kills coral colonies and small animals (like worms, gastropods, bivalves and crustaceans) in the vicinity. Unfortunately, fishing with poison is practiced all over Southeast Asia, the driving force being a large market (Johannes and Riepen 1995; Fig. 6)



Fig. 5. Head of a Napoleon Wrasse (*Cheilinus undulatus*). In top restaurants in Hong Kong, prices of up to 80 US\$ per kg are accepted and for a pair of lips even up to 2 000 US\$.

The local fishermen receive only a very small share of the market value of the fish, but for a little additional income they are willing to take the small risk of being caught using poison. Usually the fishermen are protected by the navy or the fisheries authorities, who accept bribes in return for turning a blind eye.

Aquarium fish can die even weeks after capture due to the long-term, chronic

damage caused by the poison. However, the buyer does not know the real reason the fish die. Very little is known about the potential impact of the residue of the poison in fish consumed as food. The long-term damage results in endless coral cemeteries underwater.

Tourism

Tourism can damage reefs in many ways. Long coastal stretches are plastered with hotels, sewage is discharged straight into the sea and visitors pour by the hundreds into the water, either with water-vehicles or by diving. Frequently hotels or the hotel roads are built with coral blocks that have been cut out of the reef in front of the hotel. At the same time, more and more tourists require larger airports, whose runways are sometimes even built on reef-tops (Fig. 7).

Many hotels have tried to save large amounts of money by systematically

destroying reefs in front of their door to use as cheap building materials. But more and more of them pay a large price. When the increasing coastal erosion due to the missing protective reef starts to reach and erode the hotel walls, millions of dollars are needed for artificial constructions to break the waves (Clark 1996). Furthermore, tourists keen on snorkelling around unspoilt reefs do not return.

Unfortunately tourism also supports a very lively trade in corals, bivalves and shells of gastropods. Thousands of tons are traded every year and the global market share of the Philippines is 90 per cent. Protected species like the tritons trumpet and the giant clam, which are in danger of extinction, are traded illegally. Tropical shells also find their way to Germany and are sold on the beaches of North and Baltic Sea.

Growing tourism is also the driving force behind rapid coastal development and

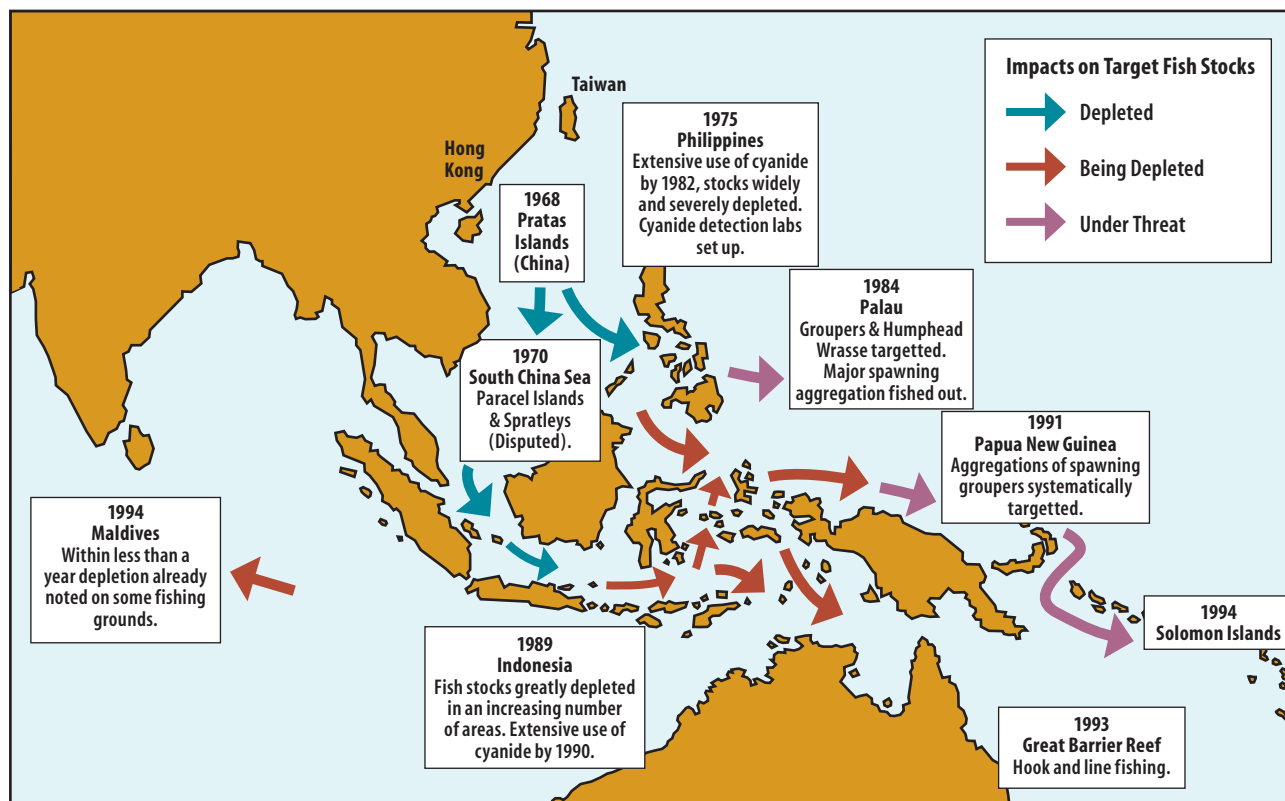


Fig. 6. Fishing with poison in Southeast Asia. After the Philippines and Indonesia have been over exploited, the illegal practices move on to the Maldives in the west and to the Pacific Islands in the east.



Fig. 7. International Airport Bali: the runway has been extended by several hundred meters to the west, in order to provide for large aircraft like the 747. A beautiful reef, right in the tourist centre Kuta, has been sacrificed.

construction on coasts worldwide (Caribbean and Southeast Asia), but particularly at the Red Sea (Fig. 8). In the Caribbean, where the total turnover from tourism is calculated at some US\$ 9 billion per year, tourism contributes 50 per cent of the GNP in some countries. The Florida Keys, for example, had a gross turnover of US\$ 1.6 billion from marine tourism in 1997 (Bryant et al. 1998).

Adventure holidays, often sold as “soft-tourism”, and the diving business have a much stronger impact than has previously been assumed, according to three new studies from the Great Barrier Reef in Australia, the Red Sea and the Caribbean (Harriot et al. 1997; Hawkins and Roberts 1994). For example, the number of divers is increasing steadily and so also the number of contacts of divers with corals (about 35 to 100 contacts per dive) that harms corals. In the Red Sea more than 30 per cent of all reefs are already negatively affected. This is particularly true for Egypt, where plans have been drawn up to intensify marine tourism tenfold within the next five years!

There are natural and anthropogenic factors that threaten reefs, e.g., rapidly increasing sedimentation and eutrophication caused by unwise agriculture and forestry practices (Fig. 9). The number of disturbance factors are increasing and the intervals between individual disturbances are becoming shorter and shorter, so that

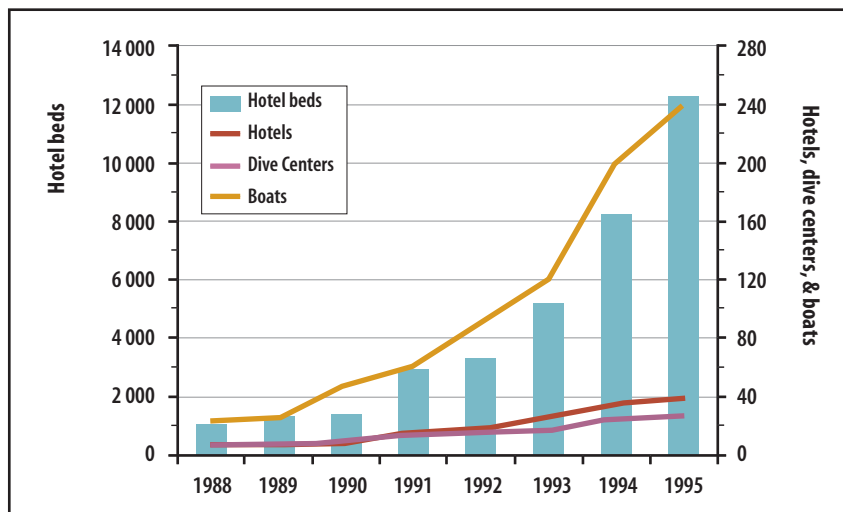


Fig. 8. Development of tourism at the Red Sea. The number of hotel beds and diving tourists has sharply increased since 1988.

even the strongest reef system does not have a chance to recover from injuries. Periodically occurring natural irregularities, e.g., ENSO in 1997-1998, have such a catastrophic impact that reefs bleach and subsequently die on a global scale.

Ways out?

Fortunately the number of marine parks and marine protected areas (MPs and MPAs) have increased worldwide and also in developing countries. In Indonesia there are plans to double the area by 2005 (Kunzmann 1998, 2002). Large international programs like the International Year of the Reef (IYOR 1997) or the International Year of the Ocean (IYO 1998) have contributed massively to increasing the awareness of these issues among the local populations. Finally development banks have initiated several large projects for the protection and rehabilitation of marine systems, e.g., the Coral Reef Rehabilitation and Monitoring Project (COREMAP) in Indonesia, financially supported by the World Bank, the Asian Development Bank and Japan.

Management of tourism, destructive fishing practices and coastal development have to be regulated and should be



Fig. 9. Padang, West Sumatra: The dirty plumes of the rivers Kuranji and Banjir are clearly visible. After heavy rainfall they can be traced up to 15 km in front of the coastline. The sediment and fertiliser from uncontrolled agriculture and forestry harm reefs.

subordinated under a concept of sustainable development of marine ecosystems. Otherwise coral reefs, a source of income and food for millions of people, will have little chance of survival. In order to achieve this, it is necessary

to inform politicians, decision-makers and economic leaders of all potential commercial aspects of marine systems. Some of these are:

Potential function of the reef	Potential yield per year and km ² reef ³
Coastal Protection	50 Mio. US\$ ⁴
Fisheries (10-30 t/km ²)	0.1 to 0.15 Mio. US\$ ⁵
Tourism	20 Mio. US\$
Marine natural products/pharmacology	? US\$ ⁶
Biodiversity/ gene pool	? US\$ ⁷

Final remarks

The World Resources Institute Report 1998 summarizes as follows:

- Fifty-eight per cent of all reefs worldwide are endangered through anthropogenic influences.
- In Southeast Asia, 80 per cent of all reefs are negatively impacted.
- The main factors are over-extensive and destructive use, as well as an increasing coastal development.
- Globally there are more than 400 MPAs, but many are only on paper and about 150 are smaller than one km².
- 40 countries with reefs do not have a single MPA.

This is a reason for concern. The sum of factors and their cumulative effects have destroyed many reefs beyond repair. There are still isolated reefs in excellent condition, for example, in the South Pacific and these should be protected. It is recommended that tropical countries should be given

assistance for this. Moreover, we should no longer use short-term economic reasons as excuses not to implement partnership projects. Many times it has been discovered too late that this is short-sighted, because in the end we all have to pay the price.

Acknowledgements

Marc Kochzius from the Center for Tropical Marine Ecology (ZMT) contributed Figs. 5 and 8 and unpublished data. Sabine Kadler from ZMT prepared the slides.

References

- Bryant, D., L. Burke, J. McManus and M. Spalding. 1998. Reefs at risk. World Resources Institute, Washington. 56 p.
- Cesar, H., C. G. Lundin, S. Bettencourt and J. Dixon. 1997. Indonesian coral reefs - an economic analysis of precious but threatened resource. *Ambio* 26(6): 345-350.
- Clark, J.R. 1996. Coastal zone management handbook. CRC Lewis Publishers, New York, London, Tokyo.
- Cornish, A.S. and D. McKellar. 1998. A history of fishing with explosives and poisons in Hong Kong waters. *Naga* 21(3): 4-9.
- Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.
- Der Spiegel. 1999. Paradies unter grünem Teppich. *Spiegel* No. 4: 168-172.
- FAO 1996. Yearbook of fishery statistics - fishery commodities. FAO Fisheries Series 83: 1-179.
- Harriott, V.J., D. Davis and S.A. Banks. 1997. Recreational diving and its impact in marine protected areas in eastern Australia. *Ambio* 26(3): 173-179.
- Hawkins, J.P. and C.M. Roberts. 1994. The growth of coastal tourism in the Red Sea: present and future effects on coral reefs. *Ambio* 23(8): 503-508.
- Johannes, R.E. and M. Riepen. 1995. Environmental, economic and social implications of the live reef fish trade in Asia and the Western Pacific. Unpublished by TNC-Washington (sponsored by SPC, AIDAB).
- Kunzmann, A. 1997. The coral reefs of West Sumatra, p. 1249-1262. *In* T. Tomascik, A.M. Mah, A. Nontji, M. Kasim Moosa (eds.) The ecology of the Indonesian Seas. Part two. Periplus Editions (HK) Ltd. Singapore.
- Kunzmann, A. 1998. "Management" of marine ecosystems in West Sumatra: theory and everyday practice. *Image of Indonesia* IV(5): 19-22.
- Kunzmann, A. 2002. On the way to management of West Sumatra's coastal ecosystems. *Naga* 24(1): 4-10.
- Lee, C. and Y. Sadovy. 1998. A taste for live fish: Hong Kong's live reef fish market. *Naga* 21(2): 38-42.
- National Geographic. 1999. Coral in peril. *Nat. Geogr.* 1: 2-30.
- Reaka-Kudla, M.L. 1997. The global biodiversity of coral reefs: a comparison with rain forests, p 83-108. *In* M.L. Reaka-Kudla, D.E. Wilson, E.O. Wilson (eds.) Biodiversity II. Joseph Henry Press, Washington, D.C.
- Wells, S. and N. Hanna. 1992. Das Greenpeace Buch der Korallenriffe. Beck, München.
- Wilkinson, C. and G. Hodgson. 1999. Coral reefs and the 1997-1998 mass bleaching. *Nature and Resources* 35(2): 16-25.

A. Kunzmann is from the Centre for Tropical Marine Ecology (ZMT), Bremen.
E-mail: akunzmann@zmt-bremen.de

³ Figures are from real projects in the Caribbean, Indonesia and Australia.

⁴ Wells and Hanna 1992; assumed longevity of manmade coastal protections is 100 years.

⁵ FAO 1996; reef catches of 9 million t/yr represent about 12 per cent of the total world catch.

⁶ Figures still unknown

⁷ Figures still unknown