

MANAGEMENT OPTIONS FOR CORAL REEF CONSERVATION

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Keywords: Coral reefs, ecosystem, conservation, eutrophication, Marine Park, Marine Protection Areas (MPAs), rehabilitation, Great Barrier Reef Marine Park Authority, Integrated coastal zone management (ICZM), Marine Environmental Quality (MEQ).

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Summary

For a great many tropical countries, coral reefs are important resources in terms of productivity and the well being of mankind. Usually, these are subject to special protection. Nevertheless, the degradation of coral reef ecosystems is common throughout the world. The growing popularity of recreational activities in coastal waters and the higher quantity of various wastes dumped into the oceans have aggravated the situation. For these reasons, the conservation of coral reefs deserves priority on the environmental and economic agendas of all coastal nations. Coral reef conservation involves the protection of not only valuable reef areas, but also the quality of all marine environments. To do this, the available options include the designation and establishment of marine protected areas, enhancement of maritime environmental quality, management of human activities, the setting up of a certification system for coastal recreation, and the promotion of public education and involvement in related affairs. Clearly, the above measures require that indigenous people share the responsibility with government agencies.

1. Introduction

Coral reefs are unique, for they are built entirely by means of biological activity. Reefs are essentially massive deposits of calcium carbonate that are produced by coral, albeit

with major additions from calcareous algae and other organisms that secrete calcium carbonate. Conditions favoring the development of reefs include the presence of water temperatures from 25 to 29°C (77 to 84°F); water depths shallower than 50 m; constant salinity greater than 30 but less than 36 parts per thousand; low sedimentation rates; sufficient circulation of pollution-free water; and pre-existing hard substrate.

Because extensive reef development is seldom found where ocean temperatures fall below 20°C (68°F), coral reefs tend to be restricted to a circum-global belt between the latitudes of 30°N and 30°S. The belt covers an estimated area of 600 000 square kilometers. However, coral assemblages can still be found at 35°N off Japan and at 32°S in the Tasman Sea of New Zealand. In Asia, for example, regions like Australia, Indonesia, Malaysia, New Zealand, the Philippines, Thailand and Taiwan have abundant resources of coral reefs. The Great Barrier Reef of Australia, covering a total area of 348,700 square kilometers and having more than 2 900 individual reefs and about 900 islands, is the largest complex of coral reefs and islands of the world.

2. Importance of Coral Reefs

Coral reefs constitute one of the Earth's most productive and diverse ecosystems. They benefit people directly by providing food, medicine, construction materials and other valuable items. More importantly, coral reefs provide support and sustenance to the other coastal ecosystems upon which people greatly depend. For these reasons, many countries reserve a fair share of their environmental agenda for the protection of their reefs. Malaysia serves as one example. Pursuant to Section 41 of the Malaysian Fisheries Act of 1985, the authorities must establish certain areas or parts of an area in Malaysian fishing waters as a marine park or marine reserve so as to manage human activities, thereby affording special protection for aquatic flora and fauna. According to this act, a marine park is defined as:

"an area of the sea zoned as a sanctuary for the coral reef community which is considered as possibly the most productive ecosystem in the world with its diversity of flora and fauna. Coral reefs are also important breeding and nursery grounds for commercially important species of marine organisms and fish."

An amendment to the Malaysian Act also regulates that the Minister must establish a National Advisory Council for Marine Park and Marine Reserves to provide consultation for reef management. Today, at least 38 marine parks have been designated.

Reefs are closely related to marine diversity and productivity. They represent essential supplies of seafood in many tropical countries. They are natural breakwaters that protect beaches and shores from erosion and storm damage. They manufacture white carbonate sand, which is supplied to beaches by waves and currents. Reefs and their associated sandy beaches are strong draw cards in the world of tourism, a major source of income and foreign exchange to dozens of tropical countries. Therefore, based on the productivity, beauty and health that coral reefs offer, they are considered essential both ecologically and economically.

3. Coral Reef Degradation

Coral reef resources have been seriously degraded in many parts of the world, and obviously this has had grave consequences for tourism, fishing, beach stability and biodiversity. For example, countries and marine reserves in the Caribbean, which once enjoyed rich coral resources have now noted significant damage and dire consequences. A reef check of Taiwan in 1998 also indicated that some 30 to 60 percent of its coral reefs experienced bleaching or damage. Some reefs are virtually beyond repair, but many that are degraded could still be returned to their nature state. The extreme loss of corals can ruin a park and severely cut into tourism. Thus, coral reef conservation deserves priority on both the environmental and economic agendas of the coastal nations concerned.

The sources of degradation of coral reefs are varied and extensive. Many sources are known in detail, others less so, and still others are yet to be discovered. Unfortunately, most coral reefs that receive human use or are located near settlements suffer damage (combined human and natural causes), lowering their value significantly and even sometimes reducing them to rubble. The leading causes of damage to coral reefs are tourism, sewage and runoff, forest cutting, agricultural practices, aquaculture, port operation, mining, dredging, power plant operation, petroleum production and climate change. The impacts to be managed in the interest of rehabilitating coral reefs include the following:

- General urban encroachment;
- Pollution from agriculture, sewage and industrial wastes which, due to their toxicity, inhibit feeding, growth and reproduction;
- Siltation and sedimentation created by dredging, filling and other related construction activities which increase erosion;
- Discharge of large volumes of freshwater which may result from stormwater outfalls;
- Oil pollution from drilling, extracting and transport by tankers and pipelines;
- Physical damage from anchors, diver activities and coral collecting;
- Great storms that smash the coral and "sandblast" their tissues;
- Diseases like whiteband and blackband disease that kill corals;
- Excessive spear, trap and cage fishing that removes too many species that are important for keeping the reef in balance (e.g., parrot fishes);
- Other destructive fishing practices, including dynamite fishing, cyanide fishing and collection of juveniles for aquariums;
- Ship groundings which smash and/or scrape away corals;
- Marine construction activities; and
- Massive losses by disease, depletion or migration of essential symbionts (e.g., sea urchins which, when in appropriate abundance, keep the reef healthy by cleaning it of algae).

A major concern in coral reef management is their protection from the above threats. In particular, marine excavation (dredging) near coral reefs suspends a mass of particulate soil. A large quantity of either coarse or fine particles bury the corals. Thus, the impact

of silty, turbid waters is one of the main causes of the destruction of coral reefs. Siltation is a consequence of deforestation, bad land management as well as of urban development, such as housing and highway construction.

Coral mining - the excavation and removal of coral materials from reef ecosystems - also requires control. Such mining is extensively undertaken in some island countries in the Indian Ocean and Southeast Asia. The practice degrades the ecosystem and leaves the shoreline exposed to erosion and storm surges, causing serious loss of beach and shoreland and damage to coastal human and marine resource habitats. Mining is the most serious of all physical interactions with coral reefs. The demolishing of coral reefs in order to produce commercial construction materials (e.g., blocks, quicklime, roadbed materials, etc.) not only destroys habitats and disrupts fishing, but also jeopardizes coastal settlements. The mining of coastal reef barriers leaves the shoreline exposed to waves and storm surges that erode beaches and destroy property. Harvesting coral reef organisms to sell as decorative items is another very damaging activity. Because corals grow slowly, the replacement of a removed coral by a new one is a process that can take several decades. In light of this, many regions of the world (e.g., Panama, Bali of Indonesia, and the United States) have banned coral mining. The Great Barrier Reef Authority (Australia) allows some mining, but under strict control.

Recreational (tourist) divers can also deplete a reef in a few years just through hand contact and foot damage. Snorkelers often tread water in shallow water, which stirs up large clouds of sediments. They are also more apt to stand on corals than are scuba divers. Natural stresses also present reef managers with problems. For instance, the prevalence of disease may be higher in corals that are stressed by mechanical damage or pollution. Corals respond to chemical and sediment stress by secreting mucus; if this becomes excessive, the mucus harbors bacteria, with fatal consequences to the coral. In recent years, the impact of climate change on reef ecosystems has been another focus of research. In particular, the high temperature of seawater is believed to be one major destructive factor in a wide range of reef bleaching.

4. Options for Coral Reef Conservation

The goals of coral reef conservation are to protect the aesthetic, historical, biological and geological values of reefs from human impact, to provide traditional and sustainable use (e.g., fisheries and tourism) as well as to maintain biological productivity and diversity. The first step in coral reef conservation should be *protection*, the elimination or reduction of the stresses responsible for the damage. The second step is *rehabilitation*, an important issue because major coral reef degradation has been experienced by dozens of countries. For these countries, it is not enough just to protect reefs that exist; the goals of reef conservation have to include the repair of the damage of the past. In general, coral reef management is expedited by either an integrated coastal zone management (ICZM) approach (regulatory control) or a protected area strategy (proprietary control) and should include both the protection and rehabilitation of coral reef resources. The major types of conservation action include the management of watersheds and wetlands, the abatement of pollution, controls on extractive industries and the prevention of destructive activities, such as anchoring in coral. Management

area planning, marine pollution control and the control of human activities are, therefore, summarized as the three major themes of coral reef conservation.

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Biographical Sketch

Wen-Yan Chiau is an Associate Professor in the Department of Marine Environment and Engineering at National Sun Yat-sen University in Kaohsiung, Taiwan. After earning his B.Sc. in Urban Planning (1976) and L.L.M. (1980) in Taiwan, he was granted his M.A. in Urban Planning (1989) and Ph.D. in City and Regional Planning (1991) from the University of Pennsylvania. Dr. Chiau's expertise is in the field of environmental planning and management, especially in the areas of coastal zone management, wetland conservation, coastal tourism, ocean policy and environmental law. He is author of the first book on coastal zone management in Chinese entitled, *Coastal Management: Theory and Practices*, published in November 2000. During his some 20 years as a planner and conservationist, he has served as both project manager and principal advisor on a wide range of projects related to the marine environment. In addition to giving lectures, conducting research projects and advising graduate students, he actively participates in related governmental affairs and serves as a member of various *ad hoc* governmental committees. Currently, he is a member of the National Council on Sustainable Development of the Executive Yuan (Cabinet), the highest-level agency formulating conservation and sustainable development policies in Taiwan. He is also concurrently an advisor for the Subcommittee on Sustainable Development of the Legislative Yuan (Congress), a reviewer of the "National Biodiversity Report" and vice coordinator of the committee on "National Oceans Policy". On a voluntary basis, Dr. Chiau contributes a great deal of his time to several NGOs in Taiwan. He is the president of Wetlands Taiwan and the CEO of the Foundation of Ocean Taiwan. As part of his active involvement in international matters vis-à-vis the marine environment, Dr. Chiau has been one of the representatives of the Chinese Taipei Delegation in the APEC Meetings of the Marine Resource Conservation Working Group since the sixth meeting in Sidney, B.C., Canada in 1994. He is an executive board member of the Asia-Pacific Environmental Council (AEC) and was responsible for organizing the sixth Asia-Pacific NGOs' Environmental Conference (APNEC-6) held in Taiwan in 2002. APNEC meetings, held every two years, have been among the most important events for NGOs in the region.