Evaluating Remote Sensing and Coastal Management Compatibility for Improved Coral Reef Management of Bunaken National Park, Indonesia

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The world’s coral reefs are at risk; this is no longer in question. Recent estimates suggest that significant reef degradation has occurred in over 93 countries, the majority of which are among the world’s least developed. Within the country of Indonesia, coral reefs provide products and services for numerous coastal and inland communities. However, coral reefs have increasingly been impacted by coastal development, land- and marine-based pollution, and destructive fishing practices. As a result, reef health has considerably declined posing a challenging task for coral reef managers.

Use of reef resources in Indonesia is essential and, yet must be managed skillfully to ensure long-term conservation. In Indonesia, government officials, park managers, and local stakeholders are faced with the combined tasks of managing reef use and conserving reef resources. One solution has been to develop marine protected areas to reduce coral reef degradation and associated fish stock depletion. Bunaken National Park provides an example of a successful marine protected area where conservation activities occur beside traditional practices. More recently, members of the park have expressed interest in involving greater scientific knowledge to address questions of coral reef health evaluation and monitoring.

This study attempts to contribute to this interest through the evaluation of remote sensing in the context of coral reef management concerns. Satellite technology provides information on the spatial location and extent of coral, seagrass, and sand substrates. This study investigates the capabilities of the IKONOS satellite to map these substrates, in addition to the specific scientific information needs of Bunaken National Park managers. The goal is determine the compatibility between remote sensing mapped features and coastal manager information needs. With this study, we wish to advance the utilization of remote sensing to address urgent coral reef management concerns in developing nations.
Remote Sensing Technologies and the Use of Reef Resources in Indonesia

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What are reefs and reef resources?

Thousands of coral polyps cover a coral mound and use seawater to build a hard, cup-shaped skeleton of calcium carbonate.

What techniques are used to improve our coral reef knowledge base?

Directed Swim

Quadrat

What does satellite mapping expand our coral reef knowledge base?

Environmental Parameters
- water quality and/or composition
- depth
- bottom features

Environmental Inventory
- biological composition
- geomorphological formations
- size and type of fish habitats

Environmental Status
- presence of bleaching
- algae dominated bottom-type
- coral disease

Satellite mapping has the benefits of covering a large area within a period of time that would equitably require days to months of ground surveying.

Coral Reef Status in Indonesia

Indonesia has 42,000 sq.km of coral reefs and 50% of these reefs are at high risk of being impacted by coastal development, marine pollution, over-exploitation and destructive fishing, and inland pollution and erosion.
Coral Reef Management in Indonesia

- In 1997, a major initiative was undertaken by the Government of Indonesia to decentralize management efforts from central to local levels for several national marine parks.
- In the current management strategy, community involvement occurs in a collaborative manner with input from government and non-government stakeholders.
- Today, management bodies have formed and take responsibility for balancing coastal development and coral reef conservation using Marine Protected Area strategies that include the formation of zones for defined activity uses.

Bunaken Island, Indonesia

Bunaken Island is located at the northern tip of the island of Sulawesi. Sulawesi is one of the main islands in Indonesia.

IKONOS Satellite Image

Spatial Resolution 4 x 4m and 1 x 1m
Spectral Resolution 450-520 nm (Blue), 520-600 (Green), 630-690 (Red), 760-900 (Near-IR)

Identification of Biophysical Features

Coral, Shallow Sand, Deep Sand, Dense Seagrass, Loose Seagrass

Integrating Remote Sensing with Coral Reef Management

1. Identification of Stakeholders
2. Identification of Information Needs through Discussions
3. Reduction of Information Needs to Basic Biophysical Features
4. Matching Information Needs with Satellite Information
5. Reintegration of Satellite Information through Discussions
Fishermen
Concern: decline in large fish populations around the island

What do we know?
1. Large fish means grouper and skipjack populations
2. Solitary species of fish
3. Eat small reef fish along the reef crest

What can we do?
Calculate the spatial location and extent of these regions.

Clusters of Healthy Reef Species Located Along the 'Reef Crest

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Result
- Remotely sensed information can address many of the biophysical information needs for coral reef management of Bunaken National Park

Lessons Learned
- Large time commitment
- Understanding of the biological marine environment
- Understanding of the social-cultural environment