

# Managing bleached coral reefs in the Gulf of Thailand

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**Abstract.** Widespread and severe coral bleaching events on most coral reefs in the Gulf of Thailand were clearly documented in 1998 and 2010. The coral reef management and restoration project in tourist hot spots in the Gulf of Thailand was initiated and funded by the network of provinces in the eastern Thailand. The project aims to survey and establish an ecological and socio-economic database for managing the coral reefs and enhance their resilience to climate change. In addition, artificial substrates for coral recruitment and ecotourism are provided at tourist hotspots with the participation of local communities in managing natural resources and environment, wherein public awareness and education are enhanced. The project shows effective collaboration between scientists, local communities and local government officials as decision-makers to integrate scientific data into policy and adaptation measures. The coral reef restoration sites can be used to support ecotourism and learning opportunities for students. Continuing efforts in capacity building, public awareness and education through disseminating printed materials and conducting training courses, workshops and seminars for stakeholders, youth, students and local government officials can enhance resilience in coastal communities. The project applies Thailand's coral reef restoration plan, comprise of 4 strategies and 15 measures that focus on passive restoration by reducing threats from tourism, water pollution, sedimentation and fisheries. Strengthening the long-term monitoring, evaluation and reporting of the project can provide lessons for conservation of coral reefs in tourist hotspots influenced by climate change, especially coral bleaching events.

**Key words:** management, bleaching, ecotourism, restoration, Gulf of Thailand.

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## Introduction

Coral bleaching events have been frequently reported in the past three decades. It is recognized as one of the most significant threat to coral reefs around the world. Recently, the 2010 coral bleaching event caused extensive coral degradation in the Andaman Sea and in the Gulf of Thailand (Yeemin et al. 2010). The need for management responses to coral bleaching is well documented. As a result of coral bleaching, most coral reefs in the world have suffered extensive stress with high coral mortality. Observations on impacts of coral bleaching and expected future trends have lead reef researchers and managers to warn the public that coral reefs are in crisis. Therefore the scientific community has suggested that the impacts of the mass coral bleaching phenomena, in combination with those from chronic local stressors, will completely control the coral reef conditions in this century (Hughes et al. 2003, Marshall and Schuttenberg 2006). While the need for coral reef management has become obvious,

determining practicable and effective management strategies has proved to be challenging.

Several studies showed that traditional management focusing on minimizing or eliminating sources of stress are not fully accomplished as related to the coral bleaching events in Thailand (Yeemin et al. 2006). Coral reef managers need information to directly mitigate the main cause of mass coral bleaching event which is a uniquely challenging problem for management of marine and coastal resources. In this paper, we present a case study of adaptive management implementation of a project to enhance the resilience to climate change-derived coral bleaching. Emphasis on the survey and establishment of an ecological and socio-economic database for managing degraded coral reefs. The artificial substrates for coral recruitment and ecotourism are provided at tourist hotspots with participation of local communities in managing natural resources and their environment. Public awareness and education are enhanced, following the 2010 coral bleaching event in the eastern Gulf of Thailand.

**Methods**

The paper takes a socio-ecological perspective to examine the issues surrounding the coral reef management and restoration project in the network

of Provinces in the eastern Thailand. The project was conducted in April 2011-January 2012 in Rayong, Chanthaburi and Trat Provinces, along the eastern coast of the Gulf of Thailand (Fig. 1).

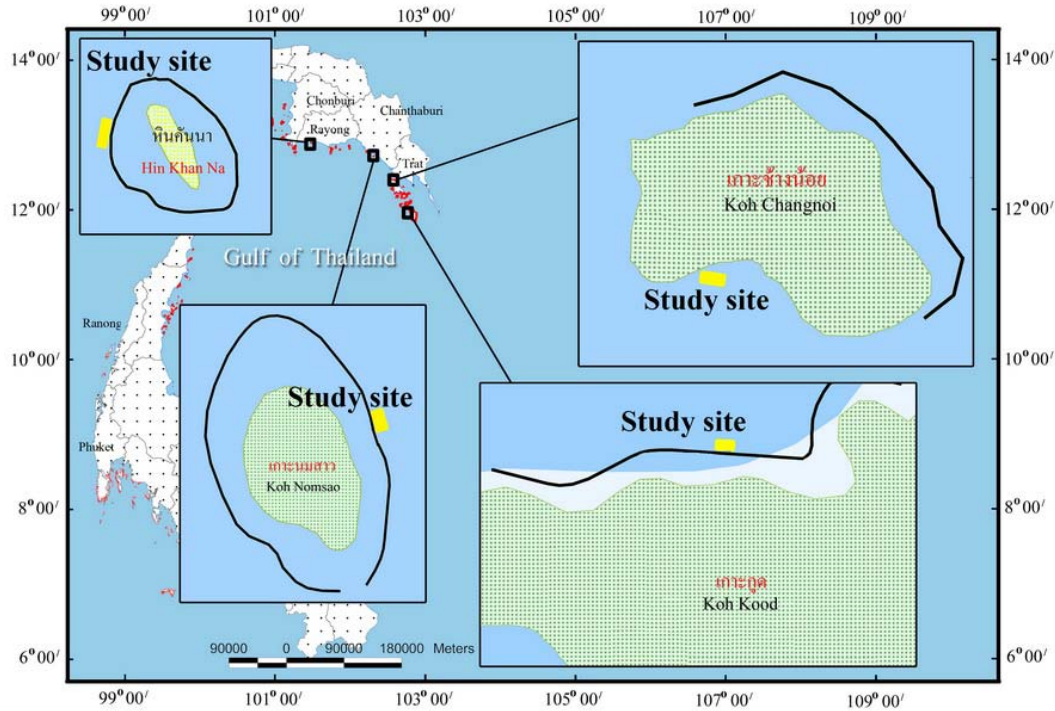


Figure 1: Map of the four study sites in the eastern Gulf of Thailand.

There has recently been a rapid and steady growth in tourism and recreational activities, such as diving, underwater photography, and sport fishing, leading to obvious increases in coral reef-related tourism activities in the eastern Gulf of Thailand. Coral reefs close to beach resorts, especially those in Chanthaburi, Rayong and Trat Provinces are now used intensively for tourism. There are two marine national parks in the eastern Gulf of Thailand, namely Mu Koh Samet National Park in Rayong Province and Mu Koh Chang National Park in Trat Province. Several methods adopted for this study include coral reef monitoring following the 2010 bleaching event. Sharing observations at meetings, and numerous formal and informal interviews with a variety of different stakeholders such as dive operators, divers, fishers, government officials, non-government organization workers and local people. The project included several stages, i.e. initiation planning, project consultation, implementation of project activities (coral reef monitoring after bleaching events, GIS database for management, installation of artificial reefs for coral recruitment, ecotourism and education, training courses for coral reef conservation and producing materials for

raising public awareness) and project monitoring and evaluation (Fig. 2).

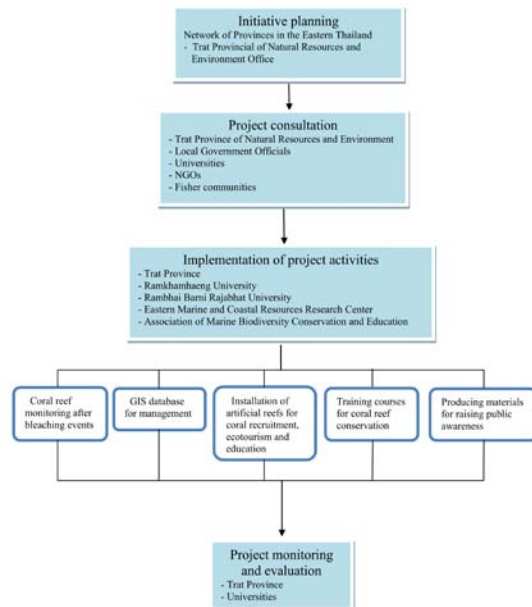


Figure 2: A flow chart for implementation of the coral reef management and restoration project.

## Results

Following the 2010 coral bleaching event, the network of provinces in the eastern Thailand provided funding for the implementation of the coral reef management and restoration project at four reef sites, i.e., Koh Samet (Rayong Province), Koh Nom Sao (Chanthaburi Province), Koh Chang and Koh Kood (Trat Province). The planning was led by Trat Provincial of Natural Resources and Environment Office. The project consultation involved several organizations, including Natural Resources and Environment Offices of Rayong, Chanthaburi and Trat Provinces, local administrative officials, Eastern Marine and Coastal Resources Research Center, Ramkhamhaeng University, Rambhai Barni Rajabhat University, Association of Marine Biodiversity Conservation and Education and fisher communities.

Socio-economic and ecological surveys on coral reefs in Rayong, Chanthaburi and Trat Provinces were conducted in April-May 2011. The ecological data will be published elsewhere. The 2010 coral bleaching event caused coral degradation at several diving hotspots. These data were gathered as GIS maps with relevant data for management at each provincial of natural resources and environment office.

Based on socio-economic and ecological surveys data and consultation between stakeholders and relevant organizations, two models of artificial reefs were selected:

Model A: additional substrate for coral recruitment by using clusters of cylindrical concretes laid in a triangular model

Model B: attaching coral fragments on a new design of small concrete model with available substrate for coral recruitment by using underwater cement or epoxy (Fig. 3).

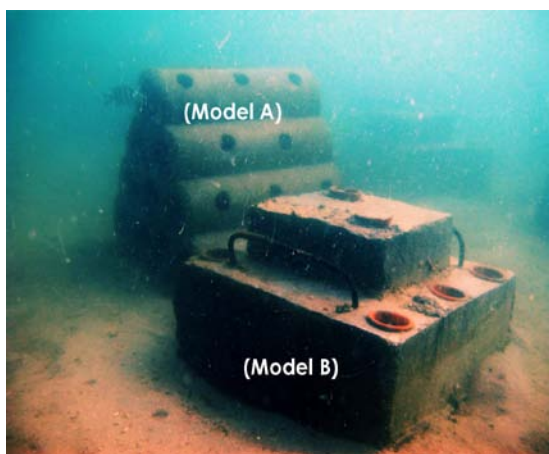


Figure 3: The artificial reef models: Model A and Model B.

Site selection was conducted through meetings of stakeholders, researchers and local government officials. We mainly considered socio-economic, physical and biological environmental factors, user conflicts and preferences and socio-economics of local stakeholders (Fig. 4). Four locations were selected for installation of the artificial reef models, i.e., at Hin Khan Na, south of Koh Samet, east of Koh Nom Sao, Koh Chang Noi, northwest of Koh Chang and west of Koh Kood.

Training courses for coral reef conservation were conducted at the four local communities where the artificial models were installed. The participants, mainly local fishermen, students, local officials and tourism companies, learned about coral reef ecology, best practices for ecotourism and coral reef conservation and management (Fig. 5).

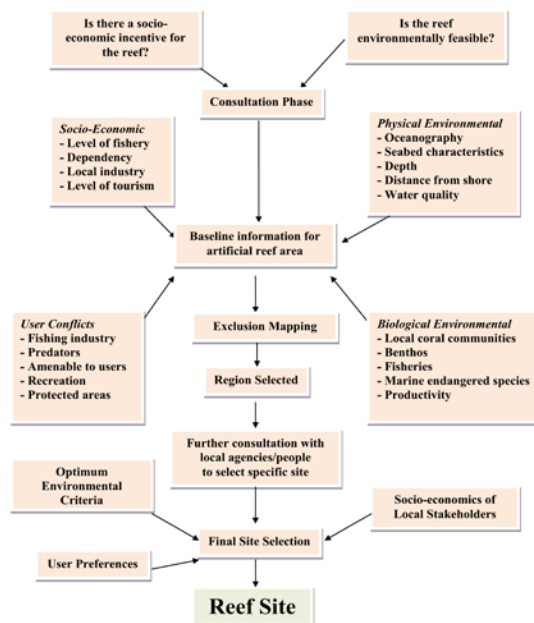


Figure 4: Site selection process for artificial reef installation. (Adapted from Wright et al. 1998)



Figure 5: A training course at Koh Kood, Mu Koh Chang.

Permanent bulletin boards, brochures and posters for raising public awareness were produced and distributed to local people, students and tourists at the four locations (Fig. 6).



Figure 6: A poster showing coral reef fishes in the eastern Gulf of Thailand.

The projects were periodically monitored and evaluated by the network of provinces in the eastern Thailand and researchers from relevant universities.

### Discussion

This project clearly shows the effective collaboration between scientists, local communities and local government officials as decision-makers integrating scientific data into policy and adaptation practices. Previous studies showed that the social-ecological system of coral reefs involves the environment, the ecosystem, human exploitation and social organization and the policies that arise from their interaction (Gutrich et al. 2005, Linkov et al. 2006, McClanahan 2011, Halpern et al. 2012). Marine protected areas (MPAs) were established in several countries as a framework for coral reef management that has been shown to enhance fishery production for local fishermen, as well as protecting and maintaining coral reefs for biodiversity and multiple socio-economic uses. Several MPAs are related to the evolution of integrated coastal management (ICM) development (White et al. 2005, David et al. 2010, Ibrahim and Shaw 2012). In this study, Mu Koh Chang and Mu Koh Samet National Parks could play a major role to conserve coral reefs in the eastern Gulf of Thailand.

The artificial reef sites can be used to support ecotourism and learning rooms for students. Several institutions and organizations, from both the government and the private sector, have expended much effort to restore degraded coral reefs in the Gulf of Thailand. The coral reef restoration projects have been developed in a large number of reef sites and implemented with a range of objectives, at various

scales, and using different methods. The lessons from these projects need to be documented to assist the development of a national strategic plan for sustainable coral reef management and maintenance of marine biodiversity in Thailand (Yeemin et al. 2006).

We suggest that continuing efforts in capacity building, public awareness and education through disseminating printed materials and conducting training courses, workshops and seminars for stakeholders, youth, students and local government officials can enhance resilience in coastal communities. Community participation in coral reef management and restoration projects is an important factor to ensure the project accomplishment (Hollup 2000, Rodriguez-Martinez 2008, Fletcher et al. 2009, Aldon et al. 2011). Although both science and management are currently failing to address the co-management of extractive activities and ecological processes that drive ecosystems, such as productivity and herbivory (Mumby and Steneck 2008). We emphasize the significance of Thailand's coral reef restoration plan which comprises 4 strategies and 15 measures. It focuses on passive restoration by reducing threats from tourism, water pollution, sedimentation and fisheries (Yeemin et al. 2010). Strengthening the long-term monitoring, evaluation and reporting of the project can provide lessons learned for conservation of coral reefs in tourism hotspots that are vulnerable climate change, especially coral bleaching events.

### Acknowledgement

This paper is an output of the coral reef management and restoration project, partly funded by network of provinces in the eastern Thailand. We thank S Pienthong, R Boonprakob, P Saenpaiboon and staff of Marine Biodiversity Research Group, Ramkhamhaeng University for their supports. This research was funded by a budget for research promotion from the Thai Government to Ramkhamhaeng University in the fiscal years B.E. 2552-2555.

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