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17D Managing bleached coral reefs

Impacts of coral bleaching, recovery and management in Thailand

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Abstract. Severe mass coral bleaching events occurred on most reef sites in Thailand in 2010. Bleaching in the Andaman Sea was more severe and extensive than in the Gulf of Thailand. Several meetings, seminars and conferences were organized by government agencies, NGOs and universities for gathering information on coral bleaching impacts, recovery trends and management. A list of recommendations for coral reef management in Thailand was provided. The important issues include: preventing coral damages from snorkeling in the shallow reefs, sediment load from coastal development, wastewater discharge from boats and land-based activities into coral reefs, temporary closure of diving sites, establish new diving sites, conducting research and monitoring for coral conservation and restoration, informing people and tourists concerning status of coral bleaching, providing sufficient man-power and budget to relevant government agencies, establishing effective networks of universities, government agencies, province offices, local administration offices, NGOs, private companies, and conservation groups. It is necessary to have effective mechanisms for project implementation under Thailand's national coral reef management plan. A list of research needed towards adaptation to coral bleaching was also provided by relevant experts and organizations. Development of young researchers and raising public awareness are urgently required for coral reef conservation in Thailand in order to manage the pressures and move societies to a sustainable pathway.

Key words: coral, bleaching, recovery, management, Thailand.

Introduction

Coral bleaching is the most severe threat posed by climate change to coral reefs in Thailand. Recently, the severe mass coral bleaching events in 2010 occurred on most reef sites in Thailand. Bleaching in the Andaman Sea was more severe and extensive than in the Gulf of Thailand (Yeemin et al. 2010). It is predicted to increase in frequency and severity in this century (Hughes et al. 2003; Hoegh-Guldberg et al. 2007; Burke et al. 2011; Hoegh-Guldberg 2011). Coral recovery from major disturbances, such as the severe coral bleaching event in 1998, was documented in some locations (Yeemin et al. 2009). However the coral recovery capacity is likely to diminish in some locations as disturbance frequencies increase. Consequently, the risk of coral bleaching each summer must be viewed in integration, because the antecedent impacts from previous events may render corals more susceptible to bleaching and disease. Both function as structuring forces shaping future condition of coral reef ecosystem (Great Barrier Reef Marine Park Authority 2010).

It is well documented that coral reef degradation may lead to socio-economic losses because of impacts to coastal fisheries, tourisms and multiple ecosystem services (Cesar 2000). The socio-economic losses that result from severe coral bleaching events were reported (Bunce and Pomeroy 2003). The extent to which severe mass coral bleaching affects society is determined by several variables, including the extent to which coral bleaching leads to coral mortality. There are varied uses of coral reefs in which coastal communities have been impacted. It is important to determine the flexibility of coastal communities to shift their dependence on coral reefs when reef degradation occurs (Marshall and Schuttenberg 2006). The future condition of coral reefs will be mainly influenced by the rate and extent of sea temperature increases and the resilience of coral reef

ecosystem (West and Salm 2003; Buddemeier et al. 2004).

Most coral reef managers realize that it is very important to consider the cumulative impacts of simultaneous threats to coral reefs. In future the coral bleaching phenomena is inevitable and coral reef managers have the responsibility to monitor, assess and respond to the ecological and socio-economic impacts of coral bleaching.

Material and Methods

To provide a strategy for coral reef management in Thailand, Department of Marine and Coastal Resources, Department of National Parks, Plant and Wildlife, a network of Thai universities, For Sea Foundation, NGOs and private companies began the development of the coral reef management strategy under coral bleaching crisis in June 2010. A review of physical oceanography data, coral reef ecology, watershed ecosystem, coastal zone management and coral reef management plans in Thailand and other countries was conducted. Several meetings, seminars workshops and conferences on coral reef related issues, especially coral bleaching impacts, recovery trends and management were reviewed and analyzed (Fig. 1).

Figure 1: A meeting between coral reef scientists, managers and stakeholders concerning coral reef bleaching impacts and management

Results

Sea surface temperatures anomalies of between 30-34°C were recorded during March-June 2010 in the Andaman Sea and the Gulf of Thailand. The Department of Marine and Coastal Resources, in collaboration with a network of Thai universities and NGOs conducted several reef surveys and reported widespread and severe coral bleaching of over 80% at several reef sites. Coral bleaching in the Andaman Sea was more severe and extensive than in the Gulf of Thailand, with the inner Gulf of Thailand exhibiting the lowest bleaching impact. The most susceptible coral taxa were *Acropora* spp. and *Pocillopora* spp. Coral mortality following the bleaching event is estimated at about 50 – 60% within the Andaman Sea, and about 30 – 40% within the Gulf of Thailand. Some coral species, especially *Porites* showed good recovery. It is estimated that the 2010 bleaching event is similar in extent but with greater severity than the 1998 bleaching event within the Gulf of Thailand, but greater in extent and severity within the Andaman Sea.

In the Andaman Sea, reefs on the eastern coast of the islands showed greater impact than reefs on the western coast, which are subjected to internal waves and generally stronger wave action. Within turbid areas with high water flow, coral colonies showed resistance to bleaching. It is possible that within these areas, reduced light penetration contributed to the overall reduction in the combined temperature/light stressors that induced bleaching. Among hard coral species, there was a mixed response to bleaching, with *Galaxea* sp., *Diploastrea heliopora*, *Heliopora coerulea* and free-living fungiids showing greatest resistance to bleaching. In addition to hard corals, other zooxanthellate taxa including soft corals, zoanthids and giant clams were also bleached (Tun et al. 2010; Yeemin 2010). A GIS database and map of coral condition in Thailand was developed. It shows coral reef status before and following the 2010 mass bleaching event for each reef site together with information on bleaching severity, coral mortality rate and change in live coral cover (Fig. 2).

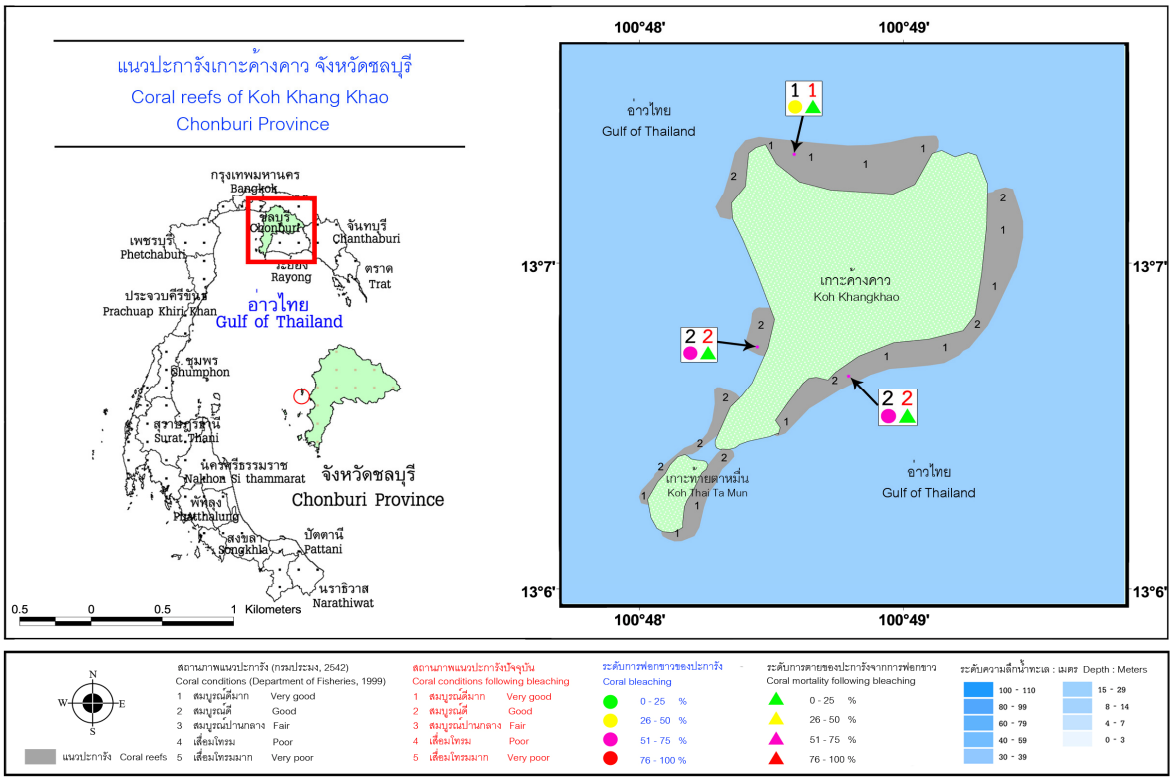

Figure 2: A GIS map of coral condition at Khang Khao Island

Proposed coral reef management actions under the coral bleaching crisis

Management actions are categorized into three groups, i.e. protect resistance, build tolerance and promote recovery.

1) Protect resistance
   - -reduce stresses on coral reefs, such as light, temperature, freshwater, etc.,
   - -protect resistant coral reefs to bleaching,
   - -select appropriate coral species and genetic trait for coral rehabilitation projects,
2) Build tolerance
   - -reduce stresses on coral reefs, such as light, temperature, freshwater, etc.,
   - -rotation or temporary closure of particular reef sites for tourism purposes,
   - -coral reef zoning for utilization,
   - -environmental-friendly coral reef utilization,
   - -reduce sedimentation loads into coral reefs,
   - -reduce nutrients and wastewater flowing into coral reefs,
3) Promote recovery
   - -control outbreaks of coral predators and space competitors,
   - -regulate appropriate fishing practices on coral reefs,
   - -control water quality from land-based, islands and tour vessels,
   - -reduce sedimentation loads into coral reefs,
   - -protect corals from direct and indirect damaged,
   - -implementation of the activities under the national coral reefs management strategic and action plans,
   - -protect the resistant areas to coral bleaching,
   - -protect the areas with available substrates for coral recruitment,
   - -establish hard substrates for coral recruitment,
   - -protect coral settlers,
   - -coral transplantation by selecting appropriate species/genetics and areas,
   - -culture of sexually and asexually derived juvenile corals,
   - -reef rehabilitation using naturally broken coral fragments,
   - -establish artificial reefs for diving/fisheries/ nursery ground

A list of research needed

- -shading effect on coral bleaching,
- -fatty acid composition and accumulation in stressed corals,
- -impacts of various stresses on coral reefs,

-criteria for coral assessment at particular reef sites,
-identify resistant coral reefs to coral bleaching events,
-management of resistant coral reef to coral bleaching events,
-biology of resistant coral species to bleaching,
-biology of resistant coral-symbiotic zooxanthella clades to bleaching,
-criteria for determination of temporary closure of particular reef sites,
-consequence of temporary closure of particular reef sites/coral reef recovery,
-how to improve management effectiveness of marine protected areas,
-impacts of various utilization on coral reefs,
-relationships between corals and predators,
-space competition on coral reefs,
-taxonomy and life history of algae/tunicates/ sponges/gastropods,
-factors determining outbreaks of algae/tunicates/ sponges/gastropods and measures to control,
-impacts of feeding fish on coral reefs,
-fishing impacts on carnivores/herbivores removal,
-impacts of illegal fishing on coral reefs,
-impacts of ghost fishing gears on coral reefs,
-patterns of fish migration between artificial reefs, stationary fishing gears and natural coral reefs,
-coral reefs recovery and regeneration of damaged coral colonies,
-monitoring and assessment of coral reef recovery,
-types of artificial substrate for coral recruitment,
-diversity and density of coral recruits, growth and survival of juvenile corals,
-comparison of effectiveness and cost-benefit of various coral rehabilitation methods

Discussion

As coral bleaching is an issue that attracts strong interest from the public, the media and decision makers, therefore coral reef managers have to provide up-to-date information concerning coral bleaching event and its impacts. Coral reef managers should proactively engage their target audiences in discussion about coral bleaching and the action that are required to build coral reef resilience. A communication strategy for responding to mass coral bleaching may have three objectives, as proposed in a reef manager's guide to coral bleaching (Marshall and Schuttenberg 2006): 1) gain support from supervisors and constituencies to respond to mass coral bleaching in the short and long term; 2) engage stakeholders in a two-way communication about the extent and severity of coral bleaching and actions that can be carried out to build reef resilience and 3) to work with the media to raise public awareness of mass coral bleaching phenomena and their impacts among the public.

New perspectives on marine protected area (MPA) design, implementation and management relevant to coral reefs with highlighting three interlinked emerging trends were proposed: 1) MPA design is evolving to merge coastal community (usually local and bottom-up) and systematic conservation planning (usually regional and top-down) approaches; 2) linking social – ecological considerations are now viewed as essential in MPA design and management, especially for coastal areas with customary tenure and community management; and 3) both 1) and 2) combined with social and ecological changes, especially with climate change, necessitate an adaptive management approach to MPA planning and management (Ban et al. 2011).

It is necessary to have effective mechanisms for project implementation under Thailand's national coral reef management plan. We highlight the development of young researchers and raising public awareness as the urgent requirement for coral reef conservation in Thailand in order to manage the pressures and move societies to a sustainable pathway.

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