Science and management of Southeast Asia’s coral reefs in the new millennium

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Abstract Rampant destruction of coral reefs throughout the later half of the past century threatens Southeast Asia’s status as the global coral reef hotspot. Increased awareness in the 1990s of the economic value of coral reefs stimulated management responses, but despite implementation of a variety of management practices, these had limited effect considering the scale and intensity of degradation. This paper examines the state of science and management of the region’s coral reefs one decade into the new millennium. Advances in the scientific understanding of coral reef processes are sufficient to support more effective management but if this is not scaled up and strongly implemented, then the region risks losing its rich reef heritage.

Keywords Coral Reefs, Southeast Asia, Science, Management

Introduction

Widespread destruction of Southeast Asia’s coral reefs was reported throughout the last half of the past century (McManus 1988; Wilkinson et al. 1993; Chou 2000). The region responded with a variety of management modes especially into the 1990s (Chou and Wilkinson 1994), catalyzed by increasing awareness of the value of reef systems (Sudara et al. 2004) and the effectiveness of management (Alcala 1988). However, management on the whole was of limited effect in view of the extent and rate of degradation. A third of the world’s coral reefs occur in the region’s seas that cover only 2.5% of the earth’s ocean surface (Chou 1994). Species richness of corals and other reef-associated flora and fauna is the highest throughout the world making Southeast Asia the global hotspot for coral reefs (Kelleher et al. 1995). Should reef degradation not slow down and management effectiveness continues to lag, the region risks losing this significant natural heritage together with its status as the global hotspot for coral reefs (Chou 1997).

The state of science and management of the region’s reefs is reviewed after a decade into the new millennium. Advances in the scientific understanding of coral reef processes are by now sufficient to support more effective management strategies but degradation rates still surpass management efforts. There is however, evidence of a slowing down of degradation rate accompanied by recovery and improvement of reef condition (Tun et al. 2008; UNEP/COBSEA 2010). Stronger science-based management has to be applied and expanded throughout the region to prevent a collapse of the ecosystem and a colossal loss of ecosystem services and their economic benefits.
Science and Management 1950–2000

Economic development was the clear focus of Southeast Asian nations and the pace intensified from the 1960s (UNEP/COBSEA 2010). Coastal development resulted in the obliteration of near-shore reefs while the impact from harvesting stemmed from the unregulated collection of reef species. Sea cucumbers and giant clams were targeted for the food trade, sea anemones and corals for the aquarium trade and a wide variety of corals and reef-associated species for the marine curio trade. Regulatory mechanisms were non-existent or obsolete and overfishing of targeted species became a concern. All these issues were highlighted in the various chapters of the section ‘Coral reefs’ in Wilkinson (1994).

Reef degradation from these impacts continued through the 1970s and was made worse by destructive fishing. Blast fishing became rampant because of the easy way to obtain fish with minimum effort and “muro-ami” operations removed fish from reefs efficiently. These practices decimated reefs to conditions beyond recovery. Recognition of the region’s uniquely rich reef systems was made in the 1980s and the concept of Marine Protected Areas (MPAs) was introduced as a means to halt wanton destruction. More attention was generated through regional and inter-governmental arrangements such as the Association of Southeast Asian Nations (ASEAN) and the Coordinating Body for the Seas of East Asia (COBSEA) but national policies for reef management remained lacking. Capacity-building for coral reef science was improved through regional projects such as the ASEAN-Australia Living Coastal Resources Project from 1987 to 1994, which initiated regional monitoring of coral reefs and established an informal network of the region’s coral reef scientists that has expanded since.

Destructive fishing carried over into the 1990s with blast fishing gradually but only partially replaced by poison fishing for the live food fish trade. Expanding market demand continues to drive overfishing. Increasing numbers of MPAs were established but management effectiveness was weak for most. Kelleher et al. (1995), Burke et al. (2002) and UP-MSI et al. (2002) all concluded that only about 10% of the region’s MPAs were effectively managed and the situation did not improve much in later years (Tun et al. 2004, 2008). An assessment that the region’s MPAs included only 8% of its coral reefs of which, only 1% were in effectively-managed MPAs (Burke et al. 2002) was of particular concern. Community-based management was shown to be effective at local levels (Christie et al. 2002; Alcala & Russ 2006) and was widely replicated throughout the Philippines.

The 1997/98 mass bleaching event affected the region’s reefs at an unprecedented scale, and highlighted the urgency in protecting reef resiliency. Protected and unstressed reefs recovered better than stressed reefs (Wilkinson 2002). Management is thus needed to prevent compromise of reef system integrity. Reef monitoring capacity was well established by then and allowed a regional assessment of the bleaching impact to be made. At the same time, increased public awareness and a better understanding and appreciation of socio-economic and ecosystem service values helped galvanize more effective reef conservation measures, including reef restoration initiatives.

In the later half of the last century, the region’s rich reef ecosystem was decimated to the extent that 11% had collapsed and a further 48% under high threat of collapse within 20 years in the absence of management intervention (Wilkinson et al. 1993). The situation carried on into the new millennium with 88% under high risk (Burke et al, 2002). Coastal development to support a growing coastal population and rapid economic development contributed to reef loss while destructive fishing and unregulated harvesting hastened reef degradation and destruction. Management response had some but limited effect, with evidence of increased public awareness and greater willingness for stakeholder participation. Scientific capacity for monitoring and assessment of reef health was firmly established (Tun et al. 2008).

Science and Management in the new millennium

A major significance of the region as a global coral reef hotspot is that many taxa present here are not found elsewhere and their loss translates into global extinctions. The unique depository of reef species has to be guarded
against further loss. Investigations into population genetics of reef organisms such as corals (Knittweis et al. 2009), fish (Lourie and Vincent 2004; Timm and Kochzius 2008), crustaceans (Barber et al. 2006), molluscs (Kochzius and Nuryanto 2008) and echinoderms (Kochzius et al. 2009) indicate high levels of genetic structuring with distinct signatures from the Indo-Pacific. A high proportion of coral, fish, gastropod and lobster species have restricted geographic ranges (Roberts et al. 2002) and remain at high risk of extinction from localized reef degradation. At the same time, Bellwood & Meyer (2009) demonstrated that the recognized hotspot of the Indo-Australian Archipelago does not support high numbers of endemics or serve as a speciation source, and suggested that conservation of areas beyond hotspots that are usually arbitrarily defined is also important.

Recovery from widespread degradation commonly starts with competitive overgrowth by opportunistic algae before any recovery is shown by the competitive ability of corals (Diaz-Pulido et al. 2009). In reef restoration efforts, the tendency is to reverse this coral-algal phase shift early and together with the short duration of many restoration initiatives, what constitutes success has not been satisfactorily addressed. There is much scope for research into reef restoration before the efficacy and cost benefits can be adequately determined (Edwards and Gomez 2007). Many reef restoration techniques have been initiated (Chou et al. 2009). They include low cost approaches to hasten reef recovery from blast fishing where rubble stabilization and rock piles were found to encourage better coral recruitment and growth compared to scattered rubble (Fox et al. 2005; Raymundo et al. 2007).

Cyanide fishing remains a concern for the irreversible damage to corals and quick detection methods for cyanide traces is needed (Mak et al. 2005). The poison caused mortality of corals and anemones at low dosages, and brief exposure resulted in long-term damage to corals and their zooxanthellae (Cervino et al. 2003). Overfishing is still a challenge and signs of it are evident at localities subjected to long-term although not intense fishing pressure (Teh and Sumaila 2007).

The 2004 Asian tsunami showed that coral reefs provided some level of coastal protection by absorbing some of the tidal energy while damage to the reefs depended very much on location and coastal bathymetry (Wilkinson et al. 2005). Most of the Southeast Asia reefs escaped the impact, except for those in the Andaman Sea closer to the earthquake that started off Sumatra.

Various reef management models have emerged ranging from government to community level efforts. The region’s over 600 Marine Protected Areas (MPAs) cover less than 10% of its coral reefs, and of this less than 1% lies within MPAs that are effectively managed (Burke et al. 2002). The more than 1000 Philippine MPAs (mostly small in size and community managed) covered between 2.7 and 3.4% of the country’s coral reefs (Weeks et al. 2010). They advocated supplementing the community-based MPAs with additional large no-take reserves for biodiversity conservation targets to be more effectively met.

Managing reefs at national or state level require strong legal and institutional structures to encourage compliance. In some locations, MPAs under the coverage of an Integrated Coastal Management (ICM) framework have positive effects on coral reefs but this may not necessarily be so for community managed no-take zones (Christie 2005). The need for integrated management to halt the degradation of coral reefs along the northern coast of Bintan Island was highlighted by Chou et al (2010). Corruption can easily negate conservation efforts at local levels and also erode the efficacy of traditional management in the face of expanding open markets (Thorburn 2000, 2001).

Against the gloomy outlook of reef destruction are successful protection and rehabilitation measures at local levels (Tun et al. 2008) and demonstration sites on reversing degradation trends have been established under different regional projects such as the UNEP/GEF South China Sea project (UNEP 2004). These initiatives have valuable lessons on what works and what does not. Factors contributing to successful management or rehabilitation need to be replicated to reduce coral reef loss and this could be the focus in the new millennium. A variety of management strategies coordinated and implemented across larger spatial scales can provide an effective network that will enhance efforts at arresting and reversing reef degradation.
The outlook

Indications of better management and a decreasing rate of coral reef decline have emerged in the new millennium (Tun et al. 2008; UNEP/COBSEA 2010), but it will take time for the degradation inertia to come to a halt before any positive signs of degradation reversal emerge. Climate change together with elevated sea surface temperature and ocean acidification are looming threats and the intense anthropogenic pressures placed on the region’s reefs can only exacerbate the impact and force reefs quickly into a state where they no longer provide meaningful ecosystem services. The region has the challenging task of reducing the intense pressure on reefs so that their resiliency improves against climate change impacts (Hughes et al. 2003).

There is greater awareness of the importance of coral reefs particular in this region which is the global coral reef hotspot. Large regional projects past and present are responsible for improving stakeholder participation and there is now stronger public and government willingness. It does not appear that the region can meet its obligation to the target set by the Convention on Biological Diversity of establishing a marine global network of MPAs with effective management by 2012 but it should continue to work towards this commitment at a later date.

There are successful protection and rehabilitation measures at local levels, which are not widely publicized but hold valuable lessons. Processes contributing to successful management or rehabilitation need to be replicated to slow down coral reef loss and this should be the continued focus in the new millennium. A variety of management strategies coordinated and implemented across larger spatial scales can provide an effective network that will enhance efforts at arresting and reversing reef degradation. There are multiple stakeholders and all can participate in this effort to conserve Southeast Asia’s coral reefs.

Advances in the scientific understanding of coral reef processes are sufficient to support more effective management strategies but degradation rates still surpass management efforts. Southeast Asia risks losing its status as global biodiversity hotspot for coral reefs if stronger science-based management is not applied or expanded. The potential economic loss is colossal and coastal communities will be severely disadvantaged.

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