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Strategies to reverse the decline in valuable and diverse coral reefs, mangroves and fisheries: The bottom of the *J*-Curve in Southeast Asia?

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Abstract

Southeast Asia, an economically 'emerging' region, contains the world's most outstanding and diverse tropical marine resources. The conservation of this biodiversity is essential both for global ecological health and the economic future of the members of the Association of Southeast Asian Nations. However, these resources are now severely threatened and will continue to be degraded from increasing and varied forms of destruction. Although Marine Protected Areas and other strategies have already been developed in the region, the effectiveness of marine resources management remains inconsistent. An analysis of economic, social, education and biological data suggests that this deficiency is linked to the level of economic development, as well as the level of scientific and resource management education and the total amount of marine resources in the country. These conclusions are used to suggest more appropriate strategies for better management of the marine resources in Southeast Asia.
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1. Introduction

Marine resources play an essential role in the economies of Southeast Asian countries, thus the conservation and protection of these irreplaceable, but threatened natural resources, is particularly urgent. However, effective management of marine resources requires considerable financial investment, strong capacity building, including employment of appropriate and experienced staff, and acceptance and cooperation by the local communities. This should be developed within a management framework built on sound scientific information on the structure and function of the ecosystems, particularly the biology and ecology of target harvest species. Unfortunately, many countries in Southeast Asia lack one or more of these requirements, and therefore cannot assure effective and sustainable management of a significant part of their rich natural resources. In addition, management plans for marine resource management often assume a low priority on government agendas, with immediate development and exploitation appearing to offer more rapid economic returns. A closer analysis of these factors may provide guidance on strategies to halt the decline of the world's most valuable and diverse coral reefs, mangroves and fisheries. The aims are to investigate: the relative importance in the management of marine resources in Southeast Asian countries; linkages among the levels of economic development, education, and management capacity; the extent and nature of the natural marine resources; and the level of 'good will' within the governments.

This paper aims to provide natural resource managers and governments in Southeast Asia with a well-considered external view, supported by 55 years of collective experience in Southeast Asia and developing countries in this particular field. It does not intend to dictate policies and strategies, which remain the responsibilities of national governments. This is a summary of a paper presented during the East Asian Seas Congress 2003: Towards a New Era of Regional Collaboration and Partnerships, held in Malaysia, in December 2003 [1].

2. The economic and ecological potential of Southeast Asia

2.1. Economics

The Southeast Asian region, along with East Asia, is particularly dynamic with the most rapidly expanding economies of any part of the world, especially during the last three decades. The region is now referred to as 'emerging' as opposed to 'developing' [2], as it progressively adjusts to the market economies of the 'North'. Most members of the Association of Southeast Asian Nations (ASEAN) are part of the 70 countries which develop, active relationships with the Organisation for Economic Co-operation and Development (OECD) through its Centre for Cooperation with non-members. They participate at OECD meetings, such as Forums for Asian Insolvency Reform or Roundtables for Corporate Governance [3]. However, the region is extremely heterogeneous and includes some of the poorest countries of the world (Cambodia, Lao PDR, Myanmar and Vietnam), alongside extremely wealthy countries like Singapore and Brunei Darussalam. Recent Gross Domestic Product (GDP) growth has been very low in Thailand (0.6%), but high in Myanmar (7.8%), Cambodia (6.3%) and Vietnam (6.0%) as these economies recover from the economic 'meltdown' of the mid-1990s (Table 1). The

Table 1
Economic and demographic data of ASEAN countries[a] [10,11,23,29,30]

	Population (2002) $\times 10^6$	GNP per capita (USD)	GDP growth (2001)	GDP growth 1996–2000 mean	Tertiary gross enrolment ratio[b]
Brunei	0.35	18,000	1.5%	2.83%	12%
Cambodia	12.5	260	6.3%	6.32%	3%
Indonesia	224.78	570	3.3%	3.52%	14%
Malaysia	23.83	3380	0.4%	3.06%	28%
Myanmar	48.9	258	9.7%	7.80%	6%
Philippines	82.84	1,040	3.2%	3.64%	31%
Singapore	4.15	24,740	−2.0%	6.66%	45%
Thailand	61.8	2000	1.8%	0.60%	35%
Vietnam	79.94	390	6.0%	6.98%	11%

[a]Figures and tables by Anne Caillaud.
[b]The number of students enrolled in tertiary education, regardless of age, as a percentage of the official school age population at that level. The gross enrolment ratio can be greater than 100% as a result of grade repetition and entry at ages younger or older than the typical ages at that grade level.

region, however, can be considered as an entity because of its cultural, social and political affinities, and its specific 'East Asian Model' of development established through the ASEAN in 1967. Similar structural components for agriculture, international trade and tourism provide major economic benefits for the ASEAN countries. The region has relatively stable governments with many based on democratic principles, a strong work ethic and a relatively strong educational status, with an average tertiary enrolment ratio of 20.5% (Table 1). However, scientific and environmental research has a lower priority and what is known about marine ecosystems is insufficient, especially in Cambodia and Myanmar where the lack of information is a major handicap.

2.2. Value of marine resources

Southeast Asia has some of the most extensive coastlines, the richest coastal resources and has been honoured with the title of 'centre of biodiversity of the World' by Veron [4]. The region hosts 44% of the world's total coral reef area and 40% of the total mangrove area (Table 2). With more than 1560 species of reef associated fish, 500 species of reef-building coral [5], more than 600 species of benthic macroalgae [6], the most diverse mangrove forests, and the second most diverse seagrass beds in the world, it is essential that the ASEAN region be at the centre of global efforts to reverse the decline of tropical coastal resources. What is at stake is not just the title of the biodiversity 'hot spot', but essential components of the region's health, safety and economy.

The economic exploitation of coastal resources is the major income source for approximately 500 million people, especially in the archipelagic countries of Indonesia (where there are an estimated 16.5 million fishers) and the Philippines [7]. Commercial fisheries for local consumption and export contribute to the region's expanding economies. Subsistence fishing and gleaning are essential for many local communities, and coral rock and sand are often used as raw material for construction, landfill and cement making. Reef

Table 2
Marine resources and their management in ASEAN countries[a] [12,15,31,32]

	Coral reef area (km^2)	% of world total	Mangrove area (km^2)	% of world total	Reef and mangrove area (km^2)	Number of MPAs	Well- managed MPAs	% of well-managed MPAs
Brunei	210	0.07	171	0.10	381	6	0	0
Cambodia	<50	<0.01	851	4.79	901	1	1	>30
Indonesia	51,020	17.94	42,550	24.91	93,570	131	3	2.3
Malaysia	3600	1.27	6424	3.76	10,024	136	22	16.2
Myanmar	1870	0.66	3790	2.23	5660	3	0	0
Philippines	25,060	8.81	107	0.94	26,667	110	14	12.7
Singapore	<100	<0.03	6	<0.01	106	4	1	25
Thailand	2130	0.75	2641	1.55	4771	17	3	17.6
Vietnam	1270	0.45	2525	1.48	3795	25	2	8

Global Coral Reef area: 284,300 km^2 [32].
Global Mangrove area: 170,756 km^2 [31].
[a]Figures and tables by Anne Caillaud.

fisheries (finfish, prawns, crabs, molluscs and seaweeds) are also vital for human health as they are a principal source of protein (up to 72% of animal protein) for many countries of the region [5]. Coral reefs and mangrove forests provide security by protecting shorelines from erosion, stabilizing sediments, and buffering tropical storm waves. Mangroves are a valuable source of timber for charcoal and woodchips. (Incidentally, a world-renowned example of nearly 100 years of long-term sustainable management of mangroves can be found in Matang Mangrove Forest Reserve, West Malaysia.) [8]

An emphatic illustration of the importance of marine resources for community sustainability was the hostage taking by the Abu Sayyaf rebel group in Jolo Island, Southern Philippines. One of their demands was "the strict implementation of fishing laws and regulations (total ban on commercial fishing by big international vessels) in the Sulu Sea, the local Muslim's traditional fishing ground, but also Basilan and Tawi-Tawi waters and the development of the local fishing industry in the area" [9].

The coral reefs and coastlines that are perceived as containing beautiful and pristine marine resources, warm climates and 'exotic' cultures are the basis for major, and predominantly non-extractive, tourism industries. Tourism is extremely important for the regional economy as it accounts for almost 5% of the ASEAN GDP, provides 9.2% of the total work force and comprises almost 10% of the total 'export' earnings [10]. International tourism receipts in the region were at least US$29.3 thousand million in 2001 [11], and tourism is the most rapidly growing sector of the global economy, with ecotourism being probably the most lucrative and 'fashionable'. Hence the development of tourism, especially ecotourism, will best succeed with high quality natural attractions, which require urgent conservation.

Marine resources in Southeast Asia are therefore essential for the well-being and economies of the people, and they need to be managed sustainably to avoid long-term catastrophic resource exhaustion and depletion. But despite improvements in government and local level management of coastal resources, they continue to decline in Southeast Asia and greater efforts are required before the straight line rate of decline can be turned into a '*J*-curve'.

3. Status and management of threatened marine resources

3.1. Coral reefs

The extraordinarily rich marine resources in the ASEAN region are undeniably the most seriously threatened. The extent of coral reef destruction is particularly severe, with 48% under high to very high threat of imminent destruction and 39% under moderate threat [12] from both local and global impacts. In Indonesia, for example, half of the 51,000 km^2 of reef areas is already heavily degraded [13]. Local impacts include: excess sediment delivered through rivers (from extensive land clearing for rural and industrial development and agriculture); pollution from land, especially excess nutrients from untreated sewage, agriculture and industrial wastes; coral rock and sand mining; coastal and port development; dredging; anchor damage; and overuse through unsustainable tourism activities. The most serious impacts in much of Southeast Asia arise from destructive fishing by both locals and foreign fleets—i.e. blast fishing; poison fishing (especially with cyanide for catching aquarium and highly priced food fish); *muro-ami* (drive-net fishing); and trawl fishing (especially in Malaysia and Thailand).

Global scale impacts include widespread coral bleaching from elevated sea-surface temperatures, linked with the El Niño-Southern Oscillation and possibly signalling the looming threat from global warming [14].

3.2. Mangrove forests

The status and prognosis for mangrove forests is equally alarming with 50–80% of the mangrove forests of the region already destroyed. Harvesting for timber and coastal development are obvious causes for this dramatic loss, but the clearing of millions of hectares of forests for shrimp (prawn) farms is the largest recent reason for mangrove destruction, notably in Indonesia, the Philippines and Thailand [15,16]. Some of these inappropriate aquaculture developments were supported by international aid agencies in attempts to improve livelihoods among poor coastal communities. Within three to seven years, most of these became unproductive due to either persistent diseases or the development of acid sulphates from the anaerobic and organic-rich mangrove mud. They were then abandoned, and have ceased to provide the previous high value role as nursery grounds for coastal fisheries.

3.3. Seagrass beds

Although the lack of data makes it difficult to give an accurate estimation of the destruction of seagrass beds in Southeast Asia, it follows that losses of seagrass beds have been comparable to coral reefs and mangroves during the past decades. The major destructive stresses are from uncontrolled trawling in shallow waters, excessive sediment pollution, increase in nutrients, poison fishing, port development and dredging. These losses compound the problems of overfishing with the loss of the nursery ground function of the seagrass beds [16].

3.4. Management of marine resources

The steady decline in marine resources demonstrates the urgent necessity for appropriate management, especially through the establishment of Marine Protected Areas (MPAs). To

best achieve their multiple roles in biodiversity conservation and fisheries sustainability, these need to be sufficiently large to encompass significant breeding populations, and/or be linked into networks to permit the flow of larvae and provide 'ecological insurance' against disturbances in some parts of the network.

The ASEAN countries have developed several models for the management of MPAs. These are: (1) the centralised or 'top-down' model whereby they are managed by a single authority, normally the government (this often applies in Indonesia, Malaysia, Thailand and Vietnam); (2) the 'bottom-up' level model, such as the predominantly community-based management projects in Indonesia, Thailand or the Philippines; and (3) management shared between several stakeholders, (this usually involves the community and government, but could also include non-governmental organizations (NGOs), intergovernmental organizations (IGOs) and universities, thereby constituting collaborative or co-management strategies) [17]. There are numerous case studies of successful management of MPAs in Southeast Asia [18,19], with the collaborative and community-based management strategies being especially fruitful, demonstrating that the paradigms for sustainable management of coastal and marine resources in the region have already been developed. However, these examples appear to be the exception, as the statistics illustrate that marine resources fail to get the adequate attention that they require. Only 7% of the total number of MPAs in the region are effectively managed, while 68% have poor or unknown management [16].

Thus, most MPAs, while they look good on paper, can be regarded as 'paper parks' [20,21]. They have been declared as MPAs, but they are protected only in theory and not in practice, as there are no management plans and only weak attempts at implementing effective control of national regulations. For many, the management effectiveness rating is 'unknown' (48.6% of the MPAs in the region) [16], which probably indicates that there is no management. Alternatively, this lack of information may be partly explained by the political and security sensitivities in Southeast Asia with some areas inaccessible for research and monitoring. This is largely due to a lack of field knowledge, experience and political will from the governments.

Very few ASEAN countries have specialized departments for MPAs. In Thailand, the National Park, Wildlife and Plant Conservation Department has been recently established, while Vietnam has a Department of Fisheries Resources Protection. In Malaysia, the management of Marine Parks and Reserves is under the Minister of Agriculture (not under the Ministry of Science, Technology and the Environment), and in the Philippines the responsibility lies with the Department of Environment and Natural Resources [5]. These circumstances may entail contradictory situations whereby people who manage terrestrial protected areas also have to deal with the conservation of a marine ecosystem or with increasing resource exploitation. In addition, there are frequent conflicts between government agencies over the control of marine areas, often accompanied by jurisdiction problems. These problems often lead to disillusionment and resentment towards the government by MPA managers and communities, especially in centralized MPAs with the community either not involved in management planning or even aware of the existence of the MPA. Community-based management or co-management appears to be the most appropriate method for the Southeast Asia region. However, even when MPAs are seen as successful, problems still remain. Successful MPAs are usually surrounded by unmanaged areas with varying levels of resource depletion and devastation, and they are rarely large enough to have an effective impact on conserving marine breeding populations. To address

these issues, the management effectiveness of MPAs is being reviewed in order to make best use of the successful models, as there remains a pressing need to develop an integrated representative network of MPAs across Southeast Asia [22].

4. Reasons for poor MPA management

4.1. Poverty

There is moderate to extreme poverty in most of the countries (e.g. Cambodia, Indonesia, Myanmar, the Philippines and Vietnam), especially among subsistence fishers. Poor coastal communities also have the highest population growth (>4% per annum in many countries) [23], and the consequent increasing population, exacerbated by coastal urbanization, leads to increasing rates of overexploitation and degradation of resources [24]. This means that management of marine resources has to operate at the community level and be cost-effective, with sites ranked on a basis of priority for both the quality of the resources and potential for success. However, statistics show that the effectiveness of coastal resources management is linked more to the national economic wealth than to the level of poverty in coastal areas. The wealthier states, with the exception of Brunei Darussalam and Singapore which are very small, are able to put more resources into effectively managing MPAs (Table 2, Fig. 1).

4.2. Education

The effectiveness of MPA management is based on the development of sound management plans, the willingness of governments and communities to implement and enforce the plans, and crucially on the long-term commitment of all stakeholders, supported by adequate funding. The development of effective management plans depends on several interacting factors. These include: a trained workforce across several disciplines; mechanisms for gathering data; analysing and disseminating information to all stakeholders; cooperation amongst the various government departments and agencies at local and national levels, as well as with NGOs; and a legislative framework that will support the plans and enable effective enforcement.

Different levels of MPA protection exist—from strict nature reserves/scientific reserves, fisheries management areas, to multiple-use management areas [25]. Unfortunately, a common situation is that management plans developed by local or international agencies, scientists or researchers are never implemented. The implementation of such management plans requires support from both the government and local communities, as well as a detailed and lengthy public education and awareness campaign to ensure that there is support from local communities [26]. Given the opportunity through co-management (e.g. education and awareness raising, collaboration in decisionmaking), these communities should have direct interest in the effective implementation and enforcement of the management plans, so they can bequeath the resources to their children and gain additional income (the staff employed to manage MPAs are frequently hired from the local community). Governments can encourage sustainable practices amongst communities by providing financial support for capacity building.

One prerequisite is the availability of trained professionals for both planning and implementation of MPA management plans, with an apparent link between the level of

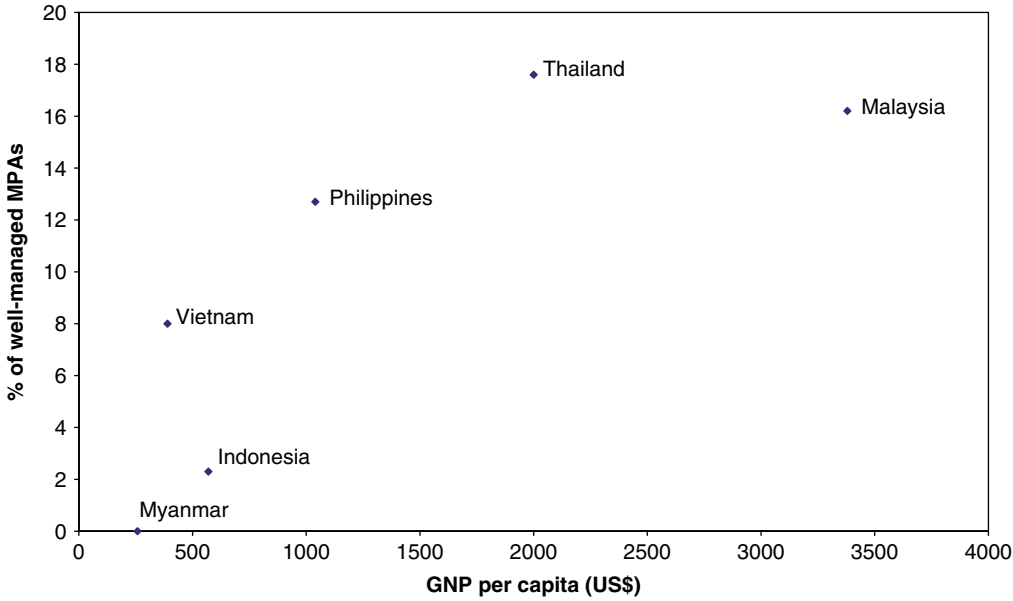

Fig. 1. The effectiveness of management of MPAs compared with the GNP per capita in Southeast Asian countries. There is a positive correlation between the national economic wealth, represented by the GNP per capita, and the percentage of well-managed MPAs. The wealthier states have more financial resources to allocate to MPA management. (Cambodia, Brunei and Singapore have been excluded because their amount of and reliance on coastal resources is far less than the other countries, see Fig. 3.)

education and the effectiveness of marine resource management. Countries with low tertiary enrolment ratios have the lowest level of MPA management, e.g. Myanmar and Indonesia (Fig. 2). Conversely, countries with the highest rate of well-managed MPAs are the ones with the highest Tertiary Gross Enrolment Ratio (Singapore, Thailand and Malaysia).

4.3. Extent of natural resources

Resource conservation and management effectiveness is also linked with the extent of national marine resources. Large amounts of marine resources are harder to manage, but conversely, the national economy may rely largely on those resources, with a greater need to manage them correctly. Although a comparison between the extent of marine resources and the effectiveness of MPAs is not conclusive, Fig. 3 reveals a tendency for a 'declining curve' (with the exceptions of Brunei, Vietnam and Myanmar), suggesting that the more marine resources a country owns, the more difficult it is to manage them efficiently. The management effectiveness of marine resources appears therefore to be negatively linked with the amount of marine resources, and positively linked with the level of education and the level of development and financial resources.

Fortunately, there is increasing capacity for science and policy development and conservation measures, including the establishment and management of protected areas. A 'critical mass' of expertise is being built in intergovernmental agencies such as the United

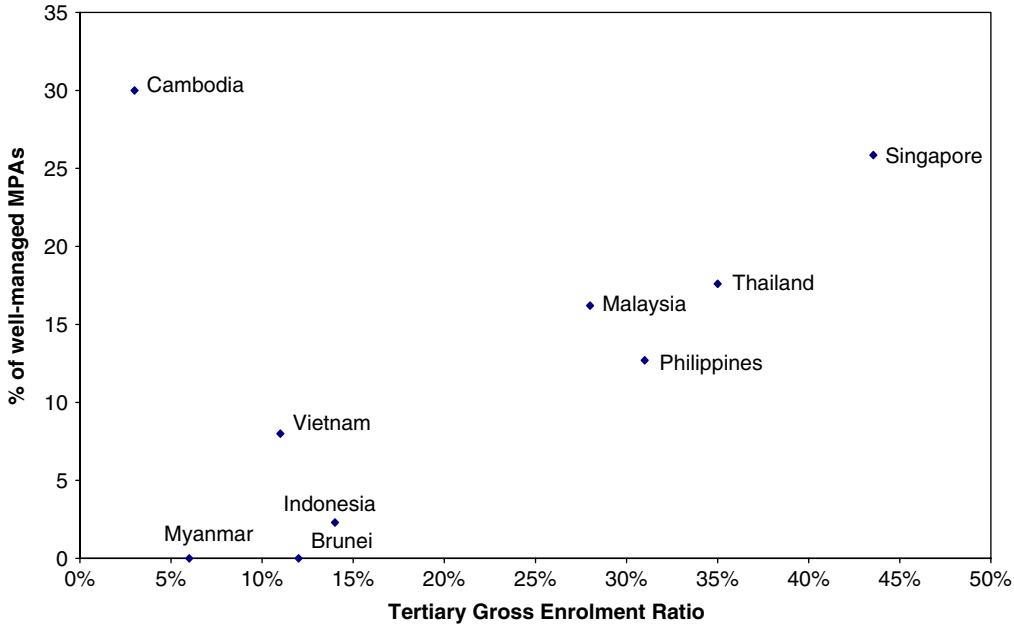

Fig. 2. The effectiveness of management of MPAs compared with the level of education in Southeast Asia. (*Figures and tables by Anne Caillaud.) There is an apparent positive link between the level of education (represented by the Tertiary Gross Enrolment Ratio) and the effectiveness of management of MPAs. Even though Brunei, Malaysia and Vietnam are outliers, their general position tends to confirm this trend. Cambodia is an exception with low tertiary gross enrolment ratio, but has only one MPA which is reported as well managed.

Nations Environment Programme (UNEP) Regional Seas Programme, the United Nations Educational, Scientific and Cultural Organization (UNESCO)/Intergovernmental Oceanographic Commission (IOC) Sub-commission for the Western Pacific, and the Global Environment Facility (GEF)/United Nations Development Programme (UNDP)/International Maritime Organization (IMO) Regional Programme on Partnerships in Environmental Management for the Seas of East Asia (PEMSEA).

Considerable expertise also resides in academic institutions and NGOs, including the Coastal Management Center (Philippines), World Wide Fund for Nature (WWF), The Nature Conservancy (TNC) and Conservation International (CI). Nonetheless, there remains a significant challenge in developing sufficient capacity for effective management in the region.

5. Recommendations to halt the decline of ASEAN marine resources

As mentioned earlier, there is an apparent link between the level of education in a country and the effectiveness of management of its marine resources. This provides a point of focus to improve resource management—i.e. improvement in the level of 'education'. This term can be ambiguous, as it could mean 'specialized' tertiary education in pertinent disciplines, as well as improving awareness among communities. Both are important.

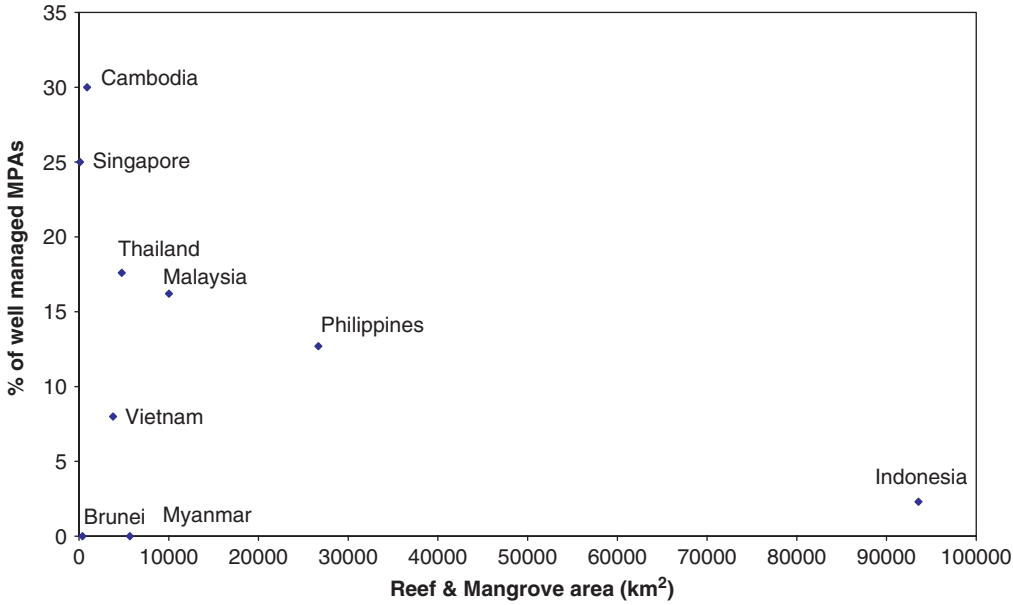

Fig. 3. The effectiveness of management of MPAs compared with the extent of marine resources in Southeast Asia. There is an apparent negative link between the effectiveness of management of MPAs and the extent of marine resources in ASEAN countries. The more marine resources a country owns, the less effective the management appears to be.

5.1. Academic education

At the academic level, governments of Southeast Asia would gain long-term economic advantages by enhancing and supporting a well-educated sector of marine environmental scientists and managers. This could take the form of financial support through scholarships or the establishment of new university departments focusing on the interdisciplinary nature of resource management (natural and physical sciences, economics, law, policy, etc.). In the initial stages, this approach may require the hiring of specialists from elsewhere in the region or further afield as lecturers to provide adequate training, and campaigns to raise awareness on the need for such training amongst better students. Politicians, senior administrators and decision makers also need to be sensitized to the value of coastal resources through international awareness programmes, international conventions and attendance at pertinent meetings. The goals of such educational programmes would be to train an appropriate number of local specialists and managers who would be able to develop management plans and design projects in consultation with the government and local experts, rather than bringing experts from outside.

Recommendation 1: Improve academic education of professional marine resource managers by establishing specialized institutes, more scholarships and long-term employment for ASEAN professionals.

5.2. Education and awareness-raising in communities

Awareness campaigns at the community level should be developed by the national governments and managers of MPAs, based on the best examples of community-managed

MPAs as lessons to transfer to other potential communities, particularly through the use of peer-to-peer exchanges between communities. This is already occurring in some countries, under the auspices of government, IGOs and NGOs (e.g. Vietnam, Philippines and Indonesia, [27]). Governments may also work jointly with local and international NGOs to convey resource management and conservation messages to communities, while the donor countries and organizations might learn from the successful case studies of community involvement in resource conservation and apply these through 'peer-to-peer' exchanges. An example is the International Coral Reef Action Network project (www.icran.org) that is developing demonstration sites of best practice in management and bringing leaders from receptive communities to observe and learn. Such education and sensitizing programmes for Southeast Asia could be run collaboratively by the ASEAN countries through the development of education packages that acknowledge the cultural mix in the region—e.g. the declaration of a Marine Resources Day, documentaries on television, and festivals that build on inherent traditions and religious beliefs. This could lead to stronger involvement of local communities and the use of traditional knowledge in the planning, monitoring and management of MPAs, thereby enhancing potential success in resource conservation.

Recommendation 2: Develop awareness-raising campaigns for user communities using local languages, religious leaders and cultural events. The end goal is to involve communities in direct management of resources by demonstrating the best examples of community-managed MPAs through the use of peer-to-peer exchanges.

5.3. Political will

There is an apparent inverse correlation between the extent of marine resources and the effectiveness of resource management: the more resources, the less management. This also indicates that the concerned governments do not make the management of marine natural resources a major priority, possibly because the apparent returns are more delayed compared to short-term gains from development and exploitation of resources. A major step that the ASEAN could undertake in raising awareness would be to conduct national and regional economic assessments of the value of marine resources. However, these resources are not only critical to national and community economies now, but will also be particularly so in the future, providing the strongest case for ecological and economical sustainability, rather than the present 'unsustainable' development.

Recommendation 3: Assess the economic value of coastal resources over short- to long-term scales and use these assessments for awareness raising at senior decision making levels, as well as for communities.

Major obstacles to implementing sustainable development with the long-term conservation of natural resources are the many inter-sectoral and inter-level disputes over the authority to manage coastal resources and a plethora of often contradictory legislation controlling use and access to these resources. While there may be clear responsibilities on land, resources in the sea are often outside traditional jurisdictional arrangements. Effective management of coastal resources requires that there is clear legislation managed by a single authority, as is the case in Thailand and the Great Barrier Reef in Australia. Therefore, it would be advisable to establish—in each ASEAN country—an institution, division or department specialized in the management of marine

resources with reporting responsibilities near or at the head of government. This is one proven method of avoiding overlapping or contradictory directives and reducing inter-sectoral disputes. This entity would be able to promote marine environmental management as part of economic progress through employment, access to marine goods and services to maintain sustainability, and especially the development of the tourism industry, which would promote ecotourism as a major non-destructive use. One role could be to prioritize sites for development and conservation, fund scientific research and support communities to apply management plans. Linking these management initiatives into ASEAN networks of sharing experiences and resources could be an effective program of the ASEAN.

Recommendation 4: Combine existing authorities vested in managing and controlling coastal and marine resources, including national, state and local governments, into a single authority that reports to the highest level of government. This will reduce inter-sectoral disputes and improve planning for sustainable and balanced development.

5.4. Mutual assistance: regional cooperation and collaboration

A more effective way of obtaining sustainable and globally effective conservation could be achieved in Southeast Asia if governments combine their efforts to maximize effective use of human resources and assist the lesser developed countries. This could take the form of expanding transboundary management of MPAs through transboundary MPAs or biosphere reserves (e.g. Turtle Islands between Malaysia and the Philippines). Other authors [28] have suggested that cooperation could be used for more sustainable management of the living natural resources of the Spratly Islands and other disputed islands in the South China Sea, through expanding the programs to share scientific findings and establishing research cooperation within Southeast Asia. Similarly, a more focused exchange of information concerning monitoring, violations of laws, improvement in management and status of resources in MPAs would be facilitated.

Collectively, the region has extensive experience with marine resources and the problems related to the project designs. Countries could all benefit from mutual support in developing aid projects, as cooperation may help them avoid situations where: (1) the themes and details of projects are introduced from outside the region; or (2) donors prefer to work on 'new' projects, instead of building on the successes of existing initiatives and employing the staff trained within those projects. ASEAN could take the lead in identifying major needs of the regions and conveying these to donor organizations. One special theme could be investigating and advancing rehabilitation of marine resources, through financial, technical and advisory assistance. This could take the form of partnerships between specialized universities and the creation of marine science cooperative training programmes, based on the model of the European Union 'Erasmus' or 'Socrates' programmes.

Recommendation 5a: Develop own expertise in the science and management of marine resources by cultivating regional curricular, scientific and management exchanges and being proactive in negotiations with donors and development agencies on project needs for the region.

Recommendation 5b: Enhance research cooperation among countries, particularly in relation to prioritizing sites, biology and status of target species, monitoring, violations of laws, improvement in management and status of resources.

5.5. Targeted international aid and assistance

Each donor country or international foundation assisting the region should consult with the other Southeast Asian countries and donors to avoid duplication of efforts and to develop larger projects covering wider areas (for instance through a network of NGOs and IGOs). Initial focus of donor effort could be given to countries with larger marine resources as a priority, to help their governments financially and technically. Focus could be on developing larger marine resource MPAs or networks of MPAs to ensure the conservation of large breeding populations, particularly of harvested species. Larger areas will have positive broad-scale benefits throughout the region, via the dispersal of larvae and subsequent restocking of coastal and marine habitats. A cooperative program is underway with three major NGOs (WWF, TNC and CI) developing a coordinated approach to the Sulu-Sulawesi Seas Marine Ecoregion [27].

International donors are advised to continue to 'invest' in aid and development projects in Southeast Asia, particularly innovative approaches to avoid duplication of effort, as efforts have a high likelihood of success because of the increasing political stability, well-educated environmental resource sectors, and strong work ethics. Positive returns will be accentuated if projects are run beyond the 'normal' three- to five-year cycles, with ten-year projects containing a series of graduated steps built on demonstrated success.

Donor countries and organizations should always include capacity building in environmental research and management within projects, and ensure that there is also provision for employment of the qualified graduates as part of their career development. All too frequently, specialized training is provided, but the value lapses if there is no in-country employment.

Recommendation 6: Develop larger, longer-term projects, including representative networks of MPAs and longer projects to build on success. Training and employing young professionals is essential for sustainability of project success.

6. Conclusion

ASEAN countries have rapidly developing economies based on a strong work ethic and increasingly well-educated workers. The countries have a rapidly developing tertiary education sector with some of the universities in the region conducting world-class marine research and teaching. The countries also have some well-trained and experienced experts in the planning and management of marine resources in MPAs; and they have excellent examples of successful MPA management, especially those where communities have played a major role in planning and management. Although the conservation of natural resources should be a cornerstone of economic development, there is an apparent lack of political and community will for natural resource management in many of the countries, and many areas within countries, with the immediate goals of rapid economic development overwhelming the need for considered and sustainable development. This often results in the over-exploitation of natural resources.

Nowhere is this more obvious than in the case of coral reefs, which are world-renowned and are the focus for a rapidly expanding tourism 'export' industry. The reefs are showing clear signs of rapid decline and in many cases obvious ecological collapse. The allocation of government and private sector resources for coral reef and natural resource conservation, in general, will return huge economic benefits in the future, particularly through sustainable tourism.

Southeast Asia is a key region for the conservation of global marine resources and the accelerating rate of use and damage necessitates urgent action. Either marine resources will continue to decline at the expense of the region's economic growth (by damaging the expanding tourism industry) and the world's biodiversity, or countries will decide that it is in their direct economic interests to halt environmental decline and potential collapse. International organizations and agencies, donor countries, specialists from all over the world, ASEAN governments and local communities will need to undertake coordinated and collaborative efforts to reverse the current rapid rate of decline in natural marine resources and make the start of this century 'the bottom of the *J*-Curve' with a positive trend in future decades.

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References

[1] Wilkinson C, Devantier L, South R. Bottom of the *J*-Curve in Southeast Asia? Strategies to halt the decline in the world's most valuable and diverse coral reefs, mangroves and fisheries. In: Report of the workshop on national coastal and ocean policies and regional collaborative arrangements, The International Conference on the Sustainable Development of the Seas of East Asia, Malaysia, 2003. p. 46–47.
[2] Fryer DW. Emerging Southeast Asia: a study in growth and stagnation. London, England: Philip; 1979.
[3] Organisation for Economic Co-operation and Development (OECD). Available from: http://www.oecd.org/.
[4] Veron JEN. Corals of the world, vol. 3. Australia: Australian Institute of Marine Sciences and CRR Qld Pty Ltd; 2000 (1382pp.).
[5] Cheung C, Alino PM, Uychiaoco AJ, Arceo HO. Marine protected areas in Southeast Asia. ASEAN Regional Centre for Biodiversity Conservation/Department of Environment and Natural Resources, 2002 (16pp.).
[6] Silva PC, Basson PW, Moe RL. Catalogue of the benthic marine algae of the Indian Ocean, vol. 79. University of California Publications in Botany; 1996 xiv +1259pp.
[7] Eiamsa-Ard M, Amornchairojkul S. The marine fisheries of Thailand, with emphasis on the Gulf of Thailand trawl fishery. In: Silvestre G, Pauly D, editors. Status and management of tropical coastal fisheries in Asia. ICLARM Conference Proceedings, vol. 53, 1997 p. 85–95.
[8] Atmadja W, Man A. Threats and pressures on mangroves and current management practices. In: Wilkinson CR, editor. The living coastal resources of Southeast Asia: status and management. Report of the consultative forum, Third ASEAN-Australia Symposium on Living Coastal Resources, Bangkok, Thailand. Townsville: Australian Institute of Marine Science; 1994. p. 62–70.
[9] Torres JJ. Into the mountain, hostaged by the Abu Sayyaf. Oxnard, CA, USA: Gallant Warriors Press; 2001 (173pp.).
[10] Asian Development Bank. Economic trends and prospects in developing Asia; Southeast Asia. In: Asian development outlook 2003. New York, USA: Oxford University Press Inc.; 2003. p. 60–103.
[11] Rosen C, editor. World resources 2000–2001: people and ecosystems: the fraying web of life. Washington DC, USA: World Resource Institute; 2002 (389pp.).
[12] Burke L, Selig L, Spalding M. Management of coastal resources. In: Reefs at risk in Southeast Asia. Washington D.C.: World Resources Institute; 2002 [Chapter 7].
[13] Wilkinson C. Status of coral reefs of the world: 2002. Townsville: Global Coral Reef Monitoring Network/ Australian Institute of Marine Science; 2002 (393pp.).

[14] Wilkinson C, Linden O, Cesar H, Hodgson G, Rubens J, Strong AE. Ecological and socio-economic impacts of 1998 coral mortality in the Indian Ocean: an ENSO impact and a warning of future change? AMBIO 1999;28:188–96.
[15] Kelleher G, Bleakley C, Wells S, editors. A global representative system of marine protected areas, vol. III. Central Indian Ocean, Arabian Seas, East Africa and East Asian Seas. Great Barrier Reef Marine Park Authority/The World Bank/The World Conservation Union (IUCN), 1995 (147pp.).
[16] Burke L, Selig E, Spalding M. Reefs at risk in Southeast Asia. World Resources Institute; 2002 (72pp.).
[17] Salm RV, Clark JR, Siirila E. Marine and coastal protected areas: a guide for planners and managers. Washington DC: IUCN; 2000 (371pp.).
[18] Green SJ. Barangay Lomboy and Cahayag fish sanctuary, Pangangan Island, Philippines: unforeseen circumstances undermine reserve effectiveness. In: Roberts CM, Hawkins JP, editors. Fully-protected marine reserves: a guide. WWF Endangered Seas Campaign/Environment Department, University of York, 2000 (134pp.).
[19] Wilkinson C, Green A, Almany J, Dionne S. Monitoring coral reef marine protected areas: a practical guide on how monitoring can support effective management of MPAs. Townsville: Global Coral Reef Monitoring Network & Australian Institute of Marine Science (68pp.).
[20] Alder J. Have tropical marine protected areas worked? An initial analysis of their success. Coastal Management 1996;24:97–114.
[21] McClanahan TR. Is there a future for coral reef parks in poor tropical countries? Coral Reefs 1999;18:321–5.
[22] The Asia-Pacific Network for Global Change. APN/UNU Roundtable Session: Post WSSD. Available from: www.apn.gr.jp/activity/unu/roundtalbe/recommend.html.
[23] Hossein J, Weiss J. Foreign direct investment and poverty in the ASEAN region. In: ASEAN economic bulletin, vol. 19/3. Singapore: Institute of Southeast Asian Studies; 2002 (128pp.).
[24] Brookfield H, Byron Y, editors. South-East Asia's environmental future: the search for sustainability. Kuala Lumpur: The United Nations University, Oxford University Press; 1993.
[25] World Conservation Monitoring Centre. IUCN Protected Areas Management Categories. Available from: http://www.ontarioparks.com/english/iuc.html.
[26] Kelleher G, Phillips A. Guidelines for marine protected areas. Gland, Switzerland: IUCN; 1999 (107pp.).
[27] DeVantier L, Alcala A, Wilkinson C. The Sulu-Sula Sea: environmental and socio-economic status, future prognosis and ameliorative policy options. Ambio 2004;33:88–97.
[28] McManus J. The Spratly Islands: a marine park. Ambio 1994;23:181–6.
[29] Fukuda-Parr S, editor. Human Development Reports 2003: Millennium development goals: a compact among nations to end human poverty. Oxford, New York: United Nations Development Programme, Oxford University Press; 2003 (375pp.).
[30] The World Bank. World Development Indicators Online. Available from: http://www.worldbank.org/data/onlinedatabases/onlinedatabases.html.
[31] Aizpuru M, Achard F, Blasco F. Global assessment of cover change of the mangrove using satellite imagery at medium to high resolution, EEC Research Project no. 15017 FIED ISP FR, Ispra, Italia, Joint Research Centre, 2000.
[32] Spalding MJ, Ravilious C, Green EP. World atlas of coral reefs. Berkeley, Los Angeles, London: UNEP, WCMC, University of California Press; 2001 (424pp.).