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Status and trends in coastal habitats of the South China Sea

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ABSTRACT

The South China Sea is an area of globally significant biological diversity. The Transboundary Diagnostic Analysis prepared for this marine basin identified the issue of coastal habitat degradation and loss as a key priority issue for action. The UNEP/GEF project entitled "*Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand*" (SCS project) focused on these concerns through implementing a series of activities under the component on habitat degradation and loss. Important outputs of this project component were national reports on coastal habitats. This paper reviews and analyses available information from these reports and recent studies to present a review of the status and trends in coastal habitats of the South China Sea. This includes a technical summary of the best available information relating to the: distribution and extent of the dominant coastal habitats of mangroves, coral reefs, and seagrass; richness of habitat building species and hotspots of biodiversity; ranking of threats and the related rates of coastal habitat degradation and loss; and the state of coastal habitat management regimes. The use of this information in developing National Action Plans for habitats and the Strategic Action Programme for the South China Sea is reviewed. It is concluded that the science-based planning fostered by the SCS project was essential in reaching multi-lateral agreement on the regional targets and priority actions for coastal habitat management in this transboundary water body.

1. Introduction

The South China Sea, including the Gulf of Thailand, is a global centre of shallow water marine biological diversity providing environmental goods and services critical to Southeast Asian economies. The coastal sub-regions of the nations bordering the South China Sea are home to 270,000,000 people, or 5% of the world's population, many of whom depend on the South China Sea for food and income. The high biological diversity and productivity of this globally significant marine basin is threatened by continuation of the current unsustainable patterns of use. It has also been seriously degraded in the recent past as a result of poorly planned coastal development.

The Transboundary Diagnostic Analysis (TDA) prepared for this marine basin identified the issue of coastal habitat degradation and loss as the key priority issue for action (Talaue-McManus, 2000). The UNEP/GEF project entitled "*Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand*"[3] focused on these concerns through implementing a series of activities as part of the project component entitled "*Habitat Degradation and Loss*". This component comprised four sub-components, addressing the four priority habitats in the region, namely mangroves, coral reefs, seagrass, and coastal wetlands. It is important to note that the scope of the SCS project was limited to the South China Sea and Gulf of Thailand. Hence project activities, data and information collection focussed only on the South China Sea coastlines of the riparian countries. Coastal areas of participating countries that lay outside the South China Sea were excluded from consideration.

National-level project activities of each habitat sub-component included the establishment or re-vitalisation of National Committees or technical working groups to compile and review national information and data on the science and management of coastal habitats. Information and data from past and on-going research and publications were used to develop overall descriptions of the distribution and diversity of coastal habitats, define the threats to the quality and expanse of habitats, quantify rates of coastal habitat loss

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[3] Hereafter referred to as the 'SCS project'.

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and degradation, and characterise existing management regimes.[4] Important outputs of these activities were national reports[5] for each habitat type that formed the background against which National Action Plans (NAPs), including required legislation, were elaborated in order to maintain nationally important habitat areas.

At the regional level, Regional Working Groups[6] (RWGs) for each habitat sub-component were formed to guide NAP development and to establish criteria and procedures for the identification of transboundary habitat areas in the South China Sea having priority for management. A key outcome of this work included the selection of priority sites within each habitat class for initiation of habitat demonstration projects. These demonstration projects were operated from 2005 to 2008 and focused *inter alia* on: reducing habitat degradation and rehabilitation of degraded habitats; promotion of co-management with stakeholder participation; establishment of cross-sectoral management mechanisms; sustaining the functions and benefits of coastal and marine ecosystems; and enhancing living standards of coastal communities.[7]

The RWGs used the NAP development process to compile a package of regional-level coastal habitat management actions for inclusion in the revised Strategic Action Programme (SAP) for the South China Sea. Experiences and lessons learned from the habitat demonstration projects were compiled and shared through the regular meetings of RWGs and used to refine NAP and regional (SAP) targets.[8] This paper reviews available information from the national reports and recent research to characterise the status of, and trends in, coastal habitats bordering the South China Sea. In this context, the proposed targets for coastal habitats contained in the South China Sea SAP are summarised to provide a baseline of the shared vision for coastal habitats of the South China Sea developed as a result of the SCS project. Efforts to strengthen national planning and local capacities for the sustainable use and management of coastal habitats are also outlined.

2. Dominant coastal habitats of the South China Sea: status and threats

2.1. Distribution and diversity of coastal habitats

The Indo-West Pacific marine biogeographic province has long been recognized as the global centre of marine tropical biodiversity. Forty-five mangrove species out of a global total of 51 (Spalding et al., 1997); 50 of 70 coral genera (Tomascik et al., 1997); 20 of 50 seagrass species (Sudara et al., 1994); and 7 of 9 giant clam species (Tomascik et al., 1997) are found in the nearshore areas of the South China Sea. Compared to the Atlantic, the tropical Indo-West Pacific is highly diverse. Only 5 mangrove species and some 35 coral species are found in the Atlantic compared with the 45 mangrove species and 450 coral species recorded from the South China Sea (UNEP, 2007a, 2008a).

Like most tropical coastlines worldwide, the dominant coastal ecosystems of the South China Sea marine basin are mangroves, coral reefs and seagrass meadows. Significant other coastal ecosystems include coastal lagoons, a common coastal landform in Viet Nam, and extensive inter-tidal unvegetated mudflats that are found in many places around the South China Sea (UNEP, 2008b). This paper focuses on the three dominant ecosystem types: mangroves, coral reefs and seagrass ecosystems as these were the focus of the SCS project.

2.1.1. Mangroves

The South China Sea is considered to be one of two global hotspots of mangrove diversity (Polidoro et al., 2010; UNEP, 2004a). According to data generated through the SCS project, the largest total area of mangrove on the South China Sea coast is observed in Indonesia (934,000 ha), followed by Malaysia (532,000 ha) and Viet Nam (157,000 ha). The combined area of mangrove observed on the South China Sea coastlines of Cambodia, China, the Philippines and Thailand is less than 150,000 ha (Table 1). The total area of mangrove on the South China Sea coast of all countries combined is estimated to be 1,770,000 ha (UNEP, 2008a), representing 11.4% of the world's remaining 15.5 million ha (FAO, 2007) of mangrove forest.

In terms of mangrove species richness, the greatest number of true mangroves are observed in Malaysia, where 41 species are recorded (FAO, 2007), followed by Indonesia and Viet Nam with 37 species each (UNEP, 2008a). The RWG on mangroves (RWG-M) identified that the richness of true mangrove species is comparatively lower in the Philippines, Thailand and China and ranges between 26 and 28 species (UNEP, 2008a). According to FAO (2007), 16 species of true mangroves occur in Cambodia (Table 1). Investigation of the latitudinal variation in the number of true mangrove species in Viet Nam indicates an increase in the number of species from higher to lower latitudes, e.g., 14 species in the Gulf of Tonkin, 18 species in mid-central Viet Nam, 23 species in south-central waters, and 33 species in the Dong Nai and Mekong estuaries in the south (Vo, 2010). Similarly, there exists considerable variation in the eastern and western Gulf of Thailand, with species richness being lower in the eastern Gulf (18 and 16 species recorded in Gulf of Thailand waters of Viet Nam and Cambodia, respectively) compared to Thai waters in the West where 27 species are observed (UNEP, 2008a).

Analysis of data compiled in the National Reports on Mangroves (UNEP, 2008a) and Chan et al. (1996) indicates that the southern part of the South China Sea is a regional hotspot in terms of mangrove area. More than 550,000 ha and 86,900 ha of mangrove are observed in Indonesia's Riau and West Kalimantan Provinces respectively, whereas Malaysia's Sarawak and Sabah regions

Table 1
Approximate total area (values rounded to three significant figures) and species richness of mangroves bordering the South China Sea determined by the RWG-M (UNEP, 2008a; FAO, 2007).

Country	Area of mangroves (ha)	Number of true mangrove species
Cambodia	72 300	16
China	23 400	26
Indonesia	934 000	37
Malaysia	532 000	42
Philippines	23 400	28
Thailand	28 000	27
Viet Nam	157 000	37
Total	1 770 000	45

[4] See Paterson and Pernetta, 2013, for a description of the procedures for information and data collection, review and management established by the SCS project.

[5] National reports on the habitats of the South China Sea can be accessed online at <http://www.unepscs.org/South_China_Sea_National_Reports>. An extensive index of supporting national language reports is also accessible online at <http://www.unepscs.org/South_China_Sea_National_Publications>

[6] See Pernetta and Jiang, 2012, for a description of the management structure of the project.

[7] An index of national habitat demonstration project information and documents can be accessed online at <http://www.unepscs.org/Habitat_Demonstration_Sites_and_Pilot_Activities_Index.html>.

[8] Achievements and lessons learned from the operation of the SCS network of habitat demonstration projects are detailed by Vo et al., 2013. Similarly, Bewers and Pernetta, 2013, review the outcomes of the SCS project and their applicability to other projects and programmes in coastal seas and marine basins.

contain mangrove areas of 167,000 ha and 365,000 ha respectively. In contrast, the total area of mangrove along the Malaysian peninsular is approximately 3,500 ha. Mangrove areas become more extensive northward in the eastern Gulf of Thailand and southern Viet Nam. In terms of areal extent, notable mangrove sites are located in: Trat and Chantaburi Provinces in Thailand, with total areas of 9500 ha and 12,500 ha respectively; Peam Krasop in Cambodia's Koh Kong Province (25,800 ha); and Ca Mau in the southern Mekong estuary (58,000 ha) and Can Gio in the Dong Nai estuary (34,500 ha) in Viet Nam.

2.1.2. Coral reefs

Southeast Asia is recognised as the global centre of coral reefs, both in terms of areal extent and species diversity. An estimated 1/3 of the Earth's coral reefs (91,700 of 284,000 sq. km) are located in the seas of Southeast Asia (Burke et al., 2002). Fringing reefs are well developed away from the major river estuaries, particularly in the Philippines and the central and southern areas of the South China Sea. All major reef types from fringing, patch or platform reefs and atolls occur in the South China Sea. Offshore, a series of large platform reefs and atolls are found; the most well-known being the Spratly Islands, the Tung-Sha Reefs and the Paracel Islands. These oceanic reefs are highly diverse and are thought to play a key role in the maintenance and replenishment of regional biodiversity and may be particularly important in the replenishment of populations of some harvested species (McManus, 1994; UNEP, 2005).

Based on data compiled by members of the Regional Working Group on Coral Reefs (RWG-CR) (UNEP, 2007a), approximately 750,000 ha of coral reef has been identified in the South China Sea coastal waters of the following six countries: Cambodia (2807 ha); Indonesia (39,300 ha); Malaysia (43,400 ha); the Philippines (464,000 ha); Thailand (90,000 ha); and Viet Nam (110,000 ha). The area of coral reefs in the waters of the South China Sea countries/territories that did not participate in the coral reef activities of the SCS project were reported by Burke et al. (2002) as follows: China (90,000 ha); Taiwan (70,000 ha); Brunei Darussalam (20,000 ha); and Singapore (5500 ha). Accordingly, the total area of coral reefs in the coastal waters bordering the South China Sea is approximately 930,000 ha.

Large coastal coral reef areas were identified by the RWG-CR to be located at the following South China Sea sites: Ninh Hai (Ninh Thuan) (1070 ha), Ca Na Bay (2270 ha), and Con Dao Islands (1000 ha) in Viet Nam; Muh Ko Chang (18,700 ha), Muh Ko Samui (39,000 ha) and Mu Koh Samei (4200 ha) in Thailand; Palau Redang (2550 ha), Palau Perhentian Besar (1820 ha) and Palau Tioman (5023 ha) in Malaysia; Anambas (6260 ha), Barelang dan Bintan (6150 ha) and Natuna (15,900 ha) in Indonesia; and the Bolinao/Lingayen Gulf (9560 ha), Calamianes Group of Islands (18,200 ha) and El Nido, Palawan (4250 ha) in the Philippines.

In terms of species richness, the southern and eastern coastlines of the South China Sea fall within the so-called coral triangle and within the isopangeneric contour of 70 coral genera (Veron, 1995). Comparative analysis of the distribution of maximum marine biodiversity for various taxonomic groups has been reviewed by Hoeksema (2007) who notes that different authors have defined different 'triangles' and applied different names to this 'centre' of marine biodiversity. Some of these triangles only include the eastern side of the South China Sea, while others encompass the southern half of the South China Sea. As a consequence of more recent surveys in Viet Nam (Vo and Hodgson, 1997; Vo, 1998; Vo et al., 2005), it is recommended that this contour be expanded westwards to cover the south-central waters of Viet Nam thus corresponding more closely to the coral triangle delimited by Briggs (2005a,b). The recent finding of the hard coral *Leptoseris kalayaanensis* in Nha Trang (westernmost location in the South China Sea), the Northeast Investigator Shoal (Kalayaan islands) and North Danger Reefs (Spratly islands) complex indicate that little is known about the coral fauna of the South China Sea relevant to the positioning of the northwestern boundary of the centre of maximum coral species richness, the Coral Triangle (Hoeksema et al., 2010). In terms of diversity at individual localities, hotspots of coral species richness occur at Nha Trang (Viet Nam) with 351 species (Vo et al., 2002) and El Nido (Palawan, Philippines) with 305 species (UNEP, 2007a) and Bolinao (Philippines) with 322 species (Licuanan, 2009). Records of more than 200 species occur at a number of sites in Viet Nam, Indonesia and the Philippines (UNEP, 2004b; UNEP, 2007a), and Malaysia (Yaman, personal communication).

2.1.3. Seagrass

The World Atlas of Seagrasses (Green and Short, 2003) provides information on the world's seagrass habitats globally and, incorporates their status in the context of environmental change. There are, however, still substantial information gaps for the South China Sea. The SCS project worked to develop the first comprehensive seagrass data set from this basin, including characterisations for seagrass sites and the first ever seagrass data sets and maps for China (UNEP, 2008c). The data, however, were based on field surveys at known seagrass locations in SCS countries and do not reflect the total distribution of seagrass or seagrass beds in the riparian countries. Some algorithms for mapping seagrass using remote sensing have been developed but have not yet been applied to the entire South China Sea coastline (UNEP, 2008d).

Of the approximately 60 seagrass species described worldwide, 18 species are found in the coastal waters of the South China Sea. The numbers of seagrass species known to occur in each country are: Cambodia, 9; China, 8; Indonesia, 12; Malaysia, 14; Thailand, 12; Philippines, 15; and Viet Nam, 14 (UNEP, 2008c). *Halophila* is the most diverse and widespread genus in coastal waters throughout the region. The coastlines of the northern sub-region, in China and northern Viet Nam, have characteristics of subtropical areas and the species include *Zostera japonica* together with *Halophila beccarii*, *Halophila ovalis*, *Halophila decipiens*, *Enhalus acoroides*, *Thalassia hemprichii*, *Halodule pinifolia*, *Halodule uninervis*, *Cymodocea rotundata* and *Ruppia maritime* (UNEP, 2004c). All but the first of these species are widespread throughout the South China Sea region. Additional seagrass species recorded in the tropical zone include *Halophila spinulosa*, *Halophila minor*, *Cymodocea serrulata*, *Syringodium isoetifolium* and *Thalassodendron ciliatum* (UNEP, 2004c).

The sub-tropical species *Z. japonica* often forms mono-specific seagrass beds and has been recorded in Tieshan Bay and Pearl Bay, Guangxi Province, and Hong Kong, China. Its distribution also extends down to northern and central Viet Nam and its occurrence in Binh Dinh Province represents the southernmost limit of this temperate species in the Indo-west Pacific. Of the tropical species, *T. ciliatum* is generally found in seagrass beds from the intertidal to the low sub-tidal zone (2–17 m) in the eastern part of Indonesia, and the southern and western shores of the Philippines. This species also occurs in the seagrass beds in Con Dao, southern Viet Nam. In the Philippines, it has been reported in Cuyo Island, the northernmost limit of its distribution in the Indo-west Pacific (UNEP, 2008c).

The largest areas of seagrass meadows identified in the South China Sea to date are in the coastal waters of Kampot Province in Cambodia (25,200 ha), Cape Bolinao in the Philippines (22,400 ha), Phu Quoc and neighbouring islands in Viet Nam (12,500 ha), and East Bintan in Indonesia (2000 ha) (UNEP, 2008d; Vo, 2010). The transboundary water area between Cambodia and Viet Nam,

including the large connected seagrass meadows of Kampot and Phu Quoc, contain possibly the largest seagrass bed in the South China Sea (37,000 ha) and may play a globally significant role as a critical fisheries *refugia* for fish stocks of significance to regional food security (see Paterson et al., 2012). The record of 10 species of seagrasses and a dugong population (combined list from UNEP, 2008c; Tu Thi Lan Huong et al., 2002) at this locality also indicates the importance of these transboundary waters to regional biodiversity conservation.

2.2. Threats to dominant coastal habitats

2.2.1. Threats to mangroves

Around 30% of the world's remaining mangrove is found in the countries participating in the SCS project and 11% of the world's total is found along the margins of the South China Sea marine basin (Polidoro et al., 2010; Spalding et al., 2010; UNEP, 2008a). Rates of loss are generally higher along the South China Sea coastlines than elsewhere in the seven countries participating in the SCS project. For example, around 80% of the mangrove bordering the Gulf of Thailand has been lost compared with only around 20% on the Andaman Sea coast of Thailand (UNEP, 2004a). The annual rates of loss in the seven countries between 1990 and 2000 were greater than the world average (Table 2). Such losses represent a loss of global biological diversity that must be a matter of global concern (UNEP, 2004a). The total area of mangrove lost in the participating countries over different time spans (70 years for the Philippines) was estimated in 1998 at 4.2 million ha suggesting that over half of the original mangrove bordering the South China Sea had been lost during the last century. The RWG-M estimated the ongoing decadal rate of loss of mangroves from the South China Sea basin in 2007 as 16% (UNEP, 2008d).

The causes of mangrove destruction identified in the TDA along the coastlines bordering the South China Sea included conversion to pond aquaculture, particularly for shrimp, clear felling of timber for woodchip production, land clearance for urban and port development and human settlements, and harvest of timber products for domestic use (Talaue-McManus, 2000; UNEP, 2004a). Contemporary causes of loss of mangrove habitat are no longer dominated by shrimp culture although this remains one cause in China, Indonesia and Viet Nam (UNEP, 2007b). Conversion of mangrove to land for industrial purposes (including harbour construction) has grown over the last ten years and is now significant in China, but of low importance in Indonesia, the Philippines and Viet Nam, and unimportant in Thailand and Cambodia (UNEP, 2007b).

Degradation of mangrove habitats as a consequence of chronic pollution from shrimp farming operations is now more prevalent in China, Indonesia and Thailand, whilst charcoal production continues to degrade mangrove in Cambodia, Indonesia and the Philippines despite legislation banning all harvesting of mangroves in Cambodia and the Philippines (UNEP, 2008e). At a regional level, the following are seen as the current anthropogenic threats to mangrove systems bordering the South China Sea: reclamation and infrastructure development; pollution from shrimp farming (China, Indonesia, Thailand); and conversion to industrial uses (China, small in the Philippines, Indonesia and Viet Nam, negligible in Cambodia and Thailand). Conversion to shrimp culture remains a potential long-term threat in Viet Nam. Natural threats include sea level rise and episodic threats, including tsunamis and typhoons (UNEP, 2008e).

Transboundary influences are seen through the global trade in shrimp, for example. The high level of world demand for shrimp is driven by demand in Japan, North America and Europe. This demand essentially sets the world price for shrimp such that economic incentives for the conversion of "non-productive" mangrove habitats operate at both the local and national levels in the producing countries. Opportunities for hard currency income and economic development fuel the motives at the national level while individual producers, at least in the short-term, derive considerable cash income from cutting mangrove and converting it to shrimp ponds (UNEP, 2008d).

On a smaller scale, trade in charcoal derived from mangrove in Cambodia to Thailand was, until very recently, a major cause of mangrove loss in the areas of Cambodia close to the Thai border. This market appears to have declined somewhat over the last five years under the influence of more widespread use of cheap and convenient liquefied natural gas in Thailand (UNEP, 2008e). When mangrove forests are destroyed and replaced by alternative forms of land use, not only are the species of plants and animals lost but also many services provided by mangrove systems are lost as well. This is well recognised in Viet Nam where the function of coastal vegetation, particularly mangroves, is considered a vital service with measurable economic benefits as a protection against hurricane damage and marine based flooding. Mangrove degradation causes losses in direct and indirect economic values that support socio-economic development on both local and national scales.

2.2.2. Threats to coral reefs

Not only are the coral reefs of South East Asia the most biologically diverse and productive reef ecosystems in the world but they are also the most threatened and damaged with unprecedented rates of destruction from anthropogenic pressures that have accelerated over recent decades (Tun et al., 2004; UNEP, 2004b). The RWG-CR identified regionally significant threats to coral reefs in the South China Sea as being over-fishing, use of destructive fishing techniques, pollution (mainly eutrophication) and increased sedimentation (Table 3) (UNEP, 2007c). Indirect causes of these

Table 2
Estimates of area (ha) (rounded to three significant figures) and rates of loss of mangrove habitat in seven countries bordering the South China Sea (based on UNEP, 2004a).

	Recent global estimate ha	Date of global estimate	National estimates of total mangrove area			Current South China Sea area ha	Rate of loss per year %	
			1980 ha	1990 ha	2000 ha		1980–1990	1990–2000
Cambodia	72 800	1997	83 000	74 600	63 700	72 400	−1.01	−1.46
China	36 900	1994	65 900	44 800	23 700	23 400	−3.20	−4.71
Indonesia	3 490 000	1988	4 250 000	3 530 000	2 930 000	934 000	−1.70	−1.70
Malaysia	587 000	1995	669 000	621 000	572 000	532 000	−0.72	−0.78
Philippines	128 000	1990	207 000	123 000	110 000	28 000	−4.02	−1.11
Thailand	244 000	2000	286 000	262 000	244 000	62 600	−0.82	−0.69
Viet Nam	253 000	1983	227 000	165 000	157 000	157 000	−2.73	−0.51
Total	4 810 000		5 790 000	4 820 000	4 100 000	1 770 000	−1.67	−1.61
World	15 800 000	1992	19 800 000	16 400 000	14 700 000		−1.74	−1.04
% World total	30.5		29.2	29.4	27.8	11.4		

Table 3
Prioritisation of the threats to coral reefs bordering the South China Sea (excluding China) (based on UNEP, 2007c).

	Cambodia		Indonesia		Malaysia		Philippines		Thailand		Viet Nam		Region
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Weighted score
Direct threats													
Over-fishing	1	0.4	1	5.2	5	29.0	1	61.9	7	84.07	1	14.69	195.2
Destructive fishing	2	0.7	2	10.5	2	11.6	2	123.8	5	60.05	2	29.38	236.1
Sedimentation	5	1.9	4	21.0	1	5.8	3	185.7	4	48.04	3	44.04	306.4
Pollution (Eutrophication)	4	1.5	5	26.2	4	23.2	5	309.6	6	72.06	4	58.72	491.2
Coral bleaching	8	3.0	3	15.7	7	40.5	9	557.2	1	12.01	5	73.4	701.8
Indirect threats													
Unsustainable fisheries and aquaculture	3	1.1	8	41.9	9	52.1	4	247.6	8	96.08	8	117.4	556.3
Coastal development	6	2.2	7	36.7	6	34.7	6	371.5	3	36.03	6	88.08	569.2
Unsustainable tourism	9	3.3	9	47.2	3	17.4	8	495.3	2	24.02	9	132.1	719.3
Deforestation on upland areas	7	2.6	6	31.4	8	46.3	7	433.4	9	108.09	7	102.8	724.6
Total area of coral reefs[a]	2 810		39 300		43 400		464 000		90 000		110 000		749 500
Proportion of total coral reef area	0.37		5.24		5.79		61.91		12.01		14.68		

[a] Rounded to three significant figures.

threats are unsustainable practices in the fisheries sector, coastal development, deforestation and unsustainable tourism. Coral bleaching is also considered a serious threat to coral reefs in the region. The RWG-CR of the SCS project estimated the ongoing decadal rate of loss of coral reef from the South China Sea basin in 2007 as 16% (UNEP, 2007c).

Table 3 presents the threats ranked for each country from 1 to 9 with 1 representing the most serious and 9 representing the least serious threat. The ratio of the coral reef area in each country compared to the total area for the South China Sea (excluding China) was used to weight the individual country ranks resulting in a regionally weighted score. The weighted scores suggest that, on a regional scale, the most serious threat is over-fishing; followed by destructive fishing; sedimentation; pollution; unsustainable fisheries practices; coastal development; coral bleaching; unsustainable tourism; and, finally, deforestation on upland areas. Extensive bleaching in the entire region occurred in 1998 and bleaching with high severity was observed in the Gulf of Thailand and the southwest South China Sea (from further south Viet Nam to Singapore) in 2010 (Tun et al., 2010).

2.2.3. Threats to seagrass

In the South China Sea region, there has been a rapid rate of seagrass loss in recent years. Indonesia has lost about 30–40% of its seagrass beds with as much as 60% being destroyed around Java. In Singapore, the patchy seagrass habitats have suffered severe damage largely through burial under landfill operations. In Thailand, losses of seagrass beds amount to about 20–30% and in the Philippines it is about 30–50%. The Regional Working Group on seagrass (RWG-SG) identified six threats to seagrass including: use of destructive fishing gears such as push nets and demersal trawl nets; increased sedimentation from coastal development; waste water effluent discharges; nutrient discharges and runoff; coastal construction; and over-fishing (UNEP, 2006a). The RWG-SG of the SCS project estimated the ongoing decadal rate of loss of seagrass habitat in the South China Sea basin in 2006 as approximately 30% (UNEP, 2006, 2008d).

Focal points from each country were asked to rank the relative importance of the six threats outlined in the previous paragraph. The regional significance of each threat was determined by the rank for each threat weighted by the proportion of the area of seagrass in the country concerned compared with the total for the region. The resulting values were summed to produce the regionally weighted total, which is inversely related to the regional significance (small values are more significant than larger values). The relative importance of the threats from a regional perspective is summarised in Table 4. The impacts of destructive fishing techniques are of particularly concern as seagrass habitat supports extensive populations of rabbit fish, crustaceans and sea urchins of subsistence and commercial significance. The national reports on seagrass indicate various local-level threats, including extensive reclamation for tourist and port development at a number of locations in the eastern Malaysian Peninsular and Puerto Galera in the Philippines, shrimp culture in the Liusha area of China and Thuy Trieu lagoon in Viet Nam, and fresh water inputs from irrigation and land clearance in Pattani Bay (Thailand) (UNEP, 2008c).

3. Current management regimes and the development of strategic action programme targets for coastal habitats

3.1. Management of coastal habitats in the South China Sea

3.1.1. Mangrove management[9]

Information relating to the management of mangrove areas in six of the seven countries bordering the South China Sea is presented in Table 5. Five categories of mangrove forest are recognised in the region: production forest, used on a sustainable basis for timber and wood chip production; conversion forest, a category in Indonesia representing areas of mangrove land designated for alternative land use under current development plans; Parks and Protected Areas; and areas in which timber extraction is not permitted but extractive use of other resources is permitted. In the case of Thailand, another category is recognised, namely "Private land, unregulated use" that accounts for 10,000 ha (UNEP, 2008d).

Table 5 illustrates the complexity of management regimes in six of the seven countries concerned but does not provide a mechanism for objectively determining the effectiveness of these regimes. For example, in Cambodia, 19% of mangroves are contained within Parks and Protected Areas for which there is no legal extractive use of either the mangrove trees or other resources. This area is also listed as being under a management regime regulated in law and, again, within the areas listed as currently being sustainably managed. The assumption is that because access to, and use of, this area is restricted, the management is sustainable. In contrast, 81% of Cambodia's mangrove are currently not regulated under the law and are subject to extraction of non-timber resources but not the mangroves themselves. Of this area, only 8820 ha are considered as being exploited in a sustainable manner. The target for Cambodia is therefore to ensure that all mangroves outside the legally protected

[9] Malaysia did not participate in the mangrove component of the project until the fifth meeting of the regional working group, hence no national compilations of mangrove data and information were provided to the project from this country.

Table 4
Regional ranking of threats to seagrass specified by the RWG-SG, 1 = most serious and 6 = least serious. (*regional score based on country score provided by the focal points and the ratio of seagrass areas of each country to that of the region*) (based on UNEP, 2006; UNEP, 2008d).

Country	Cambodia		China		Indonesia		Malaysia		Philippines		Thailand		Viet nam		Total	
Area (ha)	33 800		1 960		3 000		222		23 200		2 550		13 500		78 300	
Proportion of regional total	0.458		0.027		0.041		0.003		0.315		0.035		0.121		1.00	
	Rank	Weight score	Rank	Weight score	Rank	Weight score	Rank	Weight score	Rank	Weight score	Rank	Weight score	Rank	Weight score	Total Weight score	Regional ranking
Destructive fishing such as push nets and trawls	1	0.432	1	0.025	1	0.039	3	0.009	2	0.593	1	0.033	1	0.172	1.30	1
Sedimentation from coastal development	4	1.730	3	0.075	3	0.116	4	0.012	3	0.890	2	0.065	2	0.345	3.20	2
Wastewater effluent	3	1.300	4	0.100	5	0.194	5	0.015	4	1.187	4	0.130	5	0.862	3.78	3
Over-fishing	2	0.863	6	0.150	6	0.232	1	0.003	6	1.780	5	0.163	4	0.690	3.88	4
Nutrients	6	2.590	5	0.125	4	0.155	6	0.018	1	0.297	3	0.098	6	1.030	4.32	5
Coastal construction	5	2.160	2	0.050	2	0.077	2	0.006	5	1.480	6	0.196	3	0.517	4.49	6

Parks and Protected Areas are used in a sustainable manner by 2012. Targets developed by the Regional Working Group on Mangroves (RWG-M) for the SCS project are presented in Table 6 below. The target for enrichment planting to increase mangrove biodiversity, for example, was included following lengthy consideration by the RWG-M of the results of largely single-species mangrove reforestation initiatives in the region over recent decades.

3.1.2. Coral reef management

The characterisation of target coral reef sites bordering the South China Sea, including *inter alia* their legal status and the effectiveness of management was summarised by the RWG-CR for the SCS project in 2007 (UNEP, 2007c). In the case of Cambodia, Indonesia, Malaysia and Thailand, the total coral reef area was estimated as being the same as the areas of targeted sites. The area of coral reefs in the 82 target coral reef sites is 217,000 ha (29% of the total area in the South China Sea excluding China) of which almost 100,000 ha (13% of the total area) at 61 sites was under management at the time of SAP development (UNEP, 2007c). In terms of management effectiveness, only around 16% of this area at thirteen sites was deemed by the RWG-CR as being successfully managed. Thirty seven percent of sites were considered to be moderately well managed (medium effectiveness) while, for 24% of the sites, management effectiveness is considered low and 23% have plans but no effective management.

The general status of coral reef management in the South China Sea geographic region of the six countries was also summarised by the RWG-CR in 2007 as shown in Table 7 (UNEP, 2007c). This summary was prepared on the basis of the best available information for 82 individual coral reef areas compiled in the national reports on coral reefs (UNEP, 2007a). The area identified by the RWG-CR to be added to the total area managed sustainably by the year 2015 was approximately 54,000 ha. This would increase the total area under sustainable management to 20% of the total reef area of the South China Sea and 71% of the area of the target sites.

Coral reef monitoring has expanded in most countries bordering the South China Sea during recent decades and has provided baselines for long-term coral reef management. The data obtained in the framework of the Global Coral Reef Monitoring Network (GCRMN) indicate that the percentage of reefs in Southeast Asian countries had declined in state from one quartile category to a lower one, equivalent to a decadal loss of 16%, during the period 1994–2004.

It was noted that setting a target for the total area under management did not represent a target for the state of the reef although it could be assumed that those under management would, depending on the management regime, be more likely to sustain their biological diversity than those that were not under management. Therefore, the RWG-CR considered an additional target related to the reduction of the degradation rate. RWG-CR members agreed that improvement of coral reef management could feasibly

Table 5
Estimated areas (rounded to three significant figures) of South China Sea mangrove under different forms of land-use designation and management (based on UNEP, 2008d).

	Cambodia	China	Indonesia	Philippines	Thailand	Viet Nam	Total	%
Total area (ha)	72 400	23 400	934 000	28 000	62 600	157 000	1 280 000	100
Production forest	0	0	611 000	0	1600	18 000	631 000	49
Conversion	0	0	165 000	0	0	0	165 000	13
Parks & Protected Areas (Conservation) non-extractive use	13 600	15 800	158 000	27 100	11 500	20 000	246 000	19
Non-use of mangrove but extractive resource use (fish, crabs etc.)	58 800	7 670	0	942	39 500	119 000	226 000	18
Private land, unregulated use	0	0	0	0	10 000	0	10 000	0.8
Area currently under management Regulated in laws/regulations	13 600	15 800	769 000	27 100	11 500	155 000	992 000	78
Areas estimated as currently under sustainable management[a]	13 600 8 820	15 800 1 000[b]	158 000 100 000	26 000	11 500 1 600	20 000 18 000 46 600	421 000	33

[a] Areas considered as currently being sustainably managed include all lands designated as production forest as it is a legal requirement that these be replanted; all mangrove lands contained within National Parks and Protected Areas; and a proportion of the mangrove area subject to extractive use of non-timber resources.
[b] Estimated area outside the protected area for which some form of management plans exist.

Table 6
Targets [*Proposed areas in hectares to be subject to changes in designation and/or management regime*] for future mangrove management (based on UNEP, 2008d).

	Cambodia	China	Indonesia	Philippines	Thailand	Viet Nam	Total	% of total area of mangrove
Area to be transferred to National Parks and Protected Area status	0	5 330	20 000	631	1 400	30 000	57 400	4.5
Non-conversion of mangrove but sustainable use	0	0	165 000	0	1 600	0	166 600	13.1
Improved management relating to sustainable use	49 900	0	490 800	2 000	10 000	50 000	602 800	47.2
Replanting of deforested mangrove land	2 500	500	0	2 000	8 000	8 000	21 000	1.6
Enrichment planting to increase mangrove biodiversity	0	5 000	0	1 000	3 200	2 000	11 200	0.9

support a reduced decadal degradation rate of coral reefs in the South China Sea from 16% to 5%. Ongoing regional assessments of coral reef status will enable comparisons of degradation rates in future years.

The specific targets for coral reef management developed by the RWG-CR were (UNEP, 2008d):

- By 2015, at least 70% of the existing area of coral reefs in the 82 target coral reef sites (153,000 ha) to be put under an appropriate form of sustainable management;
- By 2015, reduce the regional decadal rate of degradation in live coral cover from the present rate of 16–5%.

3.1.3. Seagrass management

On the basis of data provided by members of the Regional Working Group on Seagrass (RWG-SG) during their eighth meeting, a total of 43 target seagrass sites for management are recorded in the coastal areas bordering the South China Sea. These comprise: Cambodia 33,800 ha from 4 sites; China 1960 ha from 4 sites; Indonesia 3035 ha from 7 sites; Malaysia 222 ha from 13 sites; Philippines 23,200 ha from 5 sites; Thailand 2550 ha from 4 sites; and Viet Nam 13,500 ha from 6 sites (UNEP, 2007d). A review of the management status of seagrass sites by the RWG-SG indicated that 12,900 ha (16.5%) of the total known area of seagrass in the South China Sea is currently under some form of management, although the effectiveness of management was rated medium to low. Very few seagrass sites had any specific legal status. To address this, the RWG-SG identified a total estimated area of seagrass of 78,300 ha of which 25,900 ha (33%) was targeted to be brought under sustainable management through implementation of NAPs and the regional SAP (UNEP, 2007d).

The RWG-SG agreed the goal of the SAP with respect to seagrass as *"To conserve, manage and sustainably utilise seagrass habitats and resources"* (UNEP, 2005a). Specific targets for the management and conservation of seagrass ecosystems in the SCS included: bringing 21 managed areas totalling approximately 25,900 ha under sustainable management by the year 2012; amendment of the management plans for seven existing MPAs with significant areas of seagrass habitat to include specific seagrass-related management actions by the year 2012; and the adoption of 7 new MPAs specifically focussing on seagrass habitats by the year 2012.

3.2. Planning for conservation and sustainable use

3.2.1. National action plan and strategic action programme development

Originally, it was intended that there would be subsets of the National Action Plans (NAPs) developed by each country for the habitat sub-components, i.e., 7 for mangroves, 6 for coral reefs, 7 for seagrass, and 7 for coastal wetlands, for a total of 27. However, only 26 NAPs were developed due to the non-participation of Malaysia in the mangrove sub-component. The original work plan called for the development of the NAPs during the preparatory phase of the project in parallel with the assembly of national data and information and the selection of demonstration sites. The work flow was such that initial discussions of the NAPs at the RWG level did not commence until the second half of 2004 (UNEP, 2004d–g), effectively at the commencement of the operational phase of the project.

Discussions were undertaken regarding the parallel and iterative development of the NAPs and the SAP and development of the SAP targets and goals. Activities for inclusion in the SAP were discussed and, following review by the RSTC, these were amended during the seventh and eighth meetings and incorporated into the consolidated text of the SAP. The final text of the SAP therefore incorporated the recommended goals and objectives, targets and activities that had been considered at various levels, both nationally and regionally, within the management structure. During the period 2007–2008, national level consultations were conducted on both the NAPs and the SAP and a number of national-level priorities for action were identified and developed as concepts for further elaboration and funding, either from national budgets or from bilateral and multilateral sources[10].

In Cambodia, the NAP focussed on the provision of guidance for the sustainable use of coastal resources. Decentralisation of responsibilities to the four coastal provinces in implementing projects for environment and resource management, including Integrated Coastal Management (ICM) and community-based management, have followed good practices established in the SCS project (UNEP, 2008f). In China, NAPs for four components were finalised and adopted in April 2007. The operation of the Shantou GEF-funded Medium Sized Project enabled implementation of wetland NAP activities. Several actions and efforts related to the SAP, including interventions for habitat protection in the Pearl River, have been implemented by different sectors with funding from the government. The NAP components were also effective in leveraging support from provincial governments for the ongoing operation of the mangrove and seagrass demonstration sites in China. This also included the replication of best practices in wetland conservation generated through the SCS project at Yelin bay with financial support from the Hainan Provincial Government (UNEP, 2008f).

In Indonesia, coastal habitat NAPs were reviewed by the National Technical Working Group. Although not all had been formally approved at the level of the Cabinet, the recommended actions were incorporated into government strategic planning and recurrent budgets. The SCS demonstration site projects received strong support from local governments and the central government is

[10] See Annex 5, "*Project Concept Papers for the Implementation of the Strategic Action Programme for the South China Sea*" of the Terminal Report of the UNEP/GEF South China Sea Project, for a complete listing of nationally developed project concepts for SAP implementation (UNEP, 2009).

Table 7
Status of coral reef management in the South China Sea biogeographic region (based on UNEP, 2007c; UNEP, 2008d) (Figures for area rounded to three significant figures).

	Cambodia	Indonesia	Malaysia	Philippines	Thailand	Viet Nam	Total
Total coral reef area in the South China Sea (ha)	2 808	39 300	43 400	464 000	90 000	110 000	750 000
Total coral reef area of the 82 target sites	2 808	39 300	43 400	36 700	89 530	57 10	217 000
Coral reef area under existing management at the 83 sites	293	12 500	28 200	2 390	54 000	2 270	99 700
Number of target sites with management information	7	7	36	9	14	9	82
Number of target sites with effective management, plans only	6	3	0	1	5	4	19
Number of target sites with low management effectiveness	0	2	11	2	5	0	20
Number of target sites with medium management effectiveness	1	2	12	6	4	5	30
Number of target sites with high management effectiveness	0	0	13	0	0	0	13
Existing management types[a]	FMA, MPA, NP	MMA, MR	MP	PLS, MCDP, MTS, MBR, ECPZ	NP, MNP, NCA,	MPA, NP, CBM, WH	
Target area to be added for management by 2015 (ha)	1 970	5 580	15 200	10 100	18 000	3 300	53 100
Total area to be under management by 2015 (ha)	2 260	18 100	43 400	12 500	72 000	5 570	154 000

[a] Cambodia - FMA: Fisheries Management Area, MPA: Marine Protected Area, NP: National Park. Indonesia - MMA: Marine Management Area, MR: Marine Reserve. Malaysia - MP: Marine Park. Philippines - PLS: Protected Land/Seascape, MCDP: Municipal Coastal Development Plan, MTS: Marine Tourism Reserve, MBR: Man & Biosphere Reserve, ECPZ: Environmental Critical Protection Zone. Thailand - NP: National Park, MNP: Marine National Park, NCA: Navy Control Area. Viet Nam - MPA: Marine Protected Area, NP: National Park, CBM: Community-based Management, WH: World Heritage.

working with local governments to implement the NAPs in the provinces bordering the SCS. In Malaysia, NAP components will be implemented with national budgets enabling Malaysia to meet the SAP targets. The Philippines finalised NAPs for all components and it is anticipated that these will be implemented and that all projects for coastal and marine management in the Philippines would follow the multi-disciplinary and ecosystem-based approaches to coastal habitat management promoted in the NAP.

In Thailand, the NAP components were combined with the National Biodiversity Strategy and Action Plan approved by the Cabinet. Priority sites have been identified by the national consultation for implementing the habitat NAPs focussing on: the protection of biodiversity, enhancement of sustainable use, mitigation of threats, public awareness and the promotion of international cooperation. In Viet Nam, NAPs for all components were developed. The priorities identified in these NAPs have, to some extent, been integrated into national policy and programmes. For example, the programme for vulnerability assessment of coastal resources and environment and the government programme regarding international cooperation on marine issues are also in the draft Biodiversity Law. A further important step was the establishment of the Viet Nam Administration of Seas and Islands in 2008 that contributes to NAP implementation.

3.2.2. Strengthening national and local capacity for coastal habitat management

Training needs and opportunities at the demonstration sites were included only in a few of the demonstration site proposals and, although substantial funds had been allocated to fund exchange of personnel between demonstration sites, in the event, no such exchanges were requested. It seems that the demands of operating and managing project activities at the site level precluded the loss of such personnel for extended periods. In contrast, a number of study tours were instituted for groups of people from the local level to travel to other demonstration sites to assess firsthand the activities and their impacts in other countries. Experience with this programme led to the Viet Nam Government supporting a large group of individuals from all coastal provinces in Viet Nam to visit Mu Koh Chang and see firsthand the work on sustainable tourist development.

The training needs and opportunities identified by the RWGs varied greatly in terms of the subject areas for training, the optimum modes of training, the duration and frequency of training, and the anticipated numbers of participants. There was such a diverse range of requests and identified needs for training that it was not practical for the project to develop a training programme that attempted to meet all needs. Following the receipt of proposals, a total of seven regional training courses were organised through partner organizations. These were: Sustainable Use and Management of Mangrove Ecosystems; Larval Fish Identification and Fish Early Life History Science; Management Models and Strategies for Coral Reef and Seagrass Ecosystems; Establishing and Managing Fisheries *Refugia* in the South China Sea; Sustainable Use of Coastal Wetlands Bordering the South China Sea; Economic Valuation of Goods and Services of Coastal Habitats of the South China Sea; and Advanced Larval Fish Identification. The training syllabi, anticipated outcomes and training materials for each workshop were reviewed during the 2007 round of project meetings and comments were communicated to the selected implementing organisations.

The programme involved 104 days of regional training and the participation of 153 individuals from the seven participating countries. A total of 66 resource persons supported the conduct of the workshops, all of whom were nationals of, or, in a few instances, residents of the participating countries. Without exception, they were experts or focal points from the South China Sea Project network. The specific outputs from the programme included: 192 PowerPoint presentations containing 5612 slides; 571 pages of text in 17 lecture notes; 61 recommended readings with a total 2231 pages of text; 7 training videos; and a package of larval fish identification resource materials. All training materials developed and used in the regional training workshops were made web-ready and loaded to the training portal section of the South China Sea project website.[11] The total cost of these seven regional training courses was US$ 338,164 corresponding to US$ 150.50 per participant day.

The interventions of the SCS project and those proposed within the framework of the National Action Plans and the revised regional Strategic Action Programme focus on site level actions

[11] http://www.unepscs.org/Training/Workshops/Materials.html

aimed at reversing the trend of environmental degradation in the South China Sea and Gulf of Thailand. This requires a high level involvement of provincial and local government officials and technical staff, as well as community groups and non-governmental organisations in the implementation of SAP and NAP related activities.

The RSTC concluded that, for the regional training programme to have maximum impact on the longer-term sustainability of ongoing interventions and future actions at the site level, there was a need for a mechanism to ensure effective transfer of knowledge and skills from individuals participating in the regional training events to colleagues involved in the execution of national and local level activities. To this end, the RSTC promoted the conduct of national "echo" seminars for each regional training workshop in each country. It was recommended that these "echo" seminars be organised and conducted by participants in the regional workshops in collaboration with relevant national Specialised Executing Agencies. It was also recommended that "echo" seminars be conducted at SCS project habitat demonstration sites and that participants be provided with abridged, local language, versions of the regional training materials. The seminars were designed to ensure maximum participation of individuals directly involved in the demonstration sites and comparable activities within the country, thus contributing to strengthening the capacity of individuals at the local level to manage coastal resources in a sustainable manner. A total of thirty seven national "echo" seminars were conducted during the period from June 2007 to June 2008, involving a total of 1592 participants and 111 total days of training within the participating countries. The total cost of these national echo-seminars was US$ 148,405 corresponding to US$ 24.60 per participant day.

3.2.3. *Establishment of a permanent online repository of habitat information and data*

The science-based planning for coastal habitat management fostered by the SCS project relied on the extensive compilation, review and analysis of information and data relating to specific habitat sites. This involved the development of comparable national data and information sets relating to, *inter alia*, the distribution and diversity of coastal habitats, the species richness and hotspots of biodiversity, present threats and the status of management. Much of this information was synthesised and published as the national reports on coastal habitats (see UNEP, 2007a; UNEP, 2008a–c) that provides a permanent record of the information used as the basis for planning. This information was also used to prepare detailed site characterisations for more than 135 habitat sites in the basin. These characterisations provide the best available information relating to the ecology and management of individual sites in a regionally comparable format.

To facilitate the establishment of a permanent and easily accessible repository of the site characterisations, the RSTC recommended the development of a simple online Geographical Information System (GIS) for data and metadata storage and presentation. Other projects and programmes have developed sophisticated information systems that were often not utilised by target audiences despite substantial expenditures on Information Technology (IT) consultants, training, and translation into national languages (e.g., the Integrated Information Management System developed by the GEF supported Partnerships for Environmental Management in the Seas of East Asia (PEMSEA) project).[12] Accordingly, it was agreed that the GIS should be based on open source software. A similar requirement was that it should provide for the longer-term, online sharing of site-level information following the closure of the project.[13]

At that time, the Internet company Google had recently launched its now widely-used Google Earth (GE) system. This technology was first introduced to the SCS partner network during the 2005 round of RWG meetings and was discussed during the project's second Regional Scientific Conference in November 2005. The potential uses for GE identified at that time included: the validation of information regarding the extent of coastal habitats (particularly mangroves and wetlands); estimation of the number of small fishing vessels in remote coastal areas; the extent of mariculture activities; and general coastal use planning. Given the rapid uptake and use of the GE system and its ease of use by non-IT specialists to develop highly intuitive online mapping systems, it was selected as the platform for the SCS project GIS.

This Google technology was used to create an extensive GIS layer for the SCS project for viewing within GE.[14] The layer provides users with an opportunity to interactively access information about the project's partner network, explore the project's suite of habitat demonstration sites, and access information and data for more than 135 mangrove, coral reef, seagrass, and wetland sites studied during the project. The online descriptions developed for each site also contain links to key project information resources, e.g., publications relating to the project's scientific and project management innovations. In 2008, the SCS project GIS layer was showcased by Google in its 'Google Earth Outreach Showcase'[15] and featured in the official Google news.[16] At that time, Google added the layer as a permanent feature of the 'outreach' map layer in GE.

The key to this initiative was combining project information and outputs together with 3-dimensional satellite images and Google Earth's rich information base. This enables users of the SCS project's GIS layer to view project information in the context of information relating to nearby cities and coastal communities, local terrain, proximity to other projects, and the severity of environmental issues facing the South China Sea. It currently acts as a permanent online repository of regionally comparable information and data on the habitat sites studied by the SCS project. A tool for the online updating of habitat site information and the addition of new sites to the GIS was incorporated into the SCS project website in 2007.[17] This system has potential for uptake by other initiatives aimed at building on the habitat information base established by the SCS project and for replication by other GEF projects with limited financial resources and technical capacity for GIS development.

4. Conclusion

The South China Sea, including the Gulf of Thailand, is located at the geographic centre of the Indo-west Pacific biogeographic province. The marine habitats of this area are not only significant from the perspective of global biodiversity conservation but are also significant in terms of food security and the livelihoods of the

[12] See the 2006 terminal evaluation of the PEMSEA project.

[13] The development of this GIS was not an anticipated output of the SCS project. Accordingly, no GEF grant funds were allocated to, or spent on, this initiative. The GIS development relied solely on after hours input from PCU staff and represents a significant example of the many contributions of co-financing to the SCS project made by individual members of the extensive partner network it established.

[14] Google Earth users can access the SCS project layer by clicking on the following link: <http://www.unepscs.org/google/South-China-Sea-Project.kmz>

[15] Available online at http://www.google.com/earth/outreach/showcase.html#kml=South_China_Sea_Project

[16] Available online at http://google-latlong.blogspot.com/2008/02/south-china-sea-project.html

[17] This online updating tool can be accessed on the SCS project website at <http://gis.unepscs.org>.

coastal communities that rely on fisheries production linked to these habitats. The SCS project established and fostered mechanisms for national and regional coordination, particularly in support of the collation and sharing of information and data relating to status and trends in coastal habitats. An important output of this work included national reports on coastal habitats that were used to inform the development of habitat NAPs and the revised SAP for the South China Sea. This represents the first attempt to develop a regional programme of action with supporting national plans aimed at reversing the degradation and loss of habitats from this marine basin.

The large network of scientists and coastal managers established by the SCS project defined the distribution and diversity of coastal habitats. The results outlined in this paper indicate significant basin-wide and intra-country variation in the richness and extent of habitat building species. For example, the richness of true mangrove species along the extensive coastline of Viet Nam has been shown to be inversely related to increases in latitude. Similarly, the Gulf of Thailand coastlines of Viet Nam and Cambodia are less rich in mangrove species than Thai waters at similar latitudes. In terms of the areal extent of mangroves, the southern areas of the South China Sea, particularly Indonesia's Riau and West Kalimantan Provinces and Malaysia's Sarawak and Sabah regions, are more significant than areas of the northern waters of the basin.

Of the basin's estimated 930,000 ha of coral reef, hot spots of hard coral species diversity contain more than 300 coral species with a maximum recorded number of 351 species at a single site and 200 species have been recorded at multiple sites. These records of species richness at the locality level and updated regional analyses confirm that the southern portion of the South China Sea is part of the coral triangle although it is suggested that the northern boundary of this triangle should be extended to conform more closely to that proposed by Briggs (2005a,b). The SCS project also made important foundational level contributions to the science and management of seagrass by developing the first comprehensive seagrass data set for this marine basin. Approximately one third of the 60 seagrass species described worldwide were found to be constituents of the 78,300 ha of seagrass beds characterised by the project. The large 37,000 ha of inter-connected seagrass meadows identified in the transboundary waters of Cambodia and Viet Nam represents almost a half of the entire seagrass documented in the South China Sea and has global significance from both the perspectives of biodiversity conservation and fisheries production.

The dominant habitats of this marine basin often act as fisheries *refugia* or areas critical to the lifecycles of the many marine resources upon which residents of coastal communities depend. Despite this, the decadal rates of decline in total area of critical habitats such as seagrass, coral reefs and mangroves in the South China Sea are high and were estimated by the SCS project RWGs to be 30%, 16%, and 16% respectively. This degradation and loss of habitats is a result of a multitude of persistent and emerging threats that were evaluated by the SCS project and described above. Of particular note are the contemporary causes of the loss of mangrove that include: reclamation and infrastructure development; pollution from shrimp farming; conversion to industrial uses; and charcoal production. The physical removal of mangrove associated with the construction of ponds for shrimp culture is currently not the dominant threat that it had been during previous decades. Overfishing and the use of destructive fishing gears such as push nets and trawls were confirmed as the dominant threats to coral reefs and seagrass.

Information on the status and trends in coastal habitats was used as the basis for development of NAPs and regional targets for coastal habitat management contained in the revised SAP for the South China Sea. This science-based planning contributed to the refinement of targets and the prioritisation of options for coastal habitat management. The target for enrichment planting to increase mangrove biodiversity, for example, was included following lengthy consideration by the RWG-M of the results of largely single-species mangrove reforestation initiatives in the region over recent decades. It is concluded that such enhancements to past practices and improvements to the scientific elements of planning would not have been generated and effectively shared between the riparian countries without the regional coordination provided through the SCS project.

It is imperative that the agreed common vision on priority locations and approaches for future habitat management actions and the commitments to action contained in the NAPs and regional SAP be sustained. The national and local capacity built and the vast repositories of management information created by the SCS project provide a solid foundation for NAP and SAP implementation, future planning, and monitoring and evaluation of management interventions.

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