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Transboundary Diagnostic Analysis for the South China Sea

L. Talaue-McManus

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Transboundary Diagnostic Analysis for the South China Sea

Compiled by:

Liana Talaue-McManus
Marine Science Institute
University of the Philippines
Diliman, Quezon City,
Philippines

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PREFACE

Countries of the South China Sea do not exist in isolation nor are they able to retain the impacts of their activities within their national boundaries. The environment is not checked by national boundaries nor is it a limitless resource that can be exploited without restraint. It becomes obvious, as this report is read and understood that the countries bordering the South China Sea have exploited the coastal resources far beyond their capacities and that, without some intervention now, they will be destroyed forever. Marine biodiversity, carbon sequestration, nursery areas for fisheries, buffer zones from the ravages of storms are all being lost and the plunder continues. This report is an inventory of the cross-boundary pollution and destruction of marine habitats that covers the South China Sea.

The national transboundary diagnostic analysis reports of seven countries participating in the Global Environment Facility South China Sea Project were analysed and summarised to prepare this report. The countries concerned are Cambodia, China, Indonesia, Malaysia, Philippines, Thailand and Viet Nam. For only two of these, Viet Nam and Cambodia, are the entire coastlines used in the report. For the others, only the coast that borders the South China Sea is included. Ideally, the country reports from which this report was compiled were prepared under the same guidelines, for some countries this was not so easily done nor rigidly adhered to, the result being lack of data or inconsistent data. The national TDAs are available from UNEP EAS/RCU.

This report, contained the most up to date information available from the participating countries, including major environmental problems in the South China Sea, transboundary analysis and sources and causes of these problems. It is a useful document for preparing project proposals, reporting on the state of the environment and as a general guide to the use and misuse of the coastal waters of the South China Sea. Environmental planners, managers and academics may find this report useful for case studies and for data.

Hugh Kirkman
Coordinator, East Asian Seas Regional Coordinating Unit

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TRANSBOUNDARY DIAGNOSTIC ANALYSIS FOR THE SOUTH CHINA SEA

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1 BACKGROUND

1.1 Global and regional significance of the South China Sea and its associated freshwater catchments

The South China Sea is a strategic body of water that is surrounded by nations that are currently at the helm of industrialization and rapid economic growth in the Asia-Pacific region. Bordered by the People's Republic of China to the north, the Republic of the Philippines to the east; Malaysia, the Republic of Singapore, the Republic of Indonesia and the Sultanate of Brunei to the south; the Kingdom of Thailand, the Kingdom of Cambodia and the Socialist Republic of Viet Nam to the west; the South China Sea has always been central to issues of economic and political stability in Southeast Asia and adjacent regions. Today, it is central to defining environmental sustainability and food security for its coastal nations.

Seven littoral states are included in this analysis which is aimed at identifying and weighting water-related problems and concerns in the South China Sea. These are China, Viet Nam, Cambodia, Thailand, Malaysia, Indonesia and the Philippines. The coastal subregions of these nations are home to 270,000,000 people or 5% of the world's population. About 122 major rivers drain 2.5×10^6 km^2 of catchment area and deliver materials, nutrients and pollutants to the South China Sea (data compiled from National TDA Reports).

The Indo-West Pacific marine biogeographic province has long been recognized as the global center 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 seagrasses 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 45 mangrove and over 450 coral species recorded from the Philippines, 200 from the Red Sea, 117 from South East India and 57 from the Persian Gulf.

Recent estimates suggest that approximately 2 million hectares of mangrove forest or 12% of the world total are located in the countries bordering the South China Sea. This represents only 31% of the estimated total found in these countries at the start of this century (National TDA Reports). Estimated rates of loss in each country range from around 0.5 to 3.5% of the total area per annum and at these present rates could result in total loss of this habitat in the region by around 2030. Chou *et al.*, (1994) estimate that 82% of the coral reefs surveyed in the South China Sea display evidence of degradation while Bryant *et al.*, (1998) suggest that 50% of the Philippine and 85% of Indonesian reefs are at high risk. Comparable estimates for degradation of seagrass habitats are not available but are unlikely to be as high as this.

The high species diversity of the shallow water habitats in this region combined with the variation in geomorphic and geological settings, and formation types, contribute to the global significance of these habitats.

This richness in flora and fauna is accompanied by the area's high natural productivity. Capture fisheries from the South China Sea contribute 10% of the world's landed catch at approx. 5 X 10^6 tons $year^{-1}$ (Pauly and Christensen, 1993). From the standpoint of aquaculture, five of the eight top shrimp producers in the world, are border states of the South China Sea. These are Indonesia (first), Viet Nam (second), China (third), Thailand (sixth), and the Philippines (eighth) (Menasveta, 1997).

The richness and productivity of the South China Sea and associated environments are, however, seriously threatened by high population growth, pollution, overharvest and habitat modification, resulting in high rates of habitat loss and impairment of the regenerative capacities of living resources. The socio-economic impacts of environmental deterioration are significant for the newly developed economies of this region. While GDP is newly dominated by the industry and service sectors, food consumption patterns rely heavily on cheap protein derived from fishery resources. The agriculture sector (including fisheries) remains a source of significant revenue and an important domestic source of food.

1.2 Purpose of the Transboundary Diagnostic Analysis (TDA)

The transboundary diagnostic analysis of the South China Sea and its associated catchment areas, is a process that focuses on identifying water-related problems and concerns, their socio-economic root causes, and the sectoral implications of actions needed to mitigate them. The analysis further seeks to determine those issues which have transboundary, i.e. involves more than one country, causes and/or impacts, appropriate mitigation of which will have to be done on a regional or bilateral basis. The analysis then becomes the basis for a strategic action program which is coordinated both at the national and regional levels.

1.3 Process of the TDA

In this TDA, national committees were formed through the initiative of the UNEP national focal points in each of the seven countries. Headed by a coordinator, each national committee was asked to prepare a country report that would provide a country-based analysis of water-related problems and concerns. To brief the seven coordinators, a first meeting was held in March 1997, during which the outline of the country reports was prepared and accepted by the group.

The first drafts of the national reports were submitted and evaluated prior to a second meeting of the national coordinators that was held in June, 1998. During this meeting, and on the basis of the causal chain analysis done by each country for each identified water-related problem, a weighting of all identified major issues was made *en banc* by the national coordinators and invited scientists from the region. The weighted issues and problems are shown in Table 1.1.

Table 1.1 Preliminary ranking of major concerns and principal issues for the South China Sea (Annex V, Second Coordinators Meeting, June 1998)

Major Concerns	Score	Rank	Principal Issues	Score	Rank
Habitat	18.5	1	Mangroves	21	1
			Coral Reef	20	2
			Seagrasses	17	6
			Estuaries	16	7
Over exploitation	17.5	2	Marine	19	3
			Freshwater	16	7
Pollution	14	3	Sewage	19	3
			Freshwater Contamination	17.5	5
			Agricultural loading	15	9
			Industrial Waste	15	9
			Sedimentation	14	11
			Solid Waste	13	12
			Hydrocarbon	12	13
			Ship-based sources	12	13
			Atmospheric	8.5	16
Freshwater concerns	9	15			

The identified regional concerns and principal issues became the foci for the preparation of the outline for this regional transboundary diagnostic analysis, which like the outline for the national reports, was deliberated upon and accepted by the national coordinators and the regional resource persons. Along with the preparation of the TDA outline, the substance of the strategic action programme was discussed.

The national reports, the transboundary diagnostic analysis and the strategic action programme are key elements in a project development activity under the Global Environment Facility (GEF) International Waters Portfolio. A project brief was developed in this analytical and participatory process, that provided mechanisms for the implementation of actions addressing the major water-related issues in the South China Sea.

2 BIOPHYSICAL AND SOCIO-ECONOMIC SETTING OF THE SOUTH CHINA SEA AND ITS ASSOCIATED FRESHWATER CATCHMENTS

2.1 Physical setting

2.1.1 Geographic subdivisions used in the TDA

The countries and watersheds relevant to the South China Sea and this report are shown in Fig. 1. The detailed geographic subdivisions used in the TDA are shown in Table 2.1, and a summary of pertinent statistics are indicated in Table 2.2. The subdivisions include 93 cities, each with a population of more than 100,000. Approximately 122 rivers running through the seven participating countries, and draining a total catchment area of 2.5 million km^2, empty into the South China Sea. The area of watershed drained by the rivers is almost twice that of the total area of the subregions, since a number of rivers such as six which enter the Viet Namese coastal waters, are transboundary.

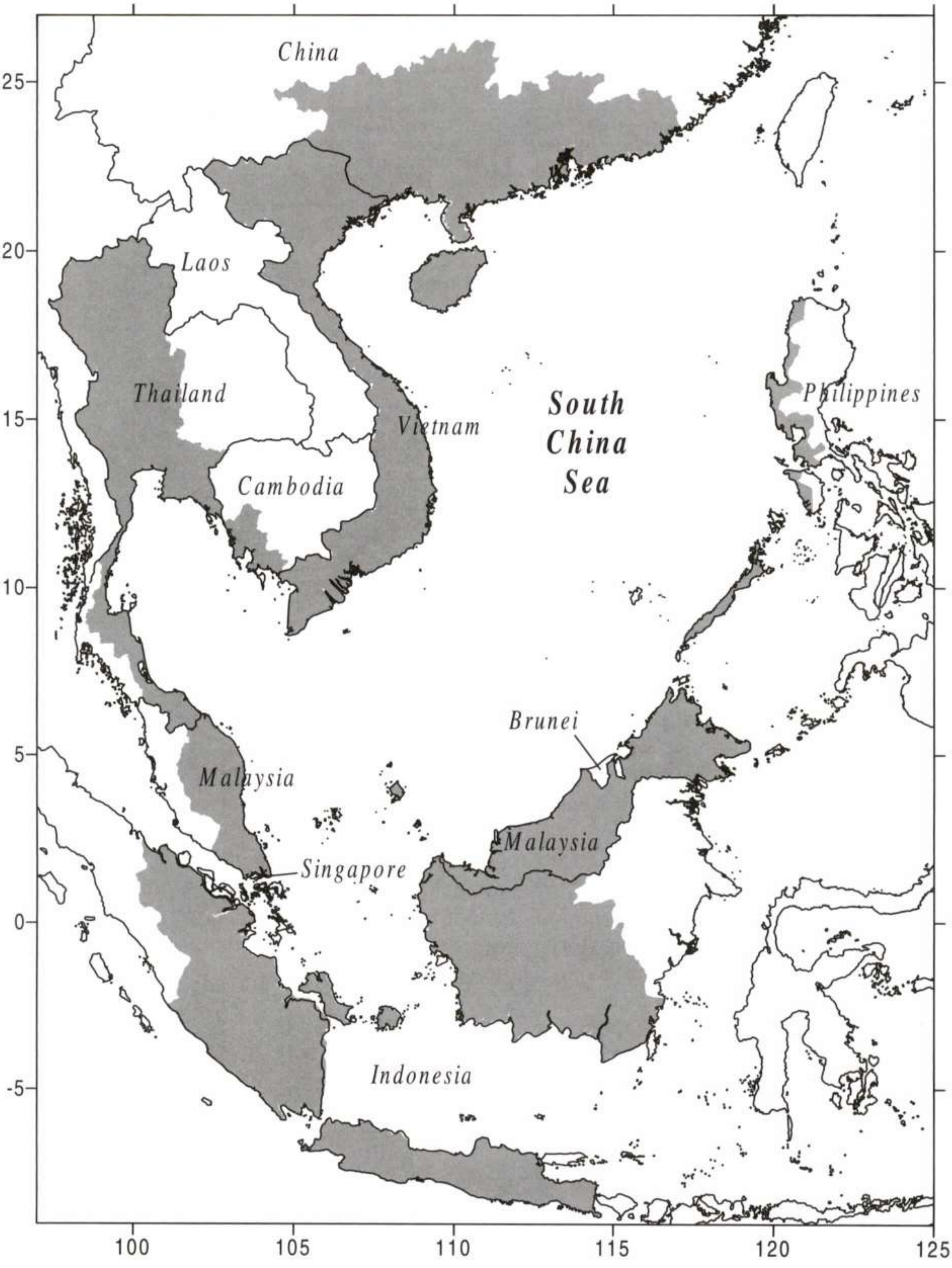

Figure 1. The countries of the South China Sea.
National boundaries and shoreline are shown by solid lines.
Shaded areas represent sub-divisions where data were analyzed in the TDA.

Table 2.1 Geographic subdivisions of the TDA-participating countries which interact with the South China Sea

Country/ Subregion	Major Cities	Major rivers	Watershed area (10^3 km^2)	Area of subregion (10^3 km^2)	Population of subregion (10^3)
Cambodia:					*1997*
Koh Kong	Koh Kong	Stung Metoek	1.14	11.16	105
		Stung Russei Chrum	2.73		
		Stung Sala Munthun	1.57		
		Stung Chhay Areng	2.11		
Sihanouk Ville	Sihanouk Ville	Prek Piphot	1.16	0.87	132
		Prek Kompong Som	2.64		
Kompot	Kompot	Prek Toeuk Chhou	2.06	5.21	603
Subtotal	**3 cities**	**7 rivers**	**13.41**	**17.24**	**840**
China:					*1995*
Guangdong	Chaozhou, Shantou, Jieyang, Shanwei, Huizhou, Shenzhen, Dongguan, Guangzhou, Zhongshan, Zhuhai, Jiangmen, Yangjiang, Maoming, Zhanjiang	Han	30.11	83.33	47,919
		Rong	4.41		
		Pearl	442.10		
		Moyang Jian	6.09 6.09		
Guangxi	Beihai, Qingzhou, Fangcheng Port	Nanliu	8.64	20.36	5,088
		Qing	2.46		
		Maoling	2.96		
Hainan	Haikou, Sanya	Nandu	7.02	33.92	5,733
		Changhua	5.15		
		Wanquanhe	3.69		
Hong Kong	Hong Kong	None	None	1.07	6,190
Macau	Macau	None	None	0.02	424
Subtotal	**21 cities**	**11 rivers**	**518.72**	**138.70**	**65,354**
Indonesia					*1994*
Riau-Batam	Tanjung Pinang	none	none	94.56	3,648
Bangka-Belitung and South Sumatera	Pangkal Pinang, Palembang	Musi	9.13	103.69	6,997
Jakarta and West Java	Jakarta	Ciliwung-Cisadne	2.24	46.89	47,547

Continued Table 2.1

Country/ Subregion	Major Cities	Major rivers	Watershed area (10^3 km^2)	Area of subregion (10^3 km^2)	Population of subregion (10^3)
East Java	Surabaya	Brantas	12.00	47.92	34,758
South Kalimantan	Banjarmasin	Barito River	32.00	37.66	2,804
West Kalimantan	Pontianak	Kapuas River	5.00	146.76	3,616
Subtotal	**7 cities**	**5 rivers**	**60.37**	**477.48**	**99,370**
Malaysia					***1991***
Kelantan	Kota Bharu	3 rivers	15.02	14.92	1,208
Terengganu	Kuala Terengganu	9 rivers	12.97	13.00	809
Pahang	Kuantan	5 rivers	42.24	35.97	1,081
Johor	Johor Baru	4 rivers	7.44	18.99	2,162
Sabah	Kota Kinabalu	11 rivers	31.31	73.62	1,809
Sarawak	Kuching	19 rivers	122.45	123.98	1,718
Subtotal	**6 cities**	**51 rivers**	**231.43**	**280.48**	**8,787**
Philippines					***1995***
Western Luzon	Laoag, Dagupan, Olongapo, Metropolitan Manila (7 cities) San Pablo, Cavite, Batangas	**Laoag**	**1.32**	29.27	22,653
		Abra	**5.12**		
		Agno	**5.95**		
		Pampanga	**9.76**		
		Pasig-Marikina-Laguna de Bay	**5.28**		
Mindoro Occidental		none	none	5.88	339
Palawan	Puerto Princesa	none	none	14.90	640
Subtotal	**16 cities**	**5 rivers**	**27.43**	**50.05**	**23,632**
Thailand					***1997***
Northern	Chiang Mai, Nakorn Sawan	Salawin	17.9	171.50	12,091
		Ping	33.90		
		Kok	7.89		
		Wang	10.79		
		Yom	23.62		
		Nan	34.33		
		Khong	57.42		
Central	Bangkok, Nonthaburi, Patumthani, Samut Prakan, Samut Sakorn, Saraburi	Chao Phraya	20.12	64.04	14,350
		Sakakrang	5.19		
		Pasak	16.29		
		Ta Chine	13.68		
Eastern	Chonburi, Rayong	Prachine buri	10.48	36.50	4,065
		Tonlasap	4.15		
		Eastern coastal	13.83		

Continued Table 2.1

Country/ Subregion	Major Cities	Major rivers	Watershed area (10^3 km^2)	Area of subregion (10^3 km^2)	Population of subregion (10^3)
Southern	Surathani, Nakorn Sri-Thammarat, Songkhla, Hatyai	Eastern coastal of South	26.35	49.89	6,636
		Tapee	12.22		
		Songkhla Reservoir	8.49		
		Pattanee	3.86		
Subtotal	**14 cities**	**18 rivers**	**320.51**	**321.93**	**37,142**
Viet Nam					***1996***
Northern Mountains	Quang Ninh	Bang Giang	4.56	5.94	813
		Kycung	6.66		
Red River Delta and Midlands	Hai Phong Thai Binh Nam Ha Ninh Binh	Thao	51.75	6.81	6,354
		Da	52.61		
		Lo	38.97		
		Red	154.72		
		Cau	6.06		
		Thuong	3.58		
		Luc Nam	3.07		
		Thai Binh	15.52		
Central Coastal Region	Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien Hue, Quang Nam-Da Nang, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, Binh Thuan	Ma	28.37	51.22	8,500
		Chu	7.55		
		Ngan Sau	3.81		
		Hieu	5.33		
		Ca	27.22		
		Tra Khuc	3.18		
		Ve	1.26		
		Ba	13.81		
South Central	Ho Chi Minh, Ba ria-Vung Tau	Dong Nai	29.52	49.82	11,314
		La Nga	4.00		
		Be	8.20		
		Sai Gon	5.56		
Mekong Delta	Tien Giang, Ben Tre, Tra Vinh, Soc Trang, Kien Giang, Minh Hai	Se San	17.5	24.16	6,076
		Sre Pock	18.28		
		Cuu Long (Mekong)	65.00 (777.00)		
Subtotal	**26 cities**	**25 rivers**	**576.09 (1353.09)**	**137.95**	**33,057**

Table 2.2 Geographic subdivisions of the TDA-participating countries which interact with the South China Sea. (Summary)

Country	Major Cities (>100,000 population)	Major rivers	Watershed area (10^3 km^2)	Area of South China Sea subregion (10^3 km^2)	Population of subregion (10^3)
Cambodia	3 cities	7 rivers	13.41	17.24	840
China (includes Hong Kong & Macau)	21 cities	11 rivers	518.72	137.70	65,354
Indonesia	7 cities	5 rivers	60.37	477.48	99,370
Malaysia	6 cities	51 rivers	231.43	280.48	8,787
Philippines	16 cities	5 rivers	27.43	50.05	23,632
Thailand	14 cities	18 rivers	320.51	321.93	37,142
Viet Nam	26 cities	25 rivers	1,353.09	137.95	33,057
Total	**93 cities**	**122 rivers**	**2,524.96**	**1,422.83**	**268,182**

2.1.2 Geomorphology and geological history

The Indian subcontinent collided with the Eurasian plate in the Late Eocene, and led to the rifting of the Sunda Shelf including Borneo, the Malaysian Peninsula and Palawan microplate. The rift is hypothesized to be the origin of the northwest sub-basin of the South China Sea (Brias *et al.,* 1993; Taponnier *et al.*, 1982). North-south spreading occurred 27 to 16 Ma causing the formation of the eastern sub-basin of this marginal sea. The southwest sub-basin was formed 20 Ma, and spreading ceased around 15.5 Ma.

2.1.3 Circulation

Two basic features characterize circulation in the South China Sea. The first is the Indonesian throughflow of Pacific waters which interact with those influenced by the Indian Ocean while in the South China Sea. It is, in fact, a warmwater closure of global thermohaline circulation that is significant in distributing sea surface temperature as well as in providing for the air-sea fluxes of heat (Tomascik *et al.*, 1997).

A second feature is a surface circulation that is heavily influenced by the Asian monsoon system, which affects the social and economic conditions of over 60% of the world's population (South China Sea Monsoon Experiment (South China SeaMEX) Science Plan, 1994). Surface currents flow north to south along the Viet Nam coast to the Java Sea during the northeast winds which blow from October to February (Wrytki, 1961). The flow reverses south to north along the western margin of the South China Sea during the southwest monsoon beginning in June.

The monsoonal system results from the location of the sea next to the land masses of Asia and Australia (Tomascik *et al.*, 1997). Two opposing monsoons converge along the Inter-tropical convergence zone (ITCZ). This zone is displaced north or south depending on solar heating, driving the seasonal change from one monsoon to another. In December to January, there is high pressure over Asia and low pressure over Australia, pushing the ITCZ further south, and causing air to blow north to south.

In June, pressure over Australia increases, and decreases over Asia, causing the ITCZ to shift north of the equator; and signaling the onset of the southwest monsoon.

A transition period occurs in March when the ITCZ is on the equator on its way northward, and when the Asian high weakens. Another slack period occurs in September with the weakening of the Australian high, and the movement of the ITCZ on the equator southwards.

The monsoonal system in the South China Sea modulates seasonal changes in pressure and interannual variability imposed by the El Niño – Southern Oscillation. The arrival of Rossby waves carrying a warm water pool to the western margin of the equatorial Pacific is buffered by the South China Sea system. The consequences of extreme climatic changes resulting from this connection are dramatic for the resources and economies of the South China Sea states.

2.2 Biogeography

2.2.1 Biogeographic distributions

Mangroves. Mangroves occupy the humid tropical belt 30° north and south of the equator, with extensions beyond these latitudes in certain areas (Spalding *et al.*, 1997). Two main centers of diversity have been identified. The eastern group includes the Indo-Pacific with its eastern limits in the central Pacific, and the western limits, along the southern tip of Africa. The western group includes mangroves found along the African and American coasts of the Atlantic Ocean, the Caribbean Sea and Gulf of Mexico, and the Pacific coastal areas of the Americas. The eastern group has about five times the species diversity recorded in the western region. Within this group, South and Southeast Asia contain 42 % of the global area occupied by mangroves, and harbor the highest diversity of mangrove species in the world.

Corals. Hermatypic or reef-forming scleractinian corals are widespread in the equatorial seas. Generic richness is highest (about 70 genera) in the Indo-Pacific center of diversity, which extends from the central Red Sea to east of Fiji (Veron, 1995). Species diversity is highest at around 450 species in the equatorial central Indo-Pacific defined by Sumatra and Java in the southwest; by Sabah and the Philippines in the northwest; and by the Philippines, eastern Indonesia and Papua New Guinea in the northeast. One-fourth of the world's charted reefs are located in this region of highest species coral diversity. Eighty percent of the reefs of Southeast Asia are exposed to medium and high risks imposed by coastal development, marine pollution, over-exploitation and destructive fishing, and land-based pollution and erosion (Bryant *et al.*, 1998).

Seagrasses. Generic richness of seagrasses is also centered in the Indo-West Pacific region (Heck and McCoy, 1978). Species diversity is highest in Malesia, a region defined by Indonesia, Borneo, Papua New Guinea and northern Australia. East Asia harbors the second highest number of seagrass species at 20 of 50 recorded species worldwide (Fortes, 1994, 1995; Sudara *et al.*, 1994).

2.2.2 Evolutionary relationships

The biogeographic distributions of flora and fauna are consequences of evolutionary and ecological processes in geological history. Two types of geological events brought this about in the South China Sea region. The breaking off of microcontinents from eastern Gondwana which now form South East Asia and the northern portion of New Guinea, is believed to be a significant mechanism in transporting tropical fauna as these plates moved north and westward (Tomascik *et al.*, 1997).

The second event was the formation of land connections and sea barriers, both of which act to impede larval dispersal, thus fragmenting species ranges and enhancing genetic isolation. A land barrier was created during the Cretaceous, connecting Laurasia to Australia. Another such barrier was formed with the collision between Sulawesi and Sula Peninsuls during the mid-Miocene, and created a continuous land mass between Laurasian Borneo and Gondwana New Guinea (12 MA to late Pliocene).

Geologically, two major theories are proposed to explain biogeographic affinities. Vicariance theory (McCoy and Heck, 1976) states that biota may have a historically wide range, which is modified by tectonic events, speciation and extinction. They used this theory in discussing relationships among seagrass, coral and mangrove species. Another theory called the Center of Origin theory, indicates that organisms increase their ranges by dispersal from a central point (Den Hartog, 1970).

For Veron (1995), the two are not mutually exclusive and both can be used in explaining coral affinities. He states that at the species level, the central Indo-Pacific is the center of diversity. Along a latitudinal gradient, there are sequences showing gradients from very high to very low species diversity, connected by boundary currents which flow poleward, taking equatorial propagules to high latitudes. The export of diversity from the equator can happen along evolutionary or ecological time frames. The evolutionary time frame seems to have an increasing influence eastward across the Pacific.

For mangroves, Spalding *et al.*, (1997) state that distributions are largely relic and state that an eastern Tethys Sea origin seems to be suggested by fossils. Dispersal proceeded across the Pacific, and perhaps through the Panama gap into the Atlantic.

2.3 Socio-economic features

2.3.1 Demographic patterns

Table 2.3 Demographic and economic parameters by subdivisions in TDA participating countries

Country/ Sub-region	Area (10^3 km^2)	Population (10^3)	Annual population growth rate (%)	GDP (growth rate/y) (10^6 USD)	%GDP-Agriculture (growth rate/y) (10^6 USD)	%GDP-Industry (growth rate/y) (10^6 USD)
Cambodia (1996-1997)						
Koh Kong	11.16	105	8.33			
Sihanouk Ville	0.87	132	3.89			
Kampot	5.21	603	5.47			
Subtotal	17.24	840	5.58	0.12 (7%) (national)	45 (1.5) (national)	20 (14.1) (national)
China (1996)						
Guangdong	83.33	48,563	1.64	70,349	12.5 (8.1)	40 (nd)
Guangxi	20.36	5,148	1.29	2,989	40 (8.3)	20 (nd)
Hainan	33.92	5,983	1.55	4,177	34 (8.9)	21 (nd)
Subtotal	137.61	59,694	1.60	77,515	16	41
Indonesia (1995-1996)						
Riau & Batam	94.56	3,647	3.70	8,519	Nd	Nd
Bangka-Belitung & South Sumatra	103.69	6,997	3.02	5,827	Nd	Nd
Jakarta & West Java	94.81	47,547	2.89	59,272	Nd	Nd
S. Kalimantan	37.66	2,804	2.33	2,456	Nd	Nd
W. Kalimantan	146.76	3,617	2.50	2,856	Nd	Nd
Subtotal	477.48	99,370	2.90	78,930	13 (nd) (national)	38 (nd) (national)
Malaysia (1996)						
Kelantan	14.92	1,208	2.7	Nd	Nd	Nd
Terengganu	13.00	808	3.7	Nd	Nd	Nd
Pahang	35.97	1,081	2.8	Nd	Nd	Nd
Johor	18.99	2,162	2.5	Nd	Nd	Nd
Sabah	73.62	1,809	5.5	Nd	Nd	Nd
Sarawak	123.98	1,718	2.5	Nd	Nd	Nd
Subtotal	280.47	8,787	3.3	86,420 (national)	Nd	Nd

Continued Table 2.3

Country/ Sub-region	Area (10^3 km^2)	Population (10^3)	Annual population growth rate (%)	GDP (growth rate/y) (10^6 USD)	%GDP-Agriculture (growth rate/y) (10^6 USD)	%GDP-Industry (growth rate/y) (10^6 USD)
Philippines (1996)						
West Luzon	29.27	22,653	2.1	Nd	Nd	Nd
Mindoro Is.	5.88	340	3.5	Nd	Nd	Nd
Palawan Is	14.90	640	3.7	Nd	Nd	Nd
Subtotal	50.05	23,633	2.1	87,864 (national)	21 (nd) (national)	32 (nd) (national)
Thailand (1997)						
North	171.50	12,091	0.9	3,609	50 (nd)	33 (nd)
Central	64.04	14,350	1.4	62,532	4 (nd)	35 (nd)
East	36.50	4,065	1.8	10,248	12 (nd)	56 (nd)
South	49.89	6,636	1.8	7,455	36 (nd)	8 (nd)
Subtotal	321.93	37,142	1.4	83,844	10 (nd)	35 (nd)
Viet Nam						
Northern Mountains	5.94	813	Nd	Nd	Nd	Nd
Red River Delta and Midlands	6.81	6,354	Nd	Nd	Nd	Nd
Central Coastal	51.22	8,500	Nd	Nd	Nd	Nd
Eastern	49.82	11,314	Nd	Nd	Nd	Nd
Southern	24.16	6,076	Nd	Nd	Nd	Nd
Subtotal	137.95	32,558	1.6 (national)	97,000 (national)	Nd	Nd

A total of 270,000,000 people live in the coastal sub-regions of seven countries involved in the TDA process, and are concentrated in 93 cities, each with over 100,000 inhabitants (Tables 2.3 and 2.4). The weighted mean growth rate in the coastal South China Sea is 2.17%, which would double the population in 32 years. In Cambodia, Indonesia and Malaysia, growth rates in the South China Sea subregions are 1.5 to 2.0 times the national growth rates.

The population distribution largely determines the delivery of basic services and the quality of access to these. Population densities are highest for the coastal subregions of China and the Philippines at 471 and 472 pers km^{-2}, resp. Malaysia and Cambodia are least dense at 31 and 49 pers km^{-2}. Hinrichsen (1998) notes that in Viet Nam, people live at even higher densities of 500-1,000 pers km^{-2} along the northern part of the Gulf of Tonkin. In some parts of Hanoi, densities can reach 35,000 pers km^{-2}. He cites tourism, increasing fisheries efforts and oil exploitation as among the major economic driving forces behind this dramatic increase in coastal populations.

2.3.2 Regional economic characteristics

Table 2.4 Summary of demographic and economic parameters (All data are for South China Sea related subregions)

Country/ Sub-region	Area (10^3 km^2)	Population (10^3)	South China Sea Annual population growth rate (%) (national rate)	Total GDP (growth rate/y) (10^6 USD)	%GDP-Agriculture (growth rate/y) (10^6 USD)	%GDP-Industry (growth rate/y (10^6 USD)
Cambodia (1996-1997)	17.24	840	5.58 (2.7)	0.12 (7%) (national)	45 (1.5)	20 (14.1)
China (1996)	137.61	59,694	1.60 (1.6)	77,515	16	41
Indonesia (1995-1996)	477.48	99,370	2.90 (1.5)	78,930	13 (nd) (national)	38 (nd) (national)
Malaysia (1996)	280.47	8,787	3.29 (2.0)	86,420 (national)	Nd	Nd
Philippines (1996)	50.05	23,633	2.13 (2.2)	87,864 (national)	21 (nd) (national)	32 (nd) (national)
Thailand (1997)	321.93	37,142	1.35 (1.0)	83,844	10 (nd)	35 (nd)
Viet Nam (1996)	137.95	32,558	1.60 (national)	97,000 (national)	Nd	Nd
South China Sea Total	1,422.73	262,024	2.17			

TDA participating countries are at various stages of industrialization (Table 2.4). Cambodia, with a national GDP of USD 0.12 million earns 45% of this from agriculture, and 20% from industry. In contrast, Indonesia relies on the industry sector for 57% of its GDP. In terms of increasing reliance on industry for the generation of GDP, the countries may be ranked as follows: Indonesia > China >Thailand > Philippines > Cambodia.

Table 2.5 Current and projected fish consumption (national data cited by Silvestre and Pauly, 1997; 1998 World Almanac)

Country	Population 1996 (10^6)	Per capita GNP (USD, 1995)	Finite growth Rate (%)	Population 2005 (10^6)	Current Fish consum ption (kg/p/y)	Total fish produced, 1994 (10^3 t/y)	Total fish required for food in 2005 at current per capita consumption (10^3 t/y)
Cambodia	10.2	215	2.7	13.0	12.0	103	156
Indonesia	197.6	940	1.5	225.9	15.5	4,060	3,502
Malaysia	20.6	3,930	2.0	24.6	29.5	1,173	726
Philippines	69.3	1,130	2.2	84.3	36.1	2,657	3,043
Thailand	61.4	2,680	1.0	67.2	25.3	3,432	1,699
Viet Nam	76.3	250	1.6	88.0	13.4	1,155	1,179

Using national data from 1995, the countries can be ranked based on per capita GNP as follows: Malaysia > Thailand > Philippines > Indonesia > Viet Nam > Cambodia (Table 2.5). For China, per capita GDP in 1994 was USD 2,500, which puts it between Thailand and the Philippines. Fish consumption is highest in the Philippines, and least in Cambodia. If one considers a minimum nutritional requirement of 21.5 kg/person/year, i.e. 50% of animal protein to be supplied by fish, Cambodia, Viet Nam, and Indonesia will need to increase per capita access to fish supply. To maintain the current pattern of consumption, total fish requirements in 2005 are shown in the last column of Table 2.5. Cambodia, the Philippines and Viet Nam will have to produce more fish just to meet domestic demands.

Table 2.6 Share of selected South China Sea countries in world exports of fishery products, in USD 1,000 (Ferdouse, 1994)

Country	1988	1989	1990	1991	1992
Indonesia	664,483	767,422	983,571	1,192,082	1,178,552
Malaysia	191,242	210,140	229,514	264,938	302,576
Philippines	407,504	409,879	395,960	467,729	393,997
Thailand	1,630,891	1,959,428	2,264,937	2,901,366	3,071,780
Brunei	300	350	380	440	400
Singapore	356,193	359,071	414,810	499,950	494,128
Total for 6 South China Sea countries	**3,250,613**	**3,706,290**	**4,289,172**	**5,326,505**	**5,441,433**
Global total	**31,804,116**	**35,886,233**	**39,539,969**	**43,546,408**	**45,451,914**
% of Global total	**10**	**10**	**11**	**12**	**12**

Table 2.7 Share of selected South China Sea countries in world imports of fishery products, in USD 1,000 (data from Ferdouse, 1994)

Country	1988	1989	1990	1991	1992
Indonesia	19,376	30,850	42,777	47,395	56,145
Malaysia	143,508	164,552	145,831	170,478	244,789
Philippines	63,063	65,730	84,809	96,109	111,000
Thailand	537,918	726,846	794,423	1,049,962	942,092
Brunei	7,404	7,180	7,160	6,780	7,000
Singapore	370,311	366,126	361,582	460,545	543,769
Total for 6 South China Sea countries	**1,141,580**	**1,361,284**	**1,436,582**	**1,831,269**	**1,904,795**
Global total	**35,269,622**	**35,886,233**	**39,539,969**	**43,546,408**	**45,451,914**
% of Global total	**3**	**4**	**4**	**4**	**4**

Despite nutritional requirements and current population growth rates, South China Sea countries in general are net exporters of fishery products. Because the need to generate foreign exchange to buy other capital inputs for industrialization is a higher priority than food security, this trade pattern will most likely continue, unless policy shifts occur to make food security of utmost importance in the national agendas of participating countries.

3 STATE OF ENVIRONMENT

3.1 Modification of habitats

3.1.1 Mangroves

Status and immediate causes of mangrove destruction. Mangroves in the seven participating countries constitute 10% of the current global area of slightly over 18 million ha (Fig. 2) (Table 3.1). The total area lost over different time spans (70 years for the Philippines) is estimated to be 4.2 million ha or 23% of the current global mangrove area. The causes of mangrove destruction include conversion to pond culture, tree felling for woodchip and pulp production, urban development and human settlements, and harvest of products for domestic use. The national impact of each economic activity is difficult to quantify for each country. Nonetheless, shrimp culture would seem to be the most pervasive economic imperative for mangrove conversion. A more thorough analysis must take into account the rate of loss brought about by each cause.

In a recent centre-page spread in the Jakarta Post the world's largest shrimp farm of 80,000 ha was described. It was claimed from mangrove at Bumi Dipasena. Integrated into the farm was a shrimp feed will producing 220 tonnes/year a hatchery producing 8 billion fry/year on a 220 ha site. Production of shrimp was estimated at 50,000 tonnes/year and 200 tonnes/day could be stored in a cold storage facility. There was a 160 megawatt power plant, waste water treatment plant, a port and housing estate for 110,000 people. The canals totalled 2,500 km.

Table 3.1 Loss and causes of mangrove destruction

Country	Original estimated cover (x 1000 ha)	Present area (x 1000 ha)	% Area lost	Causes of mangrove destruction			
				Shrimp culture	Woodchip, pulp, charcoal	Urban development/ Human settlements	Domestic use
Cambodia	170	85	50	✓			✓
China	42	15	65	✓		✓	
Indonesia	N/A	936	N/A	✓	✓	✓	
Malaysia	505	446	12	✓	✓	✓	
Philippines	400	160	60	✓		✓	✓
Thailand[1]	280	160	57	✓			
Viet Nam	400	253	37	✓			✓
TOTAL		**1,852**					
GLOBAL TOTAL		**18,108**					

Sources: Spalding *et al.*, 1997; *ISME* 1993; [1]MOSTE & The World Bank, 1999.

It should be noted that estimates of both original and present mangrove area vary greatly in the literature. Estimates used in this study are considered by the author to be the most reliable.

Transboundary issues. The major transboundary issues include losses in biodiversity and fisheries productivity, and the trading of cultured shrimps as well as woodchips and pulp. The quality of information to support the transboundary nature of these issues are assessed in the light of data provided by the national reports of the seven participating countries, and those accessed in the preparation of this analyses. The shrimp trade is well documented, while the loss of fisheries productivity is a major research gap. Trade of mangrove charcoal from Cambodia to Thailand is a major cause of mangrove loss in Cambodia (pers.comm. Phoeun Phean, Ministry of Agriculture and Fisheries, Cambodia).

Table 3.2 Transboundary issues resulting from mangrove destruction

Transboundary Issues	Countries Involved	Quality of information: G-good; F-fair; P-poor
Loss of biodiversity	All seven participating countries	F
Loss of fisheries productivity	"	P
Shrimp trade	All seven except Cambodia	G
Woodchip and charcoal	Indonesia, Malaysia, Cambodia	F

Loss of biodiversity. The incomplete inventory of flora and fauna associated with mangrove areas in the South China Sea region in the seven participating countries indicates the high biodiversity (Table 3.3). The rich species diversity is reflected in the high number of mangrove trees, finfish and penaeid shrimps, among others, that are associated with mangrove swamps. Because of the severe pressure exerted on mangroves, a number of associated species are among those classified as endangered (Table 3.4). These include the proboscis monkey, *Nasalia larvatus*, which eat young shoots and growing tips of *Sonneratia* and *Avicennia* trees, the crocodile *Crocodilus porosus* and swamp birds like *Ardea* and *Egretta* (Low et al., 1994).

Table 3.3 Biodiversity associated with mangroves

Country	Number of mangrove tree species[1]	Number of fish species[2]	Number of commercially exploited penaeid species[3]	Number of reptile species[4]	Number of bird species[4]	Number of mammal species[4]
Cambodia	42[5]				174[6]	
China	23					
Indonesia	45	138	42	7		43
Malaysia	36	99	28	7	60	19
Philippines	30	81	11	9	70	4
Thailand	35	67	20			
Viet Nam	28					

Sources: 1. Spalding *et al.*, 1993; 2. Singh *et al.*, 1994; 3. Chong *et al.*, 1994; 4. Low *et al.*, 1994; 5. Pers. Comm. Kim Nong, IDRC, Cambodia; 6. Preah Sihanouk National Park Bird List.

Table 3.4 Endangered species occurring in mangroves in Southeast Asia (Low *et al.*, 1994)

Species	Threat
Birds:	For all species:
➢ Purple heron *Ardea purpurea*	
➢ Dusky-grey heron *Ardea sumatrana*	Loss of habitat, hunting for feathers,
➢ Black-crown night heron *Nycticotrax nycticorax*	reduction of food supply due to overharvesting of bird food sources by man
➢ Black bittern *Dupetor flavicollis*	
➢ Great egret *Egretta alba*	
➢ Common bittern *Ixobrychus involucris*	
➢ Lesser adjutant stork *Leptoptilus javanicus*	
➢ Milky stork *Mycteria cinerea*	
➢ Common cormorant *Phalacrocorax carbo*	
Amphibians:	
Crab-eating frog *Rana cancrivora*	Loss of habitat
Reptiles:	
Saltwater crocodile *Crocodylus porosus*	Loss of habitat, hunting for skins
Mammals:	
➢ Long-tailed macaque *Macaca fascicularis*	➢ Hunting
➢ Malaysian flying fox *Pteropus vampyrus*	➢ Hunting
➢ Proboscis monkey *Nasalis larvatus*	➢ Loss of habitat
➢ Sumatran tiger *Panthera tigris sumatrae*	➢ Killed for skin and bones
➢ Leaf monkey *Presbytis cristata*	➢ Loss of habitat
➢ Javan rhinoceros *Rhinoceros sondaicus*	➢ Loss of habitat, hunting

Loss of fisheries productivity. Mangroves act as nursery and feeding grounds for finfish and shellfish at some stage or throughout their life cycles. Singh *et al.*, (1994) obtained studies that show high correlation between catch in coastal fisheries and the area of adjacent mangroves in study sites such as Indonesia, Malaysia, Philippines, Australia and the US. Although correlation does not imply causation, ecological studies have established the connections between mangroves, coral reefs and seagrass as far as supporting the life cycles of coastal organisms (Robertson and Duke, 1987; Twilley, 1989). Based on the precautionary principle, it is not necessary to unequivocally prove that mangrove destruction will cause a decline in the productivity of dependent biota, and consequently a decrease in their yields. Until proven otherwise, then, mangroves must be conserved if only for their probable positive relation to coastal fisheries.

The loss of renewable living resources resource is difficult to evaluate and value. For the Philippines, the loss of mangroves and the consequent losses of their functions in fisheries and other ecological services have been estimated to be US\$242 Myr^{-1}.

Shrimp trade. Six of the seven participating countries accounted for 61% of shrimp exports to Japan in 1994, 74% of those entering Hong Kong, and 42% of those imported by Taiwan of China (Ferdouse, 1996) (Table 3.6). Other markets for shrimps include the USA and EU, and the emerging markets in Asia like Singapore and South Korea.

The dominance of South China Sea countries in global shrimp production and trade, underscores the richness of their resource base in supporting a highly valued fishery product (Table 3.5). It also highlights the economic imperative behind the desire of producing countries to keep the supply flowing, often without regard for the environmental impacts increased production would bring. International financing institutions like the Asian Development Bank have provided credit assistance to ASEAN countries in their bid to meet the high and lucrative demand for shrimps (Primavera, 1994; Menasveta, 1997). At the consumers' end, the desire for more prawns should not be regarded as a mere function of their high disposable incomes, but also and more critically, of the environmental sustainability of producing the fishery product they demand.

The increase in shrimp production, with the exception of the Philippines, in the last ten years can be seen in Table 3.5. However over the last four years the largest producer, Thailand, has reduced its production of shrimp and this trend may be continuing.

Table 3.5 Production of cultured shrimp (*Penaeus monodon*, Giant tiger prawn)

Country	1988 mt	1989 mt	1990 mt	1991 mt	1992 mt	1993 mt	1994 mt	1995 mt	1996 mt	1997 mt
Indonesia	44,450	63,676	67,355	96,811	98,358	87,285	83,193	89,344	96,237	99,680
Malaysia	1,105	1,965	2,184	2,895	2,821	3,937	5,789	6,713	7,412	9,380
Philippines	41,458	43,539	47,591	45,740	75,996	86,096	90,426	88,850	76,220	40,102
Thailand	40,774	81,492	107,970	155,069	179,358	219,900	259,724	257,062	220,372	211,100
Viet Nam	20,590F*	21,020F*	23,250F*	26,700F*	28,350F*	31,500F*	33,750F*	39,000F*	48,750F*	60,000F*
Total	**148,377**	**211,692**	**248,350**	**327,215**	**384,883**	**428,718**	**472,882**	**480,969**	**448,991**	**420,262**

Source: FOA Report on Fisheries Statistics P74 B-45.
**. Estimates of FAO.*

Table 3.6 Importation by major Asian markets of shrimp from participating countries, 1994 (data from Ferdouse, 1996)

Country	Import of shrimp by major Asian Markets (mt), 1994		
	Japan	Hong Kong	Taiwan of China
Indonesia	63,666	4,202	21
Thailand	49,345	6,470	10,574
Viet Nam	32,979	6,715	
China	20,417	6,531	
Philippines	16,916	37	
Malaysia	2,279	690	
Subtotal for 6 counties (% Overall Shrimp Import by Recipient Country)	**185,602 (61%)**	**24,645 (74%)**	**10,595 (42%)**
Overall shrimp import	**302,975**	**33,191**	**25,104**

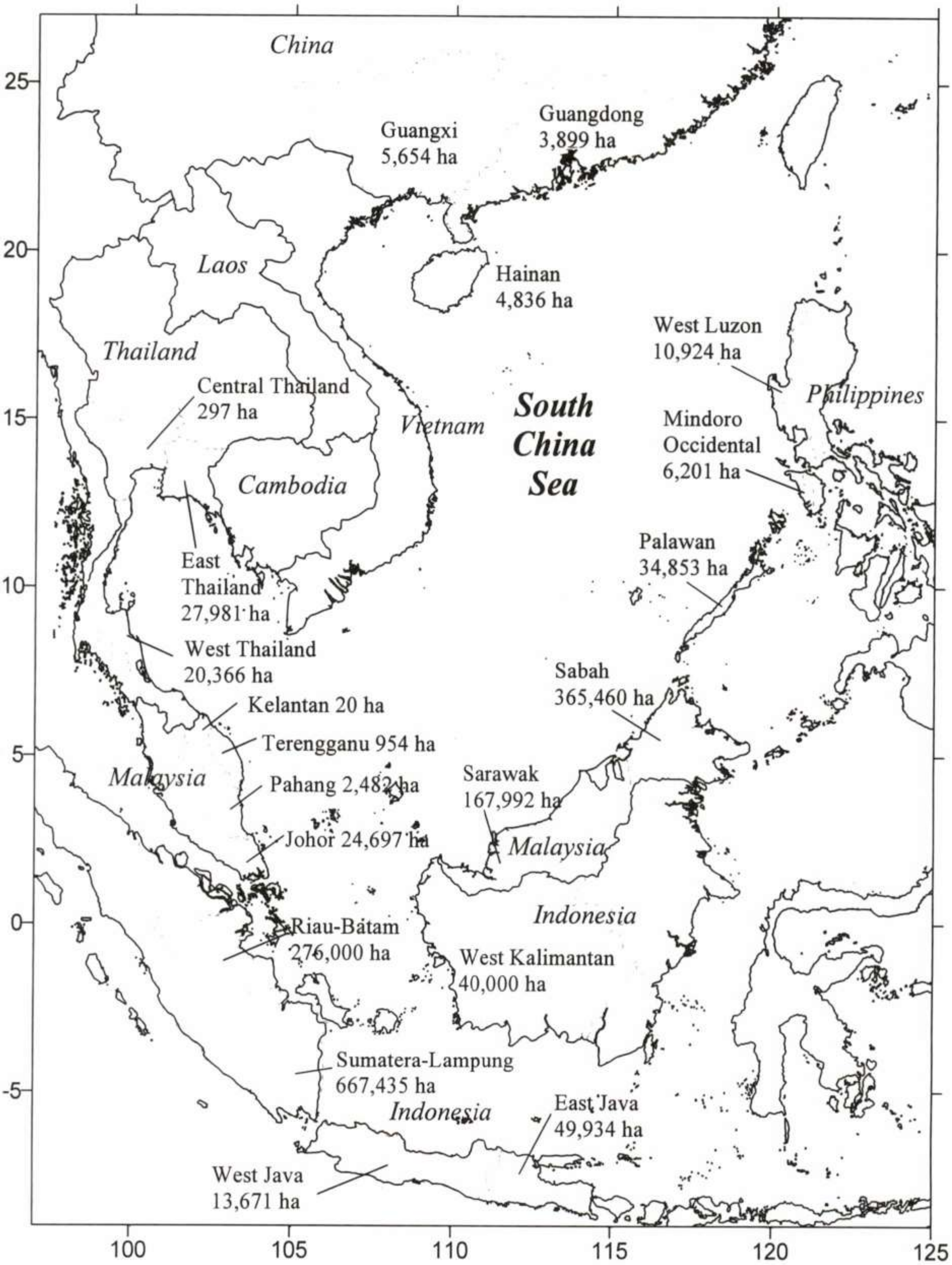

Figure 2. Mangroves in each sub-division of the South China Sea.

Shrimp culture systems. Of the three culture systems used in shrimp production, extensive culture requires the largest space, is the major culprit in mangrove conversion, and is the least productive (Menasveta and Fast, 1998). However, the extent of environmental impacts by each culture system should be assessed in terms of clearance rates, area requirements, and in terms of adverse consequences such as the extent of water quality degradation, and pressure on water resources, among others.

Extensive farming dominates and is practiced in close to 70% of global pond area. Its low capital requirements and high dependence on tidal regimes for water and natural food inputs, requires extensive mangrove areas. To increase per unit area production, the semi-intensive technique was developed, basically augmenting natural food with supplementary feeds, and the tidal flushing with a pumping system (Primavera, 1993). The intensive culture system relies heavily on artificial feeds, pumps and aerators, and may not necessarily be sited in mangroves (Menasveta, 1997).

Using productivity and environmental impacts as criteria, Primavera, (1994) states that the sustainability of successful shrimp aquaculture will require the use of semi-intensive culture systems refined by environmentally sound practices, including the appropriate management of feeds and wastewater.

Table 3.7 World shrimp culture areas and annual production by culture system, 1992-1993 (Menasveta and Fast, 1998)

Culture System	Pond Areas		Annual Shrimp Production	
	Area (ha)	% of Total	Production (mt)	% of Total
Extensive	726,900	67	159,900	22
Semi-intensive	304,000	28	304,000	42
Intensive	52,000	5	258,800	36

Shrimp culture and the introduction of exotic species. Another transboundary issue is the introduction of pathogens with the trade of brood stocks and larvae for shrimp hatcheries and grow-out ponds worldwide (Primavera, 1993). Furthermore, introduction of exotic penaeid species which promise higher growth rates and thus, higher economic returns has also occurred. In the Philippines, *Penaeus vannamei* and *P. stylirostris* from Panama were introduced to ponds in the central islands in the 1970s. *P. chinensis* from China and a stock of *P. vannamei* from Hawaii were brought in in the '80s and '90s, respectively. (Primavera, 1993). While the environmental impacts of such introduction have yet to be documented, the spread of disease and parasitic infestation that is exacerbated by poor pond management, may be symptomatic of the effect of importing foreign stocks.

Shrimp culture and trade of chemically contaminated products. The wide use of chemical products in shrimp culture, and residuals that have chemical lives long enough to threaten public health, is another associated transboundary issue. Srisomboon and Poomchatra, (1995) warn of the contamination of traded shrimp products with antibiotics and their transboundary transport. The tetracycline group of antibiotics, for example, can inhibit protein synthesis in mammalian cells, and can cause acquired resistance to a broad spectrum of microorganisms. The presence of antibiotic residues has occasionally led to the rejection of shipments from South China Sea countries, causing economic losses for exporters. It also is indicative of how far removed the production systems are from natural systems which allow organisms growing in the wild to cope with naturally occurring pathogens.

Export of wood products (logs, chips and charcoal). Unlike shrimps which are produced mainly for export, wood products derived from mangroves are consumed both by domestic and foreign markets. Because of the high revenues derived from export, it is economically more gainful and often, more environmentally threatening, when foreign demands become a market priority. Table 3.8 shows the exported wood products by three participating countries (Indonesia, Malaysia and Thailand) with data obtained from ISME, (1993). Among the wood-based activities, woodchips for use in the Japanese rayon production, seems to be the most destructive and least sustainable. Closure of operations of chip plants at levels below optimum because of extremely rapid consumption of mangrove trees has occurred. The non-banning of the woodchip industry and reliance on shortage of raw materials for their short-term but devastating operation, underscores the heavy weight of profit over environmental non-sustainability in defining harvest policies for mangroves.

Table 3.8 Export of mangrove derived wood products (data from ISME, 1993)

Exporting Country	Wood Product	Recipient countries	Details
Indonesia	Logs from Sumatra, Kalimantan and Irian Jaya	Taiwan of China, Japan	1989: 34,404 m^3 out of 45,805 m^3 produced in West Kalimantan exported
	Charcoal from Riau Province in Sumatra with 836 kilns in 1984	Singapore, Hong Kong	1983: 1983 production reached 22,207 t, valued at USD 1 M.
	Woodchips and pulp from W. and E. Kalimantan, N. Sumatra	Japan	1990: 247,497 m^3 exported
Malaysia	Woodchips from Sarawak and Sabah	Japan	Lifespan of woodchip mills ranged from 15 to 25 years because of rapid consumption of mangrove stands (e.g. 70,000 ha in 15 yrs.) with USD 3-5 M annual revenue
Thailand	90% of harvest used for charcoal; 60% of charcoal production for domestic consumption; 40% for export	Penang, Malaysia; Singapore and Hong Kong	Average harvest of wood is 783,780 m^3/yr to produce 387,800 m^3 of charcoal

3.1.2 Coral reefs

Status of coral reefs and immediate causes of degradation. Coral reefs in the seven participating countries are at various levels of degradation (Table 3.9). In sub-regions interacting with the South China Sea, reefs in Malaysia and northwest Philippines show 10 to 30 % degradation. In Thailand and Indonesia, 40 to 60% of reefs are degraded. Ninety five percent of coastal areas of Hainan are severely degraded.

Table 3.9 Extent of coral reef degradation in participating countries

Country/ Subregion of South China Sea	% Degraded Reefs[1]	No. of transects[2]	Extent of Live coral cover (national scale and includes non-South China Sea subregions)			
			% Transects with >75% live cover	% Transects with 50-75% live cover	% Transects with 25-50% live cover	% Transects with <25% live cover
Cambodia	No data	36				
China (Hainan coast)	95					
Indonesia • Western • Central	 • 60 • 40	190	2.6	24.2	31.6	41.6
Malaysia • Peninsular • Eastern	 • 10 • 30	193	11.4	52.8	27.5	8.3
Philippines • Luzon • Palawan • Rest	 • 30 • 10 • 20	238	1.3	7.5	49.2	42.0
Thailand • North Gulf • South Gulf	 • 60 • 50	178	16.9	42.1	34.8	6.2
Viet Nam	No data					
ASEAN	82					

[1,2]Chou *et al.*, 1994b.

Using published information from the ASEAN-AUSTRALIA Living Coastal Resource Resources (LCR) Project, and with sites that include areas not interacting with the South China Sea, the Philippines and Indonesia have 91 and 72% of the transects studied with less than 50% live cover (Chou *et al.*, (a), 1994: Chou *et al.*, (b), 1994b). Using a regionalized assessment, Bryant *et al.*, (1998), show that Southeast Asia harbors 27% of the world's mapped reefs, and that the reefs fringing the archipelagic nations of Indonesia and the Philippines, account for 84% of these (or 22% of the global total). Their evaluation indicates that 50% of Indonesian reefs and 85% of those in the Philippines are at high risk (Table 3.10).

The immediate causes of reef degradation in the participating countries and in Southeast Asia in general are varied, but the major ones are commonly identified in the national reports (Table 3.11). Regional assessments like those of Wilkinson *et al.*, (1994) state that pollution and sediments are major causes in countries of the Sunda shelf, and in the shallow areas of the Philippines and Indonesia. However, overfishing causes greatest degradation in the deeper areas of the archipelagoes including those in the oceanic shoals. Bryant *et al.*, (1998) enumerate overfishing, destructive fishing practices, sedimentation and pollution associated with coastal development as the major culprits. These causes were weighted in determining the three risk levels used in their evaluation. They further note that, because reefs are most extensive and most threatened in Indonesia and the Philippines, the management steps taken by them will have a major impact on "...the global heritage of reef biodiversity".

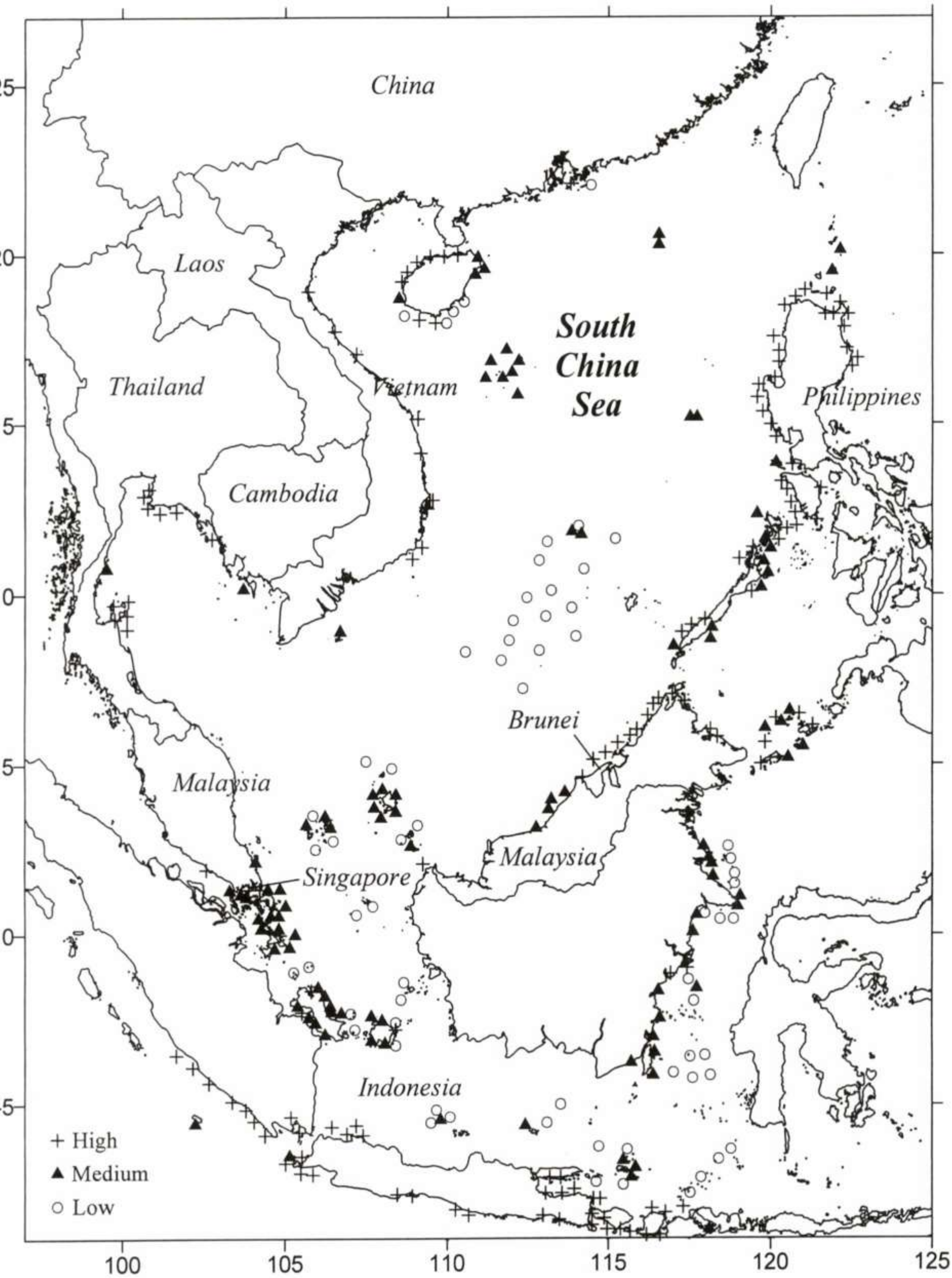

Figure 3. Known distribution of coral reefs in the South China Sea categorized by the degree of human threats.

Table 3.10 Estimates of reef area and level of vulnerability to three risk levels (after Bryant *et al.*, 1998)

Region	Coastal Population Density within 60 km from coast/km^2	Total estimated reef area (km^2)	Level of Risk		
			Low	*Medium*	*High*
Southeast Asia	128	68,100	12,300 (18%)	18,000 (26%)	37,800 (56%)
Indian Ocean	135	36,100	16,600 (46%)	10,500 (29%)	9,000 (25%)
Pacific	98	108,000	63,500 (59%)	33,900 (31%)	10,600 (10%)
Global Total		255,300			
Philippines	174	13,000	50 (0%)	1,900 (15%)	11,050 (85%)
Indonesia	93	42,000	7,000 (17%)	14,000 (33%)	21,000 (50%)

Table 3.11 Immediate causes of coral reef degradation (obtained from national reports)

Country	Immediate Causes			
	Over-exploitation	Destructive fishing practices	Sedimentation	Pollution associated with coastal development
Cambodia	✓	✓		
China	✓			
Malaysia	✓	✓	✓	✓
Indonesia	✓	✓	✓	
Philippines	✓	✓	✓	✓
Thailand	✓		✓	✓
Viet Nam	✓	✓	✓	✓

Transboundary issues. The transboundary issues associated with reef degradation include loss of biodiversity, reduction in reef fisheries, coastal tourism, threatened or endangered migratory species like marine turtles, the coral trade, and the trade of associated biota (Table 3.12). The quality of information to document or support the transboundary nature of these issues is generally fair.

Loss of biodiversity. Coral reefs are the most diverse of marine ecosystems. Table C5 summarizes salient taxonomic data for the region. Data is most dense in countries that were involved in the ASEAN-Australia LCR Project (Indonesia, Philippines, Thailand, Malaysia, and Singapore), and comparative data using similar methods for Viet Nam and Cambodia are needed. However, there is sufficient information to suggest that degraded reefs in studied areas have incurred reductions in biodiversity, and at worse, species extinctions. In Bolinao, northern Philippines, McManus *et al.*, (1992), have shown the reduction in species diversity of reef fishes together with a decline in fish abundance as a consequence of overexploitation. In the same reefs, the sea urchin

Tripneustes gratilla decreased dramatically in abundance from 210 per 100 m^2 in December 1987 to less than 1 per 100 m^2 March 1993. Consequently, there was a failure in recruitment, triggering the collapse of the sea urchin industry in 1992 (Talaue-McManus and Kesner 1995). It remains to be assessed how extinctions which are evident at local levels can impact biodiversity at larger scales.

The threats to fringing reefs of Southeast Asia are transboundary because of the high biodiversity they support. The reversing monsoonal pattern of wind and surface circulation provide for connections between oceanic shoal reefs and those which fringe the coastal states. McManus, (1994) hypothesizes that planktonic larvae of many coral reef biota from the oceanic shoals of the South China Sea can recruit in the fringing reefs of Sabah, the Philippines, Taiwan of China, coastal China, the Paracell Islands, Viet Nam or in the Natuna Islands (Indonesia), depending on the direction of water circulation. In protecting the regional biodiversity, it is imperative to take into account such connections. For example, the establishment of marine protected areas may be made more strategic within the context of interconnected reef systems and not as isolated non-interacting and self-contained units. One way to validate exchange of species and genetic biodiversity is through the examination of genetic affinities among conspecifics in various locations in the South China, with varying extent of larval dispersal. Those with short-lived larvae and therefore limited dispersal should have lower affinities, and those with long-lived pelagic larvae should have the closest genetic similarities. Ongoing studies in the region such as those being coordinated by ICLARM along with its collaborators in the region, and those conducted by the University of the Philippines Marine Science Institute South China Sea Program, can validate the reef connectivity hypothesis.

Table 3.12 Transboundary issues associated with degradation of coral reefs

Transboundary Issues	Countried Involved	Quality of Information
Loss of biodiversity	All countries except Cambodia	Poor to Fair
Endangered or threatened migratory species – marine turtles	Indonesia, Philippines, Malaysia	Poor to Fair
Reduction in reef fisheries	Oceanic shoal reefs and associated coastal reefs (e.g. Viet Nam, China, Indonesia, Malaysia, Philippines)	Poor to Fair
Coastal tourism	All countries	Fair
Coral trade	Indonesia, Philippines as exporters	Fair
Trade of associated biota like aquarium fish	Indonesia, Philippines as exporters	Fair

Table 3.13 Biodiversity associated with coral reefs

Country	No. of scleractinian species	No. of fish species unique to country	No. of chaetodontid fish species in LCR study sites	No. of turtle species (all South China Sea species are endangered and migratory)
Cambodia	No data	No data	No data	4 sp
China • Hainan • Taiwan of China	 • 110 sp • 230 sp		No data	2 sp
Indonesia	350 sp, 76 genera	42 sp, 21 fam	33 sp	3 sp
Malaysia	346 sp	0 sp	21 sp	4 sp
Philippines	421 sp	294 sp, 42 fam	35 sp	4 sp
Thailand		50 sp, 24 fam	17 sp	2 sp
Viet Nam	350 sp, 79 genera	No data	No data	No data
ASEAN Region – LCR Study Sites		787 sp, 64 fam; 34 sp in 12 families common	41 sp	Worldwide total: 7 sp.

Sources: Alino, 1994, Chantrapornsyl, 1994, Chou *et al.*, 1994 (a), Chou *et al.*, 1994 (b), Ibrahim, 1994, Leh, 1994, Marquez, 1990, Palma, 1994, Soekarno, 1994, Soehartono, 1994, Ridzwan, 1994, IUCN, 1995.

Endangered and threatened migratory species. Four species of marine turtles nest in a number of localities around the South China Sea. Through tagging recoveries, migration patterns for a number of them are emerging. Limpus, (1994) states that marine turtles are likely to navigate across 2500 km relative to their nesting areas. Turtles from Sabah are recovered or captured in Eastern Indonesia or in the Philippines. Ibrahim, (1994) reports that tags from tagged leatherback turtles from Peninsular Malaysia have been received from Hawaii, Taiwan of China, Japan and Indonesia, but mostly from the Philippines. The reason for the high frequency of recovery in the Philippines is that leatherbacks may be following a north-bound current for their post-breeding migration.

Four marine turtle species (see Table 3.14) are exploited for their meat, eggs and shell. With their long life cycle, the long interval between egg-laying, their vulnerable nesting grounds, and the high natural mortality incurred at early stages, they are unable to cope with high exploitation rates. Table 3.14 shows annual populations of marine turtles in protected nesting sites in Terengganu, along the eastern coast of Peninsular Malaysia during the period 1984-1993 (Ibrahim, 1994). Hawksbills averaged 41 per year, leatherbacks and olive ridleys at 374 and 269 per year, resp. Green turtles were most numerous at 2,902 per year. Despite the differences in numbers, egg production across species did not vary much, from 83 eggs/female/year for leatherbacks to 112 eggs/female/year for hawksbills. Comparing the annual mean egg production with the annual mean number of nesting adults, adults represent 0.9% to 1.2% of the annual egg production of a nesting population. One may use this as a proxy to infer mortality rates. Thus, all four species incur mortality rates of 99% from egg to nesting adult, with little variation.

Table 3.14 Annual nesting of marine turtles in Terengganu (data from Ibrahim, 1994)

Year	Leatherback	Green	Hawksbill	Olive Ridley
1984	788	4,292	9	293
1985	418	1,169	20	380
1986	596	4,492	123	454
1987	502	1,459	23	493
1988	367	3,542	56	308
1989	286	2,213	20	280
1990	280	1,561	72	187
1991	207	5,311	25	121
1992	231	1,688	28	78
1993	63	3,296	38	98
Annual average nesting population /year	374	2,902	41	269
Annual average egg production, 1983-1993; eggs/yr	31,164	269,116	4,591	25,903
Average eggs/female /year	83	93	112	96
Annual adult numbers/ Annual egg production	1.2%	1.1%	0.9%	1.0%

Duc and Broad (1993) estimated that about 300 to 2000 hawksbill turtles were traded in various forms in three sites in southern Vietnam (Table 3.15). The upper limit of the estimate was consistent with that indicated by Mack et al. for the year 1977 (Table 3.16). Given the small nesting population of hawksbills and their low rate of egg production, it is likely that this level of exploitation is not sustainable.

Table 3.15 Exploitation of hawksbill turtles in Viet Nam, 1993 (data from Duc and Broad, 1993)

Study Site	Captive-rearing for meat and shell	Capture of adults For meat and shell	Traded shell (kg; 1kg can be obtained from 1 adult)	Traded stuffed turtle
Kien Giang Province: Total for 1993 was 308	173	56	20	59
Con Dao Archipelago, 1970s to 1985	50-100 killed/year			
Nha Trang : 2,000 pieces traded annually			150-200/ year	200-300/year

Turtle trade. Although the data in Tables 3.16 and 3.17 are twenty years old, these represent the level of exploitation incurred by the hawksbill turtle during the early years of the CITES Convention. Exports of raw tortoise shell from Southeast Asia accounted for almost 50% of the global annual trade in 1976 and 1977. In 1978, its share increased to 82% because of the 250% increase in Indonesian exports.

Imports of raw shells were also dominated by Asia, with Taiwan of China and Japan posting the highest from 1976 to 1978. It would be interesting to see the growth or demise of the trade considering the currently endangered status of marine turtles. The figures in trade in turtles need to be updated to determine changes in patterns of export and import, and to asses the level of commitment among parties to the CITES Convention to minimize the trade of endangered turtle species.

Table 3.16 Worldwide export of raw tortoise shell (kg) from *Eretmochelys imbricata* (Hawksbill turtle) (Mack *et al.*, 1979)

Country	1976	1977	1978
Indonesia	71,373	85,577	219,585
Thailand	23,859	37,941	56,928
Philippines	15,607	27,905	38,145
Malaysia	7,253	8,879	9,311
Viet Nam	-	1,854	-
• **Total for SE Asia** • **% of World Total**	• **118,092** • **47%**	• **162,156** • **49%**	• **323,969** • **82%**
Total for Asia	141,294	265,875	329,984
Total for Oceania/Pacific Islands	55,547	1,310	36,871
Total for Central and South America	28,390	44,817	7,575
Total for Africa	9,801	3,811	3,660
Total for Caribbean	14,140	13,875	17,129
World Total	**249,172**	**329,688**	**395,219**

Table 3.17 Worldwide imports of raw tortoise shell (kg),1976-1978 (Mack *et al.*,1979)

Country	1976	1977	1978
Taiwan of China	46,652	37,704	128,846
Japan	46,060	45,818	44,039
Hong Kong	26,620	42,788	102,275
Malaysia	9,133	30,060	-
Singapore	4,140	21,002	18,469
China	3,911	3,381	3,827
Viet Nam	2,700	647	-
Thailand	1,238	2,231	-
• **Total for Asia** • **% of World Total**	• **140,454** • **75%**	• **183,631** • **71%**	• **297,456** • **96%**
Total for Europe	12,814	16,270	11,413
Total for Americas and Caribbean	23,181	11,875	194
Total for Pacific	14,000	50,714	252
World Total	**190,449**	**262,490**	**309,315**

Reduction in fisheries productivity. The transboundary nature of decreasing fisheries productivity in coral reefs can be viewed two ways. One way is to show transboundary impacts of declining fisheries in one country on another. The other way is to invoke that transboundary trade is an economic root cause of the reduction in reef fisheries productivity. Because there are very few studies addressing reef connectivities to date, it is difficult to prove the impacts of declining fisheries in terms of decreases in recruitment, growth and yield across national boundaries. The transboundary economic pressures bearing on the extraction of reef-based fishery products like corals, aquarium fish, and the exploitation of reefs for their aesthetic values by coastal tourism, are better documented as below.

It is important to show in this section that reef degradation does lead to significant losses in fisheries, whether or not such losses or the factors causing them are transboundary. Reef–based fisheries account for about 20-25% of the marine fish catch in developing countries like the Philippines and Indonesia (McManus, 1988). Because of their proximity to shore, fringing reefs are heavily exploited by subsistence fishers including gleaners, whose catch do not make it to fisheries logs. As such, the estimation of reef-based fisheries is at best rough and an undervaluation of real catches. In a Philippine marine protected reef, Russ, (1991) estimated fish yield to be in the order of 30 mt/km^2/yr. In a heavily exploited Philippine reef, McManus *et al.*, (1992) found production values of 2.7 mt/km^2/yr and 12.0 mt/km^2/yr for the reef slope and reef flat of Bolinao, resp. Thus, overexploitation leads not only to degraded reefs with lower biodiversity, but also to habitats with lower capacities to support fish.

The losses, both in biodiversity and in fisheries yield, are transboundary if reef interdependence between oceanic shoals and highly exploited fringing reefs of the South China Sea is considered. The precautionary principle should be used to promote taking collaborative management steps despite the absence of unequivocal empirical data, which often comes too late for effective mitigation.

Coastal tourism. Tables 3.18 and 3.19 provide indications of the significance of tourism in generating foreign revenues. At the same time, the industry requires infrastructure, usually situated on the coast to maximize returns from the enjoyment of white sand beaches, and coral reefs. Tourism, including resort building and pollution caused by tourist activities, according to Wilkinson and Ridzwan, (1994), is ranked as a moderate threat to coral reefs in the ASEAN context. Sudara *et al.* (1994), underscore the fact that tourism is the major reef-dependent activity that is increasing throughout the ASEAN countries. They note further that coastal tourist facilities in Pattaya Bay (Thailand), Pulau Seribu (Indonesia), and others in Malaysia and the Philippines, have wrought damage on coral reefs.

Damage begins with the construction of resort facilities, exacerbating the flow of erosional materials (Sudara *et al.*, 1994). Beaches are fortified with sand mined from adjacent reefs, some of which needs to be dredged to create sandy bottoms and navigation channels for boats. In certain cases, artificial beaches are made through reclamation. In all cases, sediments flow unabated to the fringing reefs causing smothering.

More negative impacts ensue when the facilities begin operations. Untreated sewage flows directly from discharge pipes to the reef flats and solid wastes begin to accumulate. For China-South China Sea, foreign tourists in 1996 were 9.0% of the resident population; 7.2% in Malaysia-South China Sea (1993); 6.7% in the Philippines-South China Sea (1993); and 32.6% in Thailand (1997).

Hawkins, (1998) provides a mechanism for linking tourism-generated income and coral reef conservation, a way of internalizing environmental cost into the industry through user fees, concession fees and other forms of service-money exchanges. Where subsistence people use the coastal land and waters for food and livelihood, the promotion of ecologically friendly tourism must not lead to their economic and social dislocation. Direct users have been integrated into conventional tourism as service providers, to supplement or broaden their income base, while the industry erodes the living resource and culture base. Innovative and integrated coastal management mechanisms may provide more appropriate linkages between stakeholders and the industry.

Table 3.18 Tourist visits in South China Sea-regions of the participating countries. National data was used for Cambodia, Indonesia and Viet Nam (World Tourism Organization, 1999) ([1]provided by national reports)

Country	From same country	From South China Sea countries (% of foreign tourists)	From non-South China Sea countries (% of foreign tourists)	Foreign tourists	Total number of tourists
Cambodia, (National) 1998	9,659	72,301 (33%)	136,883 (65%)	209,184	218,843
China[1] –South China Sea, 1996	34,062,167	4,785,940 (81%)	1,105,954 (19%)	5,891,894	39,954,061
Indonesia (National), 1998	604,821	2,124,179 (48%)	2,307,271 (52%)	4,431,450	5,036,271
Malaysia[1]-South China Sea, 1993	1,193,837			636,846	
Philippines[1]-South China Sea, 1993	252,523	516,110 (33%)	1,058,308 (67%)	1,574,418	1,826,941
Thailand[1] –South China Sea, 1997	70,096,104	4,741,290 (39%)	7,387,241 (61%)	12,128,531	82,224,635
Viet Nam (National) 1998	540,971	437,217 (45%)	541,940 (55%)	979,157	1,520,128

The large number of tourists visiting Thailand is a warning to the authorities that care must be taken with the environment. As fledgling tourist industries begin in Thailand and Cambodia the governments are in a good position to manage the tourists and the industry. Note that most of the tourists visiting Cambodia are actually going to Tana Lot and not the coast (Table 3.18). There was a decline in tourism in South China Sea countries (World Tourism Organization, 1999) except for Thailand between 1997 and 1999, but the general trend is shown in Table 3.19.

Table 3.19 Growth in tourism in ASEAN countries, 1985-1992 (Sudara *et al.*, 1994)

Country	1985 Million USD	1992 Million USD	Annual Growth %
Indonesia	548	2,723	56.7
Malaysia	622	1,595	22.3
Philippines	944	1,350	5.1
Singapore	1,600	5,782	35.5
Thailand	1,171	4,057	35.2

Coral trade. The export of corals from Southeast Asia, especially from Indonesia and the Philippines is a fairly well documented industry despite its illegality. From 1986 to 1989, export was not limited to these two countries, and included the significant contribution of Malaysia and Taiwan of China in certain years (Table 3.20). The ecological impact of harvest for the coral trade is localized damage (IUCN/UNEP, 1988). The transboundary aspect of the coral trade lies in the need for foreign exchange by Southeast Asian nations, among other tropical developing countries, and the need for exotic tropical ornaments by importing countries, which are developed nations like Japan, the US and those in Europe. Though legal instruments such as the coral ban in the Philippines, and the Lacey Act in the US should control illegal trade from the exporting country to the recipient country, these have not effectively stopped the coral trade. Bentley (1998) however, notes that the increase in exports by Indonesia could be explained in part by the void left by the Philippines as a result of the Philippine coral ban. The total shipment, in 1992, from the Philippines, totalled a million pieces (Table 3.21). The mean annual shipment leaving Indonesia during the period 1985-1995 reached 930,000 pieces. To date, the export of corals like coral mining for construction and for lime production, have not been banned in Indonesia. Bentley, (1998) underscores the fact that about 5,000 tons/year are harvested to meet the needs for local construction and lime production while 3,000 tons/year are for export.

Table 3.20 Coral trade by exporting/reexporting countries, 1986-1989 (based on Mulliken and Nash, 1993)

Country	No. of pieces as reported by importing country			
	1986	1987	1988	1989
Indonesia	280, 195	185,651	467,057	75,894
Philippines	750, 541	1,172,692	561,583	71,665
Singapore	7,986	230	161	75
Taiwan of China	78,442	263,706	106,051	168,641
Thailand	-	79	275	13
Malaysia	133,602	20 kg	-	-
Sri Lanka	74	72	65	398

Table 3.21 Coral shipments from the Philippines in 1992 (Mulliken and Nash, 1993)

Importing country	No. of shipments	Weight in tons	No. of pieces	Action of importing country
Belgium	3		29,554	Accepted
Italy	3		27,190	Refused
Japan		1.3		Accepted
Netherlands	3		37,665	Accepted
	2	15.5	6886	Seized
UK	1		43,782	Refused
	2	56.5		Refused
USA	354			Accepted
	88			Abandoned
	39			Seized
	2			Returned
Total for USA	483		867,136	
Total for all countries	**497**	>73.3	>1,000,000	

Table 3.22 Average annual trade of Indonesian corals for the top 15 recipient countries, 1985-1995 (Bentley, 1998)

Importer	Pieces	Importer	Pieces
USA	676,531	Canada	5,730
Japan	114,219	Singapore	2,809
Germany (FR)	38,986	Austria	1,821
Spain	21,493	Hong Kong	1,671
Italy	20,540	Malaysia	1,258
France	17,275	New Zealand	1,051
Netherlands	11,030	Korea (Rep.)	978
UK	10,253	Other countries	3,802

Trade of marine aquarium fish. The trade in marine aquarium fish caught on coral reefs is unsustainable Cyanide and other harmful chemicals are used to make aquarium fish more vulnerable to capture. These compounds, however, harm reefs, especially in the Philippines and Indonesia where the trade provides lucrative but short-term gains. Although the sale of marine aquarium fish constitutes only 10% of the ornamental fish trade (90% freshwater), it is totally dependent on wild resources (Bassleer, 1994). Ninety-nine per cent are bought by hobbyists, while the remainder goes to public aquaria and research institutes. The Philippines and Indonesia appear to be the major exporters, with the US, the EEC nations and Japan as major trading partners.

The trade of coral reef resources for ornamental purposes is degrading to reefs in the South China Sea and other regions. Clearly, the driving forces are in the demand for these resources. At the sale and collection ends, environmental concerns may be increased through public education, regulations and more stringent management. Resor, (1998) considers environmental certificates as a means to promote best handling practices among collectors, who can then demand optimal prices for their catch. However, this assumes that reefs can sustain further harvest for use other than food. In summary, the gains for foreign exchange may be miniscule in comparison to rent that is dissipated with the loss of ecological functions like the ability of reefs to support fish for food.

Table 3.23 Trade of marine aquarium fish from Indonesia and Philippines (data from Bassleer, 1994)

Origin	US imports (10^6 USD)	EEC Imports (10^6 USD)	Japan imports (10^6 USD)	Total 10^6 USD
Indonesia	9.1	2.1	4.85	16.05
Philippines	8.6	1.3	3.85	13.75
Totals	**17.7**	**3.4**	**8.70**	**29.80**

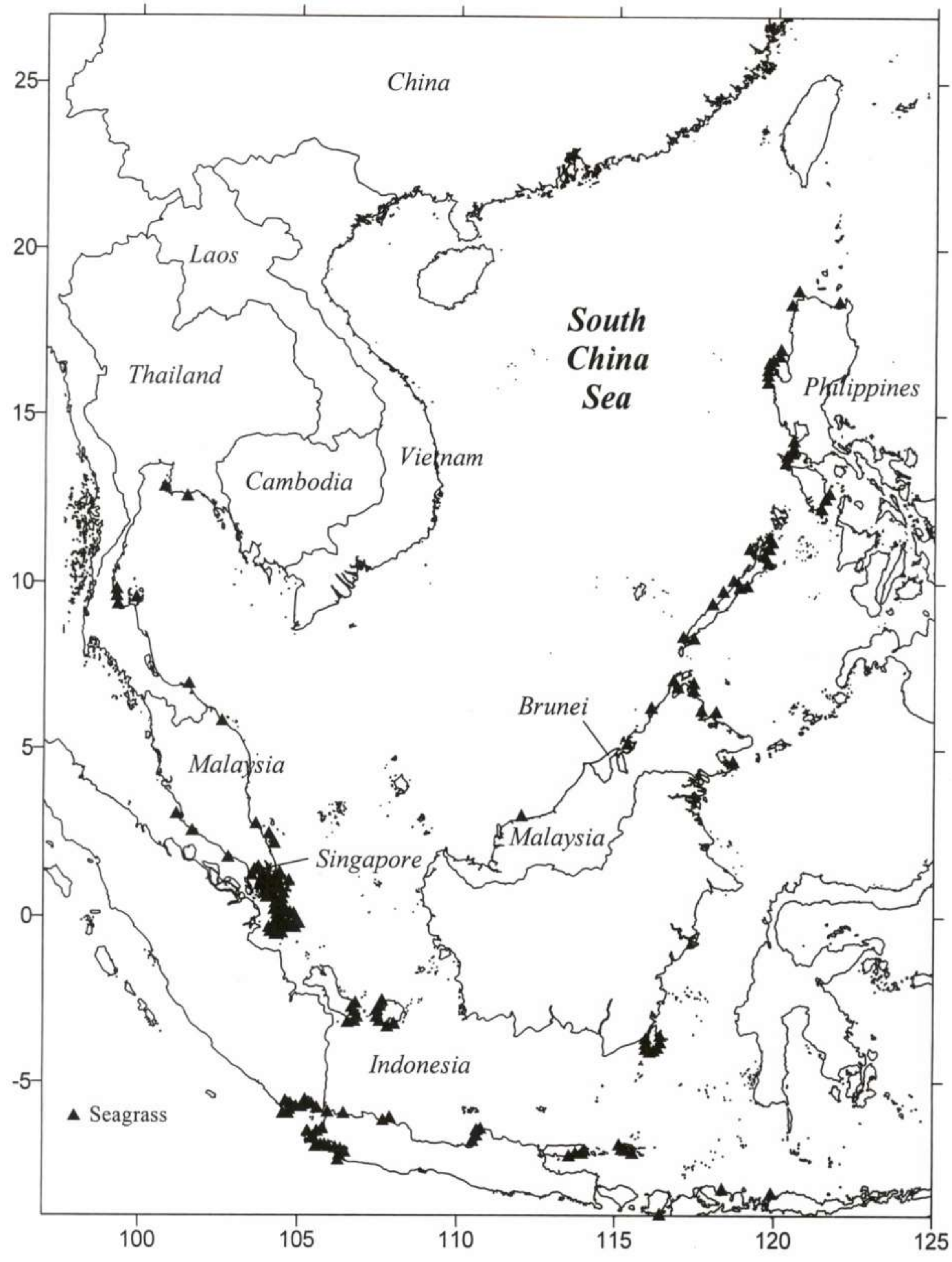

Figure 4. Known distribution of seagrass in the South China Sea.

3.1.3 Seagrasses

Status of seagrass meadows and immediate causes of degradation. Among coastal habitats, seagrass beds are the least studied compared to coral reefs and mangrove systems (Fortes, 1994, 1995). An assessment of the extent of habitat modification in Southeast Asia is at best rough, and based on a few studied areas in each country. Anywhere from 20 to 50% of seagrass areas in Indonesia, Malaysia, Philippines and Thailand are damaged based on studies conducted by the ASEAN-Australia Living Coastal Resources Project and data provided by the TDA national reports (Table 3.24). Coastal development, which releases sediments, destructive fishing methods and land-based pollution, are among the major threats.

The lack of scientific information is alarming in the face of widespread modification of seagrass areas throughout the region. Their location in reef flats and areas adjacent to mangrove areas indicate their crucial function in trapping sediments which remain suspended after they pass through mangrove areas. Thus, seagrass beds are depositional areas themselves, and clean waters for corals. The shallow depths and proximity to shore render them extremely vulnerable to all forms of destructive harvest methods, and activities on land which exacerbate the release of sediments and effluents.

Table 3.24 Extent of damage and causes of degraded seagrass meadows

Country	Extent of damage	Immediate causes of degradation
Cambodia	No data	Fishing by pushnets, trawling, transport and navigation
China	4,200 ha remaining in Guangxi region	Land reclamation
Indonesia	30-40%	Sedimentation, heavy coral mining and collection from reef flats
Malaysia	Unknown	Coastal reclamation, oil spills, land-based pollution Adverse impacts of coastal reclamation in South China Sea regions
Philippines	30-50%	Industrial development, ports and recreation
Thailand	20-30%	Waste disposal from domestic use and aquaculture, fisheries, collection for traditional medicine, land reclamation and development
Viet Nam	Unknown	Fertilizer production, animal feed production, land reclamation for agriculture and aquaculture, mats and handicrafts

Sources: Fortes, 1994, TDA National reports.

Transboundary issues. These include the loss of biodiversity, loss of fisheries productivity, and the trade of seahorses and marine turtles. The poor quality of information is a deterrent to a more quantified assessment of these issues, but their significance can be roughly determined given the information that can be accessed (Table 3.25).

Table 3.25 Transboundary issues resulting from degradation of seagrass habitats

Transboundary issues	Countries involved	Quality of information
Loss of biodiversity	All seven participating countries	Poor to Fair
Loss of fisheries productivity	Same	Poor
Seahorse trade	All except Cambodia	Poor
Marine turtle trade	All except Cambodia	Poor to fair

Loss of biodiversity. Like coral reefs and mangroves, seagrass beds are highly diverse. In Southeast Asia, 20 species of seagrasses have been recorded out of about 50 species worldwide, making the region the second most seagrass species-rich area next to Malesia, a region bounded by Indonesia, northern Australia and Papua New Guinea (Fortes, 1995). The number of adult and juvenile fish species which seagrass beds in the region harbor is high (Table 3.26). A number of endangered species like sea cows and marine turtles are known to feed in seagrass beds. (See discussion of marine turtles in section on coral reefs.).

Seagrasses, coral reefs and mangroves adjacent to or some distance from each other share similarities in biota because organisms spend various stages of their life cycles among these three coastal habitats. Siganids, for example, settle in seagrass areas as post-larvae to feed and grow. They move offshore to spawn, presumably in deep-water reefs. Fortes, (1995) obtained similarity indices for a number of sites in the Philippines (Table 3.27). The percent similarities for fish were variable and dependent on peculiarities in coastal geomorphology.

Table 3.26 Biodiversity associated with seagrass beds in the South China Sea

Country	Length of coastline (km) (National/ South China Sea regions)	No. of seagrass species	No. of associated fish species	Endangered species
Cambodia	South China Sea: 435	6[1]	No data	*Dugong dugon; Chelonia mydas*
China	South China Sea: 6,888	4	8	*Dugong dugon;* 2 turtle sp
Indonesia	NAT: 54,716	12	165	3 turtle sp
Malaysia	NAT: 4,675	10	15sp 9 fam	*Dugong dugon; 4 turtle sp*
Philippines	NAT: 22,540	16	172 sp 50 fam	*Dugong dugon*; 4 turtle sp
Thailand	South China Sea: 3,219	10	67 sp 37 fam	*Dugong dugon; turtle sp*
Viet Nam	South China Sea: 3,260	14	No data	*Dugong dugon; 1 turtle sp; 2 fish sp*
ASEAN LCR Study		20	**318 sp, 51 fam**	5 turtle sp
WORLD		50		**7 turtle sp**

Sources: Fortes, 1995, Fortes, 1994, Sudara *et al.*, 1994, National TDA Reports, [1] Kirkman, EAS/RCU pers.comm.

Table 3.27 Shared biodiversity among mangroves, seagrasses and coral reefs (data from Fortes, 1995)

Location	Biota	Seagrass-Mangrove % similarity	Seagrass-coral reef % similarity	Mangrove-coral reef % similarity
Calancan Bay, Philippines	Fish	44.4%	13.3%	
Calatagan, Philippines	Algal epiphytes	31.4%	56.2%	11.0%
All study areas in Philippines	fish	13.0%	46.3%	

Loss of fisheries productivity. The transboundary nature of the decline in fisheries productivity in seagrass areas lies in the possible connections between fringing and oceanic reefs and among fringing reefs downstream of reversing monsoonal longshore currents. The nursery and feeding roles of seagrass beds underscore their importance in maintaining the high biodiversity and high fisheries production.

There is little quantitative data to support the level of fisheries production in seagrass beds alone (McManus *et al.*, 1992) (Table 3.28). Population studies of dominant seagrass-based fish like siganids indicate their significant contribution to nearshore production, and more importantly, to the nutrition of coastal communities. More realistically, the production estimates made for coral reef fisheries should be considered as having very significant inputs from seagrasses, especially for the herbivorous species. In the Bolinao reef system of northern Philippines, siganids contribute 5 tons/km^2/year or 40% of the reef-flat fisheries (McManus *et al.*, 1992). However, siganids showed a significant decrease in mean size at first reproduction to as small as 3 cm, an unequivocal sign of selection pressure imposed by overharvest. Considering that siganid fishes dominate most seagrass beds in the region, their production can be used as an index for comparing the relative health of the beds, and the extent to which these are exploited.

Table 3.28 Seagrass-based fisheries in Southeast Asia

Country	Fisheries
Cambodia	No data
China	No data
Indonesia	Siganids (rabbitfishes) are common across seagrass beds. Other fish include lethrinids (breams), lutjanids (snappers), serranids (groupers), latids, sphyraenids (barracudas), mugils (mullets), and mullids (goatfishes).
Malaysia	Serranids, theraponids, siganids, leiognathids (slipmouths), and lethrinids are commonly caught.
Philippines	Siganids (both juveniles and adults) make up 1.23% of total marine fisheries; Siganids make up 40% of reef flat fish production of 12 t/km^2/yr in Bolinao. Harvest of shells for ornamental products using rake-like gear can have negative impacts on seagrass beds.
Thailand	Juvenile groupers and snappers; prawns and *Acetes* commercially harvested.
Viet Nam	No data
ASEAN-LCR sites	• Based on frequency: Apogonids (cardinal fish) > Gobiids (gobies) > Siganids (rabbit fish); Based on commercial importance: Siganids • Four commercially important prawn species • Two crab species exploited for food

Sources: McManus *et al.*, 1992, Poovachiranon *et al.*, 1994, Tomascik *et al.*, 1997, National TDA Reports.

Seahorse trade. Seahorses are used in Chinese medicine. The luxury trade, if left unchecked can easily lead to the demise of populations (Vincent, 1994) (Table 3.29). All participating countries except Cambodia are suppliers of seahorses, which are imported by countries where affluent Chinese communities make up a significant portion of the population. Seahorses in Southeast Asia have not made it to the CITES endangered list largely because of the scanty information on population sizes, and minimal information on the trade itself. Because they are small and slow, they are extremely vulnerable to mass harvest. Annual imports are in millions of organisms, valued at USD 55-180 per kilo dry weight, this incentive is too large for a realistic total ban. Recent studies by Vincent on pilot grow-out of seahorses with local communities in Bohol, Philippines recommend sustainable harvest practices in order to make the trade less destructive. One such step is the maintenance of pregnant individuals in holding pens until they have given birth, thus ensuring replacement of harvested individuals. Vincent, (1994) further notes that the progress in the culture of some species, living in seagrass, made in Nha Trang Oceanographic Institute in Viet Nam, may help ease the pressure on the wild populations.

Table 3.29 Salient features of the seahorse trade (data from Vincent, 1994)

EXPORTERS: China, Indonesia, Malaysia, Philippines, Singapore, Thailand, Viet Nam in Southeast Asia. Others include Australia, Belize, Brazil, Kuwait, Mexico, Pakistan, Spain, Tanzania, the United Arab Emirates, and the US.
IMPORTERS: China, Taiwan of China, Hong Kong, Singapore, Japan, Malaysia, South Korea, US.
USES: Chinese medicine for asthma, arteriosclerosis, impotence, incontinence, etc.; aquarium exhibits and for food
PRICE: USD 55 to 180 per kg of dried sea horses
ESTIMATED POPULATION SIZE: Unknown, approx 35 species worldwide
ESTIMATED GLOBAL TRADE: 20 million seahorses per year • 20 tons or 6 million animals were consumed by China in 1992. • Taiwan of China imported 3 million dried animals in 1993. • The US bought 200,000 dried seahorses from the Philippines alone in 1987, perhaps for sale in Chinatowns.

3.2 Overexploitation of living aquatic resources

3.2.1 Status of inland capture fisheries and culture production

Table 3.30 summarizes data contained in the TDA national reports of the seven participating countries. Viet Nam leads in capture fisheries production with Thailand and Indonesia-South China Sea subregions as a far second and third, resp. All together the seven countries account for 13% of global freshwater production. Freshwater aquaculture accounts for 1/5 of global production and provides fisheries 3.3 times more than that of its capture-based counterpart. Total inland aquaculture production and capture fisheries, by the 7 countries, accounts for 18% of the world total.

The economic imperatives for pursuing freshwater aquaculture are obvious. However, its growth should be pursued with policies cognizant of natural carrying capacities of freshwater systems to support production even with artificial subsidies in the form of feeds, chemicals and aeration, among others. Artificial subsidies degrade habitat quality and consequently erode the capacities of natural systems to assimilate pollutants, mineralize organics, and distribute sediments within hydrodynamic regimes. If aquaculture is to be sustained, anthropogenic inputs must be applied to maintain the health of the overall system, and not to simply increase production, which will prove to be short-lived. Afterall, the basis for aquaculture to enhance production lies in having a healthy natural system to begin with. The cost of degraded habitats is basically dissipated long-term resource rents.

Table 3.32 indicates the level of exploitation for capture marine and freshwater fisheries and the potential for expansion in aquaculture in inland waters. The qualitative determination is based on the observed level of degradation of freshwater habitats such as declining water quality, diminishing catches or culture production, and loss of biodiversity (see discussion on natural wetlands). For China, Indonesia and the Philippines, the extent of exploitation has reached full or overexploited levels. Habitat degradation has reached unsustainable levels, threatening even the safety of public health with the consumption of cultured organisms, such as when toxic algal blooms occur. Other countries have moderate scope to expand their capture and culture fisheries because habitats have remained fairly healthy. Cambodia, Viet Nam and Thailand may do so but must proceed very cautiously even in the light of economic and demographic needs.

Table 3.30 Inland capture and production in seven participating countries

Country	Capture Fisheries (t/yr)	Culture Production (t/yr)	Total
Cambodia	63,429	8,779	72,208
China-South China Sea	152,516	2,357,141	2,509,657
Indonesia-South China Sea	165,991	147,580	313,571
Malaysia	No data	No data	No data
Philippines-South China Sea	30,401	51,848	82,249
Thailand	168,502	No data	At least 168,500
Viet Nam	298,500	335,910	634,410
Total for 7 countries	At least 900,000	At least 3,000,000	At least 3,900,000
Total for world (1995)[1]	7,000,000	14,600,000	21,600,000
% of world production	13%	20%	18%

(National TDA Reports; [1]FAO 1997b).

3.2.2 Status of marine capture fisheries and coastal aquaculture

For capture fisheries the contribution of the TDA participating countries is only 8.2% of global marine production. Culture fisheries contribute a non-trivial 54% of the global total. The share of the South China Sea countries is 12% of global total marine production (Table 3.31). Unlike freshwater systems, capture fisheries production is twice that of coastal aquaculture, mainly because of the wide area of productive waters of the Sunda Shelf. All states seem to have exploited their fisheries to a high degree except for Cambodia and Malaysia which believe they can fiurther exploit marine waters (Table 3.32).

If the economic value of culture production could include the cost of environmental degradation brought about by this activity, a better comparison of the economic values of production by capture and by culture could be made. The enormous habitat degradation caused by coastal aquaculture (see discussion for mangrove habitats), is not accounted for. International financing institutions will always show positive returns for aquaculture, and this is justified by arguments of increasing food production and ensuring the capacities of developing nations to meet their protein nutritional requirements. This archaic reasoning must be substituted by appropriate policies to guide continued semi-intensive culture systems. Expansion in terms of increasing production of existing ponds can be pursued in Cambodia, and to a moderate extent in Malaysia-South China Sea and Viet Nam. The four other countries need to pursue reforestation and other mitigating measures seriously. The continued production of existing ponds may only be ensured by adapting more sustainable practices.

Table 3.31 Marine production in seven partipating South China Sea countries

Country	Capture Fisheries (t/yr)	Culture Production (t/yr)	Total
Cambodia	30,500	1,500	32,000
China-South China Sea	2,689,000	3,303,500	5,992,500
Indonesia-South China Sea	1,956,513	136,661	2,093,174
Malaysia	569,058	No data	At least 570,000
Philippines-South China Sea	120,592	At least 109	At least 120,700
Thailand[1, 2]	At least 768,650 (for 23 major species)	234,000	At least 1,003,000
Viet Nam	737,150	No data	At least 740,000
Total for 7 countries	6,871,463	3,604,465	10,475,928
Total for world (1995)[3]	84,000,000	6,700,000	90,700,000
% of world production	8.2%	54%	12%

[1]Potaros, 1995; [2] Siri Tookwinas & Dhana Yingcharoen, 1998; [3]FAO 1997b; All other data from TDA National Reports.

Table 3.32 Degree of exploitation in capture fisheries and the potential for expansion in culture production (qualitative data from TDA national reports)

Country	Degree of exploitation of capture fisheries (Low, Moderate, High)		Potential for expansion of culture production (Low, Moderate, High)	
	Marine	Inland	Marine	Inland
Cambodia	Low	Moderate	High	Moderate
China-South China Sea	High	High	Low	Low
Indonesia-South China Sea	High	High	Low	Low
Malaysia-South China Sea	Moderate	No data	Moderate	No data
Philippines-South China Sea	High	High	Low	Low
Thailand	High	Moderate	Low	Moderate
Viet Nam	High	Moderate	Moderate	Moderate

3.2.3 Status of the capture fisheries potential in the South China Sea

Maximum sustainable yield (MSY) estimates are difficult to determine and there are inherent limitations in estimating them (Hillborn and Walters, 1992). Country-based MSYs are even less credible in that the range of fish stocks is never coincident with territorial boundaries. To constrain these uncertainties, estimations at basin level are made to better approximate production potentials. Table 3.33 indicates the habitat and bathymetric subdivisions of the South China Sea that were used by Pauly and Christensen, (1993) to estimate the potential catch from the South China Sea basin. At the level of subdivisions, they showed that coral reefs 10 to 50 m are fully exploited. Shallow waters with some scope for increased production are those located along the Viet Nam/Chinese and Bornean shelves. They may have actually been realized by now. The MSYs for the rest of the shallow habitats could not be estimated, but other indicators show they are fully or over-exploited. On the whole, an additional 841,000 t/yr can be had from the South China Sea if it is possible to tap the production of the deep shelf and the open ocean by exploiting large pelagics and cephalods (Pauly and Christensen, 1993).

Yanagawa, (1997) presents another South China Sea basin-wide estimate, this time with a focus on small pelagics, which can comprise shared and straddling stocks among the littoral states (Table 3.34). His study covers the period from 1978 to 1993, during which peak years are identified. He notes that after 1987, most of the 12 small pelagic fisheries reached full levels of exploitation. Furthermore, the rapid increase from 1976 to 1983 was accompanied by alternation of major species, again indicative of massive fishing selection pressure.

Thus, at the basin level, these two studies indicate that most of the conventional small pelagic species comprising the South China Sea capture fisheries, are already fully exploited. On a habitat division basis, only a few sections of the shelf can sustain further expansion. The deepwater catch may have greater scope to sustain higher fishing pressures, but economics and technology may prove to be the major constraints in catching at great depths.

Table 3.33 Fisheries potential of the South China Sea (modified after Pauly and Christensen, 1993)

Subdivision	Area (10^3 km^2)	Primary Production (t km^{-2} yr^{-1})	Potential catch 10^3 t yr^{-1}	Actual catch 10^3 t yr^{-1}
Shallow areas to 10 m	172	3,650	No estimate but fully exploited	1,046
Reef flats and seagrasses to 10 m	21	4,023	No estimate but fully exploited	275
Gulf of Thailand to 50 m	133	3,650	No estimate but fully exploited	1,242
Viet Nam and China shelf to 50 m	280	3,003	1,860	453
Northwest Phil to 10 m	28	913	No estimate	315
Bornean shelf to 10 m	144	913	257	105
Southwest shelf to 10 m	112	2,433	No estimate but fully exploited	962
Coral reefs, 10-50 m	77	2,766	295	291
Deep shelf 50-200m	928	730	1,688	176
Open ocean 200-4000 m	1,605	400	1,686	80
Total South China Sea	**3,500**	**Mean = 1,143**		**4,945**

Table 3.34 Small pelagic fisheries in the South China Sea, 1978-1993 (Yanagawa, 1997)

Group	Peak landings (mt)	Peak year
Round scads	596,000	1991
Selar scads	229,000	1990
Jacks, cavalla and trevallies	147,000	1993
Indian mackerel	357,000	1992
Indo-Pacific mackerel	212,000	1993
Spanish mackerel	114,000	1993
Kawakawa	283,000	1992
Frigate and bullet tunas	128,000	1992
Sardines	716,000	1993
Anchovies	419,000	1993

3.2.4 Status of large pelagics: the case of tunas

Because large pelagics including tunas and perhaps sharks, are highly migratory, the global ocean, not the basin scale, is most appropriate in analyzing their state of exploitation. Four South China Sea nations are among the top ten leading tuna fishing nations of the world. The combined catch of Taiwan of China, Indonesia, the Philippines and Thailand consistently made up 23% of the global landed catch over a six-year period from 1988 to 1993. Peckham, (1995) notes that the catch of the South China Sea countries at 725,200 t and of the world at slightly over 3 million tons, has stabilized, and may indicate full state of exploitation (Table 3.35). An analysis of the trade in tuna and tuna products is discussed in 3.2.6.

Table 3.35 World production of principal tuna species by principal fishing nations, 1988-1993 (10^3 mt) (data from Peckham, 1995)

Country	1988	1989	1990	1991	1992	1993
Japan	753.2	673.1	653.9	717.1	669.1	776.6
Taiwan of China	220.4	256.7	308.1	230.4	332.2	282.0
Spain	242.4	250.3	263.1	265.8	253.5	255.0
Republic of Korea	147.1	170.9	232.7	266.5	224.6	241.0
United States	276.0	245.2	232.6	235.6	261.3	221.3
Indonesia	170.5	180.1	202.8	211.1	216.3	216.0
France	152.9	142.1	152.7	168.8	234.3	158.5
Philippines	113.0	126.8	180.8	198.0	176.0	148.5
Mexico	132.8	136.9	125.7	129.0	131.5	118.5
Thailand	92.9	82.1	102.4	84.8	74.5	78.7
Total for South China Sea countries	**596.8**	**645.7**	**794.1**	**724.3**	**799.0**	**725.2**
Global total	**2,847.9**	**2,853.0**	**3,071.1**	**3,144.8**	**3,167.9**	**3,202.00**
South China Sea contribution to Global Total	**21%**	**23%**	**26%**	**23%**	**25%**	**23%**

3.2.5 Immediate causes of overexploitation by country

Many factors cause unsustainable levels of fishing pressure, especially in the nearshore. Destructive fishing practices, bycatch, post-harvest losses, siltation and habitat destruction are among the major ones (Table 3.36) (Silvestre and Pauly, 1997). Region-wide, the issues of overexploitation are common, with perhaps qualitative differences for Cambodia which has emerged from civil strife, and for Viet Nam which has just entered the free market economy. Nonetheless, demographic and development pressures seem to be the common socio-economic drivers in the overharvest of aquatic resources.

Table 3.36 Immediate causes of overexploited coastal fisheries in participating South China Sea countries (modified after Silvestre and Pauly, 1997; National TDA Reports)

Key issues	Cam	Chi	Ind	Mal	Phil	Tha	Viet
1. Overfishing	✓	✓	✓	✓	✓	✓	✓
2. Inappropriate exploitation patterns	✓		✓	✓	✓	✓	✓
3. Destructive fishing practices	✓	✓	✓	✓	✓	✓	✓
4. Small and large scale fisheries conflicts	✓			✓	✓		✓
5. Losses due to bycatch		✓	✓	✓	✓	✓	✓
6. Post-harvest losses	✓	✓	✓	✓	✓	✓	✓
7. Siltation	✓	✓	✓	✓	✓		✓
8. Habitat destruction	✓	✓	✓	✓	✓	✓	✓
9. Reduced biodiversity	✓		✓	✓	✓	✓	✓
10. Land-based pollution	✓	✓	✓	✓	✓	✓	✓
11. Oil spills			✓	✓	✓	✓	✓

3.2.6 Transboundary issues associated with overexploitation

A significant number of the causes and impacts of overharvesting of living aquatic resources is transboundary in nature (Table 3.37). Although the information base to show these transboundary features is poor, there are significant indicators that can be used to identify and highlight them. The loss of biodiversity in marine habitats was discussed in previous sections. The presumably fully exploited states of small pelagics and tunas have also been shown retrospectively with catches reaching stable peaks, followed by a change in species composition of the fishery (Yanagawa, 1997, Peckham, 1995). The subsequent analysis will therefore deal mainly with bycatch, food security and fishery trade.

High bycatch of commercial operations. FAO, (1997a) discussed the sources of wastage in fisheries. Many terms have been used to describe wastage and the matrix below is drawn to clarify their meanings. In general, wastage is composed of discards at sea and post-harvest losses. Thus, damaged target species and bycatch make up discards. Moreover, the classification of target vs. non-target species is highly variable with species being classified as one or the other, depending on preferences and seasonality of market demands.

TOTAL CATCH	GEAR SELECTIVITY	
	Target species or group	Non-target species or group
Discarded catch (thrown away at sea; amounts not recorded nor reported)	Damaged, small size, of inferior quality; disposed of to meet quota limits – Amounts not recorded nor reported	Bycatch – Amounts not recorded nor reported
Retained catch (portion that gets landed and recorded)	Desired species or group; retained juveniles = trash fish	Incidental catch including juveniles = trash fish

Discarded bycatch comprises perhaps the most significant source of wastage in the global fisheries. FAO, (1997b) notes that if a small number of mature specimens from a healthy stock make up the bycatch, the incurred fishing mortality may cause relatively small damage. However, when the bycatch consists of many juveniles of commercially exploited stocks, the impact on the viability of populations or stocks may be severe. Commercial operations (trawling, seining, bagnetting, etc.) are perhaps the biggest source of bycatch wastage. By virtue of the efficiency of gear capture and the wide area of operations, commercial fleets make up monopolies of the sea, with a singular contribution to overexploitation. In many cases, their aggregate fishing pressure far exceeds that exerted by subsistence fishers, who are often blamed for overharvest.

FAO, (1994 in FAO, 1997b) estimated that discarding of bycatch amounted to an average of 27 million tons per year, or approximately 32% of the global annual production of marine capture fisheries. The issue is not only transboundary but of a global significance as well, especially when the catch potential of the world's oceans seems to have been reached. Assuming that this percentage is a conservative estimate for South China Sea states, this translates to 2.2 million tons/year of current (and future) fish that is lost.

Bycatch cannot be totally eliminated for biological, technological, economic and legal reasons (FAO, 1997a). However, the magnitude it has reached poses imminent danger to fish stocks and to food security. Karnicki, (1995) notes that in order to maintain 1993 world annual fish consumption rate of 13 kg/person in the year 2010, the amount of fish for direct human consumption should be increased from 72.3 to 91 million t/year. To achieve this, considering that marine stocks are fully or over exploited, he suggests three approaches. First is to reduce waste, and to use bycatch; second, increase consumption of small pelagics, and third: use unconventional species like krill.

The issue of bycatch in particular, and the need for responsible fisheries, in general, is covered by a number of international initiatives (FAO, 1997b). All drawn in 1995, they include the Rome Consensus on World Fisheries, Article 7 of the Code of Conduct on Responsible Fisheries, and the Kyoto Declaration and Plan of Action on the Sustainable Contribution of Fisheries to Food Security. They provide the broad context of global collaboration needed to implement sustainable fishing practices. The UNCLOS Agreement for the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stock focuses on stocks that are exploited within national territories as well as in the high seas. The mix of jurisdictions demands international collaboration if the bottom line is to sustain such populations. All these initiatives apply to the South China Sea, taking into account the biological state of the resources and the development goals of the littoral states.

Table 3.37 Transboundary issues on overexploitation

Transboundary issues And quality of information	Cam	Chi	Ind	Mal	Phil	Tha	Viet
Inland fisheries							
Loss of biodiversity in the Mekong River Basin, including endemic species, and migratory organisms, a number of which are considered endangered – **Poor**	✓	✓				✓	✓
Marine fisheries							
Loss of biodiversity among shared stocks and genetic resources – **Poor**	✓	✓	✓	✓	✓	✓	✓
Fully exploited production of shared and migratory stocks (small and big pelagics) – **Poor**	✓	✓	✓	✓	✓	✓	✓
High bycatch by commercial operations – **Poor**		✓	✓	✓	✓	✓	✓
Loss of breeding grounds, and recruitment and spawning areas – **Poor**	✓	✓	✓	✓	✓	✓	✓
Regional food security in ability to meet protein nutritional requirements – **Fair**	✓	✓	✓	✓	✓	✓	✓
Fishery trade of overexploited and endangered stocks – **Poor**	✓	✓	✓	✓	✓	✓	✓
Foreign poaching - **Poor**	✓		✓	✓	✓	✓	✓

Regional food security. FAO defines food security as "physical and economic access, by all people at all times, to the basic food they need (cited in Williams 1996). A fundamental question is whether the South China Sea countries, richly endowed with aquatic resources, are secure in accessing this wealth for food. Table 3.38 summarizes parameters used in this analysis to determine population pressure on fish production, and the role trade should take in achieving the seemingly diametrically opposed goals of revenue generation and food security. To maintain current patterns of fish consumption in the year 2005, Cambodia, Philippines and Viet Nam will require more fish more than they produced in 1994 assuming that 100% of the catch in these three countries will be available for domestic consumption. If Cambodia and Viet Nam wish to reach the nutritional minimum requirement of 21.5 kg/person/year in 2005 (assuming 50% dependence on fish for animal protein) they need to dramatically increase food production; Cambodia by 270% of its production in 1994, and Viet Nam by 163%. Indonesia may have enough, but the population distribution is so heterogeneous and transport infrastructure so poor that there will be severe shortages in overpopulated areas but sufficient supplies in less crowded ones. Thailand and Malaysia have successfully reduced population growth rates, so that domestic demands need not be sacrificed for export revenues.

Currently, South China Sea countries are net exporters, and will most likely remain so assuming no drastic reductions in fish production. Regionally, total population by 2005 will reach 503 million using current growth rates. For all to reach the minimum nutritional requirement, about 86% of current production will be consumed domestically for food. This implies that the region can export 14%, at most. If export levels are to increase beyond 14%, either domestic consumption will fall below the minimum requirement, total fish production will have to be increased, or population growth rate will have to be reduced. Reductions in harvest wastage will also be a strategic measure. The options may be difficult to optimize toward one goal or the other, but a compromise towards long-term benefits for society, the ecology and the economy will have to be formed now.

The South China Sea countries will have to define their priorities within an evolving context of trade globalization and the eventual removal of tariff barriers as defined by usually inequitable trade agreements. Whether or not these include the domestic demands of a growing population and the protection of their extremely vulnerable living resource base, is a most crucial decision to be made now.

Table 3.38 Fish requirements in selected South China Sea countries for the year 2005 (data as cited by Silvestre and Pauly, 1997, 1998 World Almanac)

Country	Population 1996 (10^6)	Finite growth rate (%)	Population 2005 (10^6)	Fish consumption (kg/p/y)	Total fish produced, 1994 (10^3 t/y)	Total fish required for food in 2005 (10^3 t/y)
Cambodia	10.2	2.7	13.0	12.0	103	156
Indonesia	197.6	1.5	225.9	15.5	4,060	3,502
Malaysia	20.6	2.0	24.6	29.5	1,173	726
Philippines	69.3	2.2	84.3	36.1	2,657	3,043
Thailand	61.4	1.0	67.2	25.3	3,432	1,699
Viet Nam	76.3	1.6	88.0	13.4	1,155	1,179

Fishery trade. Tables 3.39 and 3.40 give an overview of the value of the share of South China Sea countries (no data for Cambodia and Viet Nam) in the world fishery trade. Exports coming from six South China Sea countries accounted for an average of 11% of world exports yearly for the period 1988-1992. Their share of imports was only 4% of the yearly global value. Thus, the region is a net exporter of fishery products with a net trade surplus of USD 3.5 billion posted in 1992. The more affluent states of Brunei and Singapore were net importers, while the rest were net exporters, notably Thailand whose export earnings was 3.3 times that of imports.

The consumption rates of fish per capita per year (Table 3.38) shows that the Philippines, Malaysia and Thailand are above the minimum requirement of 21.5%. Indonesia, Viet Nam and Cambodia have still to reach this. Average consumption rates only apply if fish are available. For food security, further analysis will have to be made if South China Sea countries are serious in meeting nutritional needs for all. How trade impinges on fish availability becomes a significant question before meaningful macroeconomic policies can be formed at the national and regional levels.

Table 3.39 Share of selected South China Sea countries in world exports of fishery products, in USD 1,000 (data from Ferdouse, 1994)

Country	1988	1989	1990	1991	1992
Indonesia	664,483	767,422	983,571	1,192,082	1,178,552
Malaysia	191,242	210,140	229,514	264,938	302,576
Philippines	407,504	409,879	395,960	467,729	393,997
Thailand	1,630,891	1,959,428	2,264,937	2,901,366	3,071,780
Brunei	300	350	380	440	400
Singapore	356,193	359,071	414,810	499,950	494,128
Total for 6 South China Sea countries	**3,250,613**	**3,706,290**	**4,289,172**	**5,326,505**	**5,441,433**
Global total	**31,804,116**	**35,886,233**	**39,539,969**	**43,546,408**	**45,451,914**
% of Global total	**10**	**10**	**11**	**12**	**12**

Table 3.40 Share of selected South China Sea countries in world imports of fishery products, in USD 1,000 (data from Ferdouse, 1994)

Country	1988	1989	1990	1991	1992
Indonesia	19,376	30,850	42,777	47,395	56,145
Malaysia	143,508	164,552	145,831	170,478	244,789
Philippines	63,063	65,730	84,809	96,109	111,000
Thailand	537,918	726,846	794,423	1,049,962	942,092
Brunei	7,404	7,180	7,160	6,780	7,000
Singapore	370,311	366,126	361,582	460,545	543,769
Total for 6 South China Sea countries	**1,141,580**	**1,361,284**	**1,436,582**	**1,831,269**	**1,904,795**
Global total	**35,269,622**	**35,886,233**	**39,539,969**	**43,546,408**	**45,451,914**
% of Global total	**3**	**4**	**4**	**4**	**4**

The tuna trade. The status of tuna on a global scale was discussed earlier and the fisheries have probably reached a stable state of full exploitation. The role South China Sea countries play in this trade is of utmost importance. Table 3.41 highlights the fact that three South China Sea countries (Thailand, Philippines and Indonesia) were responsible for an average of 72% of the world tuna export market during the period 1990 to 1993. Using data on canned tuna production in these countries, export accounts for 91 to 96% of total production (Table 3.42). In contrast, Japan exports only 3-5% of what it produces. Spain and Portugal sell about 16 and 30 % of their production, respectively. The US does not export its canned tuna. Japan, Western Europe, and the US, used 83 to 90% of their tuna products for their domestic needs (Table 3.43).

These trading patterns indicate that affluent countries are net importers and that low-income food-deficit countries become net exporters as fish becomes a scarce commodity. These patterns evolve in response to profit being the major market force, and where agri-based economies have to exchange natural capital for hard cash.

Table 3.41 Exports of canned tuna, 1990-1993 (1000 standard cases, at 48 cans/case) (Peckham, 1995)

Country	1990	1991	1992	1993
Thailand	26,340	30,843	27,529	29,223
Philippines	4,944	4,853	5,220	6,067
Ivory Coast	4,421	5,368	4,432	5,636
Indonesia	2,098	4,642	2,150	2,818
Senegal	1,815	2,055	1,816	2,363
Spain	1,258	1,846	1,673	2,200
Ecuador	188	471	868	2,044
France	668	674	675	1,060
Malagasy	-	-	-	992
Seychelles	447	703	620	670
Italy	464	480	388	620
Maldives	528	561	558	581
Portugal	410	683	580	440
Venezuela	106	282	87	432
Japan	433	518	340	390
Total-South China Sea countries	**33,382**	**40,338**	**34,899**	**38,118**
Global total	**44,420**	**54,479**	**47,336**	**56,036**
Contribution of South China Sea countries to Global total	**75%**	**74%**	**74%**	**68%**

Table 3.42 Percentage of production exported by leading producers of canned tuna, 1990 to 1993 (data after Peckham, 1995)

Country	1990	1991	1992	1993
US	0	0	0	0
Thailand	100	98	93	95
Spain	13	16	18	24
Japan	4	5	3	4
Philippines	97	99	100	96
Mexico	0	0	0	0
Indonesia	64	91	86	91
Senegal	91	98	96	94
Portugal	24	31	32	21
Iran	0	0	0	0
Ecuador	12	34	54	100

Table 3.43 Comparison of domestic use and catch by principal markets, 1990-1993 (10^3 mt) (Peckham, 1995)

Market	1990	1991	1992	1993
Japan	834	883	867	1,014
Western Europe	686	803	805	812
United States	710	794	760	642
Other	309	338	353	334
Total Usage	**2,539**	**2,818**	**2,785**	**2,802**
Total Catch	**3,071**	**3,145**	**3,168**	**3,202**
% Used for domestic consumption	**83%**	**90%**	**88%**	**88%**

The trade of sharks and shark fisheries products. The biology of sharks is not well known and they may migrate throughout the South China Sea. They are also caught as bycatch by gear targetting tuna and swordfish, among others. Currently, the demand for shark products is running high for their medicinal, exotic food, and ornamental uses (TRAFFIC 1996). The trade in Southeast Asia is particularly interesting. Thailand started its shark fisheries in 1947 and Malaysia, 14 years later. Philippines and Indonesia began in the early '70s. To date, Indonesia leads the four South China Sea countries based on landed catch (Table 3.44). In terms of biodiversity, at least 27 species are landed in the Philippines, 17 in Thailand, and 6 in Malaysia. The faunistic overlap between Thailand and the Philippines is minimal, and between these two countries, a total of 42 species has been recorded, with only three species common to both (Table 3.45). No species list was available for Indonesia but it could very well exceed the number recorded for the Philippines.

Table 3.44 Commercial elasmobranch fisheries in South China Sea countries (1950-1991) (10^3 mt) (modified after TRAFFIC 1996)

Country	1950	1960	1970	1980	1985	1991
Thailand	2	4.3	22.4	9.5	9.2	11.8
Malaysia	-	3.2 (1961)	3.6	10.9	10.3	16.9
Indonesia	-	-	10.3 (1971)	42.9	54.3	79.8
Philippines			6.9	9.7	10.9	19

Table 3.45 Shark and ray species landed in South China Sea countries (data from TRAFFIC 1996)

Country	Philippines	Thailand	Malaysia
Aetoplatea zonura	✓		
Alopias vulpinus	✓		
Atelomycterus marmoratus	✓		
Carcharhinus amblyrhynchoides		✓	
C. amblyrhynchos	✓	✓	
C. amboinensis		✓	
C. brevipinna		✓	
C. dussumieri		✓	
C. leucas		✓	
C. limbatus		✓	
C. melanopterus	✓	✓	
C. sorrah		✓	
Centrophorus spp	✓		
Centroscyllium cf. kamoharai	✓		
Chiloscyllium griseum		✓	
C. indicum		✓	✓
C. punctatum		✓	
Dasyatis sp.			✓
Dasyatis kuhlii	✓		
Galeocerdo cuvier	✓		
Gymnura sp			✓
Hemitriakis leucoperiptera	✓		

Continued Table 3.45

Country	Philippines	Thailand	Malaysia
Hexanchus griseus	✓		
Hexatrygon sp.	✓		
Himantura uarnak	✓		
Himantura undulata	✓		
Isurus oxyrinchus	✓		
Mustelus cf. griseus	✓		
Nebrius ferrugineus	✓		
Pristis cuspidatus	✓		
Rhyncobatis djiddensis			✓
Rhincodon typus	✓		
Rhinobatidae	✓		
Rhizoprinodon acutus		✓	
R. oligolinx		✓	
Scoliodon laticaudus		✓	
S. sorrakawa			✓
Scyliorhinus tprazame	✓		
Sphyrna sp.	✓		✓
S. lewini		✓	
S. mokarran	✓	✓	
S. zygaena	✓		
Squalus acanthias	✓		
S. cf. rancureli	✓		
Taeniura lymma	✓		
Triaenodon obesus	✓		
Total	27	17	6

Table 3.46 indicates the major markets for Philippine exports on sharkfins and shark liver oil and compounds. Hong Kong, Japan, Korea and Singapore bought the most shark fins, evidently for shark fin soups. Japan was the major market for shark liver oil and compounds.

Thailand shows a clever trading strategy in importing cheap raw materials and re-exporting value added shark goods with 265 to 385% markup in price per kg (Table 3.47). In 1994, it imported, mainly from Canada, Hong Kong and Japan, shark products weighing 130,000 kg costing 10 million USD. It exported only 27% of this weight but sold it at 10.5 million USD. Major markets in 1994 included Hongkong and Japan. The trading pattern changed dramatically from 1993 to 1994. In 1993, Thailand imported 80% of the total volume of its raw materials from Asia, but exported only 28% of its products to markets in this region. In 1994, Asia accounted for 60% of both exports from and imports into Thailand.

Traditionally, shark meat is consumed domestically. The more exotic shark products, such as those used for producing squalene oil, command lucrative prices and hence, the economic push to hunt for more. Because of the high uncertainties involved in determining exploitable elasmobranch biomass, it might be prudent to limit catches for the production of high value products. The supply of shark meat for domestic consumption must also be managed appropriately. More than economic tradeoffs will have to be considered in the use of living resources whose renewal rates are finite, and when food security is at stake.

Table 3.46 Philippine exports of shark fins, shark liver oil and non-modified chemical fractions, 1993-1994 (data from TRAFFIC 1996)

Importer	Shark fins				Shark liver oil and compounds			
	1993		1994		1993		1994	
	Quantity (net kg)	Value FOB$	Quantity (net kg)	Value FOB$	Quantity (net kg)	Value FOB$	Quantity (net kg)	Value FOB$
Australia			20	200				
Brunei	698	5,214	478	5,974				
China Mainland			350	3,500				
Hong Kong	30,837	295,464	9,478	92,097				
Japan	461	17,854			97,349	806,070	26,875	207,228
Korea	500	9,760	1,800	52,380	39,017	39,017	14,400	148,104
Singapore	186	1,860	481	8,502				
Taiwan of China					190	1,000		
Total	32,682	330,152	12,607	162,653	136,556	846,087	41,275	355,332
Average Price $/kg		10.10		12.90		6.20		8.61

Table 3.47 Thailand shark fin trade, exports and imports in 1994 (data from TRAFFIC 1996)

Trading Partner	Exports out of Thailand				Imports into Thailand			
	1993		1994		1993		1994	
	Quantity (kg)	Value (Baht)	Quantity (kg)	Value (Baht)	Quantity (kg)	Value (Baht)	Quantity (kg)	Value (Baht)
Austria	13	43,652						
Australia	17	20,373						
Brunei			2	10,070				
Canada	9	4,550	5	3,198	1,918	2,317,068	26,890	14,565,421
China (Main)					2,311	2,116,682		
Chile	3	10,650						
Denmark					742	132,707		
Hong Kong	5,491	1,601,778	12,569	11,741,410	19,218	7,036,461	26,768	7,968,417
India					15,713	6,469,721		
Indonesia					12,048	4,170,578	13,795	3,755,571
Japan	661	1,181,598	6,642	5,604,932	28,390	7,568,445	38,213	6,570,914
Malaysia			2	10,070				
Myanmar			432	67,560				
Norway					3,471	1,592,460	2,240	1,357,343
US					3,073	861,328		
Viet Nam					2,146	516,666	250	60,401
Trade with Asia	28%	13%	57%	41%	80%	78%	62%	46%
Total trade	21,856	20,796,459	34,538	42,175,190	99,750	35,857,793	127,442	40,338,131
Average Price B/kg		952		1,221		359		317

Making fisheries trade responsible. Market forces have been righty blamed for overfishing, over-investment, and the consequent collapse of commercial fish stocks. They shaped the over-all development of the world fisheries (Karnicki, 1995) such that 30% of total production was traded at USD 3 billion in 1980 to USD 40 billion in 1993. In Southeast Asia, the littoral states became the leaders in shrimp culture production.

Such market forces also identify where subsidies should be infused such as in the build up of fishing fleets, the development of highly efficient fishing gear and price support, all of which led to serious economic losses through the backlash of adverse environmental impacts. Thus, the economic regimes, within which fisheries at its currently vulnerable stage can be sustained, will have to be totally redefined. Such regimes must take into account long-term ecological parameters such as renewable rates and carrying capacities, and the quality of life of domestic consumers, as the bases for economic incentives to conserve living aquatic resources.

Tietze (1995) suggests the mobilization of fisheries credit for domestic marketing in Asia and the Pacific as an approach to maximize the social and economic benefits from the fisheries. Nutritional requirements including those of marginal sectors, dependence on fish protein, traditional groups involved in markets and distribution, and the associated institutional and regulatory frameworks, are among the major social and institutional factors to be considered. Tietze notes that given limited fish supplies, a growing demand, and trade globalization, fish marketing and processing in Asia will tend towards regionalization and commercialization. Such will not necessarily lead to a decrease in the market share of domestic consumption because of:

(1) increasing purchasing power in the region,
(2) new market opportunities for value-added products,
(3) scope for processing under-utilized species, and
(4) the external supplies of raw materials with trade liberalization.

Given this broad context, the scale of credit mobilization is critical. Small-scale trade facilities reach the marginalized sectors, and the medium- to large-scale operations provide for market infrastructure needed to promote domestic trading at wider scales.

The macro and microeconomic instruments to support domestic fish markets, while protecting the living resource base, must take into account the fundamental shift in focus from profit (export markets) to domestic food security. At the regional level, the trade of shared stocks, migratory species and straddling stocks must be based on the precautionary principle where information uncertainties cannot provide for MSY estimates, but where best science can help set quota limits.

3.3 Pollution of aquatic environments

3.3.1 Overview of ranked sources of pollution

Table 3.48 summarizes the sources of pollution of the participating countries in the South China Sea, the quality of the database, and the perceived contribution of these sources to the state of aquatic environments in each country. Wastes from domestic, agricultural, and industrial sources, along with sediments and solid wastes are the major sources of pollutants that impinge on both freshwater and coastal