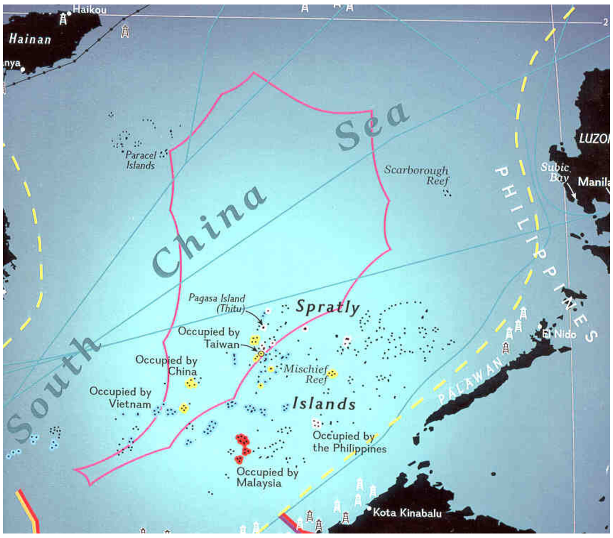

The South China Sea-Revisiting The Large Marine Ecosystem Approach

PORFIRIO M. ALIÑO
The Marine Science Institute
University of the Philippines
Diliman 1101 Quezon City
PHILIPPINES

The South China Sea is found in the East Asian Seas (EAS) region (Fig. 1) that occupies a significant portion in world fisheries production greater than 12%, and found in the world's highest diversity region (Talaue- McManus 2000). In this East Asian Seas region is often associated with those circumscribed by those referred to under the United Nations Environmental Programme regional seas context. Countries which border the region are China, the Democratic Republic of Korea, the Republic of Korea, Japan, the Philippines, Brunei, Malaysia, Singapore, Thailand, Cambodia and Vietnam. This region is composed of a diverse people with varied cultures experiencing various social and economic developmental stages (Fig. 2).

The EAS region has been observed to have a high population growth (Fig 3). Around 1.9 billion people have been estimated for this region if one considers that around 77% live within 100 km of the coast

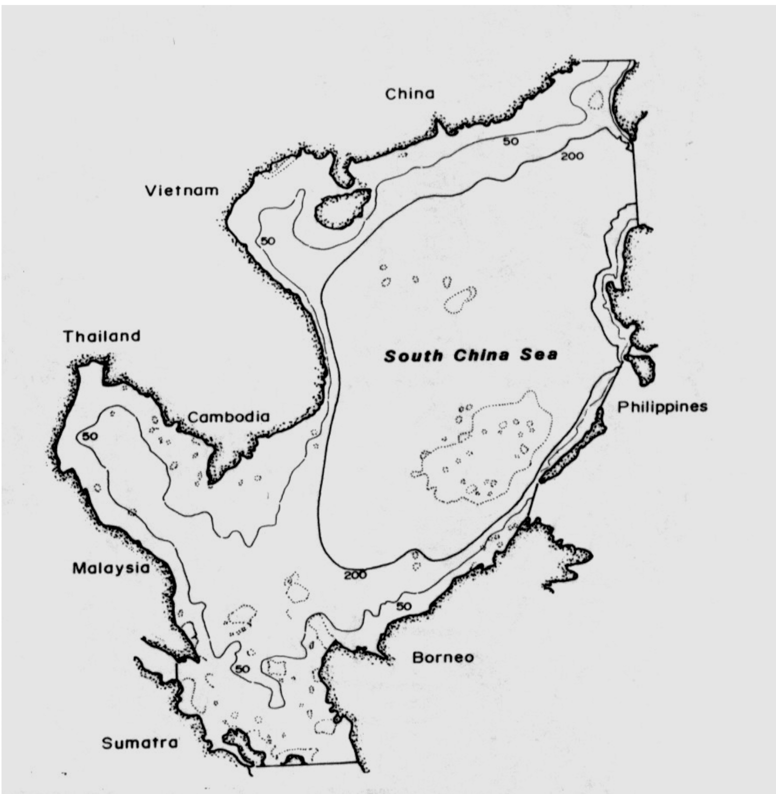

Figure 1. The South China Sea. (Source: Pauly and Christensen 1993)

Figure 2. The people of East Asia. (Source: PEMSEA 2001)

(Burke et al. 2001). Despite the diversity of cultures in the region many of its people share many common cultural heritage both mundane and sublime. It has been observed to have the highest regional economic growth as per change in real Gross Domestic Product (GDP) (Fig. 4). In this context, of the six trans-border regions (TBR) of economic growth seen in the EAS, four of which are situated within the South China Sea rim (Fig. 5).

Though it may seem that an arbitrary boundary exists, around 5 large marine ecosystems (LMEs) have been identified with two significant riverine systems (Fig.

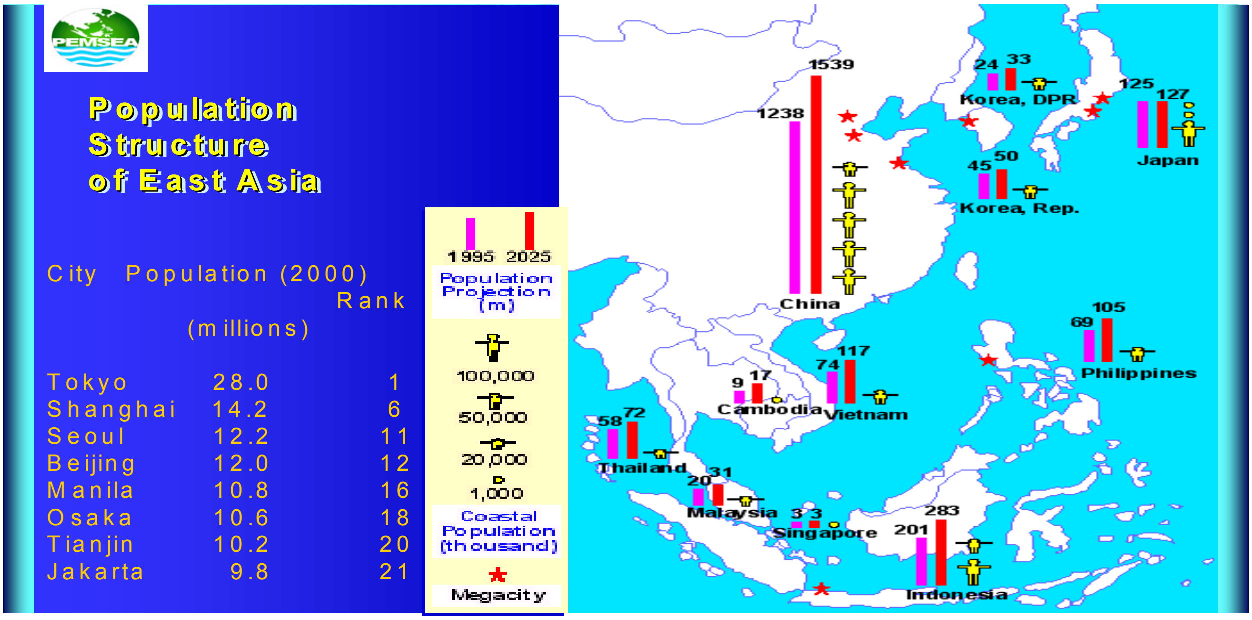

Figure 3. Population structure of East Asia. (Source: PEMSEA 2001)

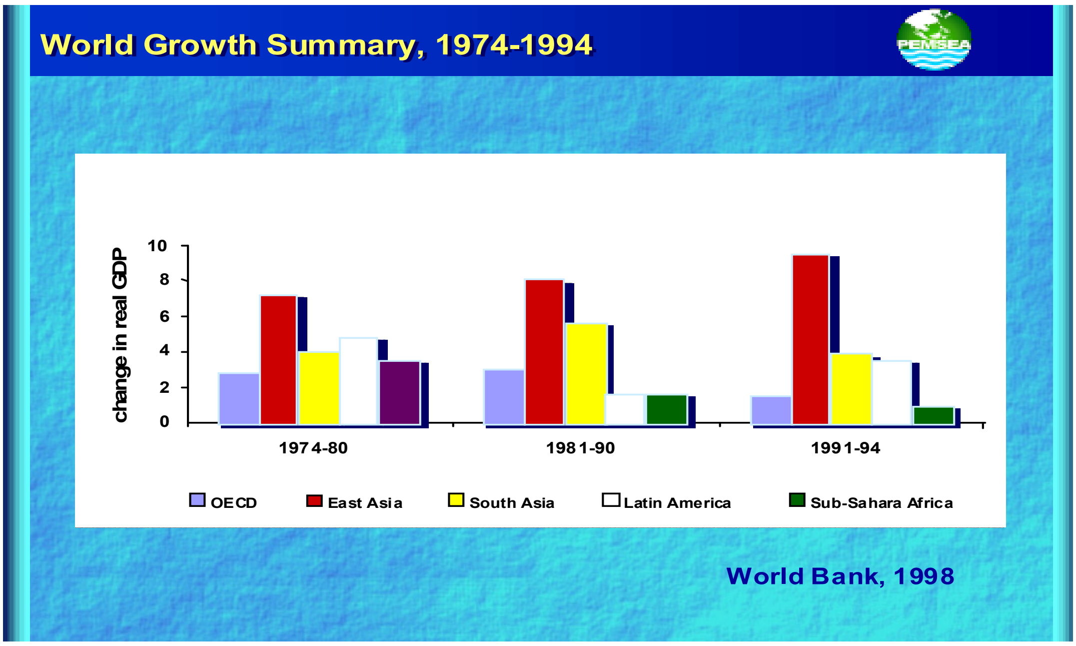

Figure 4. World growth summary (1974-1994). (Source: PEMSEA 2001)

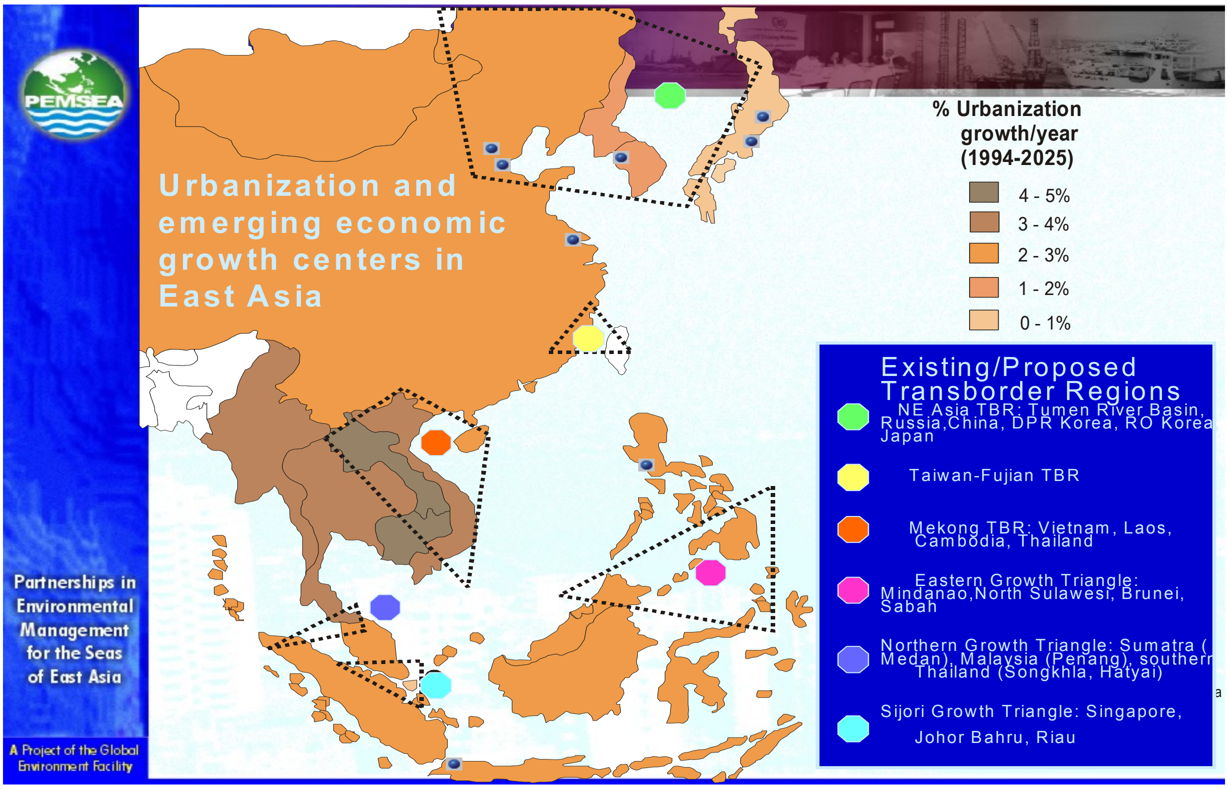

Figure 5. Urbanization and emerging economic growth centers in East Asia. (Source: PEMSEA 2001)

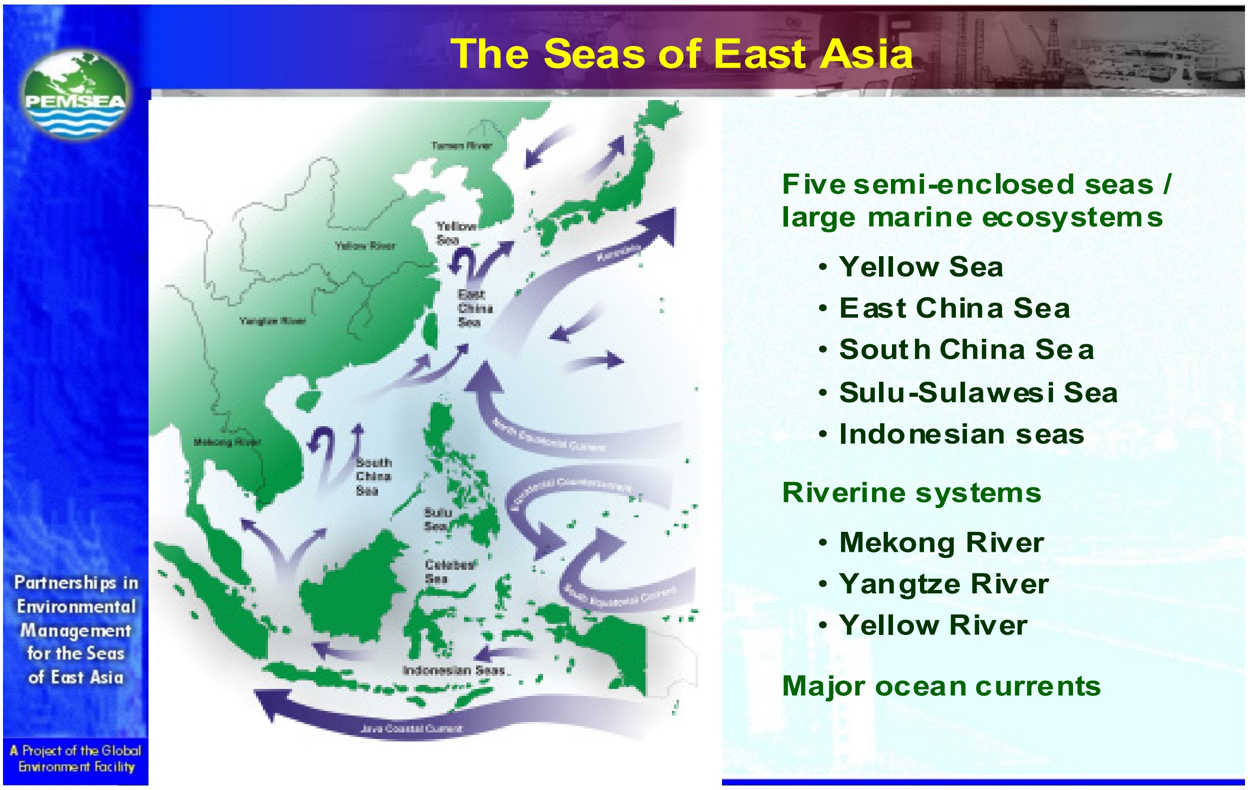

Figure 6. The seas of East Asia. (Source: PEMSEA 2001)

6) (PEMSEA 2001). Despite the seemingly arbitrary nature in delineating the LME subregions, various pathways of connectivity occur across the boundaries. Some of these pathways are seen for example through hydrographic - meteorological - oceanographic - linkages that mediate dynamics of nature of the ecosystems' productivity and movement of its bio-physical resources (Table 1).

Indeed, the seas and oceans offer more of a linkage than a barrier to its people and its ecosystems.

Table 1. Selected statistics relevant to fisheries development in Southeast Asia. (Source: Pauly and Chua 1988)

A	B	C	D	E	F	G	H	I
Brunei	5.80	163	0.2	2.4	12 000	3	3	0.5
Burma	677	2 800	37	2.2	200	443	400	1.0
Indonesia	1919	36 800	169	2.2	500	1600	900	130
Kampuchea	181	435	6.2	2.1	95	51	27	1.3
Malaysia	329	3 400	16	2.2	1 800	726	523	76.5
Papua New Guinea	462	10 000	3.3	2.7	800	13	11.2	1.0
Philippines	300	17 500	57	2.5	800	127	704	55.7
Singapore	0.62	140	2.6	1.1	6 500	191	17.1	0.0
Thailand	5.40	2 580	53	1.9	700	2100	1770	174
Vietnam	330	2 310	61	2.5	170	505	250	49.1

A. Country, ASEAN countries are in italics.
B. Area in km$^2 \cdot 10^3$ (3).
C. Coastline length in km (4–6).
D. Population in millions (3).
E. Annual population growth rate (in percent) during period 1977–1984 (3).
F. Annual per capita income (USD) (7).
G. Annual marine landings in metric tons $\cdot 10^3$ (8, 9).
H. Demersal component of marine landings in metric tons $\cdot 10^3$ (8, 10–12).
I. Penaeid shrimp production in metric tons $\cdot 10^3$ (11, 13–16).

MARINE ECOSYSTEM VALUES

Though much of the global coastal and marine ecosystems goods and services have often been undervalued (Fig. 7) (Costanza et al. 1977) some of the estimates highlight the unique significance of this region. In this region is found the highest marine biodiversity of the world (Fig. 8). Consider for example that in this area of highest marine diversity, around 2,500 fish species are found (e.g. the Philippines) while in Australia around 1,500 is estimated and only a third in the Carribean (Thresher 1992; PEMSEA 2001). This is consistently seen in other taxa such as for the scleractinian corals with

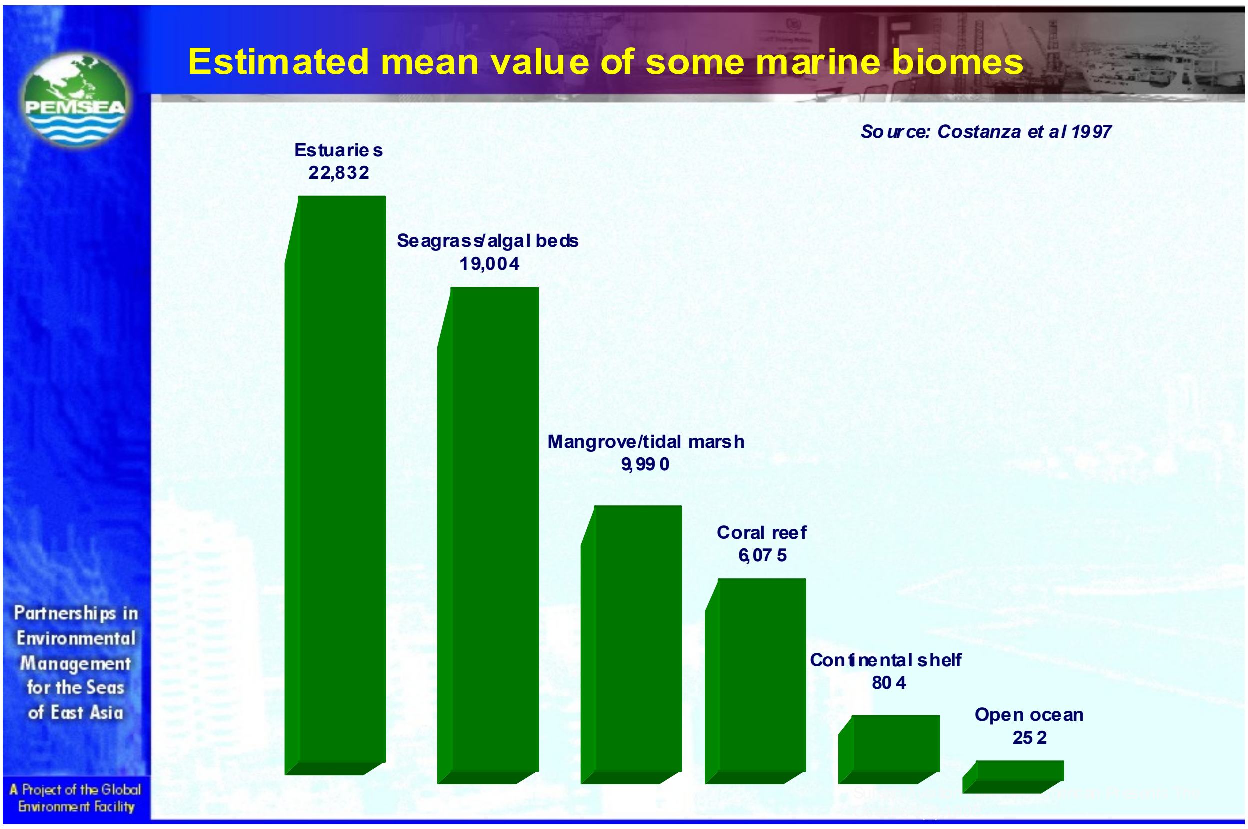

Figure 7. Estimated mean value of some marine biomes. (Source: PEMSEA 2001)

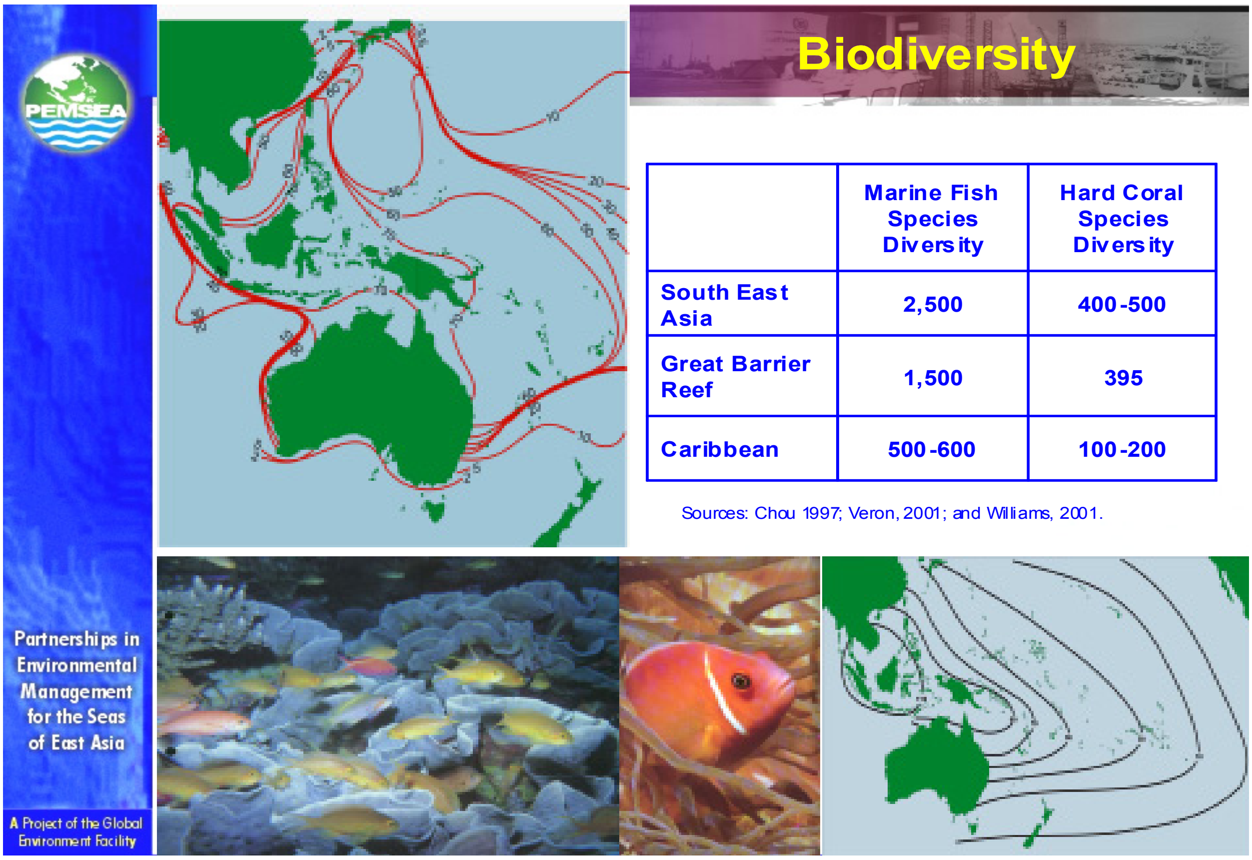

Figure 8. Biodiversity in Southeast Asia. (Source: PEMSEA 2001)

over 400 species while in the GBR would be around 400 species and only half as much in the Carribean (only 100-200 species; Veron 1995). Though the significance of the high biodiversity remains to be fully appreciated, the diverse ecosystems of Southeast Asia such as its coral reefs have been estimated at around $112.5 billion a year (Ruitenbeek 1999).

THREATS TO THE MARINE ENVIRONMENT AND RESOURCES

The marine ecosystem values provide an important life support system to the coastal states especially through food from fisheries. Estimates for the South

Table 2. South China Sea countries' share in world imports of fishery products, in USD 1,000 (data from Ferdouse 1994) (Source: Talaue-McManus 2000)

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**

Table 3. Marine production in the participating South China Sea. (Source: Talaue-McManus 2000) 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.

China Sea would be at least 10 million tons per year and occupies at least 4% (except China) share in the world imports of fishery products worth at least $45 billion (Table 2-3) (ca. 1995, Talaue-McManus 2000).

But perhaps nowhere else in the marine regions of the world, considering the rich biodiversity and dependence on the fisheries, that its fisheries are in a severe state of overexploitation (GIWA 2001). Both the Sulu-Celebes Sea and the South China Sea have rated overfishing and destructive fishing as its priority concerns. Considering the rate of population growth and the rate of fisheries exploitation in these two LMEs it has been projected that conditions will not improve in the next 20 years and may even decline (GIWA 2001). Habitat loss and modification have

Mangroves

- Mangrove loss in the ASEAN region range from 20 - 75 % of its original cover
  - Source: WRI, UNEP, UNDP and WB 2000

- In many countries of SE Asia, conversion to shrimp and fishponds used to be one of the major threats to mangroves

Figure 9. Mangrove areas have been reduced to as much as half of its original cover since the early 1900s. (Source: WRI, UNEP, UNDP and WB 2000)

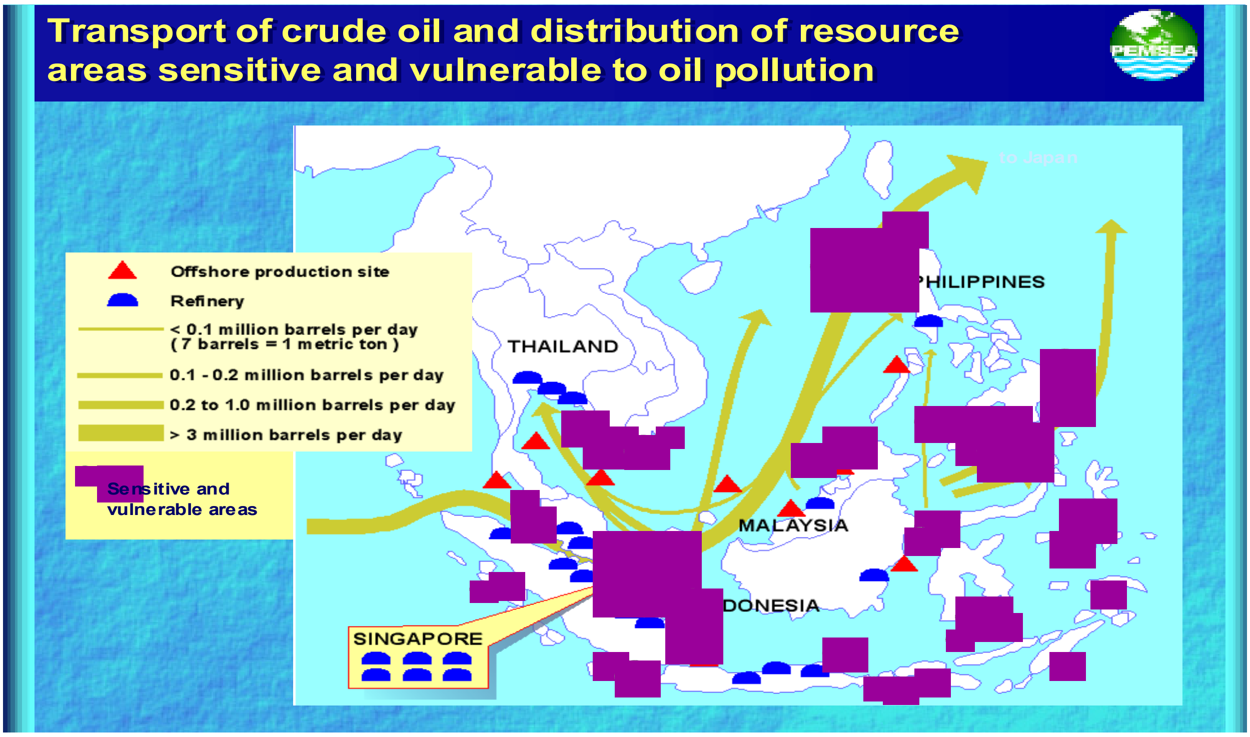

Figure 10. Transport of crude oil and distribution of resource areas sensitive and vulnerable to oil pollution. (Source: PEMSEA 2001)

been ranked as equally severe based on the poor state of its coral reef habitats and the loss of mangroves. Consider that nearly 70% of the mangroves have been destroyed in the last half decade, with more than two thirds decreasing in only the last two decades (Fig. 9) (WRI, UNEP. UNDP and WB 2000). It is ironic that the most diverse reefs which are found in the region, is the most threatened in the world (Bryant et al 1998). Almost all the reefs in the Philippines are at risk and around 70% are at risk in Indonesia. Sedimentation and silt runoff resulting from poor land-use (e.g. inappropriate agriculture practices and deforestation), remain the highest priority concern related to pollution (GIWA 2001). In the South China Sea, transport of crude oil is a threat to sensitive and vulnerable areas, considering the associated occurrence of oil spills in the last decade (Fig. 10).

Table 4. Fisheries potential of the South China Sea (modified after Pauly and Christensen 1993). (Source: Talaue-McManus 2000)

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**

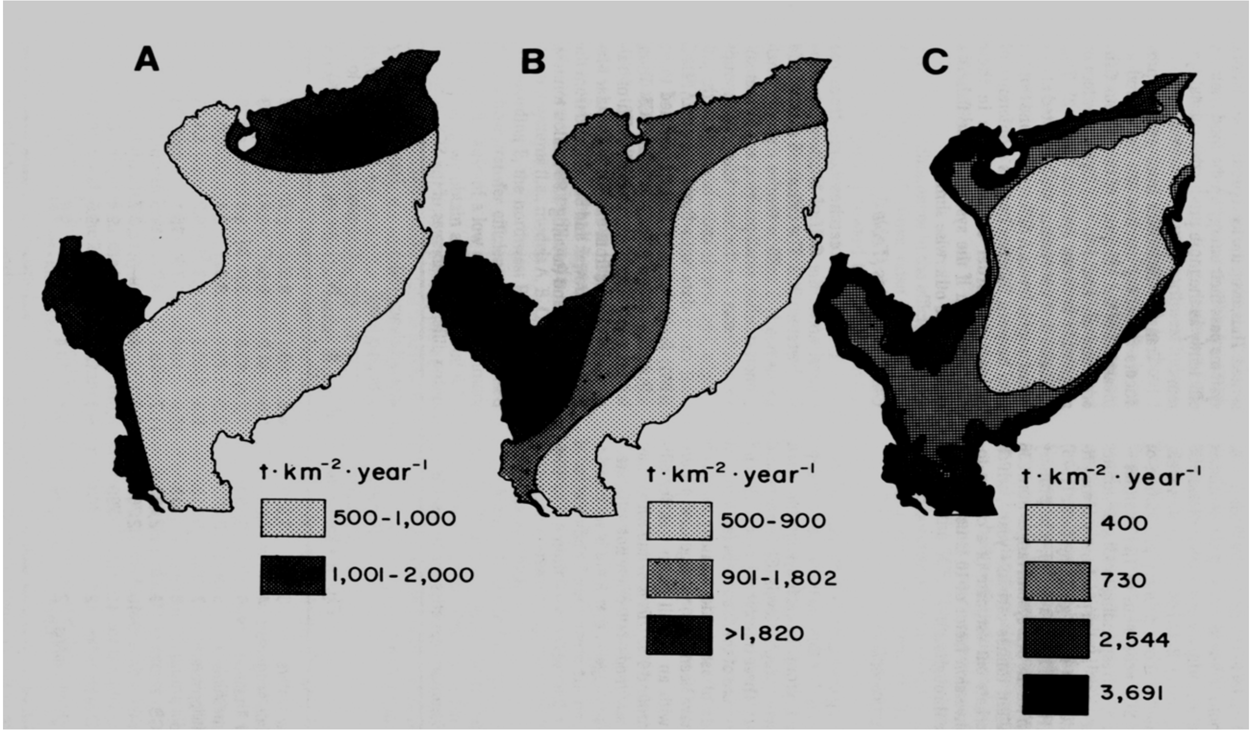

Figure 11. Mean annual distribution of primary production in the SCS. Map A, adapted from Lieth (1975), suggests a primary production of 3.36 x 10^9 tonnes carbon per year for the entire SCS. Map B, adapted from FAO (1981), suggests a total primary production of 4.2 x 10^9 tonnes carbon per year if one assumes, as in Leith (1975), an upper limit of 2,000 tonnes km^{-2} year^{-1} for the Gulf of Thailand and adjacent areas. Map C presents our depth-based stratification; the correponding estimate of total production is 4.0 x 10^9 tonnes, within eange of the other two estimates. (Source: Pauly and Christensen 1993)

Estimates of the fisheries potential in the South China Sea have been gauged based on the reported catch statistics and evaluation of primary production values from its' various habitats (Table 4, Fig. 11) (Pauly and Christensen 1993; Talaue-McManus 2000). Its high potential is seen by its significant contribution to the world's production (i.e. greater than 20%) of major tuna species by principal fishing nations (Table 5) (Talaue-McManus 2000). Unfortunately, based on these reports much of the capture fisheries potential is already fully exploited (Table 4) (Pauly and Christensen 1993; Aliño et al. 1998; Talaue-McManus 2000).

Table 5. World production of major tuna species by principal fishing nations (1988-1993) (data from Peckham 1995). (Source: Talaue-McManus 2000)

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%**

Table 6a. Selected statistics for tropical developing in Asia. (Sources: ADB 1995, 1996; WRI 1995 in Silvestre and Pauly 1997)

Country	Population (x 10^6; 1996)	Per Capita GNP (US$; 1995)	Land Area (x 10^3 km^2)	Exclusive Economic Zone (EEZ) (x 10^3 km^2)	Continental Shelf (0-200 m depth) Area (x10^3 km^2)	As % of EEZ
Bangladesh	124.0	283	144.0	76.8	55	72
Brunei Darussalam	0.3	20 400	5.8	38.6	9	22
Cambodia	10.2	215	181.0	55.6	15	27
India	943.7	335	3 287.6	2 014.9	452	22
Indonesia	197.6	940	1 904.6	5 408.6	2 777	51
Malaysia	20.6	3 930	329.8	475.6	374	79
Maldives	0.3	900	0.3	959.1	-	-
Myanmar	47.7	890	676.6	509.5	230	45
Pakistan	133.2	465	796.1	318.5	59	18
Philippines	69.3	1 130	300.0	1 786.0	178	10
Sri Lanka	18.2	660	65.6	517.4	27	5
Thailand	61.4	2 680	513.1	257.6	86	33
Vietnam	76.3	250	331.7	722.1	328	45
Total	1 702.8	-	8 536.2	13 140.3	4 588	35

SOCIAL AND ECONOMIC CONSEQUENCES: THEIR PROBABLE CAUSES

The reduction of the value of the marine ecosystems redound to lowered food security in the region which may lead to reduced supply of cheap protein (Bernaseck 1996). Consequently these could lead to a greater incidence of malnutrition. Deficits in fisheries productivity have been suggested to result in transmigration and eventually leading to social conflicts. Much of these consequences have been considered to be driven by the overcapitalization of the fishery and an undervalued ecosystem goods and services. One of the important quotes cited in humankind's folly as seen in fisheries is "the tragedy of the commons" Hardin (1968). This tragedy is exacerbated both by the dire economic deprivation of the majority of the developing states in this region and the high population growth (around 2-4%). The wide disparity in income distribution in the coastal zone further contributes to conflicts of interests due to their inequitable access to the commons these has

Table 6b. Selected 1994 fisheries statistics for tropical developing countries in Asia. (Sources: FAO 1994; Hotta 1996 in Silvestre and Pauly 1997)

Country	Total fisheries production (x 10^3 t $year^{-1}$)	Marine fisheries production (x 10^3 t $year^{-1}$)	Fishery exports (US$ x 10^6 $year^{-1}$)	Per capita fish consumption (kg·$year^{-1}$)	Number of fishers (x 10^3)
Bangladesh	1 091	251	240	8.2	55
Brunei Darussalam	6	6	-	21.9	2
Cambodia	103	30	14	12.0	75
India	4 540	2 420	1 125	4.0	3 837
Indonesia	4 060	2 970	1 583	15.5	1 523
Malaysia	1 173	1 053	325	29.5	100
Maldives	104	104	37	126.0	22
Myanmar	824	599	103	15.5	696
Pakistan	552	418	153	2.2	308
Philippines	2 657	1 666	533	36.1	733
Sri Lanka	224	211	32	16.3	98
Thailand	3 432	2 798	4 190	25.3	61
Vietnam	1 155	817	452	13.4	266
Total	19 921	13 343	8 787	8.7	7 777

also led to the disenfranchisement of the poor in the political economy of the mainstream of society. The inability of fishers and other stakeholders to get out of the loop of poverty and deprivation is also related to weak ecosystem governance due to the weak state's capabilities. Poor institutional arrangements needs to be addressed such as in lack of an effective monitoring, control and systems. In addition, distorted interactions of the public and private sector relations to the market forces further leads to the deterioration of ecosystem governance. In future, the uneven playing field for sustenance fishers can be of great concern with further globalization thrust in the region.

INITIAL OPTIONS AND RESPONSES FOR THE FUTURE

Considering the issues and concerns for the East Asian Seas Region, urgent and effective action has been the call from governments and civil society (Dight et.al 1998). Some regional programs are underway to address these concerns by formulating various Strategic Action Programs (SAP) [UNEP 2001, PEMSEA 2001 and GIWA 2001). These have been laudable efforts and are achieving some headway. Yet there seems to be a prevailing pessimism in the prospects of achieving some concrete gains to actually reverse the projected decline in the degradation of marine ecosystems and overexploitation cycle (GIWA 2001). A silver lining seems to be noted, despite the apparent decline that may be projected by the year 2020 the generally growing positive movements in the realm of environmental management albeit requiring more time to achieve the desired outcomes (i.e. around 2050, GIWA 2001). Aside from the proposed strategies mentioned earlier, some supplementary thoughts may be germane to the issues raised. Some of the constraints in the suggested strategic action programs are the following: 1) its main emphasis on the environmental sphere with less active aspects on the political economic dimensions; 2) equity concerns have also been poorly addressed; and 3) the development trajectory of coastal societies have to be well integrated into the strategic ecosystem governance agenda.

TESTING THE WATERS AND APPLYING THE LESSONS LEARNED

An area of overlapping claims among six coastal states (Brunei, China, Malaysia, Philippines, Taiwan and Vietnam) in the region is the Spratly's, found in bosom of the South China Sea (Fig. 12). It is in this area where the combined learnings from the lessons learned from each of these claimants are put to a test. Pauly and Christensen (1993) estimates show that the fisheries in the area are on the verge of being overexploited.

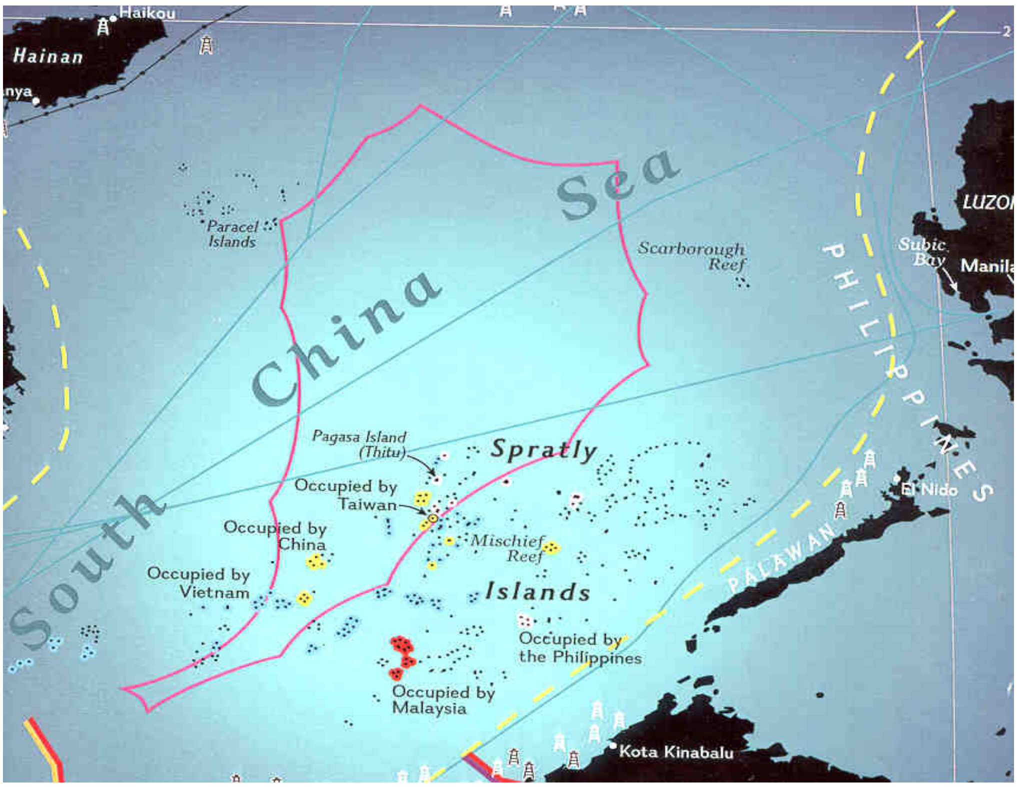

Figure 12. Conflicting claims in the South China Sea. (Source: Schadwick 1999)

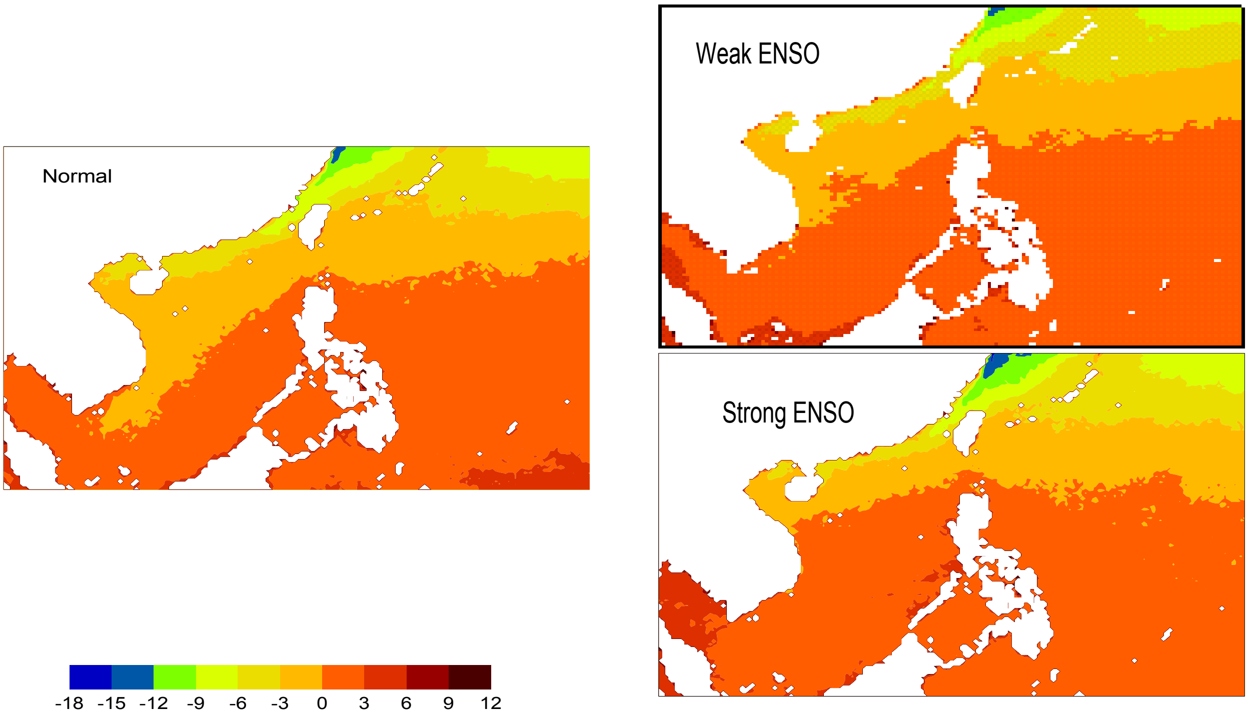

Figure 13. El Niño Southern Oscillation (ENSO) and surface temperature anomalies. (Sources: ERS-AMI and ADEOS-NSCAT in Salamante and Villanoy 2000)

Its global value as reef complex is perhaps comparable to the Great Barrier Reef in Australia together with its crucial lifesupport system in fisheries, trade and navigation have been well recognized (McManus 1994, Aliño et al. 1998). Though much of the ecosystem threats have relatively been less pronounced in this area (e.g. habitat deterioration, destructive fishing and overexploitation) the transboundary concerns both in the living and non-living resources make it a paramount global hotspot in the future. These human induced threats have been suggested to interact with natural threats (e.g. ENSO and storms) (Figs. 13-14) This can be observed by the differential recovery of

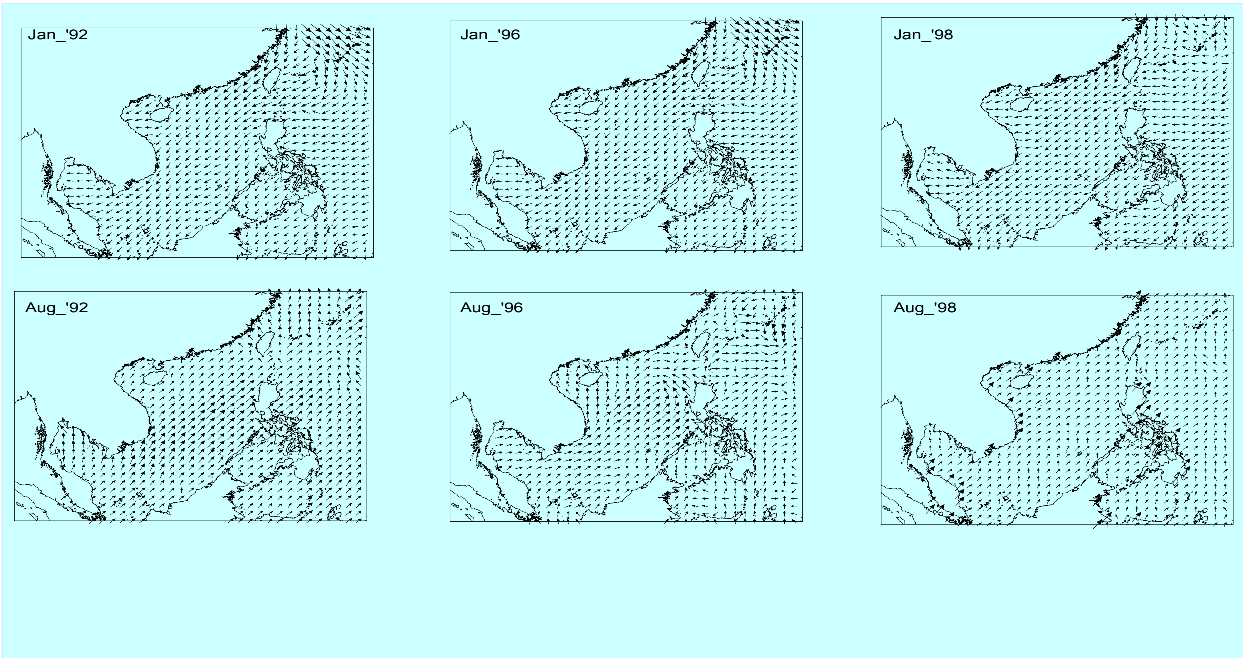

Figure 14 Moonthly wind stress field for weak ENSO (1992), Non-ENSO (1996) and strong ENSO (1998) (Source: Salamante and Villanoy 2000)

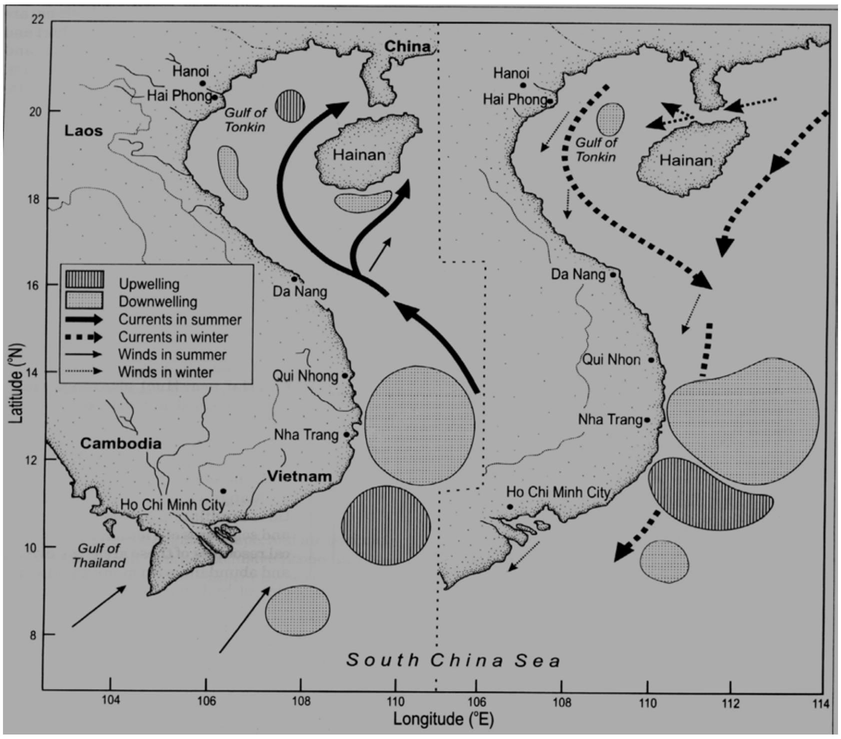

Figure 15. Sea surface currents, upwelling and downwelling areas in Viet Nam. (Source: Thuoc and Long 1997)

reefs after the bleaching event and the effects of ENSO in the upwelling regions in the South China Sea (e.g. off the coast of Vietnam and NW Philippines) (Fig 14-15).

The Spratly's has been identified as crucial source of larvae of the coastal states in this region and thus has been proposed as world heritage site (McManus 1994, WCPA 2000). Recent scientific information based on some fish species indicate that indeed shared genetic affinities between the Kalayaan Islands (part of the disputed areas) and those of the Philippines

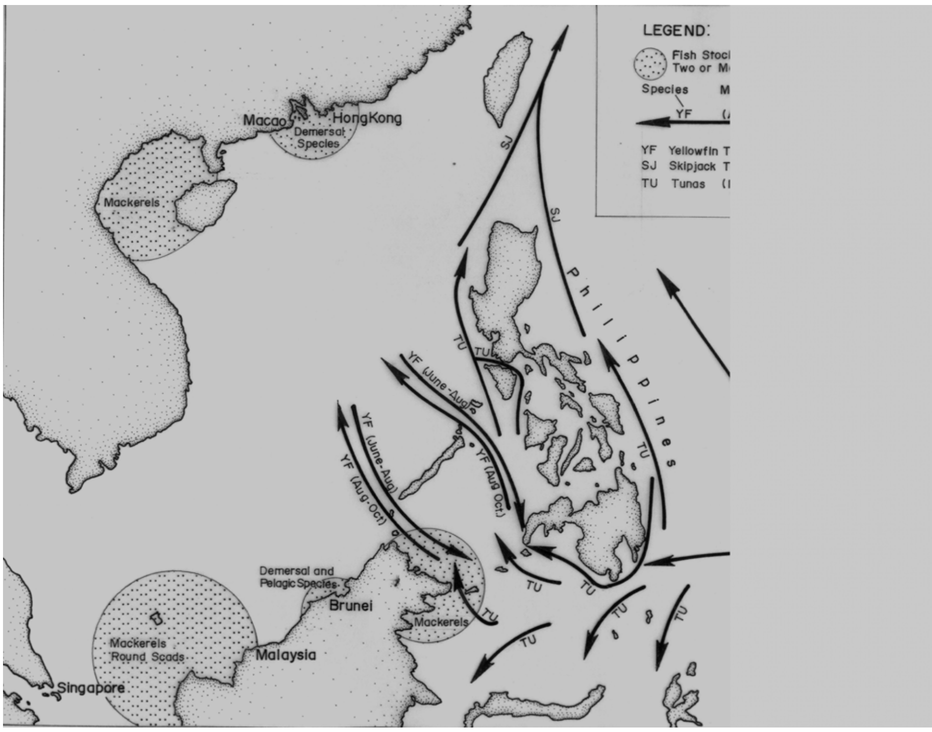

Figure 16. Inferred migratory route of some tuna species passing through the Philippines. (Source: Morgan and Valencia 1983)

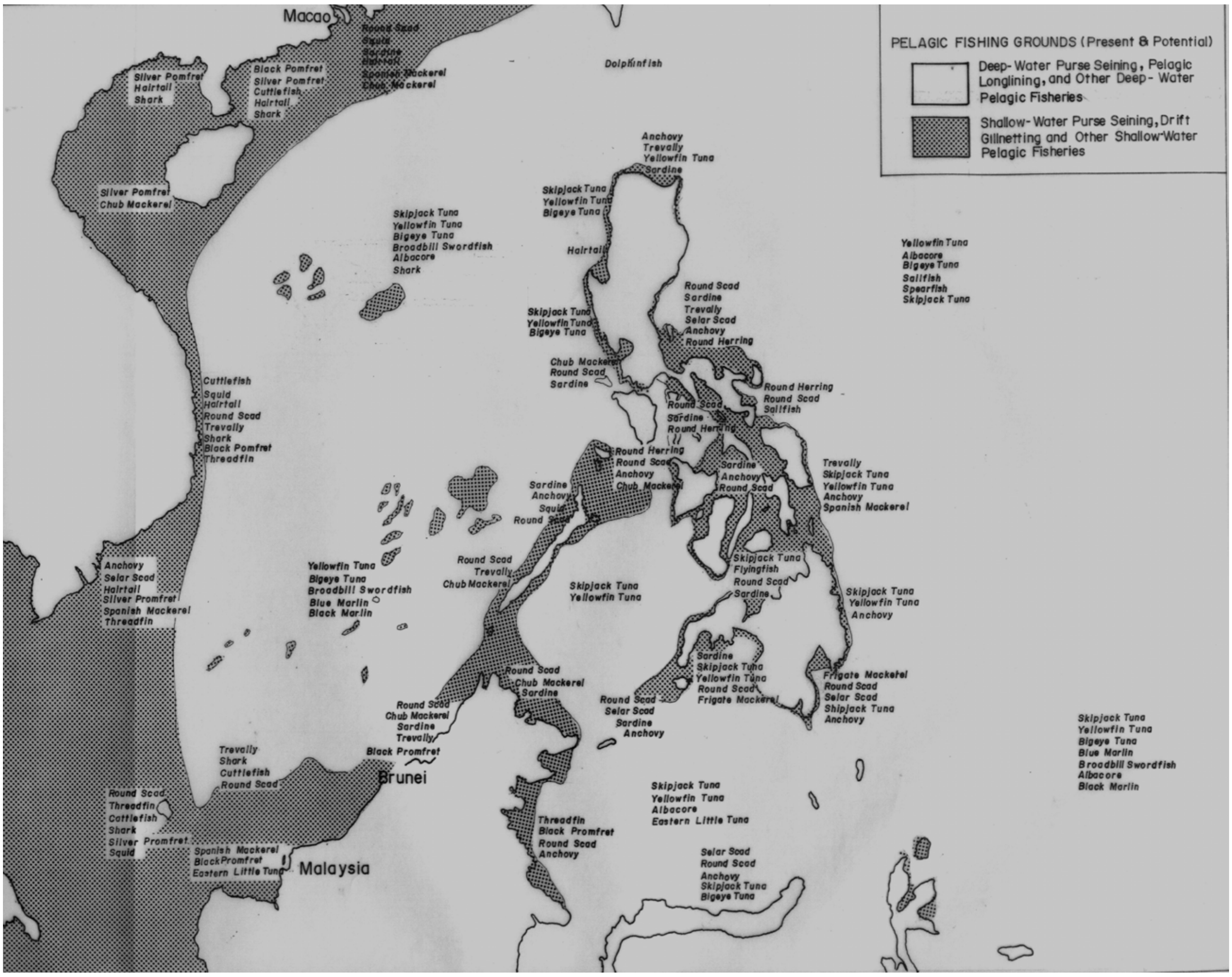

Figure 17. Some shared pelagic stocks around the Philippines espaecially in the South China Sea. (Source: Morgan and Valencia 1983)

(Ochavillo et al. 2000). Figs 16-17 show shared stocks and migration route of tuna.

Initial seeds of hope have been planted by the joint cooperative expeditions undertaken by the Philippines and Vietnam (JOMSRE 1996 and 2000). The world heritage proposal can be a golden opportunity to establish stewardship arrangements through international linkages. Learning from the understanding of the marine biodiversity shows how imperative we should cooperate and share our responsibilities to this common heritage and our future together. Initiating adaptive management efforts at each of the national fisheries management councils, by improving monitoring, control and surveillance systems based on an ecosystem framework for management could be a good start. It is with hope and perseverance that the actions at the local levels translate to the broader understanding and shared stewardship of the larger marine ecosystem of the South China Sea. Maybe in this light we can make the many Strategic Environmental Plans and Scientific Action Programs being formulated in the region be undertaken urgently and a reality of sustainable development. Perhaps we can emulate some regional cooperation models such as the Antarctic Treaty as proposed by McManus (1994) or have annual joint regional scientific, management, trade and management councils akin to that of the International Council of Exploration of the Sea (ICES).

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