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The Overfishing of Marine Resources: Socioeconomic Background in Southeast Asia

Article

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A brief review of marine fishery development in Southeast Asia is given, with emphasis on the phase of rapid growth of catches that prevailed in the 1960s–1970s, and on the high expectations this phase generated, especially in the six countries that make up the Association of Southeast Asian Nations (ASEAN). The problems of the 1980s are related to stagnating or even declining catches and serious environmental problems in coastal zones, aggravated by above-average growth of coastal populations. Environmental interventions (e.g. construction of artificial reefs; replanting of seagrasses and mangroves; conducting environmentally benign forms of coastal aquaculture; etc.) are proposed as necessary complements to any fishery-management or pollution-control scheme.

HISTORICAL AND SOCIAL BACKGROUND

On June 30, 1597, Antonio de Morga wrote to King Philip II of Spain, in his report on "Conditions in the Philippines" (1) that: "Fish is the most abundant and most general food supply. The Indians (*sic*) do not occupy themselves, as formerly, in fishing but leave this work to the Chinese. These (...) interested people have raised the prices, an evil that must be restrained and checked." also: "Fishing is done with 'salambaos' and with fine-meshed nets, with which they block up the bay and kill the small fish. These nets ought not to be employed and the size of fish will not be exhausted; for already experience has demonstrated that they are not so abundant as formerly." These fascinating quotes, now almost 400 years old, incorporate nearly all the problems presently occurring in Southeast Asia in relation to fishery research and management. These problems include:

- Descriptive, rather than quantitative accounts of fisheries as the basis of administrative intervention.
- Near-zero understanding of fisheries economics.
- A tendency for prejudices, especially those of the long lasting, ethnic sort, to short-circuit the painstaking task of differentiating causes from their effects.

As defined in this article the Southeast Asian Region is from Burma in the northwest to Papua New Guinea (PNG) in the south-east; the "core" of this region is comprised of the six members of the Association of Southeast Asian Nations (ASEAN); i.e. Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand (Figure 1).

In discussing Southeast Asian development we refer principally to these six countries, while the other four countries listed in Table 1—linked geographically, historically and culturally (2) to the ASEAN countries—are used here as background.

Following centuries of close relationships between Southeast Asians and the sea, and a wide dependence on its products for their sustenance (17–19), some first attempts to initiate "fishery development" in the modern sense were introduced, at the beginning of the present century. These first efforts were made in what is now Indonesia (20). Following World War I these efforts were extended to Kampuchea and Vietnam (21), the Philippines (22), and present day Malaysia and Singapore (23). These early attempts were prompted by different, and largely incompatible interests, for example; Japan's need for fish for consumption in Japan, and the need for larger quantities of cheap food for consumption within colonized Southeast Asia, e.g. for the plantation workers.

The early Japanese efforts have been documented by Shindo (24). However, only scattered anecdotes exist on the colonial efforts (20–23), which still need to be integrated into a comprehensive history of the region.

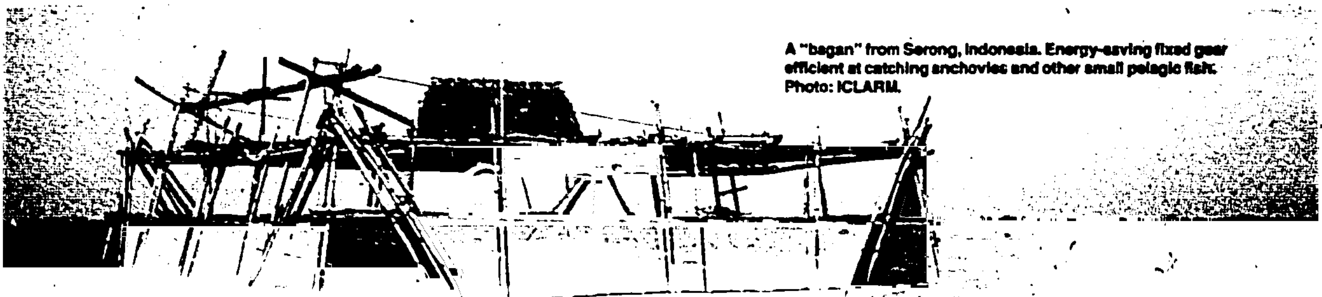
The destruction brought about by World War II, the readjustments following Independence, in the Philippines (1946), in Indonesia (1949), and in Malaysia (1957), and the temporary rollback of Japanese influence in the Southeast Asian region all contributed to very low fisheries catches in the second half of the 1940s and early 1950s. However, fishery development from the mid-1950s onward was very rapid, and was initially based on sources of capital and expertise from outside Southeast Asia. These sources included:

- Colonial administrations, where these had lasted beyond the late 1940s, as was the case in what are now Malaysia, Singapore, and Brunei (25–28).
- The technical cooperation agencies of several Western developed countries; e.g. the German Agency for Technical Cooperation (GTZ), the United States Agency for International Development (USAID), the UK Overseas Development Administration (ODA), and their sister agencies and predecessors.
- The Asian Development Bank (founded 1966).

Table 1. Selected statistics relevant to fisheries development in Southeast Asia.

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).



A "bagan" from Serong, Indonesia. Energy-saving fixed gear efficient at catching anchovies and other small pelagic fish. Photo: ICLARM.

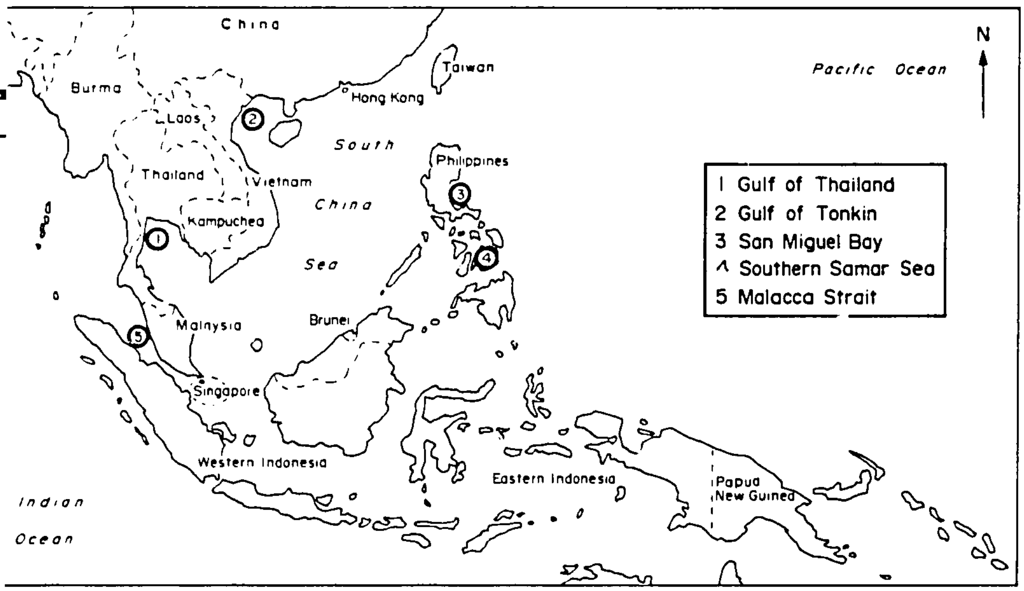


Figure 1. Map of Southeast Asia, showing some important fishing grounds mentioned in the text.

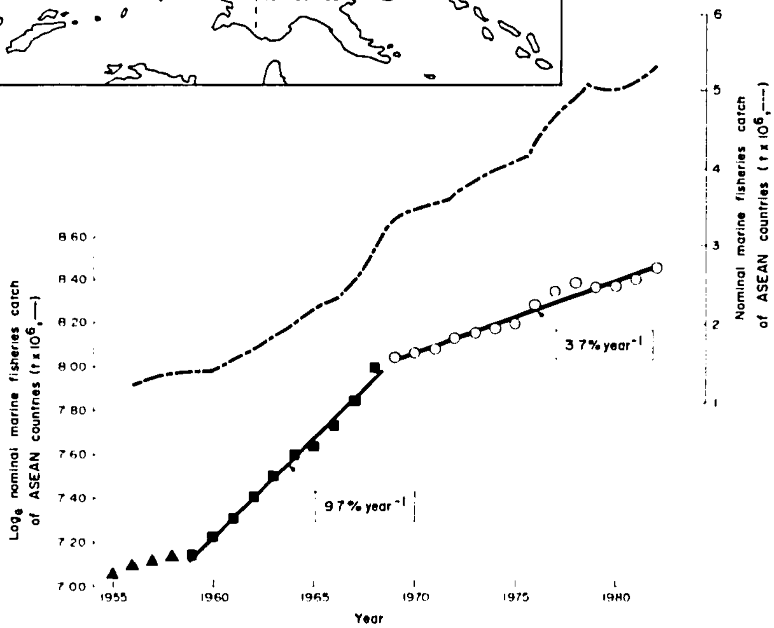


Figure 2. Evolution of nominal marine fisheries catches in the six member states of ASEAN, 1955 to 1983, based on FAO catch statistics; annual data smoothed using a 3-year running average to emphasize interannual trends.

The aggregate impact of the measures taken was stunning. Marine catches in the six ASEAN countries rose from about 1.5 million tons per year in the early 1960s to about 5.5 million in the early 1980s—an almost fourfold increase (Figure 2). This increase, predictably, occurred at different rates in different countries. Nevertheless, two major phases can be distinguished (Figure 2). The first phase covered the period from 1959 to 1968, during which time overall ASEAN catches increased by almost 10 percent per year. The second phase lasted from 1969 to the mid-1980s, during this period catches rose on an average by 3.7 percent per year. The very high rate of increase prevailing in the 1960s was largely due to conditions in the Gulf of Thailand (29), into which trawl-fishing methods—first developed in the Philippines—had been transferred by a German team under K. Tiews and from where trawling subsequently "spilled" over to Indonesia and Malaysia (30).

OVERFISHING: CAUSES AND REMEDIES

The Gulf of Thailand demersal trawl fisheries have been rather well-documented (31, 32), and several theoretical models (33) have been constructed that imply prey/predator relationships, other biological interactions, and patterns of changes in species composition that accompanied the reduction of overall stock biomass. Catch rates, proportional to biomass, declined by almost one order of magnitude between 1961 and the early 1980s (Table 2).

However, principal-component analysis of the data in Table 2 shows that over 60 percent of the variance in the data set can be explained by the first component, attributable to the effect of fishing (35). This confirms and extends a previous analysis by Pope (36) who found that 70 percent of the variance could be explained by the first principal component. Pope's analysis was based on a subset of the data in Table 2, covering the years 1963–1975.

This finding is also in line with the growing consensus among fishery biologists working on tropical multi-species stocks; i.e. that complex biological interactions, although they may play a role, need not be invoked to explain the gross changes in the structure of exploited bottom-fish communities (33). Rather, the effects of the gear itself on the populations of differently-sized and differently-shaped fish that it exploits, and on their bottom habitats, which it modifies, appear sufficient to explain most of the observed changes (37).

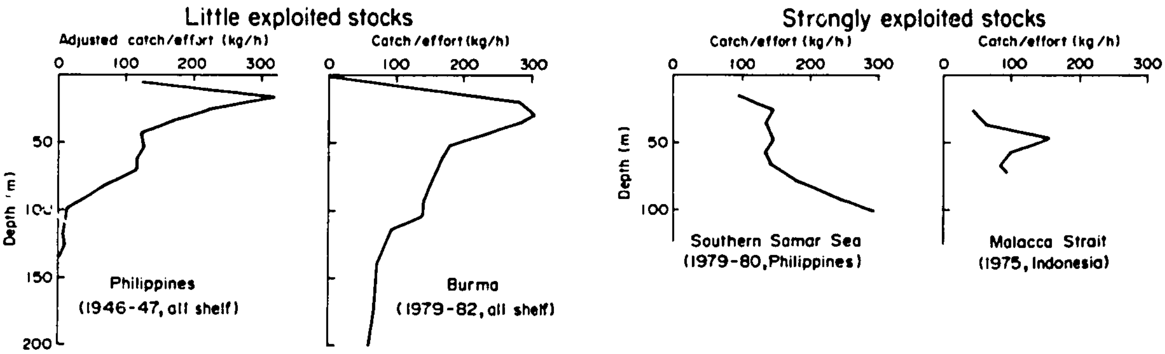
The period of rapid growth of ASEAN fisheries catches in the 1960s is psychologically important, because at that time—when the leaders of present day Southeast Asia were being formed—putting more trawlers into the water, or putting engines onto previously unmotorized boats did indeed increase catches. There was, and still

Table 2. Mean catch composition (in kg per trawling hour) during surveys conducted by R/V Pramong 2 and R/V Pramong 9 in waters <50 m of the Gulf of Thailand (For figures for all years 1961–1982 see reference 34).

Groups identified	1961	1963	1970	1975	1980
Leiognathidae	53.00	71.50	10.25	2.53	(3.09)
Carangidae	44.00	19.70	9.08	2.34	2.35
Nemipterus spp.	35.00	18.40	8.61	5.89	4.73
Sciaenidae	1.00	18.30	1.46	3.12	0.40
Mullidae	1.00	16.10	3.77	1.60	0.78
Rays	[14.89]	14.80	2.86	1.14	0.17
Saurida spp.	15.00	11.30	6.64	1.65	3.39
Tachysuridae	10.00	7.40	1.44	0.33	0.24
Loligo spp.	[2.14]	6.10	8.55	6.42	6.98
Scolopsis spp.	4.00	7.60	2.62	0.74	0.55
Priacanthus spp.	5.00	5.60	[illegible]	2.10	4.09
Sharks	[2.11]	2.10	0.75	0.14	0.05
Sphyraena spp.	3.00	2.10	1.43	0.16	0.29
Thenus spp.	3.00	2.00	0.19	0.03	0.01
Lutjanidae	3.00	1.50	2.25	0.43	0.47
Plectorhynchidae	2.00	1.30	0.63	0.11	0.20
Trichiuridae	10.00	0.90	0.94	2.87	0.39
Serranidae	2.00	0.80	0.86	0.45	0.63
Rastrelliger neglectus	(0.96)	0.80	1.54	0.14	0.17
Crabs	(0.84)	0.70	1.32	1.00	1.05
Lactarius lactarius	2.00	0.60	0.02	0.00	0.00
Shrimps	(0.72)	0.60	0.15	0.16	0.42
Pomadasys spp.	(0.48)	0.40	0.16	0.01	0.02
Scomberomorus spp.	0.20	0.40	0.56	0.30	0.52
Pampus spp.	(0.48)	0.40	0.09	0.03	0.02
Psettodes erumei	(0.48)	0.40	0.56	0.36	0.20
Chirocentrus spp.	(0.24)	0.20	0.23	0.13	0.24
Rachycentron canadus	(0.24)	0.20	0.22	0.02	0.07
Lethrinidae	0.30	0.20	0.25	0.04	0.13
Muraenesox spp.	(0.12)	0.10	0.26	0.30	0.14
Rhinobatidae	(0.50)	(1.18)	0.40	0.09	0.01
Anadontostoma spp.	(0.55)	(0.46)	0.21	[illegible]	0.04
Gerridae	(15.38)	(12.86)	2.55	0.69	0.09
Rastrelliger kanagurta	(0.96)	(0.87)	0.86	0.18	0.25
Bothidae	(1.44)	(1.20)	0.32	0.35	0.00
Cynoglossidae	(0.28)	(0.23)	0.07	0.37	0.14
Sepia spp.	[1.86]	(5.32)	2.62	2.31	1.84
Misc. fish	54.63	14.40	15.14	11.45	13.98
Total catch (including misc. fish)	297.80	248.95	97.24	46.99	48.14
No. of hauls	133	200	718	480	245

Values in round brackets extrapolated using percent in 1963 catch; values in square brackets originally referred to "sharks and rays" and "cephalopods" and were assigned to lower taxa in relation to their values in 1963.

Figure 3. Depth distribution of demersal fish concentrations in Southeast Asian waters, in little exploited and strongly exploited stocks. Note that major concentrations occur at depth of about 30 m in the former stocks (40).



is, a widespread notion that fish resources were infinite and would provide fish as needed for both domestic consumption and export (particularly of shrimp).

Only recently has the failure of successive loan schemes, the persistent (increasing) poverty of small-scale fishermen, and growing conflict within the fishery sector (mainly between small-scale fishermen and trawler operators) begun to influence the thinking of administrators and the fishery development plans they produce (37, 38). Before turning to these issues, however, a few potential misunderstandings must be cleared up, especially in regard to various elements of the latter conflict.

One of the prevailing views in high-latitude countries is that trawlers are large boats that fish far from shore. This is true for a part of the Thai trawler fleet (39), of which some units have operated as far as Oman. The overwhelming majority of Southeast Asian trawlers, however, conform with Ommanney's (25) statement, "that nowhere in tropical countries is there a heavily capitalized mechanized fishing industry such as we find in Europe, America or Japan. Nothing compares with our trawler industry with its costly ships, long voyages and elaborate marketing organization."

What has developed, in fact, are vast fleets of relatively small trawlers some of which, e.g. the "baby trawlers" of the Philippine archipelago, displace only three gross tons. These small trawlers perform short trips (usually one-day trips) and mainly fish close inshore. This is because in Southeast Asian waters, concentrations of demersal (and indeed of pelagic fish also) occur down to depths of only approximately 50 meters (Figure 3), and also because penaeid shrimp, the most valuable part of their catch, occur close inshore (41). Thus, these trawlers usually operate in the only part of the shelf that is accessible to small-scale fisheries, whose fixed gear (gill nets) they often destroy.

In addition, the trawlers in question usually use very small meshes (often two centimeters or less, Figure 4) and a sizeable part of their catch consists of the young of commercially important fish such as snappers, sea bream, etc. (43). Figure 7a shows that increased effort, principally by such trawlers, in the demersal fisheries of the Philippines has completely dissipated the economic "rent", (economic benefits above costs) potentially available from the resources, and is actually in the process of reducing total catches.

Yield per recruit analyses, conducted on the species mixes that typically occur in inshore Southeast Asian waters suggest that mesh sizes of five centimeters and more would be appropriate even if only the high-value shrimps are considered (46). However, traditional management measures patterned after the North Sea "paradigm" such as mesh-size increase and gradual reduction of effort, have usually been impossible to implement throughout Southeast Asia. This has forced fisheries administrators to resort to nontraditional approaches, of which the most prominent ones are, presently, trawling bans (in which the use of demersal

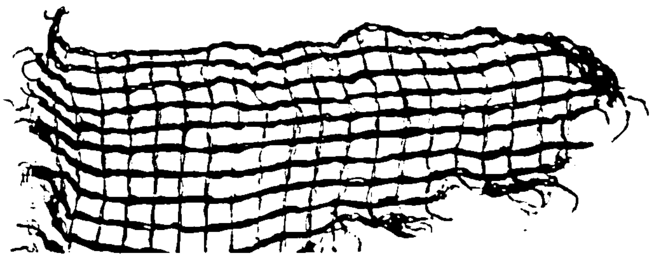
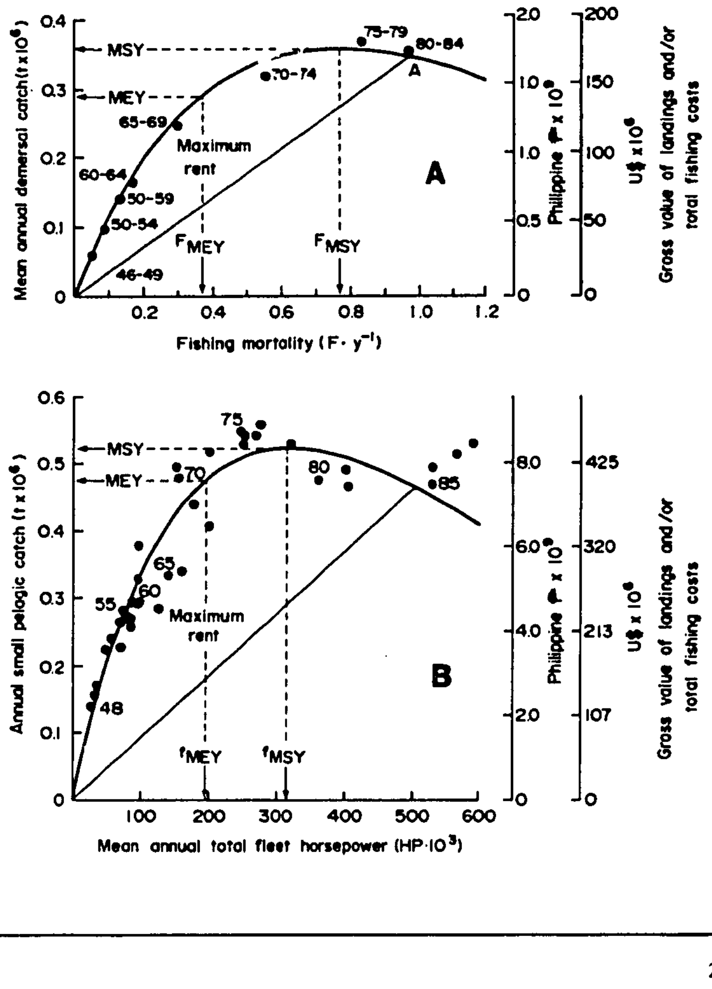


Figure 4. Actual size of material used in various areas of the Philippines to line the cod end of trawlers during the season when anchovies are abundant. The mesh shown here corresponds to 0.8 cm stretched and generates mean sizes at first capture of 2–3 cm (42).

Figure 5. Surplus-production models of the Philippines demersal (A) and small pelagics (B) fisheries showing declining catches from the mid-70s onward, due to excessive effort. Both fisheries would generate higher catches if efforts were reduced, particularly in the case of the small pelagics (anchovies, sardines, roundscads, mackerels, etc.). Both fisheries presently generate pure profits (economic rent, or social benefits) that are probably near zero (i.e. a straight cost line and production curve are assumed to intersect in the early 80s), but a very large rent (at Maximum Economic Yield, MEY) would be extracted if fishing effort and/or fishing mortality were reduced by a factor of 2–3. MSY = Maximum Sustainable Yield (44–45).



trawling gear, used principally for shrimps, is totally banned), and construction of artificial reefs.

An example of a local trawling ban is the ban declared for the Southern Samar Sea, Philippines, in November 1976. This ban appears to have had a positive impact on the fish stock as these increased (47) and a negative impact on total catches as these decreased (48). Strangely, the effect on the catches of the small-scale fishermen who actually demanded the ban is unknown. However, the most spectacular ban so far effected is the Indonesian trawling ban of 1980 (49). The full impact of this particular ban has yet to be fully assessed (38). It is thought that the effects of the ban will probably be negative for overall catches and positive for the incomes of small-scale fishermen.

Generally, the construction of artificial reefs in Southeast Asia has three functions. These functions are ranked differently—according to relevance and importance—for different countries. These functions include (50):

- Preventing inshore trawling.
- Increasing overall inshore production, or reestablishing original production levels.
- Effecting a transfer from active gears and fuel-guzzling operations to passive gears (e.g. gill nets set near artificial reefs) in which the fish "catch themselves."
- Effecting a transition, within populations of coastal fishermen from "hunter" to "rancher," with genuine aquaculture as the long-term goal.
- Achieving a transfer of resources from one segment of the population (trawl operators) to another (small-scale coastal fishermen).

Governments, bilateral aid projects, and private institutions are now constructing large numbers of artificial reefs, especially in the Philippines, Thailand and Malaysia, and interest, and hopes, for these projects are high.

Whatever the outcome, it is obvious that fishery management in the Southeast Asian region will have to change if fish, which provide over 50 percent of all the animal protein consumed (51), is to continue to play its present role.

POPULATION GROWTH AND POVERTY

A major issue in Southeast Asia is population growth. Average doubling time of the aggregate population of the ASEAN countries is presently 32 years. It is difficult to imagine Southeast Asian marine catches also doubling within this period. Thus, in the Philippines, for example, where population growth rate has recently been reported to have increased to 2.9–3.0 percent per annum (doubling time = 23 years), overall catch of marine fish has declined over the last decade. This decline in catch has taken place in spite of—or rather because of—a tremendous increase in the fishing effort (Figure 5). Moreover, in coastal areas population growth is exacerbated by massive, increasing landless-

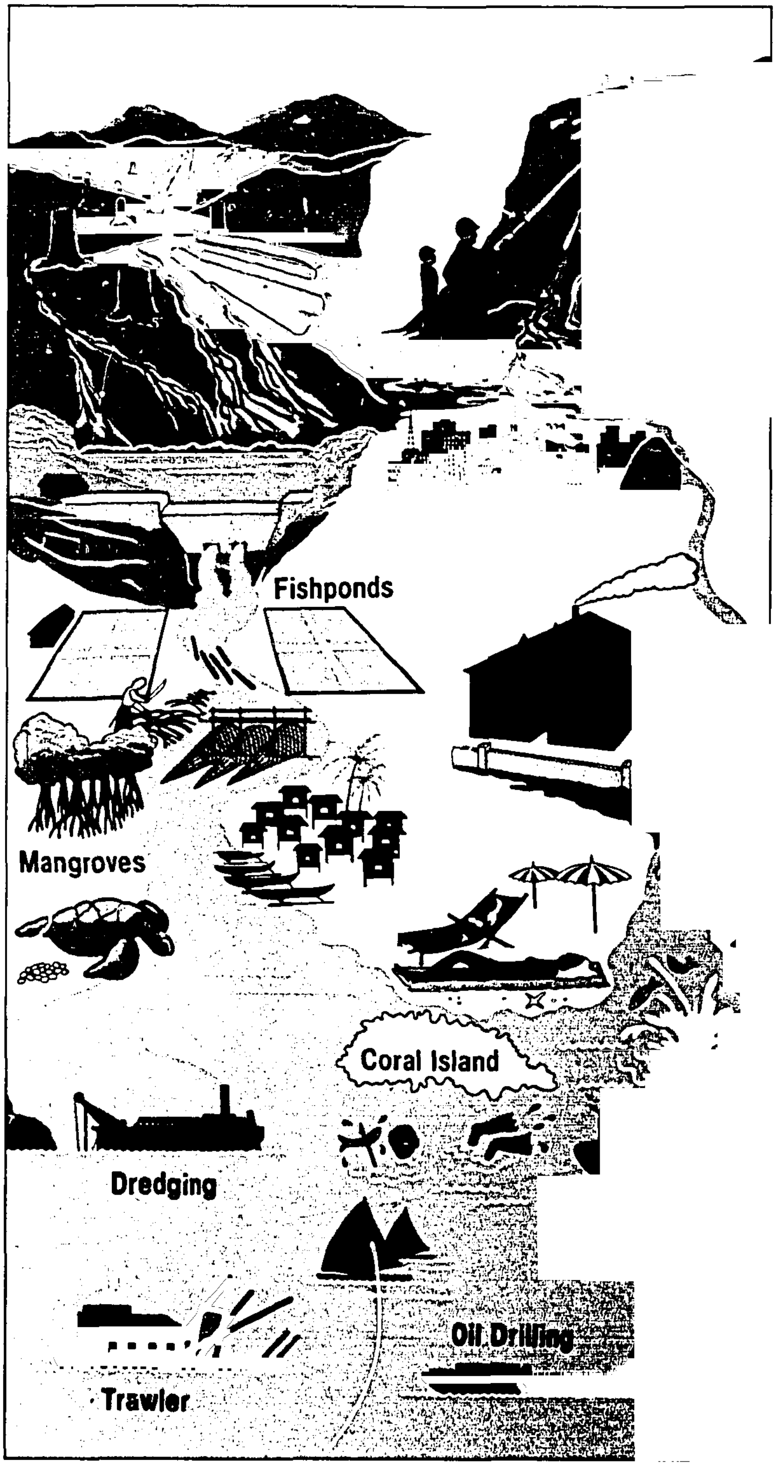


Figure 6. Range of coastal activities occurring along Southeast Asian seas and impacting the fishery sector in various (mostly deleterious) ways (53).

ness. It has been estimated that 78 percent of rural households in the Philippines own no land; the figure for Indonesia (Java) is 85 percent (52). Migration of landless farmers toward coastal areas is critical because:

- There are far more tenant farmers than fishermen, and hence a small change in the percentage of tenant farmers will tend to produce an even larger increase in the population of fishermen.
- Agricultural populations live over virtually the whole surface of an island; coastal zone processes take place, however, along a narrow "line," at the interface of land and sea. Hence, agricultural "causes" will have magnified "effect" along coastlines.
- Migrants, i.e. "new" fishermen, are not restrained in the coastal zone by webs of family and informal ties, nor do they have (as "old" fishermen sometime do) a small plot of land to resort to when catches are poor. Hence, they will usually be among the first to use techniques such as excessively fine mesh nets, dynamite, cyanide and bleaches. In the Philippines and Indonesia these techniques now constitute the major "fishing gear," especially in coralline areas.

Because poverty is the root of an array of fishery-related and other socioeconomic problems, solutions to fishing problems will be forthcoming only when the central issue, poverty itself, has been resolved.

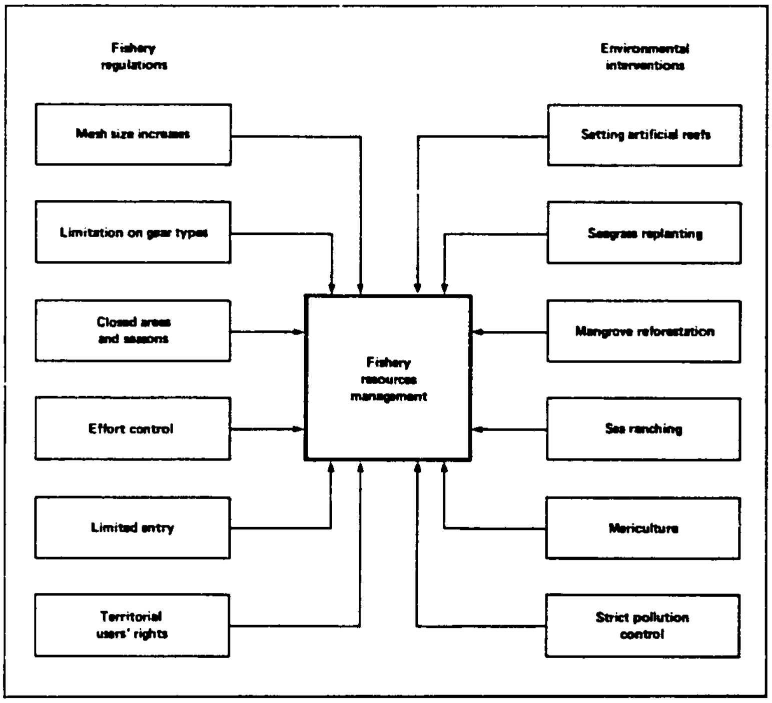


Figure 7. The dualistic nature of activities needed for coastal resources management, which must not be limited to fishery regulation(s) (left) but also include active interventions aimed at habitat rehabilitation or actual enhancement (right).

INDUSTRIALIZATION, ENVIRONMENTAL DEGRADATION AND THE NEED FOR MANAGEMENT

After World War II and independence, most Southeast Asian nations underwent rapid agricultural and industrial development. This growth provided vast investment opportunities, particularly in the 1960s and 1970s, and corresponded to the rapid phase of fishery development shown in Figure 2. Most development took place in the coastal zones that are inhabited by 70 percent of the population of Southeast Asia and where most major cities and towns are located.

The Southeast Asian countries are endowed with abundant primary resources and these are exploited for food and as raw materials for industry. Among the economic activities related to the exploitation of the nearshore or marine resources are agriculture; lumbering; ports and shipping; light and heavy industries; fishing and aquaculture; human settlement; recreation and tourism (Figure 6). However, unisectoral developments have caused serious environmental stresses on the coastal environment, especially coastal ecosystems such as mangroves, coral reefs, beaches and seagrasses. In particular, estuarine fisheries resources are greatly affected by industrial and domestic pollution. The latter includes uncontrolled discharges of generally untreated industrial effluents, sewage and mine tailings. The erosion, that has resulted from logging, has killed coral reefs by increasing the turbidity of coastal waters, such that the coral polyps no longer have enough light to photosynthesize metabolites and may even be buried by increased sedimentation.

Water pollution has also caused a number of detrimental effects on the fisheries resources, ranging from a decline in fish stocks to poor quality of fishery products. In Juru River and a large number of the river systems in Peninsular Malaysia, the fisheries resources are threatened by industrial discharges (54). In the state of Perak, the "sipat siam" (snake-skin gouramy) fishery undertaken in paddy fields was nearly wiped out due to indiscriminate use of agricultural pesticides (55).

Unregulated sewage discharges into the bays of Manila and Jakarta make fishery products, especially clams and oysters, unfit for human consumption. In Thailand, million-dollar losses to fishing and aquaculture industries resulted from disease outbreaks in 1982 (56) caused mainly by pathogenic bacteria and viruses. In addition, the increased frequency of red tides in recent years in Brunei, Malaysia, and the Philippines may be an indication of the changing conditions of the coastal aquatic environment (57).

These trends reflect an inadequate management that is structured around unisectoral developments of coastal resources. Their consequences include:

- depletion of living resources;
- heavy stress on the coastal ecosystems resulting in ecological imbalance;
- increasing rates of coastal erosion;
- increased health hazards caused by water pollution;
- increased resource-use conflicts;
- economic loss; and
- sociopolitical unrest.

Overfishing of coastal waters should be considered as a management issue of the coastal zone as a whole, which cannot be managed using simple regulatory measures. Alternatives acceptable to the fishing communities affected must be found if regulatory measures are to be effective.

While regulatory measures are important and necessary in managing fish resources, other management interventions, such as habitat enhancement and aquafarming, are necessary. Recent scientific achievements in the development of fish aggregating devices such as artificial reefs; seagrasses (58) and coral-reef rehabilitation; reforestation of mangroves; the use of shallow flats for seaweed planting; and aquafarming of invertebrates such as sea urchins and sea cucumbers are some of the alternatives that could be implemented. In addition, the raising of fish in floating-net cages and eventually fish ranching may increase yields and reduce resource-use conflicts. Figure 7 illustrates the dualistic approach implied here, some forms of which will have to be implemented if the coastal resources of Southeast Asia are to remain productive.

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59. This is International Center for Living Aquatic Resources Management (ICLARM) Contribution No. 394. ICLARM'S address: M.C. P.O. Box 1501, Makati, Metro Manila, Philippines.

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