

Management of Tropical Coastal Fisheries in Asia: An Overview of Key Challenges and Opportunities¹

G. SILVESTRE

*International Center for Living Aquatic Resources Management
MCPO Box 2631, Makati City 0718, Philippines*

D. PAULY

*International Center for Living Aquatic Resources Management
MCPO Box 2631, Makati City 0718, Philippines*

and

*Fisheries Centre, University of British Columbia
2204 Main Mall, Vancouver, BC, Canada V6T 1Z4*

SILVESTRE, G. and D. PAULY. 1997. Management of tropical coastal fisheries in Asia: an overview of key challenges and opportunities, p. 8-25. In G. Silvestre and D. Pauly (eds.) *Status and management of tropical coastal fisheries in Asia*. ICLARM Conf. Proc. 53, 208 p.

Abstract

Coastal fisheries are an important component of the fisheries sector and rural economy of tropical developing countries in Asia — generating food, employment and foreign exchange. In 1994, marine landings of these countries were about 13.3 million t (roughly 16% of world marine landings), most originating from coastal areas. The coastal fishery resources consist dominantly of species with relatively high growth, natural mortality and turnover rates; and exhibit maximum abundance in shallow depths (less than 50 m). Fishers use a multiplicity of gears, with heavy concentration in nearshore areas where abundance, catch rates and shrimp availability are highest. The management of these coastal fisheries attempts to promote three main objectives: (1) productivity/efficiency, (2) distributional equity and (3) environmental integrity. Efficient institutional/administrative arrangements are sought to attain these objectives and to maintain a balance among them.

Coastal fisheries operate in a spectrum ranging from light fishing, essentially single sector (i.e., fisheries) situations to intense fishing and multisector use of the coastal area (and its adjacent terrestrial and marine zones). Issues impacting coastal fisheries multiply through this range, requiring increasingly comprehensive and integrated analytic frames and scope of action to sustain fisheries benefits. The key issues impacting coastal fisheries in the region include: (1) overfishing, (2) inappropriate exploitation patterns, (3) post harvest losses, (4) conflicts between large and small-scale fisheries, (5) habitat degradation, (6) inadequacy of management information and research and (7) institutional weaknesses and constraints. Appropriate management strategies and actions on a broad front are necessary, and success is largely premised on institutional capabilities and resources mobilization. Moreover, the ultimate mitigation of these factors rests on effectively addressing poverty and promoting overall economic development.

Introduction

Coastal fisheries are important components of the fisheries sector and rural economy of tropical developing countries in Asia. These fisheries provide food and employment to a significant portion of the population, as well as valuable foreign exchange to the economy (Hotta 1996). In 1994, marine landings of these developing countries were about 13.3 million t (i.e., 16% of world marine landings and 12% of

world fisheries production). Roughly 8 million fishers were involved in marine fisheries and aggregate fishery exports were about \$9 billion per year. Most of the marine landings originated from fishing operations in coastal shelves (between the shoreline and 200 m depth) especially on their shallower parts (from 0 to 50 m). However, these fisheries are adversely affected by a number of problems and constraints, with serious

¹ ICLARM Contribution No. 1379.

consequences for the income of fishers, the supply of fish to consumers and poverty in rural communities.

This paper attempts to provide an overview of the main issues confronting coastal fisheries in tropical developing Asian countries as well as the corresponding management directions to help resolve or mitigate them. Numerous works provide detailed reviews of the overall situation through time and represent a substantive background and source of materials for this synopsis. Among others, the work of Aoyama (1973), Shindo (1973), Marr (1976, 1981) and Pauly (1979) and the contributions in Tiews (1973), Pauly and Murphy (1982), and Pauly and Martosubroto (1996) elaborate the situation in the 1970s. For the 1980s, reviews include Soysa et al. (1982), Sivasubramaniam (1985), IPFC (1987 a and b), APO (1988), Pauly and Chua (1988), and Pauly (1989). More recently, FAO (1992, 1995a and b), Yanagawa and Wongsanga (1993) and Hotta (1996) provide detailed situational updates.

We have avoided the detailed conventional review approach for this synopsis. The works cited above and the country specific contributions to this volume provide sufficiently detailed treatments. We have concentrated instead on drawing from the available literature the commonalities in the main issues and opportunities occurring across the countries and logically structuring them into generic categories. Many of the problems have been building up for some time and now lead to inescapable conclusions. In many respects the substance of the required solutions remains the same, though the debate over implementation strategies to effectively resolve the problems continues vigorously.

We first provide, by way of background, some basic features of coastal fisheries in tropical developing countries in Asia. A synopsis of the main fisheries management objectives pursued in these countries is then presented in generic categories based on the multiplicity of detailed objectives sought by management. Consideration of the objectives is a logical necessity for evaluating the existing situation versus the desired state. The main management issues are presented, using selected site-specific assessments for illustration. The key management interventions currently being emphasized to address these issues are then briefly discussed. Lastly, the structure of the objectives, issues and interventions is summarized and trends affecting the feasibility of management success are briefly discussed.

Sectoral Background

The scope of this study includes fisheries in coastal areas, from the shoreline to 200 m depth, situated within the area bounded by 60°E longitude in the west, 135°E longitude in the east, 10°S latitude in

the south, and 20°N latitude or the coast of mainland Asia in the north (Fig. 1). This geographical delineation includes the fisheries of 13 developing coastal states (excluding Singapore given its level of economic development and limited shelf area). Table 1 provides selected statistics pertaining to these countries, 5 in South Asia and 8 in Southeast Asia. They had a combined population of about 1.7 billion in 1996, the highest being in India and the lowest in the Maldives and Brunei Darussalam. Gross national product (GNP) per capita varied between US\$215 per annum (Cambodia) and US\$20 400 (Brunei Darussalam). It is generally low, with only 3 countries having a per capita GNP above \$2 000 (Brunei Darussalam, Malaysia and Thailand). High population growth, low incomes and underdevelopment characterize many of these countries, though accelerated economic growth is improving these conditions, particularly in Southeast Asia (ADB 1996).

The marine jurisdictional area of the countries covered here is extensive, spanning an aggregate of about 13 million km². This is roughly 1.5 times the extent of their combined land area, totaling 8.5 million km². The extent of the declared exclusive economic zones (EEZ) is highest for Indonesia, India and the Philippines and is lowest for Brunei Darussalam, Cambodia and Bangladesh (WRI 1995). Despite the large marine area, however, only 35% (4.6 million km²) of the aggregate EEZ consists of shallow, productive continental shelves. The most extensive shelves are found off Indonesia, India, Malaysia and Vietnam. The highest shelf to EEZ ratios are found in Malaysia, Bangladesh and Indonesia where over 50% of the EEZ consists of shelves. Longhurst and Pauly (1987) provide a review of the biophysical characteristics and ecology of the tropical waters discussed here and point to the significance of coastal shelves to fisheries productivity. Moreover, mangroves, coral reefs and seagrasses line the coastal fringes of these shelves and enhance their productivity particularly in Southeast Asia where the peak in biodiversity of these habitats occur (McManus 1988; Fortes 1988, 1995). These coastal habitats are coming under increased stress from various human activities due to expanding populations and economies (Gomez et al. 1990; Sen Gupta et al. 1990; Chou 1994; Holmgren 1994; and Wilkinson et al. 1994).

Table 2 summarizes selected fisheries statistics of these countries for 1994. Annual fisheries production range from 6 000 t (Brunei Darussalam) to 4 540 000 t (India), with over half of the countries producing over 1 million t each. Overall fisheries production, including inland fishery and aquaculture, was about 20 million t, or a little over 18% of global fisheries production. Exports of fish and fishery products was about \$8.8 billion, representing a significant source of foreign exchange for these economies. Over \$1 billion

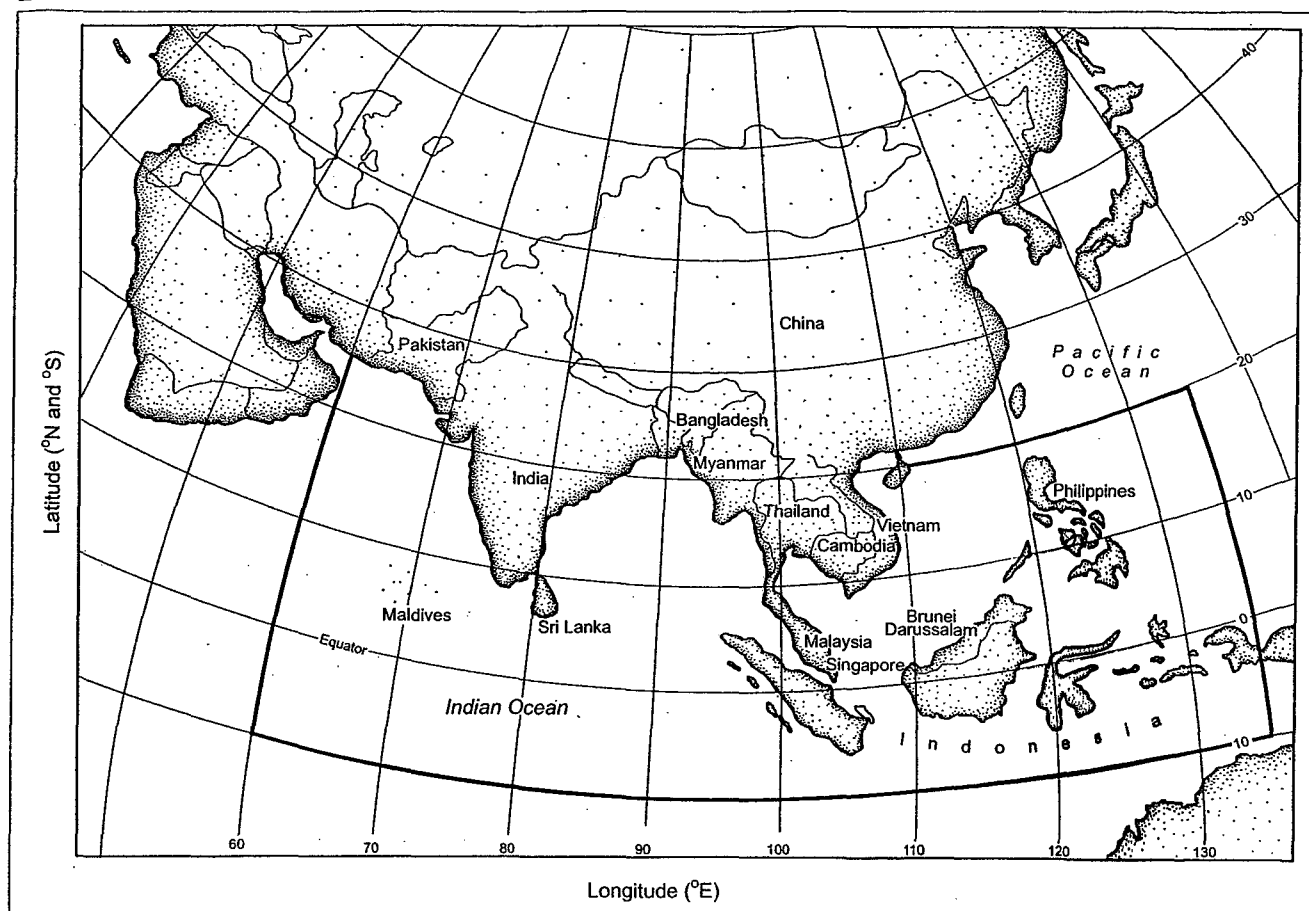


Fig. 1. Map illustrating geographical scope of this study and the location of the developing countries covered.

Table 1. Selected statistics for tropical developing countries in Asia. (Sources: ADB 1995, 1996; WRI 1995).

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

in fishery exports was registered by three countries, Thailand, Indonesia and India. Hotta (1996) estimates employment in fisheries (inland and marine fisheries, as well as aquaculture) to be about 11 million. Fish has traditionally been an important part of the diet of the population, particularly in Southeast Asia. Per capita fish consumption is highest in the Maldives,

followed by the Philippines, Malaysia, Thailand and Brunei Darussalam, with annual consumption exceeding 25 kg. The lowest per capita consumption is in the three South Asian countries, namely: Pakistan, India and Bangladesh. These statistics indicate fisheries to be an important source of food, employment and foreign exchange.

Table 2. Selected 1994 fisheries statistics for tropical developing countries in Asia. (Sources: FAO 1994; Hotta 1996).

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

Table 2 also summarizes marine fisheries catches. Aggregate marine fisheries catches were about 13.3 million t (representing roughly 16% of world marine landings), which constitutes 67% of the total fisheries production for these countries. Hence, marine fisheries contributes the bulk of fisheries production. Marine fisheries production varied between 6 000 t (Brunei Darussalam) and about 3 million t (Indonesia). Five countries, Indonesia, Thailand, India, the Philippines and Malaysia, registered marine fisheries landings exceeding 1 million t, which is indicative of extensive coastal fisheries. It is estimated that about 7.8 million fishers are working in marine fisheries in the 13 countries covered here. The number of full-time and part-time fishers varies between 1 600 in Brunei Darussalam and about 3.8 million in India, and millions more are involved part time, including women and children (Pauly 1997). The bulk of marine fisheries yields and employment originates from fishing operations in shallow, coastal shelves, indicating that coastal fisheries account for a substantial part of the food and employment generated by the fishing sector and contributes significantly to foreign exchange earnings via export of shrimps, small pelagics and demersals.

The coastal fishery resources consist of highly diverse, multispecies complexes (Pauly 1979, Longhurst and Pauly 1987). These are dominantly species with relatively high growth, natural mortality and turnover rates (Raja 1980; Ingles and Pauly 1984; Sivasubramaniam 1985; Chullasorn and Martosubroto 1986; Dwiponggo et al. 1986; and data in FishBase, Froese and Pauly 1996). A common feature of these resources is that they frequently exhibit maximum abundance in nearshore, shallow areas. Fig. 2 illustrates the depth distribution of resource abundance off Brunei Darussalam. Note that catch

rates observed through time consistently show peak abundance in waters less than 50 m. Such a distribution of resource abundance is widespread across the South and Southeast Asian area. This is very different from the situation prevailing in the North Atlantic (which provided the early models for fisheries development and industrialization in South and Southeast Asia), where commercially viable fish abundance occurs down to depths of one kilometer and more.

Another feature of these coastal fishery resources is that many of the species exhibit increasing size with depth. Fig. 3 illustrates the size range of fishes in shallow (less than 15 m depth) versus deeper waters off Brunei Darussalam (Silvestre and Matdanan 1992). This highlights the significance of nearshore areas as nursery grounds and the serious implications of concentrated small and large-scale fishing in these areas. The abundance of very valuable shrimps only in nearshore waters and the favorable concentration of finfishes in areas less than 50 m depth has encouraged the concentration of fishing effort and incursion of trawlers in shallow grounds.

The abundance and diversity of coastal fishery resources has supported vibrant, small-scale fisheries for centuries in these countries (Butcher 1996). The period between the two world wars saw various attempts to 'modernize' these fisheries. These efforts were generally unsuccessful for a variety of technical and social reasons, not least of which includes the lack of dynamism of late colonial societies (Butcher 1994). The period immediately following the Second World War was different. Starting in the Philippines, a wave of technology and investments occurred which rapidly developed the demersal and, later, the pelagic fisheries in Southeast Asia (Pauly and Chua 1989). Mechanization of coastal fisheries also occurred in South Asia, although it appears to have been more diffuse.

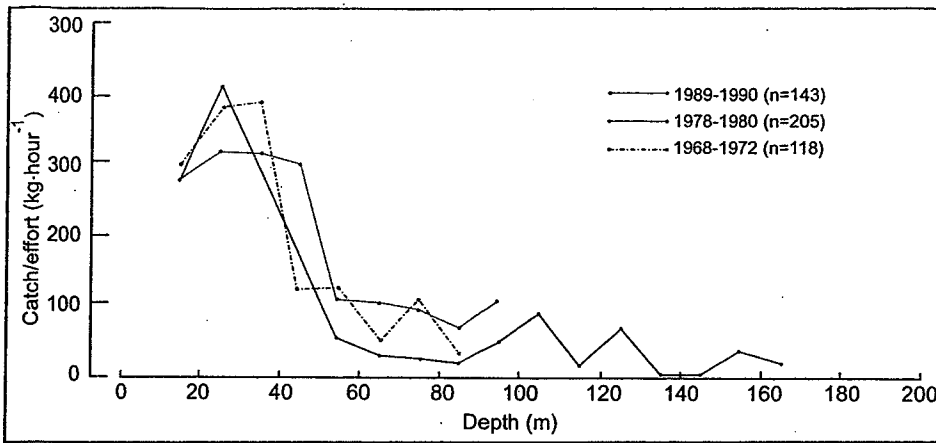


Fig. 2. Fish abundance off Brunei Darussalam (based on trawl surveys conducted around 1970, 1980 and 1990) typical of variation in resource abundance with depth observed in South and Southeast Asia. (Source: Silvestre and Matdanan 1992).

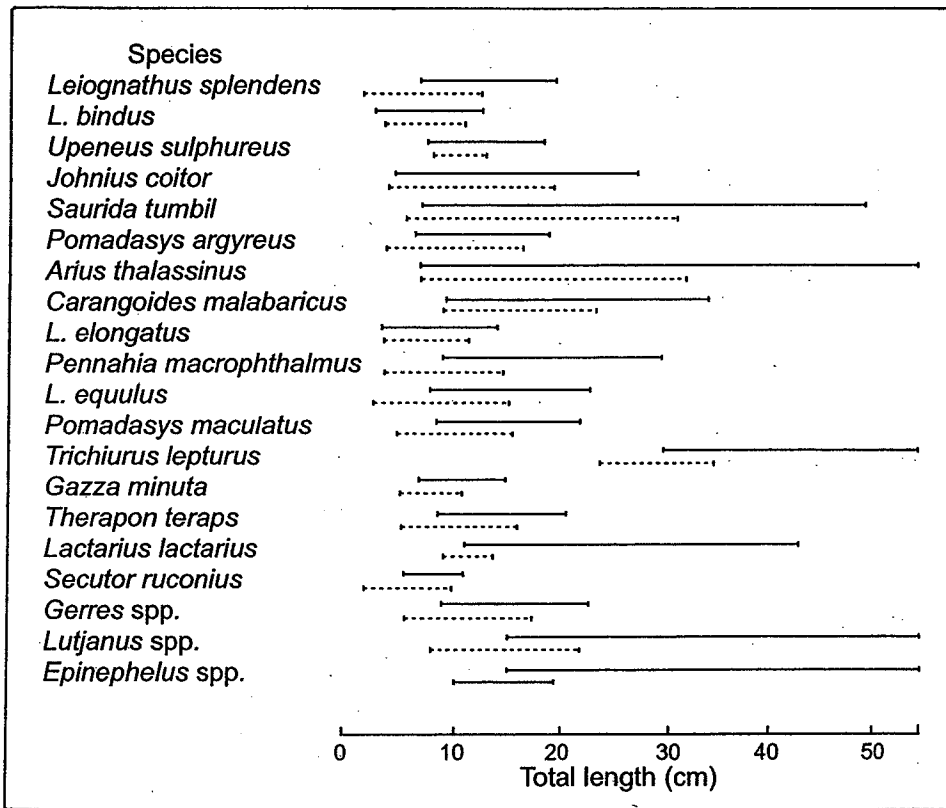


Fig. 3. Size range of fishes caught in areas less than (dashed line) and more than (solid line) 15 m depth off Brunei Darussalam illustrating trend of increasing fish sizes with depth observed in South and Southeast Asia. (Source: Silvestre and Matdanan 1992).

A multiplicity of gears are currently used to exploit the multispecies resources. These vary from relatively simple, inexpensive gears, like handlines and gillnets, using no water craft or dug-outs, to large trawls and purse seines using boats with powerful in-board engines. Sequential (and overlapping) deployment of these gears and small-/large-scale duality of coastal fisheries are common features. Fig. 4 illustrates these features in the case of Brunei Darussalam. The mix of gears used are concentrated in shallow grounds where abundance, catch rates and shrimp availability is highest. Many of the species are fished sequentially by different gears as they grow and move to deeper, offshore areas. Varied technological and biological interactions characterize the coastal fish-

eries exploitation regimes, making assessment and management rather difficult (FAO 1978; Pauly 1979; and Pauly and Murphy 1982).

The situation in Brunei Darussalam is unique in that the levels of exploitation are so low that major management problems have not occurred so far (Silvestre and Matdanan 1992). In the other countries, however, a heavy concentration of small and large-scale gears in many shallow coastal waters has led to overfishing, gear conflicts and dissipation of economic rent. Recent assessments have noted the increasing trend of overfishing of coastal fish stocks and habitat degradation (FAO 1995a; APFIC 1996). This has serious implications for fish supply as well as other benefits derived from coastal fisheries. In these

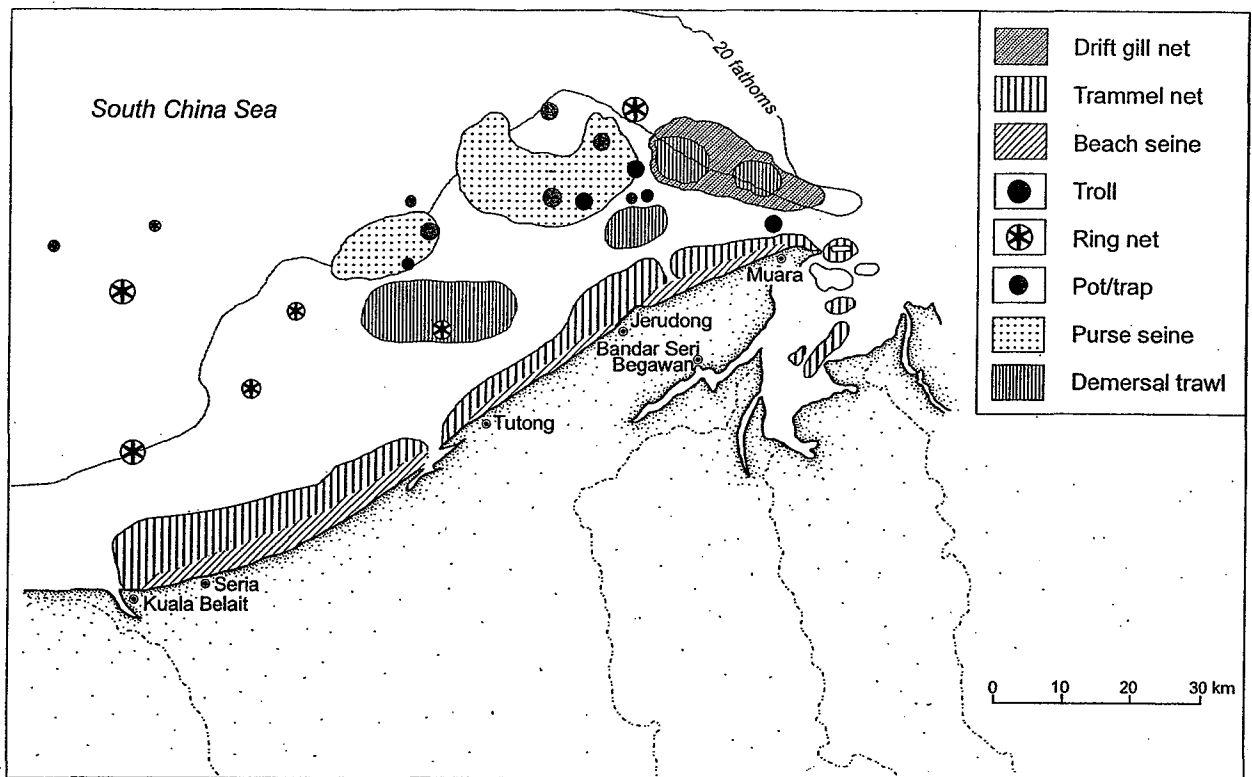


Fig. 4. Fishing area by gear type off Brunei Darussalam typical of those observed in other coastal areas in South and Southeast Asia. (Source: Khoo et al. 1987).

countries, food fish consumption is projected to grow from an aggregate of 14.2 million t in 1992 to 20 million t by 2010 (Hotta 1996).

Overview of Main Fisheries Management Objectives

Fisheries management may be viewed as a dynamic resource allocation process where the ecological, economic and institutional resources of a fisheries exploitation system are distributed with value to society (in the broad sense) as the overall goal. Some recent works covering the status of fisheries management science and related concepts are Anderson (1987), Caddy and Mahon (1995), Olver et al. (1995), Stephenson and Lane (1995), Williams (1996) and Caddy (in press). The fisheries management process includes the resolution of normative and empirical debates to determine the direction of resource allocation decisions. What constitutes value to society is ultimately determined in the political field, and highly influenced by existing needs (or perceptions of such needs), available knowledge and information (or access to them), and religious and cultural values or norms in society.

The coastal fisheries discussed here are set in a variety of natural and human conditions. There is, therefore, a wide diversity of specific objectives being pursued in their management. These objectives may be gleaned from national legislations, development plans and fisheries project documents. Some objectives are implicitly rather than explicitly stated, and many have been noted to be conflicting or incompatible when pursued simultaneously (Lawson 1978; Lilburn 1987). From the available literature we will summarize these diverse objectives into generic categories of objectives and management directions.

Fig. 5 gives a schematic representation of the conventional 'fishing system' framework in fisheries management. The arrows indicate the interactions between and among components of fishery resources and the fisheries relying on these. The framework emphasizes the essential dependence of fisheries on available resources for continued viability and a sustained flow of goods and benefits. It is a widely recognized principle of management in these countries that fisheries management systems must set up fishing regimes that appropriately match the productive capacity of the resource base.

Another feature of coastal fisheries management is the widening scope of 'fisheries management' itself.

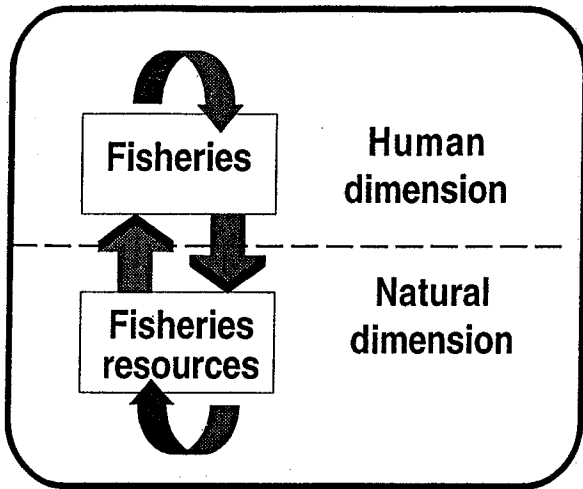


Fig. 5. Schematic representation of the conventional 'fishing system' framework in fisheries management.

Given the increasing multiplicity of issues impacting many coastal fisheries, fisheries management concerns (and objectives) have taken on a wider framework and scope of action in many areas. Fig. 6 illustrates an example of the scope of multidisciplinary work conducted in San Miguel Bay, Philippines (Silvestre 1996).

This encompasses: (1) fishery resources and the habitats (e.g., coral reefs, mangroves) and habitat characteristics (e.g., water quality) which sustains them; (2) other activities (e.g., forestry) which impact fisheries, the fishery resources and the natural environment; and (3) the socioeconomic development and policy framework within which fisheries and other economic activities operate. Similar to the situation in San Miguel Bay, coastal fisheries management in the South and Southeast Asian region increasingly entails the implementation of a wide range of measures within the confines of the traditional fisheries sector, as well as interventions requiring coordination with other sectoral agencies (e.g., forestry, agriculture) at various levels of the institutional hierarchy.

Within this frame of reference, Fig. 7 gives the typical hierarchy of objectives sought in the management of coastal fisheries in these countries. Consistent with sustainable coastal fisheries development as the overall goal, management entities attempt to: (1) optimize productivity/efficiency of the fisheries exploitation regime; (2) ensure that the benefits of production or improved productivity are distributed equitably; and (3) ensure that the productivity generated results in minimum damage to the resource

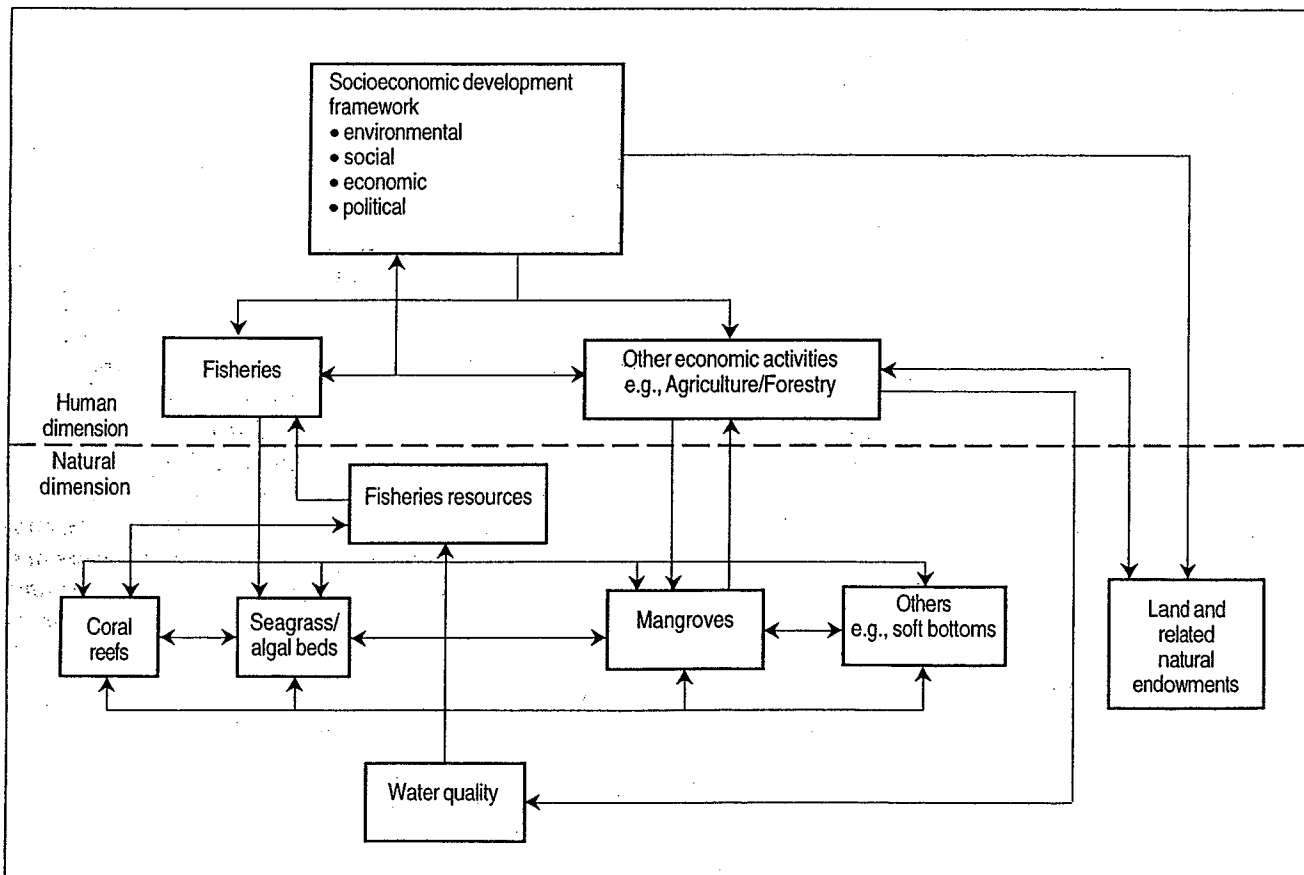


Fig. 6. Schematic representation of an expanded framework for fisheries management. Interrelations among the fisheries resources, the fisheries exploiting them, and other components of the human and natural dimensions are illustrated by arrows. (Source: Silvestre 1996).

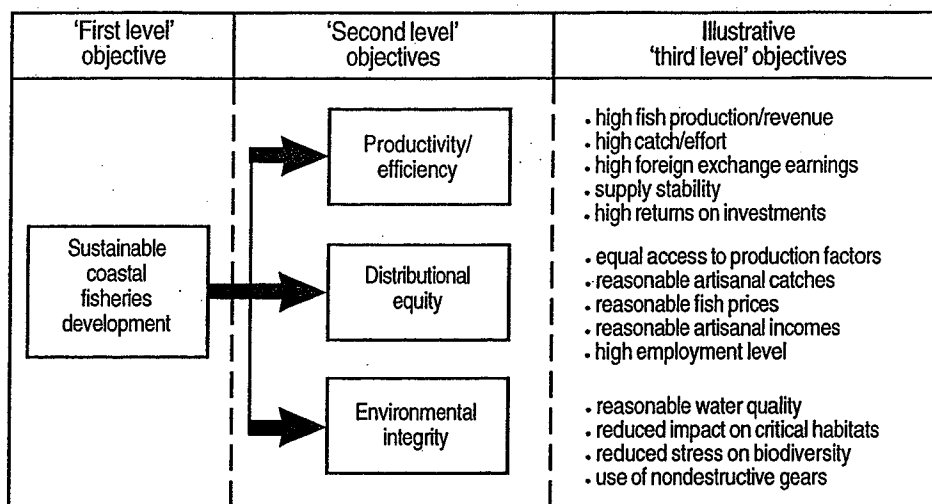


Fig. 7. General goal and objectives in fisheries management.

base and the supporting natural environment. Environmental integrity also encompasses the intergenerational equity concerns embodied in the sustainable development concept of the Brundtland Commission report (WCED 1987). These three objectives are not always mutually compatible and the optimal balance among the three is highly dependent on situational realities and have been noted to vary temporally and spatially within individual countries. Apart from the three generic ('ends') objectives above, appropriate management systems/regimes are sought to effectively attain a balance among these objectives. Hence, institutional effectiveness is a fourth generic category of ('means') objective sought in coastal fisheries management in South and Southeast Asia.

Fig. 7 also gives typical 'third-level' objectives commonly encountered. These are translated into a number of policy instruments and management measures taking the form of regulatory instruments, market-based incentives, institutional measures, research agendas and/or government support investments. For example, the licensing scheme in many countries has productivity as the main rationale. The Indonesian trawl ban (Sardjono 1980) and the 15-km exclusive municipal fishing zones in the Philippines had equity as their primary consideration. The ban on the use of poisons and explosives in fishing in many countries has environmental integrity as the main driving force.

The Challenges: Overview of Key Management Issues

Coastal fisheries in the tropical developing countries of South and Southeast Asia operate in a spectrum ranging from light fishing, essentially single sector (i.e., fisheries) situations, to intense fishing and multisector use of the coastal area (and its adjacent

terrestrial and marine zones). The number of negative factors impacting coastal fisheries multiply through this range, requiring increasingly comprehensive approaches and wider scope of action to sustain fisheries benefits. Many coastal fisheries are in (or moving into) the more industrialized, intensive stages of the fishing and coastal use spectrum, necessitating improved management efforts. We briefly outline below the main issues which require increased management attention.

Excessive Fishing Effort

High levels of fishing effort on coastal fish stocks, particularly in nearshore traditional fishing grounds, is a common management concern (Yanagawa and Wongsanga 1993; FAO 1995a and b; APFIC 1996; Hotta 1996). High fish demand (due to increasing population and incomes), burgeoning fishing populations combined with a lack of livelihood opportunities in rural areas, advances in fishing technology and accelerated industrial fisheries development has led to excessive fishing pressure and overfishing in many coastal areas. This has resulted in a leveling-off (if not decline) in landings; reduced catch rates, incomes and resource rents, and; intense competition and conflict among fishers. Fig. 8 illustrates the gravity of the issue of excessive fishing effort evident in some areas. In the case of the demersal and small pelagic fisheries in the Philippines (which are concentrated in very shallow waters), by the mid-1980s the level of effort exceeded what was required to harvest maximum economic yield by 150%-300% and maximum sustainable yield by 30%-130%. This implies dissipation of resource rents of about \$450 million annually for the demersal and small pelagic fisheries combined. The developing countries of South and Southeast Asia can ill afford the economic losses resulting from overfishing. Although there are coastal areas which remain lightly fished

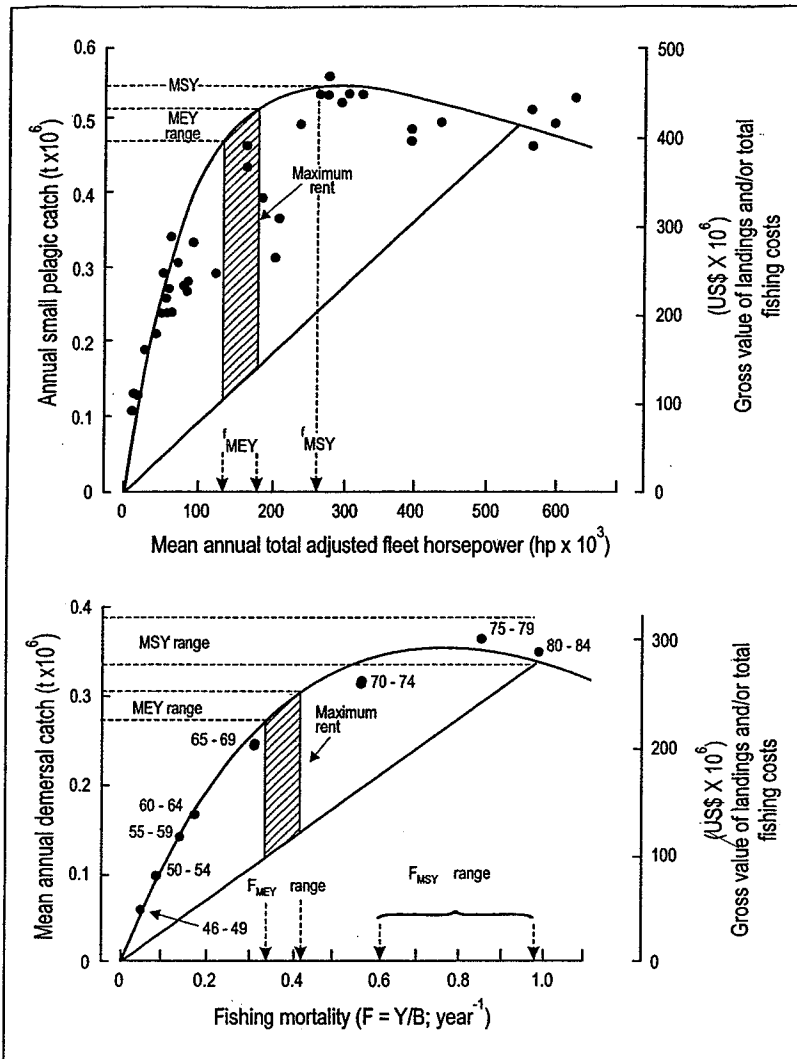


Fig. 8. Surplus production models of the Philippine small pelagic and demersal fisheries. (Sources: Silvestre and Pauly 1986; Dalzell et al. 1987).

(e.g., sparsely populated eastern Indonesia, parts of East Malaysia), the general consensus is that few coastal fish stocks can accommodate an expansion in fishing effort, and that many coastal fisheries in nearshore areas (particularly in the Gulf of Thailand, the Philippines, Bay of Bengal and western Indonesia) require significant reductions in fishing effort (Pauly and Chua 1988; FAO 1995a; APFIC 1996; Hotta 1996).

Inappropriate Exploitation Patterns

Inappropriate patterns of exploitation have led to suboptimal benefits from the exploitation of coastal fishery resources. This stems from the species and size selectivity of the mix of fishing gears used, i.e., their technological characteristics and spatio-temporal deployment in coastal fishing grounds. The selectivity of fishing gears and techniques for their assess-

ment are well documented in the literature (Hamley 1975; Pope et al. 1975; Sainsbury 1984; Silvestre et al. 1991). The theory of fishing illustrates the utility of influencing selectivity to maximize fish yields and related benefits (Beverton and Holt 1957; Ricker 1975; Gulland 1983). Armstrong et al. (1990) provides an update on the importance of selectivity to the conservation of fish stocks.

The concentration of fishing effort in shallow, coastal shelves is a problem across many areas in South and Southeast Asia. The use of explosives and poisons in fishing is also rampant in certain places. The use of fine-meshed nets by artisanal fishers in nearshore areas to catch fish (as well as milkfish and shrimp seeds for aquaculture) is a serious concern. The use of small-meshed nets by trawlers is leading to substantial losses. Fig. 9 illustrates the results of multispecies yield and value per recruit assessment of the trawl fishery operating in the Lingayen Gulf, Philippines. Note that the use of small-meshed (i.e., 2 cm) trawl codends is leading to losses of up to 20% and 35% of potential yield and value, respectively.

Post Harvest Losses

The magnitude of post harvest losses is another major concern. Alverson et al. (1994) estimates the extent of discards for the fishing areas discussed here to be over 5 million t. This is broken down as follows: western central Pacific - 2.8 million t; eastern Indian Ocean - 0.8 million t; and western Indian Ocean - 1.5 million t. This level of discards is high at roughly 40% of marine landings of the 13 developing countries covered here. There are doubts about the accuracy of these estimates, based as they are on limited observations with small spatio-temporal coverage, and better figures will become available in the coming years. However, we believe the level to be significant (see for example Khan and Alamgir, this vol.) for countries with substantial trawl fleets and a limited market for low-value marine fishes. Apart from discards, the extent of physical losses due to spoilage of landings should be limited given the possibility of conversion to fish sauce and related products (Pauly 1996a). Value loss of harvests due to reduced quality is a common concern.

Large and Small-scale Fisheries Conflicts

The question of who should have access and, thus, benefit directly from the use of coastal fishery resources is a primary consideration in the management of fisheries. Increased competition and conflict between the small and large-scale fishing sectors is characteristic of many coastal fisheries (Thomson 1988). Table 3 illustrates the uneven competition between the small-scale (i.e., municipal) and large-scale (i.e., trawl) fisheries in San Miguel Bay, Philippines. The trawlers, consisting of 89 units and belonging to only 40 households, obtain 85% of pure profit, 42% of catch value and 31% of the total catch in the San Miguel Bay fishery. The rest goes to 2 300 small-scale fishing units owned by 3 500 households and employing about 5 100 fishers. Social equity and relative factor endowments (i.e., abundant labor and limited capital) in these countries often require the resolution of these conflicts in favor of the small-scale sector, as occurred in Indonesia, the Philippines, Malaysia and Bangladesh. Competition and conflict persists due to the economic and political power of the industrial sector and requires increased management and enforcement efforts.

Trawling in coastal areas damages patch reefs as well as seagrass and soft-bottom communities (Longhurst and Pauly 1987).

Localized pollution, particularly in semi-enclosed coastal waters, is increasing in frequency due to pollutants from domestic, industrial, agricultural and mining sources (Gomez et al. 1990; Sen Gupta et al. 1990; Holmgren 1994; APFIC 1996; Hotta 1996). Deforestation is leading to increased flooding and alteration of hydrological regimes in coastal areas. The degradation of coastal habitats (e.g., coral reefs, mangroves, and seagrass/algal beds) is apparent in many areas due to the combined effects of siltation, pollution, alteration of hydrological regimes, habitat conversion and extractive activities like coral/sand mining and mangrove forestry (Fortes 1988; Chou 1994; Holmgren 1994; Wilkinson et al. 1994; Koe and Aziz 1995). Moreover, the threat of potential oil spills is increasing given increased oil tanker traffic and marine transport in the area. All these impacts have repercussions on coastal biodiversity and on the productivity of coastal fishery resources. For instance, the biomass decline associated with high effort in the surplus production models given in Fig. 8 may be aggravated by the degradation of coastal habitats in the Philippines (Barut et al., this vol).

Table 3. Summary of data on the duality of the fisheries in San Miguel Bay, Philippines. (Source: Smith et al. 1983).

Parameter	Medium + small trawlers	Small-scale fishery
Number of fishing units	89	2 300
Total horsepower	13 200	5 600
Number of owners	40	2 030
Number of households	40	3 500
Crew income/month (P) ^a	339-810	164-342
Number of fishers	500	5 100
% of total catch	31	69
% of total catch value	42	58
% of total rent	85	15

^a P = Philippine peso; then US\$1 = P10

Habitat Degradation

Coastal fish stocks and the coastal environment which sustains them are coming under increased stress from fishing and other economic activities. On an onshore-offshore axis, Table 4 summarizes ongoing economic activities in coastal and adjacent terrestrial and marine zones. The table also provides a summary of the main impacts of these activities on the coastal environment. The use of explosives and poisons in fishing occurs in many coastal fishing grounds, leading to degradation of coral reefs (Gomez 1988; Pauly and Chua 1988; Silvestre 1990; Chou 1994).

Inadequacy of Information and Research

The inadequacy of information and research inputs into the complex decision-making process that constitutes coastal fisheries management is a commonly raised issue. The appropriateness of the scope, elements, timeliness and accuracy of the available statistical information has often been questioned. Many countries require improvements in fisheries statistics and databases to make real-time management of coastal fisheries feasible (see for example FAO/SEAFDEC/SIFR 1994). Fig. 10 illustrates the patchiness of information for conducting site-specific

Table 4. Generic coastal transect summarizing main activities and issues relevant to coastal fisheries and integrated coastal zone management in South and Southeast Asia.

Major zones	Terrestrial			Coastal	Marine		
	Upland (>18% slope)	Midland (8-8% slope)	Lowland (0<8% slope)	Interface (1 km inland from HHWL-30 m depth)	Nearshore (30m-200m depth)	Offshore (>200m depth -EEZ)	Deep sea (beyond EEZ)
Main resource uses/activities	Logging Mining Agriculture	Mining Agriculture	Urban development Industries Agriculture Tourism	Mining (coral/sand) Mangrove forestry Aquaculture Fisheries Tourism Industries Urban development	Artisanal fisheries Commercial fishing Marine transport Oil drilling	Marine transport Industrial fishing Offshore development	Marine transport Industrial fishing
Main environmental issues/impacts on the coastal zone	Siltation Flooding Toxic mine tailings	Agrochemical loading Erosion Siltation Flooding	Siltation Domestic pollution	Reduced biodiversity Habitat degradation and destruction Overfishing Industrial pollution Domestic pollution	Reduced biodiversity Overfishing Oil spills	Overfishing Oil spills	Oil spills

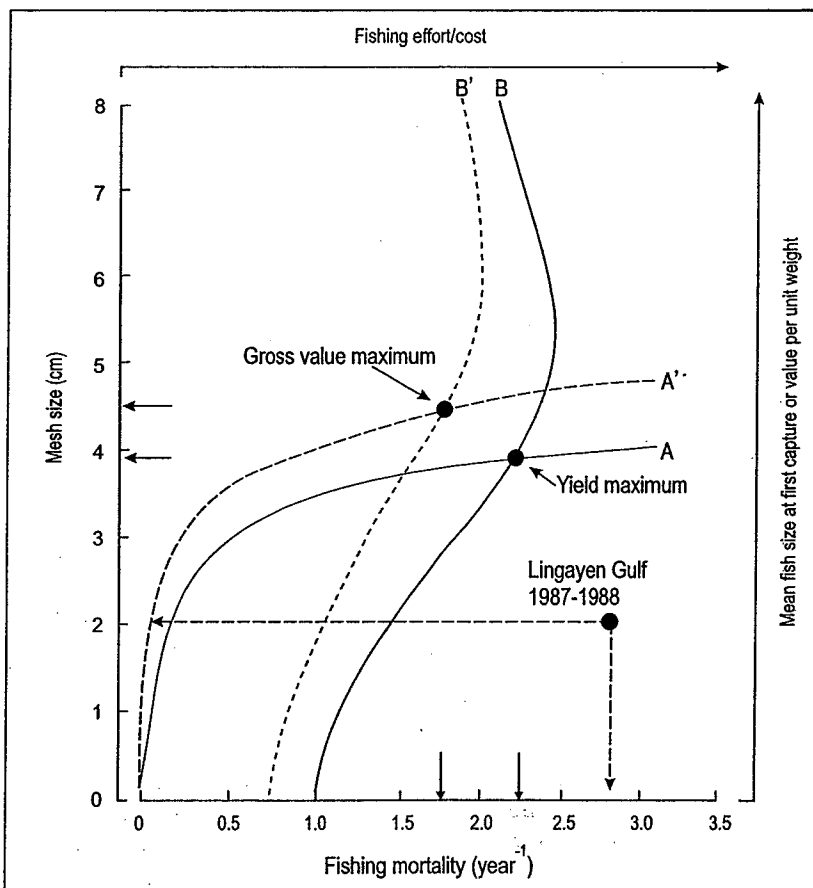


Fig. 9. Multispecies yield and value per recruit assessment of the trawl fishery in Lingayen Gulf, Philippines (Source: Silvestre 1990). Intersections of the 'eumetric' and 'cacometric' lines for yield (A and B) and gross value (A' and B') indicate mesh size and fishing mortality combinations where yield and value are maximized. Note excessively high effort and low mesh sizes in Lingayen Gulf which lead to losses of up to 20% and 35% relative to maxima in yield and value, respectively.

assessment in these countries. In this example from the Lingayen Gulf (Philippines), the spatial scope of available catch statistics does not meet assessment needs and effort information is not available. Assessment of the status of fisheries in the area is, therefore, possible only based on the results of independent trawl surveys and population censuses conducted in the past. The published results of these surveys and censuses allowed Silvestre (1990) to show that resource biomass was down to about 13% of its original level in the late 1940s, precluding further expansion of the fisheries.

The inadequacy of fisheries research in support of fisheries management efforts is also commonly cited. Much of the fisheries research is criticized for being too academic and peripheral to the management questions at hand, and for failing to take the extra step to elaborate requisite management options and measures. Many research results also remain unpublished leading to what Pauly (1995) refers to as the "shifting baseline syndrome" in fisheries. The short history of quantitative fisheries research, limitations in the available statistical baseline and limited research resources requires that past studies be documented, analyzed and made available for fisheries management purposes. For example, trawl surveys conducted

The Opportunities: Overview of Key Management Interventions

Given the multiplicity of issues impacting coastal fisheries, a variety of management interventions are prescribed in the available literature for their resolution or mitigation (Yanagawa and Wongsanga 1993; FAO 1995a and b; APFIC 1996; and Hotta 1996). We briefly outline below seven main categories of management interventions which we believe to be appropriate, given the status of coastal fisheries in these countries. Though many of these are in place, there is a common concern about the comprehensiveness and scale of the existing mix of measures to sufficiently reverse or mitigate the multiplicity of impacts on, and sustain the benefits derived from, coastal fisheries. Successful fisheries management will require effective implementation of a wide range of measures as well as fundamental shifts in management perspectives (Anderson 1987; Hilborn and Walters 1992; Pauly 1994, 1996b; Olver et al. 1995; Stephenson and Lane 1995; Caddy, in press).

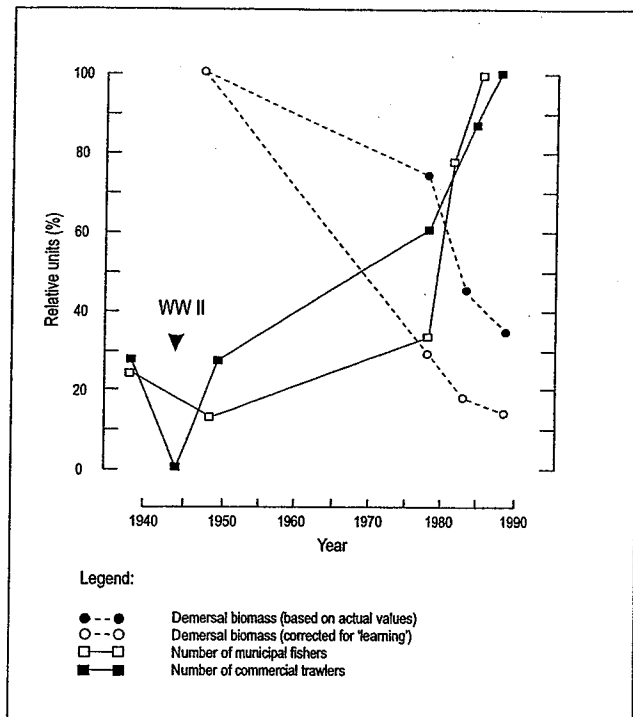


Fig. 10. Relative indices of demersal biomass, number of fishers, and number of commercial trawlers in Lingayen Gulf, Philippines from the 1930s to the 1980s. (Source: Silvestre 1990).

in many countries remain underutilized and potentially offer many insights for fisheries management (Silvestre et al. 1986; Pauly and Martosubroto 1996). Other areas commonly lacking research and information include: site-specific fisheries assessments; selectivity research; research on location and size of underfished stocks; marine protected areas; fish processing and marketing; socioeconomic research; and policy and institutional studies (IPFC 1987b; Yanagawa and Wongsanga 1993; FAO/SEAFDEC/SIFR 1994; APFIC 1996; Hotta 1996).

Institutional Weaknesses and Constraints

All these issues and concerns arise and persists due to the inability of existing institutions to deal with the changing realities of coastal fisheries. Problems and constraints commonly cited include: inadequacies in the policy and legal framework; limited personnel and technical capabilities; shortage of resources/funding; inadequate or overlapping mandates and functions; and a lack of institutional collaboration/coordination (IPFC 1987a and b; APFIC 1996; Hotta 1996). An increased emphasis on the participation of stakeholders and devolution of management authority to local levels are notable trends in many of the countries included in this study.

Limited Entry and Effort Reduction

The establishment of viable systems of rights and access to limit entry into coastal fisheries is sorely lacking. Licensing schemes in many countries are still viewed as statistical and revenue generating exercises, rather than as effective management handles to limit entry and control fishing effort. In overfished coastal areas, the obvious need is for a reduction of fishing effort, particularly in nearshore, traditional fishing grounds. The requisite effort reduction in some areas is quite substantial as in the example for Philippine demersal and small pelagic fisheries shown in Fig. 8. In this case the reduction required is about half of prevailing effort levels. This kind of situation requires direct exit interventions, enhancement of alternative livelihood prospects and occupational mobility of fishers, restructuring of relevant policy and regulatory frameworks, and the redirection of subsidies and support towards improved rural/community development. Other measures outlined below are also directly relevant to requisite effort reduction schemes in overfished coastal fisheries.

Gear, Area and Temporal Restrictions

Measures influencing the species and size, and to a certain extent the sex and maturity stage, composition of catches include: (1) technological controls or limitations, e.g., gear restrictions such as mesh regulations, hook size control, trawl bans; (2) spatial restrictions, e.g., marine sanctuaries, area closures;

and (3) temporal restrictions, e.g., seasonal closures. Regulatory instruments include various forms of species and size restrictions on landings, as well as prohibitions on landing of gravid females. Table 5 uses selected regulations in effect in the Philippines to illustrate some of the forms that these selectivity measures may take. It should be noted that a creative use of other measures, such as incentives/disincentives, can be made to influence selectivity and the resulting exploitation patterns/levels of coastal fisheries.

While much of the theoretical and methodological aspects of gear selectivity are covered in the literature, there is a considerable scope for *in situ* information on selectivity to set up measures for site-specific management. Considerable opportunities exist for a more creative use of gear restrictions, zonation schemes, marine sanctuaries or protected areas (Bohnsack 1994), and seasonal closures to influence the selectivity of coastal fisheries (Silvestre 1995). The design and operation of measures to improve selectivity will vary depending on the number of species and fishing gears used. The complexity of the selectivity problem increases from single species, single gear situations to multigear, multispecies situations (Pauly 1979; Gulland 1983). This has hindered the more creative use of gear, area and temporal restrictions.

McManus (this vol.) points to faunal assemblages associated with spatial elements which can be tapped by managers in designing area restrictions, sanctuaries or zonation schemes (see also McManus 1986, 1989, 1996). The opening and closing of the fishing season for shrimps in Australia illustrates the potential for temporal restrictions, given similarities in the dynamics of exploited shrimp species (Rothlisberg et al. 1988; Staples 1991). Attention is also required in developing and dispersing appropriate hatchery techniques for cultured species, e.g., milkfish, shrimps, groupers. The restriction of gears with small-meshed nets in nearshore areas can succeed only if aquaculture dependence on wild seeds is curtailed.

Improvement of Marketing and Post Harvest Facilities

The level of discards and (value) loss in catches require increased management intervention (Alverson et al. 1994). Post harvest facilities (i.e., salt, ice and cold storage) are lacking in strategic locations in many areas. Private-sector participation in providing these facilities needs to be enhanced given the noted inefficiency of the public sector in maintaining such facilities. Development and dissemination of appropriate processing (e.g., *surimi*) and handling techniques also require attention, as does the development and maintenance of rural road infrastructures. Improved se-

lectivity of coastal fisheries is also important in reducing the magnitude of discards.

Enhancement of Awareness and Participation of Stakeholders

Enhancing the awareness and participation of stakeholders is necessary for better and more cost-effective management of coastal fisheries. Improved transparency and institutionalized participation of stakeholders in the management decision-making process is desirable. Other measures that can be implemented include: enhancement of fishers' organizations and other NGOs; education/awareness programs; devolution/decentralization of management authority; and appropriate extension, training and credit support for nonfishing activities.

Reduction of Environmental Impacts

The need for a reduction of the impacts of fishing and other economic activities on the coastal environment that sustains fisheries is evident in many countries. Efforts toward integrated coastal zone management (Chua and Pauly 1989; Clark 1992) and the adoption of integrated coastal fisheries management approaches (Silvestre 1996), will be necessary for the reduction of undesirable impacts on the coastal environment. Other areas requiring intervention include: wider adoption of multiple-use zonation schemes; restoration/rehabilitation of coastal habitats; curtailment of destructive fishing methods; adoption of appropriate environmental impact assessment systems; and improvement and enforcement of penalties/incentives systems. Progress in the wider use of the precautionary approach and (development of mechanisms for) 'internalization' of environmental costs is highly relevant to reducing coastal environmental impacts.

Institutional Strengthening/Upgrading

Concern about the issues above persists due to the inability of existing institutions to elaborate and effect the requisite management interventions. Strengthening of the policy, regulatory and organizational frameworks relevant to fisheries is urgently required. The areas identified as needing attention include: technical, personnel and facilities upgrading; improvement of financial capability and strengthening of mandates of organizations; enhancement of organizational coordination/collaboration; increased transparency, accountability and participation in the management decision-making process, and; the development of effective and cost-efficient monitoring,

Table 5. Illustrative examples of regulatory instruments affecting the selectivity of fishing operations in the Philippines. (Source: Silvestre 1995).

Regulatory instrument	Law/ordinance ^a	Specifications	
1. Technological controls - mesh regulation	PD 704 (1975)	Prohibition of use of nets with mesh sizes less than 3 cm when stretched (nationwide).	
	FAO 155 (1986)	Regulating the use of fine-meshed nets in fishing (nationwide).	
	- 'gear' ban	PD 704 (1975)	Prohibition of commercial trawling (less than 3 GT) in waters 7 fathoms deep or less (nationwide).
		FAO 163 (1986)	Prohibition on the operation of <i>muro-ami</i> and <i>kayakas</i> in all Philippine waters (nationwide).
		FAO 188 (1993)	Regulations governing the operation of commercial fishing boats in Philippine waters using tuna purse seine nets (nationwide).
		FAO 190 (1994)	Regulations governing <i>pa-aling</i> fishing operation in Philippine waters (nationwide).
2. Spatial restrictions - area closure	PD 704 (1975)	Prohibition of commercial fishing (with the use of boats more than 3 GT) in waters less than 7 fathoms (nationwide).	
	LOI 1328 (1983)	Extended the ban on commercial trawls and purse seines within 7 km of the coastline in all provinces (nationwide).	
	RA 7160 (1992)	Extended boundaries of municipal waters from 3 nautical miles (5.5 km) to 15 km from the shoreline (nationwide).	
	3. Temporal restrictions	FAO 9 (1950)	Regulation governing the conservation of the <i>ipon</i> goby fisheries of the Ilocos provinces; open season from November to January; closed season in September, October and February (area specific i.e., Ilocos Norte).
FAO 136 (1982)		Closed season of five years for the operation of commercial fishing boats in San Miguel Bay (area specific).	
4. Others	FAO 129 (1980)	Ban on the taking or catching, selling, possession, and transportation of <i>sabalo</i> (full grown <i>bangus</i> or milkfish) (nationwide).	
	FAO 148 (1984)	Regulation for gathering, catching, taking or removing of marine tropical aquarium fish (nationwide).	

^a FAO = Fishery Administrative Order; PD = Presidential Decree; LOI = Letter of Instruction.

control and surveillance (MCS) systems (Flewelling 1995). The costs of improved management are substantial and exploration of appropriate cost-sharing schemes with industry (as the ultimate beneficiary) needs to be developed.

Enhancement of Research and Information

Management systems have to be supported by research and information. There is need for research in: appropriate size and siting of sanctuaries or protected areas; resource enhancement and habitat rehabilitation techniques; selective fishing; appropriate

fisheries management reference points; ecosystem modeling (Christensen and Pauly 1995, 1996); and policy and institutional support. Documentation and retrospective analysis of existing information and past studies (e.g., trawl surveys) is important for purposes of comparison and for the potential insights they provide for the management of coastal fisheries. Establishment of statistical baseline information should be consistent with the MCS and management reference points appropriate to the situational realities obtaining in the individual countries. There should be more research collaboration and exchange of research and experiences between the countries given similarities in their resource base and development context.

Conclusion

In the 13 developing South and Southeast Asian countries covered in this study coastal fisheries generate food, employment and foreign exchange. Many factors impact the magnitude and sustainability of these benefits. Fig. 11 shows a logical structuring of the main objectives, issues and interventions relevant to coastal fisheries management in these countries and also provides a summary of the main points covered in this paper. There are three generic categories of ('ends') objectives for the management of coastal fisheries, viz., productivity/efficiency, distributional equity and environmental integrity. A fourth generic ('means') category, institutional effectiveness/efficiency, is often considered necessary for success in attainment of the main ('ends') objectives. Seven key issues affect the attainment of these objectives and the benefits derived from coastal fisheries. Seven key management interventions for the resolution or mitigation of these issues are listed. The issues are interconnected and have cross-reinforcing tendencies, e.g., overfishing intensifies conflicts between small and large-scale fisheries leading to the use of destructive gears and increased habitat degradation. The management interventions are also interconnected, although only the link to the main issues being addressed is illustrated. Apart from providing a summary, Fig. 11 in essence presents a systems matrix of generic elements which should be considered in advancing coastal fisheries management efforts in South and Southeast Asia.

Beyond the reflection and debate, Fig. 11 illustrates the need for effective action on a wide front at various levels of the institutional hierarchy. The management interventions outlined in this paper show scope for action at the local, national and international levels. Much of the overall success will depend on national institutional capabilities. The strengthening and upgrading of these capabilities and effective implementation of the interventions outlined are in turn dependent on the resources that can be mobilized for such purposes. In the context of the development needs of these countries, there is competition for resources given other equally pressing developmental and social needs. The reviews given by Holdgate et al. (1982), Tolba and El-Kholy (1992), and FAO (1995b) identify positive and negative international trends affecting the environment, food, agriculture and fisheries particularly relevant to this study. High population growth, external debt burden, declining commodity prices, market access difficulties and the shrinking international aid 'pot' are minuses for the ability of most countries to devote sufficient resources to the problems at hand. The positive developments are increased economic growth (although this can lead to more pollution problems), environmental awareness, democratization and regional collaboration. Thus, the ultimate solutions to the multiplicity of issues impacting coastal fisheries are also premised on addressing poverty and promoting overall development in South and Southeast Asia.

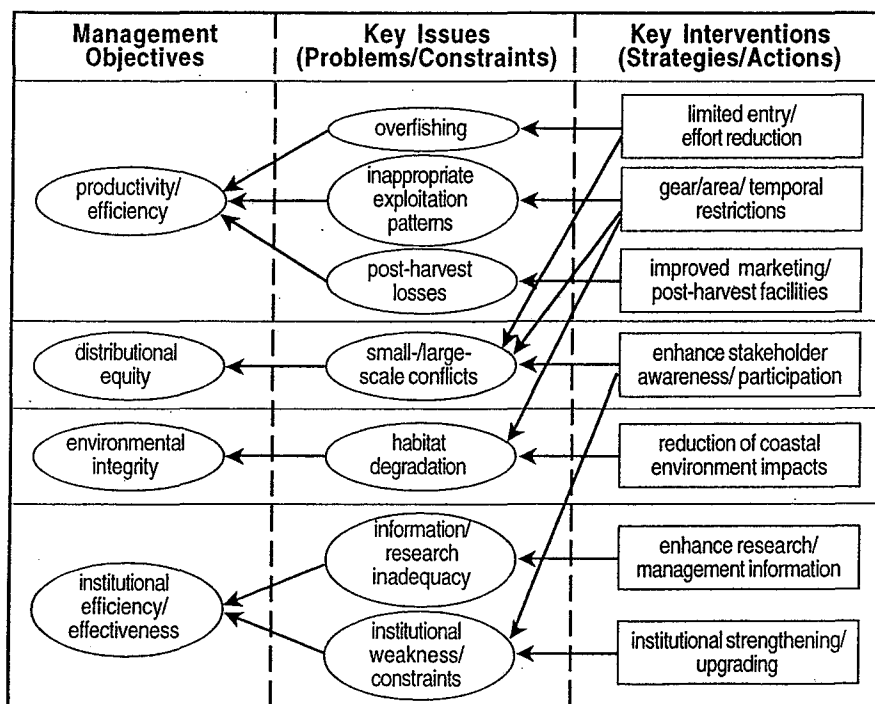


Fig. 11. Summary of management objectives, key management issues and constraints, and interventions (strategies and actions) for the coastal fisheries of the developing countries of tropical Asia. Management interventions have crosscutting benefits/implications, but only the connections to the main issue being addressed are illustrated.

Acknowledgments

Thanks are due Mr. Len Garces and Ms. Bing Santos for assistance in assembling some of the information given in the tables, and for locating important references used in this study.

References

- ADB. 1995. Key indicators of developing Asian and Pacific countries. Vol. XXVI. Asian Development Bank, Manila. 417 p.
- ADB. 1996. Asian development outlook - 1996 and 1997. Asian Development Bank, Manila. 245 p.
- Alverson, D., M. Freeberg, S. Murawski and J.G. Pope. 1994. A global assessment of fisheries bycatch and discards. FAO Fish. Tech. Pap. (339): 233 p.
- Anderson, L.G. 1987. Expansion of the fishery management paradigm to include institutional structure and function. Trans. Am. Fish. Soc. 116(3): 396-404.
- Aoyama, T. 1973. The demersal fish stocks and fisheries of the South China Sea. FAO and UNDP, Rome. SCS/DEV/73/3: 80 p.
- APFIC. 1996. Summary report of the APFIC Symposium on Environmental Aspects of Responsible Fisheries, Seoul, Republic of Korea, 15-18 October 1996. RAP Publ. 1996/42. Asia Pacific Fisheries Commission, Bangkok, Thailand. 27 p.
- APO. 1988. Fishing industry in Asia and the Pacific. Asian Productivity Organization, Tokyo. 481 p.
- Armstrong, D., R. Ferro, D. MacLennan and S. Reeves. 1990. Gear selectivity and the conservation of fish. J. Fish. Biol. 37(A): 261-262.
- Beverton, R. and S. Holt. 1957. On the dynamics of exploited fish populations. Fishery Invest., London, Ser. 2, 19: 533 p.
- Bohnsack, J.A. 1994. Marine reserves: they enhance fisheries, reduce conflicts, and protect resources. Naga, ICLARM Q. 17(3): 4-7.
- Butcher, J. 1994. Harvesting the sea. An ecological history of the marine fisheries of Southeast Asia. Research School of Pacific and Asian Studies, Australian National University. 116 p.
- Butcher, J. 1996. The marine fisheries of the Western Archipelago: towards an economic history, 1850 to the 1960s. p. 24-39. In D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 312 p.
- Caddy, J.F. and R. Mahon. 1995. Reference points for fishery management. FAO Fish. Tech. Pap. (347): 82 p.
- Caddy, J.F. Fisheries management after 2000: will new paradigms apply? Rev. Fish Biol. Fish. (In press).
- Christensen, V. and D. Pauly. 1995. Fish production, catches and the carrying capacity of the world oceans. Naga, the ICLARM Q. 18(3): 34-40.
- Christensen, V. and D. Pauly. 1996. Ecological modeling for all. Naga, the ICLARM Q. 19(2): 25-26.
- Chou, L.M. 1994. Marine environmental issues of Southeast Asia: state and development. Hydrobiologia 285: 139-150.
- Chua, T. E. and D. Pauly (eds.) 1989. Coastal area management in Southeast Asia: policies, management strategies and case studies. ICLARM Conf. Proc. 19, 254 p.
- Chullasorn, S. and P. Martosubroto. 1986. Distribution and important biological features of coastal fish resources in Southeast Asia. FAO Fish Tech. Pap. (278): 84 p.
- Clark, J.R. 1992. Integrated management of coastal zones. FAO Fish. Tech. Pap. (327): 167 p.
- Dalzell, P., P. Corpuz, R. Ganaden and D. Pauly. 1987. Estimation of maximum sustainable yield and maximum economic rent from the Philippine small pelagic fisheries. Bureau of Fisheries and Aquatic Resources Tech. Pap. Ser. 10(3), 23 p.
- Dwiponggo, A., T. Hariati, S. Banon, M.L. Palomares and D. Pauly. 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps in Indonesian waters. ICLARM Tech. Rep. 17: 91 p.
- Dwiponggo, A. 1988. Recovery of overexploited demersal resources and growth of its fishery on the north coast of Java. Indones. Agric. Res. Dev. J., 10(3): 65-72.
- FAO. 1978. Some scientific problems of multispecies fisheries. Report of the Expert Consultation on Management of Multispecies Fisheries. FAO Fish. Tech. Pap. (181): 42 p.
- FAO. 1992. Review of the state of world fishery resources. Part 1. The marine resources. FAO Fish. Circ. (710), Rev. 8, Part 1. 114 p.
- FAO. 1994. FAO yearbooks, Fishery Statistics. Vol. 78, 702 p.
- FAO. 1995a. Review of the state of world fishery resources: marine fisheries. FAO Fish Circ. (884): 105 p.
- FAO. 1995b. The state of world fisheries and aquaculture. FAO, Rome. 57 p.
- FAO/SEAFDEC/SIFR. 1994. Status of fishery information and statistics in Asia. Proceedings of the Regional Workshop on Fishery Information and Statistics in Asia, Bangkok, Thailand, 18-22 January 1994. Vol. I and II.
- Flewelling, P. 1995. An introduction to monitoring, control and surveillance for capture fisheries. FAO Fish. Tech. Pap. (338): 217 p.
- Fortes, M.D. 1988. Mangrove and seagrass beds of East Asia: habitats under stress. Ambio 17(3): 207-213.
- Fortes, M.D. 1995. Seagrasses of East Asia: environmental management perspectives. RCU/EAS Technical Reports Series No. 6.
- Froese, R. and D. Pauly. 1996. FishBase 96: concepts, design and data sources. ICLARM, Manila. 179 p.
- Gomez, E.D. 1988. Overview of environmental problems in the East Asian Seas region. Ambio 17(3): 166-169.
- Gomez, E.D., E. Deocadiz, M. Hunspreugs, A.A. Jothy, Kuan Kwee Jee, A. Soegiarto and R.S.S. Wu. 1990. State of the marine environment in the East Asian Seas Region. UNEP Regional Seas Reports and Studies No. 126. 63 p.
- Gulland, J. 1983. Fish stock assessment: a manual of basic methods. FAO/Wiley, New York. 223 p.
- Hamley, J.M. 1975. Review of gillnet selectivity. J. Fish. Res. Board Can. 32(11): 1943-1969.
- Hilborn, R. and C.J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics and uncertainty. Chapman and Hall, New York. 570 p.
- Holdgate, M., M. Kassas and G. White (eds.) 1982. The world environment, 1972-1982. A Report by UNEP. Tycooly International, Dublin.
- Holmgren, S. 1994. An environmental assessment of the Bay of Bengal region. Bay of Bengal Programme, Madras. BOBP/REP/67: 256 p.
- Hotta, M. 1996. Regional review of the fisheries and aquaculture situation and outlook in South and Southeast Asia. FAO Fish. Circ. (904): 45 p. FAO, Rome.
- Ingles, J. and D. Pauly. 1984. An atlas of the growth, mortality and recruitment of Philippine fishes. ICLARM Tech. Rep. 13:127 p.
- IPFC. 1987a. Papers presented at the Symposium on the exploitation and management of marine fishery resources in Southeast Asia, Darwin, Australia, 16-19 February 1987. RAPA Rep. 1987/10: 552 p.

- IPFC. 1987b. Report of the symposium on the exploitation and management of marine fishery resources in Southeast Asia. Darwin, Australia, 16-19 Feb. 1987. RAPA Rep. 1987/9: 39 p.
- Khoo, H.W., S. Selvanathan and H.A.M.S. Halidi. 1987. Capture fisheries, p. 89-109. *In* T.E. Chua, L.M. Chou and M.S.M. Sadorra (eds.) The coastal environmental profile of Brunei Darussalam: resource assessment and management issues. ICLARM Tech. Rep. 18, 193 p.
- Koe, L.C.C. and M.A. Aziz. 1995. Regional programme of action on land-based activities affecting coastal and marine areas in the East Asian Seas. UNEP, Bangkok. RCU/EAS Tech. Rep. Ser. (5): 117 p.
- Lawson, R. 1978. Incompatibilities and conflicts in fisheries planning in Southeast Asia. *Southeast Asian J. Soc. Sci.* 6(1-2): 115-136.
- Lilburn, B.V. 1987. Formulation of fisheries management plans. p. 507-527. *In* IPFC. Papers presented at the symposium on the exploitation and management of marine fishery resources in Southeast Asia. Darwin, Australia. 16-19 February 1987. RAPA Rep. 1987/10: 552 p.
- Longhurst, A. and D. Pauly. 1987. Ecology of tropical oceans. Academic Press, New York. 407 p.
- Marr, J.C. 1976. Fishery and resource management in Southeast Asia. RFF/PISFA Pap. 7, 62p.
- Marr, J.C. 1981. Southeast Asian marine fishery resources and fisheries. pp. 75-109. *In* L.S. Chia and C. MacAndrews (eds.). Southeast Asian Seas: Frontiers for Development. McGraw-Hill, Singapore.
- McManus, J.W. 1986. Depth zonation in a demersal fishery in the Samar Sea, Philippines, p. 483-486. *In* Maclean, J.L., Dizon, L.B., Hosillos, L.V. (eds.) The First Asian Fisheries Forum. Asian Fisheries Society, Manila, Philippines.
- McManus, J.W. 1988. Coral reefs of the ASEAN region: status and management. *Ambio* 17(3): 189-193.
- McManus, J.W. 1989. Zonation among demersal fishes in Southeast Asia: the southwest shelf of Indonesia, p. 1011-1022. *In* Proceedings of the Sixth Symp. On Coastal and Ocean Management/ASCE, 11-14 July 1989. Charleston, South Carolina.
- McManus, J.W. 1996. Marine bottom fish communities from the Indian Ocean coast of Bali to mid-Sumatra, p. 91-101. *In* D. Pauly and P. Martosubroto (eds.) Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23: 312 p.
- Olver, C.H., B.J. Shuter and C.R. Minns. 1995. Towards a definition of conservation principles for fisheries management. *Can. J. Fish. Aquat. Sci.* 52: 1584-1594.
- Pauly, D. 1979. Theory and management of tropical multispecies stocks: a review, with emphasis on the Southeast Asian demersal fisheries. ICLARM Stud. Rev. 1, 35 p.
- Pauly, D. and G.I. Murphy (eds.). 1982. Theory and management of tropical fisheries. Proceedings of the ICLARM/CSIRO Workshop on the Theory and Management of Tropical Multispecies Stocks, 12-21 January 1981, Cronulla, Australia. ICLARM Conf. Proc. 9, 360 p.
- Pauly, D. and T.E. Chua. 1988. The overfishing of marine resources: socioeconomic background in Southeast Asia. *Ambio* 17(3): 200-206.
- Pauly, D. 1989. Fisheries resources management in Southeast Asia: why bother? p. 1-10. *In* T.E. Chua and D. Pauly (eds.) 1989. Coastal area management in Southeast Asia: policies, management strategies and case studies. ICLARM Conf. Proc. 19, 254 p.
- Pauly, D. 1994. From managing fisheries to managing ecosystems. ICES, Copenhagen. ICES Inf. 24:7.
- Pauly, D. 1995. Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecol. Evol.* 10 (10): 430.
- Pauly, D. and P. Martosubroto. 1996. Baseline studies of biodiversity: the fish resources of Western Indonesia. ICLARM Stud. Rev. 23, 321 p.
- Pauly, D. 1996a. Fleet-operational, economic, and cultural determinants of by-catch uses in Southeast Asia, p. 285-288. *In* Solving by-catch: considerations for today and tomorrow. Alaska Sea Grant College Prog. Rep. No. 96-03. University of Alaska, Fairbanks.
- Pauly, D. 1996b. One hundred tons of fish and fisheries research. *Fish. Res.* 25(1): 25-38.
- Pauly, D. 1997. Small-scale fisheries in the tropics: marginality, marginalization, and some implications for fisheries management. *In* E.K. Pikitch, D.D. Huppert and M.P. Sissenwine (eds.) Global trends: fisheries management. American Fisheries Society Symposium 20, Bethesda, Maryland.
- Pope, J., A. Margetts, J. Hamley and E. Akjüz. 1975. Manual of methods for fish stock assessment, part III. Selectivity of fishing gear. FAO Tech. Pap. 41 (Rev. 1), 65 p.
- Raja, B.T.A. 1980. Current knowledge of fisheries resources in the staff area of the Bay of Bengal. Bay of Bengal Programme, Madras. BOBP/WP8, 23 p.
- Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Res. Board. Can.* (191), 382 p.
- Rothlisberg, P., D. Staples and B. Hill. 1988. Factors affecting recruitment in penaeid prawns in tropical Australia. p. 241-248. *In* A. Yañez-Arancibia and D. Pauly (eds.) IOC/FAO Workshop on Recruitment in Tropical Coastal Demersal Communities. IOC Works. Rep. No. 44.
- Sainsbury, K. 1984. Optimum mesh size for tropical multispecies trawl fisheries. *J. Cons. CIEM* 41: 129-139.
- Sardjono, I. 1980. Trawlers banned in Indonesia. ICLARM Newsl. 3(4): 3.
- Sen Gupta, R., M. Ali, A.L. Bhuiyan, M.M. Hossain, P.M. Sivalingam, S. Subasinghe and N.M. Tirmizi. 1990. State of the marine environment in the South Asian Seas Region. UNEP Reg. Seas Rep. Stud. No. 123.
- Shindo, S. 1973. General review of the trawl fishery and the demersal fish stocks of the South China Sea. FAO Fish. Tech. Pap. 120, 49 p.
- Silvestre, G.T., R.B. Regalado and D. Pauly. 1986. Status of Philippine demersal stocks-inferences from underutilized catch rate data, p. 47-96. *In* D. Pauly, J. Saeger and G. Silvestre (eds.) Resources, management and socio-economics of Philippine marine fisheries. Tech. Rep. Dep. Mar. Fish. Tech. Rep. 10, 217 p.
- Silvestre, G.T. and D. Pauly. 1986. Estimate of yield and economic rent from Philippine demersal stocks, 1946-1984. Paper presented at the WESTPAC Symposium on Marine Science in the Western Pacific, Townsville, Australia, 1-6 December 1986.
- Silvestre, G.T. 1990. Overexploitation of demersal stocks in Lingayen Gulf, Philippines, p. 973-876. *In* R. Hirano and I. Hanyu (eds.) The Second Asian Fisheries Forum, Asian Fisheries Society, Manila, Philippines.
- Silvestre, G.T., M. Soriano and D. Pauly. 1991. Sigmoid selection and the Beverton and Holt yield equation. *Asian Fish. Sci.* (4): 85-98.
- Silvestre, G.T. and H.J.H. Matdanan. 1992. Brunei Darussalam capture fisheries: A review of resources, exploitation and management, p. 1-38. *In* G. Silvestre, H.J.H. Matdanan, P.H.Y. Sharifuddin, M.W.R.N. De Silva and T.E. Chua (eds.). The coastal resources of Brunei Darussalam: status, utilization and management. ICLARM Conf. Proc. 34, 214 p.

- Silvestre, G.T. 1995. Fisheries management and the selectivity of fishing operations. FAO Consultation of Experts and Industry on Selective Fishing for Responsible Exploitation of the Resources in Asia, Beijing, 12-17 October 1995. Inf. Pap. (12): 25 p.
- Silvestre, G.T. 1996. Integrated management of coastal fisheries: lessons from initiatives in San Miguel Bay, Philippines. ICLARM, Manila, 13 p.
- Sivasubramaniam K. 1985. Marine fishery resources of the Bay of Bengal. Bay of Bengal Programme, Madras. BOBP/WP/36: 66 p.
- Smith, I.R., D. Pauly and A.N. Mines. 1983. Small-scale fisheries of San Miguel Bay, Philippines: options for management and research. ICLARM Tech. Rep. 11, 80 p.
- Soysa, C.H., L.S. Chia and W.L. Collier (eds.) 1982. Man, land and sea: coastal resource use and management in Asia and the Pacific. Agricultural Development Council, Bangkok, 320 p.
- Staples, D. 1991. Penaeid prawn recruitment: geographic comparison of recruitment patterns within the Indo-West Pacific Region. Mem. Queensland Mus. 31: 337-348.
- Stephenson, R.L. and D.E. Lane. 1995. Fisheries management science: a plea for conceptual change. Can. J. Fish. Aquat. Sci. 52: 2051-2056.
- Thomson, D. 1988. The world's two marine fishing industries — how they compare. Naga, ICLARM Q. 11(3): 17.
- Tiews, K. (ed.). 1973. Fisheries resources and their management in Southeast Asia. German Foundation for International Development, Federal Research Board for Fisheries and FAO. Berlin (West), 511 p.
- Tolba, M. and O. El-Kholy (eds.). 1992. The world environment, 1972-1992. Two decades of challenge. Chapman and Hall for UNEP, London.
- WCED. 1987. Our common future. World Commission for Environment and Development. Oxford University Press, Oxford.
- Williams, M. 1996. The transition in the contribution of living aquatic resources to food security. Food, Agriculture, and the Environment Discussion Paper 13, 41 p. International Food Policy Research Institute, Washington D.C.
- Wilkinson, C.R., S. Sudara and L.M. Chou (eds.) 1994. Proceedings, Third ASEAN-Australia Symposium on Living Coastal Resources. Vol. 1: Status reviews. Australian Institute of Marine Science, Townsville, Australia. 454 p.
- WRI. 1995. People and the environment. WRI in collaboration with UNEP and the UNDP.
- Yanagawa, H. and P. Wongsanga. 1993. Review of fishery production, provisional estimation of potential yield and the situation of fisheries in the Southeast Asian region - 1976 to 1989. SEAFDEC Spec. Publ. (18), 114 p.