The Sida Marine and Coastal Zone Initiative

Fisheries, Aquaculture and Coastal Zones in Developing Countries, mainly of the East Africa and the Southeast Asia

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Concept-paper on Fisheries, Aquaculture and Coastal Zones in Developing Countries, mainly of the East Africa and the Southeast Asia

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Foreword

This concept-paper on Fisheries, Aquaculture and Coastal Zones in Developing Countries, mainly of the East Africa and the Southeast Asia has been elaborated on request by the working team for the preparation of Sida's Marine and Coastal Zone Initiative, an intended policy programme with plans of action for development of tropical and sub-tropical marine and coastal areas.

The views presented are those of the author, Dr Armin Linquist (Swedmar, a unit of the National Swedish Board of Fishery, Göteborg) and are not necessarily shared by Sida.

The working team in Stockholm, September 1997

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by Armin Lindquist

Executive Summary

In developing countries fish plays an important part in nutrition through its supply of essential proteins. Coastal zones are most important for capture fisheries and aquaculture. Open access to fishing has created conflicts between traditional small scale fisheries and better equipped boats fishing farther offshore. All straddling and highly migratory species are during their lifetime entering EEZs of coastal countries. Fisheries with large vessels for tunas and related species have increased continously. Many bottom living fish and shellfish stocks are overexploited in the East African region and in Southeast Asia. With an adequate management higher yields could be achieved. Other uses of the coastal zone than for fishery are gaining more public attention. - Seminars/training courses in coastal sciences and demonstration sites are proposed for an integrated management of coastal zones. Technical advice is proposed for strengthening international management of fisheries through regional fushery management bodies.

Contents:

1. Introduction

1.1. Fish production and scale of fishing operations

Fish is produced in two ways, either by capture fisheries, i.e. fisheries on wild stocks or by aquaculture (for a definition of the latter see 1.4.).

Capture fisheries can be classified according to the size of operations. There are industrial, large scale fisheries with vessels mostly fishing offshore and on the high seas. Such fisheries are either for the production of fish for human consumption or for the production of fish meal and oil. In the Indian Ocean mesopelagic fish (lantern fish) in the Arabian Sea may become the basis for such an industrial fishery. Another type of "industrial" fishery is with technically well equipped vessels for tuna and tuna like species. They have freezers allowing to deep freeze the catch immediately to -20 or -40°C. Such a fishery is carried out in the Indian Ocean by vessels from the European Community, Japan, Republic of Korea.

The dominating part of marine fisheries stems however from a huge number of small vessels and fishing boats, mostly owned by local people including the crew. Such fishery is either carried out close to the shore or at some distance from the coast. Those operating farther offshore are larger and sometimes better equipped. Inspite of those obvious differences in scale, it has not been possible to find a good definition of small scale fisheries (also called "artisanal fisheries", "subsistence fisheries"). The main reason is that some of the snall scale fisheries gradually are becoming more technically advanced ("commercial fisheries") and are not for subsistence alone.

In small scale fisheries the total number of active fishermen (also those part-time) with their families, is much higher than in industrial fisheries. Globally, it seems that there in the last decade has been an increase in the number of small scale fishermen. This is partly due to persons becoming displaced from agriculture and turning to the sea as a last resort for livelihood. Fishery resources are still regarded as common property. It is not known whether such a development is documented in the literature for Indian Ocean coastal countries.

Small scale fisheries have strong social implications. The estimate is that at least a quarter but with some certainty nearly half of the entire

world catch is taken by small scale fisheries. A comparison of both types of fisheries, industrial fisheries and small scale fisheries demonstrates the labour intensive character of the small scale fisheries, see Fig. 1.

Globally, in all marine fisheries, with exception of those which are close to the shore and for subsistence only, there has been a heavy over investment in vessels and equipment. Total operating costs are much higher than revenues. The reason for this situation is to be sought in political interests to maintain an advanced marine fishery, either because of foreign policy considerations or because of the demands from national pressure groups. Technical development in gear material, gear construction and auxiliary machines for using gear, as well as better and safer fishing vessels and freezer techniques stimulated investment, entrepreneurship and national pride. Warnings for over investments were not given much weight because of income opportunities and direct or indirect governmental subsidies. A major structural change in many marine fisheries is bound to occur very soon.

1.2. Fishing methods

Methods of fishing vary according to the fish to be caught, time of the year, locality and the technical experience of the fishermen and the economic means available to him. The selection of gear depends also on tradition. With very few exceptions, all fishing gear need for their use a craft of some kind, a boat or a vessel. A craft/boat/vessel and its fishing gear need to be considered together as a unit.

Fishing methods in small scale fisheries and in industrial fisheries are very different because of the size of the craft or vessel. A kattumaran from the east coast of India assemled of logs by hand and a sophisticated trawler fishing on the horizon: those are two worlds.

However, while at first sight seems to be easy to recognize small scale operations, we stated before that the transition towards larger operation is gradually and limits are blurred. Beside industrial large factory vessels or factory-trawlers or purse seiners there are many vessels of medium size, fishing within the EEZs with rather advanced technologies. They cannot be called industrial fisheries because they are aiming at a variety of fish with different gear but never in "industrial" quantities.

The most practicable approach is to maintain the definitions used in each particular country and to make comparisons between small scale fisheries of different countries in those cases only, where this is really possible. Therefore, Fig. 1 is only indicative.

From Mozambique the following classification is known:
- industrial fisheries with vessels > 20m, which can stay at sea for more than 15 days;
- semi-industrial fisheries with vessels from 10 to 20m, staying at sea for less than 15 days;
- artisanal fisheries with crafts up to 10m length.

Some gears are preferably used in small scale fisheries, e.g. handline, floating line, bottom line, set nets, short drift nets, pots and traps. Synthetic fibres are widely used and have eased the work of the small scale fisherman. Motorization of crafts is increasing, with outboard motors or inboard machines (diesels); sails are kept for emergency cases or as an energy saver. Affordable service and repair facilities are crucial in this context. In more developed fisheries hydraulic equipment for net and pot hauling is common even in rather small boats.

Fish is also caught by hand, by angling from the shore or by sitting on poles as in Sri Lanka, and by cast (falling) nets found all over the tropics. Beach seines are used from the shore, mostly towed by hand.

Larger vessels up to 15-20m length employed in coastal fisheries use bottom trawls with one boat (sometimes also with two boats), pelagic trawls, minor purse seines, longlining, set nets and drift nets. Many vessels are specialized in fishing for demersal fish or for shellfish, only. The latter are many times discarding the less valuable by-catch of young fish.

Industrial fisheries are carried out with large purse seiners and trawlers, fishing for anchovies, sardines, herrings, jack mackerels for reduction purposes. Fishing for tuna with purse seines or longlines from large vessels can also be considered on an industrial scale. So is also squid fishing with jiggers on the high seas The largest units were factory ships: catches were processed at sea into products ready for sale. They were serviced by smaller fishing vessels, which delivered their catches at sea for processing onboard the factory ship.

Long distance fleets or distant water fleets are those which fish far from their own EEZ, either on the high seas or, after agreement in the

EEZ of a coastal country. They use bottom trawls, pelagic trawls, driftnets, jigging machines. The former Soviet Union was such a distant water fishing nation, DWFN. Closely related to factory ships are factory freezers. They are big trawlers, which only deep freeze their catches, for further processing on shore. They evolved in Europe in the 1970s and replaced subsequently factory ships.

1.3. EEZs and high seas.

About 95 per cent of the global catch is taken within the the EEZs, i.e. within an area of 200 nautical miles from the coast. This distance covers in most cases the extension of the continental shelf, i.e. the 200m-depth line. In the Indian Ocean the continental shelf is entirely within the EEZs.

On the high seas, beyond 200 nautical miles, there are almost only industrial fisheries. They fish for about 40 species, most of them tunas, pelagic squids, horse mackerel, and small pelagics. Main countries fishing on the high seas are China, Japan, The Republic of Korea and Taiwan (Province of China). There are estimates that there are about 24 000 fishing vessels which are fishing on the high seas, i.e. beyond 200 nautical miles. There is little information about the number of vessels fishing on the high seas of the Indian Ocean.

1.4. Aquaculture

The concept of aquaculture

"Aquaculture is the farming of aquatic organisms, including fishes, molluscs, crustaceans, and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as stocking, fertilising, feeding, habitat manipulation, and protection from predators. Farming also implies individual or corporate ownership of the stock being cultivated " (FAO 1991).

With this definition there seems to be no risk of confusion with capture fisheries. However, difficulties exist in fishery statistics where the interface lies between extensive aquaculture and intensive management of inland fisheries, e.g. by rearing of fish for release in natural waters. The present opinion is that fished raised and later

taken in the commercial fishery shall be referred to as taken in capture fishery.

Difficulties also exist in distinguishing between the origin of the yield of bivalves (mussels, oysters, clams etc.). What can be considered as wild harvest and what is culture? This is also true for above all crustaceans and aquatic plants. Another confusion remains regarding the distinction whether culture fishery is to be considered inland, brackish or marine. Marine species such as the milkfish *(Chanos chanos*, where larvae are collected in the sea and the fish is reared i freshwater pens), *Lates calcalifer*, and cultured marine shrimps fall presently under inland aquaculture.

Aquaculture accounts for more then 15% of word fish production by weight, the major part stemming from fresh waters (carps, tilapias). Aquaculture is very diversified and encompasses also production of baitfishes, ornamental fishes, special purpose fishes for biological control of weeds and malaria mosquitoes, mussels and macroalgae for therapeuticals and biochemicals, invertebrates as raw material for medicine, pearl oysters for pearl, crocodiles and alligators for food and luxury leathers, and microalgae for fine chemicals and biogas.

From an economic point of view one can distinguish between four types of aquaculture: (1) production of salmon and shrimp for exports to high income markets, (2) production of molluscs such as clams and oysters for high income markets and cockles and mussles for markets with a somewhat lower income, (3) production of freshwater fish, as in China, and to a much lesser degree in other Asian countries and in Europe, (4) production of seaweeds and aquatic plants.

1.5. Fish as food and *per caput* intake

Globally, the share of fish caught and used for human consumption has increased slowly during the last decade and was in '1993 over 72 %. (Figures are based on a method for calculating apparent fish consumption: production minus use for non-food purposes plus imports minus exports, all inputs on a live weight basis. The actual quantity of fish consumed is less because of loses due to handling and transports and the preparation of fish.)

The *per caput* food fish supply has not increased with the growing world population and is on an average (1988-90) 13.3 kg (but has

actually decreased from 13.6 kg in 1989 to 13.0 kg in 1993).

Worldwide, fish accounts for 16 per cent of total animal protein intake (average 1987-89), for developing countries alone 19 per cent. There are large differences between regions: whereas in North America, Latin America, Western Europe and the Near East figures are below 10 per cent, they are in Africa and in Asia over 20 per cent. People in developing countries are much more dependent on fish as a supply of animal protein (and as a source of income) than people living in developed countries.

It has to be remembered that we eat food - not "proteins" ... Traditions of acceptance of fish are therefore extremely important. Fortunately. it can be noted that acceptance of sea food is generally good in southeast Asia. An exception is Bangladesh, where people are used to freshwater fish. Acceptance is moderate in Eastern Africa countries, with the exception of Zanzibar, where marine fish is staple food.

Countries with very high fish consumption are for example Maldives, where fish accounts for more than 90% of the animal protein intake. There a number of other countries in which more than half of animal protein intake comes from fish, such as Indonesia, Japan, Kiribati, Korea D.R., Korea (Rep. of), Philippines, Solomon Islands, Sri Lanka, Tuvalu. The highest intakes per capita are noted from island countries, which could be expected. A very low consumption of fish is noted for many land-locked countries, such as Afghanistan, Swaziland.

In a longer perspective the trend has been a steady increase in the use of fish for direct human consumption. It is interesting to note that quantities available to developing countries now exceed those available to developed countries. The *per caput* consumption is, however, still much lower in developing countries and has even decreased in some regions, such as in Sub-Sahelian Africa and in Latin America. This may in some cases be due to the increase of the population.

1.6. Nutritional value

Fish has a high nutritional value. Fatty fish is valuable as food and its content of long chain, polyunsaturated fatty acids is important for improving public health, by leading to a decrease of cardiovascular diseases. Omega-3-fatty acids are likely to reduce blood pressure and to reduce the risks for blood coagulation. Fatty fish help to reduce the dietary intake of saturate fats from other sources. Nutritionists recommend the alternate consumption of fatty and lean fish.

In particular, fatty acids from fish are considered healthy for children. It has been observed, that in children, "whose small stomachs cannot digest the bulk of starchy staples, incorporation of a small quantity of fish can substantially improve the biological value of the diet and contribute to better nutrition". (Those starchy staples are maize and cassava in particular.) Furthermore, addition of small quanities of fish can add to the palatibility of food.

Fish is generally less important as a source of calories. An exception are developing regions where fatty fish often is important as a source of energy, too.

Fish is important as a source of high quality animal protein, such as lysine and of essential amino acids. In landlocked African countries fish is more accessible than other sources of animal protein.
Fish is furthermore an important source of vitamin A and D and of essential elements such as iron, phosphorous, calcium, selenium, fluor, and iodine.

2. Main issues in marine fisheries

2.1. Food security

Food security has been defined as "physical and economic access to adequate food for all household members without undue risk of losing such access" (FAO 1992) and as "to ensure that all people at all times have both physical and economic access to the basic food they need" (FAO 1996).

In the developed world temporary shortages in food are compensated for by imports, whereas in a developing country a temporary failure in supply of fish, the important source of animal protein, has serious consequences.

More than 70 per cent of the fish caught are used for direct human consumption. But the balance of the world catch, used for pigs, poultry and as feed in aquaculture, contributes eventually to food security, too.

In all developing countries fish conributes with about 19 per cent of the total animal protein consumption. This is about 4 per cent of protein from both animal and plant origin. One could say as a rule, when the overall availibility of protein becomes lower, fish gains importance as an essential source of protein. It has thus been found

that fish consumption per capita in Peru is four times higher than in Bangladesh but is much more important in Bangladesh where it provides half of a smaller total volume of animal protein available. On the other hand the high consumption of fish in Peru will likely better prevent hunger in that country. The importance of fish for the poorer parts of the population has again been demonstrated in a recent study, this time for Ghana, where smoked pelagic fish is the cheapest source of animal protein.

Thus, the importance of fish in the diet of a population has to be measured in two ways: (a) the overall *per capita* consumption, and (b) the part fish plays in the total animal protein intake.

2.2. Job generation

The importance of fisheries for the society, for personal households, is obvious. Income is generated in local markets, jobs are created for fish processing and in subsidiary industries. At least five family members are supported by each fisherman and there are different estimates of how many jobs are dependent on fisheries in secondary industries. A total factor by ten for each fisherman seems to be a realistic one.

2.3. Factors affecting coastal areas

From a biological and fisheries point of view, the following major types of coastal areas can be distinguished in the region

A. shallow waters down to 20 m:

- estuaries, important as for example breeding areas for penaeid shrimps; in Eastern Africa and in there Bay of Bengal there are numerous large estuarine areas;
- mangroves, important as nursery grounds for shrimps and many fin fish species;
- coral reef areas, with a lower limit of growth of about15m, also around islands, e g Maldives, Comores, Seychelles, heavily exploited by small scale fisheries; a great number of species groups, sucgh as Lethrinids, Scarids, Lutjanids, Carangids.

B. 20m to slope of continental shelf

- coastal areas without a particular upwelling, e g major part of east African coast; fish fauna depends on bottom conditions, which may be

rocky, with coral rubble (Lutjanids, Serranids, Denticids, Carangids, sharks, lobsters) or smooth (Mullidae, *Nemipterus* sp., Lutjanids, Serranids, Sparids);

- coastal areas with a heavy upwelling offshore and a generally high production, e g off Somalia, with sardines, Carangids, Scombroids, in deeper waters mesopelagic fish;

Coastal areas in general are affected by pollution, by habitat degradation and by spatial conflicts as illustrated in the the following examples.

Pollution originates from industrial and agricultural wastes, from pesticides and fertilizers, sewage, oil spills and ocean dumping of toxic waste. Thus the origin is from inside the coastal area, from land or pllution is transported from the sea. Fertilisers may result in an intitial increase of productivity, followed by a drecrease due to oxygen depletion. Toxic substances may become accumulated and consumption of fish becomes harmful to man. Oil spills result in a longterm waste of the habitat.

Mangroves are important for the reproduction and growth of many marine species. They are also important for the local population, using the food for cooking, poles for house building, for fishing gear and as a medicine. Clearence of mangrove areas for construction of aquaculture ponds has a major impact and can become disastrous, if not properly managed from the very beginning. In this example fisheries itself is the culprit. Fishing with explosives and chemicals are extremely destructive methods. Other examples of habitat degradation, but not caused by fisheries are coral mining and increased sedimentation from rivers due to cutting of forests.

Spatial conflicts emerge from urbanization of coastal areas, from tourism, from the establishment of industries in the coastal area, and also from insecure property rights as regards exploitation or the absence of exclusive fishing rights for fishermen.

An important element of coastal area management is an evaluation of resources. There are several questions connected with this issue: the immediate value of for example mangroves is seen through "aquaculture eyes" but not through the long term importance for biodiversity and the value mangroves may have for other uses such as charcoal production and protection of the coast against cyclones. Another difficulty emerges from external influences such as pollution and habitat destruction - how much of value a certain coastal area will

loose? This is similar to the debate on land on the monetary value of undisturbed nature.

Management of coastal areas is poses the special problem of the generally open access to coastal fishery resources. In fact, not only fishery resources are open but often also mangroves and coral reefs are open for exploitation. Furthermore, coastal areas are used as an uncontrolled sink for waste. There are neither property rights nor user rights, which restrict the free access and regulate the use. - With more than half of the world´s population now living less than 100 km from the coast, conflicts are bound to occur more often in the future.

2.4. Management of fisheries

The rational use of living resources has always been the aim in management of fisheries. Fisheries have thus been in the forefront of a modern ecological view when harvesting living resources. Inspite of this "modern way of thinking", fisheries management has not always been successful. As we have seen before, huge over-investments in marine fisheries have occurred all over the world. In fact, about 70 per cent of all marine fish stocks are heavily exploited or even overexploited.

Marine fisheries have not developed in a sustainable manner. It is a fact that warnings about limitations of biological productivity have not been taken seriously and that the very heavy over-investment in marine fisheries has developed without any built-in brakes to slow down this development. The political will has not existed to curb that development. Substantial earnings have been possible not only for the fishing industry but also for secondary industries supplying vessels, gear, auxiliary equipment, and fish processing equipment. Eventually, those overinvestments had to be paid by the tax-payer.

It has been mentioned that nearly a half of world fish production stems from small scale fisheries and the question arises whether that sector has contributed to the over-investment described above, too. Artisanal fisheries with dug-outs are certainly not the culprits for this development. Considering, however, the absence of clear limits between small scale fisheries and fisheries of a technically more advanced stage in coastal area, the latter fisheries, often with larger boats, did contribute to the development. New crafts and gear and auxiliary equipment have made fisheries safer for the crew but also

increased exploitation pressure on fish stocks.

3. The situation in Eastern and Southern Africa and in South East Asia

3.1. Marine fishery statistics 1994 by countries, ´000 t (From FAO 1996, Mozambique from Palha de Sousa 1996).

Area 51 is the Western Indian Ocean, Area 57 the Eastern Indian Ocean

Somalia, estimated	16
Kenya	6
Seychelles	5
Tanzania	43
Comoros	14
Mozambique	95
Madagascar	75
Mauritius	19
Réunion	5
South Africa, Area 51	.3
Maldives	104
Sri Lanka	224
India, Area 57	798
Bangladesh, Area 57	280
Myanmar, Area 57	600
Thailand, Area 57	854
Indonesia, Area 57	608

A comparison of those figures with the total catches in the Western and Eastern halves of the Indian Ocean is of interest, see Fig. 2. Totals are about the same, but small catches of countries from the East African coast are in Area 51 compensated for by large catches in the Arabian Sea and adjacent seas (not shown here). - Of interest is also the increase of tuna catches all over the Indian Ocean.

3.2. State of fisheries

3.2.1. General

For practical reasons four groups of resources should be distinguished: small pelagics, large pelagics, demersal fish and shellfish.

Small pelagics. Numerous acoustic reviews made by the research vessels such as "Dr. Frithjof Nansen" and "Professor Metsyatsev" off the East African coast have shown shown that there are no sizeable resources of small pelagics. To the north, however, in the Arabian Sea,

considerable resources of lanternfish (mesopelagics, *Benthosema pterotum)* have been found, occurring during daytime down to 200m, rising to the surface during the night.

Large pelagics. Tuna resources seem to be in rather good condition in the Indian Ocean with the exception of the Southern Bluefin Tuna, which is heavily exploited.

Demersal stocks. Those are finfish such as snappers, goupers, catfish, sharks and skates. They occur in costal areas and are in some areas severely overexploited.

Shellfish, such as shrimps, lobsters, mussels. The state of exploitation varies greatly within the area. While they are heavily exploited in the Bay of Bengal, they seem still to be underexploited off Somalia.

3.2.2. Western Indian Ocean, particularly East Africa and island states

General

Off Somali there are monsoon driven upwelling areas with seasons of a very high poductivity. Thus, during the southwest monsoon the Somali Current develops to become the fastest open-ocean current in the world. The coastal upwelling resulting from this is the most intensive.

Farther south the shelf becomes narrow and production is very low. It is only off Mozambique where the shelf broadens and production increases. Most of the island states of the Western Indian Ocean have a very low productivity of their coastal waters and offshore areas.

Coastal fisheries are carried out by more than 130 000 fishermen from coastal states and are locally of high economic importance. There is also a small but more lucrative fishery farther offshore executed by some of the coastal states. In general, fish resources in the region could be considered as fully exploited by now. In some countries of the southwestern Indian Ocean fish is the main source of animal protein.

On the high seas distant water fleets from Europe and eastern Asia are fishing. It should be noted that catches by distant water nations have increased dramatically through the 1990s, with Spain and France as major actors.

In the following some information on physical details and on marine fisheries of countries in the region is given (figures are all rounded to

give the order of magnitude only).

Somalia.

The EEZ 788 000 km^2, of which the shelf area covers 39 000 km^2; the length of the coastline 3300 km. - There may be some small scale 5000 fishermen. Fisheries off Somalia are presently managed only to very limited degree; most of the fisheries seems to be poorly controlled. Earlier reviews and the size of the continental shelf alone suggest that substantial catches could be made.

Kenya

The EEZ is 118 000 km^2; the continental shelf is very narrow and measures only 6500 km^2. Beyond the coral reefs and at a distance of less than 3 nm offshore the depth falls to at least 200 m. The length of the total coastline is 500 km. Important fishing centers are Lamu, Malindi, Mombasa, Shimoni and Vanga. - There are 3 900 marine artisanal fishermen and about 600 marine industrial fishermen, operating with 1800 boats. Annual catch in 1994 more than 200 000 t, but only a minor part is from marine fisheries, 6000 t. Gear used are those common in traditional fisheries, such as cast nets, gillnets, beach seines, hand lines. There is some offshore pelagic recreational fishery. There is probably also some longlining far offshore for yellowfin tuna and big-eye tuna by foreign fleets. Fishing for sale directly to tourists has become profitable.

Seychelles

The country is composed of over 100 islands, spread over a large area and resulting in a EEZ of over 1 370 000 km^2, of which 50 000 km^2 are shelf area. - Total population is 70 000, of which 1100 fishermen. Total catches are about 6000 t and *per capita* fish is high with comsumption 70kg/year. Coastal recourses seem to be underexploited. Seychelles has important licensing agreements with tuna fishing countries, giving a yearly revenue of US$ 8 million and job opportunities for some hundred Seychellois. Seychelles is an important tuna fishing centre in the Indian Ocean and has been elected the headquarters of the Indian Ocean Tuna Commission.

Tanzania

The EEZ (together with Zanzibar, see below) is 230 000 km^2; the continental shelf is very narrow. - The total marine catch is 45 000 t, most of which taken by 15 000 artisanal fishermen. Coastal

resources are considered to be fully exploited. There are 4500 dug-out canoes and small boats. Somewhat farther offshore there is an industrial trawling for shrimp by both Tanzanian and foreign vessels, for export (1000 t). There are other shrimp resources farther offshore still not fully exploited. Tuna species are fished by EU-vessels in the EEZ; catches are after annual agreements in the order of 7000 t. - Production of demersal fish is estimated to be 4.4 t/km^2/year. It is believed that there may be demersal resources farther offshore at a distance presently out of reach for artisanal fishermen.

Zanzibar

Two islands form part of the Union Republic of Tanzania. Most villages and landing sites are on the west coast. - Total population was in 1990 about 680 000, of which 16 000 were fishermen. It is estimated that 15% of the population is depending on fisheries. The total fish catch exceeds 20 000 t; *per capita* consumption is high, 30-35 kg. - There are traditional fisheries with lines, traps and nets. Most common are dugouts, with or without outriggers. Few of the fishing boats are longer than 10m and few are powered. - Demersal resources are in the order of 5 t/km^2/year, i.e. more ot less as the present catches; resources of small pelagics are about 20 000 t.

Comoros.

Three vulcanic islands forming the Republic. The EEZ is 230 000 km^2. - There are 8 000 fishermen. The number of boats is 4 700 boats, the majority non-motorized. Annual catch in 1994 13 500 t; *per capita* consumption 21 kg, mostly fresh. Gear are those used traditionally in small scale fisheries, such as hand lines, troll lines, traps and nets. With the steep drop-off around the islands most of the production is from large oceanic pelagics; demersal fish are probably heavily exploited.

Mozambique

The EEZ covers 560 000 km^2; the shelf area 70 000 km^2, the length of the coastline is 2700 km. Marine fisheries account for more than 90% of the country´s fish production. Total marine catches are in the order of 95 000 t, the possible total - if resources are properly managed - is estimated to be in the order of 400 000 t. There are some 40 000 small scale fishermen. Shrimp fisheries on the Sofala Bank off central Mozambique contribute to up to 40% of the country´s foreign exchange. Fishing effort is far too high and better results could be achieved with a drastic reduction of the fishing fleet operating in Mozambican

waters, which is partly national, partly foreign (Japan, EU). There is a five year Fishery Master Plan.

Madagascar

The EEZ covers 1 292 000 km^2, the shelf area covers 177 000 km^2, the length of the coastline is about 4500 km. The east coast is exposed to strong trade winds, while the west coast is relatively sheltered for both small scale and industrial fisheries. - The number of inhabitants is about 11 million. There are about 45 000 traditional fishermen, mainly on the west, south and north coasts. Total marine catches were in 1994 over 100 000 t, of which perhaps 80% were taken in small scale fisheries, most of the balance in industrial fisheries for shrimps, which are most important fo exports. Shrimp resources are considered to be fully exploited, perhaps with the exception of those only accessible to small scale fishermen. It has been shown that due to the regular changes weather the two generations during the year of coastal shrimp stocks are not affected by trawling. - There are still resources of small pelagics, tunas, and some crustaceans, mainly in deeper waters.

Mauritius

The islands of Mauritius and Rodrigues and some archipelagoes are forming the state of Mauritius. The EEZ is 1 180 000 km^2, the shelf area 1600 km^2 length of the coastline 170 km. - The population was in 1900 about 1 100 000, of them are 3 500 artisanal fishermen. Annual catch in 1994 19 000 t; about 40% of animal protein supply stems from fish. Gear are those traditionally used in small scale fisheries, such as hand lines, troll lines, traps and nets. National tuna fishery is developing, licences for foreign tuna vessels are economically important. Improvements in the management of resources seem to be necessary. Possibilities for development are to be found in trawling for small pelagics and in fishing in deeper waters for crustaceans and snappers.

Réunion

As Mauritius, the Prefecture de la Réunion is a vulcanic island with a very narrow shelf. - There is a coastal fishery carried out by some 400 fishermen, fishing 600 t annually, mainly with botttom lines, but also pelagic species. There is also a fishery with somewhat larger boats farther offshore. Réunion is furthermore used as a base for high seas fishing in the Indian Ocean and other areas.

3.2.3. Eastern Indian Ocean, mainly northern part

General

Catches from the Eastern Indian Ocean by bordering countries are ten times higher than those from the Eastern African countries, including island states. It should also be noted that catches in the Eastern Indian Ocean have increased since 1950 and are presently nearly ten times higher. India, Indonesia, Malaysia, Myanmar and Thailand account now for more than 90% of the total marine catch. Figures on the distribution of benthic biomass show that the highest production is found in the northern and northwestern parts, in the area between India and Sri Lanka around the Andaman Islands, Fig. 3.

Thre are close to 3 million fishermen in the regin. Fishing pressure has increased, especially in inshore areas, mostly due to population increase. The coastal fisheries off the east coast of India, the western coast of Thailand and the south coast of central Java are examples of this development. Knowledge of the state of fish stocks is generally poor "and management actions taken have usually been on an *ad hoc* basis, in most cases with lack of scientific backup." (FAO 1997).

A recent review (Derahman et al, 1996) identified a number of diffculties for capture fishery and aquaculture in the region, see Tab. 1. The most striking facts are overfishing, overcapitalizition and interference between dfferent sectors of fishery.

Most of the catch from coastal fisheries is used for local consumption, and is an affordable source of protein for most people. Shrimp and tuna catches are for export. Shrimp resources in coastal waters have become overexploited and there is a growing tendency in almost all countries to meet export needs from cultured shrimp in coastal areas.

Skipjack and yellowfin tuna are caught offshore and catches are exported. Some countries have developed their offshore fishing for tuna by longlining (Indonesia) and by purse seining (Thailand). The majority of tuna catches comes, however, from coastal areas.

There may be possibilities to increase coastal fisheries, as in West Bengal, or squid fisheries, although resources have not been assessed properly yet.

Hazards. There is very little waste treatment in coastal waters and organic material and nutrients are becoming a major problem with the increase of the coastal population. Hazards of quite another kind are

the cyclones that regularly enter the Bay of Bengal. Adequate weather forecasts are not available, communication and navigation equipment is poor in most fishing vessels, resulting in high casualties during the cyclone region.

Maldives

The EEZ covers 960 000 km^2. - Total catch 100 000 t, all marine and mostly tuna species. Maldivians are characterized as a tuna fishing and tuna eating nation, mostly using livebait pole- and line fishing. Fisheries, mainly on a "small scale" play a dominant role in the economy of the country, with 20% of the total labour force directly and indirectly engaged in fisheries. Reefs are important and in need of management. For the sea-cucumber fishery overexploitation of two valuable species has been clearly demonstrated. Another issue is the conflicting use of coral reefs for tourism for mining purposes. For fisheries somewhat farther offshore there seem to be still some possibilities for expansion. There is an interference of skipjack purse seiners with artisanal fisheries.

Sri Lanka

The EEZ is about 400 000 km^2, the shelf area covers 65 000 km^2. Mangroves are growing all along sheltered coasts and corals are found in most coastal areas. There is a coastal fishery on the continental shelf up to 30 nm offshore, an offshore fishery between 30-60 nm and a deep sea fishery beyond 60 nm. Larger vessels use gillnets and long lines for fishing large pelagics within the EEZ and beyond. About 96 000 persons are engaged in fisheries. Total marine catch is 190 000 t. A high proportion of animal protein used in local consumption comes from fish and the majority of the population prefers fish to meat.

India, Bay of Bengal coast (and the Andamans)

The EEZ covers more than 500 000 km2, the coastline measures over 2500 km and the number of fishermen exceeds 2 million. There are four states, West Bengal, Orissa, Andra Pradesh, Tamil Nadu and one Union Territory, Pondicherry. Fisheries, mostly in its artisanal form, is important in all of them. Total marine catches sum up to more than 650 000 t. In some of the states the potential has been estimated to be much higher than the present catches, as for example in West Bengal, Orissa and Tamil Nadu, see Tab. 3. Shrimps are particularly important in Tamil Nadu and West Bengal.

Small scale fisheries have been studied by and assisted through two decades within the Bay of Bengal Programme, in the beginning funded by SIDA, now by member countries themselves, Japan, Denmark, and executed by FAO. One of the most important issues is coastal area management through appropriate administrative mechanisms. Management measures, such as gear restrictions, are few and the enormous number of small fishing crafts, non motorized and motorized, creates major difficulties in competition for living resources.

Bangladesh

The EEZ covers 77 000 km^2, the shelf area 66 000 km^2; length of coast line is 480 km (excluding islands). There are There are wide mangrove forests, of which the Khulna Sundarbans are most known (with 200 000 fishermen alone). There is only one coral reef in the country. The number of marine fishermen is about 400 000. About 95 per cent of Bangladesh´s marine fishery production, which exceeds 200 000 t, originates from coastal small scale fisheries with traditional methods in brackish water areas. *Hilsa* species are important in those fisheries, as well as a number of other taxonomic groups, which are common in tropical waters. Only 5000 t are shrimp. Some of those traditional fishing methods (estuarine bagnets catching juveniles) are destructive and their impact is the reason for overexploitation of coastal resources. There is also a limited offshore fishery, mainly aimed at shrimps; large quantities of fish are reported to be discarded at sea during those operations. From existing surveys is is likely that there are considerable pelagic and groundfish offshore resources still untapped. Those resources are, however, out of reach of small scale fisheries. Bangladesh is principally a freshwater fish producer, not a marine fishing nation.

Myanmar

The EEZ covers 510 000 km^2, the shelf 250 000 km^2; the length of coastline is 2300 km. (Recent information on fisheries is not available.)

Thailand (West coast)

The coastline is about 700 km, the shelf area 100 ooo km^2. The coast is covered by mangrove forests. Estimates have been made of the production of marine fish from those mangrove areas: each hectare yields 24 t of fish and crustaceans, with a value of US$ 2777. Clearing of mangroves has until recently been done rather unlimited, to a considerable part for aqauculture purposes. There are large areas with

coral reefs. Total catches of marine fish are in the order of 300 000 t, which seems to be close to the sustainable level.
Squid fisheries are commercially important. Some of the Thai fleet fish in other countries through various joint agreements.

Malaysia (peninsular west coast)

There are extensive mangrove forests, which have been stated as the best managed forests in the world. Coral reefs are few (2). Inshore fish resources seem to reached its maximum level of exploitation.

Indonesia (provinces of Aceh, Riau and Northern Sumatera)

There are extensive mangrove forests in the northern part of Sumatera, which successively have been cleared for aquaculture purposes. Catches of marine fish of the west coast of Sumatera exceed 211 000 t, and exceed 350 000 t in the Straits of Malacca. Resources are overfished in the latter, while not yet fully utilized in the former.

3.3. Conflicting use of resources

The great number of small scale fishermen using non-motorized boats in shallow waters has resulted in some areas in a heavy exploitation of coastal resources, including juveniles and immature fish. Even traditional fishing gear such as shore seines, boat seines, set bagnets, may become very destructive, when their number increases. Modern craft and gear have not replaced traditional craft and have added to the fishing pressure and to the competition between fishermen for resources which have become scarce. State subsidies for introduction of better fishing methods have aggravated the situation.

Larger trawlers for fishing for finfish and particularly for shrimp are causing conflicts with the traditional sector as they discard large quantities of unwanted fish which could be harvested in small scale fisheries. Small immature fish are also discarded to the detriment of stocks. Furthermore, fishing operations by larger vessels have led to direct competition for access to fishing places.

The foremost issues in coastal fisheries are therefore two: (a) direct conflicts between different groups of fishermen and (b) biological overexploitation of fish resources. To this has to be added economic inefficiency because investments in larger vessels have not been measured against the limits of biological production.

Tab. 2 summarizes conflicts between different type of fisheries which

have been observed in the Bay of Bengal. According to Sivasubramanian (1994) they can be characerized as follows:

- high fishing pressure on coastal resources by a very large and increasing number of small scale fishermen;

- continous use and increasing number of traditional but destructive gear;

- introduction of more modern fishing gear and craft without replacing traditional ones, which has lead to conflicts between small scale and medium scale fisheries; such conflicts have even resulted in social instability;

- larger trawlers for shrimp and finfish discard large quantities of immature fish;

- more and more fishing boats are illegally fishing in neighbouring countries for shrimp, mackerel, tunas ad sharks;

To those observations could be added construction work for tourist hotels and tourism itself affecting the physical environment. Also aquaculture causes impacts on the coastal zone, particularly on mangrove belt, extremely important as a nursery area for fish and crustaceans.

In the wider Bay of Bengal area, from the Maldives to the northern part of Sumatera, management of coastal fisheries has developed to become the main task of the Bay of Bengal Programme, BOBP. BOBP has existed for more than 15 years and had Integrated Coastal Fisheries Management as the theme for the 20th meeting of its Advisory Committee in 1996. Pilot projects have given valuable experience for future management action. The following thirteen places of recent pilot activities were presented and discussed:

(a) integrated reef resources management in the Maldives
(b) managing ornamental fish fisheries in Sri Lanka
(c) coastal fisheries and aquaculture management in India
(in six localities in Tamil Nadu, Andhra Pradesh, Orissa and West Bengal)
(d) estuarine set bag net and push net fisheries in Bangladesh
(e) Phang-Nga Bay model community-based fisheries management system in Thailand
(f) integrated management of Pulau Payar Marine Park in Malaysia,
(g) model fishing village for Tapanuli Bay fisheries in Indonesia.

An environmental assessment of all the waters of the Bay of Bengal has been published in 1994, with detailed assessments for each country (with the exception of Myanmar).

In the region of Eastern Africa and the island states here have been numerous national and international efforts in drawing the attention to the issue of integrated coastal zone management. A thorough discussion was held at Second Policy Conference on Integrated Coastal Zone Management in Eastern Africa and Island States in 1996 and the following case studies were presented:

(a) integrated coastal area management in the Nyali-Bamburi-Shanzu site, Mombasa, Kenya
(b) Tanzania:
development of Mafia Island Park
establishing coastal management in Tanga Region
integrated coastal management - the Kunduchi initiative
integrated coastal area management initiatives at Chwaka Bay-Paje
(c) Mozambique: coastal zone management in Mecufi
integrated coastal area management of the Xai-Xai district, Gaza Province.

Country reports at the same meeting gave additional information on the efforts made or are in the pipeline.

The situation of the fisheries in the southwestern Indian Ocean have been reviewed earlier, in 1991, with the purpose to identify priorities for their management and development.

3.4. Towards a better management of fisheries in coastal zones and beyond.

Traditional management systems were good as long as there were no major changes in the number of fishermen and in the kind and number of craft and gear. When population pressure increases and new more efficient methods are introduced traditional systems are broken down.

More efficient and at the same time more selective fishing methods should be introduced, carefully with a precautionary approach. In all fishery management the active participation of fishermen is crucial. The Code of Conduct for Responsible Fisheries to which all fishing coiuntries have agreed, should put into practise where and whenever possible.

National management - Strengthening of traditional management in villages and adapting such systems to new fishing methods. This is the principle of co-management, giving users control over own resources and therefore acceptance of necessary measures. Adjusting fisheries to the carrying capacity of the living resources and the environment. The issue of establishing of users´ rights of the coastal zone, such as exclusive fishing rights. Development of regional/local councils for management of coastal areas. Such bodies should include

representatives from administration, industries, politics, science, fishermen´s organizations. This is a gradual process which depends on the capacity of the community and takes some time. - Training is needed on different levels.

In general: strengthening of the political role of fisheries in national economies. In some countries, such as the Maldives, Mozambique, Seychelles, income from fisheries is so important that its political role is obvious and undisputed. In other countries fisheries needs to get more public support.

International management. All the valuable migratory fish resources occur at some time during their life in coastal areas and thus in the EEZ of one or more countries. A concerted management action is therefore requested in accordance with the Code of Conduct for Responsible Fisheries. The UN-Agreement on Straddling Fish Stocks and Highly Migratory Stocks is particularly important for tunas in the Indian Ocean because they are exploited by several nations.

The work of the regional fishery management bodies needs to be strengthened by adding management power to existing advisory functions. In the Indian Ocean this could be achieved by *reviewing the work of the Indian Ocean Fishery Commission (IOFC) and its subsidiary bodies.* Those subsidiary committees cover the Southwest Indian Ocean and the Bay of Bengal (and also the Gulf area), and have presently an advisory function only. It should be noted that there have been discussions in the BOBP to transform that multidonor programme into an international organization with the purpose to support the Bay of Bengal Committee of the IOFC.

The Indian Ocean Tuna Commission, IOTC, is quite new and has already full management power. - Training in international fishery matters is needed and expert advice, where appropriate.

4. Conclusions, recommendations

The needs in the region for coastal zone management and adjacent waters have been identified and documented in a number of publications. For the East African region reference is made to Tab. 4, for the Bay of Bengal region to Tab. 2.

The following draft suggestions are made for a future cooperation between Sida and coastal countries for a better management of living resources.

A. A series of seminars/training courses in "coastal science" or Integrated management of coastal zones

Example of contents:
(a) basic facts on geography, hydrology, biology
(b) conflicting interests, such as industries, settlement, tourism, fisheries, aquaculture
(c) master plans for national development of coastal areas (including for aquaculture)
(d) organization of national advisory councils for integrated management of the coastal zone
(e) national management of fisheries, both coastal and offshore.

Training courses could preferably be arranged by in cooperation with FAO (practical arrangements could be similar to those training courses on fish stock assessment, financed by Denmark, and the assessments of marine resources carried out by the R/V "Dr. Frithjof Nansen", financed by Norway).

B. Assistance to demonstration activities in coastal zones, either by strengthening ongoing efforts referred to above or in new localities, all according to the preferences of the cooperating countries. This acivity could include the development of selective fishing gear for use in small scale fisheries and fisheries on the continental shelf. This type of development cooperation should be made bilaterally, Sida/host country.

C. Seminars/advice by selected experts on international management of fisheries with the aim of improving the basis for cooperation between countries in accordance with international agreements. This would *i.a.* imply strengthening the work of regional fishery management bodies. Seminars could be carried out in cooperation with FAO.

(The proposed activities are in conformity with the proposal Assistance to small island countries, see FAO Programme of Fisheries Assistance for Small Island Developing States, October 1996, with the suggestions made for the BOBP by Derahman *et al.* 1996 and with the suggestions for the Eastern African region in Lindén and Lundin 1997).

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	LARGE SCALE	SMALL SCALE
Number of fishermen employed	AROUND 500,000	OVER 12,000,000
Annual catch of marine fish for human consumption	AROUND 29 MILLION TONNES	AROUND 24 MILLION TONNES
Capital cost of each job on fishing vessels	$ 30,000-$ 300,000	$ 250-2,500
Annual catch of marine fish for industrial reduction to meal and oil, etc.	AROUND 22 MILLION TONNES	ALMOST NONE
Annual fuel oil consumption	14-19 MILLION TONNES	1-2.5 MILLION TONNES
Fish caught per tonne of fuel consumed	2-5 TONNES	10-20 TONNES
Fishermen employed for each $ 1 million invested in fishing vessels	5-30	500-4,000
Fish destroyed at sea each year as by-catch in shrimp fisheries	6-16 MILLION TONNES	NONE

Fig. 1. Comparison of large scale fisheries with small scale fisheries. From Thomson 1988.

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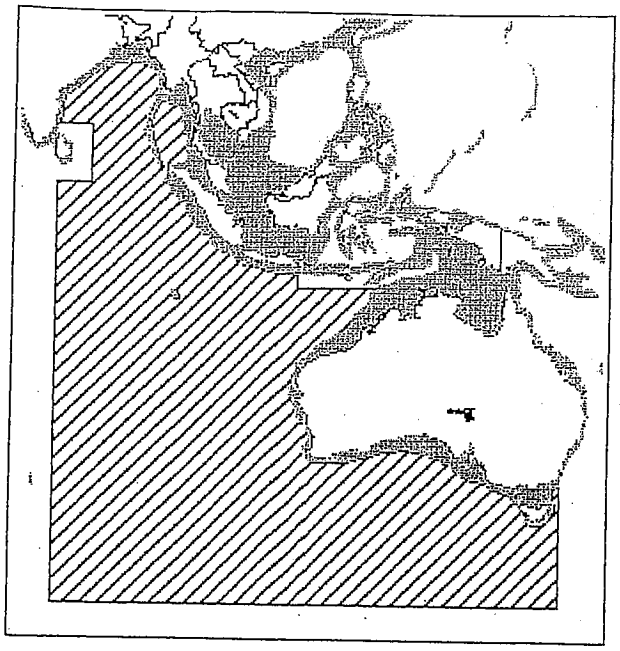
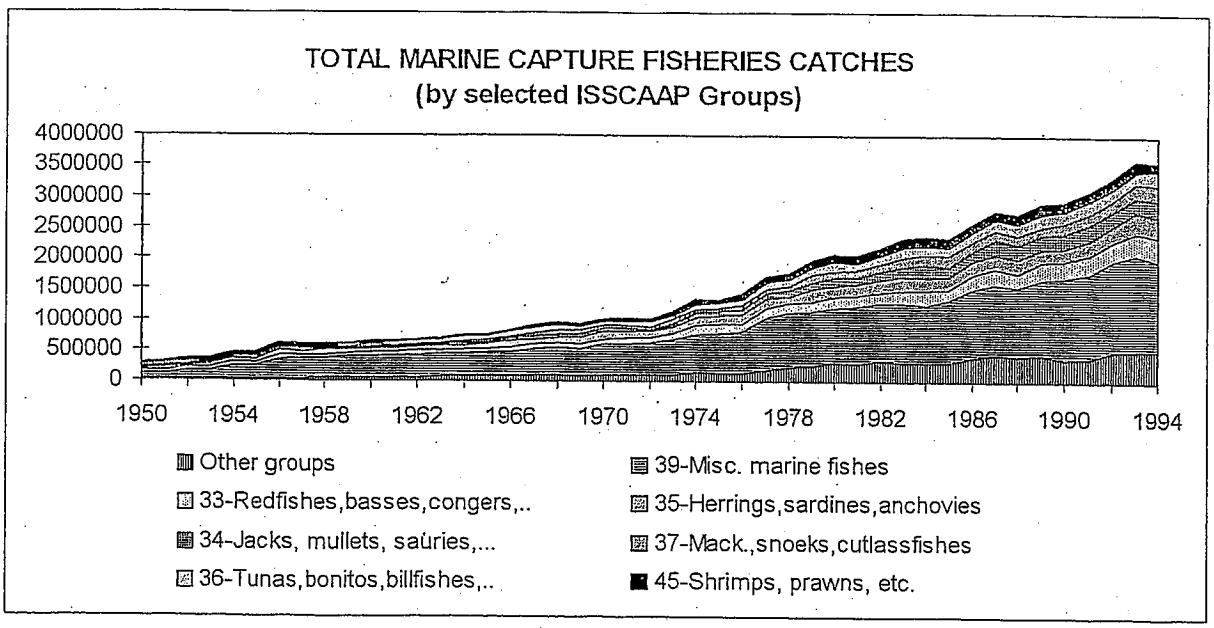




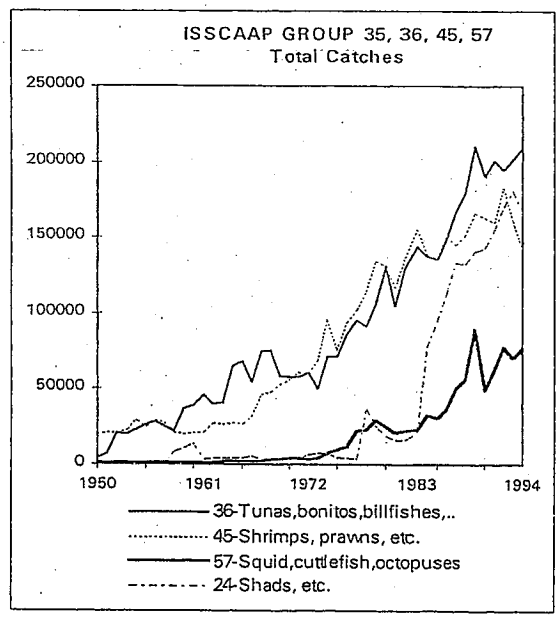
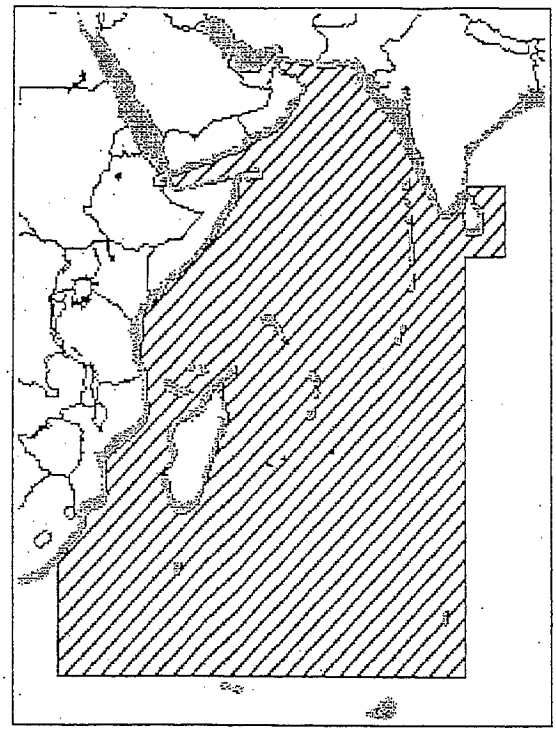
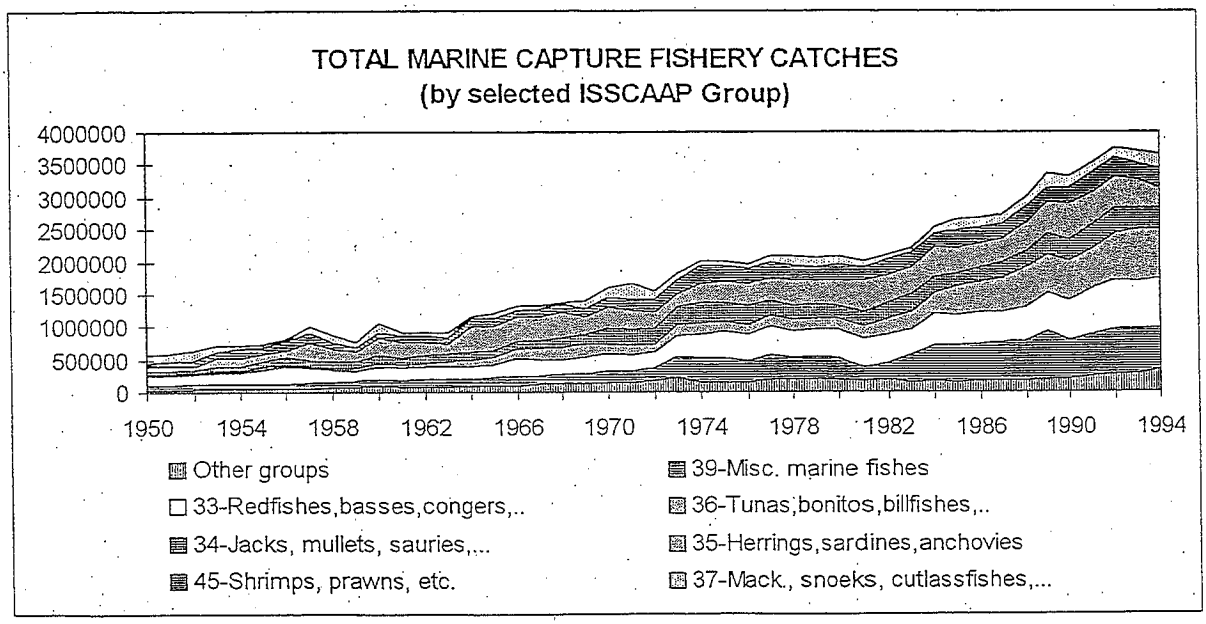


Fig. 2. Indian Ocean fishery statistics: Areas 51 and 57, development of total catches, development of mainly tuna catches.
From FAO 1997




TOTAL MARINE CAPTURE FISHERY CATCHES
(by selected ISSCAAP Group)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
Other groups
33-Redfishes,basses,congers,..
34-Jacks, mullets, sauries,...
45-Shrimps, prawns, etc.
39-Misc. marine fishes
36-Tunas,bonitos,billfishes,..
35-Herrings,sardines,anchovies
37-Mack., snoeks, cutlassfishes,...

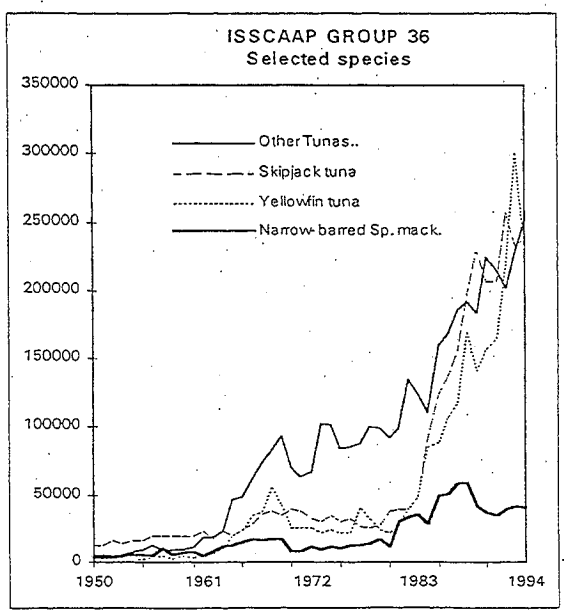

ISSCAAP GROUP 36
Selected species
350000
300000
250000
200000
150000
100000
50000
0
1950
1961
1972
1983
1994
Other Tunas..
Skipjack tuna
Yellowfin tuna
Narrow-barred Sp. mack.

Fig. 27 a. Distribution of macrobenthic biomass

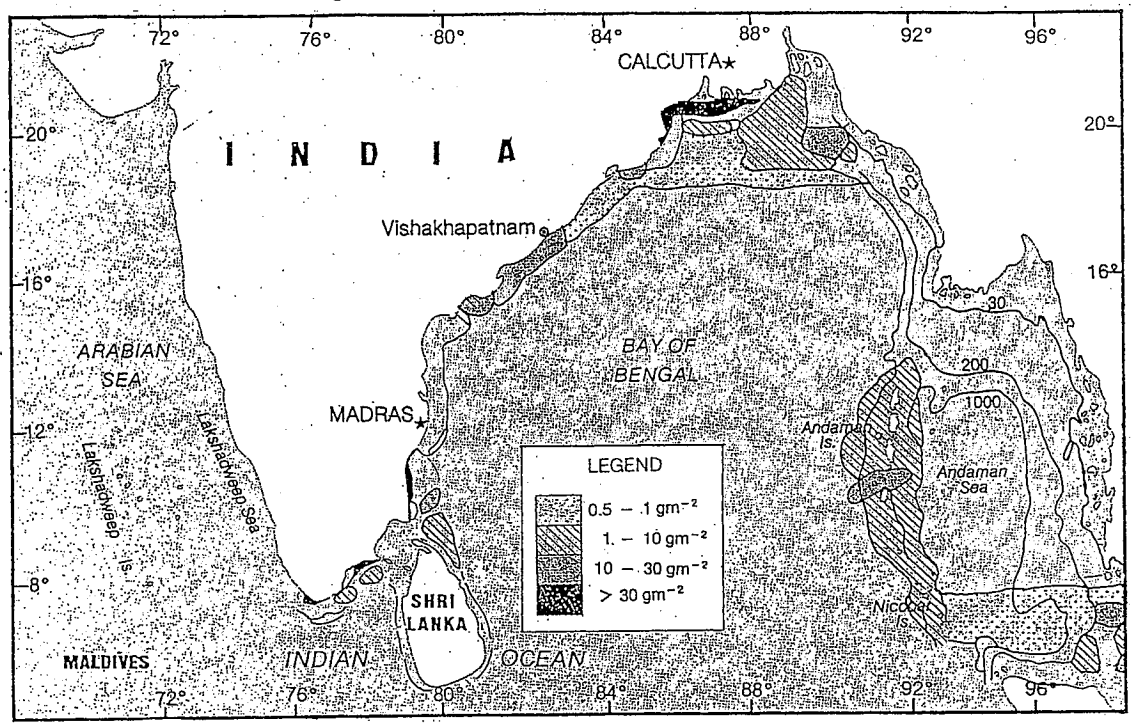


Fig. 27 b. Distribution of meiobenthic biomass

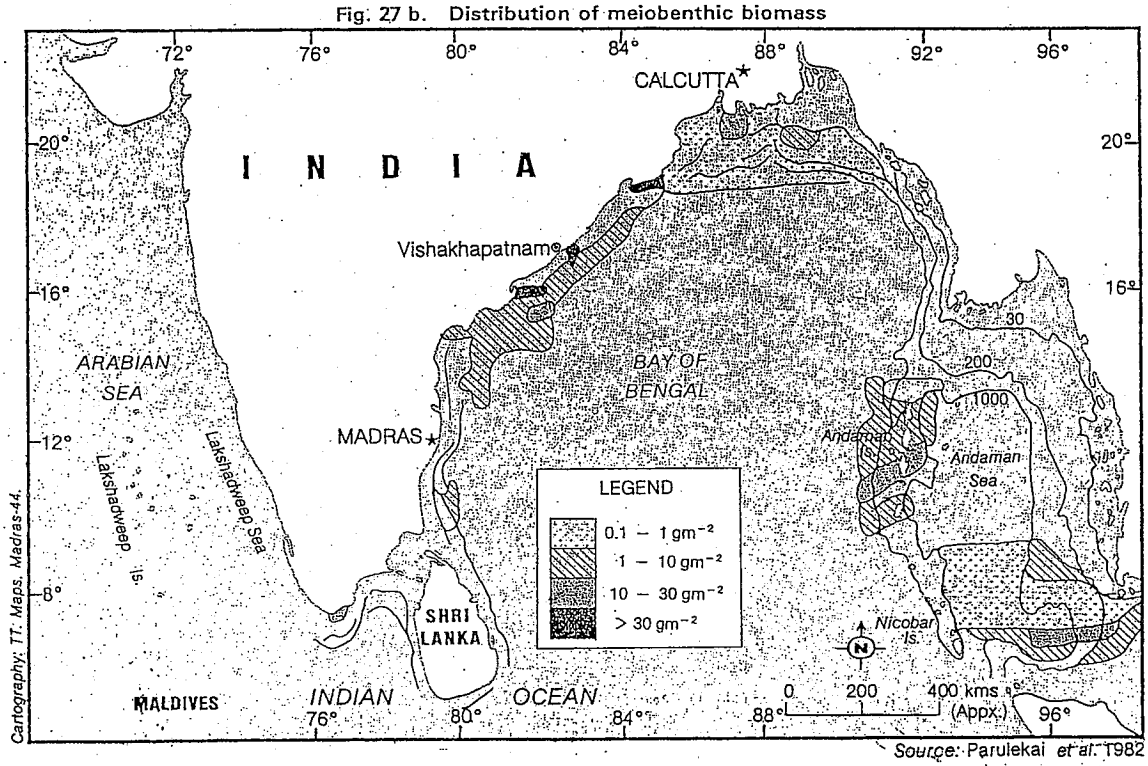


Fig. 3. Distribution of macrobenthic and meiobenthic biomasses as an expression of overall productivity in the Bay of Bengal.
From Holmgren 1994.

Coastal Capture Fisheries

Symptoms	*Causes*	*Countries*
Declining rate of catch	Overfishing, including ornamental fish, over-capitalization; inadequate and ineffective management methods; destructive fishing methods, wild seeds collection for culture; degradation of coastal environment	All BOB, less priority in Maldives
Conflicts among fisherfolk and others	Interactive fishing; inadequate management measures; lack of policies relating to access to resources	All BOB, less priority in Maldives
Changing catch composition	Changes in fishing methods and patterns; overfishing; use of more selective gears	All BOB, except Maldives
Reduction of unit value, *i.e.* reduced real earnings	Removal of predators of higher value; increased catch of juveniles; increased fishing efforts	All BOB
Wastage of bycatch	Catch juveniles, discards; inappropriate gear; post-harvest wastage; inadequate infrastructure and marketing channels	All BOB
Uneven exploitation by location and species	Uneven population and fishermen distribution; inadequate access to market; inadequate marketing; lack of infrastructure	*Location* : India and Indonesia; *Species* : All BOB
Declining employment capacity	Increasing efficiency of craft and gear; Note: In some countries, declining employment is a solution for declining catch, but in other countries declining employment opportunities is a serious social problem	All BOB
Fish mortality and public health	Harmful algal blooms; marine pollution	India, Malaysia
Relating to all symptoms identified above	Inadequate data; lack of political will; inability to enforce regulations; paucity of skills and methods in analysis and interpretation, extension and dissemination; ineffective MCS; communication gap between research and users; inadequate law and regulations; lack of participatory and community-based management approaches; lack of methodology to evaluate impacts of conservation and management measures	All BOB

Tab. 1. Main issues in fisheries in the Bay of Bengal region.
From Derahman et al. 1996

Offshore Fisheries

Symptoms	*Causes*	*Countries*
Underexploitation	Lack of fishing capacity; inadequate infrastructure; lack of assessment; high investment requirement; lack of technology; lack of product development; lack of knowledge on economic feasibility	All BOB
Conflicts	Ineffective monitoring, control and surveillance; Overlapping claims and disputed boundaries; destructive fishing; lack of resource data and information	All BOB
Lack of technology	Underutilized and untapped species; economic utilization of mesopelagic species	All BOB
Related to all symptoms noted above	Lack of data and resources; inadequate management methods, laws, regulations, and monitoring, control and surveillance	All BOB

Coastal Aquaculture

Symptoms	*Causes*	*Countries*
Environmental degradation (*in situ* and ambient) of coastal land and water	Poor management, inadequate laws and regulations; lack of standards; lack of awareness; lack of coordination among concerned agencies; inadequate mechanisms for MCS; inadequate planning and zoning; over-intensification of culture; nutritient loading; improper feeding; wild seed collection; removal of mangroves; waste disposal; impacts of farm escapees on wild stock in foreseeable future.	All BOB, except Maldives
Environmental and coastal conflicts	Multiusers; displacement of traditional users; impacts of landbased activities, salinization of soil and groundwater; wild seed collectors; introduction and production of exotic species	All BOB
Monoculture or limited culture species	Lack of technology; unavailable and lack of culture and hatchery technology; inadequate market; lack of promotion of consumption	All BOB
Inadequate seed supply	Shortage of hatchery; lack of hatchery technology; shortage of brooders and spawners	All BOB
Cost and availability of feed	Lack of technology; competing use of raw materials	All BOB
Diseases; drugs; residues; fish and public health	Lack of technology; poor culture management; overintensification; lack of trained specialists in fish diseases; lack of research on vaccine; inadequate quarantine procedures and fish transfer facilities	All BOB
Non-availability of, and competition for, water and land resources	Competing use; salinization; property rights; right allocation; enclosures; lack of survey to identify suitable sites	All BOB

Fishery - Class	*Small-scale*		*Large-scale*
CRAFT CATEGORIES USED	Traditional (nonmotorized)	Traditional + Nontraditional (Motorized)	Nontraditional (Mechanized)
I SMALL PELAGICS			
Species caught	–	Sardine, anchovy and mackerel	–
Gear interactive	Beach seine Boat seine Set bagnet (estuarine) Liftnet Small mesh gillnet	Set bagnet (marine) Liftnet Smallmesh Gillnet Purse seine Purse seine	
Fishing depth	1 - 10m	10 - 20m	20 - 50m
Size/Age of animal	Small	Medium + Large	Large
II SHELLFISH			
Species caught	–	Penaeid shrimp	–
Gear interactive	Pushnet/ Dragnet Set bagnet Boat seine Beach seine Trammelnet Trawlnet	Set bagnet Pushnet Trammelnet Trawlnet (shrimp)	
Trawlnet Fishing depth	0.5 - 10m	10 - 20m	20 - 60m
Size/Age of animal	Larvae, juveniles, sub-adults (small)	Sub-adults, adults (Medium+Large)	Sub-adults + adults(Large)
III LARGE PELAGICS			
Species involved	–	Tuna and pelagic shark	–
Gear interactive	Drift-longline Pole-and-line Trollingline Hardline	Large mesh driftnet Drift-Longline Pole-and-line Trollingline Handline	Pole-and-line Drift-longline Purse seine Drift-gillnet
Fishing depth	<200m Periphery of the C.Shelf (Inshore)	>200m Beyond C.Shelf (Offshore)	>1000m (Oceanic)
Size/Age of animal	Small	Small+Medium	Large
IV DEMERSAL FINFISH			
Species involved	Demersals croaker, catfish, Bombay duck, jack, ribbonfish, snapper, grouper, shark and skate		
Gear interactive	Set bagnet Boat seine Beach seine Bottom-set gillnet Bottom longline Handline	Bottom longline Bottom-set gillnet Trawl (shrimp) Handline Set bagnet	Trawl (finfish + shrimp)
Fishing depth	<10m	10-100m	30-80m
Size/Age of animal	Small	Medium	Large

Tab. 2. Bay of Bengal: examples of interactive fisheries of the four major categories in marine fisheries in the bordering countries.
From Sivasubramanian 1994.

Statewise marine fish catch (in t) from the Bay of Bengal during 1987-1990

State or territories	*1987-88*	*1989*	*1990*
West Bengal	61,800	96,900 (13,400)	123,000 (17,000)
Orissa	57,000	82,455 (4557)	52,832 (2750)
Andhra Pradesh	139,399	124,944 (18,162)	135,121 (17,979)
Tamil Nadu	219,000	293,129 (11,734)	306,733 (19,402)
Pondicherry	20,241	32,187 (2686)	35,261 (3571)
Andamans	10,951	15,036 (213)	13,770 (240)

Note : Marine fish landings for West Bengal include landings at Digha and Sankarpur

Source : Fishing Chimes, 11(3): 63 (June, 1991)

Figures in brackets indicate catches of marine shrimp (out of total)

Fisheries statistics along the Bay of Bengal coast

State	*No. of fishing villages*	*No. of landing centres*	*Area of brackishwater bodies (ha)*	*Marine fishermen*	*Potential brackishwater aquaculture area (ha)*	*Area under brackishwater farming (ha)*
West Bengal	652	47	210,000	404,000	300,000	30,000
Orissa	329	62	574,000	521,439	15,330	1500
Andhra Pradesh	409	379	64,000	605,796	17,000	1000
Tamil Nadu	442	343	56,000	520,903	80,000	100
Pondicherry	45	28	negligible	27,865	480	—
Andamans	43	54	115,000	2225	37,900	—

Source : Govt. of India (1988).

Benthic biomass, annual production, exploited and potential yield from continental shelf

Region	*Mean biomass (g/m^2)*	*Annual carbon production mean ($g\ C/m^2yr$)*	*Annual biomass prod. (tons/yr)*	*Potential yield (kg/ha)*	*Exploited catch (kg/ha)*
Tamil Nadu	11.91	2.139	$0.8x10^6$	238	159
Pondicherry	1.13	0.352	$8.3x10^3$	22	58
Andhra Pradesh	3.42	1.066	$0.2x10^6$	68	152
Orissa	7.34	1.760	$0.3x10^6$	147	52
West Bengal	45.49	11.853	$2x10^6$	909	35
Andamans.	7.62	1.273	$0.2x10^6$	158	3

Source : Parulekat *et al.*, 1982.

Tab 3. India, Bay of Bengal coast: catches of fish, aquaculture, biomass and potentials. From Holmgren 1994.

1. Establish policies to enhance & promote ICZM	Needs improvement	Poor
2. Establish ICZM programs addressing specific aspects, i.e., fisheries over-exploitation, erosion, protection of biodiversity	Needs improvement	Poor
3. Develop mechanisms for coordination and cooperation among sector agencies	Poor	Poor
4. Clarify jurisdictional mandates of government agencies in relation to integrated coastal management	Poor	Poor
5. Promote further links between scientists and decision makers	Poor	Poor
6. Strengthen management capabilities of relevant agencies	Needs improvement	Poor
7. Implement and rigorously enforce effective legislative instruments and incentives	Needs improvement	Poor
8. Invest in public education and awareness programs	Needs improvement	Needs improvement
9. Promote approaches and strategies to decrease pressure on coastal resources	Needs improvement	Poor
10. Promote involvement of all stakeholders in the development and implementation of ICZM	Needs improvement	Needs improvement
11. Provide appropriate incentives and guidelines for private sector to develop environmentally friendly economic activities	Poor	Poor
12. Promote bilateral and multi-lateral training relationships between countries of the region	Poor	Poor
13. Establish centres of excellence for ICZM in the region to support capacity building	Non existent	–
14. Encourage development and implementation of contingency plans for handling oil pollution disasters	Needs improvement	Poor
15. Establish and strengthen other appropriate institutions, e.g. the Marine & Coastal Biodiversity Centre in Seychelles	Non existent	–
16. Give special consideration to the problems of the island states	Needs improvement	Needs improvement

Tab. 4. Assessment of integrated costal zone management in the Easter Africa region, including the island states. From Lindén and Lundin 1996.

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