Environmental Economic Analysis of Inshore Fishery Resource Utilization of Coastal Kerala

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Introduction

The coastal zone, which is an interface between land and ocean, has enormous socio-economic importance, as these areas are characterised by an abundance of natural resources. The coastal belt of Kerala, about 590 kms long, has 226 marine fish landing centres and an equal number of fishing villages with high population density. The coastal habitat is under severe threat due to human intervention in the forms of excessive fishing in the inshore waters, shallow water mining, lifting of coastal sands, destruction of mangroves, inflow of pollutants, growing urbanisation, construction of sea walls and other related activities. These activities are bound to disturb the coastal ecosystem, affecting the sustainability of fishery resources and livelihood security of the vast majority of inhabitants. Besides, the technological advancements in fishing methods, coupled with increasing export demand for fish, lead to over-crowding of fishing units, especially during peak seasons. This condition affects the very sustainability of ecosystems and increases the need for environmental quality and conservation of resources.

Objectives

The specific objectives of the present study are to:

- Examine and document the extent of recent changes in the techno-exploitation pattern of inshore open access marine fisheries and socio-economic condition of stakeholders.
- Assess the economic impact of such changes on structure, composition and productivity of inshore marine fisheries and the livelihood security of the coastal population.
- Evaluate the economics of operation of different fishing units and their impact on fishery resource conservation, and to suggest policy measures for sustainable development of the coastal zone.
- Estimate the economic loss due to the environmental degradation of inshore marine ecosystems, and to provide sufficient socio-economic indicators to administrators and policy makers for decision-making in regional environmental planning.

Site

A preliminary survey was conducted in all the fishing villages covering the entire study area from Poovar in the south to Munambam in the north along the southern Kerala coast to identify representative sample villages of mechanised, motorised and non-mechanised fishing centres. The villages and landing centres were selected for detailed study on the basis of use patterns of marine coastal resources and intensity of operation of different craft-gear combinations, both in artisanal and mechanised sectors of Southern Kerala. (Fig. 1)

Fig.1 Map showing selected centres for the study in Southern Kerala

Methodology

The villages were classified into highly degraded, moderately degraded and comparatively undisturbed categories in relation to the intensity of environmental pollution as well as fishing. The costs and earnings data for all types of fishing units were collected on sample days from each landing centre, and the economics of different fishing units were evaluated, covering all seasons in a year (2001-2002). The socio-economic survey was conducted in all selected centres to analyse the socio-economic framework of the coastal rural sector. Secondary time series data from 1962 to 2000, relating to species-wise catch was obtained from the National Marine Living Resources Data Centre of CMFRI. It was used to study the extent of variation in catch composition, production trend of inshore marine fisheries and the impact of technological advances on marine resource base. In order to evaluate the response of those involved in fishing and allied activities regarding environmental and conservation problems of natural fishery resources, an opinion survey was also conducted in all the selected villages.

The sample centres selected for detailed study were Munambam, Cochin, Alappad Neendakara and Kochuveli for the highly degraded category; Arthungal, Valanjavazhi, Thangassery and Vizhinjam for the moderately degraded category; and Kattoor and Poovar for the comparatively undisturbed category. Among the selected centres under the highly degraded category, Munambam, Cochin and Neendakara were predominantly mechanised fishing centres having serious environmental and conservation problems. The major environmental concerns of these centres were excessive fishing pressure on the inshore region, heavy destruction of the bottom fauna, juvenile fishing, by-catches, discards and coastal pollution. Another highly degraded area covered under the study was Kochuveli village in Thiruvananthapuram District, where a large industrial unit producing titanium products is situated. Large quantities of acid wastes from this industry flow into the sea, which causes many health hazards. Some centres under the study area were considered degraded due to sea erosion and sand mining. Alappad village in Kollam district was one of the most affected and degraded villages due to the invasion of the furious sea, especially during the monsoon season.

In the moderately degraded areas, the proliferation of motorised gears, operating within the near shore areas create heavy threat to the habitat. The indiscriminate operation of a large number of mini trawl and ring seine units, operating from the landing centre at Valanjavazhi and Pallana, led to the depletion of some species of fish of commercial value and importance. The predominant use of gears with reduced mesh size leads to juvenile fishing, and thereby over fishing of many important species of fish. A large proportion of the catch in mini trawl units is composed of juveniles/sub-adults of the flatfish Cynoglossus macrostomus and shrimp Parapenaeopsis stylifera, causing damage to recruitment. Oil spills from outboard engines in the bay-landing centres such as Thangassery and Vizhinjam led pollution in the near shore waters.

The Kattoor coast of Alappuzha and Poovar in Thiruvananthapuram district are comparatively undisturbed areas. Kattoor is a natural landing centre with motorised and non-mechanised units under operation. Most of the gears under operation in Poovar are non-mechanised units, such as Catamarans (Plank built canoe), shore seine units and motorised plywood boat with gill net/ hooks and line.

The extent of damage caused by technological advancements, and thereby destructive fishing by the mechanised as well as the motorised sectors was analysed. The economic loss due to juvenile fishing by different fishing units was estimated using suitable models developed during the study. Cobb-Douglas production function was used to evaluate the economic efficiency of input utilisation in trawler operation in three different regions. The Net Present Value (NPV) was calculated for discounted economic loss due to various environmental factors.

Results and Findings

Fish landings

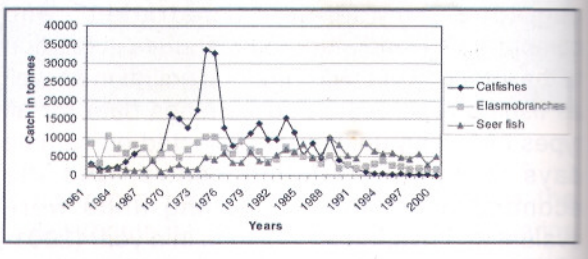
The analysis of species-wise annual landings of Kerala during the last four decades clearly

indicates that the effect of technological changes in fishing methods such as introduction of mechanisation and motorization of country crafts had affected some of the marine resources, leading to their depletion. The catfish fishery along the Kerala coast is the best example of the depletion of a resource due to indiscriminate fishing by the mechanised sector. The average annual catch of cat fish in 1961 was 3,114 t, which rose upto 33,526 t in 1974 owing to the large-scale exploitation by the mechanised trawlers and purse seiners. During the intensive mechanisation period, this came down to only 103 tonnes in 2000 (Fig. 2) .The major reason for the decline of this particular species was the over fishing of brooders by the mechanized purse seiners and trawlers.

The pelagic fish, such as the carangids, tunnies and seer fish were exploited maximum between 1985 to 1990, mostly by the motorised country crafts, especially using ring seines, gill nets and hooks and line. From then on, the catch showed a declining trend in spite of the increase in the number of motorised units in the area. Another endangered species is the polynemids, collectively called threadfins. The major cause of their depletion was the destruction of their nursery grounds by mechanised trawlers. The annual production of elasmobranches was also shown to be declining ever since their peak landings of 10,338 t in 1974, which was reduced to only 2,832 t.in 2000 (Fig.2). The heavy exploitation of sharks by the mechanised vessels along the coast reduced the catch from 7,747 t in 1983 to 1,706 t in 2000.

Certain less priced fish such as threadfin breams, lizard fish and ribbonfish considered by-catches in the mechanised trawlers, recorded an increasing trend in their catch. It was estimated that, in the total trawl landings, more than 45 percent was composed of by-catches, which included other than the above mentioned species, the juveniles and sub-adults of a wide variety of commercially important fish. The increase in the landings of the cephalopods, mainly an export item, was also noticeable in recent years.

Fig.2: Catch Trend of Cat fish, Elasmobranches and Seer fish



Socio-economics of Fishing Communities

The selected villages along the coastal stretch of Kerala between Munambam and Poovar were surveyed to assess the socio-economic status of the fishermen and the other people depending on the coastal resources for their livelihood. The total number of households ranged from about 1,000 in Kochuveli to 12,000 in Thangassery. In each village, the coastal wards, predominantly inhabited by fishermen, were covered under the survey and information was collected on socio-economic indicators such as housing pattern, family size and demographic features, literacy level, ownership of fishing equipment and employment pattern with special emphasis on fishing people, income distribution, consumption and expenditure pattern and indebtedness.

Regarding the ownership of fishing implements, the non-mechanised fishing vessel owners were more in Kochuveli and Poovar where 18 and 20 percent of the families respectively had non-mechanised catamarans with gill nets. The percentage of families having non-mechanised shore seine were 7 percent in Poovar and 4 percent in Kochuveli. In Alappad and Kattoor, 5 percent of the families were the owners of non-mechanised dinghies with gill nets. In Kochuveli, the livelihood of the fishing community was seriously affected by pollution, which was indicated by the non-existence of any improved technology in this area. Fishermen mostly used country craft and catamarans without any sort of mechanised device. In Poovar, more families were operating non-motorised catamarans and country crafts, mainly because it was an economically backward village having no facility for institutional credit. In Vizhinjam, 23 percent of the families were owner-

operators of plywood boat units with gillnet/hooks and line. Motorised mini trawl units were found more in Valanjavazhi with 24 percent of the families owning them. The households that owned mechanised trawlers were 5, 4 and 4 percent in Alappad, Neendakara and Munambam respectively.

Table 1: Ownership Pattern of Fishing Implements – Percentage Distribution of Families

Village	Non-mechanised			Motorised			Mechanised
	Shore seine	Catamaran & gillnet	Dinghy & gillnet	Plywood boat & gillnet	Ring seine unit	Mini trawl unit	Trawler
Poovar	7	18	-	8	-	-	-
Vizhinjam	-	3	-	23	-	-	-
Kochuveli	4	20		2	-	-	-
Thangassery	-	-	-	7		2	-
Neendakara	-	-	-	4	-	-	4
Alappad	-	-	5	6	4	-	5
Valanjavazhi	-	-	-	-	-	24	-
Kattoor	-	-	5	-	3	4	-
Arthungal	-	-	2	-	1	12	-

Out of the total, 69 percent of the adult population in Arthungal was employed, followed by Poovar (67%) and Valanjavazhi (61%). The lowest level of employment was in Kochuveli (47%), followed by Thangassery (51%), where most of the women were housewives. About 50 percent of the employed population in Vizhinjam, Valanjavazhi and Kattoor were wage earners in the motorised fishing units, which provided better income to fishermen. About 47 percent in Neendakara and 48 percent in Munambam were employed as wage earners in the mechanised fishing units. Only 21 percent of the people in Kochuveli and 19 percent in Poovar were engaged in fish marketing, mostly representing the women head load vendors, generating additional income to support their families. In Kochuveli, because of the discharge of effluents from the titanium factory into the sea, the intensity of fishing had come down, causing detrimental effect on the fishery. There had been a considerable shift in occupation from fishery to non-fishery activities. Many had migrated to other places for employment. About 28 percent in Valanjavazhi were engaged in processing work, mostly ladies working in shrimp peeling sheds.

On the whole, in all the villages, the expenditure pattern indicated that about 80 percent of the household expenditure was for consumption purposes. The average annual household expenditure ranged from Rs.19, 600 for the families of shrimp peeling workers in Kattoor, to Rs. 65,412 for the mechanised boat owning families in Munambam. . However, it was observed that medical expenses of families in different villages had no significant relation with the intensity or incidence of pollution. The credit utilization pattern clearly indicated that in most villages, maximum loan was availed for productive purposes.

Costs & Earnings

In the mechanised sector, the annual net profit from the trawlers having an Overall Length (OAL) of 36-42ft, 45-48ft and >50ft operating from Cochin Fisheries Harbour during 2001-2002, worked out to Rs.3.66 lakh, Rs.6.98 lakh and Rs.4.14 lakh. About 40 percent of the total expenditure was for fuel, followed by 25 percent for wages. Regarding the purse seine units, the annual net profit worked out at Rs.14.36 lakh, and was maximum for the above 50ft craft category, with the highest rate of return of 87 percent. The average revenue obtained for the mechanized gill net units was Rs.20.87 lakh, with a net profit of Rs.4.69 lakh.

The annual profit for the operation of the ring seine units with a craft of >50ft at Valanjavazhi was Rs.3.75 lakh. The major expenditure was labour charges (40%) as crews of 20-30 people, depending on the size of the craft, were engaged in a single day trip. The annual net profit obtained from a motorized mini trawl unit during the above period was Rs.1.48 lakh at Valanjavazhi and Rs.0.93 lakh at Arthungal, with the highest rate of return of 168 percent for the former landing centre. The average annual revenue from a plywood boat with gill net, operating from Vizhinjam centre was Rs.5.73 lakh with a net profit of Rs.0.77 lakh, and the net profit from the same type of unit at Thangassery centre was calculated at Rs.1.11 lakh.

Comparatively higher rates of return were obtained from the non-mechanised units, such as catamaran and shore seine units, mainly because of lower investment. The only exception was the non-mechanised dinghy with gill net, for which the rate of return was only 19 percent. The net profit from a shore seine unit worked out at Rs.1.14 lakh at Poovar and Rs.0.90 lakh at Kochuveli, with a rate of return of 126 percent and 103 percent respectively, and 95 percent of the expenses were towards labour costs. At Kochuveli, due to pollution, the average catch per unit of catamaran was much less than that of Poovar, but the average revenue was high because fishing was extended to interior ground, therefore they could get quality fish fetching higher prices.

The key economic indicators of operations of all types of fishing units were calculated and compared. Among the mechanised units, the average catch per day of operation was highest for trawlers, and the lowest was for gill net, but in terms of value realisation, it was *vice-versa*. Labour productivity was more in trawlers. Among motorised units, the catch and revenue per day of operation was highest in ring seine. Average revenue realisation was high in mini trawl due to the landings of penaeid prawns. Labour productivity and the rate of return were also found to be higher in mini trawl units. Among non-mechanised units, shore seines obtained the highest catch per day of operation. Quantity of fish produced per man, per day in shore seine was very low indicating high labour involvement in its operation.

Production Function Model

The production function analysis using Cobb-Douglas model indicates that there is scope to enhance the net profit of trawlers by increasing fishing days and the area of operation at Neendakara and Munambam, whereas at Cochin Fisheries Harbour, it is almost at the optimum level. At Neendakara landing centre, fishing days in a year can be increased from the average level of 193 to 204, and in Munambam from 203 to 229 days, to get the maximum profit. Even though the number of days fished in a year are not upto the optimum in all the major centres, it was observed that there was still excessive fishing pressure due to over crowding of fishing units.

Economic Loss due to Juvenile Fishing

The economic loss due to juvenile fishing by different fishing units was estimated using the model developed on the basis of the quantity of juveniles landed by different gears, price level of juveniles and adult fish of each species, and the approximate period of juveniles to attain adult or marketable size. Even though the annual revenue generated by a purse seiner is Rs.20.7 lakh, the annual economic loss due to juvenile fishing by the same unit works out to Rs.39.6 lakh. In the mechanised trawler, the economic loss due to juvenile fishing was Rs.28.3 lakh as against its gross annual revenue of Rs.31.2 lakh. In the motorised sector, a ring seine contributes a loss of Rs.19.1 lakh, which is higher than that of the annual revenue generated by the same unit (Rs.12.4 lakh), and for the mini trawl, the annual economic loss was estimated at Rs.6.9 lakh. Among different centres, the highest economic loss was at Neendakara harbour with Rs. 239.1 crores/year, followed by Cochin Fisheries Harbour and Munambam. As a whole, the economic loss due to juvenile fishing in the study area alone is estimated at Rs.600 crores per annum, in which the highly degraded centres contribute about 82 percent.

Economic Loss due to Pollution

Environmental problems at Kochuveli and Alappad were discussed in detail, and their effects on fisheries of the area were worked out in terms of Net Present Value (NPV) of loss of fishing income due to pollution for the next 15 years, discounted to the present level. At Kochuveli, because of the pollution problem, people are reluctant to adopt improved technologies of fishing. Due to this, the fishing intensity also has come down. Taking into account the major factors influencing the level of effort and the catch and value, the Net Present Value of estimated loss to the village due to pollution for the next 15 years comes to around Rs. 23.7 crores. Since there can be a flow of future benefits in coming years, a cost benefit analysis is done and the NPV is calculated for 15 years with a discount rate of 12 percent. NPV calculated for Kochuveli is Rs.157.4 crores. The low level of annual landings from Alappad landing centre is mainly due to the sand mining and sea erosion, resulting in the construction of a sea

wall, which obstructs the landing centre facilities. The annual economic loss due to these factors amounts to Rs.97.4 crores. The economic loss in terms of Net Present Value calculated for 15 years is Rs. 647 crores.

Loss due to Over-Fishing

Economic loss due to the extinction of some of the species of fish because of over-exploitation was worked out. The net loss due to over-fishing was estimated in terms of Net Present Value of MSY for 30 years, discounted to the present level, which was Rs.160.6 crores for catfish, Rs.458.5 crores for elasmobranches and Rs. 3.9 crores for goatfish. An additional loss of 30 percent of this amount comes in the form of consumer surplus.

Opinion Survey

An opinion survey was conducted on government policies on the conservation of resources, covering 100 people in each of the selected villages, who in one way or other are involved in fishing activities, either as fish workers, fish traders or boat owners. The survey reveals that more than 80 percent of the respondents are aware of the importance of environmental management for the conservation of natural resources, especially fishery. Many of the respondents in the degraded area believed that many economically important species of fish have disappeared or declined from that area, especially from Kochuveli. About 60 percent of the interviewed people at Alappad demanded the construction of a sea wall to protect the shore, and 100 percent to stop sand mining. All the respondents, except those involved in the operation of mini trawl, consider this net as highly destructive and detrimental to the growth of fishery in the long run. However, most of the fishermen interviewed were very cautious in making any response to the restrictive measures, which would affect their present benefits. A majority are in favour of a fishing holiday, but there is no unanimity in the type of unit or duration.

Recommendations

Policy measures have been recommended for the conservation of resources and environmental problems along the study area.

- In Kochuveli, where environmental problems affect the future benefit from fishery, it is suggested that the industrial effluents should be treated before discharging them into the sea through a buried tunnel.
- To prevent the indiscriminate exploitation of fishery resources, there should be fishing holidays for all types of mechanised fishing units and their socio-economic impact should be properly assessed.
- Since mini trawl is comparatively highly profitable and less capital intensive, there is every chance for its expansion. But, it is detrimental to the sustainable development of the fishery. Hence, further proliferation of this unit should be restricted.
- As the economic loss due to juvenile fishing is substantial, the standardised mesh size regulations should be introduced and implemented with proper monitoring for all types of gears in order to avoid juvenile fishing.
- All types of construction along the seashore, even those for developmental purposes, should be regulated, and the CRZ Act should be strictly enforced for the environmental protection of the coastal area
- Due to the economic loss due to the extinction of three species - elasmobranches, catfish and goatfish because of intensive over-fishing, other endangered species such as carangids, seer fish, threadfins, etc. have to be protected by restricting indiscriminate fishing by mechanised as well as motorised fishing units.
- Integration of coastal mariculture with small-scale inshore fisheries issuggested as a viable alternative to enhance the earnings and livelihood security of coastal fisherfolk without endangering the environment.