Indian Journal of Geo Marine Sciences
Vol. 46 (03), March 2017, pp. 485-492

Evaluation of economic performance of small scale fisheries in a tropical coastal ecosystem in southwest coast of India.

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Received 21 October 2015 ; revised 12 January 2016

Techno-economic data were collected from a representative sample of fishermen of covering both these fleets from Zuari estuary during 2014. Using this data, a group of economic indicators was determined separately for GN and AS fleets. The comparison of these indicators showed that both GN and AS fleets contributed significantly to the socio-economics of the fisherfolk in Zuari. Both the fleets were found to be economically profitable though GN showed comparatively higher profitability. After validating the results obtained from this study, it can be used as an input for constructing an ecosystem model for the estuary.

[**Key words:** Small scale fisheries, Zuari estuary, Southwest coast of India, Fisheries management, Economic performance]

Introduction

Global capture fisheries are generally classified as small scale fisheries and large scale industrial fisheries[1]. Small scale fisheries which involve 90% of the global fishermen population play a pivotal role in food and nutritional security as well as alleviating poverty of human population residing near the coastal region[2-5]. It is also observed that the small scale fisheries impact the fisheries sustainability apart from commercial mechanised fisheries[3-6]. However, the small scale fisheries can ensure the sustainable use of coastal fisheries resources under effective management framework[2, 6-8]. Globally, a great attention has been directed to the sustainable management of coastal fisheries to combat the decline of inshore fisheries resources and to protect the livelihood of coastal fisherfolk[6, 9-10].In such a situation, the socio-economic analysis is a vital component in formulating a ecosystem based fisheries management framework for the small scale fisheries in addition to the biological, environmental and ecological attributes[4, 11-12].

The economic indicators are powerful instruments in supporting the fisheries management actions since they provide the impact of such actions and endorse the management framework[13-15]. For this, quality data on the economic performance of fishing vessels is of paramount importance for preparing and implementing any management strategy. Therefore, the economic analysis of fishery related indicators also should be performed at the fishing unit level for various fishing fleet segments in a fishery[3, 13-15]. However, it is often difficult to procure the data for estimation of these indicators for small scale fisheries since the availability of information is very less[9, 17]. Presently, the data on the small scale fisheries is collected by fishermen (fishermen logbooks) as well as by the survey staff from fisheries departments[18]. However, the authenticity of this information is questionable since the data is collected not through statistically designed data collection methodologies.. In India fisheries is a state subject and,the fishing operations are categorised into three categories or fleets such as non-motorised (artisanal), motorised and mechanised based on the extent and level of fishing[20]. In the state of Goa, the contribution from mechanised, non-motorised and motorised fishing sectors to the total fish catch is estimated as 85%, 12% and 3% respectively[20-21]. Thus, the mechanised fishing sector forms the large scale fisheries and motorised and non-motorised contribute to small scale fisheries of the state.

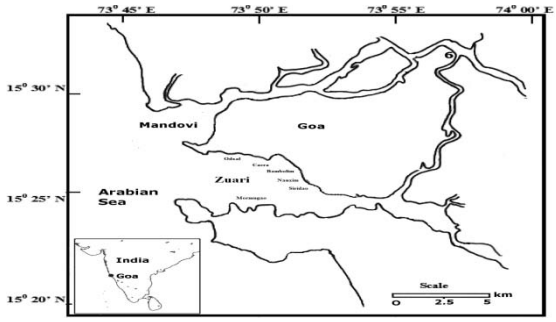

Fig. 1- Study area, Zuari estuary

Zuari estuary located in the state of Goa along the southwest coast of India supports rich diversity of finfish and shellfish resources on account of its wide spread mud flats, mangrove vegetation and occasional rocky patches[18]. Presence of rocky patches makes it unsuitable for trawling and hence, the small scale gillnet fishery represent majority of the landed fish catch and it provides livelihood for local fishermen in this ecosystem. Major fishing fleet segments in this estuary comprise of motorised (which uses an out board motor (OBM) for propulsion) gillnet fishery (GN) and artisanal gillnet fishery (AS). Since, this is the one of the most important coastal ecosystems of India, it is essential to formulate a sustainable fisheries management plan for the small scale fishery in this region which will have wider implications on the other regional fisheries. For this, an ecosystem based fisheries management can be implemented for sustainable utilisation of the fisheries resources of the estuary. Therefore the present study was carried out to provide cost structure and economic performance of the fishing fleet in terms of individual unit using cost, production and profit indicators and to estimate economic viability of the fishery.

Material and methods

Zuari estuary supports rich diversity of finfish and shellfish resources on account of its wide spread mud flats, mangrove vegetation and occasional rocky patches. The presence of rocky patches makes it unsuitable for trawling and hence, the gillnet fishery represent majority of the landed fish catch and it provides livelihood for traditional and motorised fishermen in this ecosystem. Since early 1850s, the tribal people (GAWDA tribe) are engaged in fishing in this estuary. However, most of the people who were fishing in the estuary are now moved to Portugal through Portuguese visa followed by India's independence in 1947. Historically, 1000 fishers exploited the fisheries resources of the estuary and currently only 500 fishers are actively fishing in the estuary. The Northern coastal region of the estuary holds medium fish landing centres like Siridao, Cacra, Odxal, Bambolim and Nauxim (Fig. 1) which lands about 500-1000 tonnes of fish annually (Fishermen Society log books).

The fishing fleet in the estuary can be divided into two segments: 1) Vessels made of FRP (4-8 m Length over All (LoA)) which use an OBM (less than 10 HP) operate gillnets of 30-60 mm mesh size and considered as "GN" in this study**,** 2) Vessels made of wood (2-6 m LoA) which don't use an OBM operate gillnets of 30-60 mm mesh size and considered as "AS" in this study. The size of the vessels in the estuary was within 10 m and the fishing operations were within 5 km off the coast. Considering these aspects, the fishery is assumed to be small scale fishery. Thus, the small scale fishery of Zuari comprised of 40 motorised vessels in GN fleet with 200 fisherfolk and a group of 30 non-motorised vessels with 300 fisherfolk included in the AS fleet.

The indicators of economic performance of fishing vessels are often derived from economic data collected through interviews with fishermen[3, 15, 22]. This method of data collection helps to estimate the economic position of a fishing fleet with the active participation of fishermen. A sample of 125 active fishermen (25% of total fishermen- 50 from GN fleet and 75 from AS fleet) were selected and interviewed.. In the interview, the fishers were asked about the technical details, costs and production data of fishing activity during 2014. The technical data included information about the crew (number of fishers in the vessel for carrying out the fishing activity) and fishing effort (total number of fishing days in each month and in whole year). The information asked regarding the cost of fishing included the variable costs (fuel, lubricating oil and other accessories), fixed costs (costs related to license fees, insurance, maintenance, annual instalment for bank loan if any) and investments (type, cost and lifetime of investments). The monthly catch (kg) and price (Rs./kg) data (pooled, fleet wise and species/group wise) were also collected during the study period. The current value of vessel, motor, gear and other equipments (in

case the fisher had to sell it in the same condition) were also gathered.

The economic indicators were categorised into three major groups as cost indicators, production indicators and profit indicators. The cost indicators were total capital, fixed cost, variable cost, opportunity cost, salary cost and average wage. The production indicators were vessel physical productivity (weight of catch) and vessel productivity (value of catch). The profit indicators were net profit and rate of return on investment. A detailed description of these indicators is provided in table 1. These indicators were used in this study following the guidelines of FAO[3, 14, 23] in order to describe the small scale fisheries in Zuari estuary. The salary cost indicates the fisher's income, which was taken the annual expenditure on wages for crew. The average wage was calculated by dividing the salary cost with average number of crew. The opportunity cost and the fixed costs represent the capital and operational costs, respectively. The opportunity cost of the capital reflects the alternative rate of return if the capital had been invested in the bank and it was calculated based on the average interest rate during 2014. The fixed costs included administrative cost, maintenance cost and depreciation. The depreciation is an indirect cost and represents the decline in value of assets with continuous operations. The investments were classified into vessel, gear and safety material (life jacket floats). The income generated was estimated for fleet, for individual vessel and for species/groups.

Table 1- Economic indicators related to costs, income and profit selected for analysing the efficiency of the small scale fishery in Zuari estuary (all are described on annual basis).

	Item	Description
Costs	Total Capital	Present value of the Fixed investments like vessel, gear, motor and other permanent equipments
	Fixed cost (FC)	Administrative and maintenance costs (AMC) and Depreciation (D)
	Variable cost (VC)	Fuel, lubricating oil and accessories (fish baskets, crates and tarpaulin sheet)
	Opportunity cost (OC)	It is obtained taking the product of total capital (TC) and average real interest rate, R
	Salary cost (SC) and Average Wage (AW)	The annual cost related to wages for fishermen is salary cost and the salary cost divided by average number of crew yields average wage
Production	Vessel Physical Productivity (VPP)	Average production in terms of weight of catch
	Vessel Productivity (VP)	Average production in terms of market value at first point of sale per vessel. It is calculated the product of VPP and average landing price
Profit	Net Profit (NP)	It is obtained by deducting VC, FC, OP and SC from VP
	Rate of return on investment (ROI)	Percent ratio of yearly net profit plus the opportunity cost with respect to investment

Results

The small scale fisheries in Zuari estuary is a two fleet multispecies fishery that operates throughout the year within 5 km off the coast. There was a remarkable difference in fishing capacity of GN in comparison with the AS fleet. The technical characteristic like length of the vessel was higher in case of GN compared to AS (Table 2). There were two crew members in vessels of both the fleets. The mean number of fishing days was almost similar for both the fleets and mean engine power used by the GN fleet was 8.9 HP. The vessels of the GN fleet was older in comparison with the AS fleet. The vessels in the fleet were licenced for operation of only type of gear, gillnet and both drift and bottom set gillnets of 30-60 mm mesh size were used by the fleets. The major species caught were white sardine, penaeid shrimps, silverbellies, crabs, mullets, shads, moustached anchovies, carangids, bony breams, clupeids, croakers, Indian mackerel, whitebaits, bigjawed jumper, catfishes and silverbiddies. For the two fleets, the variable, fixed, salary and opportunity costs varied in relevance. The variable costs were directly related to the total number of days of active fishing. The types of variable costs in GN fleet were the cost for fuel, lubricating oil and accessories (fish baskets, crates, tarpaulin sheet etc.). At the same time, the cost for accessories contributed to the variable cost for

AS fleet (Table 3). The fuel was the major variable cost for the GN fleet which uses an OBM for propulsion and it accounted for 92% of the total variable costs (TVC). The variable cost was very less for AS fleet in comparison with GN fleet.

The annual fixed costs included maintenance and administrative expenses and depreciation of fixed assets and permanent equipments. The administrative and maintenance cost for GN fleet was ten times as compared to the AS fleet since it contains the expenses related to the installation of engine, travel expenses in connection with licensing and registration and maintenance cost for the OBM and craft. The OBM and craft were the most expensive investments in GN fleet while only the fishing vessel accounted as depreciation on fixed expense in AS fleet. The mean life of the vessel was found to be more in GN fleet in comparison with the AS fleet.

The salary cost was significantly higher in case of GN fleet in comparison with AS fleet. There were no differentiation among the crew members and all members are given equal amount of wages. The average wage for fishers was in GN fleet in comparison with the AS fleet (Table 3). This difference was observed because of the operational differences in both the fleets. The fishers in the GN fleet have long voyages and they explored fishing grounds far off the coast compared to fishers in AS fleet. The opportunity cost was estimated using the present value of total investments (TC) stated by the fishermen who own the vessel which represent the present value of vessel and other fixed investments. For the GN fleet, the invested capital was estimated Rs. 2 13 050 of which 46% was for OBM and 44% was for vessel. For AS fleet, the vessel contributed major share (92%) of the invested capital. The opportunity cost was Rs. 14 914 and Rs. 2 339 for GN and AS respectively.

The average fish production by the vessel designated as vessel physical productivity was almost twice for the GN fleet compared to AS (Table 3). Thus, the vessel productivity in terms of value was also very high for GN fleet than AS. This higher productivity functions were also reflected in the net profit and rate of return on investment. This difference was clearly due to the high vessel capacity, efficiency and large capital investment in GN. The income generated by various species/groups was analysed for both the fleets and it revealed that fishery groups like clupeids, shrimps, crabs, mullets and small benthic carnivores contributed significantly (>80%) to the vessel productivity (Table 4). For GN fleet, groups; clupeids, shrimps, crabs, mullets and small benthic carnivores contributed 31.1%, 24.4%, 14.7%, 6.8% and 6.7% respectively. Similarly for AS fleet, groups; clupeids, shrimps, small benthic carnivores, crabs and mullets contributed 32.7%, 18.9%, 11.3%, 8.9% and 8.4% respectively. Thus, the similarity of major fishery groups for the fleets indicates that both the fleets have operated in common fishing grounds with same kind of fishing gear of similar dimension (mesh size). The rate of return on investment for the GN fleet showed that the returns are twice as the annual average interest rates given by banks. However, for AS fleet, the rates were just close to the bank rates since the net profit and investments were lower compared to GN. Inspite of a lower value of return, the low investment in fixed expenses and comparatively lower variable costs make the AS fleet economically profitable for fishing operations.

Table 2- Technical and operational data per vessel (mean ± SE) for the fleets in the small scale fishery of Zuari

Fleet	Age of vessel (years)	Length of vessel (m)	Engine power (HP)	Crew	Fishing days
AS	7.5±0.6	4.4±0.4		2.2±0.1	260.5±4.1
GN	9.6±0.8	6.5±0.4	8.9±0.1	3.1±0.1	270.3±5.1

Table 3- Annual economic performance indicators (costs, profit and profitability) for individual fishing unit in small scale fishery of Zuari estuary. (The values for costs and profits are in Rs. and units are specified for other indicators).

Economic indicators	Fishing Fleet	
Cost Indicators	GN	AS
A. Fixed Cost (FC) (Rs.)		
1.Administrative and Maintenance Cost (AMC) (Rs.)	10000	1000

2. Annual Depreciation (D) (Rs.)	39550	9517
3. Opportunity Cost (OC) (Rs.) (TC*R)*	14913.5	2339.12
Total Fixed Cost (1+2+3) (Rs.)	64463.5	12856.12
B. Investments (I) (Rs.)		
1. Cost for the craft (Rs.)	130000	40000
2. Cost for the Gear (Rs.)	30000	15000
3. Cost for the Motor (Rs.)	150000	
4. Safety materials (Rs.)	1600	1600
Total Investments (1+2+3) (Rs.)	311600	56600
C. Variable Cost (VC) (Rs.)		
1. Cost for fuel (Rs.)	72000	
2. Cost for lubricating oil (Rs.)	1000	
3. Cost for accessories (Rs.)	5000	4000
Total Variable Cost (1+2+3) (Rs.)	78000	4000
D. Salary Cost (SC) (Rs.)	110000	62400
Average Wage (Rs.)	55000	31200
Production indicators		
Vessel Physical Productivity (VPP) (tonnes)	2.5	1.17
Vessel Productivity (VP) (Rs.)	270000	81900
Profit indicators		
Total Capital (TC) (Rs.)	213050	33416
Net Profit (NP) (Rs.)	17536.5	2643.88
Rate of Return on Investment (ROI) (%)	15.2	6.1

*R= annual average interest rate (taken as 7%)

Table 4- Fleet wise percentage contribution of various species/resource groups to the total value of the landings

SN	Fishery resources	GN	AS
1	Seerfish and barracuda	0.17	0.3
2	Sting rays	0.08	0.09
3	Cephalopods	0.13	0.03
4	Horse mackerel	1.66	1.42
5	Groupers and snappers	1.93	2.49
6	Medium benthic carnivores (silver sillago, catfish, croakers, flatheads, rabbitfish, bamboo shark, grunters, pomfret, wrasse, bream, sweetlips, sickefish and scat)	5.95	7.4
7	Fullbeaks and halfbeaks	0.24	0.16
8	Small benthic carnivores (glassy perchlets, false trevally, pufferfish, silverbellies and silverbiddies)	6.72	11.27
9	Carangids	2.35	1.86
10	Indian mackerel	2.4	4.21
11	Clupeids	31.1	32.7
12	Anchovies	1.41	1.86
13	Mullets	6.77	8.4
14	Crabs	14.65	8.9
15	Shrimps	24.44	18.94

Discussion

The small scale fishery of the Zuari estuary is represented by two fleet segments; GN and AS. Both the segments have an important socio-economic role in the fishing communities along the northern coastal region of the estuary. This small scale fishery provides employment to about 500 fishermen and thus secures the livelihood of about 1000 fishermen families and a population of about 3000 fishermen. The GN fleet is found to be the basic economic fleet segment since it provides the highest profit and return on investment per vessel. A value of 10% for ROI can be considered as an indication of economic efficiency[3, 15, 24] and therefore, GN fleet was economically very efficient in terms of ROI. The AS fleet was more significant in the social point of view since it employs more fishermen compared to the GN fleet. Both the fleets were found to economically profitable during 2014 with an ROI of 15.23% and 6.1% respectively. Inspite of a lower value of return, the low investments made the AS fleet economically profitable for fishing operations. Profitability indices are efficient tools in assessment of capacity levels of fishing fleets[3, 14, 23]. Moreover, these indices help to verify the investment in fishing for profit maximisation. However, this should not affect the sustainability of the fishery. Hence, in an already profitable fishery, it is not advisable to put extra investment for profit maximisation. There is no adequate information about the small scale fisheries of Zuari in the past to perform comparative evaluation. However, a general consensus is that the costs for vessel, OBM, gear and fuel have increased rapidly which has reduced days of fishing from 310-320 in the past to 260-270 at present. Thus, this will cause a reduction in fishing effort and capitalisation of the fleet and thereby adds to the management of the fishery.

This study reports the economic performance of the small scale fishery of Zuari estuary and it adds to the economic data for fisheries sector of Goa in terms of the cost, production and profit of fishing operations. This kind of information certainly has implications on the fisheries management of the estuary. Moreover, the methodologies used in this study can be applied for analysing economic structure of other small scale fisheries settings. The indices in this study provide a link between targets and operations especially in an analytical and policy management perspective[3, 9, 25].

There are certain limitations connected with the present study. It has only described the economics of the fishing operations in the small scale fishery and do not reflect the entire facets of the fishery and fish production. The important limitation is that the study doesn't completely interpret the tropical multispecies paradigm. However, it can be used when formulating the mixed fisheries management indicators which compose biological, ecological and socioeconomic dimensions for resolving the complexities in fisheries. The use of economic indicators helps to predict the financial consequences of management actions. At the same time, the economic structure of the fishery described in the present study can be considered as an illustration for the small scale fisheries and it will be of great use for the fisheries managers while formulating the management decisions especially for seeking the sustainable economic fishery options[3, 9, 14]. In this study, the Zuari estuary sustains an economic small scale fishery with two fleet segments and contributes to the livelihood of 3000 fisherfolk. Besides, it is an important coastal ecosystem which is highly dynamic and inhabits a rich diversity of aquatic species reported in several research reports[18, 26-30]. Therefore, the present study result will definitely contribute in identifying the economic consequences of fishing effort management in this ecosystem. The ecosystem based fisheries management requires fleet wise fisheries economic data in terms of fishing costs, production and net profit. Thus, the fleet wise information on costs, production and profit of fishing operations derived from the study can be used while designing the ecosystem based fisheries management plan.

Conclusion

This study highlights the fleet wise economic performance of the small scale fishery in Zuari estuary. The results of the study will be useful in holistic management of the estuary especially to meet the requirement of fleet specific economic information for ecosystem based fisheries management. The standard economic indices in terms of cost, production and profit of fishing operations used in this study can be used for analysing other small scale fisheries systems and for designing the ecosystem based fisheries management plan.

Acknowledgement

Authors acknowledge the support and contributions from Director of Fisheries, Dr. Shamila Monteiro and Superintendent of Fisheries, Dr. Hrishikesh Pawar are greatly appreciated.

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