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Livelihood Security in small Reservoirs – Case study of Aliyar (Tamil Nadu)

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Abstract

Reservoirs play an important role in the nutritional and livelihood security of fisher folk who belong to to weaker sections of the society. In India, there are 19,134 small reservoirs covering a water spread area of 14,85,557 ha. The present study is about ten gillnet fishing units operating in Aliyar dam, a small reservoir situated in Tamil Nadu. The common fishes stocked in this reservoir are Indian major carps *viz.,* catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*). Fishing was the mainstay of the stakeholders surveyed at Aliyar and their livelihood was entirely dependent on it. At Aliyar reservoir, fishing rights were given annually to these fishing units. Currently the average investment made towards each fishing unit ranged from Rs.0.55 to Rs.2 lakhs. The fishing tools used in the reservoirs were coracles (bamboo and FRP) and nylon monofilament gillnets of various mesh sizes ranging from 100 to 300 mm. The average fish catch was 10 to 20 kg per fishing unit per day. The marketing of the fish catch was done through Tamil Nadu Fisheries Development Corporation (TNFDC) and the fishermen got 60% of the share price obtained as income from fish sales. The average monthly income of fishermen varied from Rs.600 to Rs.1200. In this paper, institutional arrangements for the Aliyar reservoir fishing activities, socio-economic status of fishers, economics of operation of fishing units and income equality criteria of fisheries are discussed. Finally, overall livelihood security index of fishers was worked as 37.3% includes based on food, educational, health and economic security of the fisher folk which was 53.7, 29.0, 36.1 and 30.5% respectively. Household livelihood security indices were used to assess the socio-economic conditions of fishers.

Keywords: Reservoir fishing, gini coefficient, composite index, livelihood security

Introduction

Reservoir fisheries play a vital role in the inland fisheries production thereby meting out to the nutritional and livelihood security of weaker sections of the society especially in developing countries. In India, there are 19,134 small, 180 medium and 56 large reservoirs and the primary purpose of construction of these reservoirs were for irrigation, soil conservation, hydel power generation and domestic water supply (Sugunan, 1995). However, reservoirs are exploited for culture based fisheries and contribute significantly to the freshwater fish production from India. Small reservoirs are more productive and both perennial and seasonal reservoirs are intensively exploited for fish production by active scientific management. Many of the reservoirs were used to rehabilitate displaced weaker section of society by providing them with alternate employment. In many reservoirs government has made institutional arrangements mainly to improve economic condition of stakeholders by encouraging them to go for sustainable way of fishing, to generate continuous income, to meet out their family needs and to lead happy life. Few studies have attempted to give a comprehensive account of socio-economic and livelihood aspects of fishers and management in small reservoirs (Chrispin et al., 2016; Paul et al., 2020). While working with the poor and weaker section of society livelihood approaches are commonly used (Hussein, 2002). This approach gives emphasis on identifying the real needs of the people and integrating them in the programmes for service delivery. Balasubramaniam et al. (2001) have evaluated the differential characteristics of reservoir fishermen operating gill net,

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shore seines and gill net combinations in Hirakud reservoir and studied the technological adoption. Chrispin (2016) has studied the socio-economic and ecological aspects of fisheries and management at Pechiparai reservoir of Kanyakumari district and suggested management measures to ensure sustainable livelihood of fishers of the reservoir. The Aliyar reservoir was built across the Aliyar river mainly for irrigation purposes. Stocking, management, fishing and marketing rights of the reservoir fishes are under the control of Tamil Nadu Fisheries Development Corporation (TNFDC). The fishing operation are done by the ten migrant fisher families settled near the Aliyar reservoir. Being a productive reservoir, the Aliyar dam serves as the only livelihood option for the migratory fishermen who operate in the reservoir. It is essential to evaluate their socio-economic conditions, analyze their needs and ascertain food, health, education and economic security so as to suggest further policy for their upliftment. This study attempts to analyse income generated from the gillnet fishing and their improvement in their socio-economic conditions which was measured using a livelihood approach which dealt with various aspects such as food, education, health and economic level of the fisher families settled near the Aliyar reservoir (Hahn et al., 2009; Chinnadurai et al., 2012). Further, to understand income level inequality among the fishing units, the inequality index of Gini coefficient was used. The Gini coefficient was introduced by Italian statistician Corrado Gini (Gini, 1921), and has since been in wide use in studies related to resource allocation and measurement of inequality among the population in the domains of income, wealth, health care, and energy (Berndt et al., 2003; Chandrasekar, 2004).

Materials and Methods

The data was collected from the ten fisher family units pertaining to income and livelihood related activities in the Aliyar reservoir. Time series data of daily fish catch by the individual fishing units were collected from the TNFDC records during the financial year 2017-18. For computation of household livelihood index, pre-defined indicators on the well-being and complex needs of fishers at household level were used. The components of livelihood security included in the study were income, assets, food, nutrition, education, water, sanitation, primary health and reproductive health. The data using pre-tested structured questionnaires was collected through individual household survey during the study period from the fisher households. The aggregate measures of the above components were grouped into to the four domains as household livelihood security areas *viz.,* food security, educational security, health security and economic security. The socio-economic indicators considered for the study were gender, age, literacy, health, employment, income, expenditure pattern, savings, indebtedness, ownership of house, food consumption pattern and health status (Ghanim, 2000). Based on the data collected, Gini coefficient and livelihood security index were computed.

The Gini coefficient is the proportion of area under the diagonal line (egalitarian line) and the Lorenz curve line. The Lorenz curve lies below the diagonal and its slope would increasingly rise, as one would move to higher levels of income. This inequality arising out of Lorenz curve *viz.,* a divergence from the ideal situation of perfect equality is revealed by the Gini coefficient.

$$G = 1 + 1/_{n} - \left\{2/_{(n^2 z)}\right\} \sum_{i=1}^{n} (n + 1 - i)Yi$$

where,

G = Gini coefficient

n = sample size

Yi = income of the i^{th} fisher unit.

and $Z = \sum \frac{Yi}{n}$, is the average income of the sample units

The general well being of an individual is influenced by the level of income, education, health and availability of food. These are the four main factors and upon achieving a satisfactory level with respect to these factors, an individual will be able to maintain his household and ensure security of his future generation in the society. Household Livelihood Security index is a tool for assessing and measuring the wellbeing of population at the household level as well as the complex needs of families. It is used as a balanced weighted average approach with a large number of indicators, where each indicator contributes equally to the overall index. The indicators are grouped into different domains representing areas which play a key role in sustaining livelihood and well-being of a community such as economic, food, health and education. Each of the components were identified separately and an aggregate measure of livelihood security was derived by giving equal weightage. Lindenberg

(2002) analysed livelihood security areas under five broad dimensions: economic security, food security, health security, educational security and empowerment. CARE (2004) developed a set of multiple indicators to assess each of the HLS dimensions based on a reflective workshop involving several other NGOs in Bangladesh.

The variables included under each of the identified household livelihood security domains were allotted scores in descending order. These indices focused directly on the resources and its potential and constraints to family wellbeing of the fishers. The index helped to identify intra household economic and social dynamics and the coping mechanism of family to combat poverty and scarcity. Each of the domain was based on key criteria / determinants which serve as indicators of livelihood security which were identified separately. An aggregate measure of livelihood security was derived by giving equal weightage to the four domain indices such as economic security, food security, health security and educational security.

A composite index proposed by Chinnadurai et al. (2012), was used as an analytical tool to standardise each of the household indicators. When the observed values are positively related to the development, the standardization is achieved by employing the formula

$$Y_{id} = \frac{X_{id} - \text{Min } (X_{id})}{\text{Max } (X_{id}) - \text{Min } (X_{id})}$$

If not so,

$$Y_{id} = \frac{\text{Max } (X_{id}) - X_{id}}{\text{Max } (X_{id}) - \text{Min } (X_{id})}$$

where,

Y_{id} is normalised value of i^{th} parameter of the d^{th} household.

X_{id} is observed value of i^{th} parameter of the d^{th} household.

Min (X_{id}) is minimum value of i^{th} parameter of the d^{th} household.

Max (X_{id}) is maximum value of i^{th} parameter of the d^{th} household.

The standardized indices lies between 0 and 1. The level of livelihood security of d^{th} fisher was assumed to be a linear sum of Y_{id} as

$$Yd = \sum w_i \, Y_{id}$$

where w_i ($0<w_i<1$) are the weights determined by

$$w_i = \frac{k}{\sqrt{\text{variance } (y_1)}}$$

and

$$k = \left(\sum \frac{1}{\sqrt{\text{variance } (y_1)}} \right)^{-1}$$

These Y_{id} are calculated for each sub-component 'i' of all the four areas *viz.,* economic security, food security, health security & educational security.

Results and Discussion

A total of 10 fishing units operated at Aliyar comprised of a coracle and mono-filament gill nets of mesh sizes ranging from 110 to 300 mm set in the water for a length of 1 km to harvest the fish. The livelihood of the fishermen of Aliyar was entirely based on daily fish catch such as catla *(Labeo catla)*, rohu *(Labeo rohita)*, mrigal *(Cirrhinus cirrhosus)*, and few local fishes *viz.,* barb fishes *(Barbus barbus)*, halfbeak *(Hemiramphidae),* full beak gar fish *(Belone belone),* Tilapia *(Oreochromis niloticus)*, etc. Culture fisheries was carried out by releasing fingerlings of IMC of 7 to 8 cm into the reservoir as stock and are harvested upon reaching the marketable size of 1 kg. Regardless of the species the catch is priced according to grades in rupees per kg as shown in the Table 1. Grading of fishes is done based on the size and weight of the individual fish and the price varies according to the grade. TThe stocking and management is under the control of Tamil Nadu Fisheries Development Corporation (TNFDC). The per kg price of fish harvested and share of fishermen are fixed by the corporation based on grading of fishes. The local consumer demand of fresh reservoir fish is met through TNFDC sales outlet and the unsold catch is routed to Pollachi, Tirupur and Coimbatore outlets of (TNFDC). Depending on the water availability in reservoir, stocking and release of fingerlings is carried out after taking into consideration the biomass, growth rate & harvest time of species (Jyotishi & Parthasarathy, 2007).

Table 1. List of price fixed for fishes in Aliyar reservoir sale counter (Rs/Kg)

Fish Grade	Fishermen selling price	Reservoir Price	Local sales price
I	96	101	160
II	60	85	130
III	55	65	90
IV	20	40	80

The fishermen reside near the dam site in make shift sheds. The regular periodic maintenance of attendance and accounts related to individual fishing units, catch and sales is done by TNFDC. The Corporation also maintains nursery ponds for fish seed production and release them into the reservoir at appropriate time every year for stocking. The total fish sales revenue is shared by the fishermen and TNFDC in 6:4 ratio. With no other source of income the fishermen manage their expenses within this earnings. TNFDC provides soft loans for the purchase of fishing nets, repair and maintenance of coracle etc. and this adjusted against their daily catch revenue.

The fishermen operating at Aliyar reservoir are migrants from Bodi, a town which is 120 km away from Aliyar. Their settlement at Aliyar for livelihood dates back 30 to 35 years owing to unemployment at their native place. Majority of the fishermen are above 50 years of age and barring one fisher all the others have education up to primary level only (Table 2). Total investment for fishing tools by the fishers is around Rs.60,000. They enjoy the exclusive fishing rights at Aliyar dam and as far as fisheries is concerned, they are under control of TNFDC. The entire chain of activities right from stocking of fingerlings to marketing is managed by TNFDC. Fishers are licensed to operate in the reservoir on share basis Sinha & Katiha (2002). Fishermen were provided with temporary lands by TNFDC along with Rs.5,000 for construction of small houses / sheds (10 X 12ft). The average monthly expenditure of the fishers varied from Rs.15,000 to Rs.25,000. Fishing craft used by the fishers are coracles made of bamboo and FRP. Gillnets of various mesh sizes ranging from 110, 120, 140, 160, 260, 280 and 300 mm made up of nylon monofilament are used for fishing. Mesh size of 300 mm is used when the water level is full during September- October and smaller mesh sizes like 55-60 mm are also used occasionally to catch native fishes during the rains. Fish catch varies between 10 kg to 20 kg per fishing unit and the family income varied from Rs.800 to Rs.1,600 per day. Each individual fishing unit visit the dam site two times per day, first for setting the gear in the fishing ground and then to remove the net with the catch. The whole operation of net setting takes 3 to 4 hours in the evening and an equal time in the morning for harvest of fish catch.

Table 2. General details of the respondents fishing investment and income in the Aliyar reservoir

Particulars	Mean ± SE	% of respondents
Age (years)		
Below 40	38.5 ± 7.2	5
40 to 50	45.0 ± 6.12	8
Above 50	52.5 ± 9.05	85
Experience (years)		
Less than 30	23.7 ± 2.13	10
30 to 35	33.0 ± 6.30	85
More than 35	36.0 ± 11.24	5
Education		
Up to Primary level	-	80
Up to High school	-	10
Family size (no.)		
2 to 4	4.0 ± 1.02	75
5 to 6	5.5 ± 3.05	15
More than 6	6.5 ± 4.63	10
Religion		
Hindus	-	40
Christians	-	60
Occupation		
Primary (Fishing)	-	100
Secondary (Any other)	-	0
Investment		
Fishing craft (Rs.)	15000 ± 0	-
Fishing gear (Rs.)	30000 ± 2.15	-
Other accessories	15000 ± 5.65	-
Average monthly expenditure		
Rs.15000 to 20000	17500 ± 14.20	20
More than 20000	23200 ± 10.32	80
Annual income (Rs.)		
Rs.2 lakhs - Rs.3 lakhs	215000 ±12.45	20
Rs.3 lakhs – Rs.4 lakhs	350000 ± 19.56	80

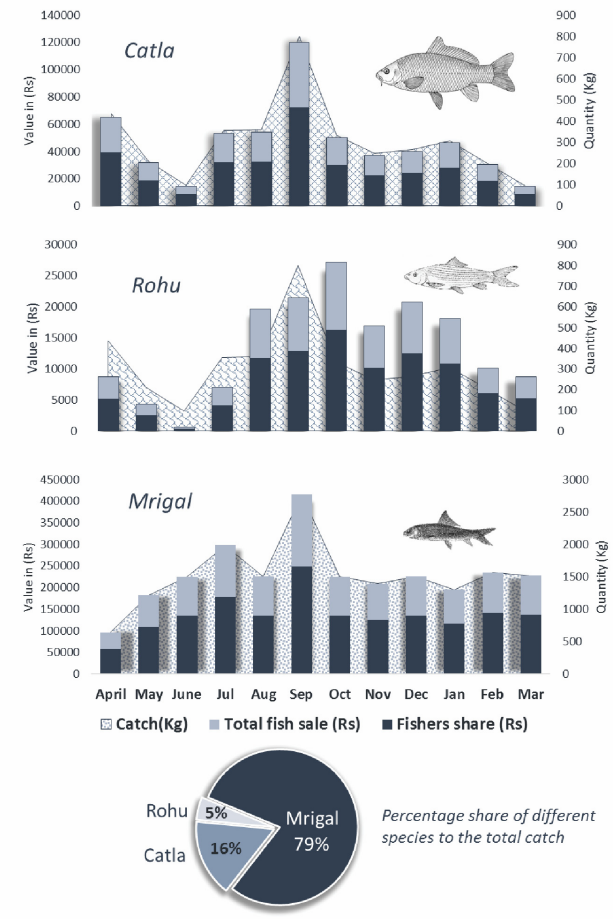

Fig. 1. Month-wise fish catch, sale and fisher income share particular of catla, rohu and mrigal in Aliyar reservoir (2017-18)

The time series data on daily fish catch on catla, rohu & mrigal, sale amount in terms of rupees and fishing unit share in rupees pertaining to 2017-18 were collected from the Aliyar reservoir sales office counter and analysed (Fig. 1). During September both catla and mrigal catch was high, where as in case of rohu, the catch was observed to be more during August. The average weight per fish of catla, rohu & mrigal harvested was 3.3, 1.3 and 1.4 Kg respectively. The total quantity of all fish caught during the year 2017-18 was 23.2 tonnes, which fetched a revenue of total Rs. 34.8 lakhs. Out of the total fish catch, mrigal contributed 79% of total sale quantity and value, whereas catla and rohu contribute 16 and 5% respectively. Out of the total fish sale value, the average income of fishers from the total revenue generated from overall fish catch is about 60% in terms of value i.e Rs. 20.9 lakhs which is approximately Rs.17,400 /month/ fishing unit which is thus an important source of income for the fishers depending on Aliyar reservoir for fishing.

Table 3. Annual average economics of operation of individual fishing unit in Aliyar reservoir

Particulars	Amount (Rs.)
Coracle	13000
Gill net (110 to 260 mm)	65000
Total Capital Investment	**78000**
Interest on fixed capital	7800
Depreciation	11700
Annualised fixed cost	**19500**
Variable cost	
Imputed wages	150000
Repair & maintenance	50000
Total operational cost	**200000**
Total cost	**219500**
Revenue	**270000**
Annual Net Profit	50500
Benefit cost ratio (BCR)	**1.23**
Net Present Value	**175448**
IRR	**64%**

The average annual investment towards individual fishing units operating at Aliyar reservoir was calculated and is presented in Table 3. It was observed that the initial investment required was Rs.80,000 out of which the expenditure towards gear was about 83%. The cost of coracle varied depending on the material used. For FRP coracles the cost ranged from Rs.18,000 to 20,000 and for other local materials like bamboo, the cost varied from Rs.8000 to 10000. The Benefit Cost Ratio (BCR) was 1.23 which indicates that the fishery is economically feasible. The Net Present Value, difference between expenditures and revenues, was computed as Rs.1.75 lakhs, which has been discounted using the social opportunity cost of capital with discount factor at 10%. IRR, an indicator of the efficiency of an investment was 64%, indicating that the effort made by each fishing unit is efficient.

The estimation of Gini ratio is defined as twice the area between Lorenz curve and egalitarian line. This ratio varies between zero (for total equality) and one (for total inequality). The important feature of Gini ratio is that equi-proportional increase at all income

levels would not affect the Gini ratio. However, it is sensitive to disproportionate changes at all levels of income. The income distribution pattern among the fisher household units of Aliyar was studied using Gini-coefficient and Lorenz curve. Fig. 2 depicts the results of Lorenz curve fitted to the data which gives the distribution of income among fisher households. Gini coefficient ratio for income inequality among Aliyar fishermen was worked out as 0.23 using cumulative percentage of their average monthly income. The inequality in the income distribution among these fishing unit families are 23%, which indicates that almost 77% of the fisher families come under the category of having equal income level. Based on the results we can deduce that inequality in income among the fisher families was considerably reduced and the income inequality of 23% among the fishing unit is mainly due to the variations in the catch, owing to the level of effort and skill set among the fishers. The fishers at Aliyar are similar w.r.t their social background as all of them are migrant fishermen. However it was noticed that the fishers had varied skill levels and attitude towards fishing. A few of them were not very regular in fishing with habit of absenting from work due to alcoholism. As the income from reservoir fishing was daily, these fishermen tend to spend it for their comfort and return to fishing only when money gets exhausted. Addiction towards liquor was found to be a menace in this community. This led to disproportionate income level among the fisher's even if it meant to a small extent. This phenomenon is revealed by the Gini quotient reflecting inequality

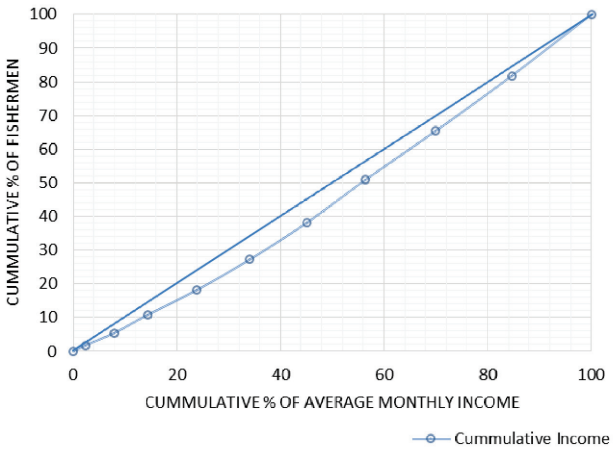

Fig. 2. Inequality in income pattern among Aliyar reservoir fisher households

The livelihood security indices for the 10 fishing household units at Aliyar was studied. These indicators were food security, educational security, health security and economic security and the parameters used are presented in the Table 4. It is found that food security index was about 53.7% indicating that the first and foremost requirement namely food for livelihood was met through the income generated from fishing at Aliyar reservoir which is also the only source of income. In general, except for the food security all other security indices calculated were low, owing to the illiteracy, lack of motivation and their minimum basic infrastructure requirements.

The fishers spent or saved the income earned through fishing for their children's education, marriage and construction of house at their native place. The children of the fishers were residing at their respective native places and only the couples fishermen with their wives stayed at Aliyar. The indices calculated revealed that the present living

Table 4. Livelihood security index of the sample fishing household units at Aliyar reservoir

Livelihood security particulars	Value
Food security	**0.537**
Frequency of food consumption	0.084
Quality of food consumption	0.149
Source of cereals	0.118
Source of food items	0.187
Educational security	**0.290**
Literacy	0.150
Type of school studying	0.140
Health security	**0.361**
Primary health	0.077
Reproductive health	0.096
Water	0.171
Sanitation	0.018
Economic security	**0.305**
Ownership of the house	0.011
Income earned	0.185
Borrowings	0.010
Savings	0.032
Fuel used for cooking purpose	0.067
Livelihood Security Index	**0.373**

conditions at the household was poor, as reflected in the low economic security (30.5%). They venture out of the reservoir area only for activities like taking care of family needs, purchase of gear material, visit to hospital and for occasionally attending family functions. The fishers have scaled down their requirement to bare minimum and the occasional loan taken from TNFDC which is usually less than Rs.10,000 towards operational cost gets deducted by TNFDC from their income. Further, fishers tend to use a major percentage of their income for meeting their household needs in their native places, including educating their children. So presentthe overall management and fulfilment of livelihood needs of fishers was not ideal as in Aliyar reservoir the future generation werein in their native village.

An overall livelihood index of 37.3% was observed which was mainly mainly due to the poor infrastructure facilities for their housing were shown 1.1% in terms of house ownership comes under the economic security and majority of the fishers have been continuing in fishing for the past 20 to 30 years. Even after 30 years in the sector, the fishermen livelihood conditions are as that of migrant labour without any permanent set-up. The family is not complete as the children of these fishers are not settled with them, which leads to social problems. Overall management of fishery by TNFDC is satisfactory, but however only when the livelihood aspects pointed out are fulfilled the fishery model cannot be called as successful. If the situation at the reservoir does not improve, the next generation of fishermen community will not pursue fishing as their occupation as they do not possess any fishing experience and are not motivated into fishing. Even though there exists successful reservoir and marketing arrangement and there is lack of proper living conditions for the fishers is existing. There is an urgent need for intervention to improve living conditions by providing basic housing infrastructure facilities like drinking water facilities, electricity etc. It will benefit not only the existing fisher families, but also the next generation of the same community who will get motivation to take up fishing as livelihood.

The TNFDC which manages the activities at the reservoir site provides a feasible reservoir fishing business model, because it ensures continuous employment for the fishers almost throughout the year, which has reflected in their income inequality among fishers and in turn meets their livelihood security. The food subsidy provided by Tamil Nadu government through PDS reduces their household expenditure on food as well. Even though the income level of the fishers has increased, the overall consumption has not increased at the reservoir site. Instead, the income earned through fishing is spent at their native places towards expenditure for family needs. The present livelihood option of fishing has to be elevated to the next level by providing the basic infrastructure facilities for the fishermen for long term sustainability. As such, fishing when seen as an occupation, is considered as low in status by the society Ekka et al. (2012), which will deter the next generation of these fishers to pursue the occupation. Therefore, the reservoir fisheries has to be developed by adopting diversification of initiatives and vertical integration must be attempted in the form of setting up value addition facility and elevate the status of fishers to a regular employment, for example as TNFDC or Corporation Staff. There is also need to provide proper housing facilities for the fishermen. Such a change will enable the next generation to view fishing as a lucrative job which will ensure livelihood security.

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