

Revised paper (clean)

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Title: Fishers' livelihood diversification in Bhagirathi-Hooghly stretch of Ganga river in India

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ABSTRACT

For the resource-poor fishers, livelihood diversification is a strategy to cope up with the uncertainty and inadequateness of the fisheries as a profession. The present study is an attempt to assess the socio-economic conditions together with livelihood diversification of the fishermen households of Bhagirathi-Hooghly stretch of Ganga river. Data were collected by personally interviewing 500 fishermen from 560 km stretch of Sagar to Farakka in West Bengal using survey schedules in 2016. Analysis of data indicated that the socio-economic conditions of the fishermen households are not encouraging. Fishing is the main occupation of around 88.60 % of the fishers and overall, fishing contributes 70.30 percent to the total income of the family. Average number of income generating activities per household ranged from 1.43 in lower stretch to 1.79 in upper stretch. Further, it was found that not only the average household income and numbers of income sources are limited but their level of diversification is also quite low. The monthly income of the household was found to be Rs. 9391. The income is higher in lower stretch because of higher catch and high value fish in the catch. Fishery as an only profession is unable to provide a decent life. Further, the study revealed that among other factors the Simpson index contributes positively and significantly towards per capita income of the fisher households. However, in absence of suitable alternative opportunities the resource is under pressure. The government needs to develop appropriate strategies to facilitate successful livelihood diversification. Facilities may be created for non-fishing activities like fish marketing kiosks, cloth weaving facilities, agro-processing in fruit orchard areas, e-rickshaws. They may be trained in some other income generating activities like carpentry, embroidery, dress making, driving etc for better livelihood of the poor riverine fishers.

Keywords: Occupation, diversification, riverine fisher, Ganga, India

Introduction

The Ganga river system is a rich ecosystem which supports about 10-13 million riverine fisher folk and about 300 freshwater fish species (SANDRP, 2014). The system provides livelihood and nutritional security to millions of people, however, in the post independence era the river has been equated to irrigation, water supply, and hydro power only, riverine fisheries have been completely ignored (SANDRP, 2014). The report further says that large dams, barrages and hydropower projects, adversely affected river flows, impacted hydrological connectivity between rivers and wetlands. Together with this, alarming levels of pollution, riverfront encroachment, rampant sand mining and unregulated overexploitation of fish resources are causing its fishery resources rapidly declining. Fisheries is a good indicator of the biophysical, ecological and social integrity of the river basin. Hence, the declining fisheries in the Ganga river system shows its poor ecological and social integrity.

Livelihood diversification is a process by which households engage in multiple income generating activities. It is widely seen in the academic literature and international development arena as a strategy for spreading risk and reducing vulnerability (Brugere *et al.*, 2008). It is an important strategy to help the rural people to come out of poverty. A study of Food and Agriculture Organization (FAO) on farming systems and poverty has suggested that diversification is the most important source of poverty reduction for small farmers in South and South-East Asia (FAO/World Bank, 2001). Some studies are available on fishers livelihood diversification from Kenya (Hoorweg *et al.*, 2008), Ghana (Gordon and Pulis, 2010), Brazil (Giesbrecht, 2011), Nigeria (Adeleke and Fagbenro, 2013; Talabi and Oyesola, 2014), Laos (Martin *et al.*, 2013), however, livelihood diversification studies on fishers are scarce in India. In the Bhagirathi-Hooghly stretch of the Ganga river, a sizeable population of

fishers depend on fishing for their livelihood and daily sustenance. However, due to declining fisheries they are facing hardships in managing their livelihood. Against this backdrop, this study has examined the socio economic conditions and nature and extent of livelihood diversification of fishers households in Bhagirathi-Hooghly stretch of Ganga river across the different stretches.

Methodology

Primary data were collected by personally interviewing the fishermen using open ended survey schedules. The study was conducted during the month of March-May, 2016 and September-October, 2016 covering a total of 500 fishers from 32 sampling sites of 560 km stretch from Sagar to Farakka in West Bengal. Multi-stage stratified random sampling design was adopted to select the fishermen from all the three stretches.

Table 1. Sampling sites in the three designated zones

The study area was divided into three stretches depending upon the width of the river and intensity of fisheries activities. The lower stretch is from Sagar to Dakshineswar. Here the river is wide and fishing activity is very intense. The upper stretch is from Nabadwip to Farakka, where the river is comparatively narrower. The middle stretch is from Dakshineswar to Nabadwip, where the width of the river and fishing intensity is medium.

The extent of livelihood diversification was analysed from three points of view: (i) number of sources of income, (ii) shares of fisheries and non-fisheries income in the total household income, and (iii) by constructing appropriate diversification indices. Level of diversification is measured by various types of concentration and diversification indices (Chand, 1995;

Shiyani and Pandya, 1998). Five different measures of diversification used in the study are described below.

Herfindahl Hirschman Index (H.H.I.)

$$H.I. = \sum_{i=1}^N P_i^2$$

where N is the number of economic activities, P_i is the share of i^{th} activity in total household income

The Herfindahl Hirschman index, is a widely-used measure of income/livelihood concentration in the literature (As for example Hawaii, 2008). This index denotes the extent to which a particular household income is received by a few or large number of activities. The index varies from 0 (perfect diversification) to 1 (perfect concentration). Thus, a lower index signifies greater diversification.

Simpson Index (S.I.)

$$D. = 1 - \sum_{i=1}^N P_i^2$$

It is a measure of diversification and most widely used (as for example Khatun and Roy, 2016). It is inverse of H.H.I. This index also varies from 0 to 1, however, the 1 indicates perfect diversification and 0 indicates perfect concentration. Thus, an increase in the index signifies greater diversification

Ogive Index (O.I.)

$$O.I. = \sum_i^N \frac{\left(P_i - \frac{1}{N}\right)^2}{\frac{1}{N}}$$

The diversity of a household would be greater when its economic activities are more equally distributed among its sectors (Rodgers, 1957). With an equal distribution, the Ogive index equals zero as the P_i is equal to $1/N$. In this situation, the household has got perfect diversity. A higher value indicates more unequal distribution. However, the measure is sensitive to the level of sectoral aggregation (i.e., the chosen number of sectors, N) used to organize the data (Hawaii Economic Issues, 2011). The value of N defines a household's economic structure being either diverse or specialized, both relative to other household's and over time (Grossberg, 1982 and Jackson, 1984). Both Ogive and Entropy indices yield similar diversity rankings.

Entropy Index (E.I.)

$$E. I. = \sum_{i=1}^N P_i \log\left(\frac{1}{P_i}\right) = - \sum_{i=1}^N \log_N P_i$$

where log is natural logarithm.

The entropy measure compares the existing income distributions among the income generating activities to an equi-proportional distribution. Higher entropy index values indicate greater relative diversification, while lower values indicate relatively more specialization (Hawaii Economic Issues, 2011). The minimum value of zero (maximum specialization) would occur if household gets the total income from one activity. On the other hand, if income is distributed equally among the N sectors, the index would be highest. If the index is maximum there exists perfect diversity.

Composite Entropy Index (C.E.I.)

$$C. E. I. = E. I. \times \left(1 - \frac{1}{N}\right)$$

Since $-\log N P_i$ is used as weights, it assigns more weight to lower values and less weight to higher values of P_i . The index 0 indicates the perfect concentration.

Factors affecting per capita family income

The multiple linear regression analysis was employed to identify the factors affecting the per capita income of the fisher households. For this the data of upper stretch were utilized. At the lower stretch the river is very wide leading to more fishing area and both fresh water and estuarine fishes are available in this stretch. Moreover, high value fishes like mullets, sea bass, hilsa, prawns and shrimps are available in more quantity here. Hence fishermen are getting more income from fisheries itself and their per capita income is more than that of upper and middle stretches although the diversification is less. Hence the effect of independent variables including livelihood diversification will be masked in this stretch. Some of the conditions of lower stretch also prevail in middle stretch. Hence, regression analysis was fitted taking data from upper stretch only. The following model was selected:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + u$$

Where,

Y	=	Per capita income in ₹
a	=	Constant term,
b_i 's	=	Regression coefficients,
X_1	=	Simpson Index,
X_2	=	Family size in numbers,
X_3	=	Age of the respondent in years,
X_4	=	Square of X_3 ,
X_5	=	Education of the respondent (year of schooling),

U = Random term assumed to follow normal distribution with zero mean and constant variance σ_e^2 .

Results of this multiple linear regression analysis have been reported in Table 7.

Results and discussion

Socio-economic conditions

Almost every village along the sides of the river is having some fishermen who earn their livelihood by fishing in the river. There is no census data available regarding fishers specifically involved in capture fisheries in the entire studied stretch. However, some earlier data are available related to specific gear employed by the fishers. Hilsa fishery is most important in the studied stretch. It was reported that an estimated 20,390 number of fishermen were involved in hilsa fishery in lower stretch below Dakshineswar, whereas about 5600 number of hilsa fishermen are there in the stretch of Dakshineswar to Farakka in middle and upper stretches (Bhuamik and Sharma, 2012).

Analysis of data indicated that the socio-economic conditions of the fishermen households are not encouraging. The years of schooling as an indicator of education level of the head of the household, is only around 2 (1.66) and majority of them are illiterate (40.40 %). The average size of the family is around 4. To 89% fisherman respondent the fishing was the primary occupation. The figure ranged from 84.5% in upper stretch to 92% in lower stretch. Fish vending, Ferry service, Tourism, Driving, Labour, Petty business and Rickshaw van pulling were the other sectors of primary occupation.

Table 2. Socio-economic characteristics of the respondent fishermen

Overall, the contribution of fishing occupation in total income was estimated to be 70.30 percent. Generally one member of the family are engaged in fishing, in lower zone the fisherwomen also plays an active role in fishing. The fishermen do fishing for 5-12 hours daily, depending upon the season.

Extent of livelihood diversification

Number of sources of income

The Table 3 shows that fishermen of all the stretches have diversified income sources, but the extent varies. Average number of income generating activities per household ranged from 1.43 in lower stretch to 1.79 in upper stretch. In upper stretch, the number of income sources was highest (1.79), followed by middle stretch (1.57) and lower stretch (1.43). In upper stretch, more number of fishermen households were involved in non-fishing activities. At this stretch the fisheries alone could not provide sufficient livelihood, hence, they are engaged in other income generating activities. In general, in lower stretch the fisheries provide sufficient income which discouraged the fishermen to diversify their portfolio.

Table 3. Average numbers of income sources of the fishermen household in different stretches*

Income from fisheries and non-fisheries Sources

The magnitude and proportion of farm and nonfarm incomes in total income by households of each stretch are presented in Table 4. Fisheries remains the most important source of livelihood across all the stretches. The study has revealed that on an average 30 per cent of the total household income were derived from non fisheries sources. However, these proportions varied widely across different sectors. In lower and middle stretches, the contribution of fishing in total income of household was found to be 75.88 % and 72.04 %

respectively. In upper stretch, the contribution of fisheries was 65.32%. Overall, the contribution of fishing occupation in total income was estimated to be 70.30 %.

Table 4. Contribution of fisheries in household income

A small amount of income comes from labour wage, service, petty business, etc. In the season of less catch, the youth generally engage themselves in the labour wage works or rickshaw van pulling to earn their livelihood. Members of 20.5% of the households are found to be engaged in self employed activities in upper stretch, overall the figure was found to be 12.8%. The table shows that in upper stretch, more number of fishermen households are involved in non-fishing activities. At this stretch the fishing activities alone could not suffice as a livelihood option, hence, they are engaged in other income generating activities. In upper stretch more number of households were engaged in labour wage work, self employment avenues and business. Reliance on non-fisheries sources of income, particularly by the labourers, in upper stretch is also evident from the Table 5.

Table 5: Different non-fishing sources of livelihood of the fishermen household

Livelihood diversification indices

Five types of diversification indices were used to measure the level of livelihood diversification in the study area. The values of all these indices are shown in Table 6. A perusal of the table revealed that the level of diversification, measured by Simpson index (D), for all the stretches was low. Other indices also had more or less similar values. Therefore, in the upper stretch not only the average per capita income is less the diversification is also higher. The level of diversification was lowest in lower stretch.

Table 6. Livelihood diversification indices

Factors affecting per capita family income

The multiple linear regression was employed to identify the factors affecting the per capita income of the fisher households. The results of the regression have been given in Table 7.

Table 7: Factors affecting per capita income

The table reveals that Simpson index, Family size, Age_respondent, Education_respondent are the factors which affect the per capita income significantly. Among them Simpson index contributes positively, which implies that as the livelihood of the fisher is diversified the per capita income increases. In the upper stretch the income from fisheries is less due to less catch and fishers have to go for other income sources. Hence fishermen households with more livelihood options are better off. Education of the respondent came out as a highly significant factor for variation of personal income. The age contributes positively upto a certain point, then it contributes negatively as evident through the negative coefficient of Age². Therefore, over-aged respondent fisher could not contribute sufficiently towards family income.

Summary and Conclusions

The study showed that fishery was the only profession to a sizeable number of fisherfolks. However, it is unable to provide a decent life. Various ICAR-CIFRI study shows that the fish catch from the river Ganges is declining (Vass *et al.*, 2008). ICAR-CIFRI recorded that the average catch per kilometer of the river at Allahabad, declined to 362 kg km⁻¹ during the 2000s from 1344 kg km⁻¹ during 1950s. There has also been a noticeable shift in species composition in catches. The catch of major carps declined drastically; hilsa catch also

decreased. Exotic fishes like tilapia and common carp have started appearing in the 2000s. The IUCN report (Ahsan *et al*, 2014) also emphasized that overexploitation was one of the causes of dwindling of Hilsa catch.

Vass *et al*. (2010) also observed that the increased fishing pressure due to higher demand for fish, followed by indiscriminate fishing methods, increased fishing effort leading to over exploitation, which gradually led to a drop in the catch per unit effort. With the decreasing natural stocks the fishers had to increase fishing effort for whatever species or size of fish were available to support their livelihoods.

Therefore, in absence of suitable alternative opportunities the resource is under pressure. There is a need of shifting sizeable chunk of fishers from fishing profession to non fishing activities. However, without alternate livelihoods, any form of management plans will not succeed. Facilities may be provided for fish marketing kiosks, cloth weaving facilities, agro-processing in fruit orchard areas, e-rickshaws. They also may be trained in some other income generating activities like carpentry, embroidery, dress making, driving etc. Other alternative livelihoods include working with river management authorities, conservation agencies, ecotourism, agriculture etc.

The government should develop appropriate strategies, especially for the resource-poor fishers households to facilitate successful livelihood diversification. Education being an effective means of increasing livelihood diversification strategies, targeting of education and skill development trainings for the poor fishers would have a large impact on their ability to diversify livelihood options.

Acknowledgements: Authors are thankful to Sh. B.N. Das, Sh. A.R. Chowdhury for their help in primary data collection. The financial help provided by Inland Water Ways Authority of India is acknowledged. The corrections and suggestions made by unanimous reviewer have greatly improved the quality of the manuscript.

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Tables

Table 1. Sampling sites in the three designated zones

Stretch	Distance (km)	No. of sampling sites	Name of the sites	Number of households
Lower Stretch	0 – 154	8	Sagar light house, Diamond Harbour, Hanrar Khal, Noorpur/ Roy Chak, Burul, Godakhali, Jagannathpur 11 No. Lockgate (Uluberia), Baranagar/Bally/ Barendrapara	100
Middle Stretch	154 – 278	10	Barrackpore/ Nawabganj/Debitala, Halisahar (Acharjeepally, Lalkuthi, Sarkarpara), Sannyalchar, Medgachi, Hatathpally (Kalyani), Shamsundarighat, Khasbati, Hooghly ghat, Tribeni, Balagarh	200
Upper Stretch	278 - 560	14	Katwa/Moraghat, Rajachar, Palassey (Ramnagar), Sundarpur Reach, Hotnagar, Chowrigachha, Lalbagh, Jiaganj, Jangipur, Raghunathganj, Sarala Kishorepur, Hasipur, Putimari, Farakka	200
Total	560	32		500

Table 2. Socio-economic characteristics of the respondent fishermen

Parameters	Lower stretch (100)	Middle stretch (200)	Upper stretch (200)	Entire stretch [#] (500)
Average age (years)	42.13	50.24	44.77	46.43
Avg. family size (numbers)	4.04	3.91	4.21	4.06
Illiteracy (%)	50.00	36.00	40.00	40.40
Can read and write (%)	9	17	9.5	12.4
Average years of schooling	2.39	1.39	1.58	1.66

Note: Figures in the parentheses indicate the number of family surveyed # Weighted average of three stretches.

Table 3. Average numbers of income sources of the fishermen household* in different stretches

Lower stretch	Middle stretch	Upper stretch	Entire stretch [#]
1.43	1.57	1.79	1.63

*Taking into account all the family members;# Weighted average of three stretches.

Table 4. Contribution of fisheries in household income*

	Lower stretch	Middle stretch	Upper stretch	Entire stretch [#]
Total monthly income (Rs.)	10226	9380	8984	9391
Income from fishing (Rs.)	7759	6758	5868	6602
Contribution of fishing (%)	75.88	72.04	65.32	70.30

*Taking into account all the family members; # Weighted average of three stretches.

Table 5: Different non-fishing sources of livelihood of the fishermen household

Economic diversification (% of household)	Lower stretch	Middle stretch	Upper stretch	Entire stretch [#]
Labour	17.00	24.00	25.00	23.00
Driver	2.00	1.00	2.50	1.80
Self employed	7.00	8.00	20.50	12.80
Service	9.00	4.50	7.50	6.60
Business	3.00	6.00	10.50	7.20
Fish vending	2.00	7.50	3.00	4.60
Rickshaw puller	3.00	2.50	3.00	2.80
Others	0.00	3.50	4.50	3.20

*Taking into account all the family members;# Weighted average of three stretches.

Table 6. Livelihood diversification indices

Stretch	Herfindahl Hirschman	Simpson	Ogive	Entropy	Composite Entropy	Per capita monthly income (₹)
Lower	0.7978	0.2022	2.1874	0.3825	0.2026	2893.8
Middle	0.7407	0.2593	1.9627	0.4964	0.2593	2576.3
Upper	0.6921	0.3079	1.7676	0.5427	0.3046	2328.7
Overall	0.7328	0.2672	1.93	0.4919	0.266	2541.4

Table 7: Factors affecting per capita income

Variables	Coefficients	Standard Error	t Stat	P-value
Intercept	7.781749	0.186662	41.68896	6.8E-164
Simpson index	0.137143	0.060452	2.268612	0.023723
Family size	-0.17352	0.011183	-15.5161	1.62E-44
Age_respondent	0.016798	0.007899	2.126606	0.033948
Age_respondent ²	-8.9E-05	8.24E-05	-1.07936	0.280952
Education_respondent	0.019651	0.004706	4.176143	3.51E-05

R²=0.63, N = 200