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Article

Sustainable rural livelihood-based approach on the impacts of climate change on small-scale fish farmers of Noakhali, Bangladesh

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Abstract: Climate change is a very common phenomenon which may affect rural livelihoods. A sustainable rural livelihoods approach was taken for this study to observe household incomes and any impact of climate to the livelihoods. It was found that there was negative correlation (Pearson value -0.449) to the income of males and females in 2014. Assumption of impact of climate change on income was not statistically significant in male farmers while it was statistically significant (Pearson value 0.332) in the year 2013 for female respondents. This current study suggests diversification in income generating activities and introduction of fair trade for betterment of the fishers.

Keywords: sustainable rural livelihood; fishers; climate change

1. Introduction

Noakhali is a coastal district of Bangladesh in which lot of people are dependent on fisheries sector. Aquaculture and capture fisheries practices have significantly increased in the recent years. DoF-DANIDA played a very important role in doing so as it is well known that fish is one of the main sources of protein for the poor (Jia *et al*., 2001). Bangladesh is a highly populated country the population of which has an increasing trend. Regular production costs and benefits from aquaculture ponds were found to be satisfactory in a study, the results of which were confirmed by another study (Hasan and Bhowmik, 2016).

A rural livelihood is sustainable when it can cope with stresses and shocks and also can adapt to vulnerabilities to lead life sustainably (Hoon *et al*., 1997). DFID's sustainable livelihood framework is to reflect holistically about the susceptibility features poor might be unprotected to, the assets and resources that care them prosper and live, and the plans and institutions (Government and non-government organizations). The framework exhibits how sustainable livelihoods are achieved through access to a diverse livelihood resources that are collective in the hunt of livelihood strategies. Diverse resources are essential to obtain positive livelihood outcomes. This current study has considered livelihood assets of very poor 50 male and 50 female fishers and their yearly incomes from fisheries resources in the changing climate of Noakhali.

2. Materials and Methods

Widespread field visits, meetings and personal communications were done to study the ruling categories of fish farming in Noakhali. People who had worked for NGOs and Government informed about the aquaculture practices in the different levels and the poor households. Key informants also gave information about the susceptibilities, adaptation and livelihoods of fish farmers. Familiar meetings were set with the informants. Focus Group Discussions (FGDs) with the poor farmers were arranged to have better ideas of the vulnerability context and their resilience to those vulnerabilities. Questionnaire was used during the interviews (Hasan and

Bhowmik, 2016) and data were finalized about the yearly profits from fisheries for the rural livelihoods. SPSS software was used for statistical analysis.

3. Results and Discussion

Year-wise data of income from 50 male farmers and 50 female farmers were collected for the period of 2010-2015 to have a little idea if there is any effect of the changing climate of these years incomes of the farmers (Table 1). It was found that yearly incomes were decreasing for both males and females who were involved somehow with fish farming. It was found that in some years, female incomes had been positively and negatively affected by male incomes (Table 2 a-f). There was negative correlation (Pearson value -0.449) in the income of these selected poor male and female farmers in 2014 where the correlation was significant at the level of 0.01.

Table 1. Male and female respondents' income during 2010 to 2015 (males at left) in Taka.

2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
24000	23500	23800	20000	19000	15000	18000	18100	17000	12000	10000	6000
23000	22400	22800	17000	18000	14000	17000	18000	17100	11900	10900	5900
24000	23000	23000	16000	17000	13900	17100	17100	16000	11500	10100	6000
22000	18000	24000	16000	15000	13900	17100	15000	15000	11600	11000	7100
25000	19000	23000	16000	15500	14000	16000	15200	14000	11700	12000	6000
23000	20000	22500	17000	15000	20000	15000	15300	13000	11000	12100	5900
22000	20200	22400	17100	16500	20100	15000	15200	12900	12000	12000	6200
18000	20300	22200	16900	17500	14100	14900	15900	12900	13000	12000	7100
24000	22300	21200	16900	16000	14300	14900	15600	13100	12800	11900	6000
19000	24000	20200	17000	15000	20000	14800	15300	13800	12900	11900	5900
23500	24200	23000	16500	14000	19900	13800	15200	13300	11000	12000	6000
22400	24300	22000	16000	15000	18000	14500	15100	14500	11000	10000	6000
24000	23300	21900	15900	15000	17000	14500	15000	15000	12000	10000	6100
25000	21000	21900	16000	15100	13800	15500	14900	15550	13000	9000	6200
25200	21200	20800	18000	16000	13900	16500	13900	14350	10000	9500	6300
22900	21900	17000	19000	16900	14000	17000	14000	14500	11000	9800	6100
24000	21900	18000	20000	20000	14900	16000	15000	14000	11900	9500	6200
23000	21800	19000	19000	20100	14500	15900	15100	15000	12100	10000	6100
25000	22000	18900	18000	18000	17000	15900	15200	15500	11900	9800	6000
23500	23000	19000	17000	19000	20000	15700	13900	14500	11800	9700	5900
22500	22300	18200	16000	20000	17000	15400	14000	15000	11700	9500	5800
22900	22000	20000	20000	21000	13000	15500	14100	14500	11500	10000	6000
22900	22800	21000	21000	19000	12900	15300	14200	14500	12000	10000	6000
23000	21000	21200	18000	18000	13000	15500	14100	13000	11000	9800	5900
24000	20200	22900	17000	17000	14000	15200	15000	12500	10900	9900	6100
25100	20100	20800	16000	16000	13900	15400	15100	12000	12000	9800	5000
24000	20000	20800	15000	15000	13000	15100	16000	12900	12100	9700	6000
23500	20100	20100	16800	14000	14000	14000	17000	12800	12000	9600	6500
22500	20200	20200	17000	15000	13100	14100	18000	12700	12100	9000	6100
23500	21000	20300	18000	16000	13200	14200	18200	12600	11900	8000	6000
24500	22000	21300	17000	16000	13800	14300	18100	12700	11800	9000	5900
23500	22300	21400	19000	16000	13000	14400	18000	12800	11700	8000	6000
22500	22300	22400	20000	15500	14000	14100	17000	12700	11800	8900	6100
24000	22400	23000	21000	15500	14100	14000	17500	13000	10000	9000	6000
25000	21000	21000	19000	14500	14200	14200	16500	13100	10100	10000	5800
26000	20000	20500	18000	17000	14300	14300	15000	13200	10200	8100	5900
21300	23000	17500	17000	18000	14000	14100	15500	13300	10900	7000	5900
22400	24000	23000	17000	18200	13900	14000	16500	12900	12100	6000	6000
20200	24000	24000	18000	17000	13900	13900	17000	13000	13000	7800	6100
23500	22000	22000	19000	17100	14000	14100	18000	13200	13100	8000	6200
24500	23300	21000	20000	18000	12900	14200	19000	13400	12000	9100	8000
21500	24300	18000	21000	19000	13000	14300	19100	13500	12600	6000	6000
20500	25300	17000	20000	18000	14000	14100	20100	14000	11600	6900	6300
24000	23000	16000	16000	19000	13000	14000	14000	13900	10900	7000	6000
25000	22000	24000	17000	20000	13000	14100	17000	13800	11000	6100	6300
21000	23000	25000	18000	18200	12700	14200	15500	13000	11900	7000	6500

23800	21000	24900	19000	18200	14000	14300	16500	12900	12000	7100	7000
24200	22500	22900	20000	18300	13000	15000	14000	13000	12100	6900	7900
23500	23000	21000	21000	19000	12800	15100	15000	12900	11000	6000	5900
24500	21000	20000	19000	20000	13100	15200	15100	13100	10000	6000	5800

Table 2a. Relationship of yearly incomes of males and females in 2010 (N=50).

	Female
Male	
Pearson Correlation	0.162
Significance (2-tailed)	0.261

Table 2b. Relationship of yearly incomes of males and females in 2011 (N=50).

	Female
Male	
Pearson Correlation	0.257
Significance (2-tailed)	0.072

Table 2c. Relationship of yearly incomes of males and females in 2012 (N=50).

	Female
Male	
Pearson Correlation	-0.055
Significance (2-tailed)	0.706

Table 2d. Relationship of yearly incomes of males and females in 2013 (N=50).

	Female
Male	
Pearson Correlation	-.104
Significance (2-tailed)	0.472

Table 2e. Relationship of yearly incomes of males and females in 2014 (N=50).

	Female
Male	
Pearson Correlation	-.449
Significance (2-tailed)	0.001

Table 2f. Relationship of yearly incomes of males and females in 2015 (N=50).

	Female
Male	
Pearson Correlation	-0.198
Significance (2-tailed)	0.168

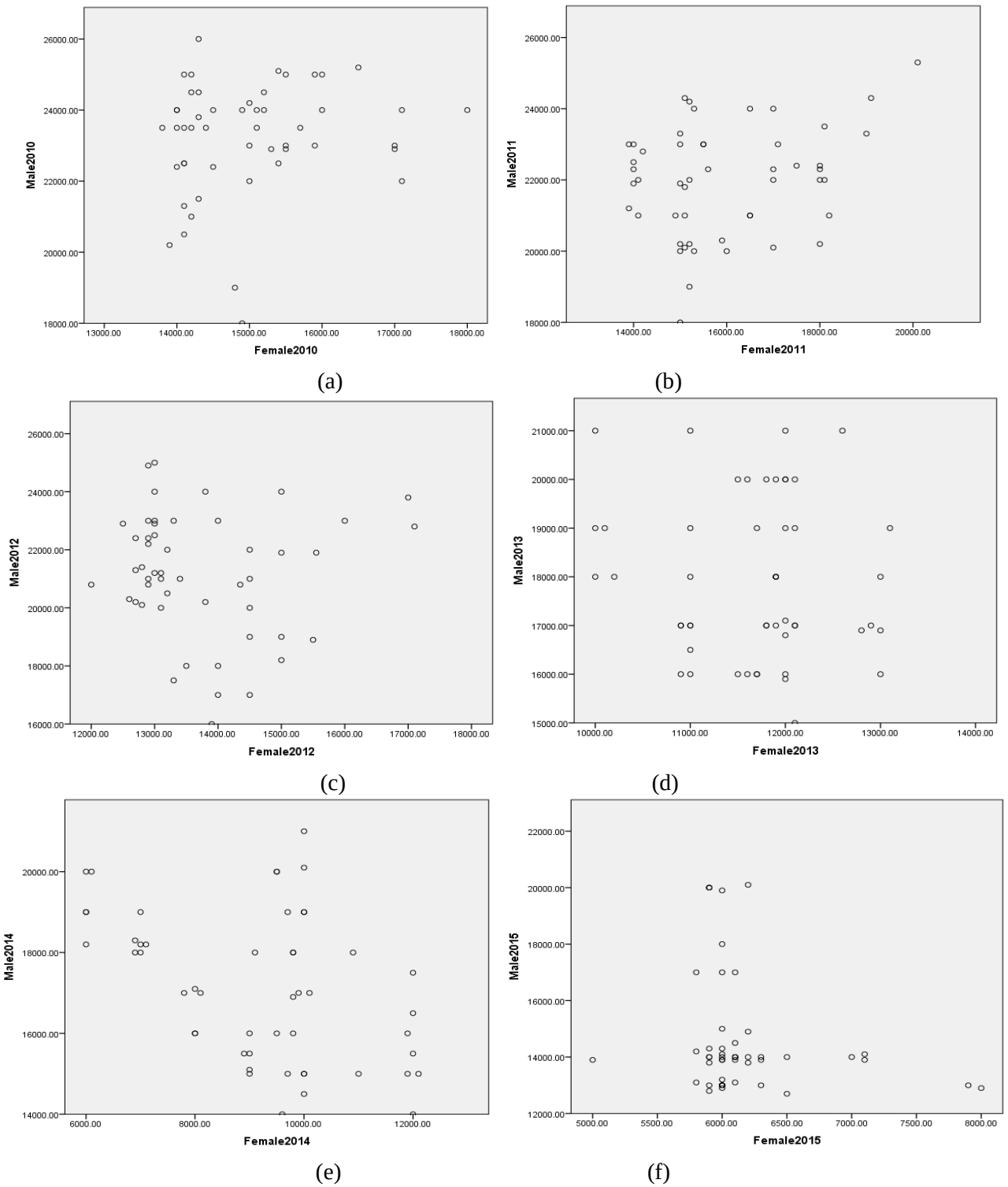

Figure 1. Scatter plots showing the linearity level of male and female incomes from 2010 to 2015.

Figure 1 shows that male and female incomes in scatter-dot plots during the period of 2010 to 2015. In most of the years their income did not show linearity.

The vulnerabilities regarding the incomes of poor farmers are listed in Table 3.

Table 3. List of vulnerabilities faced by the poor fish farmers.

Serial no.	Shocks, trends and seasonality pattern (Vulnerabilities)
1.	Increased storms and storm surges
2.	Stagnant water bodies
3.	Salinity intrusion
4.	Diseases
5.	Introduction of new dengue fever
6.	Increased amount of rain in the rainy season
7.	Marketing problem due to lot of intermediaries
8.	Lack of fare trade

Table 4. Correlations between the impact of climate change and male income.

	Impact of climate change
Male 2010	
Pearson Correlation	0.125
Significance (2-tailed)	0.386
Male 2011	
Pearson Correlation	0.021
Significance	0.883
Male 2012	
Pearson Correlation	0.102
Significance (2-tailed)	0.479
Male 2013	
Pearson Correlation	0.188
Significance (2-tailed)	0.191
Male 2014	
Pearson Correlation	0.230
Significance (2-tailed)	0.108
Male 2015	
Pearson Correlation	-0.101
Significance (2-tailed)	0.484

Table 5. Correlations between the impact of climate change and female income.

	Impact of climate change
Female 2010	
Pearson Correlation	-0.031
Significance (2-tailed)	0.831
Female 2011	
Pearson Correlation	0.003
Significance	0.984
Female 2012	
Pearson Correlation	-0.114
Significance (2-tailed)	0.431
Female 2013	
Pearson Correlation	0.332
Significance (2-tailed)	0.018
Female 2014	
Pearson Correlation	0.260
Significance (2-tailed)	0.069
Female 2015	
Pearson Correlation	-0.181
Significance (2-tailed)	0.209

Male and female respondents (Yes=1, No=0), mentioned that there was increased vulnerability for changing climate which have affected their incomes. A correlation test has been mentioned in Table 4 where it was found that there was no statistical significance showing the impact of climate change on their income. But in case of

female farmers, there was statistical significance at the level of 0.05 which mentions that there was impact of changing climate on their income in 2013 (Table 5).

DANIDA with Department of Fisheries had been playing a very important role in the development of aquaculture and fisheries in the district of Noakhali through Regional Fisheries and Livestock Development Component project which ended in 2012 (Ahmed and De Wilde, 2011). From the income data of the poor farmers, it was found that there was a decreasing trend in income after 2012. Personal communications (Giasuddin, 2015) also mentioned the fact that many fish farms which were being provided technology closed farming of some species after the international organization left. A list has been provided in this study mentioning the vulnerabilities of fish farmers. Authors think lack of fare trade is the most important vulnerability than the climate change that impact on fishers income. Vietnam coffee farmers have opportunity to fare trade which means that they can get higher price for their product. Establishment of fare trade in this area for fish is very important so that the farmers can get the price if they could sell their products directly in towns or could export. Minimizing the intermediaries are very important.

Table 6. Usual costs and revenues from aquaculture in the area.

Cost and revenue USD/ha/year	**Community ponds**	**Paddy lands**
Total Costs (TC)	704.96	369.60
Total return (TR)	1610.29	732.38
Net revenue	905.33	362.78
Benefit-cost ratio	2.28	1.98

Source: Hasan and Bhowmik (2016)

Table 6 has been retrieved from Hasan and Bhowmik (2016) which mentions the usual production costs and revenues from different types of farming system mostly available in Noakhali. Diversification has been suggested for increasing incomes of the fishers (Hasan *et al*., 2014) that can bring more money when agricultural practices are included with fish farming practices. The poor farmers who have a pond can produce vegetables and fruits besides their ponds or start cattle farming. Proper natural resource management plan can be introduced to help the poor farmers. Bangladesh partially as a result of noteworthy benefactor support, implemented stocking and culture-based practices of fisheries as national strategies to support a fast-rising population (Valvo and Thompson, 2007). The Department of Fisheries, Government of Bangladesh has been in charge for managing the quick development of fish farming in Bangladesh with a perception on giving attention to poverty (Ahmed and De Wilde, 2011). Shocks, trends and vulnerabilities found in this study was similar to the previous studies held in this area that affect the livelihood assets. However, Government of Bangladesh along with International Organizations had provided technical support to help in 'transforming structures and processes to the development of farmers livelihood' which has been a part of the DFID's Sustainable Rural Livelihood (DFID, 1999).

4. Conclusions

The climate change vulnerabilities might affect the fish farmers. Government of Bangladesh has taken climate change strategy plans which should help the farmers (MoEF, 2008). Additional technology provided through the fisheries extension activities along with supporting in developing alternative income generating activities may help the farmers to be more resilient to climate change.

Conflict of interest

None to declare.

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