

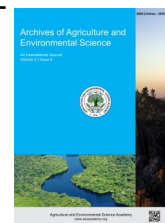


e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE



Enhancement of climate-resilient livelihoods in coastal agricultural communities with an emphasis on women

Nirmal Chandra Roy* , Md. Atick Chowdhury  and Kazi Rabeya Akther 

Department of Fish Biology and Genetics, Faculty of Fisheries, Sylhet Agricultural University, Sylhet - 3100, BANGLADESH
*Corresponding author's E-mail: ncroy@sau.ac.bd

ARTICLE HISTORY

Received: 25 September 2021
Revised received: 22 November 2021
Accepted: 17 December 2021

Keywords

Adaptive capacity
Agricultural community
Alternative livelihood
Climate change
Perception

ABSTRACT

Climate change is causing widespread concerns along the coast, reducing agricultural productivity and destroying livelihoods. A study was conducted in two cyclone-prone districts of Bangladesh, Khulna and Satkhira, with a focus on women, to improve the climate-resilient livelihoods of coastal communities. Participatory rural appraisal techniques were used to collect community perceptions of climate change and variability, as well as adaptation options. A total of 699 participants were involved, where 466 respondents were in the treatment group mostly vulnerable to climate change, and 233 were in the control group similarly matched to the treatment groups. Female respondents were adequately involved in this research and accounted for 63% of the treatment and 60% of the control areas. Climate change was impulsive, according to the findings, and variability has increased over time with no optimistic outlook. The women had an idea about climate change, with 62.7% in the treatment group and 58% in the control group being aware of it. About 55.3% in treatment and 45% in control were willing to take preventative measures against climate change. Natural disasters and difficulty in selling their products impacted agricultural harvests, and as a result, both the treatment and control groups attempted to adapt to the alternative livelihoods in response to climate change. Respondents cited changes in rainfall patterns, cyclones, saline water intrusion, and other factors as causing lower yields and crop damage. To improve the adaptive capacities of their climate-resilient livelihoods, communities adapted to the changing environment by accepting high-yielding salt-tolerant varieties, introducing new technologies, and modifying livelihood options.

©2021 Agriculture and Environmental Science Academy

Citation of this article: Roy, N. C., Md. Chowdhury, M. A., & Akther, K. R. (2021). Enhancement of climate-resilient livelihoods in coastal agricultural communities with an emphasis on women. *Archives of Agriculture and Environmental Science*, 6(4), 441-452, <https://dx.doi.org/10.26832/24566632.2021.060405>

INTRODUCTION

Bangladesh is widely regarded as one of the world's most climate-vulnerable nations. Natural disasters occur frequently, resulting in loss of life, damage to infrastructure and economic assets, and a negative impact on lives and livelihoods, particularly for poor people living in remote or ecologically vulnerable areas of the country, such as river islands and cyclone-prone coastal belts (MoEF, 2009). The coastal belt of Bangladesh's south-west is mostly found in critical condition for natural disasters due to various types of climate change impact. The coastal

belt's people suffer significant challenges in their lives and livelihoods, with women and children bearing the brunt of the impact (Adeniyi *et al.*, 2013; Kabir *et al.*, 2016). The long-term development and devastation caused by climate change on the environment of climate-vulnerable areas has a significant impact on human health, natural resources, physical infrastructure, food scarcity, and economic activity. All of those are mostly threatened by climate change and variability (Hug *et al.*, 2006). Climate variability is mostly exposed by droughts, uncertain rainfall, floods, and the utmost climatic conditions. This situation arose as a result of the critical state of crops, agriculture,

and food security in many parts of the world, particularly in developing countries (World Bank, 2010). Natural disasters create problems, mostly for the livelihoods of the coastal community. The coastal belt depends mostly on agricultural production for livelihood. But adverse climatic conditions create a vulnerable situation for the livelihoods and lives of the coastal community. There is no choice but to adapt to this issue by developing alternative livelihoods and improving adaptation capacities in the coastal belt to address this burning issue. The coastal region is ecologically enriched by the mix of coastal mangrove forest, productive agricultural land, and, most crucially, tidal inundation, which aids in various economic activities such as shrimp and crab farming. But the adaptation of the different alternative livelihoods in the coastal regions like Khulna and Satkhira district is being modulated by different factors. Climate change is a worldwide issue, but adaptation is only site-specific. The term 'adaptation' is related to coping with a new innovation or technology. But the adaptive capacity is impacted by different types of factors in the coastal area, such as insufficient knowledge about climate change, assets and appropriate use of new technology, infrastructures, and perceptions, inter alia (Adger et al., 2003). As a result, both male and female understanding and savviness about the impact of climate change and its mitigation play a significant role. Both male and female participation play a major role in overcoming the livelihood problems in the coastal communities. Livelihood adaptation in the coastal agricultural communities is very important because climate change impacts directly on the economic losses of Bangladesh.

According to the Climate Change Vulnerability Index of 2015, the per capita gross domestic product (GDP) of about \$1,220 is

the economic loss due to climate change in Bangladesh. It is also estimated to have cost around \$12 billion over the last 40 years, resulting in a 0.5 to 1.0 percent annual GDP reduction (World Bank, 2016). The climatic factors that cause droughts, storms, cyclones, floods, river erosion, loss of agricultural lands, and salinity inclusion in the coastal belt cause harm to the agro-based economy and threaten the livelihoods of a million people. Climate-resilient livelihood adaptation and boosting the adaptive capacity in the coastal agricultural communities and women's participation could bring productive outcomes. The main objectives of the research work were to identify women's perceptions of climate change, livelihood adaptation, and the capacities of women to cope with changeable livelihoods in order to reduce the vulnerability of the coastal agricultural community.

MATERIALS AND METHODS

Study area

The study was carried out in four upazilas (Koyra, Paikgacha, Assasuni, and Shymnagar) in Khulna and Satkhira districts (Figure 1). These two are Bangladesh's southern coastal belts, featuring climate-sensitive districts. The study areas were chosen with the knowledge that they are mostly vulnerable to climate change, tidal surge, salt water intrusion, and poor communities. Natural disasters such as floods, cyclones, temperature rise, and salinity inclusion were also found to be prominent phenomena (Abedin et al., 2012), promoting the adaptive capacities of coastal communities to address them, especially women and adverse climatic changes.

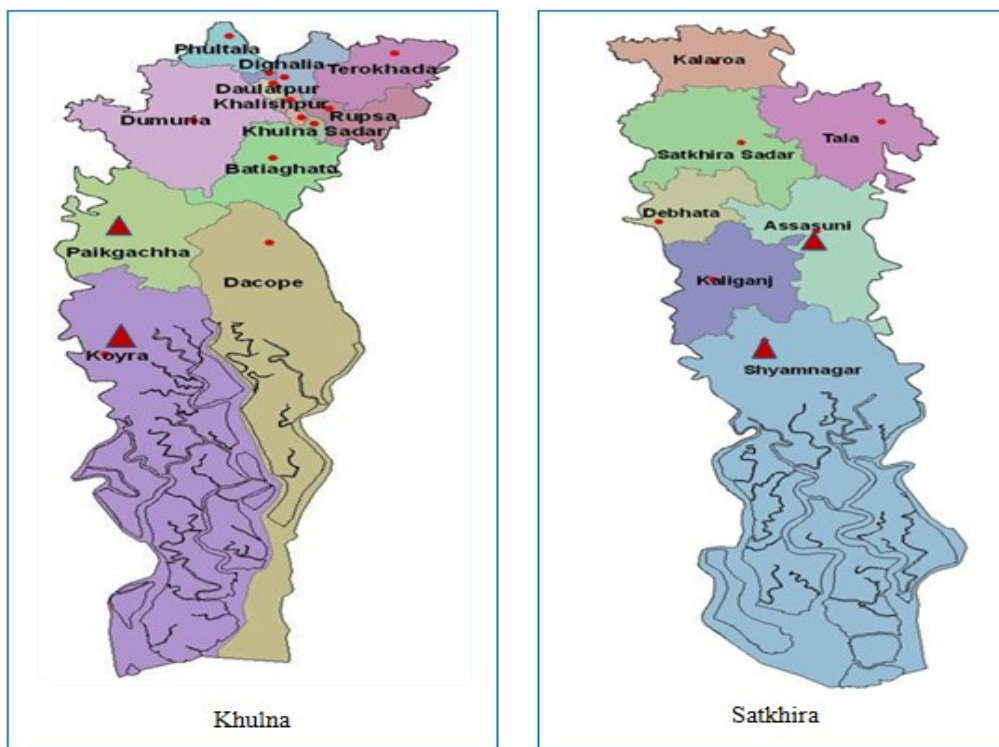


Figure 1. Map showing the study area (▲) of Khulna and Satkhira districts of Bangladesh.

Data collection

The study was conducted for a period of nine months from April to December 2019, and focused on climate change awareness, practical experience on climate change, climate adaptive livelihoods, alternative livelihoods and income generation, and women's significant participation in those purposes for the agricultural community of the coastal belt. The research information was collected from the responses of the selected areas. The treatment group was considered to be those households that had received benefits under different developmental programs, while the control group considered those households as possibly outside of the program. A total of 699 respondents were selected, of whom 466 were within treatment areas and mostly vulnerable to climate change. The other 233 were considered control groups, which were similarly affected as treatment areas. The ratio of the treatment and control groups in the study was about 2:1. In an ideal scenario, control samples were collected in the same manner as treatment samples. The control group needs to be selected purposely to best match the similar climate risk exposure. The research information was collected by using Participatory Rural Appraisal (PRA) tools such as Face-to-Face (F2F) questionnaire interviews, Focus Group Discussions (FGDs), and Key Informant Interviews (KIIs) for primary data collections, and secondary data was collected from different sources. Articles from journals, newspapers, monographs, booklets, and brochures published by relevant government departments were reviewed. NGOs, CBOs, and local groups were consulted for the gathering of overall information. There were eight FGDs that were held at different places in the selected areas; each contained 12-15 members, and four KIIs were conducted to get more insights on the subject matter from the relevant stakeholders, including local government institutions. Key informants were selected from the Upazila staff, representatives from relevant NGOs, local leaders, etc.

Data processing and analysis

The assembled data was analyzed after being verified to avoid

errors and incompatibility. Data was analyzed using Microsoft Office Excel 2013 and IBM SPSS Statistics version 22. The tabular and graphical presentations are also applied for processing by using simple statistical tools.

RESULTS AND DISCUSSION

Study areas, respondents and socio-demographic information

Among the respondents in the study, 38% were men and 62% were women, which represented 41% and 59% of the respondents from Khulna and Satkhira districts, respectively. Participants were relatively young to middle-aged, with about 54% (both male and female) between the ages of 18 and 35; about 24% were 36 to 50 years old; and 22% were over 50 years old. Nearly 28% of respondents completed primary education (Class I-V), 27% completed junior education (Class VI-X), 10% completed SSC, and 5% completed HSC. It was found that 20% of respondents knew how to write their names only, while 10% were totally illiterate. In this study, families were categorized into two types: nuclear families and joint families with several members. The great majority belong to joint families, which is nearly 61%, and only 39% live in nuclear families. 54% of the respondents were in 5-6 member families. The highest annual income earner was considered to be between 75,001 and 100,000 BDT, while the medium and lowest annual income earners ranged from 50,001 to 75,000 BDT and 20,000 to 50,000 BDT, respectively. Scientists reported that most of the respondents (53.25%) were medium-income earners, while 33.25% of the lowest income earners and only 13.50% of the highest income earners were observed in the hilsa fishers' family of the lower Meghna River, Bangladesh (Roy et al., 2016). It was found that the highest number (46%) of the fishers' annual income ranged between 50,000 and 75,000 BDT in Nijhum Dwip, Noakhali, which was more or less similar to the present findings (Rahman et al., 2012).

Table 1. Respondent's views (%) of reported ideas on awareness of climate change.

Criteria	Treatment	Control	P (Treat. vs Cont.)
Have idea on climate change (reported)	58.4	59.9	0.45
Male respondent	52.3	61.8	
Female respondent	62.7	58.0	
Reported ideas on climate change ^a			
Flood/Heavy flood	52.4	53.5	
Drought	47.5	49.1	
Heavy rainfall	32.3	37.8	
Unusual change of nature	32.5	32.6	
Storm/Cyclone	74.8	77.5	
Irregular rainfall	35.1	38.1	
High temperature	72.8	56.7	
High tidal wave	24.8	14.5	
River erosion	43.3	38.0	

^a Multiple responses

Table 2. Respondents (%) observed weather change pattern over the last 10-30 years.

Criteria	Treatment	Control
Climate has been changed over the last 10-30 years (%)	91.7	87.0
How ^a (%)		
Temperature increased	92.0	89.8
Irregular rainfall	49.3	53.9
Heavy rainfall	20.2	23.0
Insufficient rainfall	34.8	32.9
Increased frequency and magnitude of flood	40.1	36.0
Increased frequency of cyclone	60.5	57.6
Sea level rise	27.0	14.3
Increased river erosion	41.4	34.0

^a Multiple responses**Table 3.** Respondents' opinion (%) about livelihoods adopt in climate change situation.

Indicator	Treatment	Control	P
Aware of adopt climate change situation adoptive livelihoods	7.8	5.9	0.062
Have livelihoods that adopt the climate change situation	6.8	3.4	0.000
Net income from climate adaptive option (average, BDT)	5,689	3,977	0.116
Median income	8,000	8,000	
Boys or/and girls received training on adaptive learning to increase awareness ^a	2.6	9.2	
School	75.0	94.9	
Community based communications	13.5	11.2	
Others	13.5	3.1	

^a Multiple responses

Awareness about climate change

The participants in this study were unfamiliar with the effects of climate change. Different respondents were given various responses about climate change. Climate change awareness needs to be the kind of practical awareness that the respondents reflected on during the study. The overall criteria (Table 1) were reflected in 58.4% of the respondents who have some ideas about climate change in the treatment area, compared to 59.9% of respondents in the control area, among non-significance differences ($P < 0.45$). The female respondents were 62.7% in treatment and 58% in control areas with the idea of climate change. The study results also revealed that storm/cyclone was the highest known option for climate change effects, as rated by 74.8% and 77.5% of respondents in the treatment and control groups, respectively, which was followed by high temperature, flood/heavy flood, drought, river erosion, irregular rainfall, heavy rainfall, unusual change of nature, and high tidal wave, with little variation in the scores of the treatment and control groups across the selected areas. In the treatment group, 72.8% of respondents stated that climate change means high temperature when 52.4% stated that it means floods, while 47.5% interpreted climate change as meaning drought, 43.3% stated river erosion, 35.1% stated irregular rainfall, 32.5% stated unusual change of nature, 32.3% stated heavy rainfall, and 24.8% stated high tidal waves, while the scores are more or less similar in control areas (Table 1).

The people of the coastal community expressed concern about climate change in light of particular climate change factors that they face in the coastal area, where they are closely related. They observed different types of climatic changes like sea level rise, cyclone, sidr, storms, aila, floods, influx, salinization in the agricultural lands, increasing temperature, and uneven rainfall patterns. All of those have significant impacts on their lives and

health (Kabir et al., 2016). The climate is changing due to adverse impacts from anthropogenic activities. In the case of noticing climate change over the last 10-30 years, about 91.7% and 87% of respondents agreed in both treatment and control groups, respectively (Table 2). With the changing climate, the temperature was increased (opinions by 92% and 89.8% of respondents). In parallel, other criteria of climate conditions were also changed according to the respondents' opinion. In the last 30 years, the country has experienced nearly 200 climatic disasters, including droughts, extreme temperature, floods, and storms. Those natural disasters killed thousands of people, destroyed houses and infrastructure, destroyed chains of livelihoods, and cost approximately \$16 billion in damage (Oxfam International, 2011). It was discovered that approximately 97.1% of Bangladesh's coastal area and approximately 35 million people in the coastal region are primarily vulnerable and directly exposed to various climate change hazards (Shamsuddoha et al., 2013). Those hazards are cyclones, storms, coastal flooding, salinization, increasing temperature, and sea level rise.

Livelihood dependency on climate change

Most of the people of Bangladesh are mainly dependent on agricultural production for their livelihood. But the climatic conditions are sensitive to livelihood. Because most agricultural products depend on climate change for their production, like fish and crop farming, livestock rearing, and also the lifestyles of poor people. The respondents were asked if they were aware of any such types of livelihoods that may be affected by climate change. Only 7.8% (treatment) and 5.9% (control) of respondents were aware, indicating that the majority of people were unaware of the impact of climate change on their livelihood (Table 3). In this situation, net income of only 5,689 BDT

Table 4. Agriculture land ownership and average land holding in the study area.

Indicator	Treatment	Control	P
Have agriculture land ownership (%)	26.7	27.8	0.495
Average land (decimal)	104.6	70.5	0.019

Table 5. Respondents (%) opinion about sale product in the market.

Indicator	Treatment	Control	P
Do you produce any product to sale in the market?	13.4	17.0	0.009
Fisheries product	41.4	20.0	
Agricultural product	38.8	32.8	
Shrimp or crab fry	21.6	5.0	
Vegetables	10.1	25.6	
Fruits	7.8	8.3	
Eggs	6.0	23.3	
Livestock (meat)	4.1	0.6	
Poultry (meat)	3.7	3.9	
Milk	3.4	4.4	
Manufacturing products	1.9	2.2	
Handicrafts	1.5	6.1	
Feel problems to sale products	28.0	34.4	
Faced problems ^a			
Fair price (gap between end user and producer)	77.3	83.9	
Distance	64.0	59.7	
Lack of buyer at right time	33.3	24.2	
Storage and preservation	17.3	12.9	

^a Multiple responses

(treatment) and 3,977 BDT (control) was used for livelihood purposes to adopt climate change. Table 3 also shows that primarily school-aged boys or girls (75% in treatment and 94.9% in control) were trained in adaptive learning to increase climate change awareness, whereas community-based communications were involved in only 13.5% and 11.2% of the treatment and control areas, respectively. The non-significant average net incomes from climate adaptation were 5,689 BDT in treatment and 3,977 BDT in control, with a median income of 8,000 BDT in both situations. The income was very poor due to the fact that the socio-economic conditions were not good in the studied areas.

It may be assumed that there are some knowledge gaps for climate change adoption technology in the studied areas. There are different types of climate adaptation technologies in Bangladesh, but that technology remains unused due to a lack of knowledge. It is also found that there are lots of knowledge gaps in those technological adaptations. The knowledge gaps are at different levels, such as: i) knowledge gaps in production; ii) knowledge gaps in interlinkage; and iii) failing to transfer the knowledge to the uptaker. The economy of Bangladesh is still mainly dependent on the agricultural sector. But there is a lack of appropriate application of climatic adaptive technology (UNEP, 2014). The researchers found that the agricultural sectors of Bangladesh use about 1.2 million hectares of land for agricultural production. But the agricultural sectors are mostly vulnerable to different climatic factors and their adverse effects, such as extreme temperature, uncertain rainfall patterns, uneven floods, droughts, and increasing salinization. Crop production and crop yield are mostly hampered by those climatic factors (Asia Foundation, 2012). In the studied area, it was

found that agriculture land ownership was about 26.7%, with an average land holding capacity of 104.6 decimal in the treatment area, whereas the significantly different values (27.8% agriculture land ownership and land holding of 70.5 decimal) were observed in control areas (Table 4).

A vast majority of the population of Bangladesh depends on the agricultural sector for their livelihood. According to the study, 47.5% of people directly and about 70% of people indirectly depend on the agricultural sector for their livelihood. The agricultural sector plays a significant role in the elimination of poverty and increasing nutritional balance in our country (Planning Commission, 2015). It was observed that people were producing their own agricultural products for sale in the market. Fisheries products were in the highest position (41.4% in treatment and 20% in control), then agricultural production was second highest, and shrimp or crab fry, vegetables, fruits, eggs, livestock, poultry (meat), and milk were also important in coastal studied areas (Table 5). Many producers face problems selling their products due to fair prices (77.3% in treatment and 83.9% in control), market distance from their household (64% in treatment and 59.7% in control), lack of buyers at the right time, storage and preservation, etc.

To overcome this situation, the respondents seek assistance needed in standardization, storage, marketing, contact farming, and loan facilities. Most of the respondents (84% in treatment and 77.8% in control) were seeking to assist with standardization, storage, and marketing facilities. Some respondents (21.6% in treatment and 27.2% in control) were seeking producer-led marketing facilities, while 5.6% in treatment and 3.3% in control required financial/loan facilities (Figure 2). About 7% (treatment) of respondents sought assistance with contact

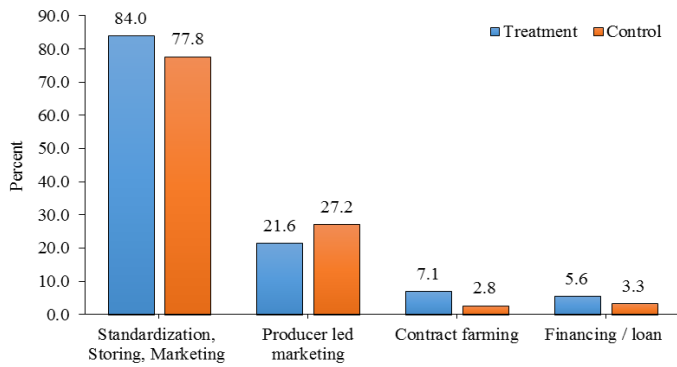


Figure 2. Respondents (%) opinion on assistance needed for product sale system in the market.

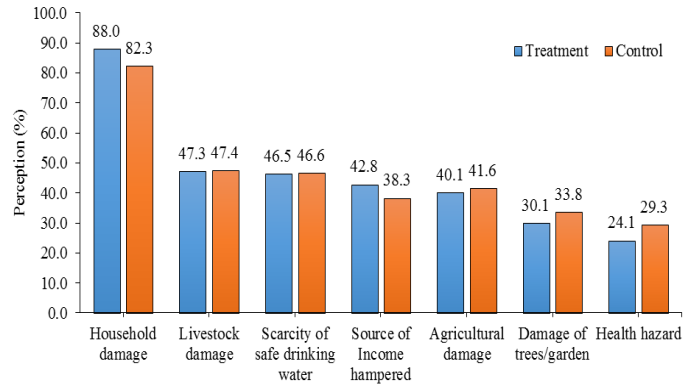


Figure 3. Respondent (%) opinion on the different types of loss affected by disaster.

farming. In the contact farming system, the farmers are committed to supplying a certain amount of product to the contacted company. So, it is an important way to promote market devolution in coastal areas. Contract farming has become an increasingly potential issue where the responsibilities to be performed by both the farmers and the companies have become clear. Increased use of financial services can help farmers access inputs and other resources, which can help to improve agricultural productivity. Strong agricultural value chains create livelihoods, increase income, and promote economic growth. Use of sustainable agricultural and improved storage practices also helps farmers to increase agricultural production and provide better protection for crops that are harvested. All of these practices are expected to directly benefit households and lead to increased livelihood conditions.

The results indicate that the marketing facilities and marketing process should be developed in coastal areas, with an emphasis on conducting training programs for producers and other stakeholders. The market channel is a chain of transferring goods from the producer to consumers, and it is done by middlemen, who are essential for coastal community damage. These results are the most concerning about household damage. So, it needs to address how to protect their household during a natural disaster. However, agricultural (crops, livestock, and fisheries) production damage and a lack of safe drinking water were also serious concerns for the household's life and food security.

The respondents were asked how climate change affects their household. They reported that climate change affects their household in different ways, such as loss of house, drinking water, loss of income, loss of land and agricultural production, etc. The overall situation was observed to have 88% of respondents' household damage due to climate change in treatment areas and 82.3% in control areas (Figure 3). On the other hand, about 46.5% of respondents reported scarcity of safe drinking water, 47.3% of respondents reported livestock damage, loss of income of 42.8%, agricultural production losses of 40.1%, health hazards (24.1%), and damage to trees and garden (30.1%) in treatment areas. In control areas, the indicators are comparatively lower in all cases except agricultural damage, tree/gardens damage, and health, where scores are higher in comparison to treatment areas. All indicators in treatment and control areas were found to have a little bit of variation due to the position of household

placement in sensitive areas. The studied area had high unemployment because the majority of the people were found engaged in agricultural production like fish and crop cultivation. The water logging condition has also resulted in different types of losses in the coastal community, such as destroyed houses, crops, shrimp farms, infrastructures, etc. This in turn has caused significant displacement and humanitarian challenges in providing safe water supply, sanitation, shelter, and food security.

Income generation from livelihood

Many participants expressed that their preferred access to natural resources might be private/owned land, rivers, khas land, khas khal, trees, etc. It was found in the study that about 43.4% (treatment) and 47.6% (control) of respondents had to choose private/owned land, and other options such as fishing nets, cowsheds or chicken coups, and homestead gardens also had to be addressed (Table 6). There are so many sectors involved in family income and livelihood in coastal areas. In flood-prone areas, the people were very poor, and the livelihoods of the vast majority of the population were based on day laborers and agri-aqua labourers. Therefore, about 70% of respondents chose day labour income as the major source of earning for their livelihood. The main three income sectors were identified as day labour, fishing, and agri/aqua labour in the studied areas. Other sources of income were aquaculture producers, aquaculture enterprises, transport workers (drivers), etc. (Table 7). It was also found that the average monthly income was 7766 and 7469 BDT/month in the treatment and control areas, respectively. This finding proves that the socio-economic conditions of the studied areas are very poor. When respondents were asked about their secondary income sources for livelihood, the majority (74.4% in treatment and 71.6% in control) of participants replied that they had no sources (Table 8). However, many people have secondary income sources like poultry rearing, wage labour, agriculture farming, fishing, etc. It may depend on the available facilities in the local area. The monthly average income from secondary income sources was very poor. There were only 2,389 BDT in treatment areas and 2,883 BDT in control areas.

In the research work, the last year's income sources of the respondents are shown in Table 9. It was found that most respondents (about 64% in both cases) were involved in day labor

Table 6. Access to natural resources for preferred livelihood.

Characteristics	Treatment	Control
Access to natural resources (%)		
Private / owned land	43.4	47.6
River	23.1	17.6
Khas land	12.3	11.8
Khas khal	5.4	4.2
Tree	5.3	4.5
Type of financial assets HHS have (%) ^a		
Livestock (Cow, goat, sheep, poultry, other birds)	57.5	63.3
Fishing net	35.3	30.5
Cowshed or chicken coup	27.8	25.9
Homestead gardens	8.0	11.0
Boat	3.2	1.6
Power tiller / plough	0.6	1.2

^a Multiple responses

Table 7. Major income earning sector for livelihood.

Characteristics	Treatment	Control
Major income earning sector (%) ^a		
Day labour	69.3	69.6
Fishing	20.7	17.4
Agri/Aqua labour	14.6	18.1
Aquacultural producers	11.0	11.6
Agricultural producers	7.5	10.8
Aquacultural enterprise	6.7	3.8
Transport workers (driver)	5.5	7.2
Trading	5.3	7.5
River dependent livelihood	3.6	5.7
Sales related	3.1	3.8
Private service	2.6	3.1
Agricultural enterprise	2.3	3.9
Non-agricultural	2.2	3.0
Skilled Labor	1.6	2.4
Forest dependent livelihood	1.2	1.3
Public service	1.1	0.6
Boating	0.8	0.9
Water transporter	0.5	1.8
NGO service	0.3	0.4
Monthly income from the mentioned sources (BDT)		
Average	7,766	7,469
Median	6,500	6,000

^a Multiple responses

(agricultural or non). Other important income sources were identified as selling fish (21.2% in treatment and 17.9% in control) and selling agricultural products (10.3% in treatment and 11.2 in control). Very few respondents were involved in truck/van driving, small shops, handicrafts, vegetable selling, etc. It is reported that the people of the studied areas are vulnerable, and they have no agricultural land. In this connection, the monthly average income was only 5,624 BDT in treatment areas and 3,977 BDT in control areas. It was also found that very few respondents (6.76% in the treatment area and 3.39% in the control area) were also involved with the adaptive livelihood option for the climate.

Impact of climate change on households

In the research work, the respondents were asked how climate change affects their household. They reported that climate change affects their household in different ways, such as loss of house, drinking water, loss of income, loss of land and agricultural production, etc. The overall situation was observed to have

71.5% of respondents affected by climate change in treatment and 73% of those in control areas, with a statistically non-significant (P is 0.382) (Table 10). As summarized in Table 10, indicator estimates were calculated to resolve the climate change problem through household initiative; the cumulative non-significant impact of 6.5% and 6.9% of households taking initiative in treatment and control areas, respectively. The major initiatives were observed to be tree plantation and raising the homeland (0.3% and 0.7%, same value in treatment and control). Due to climate change (Figure 5), the yearly family expenditures for this purpose were 9,769.9 and 7,478.2 BDT in the treatment and control groups, respectively. When the respondents were asked what the reason behind not taking initiation was, the majority portion of respondents (66.3% in treatment and 58% control) answered that they didn't know what to do, and other respondents said they did know what to do, but lacked finance, had too big of a problem, didn't have enough skills, and didn't feel the necessity to take initiation to overcome household effects due to climate change.

Table 8. Secondary income sources for livelihood.

Characteristics	Treatment	Control
Secondary income sources (%) ^a		
No source	74.4	71.6
Poultry rearing	8.3	12.9
Wage labour/Day labour	8.1	6.6
Farming/Agriculture	7.1	6.2
Animal husbandry	5.6	8.6
Marine/Fishing	4.9	5.2
Shrimp farming/Aquaculture	3.4	2.4
Small enterprises	1.3	1.2
Other	1.2	2.3
Factory work	0.4	0.9
Kitchen garden	0.4	0.9
Official work	0.2	0.2
Monthly income from the mentioned sources		
Average	2,389	2,883
Median	1,500	1,000

^a Multiple responses**Table 9.** Major income sources from last year (%) for livelihood under the study.

Characteristics	Treatment	Control
Major income sources ^a		
Day laborer (agriculture or non)	64.0	64.3
Selling fish	21.2	17.9
Selling agricultural products (other than vegetables)	10.3	11.2
Other	4.0	6.1
Truck/ Van driver	3.5	4.2
Small business (shop)	3.1	4.2
Salary	2.8	3.1
Selling vegetables	2.4	2.5
Handicrafts	1.8	2.1
Selling animals	1.7	2.5
Don't know	1.6	1.0
Self-employed (carpenter, etc.)	1.1	0.8
Selling animal products	0.9	1.2
Domestic work	0.8	0.3
Rickshaw driver	0.8	1.2
Do you have any current climate adaptive livelihood option?		
Yes (%)	6.76	3.39
Monthly income from the mentioned sources		
Average	5,624	3,977
Median	5,000	2,000

^a Multiple responses**Table 10.** Respondents' opinion on how climate change affects initiatives (%) at the household level.

Indicator	Treatment	Control	P
HH affected due to climate change	71.5	73.0	0.382
HHs took initiative to resolve the climate change problem	6.5	6.9	0.658
Initiatives taken ^a			
Tree plantation	0.3	0.3	
Raise homeland	0.7	0.7	
Work to improve the dam	0.0	0.0	
Reasons for not taking initiative ^a			
Don't know what to do	66.3	58.0	
Know what to do, but lack of	36.4	40.8	
It's too big problem for me to	26.6	32.2	
Don't have enough skill	25.0	24.7	
Didn't feel necessity to do	18.1	12.4	

^a Multiple responses

Table 11. What type damage affected their family life (%) caused by natural disaster?

Indicator	Treatment	Control	P
If any disaster like Ayla affects in your area, how your family affected?			0.000
Household damage	93.8	92.4	
Drinking water crisis	68.6	65.3	
Livelihood damage	59.8	57.7	
Livestock damage	40.2	36.4	
Crop damage	24.4	23.2	
Permanent displace	12.1	10.4	
Other	0.2	0.0	

^a Multiple responses**Table 12.** Respondents' (%) opinion on how natural disaster affects their family in the last 20 years.

Indicator	Treatment	Control	P
Family affected by disaster in the last 20 years	83.3	77.8	0.000
Names of disaster ^a			
Ailla	96.6	98.2	
Sidar	67.0	75.8	
Fani	30.9	27.9	
Other	0.5	0.1	
Mohashen	1.0	1.0	
Nargis	1.0	0.8	
Flood	2.0	1.2	
Big cyclone	5.0	3.0	

^a Multiple responses**Table 13.** Alternative livelihood options (%) in the last five years for climate adoption.

Indicator	Treatment	Control	P
Did you try any alternative livelihood in last 5 years?	14.0	14.6	0.634
Alternative livelihoods tried in last five years ^a			
Small entrepreneurship	35.0	9.1	
Handicrafts	31.7	18.2	
Creating cooperatives	20.0	0.0	
Cash crops	15.0	36.4	
Better access to markets	13.3	27.3	
Other	11.7	27.3	
Sustainable harvesting	10.0	9.1	
Natural Resource Extraction	8.3	0.0	
Selling surplus food	1.7	0.0	

^a Multiple responses

In this study, most of the respondents reported being affected by climate change, with 79.5% reporting loss of houses due to climate change, like cyclones or any other natural disaster (Figure 4). On the other hand, about 57.3% of respondents reported scarcity of safe drinking water, loss of income (49.7%), agricultural production losses (36.1%), loss of agricultural land (30.4%), loss of domestic animals (39.7%), health hazards (18.9%), and loss of trees and gardens (18.9%) in treatment areas. It was a very painful loss of life in households, where 8.3% of respondents reported loss of life and 5.7% migrated to other places in the treatment areas. In control areas, the indicators are comparatively lower in all cases except agricultural production, loss of agricultural land, health hazards, and loss of life, where scores are higher compared to treatment areas. The highest respondents (10.1%) observed loss of life in control areas. All indicators in treatment and control areas were found to have a little bit of variation due to the position of household placement in sensitive areas (Figure 4). Researchers found that there was an intense shortage of food and a scarcity of pure drinking water

just after the disaster in coastal areas (Kabir et al., 2016). It was also found that the fisheries and agriculture products were insufficient after the natural disaster that impacted the coastal belt of Bangladesh. Millions of people's lives and livelihoods are seriously impacted by climate change in Bangladesh (Kabir et al., 2016).

The respondents also indicated that household damage, drinking water crisis, livelihood damage, livestock damage, crop damage, and permanent displacement were faced by natural disasters (Table 11), where household damage was a serious concern (93.8%) due to having a hard-core poor community with mud and kacha houses. They were also facing a drinking water crisis and agricultural (crops, fish, and livestock) damage. For the last 20 years, most of the respondents (83.3% in treatment and 77.8% in control) reported their family was affected by natural disasters, with nearly a cent affected by Ailla (96.6%), followed by Sidar (67%), Fani (30.9%), and others (9.5%) (Table 12).

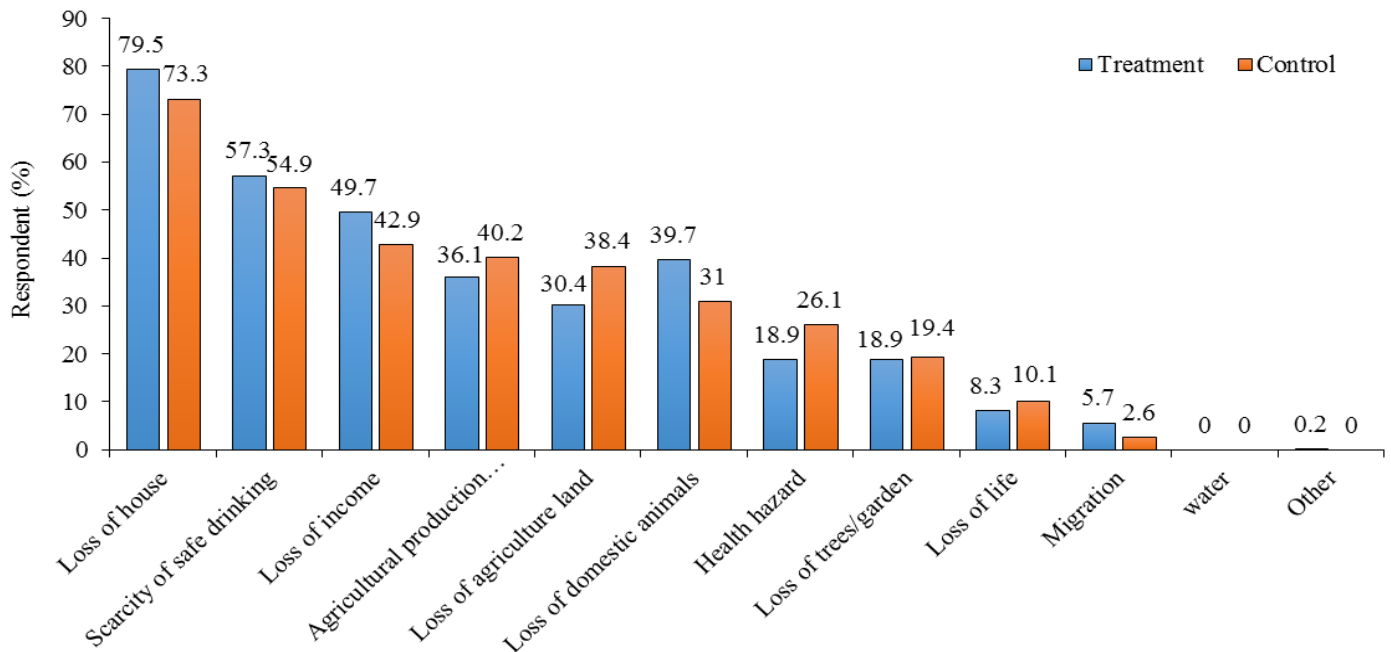


Figure 4. Respondents' opinion on how climate change affects at the household level.

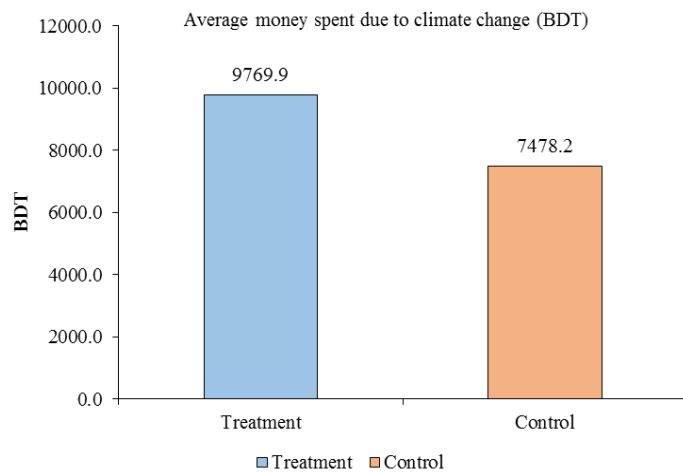


Figure 5. Yearly family expenditures due to climate change.

Alternative livelihood strategies for climate change

Climate change is creating great problems in the lives and livelihoods of the people in the study area. The respondents of the study were exposed to the fact that climate change was altering their lifestyle. They have to borrow money from the *Mohajon* or NGO to mitigate their problems. The coastal agricultural communities were trying to mitigate the problems by earning money from other sources. However, the study found that people were trying to find alternative livelihoods in the last 5 years. It was found to have almost the same score (14%) in both the areas of treatment and control. The respondents were involved in different alternative livelihood activities, where the top five alternative activities were small entrepreneurship, handicrafts, creating cooperatives, cash crops, and better excess to market. Small business ownership was the highest option (35%) as an alternative livelihood for the treatment areas, while cash crops (36.4%) were the best option for control areas (Table 13).

It was found that the south-west part of the coastal belt was mostly vulnerable to climate change. Climate change, along with

environmental degradation, is the burning issue for the households of the coastal communities, mainly the poor people of the coastal belt. That's why it was so desperately needed to develop an alternative livelihood system to overcome the burning issue and resolve the food scarcity problem (Faisal and Parveen, 2004). The researchers found that coastal communities cope with the changing climatic conditions. They find alternative livelihoods such as rice-fish culture, tilapia culture, carp-prawn culture, and also the highly productive salt-tolerant rice cultivation, etc. (Rashid et al., 2014).

Suitable alternative livelihood

Considering the suitability of alternative livelihood options (Table 14), 46.6% (treatment) of respondents chose small trades, followed by 31% of handicrafts, 19.3% of saline-tolerant aquaculture, 18.2% of aqua geponic, and 12.9% salt-tolerant agriculture, etc. In the case of fish culture, which interested people, about 83% chose shrimp, followed by crab (49%), tilapia, vetki, parshe, etc. There were so many existing challenges for the execution of that alternative livelihood program due to a shortage of finance, knowledge and skills, a lack of confidence in technology, a lack of trust in technology providers, and a lack of confidence in the market. Respondents reported that finance, knowledge, and skills were the main challenges for alternative livelihoods.

In the research work, there were huge numbers of female participants involved. In treatment areas, the female respondents were 295 (63%) out of a total of 466, while in control areas, it was 140 (60%) out of a total of 233. As a result, the female participants were involved in everything related to the studied information. The female respondents were involved properly with delivering their information required for research work, which is presented in Table 15. It was observed that the women had an idea about climate change (62.7% in treatment and 58% in control areas) and they were willing to take preventive

Table 14. Suitable alternative livelihood options (%) for climate adoption.

Indicator	Treatment		Control	
	Yes	No	Yes	No
Which of the following would be suitable for you to adapt ^a				
Small trades	46.6		44.4	
Handicrafts / Small cottage	31.0		23.6	
Saline tolerant aquaculture	19.3		8.5	
Aqua geponics	18.2		20.1	
Salt tolerant agriculture	12.9		16.5	
Saline resistant agroforestry	12.5		9.5	
Saline tolerant horticulture	8.2		5.7	
Interested to cultivate ^a				
Shrimp	83.8		83.2	
Crab	49.6		40.4	
Tilapia	21.9		30.3	
Vetki	17.2		15.4	
Parshe	13.1		14.0	
Nilotica	11.5		18.9	
Tengra	11.4		11.1	
Khorkuno	9.8		13.3	
Vangon	8.9		6.9	
Kuche (Eel)]	0.5		0.3	
Existing challenges of these alternative livelihood sources ^a				
Finance	86.0		88.3	
Knowledge and skill	78.3		66.6	
Lack of confidence on technology	19.6		17.1	
Lack of trust on technology providers	10.0		4.2	
Lack of confidence on	3.7		1.5	
Lack of confidence on market	1.8		1.6	

^a Multiple responses**Table 15.** Women involvement (%) in climate vulnerability context for livelihood.

Indicator	Treatment		Control	
	Yes	No	Yes	No
Have idea on climate change?				
Male respondent	52.3	47.7	61.8	38.2
Female respondent	62.7	37.3	58.0	42.0
Willing to take preventive measure against climate change				
Male respondent	56.0	44.0	43.9	56.1
Female respondent	55.3	44.7	45.0	55.0
Have climate adaptive livelihood option				
Male respondent	6.6	93.4	4.5	95.5
Female respondent	7.0	93.0	2.4	97.6
HHs produce any product to sale in the market				
Male respondent	12.4	87.6	21.1	78.9
Female respondent	14.3	85.7	13.2	86.8
Find problems to sale your products				
Male respondent	26.0	74.0	30.8	69.2
Female respondent	29.7	70.3	39.7	60.3
Agricultural crop affected by natural disaster				
Male respondent	61.9	38.1	63.0	37.0
Female respondent	65.8	34.2	57.9	42.1
Tried to adopt alternative livelihood				
Male respondent	16.0	84.0	19.1	80.9
Female respondent	12.6	87.4	10.5	89.5

measures against it (55.3% in treatment and 45% in control). They were also involved in identifying the agricultural crops affected by the natural disaster (65.8% in treatment and 57.9% in control) and the problems identified for selling their products (29.7% in treatment and 39.7% in control). They also tried to adopt alternative livelihoods (12.6% in treatment and 10.5% in control) for climate change. However, these findings are women's focus with all respect to covering the indicator of climate vulnerability context.

Conclusion

The livelihoods of coastal agricultural people are threatened by adverse climate change. According to the findings, male and female awareness, as well as female participation in this poor environment condition, are extremely important. With the significant participation of women, climate-resilient alternative livelihoods in coastal farming communities will increase substantially. Climate-vulnerable regions in Bangladesh should be taken into account, and a suitable demonstration for climate-resilient livelihood adaptation should be established. Women's engagement, as well as men's, will assist to increase the adaptability of alternative livelihoods. Further research, making climate resilient livelihoods the greatest option for demonstration, and boosting community participation, both male and female, will ensure the best climate resilient alternative livelihood adaptation possibilities.

ACKNOWLEDGEMENT

The authors are thankful to the farmers, development workers, respondents, their families, and different stakeholders who are directly or indirectly involved in conducting this field research.

Declaration of competing interest

This article has not published previously and it is not under consideration for publication elsewhere, its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. We also have no conflicts of interest to disclose.

Open Access: This is an open access article distributed under the terms of the Creative Commons Attribution NonCommercial 4.0 International License, which permits unrestricted use, distribution,

and reproduction in any medium, provided the original author(s) or sources are credited.

REFERENCES

- Abedin, M. A., Habiba, U., & Shaw, R. (2012). Health: Impacts of salinity, arsenic and drought in South-western Bangladesh. In Shaw, R. and Tran, P., (Eds.), Environment Disaster Linkages (Community, Environment and Disaster Risk management, Vol 9). Emerald Group Publishing Limited, Bingley, UK, pp. 165-193, [https://doi.org/10.1108/S2040-7262\(2012\)0000009016](https://doi.org/10.1108/S2040-7262(2012)0000009016)
- Adeniyi, A. C., Grace, O. O., & Opeyemi, A. A. F. (2013). Climate change impact on female gender in Nigeria. *Research Journal of Agricultural and Environment Management*, 2(5), 115-120.
- Adger, W. N., Hug, S., Brown, K., Conway, D., & Hume, M. (2003). Adaptation to Climate Change in Developing World. *Progress in Development Studies*, 3(3), 179-195.
- Asia Foundation. (2012). A Situation Analysis of Climate Change Adaptation Initiatives in Bangladesh. Survey Report, Dhaka, Bangladesh, pp. 17.
- Faisal, I., & Parveen, S. (2004). Food security in the face of climate change, population growth, and resource constraints: implications for Bangladesh. *Environmental Management*, 34(4), 487-498.
- Hug, S., Hannah, R., & Laurel, A. M. (2006). Climate Change and Development Links. International Institute for Environment and Development (IIED), Gatekeeper Series 123, London, pp. 25.
- Kabir, R., Khan Hafiz, T. A., Ball, E., & Caldwell, K. (2016). Climate Change Impact: The Experience of the Coastal Areas of Bangladesh Affected by Cyclones Sidr and Aila. *Journal of Environmental and Public Health*, ID 9654753, <https://doi.org/10.1155/2016/9654753>
- MoEF. (2009). Bangladesh Climate Change Strategy and Action Plan 2009. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh. Dhaka, Bangladesh. pp. xvi+68.
- Oxfam International. (2011). Owing Adaptation. Factsheet, Bangladesh, 1-5
- Planning Commission. (2015). Agriculture Sector Development Strategy. Background Paper for Preparation of 7th Five Year Plan. Government of the People's Republic of Bangladesh. Dhaka, Bangladesh, 257-303.
- Rahman, M. M., Rahman, M., Hasan, M. M., & Islam, M. R. U. (2012). Livelihood status and the potential of alternative income generating activities of fishers' community of Nijhum Dwip under Hatiya upazila of Noakhali district Bangladesh. *Bangladesh Research Publications Journal*, 6 (4), 370-379.
- Rashid, H., Afroz, S., Gaydon, D., Muttaleb, A., Poulton, P., Roth, C., et al. (2014). Climate Change Perception and Adaptation Options for Agriculture in Southern Khulna of Bangladesh. *Applied Ecology and Environmental Sciences*, 2(1), 25-31.
- Roy, N. C., Haque, M. M.-Ul., Momi, M. A., Rahman, M. H., & Habib, A. Z. (2016). Livelihood status and socioeconomic condition of Hilsa fishers of lower Meghna river basin, Bangladesh. *Trends in Fisheries Research*, 5(2), 8-13.
- Shamsuddoha, M., Islam, M., Haque, M., Rahman, M., Roberts, E., Hasemann, A., et al. (2013). Local Perspective on Loss and Damage in the Context of Extreme Events: Insights from Cyclone-Affected Communities in Coastal Bangladesh. Dhaka, Bangladesh: Center for Participatory Research and Development (CPRD). Dhaka, Bangladesh, 1-28.
- UNEP. (2014). The Adaptation Gap Report 2014. United Nations Environment Programme (UNEP), Nairobi, pp. 88. <http://www.unep.org/climatechange/adaptation/gapreport2014>.
- World Bank. (2010). World Development Report 2010: Development and Climate Change. The World Bank, Washington DC, pp. 444. <https://openknowledge.worldbank.org/handle/10986/4387> License: CC BY 3.0 IGO.
- World Bank. (2016). Bangladesh: Building Resilience to Climate Change. Newsletter, IBRD, IDA, The World Bank.