# Livelihoods Assessment Report – Climate-resilient agricultural livelihoods for coastal communities of Khulna and Satkhira

**Prepared for Government of Bangladesh, Ministry of Women and Children Affairs –**

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## I. Executive Summary

This study was commissioned to identify mechanisms to support vulnerable communities, especially women, across southwest Bangladesh through gender responsive, climate change resilient livelihood options and value chains for building resilience to climate change. The objective of the study was the identification, analysis, prioritization, and design of suitable and sustainable gender responsive climate change resilient livelihood options for the target community and to design respective interventions enabling them to cope with the short-term, mid-term, and long-term effects of climate change impacts, in particular climate change-induced salinity, on existing and potential livelihood options. Through a detailed process involving GIS mapping, a literature review, focus group discussions, household level surveys, participatory market review, value chain analysis, and key informant interviews, this study provides a set of recommendations on possible gender responsive, transformative, climate change resilient livelihood options to increase women's resilience to climate change.

A large portion of the coastal population of Bangladesh is highly exposed to climate change impacts. Particularly, climate-induced increases in the salinity of soil and fresh water aquifers (through sea level rise and cyclone-driven salt water inundations) pose a significant threat to agricultural-based livelihoods. Both Khulna and Satkhira experience extreme and increasingly common weather phenomena such as tropical cyclones, storm surges, floods and droughts on regular basis. These events severely impact the agricultural sector, drinking water supply, homes and infrastructure in both districts, putting people's lives, livelihoods and assets at risk. The vulnerability of coastal communities to these changes in their environment is shaped by the topography, by virtue of being low-lying and pervaded by river networks, due to pervasive poverty, and due to a limited enabling environment to allow the shift towards alternative, climate change resilient livelihoods. Between 16 and 35 per cent of people living in Khulna and Satkhira are extremely poor. Gender inequality prevails in these districts through various societal and cultural norms that shape women's day-to-day activities as well as their capacity to adapt to climate change. For example, women have less decision-making power within the household and the workplace, and are expected to manage the household and care for the family. Compounding these factors, climate change aggravates the burden of unpaid care work, creating a cycle which undermines their climate change resilience.

This study assesses the gaps and barriers in existing development programmes, identifies the climate vulnerabilities of the livelihoods practised by the target population, examine lessons learned as well as best practices evident in climate adaptation and livelihood programmes implemented in Bangladesh, identifies and assesses alternative climate change resilient livelihood options, and recommends a portfolio of gender responsive, economically viable, sustainable and climate resilient livelihood options and value chains.

The challenges faced by the local community are diverse and compounded by adverse climate change impacts. They range from loss of productive agricultural land, due to increased salinity and depletion of land from tidal surges. Additionally, limited penetration of the private sector and of government extension agencies constrains the ability of these communities to switch to alternative options. Moreover, traditional non-adaptive and maladaptive livelihood options are predominant in this region, and few initiatives have been taken to support communities to shift towards more climate change resilient livelihood options.

The study also looked into past and on-going efforts of various national and donor funded projects operating with similar mandates in the target regions. The review of initiatives by the government and other development partners across the country demonstrates that there have been several development efforts taken in the coastal region, with high levels of investment. However, it is evident that many interventions have had too narrow a focus, and did not fully take into account climate change considerations, which would trigger transformational change in the lives and livelihoods of the most affected people. The particular needs of the community at risk, in regard to livelihood shifts in the face of a changing climate, are in many cases overlooked in project design.

The study also examined best practices, from which certain elements can be adopted in order to ensure a safe and sustainable exit strategy for the proposed project. For instance, activities related to forming a sustainable public private platform can help to ensure effective handover of the project functions after its closure. To ensure a sustainable exit strategy, this assignment therefore proposes creating an enabling environment for the local private sector to become an active partner. In this way, the proposed project anticipates that creating a mutually beneficial partnership between public extension agencies and the private sector, alongside effective linkages with the target beneficiaries, would enable strengthened, business-focused relationships. This would allow for

the development of a sustainable model for the project over longer timescales. It should be noted, however, that many of the best practices reviewed have yet to reach scale because of resource constraints in terms of finance and capacity.

A range of constraints to supporting vulnerable women and communities to shift towards climate change resilient livelihoods were identified. These include: (i) limited awareness and knowledge amongst coastal communities and women for making climate risk-informed livelihood decisions; (ii) limited technical capacity of coastal communities to shift towards climate change resilient livelihoods; (iii) constrained access to climate resilient agricultural markets and value chains, and limited availability of value-addition activities for alternative, climate change resilient livelihoods; (iv) limited access to additional finance to shift towards climate change resilient livelihoods and limited understanding among coastal communities of local financial institutions (for example, micro-finance institutions, the Bangladesh Rural Development Bank, commercial banks); and (v) limited institutional capacities to plan, foster and facilitate the development of climate resilient livelihoods, as well as weak vertical and horizontal coordination and knowledge management between government institutions on climate risk management.

The investigation showed that there is an urgent demand to enable coastal communities in the southwest of Bangladesh to enhance their resilience against climate change and to avoid potentially hazardous development trajectories related to currently practised non-adaptive livelihoods. Furthermore, the findings of the investigation emphasized that although women are particularly vulnerable to climate change impacts, recognizing their role and context-specific knowledge of resource management is essential to building community level resilience, and that women are powerful agents of change when given the opportunity to participate in the design and leadership of resilience interventions. Finally, the investigation revealed that the vulnerability of the coastal region is significantly higher in two districts, namely Khulna and Satkhira. 39 unions within these 5 sub-districts are affected the most due to severe salinity induced by climate change and have therefore been selected as target areas for the proposed interventions.

The targeting of women in these unions was anchored in identifying those that currently practice non-adaptive or maladaptive livelihoods and are extremely poor and vulnerable, thereby requiring support to switch to climate change resilient livelihoods. Given the impacts of salinity on agricultural livelihoods, the targeted population is comprised of smallholder farmers, fishers and agricultural labourers. This targeting process included a stocktake of existing livelihoods practiced by households in the region and the identification of adaptive, non-adaptive and maladaptive livelihoods. Through this process a total number of 25,425 direct female beneficiaries (from 25,425 households) were identified.

For identifying climate change resilient livelihood options, an analysis of 38 livelihood options was undertaken building on knowledge gained from community-level assessments and the assessment of best practices in comparable settings. As a first step, the climate change resilience of these options was assessed, in particular related to salinity and cyclone resilience and fresh water dependency. This led to shortlisting 17 livelihood options. As a next step, a comprehensive screening of these options was undertaken which considered the following aspects of the livelihood options: (i) profitability and market potential/value chain access; (ii) gender responsiveness and transformation potential; (iii) socio-economic considerations and community acceptance; and (iv) environmental impacts. A total of 8 livelihood options were identified as gender responsive and climate change resilient and it is recommended that these be incorporated into the project design.

The eight, proposed climate change resilient livelihoods are: (i) crab farming and trading; (ii) crab nursery; (iii) aqua-geoponics; (iv) hydroponics; (v) plant nursery; (vi) sesame cultivation; (vii) home stead gardening; and (viii) crab and fish feed processing. These livelihood options are resilient in the face of the changing climate, are suitable for women's participation and empowerment and are appropriate for the local market system. However, the communities require additional support in the form of capacity development and assets to allow a smooth transition to these climate resilient livelihoods.

A locally-appropriate selection of the proposed livelihood options has been identified for each of the unions, and the number of options per union has been limited to four in order to allow for a continuation of existing climate change resilient livelihoods in the portfolio of income-generating activities of each household. Likewise, while assigning the livelihood options, geographic and environmental aspects were taken into consideration, such as proximity to the Sundarbans Protected Forest or river systems.

Alongside assessing the suitability of possible livelihood options for each location, the need for direct support required by the women at individual household (HH) and community level has been identified. To promote economies of scale, peer-to-peer learning and cost-effective, community-based approaches to livelihood support are proposed. These include clustering of HHs into groups and engaging them as a unit for capacity building, market access, knowledge and skills transfer, etc. After comprehensive investigation of the union-specific circumstances, such as elevation, salinity levels and existing skills and capacity, interventions have been proposed that will enable coastal communities, especially women, to shift towards climate change resilient livelihoods. A total of 198 aquaculture-based and 819 agriculture-based Women Livelihood Groups (WLGs) are proposed to be formed for the project. This is, however, a tentative distribution of livelihood options to the different WLGs based on the ward specific analysis that were undertaken. The actual selection of livelihoods for the different group will be decided upon through a participative process during the implementation phase of the project. Additionally, it is proposed that one hatchery be upgraded to facilitate the sustainable development of a currently non-coherent crab value chain.

The elements that are crucial to success of the proposed interventions have been identified as: (i) capacity building of women producer groups, local communities, Ministry of Women and Children Affairs (MoWCA), local government institutions (LGIs), and non-government organizations and community-based organizations (NGOs/CBOs); (ii) adequate and suitable access to resources for the beneficiaries and value chain actors; (iii) collaborative approach between government and development partners; (iv) private sector engagement; and (v) improved climate adaptation knowledge, attitude and practices among communities, uptake or self-propagation at scale with respect to proposed resilient livelihood interventions and community ownership building for long-term adaptive capacities.

Exit strategies and sustainability mechanisms have also been designed based on local conditions and capacities. The sustainability of the interventions will be ensured through livelihood options having climate resiliency, economic impact, by strengthening the institutional and social structure of the main stakeholders and community organizations, improving financial management, providing technical support, ensuring environmental sustainability and creating linkages across institutions for building an enabling environment. Local inputs suppliers or service providers will play a vital role by supplying quality inputs, updated information and by strengthening business relationships. Viable strategies have also been identified to ensure operations and maintenance of community-level livelihoods and value chain upgrading facilities. This will ensure sustainability of interventions during and after the project implementation.

Public private partnerships will provide a platform at upazila level for creating an enabling environment for climate change resilient livelihoods. The proposed public private model will enable the project to gradually transfer ownership to a platform which is transparent and accountable due to the presence of government and private sector representatives. It is hoped that the engagement of the private sector will reduce dependency on external aid and project-driven support, thereby facilitating the sustainable adoption of the proposed livelihoods. The sustainability of the climate resilient market systems and subsequent value chain development will depend largely on the effectiveness of building linkages between the target groups and their business partners.

This report informs the feasibility study and project design for the proposed GCF project. The project could build the adaptive capacities of women in coastal communities of southwest Bangladesh and enable them to take up resilient, adaptive livelihoods in the face of climate-induced salinity.

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A complete list of abbreviations can be found in the Feasibility Study.

# 1. Introduction to Task and Methodology

## 1.1. Introduction and Objectives

This study was commissioned to identify mechanisms to support vulnerable communities, especially women, across southwest Bangladesh through gender responsive, climate change resilient livelihood options and value chains for building resilience to climate change. The objective of the study was the identification, analysis, prioritization and design of suitable and sustainable gender responsive climate change resilient livelihood options for the target community and to design interventions enabling them to cope with the short-term, mid-term and long-term effects of climate change impacts, in particular climate change-induced salinity, on the existing and potential livelihood options. Incorporating the results of GIS mapping, a literature review, focus group discussions, household level surveys, participatory market reviews, value chain analysis, and key informant interviews, this study provides a set of recommendations of gender responsive, transformative, climate change resilient livelihood options to increase women's climate change resilience.

A large portion of the coastal population of Bangladesh is highly exposed to climate change impacts. Particularly, climate-induced increases in the salinity of soil and fresh water aquifers (through sea level rise and cyclone driven salt water inundations) pose a significant threat to agriculture-based livelihoods. Both Khulna and Satkhira districts experience extreme and increasingly common weather phenomena such as tropical cyclones, storm surges, floods and droughts. These events severely impact the agricultural sector, drinking water supply, homes and infrastructure in these two districts, putting people's lives, livelihoods and assets at risk. The vulnerability of coastal communities to these changes in their environment is shaped by the topography, by virtue of being low-lying and pervaded by river-networks, by pervasive poverty and by a general environment that limits peoples' ability to shift towards alternative, climate change resilient livelihoods. Between 16 and 35 per cent of people living in Khulna and Satkhira are extremely poor. Gender inequality prevails in these districts through various societal and cultural norms that shape women's day-to-day activities as well as their capacity to adapt to climate change. Women have less decision-making power within the household and at the workplace, and are expected to manage the household and care for the family. Compounding these factors, climate change aggravates the burden of unpaid care work, creating a cycle which undermines their climate change resilience.

To gain insights into the complex dynamics of shifting non-climate adaptive lives and livelihoods towards climate change resilient livelihoods, this report: (i) analyses the climate resiliency of current livelihoods practised in coastal areas in southwest Bangladesh and their gender-specific vulnerabilities to climate change impacts; (ii) identifies gaps in current support programme coverage and potential barriers to implementing a switch from non-adaptive to climate change resilient livelihoods; and (iii) proposes climate change resilient livelihood alternatives for women to enable them to sustain their lives and livelihoods in the face of increasing climate change impacts.

This study informs the design of the proposed GCF funded project which targets women in freshwater-dependent households in southwest Bangladesh, particularly those associated with agriculture-based livelihoods, with the aim of empowering them and increasing their climate change resilience. The overall project objective is to increase the resilience of vulnerable women through drinking water security and adaptive livelihoods. The proposed phase I of the project will be implemented in the most vulnerable sub-districts of Khulna and Sathkira, where a high share of the population is poor and/or extremely poor, and where exposure to climate change-driven saltwater intrusion and cyclones is high.

## 1.2. Methodology

The study is based on a range of assessments to identify the most feasible climate change resilient livelihoods for women in the coastal communities of southwest Bangladesh. It has been conducted by a multidisciplinary team of experts in agriculture, aquaculture, climate change, gender and market development, and is based on a mixed-methods approach. The sequential investigation involving a literature review, participatory field assessments, remote sensing exercises and stakeholder consultations during data interpretation and analysis has helped to ensure an inclusive and dynamic study process; one that incorporates local attitudes towards the study results, while at the same time providing evidence-based and scientifically sound proposals for climate change resilient livelihoods. A comprehensive overview of all stakeholder consultations can be found in Annex XIII (Stakeholder Engagement Plan) of the GCF proposal.

Table 1 below shows the study process along with the various that were applied methods. These are described in more detail in the subsequent Chapters.

*Table 1: Study Process and Methods*

| Phase | Methods |
|---|---|
| Inception and building knowledge foundation | - Literature review<br>- Draft household survey, participatory rapid appraisal (PRA), focus group discussions (FGD) and key informant interviews (KII) |
| Data collection | - PRA<br>- Household survey<br>- FGD<br>- KII |
| Data analysis and vetting | - Analysis of Landsat satellite images<br>- Multi-criteria poverty index analysis<br>- GIS mapping<br>- Market assessment and value chain analysis<br>- Livelihood options screening and analysis<br>- Cost and budget estimations<br>- Stakeholder consultations (including communities, union parishads, and MoWCA) |

#### 1.2.1. Literature Review and Union Profiling

To create the bases for the study an extensive literature review was undertaken and the findings have been fed into the Chapters on the national and coastal context (Chapter 2), climate change (Chapter 3), past and on-going efforts (Chapter 4) and a gaps and constraints analysis (Chapter 5). Existing literature on climate resilient livelihood options providing income-generating opportunities for women was reviewed to produce a tentative list of potentially viable climate change resilient livelihood options for women in the coastal region of Bangladesh.

A more focused literature review centred on:

- Climate change impacts on agriculture-based livelihoods and on women
- Livelihood choices, barriers, and current coping strategies towards climate stresses
- The situation of women and girls in terms of social, economic and environmental factors
- Commercialization potential, market and value chain access of proposed climate change resilient livelihoods (see Chapter 6)
- Potential environmental and socio-economic impacts of proposed climate change resilient livelihoods (see Chapter 6)

Based on existing literature as well as primary data, profiles of all 39 target unions (see Sections 1.2.7) were prepared outlining:

- Demographic information focusing on exposure to climate change (primary and secondary data)
- Ward-level population data (based on PRAs conducted by Water Aid)
- Current livelihood options (literature, KIIs, PRAs)
- On-going projects implemented by different organizations (literature and KIIs)
- Access to finance (literature and KIIs)
- Union maps (see Annexes 3 to 7 in this report and Annex IId of the GCF proposal package)

#### 1.2.2. Household Survey, Participatory Rapid Appraisal, Focus Group Discussions, and Key Informant Interviews

The field data collection was designed to allow communities to express their perceptions about potential livelihoods, identify barriers and concerns and to gain an understanding about recent changes to their livelihoods as well as potential drivers. The investigation employed a range of community-level assessment tools (see Table 2).

The in-depth information was mainly collected through a household survey with a total of 353 respondents in 39 unions in the five targeted upazilas. The household survey was designed based on the sustainable livelihoods

approach while integrating a strong climate change and gender focus. The survey was conducted in two stages. The first part of the survey was conducted in one upazila (Shyamnagar). During the second stage, the remaining 4 upazilas were covered. A random sampling method was used to select the respondents who were all females between 18 and 49 years of age.

More general information about local geography, population figures, socio-economic and bio-physical contexts, existing livelihoods, household income structures and market structures was collected through participatory rapid appraisals (PRAs) at the community and union level. A focus group discussion (FGD) as a PRA tool was conducted at each union headquarter with different union officials and community representatives, including the chairman, members and secretary of the union parishad. The number of FGD participants varied from 5 to 10. The information collected was verified through key informant interviews (KII), which also provided insights into existing technologies, capacities and perceptions around the feasibility of implementing different climate change resilient livelihoods in the local context. A record of these stakeholder consultations can be found in Annex XIIIc of the GCF proposal package.

Additionally, transect walks were undertaken to identify market places, housing structures and living conditions of local communities. This data was later consolidated with information from the PRAs, satellite imagery, market analysis, KIIs, and literature review.

*Table 2: Overview of Community-level Assessments*

| Tool | Times/ No. of Respondents | Confidence Level | Confidence Interval |
|---|---|---|---|
| Household survey | 1/ 353 | 99% | 4.65 |
| Participatory rapid appraisal | 195/ 5-10 | N/A | N/A |
| Focus group discussions | 204 times | N/A | N/A |
| Key informant interviews | 51 respondents | N/A | N/A |
| Transect walks | 195 times | N/A | N/A |

### 1.2.3. Satellite Imagery

Satellite imagery was used for two assessments during this study: (i) to analyse land use, cover and change in the districts of Khulna and Sathkira; and (ii) to determine the quality of the building structures of local households.

For the analysis of land use, cover and change, historical Landsat satellite images from 1995, 2005, and 2015 were assessed (see Table 3). The images revealed information that allowed the identification of land use and cover, e.g. agricultural land, aquaculture land, mangrove forest, rivers, or settlements. Large maintained ponds could mostly be classified as being used for aquaculture, whereas it was not possible distinguish between freshwater and brackish water. All images stem from the winter season in order to avoid any assessment errors. Based on this information GIS maps were prepared (see Section below).

*Table 3: Acquisition Dates and Resolution of the Images Used*

| Date of Image Acquisition | Sensor | Bands | Resolution |
|---|---|---|---|
| 08 December 1995 | TM | 7 bands | 30 metre |
| 07 January 2005 | TM | 7 bands | 30 metre |
| 21 December 2015 | Landsat 8 | 11 bands | 30 metre |

A more recent set of satellite images with a lower resolution was used to classify the housing structures of coastal communities as either: (i) Pucca (houses built with conventional high-quality materials); (ii) Semi-pucca (small, simple one-story mud (*kacha*) structures); and (iii) Kutcha and Jhupri (mud structure with straw roofs). This information fed in to the calculation of the Multi-Criteria Poverty Index (MCPI) which was used to identify potential beneficiaries most vulnerable to climate change impacts (see Section 1.2.7). The satellite images and their interpretations were verified through transect walks.

#### 1.2.4. GIS-based Mapping

The information gained through the aforementioned data collection methods was used to produce various GIS maps showing historical trends of land use changes, key geographic and socio-economic characteristics, infrastructure and market places in the target unions in Khulna and Sathkira (see Section 1.2.7). During the PRAs, a base map of each union was collectively developed and participants determined the spatial information about climate change risks, practiced livelihoods, market places, infrastructure, etc. Additional data was obtained from Google Earth images and the CEGIS Archive and National Water Resources Databases (NWRD).

The GIS maps are used throughout this report, in particular in the union profiles. For each union, a different set of maps has been prepared, consisting of: (i) base map; (ii) livelihood map; (iii) market place map; (iv) MCPI-poverty map; (v) digital elevation model (DEM) map; and (vi) land use/cover map.

#### 1.2.5. Multi-criteria Livelihoods Screening and Filtering

A multi-criteria screening and filtering of livelihood options was conducted to identify alternative, climate change resilient livelihoods for women and coastal communities in southwest Bangladesh (see Chapter 6). The screening process was based on three steps: (i) stocktake of existing and potential livelihood options; (ii) screening the portfolio of livelihood options against a 1$^{st}$ filter addressing their climate change resiliency potential; and (iii) screening the livelihood options against a 2$^{nd}$ filter relating to their gender responsiveness and contextual feasibility.

As a first step, a portfolio of potential livelihood options was developed using information gained during the PRAs on existing livelihoods in the wards as well as analysis of climate change resilient livelihoods that had already been tested and practiced in other regions of Bangladesh or in a comparable context.

As a next step, the livelihood options were screened against three criteria, namely: (i) salinity tolerance; (ii) cyclone resistance; and (iii) climate change resilience.

At the end of the first screening process, an evidence-based judgement was made as to whether the livelihood options could be considered climate change resilient, non-adaptive or maladaptive. All non- and maladaptive livelihoods or livelihoods that could not be considered within the scope of the project were removed from the list.

Subsequently, the livelihoods that were recognised as adaptive were screened against a second set of criteria, namely: (i) gender responsiveness; (ii) profitability and market/ value chain access; (iii) socio-economic considerations and community acceptance; and (iv) environmental impacts.

After the second screening process, a total of 10 livelihood options were identified as demonstrating the highest potential for building women's resilience to climate change in coastal communities of southwest Bangladesh.

#### 1.2.6. Value Chain and Market System Analysis for Proposed Climate Change Resilient Livelihoods

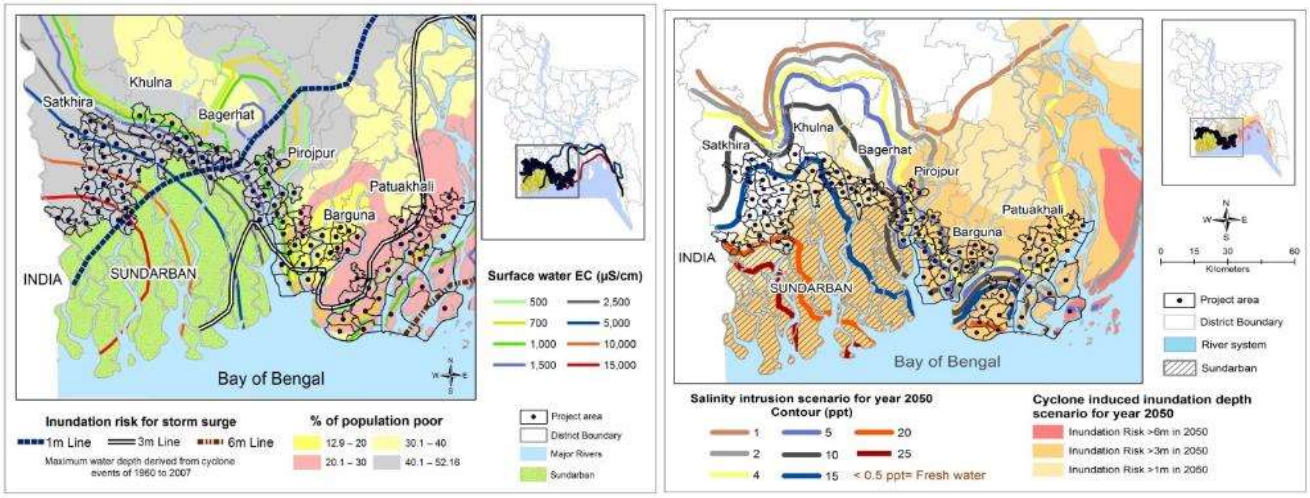
The value chain analysis was based on the Participatory Market System Development (PMSD) tool customised for the climate change context and developed by Practical Action. In this process, data gained through the PRAs, KIIs, FGDs and transect walks was analysed to identify existing market structures and value chains in Khulna and Satkhira. This helped to provide an understanding of the status quo and potential to scale-up existing markets or create alternative ones.

As a next step, the value chains of the ten, alternative climate change resilient livelihood options, identified through the multi-criteria livelihood screening process outlined above, were analysed in greater depth. Two value chains were mapped and assessed (see Sections 6.4.1 and 6.4.2) to gain information about their climate change resilience, value chain actors, existing and potential new market linkages, gender responsiveness and market system development potential. The latter also included the identification of missing market actors or linkages that would be required to develop sustainable and climate resilient value chains (for example, the need for a crab hatchery for promoting crab farming on a large scale and in order to avoid putting additional pressure on the natural environment caused by catching of crab seedlings in river systems). To promote feasible and climate change resilient value chains, the potential to include private actors in developing new market structures was also assessed and explored.

### 1.2.7. Targeting of Beneficiaries

***Identification of target districts and unions:*** A total of six districts (namely Satkhira, Khulna, Bagerhat, Pirojpur, Barguna and Patuakhali) were identified as potential project areas due to their high exposure to climate-induced salinity and disasters, and high poverty levels and vulnerabilities among the coastal communities. Figure 1(a) shows current inundation risk and surface water salinity overlaid with current poverty levels, whereas Figure 1(b) shows projected inundation risk and surface salinity for 2050. A greater percentage of poor people live in Satkhira, Khulna and Bagerhat districts, where higher surface water salinities can also be found; indicating that districts to the west are currently the most vulnerable and suffer the highest impacts due to salinity (Figure 1(a)). However, Figure 1(b) shows that future increases in salinity intrusion and cyclone-induced inundation will occur in districts to the east, namely Patuakhali, Barguna, and Pirojpur, thereby increasing impacts on livelihoods and drinking water. Districts to the west, especially Satkhira and Khulna, should therefore be targeted first and offer the opportunity to test adaptation options which will eventually, in the future and because of climate change, be needed in districts further east.

In Khulna and Satkhira a total of 39 unions (18 in Sathkira and 21 in Khulna) were selected. These unions were chosen as they: (i) face the highest current and projected levels of salinization; and (ii) are home to a particularly large poor population as revealed during the PRAs and data analysis.




(a) (b)

*Figure 1: (a) Current Poverty, Inundation Risk and Surface Salinity; (b) Future (2050) Modelled Salinity Intrusion and Cyclone-Induced Inundation Risk*

***Identification of targeted wards:*** As a next step, the target wards in each of the 39 unions were analysed in depth to identify the most vulnerable communities to climate change. For this exercise, poverty and Digital Elevation Model (DEM) maps were produced using data from a national census study and PRAs. The wards were selected based on the following criteria:

- Current and projected salinity levels: Maps of soil and ground water salinity were used to detect those wards most affected by and vulnerable to climate-induced salinization processes (see Figure 1(a) and (b)). Additionally, land use change data (1995, 2005, and 2015) were considered to identify wards where major shifts from agriculture towards aquaculture usage took place, as a potential indicator of salinization processes.
- High levels of poverty: Maps were produced and considered that detected particularly poor people based on a multi-criteria poverty index (MCPI) using: (i) income poverty indicators; (ii) percentage of day labourers; and (iii) a satellite imagery analysis of housing structures (see Annex 1 for more details on the approach used to calculate the MCPI of each ward).
- High exposure of beneficiaries to salinity intrusion due to low elevation: Wards with a low elevation were considered particularly vulnerable to salinity intrusion (see Figure 3).

Through this process a total number of 101 out of 350 wards in the 39 target unions were identified as potential project areas.

***Identification of targeted beneficiaries for climate change resilient livelihood interventions:*** Subsequently, potential beneficiaries were identified based on current livelihood practices and coverage of on-going or future efforts by other government or donor projects. This information was gained through PRAs, an extensive literature review and stakeholder consultations. The population figures gained from the PRAs were verified by local union parishads (local government entities) and adjusted for minor corrections.

This process included a stocktake of existing livelihoods practiced by households in the region and the identification of adaptive (climate change resilient), non-adaptive, and maladaptive livelihoods. This process comprised:

- Conducting PRAs at union level to receive current figures relating to the distribution of livelihoods among households at ward level. For each household, the main livelihood (practiced for several months a year and constituting the main source of income) was identified, as well as secondary livelihoods. The figures were then verified by the union parishads.
- Based on these figures, households engaged in non- and/or maladaptive livelihoods were identified as potential beneficiaries. This process was based on extensive screening of existing livelihoods (see Chapter 6). The highest percentage of people involved in non-adaptive livelihoods was applied on the overall household of that ward, to identify the most vulnerable households. This avoided potential overlaps, assuming that one household may be engaged in multiple livelihood options.

Through this process a total number of 25,450 direct female beneficiaries (from 25,450 households) were identified.

#### 1.2.8. Cost Estimates for Economic Potential of Proposed Climate Change Resilient Livelihoods and Proposed Project Interventions

In order to have a solid understanding of the cost of proposed climate change resilient livelihood interventions for the GCF funded project, a literature review and consultation of public, NGO, and private actors were conducted[1]. Based on this information a cost estimate and cost-benefit analysis for each proposed climate change resilient livelihood option was developed. The cost items were verified through key informants and represent the most realistic prices in the local context of Bangladesh. The cost-benefit analysis for each livelihood reflects the total cost for a single unit of the livelihood option and the benefits of one production cycle (see Sections 6.3). This allowed the potential total revenues, profit margin and cost-benefit ratio to be determined.

In addition, the cost for capacity building and overhead costs for project implementation have been estimated, leading to an overall budget for the livelihood component of the proposed GCF funded project (see Chapter 8).

## 2. Baseline - National and Coastal Context

The following chapter provides a brief summary of socio-economic, cultural, and geographic characteristics of the project region that are relevant to the investigation of potential alternative climate resilient livelihoods. A comprehensive analysis of these baseline information can be found in the Feasibility Study (Annex IIa) of the GCF proposal.

### 2.1. Geography

Bangladesh, located in South Asia (20°34´ to 26°38´N and 88°01´ to 92°41´E), has a land area of 147,570 km$^2$ with an extensive coastline stretching along the Bay of Bengal (see Figure 2). It shares borders with India to the west, north and northeast, and Myanmar to the southeast. Except for hilly regions in the northeast and southeast and some highlands in the north and north-western parts, the country is predominantly flat and low-

[1] Annex XII of the GCF proposals shows a list of stakeholder consultations

lying[2]. The mean elevation is 4 to 5m above sea level and about 10 per cent of the land stands at 1m above sea level[3].

Bangladesh sits on the world's largest delta, formed by the convergence of the Ganges, Brahmaputra, and Meghna river systems, which discharge into the Bay of Bengal through a single outfall (see Figure 2). Deltaic floodplains cover 80 per cent of the country and are overlapped by over 310 rivers[4,5]. These rivers carry heavy silt loads which clog distributaries and reduce freshwater availability during the dry season[6].

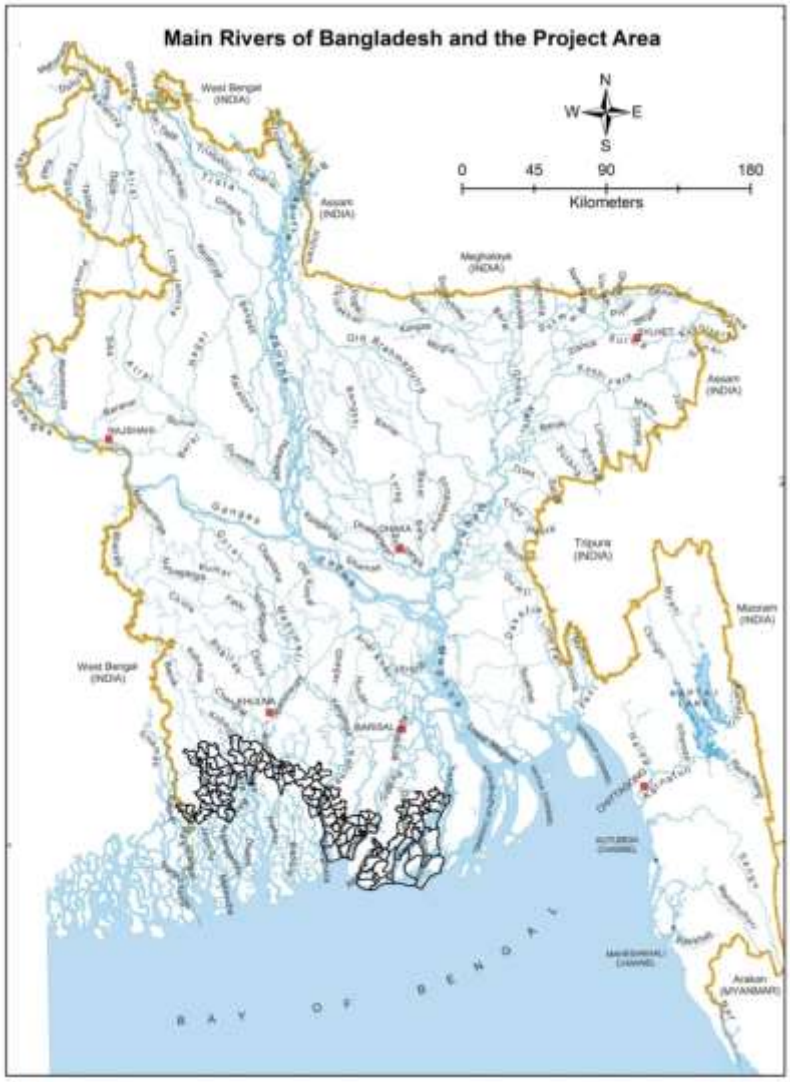



*Figure 2: Main Rivers of Bangladesh (proposed project area in six districts is outlined in the map[7]*

[2] Government of the People's Republic of Bangladesh, Ministry of Environment and Forests (2012). *Second National Communication of Bangladesh to the United Nations Framework Convention on Climate Change*. Available online at: http://unfccc.int/resource/docs/natc/bgdnc2.pdf

[3] Climate Investment Funds (CIF), (2010). *Strategic Programme for Climate Resilience (SPCR) Bangladesh*, CIF. Available online at: https://www-cif.climateinvestmentfunds.org/sites/default/files/PPCR%205%20SPCR%20Bangladesh%20nov2010.pdf

[4] Idem 2

[5] Idem 3

[6] Idem 3

[7] Adapted from PMO 2017

Encompassing a total of 19 districts along a 710km coastline, the coastal zone of Bangladesh covers an area of over 47,150 sq km and is home to 38.52 million people[8]. The coastal zone is characterized by a wide network of rivers and channels. Additionally, strong tidal fluctuations affect freshwater levels. The low-lying coastline is also susceptible to erosion and inundations from tidal surges.

Figure 2 shows the target areas of the proposed GCF project. Phase I would entail Satkhira and Khulna districts. A potential phase II would further include Bagerhat, Pirojpur, Barguna, and Patuakhali districts. All six districts share common development challenges and characteristics that shape their constraints in freshwater availability and potential for agricultural livelihoods.

### 2.2. Climate and Agro-ecological Zones

According to the Köppen and Geiger's climate classification system, most of the territory of Bangladesh, including its coastal region, is dominated by a Tropical Savanna climate (Aw), with rainy summers and mostly dry winters[9]. The southwest monsoons, which originate over the Indian Ocean, bring most of the rain and are an important factor in determining Bangladesh's climate. The country's climate is also impacted by the El Niño Southern Oscillation, which usually causes dry conditions, and the Easterly Trade winds which bring dry air and relatively warmer temperatures[10].

The mean annual temperature in Bangladesh is 25°C.[11] Temperatures are lower between December and March (January is the coldest month, with a mean temperature of 18.4°C) and higher towards the middle of the year (28°C between May and September)[12]. Maximum temperatures throughout the year range between 38°C and 41°C[13].

There are four recognizable seasons in Bangladesh:

**The Pre-Monsoon Season (March - May)** is characterized by warm temperatures (27 °C on average and a maximum average of 36.7°C), very high rates of evaporation, and erratic, occasionally heavy rainfall and thunderstorms occurring from March to June. The volume of rainfall during this period ranges from 15mm in the western central region to more than 80mm/year in the northeast region. During the pre-monsoon season, temperatures graduate with warmer zones in the southwest and cooler zones in the northeast[14,15].

**The Monsoon Season (June - September)** is typically hot, with high humidity (around 87 percent) and heavy torrential rainfall contributing to most of the year's rainfall. Mean monsoon temperatures are higher in western districts. Warm conditions generally prevail throughout the season and are interspersed with cooler days during heavy downpours[16,17].

**The Post-Monsoon Season (October - November)** is short and characterized by less rainfall and lower temperatures, particularly in the evenings[18].

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[8] Bangladesh Bureau of Statistics (BBS) (2011). *GDP of Bangladesh 2007-8 to 2010-2011*. Statistics Division, Ministry of Planning, Dhaka, Bangladesh

[9] Climate-Data.org (2017). *Bangladesh climate*. Accessed on January 2017. Available online at: https://en.climate-data.org/country/166/

[10] Climate Change Knowledge Portal (CCKP), (2017). *Bangladesh dashboard, climate profile*. The World Bank Group . Available online at: http://sdwebx.worldbank.org/climateportal/countryprofile/home.cfm?page=country_profile&CCode=BGD&ThisTab=ClimateBaseline

[11] Calculated for the 1960-1990 period from data provided by CCKP (2017). Available online at: http://sdwebx.worldbank.org/climateportal/?page=downscaled_data_download&menu=historical

[12] Calculated for the 1960-1990 period from data provided by CCKP (2017). Available online at: http://sdwebx.worldbank.org/climateportal/?page=downscaled_data_download&menu=historical

[13] Idem 2

[14] Global Facility for Disaster Reduction and Recovery (GFDRR) (2011). *Vulnerability, Risk Reduction, and Adaptation to Climate Change: Bangladesh.* Available online at: http://sdwebx.worldbank.org/climateportal/countryprofile/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_BGD.pdf

[15] Sarwwar Hossain, K. R. and D. K. D. (2014). *Spatial and Temporal Variability of Rainfall over the South-West Coast of Bangladesh Climate.* Vol. 2, pp. 28–46

[16] Idem 14

[17] Saiful Islam, A.K.M. et al. (2014). *Impact of Climate Change on Heavy Rainfall in Bangladesh Final Report*. Institute of Water and Flood Management (IWFM). Bangladesh University of Engineering and Technology (BUET). Available online at: http://teacher.buet.ac.bd/akmsaifulislam/reports/Heavy_Rainfall_report.pdf

[18] Idem 14

**The Winter Season (December - February)** is relatively cool and dry, with average temperatures ranging from a minimum of 7.2°C to 12.8°C and a maximum of 23.9 to 31.1°C. Minimum temperatures occasionally fall below 5°C in the north, although frost is extremely rare. There is a south to north thermal gradient in winter mean temperature meaning that, generally, the southern districts are 5°C warmer than the northern districts[19].

Bangladesh has been divided into 30 agro-ecological zones (AEZ), which are based on physiography, soils, land level (in relation to flooding) and agro-climatology. The largest portion of the Khulna and Satkhira districts, in southwest Bangladesh, is included in the Ganges Tidal Floodplain AEZ. The Ganges Tidal Floodplain AEZ is characterized by smooth and low-lying terrain. Riverbanks generally stand about a metre or less above the level of adjoining basins. Slightly calcareous loamy soils are found on the riverbanks and non-calcareous grey and dark grey floodplain soils (heavy silt clays) dominate in the basin. Their organic matter content is medium (1.7- 3.4 per cent)[20]. Acid sulphate soils also occupy significant patches and become extremely acidic during the dry season. Across most of this AEZ, the topsoils are acidic and sub-soils are neutral to mildly alkaline. In general, soil fertility is high, and the organic matter content is medium to high[21,22].

The whole area of the Ganges Tidal Floodplain AEZ lies within the cyclone zone and experiences a mean annual temperature of about 26.4°C. Precipitation shifts from about 1,700mm/year in the west to 3,300mm/year in the southeast. Surface water resources are abundant. Most places are less than 500 metres from a tidal river or crack. Historically the proximity to the Bay of Bengal led to salinization of ground water in near surface aquifers throughout most of this region, and salinity levels in the recent years have been impacted by a decline in upstream freshwater flow, sea-level rise and also by land use changes (for example, coastal embankment-induced waterlogging and shrimp farming)[23]. Data from the Bangladesh Water Development Board (BWDB 2012) indicates that groundwater salinity in many of the project areas is beyond the limit for potable and irrigation use (>2500 uS/cm).

### 2.3. Extreme Weather Events

Bangladesh experiences extreme weather phenomena like tropical cyclones, storm surges, floods, and droughts on an annual basis[24]. These events severely impact the country's agricultural sector, drinking water supply, homes and infrastructure, putting people's lives, livelihoods and assets at risk[25].

The low-lying topography and seasonal variations in precipitation combined with hydropower development makes Bangladesh very perceptible to **floods**. Most years, between 30 and 50 per cent of the country is affected by floods[26]. Within the last 25 years, Bangladesh had experienced six severe floods. In 2007, two successive floods inundated over 70 per cent of the country, destroyed over 85,000 houses and 1.2 million acres of crops affecting almost 1 million households[27]. Additionally, nearly a third of the coastal area is susceptible to tidal inundation[28].

Like floods, **droughts** in Bangladesh are also seasonal, affecting mainly the north-western region. Droughts damage crops, and often cause seasonal hunger particularly in the months preceding the November-December rice harvests[29].

**Cyclones** generally form in the Bay of Bengal in the months just before and after the monsoon. They are accompanied by high winds of over 150km/h, which can trigger storm surges up to thirteen meters high. The storm surges tend to be higher in Bangladesh than in neighbouring countries as the Bay of Bengal narrows

[19] Idem 14
[20] Fazlul Haque Bhuiyan, A.K. and Bhuiya, S. U. (2004). *The Characterization of the Agro-ecological Context in which FAnGR (Farm Animal Genetic Resources) are Found*. ILRI. Available online at: http://www.fangrasia.org/admin/admin_content/files/38843.pdf
[21] Banglapedia: National Encyclopedia of Bangladesh (2014). *Agroecological Zone*. Accessed on March 15, 2017. Available online at: http://en.banglapedia.org/index.php?title=Agroecological_Zone
[22] Idem 20
[23] Idem 20
[24] Idem 14
[25] World Health Organization (WHO) (2015). *Bangladesh "Climate-Proofs" to protect Health*. Available online at: http://www.who.int/features/2015/climate-proofing-bangladesh/en/
[26] Idem 3
[27] Idem 3
[28] Idem 3
[29] Idem 3

towards the north building up higher waves[30]. Particularly in the low-lying coastal areas, these high storm surges inundate land and, in conjunction with the high wind speeds, can lead to significant negative impacts such as the loss of lives, livelihoods and asset damage.

Bangladesh has some of the highest casualties from cyclones. Cyclones and associated storm surges and floods have led to almost all of the nearly 520,000 natural disaster deaths recorded over the past 40 years in the country[31]. Sixty per cent of worldwide deaths caused by cyclones in the last 20 years were in Bangladesh[32]. Cyclones in Bangladesh killed almost 300,000 people in 1970; 15,000 in 1985 and 138,900 people in 1991[33]. Cyclone Sidr in 2007 affected 2.3 million households and cost an estimated USD1.7 billion in damages and losses[34,35]. Cyclone Aila in 2009 affected nearly 5 million people and caused over USD60 million in infrastructure damages[36].

An associated impact of cycles with potential for long-term impact is the intrusion of saline seawater into coastal groundwater aquifers and soils. Recurring cyclones and storm surges in conjunction with urban development (e.g. dams) frequently lead to waterlogging of saline water and saline intrusion. This can significantly affect agriculture-based livelihoods[37].

### 2.4. Socio-economic Characteristics

Bangladesh is one of the most densely populated and poorest countries in South Asia, and has a high level of gender inequality, particularly in rural areas, which hinders overall development. Women are disproportionately represented amongst the poor, have considerably lower access to formal employment and earn less when employed, while continuing to face high levels of gender-based violence (GBV). Traditional gender roles, shaped by cultural and religious factors, constrain livelihood options available to women living in coastal areas, and limit their ability to cope with increasing environmental impacts on their lives, making them particularly vulnerable to climate change.

#### 2.4.1. Population

With 1,236.8 persons per square kilometre and a total population of 160,996,000 Bangladesh ranked in 2015 as the tenth most densely populated country in the world[38]. The population is growing at an estimated rate of 1.59 per cent per year[39]. With 18 million inhabitants, the highest population density can be found in Dhaka city and its surrounding areas[40].

#### 2.4.2. Economic Status

Bangladesh has made considerable economic progress over the past two decades. It attained Low-Middle-Income Country status in 2014 and has the vision of becoming a Middle-Income Country by 2021.

According to the World Bank, the Gross Domestic Product (GDP) of Bangladesh in 2015 was USD195.079 billion, and GDP per capita was USD1,211.7.[41] In 2010, 31.5 per cent of the population lived under the national poverty line, 18.52 per cent of the population lived on less than USD1.9 per day and 56.8 per cent of the population on less than USD3.10 per day. Official poverty indicators show a slightly higher percentage of the population living

[30] Qwadir, D.A and Iqbal, A. (2008). *Tropical Cyclones Impacts on Coastal Livelihoods – Investigation of the Coastal Inhabitants of Bangladesh*. International Union for the Conservation of Nature. Available online at: https://portals.iucn.org/library/sites/library/files/documents/2008-067.pdf
[31] Idem 14
[32] Idem 3
[33] Guha-Sapir, D. et al. (2017). *EM-DAT: The CRED/OFDA International Disaster Database.* Université Catholique de Louvain, Brussels. Accessed April 10, 2017. Available online at: www.emdat.be.
[34] Global Facility for Disaster Reduction and Recovery (GFDRR) (2017). *Bangladesh Country Profile*. Accessed March 15, 2017. Available online at: https://www.gfdrr.org/bangladesh
[35] Idem 3
[36] Idem 3
[37] European Commission, European Civil Protection and Humanitarian Aid Operations (2017). *Bangladesh Echo Factsheet*. Available online at: http://ec.europa.eu/echo/files/aid/countries/factsheets/bangladesh_en.pdf
[38] World Bank (2015). *World Bank Data: Population Density*. Accessed on March 21, 2017. Available online at: http://data.worldbank.org/indicator/EN.POP.DNST
[39] Idem 37
[40] World Population Review (2016). *Dhaka Population.* Accessed April 10, 2017. Available online at: http://worldpopulationreview.com/world-cities/dhaka-population/
[41] World Bank (2017). *Development Indicators for Bangladesh*. Accessed April 10, 2017. Available online at: http://data.worldbank.org/country/bangladesh

below the absolute poverty line in the coastal zone compared to the country as a whole (52 per cent versus 49 per cent), while GDP per capita and the annual GDP growth rates in the coastal zone are more or less similar to the national averages.

The southwest of Bangladesh is amongst the poorer regions of the country. Between 16 and 35 per cent of people living in Khulna are extremely poor. In Barisal, the percentage of extremely poor ranges from 6 per cent in the southern most districts to more than 35 per cent in the city.

In 2016, the total labour force of Bangladesh was 72,027,272 of which 34.55 per cent were women. The agricultural sector constituted the major share of total labour at 47.5 per cent, in 2010, followed by the service sector at 30.3 per cent and industry with 17.7 per cent[42]. This shows the predominant dependency, particularly of the rural population, on agricultural livelihoods.

#### 2.4.3. Marginalized Groups

Although Bangladesh is a majority Muslim country (90 per cent), the districts of Sathkira and Khulna also have a significantly higher Hindu minority population (~30 per cent) than the national average. Other ethnic and religious minorities are also present, including the indigenous Munda group, known locally as *adivasi*. These marginalized groups can also experience exacerbated vulnerability to climate change due to social exclusion, insecure land tenure and landlessness, and discrimination with regards to access to resources such as land and water.[43] Certain studies and consultations also reveal that livelihood preferences vary among marginalized groups, and that marginalized groups dominate some livelihood activities in the region. For example, crab collection is currently dominated by Hindu community members (~70 per cent), whereas only 30 per cent are Muslims. For more information on the indigenous Munda group and their livelihood preferences in the target districts see Annex VIc Indigenous People's Plan.

#### 2.4.4. Gender Roles

Bangladesh ranks 111$^{th}$ out of 188 on the Gender Inequality Index (GII)[44] developed by the UNDP. Gender inequality in Bangladesh arises from various societal and cultural norms that impact women's day-to-day activities as well as their capacity to adapt to climate change. Women have less decision-making power within the household and at the workplace and are expected to manage the household and care for the family. Men, by contrast, are expected to work and financially support the family.

As Bangladesh is a traditional Muslim society, women's participation in economic activities in general, as well as in agricultural and aquacultural livelihood value chains, is constrained. Despite this, there is an increasing trend of women's participation within the agriculture sector. Statistics show that women's participation in agricultural labour increased from 48.1 per cent in 1999-2000 to 68.1 per cent in 2005-2006[45]. This trend was partly driven by the empowerment of women by NGOs and the migration of male family members from agriculture to more profitable non-farming activities. In the absence of male family members, women's role is gradually changing from unpaid family worker to farm manager.

In the southwest coastal region, women's activities adhere to traditional gender roles. As in the rest of the country, whereas men often leave the house for income-generating activities, women take care of the domestic space and the family. Women also oversee obtaining safe drinking water for their families, which can often mean having to travel long distances to access a relatively clean water source. Women in Hindu communities are more likely to work on the farms than women in Muslim communities, although this has changed over the last few decades. A study by UN Women (2014)[46] indicates that in coastal districts, 63.7 per cent of women pursue income-generating activities, with poultry and livestock rearing and homestead gardening constituting their main livelihood activities.

[42] Sarder Syed Ahmed and Md. Rezaul Karim Khan (2015). *Employment and Unemployment situation in Bangladesh: A dismal picture of Development*. Biennial Conference Paper. Accessed April 10, 2017. Available online at: http://bea-bd.org/site/images/pdf/010.pdf
[43] US Department of State (2011). *International Religious Freedom Report*. Bureau of Democracy Human Rights and Labor
[44] The GII is measured based on the quality of reproductive health, the degree of empowerment, and women's economic status in the country.
[45] Labour Force Survey (1999-2006)
[46] UN Women BCAS (2014) UN Women, Bangladesh Centre for Advanced Studies (BCAS) (2014). *Baseline Study on the Socio-Economic Conditions of Women in Three Eco-Zones of Bangladesh*. UN Women, BCAS, Norwegian Embassy, Dhaka. Available online at: http://www.uncclearn.org/sites/default/files/inventory/unwoman30112015.pdf

As shrimp and prawn aquaculture in the southwest coastal zones of Bangladesh has spread rapidly over the last decade, mainly in converted rice fields known as 'ghers', women have been increasingly involved in various parts of this value chain, though their labour is often unacknowledged and undervalued[47]. In the aquaculture context of Bangladesh, homestead pond fish culture is one of the strongest candidates for small-scale aquaculture involving women, as women find ponds easily manageable in addition to their workload of daily chores[48]. This emphasizes the importance of situating small-scale, community-level aquaculture interventions as close to beneficiary homes as possible, with literature confirming that women are also involved in catching fish from *ghers* for family consumption when located within 2km[49]. Women already manage many routine operations in *gher* aquaculture, such as fertilization and feeding, and they also participate in post-harvest management including sorting, grading and washing of fish. However, their involvement is very limited in terms of fish stocking, transportation, and marketing[50]. Female workers in shrimp farms, depots and processing plants not only endure gender discrimination in wage rates, sometimes earning only 40 per cent the wage of men, but they also face hazardous working conditions, widespread sexual harassment and verbal abuse. For a detailed analysis of the gendered dimensions of climate change vulnerability and present and future roles in climate change resilient livelihoods, see below as well as Annex XIIIe Gender Assessment and Action Plan.

### 2.5. Livelihoods with a Focus on the Agricultural/ Aquacultural Sector

Traditionally, the livelihoods of the coastal populations of Bangladesh have depended on agriculture, aquaculture, forestry, near shore transportation and salt farming, among other activities. However, in recent decades, there has been a change in land use patterns, with a switch from traditional agriculture to shrimp farming, which can be profitable under increased land and water salinization, while simultaneously perpetuating the salinization problem and further marginalizing vulnerable communities. The advent of shrimp farming as a replacement of crop agriculture in many areas of south-western Bangladesh has affected traditional livelihood activities and resources as it has negatively impacted fisheries, ecosystems, grazing grounds, soils and water and long-standing social systems and relations[51].

Transplanted aman remains the main crop throughout the coastal region. Aus and rabi crops (mainly kheshari and chilli) are widely grown in non-saline areas. Other crops are betelnut, coconut, betelleaf, guava and vegetables. The main cropping patterns are Boro –Fallow-Fallow, Fallow-Shrimp – T.aman, and Fallow - T.aus - T.aman. Traditionally, the main livestock raised in the region includes indigenous swamp and river buffaloes, black Bengal goat, indigenous cattle and indigenous chicken[52].

Climate-related barriers to the rural development of the coastal area include exposure to cyclones and storm surges; waterlogging; the high Ganges flood in September-October, which occasionally damages transplanted aman; and soil and water salinity. Non-climatic barriers to the development of Bangladesh's southern areas are, among others, heavy clay basin soils which are difficult to plough; extremely acidic soil conditions in some areas; high arsenic content of groundwater in some areas; various forms of pollution (including sewerage, pesticide and industrial residuals – high in heavy metals); difficult communications except by boat; and the remoteness of the southern part of the region from urban markets[53, 54].

### 2.6. Targeted Districts in Phase I: Khulna and Sathkira

The coastal south-western part of Bangladesh accounts for around 16 per cent of the total land area and 10 per cent of the national population[55]. According to the 2011 Population and Housing Census, 1.38 per cent of the national population lives in the Satkhira District. The district's total population stands at 2,063,609 (50.5 per cent female), located mostly in the rural areas with just 9.95 per cent of the population living in urban centres. In

[47] Huq, Nazmul, Huge, Jean, Boon, Emmanuel, Gain, K, Animesh (2015). *Climate Change Impacts in Agricultural Communities in Rural Areas of Coastal Bangladesh: A Tale of Many Stories*. Sustainability. 7, 8437-8460; doi:10.3390/su7078437

[48] Das, J. and Khan, M.S. (2016). *Women and Aquaculture in Bangladesh: The Unpaid Labour*. Accessed May 10, 2017. Available online at: http://www.bangladeshsociology.org/9.pdf

[49] Idem 47

[50] Idem 47

[51] Rahman et al. (2013). Shrimp Cultivation with Water Salinity in Bangladesh: The Implications of an Ecological Model. *Universal Journal of Public Health*, vol. 1, pp. 131-142

[52] Idem 20

[53] Idem 20

[54] Idem 15

[55] Idem 15

Satkhira, the population is growing at an annual rate of 0.62 per cent and the population density stands at 520 people per square kilometre[56]. As for the District of Khulna, the 2011 census reports a population of 2,407,678 (49.29 per cent female). Khulna's population is equivalent to 1.61 per cent of the national population, although it is declining (negative annual growth rate of -0.25 per cent). The average population density in this district is 528 people per square kilometre and 33.54 per cent of its inhabitants live in urban centres[57].

The 2011 Population and Housing Census reports that in the District of Khulna, 281,247 people above the age of 10, including 9,800 females, were employed in agriculture while the district's industry employed 102,252 people[58]. As for Satkhira, the census reported that from the 582,781 people above the age of 10 employed; 388,746 were employed in agriculture and 33,103 in industry. The Census also reported that 15,379 females were engaged in agricultural employment[59].

The coastal zone of Bangladesh covers an area of over 47,150 km$^2$ and is characterized by a wide network of rivers and channels, many islands, the Swatch of No Ground (underwater canyon located 45 km south of the Sundarbans in Bangladesh) and the shallow northern Bay of Bengal. This zone experiences high discharge of water and sediments, strong tidal influence and wind actions, tropical cyclones and storm surges.

The average elevation of the coastal zone ranges from 1-2 m in the southwest and from 4-5 m in the southeast (see Figure 3). The low-lying flat topography and dynamic morphology of the zone significantly contributes to its vulnerability to sea level change.

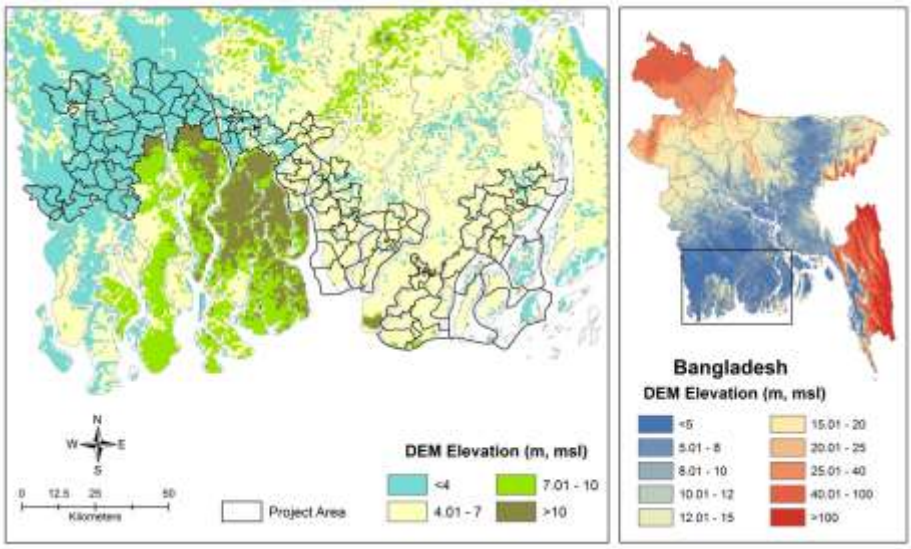


*Figure 3: Elevation Map of the Southwest Coastal Zone Showing Project Target Areas (prepared using NASA's SRTM data)*

As protection against the instability of low-lying lands, 129 polders were built in the coastal region by a project supported by the Government of Netherlands.

Based on three hydro-morphological characteristics - level of tidal fluctuations, salinity conditions (both surface and groundwater), and risks of cyclones, storm surges and tidal influence - the coastal zone can be delineated into three regions[60]: (i) the Ganges Tidal Plain or the Western Coastal Region; (ii) the Meghna Deltaic Plain or the Central Coastal Region; and (iii) the Chittagong Coastal Plain or the Eastern Coastal Region.

[56] Bangladesh Bureau of Statistics (BBS) (2015a). *Population and Housing Census 2011, Satkhira Zila Report*. Available online at: http://203.112.218.65/WebTestApplication/userfiles/Image/PopCenZilz2011/Zila-Satkhira.pdf
[57] Bangladesh Bureau of Statistics (BBS) (2015b). *Population and Housing Census 2011, Khulna Zila Report*. Available online at: http://203.112.218.65/WebTestApplication/userfiles/Image/PopCenZilz2011/Zila-Khulna.pdf.
[58] Idem 57
[59] Idem 56
[60] Shahid S. (2010). Recent Trends in the Climate of Bangladesh. *Climate Research*, vol. 42, pp. 185–193

Both Khulna and Satkhira districts are located in the south-western Coastal Region or the Ganges Tidal Plain. The Sundarbans act as a natural barrier against cyclones, storm surges and soil erosion, and provide some stability to the zone. Swamps, tidal flood plains and natural levees with numerous tidal creeks are also present in the zone. A semi-active delta, the soils are composed mostly of silty loams or alluvium washed down from the Himalayas[61]. The Ganges Tidal Plain is also considered as the most salinity prone region on the coast. The western part of the south-western region remains somewhat more saline than the eastern part.

Precipitation records for south-western Bangladesh (1961 – 2010) indicate that in Khulna, the mean annual precipitation is 1,779.15mm and the mean number of rainy days per year 105.84 (with coefficients of variation of 21.41 and 19.84 respectively). In Satkhira, the mean annual precipitation is 1,718.73mm and there are on average 107.51 rainy days per year (with coefficients of variation of 16.24 and 15.60 respectively)[62].

As mentioned earlier, livelihoods of the coastal populations of Bangladesh traditionally depended on agriculture, aquaculture, forestry, near shore transportation and salt farming, among other activities. However, in recent decades, a significant change in land use patterns has occurred and shrimp farming has displaced rice production as the main and most economically profitable use of land in the region, with Khulna and Satkhira turning into leading shrimp production districts in Bangladesh. As Rahman et al. (2013) explain, this change has brought serious negative consequences to the region's soil, water and environment as well as to the lives and livelihoods of the poor coastal communities and adds to the impacts of climate change they already experience[63].

The results of a survey conducted in 768 households in the districts of Khulna and Satkhira earlier in 2017 show that climate variability, cyclones and salinization of soil and water have affected their livelihood options over the past 15 years. According to survey respondents, the livelihoods most affected by climate-related hazards have been day labour or wage labour in crop cultivation in Satkhira and day labour or wage labour in crop cultivation and crop agriculture on their own or rented land for trade in Khulna. The survey further indicated that currently 57 per cent of the members of coastal households in Satkhira are engaged in on-farm livelihoods (on their own, rented or leased land), while 15 per cent are employed as labour and wage workers and in off-farm jobs. In Khulna, the percentage of household members involved in agricultural production is lower (48 per cent) and there is a relatively higher participation in labour and wage work than in Satkhira (see Figure 4).

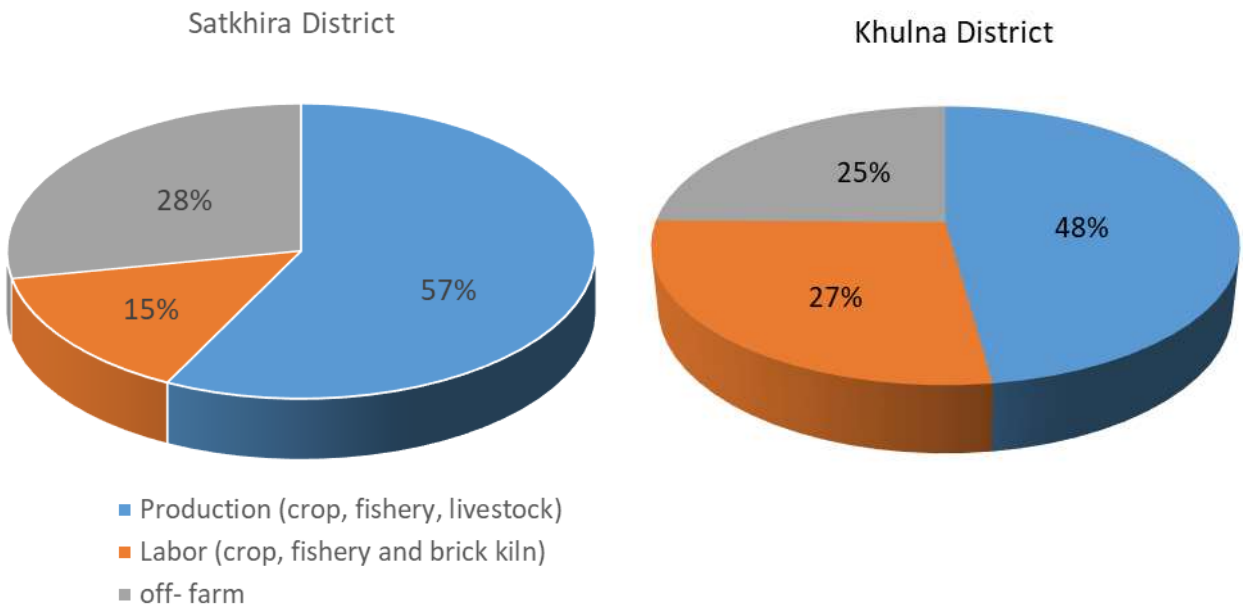


*Figure 4: Household Members Engaged in Main Livelihood Activities in Satkhira and Khulna Districts (2017).*

[61] Islam, M. S. (2001). *Sea-level changes in Bangladesh: The last ten thousand years*. Asiatic Society of Bangladesh.
[62] Idem 17
[63] Idem 51

## 3. Climate Change Impacts on Coastal Livelihoods

The geographic and climatic characteristics of Bangladesh in conjunction with the marginalised socio-economic situation of large parts of the population makes the nation particularly susceptible to the impacts of climate change. The country has been repeatedly listed as being among the most vulnerable countries to climate change around the globe[64,65,66]. According to the World Risk Index, Bangladesh ranks fifth of countries most at risk from a natural disaster, scoring 32 per cent for exposure, 40 per cent for susceptibility, 57 per cent in lack of adaptive capacities, 61 per cent for vulnerability and 86 per cent in lack of coping capacities[67]. These estimates are shared by the Intergovernmental Panel on Climate Change (IPCC) which noted that Bangladesh will be among the worst victims of, since it is amongst the most vulnerable to, climate change. The key ocean and climate drivers projected to affect the nation are: (i) variations in air and ocean temperatures; (ii) changes in precipitation patterns; (iii) sea level rise; and (iv) intensification of extreme weather phenomena, such as cyclones. The following Chapter provides a brief overview of these climate change impacts, especially those most relevant to this project. A more extensive analysis of observed and projected climate change impacts can be found in the Feasibility Study (Annex IIa) of the GCF proposal.

### 3.1. Precipitation Trends

There is an observed trend towards a shift in seasonal precipitation patterns and towards more rainy days throughout the year, particularly in the districts of Khulna and Shatkira[68]. These seasonal rainfall changes have direct and negative implications for the region's farming activities. Climate change is projected to fuel these alterations in rainfall patterns and demands that the local population and ecosystems adapt accordingly.

In Khulna, reduced pre-monsoon rainfall could increase irrigation demand, particularly for Boro rice production. Increasing post-monsoon rainfall is a concern for Jute and Aman paddy production. Combined with floodwaters from outside the territory, higher post-monsoon rainfall could also increase the risk of flood events. At the same time, heavier rainfall in the post-monsoon and winter seasons could, in theory, facilitate the implementation of clean water technologies (e.g. rain water harvesting systems) and help the local communities to cope with additional climate-induced stress on already scarce freshwater resources[69].

### 3.2. Cyclones and Tidal Surge

While an increasing frequency of cyclones and storm surges in Bangladesh has been reported in recent decades (e.g. SPCR 2010), climate change projections suggest that in the future, the Bay of Bengal may see more intense, though not necessarily more frequent cyclones[70]. More intense cyclones can lead to devastating impacts for agriculture-based rural households in coastal areas.

Currently, an estimated 8.3 million Bangladeshis live in high cyclone risk areas. This figure is expected to grow up to 20.3 million people by 2050 due to climate-induced intensification of cyclones[71]. Figure 5 displays those coastal project areas projected to be threatened by inundations and storm surges from intensified cyclones by 2050. These inundations can intensify the pace of soil salinization and significantly impact agriculture-based livelihoods (see Section 3.3).

[64] Maplecroft (2013). *Climate change vulnerability index 2012*. Maplecroft. Available online at: http://maplecroft.com/themes/cc/
[65] Maplecroft (2014). *Climate change vulnerability index 2013*. Maplecroft. Available online at: http://maplecroft.com/themes/cc/
[66] Maplecroft (2015). *Climate change vulnerability index 2014*. Maplecroft. Available online at: http://maplecroft.com/themes/cc/
[67] The 2014 World Risk Report (WRR 2014). UNU-EHS and the Alliance Development Works
[68] Idem 15
[69] Idem 15
[70] USAID (2012). *Bangladesh Climate Vulnerability Profile*. Accessed March 12, 2017. Available online at: https://www.climatelinks.org/sites/default/files/asset/document/bangladesh_climate_vulnerability_profile_jan2013.pdf ()
[71] World Health Organization (WHO) (2015). *Bangladesh "Climate-Proofs" to protect Health*. Accessed March 15, 2017. Available online at: http://www.who.int/features/2015/climate-proofing-bangladesh/en/

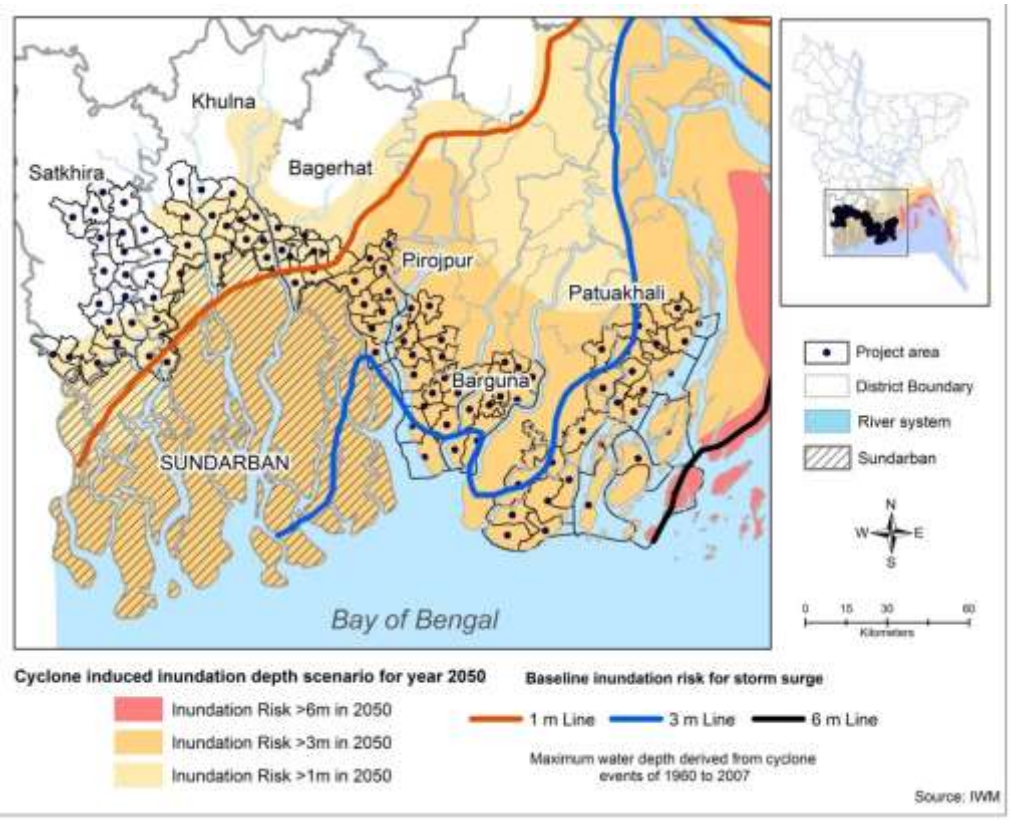


*Figure 5: Cyclone Inundation Map in 2050 Under a Climate Change Scenario*[72]

Intensified cyclones, due to climate change, are projected to damage assets and infrastructure and threaten human lives, particularly in the coastal regions of Bangladesh. The World Bank calculated that the damage and losses of an average cyclone (based on historic cyclone impact data) amounts to around USD1.8 billion (around 2.4 per cent of the Bangladesh's GDP in 2010), with housing and the agricultural sector most affected[73].

Infrastructure will also be at severe risk of damage from intensified cyclones. Current infrastructure is often poorly built and maintained[74]. Damaged roads can reduce market access and interrupt value chains, which, consequently, can have severe impacts on rural smallholders in particular, who depend on middle men and distant buyers to sell their crops. Similarly, interrupted water and electricity supply systems could hinder post-disaster recovery processes of the rural poor.

Apart from direct wind and extreme precipitation-related impacts, intensified cyclone-related tidal surges pose a significant threat to agricultural areas through inundations. Polders are particularly vulnerable to higher tidal surges, because once a polder embankment is breached, the island often stays waterlogged for some time, making agriculture and other livelihood activities nearly impossible. Figure 6 shows the number of polders in the region that risk being overtopped by 2050 under changing climate conditions. In particular, saltwater inundations can lead to long-term impacts on freshwater availability and increase the levels of soil salinity, as outlined in subsequent Sections.

[72] Dasgupta. S. et al. (2014). *Climate Change, Soil Salinity, and the Economics of High-Yield Rice Production in Coastal Bangladesh.* Policy Research Working Paper 7140. The World Bank. Accessed March 10, 2017. Available online at: http://documents.worldbank.org/curated/en/131161468004833954/pdf/WPS7140.pdf

[73] World Bank (2010). *The Economics of Adaptation to Climate Change. A Synthesis Report. Final Consultation Draft*. The World Bank, Washington DC. Accessed March 15, 2017. Available online at: https://siteresources.worldbank.org/EXTCC/Resources/EACC_FinalSynthesisReport0803_2010.pdf

[74] Idem 73

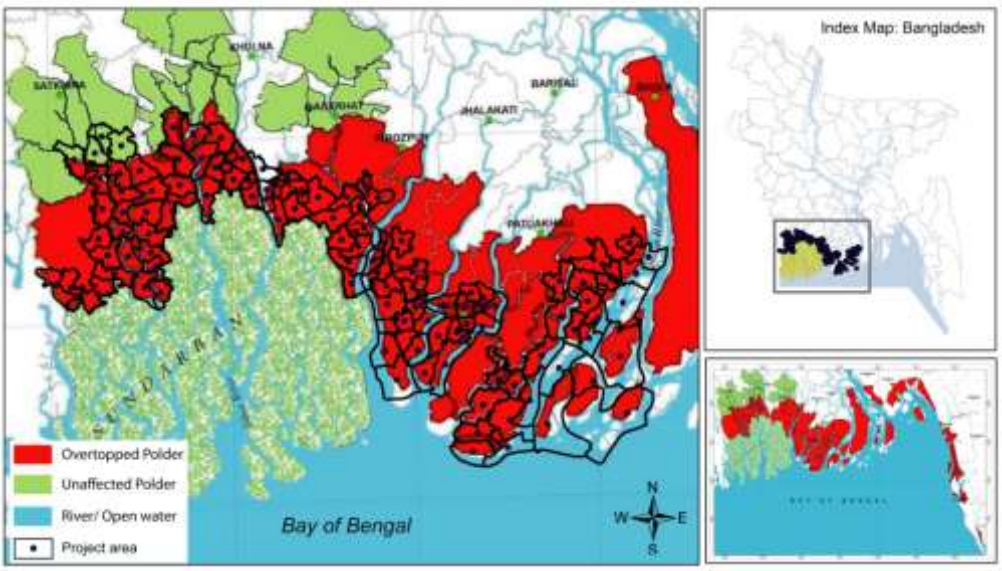


*Figure 6: Polders Breached by Cyclone Storm Surge in 2050 Under Changing Climatic Conditions*[75]

### 3.3. Salinity Intrusion and its Impacts on Freshwater-based Agricultural Livelihoods

Salinity intrusion is a major problem in Bangladesh's coastal zone. The major drivers of increasing salinity intrusion are sea level rise and cyclone-induced storm surges due to climate change (see Feasibility Study, Annex IIa to the GCF proposal).

Other drivers for increasing salinity are land use change (e.g. empoldering of coastal areas) and reduced upstream freshwater flow into the river system of the coastal delta, which leads to saltwater intrusion, especially during the dry season[76].

According to Miah et al. (2010) the saline area in 10 coastal districts increased by an average of 27 per cent between 1973 and 2009[77]. This trend is in line with another study, which found that coastal soil salinity is gradually increasing[78]. In addition to soil salinity, surface and river water salinity of coastal rivers is also increasing and there is unanimous agreement between climate change scientists and hydrologists that river salinity in the Sundarbans area will increase due to sea level rise in a changing climate[79]. In the greater Khulna district alone, an increase in river salinity of 20.5% to 43.3 % between 2004 and 2009 was recorded[80].

Under a scenario of 30cm SLR, the surface water salinity pattern will experience significant changes. The present dry season saline front (2 ppt) is projected to move 30km to 70km north affecting most of Khulna, Jessore, Barisal, Patuakhali and Noakhali (greater) districts[81]. With a 1m SLR, the saline front is projected to expand further on the northeastern side of Bangladesh. Most of Barisal, Patuakhali, Sundarbans, Bhola, Hatia and Sandwip will be directly inundated by brackish water or will face serious saline water logging problems. A hydrodynamic model constructed by Bhuiyan and Dutta (2012) for the Gorai River network in the country's southwest region indicates that a SLR of 0.59m could increase the salinity of the river by 0.9 ppt at the level of the Port of Mongla in the Bagherat District. The model also shows that a salinity front of 10 ppt could move 21km upstream in Passur River and that, overall, salinity intrusion due to SLR will be higher in the western part

[75] Dasgupta, S. et al. (2015). 'River Salinity and Climate Change: Evidence from Coastal Bangladesh' in John Whalley and Jiahua Pan (eds.) *Asia and the World Economy - Actions on Climate Change by Asian Countries*, vol. 3, World Scientific Press, pp. 205-242
[76] Miah, M.U. (2010*). Assessing Long-term Impacts of Vulnerabilities on Crop Production due to Climate Change in the Coastal Areas of Bangladesh.* Bangladesh Center for Advanced Studies, Dhaka. Accessed March 15, 2017. Available online at: http://fpmu.gov.bd/agridrupal/sites/default/files/Muslem_Uddin_Miah-PR10-08.pdf
[77] Idem 76
[78] Idem 72
[79] Dasgupta, S. et al. (2016). *Impact of Climate Change and Aquatic Salinization on Fish Habitats and Poor Communities in Southwest Coastal Bangladesh and Bangladesh Sundarbans*. Policy Research Working Paper 7593, The World Bank. Available online at: http://documents.worldbank.org/curated/en/199851468000266963/pdf/WPS7593.pdf
[80] Idem 76
[81] Idem 72

of the Gorai's network, most likely due to lower discharges from the rivers in this area. These levels of salinity will make water unsuitable for drinking or agricultural purposes[82].

Nearly 6 million people are already exposed to high salinity (>5 ppt), and because of climate change the number is expected to increase to 13.6 million by 2050 and 14.8 million by 2080, with the population in Khulna, Satkhira, and Bagerhat being affected the most. This will significantly affect agricultural production in these areas[83].

The impacts of climate-induced salinity on agriculture-based (agriculture, aquaculture, livestock) livelihoods are significant and pose a tremendous risk to Bangladesh's agro-based economy. Local communities experience direct damage to crops, decreasing freshwater fish stocks, and income loss, which lead to increased vulnerability. Further, the reduced availability of grass due to salinity also reduces the feasibility of livestock rearing. This, subsequently, triggers the need for adaptive responses in livelihood choices and production patterns[84].

Under a moderate climate change scenario, the crop loss due to sea level rise-induced salinity intrusion could be about 0.2 million metric tonnes[85]. Another study is supportive of this projection and estimates a climate-induced increase of salinity in irrigation water of 5 ppt could lead to a reduction of farm productivity by up to 50%[86]. Another study, focusing on the Khulna, Bagerhat, and Satkhira districts, projects that a 32cm SLR will reduce the are suitable for growing Aman rice from 88 per cent to 60 per cent, and a 88cm SLR could shrink the cultivable area to 12 per cent[87].

Furthermore, increasing climate-induced salinity impacts the availability of fresh and brackish water fish and marine species in the coastal areas of Bangladesh[88]. A study conducted by Gain et al. (2008) on the impact of river salinity on fish diversity in the southwest coastal region of Bangladesh, including Khulna and Bagerhat districts, identified a clear correlation between a decline of 59 per cent of freshwater fish species and increasing salinity levels in the river systems[89].

Another study applies 27 alternate climate change scenarios to extrapolate salinity trends in coastal rivers, between 2012 and 2050, to project the impact on stocks of 83 different fish species[90,91]. These species are commonly consumed in Bangladesh's coastal zones and are an integral part of the current nutrition of local communities. Increase in salinity is expected to adversely impact the reproductive cycle and capacity, spawning area and feeding, breeding and longitudinal migration of many of the fish species[92]. The results further indicate that the expansion of brackish water into freshwater habitats will cause the loss of fish species in 76 coastal upazilas (9 upazilas in Khulna are projected to experience some of the highest losses), with poor households likely to be worst affected.

### 3.4. Social Impacts with a Focus on Women and Children

#### 3.4.1. Gender Inequality in Vulnerability to Disasters and Climate Change

The IPCC recognized in 2001 that "climate change impacts will be differently distributed among different regions, generations, age classes, income groups, occupations and genders", noting also that the impacts will disproportionately affect developing countries and the poor within all countries, exacerbating inequities in

[82] Bhuiyan, J.A.N. and Dutta, D. (2012). Assessing Impacts of Sea Level Rise on River Salinity in the Gorai River Network, Bangladesh. *Estuarine, Coastal and Shelf Science,* vol. 96, pp. 219-227

[83] Mohal, N. and Hossain, M.M.A. (2007). *Investigating the Impact of Relative Sea Level Rise on Coastal Communities and their Livelihoods in Bangladesh.* Draft Final Report Submitted to UK Department for Environment Food and Rural Affairs, Institute of Water Modelling (IWM) and Center for Environmental and Geographic Information Services (CEGIS), Dhaka.

[84] Huq, N. et al. (2015). Climate Change Impacts in Agricultural Communities in Rural Areas of Coastal Bangladesh: A Tale of Many Stories. *Sustainability* vol 7, pp. 8437–8460

[85] Mainuddin, K. et al. (2011). *Planning and Costing Agriculture's Adaptation to Climate Change in the Salinity Prone Cropping System of Bangladesh.* International Institute for Environment and Development (IIED), London. Available online at: http://pubs.iied.org/pdfs/G03173.pdf

[86] Clarke, D. et al. (2015). Projections of on-farm salinity in coastal Bangladesh. *Environmental Science: Processes & Impacts*, vol. 00, pp. 1-10

[87] Pender, J.S. (2008). *What Is Climate Change? And How It Will Affect Bangladesh*. Briefing Paper. (Final Draft). Dhaka, Bangladesh: Church of Bangladesh Social Development Programme.

[88] Idem 76

[89] Gain, A.K., Uddin, M.N and Sana, P. (2008). Impact of River Salinity on Fish Diversity in the South-West Coastal Region of Bangladesh. *International Journal of Ecology and Environmental Sciences*, vol. 34, pp. 49-54

[90] Idem 79

[91] Idem 79

[92] Idem 79

health status and access to adequate food, clean water, and other resources[93]. Today, women represent more than half of the world's poor[94] and in Bangladesh the poorest of the poor are women[95]; although exact estimates of the relative proportion and magnitude of women's poverty are difficult to arrive at given that poverty estimates are based on household level surveys and data, which in general do not permit gender disaggregation[96]. Nonetheless, an international index shows that gender equality in Bangladesh is low; the country ranks 116 out of 137 countries in the Gender Inequality Index, which reflects the huge differences in the daily lives of men and women in the country, particularly in rural areas[97]. The poverty rate of female-headed households is higher than that of male-headed households in the agricultural districts and there is a difference between the sexes in terms of the completion rate of primary and secondary education[98]. Under the country's existing patriarchal system, which to a large extent determines women's roles and mobility, women have limited access to resources, property, education and income-earning opportunities, as decision-making and control of resources at the household level are generally in the hands of men[99,100].

All these aspects lead to a higher vulnerability of women in Bangladesh to climate change compared to men. Apart from the direct impacts of climate change, indirect impacts such as increases of infectious disease could create an additional burden for women as they are traditionally responsible for caring for sick relatives. Another major impact on women's lives in the coastal region will stem from reduced freshwater availability, which can lead to women having to travel longer distances to obtain water for their households. This will also limit the time women have for income generation, thereby heightening poverty and taking a toll on their own health status[101]. Climate change impacts on food production will further disproportionately affect the nutrition and health of poor women[102].

The IPCC suggests that differences in vulnerability to climate change (among countries and population groups) can be clearly observed in patterns of vulnerability towards natural disasters[103]. In general, women have less access to resources that are essential in disaster preparedness, mitigation and rehabilitation[104] and women and children are 14 times more likely to die than men during disasters[105]. In Bangladesh, as in global estimates, women are more affected and suffer more during and after disasters than men. Cyclones affecting the coastal areas exemplify gender disparities in vulnerability to hazards. During Cyclone Sidr, for example, many of the female casualties in coastal Bangladesh occurred because women, who are in their majority homebound, were busy tending the family livestock when the cyclone struck and could not leave without prior preparations; others died because their traditional Sari clothing got trapped in trees and other objects while running and other women perished trying to rescue or search for children who could not evacuate fast enough[106,107]. The cyclone was announced by men to men (which is the way warning systems work in the region)[108] with many women

[93] IPCC (2001). *Climate Change 2001. Impacts, Adaptation and Vulnerability. Contributions of the Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge.
[94] United Nations (2015). *The World's Women 2015: Trends and Statistics*. United Nations, Department of Economic and Social Affairs, Statistics Division, New York. Available online at: https://unstats.un.org/unsd/gender/downloads/worldswomen2015_report.pdf
[95] Yunus, M. and Jolis, A. (1998). *Banker to the poor: the autobiography of Muhammad Yunus, founder of the Grameen Bank*. Aurum Press, London
[96] Idem 94
[97] Idem 44
[98] Idem 44
[99] Ministry of Environment and Forests (2012). Second National Communication of Bangladesh to the UNFCCC. Available online at: http://unfccc.int/resource/docs/natc/bgdnc2.pdf
[100] UN Women (2009). Fact Sheet: Women, Gender Equality and Climate Change. Available online at: http://www.un.org/womenwatch/feature/climate_change/downloads/Women_and_Climate_Change_Factsheet.pdf
[101] Brody, A., Demetriades, J. and Esplen, E. (2008). *Gender and Climate Change: Mapping the Linkages.* BRIDGE, Institute of Development Studies (IDS), University of Sussex, Brighton. Available online at: https://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/DFID_Gender_Climate_Change.pdf
[102] Idem 99
[103] Idem 99
[104] Irene Dankelman (2010). *Gender and Climate Change: An Introduction*.
[105] Araujo, A. and Quesada-Aguilar, A. (2007). *Gender Equality and Adaptation*. Women's Environment and Development Organization (WEDO). Available online at: http://www.wedo.org/wp-content/uploads/genderequaladaptation.pdf
[106] Kabir, R. et al. (2016). Climate Change Impact: The Experience of the Coastal Areas of Bangladesh Affected by Cyclones Sidr and Aila. *Journal of Environmental and Public Health* , vol. 2016, pp. 1-9, doi: http://dx.doi.org/10.1155/2016/9654753
[107] Alam, E. and Collins, A. E. (2010). Cyclone Disaster Vulnerability and Response Experiences in Coastal Bangladesh. *Disasters,* vol. 34, pp. 931-954
[108] Idem 104

lacking the necessary information to evacuate, instead remaining at home and facing serious risks.[109] Disaster preparedness requires decision-making and leadership yet in coastal Bangladesh, women are generally excluded from such roles[110]. Post-disaster situations also take their toll on women. Often, women find facilities for personal hygiene in shelters are inadequate, and with few alternatives are exposed to urinary tract diseases[111]; are sexually abused while looking for firewood or reconstruction materials; their nutrition status deteriorates as they eat less in order to offering more food to other household members and they lose, without the capacity to recover, the natural resources and livelihood assets they depend upon. For example, cyclone Sidr contaminated at least 6,000 ponds with saline water, on which families and particularly women relied for small vegetable farming and domestic water requirements.[112] In the aftermath of cyclones it has been found that families invest less in children's education, which contributes to perpetuating high poverty levels in years to come[113].

### 3.4.2. Women's Capacity and Resilience

According to a 2014 study by UN Women,[114] 63.7 per cent of women participate in income-generating activities in the coastal districts of Bangladesh. Their major sources of livelihood are poultry and livestock rearing and homestead gardening. The household survey conducted in Satkhira and Khulna in 2017 shows a clear change in the livelihood trajectories of women in these coastal districts over the past 20 years. The major changes relate to an increasing engagement of female household members in poultry rearing and trade, in day or wage crop cultivation and brick kilns and in clerical work. Female engagement in handicrafts, professional work and other livelihood sources has declined over the past 20 years, particularly in Khulna (see Figure 7 and Figure 8). Whilst these responses show that women strive to bring an income home, the UN Women study makes clear recommendations for training and capacity building for women to better adapt and build resilience to climate change. It suggests that women should have access to training for economic activities that are resistant to floods, droughts, and salinity resilient, as appropriate for the area. The study also suggests that women must maximize the diversification of their livelihood options to increase economic security and that they need increased training in financial skills to plan for crisis.

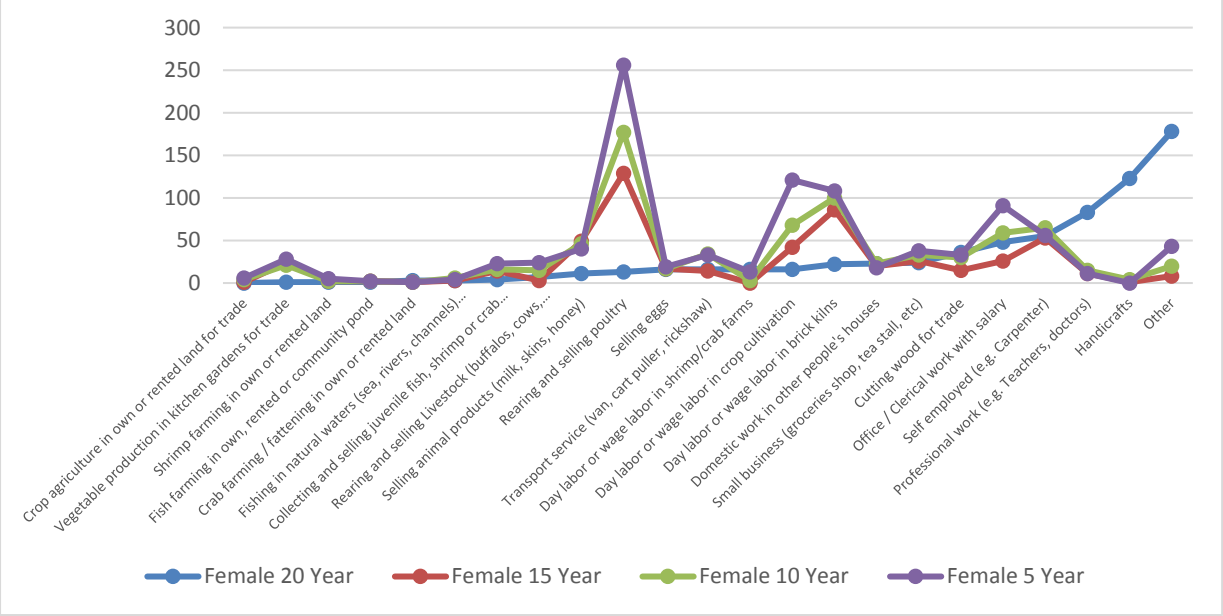


*Figure 7: Female Livelihood Trajectories in Khulna District*

[109] Idem 106
[110] Idem 105
[111] Idem 2
[112] Idem 104
[113] Mottaleb, K.A. et al. (2013). The Effects of Natural Disasters on Farm Household Income and Expenditures: A Study on Rice Farmers in Bangladesh. *Agricultural Systems* vol. 121 pp. 43–52
[114] Idem 104

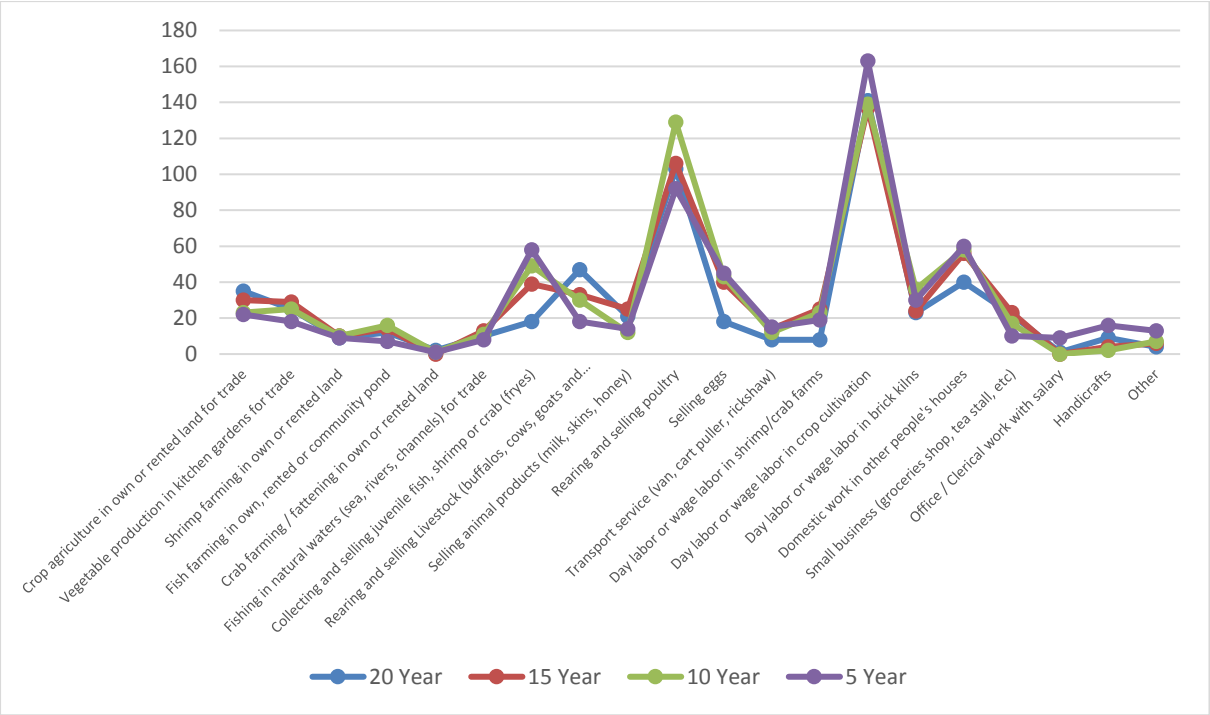


*Figure 8: Female Livelihood Trajectories in Satkhira District*

## 4. Past and On-going Efforts to Support Climate Change Resilient Livelihood Development, Best Practices and Lessons Learned

Increasing climate change related risks and substantial development challenges posed by the same, especially in the climate vulnerable areas including coastal Bangladesh, have created multidimensional development needs. In order to address these needs, different actors in Bangladesh have initiated programmes and projects to enhance the resilience of vulnerable households and women. The following Sections provides an overview of relevant past and on-going efforts to support climate change resilient livelihood development by: (i) the government (Section 4.1); (ii) the donor community (Section 4.2); and (iii) the private sector (Section 4.3). Subsequently, best practices and lessons learned are discussed in Section 4.4. The purpose of this review is to avoid any overlaps between the proposed interventions with on-going efforts and to ensure that the livelihood options recommended by this study are the most suitable for the specific context found on the south-western coast.

### 4.1. Government-led Programmes and Initiatives

There are a range of programmes and initiatives led by the Government of Bangladesh (GoB) which aim to promote and facilitate climate change resilient livelihood development in coastal zones of Bangladesh, particularly for women. Table 4 provides an overview of all major government-led projects, of which some of the more complex interventions are described below in more detail. More detailed information about these projects, as well as additional projects and programmes can be found in the Feasibility Study (Annex IIa) of the GCF proposal.

The GoB, within its fiscal role, has developed some framework plans and programmes addressing climate change adaptation. In 2008, and further amended in 2009, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was formulated and provides a guideline for adaptation interventions in the country.

The National Sustainable Development Strategy (NSDS), prepared with support from the United Nation Environment Programme (UNEP), identifies Environment, Natural Resource and Disaster Management as one of the Strategic Priority Areas and describes a wide variety of actions needed for ensuring sustainable production and consumption, as well as environmental sustainability.

According to the 6th Five-year Development Plan, the Government, with the support of development partners, has invested in:

- Flood management schemes
- Coastal embankment projects
- Cyclone shelter development projects
- Comprehensive disaster management projects
- Irrigation schemes
- Agricultural research programs
- Coastal 'greenbelt' projects

These investments in 'climate proofing' have produced major impacts on economic growth and poverty reduction. Over the last 10-15 years, the number of fatalities from natural disasters has declined, as the country's ability to manage risks, especially floods and cyclones, has improved and community-based systems have been put in place.

The seventh Five-year Plan (2016-2020) emphasizes the importance of appropriate policy and institutional capacity building for biodiversity conservation, forest ecosystem restoration, and climate resilient development at all levels of government.

The districts of Khulna and Satkhira were identified as being among the most vulnerable districts in Bangladesh to climate change. Thus, they became a key focus of the GoB's and development partners' interventions for addressing climate change impacts. This is reflected through the strong emphasis of government support programmes on the coastal belt as shown in Table 4. Many of the large-scale programmes from development partners (e.g. official development assistance, international climate finance or NGOs) in the south-western region are co-funded by the GoB.

*Table 4: Relevant Government Funded projects*

| Title | Implementing entity/ies | Budget | Duration | Target location | Key focus |
|---|---|---|---|---|---|
| Bangladesh Climate Change Resilience Fund (BCCRF)[115] | Ministry of Environment and Forests | USD146.9 million, out of which USD35.3 million is invested in CCA across the country | 2009 – on-going | All drought, flood and saline prone areas across the country | Agricultural adaptation in climate risk prone areas with the Department of Agriculture and Community Climate Change Project with the Palli Karma Shahayak Foundation |
| Bangladesh Climate Change Trust Fund (BCCTF)[116] | Ministry of Environment and Forests | Approx. USD400 million [117]<br>Cyclone recovery:<br>- 400,000,000 BDT – Khulna<br>- 1,707,000,000 BDT – Satkhira<br>Water infrastructure:<br>- 500,000,000 – Satkhira | 2009/10 – on-going | Coastal districts, including Khulna and Satkhira | Construction of embankments and river bank protective work, building cyclone resilient houses, excavation /re-excavation of canals, construction of water control infrastructures including regulators/sluice gates, waste management and drainage infrastructure, introduction and dissemination of stress tolerant crop varieties and seeds, afforestation and installation of solar panels. |
| Pilot Programme for Climate Resilience (PPCR)[118] | International Financial Cooperation and the Ministry of Environment and Forests | Investments from the PPCR in Bangladesh total USD109.4 million, with USD572 million in co-financing, for a total portfolio of USD681.4 million.[119] | 2015-2017 (pilot phase) | Rural coastal districts | Climate smart agriculture technology, coastal protection through climate proofing of coastal embankments and polders, rural infrastructure and greenbelt, water supply and sanitation, drainage and basic urban services, cyclone shelter, emergency access roads, boat landing, growth centre, improve coastal connectivity, climate resilient housing and livelihood improvement. |
| Community Based Adaptation to Climate Change | Ministry of Environment and Forests, Bangladesh Forest Research Institute, Department | USD8,550,389 | 2009-2015 | Four coastal districts - Borguna, Noakhali, Bhola and Chittagong | The project introduced diversified livelihood activities in forestry, agriculture, aquaculture and livestock-based adaptation measures. It also included a capacity building component for government officials, support at policy level and knowledge sharing within and outside Bangladesh. |

[115] Global Climate Change Alliance+ (2016) . The Bangladesh Climate Change Resilience Fund (BCCRF). Available online at: http://www.gcca.eu/national-programmes/asia/gcca-bangladesh-climate-change-resilience-fund-bccrf

[116] Bangladesh Climate Change Trust Fund (2016). Projects and Budget 2015-2016. Available online at, http://www.bcct.gov.bd/images/notice/k.pdf

[117] Idem 116

[118] Climate Investment Fund (2016). *Bangladesh PPCR 2016 Report*. Available online at: https://www-cif.climateinvestmentfunds.org/sites/default/files/meeting-documents/bangladesh_ppcr_2016_monitoring_report.pdf

[119] Idem 117

| | | | | | |
|---|---|---|---|---|---|
| through Coastal Afforestation | of Agricultural Extension, Ministry of Fisheries and Livestock, Ministry of Land | | | | |

### 4.2. Donor-led Programmes and Initiatives

As a developing country that is particularly vulnerable to climate change impacts and home to a large proportion of poor people, Bangladesh receives significant development assistance and support. Many large-scale programmes are co-funded by the GoB. Table 5 provides an overview of CSO/NGO funded projects of relevance to this proposed GCF project. More details on these projects, as well as additional projects of relevance, can be found in the Feasibility Study (Annex IIa) of the GCF proposal.

Non-government interventions represent an integral part of efforts to promote climate resilient development and capacity among coastal communities and local government institutions. The GoB often lacks the financial means and capacity to adequately address all needs or the rural society, in particular in south-western Bangladesh. It is difficult for the central government and sectoral agencies to reach the rural poor community and build their capacity to adapt to climate change events. Therefore, utilising the capacity of implementing organizations is an important strategy for facilitating community based adaptation.

The most active international NGOs working on resilient livelihood development and climate resilience in Bangladesh include: CARE, Action Aid, Oxfam, Practical Action, CARITAS, BRAC, and IUCN. CARE was one of the pioneers working in the field of climate change adaptation. Its Reducing Vulnerability to Climate Change (RVCC) project was a three-year action learning project carried out in communities in the south-western region (see Table 7). The approach involved promoting and testing strategies and technologies to reduce the vulnerability of the poorest to extreme weather events. These strategies evolved over the course of the project. The project contributed knowledge on a range of issues relevant to local adaptation, including: the uptake of salt tolerant rice varieties (in collaboration with the Bangladesh Rice Research Institute) and other crops and drought resistant crops; approaches to livestock rearing in the context of regular flooding; reduced health impacts of flooding through sanitary latrines; development of rainwater harvesting systems and other technologies for improved access to safe drinking water; and adaptations in housing construction to make it more resistant to storms (Ahmed 2008).

Action Aid Bangladesh has been integrating climate change adaptation into their disaster risk reduction programmes for several years. Their project “Building Community Resilience to Climate Change Adaptation and Disaster Risk Reduction” aims to carry out community-based action research on climate change adaptation and disaster risk reduction to support communities to better cope with climate and non-climate stressors.

Practical Action Bangladesh has also started integrating climate change adaptation issues into disaster management. A recently completed project “Mainstreaming Livelihood-centred Approaches to Disaster Management” focused on the roles and linkages between vulnerable communities, district and national level government institutions, and humanitarian agencies with regard to disaster preparedness and mitigation[120]. Furthermore, the Zurich funded V2R and V2R++ provides some good examples of the organization's interventions in climate change adaptation. Similarly, World Fish has supported coastal communities in south-western Bangladesh with two climate smart agriculture and aquaculture innovations, namely fish cages and pond polyculture, to increase their resilience to climate risks, as well as generate income, enhance nutrition and provide new livelihood opportunities. Both projects - the Cereal Systems Initiative for South Asia in Bangladesh (CSISA-BD) and Aquaculture for Income and Nutrition (AIN) - have targeted resource-poor and vulnerable households as recipients of smallholder aquaculture innovations and are making concerted efforts to involve women.

Besides international development organizations, there are some small projects which are addressing climate change issues in Bangladesh under the Coastal Development Partnership (CDP)[121], a coordinating secretariat for a network of NGOs trying to relieve the suffering of people living in waterlogged areas in the southwest coastal region of Bangladesh (see the projects without budget figures in Table 7).

In addition to these actions, Annex 2 provides an overview of additional local CSO/NGO-led interventions in the five targeted upazilas for which gender-disaggregated beneficiary numbers are available. The tables provide details of 17 interventions in Assasuni upazilas, 18 interventions in Shyamnagar upazilas, 21 interventions in Paikgacha upazilas, 12 interventions in Dacope upzaila and 10 interventions in Koyra upazilas.

[120] Practical Action (2009)
[121] Coastal Development Partnership. Climate Change, Environmental Justice & Conservation (Climate ECO). Available online at: http://www.cdpbd.org/index.php/programs/74-climate-change

*Table 5: Relevant CSO/NGO Funded Projects*

| Title | Implementing entity/ies | Budget | Duration | Target location | Key focus |
|---|---|---|---|---|---|
| Community Climate Change Project[122] | Palli Karma-Sahayak Foundation (PKSF), 41 partner NGOs in different districts | USD12.5 million | 2012 - 2016 | 15 districts and 37 upazilas, including Shyamnagar and Assasuni in Sathkira (activities addressing salinity and drought) and Dacope in Khulna | The objectives of the project were to enhance the capacity of selected communities to increase their resilience to the impacts of climate change. This was expected to be achieved through the establishment of an effective grant financing mechanism within PKSF to channel funds to non-governmental organizations. Major functions of the project were inclusive financial services; people centred holistic programme (ENRICH); farming and enterprise development; social protection; capacity building; advocacy and knowledge management and research and development. |
| Promoting Climate Resilient Agriculture and Food Security[123] | IFC, CIF, GoB | USD3 million | 2015 - 2017 (pilot phase); - on-going | Barguna, Potuakhali, Bhola, Pirojpur, Feni, Lakshimipur, Noakhali, Chittagong, Cox's Bazar, Bagerhat, Khulna and Satkhira | • Create result-based evidence on agricultural products and practices that are adapted to the changing agro-climatic conditions of the coastal zones, thereby ensuring food security and livelihoods for the most vulnerable.<br>• Approximately 75,000 farmers, including at least 5,000 women, will be introduced to climate-resilient technologies and trained in their adoption and use. |
| Reducing Vulnerability to Climate Change (RVCC) | CARE Bangladesh, 16 partner organisations (CIDA funded) | Not available | 2001 - 2006 | Southwest Bangladesh | Project objectives:<br>• Vulnerable households demonstrate improved capacity to innovate in their livelihood strategies, reducing vulnerability to climate change<br>• Communities demonstrate increased capacity to develop and implement community-level adaptation strategies<br>• Local partners demonstrate increased capacity to collect and disseminate information related to climate change, and to advocate with the government on climate change<br>• Project partners interact regularly with national-level climate change stakeholders on policy advocacy issues |
| Awareness Creation among the shrimp Farmers | World Fish Center | Southwest coastal region of Bangladesh. | 2006 | Southwest Bangladesh (part of the Coastal Development Partnership (CDP)) | Awareness creation among shrimp farmers on socially responsive and environmentally friendly shrimp culture. |

[122] Kader, M.F. (2015). *Presentation on Community Climate Change Project(CCCP) of PKSF*. Ministry of Finance, Indonesia and UNDP Bangkok Regional Hub. Available online at: https://www.climatefinance-developmenteffectiveness.org/sites/default/files/event/CFSDforum2015/workshop/Community%20Climate%20Change%20Project%20(CCCP)%20of%20PKSF-Mohammad%20Fazlul%20Kader.pdf

[123] Climate Investment Fund. Investment Project 1: Promoting Climate Resilient Agriculture and Food Security. Available online at: https://www.climateinvestmentfunds.org/projects/investment-project-1-promoting-climate-resilient-agriculture-and-food-security

| | | | | | |
|---|---|---|---|---|---|
| Save Sundarban: Ensuring Peoples' Livelihood through Rights to Natural Resources | Action Aid Bangladesh | Not available | Not available | Southwest Bangladesh (part of the Coastal Development Partnership (CDP)) | In 2001, the project conducted a holistic campaign at local, national and international levels for conserving biodiversity and safeguarding the culture and livelihood opportunities of poor people traditionally dependant on forest related occupations. |

### 4.3. Private Sector

Currently, there are limited number of traceable private sector investments in climate change adaption in Bangladesh. Some donor and government-led programmes have started to initiate public-private partnerships to overcome this gap. Under the Climate Resilient Agriculture and Food Security component of the PPCR[124] an agreement with one client (a private input company) has been finalized and the Training of Trainers (ToT) has been commenced. Furthermore, one private input company (Supreme Seeds) has signed an agreement to invest in reaching vulnerable polder areas in the south with the objective of promoting climate smart agriculture techniques. This project includes SMEs with supply chains extending to the south, as well as those offering products or services to vulnerable populations in the south. Under this project, two insurance products have been developed by Green Delta Insurance.

### 4.4. Best Practices and Lessons Learned

Over the centuries, climate variability and extreme weather events have caused damage to people's lives, assets, resources and livelihood practices, eventually leading people to devise coping strategies for survival. The coping mechanisms practised within the communities and their traditional knowledge base enable them to organize at the community level and manage disasters. Their knowledge regarding the management of their livelihoods in different climatic scenarios has been found to be substantial and many adaptation strategies have been practiced from the local to national levels across Bangladesh[125]. Alauddin and Rahman (2013)[126] discuss some infrastructural adaptation options practised in Bangladesh to mitigate risk such as flood shelters, cyclone shelters and embankments in flood and coastal areas, plinth raising of houses to protect them and homesteads from the risks of climatic disasters and tree plantations[127].

To address the livelihood adaptation needs in the target districts of Khulna and Satkhira, some climate change resilient livelihood practices that can be considered for the project have been identified. The most relevant amongst them are highlighted in the Sections below and have been organised into the following three categories: (i) agriculture adaptation practices; (ii) aquaculture adaptation practices; and (iii) other adaptation practices or relevance to resilient livelihoods.

#### 4.4.1. Agriculture Adaptation Practices

Agriculture is the dominant livelihood option across rural areas of Bangladesh, such as the southwestern coastline, and is the most vulnerable livelihood to increasing climate-induced impacts such as salinity intrusion, tidal surges and intensified cyclones[128]. Climate change and climate variability are affecting land use patterns, cropping systems, productivity and optimum agriculture output[129]. This adversely affects the livelihoods, economic activities and environments of these regions[130]. A variety adaptation responses enabling farmers to cope with these changes have been successfully tested and implemented in Bangladesh and around the world. Those considered relevant to the proposed GCF project (see Chapter 6) are discussed below.

**Rice varieties:** Successful adaptation practices in rice cultivation in regions with increasing salinization processes include the use of salt resilient rice varieties such as Bina dhan - 8, Binadhan - 10, BRRI dhan - 47, BRRI dhan - 55. These varieties are already cultivated by more than one million farmers in Bangladesh. Bina dhan - 8 and Bina dhan - 10 have been cultivated by farmers in Satkhira, Khulna and Bagerhat districts during the Boro season. These varieties have the salt tolerance capacity to survive up to 10-12ds/m. Farmers often use the BRRI dhan - 47 variety as it also requires less water and its tolerance to dry soil is quite high (Alam et al. 2013). BINA dhan - 8 varieties can tolerate salinity of EC8-10ds/m at mature stage and are cultivated by farmers in the south-

[124] Idem 118
[125] Idem 85
[126] Alauddin, S.M. and Rahman, K.F. (2013). Vulnerability to Climate Change and Adaptation Practices in Bangladesh. *J. SUB*, vol. 4, pp. 25–42
[127] Arfanuzzaman M., Mamnun N., Islam M.S., Dilshad T. and Syed M.A. (2016). *Evaluation of Adaptation Practices in the Agriculture Sector of Bangladesh: An Ecosystem Based Assessment*. Bangladesh Centre for Advanced Studies (BCAS). Available online at : http://www.mdpi.com/2225-1154/4/1/11/pdf
[128] Idem 85
[129] Government of the People's Republic of Bangladesh, Ministry of Environment and Forest (2009). *Bangladesh Climate Change Strategy and Action Plan 2009*. Ministry of Environment and Forest, Dhaka. Available online at: http://www.climatechangecell.org.bd/Documents/climate_change_strategy2009.pdf
[130] Idem 84

western regions[131]. Another variety used in the area is salt resistant Aman rice[132]. The existing uptake of these varieties by farmers in the south-western region demonstrates their potential for further promotion.

**Homestead gardening:** Homestead gardening is a widely accepted practice in Bangladesh and mainly managed by women. It ensures food security and additional income by enhancing livelihoods of poor people. Thus, homestead gardening is considered a good adaptation practice. Homestead gardening is well-adapted to low soil moisture and high temperature[133]. The selection of cultivated vegetables can be adapted to soil quality and environmental factors, for example tomatoes can be planted in saline areas due to their relative resilience (see Chapter 6). Other plants suitable in saline areas include salt tolerant sugarcane varieties ISWARDI-40, BINA sarisa-5 and BINA sarisa-6, sweet potato varieties like BARI SP-6 and BARI SP-7, BARI Mung-5 and 6, BARI Sweet Gourd-1 and 2, spinach, BARI Tomato-1, Knolkhol and beet. The climate change resilience of homestead gardening can further be advanced through introducing agriculture technologies such hydroponics.

**Vegetable cultivation in floating gardens/ hydroponics/ aqua-geoponics[134]:** These cultivation techniques are good instruments for farmers to cope with the future effects of climate change. The analysis of climate change adaptation practices in thirty agro-ecological zones of Bangladesh revealed that vegetables cultivated in floating beds can be utilised to cope with climate-induced inundations in south-western Bangladesh[135]. Furthermore, floating beds are already a common practice in Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokhathi districts where land remains submerged throughout most of the year. Farmers are raising seedlings and producing vegetables, spices and more than thirty crops[136] using this technique. Cultivated vegetables in floating beds include okra (lady's finger), cucumber, bitterguard, khol rabi, pumpkin, water gourd, turmeric, ginger, karalla, arum, tomato, turturi and potato[137,138] .

Other suitable adaptive technologies include aqua-geoponics and hydroponics. Hydroponics cultivation of vegetables has been fast and field visits of farmers in Khulna have confirmed that this technology is practical and advantageous over conventional methods of crop production. Due to short growing cycles the profitability potential is high and the design permits use where limited land is available. Aqua-geoponic technology has been shown to have comparable positive characteristics[139] and its potential to support simultaneous fish and vegetable cultivation represents an additional benefit.

**Sorjan system:** The sorjan cropping system is an intensive method of growing crops on alternately raised beds and deep sinks. Farmers and stakeholders in Kolapara region are practicing the sorjan system in saline tidal flooding areas through constructing embankments. Shallow depth sorjans are suitable for the year-round cultivation of vegetables and monsoon rice. The sorjan systems with higher depths also allow rice-fish or rice-duck farming along with year-round vegetable cultivation. The sorjan system is very popular among farmers in the coastal region of Patuakhali and it has been shown to have high market potential[140].

**Raised beds using mulching:** The use of mulching in combination with raised beds has been shown to serve as a suitable adaptation option in the coastal regions of Bangladesh where salinization poses an increasing threat

[131] Disaster and Climate Risk Management in Agriculture Project. (2011). *Climate Change of Bangladesh: Adaptation Solution in Vulnerable Areas*

[132] Karim, M. (1986). *Brachishwater aquaculture in Bangladesh: A Review.* Republic of Bangladesh, Ministry of Fisheries and Livestock Fisheries Research Institute, Dhaka, Bangladesh.

[133] Food and Agriculture Organization (2008). *Community Based Adaptation in Action, A case study from Bangladesh, Improved adaptive capacity to climate change for sustainable livelihoods in agriculture sectors*. Available online at: http://www.fao.org/3/a-i0481e.pdf

[134] Sutradhar, L.C. et al. (2015). A Review of Good Adaptation Practices on Climate Change in Bangladesh. *5 th International Conference on Water& Flood Management (ICWFM-2015).* Available online at: http://teacher.buet.ac.bd/akmsaifulislam/publication/76-ID_155_ICWFM-2015-607-614.pdf

[135] Oxfam International (2009). *Final Report on Climate Change Adaptation Practices in Thirty Agroecological Zones (AEZs) of Bangladesh*

[136] Agriculture Advisory Society (2012). *Annual activity Report*. Available online at: http://aas-bd.org/wp-content/uploads/2014/04/Annual-Activity-Report-2012.pdf

[137] Alauddin, S.M. and Rahman, K.F. (2013). Vulnerability to Climate Change and Adaptation Practice in Bangladesh. *Journal of SUB*, 4(2), 25-42.

[138] UNFCCC (2006). *Technologies for adaptation to climate change*. Available online at: http://unfccc.int/resource/docs/publications/tech_for_adaptation_06.pdf

[139] Reyaul Haq, A.H.M. (2016). *Innovation in Adaptive Livelihood in a Selected Coastal Sub-district in Bangladesh (Feasibility of the Adaptation Technology in Food Production)*

[140] Sattar, S.A. and Abedin, M.Z. (2012). *Option for coastal farmers of Bangladesh adapting to impacts of climate change*. International Conference of Environment, Agriculture and Food sciences (ICEAFS), Phuket, Thailand

to agriculture production[141]. Farmers are cultivating potatoes using straw mulch and zero tillage. Other crops that perform well in raised beds using mulching include watermelon, okra, and BARI Tamato-3[142,143].

**Two crop production cycles:** Two crop production cycles are also popular in the coastal region of Bangladesh where the cultivation of sunflower, chickpea and Khesari after a growing cycle of T. Aman rice supplements nutrition needs[144] . It is also a method that is practised and accepted among coastal farmers.

#### 4.4.2. Aquaculture Adaptation Practices

**Shrimp:** Communities and stakeholders of coastal, drought prone and hilly areas of Bangladesh have succeeded in applying risk reduction adaptation practices within the aquaculture sector. For example, undertaking shrimp farming in *ghers* (ponds) during the high salinity period (January-July) and freshwater carp farming during the low salinity period (August-December). Although the conversion of agricultural land (rice paddy) for shrimp farming is considered maladaptive as it exacerbates salinization of soil and leads to food insecurity, tidal flood planes that are periodically flooded with brackish water are more suitable for meeting growing aquaculture demands due to the increasingly saline conditions they provide.

**Crab fattening:** Crab fattening is increasingly accepted as a livelihood practice for many families in the southwest coastal districts of Shatkhira, Bagerhat and Khulna. Crab fattening became a prominent livelihood practice among coastal communities due to its resilience against tidal inundations, water logging and saline water, and thanks to the availability of feed, its profitability, low requirements for initial investments and high market demand in Dhaka and abroad[145]. This livelihood is also practised by farmers of the Chittagong region who culture in *gher* and fatten mud crabs (*Scylla scrrata*)[146].

**Crab nurseries:** Crab seedlings are currently caught in the wild from mangrove areas and estuaries, putting signifcant pressure on local ecosystems in Bangladesh by depleting wild stocks and impacting costal biodiversity. Furthermore, women and children tend to work in segments of the value chain, which are more flexible and insecure such as fry catching, and are subject to unsafe and insecure working conditions. As wild stocks of crab ry are depleted and the market demand for crabs grows, there is a strong need for crab hatcheries and nurseries in order for the the sector to grow. Realising this demand, the USAID funded Aquaculture Income and Nutrition project implemented in Khulna by World Fish has successfully produced crab seeds up to crablet size. The collaboration between BFRI, Marine Fisheries and Technology Station (MFTS) and WorldFish succeeded in producing hatchery crablets for the first time in Bangladesh. The proposed GCF project can build on this experience for the design of proposed livelihoods.

#### 4.4.3. Other Adaptation Practices of Importance for Resilient Livelihoods

Apart from the options related to agriculture and aquaculture, the literature review and assessments led tothe identification of other successful actions that have created the conditions required for the uptake of climate change resilient livelihoods, particularly by women.

**Women's economic empowerment through a private sector-led approach:** In the recent past (between 2007 and 2016) an initiative by the Local Agri-business Network project of Katalyst, funded by SDC, DFID and DANIDA, with technical support from government extension agencies, piloted the concept of public-private partnerships (PPPs) at the local level with the idea that it would encourage investment in rural areas. As this partnership model was owned by local level private sector actors, such as traders and local level government extension agencies, it created a strong sense of responsibility among these actors to ensure that the partnership achieved its goals. These goals were determined by the stakeholders of the partnerships before each agricultural season. Based on the possible challenges that a particular sector might face during the season, such as flood and drought related crop loss, the partnership took precautions to prevent these losses. Furthermore, these partnerships also worked closely with the traders to find ways of selling their goods on time so that minimal losses were

[141] Idem 134
[142] Idem 133
[143] Idem 137
[144] Miah, M. A. M., Rashid, M.A., Shiblee S.M.A. (2014). Assessments of Socioeconomic Impacts of Oilseed Research and Development in Bangladesh
[145] Alam, M., Ahammad, R., Nandy, P. and Rhaman, S. (2013). *Coastal Livelihood Adaptation in Changing Climate: Bangladesh Experience of NAPA Priority Project Implementation*. Springer Japan, DOI 10.1007/978-4-431-54249-0_14.
[146] Abdulla-Bin, S. B. M. (2013). *The potential of crab harvesting and fattening as sources of sustainable climate resilience for the coastal poor people*. Available online at: http://dspace.bau.edu.bd/jspui/handle/1/307

incurred. These small-scale micro PPPs in Bangladesh have shown that they are able to self-sustain beyond the project lifetime.

Evidence gathered from private sector development projects in Bangladesh indicates that such partnerships required minimal financial assistance from development partners and that the stakeholders' individual investment of their time and resources helped creating a sense of ownership. Hence, facilitating partnership formation at a local level can strengthen cooperation among stakeholders, increase their resilience against climate-induced impacts, and, consequently, increase the sustainability of project interventions.

**Community-based approaches and livelihood diversification:** Another approach that has proved successful when it comes to developing alternative, climate change resilient livelihoods is a focus on communities rather than on individual beneficiaries. The CIDA funded project Reducing Vulnerability to Climate Change (RVCC) (outlined above), as well as other projects in Bangladesh, successfully tested and implemented this approach and found that community level interventions enable the pooling of resources and skills to cope with stresses such as extreme weather events or market shocks.

Another insight that was gained in the RVCC project was that livelihood diversification increases the climate change resilience of households. Many households in rural Bangladesh already maintain a portfolio rather than focus on one livelihood. This provides them with different streams of income and options to make a living even if climate change impacts affect the profitability of one of those options, for example in the event that an inundation destroys a yield. However, it will be important to educate people about climate change impacts to facilitate them in their decision-making process regarding which livelihoods will be sustainable and favourable in a changing environment due to climate change.

**Access to finance, e.g. microfinance loan schemes:** Another component that can enhance the sustainability of investments in promoting alternative, including climate change resilient, livelihoods is secure access to finance for beneficiaries to sustain or expand their livelihoods. The project Access to Markets and Social Inclusion of Minorities funded by HEKS/EPER, is a good example of how improved access to finance enabled beneficiaries to operate profitably. The project focused on improving living conditions of Dalits and Adivasi (ethnic minorities) and selected beef and native chicken as two potential sub-sectors through employing a participatory value chain analysis method. The project did not provide any direct support to beneficiaries, but requested microfinance institutions (MFIs) and banks to provide loans to the target groups. Initial hesitation on the side of MFIs and banks to provide loans to people with no assets and similarly low confidence among beneficiaries to take out a loan to raise bulls and native chickens created certain barriers. These barriers were overcome through a successful pilot phase during which 10 to 20 beneficiaries received a loan from each partnering MFI. At the end of the production cycle these businesses became profitable for both beneficiaries and MFIs. Subsequently, this model was scaled-up with more MFIs and commercial banks (for example, Mutual Trust Bank and Rajshahi Krishi Unnayan Bank) crowding in and providing a total of BDT 83.845 million (USD1.05 million) through loans for 1,586 new market actors. Of them, 1,481 were beef producers, 10 were native chicken producers and 95 were other value chain actors such as service providers and traders. According to the final project evaluation, the average income of 2,800 producers (91.81 per cent women) increased by 103.12 per cent, representing an annual increase of 34.37 per cent[147].

One of the intervention's rationale was that value chain development for Dalit and Adibashi (D/A) would improve access to markets and enhance dia-praxis between D/A and mainstream society if the GoB remained committed to poverty reduction. Project monitoring showed that besides facilitating direct access to loans by beneficiaries, it was important to support value chain development in order to link the new livelihoods with other market actors. A study[148] found that after the project interventions, 90 per cent of Dalit and Adivashis beneficiaries had access to quality inputs, service providers and mainstream markets. The project successfully built the capacity of the beneficiaries to learn business skills, operate as independent actors in a value chain and access finance.

The project was also based on the understanding that building the capacity of HEKS development partners, service providers and producers would improve the productivity of D/A if development partners are aware of the high potential of the market development approach and designate existing staff to market development

[147] Practical Action (2016)
[148] Practical Action (2016)

activities. Thus, service providers were trained in market mapping, demand generation estimation and marketing and their capacities in these aspects were substantially increased.

### 4.5. Key Lessons Learned

Besides the best practices outlined above, some lessons can also be learned from coastal climate change adaptation programmes and other projects in comparable contexts. The main lessons identified as relevant for the proposed project are:

**1. Involve a range of stakeholders from different government departments to primary stakeholders (including marginalized groups) to create appropriate adaptation measures[149]:** Given the multitude of stakeholders, integrated communication and coordination will be key for successful implementation of adaptation projects. Identifying different needs and implementing them with multiple perspectives can help to identify barriers and mitigation options. The project should aim to address these potential risks by coordinating closely with on-going activities of the government, private sector, financing institutions, and other relevant stakeholders. Ensuring the participation of women, girls, youth, indigenous people, religious minorities, and persons with disabilities in planning and implementation is also fundamental**.**

**2. Ensure that there is on-going cooperation and consistent support between the stakeholders and the government:** Communication between stakeholders, the project team, sponsors and the wider society in Bangladesh. In the absence of an integrated coastal development strategy that incorporates climate risks, the current set of ad-hoc activities is unlikely to address emerging climate change impacts, including variability, problems coherently. There is a need to develop integrated market development strategies based on existing opportunities, an understanding of the level of climatic risks, and the political and economic feasibility of adaptation to climate change response options. This information will be indispensable for the government to utilize over coming decades.

**3. Involve district, upazilas, union authorities and local communities at all stages of project implementation:** Involving local residents in various stages of the project can be beneficial. Awareness-raising of projected impacts and potential solutions should be conducted in a participatory way through local media and other appropriate channels. The Participatory Market Systems Development[150] approach provides a suitable example in this regard.

**4. Identify risk management/ vulnerability and areas for synergies with other sectors during the initial stages of the project:** Identify complementarities and establish linkages with other programmes and sectors (such as market actors, private sector, banks, financing institutions). The project can further generate adaptation benefits by facilitating the integration of climate risk into existing poverty reduction and rural development strategies, especially in relation to coastal regions.

**5. Institutional capacity building:** Local level institutes need to be equipped with knowledge on climate change so that they can help local people to adapt to changes. Markets and livelihood related local level institutes and the private sector have technical people and are capable of incorporating climate change into their design provided higher level decision-making and funds are available. It is also important that changes in infrastructure design incorporate local level data and information on climate change impacts on different infrastructures. Awareness raising and targeted capacity building for different groups is necessary to promote rural development and livelihoods of the local community. Incorporation of climate change issues into sectoral policies and institutional mandates for awareness raising at senior levels (decision-makers) is equally important.

In addition to these major lessons, which translate into project design recommendations, Table 6 provides an overview of further insights gained and captured through this study. The key lessons and their adaptation potential stem from climate change adaptation interventions implemented in comparable geographic contexts within Bangladesh and across the globe.

*Table 6: Key Lessons Learned and Adaptation Potential Overview*

[149] Adaption Learning Mechanism. Available online at: www.adaptationlearning.net

[150] Practical Action. *The PMSD Roadmap Facilitating Market Systems*. Available online at: http://www.pmsdroadmap.org/uploads/2/2/6/3/22638306/pmsd_flyer_final_version_updated_sep13_opt.pdf

| Key Lessons | Adaptation Potential |
|---|---|
| Ecosystem-based adaptation and community-based adaptation overlap and inform each other[151] | There is significant overlap between ecosystem-based adaptation and community-based adaptation. Both approaches aim to reduce exposure and sensitivity of ecosystems and communities, while increasing their capacity to adapt to climate changes. |
| Adaptation can be integrated into existing development and conservation activities. | Confronting the impacts of climate change is most successful when it is not considered a separate and completely new challenge, but rather incorporated into existing development and conservation activities in order to be effective and sustainable in the long term. For example, adaptation efforts should support the conservation of natural capital, which builds resilience, for example by maintaining mangrove habitats and aquatic biodiversity. |
| Similar types of systemic barriers and challenges exist | Communities experience a range of climate change-related barriers and challenges, including: • A lack of knowledge and understanding of key issues, for example climate change and its impacts, long-term effects of unsustainable practices and habitat destruction • A lack of technical expertise to assess problems and develop solutions • Unwillingness or inability to change behaviours • Low levels of education and literacy • Language and cultural barriers • Political barriers, for example land use conflicts or lack of regulations, disinterest or corruption among community leaders, lack of participatory and democratic processes in decision-making. |
| Methods to overcome systemic barriers are widespread and replicable | Many of the strategies designed and implemented by organizations and communities to overcome these barriers can be replicated in other locations. The underlying principles and techniques employed to overcome systemic barriers are already in use around the world. |
| Education, capacity building and training facilitate the success of adaptation | To improve knowledge, understanding and technical expertise, many communities have incorporated education and training components into their adaptation efforts. Focusing on building capacity as an integral part of any adaptation strategy can help other communities to bridge knowledge gaps, enhance technical skills and ensure the long-term resource management and behaviour change that are essential to successful locally-driven adaptation. |
| Showcasing results and cultivating local leaders can foster continued behaviour change | Facilitating behavioural change can be difficult for many communities, regardless of the issue being addressed. Some organizations find that building trust and encouraging the changing of behaviour can be accomplished by empowering community leaders to help communicate ideas and advocate for change. Local leaders also play a key role in sustaining the behaviour over the long term. In addition, solutions that have visible results can help community members see the benefits of behavioural change. |
| Including political leaders and government agencies enhances stakeholder engagement | Stakeholder involvement is essential in the development, implementation and evaluation of adaptation solutions. Empowering and engaging a diverse set of stakeholders can help to overcome language, cultural, political and financial barriers. |
| Seeking long-term financial and technical support from international donors, non-profit organizations, the private sector and other financing institutions while also engaging community members, is often the key to success. | To address financial and technical challenges, communities often partner with local, regional and national government agencies, non-profit organizations, international donors, and academic institutions. For projects initiated by an international non-profit organization, success can often be attributed to the establishment of partnerships with local institutions, respecting local cultures and knowledge, developing educational materials in local languages and using participatory approaches to foster local ownership and leadership are key in this regard. |
| Effective solutions often entail coordinated action at several levels | Low-cost, no-regret adaptation measures (activities that yield benefits even in the absence of climate change) can be taken up even if a community lacks access to high-quality climate change projections. There are barriers and climate change impacts that cannot be addressed at the local level alone, however, such as national legal barriers to implementing a solution. In such cases, effective solutions require coordinated action from all relevant levels—local, regional, national and global. |

[151] Solution Search (2014). *Solution Search: Adapting to a Changing Climate*. Available online at: http://solutionsearch.org/contest/adaptingchanging-climate

| | |
|---|---|
| Market-driven solutions demonstrate good potential to increase community resilience | The livelihood of the community depends on the extent to which it is linked to markets and considered a regular economic activity rather than a subsistence activity. This, in turn, encourages community members to build further resilience and to gradually drive themselves out of poverty. |

## 5. Gaps and Constraints Analysis to Initiate Livelihood Changes

This Chapter provides insights into gaps in coverage of current and planned livelihood interventions (outlined above) to identify how the proposed GCF project can provide non-duplicative support to coastal communities, and women, to adapt to climate change. The Chapter also describes potential constraints that could hinder successful implementation of proposed interventions. These insights will be considered in the design process of the project to ensure that context-specific circumstances are taken into account and to reduce potential threats to the sustainability of the interventions. The information provided is based on consultations with the target population and other stakeholders, as well as a livelihood trajectory analysis and the literature review. In addition, existing projects, programmes and interventions in the target districts were identified and the analysis also draws on operational experiences and lessons learned.

### 5.1. Gaps in Coverage and Scope

The screening of existing projects and programmes that support women to take up alternative, climate change resilient livelihoods in south-western Bangladesh, showed that most projects either do not primarily focus on women's livelihood needs, or they do not consider climate change impacts in project design. The latter can seriously undermine any development progress and project achievements, considering the severe impacts of climate change, especially salinity, on coastal communities, the effects of which are already being felt by communities. Existing projects that consider climate change and livelihood support in conjunction do not geographically overlap with the proposed GCF intervention, or can be considered complementary. Some of the existing relevant projects are outlined below:

**Financial mechanisms for risk management and climate change adaptation:** Information collected from the project areas shows that about 20 NGO/INGOs are actively involved in implementation of development projects on micro-finance, health and nutrition and family planning, education, governance, *Khashland* management, bio-gas, improved cooking stoves, disaster risk reduction and livelihoods. The direct beneficiaries of these projects is estimated to be 0.4 million, an additional 2.5 million people being covered indirectly. More than fifty per cent of the direct beneficiaries of these projects are women. Details have been included in the previous Section.

The study found that the funds administered by national NGOs were principally destined for micro-credit, with a negligible portion allocated to other priorities. NGO-led microfinance programmes rarely matched with the needs of the poor to appropriately adapt to climate change. As such, extremely poor people's access to NGO finance is limited, although some NGOs have been able to adapt their micro-finance programme to manage risk and support climate change resilient livelihood activities.

**Market linkage initiative:** One of the key gaps found in the review of existing programs is the lack of market linkage initiatives for establishing climate change resilient value chains. Existing livelihood development activities mostly focus on subsistence purposes or the producers, rather than developing adequate climate resilient value chains and market linkages. Additionally, it was found that women's involvement in potentially climate change resilient value chains is extremely low, women currently lack relevant skills and face multiple socio-cultural barriers.

**Government and development partnership:** Consultations with local stakeholders revealed that climate change and cyclone impacts in the target areas led to significant losses and reduced agricultural productivity. Traditional livelihood options and limited coverage by GoB/NGO initiatives are not able to meet food security needs of the poorest people. Currently, collaboration or integrated initiatives between the GoB and NGOs is limited.

**Private sector engagement:** In general, the private sector has been absent in climate change adaptation initiatives, mostly because these actors do not appear to understand the potential economic benefits for their operations. Business opportunities are not actively communicated to the private sector to attract their investments in adaptation.

**Gender mainstreaming and participation:** Women are among the most vulnerable in the face of climate change and disaster events, being more dependent than men on natural resources threatened by climate change for their livelihoods, with the responsibility to secure water, food and fuel for cooking and heating for their households. It has also been shown that women in Bangladesh face social, economic and political barriers that limit their coping capacity, including unequal access to resources, limited access to information and skills, as well as cultural restrictions that limit their mobility[152]. In Bangladesh, women's participation in planning and decision-making on climate protection is still very low and existing projects and government interventions have failed to significantly increase the representation of women in decision-making processes that influence local level livelihood planning. It is therefore essential to address this gap by integrating women and other marginalized groups into community planning processes.

**Capacity building and institutional development:** Adapting livelihoods to climate change requires significant support in terms of building the technical capacities of people and local institutions for: i) improved adaptation to climate variability and change at all relevant levels, addressing climate information needs, knowledge gaps, key skills and competencies and technology needs, and (ii) implementation of climate change resilient activities in a participatory manner. Existing projects do not adequately train local-level decision-makers on climate change risks and adaptation strategies.

### 5.2. Constraints to Promoting a Shift to Climate Change Resilient Livelihoods

#### 5.2.1. Constraint 1: Limited ability and available information among coastal communities and women to make climate-risk informed livelihood decisions

A large share of the livelihoods practised by extremely poor people in coastal areas of Bangladesh already is, or will be, heavily impacted by increasing salinization of soil and freshwater bodies. This diminishes the potential profitability or feasibility of their current income opportunities. Many of the recent livelihood changes (within the last 5-10 years), such as shifting to shrimp farming (which leads to further salinization of surrounding areas due to the release of highly saline water after each growing cycle) or cultivating highly freshwater dependent watermelons, have been maladaptive and have exacerbated vulnerability. This indicates that there is a limited awareness of climate change impacts among local households, particularly women, and low capacity for incorporating climate change risks in strategic livelihood choices. Capacity building is therefore urgently needed in order for women and their families to understand the extent and type of climate change related threats to their livelihoods and how they can be managed.

#### 5.2.2. Constraint 2: Limited access and understanding of climate compatible technology and techniques of coastal communities to shift towards climate change resilient livelihoods

Closely linked to the lack of awareness, the capacity to start adopting more climate change resilient livelihoods through switching to advanced agricultural practices (for example, by adopting saline tolerant crop varieties or adjusting cropping patterns), and technologies (such as drip irrigation, hydroponics and aqua-geoponics) is also extremely limited. This is mostly due to a lack of skills and knowledge about appropriate practices and technologies and changing conditions. Although there have been some initial shifts by farmers towards climate change resilient livelihoods (for example, some are cultivating salt resilient vegetables), overall knowledge regarding innovative and new techniques is limited, in particular among women. Exposing women to these innovative approaches and technical solutions can enable them to take strategic action. Also, access to and training on how to use climate and soil salinity data, information about optimal cropping patterns, and crop model sensitivity and uncertainty, can also increase the technical capacity of coastal communities to manage climate risk. There is currently also limited access to certain agricultural and fishery-related technologies and inputs (such as salt resilient seeds) at affordable prices, meaning they are often beyond the reach of poor and extremely poor households. Building understanding of technologies and cultivation practices and providing some initial inputs has the potential to create market demand for adaptive farming and fisheries technologies which, in turn, can increase the availability of these solutions in southwest Bangladesh.

[152] United Nations (2009). *World Survey on the Role of Women in Development: Women's Control over Economic Resources and Access to Financial Resources, including Microfinance*. Available online at: http://www.un.org/womenwatch/daw/public/WorldSurvey2009.pdf

#### 5.2.3. Constraint 3: Constrained access to climate-resilient value chains and agricultural markets, and limited available value-addition activities for alternative, climate change resilient livelihoods

Many households that depend on agricultural activities lack the skills to incubate, manage and grow their businesses and leverage market linkages. This is particularly true for women, who in addition to lacking necessary skills, face considerable social constraints in equitably accessing markets. Climate-resilient agricultural production demonstrates strong potential to provide opportunities for enhanced incomes. However, there is a clear need for business skill development to ensure the sustainable operation of new livelihoods, and avoid a shift back to traditional practices after the project comes to an end. In particular, extremely poor and poor households have limited access and capacity for commercial production and participation in local markets. Most of the households are homestead level producers, selling only a small part of their produce to petty traders who visit them. This lack of link to buyers, as well as a lack of knowledge regarding market prices, negotiation skills or alternative incomes, means that producers receive extremely low prices for their products. During field research, relatively few farmers identified themselves as commercial producers.

Proximity to markets, limited competition between upscale market actors and traders or new technologies, and low quality of available products are additional constraints expressed by local communities. This undermines the functionality of markets and reduces innovation potential. This can also translate into path-dependency on non-sustainable practices. For example, there is limited availability of saline resilient crops, as well as crab and brackish water fish seedlings due to over-extraction and depletion of wild stocks; a highly destructive practice that presents clear limitations in terms of scalability and brings about negative environmental impacts that reduce the wild stocks on which many extremely poor people depend for their nutrition. While some fish and crab hatcheries and nurseries do exist, supply to all project upazilas is limited due to low market incentives. Increasing demand for seedlings and reducing investment barriers could attract investments, thereby improving value chains and promoting competitive prices for non-natural seedlings.

Thus, there is a need to create new value chains for climate change resilient livelihoods and to upgrade existing value chains to cater for new demand for inputs and outputs related to climate change resilient livelihoods.

#### 5.2.4. Constraint 4: Limited access to additional finance to shift towards climate change resilient livelihoods (micro-finance, BRDB, banks)

The poverty rate of coastal communities in the southwest of Bangladesh is high. Repeated climate change-driven saltwater inundations and cyclones can lead to significant crop and asset losses among the mostly agricultural-based households. This further marginalises the poor and leaves them with limited financial means to start or recover climate change resilient livelihoods. The majority of existing governmental support programmes, particularly those which target women, do not incorporate increasing climate risk into their design and this undermines their effectiveness to enable the poor to deal with increasing climate change impacts. Similarly, financial institutions operating in the project areas are not aware of climate change impacts and exclude them in the design of their loan products and services. In the project area, farmers borrow money through both informal (relatives, friends, money lenders) and formal loans (for example, from the Bangladesh Rural Development Board (BRDB) or NGOs). This loan type is available for agriculture production and to diversify agriculture. The amount loaned by the BRDB is generally BDT 10–35 thousand with an annual service charge of 11 percent. The return period is 12 months with weekly re-payments. The annual interest rate of the BRDB loan (i.e. service charge) is one of the lowest currently available on the market, thus providing a 'best-case' scenario, yet landless or marginal farmers do not have easy access to this loan because of membership criteria that the targeted beneficiaries cannot meet due to their low socio-economic status.

#### 5.2.5. Constraint 5: Limited understanding among coastal communities of local financial institutions

In addition to the limited access to additional finance outlined above, limited awareness of many households about low-interest loans is another constraint to access, particularly for women. In some instances, families are also denied access to low interest loan programmes due to outstanding loans hence they end up taking out high interest loans in moments of extreme need, such as after climate-induced cyclone or for sudden medical needs. This often traps them in a cycle of debt. Adequate climate risk-informed business skill development, including knowledge transfer on how to access sensible financial services, can enable coastal households to take up technological adaptation.

#### 5.2.6. Constraint 6: Limited institutional capacities to plan, foster and facilitate climate resilient livelihood development

Despite some progress in climate change training for GoB institutions, overall capacity to mainstream climate change risks into livelihood planning processes is weak. Relevant government bodies include the Ministry of Women and Child Affairs (MoWCA), the Department of Agricultural Extension (DAE) and the Fisheries Department. Discussions with these institutions at project area level reveals that they understand various challenges like crop failure, low yield and saline intrusion and their vague linkages to climate change, however limited human and technical capacity prevents them from using this knowledge to support people in their constituency to shift to climate change resilient livelihoods. Furthermore, the public extension services of the ministries are not actively operating in most of the project areas. Thus, farmers, especially women farmers, are not getting the information they require about treating saline soil for vegetable cultivation and using proper cultivation techniques to ensure high productivity. This results in farmers being unable to produce vegetables or producing poor quality vegetables which constraints their profit. There is a need for training of government officials to fully understand complex interrelations between climate change impacts and their agendas, and to enable them to utilise this knowledge to support local people.

#### 5.2.7. Constraint 7: Weak vertical and horizontal coordination and knowledge management between government institutions on climate risk management

Limited coordination between government entities is another constraint reducing effectiveness, particularly of cross-sectoral climate resilience building interventions. Climate risk reduction of coastal communities is a complex process demanding a systemic approach and multidisciplinary expertise. Achieving community and household level acceptance towards empowering women to pursue new livelihoods and operate community level interventions is best facilitated through comprehensive support programmes led by government institutions with various mandates and operating at different levels. Individual interventions implemented by one entity, such as the MoWCA, without proper coordination with other ministries and government entities will constrain available knowledge and capacity, such as information on agricultural technologies or supporting local backing of women-led initiatives. This can lead to planning failures and short-lived support without resulting in transformational changes that actually improve climate resiliency through the up-take of adequate livelihoods by coastal people.

## 6. Analysis of Baseline and Potential Climate Change Resilient Livelihood Options

This Chapter investigates current livelihoods in coastal communities or comparable settings and identifies - through a two-staged screening process - alternative, climate change resilient livelihoods suitable for women in southwest Bangladesh that will be proposed for the GCF project. This options analysis builds upon knowledge gained from community level assessments (household surveys, GIS mapping, PRAs, FGDs, market and value chain analyses and stakeholder consultations – see Stakeholder Engagement Plan in Annex XIIId of the GCF proposal) and the findings on proven best practices in comparable settings (see Chapter 4).

A total of 38 livelihoods were identified that were either being practised in the potential project region or showed some potential as climate change resilient livelihoods. First, these 38 livelihoods were screened in order to assess their climate change resilience potential, in particular related to salinity and cyclone resilience and freshwater dependency (see Table 8). A second screening of these options was subsequently undertaken in order to consider the following factors (see Table 9): (i) profitability and market potential/value chain access; (ii) gender responsiveness and transformation potential; (iii) socio-economic considerations and community acceptance; and (iv) environmental impacts.

- Following this options analysis, this Chapter provides profiles of the livelihoods that were identified as being suitable for the proposed project (see Chapter 10). In addition to these livelihood profiles, the Chapter provides a brief description of proposed value chain upgrading facilities (including crab hatchery and crab feed processing enterprises). Demand for these facilities, which would enable the proposed climate change resilient livelihoods to be started at the project scale without causing major environmental and social impacts, was identified through the market and value chain analysis (see sample union profiles in Annex 3 to 7 in this report and Annex IId of the GCF proposal package, and Sections 6.4.1 and 6.4.2 on value chain analysis).

In Khulna and Satkhira the majority of people have historically been involved in small-scale farming activities. Due to both climate and non-climatic drivers (see Chapters 2 and 3) soil fertility has reduced significantly over time leading to a shift towards the aquaculture sector (mainly shrimp farming). Figure 10 shows the tremendous land use changes which have occurred in the target districts between 1995, 2005, and 2015. This transformation of land use and related livelihoods is due both to external factors - such as market demand for shrimp and higher revenues than from traditional agriculture - and is also related to increasing soil salinity levels, particularly after cyclone-induced inundations during cyclone Sidr in 2007 and cyclone Aila in 2009.

The Government of Bangladesh, with international support, tried to proactively protect coastal areas from tidal waves and saline water intrusion through the construction of embankments. However, waterlogging due to poor drainage within the embankments reduced traditional rice production and created a favourable environment for shrimp farming in polders. With salinity reducing rice yields and better economic perspectives brought by shrimp production, coastal farmers and large enterprises have converted agricultural land, mostly rice paddies, into shrimp farms in an unplanned and dangerous way, using saline water carried by canals and rivers from the Bay of Bengal.[153] The shrimp farming industry has grown at a rate of 20 to 30% since the 1990s and currently Bangladesh is responsible for around 2.5% of global shrimp production; Khulna and Satkhira are amongst the leading shrimp producing districts in the country[154]. However, shrimp farming is unsustainable from an ecosystem and livelihoods perspective and has augmented inequalities in land ownership and social exclusion, with smallholdings declining as large and very large shrimp farmers have acquired more land[155]. Although shrimp farming offers some seasonal income to poor landless people in the area, via activities such as fry collection, weeding out and de-heading, the negative effects it has on coastal livelihoods are manifested in many ways. Through saline water percolation, shrimp farming affects adjacent agricultural lands and natural vegetation[156]; its expansion has increased deforestation (e.g. of mangroves) and reduced grazing grounds and the forest resources local communities depended upon; the use of wetlands in the industry has blocked fish migration areas, destroying natural fish feeding and breeding grounds and ultimately declining fish stocks. With reduced grazing grounds, ownership of cattle and goats has declined and people have shifted to rearing chickens and ducks[157]. Shrimp farming expansion has also been detrimental in terms of health and nutrition as fresh groundwater sources become salinized, triggering salinity-related disease and burdening poor communities and women since they are responsible for collecting freshwater from increasingly distant sources. In addition, increasing skin disease has been related to the collection of fries, which requires women to spend multiple hours per day in the water. With increasing salinity levels and livelihood losses, rural people are migrating to the cities in search of job opportunities[158].

The detrimental effects of shrimp farming on traditional livelihoods exacerbate the impacts of climate change on coastal populations. With few alternatives to diversify their income, most poor coastal communities are still dependent on small-scale crop cultivation and fishing and are frequently unemployed due to tidal flooding and other natural disasters, resulting in food insecurity[159]. Women in particular are being increasingly marginalized due to these climate-induced land conversion trends, for example their participation in agriculture significantly decreased between 2001 and 2011 in Khulna and Satkhira (see Figure 11).

[153] Rahman et al. (2013). Shrimp Cultivation with Water Salinity in Bangladesh: The Implications of an Ecological Model. *Universal Journal of Public Health* 1: 131-142. Available online at: http://www.hrpub.org/download/201310/ujph.2013.010313.pdf
[154] Idem 152
[155] Idem 152
[156] Islam, M.S. et al. (2002). Socioeconomic and Environmental Impacts of Alternate Shrimp-Crop Farming in Bangladesh. *Bangladesh Journal of Agricultural Economics* 1: 63-76. Available online at: http://ageconsearch.umn.edu/bitstream/201462/2/Resear_01%20Vol-XXV_1.pdf
[157] Idem 152
[158] Idem 152
[159] Miah, M. M. U. (2010). *Assessing long-term impacts and vulnerabilities on crop production due to climate change in the coastal areas of Bangladesh*. Final Report PR #10/08. Available online at: http://fpmu.gov.bd/agridrupal/sites/default/files/Muslem_Uddin_Miah-PR10-08.pdf

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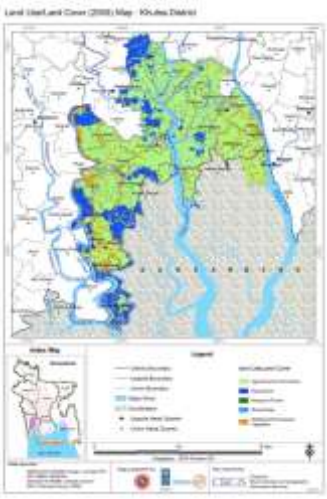
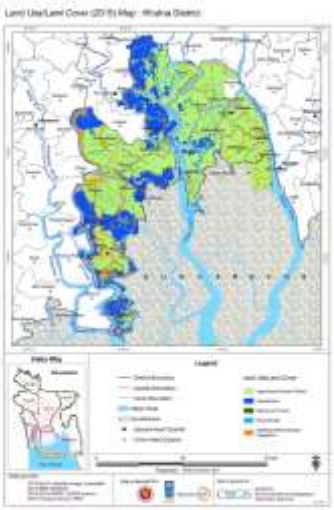
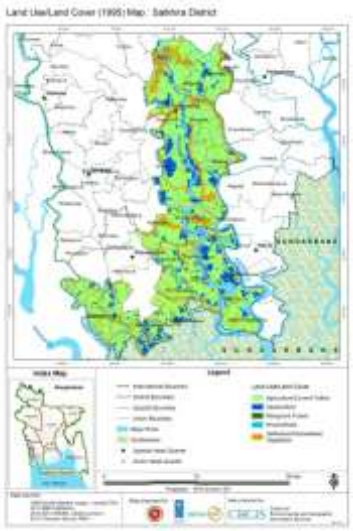
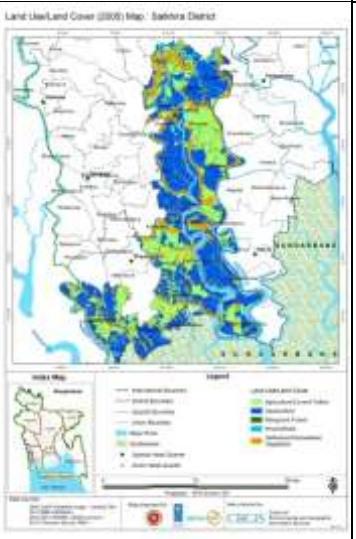
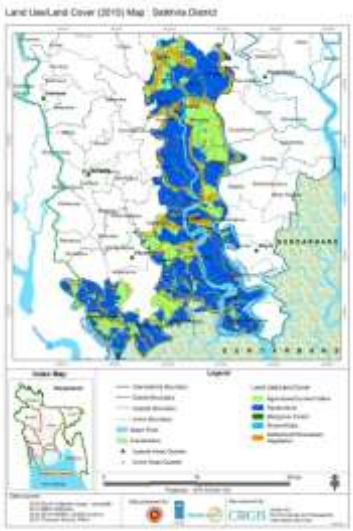
|  |  |  |
| District: Khulna<br>Land use cover map in 1995 | District: Khulna<br>Land use cover map in 2005 | District: Khulna<br>Land use cover map in 2015 |
|  |  |  |
| District: Satkhira<br>Land use cover map in 1995 | District: Satkhira<br>Land use cover map in 2005 | District: Satkhira<br>Land use cover map in 2015 |

*Figure 9: Land Use Changes in Khulna and Satkhira Between 1995 and 2015*

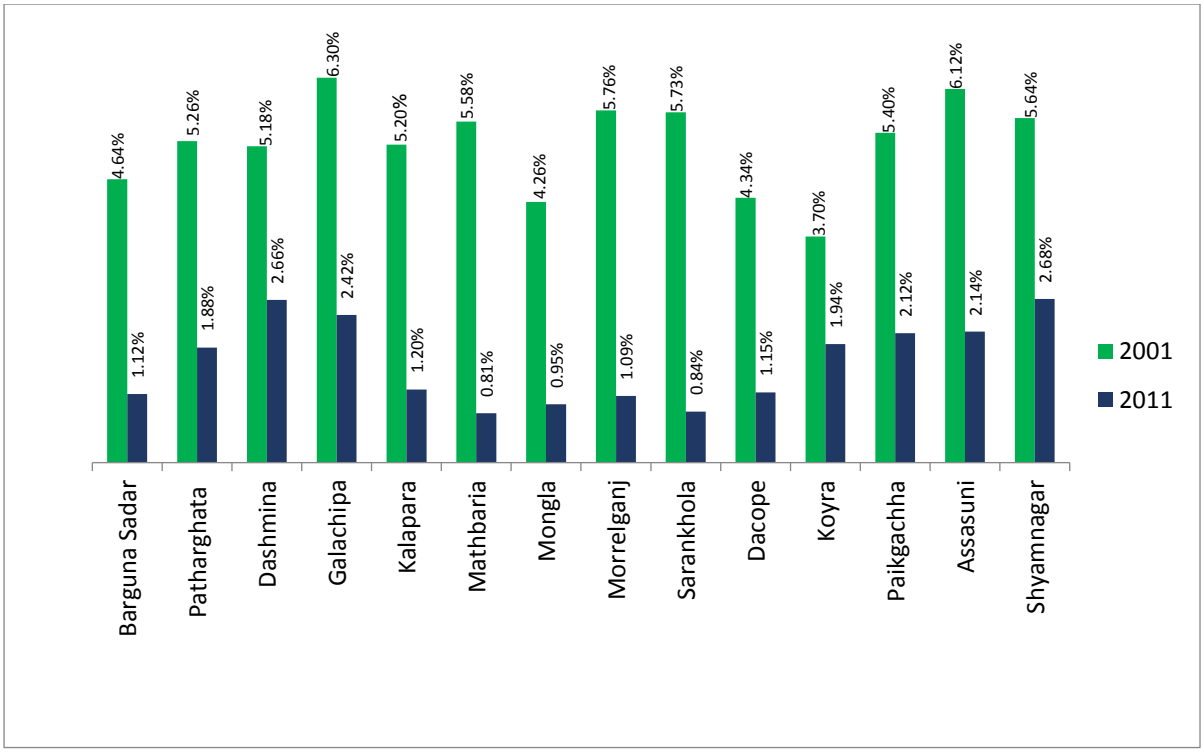



*Figure 10: Decrease in Participation of Female Population in Agriculture Between 2001 and 2011*[160]

Local perceptions captured in a survey conducted by Kabir et al. (2016) in two coastal districts (one of them Khulna) illustrate the challenges traditional coastal livelihoods in Bangladesh have experienced in recent years. The interviewed communities informed that storms, cyclones and flooding have affected their areas more

[160] Idem 8

frequently over the last decade than ever before in their living memory[161]. They struggle to reconstruct the quality of life they enjoyed before cyclones Sidr and Aila struck their area, damaging protective barriers and inundating their agricultural lands with saline water the rendering the majority unsuitable for crop production. High salinity also prevents cattle from accessing sufficient food and the animals become too weak to plough the hard soils. Consequently, poor people who used to cultivate crops and graze their cattle on the open space of shoals have been forced to change their cultivation patterns or to abandon the land they cultivated before. With the influx of saline water brought by cyclones and tidal flooding, sweet water fish died and water hyacinth and crops rot. During the surveys, the local population also reflected on how high salinity, tidal flooding and cyclones have affected other livelihood sources including casual labour (mostly provided by the agricultural sector, for example during harvesting and weeding), fishing, hunting and crafting[162]. Sidr and Aila wrecked fishing boats, which poor locals have not been able to purchase again. The families who lost everything (livestock, fishing gear, agricultural land, housing, etc.) during cyclones used the financial assistance available to them to re-establish their houses and meet their daily needs. However, these were already poor families, dependent on fishing and small-scale farming before Aila and Sidr. They have worked hard for years after these events and have not yet managed to recover from the brutal losses they suffered. Some of the families tried to take out loans from local NGOs but failed to make the repayments, simply because with recurrent disasters growing crops to sell has become extremely difficult. Not meeting their financial commitments, as reported in the survey, can trap them in a cycle of debt where one loan is obtained to pay off another.

The results of a survey conducted in 353 households in the districts of Khulna and Satkhira in early 2017 show that climate variability, cyclones and salinization of soil and water affected their livelihood options over the past 15 years.

### 6.1. Options Analysis of Potential Alternative, Climate Change Resilient Livelihoods

A comprehensive assessment has been conducted to establish a baseline to identify the current livelihoods of the target communities. The development of the list of existing livelihood options considers the commercial activities and resources of the target beneficiaries and the wider community. From a literature review of livelihood studies conducted in the target region of south-western coastal Bangladesh and in geographical locations with similar characteristics, a list of existing livelihood options has been derived. This list has been further validated through FGDs, household surveys, GIS mapping of livelihood option, and PRA exercises. The preliminary list has been divided into the following four categories:

A. Agriculture based livelihoods
B. Aquaculture based livelihoods
C. Livestock based livelihoods
D. Others

[161] Kabir, R. et al. (2016). Climate Change Impact: The Experience of the Coastal Areas of Bangladesh Affected by Cyclones Sidr and Aila. *Journal of Environmental and Public Health* Volume 2016: 1-9. Available online at: https://www.hindawi.com/journals/jeph/2016/9654753/

[162] Idem 161

*Table 7: List of Existing and Potential Livelihood Options*

| List of Existing Livelihood Options in Project Area | | | | |
|---|---|---|---|---|
| **Agriculture based livelihoods** | **Aquaculture based livelihoods** | **Livestock based livelihoods** | **Others** | |
| -> Rice/ paddy cultivation<br>-> Fruit cultivation (e.g. sofeda/ sapota, tamarind, pomegranate, apple, boroi/ jujube)<br>-> Watermelon<br>-> Tree nursery (mangrove, fruit, timber)<br>-> Homestead vegetable production in kitchen gardens for subsistence<br>-> Maize cultivation<br>-> Sesame/ linseed cultivation | -> Fishing in natural waters (sea, rivers, channels) for trade<br>-> Shrimp farming in own, rented or community pond<br>-> Crab farming/ fattening in own or rented land<br>-> Brackish water fish cultivation (Tilapia, Pharsha, Khorkuno-bata, vetki, vangan, paira, cat fish, and other saline tolerant common carp)<br>-> Fingerling catching from river/sea<br>-> Crablet catching from river and Sundarbans<br>-> Fish trading and retailing<br>-> Crab trading and retailing | -> Native chicken rearing and selling<br>-> Poultry farm (broiler and Sonali)<br>-> Duck rearing<br>-> Selling eggs<br>-> Sheep and goat rearing<br>-> Cow/ buffalo rearing and selling<br>-> Beef fattening<br>-> Small dairy farm<br>-> Selling animal products (milk, skins, honey) | -> Handicrafts<br>-> Small business (groceries shop, tea stall, etc.)<br>-> Water purification and vending<br>-> Tailoring<br>-> Mat making<br>-> Domestic work in other people's houses<br>-> Day/ wage labour in Gher, rice, brick fields<br>-> Cutting wood for trade | -> Self-employed (carpentry)<br>-> Professional work (teachers, doctors)<br>-> Office staff / clerical work |
| **Additional Potential Livelihood Options (based on best practice examples)** | | | | |
| -> Agua-geoponics<br>-> Hydroponics<br>-> Vermicomposting | -> Agua-geoponics<br>-> Hydroponics<br>-> Crab and fish feed processing and trading | | | |

The selected portfolio of livelihood options was screened against their climate-resiliency, in particular to the impacts of climate-induced salinity and cyclones. The results of this screening process are summarised in Table 10 below.

In the first column of the table the livelihoods are analysed with respect to their saline tolerance. It is important to consider this tolerance in relation to projected soil and river salinity levels under a climate change scenario in the coastal belt. Under a scenario of 30cm sea level rise (SLR), the surface water salinity pattern will experience significant changes. The present dry season saline front (2ppt) is projected to move 30km to 70 km north affecting most of Khulna, Jessore, Barisal, Patuakhali and Noakhali (greater) districts[163]. With a 1m SLR, the saline front is projected to move further north along the north-eastern side of Bangladesh. Figure 11 shows projected soil salinity levels for 2050. The project areas on the western side of the map are predicted to experience an increase of soil salinity up to 6-15ds/m (which is around 3.84-9.6ppt). It is important to note, however, that soil and river salinity will vary within the different target unions and wards and is shaped by geographical features such as elevation, the quality of existing and future embankments and the strength of freshwater river flow, amongst others. Thus, it will be possible to grow some moderate saline crops in areas with higher elevation (or using raised beds for small-scale plantation) for a longer time than the average projected soil salinity of the region might indicate. The actual site-specific features will be considered during the implementation phase of the project.

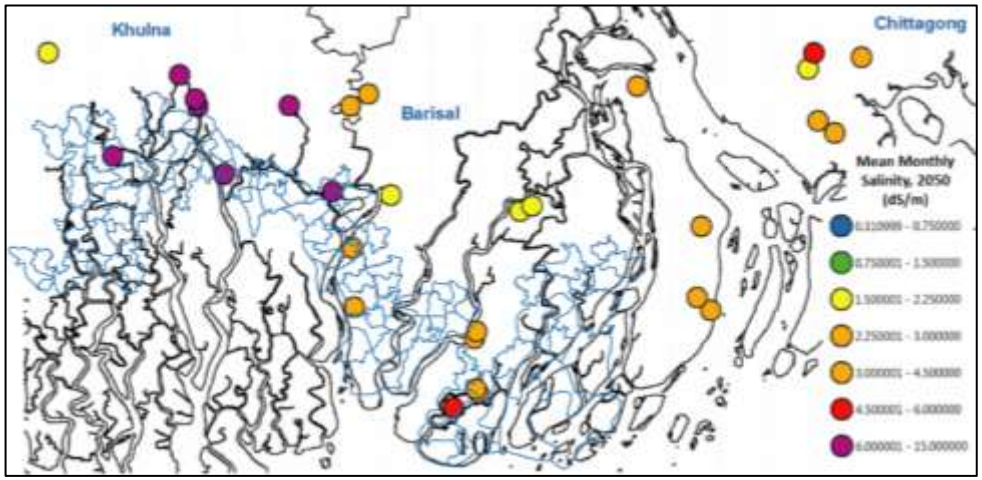



*Figure* 11. *Predicted Soil Salinity in 2050 (2ds/m equals 1.28 ppt)*[164]

163 Dasgupta S., et al. (2014). *Facing the Hungry Tide: Climate Change, Livelihood Theats, and Household Responses in Coastal Bangladesh*. World Bank Policy Research Working Paper No. 7148. December
164 Dasgupta S., Hossain M. M, Huq M., Wheeler D. (2014). *Climate Change, Soil Salinity and the Economics of High-Yield Rice Production in Coastal Bangladesh*. Policy Research Working Paper (forthcoming), Development Research Group, World Bank

*Table 8: Analysis of Climate Change Resiliency of Potential Livelihood Options*

| Potential Livelihood Options | | | | |
|---|---|---|---|---|
| **Livelihood Options** | **Saline Tolerance** | **Cyclone Risks** | **Climate Change Resilience** | **Comment** |
| **Agriculture based livelihoods** | | | | |
| **1. Rice (T.Amon) and paddy cultivation** | The rice variety (T-Amon) is relatively salt resilient and is able to tolerate a salinity of up to 8 ds·m−1 (equivalent to 5.12 ppm). | Cyclone-induced tidal floods may cause saline intrusion into rice paddies and destroy crops. *Risk mitigation: Additional embankments could make paddies more flood-resilient.* | Estimated impacts of both observed and projected climate change impacts on cereal crop yields in different regions indicate that annual yield loss can be up to 35 per cent for rice (traditional rice species)[165]. Changes in crop cultivation suitability and associated agriculture biodiversity, decrease in input use efficiency, and prevalence of pests and diseases are some of the major impacts of climate change on agriculture[166]. | Cultivating salt resilient rice (T.Amon) varieties can be considered as a climate change resilient livelihood option. |
| **2. Maize** | Maize is sensitive to salinity. Its economic losses start above 2.7 ds·m−1 and yields decrease by about 10 per cent at EC 3.7 ds·m−1, 25 per cent at 6.0 and 50 per cent at 7.0 ds·m−1[167]. | Maize is vulnerable to cyclone-induced tidal surges of salt and freshwater. Further, direct wind impacts on maize can be severe. | Estimated impacts of both observed and projected climate change impacts on cereal crop yields in different regions indicate that the yield losses can be up to 60 per cent for maize, depending on the location[168]. Although maize can be cultivated in saline conditions, irrigation requires freshwater. In the target regions, the soil conditions and land suitable for maize cultivation are very limited and the output will not be commercially viable. Production costs may be higher than the profit. | Cannot be considered as a climate change resilient livelihood option due to dependency on freshwater irrigation and low profitability. |
| **3. Sesame seed oil** | Some sesame cultivars are tolerant to salinity stress up to EC 6 ds·m−1[169]. | Sesame oil seed crops would be vulnerable to cyclones and extreme winds. In order to reduce | Like maize, sesame is relatively salinity tolerant. Unlike maize, sesame requires less irrigation and can tolerate saline water for irrigation. Moreover, the soil and climate conditions suit cultivation of sesame at a commercial | Can be considered as a climate change resilient livelihood option due to relative salt resilience and profitability. |

[165] Porter et al. (2014*). Food security and food production systems Field*. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA (2014), pp. 485-533

[166] Zabel et al. (2014). *Global agricultural land resources — a high resolution suitability evaluation and its perspectives until 2100 under climate change conditions*. PLoS ONE, 9 (9) (2014), Article e107522, 10.1371/journal.pone.0107522

[167] Amacher, J.K., Koenig, R. and Kitchen, B. (2000). *Salinity and Plant Tolerance.* All Archived Publications, Paper 43, Utah State University. Available online at: https://extension.usu.edu/files/publications/publication/AG-SO-03.pdf

[168] Idem 165

[169]Azad, A. (2004). *Effect of Salinity on Growth and Yield in Three Sesame Cultivars*. MSc Thesis, Department of Crop Botany, Bangladesh Agricultural University. Available online at: https://www.google.ch/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwilq3AifnSAhUCORoKHVRgAAAQFgghMAA&url=http%3A%2F%2Fwww.saulibrary.edu.bd%2Fdaatj%2Fpublic%2Findex.php%2FgetDownload%2FBAU200401_16crop_5.pdf&usg=AFQjCNHf9dRzyXcEAt7rAh8vlNiHNIky4g

| | | | | |
|---|---|---|---|---|
| | | losses, early warning systems can be used to notify communities of potential losses to maximize harvest before an extreme weather event. | scale in the target regions. Existing demand for sesame and profitability makes it commercially viable. | |
| **4. Fruit cultivation (e.g. tamarind, apples, watermelon)** | The salt resilience of non-tree fruit plants varies significantly between the species. Watermelon could be identified as being slightly more resilient. FAO "Crop Salt Tolerance Data" provides evidence that watermelon is moderately sensitive to salinity[170]. | Fruit plants are vulnerable to potential cyclone-induced tidal surges of salt. | Unseasonal rainfall may have a serious negative impact on watermelon and other fruit crops. Many fruits are highly freshwater dependent. Therefore, promoting fruit cultivation, particularly melon, would be maladaptive in an increasingly water-scarce area. | Cannot be considered as a climate change resilient livelihood option due to the vulnerability to inundations and freshwater dependency. |
| **5. Plant nursery for fruit trees** | Sensitivity to saltwater of fruit trees depends on the species. Species such as *Acacia auriculiformis, Acacia hybrid, Achras sapota, Casuarina equisetifolia, Leucaena leucocephala and Tamarindus indica*, are moderately salt tolerant[171]. According to farmers' experience, coconut, velvety apple and date palm are high salt tolerant species[172]. Secondary literature indicates that coconut and date palm are high salt or strong salinity (12.1-16.0 dS/m) tolerant species[173]. | Low risk of flooding by tide and cyclone-related inundations if drainage system is in placer. Coconut has reportedly been affected by more frequent cyclones[174]. | The irrigation needs of fruit trees differ between species, but only those species with low irrigation needs will be considered for the livelihood interventions. | Can be considered as a climate change resilient livelihood option due to relatively high salt resilience. |
| **6. Vermicomposting** | The process of vermicomposting is dependent on input materials. No evidence could be identified to show whether increased soil salinity will affect plants that are used for the process of vermicomposting. Secondary salinity induced by the application of organic fertilizers is not considered particularly worrying. However, Li-Xian et al. (2007) showed that the increase or decrease in the concentration of a determined ion in the soil depended on its | Depending on location of vermicomposting, flood risk and vulnerability towards extreme winds can be considered low. | The key input of vermicomposting is earthworms which requires specific soil conditions. Saline soil can negatively impact the effectiveness of the earthworm and reduce the quality and usability of produced fertilizers. The nitrogen transfer by the earthworms in the compost fertilizer is hindered due to saline soil. | Cannot be considered as a climate change resilient livelihood option. |

[170] Food and Agriculture Organization of the United Nations (FAO). *Crop Salt Tolerance Data*, FAO. Available online at: http://www.fao.org/docrep/005/y4263e/y4263e0e.htm
[171] Miah, A. Q. M. (2013). Salt Tolerances of Some Mainland Tree Species Select as Through Nursery Screening. *Pakistan Journal of Biological Sciences*, vol. 16, pp. 945–949
[172] Islam, A. S., Miah, A. Q. M. and Habib, A. M. (2013). Diversity Of Fruit And Timber Tree Species In The Coastal Homesteads Of Southern Bangladesh. *Journal of the Asiatic Society of Bangladesh Science*, vol. 39 pp. 83–94
[173] Dutta, A.K. and Iftekhar, M.S. (2004). *Tree species survival in the Homestead forests of salt affected areas: a perception analysis for Bangladesh*. J. Biol. Sci. 4 (3), 309– 313.
[174] Wright, H., Kristjanson, P. and Batta, G. (2012). *Understanding Adaptive Capacity: Sustainable Livelihoods and Food Security in Coastal Bangladesh*. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) Working Paper No. 32, CGIAR Copenhagen. Available online at: https://cgspace.cgiar.org/rest/bitstreams/17256/retrieve.

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| | concentration in the compost, the application rate, the removal of the crops and to leaching[175]. | | | |
| **7. Aqua-geoponics[176]** | The technology itself will function with some levels of saline water. The salt resilience of cultivated plants varies by species. Some moderately saline tolerant vegetables which can be used include BARI tomato (4.1-8.0 dS m-1)[177], spinach (ECe: <6.0 dS/m)[178]. These vegetables can be paired with brackish water fish species to utilise the aqua-geoponics approach. | Low risk of cyclone-induced flooding. Extreme winds could be a threat to the system. *Risk mitigation: The growing cycle during the cyclone season can be avoided.* | The climate change resilience of aqua-geoponics can be assumed to be high, as it is a technology solution that can adjust its production to varying salinity levels and available through the selection of plants and fish species and structure of technology. | Can be considered as a climate change resilient livelihood option due to its multiple income opportunity that can be derived from a single cultivable plot. |
| **8. Hydroponics** | The technology itself can be set up on land or as a floating garden. Both options can deal with some levels of salinity, whereas the resilience depends on the selected plant species (see aqua-geoponics above). | Low risk of cyclone-induced flooding. Extreme winds could be a threat to the system. *Risk mitigation: The growing cycle during the cyclone season can be avoided.* | The climate change resilience of hydroponics can be assumed to be high, as it is a technology solution that can adjust production to varying salinity levels and available space through the selection of plants and fish species and structure of technology. | Can be considered as a climate change resilient livelihood option. |
| **9. Homestead gardening** | Resilience depends on the species grown. Tomato, for example, is moderately sensitive to salinity. Its economic losses start above 25 ds·m−1 and yields decrease about 10 per cent at EC 3.5 ds·m−1.25 per cent at 5.0 and 50 per cent at 7.6 ds·m−1. | Low risk of flooding by tide and cyclone if proper drainage system is installed. | Unseasonal rainfall may have serious negative impacts on vegetables. Irrigation requirements depend on the plant, which should be selected according to water quality and availability. | Depending on the crops, this can be considered as a climate change resilient livelihood option. |
| **Aquaculture based livelihoods** | | | | |
| **10. Shrimp farming in own, rented or community pond** | Salt water shrimp aquaculture is resilient against increasing salinization processes. However, shrimp farming exacerbates the rate of salinization due to leaks in tanks, spills and seasonal release of highly saline water into surrounding agricultural lands[179]. | Cyclones can overtop shrimp farms leading to losses of stock. Ponds are quite resilient against extreme winds. | This is an adaptive livelihood option. However, it presents risks associated with its propensity to increase salt deposits. The surrounding soil where shrimp enclosures are set up collect salt deposits and agricultural cultivation is hampered. | This cannot be considered as a potential option due to its maladaptive consequences of exacerbating the rate of salinization. |

[175] Silva C.M.M.S. and Fay E. F. (2016). *Effect of Salinity on Soil Microorganism.* Available online at: https://www.researchgate.net/publication/221922968

[176] Haque et al. (2015). Integrated floating cage aquageoponics system (IFCAS): An innovation in fish and vegetable production for shaded ponds in Bangladesh. *Aquaculture Reports.* Available online at: http://www.sciencedirect.com/science/article/pii/S2352513415000125

[177] Siddiky, M. A., Sardar, P. K., Hossain, M. M., Khan, M. S. and Uddin, M. K. (2012). Screening of Different Tomato Varieties in Saline Areas of Bangladesh. *International Journal of Research, Innovation and Technology,* vol 2, pp. 13-18

[178] Mainul, A. (2010). *Saline Soils of Bangladesh*. Soil Resource Development Institute (SRDI), SRMAF Project, Ministry of Agriculture, Dhaka. Available online at: http://srdi.portal.gov.bd/sites/default/files/files/srdi.portal.gov.bd/publications/bc598e7a_df21_49ee_882e_0302c974015f/Soil%20salinity%20report-Nov%202010.pdf

[179] Flaherty, M. and Vandergeest P. (1998). Low -salt shrimp aquaculture in Thailand: Good-bye coastline hello Khon Kaen!. *Environmental Management*, 22(6), 817–830.

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| **11. Crab farming** | Saline tolerant 5 to 40 ppt, optimal salinity depending on the species[180]. | May be affected by cyclone-induced inundations and/or seasonal waterlogging i.e. the ponds flood and crabs escape[181]. Relatively resilient against extreme winds. *Mitigation option*: *In order to reduce losses from cyclone inundations, embankments can be built and avoiding one production cycle (3months) can reduce the seasonal cyclone risk.* | This activity must be carefully managed to ensure that that crab seedlings are not obtained from the wild, affecting wild stocks. No additional freshwater will be needed to pursue this livelihood, as crabs can be raised in brackish to highly saline ponds. Crab farming should avoid the pitfalls of shrimp farming in terms of seasonal release of highly saline water into surrounding agriculture land by only being practiced in tidal zones that are inundated with brackish water. | Can be considered as a climate change resilient livelihood option due to relative high salt resilience. |
| **12. Brackish water fish farming and trading (e.g. Pharsha, cat fish)** | This depends on the species. The Thai silver carp, *Barbodes gonionotus*, for example can grow well under 7 ppt, but die within 96 hours at salinity higher than 12 ppt[182]. | Cyclones can overtop fish farms with more saline water damaging the Gher dyke. Ponds are quite resilient against extreme winds. *Mitigation option: Avoiding one production cycle (3months) can reduce the seasonal cyclone risk .* | Brackish water fish seedlings can be obtained from existing local markets. Semi-intensive or extensive system would have greater climate change resilience in the form of technology and management[183]. No additional fresh water will be needed to pursue this livelihood since brackish water fish can be raised in brackish to highly saline ponds. | Can be considered as a climate change resilient livelihood option. Further focus should be given on Tilapia farming (see below). |
| **13. Tilapia farming** | Saline tolerant up to 15ppt[184]. | Cyclones can overtop tilapia farm and fish could escape. | Fingerlings are easily available at local markets and do not need a hatchery since they are monosex. Even in small farms, Tilapia may not dominate other species. Freshwater requirements are determined by water | Can be considered as a climate change resilient livelihood option. |

[180] Shelley, C. and Lovatelli, A. (2011). *Mud crab aquaculture A practical manual*. FAO Technical Paper No. 567, FAO, Rome. Available online at: http://www.fao.org/docrep/015/ba0110e/ba0110e.pdf
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[182]Akther, M., Mollah, A.R. and Kadir, M. (2009). Laboratory investigation on salinity tolerance to *Barbodes gonionotus* (Bleeker). *Progressive Agriculture*, vol. 20, pp. 193–200
[183] ICEM (2013). *USAID Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin: Main Report*. Prepared for the United States Agency for International Development by ICEM – International Centre for Environmental Management. Bangkok: USAID Mekong ARCC Project. Available online at: www.mekongarcc.net/resource.
[184] Monwar, M. M., Sarker, A. K. M. R. A. and Das, N. G. (2013).Polyculture of Seabass with Tilapia for the Utilization of Brown Fields in the Coastal Areas of Cox's Bazar, Bangladesh. *International Journal of Fisheries and Aquaculture*, vol. 5, pp. 104–109

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| | | *Mitigation option: Avoiding one production cycle (3months) can reduce the seasonal cyclone risk.* | balance calculations including evaporation loss, seepage loss and water exchange for water quality management. However, there is a lack of information on the impacts of Tilapia on ecosystems and local fish diversity. | |
| **14. Fishing in natural waters (sea, rivers, channels) for trade** | Increased salinity and change in water quality can instigate a change in species composition and distribution especially in coastal areas. There will be clear change in seasonal abundance of individual fish species. There is an observed trend of decreasing fish stocks due to increasing salinity in southwest Bangladesh[185]. | Cyclones can damage boats and fishing equipment. | This is primarily a maladaptive approach. Fishing from natural sources would result in overfishing and reduction of natural fish stock. Overfishing, though profitable in the short run, would worsen the ecosystem by reducing natural sources and thus would be an unsustainable livelihood option. Further, fishing is a high-risk livelihood activity "due to the fugitive nature of the resource, the hostile environment of the seas, and perishability of the product"[186]. | Cannot be considered as a climate change resilient livelihood option. |
| **15. Fish fingerling catching from river/ sea** | Increased salinity and change in water quality can instigate a change in species composition and distribution especially in coastal areas. There will be clear change in seasonal abundance of individual fish species. | Cyclones can damage fishing equipment or prevent people from being able to safely pursue this livelihood. | Alongside the decreasing availability of fish, extracting large amounts of fish fingerings from natural waters could have severe negative impacts on aquatic ecosystems. Thus, this is a maladaptive approach. Creating dependency on natural sources for obtaining fish fingerlings can lead to depletion. The methods applied for capturing fingerlings are also harmful for the ecosystem. This is because the fishing nets which are used are very fine and tear easily. The fishermen discard the fishing nets affecting other aquatic life. | Cannot be considered as a climate change resilient livelihood option. |
| **16. Crablet catching from river and Sundarbans** | Saline tolerant up to 40ppt, optimal salinity depends on the species[187]. Due to saline habitat and the largest mangrove Sundarbans close to the region, collection of young crabs and nurturing in separate ponds is an increasingly preferred option for income generation[188]. | Cyclones can damage fishing equipment or prevent people from being able to safely pursue this livelihood. | Extracting large amounts of crablets from natural waters has severe negative impacts on aquatic ecosystems and their biodiversity. Thus, it is considered a maladaptive livelihood option. | Cannot be considered as a climate change resilient livelihood option. |
| **17. Crab and fish feed processing** | The processing of crab and fish feed and trading will not be directly impacted from increasing salinity levels. | Depending on the building structure of the processing facility or | Crab and fish feed processing will face few climate-induced constraints if inputs are available. However, if crab and fish feed inputs depend on fish fingerlings and | Can be considered as a potential climate change resilient livelihood option. |

[185] Idem 79.
[186] MRAG (2011). *Fisheries and livelihood*. Fisheries Management Science Programme (FMSP), Marine Resources Assessment Group (MRAG), and Department for International Development (DFID), London. Available online at: www.mrag.co.uk/Documents/PolicyBrief4_Livelihoods.pdf
[187] Idem 179
[188] Alam, M., Ahammad, R., Nandy, P. and Rahman, S., (2013). Coastal Livelihood Adaptation in Changing Climate: Bangladesh Experience of NAPA Priority Project Implementation. *Climate Change Adaptation Actions in Bangladesh, Disaster Risk Reduction.* Springer, Tokyo, pp. 253–276

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| | | workplace, the livelihood can be cyclone and flood resilient. | by-catch from fishing in natural waters, then producing feed can have serious impacts on aquatic ecosystems. | |
| **18. Crab trading** | The process of crab trading will not be directly impacted from increasing salinity levels. | Depending on the building structure of storages or mode of transportation, cyclone and floods risk can be minimised. | | Can be considered as a potential climate change resilient livelihood option |
| **Livestock based livelihoods** | | | | |
| **19. Chicken rearing**<br>**20. Poultry farm**<br>**21. Selling eggs** | Poultry is not highly salt resilient and could be affected by increasing salinity in water sources and feed. | Cyclone-induced inundations can reduce the availability of dry spaces for rearing chicken[189]. Extreme winds pose a high risk to poultry. | Increasing feed scarcity due to plant species changes caused by salinization reduces the feasibility of rearing poultry (according to field observations). Dependency of poultry on freshwater is high. | Cannot be considered as a climate change resilient livelihood option. |
| **22. Duck rearing** | The rice-duck farming system has proven suitable in salt-affected areas[190]. Sea ducks can be raised in salty water and drought prone areas[191]. | Cyclone-induced inundations can reduce available space for rearing ducks. | Scarcity of scavenging feed (according to field observations) in the summer season and inadequate knowledge on duck nutrition are the main constraints that reduce the potential of duck rearing as an adaptive livelihood in southwest Bangladesh. | Cannot be considered as a climate change resilient livelihood option. |
| **23. Sheep** | Sheep can tolerate higher salt concentrations than other livestock (13,000 in milligrams per litre (mg/L), but sudden changes to more saline water may cause lowered production because sheep may not drink the more saline water immediately. Salt resilient Samna grass can be used as feed. | Cyclone-induced inundations can reduce the availability of dry spaces for rearing sheep. Vulnerable to extreme winds. | High tolerance to salinity and resilience to lower intake of feed and water makes sheep more resilient than any other livestock. An adult sheep can survive with 2-6 litres of water per day[192]. | Can be considered as a potential climate change resilient livelihood option. |
| **24. Goat rearing** | Goats are less salt-resilient than sheep and their health and growth ability would be impacted by higher intake of salt through feed and water. | Cyclone-induced inundations can reduce the availability of dry spaces for rearing goats. Vulnerable to extreme winds. | Shortages in availability of fodder and freshwater will have severe consequences on the feasibility of goats as a source of milk and meat. Further, goats are highly vulnerable to wind and rain as they easily get sick primarily due to cold related diseases. | Cannot be considered as a climate change resilient livelihood option. |

[189]Nasreen M., Hossain K.M., Azad A.K. *Climate Change and Livelihood in Bangladesh: Experiences of People Living in Coastal Regions.*
[190] Food and Agriculture Organization. *Technologies and Practices for Small Agricultural Producers* (TECA).Available online at: http://teca.fao.org/
[191] Radio the Voice of Vietnam
[192] Sheepconnect. *Water for Livestock.* Available online at: http://www.sheepconnectsa.com.au/water-security/water-quality-for-livestock (accessed March 2017)

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| **25. Cow/ buffalo rearing**<br>**26. Small dairy farm** | The main impact of salinization on cows and buffalos is the reduced availability of fodder, which significantly impacts their health and wellbeing. | Cyclone-induced inundations can reduce the available of dry space to rear cows/buffaloes. Relatively vulnerable to extreme winds. | Shortages in availability of fodder and freshwater will have severe consequences on the feasibility of cows and buffalos as a source of milk and meat. | Cannot be considered as a climate change resilient livelihood option. |
| **27. Selling livestock products (milk, meat)** | The process of crab trading will not be directly impacted from increasing salinity levels. | Depending on the building structure, infrastructure and markets, cyclones and floods can pose a threat to the ability to trade. | Reduced availability of animal products due to climate-induced changes in livestock will significantly impact the potential of larger-scale trade of animal products from the project regions. | Cannot be considered as a climate change resilient livelihood option. |
| **Other livelihoods (Non-Agriculture)** | | | | |
| **28. Mat making** | The input products for mat making, a plant called Mele, is not overly resilient to salinity. It has been found that it can germinate up to 217 mM of Na + (ca. 5 per cent NaC1). A significant weight decrease was found in seedlings at salinities between 25 and 50 mM NaC1 (ca. 3 per cent) but no leaf wilting or death[193]. | Cyclone-induced inundations can destroy Mele – the input for mat making. | Reduced availability of input materials, due to climate change impacts, can reduce sustainability of mat making as a livelihood option. | Cannot be considered as a potential climate change resilient livelihood option due to unavailability of input materials. |
| **29. Handicrafts** | The activity of handicraft production will not directly be impacted from increasing salinity levels. However, the reduced availability due to salinity will reduce feasibility of the activity. | Depending on the building structure of workplace and input storage space the production can be cyclone and flood resilient. | Heavily dependent on natural resource base, for example agricultural by-products like straw or coconut shells. Coconut has reportedly been affected by more frequent cyclones[194]. If the natural resource base is threatened, the existence of the handicrafts also remains under threat. | Cannot be considered as a potential climate change resilient livelihood option. |
| **30. Small business (groceries, tea, etc.)** | The operations of small businesses will not directly be impacted from increasing salinity levels. | Depending on the building structure of the businesses they can be cyclone and flood resilient. | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Cannot be considered as a potential climate change resilient livelihood option. |
| **31. Water purification and vending** | Dependent on natural resource base, either freshwater ponds or rainwater harvesting. Reliance on both can be expected to lead towards a scenario of | Depending on the building and distribution structure of the purification facility/ | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Cannot be considered as a potential climate change resilient livelihood option due to limited availability of freshwater ponds. |

[193] Howard-Williams (1975). *Cattail Invasion and Persistence Salt Marsh: The Role of Salinity in a Coastal Reduction*. Available online at: http://portal.nceas.ucsb.edu/working_group/valuation-of-coastal-habitats/meta-analysis/papers-for-meta-analysis-database/salt-marsh-articles-chris/beare1987estuaries.pdf
[194] Idem 174

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| | scarcity at some point in time due to increased salinity and variability in precipitation trends. | operations this livelihood can be cyclone and flood resilient. | | |
| **32. Day labour or wage labour in Gher, rice and brick fields** | Not directly impacted by salinity. | Cyclone-induced inundations and direct wind can destroy brick fields and workplaces. | Depending on the field of work, conditions and salary this can be an adaptive livelihood, while not transformative since it sustains or creates dependencies on employers. | Depending on the sector it can be considered as a potential climate change resilient livelihood option. |
| **33. Cutting wood for trade** | Different tree species will be impacted by salinity to varying degrees. | Availability of trees can be reduced through cyclone-induced inundations and extreme winds. | Enabling local people to cut trees can be considered maladaptive, due to the significant environmental impacts and potential successive consequences. | Cannot be considered as a potential climate change resilient livelihood option due to its maladaptive nature. |
| **34. Self-employed (carpentry)** | Not directly impacted by salinity. | Availability of wood can be reduced through cyclone-induced inundations and extreme winds. | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Can be considered as a potential climate change resilient livelihood option, but will be excluded from further screening due to limited scalability potential within project scope. |
| **35. Professional work (teachers, doctors)** | Not directly impacted by salinity. | Depending on the building structure of the workplace this livelihood can be cyclone and flood resilient. | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Can be considered as a potential climate change resilient livelihood option, but will be excluded from further screening due to limited scalability potential within project scope. |
| **36. Office staff/ clerical work** | Not directly impacted by salinity. | Depending on the building structure of the workplace this livelihood can be cyclone and flood resilient. | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Can be considered as a potential climate change resilient livelihood option, but will be excluded from further screened livelihood options due to limited scalability potential within project scope. |
| **37. Tailoring** | Not directly impacted by salinity. | Depending on the building structure of the workplace this livelihood can be cyclone and flood resilient. | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Can be considered as a potential climate change resilient livelihood option, but will be excluded from further screening due to limited scalability potential within project scope. |

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| **38. Domestic helper/ maid** | Not directly impacted by salinity. | Depending on the building structure of the workplace this livelihood can be cyclone and flood resilient. | Due to the scope and focus of the proposed project, this livelihood option was not considered as a potential scalable livelihood option. | Can be considered as a potential climate change resilient livelihood option, but will be excluded from further screening due to limited scalability potential within project scope. |

Based on this first filter of the screening process, the following 13 livelihoods were identified as potential climate change resilient livelihood options to be screened in a second step against sustainability and socio-economic criteria:

- Hydroponics
- Aqua-geoponics
- Homestead gardening
- Plant nursery
- Vermicomposting
- Sesame cultivation
- Crab farming
- Crab nursery
- Tilapia farming
- Sheep
- Brackish water fish farming
- Crab and fish feed processing
- Rice T. Amon

*Table 9: Analysis of Gender, Market, Environmental and Socio-economic Factors Relating to Potential Livelihood options*

| Potential Livelihood Options | | | | | |
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| **Livelihoods Options** | **Profitability and Market/ Value Chain Access** | **Gender Responsiveness** | **Socio-economic Considerations and Community Acceptance** | **Environmental Impacts (considering scalability)** | **Comments** |
| **1. Aqua-geoponics[195]** | The profitability of products from aqua-geoponics technology will depend on the plant and fish species grown. Generally, this livelihood can provide women with vegetables and fish for household consumption, while the surplus can be sold at existing local markets. The independency of this technique from local soil conditions (which are becoming increasingly saline) is a competitive advantage of using aqua- | Looking at existing best practices in the region, it has been identified that women are capable of managing aqua-geoponics systems with some capacity building support. The technology can be set up within the proximity of the household or within the community where women feel safe and supported. The household systems are most convenient for women, however the community approach can also encourage women to develop collective management and ownership | Existing best practice shows that usage of common resources makes community approaches to aqua-geoponics highly acceptable. Very small-scale systems may be vulnerable to theft. Larger-scale initiatives can be secured with proper management and tenure arrangements should be secured through leasing. | Aqua-geoponics systems are integrated farming systems in which the waste produced by the farmed fish supplies nutrients for plants grown hydroponically, which purify the water in the system. This system therefore makes use of the output ammonia from one system (aquaculture) as an input for another sub-system (vegetable cultivation), minimizing ecosystem impacts, | This option has not been derived from existing livelihood options; rather, it has been derived from best practices for fighting climate vulnerabilities in the target region. Proposed as a sustainable livelihood option. |

[195]The term aqua-geoponics is the combination of aqua, geo and ponics which mean pond water, pond mud/soil and cultivation, respectively (Haque et al., 2015).

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| | geoponics compared with traditional cultivation techniques. | systems. Locations of collective systems should be chosen in consultation with women beneficiaries and technologies should be gender responsive, for example the avoidance of heavy cages and the use of shaded ponds have been shown to be preferred by women. | | and utilizing natural ecosystem functions to minimize waste and enhance production. The overall sustainability of the system is also determined by the species of fish cultivated, and should avoid invasive or carnivorous species to reduce ecosystem impacts and feed demand. | |
| **2. Hydroponics** | The profitability of products from hydroponics technology will depend on the plants grown. Generally, this livelihood can provide women with vegetables for household consumption, while the surplus can be sold at existing local markets. The independency of this technique from local soil conditions (which are becoming increasingly saline) is a competitive advantage of using hydroponics compared with traditional cultivation techniques. | Looking at existing best practices in the region, it has been identified that women are very capable of managing the hydroponics system with limited capacity building support. Locating the hydroponics site close to the household or within the community helps women feel safe and supported. | Existing best practices show that usage of common resources makes the community approach to hydroponics very acceptable. Household and community level interventions enable women to remain in the proximity of the household while distributing their time between other household activities such as childcare. | Platforms for floating gardens are typically constructed with natural materials, including bamboo and water hyacinth, an invasive aquatic weed, which is abundantly available, and uses minimum inputs. The agricultural practice is well established, culturally appropriate and has environmental benefits if limited inputs are used. | This option has not been derived from existing livelihood options; rather, it has been derived from best practices for fighting climate vulnerabilities in the target region. Proposed as a sustainable livelihood option. |
| **3. Homestead gardening** | The vegetables that are grown in these regions include potato, brinjal, bitter gourd, snake gourd, spinach, pumpkin, okra, summer tomato and chili. Production volume at homestead level is very low. People are cultivating vegetables during the period of lower salinity, between August and December. Some of the major constraints identified include the lack of knowledge amongst farmers about using inputs and cultivation techniques. This can be addressed by ensuring that input suppliers in the region have better linkages with input companies so they can be trained to provide | Women, responsible for most home-based activities, are at the centre of looking after homestead gardens. They have full autonomy of homestead vegetable systems and can nurture the plants and harvest the vegetables on their own. The products are used to ensure family food security and surplus products can be sold to on neighbourhood markets, which allows them a little extra earning that they can save for periods of crisis. | Traditionally, homestead gardening is used for growing some kitchen vegetables. Very well accepted, appreciated and sometimes, good vegetable products are matter of pride among the community. Exchange of vegetables, part of the traditional practice, helps strengthen bonds with other community members. | Homestead gardens are well established, and require minimal inputs. Production can be maximized using simple techniques such as mixed cropping, high quality seeds, raised beds and organic fertilizer. Pesticide use can be prohibited, easily avoided with Integrated Pest Control methods, such as hand collection, Neem extract application and bagging. The waste from the vegetables has nutrient enhancement potential for the soil after degradation. | Proposed as a sustainable livelihood option. It is financially viable, but has a constrained capability to upscale production. However, this option is important for sustainable household food consumption and will help to meet the nutritional needs of the household, thereby supporting the health requirements of vulnerable communities. |

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| | information about the right use of inputs and also give advice about cultivation techniques to producers. | | | | |
| **4. Rice (T.Amon)** | The cost benefit ratio for saline tolerant rice is 1.2 which indicates that spending USD1 on a saline tolerant rice variety production system gives USD1.2 net return. Thus, a saline tolerant variety is a commercially profitable and economically viable adaptation option in the saline prone areas of Bangladesh. However, these seeds are not usually available in the market place. Market price is another problem. In most cases, the price of rice produced from saline tolerant varieties is lower than that of normal rice varieties. | It is a more male oriented sector. Women's role is mostly confined to post-harvesting activities, although, in general, these activities are very laborious for women, but traditionally, they are used to getting engaged with these tasks. | Socially well-accepted role of women in post-harvest activities. | No significant negative impacts of rice production on the environment were identified while conducting the study. | Not proposed as a viable livelihood option as the marketability is a key barrier. |
| **5. Sesame seed /oil** | Cost-benefit ratio is 1.31. Suitable for production in the target region in the Kharif 1 season.[196] Processing and crop diversification have a high profitability potential, both in the national and international markets. Existing best practice and field observations show high potential for productivity and profitability if produced at a large scale. Sesame requires limited inputs - mainly good quality seeds and improved cultivation practices. Sesame seeds can be used for oil processing locally. Besides this, certain varieties of seed can be processed for value addition. | As observed in the field, women are engaged in post-harvesting activities such as threshing, cleaning, drying, storage and milling as part of their household activities.<br>Although, in general these activities are very laborious for women, traditionally, they are engaged with these tasks.<br>Women farmers can potentially market their sesame directly to food traders or processors and get a higher price.<br>Field observations revealed that effective exchange of knowledge and expertise will encourage more women of the community to practice the livelihood option facilitating the opportunity for bulking in the region. | Because this brings in high profits, socially and economically, it has high potential for transforming livelihoods. | Sesame is a moderately saline resistant crop, which can be grown in a Sesame- T.Aman rice-Fallow cropping pattern. Chemical fertilizers such as urea, TSP, MP, gypsum, zinc sulfate and boric acid are often used which have negative environmental impacts and deplete soil quality overtime. Environmental impacts can be mitigated by encouraging Integrated Plant Nutrient management and the use of organic fertilizer (manure, crop residues, compost) to decrease input costs and promote soil health. | Proposed as a sustainable livelihood option. |

[196]Tajuddin, S. M. (2010) 'The Impacts of Climate Change on the Coastal Belt of Bangladesh: An Investigation of Risks & Adaptations on Agricultural Sector' Proceedings of International Conference on Environmental Aspects of Bangladesh, available at: http://benjapan.org/iceab10/4.pdf

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| **6. Plant nursery** | Cost-benefit ratio is 1.43. Has a profitability potential in the target region and can be supplied to other climate affected regions for future protection. Target households can collect seeds and saplings from local sources almost at no cost, and develop a nursery. It is very feasible as a community enterprise. The marketing system is quite straight forward. Villagers are the main customers. Plants can also be sold in nearby markets. | Just like homestead vegetable gardening, women, staying at home, or merely walking around the neighbourhood, can look after the plant nursery. They can sell the plants in the neighbourhood and to interested buyers within the proximity of the homestead, allows them to generate extra earning, which they can save for crisis periods. | Very well-accepted, appreciated and sometimes plants with good quality fruit products are matter of pride among the community. Socio-economically it carries value as it helps enhance the resilience of the community together. | Smaller scale plant nurseries, mainly for fruit trees, do not create any significant environmental risks if Integrated Pest Management and locally available organize fertilizer is used. | Good option for maintaining a balance in the local ecosystem, as well as for meeting demand in the area. Proposed as a sustainable livelihood option. |
| **7. Vermi-composting** | Raw materials or inputs such cow dung or poultry litter for composting may not be easily available. Subject to increase in opportunity for vegetable gardening and nursery. Although it is good for amendment of soils, due to reduced availability of agricultural lands, probability of using vermicomposting is also reduced. | Considering the restricted or limited mobility of women, this option is suitable at both household and community levels. The women of the community can take care of all the steps of the composting process, staying in the homestead. | Socially, composting is now a popular activity. Economically, this option is very much dependent on demand. The target region is expected to have fewer and fewer resources for cultivating crops. Use of vermicomposting will depend on personal interest. | Environmentally, it is harmless. Instead, vermi-composting enhances soil fertility subject to usage over a significant time period. | Not proposed as a viable livelihood option. People can use this in addition to a main livelihood activity, like plant nursery, which has greater potential. |
| **8. Crab and fish feed processing** | The average cost benefit ratio is 1.10. There is huge demand for crab and fish feed in the project unions. Raw materials or inputs like oil cake, rice bran, shrimp and fish waste are locally available and can be used to make low cost quality feed for fish cultivation. Will help balance the ecosystem and meet the demand of the target regions. Considering the increasing trend of brackish water fish and Tilapia farming in the region, this can be a highly profitable occupation both at household and community levels. | Currently, very few women are involved in commercial feed production (estimated at less than 3 per cent of the total workforce). Considering the restricted or limited mobility of women, this option is suitable at both household and community levels. This will empower women with adequate knowledge on feed processing and packaging. | Currently in Bangladesh about 10,000 people are estimated to be directly involved in raw material and additive trading, feed production and feed trading, and this number is likely to increase as demand for fish feed increases. The access of small farmers (pond size 0.08–0.1 ha) to feeds is very limited because of unavailable initial investment capacity and credit facilities for purchasing feeds. | Feed production and transport have several environmental implications. Life cycle analysis was used to characterize feed ingredients and the value chain activities according to three impact categories:<br>1. Global warming potential;<br>2. Acidification potential;<br>3. Freshwater and marine eutrophication potential.<br>In addition to eutrophication, formulation of live feeds usually depends on by-catch from marine fisheries, which puts pressure on wild stocks. The composition of fish feed must be carefully managed, | Proposed as a viable livelihood option to enable a sustainable feed provision for crab farms and an alternative to using wild catch as feed. |

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| | | | | and the use of small-low value fish eliminated from the crab and fish feed processing value chain. | |
| **9. Tilapia farming** | Tilapia is a fast-growing fish species with short production cycles (3 months) and relatively low on-going investments, e.g. for feed and fingerlings. The cost-benefit ratio (1.88) indicates that it has high profitability potential. There is a market demand for all sizes of Tilapia. Bulking and trading is possible at community level. | Tilapia farming at the household level can enable women to remain in the proximity of the household while distributing their time between other household activities such as childcare without harming social responsibilities. Currently women are primarily involved in seeding and feeding, but appropriately designed, gender responsive systems can allow the full participation and management of women.<br>At the community level, women can learn to collectively represent their business interests and can be empowered in negotiating selling prices. However, complementary measures should be taken to reduce the burden of unpaid household level, to ensure the ownership of systems and choose site locations in a participatory manner. | Can be managed both at household and community level. Collective efforts by women for accessing resources helps community bonding. Resilient source of income improves the overall socio-economic condition of the community. | Tilapia farming has a range of adverse impacts on the environment and production systems must be carefully designed and managed to mitigate these impacts, ranging from management of feed and effluents, water quality and disease. The greatest adverse impact of Tilapia is on biodiversity of receiving aquatic ecosystems, given that Tilapia is an a highly invasive species. | Not proposed as a viable livelihood option due to invasiveness nature of Tilapia. |
| **10. Crab farming/ crab nursery** | The average cost-benefit ratio (1.98) indicates that there is great business potential in mud crab farming (see Section 6.3.6). Local and international buyer markets and value chains are already established. Crablets and feeds are locally available so farming can be done at household and community level. Bulking and trading is also possible at community level. | Crab farming and trading could empower women through collective efforts and learning exchange opportunities. Farming at household level enables women to practice the livelihood activity independently. At community level, women can seek services and access resources collectively, thereby exercising their negotiating power. Exchange of services and products enables women of the community to achieve a greater level of empowerment. | Can be managed at community level. This enables women to remain within the proximity of the household while distributing their time between other household activities, such as child care, without harming social responsibilities.<br>Collective efforts for accessing resources helps community bonding which in turn enhances resilience building capacity. Resilient source of income improves the overall socio- | The over extraction of wild crablets is a major environmental impact of crab farming. In order to promote crab farming as a sustainable livelihood option it is essential that crab hatcheries also be promoted to provide crablets. Crab farming in ghers (ponds) should occur in targeted, suitable aquatic systems of limited spatial extent and within already saline tidally-inundated areas, rather than | Proposed as a sustainable livelihood option. |

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| | | | economic condition of the community. | openly stocked or spread. Crab ponds should not be established on land that can be used for agriculture but would be suitable in converted shrimp ponds or with improved traditional methods in small-scale mangrove pen culture. Given that crab cultivation is already limited by wild stock depletion, the establishment of crab hatcheries as a source of crablets could have environmental benefits for the sector with sufficient regulatory support. | |
| **11. Brackish water fish farming** | Brackish water fish farming can be a profitable activity in the project area. It has high export value potential and can also be used to meet local and national demand. Fingerlings can be obtained from nurseries. Brackish water fish farming requires limited external feed as most feed comes from water bodies (e.g. plankton, rice bran). This fish farming can be done in domestic ponds or channels connected with tidal creeks during periods of low salinity (10-15ppt, August to December). Bulking and trading is possible at community level. | Considering the restricted or limited mobility of women, and the fact that this option is suitable at both household and community levels, it is expected that brackish water fish farming and trading could empower women through collective efforts and learning exchange opportunities. Farming at household level enables women to practice the livelihood activity independently. At community level, women can seek services and access resources collectively, thereby exercising their negotiating power. Exchange of services and products enables the women of the community to achieve a greater level of empowerment. Women need credit or cash support to invest in farming and trading. | Can be managed both at household and community level. This option enables women to remain in the proximity of the household while distributing their time between other household activities, such as childcare without, harming social responsibilities. Collective efforts for accessing resources help community bonding which in turn enhanced resilience building capacity. Resilient source of income improves the overall socio-economic condition of the community. | Brackish water aquaculture has a range of environmental impacts, which can be managed through careful system design (small-scale, semi-intensive) or in aqua-geoponics systems for effluent management. Species selection should include only native species to avoid ecosystems impacts, and feed demand can be managed through the selection of non-carnivorous species, which can rely on plant-based feed from local sources of formulated feed. No highly saline water is used as in shrimp farms, and the selection of fish varieties can be adjusted to existing and rising salinity levels. | Not proposed as a viable livelihood option due to risks posed through wild fish fry collection. |

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| **12. Sheep** | The average cost-benefit ratio of sheep rearing is 1.98 in the coastal regions. Under traditional feeding systems, the sheep are raised on harvested or fallow lands, roads and canal sides and also graze on aquatic weeds and grasses in knee-deep water. There is high demand for sheep meat in local and national markets, however, availability of feed and fodder is the main barrier for sheep rearing in the coastal region. Saline tolerant grass or leaves from different trees could solve the problem but as the target households have limited or no land or insufficient trees, commercial sheep rearing is not feasible. Besides this, native sheep suffer from diarrhoea, pneumonia, lice infestation, dirty fleece, mycotic dermatitis and other skin diseases in all seasons, especially in the rainy season. | Considering the restricted or limited mobility of women, the fact that this option is suitable at both household and community levels is advantageous. The women of the community can take care of the sheep by staying in the homestead. As a traditional practice, women are used to taking care of sheep and other livestock. Women can sometimes sell the milk to their neighbours without violating mobility restrictions. Also, they can save any income earned on their own which can be provide support in times of crisis. | Well -supported socially. Economically, as selling can be done at the homestead level, very acceptable to the community. | Large-scale sheep farming might have some environmental issues, whereas small-scale rearing will not. | Not proposed as a viable livelihood option due to constraint commercialisation option and scope of the project. |

Based on this two-stage screening process, the following eight livelihoods were identified as being climate change resilient livelihood options to be recommended for and considered in the proposed project design:

- Hydroponics
- Aqua-geoponics
- Homestead gardening
- Plant nursery
- Sesame cultivation
- Crab farming
- Crab nursery
- Crab and fish feed processing

### 6.2. Switching Vulnerable Non-adaptive Agricultural Livelihoods to Climate Change Resilient Livelihoods

Table 10 provides an overview of the non-adaptive livelihood categories identified by this study alongside the proposed alternative livelihoods for each category, including a summary of their adaptiveness to climate change impacts.

*Table 10: Switching Non-adaptive to Climate Change Resilient Livelihoods*

| Category of Climate Resilient Livelihoods | Target Households | Climate Resilient Livelihoods and Value Chain Development to be Supported | Rationale: How these Livelihoods Link to the Overall Strategy to Shift Non-adaptive to Climate Change Resilient Livelihoods | How these Livelihoods and Value Chains are Adaptive in Light of Projected Risks |
|---|---|---|---|---|
| **Category A: Agriculture-based Livelihoods** | These opportunities are targeted at households that practice agriculture-based livelihoods and which are threatened by increased soil salinity driven by cyclone-related tidal surges and sea level rise. | **Climate change resilient livelihoods:** Homestead gardening, hydroponics, plant nursery, sesame cultivation | These livelihoods will be based on saline resilient crop varieties and can be established on existing small plots of land of small landholders. Some production systems (aqua-geoponics) are also easy to deconstruct and relocate. | Households whose livelihoods are largely dependent on agricultural activities, which are being impacted negatively by climate change, can diversify into producing saline tolerant crops and vegetables, as well as processing, marketing and trading agricultural products that are climate change resilient. These livelihood options would:<br>- Enable the beneficiaries to shorten crop production time through using advanced agricultural technologies to cope with seasonal variations in soil salinity levels;<br>- Utilize saline resilient crop varieties to cope with projected, increasing levels of soil salinity;<br>- Adopt the climate smart practice of intensive cropping by harvesting short duration crops and vegetables, thereby ensuring regular cash flow for the household;<br>- Utilize less freshwater for irrigation by planting varieties of crops and vegetable that require little irrigation and by employing advanced agricultural techniques such as hydroponics and aqua-geoponics;<br>- Enable the household to adopt low cost and high yield organic fertilizer that reduces soil salinity[197];<br>- Add value to climate resilient agriculture products, thereby the target households would effectively promote wider up-take. |
| | | **Climate change resilient livelihoods:** Aqua-geoponics | This livelihood addresses the issue of climate-induced reduction of cultivable land and provides options to move crop production into rivers and canals by means of aqua-geoponics and floating cultivation (floating gardens) utilising saline resilient crop and vegetable varieties. | |
| | | **Climate change resilient livelihoods:** Crab and fish feed processing | These livelihoods support the most marginal community members who lack assets to maintain traditional agriculture-based livelihoods and who work as seasonal agri-labourers, thereby supporting income-generating opportunities that are resilient to climate change driven salinization processes. | |
| **Category B: Aquaculture-based Livelihoods** | These opportunities are targeted at households whose freshwater based fishery livelihoods are threatened by increasing salinity levels of river | **Climate change resilient livelihoods:** Crab farming, crab nursery | These livelihood options will enable households with pre-existing skills in fisheries management to adapt their species towards saline resilient fish | Households whose livelihoods are largely dependent on fisheries activities, which are being impacted negatively by climate change, are able to adapt their fish farming activities because they would:<br>- Utilize species resilient to high levels of salinity |

[197] Mariangela Diacono. Francesco Montemurro. 2015. Effectiveness of Organic Wastes as Fertilizers and Amendments in Salt-Affected Soils.

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|---|---|---|---|---|
| | systems and brackish water bodies leading to a reduction of available fish species. | **Value chain development:** Crab hatchery | varieties, capable of coping with increasing salinity levels. | - Run shorter production cycles to reduce the risk of seasonal change or cyclone-related impacts on breeding cycles (for example, crab fattening is done over a period of 12-22 days and aqua-geoponics within 120 days)<br>- Enable the households to maintain their fishery activities in the water bodies they have traditionally used, even with increasing salinity. |

### 6.3. Profiles of Proposed Climate Change Resilient Livelihoods

Based on the two-phased screening process described above, eight climate change resilient livelihoods are being proposed for the GCF project. The following Chapter provides a short profile of each of these livelihoods, briefly outlining its adaptive potential, sustainability, gender-sensitivity, profitability potential, and proposed implementation modalities.

All the prices shown in the cost-benefit analysis and cost calculations in the livelihood profiles below are based on current market prices in the project area.

#### 6.3.1. Homestead Gardening

**Climate change resilience:** Homestead gardening is one of the world's most ancient agricultural practices, which has been shown to be adaptable to changing climates through adjusting the plants grown and cultivation techniques. The main expected climate change impacts in the project region are salinization and cyclones. The projected increase in soil salinity for Khulna and Satkhira by 2050 ranges between 6-15ds/m. Depending on the plant species grown in homestead gardens, the salinity resilience of the plants can cope with these salinization levels, for example tomato yields decrease by 50 per cent at 7.6 ds/m, but can withstand up to 25 ds/m[198]. Similarly, spinach is resilient up to 6.0 ds/m[199]. Salt resilient fruit varieties include papaya and tamarind. In order to avoid any reduction in yield and allow for planting of slightly less saline resilient vegetables, the beds of the gardens can be raised, which also increases their resilience to cyclone-induced inundations. Overall, the freshwater requirements of homestead gardens is low due to the small-scale and can be covered from available fresh/ slightly-saline water sources in the wards, even under climate change-induced seasonal variations in rainfall patterns. Climate change models suggest higher than average monsoon rainfall can be expected in the future, such as the findings of Agrawala et al. (2003)[200], which are reported in key government publications. Table 11 below summarizes the modelling data that represents climate change scenarios for the country under three different timelines. Overall, it is expected that winter months (December, January, and February) will become warmer and drier while the monsoon months (June, July, and August) will become warmer and wetter.

Table 11: Temperature and Precipitation Scenarios Used in GoB Documents

| Timeline | Mean Temperature Change (°C) | | | Mean Precipitation Change (%) | | | Sea Level Rise (cm) |
|---|---|---|---|---|---|---|---|
| | Annual | DJF | JJA | Annual | DJF | JJA | |
| 2030 | 1.0 | 1.1 | 0.8 | 5 | -2 | 6 | 14 |
| 2050 | 1.4 | 1.6 | 1.1 | 6 | -5 | 8 | 32 |
| 2100 | 2.4 | 2.7 | 1.9 | 10 | -10 | 12 | 88 |

**Note**: December, January and February (DJF) indicates the dry season, comprising of December, January and February, while June, July and August (JJA) indicates peak monsoon season, comprising of June, July, and August[201].

The other main criteria for promoting homestead gardening as a suitable climate change resilient livelihood option are:

- Potential to empower women through the possibility of maintaining gardens in proximity to households, ensuring the activity does not add to women's unpaid burden of work;
- Depending on the species grown, there is a moderate level of salinity resilience;
- Improved availability of fresh vegetables will lead to enhanced nutrient intake within the household.

**Implementation modalities and scope of proposed intervention:** The project will enable women to start homestead gardening in their households in wards with moderately saline soils. The women will receive assets and inputs (see Table 14) to grow plants on their own premises or, in rare cases, land in proximity to their houses will be leased. Groups of 25 women beneficiaries will be formed into one women's livelihood group (WLG) to jointly receive training, exchange experiences, and to jointly interact with other market actors in case they produce excess yields that can be sold at local markets. Since climate change will increase soil salinity in the future, the gardens will be grown in raised beds and the WLG will be introduced to

[198] M.A. Siddiky, P.K. Sardar, M.M. Hossain, M.S. Khan and M. Khabir Uddin. 2012. Screening of Different Tomato Varieties in Saline Areas of Bangladesh. Int. J. Agril. Res. Innov. & Tech. 2 (1): 13-18, June, 2012

[199] Ministry of Agriculture, Government of Bangladesh. 2010. Saline Soils of Bangladesh. Government of Bangladesh.

[200] Agrawala S, Ota T, Ahmed A, Smith J, Aalst Mv. (2003). Development and climate change in Bangladesh: focus on coastal flooding and the Sunderbans. Organisation for Economic Co-operation and Development (OECD)

[201] Ministry of Environment and Forest (2005). National Adaptation Programme of Action (NAPA): Final Report. Ministry of Environment and Forests (MoEF), Government of the People's Republic of Bangladesh, Dhaka

alternative growing techniques such as hydroponics, as well as integrated pest management to eliminate any use of inputs. As a contingency for severe climate-induced interferences with the uptake of this livelihood option, the project design allows for some of the women to uptake a second livelihood (see Section 7.7.1). More comprehensive information on project implementation modalities, sustainability mechanisms, Operation and Maintenance (O&M) training and exit strategies are described in Section 7.7.

**Suitability for engaging women:** Home gardening in rural Bangladesh has traditionally been undertaken by women who are also responsible for maintaining household food security and nutrition. Activities in the homestead in rural Bangladesh, ranging from selection of seeds to harvesting and storing of crops, are managed predominantly by women[15]. This existing responsibility and knowledge that women possess to manage homestead gardens can be utilised in this project. This will provide them with income opportunities. Further, the women are generally the nutritional gatekeepers of their households, meaning they are the principal decision-makers when it comes to procuring and preparing vegetables for their children. Therefore, if women are targeted there is a greater likelihood that the vegetables will be utilized for household consumption and will improve the nutrient content of the family diet, especially for children and women. Promoting homestead gardening as a climate change resilient livelihood can enable the women to work in proximity of the household and also take care of their children.

**Environmental sustainability:** There are no negative environmental impacts to be expected from this livelihood option as no chemical fertilisers or other harmful agricultural practices will be introduced. Production can be maximized using simple techniques such as mixed cropping, high quality seeds, raised beds, and organic fertilizer. Pesticide use should be prohibited, and can be avoided with Integrated Pest Control methods, such as hand collection, Neem extract application and bagging. The waste from the vegetables has nutrient enhancement potential for the soil after degradation.

**Economic sustainability and profitability potential:** Studies conducted around the world have shown that under most circumstances, home production of vegetables results in significant improvements in nutrient intake (availability and consumption) for women and children. It has been observed that vegetables produced in the garden are mostly consumed by household members. The same report concluded that the supplementary income earned from vegetable sales is used to purchase additional nutrient-rich foods.

Table 14 provides an example cost-benefit analysis of homestead gardening at household level for one female beneficiary (from one household). The calculation shows a positive profit margin in the case that the woman decides to sell all vegetables produced and not use them for household consumption.

*Table 12: Cost-benefit Analysis of Homestead Gardening for One Female Beneficiary (Over a 4-month Production Cycle on 4 Decimals of Land)*

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income:** | Potato | 6monds x BDT 680 | 3,840 |
| | Green chili | 3kgx BDT 200 | 600 |
| | Brinjal | 65kg x BDT 25 | 1,625 |
| | Bit | 20kg x BDT 14 | 280 |
| | Red amaranth (Lalsak) | 70kg x BDT 10 | 700 |
| | Cauliflower | 40 x BDT 40 / piece | 1600 |
| | Bitter gourd | 4kg x BDT 40 | 160 |
| | Radish | 40kg x BDT 16 | 640 |
| | Amaranth (palon sak) | 70Kg x BDT 10 | 700 |
| | **Total** | | **10,145** |
| **Cost of Production:** | | | |
| | Ledge value of land (4dec.) | 4Deci.x BDT 400/2 | 800 |
| | Potato seed | 20 kg x BDT 32 | 640 |
| | DAP Fertilizer | 4kg x BDT 28 | 112 |
| | TSP Fertilizer | 3kg x BDT 30 | 90 |
| | Boron | 200gm x BDT 40 | 800 |
| | Gypsum | 2kg x BDT 16 | 32 |
| | Paid labour (land preparation: potato, brijal, amaranth, cauliflower) | 4 nos x BDT 250 | 1,000 |

| | | | |
|---|---|---|---|
| | **Total Production Cost** | | **3474** |
| | **Gross Profit** | | **6,671** |
| | Finance charge (seasonal loan from MFI) | 12.5% interest rate for 5,474 capital over six months | 342.12 |
| **Net profit** | | | **4,328.87** |

### 6.3.2. Sesame Production

**Climate change resilience:** Sesame production in the coastal belt of Bangladesh is slowly gaining popularity among farmers primarily due to its relatively high saline tolerance. Sesame is able to tolerate up to 6ds/m, which resembles the lower band of projected salinity for the project area by 2050. Thus, the livelihood is being proposed, but only in those wards with a slightly higher elevation and lower-than-average on-the-ground saline soils. This higher elevation, alongside embankments, can safeguard sesame crops from waterlogging, which they are sensitive to. Besides the salt resilience, sesame has been selected due to its low demand for freshwater for irrigation. The FAO has piloted sesame cultivation in Bangladesh and concluded that the crop can also be grown in drought-affected areas with irregular rainfall, which makes it a suitable crop in light of climate change. Based on discussions with local farmers and upazila agriculture officers during the PRA exercise, it was understood that sesame cultivation is considered a potential local adaptation option in light of increasing salinity in the region. The only vulnerability against projected climate change impacts is that plants that are 50-100cm in size could be impacted by extreme cyclonic winds. However, sesame will be proposed as an option due to its other adaptive characteristics, but only in areas that are more elevated and sheltered from existing plantations against extreme winds. Beneficiaries will be trained to maximize harvests in advance of an extreme weather event, of which they will be notified by early warning systems.

The other main criteria for promoting sesame production as a suitable climate change resilient livelihood option are:

- Sesame is relative salt tolerant and tolerate up to EC 6 ds/m[202];
- Demands relatively little fresh water for irrigation;
- Very high profitability potential, existing markets and value chains, and increasing national and international demand.

**Implementation modalities and scope of proposed intervention:** The project will enable women to start cultivating sesame jointly as a group on one or several larger plots of leased land. The commercial viability of growing sesame only arises when it is grown at a larger scale. 25 women beneficiaries will be formed into one WLG and will be provided with assets and inputs (see Table 16) to start cultivating sesame within their ward, and in close proximity to their households. The WLGs will receive technical and business skills trainings, exchange experiences, and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

Sesame is produced in Bangladesh during October to March. It requires land free from waterlogging. High lands with sandy loam or loam soil will be selected for sesame cultivation. The land should be prepared for sesame cultivation between October and mid-November. The cultivation techniques currently used demand a range of fertilizers (see Table 15). In order to reduce dependence on inputs, as well as environmental impacts, beneficiaries will be trained in organic techniques by extension agents as well as in Integrated Pest Management. Sesame requires the first irrigation 25-30 days after the flowering stage. In the case of low or no soil moisture, a second irrigation can be applied after 55-60 days at its grain formation stage. Harvesting is usually carried out after 85 to 95 days of sowing.

*Table 13: Overview of Fertilizers Required for Sesame Production*

| Name of Fertilizer | Dosage per Hectare |
|---|---|
| Urea | 100 kg |
| TSP | 130 kg |
| MP | 40 kg |
| Gypsum | 100 kg |
| Zinc Sulphate | 5 kg |

[202]Idem 169.

| | |
|---|---|
| Boron | 8 kg |

**Suitability for engaging women:** Like other cash crops in Bangladesh, the cultivation process is predominantly carried out by men. The participation of women in sesame cultivation is primarily observed during and after harvesting, when the processing and drying of sesame is generally carried out by women. Value-addition activities, such as making sesame snacks and processing sesame oil, can also be carried out by women. The by-products obtained after the processing of sesame can be used as feed for household livestock, especially chickens, which can also be processed by women. These activities are more suitable at the community level and can help to generate a source of earning for women, mostly after the harvesting is completed.

**Environmental sustainability:** Chemical fertilizers such as urea, TSP, MP, gypsum, zinc sulfate and boric acid are often used which have negative environmental impacts and deplete soil quality overtime. Environmental impacts can be mitigated by encouraging Integrated Plant Nutrient management and the use of organic fertilizer (manure, crop residues, compost) to decrease input costs and promote soil health.

**Economic sustainability and profitability potential:** Table 16 provides a cost-benefit analysis of sesame production at community level (for 25 women producers) over one production cycle of 3.5 months. The profit of this livelihood is high. Market analysis shows that there is seasonal demand from local and international markets for sesame and there are several options for adding value to yields, including producing sesame snacks and oil.

*Table 14: Cost-benefit Analysis of Sesame for 25 Women (Over a 3.5-month Production Cycle, Once a Year, on 1 Hectare of Land)*

| Item | Detail | | Cost Breakdown | Cost in BDT |
|---|---|---|---|---|
| **Income** | Sale of Sesame | | 1250 Kg x BDT 50 | **62,500** |
| **Cost of production** | | | | |
| | Seed | | 7.5 kg x BDT 150 | 1,125 |
| | Fertilizer | | | 7,860 |
| | Paid labour | | 40 x BDT 400 | 16,000 |
| | Plough | | BDT 3,500 | 3,500 |
| | Land lease | | BDT 15,000 | 15,000 |
| | **Total production cost** | | | **43,485** |
| **Gross profit** | | | | **19,014** |
| | Finance charge (seasonal loan from MFI) | 12.5% interest rate for 45,486 capital over six months | | 5436 |
| **Net profit** | | | | **13,578** |

### 6.3.3. Hydroponics

**Climate change resilience:** The hydroponics method enables the cultivation of plants in a soil-less medium, or an aquatic-based environment. It uses mineral nutrient solutions to feed the plants in water, without soil. This allows the use of hydroponics to cultivate vegetables and other crops in areas with highly saline soils as long as the saline resilience of the plants correlates with the salinity levels of the fresh or brackish water used for irrigation. As outlined in the livelihood profile of homestead gardening, there are a range of vegetables and fruits that fulfil these criteria. A common form of hydroponics is vertical hydroponics, which can be located next to individual households or locations in proximity to houses that are sheltered from extreme winds.

In some flood affected parts of Bangladesh a unique hydroponics system is being developed in which plants can be grown on the water on a floating organic bed of water hyacinth, algae and other plant residues. This environmentally-friendly traditional cultivation technique utilizes the natural resources of wetlands to grow vegetables and other crops almost all year round providing high climate change resilience. In this form of hydroponics, the bed is made of biodegradable materials, it degrades day by day and after the full degradation, the bed can be used as compost for agriculture. In areas subject to prolonged floods and waterlogging, this Bengali form of hydroponics represents a potential climate resilient agriculture practice. Thus, both vertical hydroponics and this Bengali form of hydroponics will be proposed for this project. When hydroponics is employed, particularly without the use of fertilizers and pesticides, it can have significant environmental benefits.

The cyclone resilience of the technology depends on the location and scope of cultivation; hence site and crop selection can represent adequate risk mitigation options. Additionally, one growing cycle during the cyclone season can be avoided.

Other main criteria for promoting hydroponic gardening as a suitable climate change resilient livelihood option are:

- Potential to empower women through possibility to maintain garden in proximity to households;
- Depending on the species grown, there is moderate level of saline resilience;
- Improved availability of fresh vegetables enhances nutrient intake of household;
- Environmental benefits of low-input agriculture with locally sourced materials.

**Implementation modalities and scope of proposed intervention:** The project will enable women to start cultivating vegetables and other plants using the hydroponics technique. Both vertical hydroponics and floating garden hydroponic technique will be used, even within the same ward or by the same women's group. The allocation of which form of hydroponics will be provided to the women will depend upon on the geographic features of the ward and will be defined in consultation with stakeholders during the project implementation phase. 25 women beneficiaries will be formed into one WLG and will be provided with assets and inputs (see Table 17) to start hydroponic gardening within ponds in their wards or in land close to their households. The scope of the hydroponic gardens will vary between different sites, however it is expected that gardens will be maintained by 2 females or small sub-groups. The WLGs will receive technical and business skills trainings, exchange experiences, and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

**Suitability for engaging women:** Hydroponics cultivation increases the capacity of poor and marginal peasants, including extremely poor women, to adapt to increasing precipitation. Women will be able to cultivate eco-friendly vegetables and other crops year-round to enhance family income and nutrition.

**Environmental sustainability:** The abundance of rivers and canals in the target region is appropriate for the promotion of floating gardens. Given the salinity of the rivers in the target region, this livelihood option will adopt those plant varieties most tolerant to salinity. Moreover, floating gardens are functional for most part of the year. Even during storm surges, the buoyancy of floating gardens facilitates resilience and sustainability of this option. As this livelihood option will be placed in water that means, it does not require irrigation. Platforms for floating gardens are typically constructed with natural materials, including bamboo and water hyacinth, an invasive aquatic weed, which is abundantly available, and uses minimum inputs. It is essential that as the practice expands, fertilizers and pesticides be avoided as this can have severe impacts on water quality. Overall, the agricultural practice is well-established, uses few inputs, is culturally appropriate and can have significant environmental benefits (if no inputs are used).

Key environmental benefits of hydroponics include:[203]

- Requires up to 50 per cent less land to grow the same amount of crops, leaving more land for other uses such as wildlife reserves, and can save trees which would otherwise be cleared for agricultural purposes.
- Requires 10 per cent less water than would be required for growing in soil. The only water lost with hydroponics is through evaporation or occasional changes to the feeding solution.
- Requires 60 per cent less fertilizer. The hydroponic growing solution circulates through the plants roots, the plants absorb what they need, and nutrients are not lost due to settling or crystallizing in the soil. Only organic fertilizer will be employed and carefully limited to ensure that eutrophication impacts on rivers are minimal.
- No pesticide use. Due to the fact the use of soil is eliminated (which holds bacteria and many common insects), there is no need for toxic pesticides to protect plants. The use of pesticides will be prohibited and Integrated Pest and Nutrient Management techniques will be taught to beneficiaries.

[203] Wimmer, C. (2014) *The Environmental Benefits of Hydroponics,* ECOPOST July 14, 2014, available at: https://ecopostblog.wordpress.com/2014/07/14/the-environmental-benefits-of-hydroponics/

**Economic sustainability and profitability potential:** Table 17 below provides a cost-benefit analysis of a floating hydroponic garden implemented at household level in 25 households. It shows a clear positive profit at the end of a 4-month production cycle.

Table 15: Cost-Benefit Analysis of Hydroponic Farming at Household Level for 25 Households (Over 1 Acre of Land, during a 4-month Production Cycle)

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income** | 18,000 kg kang kong | 18,000 Kg x Av. BDT 15 | 270,000 |
| | 1,600 kg vegetable | 1,600 kg x Av. BDT 21 | 33,600 |
| | **Total sale value** | | **303,600** |
| **Cost of production** | | | |
| | Seed 37,500 gm x BDT 1 | 37,500 gm x BDT1 | 37,500 |
| | Bamboo 200 gm x BDT 110 | 200 gm x BDT 110 | 22,000 |
| | Nylon net and rope 75 kg | 75 kg x BDT 534 | 40,050 |
| | Labour for water hyacinth collection & bed preparation | 400 x BDT 250 | 100,000 |
| | **Total production cost** | | 199,550 |
| | **Gross profit** | | **104,050** |
| | | | |
| | Finance charge (if capital covered from 1 cycle out of 3 cycles a year) | 12.5% interest rate for 104,050 capital for four months | 5,419.27 |
| **Net profit** | | | **98,630.73** |

### 6.3.4. Aqua-geoponics

**Climate change resilience:** The climate change resilience of aqua-geoponic systems is comparable to the floating garden hydroponic system. Aqua-geoponics systems combine aquaculture fish cultivation with hydroponic gardening (see pictures below) through creating a mutual-beneficial relationship between fish and plants[204]. The pictures show a form of aqua-geoponics as a floating system in a water body, which will be proposed in this project. This Integrated Floating Cage Aqua-geoponics System (IFCAS) has been developed by Haque for shaded ponds (traditional rural homestead ponds where there are large trees) across the Barisal region of Bangladesh[205]. This technique allows households to produce fish and vegetables simultaneously from shaded ponds where previously it was not possible to produce vegetables on dikes due to lack of available sunlight and presence of roots of larger trees. This system simplifies the process even during the peak monsoon season when it is difficult to harvest fish from deeper ponds because of the irregular nature of the pond bottom.

The salinity resilience of the proposed aqua-geoponic systems, or the cultivated plants and grown fish, needs to correlate with the salinity levels of the brackish water in which the system will be located. As outlined in the livelihood profile of homestead gardening, there are a range of vegetables and fruits that are suitable for cultivation with brackish water for irrigation. As for the fish, a brackish water fish species with a salt resilience that correlates with the chosen pond/ water body will be used.

The cyclone resilience of the systems depends on the location and scope of the cultivation; hence site, fish species and crop selection can provide adequate risk mitigation options. Additionally, one growing cycle during the cyclone season can be avoided.

Other main criteria for promoting aqua-geoponics as a suitable climate change resilient livelihood option are:

- Potential to empower women through possibility of maintaining garden in proximity to households;
- Depending on the species grown, there is moderate level of saline resilience;
- Improved availability of fresh vegetables enhances nutrient intake of household.

[204] Hazrat, A. et al. (2016) 'Suitability of Different Fish Species for Cultivation in Integrated Floating Cage Aqua-geoponics Systems (IFCAS) in Bangladesh', *Aquaculture Reports*, vol. 4, pp. 93–100
[205] Idem 176

**Implementation modalities and scope of proposed intervention:** The project will enable women to start cultivating plants and brackish water fish using the floating aqua-geoponics systems. 25 women beneficiaries will be formed into one WLG and provided with assets and inputs (see Table 18) to start aqua-geoponic gardening and fish cultivation within ponds in their wards and in proximity to their households. Due to the high input cost and profitability, inputs will only be provided once in the project. The women are expected to purchase inputs from the revenues as co-finance and in order to increase their sense of ownership. The scope of the aqua-geoponic systems will vary between different sites, while it is expected that most beneficiary groups will maintain 25 units owned by individual households in one aqua-geoponic system. The WLGs will receive technical and business skills trainings, exchange experiences, and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

**Suitability for engaging women:** The process of aqua-geoponics is relatively new in Bangladesh. Given the nature of its operation, it is suitable to be managed in a household where there is a pond. As women have access to the household ponds, they would be able to take care of the fish, as well as the vegetables grown in the IFCAS system. However, the suitability of women using this approach at the community level has not be explored yet, as this is a new system and only limited data is available on socio-economic outcomes for women. Given that cages can be heavy, certain studies have shown that careful intervention design can improve usability of such systems for women. Care will also have to be taken to ensure that women retain ownership and control of assets, through community sensitization, tenure arrangements and monitoring.

**Environmental sustainability:** Salinity of 2.71 ppt can be sustained with this technology. Low risk of damage from flooding causes by tides and cyclones is another positive feature of this livelihood option. The fish grown in the system release ammonia and the plants in the integrated systems take in the ammonia through their root systems as nutrients, thereby purifying the water. This can be considered a natural cleaning process for the ecosystem. Seasonal choices can be made to avoid the risk of severe cyclone damage. Aqua-geoponics is an environmentally friendly practice that involves the cultivation of crops in a non-soil medium (known as hydroponics) by feeding the plants with nutrient-rich water from intensively cultured aquatic organisms such as fish (i.e. aquaculture). The benefits to aqua-geoponic crop production include increased plant growth rates, a smaller production footprint than soil cropping, reduced water resource inputs and reduction of plant pathogens.[206] Finally, care will be taken to ensure no pesticides are used which would accumulate in fish. Fertilizer is not required given the ammonia released by fish. The fish species proposed are varieties of local mullet with high salinity tolerance and which do not require fish in their feed (there are not carnivorous). This reduces costs and the impacts of cultivation.

**Economic sustainability and profitability potential:** A cost-benefit analysis was performed to calculate the profitability of this option under different circumstances. The structural cost of IFCAS is USD11 per year based on depreciation costs. Fish production in IFCAS as a fixed cost for a four-month trial is estimated at USD3.7. The average four-month gross income from fish and vegetable production in IFCAS varies from USD61 to USD144. Average gross income is USD119 and USD83 for moderately shaded ponds (MSP) and highly shaded ponds (HSP), respectively, which is significantly different ($P < 0.05$) because of the different levels of production. Table 18 below shows a cost-benefit analysis of aqua-geoponics for one household over a 4-month production cycle.

*Table 16: Cost-benefit Analysis of Individual Floating Cage Aqua-geoponic System (9 cubic metres) for One Household (Over a 4-month Production Cycle)*

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income** | 150 kg climbing perch (Vietnamese *koi*) | 150 Kg x Av. BDT 150 | **22,500** |
| | 16 kg vegetable | 16 kg x Av. BDT 21 | **336** |
| | **Total sale value** | | **22,836** |
| **Cost of production** | | | |
| | 9 cubic meter cage construction (can use 21 cycles, so @ BDT 444/cycle) | BDT 9,315/21 | 444 |
| | Fingerling (1,500@ BDT 2.50 /nos) | BDT 2.5 x 1,500 nos | 3,750 |

[206] Pattillo, A. (2016). *Food Safety, Economics and Environmental Impacts of Aquaponics in Iowa*. Leopold Center Completed Grant Reports, Report No 507. Available online at: http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1506&context=leopold_grantreports

| | | | | |
|---|---|---|---|---|
| | Vegetable seedling (6 nos@BDT5) | | BDT 5 x 6 | 30 |
| | Fish feed (180 kg x BDT 46) | | BDT 46 x 180 Kg | 8,280 |
| | **Total production cost** | | | 12,504 |
| | **Gross profit** | | | **10,332** |
| | | | | |
| | Finance charge (if capital covered from 01 cycle out of 3 cycles a year; 33%) | 12.5% interest rate for 10,332 capital over four months | | 430.50 |
| **Net profit** | | | | **9,901.5** |

### 6.3.5. Plant Nursery for Fruit Trees

**Climate change resilience:** Plant nurseries have been selected as a climate change resilient livelihood suitable for the project region due to the relatively high flexibility in the selection of plants grown and potential benefits for climate risk protection (e.g. from cyclones) through increased tree plantation due to the enabling nature of the nursery. Salt resilient tree species able to cope with the projected soil salinity levels by 2050 outlined above include *Acacia auriculiformis, Acacia hybrid, Achras sapota, Casuarina equisetifolia, Leucaena leucocephala* and *Tamarindus indica*, all of which are moderately salt tolerant[207]. Further, according to farmers experiences, coconut, velvety apple and date palm are high salt tolerant species[208]. Coconut and date palm, for example, can withstand salinity levels of 12.1-16.0 ds/m[209].

Small-scale nursery owners can play a vital role in biodiversity conservation and improving the resilience of the coastal zone against extreme winds through providing seedlings for forest tree species, horticultural species, flower species and medicinal plants appropriate for afforestation, reforestation, social forestry, agro-forestry, shelter belts and home gardening in the target geographic areas of Bangladesh.

Other main criteria for promoting tree nurseries as a suitable climate change resilient livelihood option are:

- Some fruit tree species, such as coconut, velvety apple, tamarind, and date palm, are highly salt tolerant[210].
- Potential to be practiced at a community level and to enhance the companionship and climate resilience within.
- There is a steady local demand for fruit trees.

**Implementation modalities and scope of proposed intervention:** The project will enable women to join up as a group to start growing fruit trees to a marketable size on one or several plots of leased land. 25 women will be formed into one WLG and provided with assets and inputs (see Table 19) to start the plant nursery within their ward and in proximity of their households. Due to the high input cost and profitability, inputs will only be provided once by the project. The women are expected to purchase inputs from the revenues as co-finance and in order to increase their sense of ownership. The WLGs will receive technical and business skills trainings, exchange experiences, and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

**Suitability for engaging women:** Plant nurseries are well-suited to women. The maintenance of a plant nursery requires a certain level of capacity development, which, if provided to women, would be able to generate employment opportunities and income. This activity is best suited for implementation at community level, hence the need to create WLGs to carry out the activities in coordination.

**Environmental sustainability:** Smaller scale plant nurseries, mainly for fruit trees, do not create any significant environmental risks.

**Economic sustainability and profitability potential:** Table 17 shows the cost-benefit analysis for a plant nursery engaging 25 women, showing that this livelihood activity is profitable.

[207] Salt Tolerances of Some Mainland Tree Species Select as Through Nursery Screening http://scialert.net/fulltext/?doi=pjbs.2013.945.949&org=11
[208] Islam S.A., Miah M.A.Q. and Habib M.A.(2013). Diversity of fruit and timber tree species in the coastal homesteads of southern Bangladesh. *Asian. Society Bangladesh*, Sci. 39(1): 83-94.
[209] Idem 173
[210] Idem 208

*Table 17: Cost-benefit Analysis of Plant Nursery for 25 Women (Over a One-year Production Cycle on 1 Hectare of Land)*

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income:** | Fruit (8,210 x BDT 28), medicinal and ornamental (8,260 x BDT 27) and wood /forest plants (9,000 x BDT 45) /ha | (229,880 + 223,020 + 405,000) | **857,900** |
| **Cost of production: Variable cost** | | | |
| | Seed and seedling | - | 146,045 |
| | Organic manure: cow dung | 20,000 kg x 4 | 80,000 |
| | Organic manure: oilcake | 600 kg x BDT 10 | 6,000 |
| | Chemical fertilizer (Urea, TSP, MoP) | 2,349 x BDT 10 | 23,490 |
| | Soil | - | 8,000 |
| | Additional labour | 2 x BDT 84,000 | 168,000 |
| | Earthen top | - | 40,000 |
| | Polythene | - | 20,000 |
| | Irrigation charge | - | 15,000 |
| | Insecticides | - | 7,052 |
| | **Total variable cost** | | **513,587** |
| **Cost of production: Variable cost** | | | |
| | Cost of family/ community labour | - | - |
| | Land leasing | 1 ha | 25,000 |
| | Depreciation of tools & equipment | - | 3,000 |
| | **Total fixed cost** | | **28,000** |
| | **Total cost** | | **541,587** |
| **Gross Profit** | | | 316,312 |
| | Finance charge (seasonal loan from MFI) | 10% interest rate for 45,486 capital over six months | 54,159 |
| **Net profit** | | | **262,155** |

### 6.3.6. Crab Farming

**Climate change resilience:** Crabs can withstand high levels of salinity, of between 5 and 40 ppt, and are, thus, suitable for coping with projected salinization in the target areas. Ponds will be protected against cyclone-induced inundations using embankments and are relatively resilient against extreme winds. In the project region, there is an existing market, which is currently expanding, and the farming practice builds upon existing skills of many beneficiaries.

Other main criteria for promoting crab farming as a suitable climate change resilient livelihood option are:

- Potential to empower women due to the possibility of operating in proximity to households;
- Crabs have a short production cycle of 12 to 22 days, demonstrate high profitability potential and can be sold in existing market structures.

Crab cultivation is an increasingly popular livelihood option in the Bay of Bengal due to increasing salinity levels and reduced availability of arable land. However, unless informed by sustainable practices and appropriate regulations, this livelihood option could further marginalize the poor due to elite capture. Thus, the GCF project has the opportunity to lead climate resilient and fair development in the coastal region through enabling coastal women to grow crab seedlings to marketable sizes and adopt sustainable cultivation techniques.

The major challenge related to establishing crab farming in Bangladesh is the scarcity of seed. Wild populations of mud crab are declining throughout Southeast Asia due to over-exploitation, loss of natural mangrove habitat and coastal environmental degradation from erosion and tidal surges. In order to mitigate these challenges, it is essential to develop a market system that supports crab farmers with sufficient non-wild cultivated crab fries and seedlings. This means promoting the establishment of hatcheries and nurseries in the target region, which would reduce demand for wild crab seedlings. This would also mean that a new value chain revolving around the crab hatcheries and nurseries could be developed, thereby creating further job opportunities.

**Implementation modalities and scope of proposed intervention:** The project will enable women to join up as a group to start cultivating crabs to a marketable size in around 33 decimal ponds. The project will lease ponds that were previously used for shrimp farms or rice paddies, but will not convert agriculture land into crab farms. 25 women beneficiaries will be formed into one WLG and provided with assets and inputs (see Table 21) to start the crab farm within the proximity of their households. The WLGs will receive technical and business skills trainings, exchange experiences and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

**Suitability for engaging women:** Women will be given the opportunity to participate throughout the crab value chain and will be trained in aquaculture techniques and management. Pond-based crab nurseries and crab fattening will be established in community locations, chosen according to environmental considerations and community preference, while also being within 2km of households so that women can engage in this option through both farming and in other parts of the value chain where they are currently under-represented, such as buying and selling. The overall production process of crab fattening has great potential to be executed at community level, and establishing community farms rather than household farms will allow for more rigorous environmental management of each pond. Defective crabs that cannot be exported can provide a source of nutrition for the household as well.

**Environmental sustainability:** Crab can be cultivated in semi-saline water and demonstrate potential for adaptability to increasing salinity. Existing value chain actors in the target region can play a crucial role in ensuring the long-term commercial production of crabs. A major environmental and sustainability consideration is that once a farmer cultivates crab on a piece of land he cannot go back to other crops as the land becomes infertile. For this reason, and to avoid the maladaptation impacts of shrimp farming, only land that has already been converted for shrimp ponds will be used.

The expert panel responsible for reviewing the livelihood options proposed in this study identified a few environmental risks and mitigation options related to crab farming, as described in Table 20 below:

*Table 18: Environmental Risks of Crab Farming and Mitigation Options*

| Risk | Level | Mitigation Options |
|---|---|---|
| Over-extraction of wild stocks while catching crablets | High | For crab farming intensification, wild catch will be prohibited and training will be given to local communities on the problems associated with over-extraction of wild fry and crablets. Government and private sector initiatives to establish crab hatcheries in the area are progressing, and will be supported by the project, which will supply the wild stock required for nurseries and farming, providing an alternative to wild sourcing of crablets. |
| Location of aquaculture can pose a risk to mangrove conservation | Medium | All crab farming areas will be chosen inland and the siting will be strictly controlled so as to avoid encroachment into mangrove areas or damage to mangroves. The farms will use existing shrimp *ghers* and will not convert any land that can be used for other purposes, such as agriculture. The project will also support community sensitization in mangrove conservation. |
| Potential of increasing human-wildlife conflicts | Medium | Human-wildlife conflicts occur in areas within mangroves that act as a habitat for a range of species including large mammals such as the Royal Bengal Tiger. These conflicts can occur due to communities entering protected mangrove areas to collect fuelwood, for fishing and for non-timber forest products such as wild fry. As the project will propose creating market linkages for crab farming through the establishment of hatcheries, dependency on wild stock will be reduced, thereby reducing human wildlife conflicts. |
| Potential for crab farming in brackish water may lead to increased salinization in soil and water bodies | Medium | The root cause of salinity is linked to the increased salinity in coastal river systems due to SLR and tidal surges, and has been exacerbated in the study areas through the use of saline water for shrimp farming on agricultural land. The project will avoid converting land that can be used for agriculture and that is not already inundated with brackish water. Crabs farms will only be placed in converted shrimp *ghers* located in the tidal zones, which naturally experience saline water inflows. Pond soil will be tested in order to determine the potential for salinity seepage into surrounding areas, and, if appropriate, will be lined with clay. Soil and water will be monitored in order to ensure that salinity levels in surrounding soil and water bodies are not increasing as a result of seepage or water releases. |

**Economic sustainability and profitability potential:** Table 19 shows the cost-benefit analysis for crab farming engaging 25 women. The CBA shows that this livelihood activity is profitable.

*Table 19: Cost-benefit Analysis of Community Level Transgender Crab Farming for 25 women (Over a 2.5-month Production Cycle, Four Cycles per Year (with a 3-month Break to Respect the Government Ban) in 1 Bigha (33 Decimal) Pond)*

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income:** | Crab (300Kg, @ av. BDT 750, from F1 to F2 size) | 2,800 Kg x BDT 750 | **210,000** |
| **Cost of production:** | | | |
| | Pond lease for one cycle (BDT 7,000/yr) | BDT 7,000/4 | 1,750 |
| | Bamboo (07 peace for two years) | BDT 250 x 7/8 | 218.75 |
| | Nylon Rope (1.5 Kg, @BDT 165) | BDT 165 x 1.5 kg | 248 |
| | Lime (10kg, @BDT 16) | BDT 16 x 10 kg | 160 |
| | Small Crab (KS3 crab, 200kg, @BDT 300) | BDT 300 x 200 Kg | 60,000 |
| | Feed (small snail, 10 beg, @BDT 300) | BDT 300 x 10 | 3,000 |
| | Labour for pond repair (10) and harvesting (3) | BDT 300 x 13 | 3,900 |
| | Transport cost | | 1,000 |
| | **Total production cost** | | **70,276.25** |
| **Gross Profit** | | | **139,723.75** |
| | Finance charge (if capital covered from 1 cycle out of 4 /year; 25%) | 6.25% interest rate for 69,276.75 capital over six months | 8,732.73 |
| **Net profit** | | | **130,991.02** |

### 6.3.7. Crab Nursery

**Climate change resilience:** Crabs can withstand high levels of salinity, of between 5 and 40 ppt, and are, thus, suitable for coping with projected salinization in the target areas. As outlined above, it will be essential to establish crab nurseries and hatcheries alongside crab cultivation in order to mitigate the pressure on natural environment and neighbouring Sundarbans. Currently, seed crabs are collected entirely from natural habitats in Bangladesh. Usually, mud crabs mature at a carapace width of 10cm at the age of about six months and spawning takes place within 10 days after eyestalk ablation. Hatching takes place after about 17 days of spawning at temperatures between 23° and 25°C. A 250g female may produce up to 1.5 million first zoea (Z1) larvae, which take 2-3 days for each intermoult to reach the megalopa stage. The megalopa in 7-8 days metamorphoses to the first crab (juvenile) stage.

Other main criteria for promoting crab nurseries as a suitable climate change resilient livelihood option are:

- Relatively cyclone and extreme wind resilient;
- Provides inputs of crab seedlings to crab farms and prevents wild catching of crab seedlings in local river systems;
- Increasing market demand for crab seedlings.

The hatching rate may be close to 100 per cent, however mortality is heaviest during changes between zoea, megalopa and juveniles. Various feeds including the rotifer (Brachionus chlorella), the brine shrimp (Artemia) and copepods are used to feed the larvae.

**Implementation modalities and scope of proposed intervention:** The project will enable women to join up as a group start crab nurseries and breed crab fries and crab seedlings. The crab seedlings will be grown in around 33 decimal ponds, whereas highly saline seawater (22-35ppt) is best for larval rearing and parts of the nurseries. In order to avoid any leakage of saline water into surrounding areas, the ponds will be surrounded by clay front liners after soil testing. The project will lease ponds that were previously used for shrimp farms or rice paddies, but will not convert agriculture land into crab farms. 25 women beneficiaries will be formed into one WLG and provided with assets and inputs (see Table 22) to start the crab farm within the proximity of their households. The WLGs will receive technical and business skills training, exchange experiences and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

**Suitability for engaging women:** Information about women's participation in crab nurseries is currently limited, however, observations indicate that women play an integral role in mud crab farming in Bangladesh. Many women in the target districts of Sathkira and Khulna are already directly involved in mud crab farming through participation with their families. Similar to

the fish and shrimp value chains, women are mostly involved in applying feed to crabs and harvesting, with fewer currently involved in pond preparation before stocking. Participation of women in crab marketing is very low. Furthermore, women also tend to be involved in wild fry collection, often facing dangerous working conditions and harassment. The promotion of hatcheries and supporting women to participate in all aspects of the crab value chain, therefore presents a gender transformative approach in the target districts.

**Environmental sustainability:** Mud crab farmers still depend largely on natural wild seed. Therefore, availability of seed is a limiting factor for the expansion of crab culture in Bangladesh. Most farmers collect crab seeds from the tidal rivers and seacoast by using different nets, which can have a negative impact on local biodiversity. The potential environmental risks of crab farming and hatchery is described under the previous Chapter. It is essential that crab farming expansion depend on hatchery stock rather than wild stock, given that mud crab culture is already a significant industry for poor coastal communities. The project will also include regulatory support for better crab conservation in the Sundarbans and the prohibition of wild fry collection.

**Economic sustainability and profitability potential:** Table 20 shows the cost-benefit analysis for a crab nursery engaging 25 women. The CBA shows that this livelihood activity is profitable.

*Table 20: Cost-benefit Analysis of Individual Crab Nursery Engaging 10-12 Women (One 40-day Production Cycle in 17 Decimals (12 Decimals for Rearing and 5 Decimal for Further Rearing), 9 Cycles in a Year)*

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income** | Crablet @ 180 (80-100gm) | 150 Kg x BDT 180 | **27,000** |
| **Cost of production** | | | |
| | Pond lease value (01 cycle for 17Decimal,) (BDT 4,000 per year /33 Decimal) | BDT 2,060/9 | 229 |
| | Pond-1 (12 Decimal Hapa) preparation (3 nos) | BDT 900 x 3 | 2700 |
| | Bamboo for hapa preparation (2 nos, BDT 300) | BDT 300 x 2 | 600 |
| | Crablet (3-5 gm, @BDT 2; 1,800 pcs) | BDT 1,800 x 2 | 3,600 |
| | Feed (90 Kg, @BDT 10 /Kg) | BDT 90 x 10 | 900 |
| | Pond-2 preparation (net bamboo rope) (5 decimal) for rearing grow out phase | BDT 250 x 3 | 750 |
| | Additional labour and other costs | - | 1500 |
| | **Total production cost** | | **10,279** |
| **Gross Profit** | | | **16,721** |
| | Finance charge (capital covered from MFI as credit, interest 25% per year) | 2.78 % on BDT 10,279.00 for one cycle (40 days) | 286 |
| **Net profit** | | | **16,435** |

### 6.3.8. Crab and Fish Feed Processing Enterprises

**Climate change resilience:** The climate change resilience of crab and fish feed processing can be considered high because the activity is not directly dependent on freshwater or soil to cultivate any species, but solely requires handling inputs in a sheltered building. The livelihood will take place indoors and will involve the use of processing machinery. Thus, the vulnerability of the activity is predominately determined by the location of the machinery and building structure in which it is housed. Both factors will be considered in the site selection process and higher elevated areas and cyclone resistant (existing) buildings will be chosen to set up operations of the processing facility. The potential impact from climate change on the production could stem from a shortage of specific ingredients, whereas the overall supply is not threatened under current projected climate change impact scenarios. The main ingredients for crab and fish feed processing will be a mixture of rice bran, maize, mustard oil cake, soybean and shrimp head, all of which are readily available locally.

Other main criteria for promoting crab and fish feed processing as a suitable climate change resilient livelihood option are:

- Potential to empower women through the possibility for operations in close proximity to households.
- High market demand and profitability prospects through evolving aquaculture economy in southwest Bangladesh
- It fills a gap in the current value chain of the aquaculture sector in southwest Bangladesh and can promote climate resilient development of the sector

**Implementation modalities and scope of proposed intervention:** The project will enable women to start processing and producing crab and fish feed as a group at a joint production site on leased land and rented building structures. Usually, a one storied L-shaped 25 square feet building is required for a fish feed processing plant, and a similar structure will be used for the crab and fish feed processing. As the process of crab and fish feed production is labour intensive at the proposed scale, a total of 25 women will be formed into a WLG and provided with one processing machine, along with other assets and inputs (see Table 23) to start operations within their ward and in proximity to their households. Some group members will receive extensive training on operations and maintenance of the machinery. All WLG members will receive technical skill training to use the machinery and business skills trainings, exchange experiences and market linkages with suppliers and buyers will be facilitated. More comprehensive information on project implementation modalities, sustainability mechanisms, O&M training and exit strategies are described in Section 7.7.

The energy supply for machinery will initially be covered through the national grid. The WLG will be encouraged to build up savings from their profit to invest in a solar system. The scale of the operation can be considered small to medium, with the women operating one machine with a production capacity of 500kg crab/fish feed per day. Accordingly, total crab/fish feed production during one month would be 15,000kg.

**Suitability for engaging women:** This livelihood option is suitable for women who can be engaged as processors, labourers or forward market-linking entrepreneurs. Feed processing will be carried out at community-level activity and within a suitable range of the women's households.

**Environmental sustainability:** Feeds are the main nutrient input in aquaculture operations and their environmental impacts stem from sourcing the ingredients used to make the feed itself, as well as the role of the feed within fish and crab farming. The environmental impacts of feed when used during farming include nutrients (mainly ammonia) excreted by fish and crab through their gills, faeces and urine, and unused feed can contribute to nutrient loads in the water. The main products released into natural water are nutrients such as phosphorus and nitrogen, as well as solids. Most solids produced from uneaten feeds and faeces settle in the sediment within and near the farm, and depending on depth, currents and mixing will likely have eutrophication impacts near the farm. The flux of ammonia and phosphates to the overlying water layer may also lead to changes in the structure of the benthic population. These effects of fish/crab feed on the environment can be minimized by employing adequate measures relating to the management of fish/crab farms, and by implementing an optimized fish/crab feeding management system. Some key measures include: (i) suitable site selection and timed releases to maximize dispersion and mixing; (ii) water depuration and recirculating system; (iii) integrated aquaculture and polyculture; (iv) biological alternatives to drugs; (v) farm environmental management (vi) lowering nitrogen and phosphorus content of feeds; and (vii) use of enzymes in the feed.

To minimize any risk towards the environment through fish/crab feed processing, care must also be taken not to waste feed. Some feed waste is unavoidable, but can be minimized to reduce pollution. One way to reduce waste in the aqua-geoponics cage systems is to use currently available equipment for feeding control.

**Economic sustainability and profitability potential:** There are more than 33,571 pond and shrimp *gher* in the study area where people are cultivating brackish water fish such as Vangon, Bata, Paira, Vetki and Tilapia, as well as shrimp along with crab[211]. As a result, there is huge demand for fish feed in the area. The present study found that an average of 70 to 80 tons of feed per day is require in each upazila yet at present only 50 to 60 tons/upazila is being supplied by local feed dealers. CP, Mega and Aftab fish feed companies are prominent in these areas for supplying fish feed.

The manufactured ready feed available from a range of private sector companies such as Mega Feed and Globe Feed are inadequate for meeting demand in the south-western coastal area. In fact, the availability and use of ready feed is low due to limited market penetration. Farmers have complained about the quality of fish ingredients and ready feed. The Fisheries Department has limited manpower, less control over the feed market and often does not give priority to controlling or monitoring the quality of fish feed rigorously. Hence the proposed livelihood option represents an appropriate measure for providing a regular supply of quality feed to the target region. The processing enterprises should be linked to groups of fish and crab farmers in order to create a win-win solution: regular feed supply and profit for feed processors. For example, a fish/crab feed processing group could be linked with two or more aqua-geoponics and crab farming groups.

[211] Idem 56.

A critical factor of fish/crab feed production or processing is the availability of feed ingredients at low prices in required quantity, availability of electricity, gas and water supplies, adequate storage facilities, maintaining production records and management practices for successful marketing and traceability and developing strong market linkages for effective sale of fish feed. The procurement of ingredients at the lowest prices will be required to maximize profitability and will rely on sourcing from wholesale stores/markets in the area and procurement of agricultural by-products, such as rice bran from rice processing plants. Other key activities include checking the quantity and quality of the raw materials procured. Once the raw materials are procured, the main steps in small-scale feed preparation include grinding, screening, weighing, mixing, kneading, pelleting, drying and packaging.

Table 21 shows the cost-benefit analysis for fish/crab feed processing engaging 25 women. The CBA shows that this livelihood activity is profitable.

*Table 21: Cost-benefit Analysis of Community Level (25 Women Processors) Crab Feed Processing (30-days Production/ Processing Cycle (4 decimal)*

| Item | Detail | Cost Breakdown | Cost in BDT |
|---|---|---|---|
| **Income** | Sale of 15 M. tons/month | Av. BDT 80/ kg x 500Kg /day x 30day | **1,200,000** |
| **Cost of processing business: dry condition** | | | |
| | Land lease (4 dec@ BDT 4,000/yr 0.5 yr) | BDT 4,000/12 | 333.33 |
| | Depreciation of machines (a combine system with 1 holler for dry shrimp head: BDT25k ,1 for maize BDT 35k, 1main holler BDT 30K): BDT 90,000 | BDT 90,000 x .1/12 (av. 10 years life time) | 750 |
| | Electricity bill (@BDT 1,500 x 1 months) | BDT 1,000 x 1 months | 1,500 |
| | Paid labour (1 no, BDT 12k/ month) | BDT 12,000 x 1 months | 12,000 |
| | **Cost of feed Ingredients** | | 0 |
| | Shrimp head dry (50 kg/day, BDT300/kg) | 50 kg x BDT 300/kg x 30 days | 450,000 |
| | Maize (100 kg/day, BDT 25/kg) | 100 kg x BDT 25/kg x 30 days | 75,000 |
| | Soy bean (50 kg/day, BDT 40 /kg) | 50 kg x BDT 40/kg x 30 days | 60,000 |
| | Mustard oil cake (100 kg/day, BDT 35/kg) | 100 kg x BDT 35/kg x 30 days | 105,000 |
| | Rice bran (150 kg /day, BDT 14 /kg) | 150kg x BDT 14/kg x 30 days | 63,000 |
| | Fish processing dry by-products (50kg/day, BDT150/kg) | 50 kg x BDT 150/kg x 30 days | 225,000 |
| | Vitamins & minerals (5 kg/day, BDT 150/kg) | 5 kg x BDT 150/kg x 30 days | 22,500 |
| | Salt (5Kg/day, BDT25/Kg) | 5 kg x BDT 25/kg x 30 days | 3,750 |
| | **Total processing cost** | | **1,018,833.33** |
| **Gross profit** | | | **181,166.67** |
| Capital expenditure (SME loan 10% from bank) | | | 8,490.28 |
| **Net profit** | | | **172,676.39** |

### 6.4. Profiles of Interventions for Climate Resilient, Value Chain Development and Market Linkages

It is important to support climate resilient, value chain development in order to enable livelihoods to function at scale. The following Chapter provides an assessment of the two relevant value chains in the region to the proposed options, namely the crab value chain and the vegetable value chain. It is based on a market and value chain assessment as well as local expert and stakeholder consultations (see Stakeholder Engagement Plan in Annex XIIId of the GCF proposal). A value chain analysis was conducted in all five targeted upazilas between 4$^{th}$ and 11$^{th}$ February 2017. Through the assessment it became apparent that there is a need to upgrade (an) existing crab hatchery/ies to allow for sustainable development of the crab value chain and implementation of the proposed interventions under this project.

#### 6.4.1. Climate Resilient Crab Value Chain

This value chain is of relevance to the proposed livelihoods of crab nursery, crab farming, and crab and fish feed processing. The crab value chain is resilient to climate change impacts in line with the identified climate change resilience of the crab fattening/ farming, crab farming livelihoods and crab feed processing (see Sections 6.1, 6.3.6, 6.3.7 and 6.3.8), it is apparent that the crab feed value chain and economic sector is able to cope with increasing salinization processes. Raised embankments and considerations of cyclone impacts in the design of new infrastructure and crab farms can make the value chain entities resilient against strong winds and inundations. Ongoing coastal development projects (see Feasibility Study –

Annex IIa – of the GCF proposal) are improving the coastal road and transport infrastructure, also considering projected climate change impacts in their design.

**Current nature of the value chain:** Crab fattening is a climate change resilient and profitable livelihood option, which is growing and gradually turning into one of the main livelihood options in coastal Bangladesh. There are three types of crab fattening: (i) Male crab fattening; (ii) Female crab fattening; and (iii) Transgender crab fattening. Female and transgender crab fattening is more profitable. Poor and vulnerable populations in the coastal zone are currently participating in crab fattening along with fish and shrimp culture. While crab farming based on the collection of crabs from the wild for fattening or grow-out has probably taken place for hundreds of years, the availability of wild seed has become a limiting factor due to over-extraction. Recognizing this challenge, the GoB has recently invested in the hatchery production of crabs, with most research and development taking place over the last few decades. To date there are two crab hatcheries operational in southwest Bangladesh, of which one is a directly and one indirectly owned by the government. The Bangladesh Fisheries Research Institute, directly owned by the GoB, operates a brackish water center with a hatchery. The Palli Karma-Sahayak Foundation (PKSF) financed the other hatchery which is owned and operated by Nawabeki Ganomukhi Foundation (NGF). PKSF is a foundation that was established by the Government of Bangladesh in May 1990 for sustainable poverty reduction through employment generation. Thus, it is still considered as 'government' owned despite its independent legal status. PKSF indicated in consultations that they are planning to enhance their production capacity of non-natural crablets and also consider the development of additional hatcheries within the projects lifetime. Crablets are collected from natural sources in most instances, which, as mentioned above, is damaging local biodiversity. Hence there is a need to upgrade the production capacity of existing hatcheries to provide sufficient non-wild crablets to meet increasing demand.


*Figure 12 Flow Diagram of Crab Value Chain*

**Function of stakeholders:** Small-scale fatteners purchase small crabs (females below 130gm and males below 160gm) and rear them for 10-15 days. Usually, surplus export from the wholesaler is purchased by small-scale fatteners. Two ways to fatten crabs are:

*i)* *Gher*-owners[212] feed and rear the crablet for four to six months with shrimp and after that the crablet is sold to local *Foriya* (small-scale traders) from household doorsteps;

*ii)* Catchers sell river and sea crab from the Sundarban.

All fatteners sell crab to small-scale traders *(foriya)*. After purchasing from producers, the crabs are cleaned and taken to the wholesaler (*arotdar)* who separates them by size and sex before packaging the export quality in bamboo cages leaving the rest to be retailed at the local market to crab fatteners.

**Activities that are undertaken by producers for livelihood options:** Activities that are associated with the target components of the value chain are:

- Crab nursery: Nursery entrepreneurs purchase crablets weighing three to five grams from a crab hatchery, then they prepare two ponds; one for primary rearing and another for further rearing.
- Crab fattening/farming: For crab fattening/farming, producers purchase baby crabs or crablets (80-100 grams or more), prepare ponds by fencing (dividing ponds into four parts using bamboo fencing), rear the crabs at the ponds,

[212] *gher* is an enclosure

purchase and provide small fish (Tilapia) as feed, harvest within 10-15 days and transport for sale to the local collector or depot (*arot)* (wholesale centre).

The market map shown in Figure 13 illustrates the stakeholders involved with the crab value chain from production to the end-consumer.

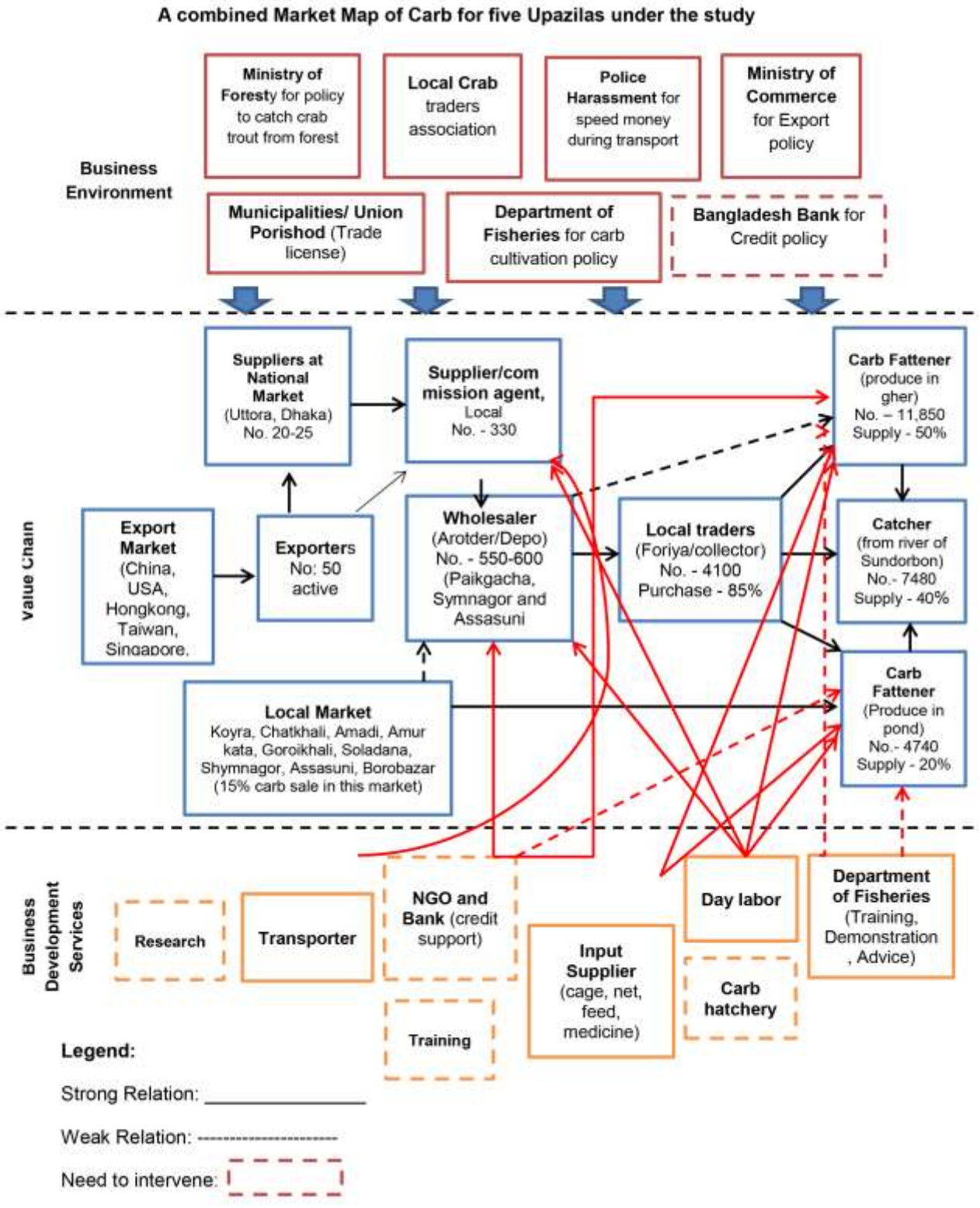


*Figure 13 Crab Market Map for Five Upazilas in the Study*

**Step-by-step value addition:** Small-scale traders add value by cleaning and transporting the crab before selling to the wholesaler, for which they make BDT 30 to 40 per kg.

The wholesaler adds value after purchasing from the small-scale trader by sorting according to sex and size before packaging in bamboo cages for supplier and commission agents, making BDT 20 to 30 per kg.

After collection from the wholesaler, the supplier transports to another supplier at Uttara Dhaka who subsequently adds value by grading the quality, removing dead crabs and supplying the export quality packaging for which five to ten per cent is charged.

**Market system of crab:** There are 12 to 15 crab markets in each upazila among which Chatkhali, Amadi, Amur kata, Goroikhali, Soladana, Godaipur Notun bazar, Kopilmuni Shymnagor, Assasuni and Borobazar are famous. At the regional level, there is a market in Khulna. From the regional level the supplier and commission agents deliver crabs to the national market in Uttara, Dhaka. Eighty-five per cent of the crabs are exported to China, the USA, Hong Kong, Taiwan, Singapore, Malaysia and Indonesia with up to a thirteen hours air-travel time from the depot/wholesaler to the airport. The remaining crabs are consumed within Bangladesh. Based on weight, quality, gender and the variety of crab, they sell at BDT 400 to 1,200 per kg. According to local experts, total exports of mud crab are considered to be worth around BDT 1,500 million (USD18.75 million) of which BDT 700 million (USD8.75 million) comes from southwest Bangladesh. An estimated 150,000 crab farmers in Bangladesh are currently involved in this livelihood. Another 50,000-60,000 are mud crab fishers (seedling collectors) in the Sundarbarns[213].

**Business environment:** The GoB identified crab aquaculture production as a key sector to promote in the coastal region of Bangladesh due to its climate resilience and high profitability potential, and has created favourable policies for crab farmers. However, the GoB also clearly identified the environmental risks associated with wild crab seedling catchments, particularly in sensitive ecosystems such as the Sundabarns, and are releasing restrictions on catchers. To cover the growing demand for crablets, there is a clear need to develop more or upgrade existing crab hatcheries. To date, the Nawabeki Ganomukhi Foundation (NGF) hatcheries are working to nine per cent capacity and produce 30kg of crablets or small crabs weighing three to five grams. PKSF plans, independently to this project, develop improve the production capacity of the NGF operated hatchery and considers the development of additional hatcheries. Other trials for hatcheries have been conducted by World Fish in 2013-14 at Cox's Bazar and GIZ at Paikgachha in 2016. There is also the government-owned and BFRI-managed crab hatchery in Paikgacha with a comparable production capacity to the NGF crab hatchery.

**Business development opportunity:** Crab demand is high in the export market. During the peak production season, i.e. November to May, each day 150 million tons of crab is available for supply that is able to fulfil 80 per cent of the present market demand. April to December is the lean season when production becomes 50 million ton/day and can meet less than 30 per cent of demand. Market trends indicate that demand for crab is increasing gradually, implying that crab production will need to increase for the national and international markets.

**Value chain upgrading opportunities and barriers:** Looking at the barriers with non-adaptive livelihood options like agriculture, crab has the potential to shift the vulnerable population to a more climate change resilient and economically viable option. To meet predicted demands, effective vertical linkages need to be created between firms at different levels of the value chain and through training producers on improved rearing processes such as crab farm management, biosecurity and health management, timely feeding, treatment and medication, along with pond and water management. Unavailability of crab hatcheries and scarcity of input sellers are an additional major barrier in this sector. Higher returns from this sector will depend upon successfully overcoming such barriers.

To overcome this barrier and to avoid creating any additional demand for natural crablets through this project, the exact demand-supply of input mother crabs, crablets and junevile crabs have been calculated and are presented in Table 22. This

[213] Shelley C., YH & CC Shelley Pty Ltd (2013). *Scoping study for mud crab farming in Bangladesh – Part 2.* Available online at: http://pubs.iclarm.net/resource_centre/Final-Report-Mud-Crab-Bangladesh-March-2013.pdf

project proposes to upgrade the existing BFRI – government owned – crab hatchery to meet international biosecurity and sustainable production standards, as well as to increase productivity. Based on local experts' conservative calculations (considering a 5 per cent survival rate of crab seedlings in the hatcheries) the upgraded and expanded crab hatchery will be able to produce 600,000 crablets per 3 months production cycle, leading to a yearly production of around 2.4 million crablets. This will cover the input demand of three nurseries of around 2.48 million crablets, considering a stocking density of 2,000 crablets per decimal, 34 decimal nurseries (1 WLG), and a 40-day production cycle. Considering a 75 per cent survival rate, the three nurseries will produce around 1.86 million juvenile crabs. This can cover the input demand for juvenile crabs of 176 crab farms/fatteners of 1.85 million juvenile crabs, which will produce, based on a 70 per cent survival rate, a total of around 1.3 million marketable crabs per year. This calculation provides the basis for the number of crab nurseries and farms that will be proposed under this project in order to avoid creating additional incentives to catch wild crablets. The existing crab hatchery indicated in consultations that they will provide a sufficient amount of output to the crab farms and nurseries established under this project at competitive prices and on a 'first-customer' basis.

*Table 22: Crab Value Chain Input Demand and Supply Calculation*[214]

| | **Crab Hatchery**[215] | **Crab Nurseries**[216] | **Crab Farms**[217] |
|---|---|---|---|
| **Number of enterprises** | 1 | 4 | 176 |
| **Production cycle (day/month)** | 3 months | 40 days | 3 months |
| DEMAND (INPUT) | | | |
| **Mother crab/ crablet/ juvenile crab demand/ one enterprise/ year (#)** | 200 | 620,500[218] | 10,560[219] |
| **Mother crab/ crablet/ juvenile crab demand/ all enterprises/ year (#)** | 200 | 2,482,000[220] | 1,858,560[221] |
| SUPPLY (OUTPUT) | | | |
| **Production/enterprise/cycle (#)** | 600,000 | 51,000[222] | 1,848[223] |
| **Production of enterprise/year (#)** | 2,400,000 | 465,375[224] | 7,392[225] |
| **Production of all enterprises/year (#)** | 2,400,000 | 1,861,500[226] | 1,300,992[227] |

Other identified barriers and constraints, as well as potential mitigation strategies, are outlined in Table 23.

*Table 23: Producer and Trader Level Barriers for Crab Value Chain and Solution Analysis*

| **Constraints** | **Cause of constraints** | **Probable solution** | **Potential provider** |
|---|---|---|---|
| **Inadequate technical knowledge among producers on proper crab pond preparation, disease identification, water treatment and feeding management** | Unavailability of expert training initiative. | Provide capacity building training. | Department of Fisheries and NGOs |
| **Insufficient crablets for fattening** | Lack of a commercial hatchery. | Facilitate the establishment of a larval rearing hatchery. | Entrepreneurs and NGOs |
| **Lack of loan facilities to crab businesses and crab fatteners** | Banks yet to understand crab fattening as a profitable enterprise. | Facilitate understanding around the profitability of the enterprise and the need to make formalities easier for | Banks and MFIs |

[214] Based on BRFI and aquaculture experts involved in the crab value chain in Bangladesh.
[215] Assuming a conservative 5% survival rate of number of crablets/cycle = around 300,000.
[216] Number of required crablets per decimal is 2,000; Number of decimals per average nursery is 34 decimals (2 sub-groups of women will each manage a 17 decimal pond-sized nursery); Survival rate once crablets are stocked is 75%.
[217] Stocking density of juveniles per decimal is 80; Survival rate of crabs is 70%; Number of decimals of average crab farm is 33.
[218] 2000 crablets * 34 (decimals) = 68,000 *9.125 (365 days/40 days) = 620,500
[219] 80 crablets * 33 (decimals) = 2,640 * 4 (12 months/3 months) = 10,560
[220] 620,500 * 4 (nurseries) = 2,482,000
[221] 10,560 * 176 (crab farms) = 2,386,560
[222] 2000 * 34 (decimals) * 0.75 (% survival rate) = 51,000
[223] 80 crablets * 33 (decimals) * 0.7 (% survival rate) = 1,848
[224] 51,000 * 9.125 (365 days/40 days) = 465,375
[225] 1,848 * 4 (12 months/3 months) = 7,392
[226] 465,375 * 4 = 1,861,500
[227] 7,392 * 176 = 1,670,592

| | | | |
|---|---|---|---|
| | Formalities of banks are also a barrier. MFI have started providing loan. | small businesses to meet. MFIs also need to facilitate access to loans. | |
| **Police harassment during transportation of crabs** | Lack of prioritization and protection of crab transportation. | Facilitate government dialogue on how to increase security for crab transport. | Department of Fisheries and police |
| **Producers do not receive a fair price** | Market price information gaps and lack of bargaining power. | Provide WLGs with transparent market price information and support them in building up negotiation power. | NGO and producer organizations |
| **Crab mortality during transportation** | Poor road conditions. | Timely and quality maintenance of roads to facilitate transport. | Local Government Engineering Department, Ministry of Local Government, Rural development and Cooperatives) and Roads and Highways Department, People's Republic of Bangladesh |

**Gender responsiveness:** Current initiatives attempt to engage women who have assets in terms of ponds, land or capital and who demonstrate willingness, in the crab value chain. In recent years, these practices have helped to minimize social gender barriers by engaging women in crab fattening and trading. The women´s groups proposed by this study would mostly operate at community level, whereas current practices are mostly at individual level. In addition, the skills, asset support and market and financial service linkages proposed by this study would empower the community women with greater decision-making ability as well as greater resilience to the impacts of climate change, by diversifying incomes and capitalizing on increasing saline conditions. The proposed livelihood options are socially acceptable in the target region.

#### 6.4.2. Climate Resilient Vegetable and Crop Value Chains

This value chain is of relevance to the proposed livelihoods of sesame cultivation, homestead gardening, hydroponics, aqua-geoponics and plant nursery. In line with the identified climate change resilience of the proposed vegetable producing livelihoods of homestead gardening, hydroponics, aqua-geoponics, sesame cultivation, and plant nursery (see Sections 6.1, 6.3.1, 6.3.2, 6.3.3, 6.3.4, and 6.3.5) it is apparent that the vegetable value chain and associated economic sectors can be highly resilient to climate change and able to cope with increasing salinization processes and cyclone impacts. Similar to the crab value chain, the vegetable value chains benefit from ongoing development projects in the coastal region of Bangladesh that, partly consider climate change impacts in their design, and increase the resilience of road and transportation infrastructure (see Section above). Besides this, the use organic fertilisers and plant cultivation have positive emission reduction (mitigation) affects and potential[228].

**Current nature of vegetable value chains**: Vegetable cultivation is a long-practised livelihood throughout Bangladesh. It has a large market demand and maximum return with minimum cost, requiring low investment. Salt resilient crop varieties as outlined in the options analysis in combination with the usage of advanced growing techniques (such as aqua-geoponics or hydroponics) make vegetable cultivation climate change resilient. The vegetable value chain also has potential to generate employment for women. Introducing simple technology, commercial production planning and market interventions can improve the economic status of marginalised women and adolescent girls.

Limited coverage of agricultural services, inadequate capital, and lack of improved cultivation knowledge, particularly techniques that do not rely on pesticides and fertilizers, are the main constraints faced by vegetable farmers. Vegetable consumption is comparatively low in the target region because coastal people are used to consuming fish rather than

[228] Food and Agriculture Organization of the United Nations (2011). *Organic Agriculture and Climate Change Mitigation*. Available online at: http://www.fao.org/fileadmin/templates/organicag/pdf/11_12_2_RTOACC_23_webfiles.pdf

vegetables. Thanks to a mass awareness raising programme run by the government, the media and NGOs, vegetable production and consumption increased significantly before cyclone Ayla. After Ayla, soil salinity increased significantly due to waterlogging in different places. Vegetable production has become high, medium and low in low, medium and high salinity areas, respectively. However, overall, consumption has gradually increased. Vegetables tend to be sourced from nearby districts as the local market has a huge demand. If production increases, dependency on other districts will be reduced and prices will stabilize. Furthermore, if producers and local traders develop linkages with regional markets, market opportunities will be created for both producers and traders to earn more profit by sending vegetables from moderate or low saline-effected areas of the target upazilas (sub-districts) to the highly saline-effected areas.

There is a growing demand for vegetables among the expanding urban population, and a need for increased vegetable consumption to improve household nutrition, given that the consumption of vegetables is currently lower than the recommended amount. Nationally, the consumption of vegetables is 50-70g per head per day, compared with the recommended amount of 200g per head per day from a nutritional point of view. Day-to-day production of vegetables is declining whereas demand is increasing. Demand from local markets is high and only 65 per cent is fulfilled by local production, with the remaining 35 per cent imported from nearby districts.

**Function of stakeholders**: Under this value chain, major functional aspects carried out by key stakeholders are as follows:

**Vegetable producer**: In these five upazilas, 85 per cent of producers are involved in vegetable production at homestead level. A total of 1,399 acres are cultivated for vegetable production. Most of the producers are subsistence farmers and consume the majority of production, with any surplus sold to small-scale traders and local hat/bazars.

**Vegetable *foriya*:** Local level *foriya* (collectors) collect vegetables from the community and sometimes from the local hat and sell it to small-scale traders and wholesalers (*arothder*). Around 300 collectors are working in the target areas. Currently they are not sharing any information about price and quality with the producers. They are enjoying benefits of approximately BDT 5 to 7 per kg.

**Small-scale traders**: Small-scale traders purchase from the collectors or producers at upazila markets and sell to upazila consumers and wholesalers (*arothder*). Around 380 small-scale traders are working in the target areas. They enjoying profits of approximately BDT 5 per kg.

**Wholesalers or *arotdar***: Wholesalers purchase vegetables from small-scale traders, bulking and selling them to district level retailers. A portion are packed in plastic and supplied to district level wholesalers. Most of the wholesalers work as commission agents. Others work as traders as well as commission agents.

**Market system of vegetable value chain:** There are more than 30-34 markets in each upazila. A total of 163 hats/bazars operate in Assasuni and Shymnagor of Sathkhira District and Paikgacha, Dacope and Koira upazilas of Khulna District[229]. Buyers of the vegetables are local household consumers, *foriyas* (collectors), traders at upazila level and wholesalers (*arotders*) at district markets. Producers sell their vegetables to the local hats/bazars, to local household customers and *foriyas*. *Foriyas* sell the vegetables on to traders, then the vegetables are supplied to district markets through a wholesaler. An estimated 300 collectors, 380 traders (upazila level), and 50 wholesalers exist in the supply chain in the target areas. Producers sell around 35 per cent to household customers and 65 per cent in local hats and to collectors at local hats. Around 30 per cent of total production is supplied to the district market through collectors and wholesalers. According to the traders, there is high demand for vegetables produced in the region. It is evident that a silent competition exists between *foriya* because there is large demand for vegetables in local and district markets. *Foriya* frequently visit the villages to purchase vegetables and sometimes pay BDT 2 to 3 per kg more to get the vegetables.

There are many stakeholders involved in the vegetable value chain, adding value from production to end-consumption through transportation, bulking and packaging. The market map provided in Figure 14 shows the relationships between actors are not stable, that the market stakeholders do not organize and tend to do business individually. To strengthen productivity, interventions are required in the dotted areas of the market map. For example, there is a need to develop producer groups and collector groups and the technical and marketing skills of these groups. Quality inputs (for example, seed and organic fertilizer) are scarce in the target areas and improved cultivation techniques and forms of integrated pest control have to be

[229] Idem 56.

disseminated. Hence the need to incorporate renowned input companies, improve performance of service markets and develop the supply system. There is a need to introduce collective production and supply.

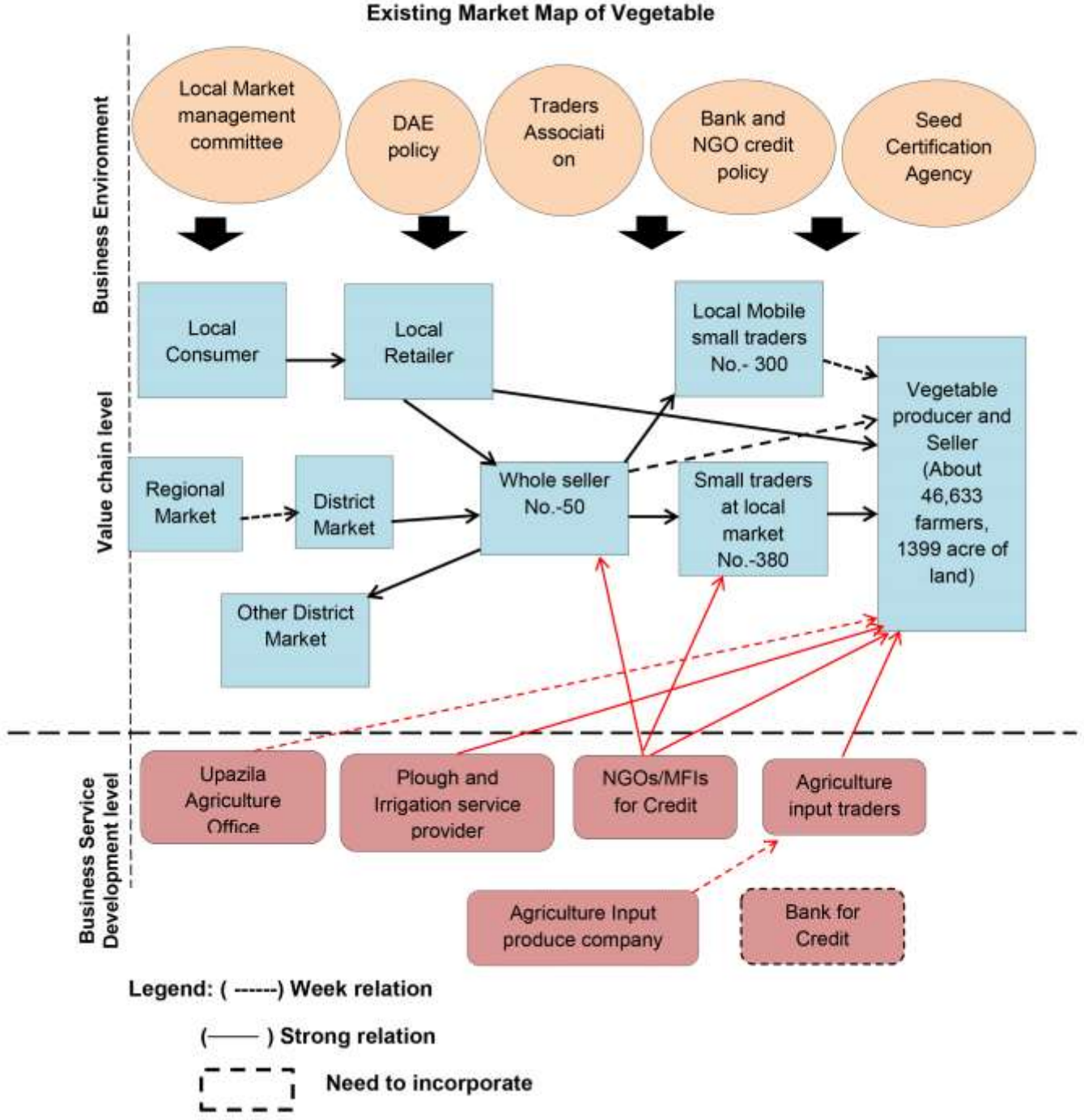


*Figure 14 Vegetable Market Map*

**Business enabling environment (BEE):** Microfinance institutions (MFIs), banks, local police authorities and the Association and Department of Agriculture Extension (DAE) influence the business environment through their policies. MFIs and banks have policies to provide credit to vegetable producers, traders and input sellers. In these five upazilas, there are 105 branches

of national and private banks and a total of 29 MFIs actively providing credit support to the value chain stakeholders. In most cases, these institutes provide credit with an interest rate from 10 per cent (banks) to 12.5 per cent (MFIs) with weekly and sometimes monthly instalments.

The upazila Nirbahi Officer or market association have fixed the local hat tax, which creates a barrier for small-scale producers to sell directly to the market since the tax rates are comparatively higher for them. The DAE delivers technical knowledge for improved production. Low quality input sellers are targeted in these remote coastal areas for selling their products. The DAE has the authority to prevent the sale of fake fertilizers and low-quality seed sale. However, more frequent monitoring of low quality agro-input by the DAE is required.

**Value chain upgrading opportunities:** Women in the target rural areas are already directly involved in homestead vegetable cultivation which contributes to covering family expenses. There is scope for improvement through developing producers' skills on commercially viable vegetables, strengthening inputs to collective supply systems, developing affordable credit and networks with buyers and developing collection points.

The DAE and agricultural input sellers are technical and advisory service providers. According to the DAE, they have offices at the upazila level from where experts provide technical knowledge on cultivation to vegetable farmers. There are only around two to three plough/tilling service providers at union level. This is because farmers mostly cultivate vegetables at the homestead or on the dike of the *gher*. A few MFIs and government banks provide credit. Agricultural inputs and service delivery, sale hubs, or retailers at village level are needed to improve services. The input supply system to the community needs to be improved, as well as the availability of customized credit facilities.

**Constraints Analysis**

*Table 24: Constraints Analysis*

| Constraint | Cause of constraint | Probable solutions | Potential provider |
|---|---|---|---|
| **Lack of adequate information on technologies** | Producers do not get any training on improved agricultural technologies like hydroponics or aqua-geoponics. | Arranging necessary skill training and refresher sessions for producers. Developing a network building facility with government departments. | NGO, DAE, service providers and lead farmers |
| **Producers have limited access to quality seed and organic fertilizer** | Lack of quality input sellers and lack of supply. Lack of knowledge and skills to prepare quick compost or vermin-compost. | Facilitate networks between quality input sellers and producers. Provide knowledge and skills so that farmers can prepare organic fertilizer. | Upazila Agriculture Office, input traders and NGOs |
| **Producers do not get a fair price for vegetable** | Lack of timely market information. | Ensure timely market information with regard to price and organize value chain tour. | NGO, DAE, service providers and lead farmers |
| **Producers do not know how to produce high yield variety vegetable** | Lack of training on improved vegetable cultivation method. | Provide training. | Upazila Agriculture Office and NGOs |
| **Lack of capital** | Lack of implementation of micro credit policy for vegetable producers. | Ensure credit with special interest to vegetable entrepreneurs. | Lead farmers, MFIs, NGOs, and banks |
| **Producers do not know how to control insect infestations or disease** | Insufficient training on insect and disease control and the use of toxic pesticides. | Provide training on insect and disease control processes using integrated pest management methods and locally appropriate natural pest control methods such as neem leaf. | Upazila Agriculture Office and NGOs |
| **Lack of access to markets** | Poor connections with big traders and regional markets. | Develop linkages with regional markets and big traders. | Lead output traders |
| **Scarcity of irrigation** | During the dry season, water becomes more saline and there is a lack of deep tube-wells. | Facilitate the shift towards less freshwater-dependent, salt resilient crop varieties, and improve secure water access. | LEGD, DAE and NGOs |

**Gender responsiveness:** Vegetable cultivation at the homestead is culturally and locally appropriate for vulnerable women as they are able to produce vegetables in the homestead area whilst performing other household activities. Given women's central role in ensuring adequate household nutrition, vegetable gardens serve to enrich diets and improve health outcomes. Vegetable production is a profitable venture that enhances farmers' monthly net income. Furthermore, vegetable production is an effective means for income generation and employment creation, especially for women in the riverine regions, and would ultimately reduce poverty and improve livelihoods. For strengthening collective production, buying of high-quality organic inputs and bulk selling would benefit vegetable farmers and women would benefit from improved participation in local markets. Farm-gate selling of vegetables is common in target areas, and a group of local women have the mobility to access market places to sell vegetables as a vegetable retailer. Therefore, establishing women´s groups provides the opportunity for women to control their business profits and income and this practice will be encouraged and supported in target communities. Technical training for hydroponics, improved variety cultivation, pond management and fertilizer management can be provided both at household and community level, which would enable women to remain within the household or within the community and manage the entrepreneurship with ease, thus empowering community women to make decisions. All livelihood options under this value chain are socially acceptable in the target region.

#### 6.4.3. Crab hatchery

**Climate change resilience:** In order to avoid negative impacts on the environment through wild catch and to enable a scalable and sustainable crab value chain development, it is essential for the project to upgrade one existing crab hatchery. Hatcheries are typically designed to produce a certain number of crablets per month or per year. The design of the upgrade needs a conservative approach in considering the productive capacity, to ensure as far as possible that production targets are met. For the demand calculations of crab lets to supply a total of 176 crab farms, a conservative survival rate of 5 per cent was considered in this project (see Table 22). The advantage is that whilst production costs are based on a relatively low survival rate, as survival rates improve, the cost of production and subsequent profitability of the hatchery can also improve. This is particularly the case in larval rearing, as most production costs per tonne of water are fixed, independent of the number of larvae raised and crablets produced.

**Implementation modalities and scope of proposed intervention:** In order to minimize disease risks, to maximize production and to ensure that operations have adequate levels of sanitation and biosecurity, as well as waste water treatment it is suggested in this project to upgrade the existing Bangladesh Fisheries Research Institute (BFRI) crab hatchery in the project area to meet international standards and expand their production capacity. The existing crab hatchery are operated by BFRI has agreed to provide support to the women beneficiaries as first customer for crab-let with upgraded facilities.

## 7. Recommended Interventions to Support Climate Change Resilient Livelihoods Focusing on Women in the Target Areas

The proposed livelihood options are considered as pathways to support women in the Khulna and Satkhira districts to increase their climate change resilience. This Chapter summarises the proposed project interventions at upazila level, based on context-specific investigations and stakeholder consultations (see Stakeholder Engagement Plan in Annex XIIId of the GCF proposal). Five examples of union profiles can be found in Annexes 3 to 7, the additional union profiles can be found in Annex IId of the GCF proposal package. The target upazilas are Shyamnagar and Assassuni in Satkhira district, and Dacobe, Koyra and Paikgacha in the Khulna district. All upazilas and proposed interventions within are outlined below. A total of 198 aquaculture-based and 819 agriculture-based Women Livelihood Groups (WLGs) are proposed to be formed for the project. This, however, is a tentative distribution of livelihood options to the different WLGs based on the ward specific analysis that were undertaken. The actual selection of livelihoods for the different group will be decided upon through a participative process of livelihood planning during the implementation phase of the project.

### 7.1. Overview of All Proposed Climate Change Resilient Livelihood and Value Chain Development interventions

Table 25 provides a summary of the proposed interventions at union level as well as targeted beneficiaries and associated costs. The interventions will reach approximately 111,870 beneficiaries (25,425 WLGs * 4.4 average people per household) and 25,425 women will be, as part of 1,017 Women Livelihood Groups, enabled to uptake and shift towards alternative,

climate change resilient livelihoods. The total direct investment in support in the form of assets and inputs, and the upgrade of one existing crab hatchery, will be around BDT 93,834,290.

*Table 25: Summary of Proposed Livelihood Interventions per Union*

| Upazila | Livelihood options proposed | No. of unions | No. of groups | Women beneficiaries | Unit cost per livelihood | BDT investment |
|---|---|---|---|---|---|---|
| **Shyamnagar** | Homestead gardening | 4 | 23 | 575 | 106,850 BDT | 2,457,550 BDT |
| | Hydroponics | 8 | 38 | 950 | 325,000 BDT | 12,350,000 BDT |
| | Aqua-geoponics | 2 | 6 | 150 | 518,400 BDT | 3,110,400 BDT |
| | Sesame cultivation | | | | | 0 BDT |
| | Plant nursery | 3 | 4 | 100 | 541,587 BDT | 2,166,348 BDT |
| | Crab farm/fattening | 8 | 94 | 2,350 | 271,264 BDT | 25,498,816 BDT |
| | Crab nursery | 2 | 2 | 50 | 360,515 BDT | 721,030 BDT |
| | Crab feed processing | 4 | 11 | 275 | 1,260,250 BDT | 13,862,750 BDT |
| | Crab hatchery | | | | | |
| **Dacope** | Homestead gardening | 6 | 44 | 1,100 | 106,850 BDT | 4,701,400 BDT |
| | Hydroponics | 8 | 91 | 2,275 | 325,000 BDT | 29,575,000 BDT |
| | Aqua-geoponics | 3 | 10 | 250 | 518,400 BDT | 5,184,000 BDT |
| | Sesame cultivation | 3 | 32 | 800 | 543,563 BDT | 17,394,016 BDT |
| | Plant nursery | 4 | 8 | 200 | 541,587 BDT | 4,332,696 BDT |
| | Crab farm/fattening | | | | | 0 BDT |
| | Crab nursery | | | | | 0 BDT |
| | Crab feed processing | | | | | 0 BDT |
| | Crab hatchery | | | | | 0 BDT |
| **Koyra** | Homestead gardening | 7 | 38 | 950 | 106,850 BDT | 4,060,300 BDT |
| | Hydroponics | 7 | 77 | 1,925 | 325,000 BDT | 25,025,000 BDT |
| | Aqua-geoponics | 1 | 5 | 125 | 518,400 BDT | 2,592,000 BDT |
| | Sesame cultivation | 3 | 25 | 625 | 543,563 BDT | 13,589,075 BDT |
| | Plant nursery | 5 | 10 | 250 | 541,587 BDT | 5,415,870 BDT |
| | Crab farm/fattening | | | | | 0 BDT |
| | Crab nursery | | | | | 0 BDT |
| | Crab feed processing | | | | | 0 BDT |
| | Crab hatchery | | | | | 0 BDT |
| **Paikgacha** | Homestead gardening | 2 | 12 | 300 | 106,850 BDT | 1,282,200 BDT |
| | Hydroponics | 1 | 2 | 50 | 325,000 BDT | 650,000 BDT |
| | Aqua-geoponics | 1 | 9 | 225 | 518,400 BDT | 4,665,600 BDT |
| | Sesame cultivation | 1 | 7 | 175 | 543,563 BDT | 3,804,941 BDT |
| | Plant nursery | 4 | 8 | 200 | 541,587 BDT | 4,332,696 BDT |
| | Crab farm/fattening | 5 | 82 | 2,050 | 271,264 BDT | 22,243,648 BDT |
| | Crab nursery | 2 | 2 | 50 | 360,515 BDT | 721,030 BDT |
| | Crab feed processing | 4 | 7 | 175 | 1,260,250 BDT | 8,821,750 BDT |
| | Crab hatchery | 1 | (1 upgrade) | | 93,834,290 BDT | 93,834,290 BDT |
| **Assasuni** | Homestead gardening | 8 | 72 | 1,800 | 106,850 BDT | 7,693,200 BDT |
| | Hydroponics | 10 | 202 | 5,050 | 325,000 BDT | 65,650,000 BDT |
| | Aqua-geoponics | 5 | 31 | 775 | 518,400 BDT | 16,070,400 BDT |
| | Sesame cultivation | 3 | 50 | 1,250 | 543,563 BDT | 27,178,150 BDT |
| | Plant nursery | 5 | 15 | 375 | 541,587 BDT | 8,123,805 BDT |
| | Crab farm/fattening | | | | | 0 BDT |
| | Crab nursery | | | | | 0 BDT |
| | Crab feed processing | | | | | 0 BDT |
| | Crab hatchery | | | | | 0 BDT |

| | | | | | |
|---|---|---|---|---|---|
| Total | | 1,017 | 25,425 | | 437,107,961 BDT |

### 7.2. Upazila 1: Shyamnagar

#### 7.2.1. Background

Shyamnagar upazila in Satkhira district covers an area of 1,968.24 sq km. It is located in between 21°36' and 22°24' northern latitudes and in between 89°00' and 89°19' eastern longitudes[230]. The upazila is bounded by Kaliganj (Satkhira) and Assasuni Upazilas in the north, Hingalganj in north, 24 Parganas district in the Indian state of West Bengal to the west, Koyraon to the south, and Assasuni Upazila to the east[231].

Shyamnagar upazila is part of the Gangetic delta with a multitude of rivers and canals dividing the area and shaping the landscape. The upazila is largely covered by forest, natural water bodies (though most of them are saline) and cultivable land. A key attraction of this upazila is its proximity to the mangrove forest Sundarbans. These resources are used in various ways for the growth and development of society. Due to its geographical location, the upazila has repeatedly been affected by different kinds of climate-induced natural hazards, like tidal surges, cyclones, salinity, riverbank erosion, waterlogging, drought and insect infestations.

Shyamnagar has 12 Unions, 127 Mauzas/Mahallas and 216 villages. The Unions are: Vurulia (Bhurulia), Kashimari, ShyamnagarSadar, Ishwaripur, Burigowalini, Koikhali, Munsigong, Nurnagar, Podmopukur, Ramjannagor, Atulia and Gabura. In these Unions lives a total population of 216,125 (see Table 26). Additional socio-economic statistics are shown in Table 27.

*Table 26: Demographic Information of Shyamnagar Upazila*

| Union | Wards | Villages | Number of HH | Population |
|---|---|---|---|---|
| Atulia | 9 | 34 | 6,684 | 30,413 |
| Ramjannagar | 9 | 14 | 4,735 | 21,932 |
| Kashimari | 9 | 16 | 5,704 | 26,657 |
| Burigoalini | 9 | 24 | 5,488 | 24,914 |
| Gabura | 9 | 17 | 6,808 | 31,115 |
| Kaikhali | 9 | 18 | 5,573 | 24,608 |
| Padmapukur | 9 | 12 | 6,279 | 24,654 |
| Munshiganj | 9 | 19 | 9,187 | 31,832 |
| **Total** | **72** | **154** | **50,457** | **216,125** |

The main sources of income in the upazila are agriculture (64.98 per cent), followed by commerce (14.60 per cent), non-agricultural labour (6.02 per cent), services (3.53 per cent), transport and communication (1.58 per cent), construction (0.94 per cent), industry (0.61 per cent), rent and remittance (0.20 per cent) religious services (0.16 per cent), and others (7.34 per cent). 56.69 per cent of the population owns land while 43.31% is landless[232]. Main agricultural crops are paddy, jute, wheat, potato, mustard, sesame, linseed, pulses, and vegetables[233]. Shyamnagar is home to both aquatic and terrestrial eco-systems, providing livelihood opportunities for fresh and saline water fisheries, crop vegetation and social forestry. Limited employment opportunities are also available in cottage industries like goldsmith, blacksmith, potteries, weaving, embroidery, bamboo work and woodwork.

Shyamnagar has around 42 hat and bazars (local market places), of which most notable are Shyamnagar Hat, Nawabeki Hat, Bhetkhali Hat, Harinagar Hat, Munshiganj Hat, Gabura Hat, Nurnagar Bazar, Baruni Mela at Ishwaripur, Katakhali Shiva Mela and Baishakhi Mela (local fairs held during different festivals). Main export products are paddy, jute and shrimp. Infrastructure includes pucca roads (brick layered) (67km), semi-pucca roads (35km), mud roads (811km) and a waterway (73 nautical

[230] Wikipedia
[231] Banglapedia. Available online at: http://en.banglapedia.org/index.php?title=Shyamnagar_Upazila
[232] Idem 230
[233] Idem 230

miles)[234]. All the Unions of the upazila are supplied by a rural electrification network; however only 7.40 per cent of households have access to electricity.

Operationally important NGOs are BRAC, Asa, Caritas, Progati, World Vision, Shushilon, Satkhira Unnayan Sangstha (SUS), Jagorani Chakra Foundation (JCF), Nowabenki Gonomukhi Foundation, Grameen Bank, Dhaka Ahsania Mission (DAM), and the Christian Commission for Development in Bangladesh (CCDB).

*Table 27: Basic Socio-economic Statistics for Shymnagar Upazila[235]*

| ***Household Information*** | ***Shymnagar Average*** |
|---|---|
| *Household size (number of people)* | 4.39 |
| *Male %* | 48.21 |
| *Female %* | 51.79 |
| *Girls of age (15-18 years) %* | 4.6 |
| ***Education*** | |
| *Illiterate adult over 18 years of age %* | 51.38 |
| *Male % (exclude Illiterate)* | 53.77 |
| *Female % (exclude Illiterate)* | 43.91 |
| ***Income*** | |
| *Share of household income* | |
| *Male %* | 43.4 |
| *Female %* | 56.6 |
| *Average income/ HH (monthly)* | 6,186.89 |
| *Average expenditure/ HH (monthly)* | 6,234.20 |
| *Average HH savings (in BDT per month)* | 585.4 |
| *Average HH deficit (in BDT per month)* | 777.5 |
| ***Occupation*** | |
| *Agricultural production and labour %* | 37.00 |
| *Fisheries and labour in fishers %* | 41.30 |
| *Livestock %* | 17.40 |
| *Off farm and small-scale business%* | 4.30 |

### 7.2.2. Proposed Climate Change Resilient Livelihood Options

*Table 28: Proposed Livelihood Options in Shymnagar Upazila*

| Livelihood Option | No. of Women | Unions | Rationale for Union Selection | Rationale for Livelihood Selection |
|---|---|---|---|---|
| **Crab fattening** | 2,350 | Gabura, Burigoalini, Munshiganj, Atulia, Kaikhali, Kashimari, Padmapukur and Ramjannagar | Water quality (pH, Ammonia, temperature, salinity, dissolved oxygen and alkalinity level) is very suitable for crab fattening in both open and closed systems. There is an existing crab hatchery in this upazila, which can provide a sustainable supply of crablets if upgraded. | Existing practice (traditional and progressive), water body, knowledge and skills, profitability and demand create wider scope and opportunities crab fattening. |
| **Crab nursery** | 50 | Burigoalini and Atulia | Water quality (pH, Ammonia, temperature, salinity, dissolved oxygen and alkalinity level) is very suitable for crab nurseries in both open and close systems. There is an existing crab hatchery in this upazila, | Burigoalini is centrally located, adjacent to the river and hosts a crab hatchery. Farmers from all Unions can come and collect crablets from Burigoalini market as it is a big market in the region. It is also connected to Khulna and Dhaka markets. |

[234] Idem 118
[235] Idem 8

| | | | | |
|---|---|---|---|---|
| | | | which can provide a sustainable supply of crablets if upgraded. | |
| **Crab feed processing** | 275 | Atulia, Ramjannagar, Kashimari and Munshiganj | There is an existing crab hatchery in this upazila, which allows for the sustainable expansion of the crab value chain. This consequently creates demand for crab feed. | Crab feed processing will be essential to meet increasing demand for crab feed and to mitigate the risk of crab farmers depending on and depleting wild sources of crab feed. |
| **Plant nursery** | 100 | Kashimari, Ramjannagar and Atulia | There is high demand for small plants and fruit trees, which the nurseries in these Unions can provide, especially salt-resilient species. | Farmers can start to plant nurseries with training from local horticulture centres and by collecting locally available seeds and plants. |
| **Hydroponics/ Aqua-geoponics** | 1,100 | Burigoalini, Munshiganj, Kaikhali, Atulia, Ramjannagar, Padmapukur and Gabura | A good number of water bodies are available in these Unions. There has been increasing interest in the use of hydroponic or soilless techniques for producing greenhouse horticultural crops in the area. | In combination with greenhouses or protective covers, hydroponics uses advanced technology. It is highly productive, uses little freshwater and land, and protects the environment. |
| **Homestead gardening** | 575 | Atulia, Ramjannagar, Gabura and Kaikhali | The elevation and projected salinity in the selected wards, in combination with raised bed and other growing techniques, are ideal for the promotion of homestead gardening. | Can be managed at homestead level. Household's nutritional needs can be met with this livelihood, while at the same time surplus production can provide an additional source of income. |

### 7.2.3. Interventions for Climate Resilient Value Chain Development and Market Linkages

*Table 29: Proposed Value Chain Development and Market Linkages Interventions in Shyamnagar Upazila*

| Value Chain (Associated Livelihoods) | Current State and/or Constraints of Value Chain | Proposed Interventions |
|---|---|---|
| **Crab** (crab farm, crab nursery) | There is insufficient availability of non-wild crablets and juvenile crabs. Crablets caught in the wild are currently available at 29 local crab/fish depot in the targeted unions of Shyamnagar upazila. Out of these 29 depots, 13 depots are in Gabura and the major sellers of crablets. There is no crab let depot in Ramjanagar. The existing crab hatchery in Burigoalini, operated by NGF, is producing some non-natural crablets, but at its current production capacity, would be insufficient to cover all proposed new crab farms with the necessary inputs. However, PKSF, the funder of the hatchery indicated in consultations that they will upgrade the hatchery and also consider developing additional ones. | • Coordinate with the NGF hatchery regarding potential collaborations during the inception phase of the proposed project. Establish secured supply of crablets from BFRI hatchery in Paikgacha, which is proposed to be upgraded to provide a sustainable and sufficient supply of crablets to the proposed 94 crab farms and 2 crab nurseries for this upazila. |
| | Market linkages of existing crab farmers with buyers and traders are established, but weakly established, and it can be assumed that they will be able to develop in line with the additional volume of crabs. | • Facilitate networking of value chain actors through linkage creation between WLGs and input suppliers and traders<br>• Create public-private (PP) platforms to foster upazila-wide coordination and cooperation between value chain actors. |
| | There are a range of microcredit institutions available in the upazila that can provide women beneficiaries with access to finance to sustain and grow their crab enterprises. | • Train women beneficiaries in financial management and create linkages with microcredit organisations for investments in pond, feeds, etc.<br>• Potential partners: Input companies, MFIs. |

| | | |
|---|---|---|
| **Fruit trees and other plants** (plant nursery) | Limited knowledge of existing sellers of salt-resilient plants to meet increasing demand and limited capacity to provide local buyers appropriate technical guidance. | • Provide training and set up demonstration plots to showcase nursery development practices.<br>• Potential partners: Local gardeners from the Horticulture Department under the Ministry of Agriculture and the Technology Park of Shyamnagar |
| **Vegetables** (hydroponics/ aqua-geoponics/ homestead gardening) | Vegetables are cultivated at homestead, especially in the elevated unions like Ramjannagar and Koikhali, but extremely poor women lack knowledge and skills for vegetable cultivation. In the homestead, activities ranging from selection of seeds to harvesting and storing crops are managed predominantly by women. | • Provide training and set up demonstration plots to showcase better cultivation practices.<br>• Potential partners: MFIs, seed companies. |

#### 7.2.4. Costing

In Shyamnagar, a total of 178 WLGs, involving 4,450 women beneficiaries will be directly reached by the proposed interventions. The total direct intervention cost for covering the beneficiaries sums up to around BDT 13,272,937 (see Table 30). These cost estimates reflect current market prices for goods and assets, and based on the proposed interventions identified at ward level (see Union Profiles – Annex 3-7 in this report and Annex IId of the GCF proposal package).

*Table 30: Summary of Intervention Costs for Shyamnagar Upazila*

| Livelihood Option | BDT Investment | Unions | No. of WLGs |
|---|---|---|---|
| Homestead gardening | 2,457,550 BDT | 4 | 23 |
| Hydroponics | 12,350,000 BDT | 7 | 38 |
| Aqua-geoponics | 3,110,400 BDT | 2 | 6 |
| Plant nursery | 2,166,348 BDT | 3 | 4 |
| Crab farm | 25,498,816 BDT | 8 | 94 |
| Crab nursery | 721,030 BDT | 2 | 2 |
| Crab and fish feed processing | 2,166,348 BDT | 4 | 11 |
| **Total** | **13,272,937 BDT** | | **178** |

### 7.3. Upazila 2: Dacope

#### 7.3.1. Background

Dacope upazila (Khulna district) is located between 22°24' and 22°40' northern latitudes and 89°24' and 89°35' eastern longitudes. It is bounded by the Pasur River to the south, Batiaghata upazila to the north, Rampal and Mongla upazilas to the east, and Paikgachha and Koyra upazilas to the west[236].

Dacope consists of 10 Union parishads, 26 Mouzas and 107 villages. The Unions are Kamarkhola, Kailasganj, Khulna Range, Chalna, Tildanga, Dacope, Bajua, Banishanta, Laudubi and Sutarkhali. Public infrastructure in this upazila is poor; only 18 km of road is pucca, while 92 km road is semi-pucca and 275.67 km is mud tracks. All the Unions of the upazila are linked to a rural electrification network, however only 6.35 per cent of households have access to electricity[237].

The main sources of income are agriculture (66.07 per cent), commerce (12.86 per cent), non-agricultural labour (4.85 per cent), services (4.10 per cent), transport and communication (1.72 per cent), construction (0.93 per cent), rent and remittance (0.05 per cent) and others (9.42 per cent)[238]. The main crops are paddy, potato and pumpkin. Extinct or nearly extinct crops are jute, sesame, aush and boro paddy. The key reason for these crops having faded out is salinity in the region. The main fruits grown are coconut, guava, plum, sofeda, bangi and watermelon. A good number of households are involved in fisheries, as well as dairy and poultry production. In this upazila shrimp cultivation is also conducted in an extended form. However, the popularity of shrimp cultivation in the region has resulted in formation of water enclosures (locally called *ghers*). These water enclosures collect salt deposits during the shrimp cultivation season and, as a result, increase soil salinity thereby

[236] Banglapedia
[237] Idem 8
[238] Idem 8

hampering the cultivation of crops and fruit trees. In some Unions, alternative enterprises such as duck rearing, homestead gardening, vermin-compost production, sunflower cultivation, mushroom culture and fish culture in mini ponds or narrow canals have been introduced to support adaptation to climate change.

Operationally important NGOs are Asa, BRAC, Caritas, Proshika, World Vision, Gonoshahajjo Sangstha, HEED Bangladesh, Step, World Fish, Rupantar and Prodipon, Society for Participatory Education and Development (SPED) and Paschim Bajua Students Welfare Association.

Dacope has a population of 137,681 (see Table 31). Further socio-economic data is shown in Table 32.

*Table 31: Demographic Information for Dacope Upazila*

| Union | Wards | Villages | Number of HH | Population |
|---|---|---|---|---|
| Dacope Sadar | 9 | 12 | 1,617 | 7,048 |
| Bajua | 9 | 20 | 3,809 | 15,754 |
| Bani Shanta | 9 | 15 | 3,303 | 14,607 |
| Suterkhali | 9 | 13 | 6,286 | 30,060 |
| Pankhali | 9 | 11 | 3,569 | 15,570 |
| Til Danga | 9 | 12 | 4,294 | 17,006 |
| Kamarkhol | 9 | 19 | 3,601 | 13,897 |
| Lawdob | 9 | 34 | 2,338 | 9,223 |
| Kailashganj | 9 | 13 | 3,741 | 14,517 |
| **Total** | **81** | **149** | **32,289** | **137,681** |

*Table 32: Basic Socio-economic Statistics for Dacobe Upazila*[239]

| ***Household Information*** | ***Dacope Average*** |
|---|---|
| *Household size* | 4.13 |
| *Male %* | 50.08 |
| *Female %* | 49.91 |
| *Girls of Age (15-18 years) %* | 3.99 |
| ***Education*** | |
| *Illiterate adult over 18 years of age %* | 44.00 |
| *Male % (exclude Illiterate)* | 62.94 |
| *Female % (exclude Illiterate)* | 49.05 |
| ***Income*** | |
| *Share of household income* | |
| *Male %* | 36 |
| *Female %* | 64 |
| *Average income/ HH (monthly)* | 8,488.00 |
| *Average expenditure/ HH (monthly)* | 7,045.79 |
| *Average HH savings (in BDT per month)* | 1,383.87 |
| *Average HH deficit (in BDT per month)* | 608.11 |
| ***Occupation*** | |
| *Agricultural production and labour %* | 32.10 |
| *Fisheries and labour in fisheries %* | 34.60 |
| *Livestock %* | 2.50 |
| *Off farm and small-scale business %* | 28.40 |

### 7.3.2. Proposed Climate Change Resilient Livelihood Options

Livelihood options are proposed for a total of 5,575 target households within this upazila, as described in Table 33.

*Table 33: Proposed Livelihood Options in Dacope Upazila*

[239] Idem 8

| Livelihood Option | No. of Women | Unions | Rationale for Union Selection | Rationale for Livelihood Selection |
|---|---|---|---|---|
| **Plant nursery** | 200 | Sutarkhali, Kamarkhola, Pankhali and Kailashganj | There is high demand for small plants and fruit trees, which the nurseries in these Unions can meet, especially salt-resilient species. | Farmers can easily start up a plant nursery with training from local horticulture centres or by collecting locally available seeds and plants. It is profitable (the benefit cost ratio is 1.43) and there is a huge demand for plants. |
| **Homestead gardening** | 1,100 | Banishanta, Sutarkhali, Pankhali, Tildanga, Kamarkhola and Kailashganj | The elevation and projected salinity in the selected wards, in combination with raised bed and other growing techniques, are ideal for the promotion of homestead gardening. | Women farmers can easily start homestead gardening with training from local horticulture centre. |
| **Hydroponics/ Aqua-geoponics** | 2,525 | Dacope Sadar, Banishanta, Sutarkhali, Pankhali, Kamarkhola, Laudubi, Kailashganj and Tildanga | There are a good number of water bodies available in these Unions. There has been increasing interest in the use of hydroponic or soilless techniques for producing greenhouse horticultural crops in the area. | In combination with greenhouses or protective covers, hydroponics uses advanced technology and is capital intensive. But it is highly productive, conserves water and land and protects the environment when inputs and pesticides are not used. |
| **Sesame** | 800 | Sutarkhali, Dacop Sadar and Bajua | Some people are traditionally producing sesame in this Union and there are good prospects for commercial production by poor women. | Sesame is one of the most important high value oil crops in Bangladesh. Local people think that sesame has better resistance to diseases and pests. Development of improved agronomic and management practices are required. |

### 7.3.3. Interventions for Climate Resilient Value Chain Development and Market Linkages

*Table 34: Proposed Value Chain Development and Market Linkages Interventions in Dacope Upazila*

| Value chain (Associated Livelihoods) | Current State and/or Constraints of Value Chain | Proposed interventions |
|---|---|---|
| **Fruit trees and other plants** (plant nursery) | Coconut, guava, plum, and sofeda are grown in Paankhali, Laudubi, Bajua and few places of other unions. But limited knowledge of existing tree nurserers about growing techniques and saline-resilient plants constraint them to meet increasing demand. Appropriate technical guidance would be effective here. | • Provide training and set up demonstration plots to showcase nursery development practices.<br>• Potential partners: Local gardeners from the horticulture department. |
| **Vegetables** (hydroponics/ aqua-geoponics/ homestead gardening) | Extremely poor women lack knowledge and skills for vegetable cultivation. In the homestead, activities ranging from selection of seeds to harvesting and storing crops are managed predominantly by women. | • Provide training and set up demonstration plots to establish vegetable gardens in the homestead.<br>• Create service providers (input retailers) to provide technical advice for cultivating in small plots.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |
| **Sesame** (sesame cultivation) | Women farmers do not currently use effective cultivation techniques to grow sesame in this upazila. | • Create service providers (input retailers) to provide technical advice for cultivation.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |

#### 7.3.4. Costing

In Dacope, a total of 185 WLGs composed of 4,625 women beneficiaries will be directly reached by the proposed interventions. The total direct intervention cost for covering the beneficiaries sums up to around BDT 61,187,112 (see Table 35). These cost estimates reflect current market prices for goods and assets, and based on the proposed interventions identified at ward level (see Union Profiles – Annex 3-7 in this report and Annex IId of the GCF proposal package).

*Table 35: Summary of Intervention Costs for Dacope Upazila*

| Livelihood Option | BDT Investment | Unions | No. of WLGs |
|---|---|---|---|
| Homestead gardening | 4,701,400 BDT | 6 | 44 |
| Hydroponics | 29,575,000 BDT | 8 | 91 |
| Aqua-geoponics | 5,184,000 BDT | 3 | 10 |
| Sesame cultivation | 17,394,016 BDT | 3 | 32 |
| Plant nursery | 4,332,696 BDT | 4 | 8 |
| **Total** | **61,187,112 BDT** | | **185** |

### 7.4. Upazila 3: Koyra

#### 7.4.1. Background

Koyra upazila (Khulna district) stretches over an area of 1,775.41 sq km, including 951.66 sq km of Sundarbans mangrove forest. This large share of forested area leads to a concentration of the population in an area of around 263 sq km. Infrastructure includes Pucca roads (21km), semi-pucca roads (80km) and mud roads (142 m). Koyra has 7 Unions/Wards, 72 Mauzas/Mahallas and 131 villages. The Unions are: Bagali, Moheswaripur, Moharajpur, Koyra, UttorBetkashi, Daskin Betkashi and Amadi. There are 28 markets out of which Hugla Hat, Amadi Hat, Ghorilal Hat, Sutar Hat, Ghugrakati Hat, Khoralkati Hat, Jorsingh Bazar, DakshinBetkashiBanbibirMela, PadmapukurRathMela and HariharpurRathMela are the most notable. Main exports are fish fry, timber, golpata, honey and handicrafts.

Sundarbans, the mangrove forest of Bangladesh, is situated in the southern part of Koyra. Most of the lands and water bodies of this area have been converted to shrimp culture ponds by canalling saline water. In this aquaculture practice, more and more freshwater areas are being permanently converted into saline water bodies. This is alarming because it reduces the availability of freshwater resources for local people and significantly changes the components of biodiversity. The most common natural disasters experienced here include riverbank erosion, tidal surges and salinity. Periodically, due to the unavailability of employment, some people of this area move to other districts to look for work.

The main sources of income are agriculture (66.64 per cent), commerce (12.66 per cent), non-agricultural labour (7.12 per cent), services (3.54 per cent), transport and communication (1.85 per cent), construction (1.31 per cent), industry (0.51 per cent), religious services (0.31 per cent), rent and remittance (0.09 per cent) and others (7.29 per cent). 62.76 per cent of people own land and 37.24 per cent are landless. People living in Koyra are mostly dependent on farming, fishing and daily labour. A limited number of NGOs, in comparison with other upazilas, are operating in Koyra. Current NGOs include BRAC, ASA, Jagorani Chakro Foundation (JCF), Grameen Bank, and Satkhira Unnayan Sangstha (SUS), which mainly operate micro-finance programmes. World Vision, Uttaran, Shushlan, Islamic Relief and Caritas implement nutrition, livelihoods, disaster risk reduction and climate change programmes.

The total population of Koyra is 199,934 (see Table 36). Further socio-economic information is shown in Table 37.

*Table 36: Demographic Information of Koyra Upazila*

| Union | Wards | Villages | Number of HH | Population |
|---|---|---|---|---|
| Amadi | 9 | 30 | 8,404 | 33,184 |
| Bagali | 9 | 28 | 7,625 | 34,478 |
| Dakshin Bedkashi | 9 | 17 | 3,456 | 16,756 |
| Koyra | 9 | 13 | 7,002 | 33,231 |
| Maharajpur | 9 | 24 | 6,128 | 31,069 |
| Maheshwaripur | 9 | 23 | 6,356 | 29,993 |
| Uttar Bedkashi | 9 | 24 | 3,863 | 15,225 |
| **Total** | **63** | **159** | **42,834** | **193,934** |

*Table 37: Basic Socio-economic Statistics for Koyra Upazila*[240]

| ***Household Information*** | ***Koyra Average*** |
|---|---|
| *Household size* | 4.24 |
| *Male %* | 49.19 |
| *Female %* | 50.81 |
| *Girls of Age (15-18 years) %* | 4.11 |
| ***Education*** | |
| *Illiterate adult over 18 years of age %* | 49.64 |
| *Male % (exclude Illiterate)* | 55.77 |
| *Female % (exclude Illiterate)* | 45.20 |
| ***Income*** | |
| *Share of Household income* | |
| *Male %* | 33 |
| *Female %* | 67 |
| *Average income/ HH (monthly)* | 4,611.04 |
| *Average expenditure/ HH (monthly)* | 5,425 |
| *Average HH savings (in BDT per month)* | 585.41 |
| *Average HH deficit (in BDT per month)* | 777.47 |
| ***Occupation*** | |
| *Agricultural production and labour %* | 54.00 |
| *Fisheries and labour in fishers %* | 22.20 |
| *Livestock %* | 1.60 |
| *Off farm and small-scale business %* | 22.20 |

### 7.4.2. Proposed Climate Change Resilient Livelihood Options

*Table 38: Proposed Livelihood Options for Koyra Upazila*

| Livelihood Option | No. of Women | Unions | Rationale for Union Selection | Rationale for Livelihood Selection |
|---|---|---|---|---|
| **Plant nursery** | 250 | Amadi, Bagali, Koyra Sadar, Maharajpur, and Uttar Bedkashi | There is high demand for small plants and fruit trees, which the nurseries in these unions can meet, especially salt-resilient species. | Farmers can easily start up plant nurseries with training from local horticulture centres and they can start collecting locally available seeds and plants. |
| **Vegetable homestead gardening** | 950 | Amadi, Koyra Sadar, Maharajpur, North Bedkashi, South Bedkashi, and Moheshwaripur | The Union has plain and fertile arable land and homesteads suitable for vegetable cultivation. | Women farmers can easily start planting nurseries with training from local horticulture centres. |
| **Sesame** | 625 | North Bedkashi, South Bedkashi, and Bagali | Some people are traditionally cultivating sesame and there are good prospects for commercial production by poor women. | Sesame is one of the most important high value oil crops in Bangladesh. Local people think that sesame has better resistance to diseases and pests. Development of improved agronomic and management practices is required. |
| **Hydroponics/ Aqua-geoponics** | 2,050 | Amadi, Moharajpur, Moheshwaripur, Koyra Sadar, South | There are a good number of water bodies available in these Unions. There has been increasing interest in the use of hydroponic or soilless techniques for producing | In combination with greenhouses or protective covers, hydroponics uses advanced technology and is capital intensive. But it is highly productive, conserves water and land and protects the |

[240] Idem 8

| | | | | |
|---|---|---|---|---|
| | | Bedkashi, and North Bedkashi | greenhouse horticultural crops in the area. | environment when practiced without fertilizer and pesticides. |

#### 7.4.3. Interventions for Climate Resilient Value Chain Development and Market Linkages

*Table 39: Proposed Value Chain Development and Market Linkages Interventions in Koyra Upazila*

| Value Chain (Associated Livelihoods) | Current State and/or Constraints of Value Chain | Proposed Interventions |
|---|---|---|
| **Fruit trees and other plants** (plant nursery) | Amadi, Bagali, Koyra Sadar and some places of Uttar Bedkashi produce fruits and timber trees like date, palm, mango papaya, mahogany. But limited knowledge of existing nurseries of saline resilient plants to meet increasing demand and limited capacity to provide local buyers appropriate technical guidance. | • Provide training and set up demonstration plots to showcase nursery development practices.<br>• Potential partners: Local gardeners from the horticulture department. |
| **Vegetables** (hydroponics/ aqua-geoponics/ homestead gardening) | In Koyra, vegetables like brinjal, bitter gourd, pumpkin and potato are widely grown. But farmers need improved verities that are more adaptive to the local soil condition. Although in the homestead, activities ranging from selection of seeds to harvesting and storing crops are managed predominantly by women but extremely poor women lack knowledge and skills for vegetable cultivation. | • Provide training and set up demonstration plots to establish vegetable gardens in the homestead.<br>• Create service providers (input retailers) to provide technical advice for cultivating in small plots.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |
| **Sesame** (sesame cultivation) | Women farmers do not currently use effective cultivation techniques due to limited financial resources as well as exposure to growing technology. | • Create service providers (input retailers) to provide technical advice for cultivation.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |

#### 7.4.4. Costing

In Koyra, a total of 155 WLGs involving 3,875 women beneficiaries will be directly reached by the proposed interventions. The total direct intervention cost for covering the beneficiaries sums up to around BDT 50,682,245 (see Table 40). These cost estimates reflect current market prices for goods and assets, and based on the proposed interventions identified at ward level (see Union Profiles – Annex 3-7 in this report and Annex IId of the GCF proposal package).

*Table 40: Summary of Intervention Costs for Koyra Upazila*

| Livelihood Option | BDT investment | Unions | No. of WLGs |
|---|---|---|---|
| Homestead gardening | 4,060,300 BDT | 7 | 38 |
| Hydroponics | 25,025,000 BDT | 6 | 77 |
| Aqua-geoponics | 2,592,000 BDT | 1 | 5 |
| Sesame cultivation | 13,589,075.00 BDT | 3 | 25 |
| Plant nursery | 5,415,870 BDT | 5 | 10 |
| **Total** | **50,682,245 BDT** | | **155** |

### 7.5. Upazila 4: Paikgacha

#### 7.5.1. Background

Paikgachha upazila (Khulna district) is located at 22.5889°N 89.3361°E. It is surrounded by Dacope, Botiaghata, Dumuria, Assasuni and Koyra. The Sibsa, Karulia and Vadra are the main rivers in Paikgacha[241]. Kobadak sub-system and Sibsha river systems govern the water flow in the Paikgacha region. The total length of the river is about 100km and it crosses about 27km

[241]Idem 236

through Paikgacha[242]. The river experiences regular tides and its water is saline throughout the year, however salinity drops during the rainy season. Road communication facilities in the upazila include pucca roads (50km), semi-pucca roads (100km), muddy roads (465km) and waterway (15 nautical miles). Paikgachha Bridge connects Paikgachha with its southern part and Koyra upazila successfully.

Total area of the upazila is 411.19 sq km, of which land area is 304.08 sq km. Soil conditions are mostly *doash* or loamy (57737), *bele* or sandy (19245) and *etel* or clay (6415). Almost 95 per cent (66,929 acres) of the total land (70,450 acres) is low-lying land[243]. As a result, out of the 57,801 acres of usable land, 34,911 acres are used temporarily for cultivating crops. Only 3,597 acres are permanently used for crop production.

Most of the people in the upazila are involved in agriculture. Landowners constitute 54.28 per cent of the population and landless 45.72 per cent. As far as human capital is concerned, peoples' skills of agricultural practices related to paddy, jute, wheat, pulse, sesame, betel leaf, turmeric and vegetable cultivation. People are also involved in production of fruits such as mango, blackberry, jackfruit, sapodilla, lemon and coconut. Besides this, people in the upazila also work in the fishery (2,837), dairy (63) and poultry sectors (48)[244]. Both traditional and more modern skills are used to carry out these activities. As most of the vulnerable households operate with traditional skills, skill development and support programmes can enhance their climate change resilience.

The total population of Paikgacha is 109,258 (see Table 41). The literacy rate in the upazila is quite high at 52.8 per cent. However, according to the household survey, the literacy rate among extremely poor women is very low. Most of the adult females (over 18 years) are illiterate, with only 13 women having completed 6 to 12 years of schooling. Further socio-economic information is shown in Table 42.

*Table 41: Demographic Information of Paikgacha Upazila*

| Union | Wards | Villages | Number of HH | Population |
|---|---|---|---|---|
| Deluti | 9 | 23 | 3,922 | 15,555 |
| Lata | 9 | 23 | 2,651 | 10,856 |
| Chandkhali | 9 | 31 | 7,600 | 37,735 |
| Garaikhali | 9 | 15 | 4,722 | 22,806 |
| Soladana | 9 | 33 | 4,777 | 22,307 |
| **Total** | **45** | **125** | **23,672** | **109,258** |

A mix of local, national and international NGOs are involved in development activities in the upazila. The most notable are BRAC, Pradipan, Rupantar, Shushilan, ASA, Bondhu Kallyan Foundation, CSS, Dolit, Nobolok, Nirjera Kori RRF Rural reconstruction foundation, Srijoni Bangladesh, TMSS, SUS, World Vision, Caritas, Mukti Foundation, Grameen Shakti, NariUnnayan Sangstha, Proshika and Uttaran. These organisations work with poor communities on programmes covering health, education, family planning, nutrition, livelihood, micro-finance, biogas, improved cook stoves, legal aid and improving governance. Microfinance organisations have formed savings and credit groups in almost all villages of the upazila.

*Table 42: Basic Socio-economic Statistics of Paikgacha Upazila*[245]

[242]Idem 236
[243]Idem 236
[244] Idem 236
[245] Idem 8

| *Household Information* | *Paikgacha Average* |
|---|---|
| *Household size* | 4.14 |
| *Male %* | 49.96 |
| *Female %* | 50.03 |
| *Girls of age (15-18 years) %* | 4.12 |
| ***Education*** | |
| *Illiterate adult over 18 years of age %* | 47.17 |
| *Male % (exclude Illiterate)* | 58.58 |
| *Female % (exclude Illiterate)* | 47.12 |
| ***Income*** | |
| *Share of household income* | |
| *Male %* | 40 |
| *Female %* | 60 |
| *Average Income/ HH (monthly)* | 5,898.21 |
| *Average expenditure/ HH (monthly)* | 6,408.03 |
| *Average HH savings (in BDT per month)* | 1,655.43 |
| *Average HH deficit (in BDT per month)* | 1,067.4 |
| ***Occupation*** | |
| *Agricultural production and labour %* | 37.00 |
| *Fisheries and labour in fishers %* | 41.30 |
| *Livestock %* | 17.40 |
| *Off farm and small-scale business %* | 4.30 |

### 7.5.2. Proposed Climate Change Resilient Livelihood Options

*Table 43: Proposed livelihood options in Paikgacha upazila*

| Livelihood Option | No. of Women | Unions | Rationale for Union Selection | Rationale for Livelihood Selection |
|---|---|---|---|---|
| **Vegetable homestead gardening** | 300 | Garaikhali and Chandkhali | These Unions have plain and fertile arable land ideal for homesteads for vegetable cultivation. | Women farmers can easily start planting nurseries with training from local horticulture centres. |
| **Crab fattening** | 2,050 | Garaikhali, Soladana, Chandkhali, Deluti and Lata | Water quality (pH, Ammonia, temperature, salinity, dissolved oxygen and alkalinity level) is very suitable for crab fattening in both open and close systems. There is an existing crab hatchery in this upazila, which can provide a sustainable supply of crablets if upgraded. | Existing practice (traditional and progressive), water body, knowledge and skills, profitability, and demand create opportunities to scale-up crab fattening. |
| **Crab nursery** | 50 | Soladana and Lata | Water quality (pH, Ammonia, temperature, salinity, dissolved oxygen and alkalinity level) is very suitable for crab fattening in both open and close systems. There is an existing crab hatchery in this upazila, which can provide a sustainable supply of crablets if upgraded. | Both Unions are centrally located, adjacent to the river and farmers from all other unions can come and collect crablets from Soladana and Lata markets. |
| **Crab feed processing** | 175 | Soladana, Garaikhali, Chandkhali and Deluti | There is an existing crab hatchery in this upazila, which allows for the sustainable expansion of the crab value chain. This consequently creates demand for crab feed. | Crab feed processing will be required for supporting the crab farming sector and also for reducing dependency of crab for feed on wild sources. |
| **Hydroponics/Aqua-geoponics** | 275 | Deluti and Garaikhali | There are a good number of water bodies available in these Unions. There has been increasing interest in | In combination with greenhouses or protective covers, hydroponics uses advanced technology and is capital |

| | | | | |
|---|---|---|---|---|
| | | | the use of hydroponic or soilless techniques for producing greenhouse horticultural crops in the area. | intensive. But it is highly productive, conserves water and land and protects the environment when practiced without fertilizers and pesticides. |
| **Plant nursery** | 200 | Chandkhali, Deluti, Lata and Soladana | There is high demand for small plants and fruit trees, which the nurseries in these Unions can meet, especially salt-resilient species. | Farmers can easily start up plant nurseries with training from local horticulture centres and they can start collecting locally available seeds and plants. |
| **Sesame** | 175 | Deluti | Some people are traditionally cultivating sesame and there are good prospects for commercial production by the poor women. | Sesame is one of the most important high value oil crops in Bangladesh. Local people think that sesame has better resistance to diseases and pests, development of improved agronomic and management practices is required. |

### 7.5.3. Interventions for Climate Resilient Value Chain Development and Market Linkages

*Table 44: Proposed Value Chain Development and Market Linkages Interventions in Paikgacha Upazila*

| Value Chain (Associated Livelihoods) | Current State and/or Constraints of Value Chain | Proposed Interventions |
|---|---|---|
| **Crab** (crab farm, crab nursery) | There is insufficient availability of non-wild crablets and juvenile crabs. Available wild catch crablets are sold at 11 depots in Paikgacha. The existing crab hatchery, operated by BRFI, at its current production capacity would be insufficient to cover all proposed new crab farms with the necessary inputs. | • Upgrade of existing crab hatchery to provide a sustainable and sufficient supply with crablets to the proposed 82 crab farms and 2 crab nurseries for this upazila and the proposed crab farms and nurseries in Shyamnagar upazila. |
| | Market linkages of existing crab farmers with buyers and traders are established and it can be assumed that they will be able to develop in line with the additional volume of crabs. | • Facilitate networking of value chain actors through linkage creation between WLGs and input suppliers/ traders<br>• Create PP platforms to foster upazila-wide coordination and cooperation between value chain actors. |
| | There are a range of microcredit institutions available in the upazila that can provide women beneficiaries with access to finance to sustain and grown their crab enterprises. | • Train women beneficiaries in financial management and create linkages with microcredit organisations for investments in pond, feeds, etc.<br>• Potential partners: Input companies, MFIs. |
| **Fruit trees and other plants** (plant nursery) | Limited knowledge of existing sellers of salt-resilient plants to meet increasing demand and limited capacity to provide local buyers appropriate technical guidance. | • Provide training and set up demonstration plots to showcase nursery development practices.<br>• Potential partners: Local gardeners from the horticulture department. |
| **Vegetables** (hydroponics/ aqua-geoponics/ homestead gardening) | Extremely poor women lack knowledge and skills for vegetable cultivation. In the homestead, activities ranging from selection of seeds to harvesting and storing crops are managed predominantly by women. | • Provide training and set up demonstration plots to establish vegetable gardens in the homestead.<br>• Create service providers (input retailers) to provide technical advice for cultivating in small plots.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |
| **Sesame** (sesame cultivation) | Women farmers do not have adequate technical knowledge and skills on effective cultivation techniques. As a result, productivity is low and quality of product is poor. | • Create service providers (input retailers) to provide technical advice for cultivation.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |

#### 7.5.4. Costing

In Paikgacha, a total of 130 WLGs involving 3,250 women beneficiaries will be directly reached by the proposed interventions. The total direct intervention cost for covering the beneficiaries sums up to around BDT 140,311,807 (see Table 45). These cost estimates reflect current market prices for goods and assets, and based on the proposed interventions identified at ward level (see Union Profiles – Annex 3-7 in this report and Annex IId of the GCF proposal package).

*Table 45: Summary of Intervention Costs for Paikgachha Upazila*

| Livelihood Option | BDT Investment | Unions | No. of WLGs |
|---|---|---|---|
| Homestead gardening | 1,282,200 BDT | 2 | 12 |
| Hydroponics | 650,000 BDT | 1 | 2 |
| Aqua-geoponics | 4,665,600 BDT | 1 | 9 |
| Sesame cultivation | 3,804,941 BDT | 1 | 7 |
| Plant nursery | 4,332,696 BDT | 4 | 8 |
| Crab farm | 22,243,648 BDT | 5 | 82 |
| Crab nursery | 721,030 BDT | 2 | 2 |
| Crab feed processing | 8,821,750 BDT | 4 | 7 |
| Crab hatchery | 93,834,290 BDT | 1 | |
| **Total** | **140,311,807 BDT** | | **130** |

### 7.6. Upazila 5: Assasuni

#### 7.6.1. Background

Assasuni upazila (Satkhira district) is located in between 22°21' and 22°40' northern latitudes and 89°03' and 89°17' eastern longitudes[246]. It is bounded by Satkhirasadar and Tala upazilas to the north, Shyamnagar upazila to the south, Paikgachha and Koyra upazilas to the east and Kaliganj and Debhata upazilas to the west. The area of Assasuni upazila is 402.36 sq km. Notable rivers are Kobadak, Betna and Kholpetua, and Puinjala and Cheutia canals. Assasuni has 11 Unions/Wards, 143 Mauzas/Mahallas and 242 villages. The Unions are: Anulia, Assasuni, Kadakati, Kulla, Khajra, Durgapur, Pratap Nagar, Baradal, Budhhata, Sreeula and Sobhnali. The total number of hats and bazars is 45, the most notable of which are Budhhata and Baradal Hat.

Like other upazilas in Satkhira district, about 75 per cent people of Assasuni upazila are living below the poverty line. Main occupations of the population are agriculture, fishing, day labour, rickshaw/auto bike pulling and small trades. The main agricultural crop is paddy. There are lots of forests cultivated by the government and private farmers. Women and children are engaged in fishing. Children´s involvement is of particular concern since it deprived them of their right to education. The principle sources of income are agriculture (63.11 per cent), commerce (16.98 per cent), non-agricultural labour (5.12 per cent), services (3.56 per cent), transport and communication (1.74 per cent), industry (0.96 per cent), construction (0.62 per cent), religious services (0.24 per cent), rent and remittance (0.14 per cent) and others (7.53 per cent)[247]. 58.34 per cent of the population owns land, while 41.66 per cent is landless[248]. Main crops include paddy, jute, potato, wheat, pulses, sugarcane and vegetables. There are some extinct or nearly extinct crops like linseed, sesame, sweet potato, mungbean and khesari. However, sesame has lot of potential where people are cultivating this commercially and integrating production with processing activities.

Road infrastructure in this upazila is of poor quality; only 46.40km road is Pucca, and about 462.66km road consists of muddy tracks. There is no government or private bank in some Unions. The NGOs involved in micro–credit/financing programmes in the upazila are BRAC, Satkhira Unnayan Sangstha (SUS), Jagorani Chakra Foundation (JCF), Nowabenki Gonomukhi Foundation (NGF), Asa, Grameen Bank, Unnayan Prochesta and the Rural Reconstruction Foundation (RRF). World Vision, Caritas, Solidarities international, Muslim Aid, Uttaran, Shushilan and Rupantor are all implementing disaster risk reduction and climate change, nutrition, livelihood and good governance programmes.

The upazila has a total population of 242,056 (see Table 46). Further socio-economic information is shown in Table 47.

[246] Idem 230
[247] Idem 236
[248] Idem 236

*Table 46: Demographic Information for Assasuni Upazila*

| Union | Wards | Villages | Number of HH | Population |
|---|---|---|---|---|
| Anulia | 9 | 24 | 5,525 | 24,710 |
| Durgapur | 9 | 14 | 3,419 | 16,201 |
| Sreeula | 9 | 23 | 5,760 | 25,962 |
| Budhata | 9 | 24 | 6,253 | 29,540 |
| Barodal | 9 | 23 | 5,919 | 28,038 |
| Khajra | 9 | 26 | 5,708 | 26,047 |
| Kulla | 9 | 21 | 5,890 | 24,562 |
| Kadakati | 9 | 24 | 3,181 | 14,121 |
| Assasuni | 9 | 25 | 5,418 | 23,625 |
| Protap Nagar | 9 | 18 | 6,191 | 29,251 |
| **Total** | **90** | **222** | **53,264** | **242,056** |

*Table 47: Basic Socio-economic Statistics for Assasuni Upazilas*[249]

| ***Household Information*** | ***Assasuni Average*** |
|---|---|
| *Household size (no of people)* | 4.33 |
| *Male %* | 49.85 |
| *Female %* | 50.14 |
| *Girls of age (15-18 years) %* | 4.54 |
| ***Education*** | |
| *Illiterate adult over 18 years of age %* | 50.17 |
| *Male % (exclude Illiterate)* | 54.95 |
| *Female % (exclude Illiterate)* | 45.05 |
| ***Income*** | |
| *Share of household income* | |
| *Male %* | 35.00 |
| *Female %* | 65.00 |
| *Average income/ HH (monthly)* | 4,311.52 |
| *Average expenditure/ HH (monthly)* | 3,975.00 |
| *Average HH savings (in BDT per month)* | 1,787.67 |
| *Average HH deficit (in BDT per month)* | 1,052.61 |
| ***Occupation*** | |
| *Agricultural production and labour %* | 56.80 |
| *Fisheries and labour in fishers %* | 14.80 |
| *Livestock %* | 8.60 |
| *Off farm and small-scale business %* | 19.75 |

### 7.6.2. Proposed Climate Change Resilient Livelihood Options

*Table 48: Proposed Livelihood Options in Assasuni Upazila*

| Livelihood Option | No. of Women | Unions | Rationale for Union Selection | Rationale for Livelihood Selection |
|---|---|---|---|---|
| **Plant nursery** | 375 | Sreeula, Anulia, Bardal, Kulla and Kadakati | There is high demand for small plants and fruit trees, which the nurseries in these unions can meet, especially salt-resilient species. | Farmers can easily start up plant nurseries with training from local horticulture centres and they can start collecting locally available seeds and plants. |

[249] Idem 8.

| | | | | |
|---|---|---|---|---|
| **Vegetable homestead gardening** | 1,800 | Anulia, Sreeula, Budhhata, Bardal, Kulla, Kadakati, Assasuni Sadar and Pratapnagar | The elevation and projected salinity in the selected wards, in combination with raised bed and other growing techniques, are ideal for homestead gardening. | Women farmers can easily start planting nurseries with training from local horticulture centres. |
| **Hydroponics/ Aqua-geoponics** | 5,825 | Anulia, Durgapur, Sreeula, Budhata Pratapnagar, Bardal, Khajra, Kulla, Assasuni Sadar, Kadakati and Protapnagar | A good number of water bodies are available in these Unions. There has been increasing interest in the use of hydroponic or soilless techniques for producing greenhouse horticultural crops in the area. | In combination with greenhouses or protective covers, hydroponics uses advanced technology and is capital intensive. But it is highly productive, conserves use of water and land, and protects the environment when practiced without fertilizers and pesticides. |
| **Sesame** | 1,250 | Budhata, Khajra and Assasuni Sadar | Some people are traditionally cultivating sesame and there are good prospects for commercial production by poor women. | Sesame is one of the most important high value oil crops in Bangladesh. Local people think that sesame has better resistance to diseases and pests. Development of improved agronomic and management practices is required. |

### 7.6.3. Interventions for Climate Resilient Value Chain Development and Market Linkages

*Table 49: Proposed Value Chain Development and Market Linkages Interventions in Assasuni Upazila*

| Value Chain (Associated Livelihoods) | Current State and/or Constraints of Calue Chain | Proposed Interventions |
|---|---|---|
| **Fruit trees and other plants** (plant nursery) | Limited knowledge of existing sellers of salt-resilient plants to meet increasing demand and limited capacity to provide local buyers appropriate technical guidance.<br>Assasuni Sadar, Kulla, Anulia, Budhahata and Pratapnagar union and some parts of Durgapur, Khajra and Sreeula are known for fruit and vegetables cultivation. Major fruits produce these unions are Sofeda, tamarind, black berry, banana and mango. Nursery owners have limited knowledge of saline resilient plants to meet increasing demand of farmers. They have limited capacity to provide technical know-how to local plant traders. | • Provide training and set up demonstration plots to showcase nursery development practices.<br>• Potential partners: Local gardeners from the horticulture department. |
| **Vegetables** (hydroponics/ aqua-geoponics/ homestead gardening) | Extremely poor women lack knowledge and skills for vegetable cultivation. In the homestead, activities ranging from selection of seeds to harvesting and storing crops are managed predominantly by women. | • Provide training and set up demonstration plots to establish vegetable gardens in the homestead.<br>• Create service providers (input retailers) to provide technical advice for cultivating in small plots.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |
| **Sesame** (sesame cultivation) | Women farmers do not currently use effective cultivation techniques. | • Create service providers (input retailers) to provide technical advice for cultivation.<br>• Potential partners: MFIs, seed companies/ retailers and the DAE. |

### 7.6.4. Costing

In Assassuni, a total of 370 WLGs involving 9,250 women beneficiaries will be directly reached by the proposed interventions. The total direct intervention cost for covering the beneficiaries sums up to around BDT 124,715,555 (see Table 50). These

cost estimates reflect current market prices for goods and assets, and based on the proposed interventions identified at ward level (see Union Profiles – Annex 3-7 in this report and Annex IId of the GCF proposal package).

*Table 50: Summary of Intervention Costs for Assasuni Upazila*

| Livelihood Option | BDT Investment | Unions | Nr. of WLGs |
|---|---|---|---|
| Homestead gardening | 7,693,200 BDT | 8 | 72 |
| Hydroponics | 65,650,000 BDT | 11 | 202 |
| Aqua-geoponics | 16,070,400 BDT | 5 | 31 |
| Sesame cultivation | 27,178,150 BDT | 3 | 50 |
| Plant nursery | 8,123,805 BDT | 5 | 15 |
| **Total** | **124,715,555 BDT** | | **370** |

### 7.7. Implementation Modalities, Sustainability and Scalability of Climate Change Resilient Livelihoods

The work to promote climate resilient livelihoods has been designed in consultation with local communities, NGOs/ CBOs, traders' associations and government agencies. These consultations were used to identify gender sensitive climate change resilient livelihood options and interventions that will be implemented by the MoWCA through engagement with local communities and by sub-contracting NGOs and government officials in the targeted districts, upazilas and unions. The project approach is centred on community participation and engagement with producer groups in order to foster ownership and empowerment of poor women during the implementation of project interventions. The integration of climate change resilient practices into traditional and non-traditional livelihoods will be promoted, thereby facilitating the adoption of such practices over the long-term. Targeted capacity building and training will inform planning, design and implementation of adaptation measures based on the local socio-economic and environmental contexts.

The following Sections provides an overview of the implementation modalities, sustainability considerations and mechanisms and the project exit strategy.

#### 7.7.1. Implementation Modalities

Based on the identified best practices of livelihood projects in Bangladesh and in light of increasing climate change impacts, the project proposes to focus on community-level interventions. The scheduled implementation of different project components will facilitate women to build up their capacities, empower them to shift towards climate change resilient livelihoods, create climate resilient value chains, and provide continuous support and skills development to ensure sustainable uptake of the interventions (see GCF proposal for the implementation schedule). All interventions aim to integrate the following three components: (i) establishing women´s livelihood groups; (ii) facilitating value chain and market linkage development; and (iii) supporting climate change resilient livelihood development processes. The adoption modalities for each element is outlined below.

**Women livelihood group interventions:** As a first step, a Women's Livelihood Group (WLG) of 25 women will be organised at the ward level for each proposed livelihood option. In some wards, there existing women´s groups will be incorporated into the WLG or rehabilitated in case they are dysfunctional or if group members meet the target criteria for this proposed GCF project. In other wards, new groups will be formed. The group members will be clustered according to existing capacities (financial and technical) and their geographic location in order to avoid creating mobility barriers, such as long commutes. During formation, a participatory market mapping exercise will be conducted during which the group members will be introduced to the proposed livelihood options and jointly identify market potentials, implementation barriers and mitigation options, their capacities and needs for support. During these facilitated workshops, the women will plan their livelihoods and gain an understanding of potential profit margins, required skills and market linkages. For the climate risk awareness building events, the WLGs will collaborate with Union Disaster Management Committees (UDMCs) and *Paani* Committees to: (i) develop and disseminate awareness materials, including Information Education and Communication (IEC) materials, as well as Behavioural Change Communication (BCC) materials; (ii) display local activities/land use and climate related hazards on GIS maps; (iii) conduct awareness raising activities at public gatherings and cultural activities. The WLGs will meet on a regular basis to create strong linkages between the women and on-going training with different foci (as outlined above) will be provided.

During this process, the women will be clustered into livelihood-specific groups based on their existing skills, preferences, and willingness to co-finance larger initial investments to start the livelihood, as in the case of crab feed processing. Considering the different costs to start the different livelihood options, with most ranging between USD4,000 and 5,000 for 25 women, the cost of for crab feed processing at around USD15,000 is significantly higher. Thus, the project would cover only a share of the costs for the women taking up crab feed processing and would expect them to provide some co-finance. The incentive for women to take up crab feed processing is that profits can be expected to be 3 to 4 times higher than with the other livelihoods. To increase the feasibility that women are able to provide co-financing for crab feed processing, as well as for additional input costs, they will be connected to local microfinance institutions that are operating in the project areas. Initial discussions with MFIs have indicated that they are willing to provide credits of USD500 per household for the project livelihood groups.

In the next phase, the women will be provided with the assets and initial inputs required for one production cycle of the livelihood. These provisions will be accompanied by technical skills training to build the women´s capacity to start the alternative, climate change resilient livelihood. After the first production cycle, the women will be required to use their profits to purchase inputs and self-sufficiently maintain and operate their micro-businesses. However, the duration of support and phasing-out of input support can be extended on a case-by-case basis depending on the socio-economic and societal status of the women, for example for single mothers or beneficiaries whose livelihood is damaged/affected by cyclones or other extreme weather-related events during the implementation of the project could receive a longer project support. Land lease costs will be covered by project funds for the whole project length.

There will also be a 10 per cent contingency budget available to cover sustainable land lease costs for the WLG throughout the project's lifetime, as well as additional inputs and assets required to ensure year-round employment for the women beneficiaries. Due to seasonal variations which might influence the feasibility of pursuing just one climate change resilient livelihood, and based on the confirmed (through field data) assumption that most households and women are involved in a portfolio of income-generating activities throughout the year, the project will allow some women - on a needs-based approach - to be part of more than one WLG (or switch between WLGs) in their wards to gain skills and knowledge to practice different livelihoods. Additional support from the contingency budget provided in the form of assets and inputs will be dispersed based on an analysis of various factors, including how much project support was previously received, the socio-economic situation of the women, and the seasonal influence of climate change on the livelihoods being pursued. For example, those women who were able to start homestead gardening with the provision of relatively low-cost assets and input will be more likely to receive additional support to uptake a second livelihood than women who received more substantial support to start crab fattening; a highly profitable livelihood with relatively high initial assets and input costs.

The WLGs will receive different forms of training in skills relevant to sustainably operating their business (see more details in the next Section on sustainability and exit strategy). These trainings will comprise of the technical abilities to take up the livelihood, improved knowledge about climate change in order to be able to consider potential impacts in livelihood planning processes, basic business skills, marketing and finance planning, and operations and maintenance.

The project will also enable women to strengthen their interaction with relevant stakeholders along the livelihood value chain and to improve overall sectorial coordination (see next Section).

**Value chain and market linkage development:** To enable women to shift to alternative, climate change resilient livelihoods in southwest Bangladesh at the proposed project scale and without causing negative environmental and social impacts, there is a need to develop climate resilient value chains and market linkages. The main interventions in this regard are proposed as the upgrading of one crab hatchery, which is operated by the Bangladesh Fisheries Research Institute (BFRI) – a government entity with experience in operating hatcheries for the aquaculture sector. The hatchery confirmed that they will prioritize supply of crablets to the women beneficiaries targeted in the proposed project. The crab hatchery will be upgraded to ensure the biosecurity of the facility and to expand production capacity to ensure the sustainability of this climate resilient livelihood pathway over time. Technical skills training of staff from the hatchery will be provided at comparable and well-established hatcheries in another Asian country, such as the Philippines.

**Support to facilitate climate change resilient livelihood development processes:** The implementation of the project will be supported by governmental and non-governmental development partners, in particular the MoWCA, Department of Public Health Engineering (DPHE), LGIs, Union Parishads (UPs), NGOs and academic institutions. Direct support for women to shift

towards alternative, climate change resilient livelihoods will be provided through NGOs. Engagement with national and international agencies that either implement interventions or work in the target areas and have standing within the target communities will be undertaken to ensure local buy-in. Additionally, private sector actors, such as business service providers, traders and retailers will be invited to awareness raising events about climate resilient value chains, as well as networking workshops in order to facilitate and improve market linkages with the WLGs.

The organisational structure of the project will include a small headquarter in Dhaka responsible for overseeing implementation and field offices at district level in Khulna and Satkhira, as well as in the five targeted upazilas.

With respect to the capacity development of implementing organizations, including the MoWCA and LGIs, livelihood and market development experts will provide formal as well as on-the-job capacity building activities. This includes the training of trainers (ToT) to effectively and sustainably spread the knowledge acquired.

#### 7.7.2. Sustainability

To ensure project sustainability a range of different strategies will be followed and mechanisms will be established. These are described below and include: (i) gender responsive decision-making processes; (ii) organisational structure of WLGs and stakeholder engagement; (iii) financial management and economic sustainability; (iv) public private platforms; (v) introduction of new adaptive technologies and interventions; (vi) environmental management; and (vii) the sensible expansion of climate resilient markets and value chains. The introduction of new approaches to integrating climate change and developing the climate change resilience of vulnerable women will have multiple benefits, which extend beyond the lifetime of this project.

**Gender responsive decision-making process:** Community groups will be trained to evaluate gender norms and inequities in relation to socio-cultural expectations, stereotypes and discrimination, and their impact on male and female relationships. This evaluation is important as it will encourage men, women and adolescent girls to participate equally in agricultural, fisheries/ livestock production, income generation and household activities, to the maximum benefit of households. This training will also include skill building for women beneficiaries on how to negotiate ownership of assets, equipment or land. The training and community sensitization activities will also target male family members to make sure they do not compel women members to transfer ownership to their male counterparts.

**Organisational structure of the WLGs and stakeholder engagement:** Organization of the 1,017 women livelihood groups will serve to establish a peer-to-peer social support system amongst the target households. This is important as poor women generally have only a few livelihood resources to draw upon or enable them to develop alternative livelihoods. Groups will tend to have stronger bonds with private and public sectors and will be able to develop organizational structures, financial management, governance, human resource management, linkages, a communication strategy and strategies for resource mobilization from both private and public sources through negotiation and bargaining. To ensure continuation beyond the project's lifetime, the project will work with women producers to develop a management structure of the WLGs for provision of material support and, at a later stage, in order to link individuals, groups or sub-groups of 4 to 5 members with each other to facilitate problem solving and the possibility of developing their own support structures. Whilst providing technical and business skill training to members of the WLGs is important, it will be critical to have follow up and peer-to-peer training in order that these skills are retained. Furthermore, it will be necessary to ensure that the WLGs do not become dependent on 1 or 2 members for critical functions, and that group sustainability and management is able to continue if key members either leave or are unable to perform their functions.

Organization of the poorest community groups into WLGs will provide these women with a peer-to-peer social support system. This is important as the extremely poor generally have only few livelihood resources to draw upon and cannot risk undertaking drastic livelihood changes. The 1,017 WLGs will have stronger bonds with private and public sectors. They will be able to develop organizational structures, financial management, governance, human resource management, communication strategies and decision-making processes for mobilisation of resources from both private and public sources through negotiation and bargaining. Having support from the wider community will increase their confidence. Local economic growth led by their involvement in progressive livelihood options and market led value chain activities will enable them to operate in the complex market system. Through their collective voice, a systemic change will be initiated in their surrounding market and social environment.

To facilitate market linkages the project will establish an organisational structure promoting women´s representation at different levels in their economic sectors. At the ward level women will have a voice through their WLGs. At the Union level, interactions will be facilitated between LGI representatives (ministerial extension officers) and Union level WLG committees, consisting of members from the different livelihood-specific WLGs across the union. At the upazila level, public private platforms will be formed (see next Section).

**Public private platforms:** Public private (PP) platforms are relatively new concepts in climate resilient development projects in Bangladesh. However, initial experiences show that they have the potential to work sustainably, with minimal external support (see Section 4.4). Therefore, this project intends to establish PP platforms at upazila level. These platforms will enable women beneficiaries to interact with relevant value chain actors (public and private stakeholders) and jointly work on sustainable market development, initiate new and strengthen existing linkages within the value chains and jointly identify and address barriers. There will be 20 to 25 representatives per PP platform (8 WLG representatives, 6 value chain actors, 6 representatives from the DAE, the Fisheries Department, the MoWCA, banks and financial institutions, as well as one or two from NGOs). Initially, it is expected that the MoWCA will host the platforms and this responsibility will gradually be handed over to private businesses and the WLGs.

The PP platform will form collaborations based on mutual interest and win-win scenarios. At the ward level, the WLGs have the incentive to obtain services and information based on their feedback. At the union level the WLG committees and the local level government officers would have the incentive to easily monitor the status and situation of the WLGs. At the upazila level, the government agencies have mandates to provide timely delivery of services that can be easily facilitated by this platform. Moreover, the private sector would be enabled to reach out to the last mile consumer and increase their customer base. PP platforms can further act as feedback mechanisms through which local concerns or best practices can be brought to the attention of value chain actors and upazila level LGIs. This will, in the ideal case, lead to joint problem-solving processes.

In each of the of the 5 target upazilas one PP platform will be established to create an enabling environment, promote climate resilient livelihood and value chain governance and development, and, ultimately, act as an effective collaborative mechanism as part of the project's exit strategy.

**Financial management and economic sustainability:** Improving the abilities of the women to create sustainable income and manage their finances constitutes another objective of the project. During the WLG meetings and organised thematic workshops the women will learn basic business and financial management skills. As literacy rates among target households might be low, appropriate support will be given to those with special needs. If the interventions involve sharing profits and operating a community-level enterprise (e.g. larger crab pond), those women with the highest capacities in the WLGs will be selected and trained to handle finance or fulfil other functions in the group. The financial support (in form of assets and inputs) for the women and groups will be phased out throughout the project lifetime to increase the sense of ownership and responsibility among the beneficiaries. Overall, the development of assets and steady income will lead to economic empowerment and established market linkages will allow women to identify and realise opportunities beyond the project's lifetime.

**Introduction of new climate change resilient technologies and interventions:** The project will introduce new technologies like hydroponics and aqua-geoponics at individual and community levels, which will be long lasting and can be used after the project terminates. These technology-focused livelihood interventions are designed to withstand sudden and incremental climate change impacts, will be located within the proximity of the women's households, and will increase the productivity of women producers when compared to traditional technologies. The technologies, apart from the ones used at the crab hatchery, are easy to maintain and apply. Women will be trained to maintain and operate the technologies through developing new skills in order to ensure continuation of use after the project lifetime.

In addition, through different workshops with value chain actors and at the ward level, the WLGs will be exposed to roadshows of different adaptive technologies and innovations relevant to their respective livelihoods. This will facilitate the women to make adjustments to their production techniques in the event that new adaptive technologies enter their value chains. By improving access to information about new technologies, the project will support women to take up the best-suited technologies to adapt to increasing climate change impacts as well as maintaining competitive production levels.

**Environmental sustainability:** The process of selecting livelihood options and value chain expansion activities has explicitly considered the need to reduce environmental impacts, while at the same time enhance environmental benefits. Improved agricultural practices, such as training in organic and pesticide-free techniques, will lead to a significant reduction of the use of chemical fertilizers and pesticides in homestead and community agriculture, with multiplier effects expected for public health and water quality. Importantly, the proposed interventions involve the introduction of optimized aquaculture techniques, essential in a context of rapidly expanding small-scale aquaculture in the area, which will include the incorporation of a range of environmental management practices within the target districts. Currently, small-scale semi-intensive aquaculture in Bangladesh does not make adequate use of effluent management techniques such as timed and coordinated releases or water from ponds into receiving estuaries, measures to prevent salinity seepage, optimized pond (*gher*) construction, nor of innovative practices in bioremediation using halophytic plants, all of which will be introduced as part of the proposed livelihood interventions. Given the pressures on wild stocks in Bangladesh, both from collection of wild fry from mangrove areas, as well as the use of by-catch for feed processing, the project will address both of these factors by upgrading a crab hatchery for the supply of crab seed and introducing a low-fish/ no-fish meal fish feed formulation in aqua-geoponics and crab farming. To strengthen the impacts of these interventions, the project will also provide regulatory support to the GoB on environmental management in aquaculture (ensuring no expansion of small-scale farms into areas close to mangroves or agricultural land) as well regulatory support to shift away from wild fry collection to hatchery produced stock. The introduction of modern technology and water treatment facilities will vastly improve the biosafety and environmental management of the hatchery. Finally, the fish species used for aquaculture have been chosen to avoid ecosystems impacts from the introduction/promotion of invasive species and to avoid carnivorous species, which would require a much higher weight of fishmeal for feed. Overall, these improved practices will directly contribute to long-term environmental sustainability, even though climate change is expected to worsen associated climate stresses.

**Sensible expansion of climate resilient markets and value chains:** Expansion of climate resilient livelihood options should be taken up by sector stakeholders (private/public) after the project finishes. Basically, two mechanisms can be expected to work in favour of 'self-propagation': (i) neighbours of women beneficiaries might copy and uptake innovations, if they see that they are indeed profitable; and (ii) it is expected (and has been proven in previous interventions) that service providers will crowd-in if they see a profitable business opportunity being taken up by a competitor.

The intervention strategies will be to initially ensure a livelihood option is workable with defined target groups and close monitoring of the livelihood options will be carried out for each location. The appropriate mix of options will be modified based on uptake and market linkages, with the aim of maximizing coverage, scale and impact. The idea is to develop appropriate business models, promote adoption of new methods and technologies, and trigger behavioural changes that are adaptable to the different circumstances of beneficiaries.

### 7.7.3. Exit Strategy

As part of its exit strategy, the project will undertake following measures:

**Capacity building of WLGs, local communities, MoWCA, and NGOs/ CBOs:** Capacity building will support the adoption of climate resilient livelihoods. The proposed project will promote mainstreaming of climate change concerns into institutional planning and coordination within the MoWCA to foster cross-sectoral and comprehensive approaches to climate change adaptation. Project activities will build institutional and technical capacities of MoWCA officials, producer groups, local communities, NGOs/CBOs and private sector actors to plan and implement measures for climate change adaptation. Strong engagement with government agencies, relevant institutions and local communities in participatory planning and implementation will ensure that project interventions are responsive to the needs and priorities of the targeted beneficiaries as well as ensuring that the relevant technical, institutional and financial capacities are built to support on-going climate change adaptation after the project's implementation period.

**Access to finance:** Finance is very important in enabling the target households to invest in further developing the livelihood option they started with project funding. Without access to finance, these households may be unable to continue climate change resilient livelihood options for long periods. One way of ensuring access to finance among target households is to organize them into groups to start joint savings programmes, which will ensure finances are available to continue group activities, as well as develop a pool of finance, which can be used to make small loans to group members when either climate or financial conditions are difficult. The project will arrange skill training and linkage building workshops with banks to assist

beneficiaries to gain access to finance initially, as well as encouraging savings and investments practices, especially during productive years. Initial discussions with MFIs have indicated that they are willing to provide credits of USD500 per HH for the project livelihood groups.

**Contingency planning for producer groups:** Support will be needed in case of loss and damage due to either excessive droughts/floods or a damaging cyclone. The MoWCA, with the assistance of development partners, will help each of the producer groups develop emergency contingency plans to manage risks posed to livelihood options in such events. Technical support will be provided to the groups for developing/revising contingency plans, as well as developing recovery plans to enable livelihoods to recover with minimal disruption and cost. These plans should be linked to the group/community saving schemes and set out how best to use different levels of available funds to recover from such impacts. In addition, the project will foster the formation of last-mile early warning communication through women and girl volunteer groups (15 group members with 3 sub-groups of 5 women per ward). This improved local level early warning system will provide preventive information on disaster preparedness and risk reduction, and will train the ward population and WLG members through mock alarms on how to best secure their livelihoods and assets.

**Post-project operations and maintenance:** The beneficiaries will undertake on-going maintenance and operation of the assets and tools provided for each livelihood in the villages. MoWCA will assist the beneficiaries to develop ownership of mechanisms along with management, marketing, and financing plans. One-time GCF finance will be used to develop operations and maintenance (O&M) plans during the project implementation. More intensive O&M will be required for the crab hatchery. Due to the ownership situation of the two facilities to be upgraded, while the responsibility for O&M will remain with BFRI, the project will support the initial development of an O&M plan.

**Uptake:** Sector stakeholders (private/public) will use various mechanisms to facilitate the uptake of the livelihoods by the women producer groups/ beneficiaries. Apart from training in business and technical skills, two additional mechanisms will work in favour of uptake and further propagation of climate resilient livelihoods in the project area. The first is at the level of individual target beneficiaries, where the copying effect will play a role in that neighbours will adopt innovations if they see that they are indeed profitable. Secondly, service providers involved in input/output trading will play a vital role by supplying finance, quality inputs, information, knowledge and skills for uptake. The project will identify scale agents and their incentives to ensure that the successful pilots will be replicated and scaled-up. The scale agents include private sector companies, banks and MFIs. The project has support provision for financial market analysis, financial service linkage workshops and orientation on financial linkages for WLG leaders. This will help leverage loan finance for climate resilient livelihood activities, thereby supporting on-going implementation and scaling-up beyond the project lifespan.

## 8. Financial Needs

The total direct cost of providing the women beneficiaries with asset and tools to start climate resilient livelihoods and the upgrade of one existing crab hatchery to meet international environment standards and increase their productivity would be around USD1,161,603 (see Table 51). All additional costs for capacity training of beneficiaries, value chain actors, and government entitites, NGO execution, and other executive costs are outlined in detail in the GCF proposal.

*Table 51: Budget Summary*

| Livelihood Option | Nr. of WLGs | Cost in BDT | Cost in USD | % |
|---|---|---|---|---|
| Homestead gardening | 189 | 20,194,650 BDT | 250,413.66 | 4.23 % |
| Hydroponics | 410 | 133,250,000 BDT | 1,652,300.00 | 30.54 % |
| Aqua-geoponics | 61 | 31,622,400 BDT | 392,117.76 | 7.25 % |
| Sesame cultivation | 114 | 61,966,182 BDT | 768,380.66 | 14.20 % |
| Plant nursery | 45 | 24,371,415 BDT | 302,205.55 | 5.59 % |
| Crab farm | 176 | 47,742,464 BDT | 592,006.55 | 10.94 % |
| Crab nursery | 4 | 1,442,060 BDT | 17,881.54 | 0.33 % |
| Crab and fish feed processing | 18 | 22,684,500 BDT | 281,287.80 | 5.20 % |
| Crab hatchery | (1 upgrade) | 93,834,290 BDT | 1,161,603.00 | 21.49 % |

| | | | | |
|---|---|---|---|---|
| **Total** | **WLG: 1,017** | **437,107,961 BDT** | **5,418,196.52** | **100 %** |

## 9. Concluding Remarks

The investigation has shown that there is an urgent demand to enable coastal communities in the southwest of Bangladesh, and women in particular, to enhance their resilience to climate change and escape potentially hazardous development trajectories related to the maladaptive livelihoods that are currently practised in the region. In particular, climate-induced increases in the salinity of soils and freshwater aquifers (through sea level rise and cyclone driven salt-water inundations) poses a significant threat towards agriculture-based livelihoods. Both Khulna and Satkhira districts experience extreme weather phenomena like tropical cyclones, storm surges, floods and droughts on regular basis. These events severely impact the region's agricultural sector, drinking water supply, homes and infrastructure, putting people's lives, livelihoods and assets at risk. Between 16 and 40 per cent of people living in Khulna and Satkhira are extremely poor. Gender inequality prevails in these districts through various societal and cultural norms that impact women's day-to-day activities as well as their capacity to adapt to climate change. Women have less decision-making power within the household and at the workplace and are expected to manage household and care for the family.

This assessment investigated the potential to use GCF support and co-finance to enable vulnerable women in southwest Bangladesh to engage in various climate change resilient livelihood options that have potential for income and employment generation, value chain upgrading and inclusive market development, leading to transformative change in gender roles and increased resilience of beneficiaries. Existing development support and best practices have been taken into account in the assessment of potential climate resilient livelihood options in order to ensure that there are no overlaps with other on-going efforts designed to support coastal communities in southwest Bangladesh and to ensure that previous lessons learned about successful and unsuccessful approaches are incorporated into project design. The best practices that have shaped the design of the proposed livelihood options suitable in saline areas include the use of hydroponic and aqua-geoponic technologies, floating garden principles, raised beds using mulching, two crop production cycles, community centric interventions and the formation of public private platforms.

A range of constraints to supporting vulnerable women to shift to climate change resilient livelihoods were identified. These are: (i) limited ability and available information among coastal communities and women to make climate-risk informed livelihood decisions; (ii) limited access and understanding of climate compatible technology and techniques of coastal communities to shift towards climate change resilient livelihoods; (iii) constrained access to climate-resilient value chains and agricultural markets, and limited available value-addition activities for alternative, climate change resilient livelihoods; (iv) limited access to additional finance to shift towards climate change resilient livelihoods (micro-finance, BRDB, banks); (v) limited understanding among coastal communities of local financial institutions; (vi) limited institutional capacities to plan, foster and facilitate climate resilient livelihood development; and (vii) weak vertical and horizontal coordination and knowledge management between government institutions on climate risk management.

These barriers, as well as best practices identified from other projects/ interventions in Bangladesh, were considered in the selection process of proposed livelihoods and in the design of the interventions. A total of 38 livelihood options were screened in relation to their climate change resilience, saline tolerance, cyclone resilience, gender responsiveness, market potential, environmental impacts and socio-economic considerations. This multi-criteria options analysis led to the identification of eight proposed adaptive and climate resilient livelihoods that the GCF project could implement in the project districts. These are: (i) crab farming; (ii) crab nursery; (iii) aqua-geoponics; (iv) hydroponics; (v) plant nursery; (vi) sesame cultivation; (vii) home stead vegetable gardening; and (viii) crab and fish feed processing.

The proposed project will cluster the targeted women into groups of 25 to engage in the new livelihoods. The women´s groups will receive training in technical and business skills, on how to create market linkages and access to finance to expand livelihood options. Participatory market mapping for livelihood planning will enable the beneficiaries to mobilize additional resources for livelihood development.

The sustainability of the interventions will be ensured through livelihood options having economic impact, strengthening the institutional and social structure of the groups or community organizations, improving financial management, technical support, environmental management and creating evidence for policy backup. The project encourages more individual

farmer entrepreneurs to adopt the innovations. Local inputs suppliers or service providers will play a vital role by supplying quality inputs, updated information and strengthening business relationships. The project will give emphasis to operations and maintenance of community-level livelihoods and value chain upgrading facilities. This will ensure the sustainability of interventions during and after the project implementation. Public private platforms at upazila level with create an enabling environment for the climate change resilient livelihoods to develop and grow.

After comprehensive investigations of the union-specific circumstances, such as elevation, salinity levels, existing skills and capacity, it has been possible to suggest livelihood interventions that will enable coastal communities, especially women, to shift towards the proposed climate change resilient livelihoods. A total of 198 aquaculture-based and 819 agriculture-based interventions has been proposed. In addition, the upgrading of one existing hatchery is proposed to allow for the growth and sustainable development of a currently non-coherent crab value chain.

The proposed interventions have a total cost of around USD1,161,603 (93,787,842 BDT).

The elements that are crucial to the success of the proposed interventions have been identified as: (i) capacity building of producer groups, local communities, MoWCA, and NGOs/CBOs; (ii) adequate and suitable access to finance for the community members; (iii) a collaborative approach between government and development partners; (iv) private sector engagement; (v) improved climate adaptation knowledge, attitude and practices among communities; (vi) uptake and self-propagation at scale with respect to the proposed interventions; and (vii) community ownership building.

The design of the project is expected be instrumental in supporting the mainstreaming and adoption of climate resilient livelihoods in the target regions. The proposed public private platforms will enable the project to gradually transfer ownership to a collaborative group of stakeholders, which is transparent and accountable due to the presence of government and private sector representatives. It is hoped that the engagement of the private sector will reduce dependency on external aid and project driven support, ultimately leading to self-sustainable climate resilient livelihoods. The sustainability of the climate resilient market systems and the subsequent value chain development will depend largely on the projects effectiveness in facilitating linkages between the target groups and their business partners.

## 10. Appendices

**Annex 1: Multi-criteria Poverty Index Approach**

The Multi Criteria Poverty Index (MCPI) is calculated using Banishanta union of Dacope upazila in Khulna district as a sample union. The index has been calculated considering three parameters: (i) income poverty; (ii) housing poverty; and (iii) livelihood poverty. The calculation is as follows:

*Table 52: Example Calculation of Multi-dimensional Poverty Index Figure for Baniashanta Union*

| Type | Income (BDT) | % of HH (X) | Weight Factor (WF) | WF * (X) | Sub-Index |
|---|---|---|---|---|---|
| Income poverty (based on PRA) | 0 to 5,000 | 36 | 1.00 | 36 | |
| | 5,001 to 10,000 | 21 | 0.75 | 16 | |
| | 10,001 to 15,000 | 26 | 0.50 | 13 | |
| | 15,001 and above | 17 | 0.25 | 4 | |
| | **Total** | **100** | | **69** | **0.69** |
| Housing poverty (based on PRA) | Pucca | 8 | 0.25 | 2 | |
| | Semi-pucca | 12 | 0.50 | 6 | |
| | Kutcha+jhupri | 80 | 1.00 | 80 | |
| | **Total** | **100** | | 88 | 0.88 |
| Livelihood poverty (based on PRA) | % of Labour (Class) | | | Weight factor | |
| | 75-100 (weight 1.0) | 80 | 1.00 | 1 | |
| | 50-75 (weight 0.75) | 0 | 0.75 | 0 | |
| | 25-50 (weight 0.50) | 0 | 0.50 | 0 | |
| | 0-25 (weight 0.25) | 0 | 0.25 | 0 | |
| | **Total** | | | **1** | **1** |
| | | | | **Total score** | **2.57** |

| | | |
|---|---|---|
| | MCPI | 0.86 |

The poverty level is categorized as follows:

- MCPI Score <0.00 – 0.25> Non-Poor
- MCPI Score <0.26 – 0.50> Poor
- MCPI Score <0.51 – 0.75> Extreme Poor
- MCPI Score <0.76 – 1.00> Ultra Poor

**Annex 2: Upazila-wide NGO Activities in the Districts of Khulna and Satkhira**

The table below shows the NGOs working in the target upazilas.

*Table 53: CSO/ NGO Activities in Assasuni Upazila*

| NGO | Thematic Focus | Beneficiaries | Male | Female | Starting Year |
|---|---|---|---|---|---|
| World vision | Nutrition | 3,000 | 1,800 | 1,200 | 2010 |
| Solidarities international | DRR & CC | 1,200 | 800 | 400 | 2014 |
| Karitash | Livelihood | 1,800 | 1,100 | 700 | 2011 |
| BRAC | Microfinance | 4,000 | 200 | 3,800 | 2000 |
| Muslim Aid | DRR & CC | 800 | 600 | 200 | 2013 |
| Shushilan | Livelihood, nutrition & DRR | 19,000 | 11,000 | 8,000 | 2011 |
| Uttaran | Livelihood, microfinance | 2,800 | 1,800 | 1,000 | 2013 |
| Satkhira Unnayan Sangstha (SUS) | Microfinance | 2,500 | 500 | 2,000 | 2013 |
| Association for Social Advancement (ASA) | Microfinance | 3,500 | 400 | 3,100 | 2003 |
| Jagorani Chakra Foundation (JCF) | Microfinance | 3,200 | 700 | 2,500 | 2005 |
| Nowabenki Gonomukhi Foundation (NGF) | Microfinance | 2,000 | 300 | 1,700 | 2014 |
| Institute of Development Education for Advancement of Landless (IDEAL) | Nutrition, microfinance | 1,800 | 700 | 1,100 | 2012 |
| Grameen Bank | Microfinance | 4,000 | 500 | 3,500 | 2000 |
| Unnayan Prochesta | Microfinance | 1,000 | 200 | 800 | 2012 |
| Agrogoti | DRR & CC | 1,200 | 400 | 800 | 2013 |
| Rupantar | DRR, CC, and awareness | 2,000 | 1,200 | 800 | 2008 |
| Rural Reconstruction Foundation (RRF) | Microfinance, energy | 1,500 | 600 | 900 | 2011 |
| **TOTAL** | | 55,300 | | | |

*Table 54: CSO/ NGO Activities in Shyamnagar Upazila*

| NGO | Thematic focus | Beneficiaries | Male | Female | Starting year |
|---|---|---|---|---|---|
| World Vision | Nutrition and Livelihood | 3,500 | 2,000 | 1,500 | 2007 |
| Karitash | Livelihood and awareness | 2,000 | 1,300 | 700 | 2005 |
| BRAC | Microfinance and nutrition | 3,000 | 1,800 | 1,200 | 2000 |
| SUS | Microfinance | 2,000 | 400 | 1,600 | 2009 |
| JCF | Microfinance | 2,500 | 500 | 2,000 | 2005 |
| NGF | Microfinance and livelihood | 3,000 | 700 | 2,300 | 2005 |
| Grameen Bank | Microfinance | 3,500 | 500 | 3,000 | 2000 |
| Dhaka Ahsania Mission (DAM) | Awareness on save Sundarban, biodiversity conservation | 1,000 | 700 | 300 | 2009 |
| ASA | Microcredit | 2,500 | 500 | 2,000 | 2000 |
| Islamic Relief International | Livelihood | 1,400 | 700 | 700 | 2011 |
| Christian Commission for Development in Bangladesh (CCDB) | Awareness on save Sundarban, biodiversity conservation | 1,600 | 900 | 700 | 2011 |
| Wild Team | Awareness on save Sundarban, biodiversity conservation, save tiger | 2,000 | 1,600 | 400 | 2012 |

| | | | | | |
|---|---|---|---|---|---|
| Center for Natural Resource Studies (CNRS) | Livelihood | 3,000 | 2,100 | 900 | 2010 |
| JOAR Eco Cottage | Eco Cottage | 500 | 200 | 300 | 2008 |
| LEADERS | Microfinance, livelihood | 2,500 | 1,700 | 800 | 2007 |
| Progoti | Microfinance and awareness | 1,500 | 600 | 900 | 2006 |
| Nakshikatha | Handicraft training | 400 | 0 | 400 | 2004 |
| Shushilan | Livelihood, nutrition, microfinance, DRR | 20,000 | 11,000 | 9,000 | 1999 |
| **TOTAL** | | 55,900 | | | |

*Table 55: CSO/ NGO Activities in Paikgacha Upazila*

| NGO | Thematic Focus | Beneficiaries | Male | Female | Starting Year |
|---|---|---|---|---|---|
| BRAC | Microfinance | 4,500 | 2,728 | 1,772 | 2014 |
| Pradipan | Health and microfinance | 4,235 | 2,500 | 1,735 | 2010 |
| Rupantar | Legal aid | 1,800 | 1,300 | 500 | 2010 |
| Shushilan | Health, family planning, governance | 18,000 | 8,500 | 9,500 | 2014 |
| ASA | Microfinance | 4,000 | 840 | 3,160 | 2008 |
| Bondhu Kallyan Foundation | Microfinance | 1,294 | 103 | 1,191 | 2009 |
| CSS | Education, health microfinance | 1,918 | 192 | 1,726 | 2010 |
| Dolit | Women and child | 1,550 | 580 | 970 | 2009 |
| Nobolok | Health and sanitation, | 3,788 | 2,500 | 1,288 | 2010 |
| Nirjera Kori | Khas land management | 4,204 | 1,547 | 2,657 | 2010 |
| Rural Reconstruction Foundation (RRF) | Microfinance | 7,848 | 3,457 | 4,391 | 2011 |
| Srijoni Bangladesh | Bio gas, improved cook stove | 2,540 | 1,342 | 1,198 | 2009 |
| TMSS | Microfinance | 542 | 78 | 464 | 2008 |
| SUS | Microfinance | 4,211 | 2,147 | 2,064 | 2010 |
| World Vision | Nutrition | 2,200 | 700 | 1,500 | 2007 |
| Karitash | Livelihood | 1,500 | 900 | 600 | 2004 |
| Mukti Foundation | Health and WASH | 4,500 | 1,847 | 2,653 | 2010 |
| Grameen Shakti | Microfinance | 16,219 | 8,971 | 7,248 | 2009 |
| Nari Unnayan Sangstha | Microfinance | 11,362 | 780 | 10,582 | 2008 |
| Proshika | Microfinance | 17,021 | 8,794 | 8,227 | 2009 |
| Uttaran | Health education | 8,450 | 5,547 | 2,903 | 2010 |
| **TOTAL** | | 121,682 | | | |

*Table 56: CSO/ NGO Activities in Dacope Upazila*

| NGO | Thematic Focus | Beneficiaries | Male | Female | Starting Year |
|---|---|---|---|---|---|
| ASA | Microfinance | 3,000 | 600 | 2,400 | 2000 |
| JCF | Microfinance | 2,000 | 400 | 1,600 | 2010 |
| Grameen Bank | Microfinance | 4,000 | 900 | 3,100 | 2000 |
| BRAC | Microfinance and nutrition | 5,000 | 1,100 | 3,900 | 2000 |
| SUS | Microfinance | 1,500 | 300 | 1,200 | 2009 |
| Rupantar | Nutrition and awareness | 1,800 | 1,300 | 500 | 2006 |
| Shuishilan | DRR, nutrition, and livelihood | 4,000 | 2,005 | 1,995 | 2006 |
| World vision | Nutrition and DRR | 3,000 | 1,900 | 1,100 | 2004 |
| Karitas | Livelihood awareness | 2,200 | 1,600 | 600 | 2003 |
| Muslim Aid | DRR | 1,200 | 700 | 500 | 2005 |
| DAM | DRR and awareness | 1,500 | 1,000 | 500 | 2011 |
| Islamic Relief International | Livelihood and awareness | 1,800 | 1,200 | 600 | 2006 |
| **TOTAL** | | 31,000 | | | |

*Table 57: CSO/ NGO Activities in Koyra Upazila*

| NGO | Thematic Focus | Beneficiaries | Male | Female | Starting year |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| World Vision | Livelihood and nutrition | 3,500 | 1,900 | 1,600 | 2006 |
| Karitash | Livelihood and nutrition | 2,500 | 1,600 | 900 | 2005 |
| BRAC | Microfinance | 3,000 | 400 | 2,600 | 2000 |
| Shushilan | DRR, nutrition, and livelihood | 8,000 | 6,500 | 1,500 | 2006 |
| Uttaran | DRR microfinance | 3,500 | 2,400 | 1,100 | 2010 |
| SUS | Microfinance | 2,000 | 300 | 1,700 | 2005 |
| ASA | Microfinance | 2,500 | 400 | 2,100 | 2000 |
| JCF | Microfinance | 2,200 | 500 | 1,700 | 2004 |
| Grameen Bank | Microfinance | 4,000 | 700 | 3,300 | 2000 |
| Rupantar | DRR and awareness | 1,800 | 700 | 1,100 | 2004 |
| **TOTAL** | | 33,000 | | | |

**Annex 3: Burigoalini Union Profile**

<table>
<tr><td>Union</td><td>Burigoalini</td></tr>
<tr><td>Upazila</td><td>Shyamnagar</td></tr>
<tr><td>District</td><td>Satkhira</td></tr>
<tr><td>Location</td><td>Burigoalini Union is situated next to the mangrove forests of the Sundarbans in the Satkhira district in the southeastern part of the Shyamnagar upzila. The Kholpetua River flows through the eastern side of the Union. To the west lies Isshoripur Union, and to the north lies Atulia Union. Burigoalini is approximately 44 km2in length from east to west. There are 20 villages within 9 wards of the Union. Embankments share boundaries with wards 2, 4, 5, 7, 8 and 9. The Malonchi river separates the Union from the Sundarbans.</td></tr>
<tr><td>Geography</td><td>The total area of the union is 43.10 km² of which around fifty percent of land is 0m to 0.75m in elevation (see Figure 3). The fact that the Union is so low-lying means it is vulnerable towards cyclone-induced inundations and salinity intrusion.</td></tr>
<tr><td>Demography</td><td>The ward-wise population of the union is shown in the table below. Based on the multi-criteria poverty index it is apparent that all wards in this union fall under the extreme poverty range (see figure 3).
<table>
<tr><th>Ward No.</th><th>Villages</th><th>Households (HH)</th><th>Population</th></tr>
<tr><td>1</td><td>3</td><td>662</td><td>3,101</td></tr>
<tr><td>2</td><td>3</td><td>947</td><td>4,235</td></tr>
<tr><td>3</td><td>2</td><td>713</td><td>3,139</td></tr>
<tr><td>4</td><td>4</td><td>427</td><td>1,997</td></tr>
<tr><td>5</td><td>4</td><td>431</td><td>1,891</td></tr>
<tr><td>6</td><td>1</td><td>424</td><td>2,004</td></tr>
<tr><td>7</td><td>2</td><td>756</td><td>3,404</td></tr>
<tr><td>8</td><td>2</td><td>746</td><td>3,404</td></tr>
<tr><td>9</td><td>3</td><td>383</td><td>1,740</td></tr>
<tr><td></td><td>24</td><td>5,489</td><td>24,915</td></tr>
</table></td></tr>
<tr><td>Distance from District/ Upazila headquarter</td><td>The Union is approximately 17 Km from the Upazila headquarters and 72km from the Satkhira region headquarters. The Union Council complex is situated at Burigoalini.</td></tr>
<tr><td>Nature of soil</td><td>Saline, clay, sandy loamy soil.</td></tr>
<tr><td>Road infrastructure</td><td>Pucca (paved) road (20km) and earth road (45km).</td></tr>
<tr><td>Common transportation means</td><td>Launch, trawler, engine van and motorbike and bus/coach.</td></tr>
<tr><td>Agriculture and aquaculture overview</td><td>Land use patterns in the Union have changed significantly since 1995 (see Figure 2). Crops, such as paddy, mustard, pulses, lentil, leafs and vegetables, used to be cultivated before the Aila cyclone hit. As a result of the saline soil conditions and the absence of a supply of sweet water which ensued after the cyclone, only single-crop sowed rice and some vegetables are now cultivated. Around ninety five percent of land of the Union is used for aquaculture practices such as shrimp, fish and crab cultivation. The rest of the land is used for paddy cultivation and homestead vegetation.</td></tr>
<tr><td>Markets and growth centres</td><td>For the sale and purchase of goods, there are three prominent local markets in the Union. There are two fish/crab depots and one fish depot. Aside from these, some producers and traders reach out to district level markets for the buying and selling of products. The major markets and growth centers of the Union are shown in Figure 1.</td></tr>
</table>

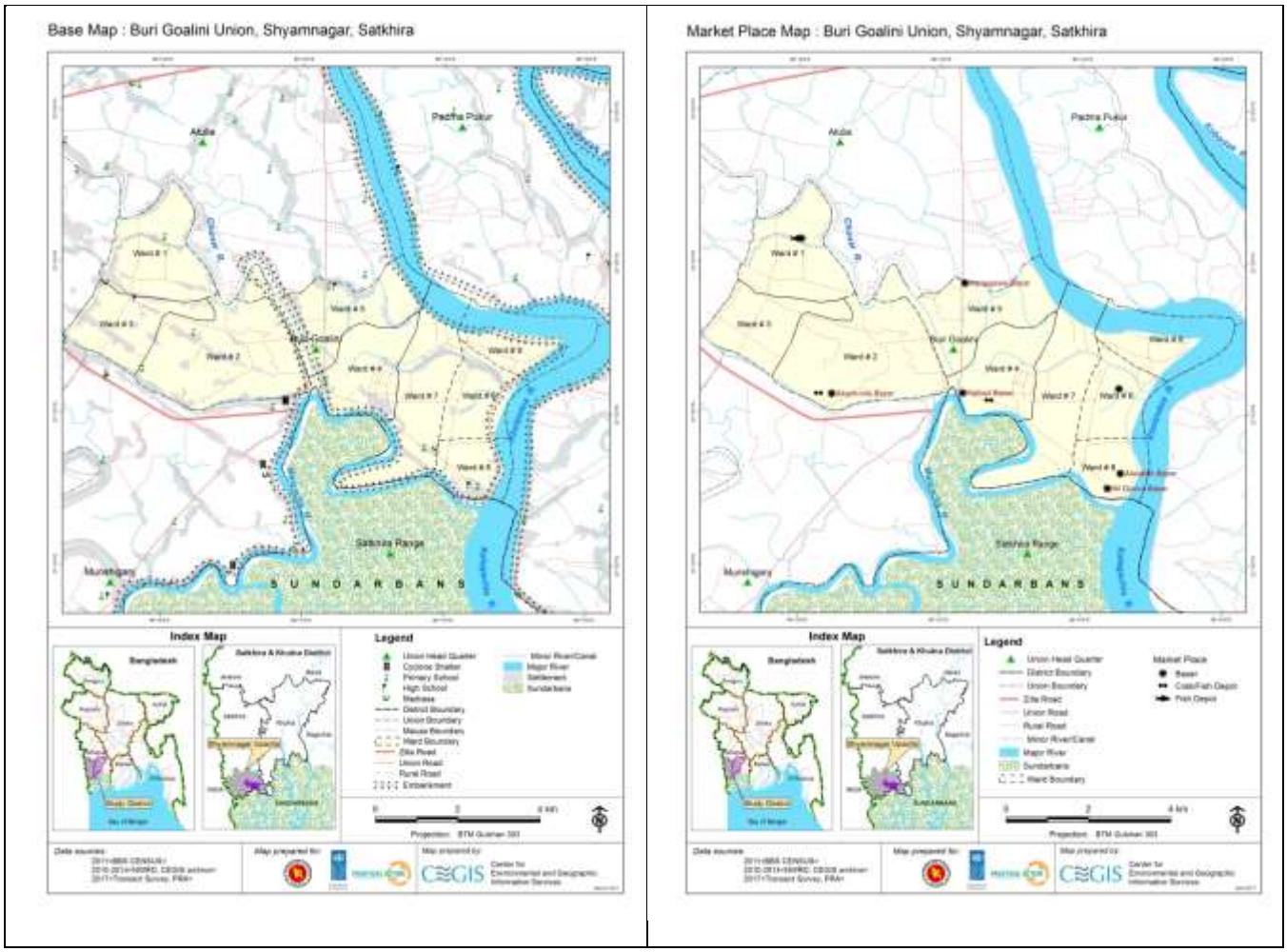


*Figure 01: Base Map, and Markets and Growth Centres in Burigoalini Union*

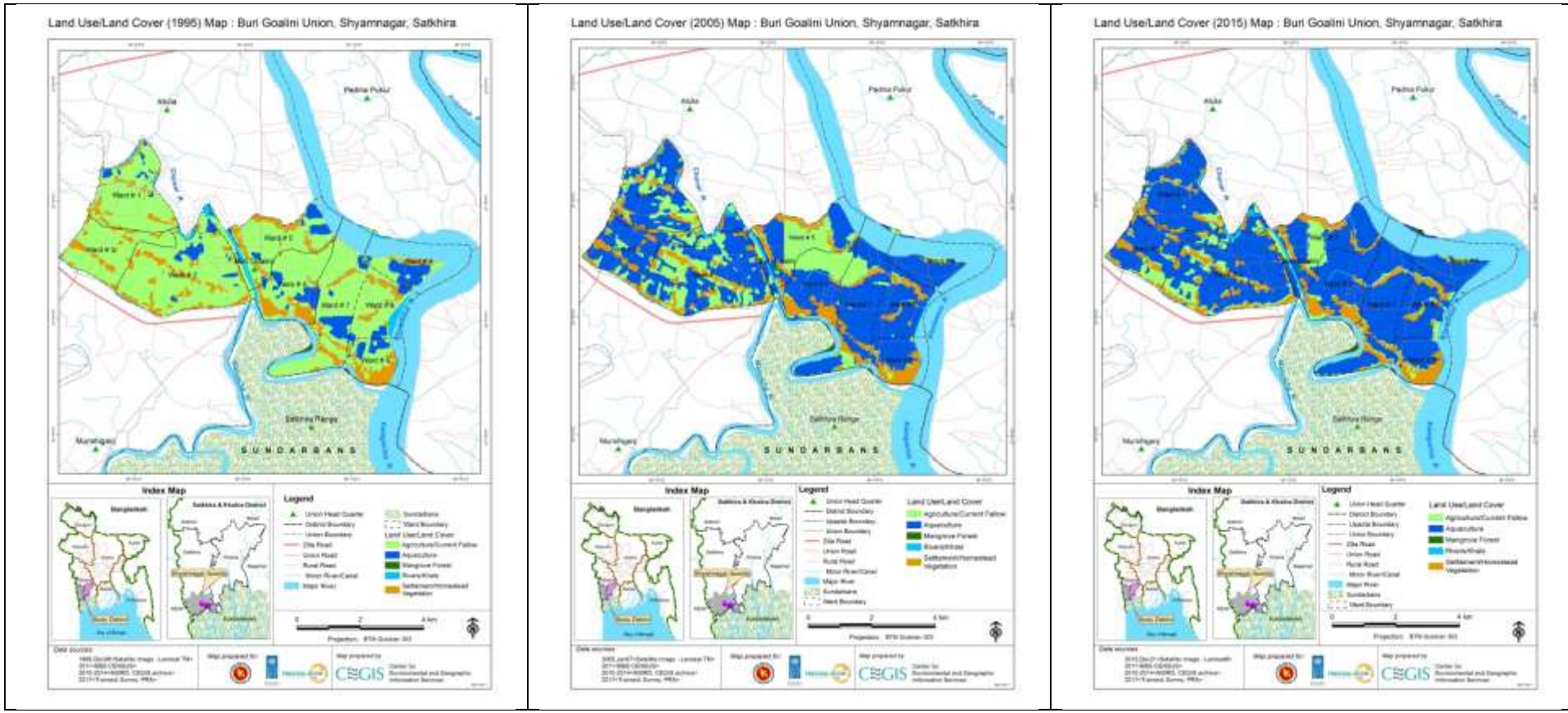


*Figure 02: Change in Land Use Pattern since 1995 in Burigoalini Union*

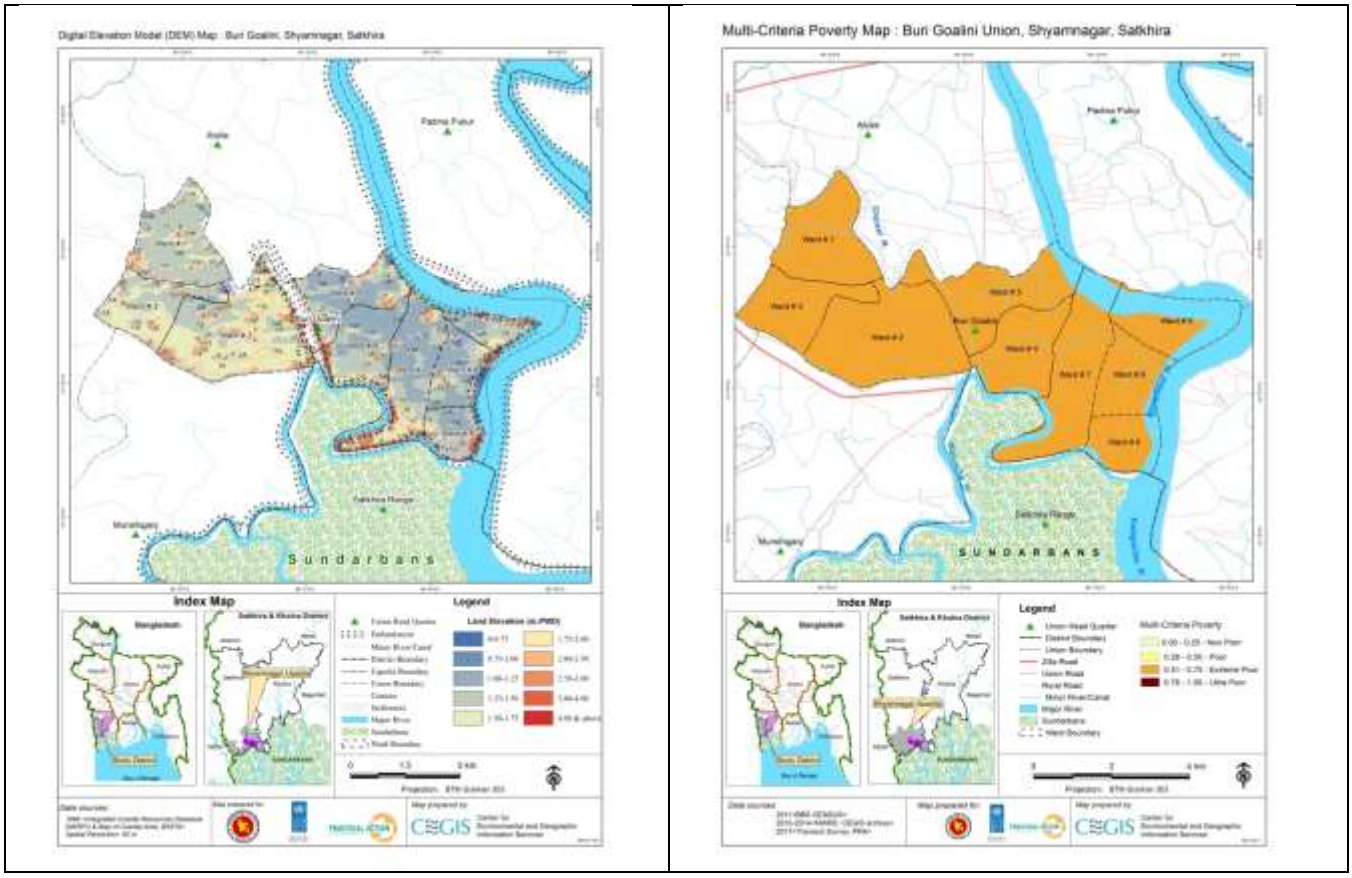


*Figure 03: DEM Map and Poverty Map*

**2. Existing Livelihoods**

PRA and GIS maps reveal that the major livelihoods that are currently practiced in the Union are agricultural day labour shrimp and crab farming (see Figure 4 and Table 1). It is noteworthy to add that one single household can be engaged with four to five different income generating activities for maintaining their livelihoods.

*Table 1: Currently Practiced Livelihoods based on PRA (red highlighted livelihoods were identified as being non-adaptive)*

| Ward_ Number | Agr. labour | Fishery | Business | Service | Other_OCC | Prawn | Sesame | Shrimp | Watermelon | Crab | Paddy | Mustard | Vegetable | Fishing | FRUIT_ORCH | Poultry | Collector from Sundarbans |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward # 1 | **41** | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 2 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 4 | **27** | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 70 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 7 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 90 | **12** | 0 | 0 | 0 | 0 | 0 | 0 |

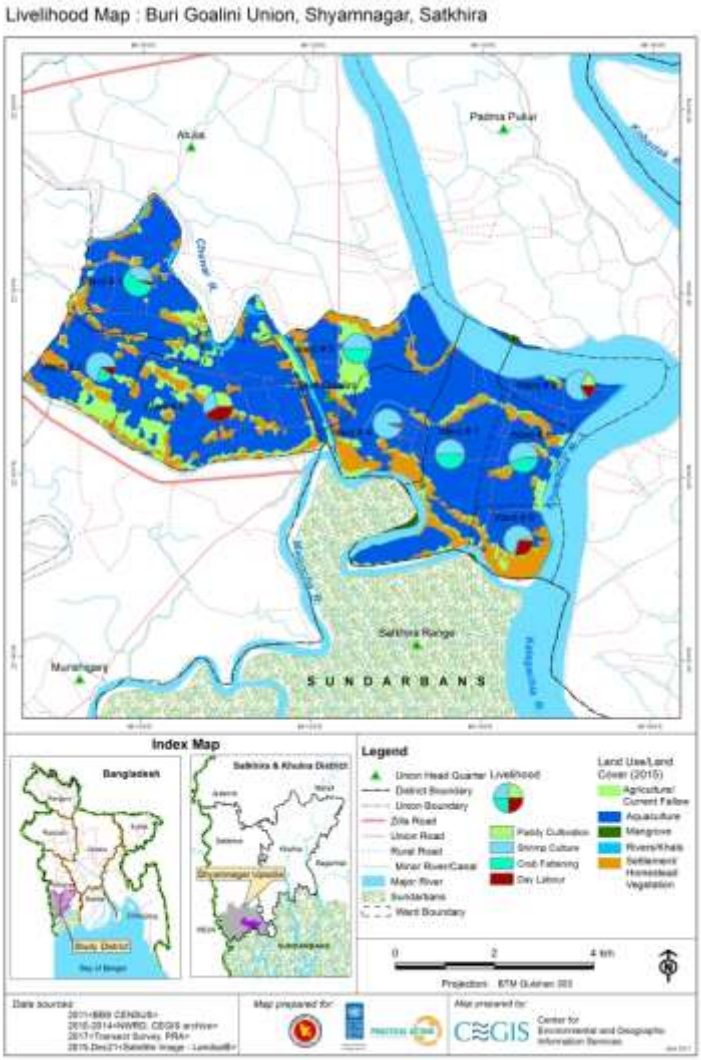


*Figure 04: Existing Livelihoods in Burigoalini Union*

**3. Proposed Climate Change Resilient Livelihood Strategies for the Union**

**3.1. Targeted Beneficiaries**

The target beneficiaries selected from this Union will include those individuals who currently practice a livelihood that will not only be severely affected by increasing salinity but can also be considered as being non-adaptive. These livelihoods include agricultural labourers, shrimp farmers, and crab farmers (see Table 1). The beneficiary selection process took into account the fact that each household is engaged in a portfolio of up to 5 different livelihood activities throughout the year plus the changing of production cycles. Thus, the highest percentage of the households practicing a non-adaptive livelihood in the ward was taken as a basis for identifying the targeted households (see Table 2). The project will therefore provide an alternative, adaptive and climate change resilient livelihood for one woman per household and twenty-five women will be clustered into one Women's Livelihood Group (WLG).

*Table 2: Targeted Households and Women*

| Ward No | Total HH | % Non-adaptive | Target HH | Targeted WLGs (≈ 25 women per group) |
|---|---|---|---|---|
| Ward # 1 | 662 | 41 | 271 | 11 |
| Ward # 4 | 427 | 27 | 115 | 5 |
| Ward # 7 | 756 | 12 | 91 | 4 |

| | | | | |
|---|---|---|---|---|
| **Total** | **1,845** | | **Total: 477** | **Total: 20** |

### 3.2. Rational for Proposed Climate Change Resilient Livelihoods for the Union

Considering the geographic and socio-economic characteristics of the union and projected climate change impacts of the Union, crab farming, crab nursery, aqua-geoponics, and hydroponics are proposed as climate change resilient livelihoods for this union (see Table 3).

*Table 3: Rational for Proposed Livelihoods*

| Livelihood Option | Rational for Selecting the Proposed Livelihood Option for this Union |
|---|---|
| Crab farming | Water quality (pH, ammonia, temperature, salinity, dissolved oxygen, and alkalinity level) in available old paddy fields or shrimp ponds are suitable for crab farming. Local people are knowledgeable in aquaculture techniques. Livelihood inputs and water bodies are both available in the Union. |
| Crab nursery | The water quality (pH, ammonia, temperature, salinity, dissolved oxygen, and alkalinity level) of the existing old paddy fields or shrimp ponds can be suitable for crab nurseries in both open and close systems. Crab nurseries are the backward linkage of crab fattening and are needed to provide sufficient supply of crab-lets for the crab farms. The idea would be for the nurseries to collect crab-lets from hatcheries which the project will establish in the Union. |
| Aqua-geoponics | Owing to the high number of water bodies available in this Union and in order to cope with increasing soil salinization, there has been increasing interest in the use of aqua-geoponics or soil-less techniques for producing greenhouse horticultural crops in the area. Aqua-geoponic systems are highly productive, require little to no fresh water for irrigation, and produce vegetables and fish that can be consumed at household level and/or sold at local markets. The beneficiaries, who will be trained in aqua-geoponics system, already have agricultural skills which can be built upon. |
| Hydroponics | A good number of water bodies are available in this Union. There has been increasing interest in the use of hydroponic or soilless techniques for producing horticultural crops in the area to cope with increasing soil salinization processes. The beneficiaries who will be trained in hydroponic systems already have skills in agriculture, which can be built upon. |

### 3.3. Proposed Value Chain Development and Market Linkages

The value chains for the proposed livelihood options are mostly well established. The required inputs of seeds and fertilisers for aqua-geoponics and hydroponic systems are available at local markets where the surplus yields that are not consumed in the households can be sold. There are seven local markets existent in the union. For the crab value chain, there is a need to establish linkages with input suppliers of crab-lets from the hatchery in this union and other crab hatcheries. The existing crab hatchery, operated by NGF and funded by PKSF, is according to consultations with PKSF supposed to be upgraded in its production capacity and additional hatcheries are considered to be developed. The demand created through the proposed women groups starting crab farms in this union and Shyamnagar upazila through this project will be covered through the upgraded BFRI operated crab hatchery in Paikgacha. Already existent in this Union are two fish/crab depots and one fish depot which can become part of the value chain that can store and trade the crabs. Traders active in the Union already reach out to district level markets to buy and sell. Additional capacity building and intensive facilitation will be required to link them with international markets and cope with trading higher quantities of crabs. Thus, there will be no direct value chain development facilities financed through this project, but rather skills, training and market linkage facilitation will be otherwise provided.

### 3.4. Overview of Proposed Interventions and Cost Estimates

Table gives an overview of all direct project interventions and associated costs that are proposed for this Union.

*Table 4: Overview of Proposed Interventions and Cost of Interventions*

| Ward No. | Targeted population | Targeted HHs | Targeted WLGs | Proposed interventions (figures stand for WLGs of 25 women) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Livelihoods / VLC Development | | | |
| | | | | Crab fattening | Crab nursery | Aqua-geoponics | Hydroponics |
| 1 | 3,101 | 271 | 11 | 8 | | 3 | |
| 4 | 1,997 | 115 | 5 | 4 | 1 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 3,404 | 91 | 4 | | | | 4 |
| **Total** | **8,502** | **477** | **20** | **12** | **1** | **3** | **4** |
| | | | Assets | 81,040 BDT | 261,140 BDT | 232,875 BDT | 225,000 BDT |
| | | | Inputs per production cycle | 190,224 BDT | 99,375 BDT | 285,525 BDT | 100,000 BDT |
| | | | **Total cost per LH** | 271,264 BDT | 360,515 BDT | 518,400 BDT | 325,000 BDT |
| | | | Cost for 1 production cycle (assets + inputs) | 3,255,168 BDT | 360,515 BDT | 1,555,200 BDT | 1,300,000 BDT |
| | | | **Total intervention costs for the union** | **53,364,804 BDT** | | | |

**Annex 4: Tildanga Union Profile**

| | |
|---|---|
| Union | Tildanga |
| Upazila | Dacope |
| District | Khulna |
| Location | The Tildanga Union is located in Bangladesh at 22.525030 latitude and 89.422724 longitude. The Bhadra river flows in the northwest of the Union and the Chora river flows to the east. The rivers of Badrugachha, Sibsa and Dhaki surround all sides of the Tildanga Union except in the north-eastern part. To the south of Tildanga lies the Kamarkhola Union. The Sundarbans lie 10km from the Parishad Union. |
| Geography | The total land area of the Union is 44.07 km$^2$, of which approximately eighty percent of land is 0m to 1.75m in elevation (see Figure 3). The fact that the Union is so low-lying means it is vulnerable towards cyclone-induced inundations and salinity intrusion. |
| Demography | The ward-wise population of the Union is shown in the table below. Based on the multi-criteria poverty index it is apparent that all the wards a population that falls under the extreme poor range (see Figure 3). |

| Ward No. | Villages | Households (HH) | Population |
|---|---|---|---|
| 1 | 1 | 775 | 2,857 |
| 2 | 3 | 457 | 1,806 |
| 3 | 1 | 482 | 1,679 |
| 4 | 1 | 397 | 1,661 |
| 5 | 1 | 448 | 1,926 |
| 6 | 1 | 460 | 1,960 |
| 7 | 1 | 482 | 1,852 |
| 8 | 1 | 362 | 1,475 |
| 9 | 2 | 432 | 1,790 |
| | **12** | **4,295** | **17,006** |

| | |
|---|---|
| Distance from District/ Upazila headquarter | The Union is situated 30km from the Khulna District Sadar and 0.8km from Dacope Upazila. |
| Nature of soil | Clay and sandy loamy soil. |
| Road infrastructure | The Union consists of 17 km Pucca (paved) roads, 22 km semi-pucca roads and 35km mud roads. Almost all the villages in the Union are linked via earth roads. |
| Transportation means | Boat, launch (ferry), boats, engine van and motor bike. |
| Agriculture and aquaculture overview | Land use patterns in the Union have changed significantly since 1995. These changes are shown in Figure 2. Crops, such as paddy, mustard, pulses, lentil, leafs and vegetables used to be cultivated before the Aila cyclone hit. As a result of saline soil and the absence of a supply of sweet water which ensued after the cyclone, only single-crop sowed rice and some vegetables are now cultivated. Approximately ninety percent of land in the Union is used for agriculture practices such as paddy, watermelon and sesame, as well as homestead vegetable cultivation. The remaining 10% is used for shrimp, fish and crab cultivation. |
| Markets and growth centers | For the sale and purchase of goods, there are three prominent local markets in the Union. There is also one bagda shrimp hatchery and nine fish/crab depots. Aside from these, some producers and traders reach out to district level markets for the buying and selling of products. The major markets and growth centers of the Union are shown in Figure 3. |

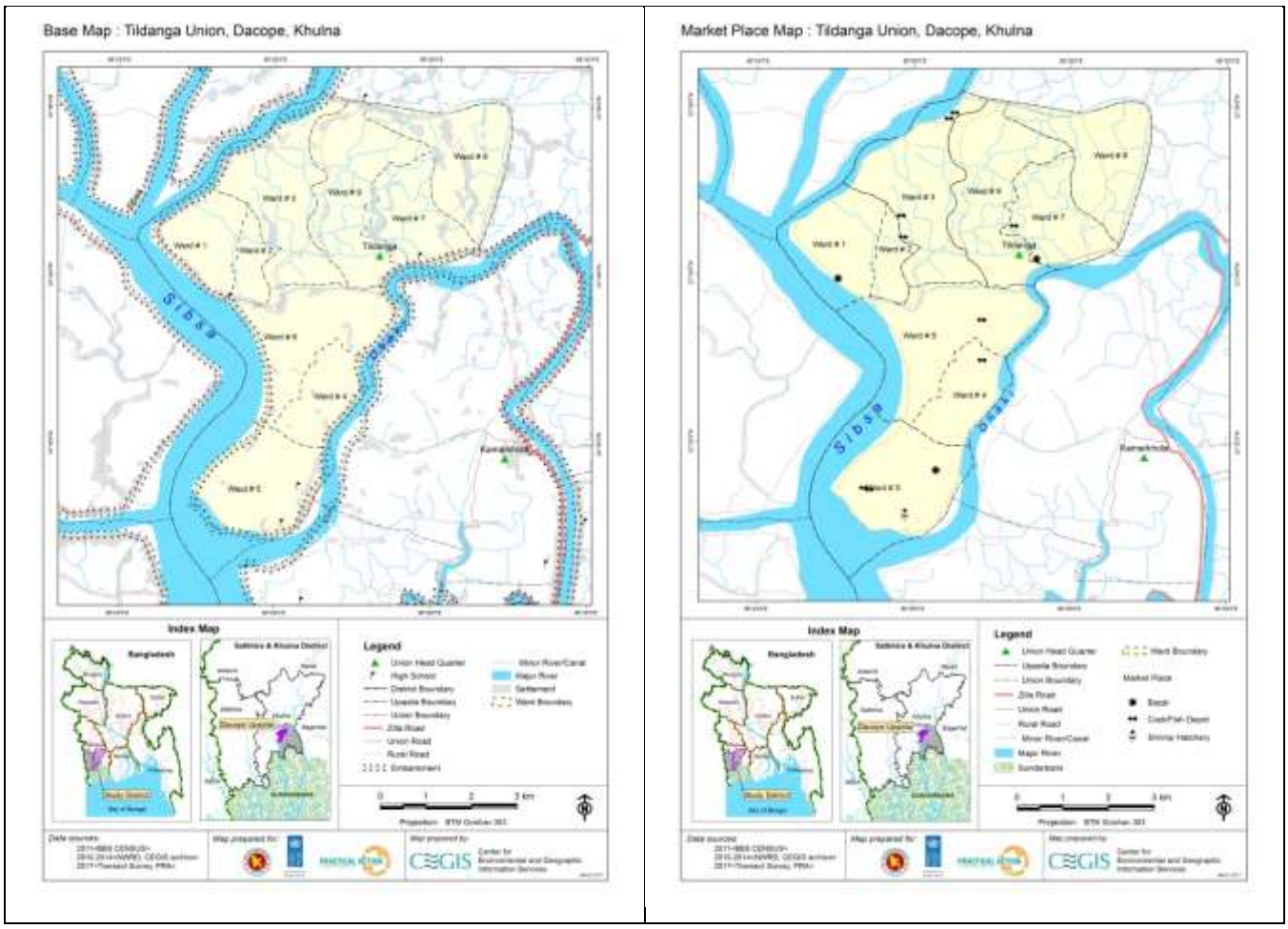


*Figure 01: Base Map, and Markets and Growth Centers in Tildanga Union*

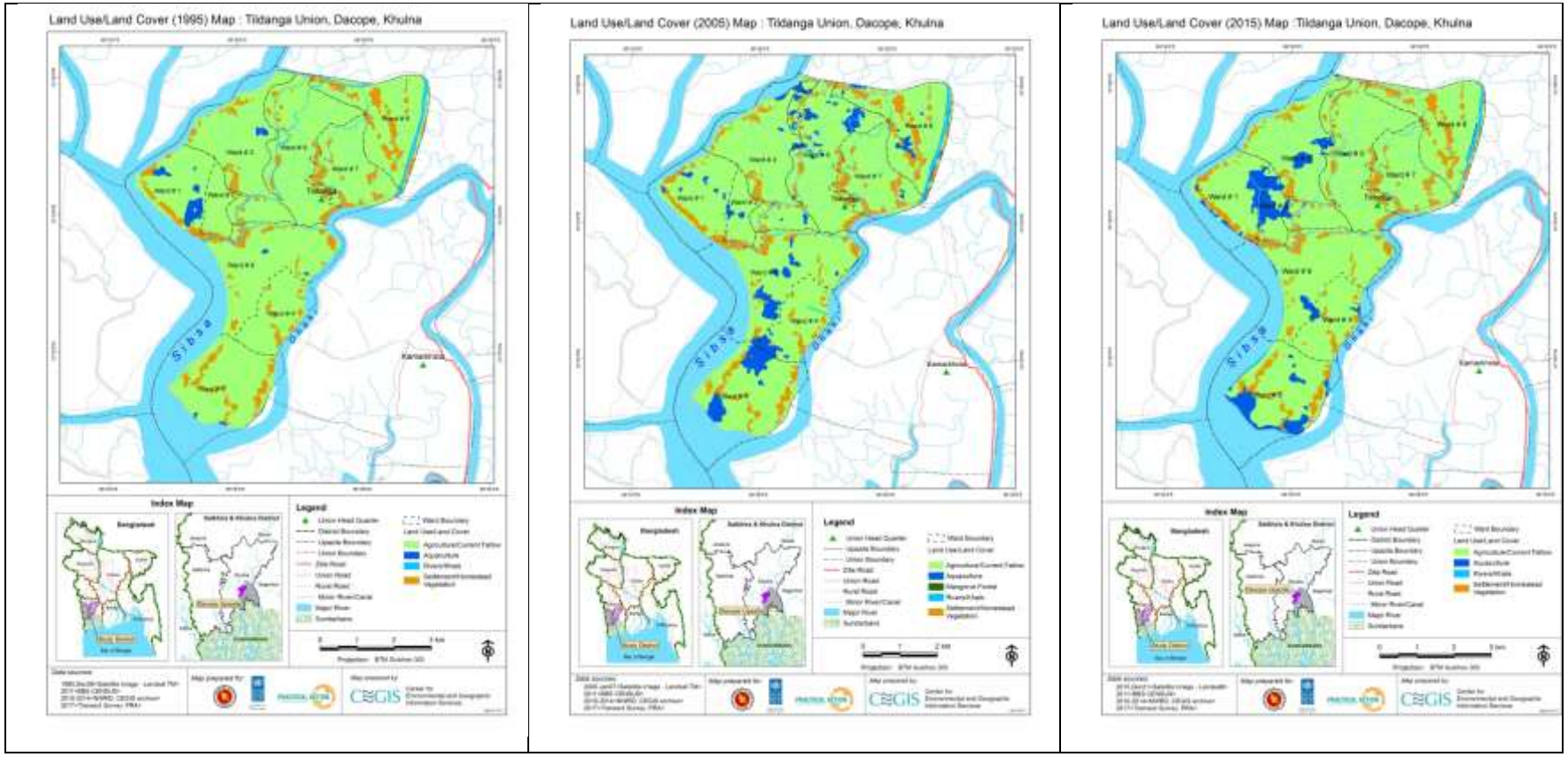


*Figure 02: Change in Land Use Pattern since 1995 in Tildanga Union*

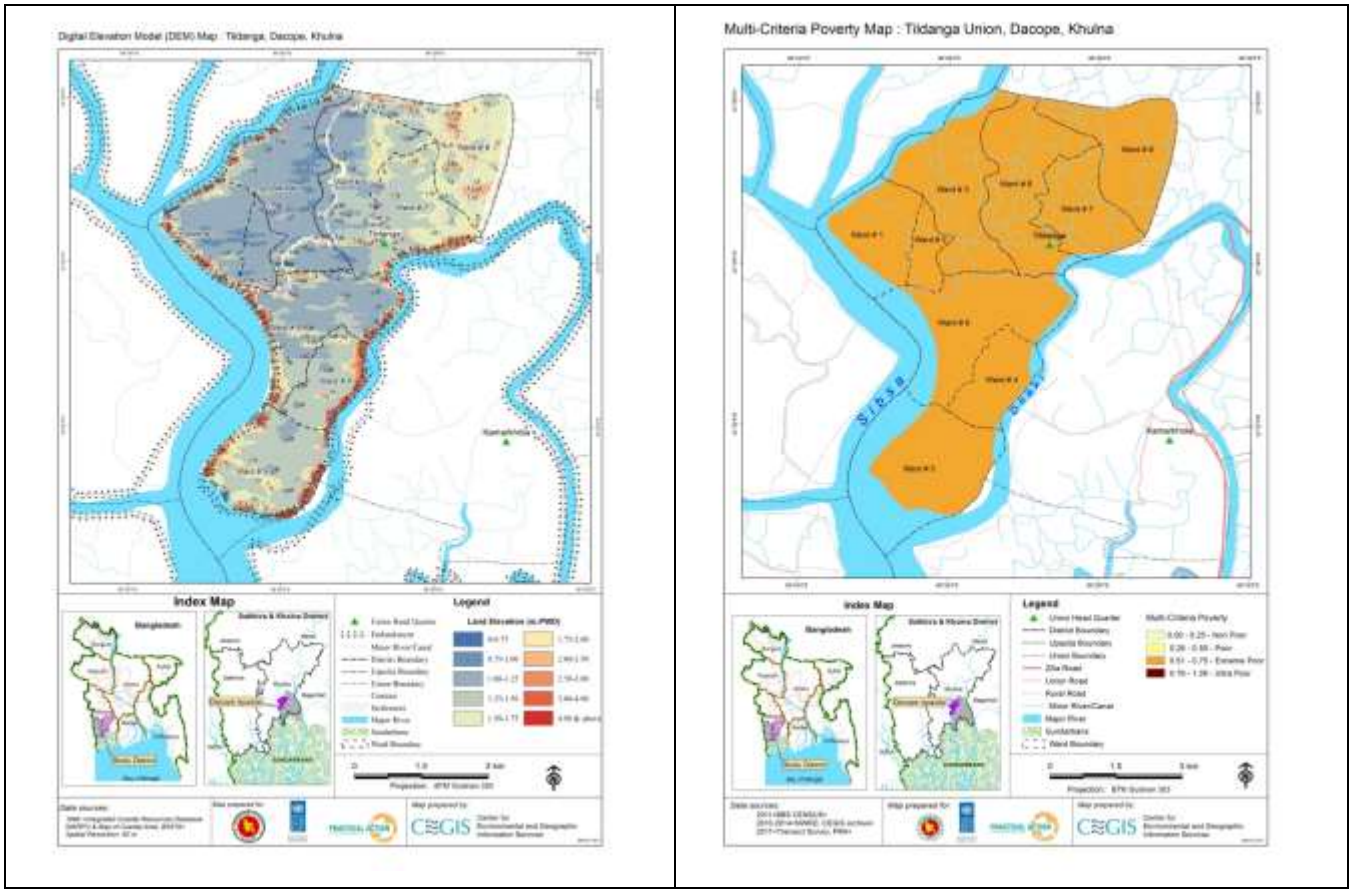


*Figure 03: DEM and Poverty Map*

**2. Existing Livelihoods**

PRA and GIS maps reveal that the major livelihoods currently practiced in the Union are paddy cultivation and agricultural day labour (see Figure 4 and Table 1). It is noteworthy to add that one single household can be engaged with four to five different income generating activities for maintaining their livelihoods. While the poverty levels in all wards were identified as being extremely poor, wards 1 and 3 were selected due to being particularly low-lying and vulnerable to salinization processes (see Figure 3).

*Table 1: Currently Practiced Livelihoods in Targeted Wards (based on PRA; red highlighted livelihoods were identified as being non-adaptive)*

| Ward_ Number | Agr. labour | Fishery | Business | Service | Other_OCC | Prawn | Sesame | Shrimp | Watermelon | Crab | Paddy | Mustard | Vegetable | Fishing | Fruit_ ORCH | Poultry | Collector from Sundarbans |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward # 1 | **44** | 16 | 0 | 0 | 40 | 0 | 1 | 2 | 1 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 3 | 25 | 29 | 0 | 0 | 35 | 0 | 2 | 1 | 3 | 0 | **42** | 0 | 0 | 0 | 0 | 0 | 0 |

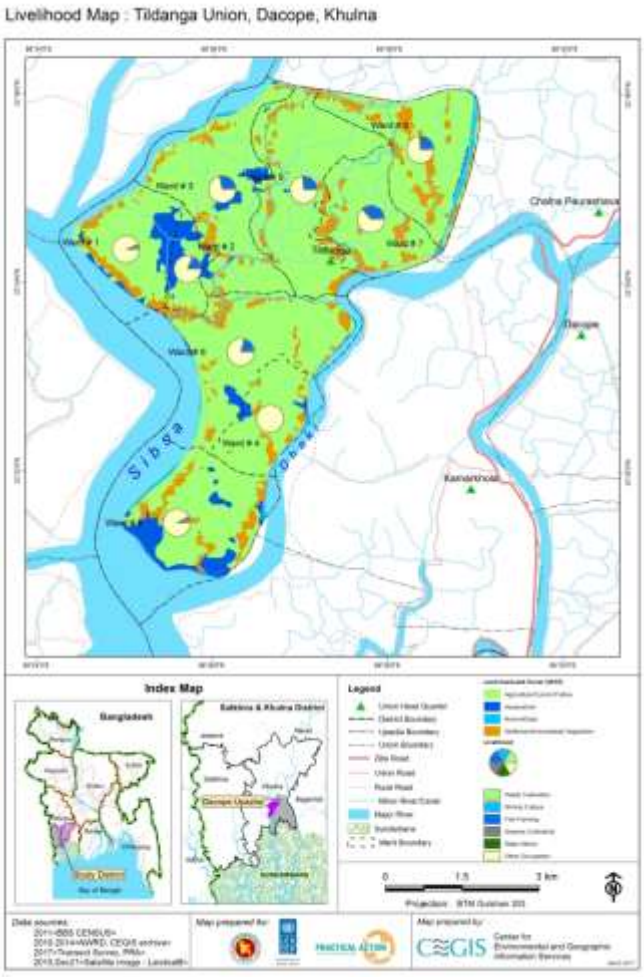


*Figure 04: Existing Livelihoods in Tildanga Union*

**3. Proposed Climate Change Resilient Livelihood Strategies for the Union**

**3.1. Targeted Beneficiaries**

The target beneficiaries selected from this Union will include those individuals who currently practice a livelihood that will not only be severely affected by the increasing salinity but can also be considered as being non-adaptive. These livelihoods include agricultural labourers and paddy farmers (see Table 1). The beneficiary selection process took into account the fact that each household is engaged in a portfolio of up to 5 different livelihood activities throughout the year plus the changing of production cycles. Thus, the highest percentage of the households practicing a non-adaptive livelihood in the ward was taken as a basis for identifying the targeted households (see Table 2). The project will therefore provide an alternative and adaptive livelihood for one woman per household and twenty-five women will be clustered into one Women's Livelihood Group (WLG).

*Table 2: Targeted Households and Women*

| Ward No | Total HH | % Non-adaptive | Target HH | Targeted WLGs (≈ 25 women per group) |
|---|---|---|---|---|
| Ward # 1 | 775 | 40 | 341 | 14 |
| Ward # 3 | 482 | 42 | 202 | 8 |
| **Total** | **1,257** | | **Total: 543** | **Total: 22** |

### 3.2. Rational for Proposed Climate Change Resilient Livelihoods for the Union

Considering the geographic and socio-economic characteristics of the union and the projected climate change impacts of Tildanga, homestead gardening, aqua-geoponics, and hydroponics are proposed as adaptive livelihoods for this union (see table 3).

*Table 3: Rational for Proposed Livelihoods*

| Livelihood Option | Rational for selecting the proposed livelihood option for this union |
|---|---|
| Homestead gardening | Existing practice and moderate salinity in some area makes vegetable cultivation feasible. The Union has plain and fertile arable land meaning that vegetable cultivation within households, especially in combination with raised beds and other agricultural practices, can be sustainably practiced. |
| Aqua-geoponics | Owing to the high number of water bodies available in this Union and in order to cope with increasing soil salinization, there has been increasing interest in the use of aqua-geoponics or soil-less techniques for producing greenhouse horticultural crops in the area. Aqua-geoponic systems are highly productive, require little to no fresh water for irrigation, and produce vegetables and fish that can be consumed at household level and/or sold at local markets. The beneficiaries who will be trained in aqua-geoponics system, already have agricultural skills which can be built upon. |
| Hydroponics | A good number of water bodies are available in this Union. There has been increasing interest in the use of hydroponic or soilless techniques for producing horticultural crops in the area to cope with increasing soil salinization processes. The beneficiaries who will be trained in hydroponic systems already have skills in agriculture, which can be built upon. |

### 3.3. Proposed Value Chain Development and Market Linkages

The value chains for the proposed livelihood options are mostly well established. The required inputs of seeds and fertilisers for hydroponic and aqua-geoponics systems, and homestead gardening are available at local markets where the surplus yields that are not consumed in the households can be sold. Already existing in the Union are three prominent local markets. Traders who are active in the Union already reach out to district level markets in order to buy and sell. Thus, there will be no direct value chain development facilities financed through this project, but rather skills, training and market linkage facilitation will be otherwise provided.

### 3.4. Overview of Proposed Interventions and Cost Estimates

Table gives an overview of all direct project interventions and associated costs that are proposed for this Union.

*Table 4: Overview of Proposed Interventions and Cost of Interventions*

| Ward No. | Targeted population | Targeted HHs | Targeted WLGs | Proposed interventions (figures stand for WLGs of 25 women) | | |
|---|---|---|---|---|---|---|
| | | | | Livelihoods / VLC Development | | |
| | | | | Homestead gardening | Aqua-geoponics | Hydroponics |
| 1 | 2,857 | 341 | 14 | 6 | | 8 |
| 3 | 1,679 | 202 | 8 | | 4 | 4 |
| **Total** | **4,536** | **543** | **22** | **6** | **4** | **12** |
| Assets | | | | 65,000 BDT | 232,875 BDT | 225,000 BDT |
| Inputs per production cycle | | | | 41,850 BDT | 285,525 BDT | 100,000 BDT |
| **Total cost per LH** | | | | **106,850 BDT** | **518,400 BDT** | **325,000 BDT** |
| Cost for 1 production cycle (assets + inputs) | | | | 641,100 BDT | 2,073,600 BDT | 3,900,000 BDT |
| **Total intervention costs for the union** | | | | **6,614,700 BDT** | | |

**Annex 5: Kulla Union Profile**

| | |
|---|---|
| Union | Kulla |
| Upazila | Assasuni |
| District | Satkhira |

<table>
<tr><td>Location</td><td>Kulla union is located in the south-western part of Bangladesh at 22° 36' 39.6756'' N and 89° 8' 56.166'' E of Satkhira district. To the east lies the Kadakati Union and to the west lies Budhhata Union. The Tala Union lies to the north and the Assasuni Union to the south. The embankments of the Betna river form the southern and southwestern boundaries. This river also separates the ward 1 and ward 2 of the Union from each other.</td></tr>
<tr><td>Geography</td><td>The total land area of the Union is 20.58km², of which around seventy percent of land is 1.0m to 1.5m in elevation (see Figure 3). The fact that the Union is so low-lying means that it is vulnerable towards cyclone-induced inundations and salinity intrusion.</td></tr>
<tr><td>Population</td><td>The ward-wise population of the Union is shown in the table below. Based on the multi-criteria poverty index it is apparent that the majority of population in wards 5, 6 and 9 are ultra-poor, whereas the rest of the population falls under the extremely poor range (see Figure 3).
<table>
<tr><th>Ward No.</th><th>Villages</th><th>Households (HH)</th><th>Population</th></tr>
<tr><td>1</td><td>1</td><td>651</td><td>2,758</td></tr>
<tr><td>2</td><td>2</td><td>1,034</td><td>3,447</td></tr>
<tr><td>3</td><td>1</td><td>468</td><td>2,327</td></tr>
<tr><td>4</td><td>2</td><td>1,034</td><td>4,309</td></tr>
<tr><td>5</td><td>2</td><td>603</td><td>2,499</td></tr>
<tr><td>6</td><td>6</td><td>566</td><td>2,155</td></tr>
<tr><td>7</td><td>2</td><td>462</td><td>2,241</td></tr>
<tr><td>8</td><td>3</td><td>603</td><td>2,586</td></tr>
<tr><td>9</td><td>2</td><td>468</td><td>2,241</td></tr>
<tr><td></td><td>21</td><td>5,889</td><td>24,563</td></tr>
</table></td></tr>
<tr><td>Distance from District/ upazila headquarter</td><td>Kulla union is only 15 km away from Assasuni Upazila head quarter</td></tr>
<tr><td>Nature of soil</td><td>Saline, clay, sandy loamy soil.</td></tr>
<tr><td>Road infrastructure</td><td>The road infrastructure is of average quality in this Union. In the rainy season, it gets disconnected from other areas. Of the total road network, approximately 21% are paved, 16% are brick soled and the rest are earth roads.</td></tr>
<tr><td>Common transportation means</td><td>Motor bike, van, bicycle, bus, and launch (ferry).</td></tr>
<tr><td>Agriculture and aquaculture overview</td><td>Land use patterns in the Union have changed significantly since 1995 (see Figure 2). Crops, such as paddy, mustard, pulses, lentil, leafs and vegetables, used to be cultivated before the Aila cyclone hit. Due to the saline soil and absent supply of sweet water, now only single-crop sowed rice and some vegetables are cultivated. As a result of saline soil and the absence of a supply of sweet water which ensued after the cyclone, only single-crop sowed rice and some vegetables are now cultivated. Approximately fifty percent of the land in this Union is used for aquaculture practice such as shrimp, fish and crab cultivation. The rest of the land is used for paddy and sesame cultivation as well as homestead gardening.</td></tr>
<tr><td>Markets and growth centers</td><td>For selling and purchasing goods there are four prominent local markets in Kulla Union. The major markets and growth centers in the Union are shown in Figure 01.</td></tr>
</table>

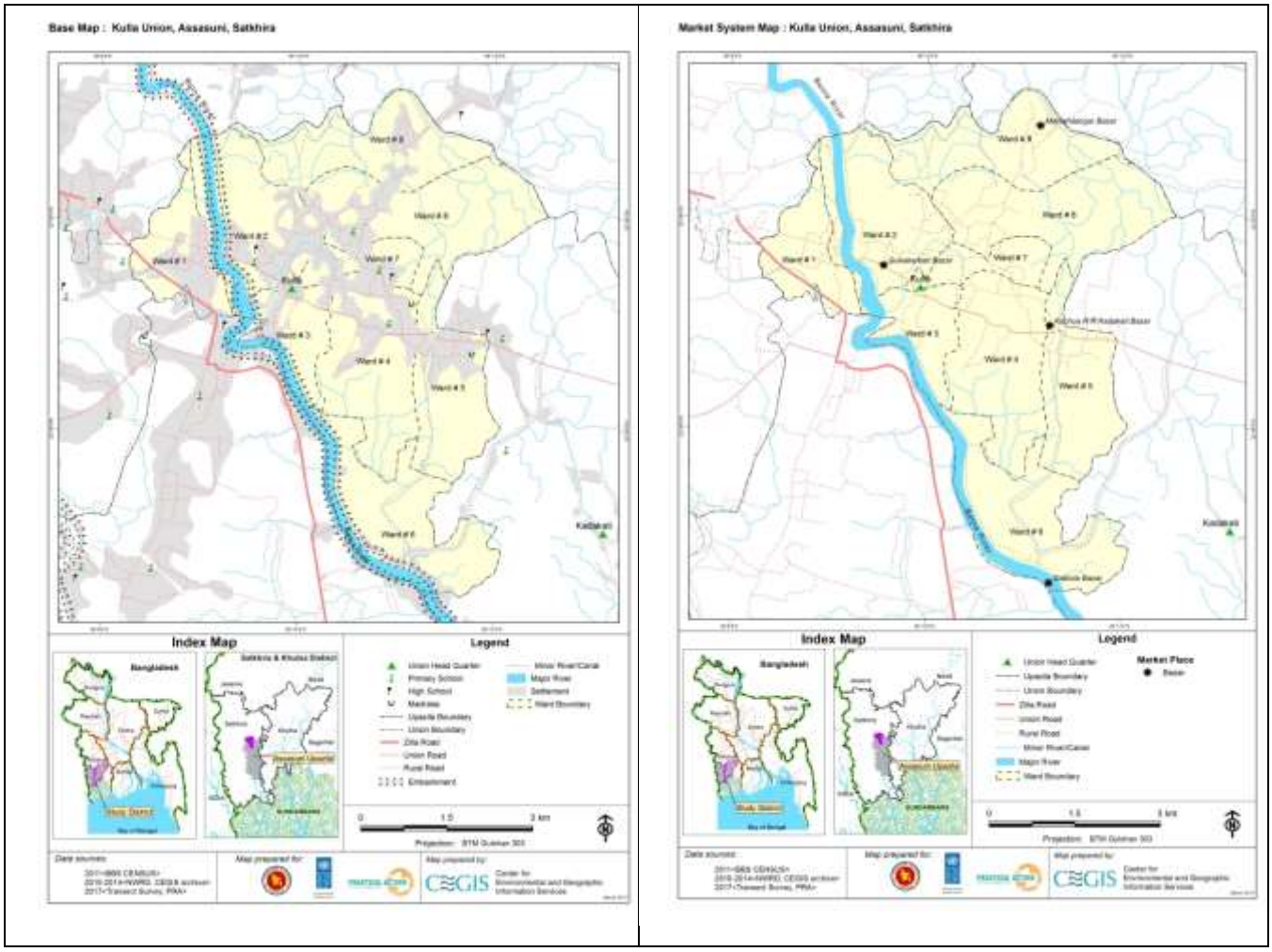


*Figure 01: Base Map, and Markets and Growth Centers in Kulla Union*

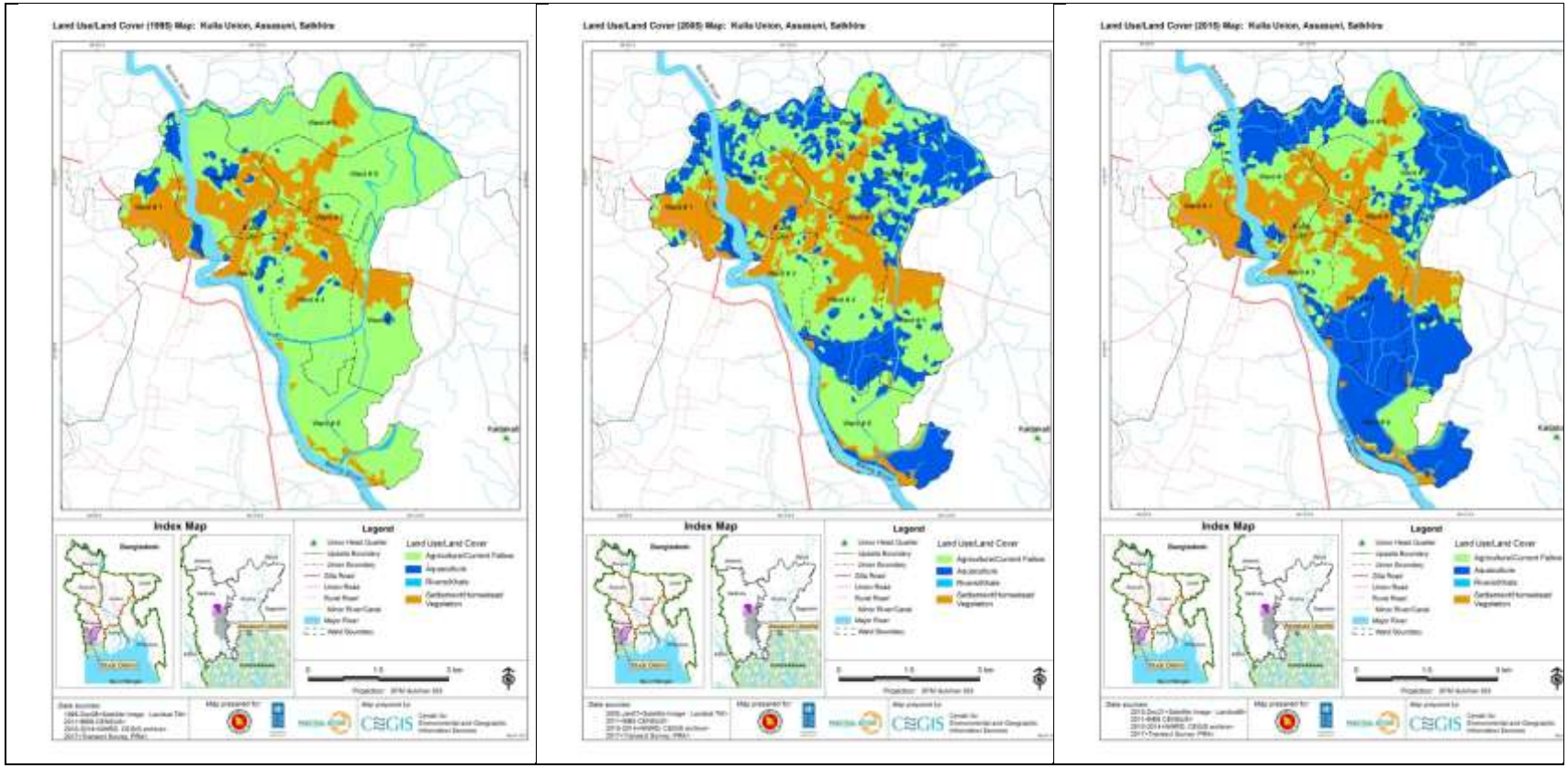


*Figure 02: Change in Land Use Pattern since 1995 in Kulla Union*

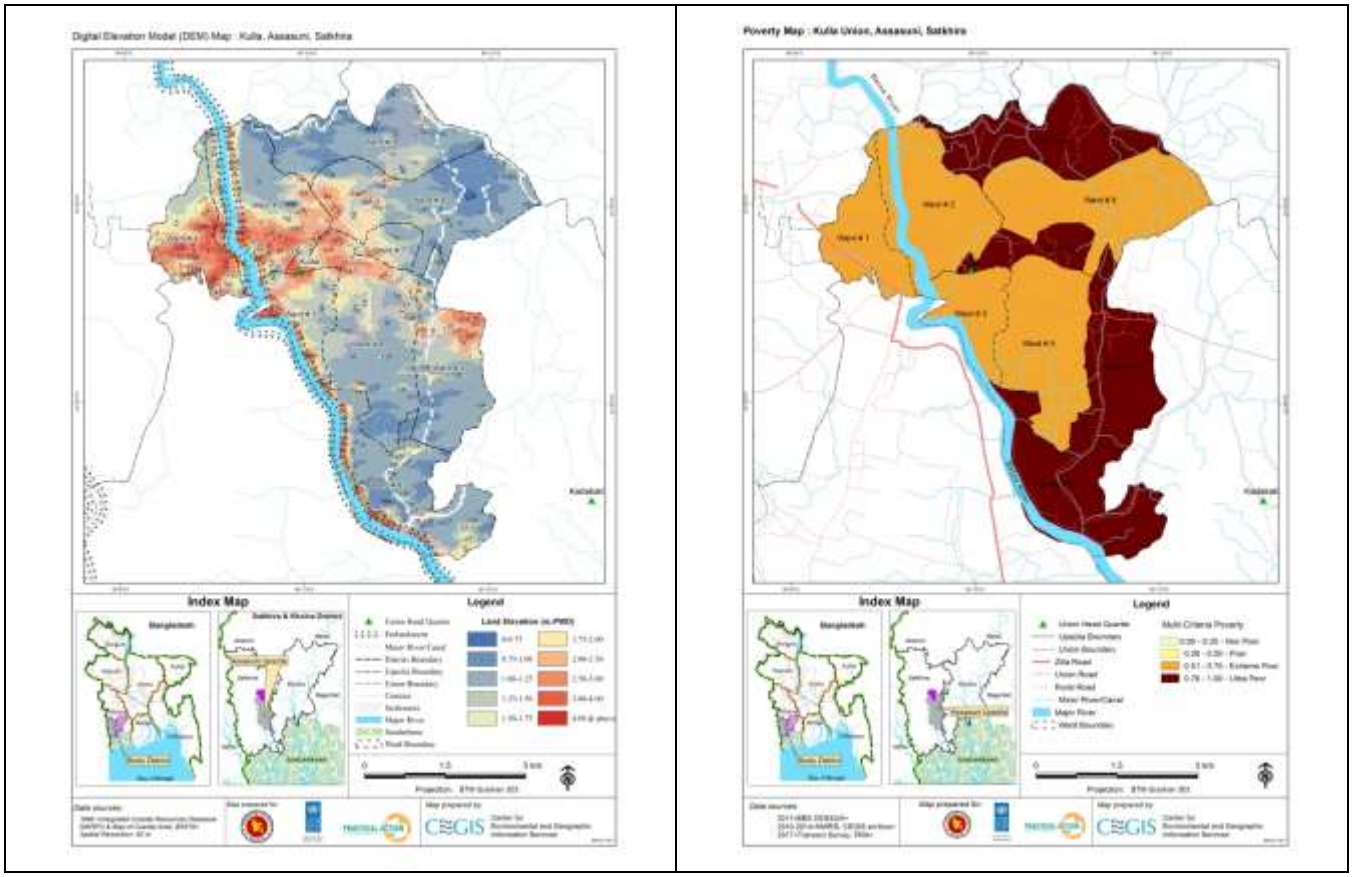


*Figure 03: DEM and Poverty Map*

**2. Existing Livelihoods**

PRA and GIS maps reveals that the major livelihoods that are currently practiced in this union are paddy cultivation, agriculture day labourer, and shrimp farming (see figure 04 and table 01). It is noteworthy to add that one single household is engaged with four to five different income generating activities for maintaining their livelihoods. The women in ward 5,6, and 9 were identified as the wards most in need for the project support. This is in part due to the fact that these wards fall into the ultra-poor category in the poverty index and that they are particularly low-lying and, thus, vulnerable to soil and groundwater salinization processes (see figure 3).

*Table 1: Currently Practiced Livelihoods in Targeted Wards (based on PRA; red highlighted livelihoods were identified as being non-adaptive)*

| Ward Number | Agr. labour | Fishery | Business | Service | Other_OCC | Prawn | Sesame | Shrimp | Watermelon | Crab | Paddy | Mustard | Vegetable | Fishing | Fruit_ORCH | Poultry | Collector from Sundarbans |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward # 5 | **70** | 0 | 0 | 0 | 0 | 0 | 2 | 75 | 0 | 10 | 40 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 6 | **68** | 0 | 0 | 0 | 0 | 0 | 3 | 75 | 0 | 10 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 9 | 40 | 0 | 0 | 0 | 0 | 0 | 2 | 80 | 0 | 10 | **65** | 0 | 0 | 0 | 0 | 0 | 0 |

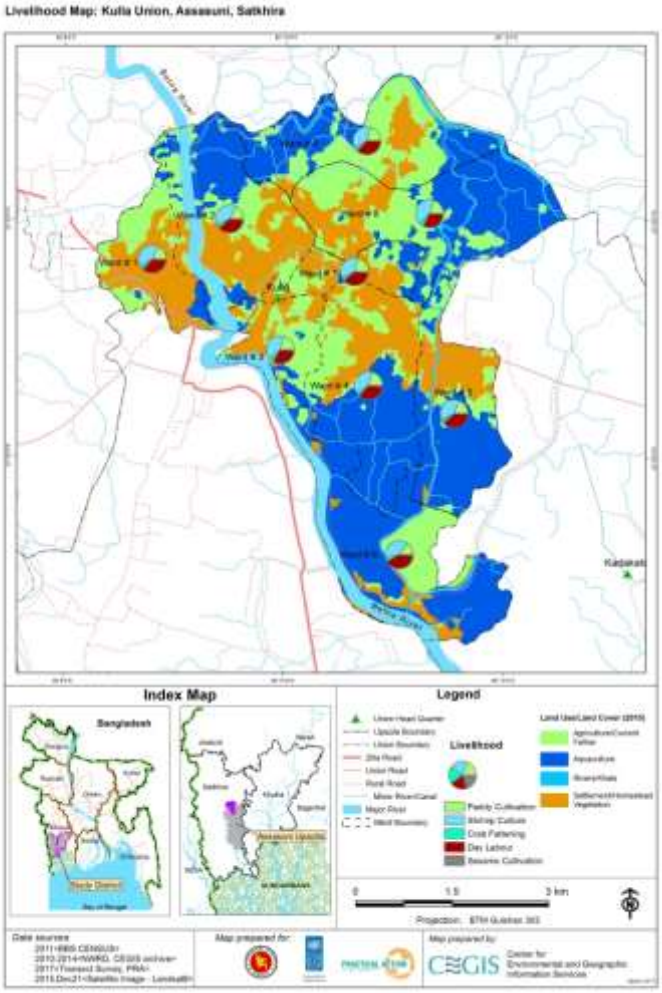


*Figure 04: Existing Livelihoods of Kulla Union*

## 3. Proposed Climate Change Resilient Livelihood Strategies for the Union

### 3.1. Targeted Beneficiaries

The target beneficiaries selected from this Union will include those individuals who currently practice a livelihood that will not only be severely affected by increasing salinity but can also be considered as being non-adaptive. These livelihoods include agriculture labourers, paddy farmers, and people cultivating water melon (see table 1). The beneficiary selection process took into account the fact that each household is engaged in a portfolio of up to 5 different livelihood activities throughout the year plus the changing of production cycles. Thus, the highest percentage of the households practicing a non-adaptive livelihood in the ward was taken as a basis for identifying the targeted households (see table 2). The project will therefore provide an alternative, climate change resilient livelihood for one woman per household and twenty-five women will be clustered into one Women's Livelihood Group (WLG).

*Table 2: Targeted Households and Women*

| Ward No | Total HH | % Non-adaptive | Target HH | Targeted WLGs (≈ 25 women per group) |
|---|---|---|---|---|
| Ward # 5 | 603 | 70 | 422 | 17 |
| Ward # 6 | 566 | 68 | 385 | 15 |
| Ward # 9 | 468 | 65 | 304 | 12 |
| **Total** | **1,637** | | **Total: 1,111** | **Total: 44** |

### 3.2. Rational for Proposed Climate Change Resilient Livelihoods for the union

Considering the geographic and socio-economic characteristics of the union and projected climate change impacts, homestead gardening, aqua-geoponics, plant nursery, and hydroponics are proposed as climate change resilient livelihoods for this union (see Table 3).

*Table 3: Rational for Proposed Livelihoods*

| Livelihood Option | Rational for Selecting the Proposed Livelihood Option for this Union |
|---|---|
| Homestead gardening | Existing practice and moderate salinity in some area makes vegetable cultivation feasible. The Union has plain and fertile arable land meaning that vegetable cultivation within households, especially in combination with raised beds and other agricultural practices, can be sustainably practiced. |
| Aqua-geoponics | Owing to the high number of water bodies available in this Union and in order to cope with increasing soil salinization, there has been increasing interest in the use of aqua-geoponics or soil-less techniques for producing greenhouse horticultural crops in the area. Aqua-geoponic systems are highly productive, require little to no fresh water for irrigation, and produce vegetables and fish that can be consumed at household level and/or sold at local markets. The beneficiaries, who will be trained in aqua-geoponics system, already have agricultural skills which can be built upon. |
| Hydroponics | A good number of water bodies are available in this Union. There has been increasing interest in the use of hydroponic or soilless techniques for producing horticultural crops in the area to cope with increasing soil salinization processes. The beneficiaries who will be trained in hydroponic systems already have skills in agriculture, which can be built upon. |
| Plant nursery | This Union provides adequate moderate saline and fertile land, and soils. Seeds and inputs for organic fertilisers are locally available. Women are also able to build upon their experience in agriculture farming. |

### 3.3. Proposed Value Chain Development and Market Linkages

The value chains for the proposed livelihood options are mostly well established. The required inputs of seeds and fertilisers for aqua-geoponics and hydroponic systems, homestead gardening and plant nursery are available at 14 local markets where the surplus yields that are not consumed in the households can be sold. Traders active in the Union already reach out to district level markets to buy and sell. Additional capacity building and intensive facilitation will be required to link them with international markets and cope with trading higher quantities of vegetables. However, this will be not required for the scale of production expected from the proposed interventions. Thus, there will be no direct value chain development facilities financed through this project, but rather skills, training and market linkage facilitation will be otherwise provided.

### 3.4. Overview of Proposed Interventions and Cost Estimates

Table gives an overview about all direct project interventions and associated costs that are proposed for this union.

*Table 4: Overview of Proposed Interventions and Cost of Interventions*

| Ward No. | Targeted population | Targeted HHs | Targeted WLGs | Proposed Interventions (figures stand for WLGs of 25 women) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Livelihoods / VLC Development | | | |
| | | | | Homestead gardening | Aqua-geoponics | Hydroponics | Plant nursery |
| 5 | 2,499 | 422 | 17 | 5 | | 10 | 2 |
| 6 | 2,155 | 385 | 15 | 4 | | 10 | 1 |
| 9 | 2,241 | 304 | 12 | | 5 | 7 | |
| **Total** | **6,895** | **1,111** | **44** | **9** | **5** | **27** | **3** |
| | | | Assets | 65,000 BDT | 232,875 BDT | 225,000 BDT | 376,000 BDT |
| | | | Inputs per production cycle | 41,850 BDT | 285,525 BDT | 100,000 BDT | 165,587 BDT |
| | | | **Total cost per LH** | **106,850 BDT** | **518,400 BDT** | **325,000 BDT** | **541,587 BDT** |
| | | | Cost for 1 production cycle (assets + inputs) | 961,650 BDT | 2,592,000 BDT | 8,775,000 BDT | 1,624,761 BDT |
| | | | **Total intervention costs for the union** | **13,953,411 BDT** | | | |

**Annex 6: Lata Union Profile**

<table>
<tr><td>Union</td><td>Lata</td></tr>
<tr><td>Upazila</td><td>Paikgacha</td></tr>
<tr><td>District</td><td>Khulna</td></tr>
<tr><td>Location</td><td>The Union has Magurkhali union to the north, Soladana union to the South, Deluti to the east and Kapilmuni Union to the west side. North, south and west boundaries are formed by embankments. Another embankment separates ward no 8 and 9 from other wards of the union.</td></tr>
<tr><td>Geography</td><td>The total land area of the union is 47 square km of which around ninety percent of land falls under 0 m to 1.75 m elevation (see figure 3). The fact that the Union is so low-lying means that it is vulnerable towards cyclone-induced inundations and salinity intrusion.</td></tr>
<tr><td>Demography</td><td>The ward-wise population of the union is shown in the table below. Based on the multi-criteria poverty index it is apparent that majority of the population in all the wards falls under extreme poor range (see figure 3).
<table>
<tr><th>Ward No.</th><th>Villages</th><th>Households (HH)</th><th>Population</th></tr>
<tr><td>1</td><td>2</td><td>296</td><td>1,341</td></tr>
<tr><td>2</td><td>3</td><td>341</td><td>1,470</td></tr>
<tr><td>3</td><td>3</td><td>208</td><td>877</td></tr>
<tr><td>4</td><td>3</td><td>313</td><td>1,105</td></tr>
<tr><td>5</td><td>3</td><td>265</td><td>1,197</td></tr>
<tr><td>6</td><td>2</td><td>240</td><td>1,087</td></tr>
<tr><td>7</td><td>1</td><td>264</td><td>1,133</td></tr>
<tr><td>8</td><td>4</td><td>384</td><td>1,504</td></tr>
<tr><td>9</td><td>2</td><td>340</td><td>1,142</td></tr>
<tr><td></td><td>23</td><td>2651</td><td>10,856</td></tr>
</table></td></tr>
<tr><td>Distance from District/Upazila headquarter</td><td>Lata Union is located 48.47 km away from Khulna District headquarter and 16.22 km away from Paikgacha Upazila and 58.64 km far from the Sundarbans.</td></tr>
<tr><td>Nature of soil</td><td>Saline, clay, sandy loamy soil.</td></tr>
<tr><td>Road infrastructure</td><td>Pucca (paved) road – 20 kilometers, brick soling – 18 kilometers, earthen road – 42 kilometers.</td></tr>
<tr><td>Common transportation means</td><td>Mechanized water vessel, trawler, engine van and motor bike and bus/coach.</td></tr>
<tr><td>Agriculture and aquaculture overview</td><td>Land use patterns in the Union have changed significantly since 1995 (see Figure 2).Crops, such as paddy, mustard, pulses, lentil, leafs and vegetables, used to be cultivated before the Aila cyclone hit. Due to the saline soil and absent supply of sweet water, now only single-crop sowed rice and some vegetables are cultivated. As a result of saline soil and the absence of a supply of sweet water which ensued after the cyclone, only single-crop sowed rice and some vegetables are now cultivated. Around ninety percent of the land in this Union are used for aquaculture practice such as shrimp, fish and crab cultivation. Rest of the land is used for paddy cultivation. A significant portion of land is used for homestead vegetation unlike other Unions.</td></tr>
<tr><td>Markets and growth centers</td><td>There are six prominent local markets in Lata Union. Besides, there are one crab/fish depot and 16 shrimp depots in this union. The major markets and growth centers of this union are shown in figure 1.</td></tr>
</table>

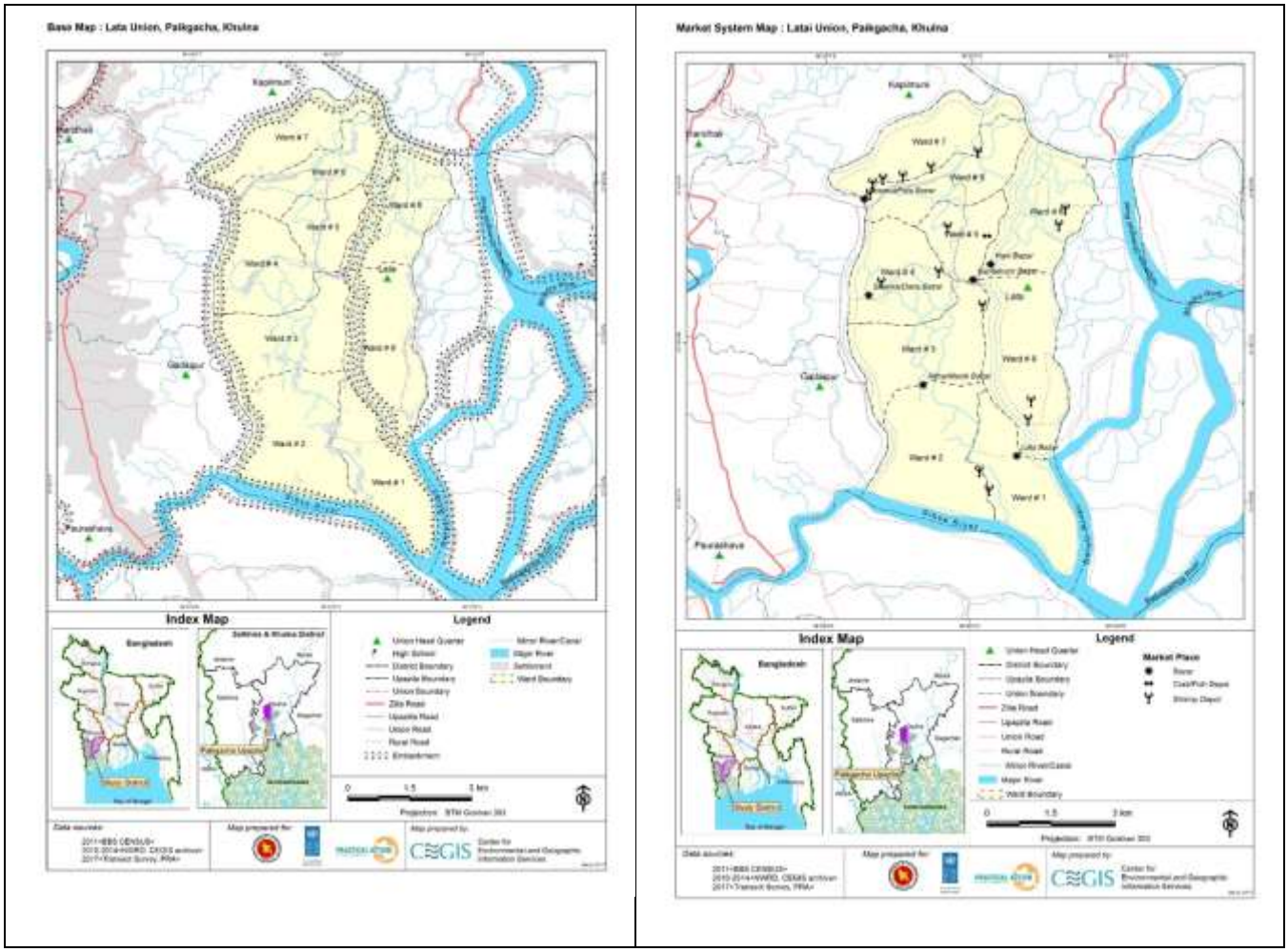


*Figure 1: Base Map, and Markets and Growth Centers in Lata Union*

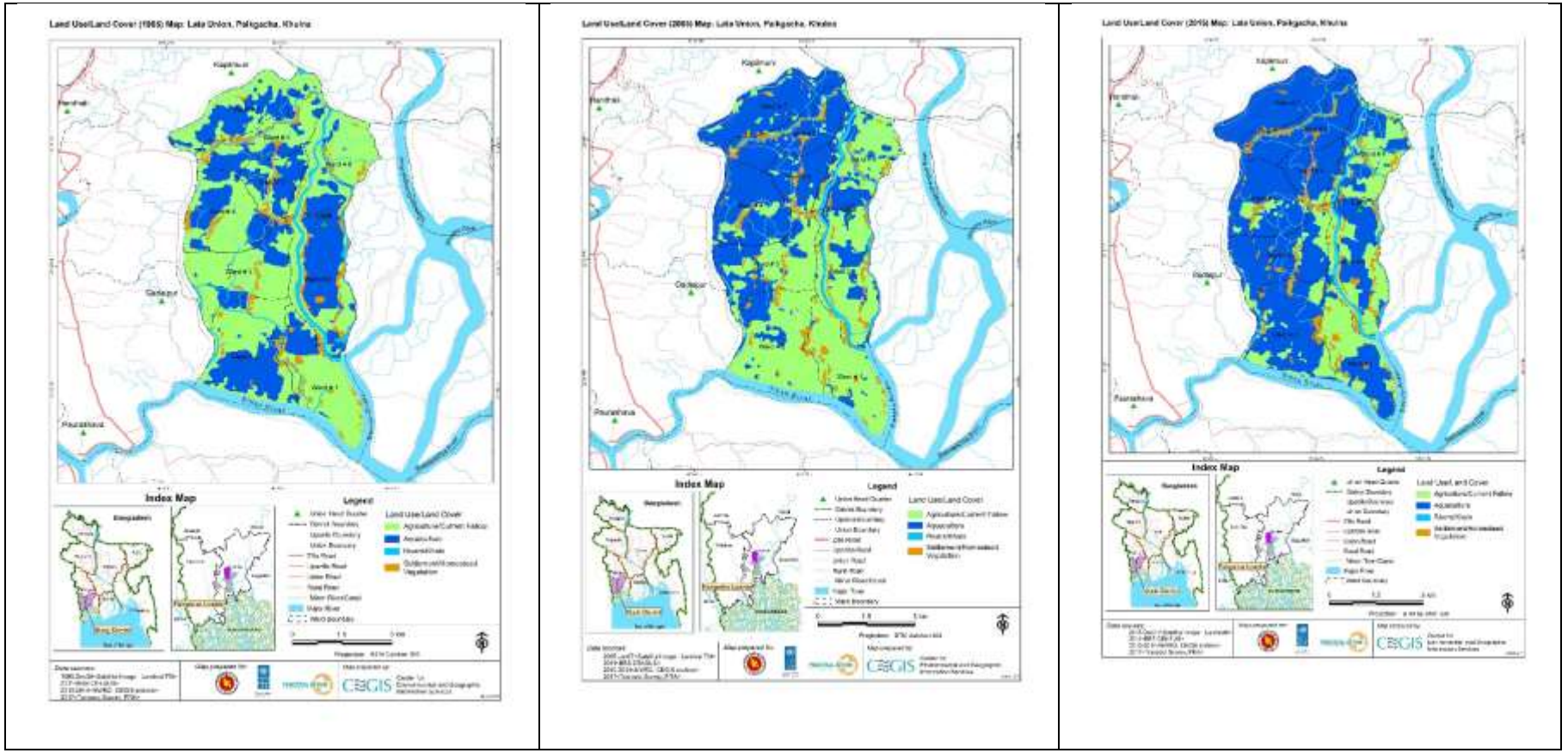


*Figure 2: Change in Land Use Pattern since 1995 in Lata Union*

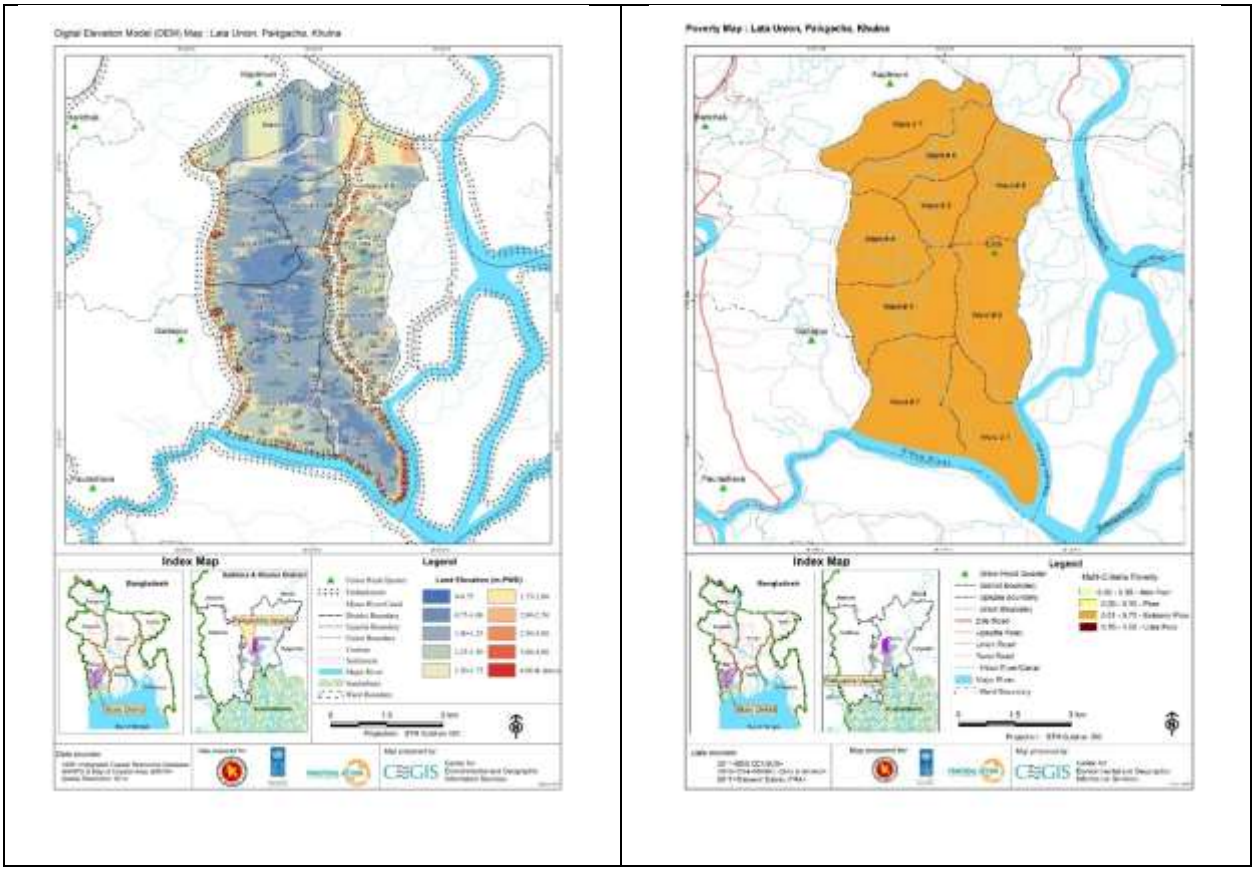


*Figure 03: DEM and Poverty Map*

**2. Existing Livelihoods**

PRA and GIS maps reveal that the major livelihoods that are currently practiced in this Union are paddy cultivation, agriculture day labourer, and shrimp farming (see Figure 4 and Table 1). It is noteworthy to add that one single household can be engaged with up to four to five different income generating activities for maintaining their livelihoods. The women in wards 3 and 4 were identified as the wards most in need for the project support. This is in part due to the fact that these wards fall into the extremely poor category in the poverty index but also that they are very vulnerable to soil and groundwater salinization processes (see Figure 3).

*Table 1: Currently Practiced Livelihoods (based on PRA; red highlighted livelihoods were identified as being non-adaptive)*

| Ward_Number | Agr. labour | Fishery | Business | Service | Other_OCC | Prawn | Sesame | Shrimp | Watermelon | Crab | Paddy | Mustard | Vegetable | Fishing | Fruit_ORCH | Poultry | Collector from Sundarbans |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward # 3 | **50** | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 0 | 13 | 14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 4 | **60** | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 38 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |

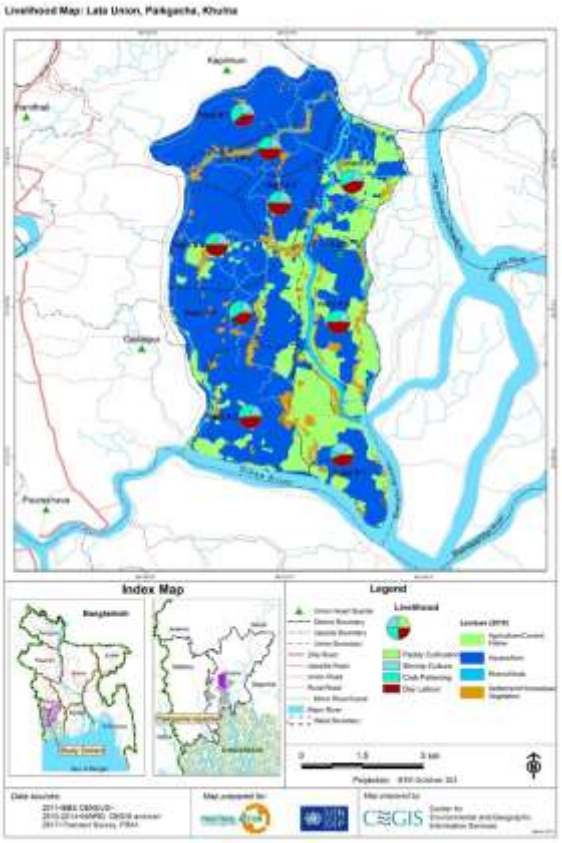


*Figure 04: Existing Livelihoods in Lata Union*

### 3. Proposed Climate Change Resilient Livelihood Strategies for the Union

#### 3.1. Targeted Beneficiaries

The target beneficiaries selected from this Union will include those individuals who currently practice a livelihood that will not only be severely affected by increasing salinity but can also be considered as being non-adaptive. These livelihoods include agriculture labourers, paddy farmers, and people cultivating water melon (see table 1). The beneficiary selection process took into account the fact that each household is engaged in a portfolio of up to 5 different livelihood activities throughout the year plus the changing of production cycles. Thus, the highest percentage of the households practicing a non-adaptive livelihood in the ward was taken as a basis for identifying the targeted households (see table 2). The project will therefore provide an alternative, adaptive and climate change resilient livelihood for one woman per household and twenty-five women will be clustered into one Women's Livelihood Group (WLG).

*Table 2: Targeted Households and Women*

| Ward No | Total HH | % Non-adaptive | Target HH | Targeted WLGs (≈ 25 women per group) |
|---|---|---|---|---|
| Ward # 3 | 208 | 50 | 104 | 4 |
| Ward # 4 | 313 | 60 | 188 | 8 |
| | 521 | | **Total: 292** | **Total: 12** |

#### 3.2. Rational for Proposed Climate Change Resilient Livelihoods for the Union

Considering the geographic and socio-economic characteristics of the union and projected climate change impacts, crab farming, crab nursery, and plant nursery are proposed as climate change resilient livelihoods for this union (see table 3).

*Table 3: Rational for proposed livelihoods*

| Livelihood Option | Rational for selecting the proposed livelihood option for this union |
|---|---|
| Crab farming | Water quality (pH, ammonia, temperature, salinity, dissolved oxygen, and alkalinity level) in available old paddy fields or shrimp ponds are suitable for crab farming. Local people are knowledgeable in aquaculture techniques. Inputs and water bodies are available in the union. |
| Crab nursery | The water quality (pH, ammonia, temperature, salinity, dissolved oxygen, and alkalinity level) of the existing old paddy fields or shrimp ponds can be suitable for crab nurseries in both open and close systems. Crab nurseries are the backward linkage of crab fattening and are needed to provide sufficient supply of crab-lets for the crab farms. The idea would be for the nurseries to collect crab-lets from hatcheries which the project will establish in the Upazila. |
| Plant nursery | This union provides adequate moderate saline and fertile land, and soils. Seeds and inputs for organic fertilisers are locally available. Women are also able to build upon their experience in agriculture farming. |

### 3.3. Proposed Value Chain Development and Market Linkages

The value chains for the proposed livelihood options are mostly well-established. The required inputs of seeds and fertilisers for homestead gardening and plant nursery are available at local markets at which surplus yields that are not consumed in the households can be sold. There are three local markets existent in the union. For the crab value chain, there is a need to establish linkages with input suppliers of crab-lets from the hatchery in Soladana union (which will be upgraded through this project). Already existent in this union are 16 shrimp depots and one crab/fish depots which can become part of the value chain to store and trade the produced crabs. Traders active in the union already reach out to district level market to buy and sell. Additional capacity building and intensive facilitation will be required to link them with international markets and cope with trading higher quantities of crabs. Thus, there will be no direct value chain development facilities financed through this project, but skills training and market linkage facilitation will be provided.

### 3.4. Overview of Proposed Interventions and Cost Estimates

Table gives an overview of all direct project interventions and associated costs that are proposed for this union.

*Table 4: Overview of Proposed Interventions and Cost of Interventions*

| Ward No. | Targeted population | Targeted HHs | Targeted WLGs | Proposed Interventions (figures stand for WLGs of 25 women) | | |
|---|---|---|---|---|---|---|
| | | | | Livelihoods / VLC Development | | |
| | | | | Crab farming | Crab nursery | Plant nursery |
| 3 | 877 | 104 | 4 | 4 | | |
| 4 | 1,105 | 188 | 8 | 6 | 1 | 1 |
| **Total** | **1,982** | **292** | **12** | **10** | **1** | **1** |
| | | | Assets | 81,040 BDT | 261,140 BDT | 376,000 BDT |
| | | | Inputs per production cycle | 190,224 BDT | 99,375 BDT | 165,587 BDT |
| | | | **Total cost per LH** | **271,264 BDT** | **360,515 BDT** | **541,587 BDT** |
| | | | Cost for 1 production cycle (assets + inputs) | 2,712,640 BDT | 360,515 BDT | 541,587 BDT |
| | | | **Total intervention costs for the union** | **3,614,742 BDT** | | |

**Annex 7: Moharajpur Union Profile**

| | |
|---|---|
| Union | Moharajpur |
| Upazila | Koyra |
| District | Khulna |

<table>
<tr><td>Location</td><td>The Moharajpur Union is located between 22º12' and 22º 31' north latitudes and in between 89º 15' and 89º 26' east longitude; in close proximity to the Sundarbans. Moharajpur Union is one of the most disaster vulnerable Unions of Koyra Upazilla. Embankments form the western and eastern boundaries.</td></tr>
<tr><td>Geography</td><td>The total area of the Union is 33.38km², of which around seventy percent of land is .5 m to 1.25 m in elevation (see Figure 3). The fact that the Union is so low-lying, means that it is vulnerable to cyclone-induced inundations and salinity intrusion.</td></tr>
<tr><td>Demography</td><td>The ward-wise population of the Union is shown in the table below. Based on the multi-criteria poverty index it is apparent the population of four wards fall into the ultra-poor category, while the remaining wards can be classified as being extremely poor (see Figure 3).
<table>
<tr><th>Ward No.</th><th>Villages</th><th>Households (HH)</th><th>Population</th></tr>
<tr><td>1</td><td>1</td><td>1,104</td><td>5,906</td></tr>
<tr><td>2</td><td>2</td><td>739</td><td>3,951</td></tr>
<tr><td>3</td><td>4</td><td>583</td><td>2,849</td></tr>
<tr><td>4</td><td>2</td><td>698</td><td>3,469</td></tr>
<tr><td>5</td><td>3</td><td>534</td><td>2,642</td></tr>
<tr><td>6</td><td>3</td><td>715</td><td>3,559</td></tr>
<tr><td>7</td><td>3</td><td>624</td><td>3,073</td></tr>
<tr><td>8</td><td>1</td><td>582</td><td>2,900</td></tr>
<tr><td>9</td><td>5</td><td>549</td><td>2,720</td></tr>
<tr><td></td><td>24</td><td>6,128</td><td>31,069</td></tr>
</table></td></tr>
<tr><td>Distance from District/ Upazila Headquarter</td><td>Moharajpur Union is situated around 60km away from the District Sadar and 3km from the Upazila.</td></tr>
<tr><td>Nature of Soil</td><td>Saline, clay, sandy loamy soil.</td></tr>
<tr><td>Road Infrastructure</td><td>This Union is located along the Koyra Upazila road, and therefore it is well connected to the bus service from Khulna District. Easier access to Upazila and Union is also possible from Khulna BIWTA port, via steamer and other river vessels. There are 7km of paved roadways in the Union.</td></tr>
<tr><td>Common Transportation Means</td><td>Moharajpur Union is connected with Upazila Sadar by a brick built road, whereby movement is possible by bus, tricycle, rickshaw, private car and an unfit vehicle called Nosimon.</td></tr>
<tr><td>Agriculture and Aquaculture Overview</td><td>Land use patterns in the Union have changed significantly since 1995 (see Figure 2). Crops, such as paddy, mustard, pulses, lentil, leafs and vegetables, used to be cultivated before the Aila cyclone hit. As a result of the saline soil and the absence of a supply of sweet water, which ensued after the cyclone, only single-crop sowed rice and some vegetables are now cultivated. Approximately seventy percent of the land in this Union is used for aquaculture practice such as shrimp, fish and crab cultivation. The rest of the land is used for paddy cultivation and homestead gardening.</td></tr>
<tr><td>Markets and Growth Centres</td><td>There are five prominent local markets in Moharajpur Union for selling and purchasing goods. In addition, there are eight crab depots and eleven fish depots available in this Union. Beside these, some producers and traders have reached out to buy and sell at the markets in Khulna. The major markets and growth centres of this Union are shown in Figure 1.</td></tr>
</table>

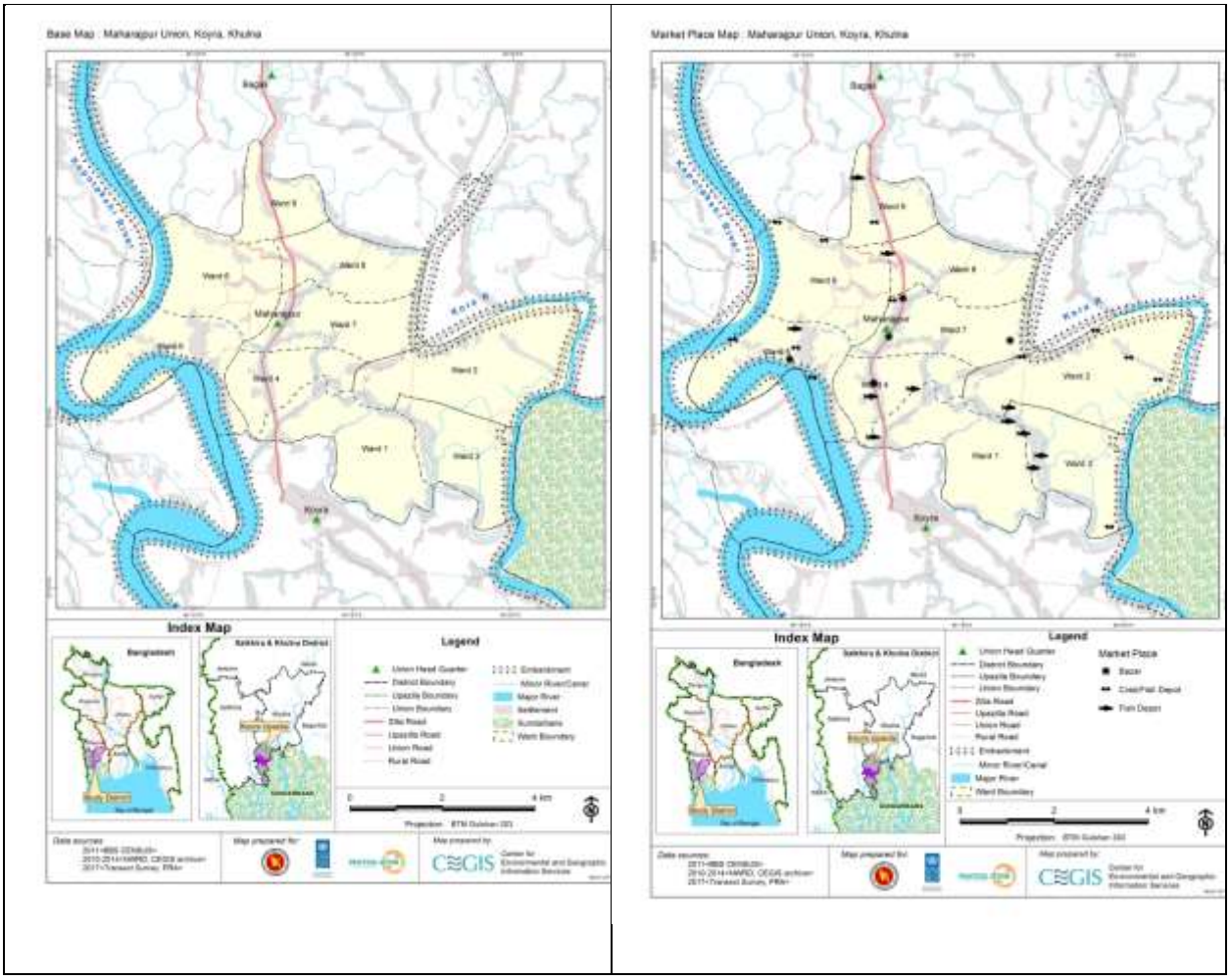


*Figure 01: Base Map, and Markets and Growth Centers in Maharajapur Union*

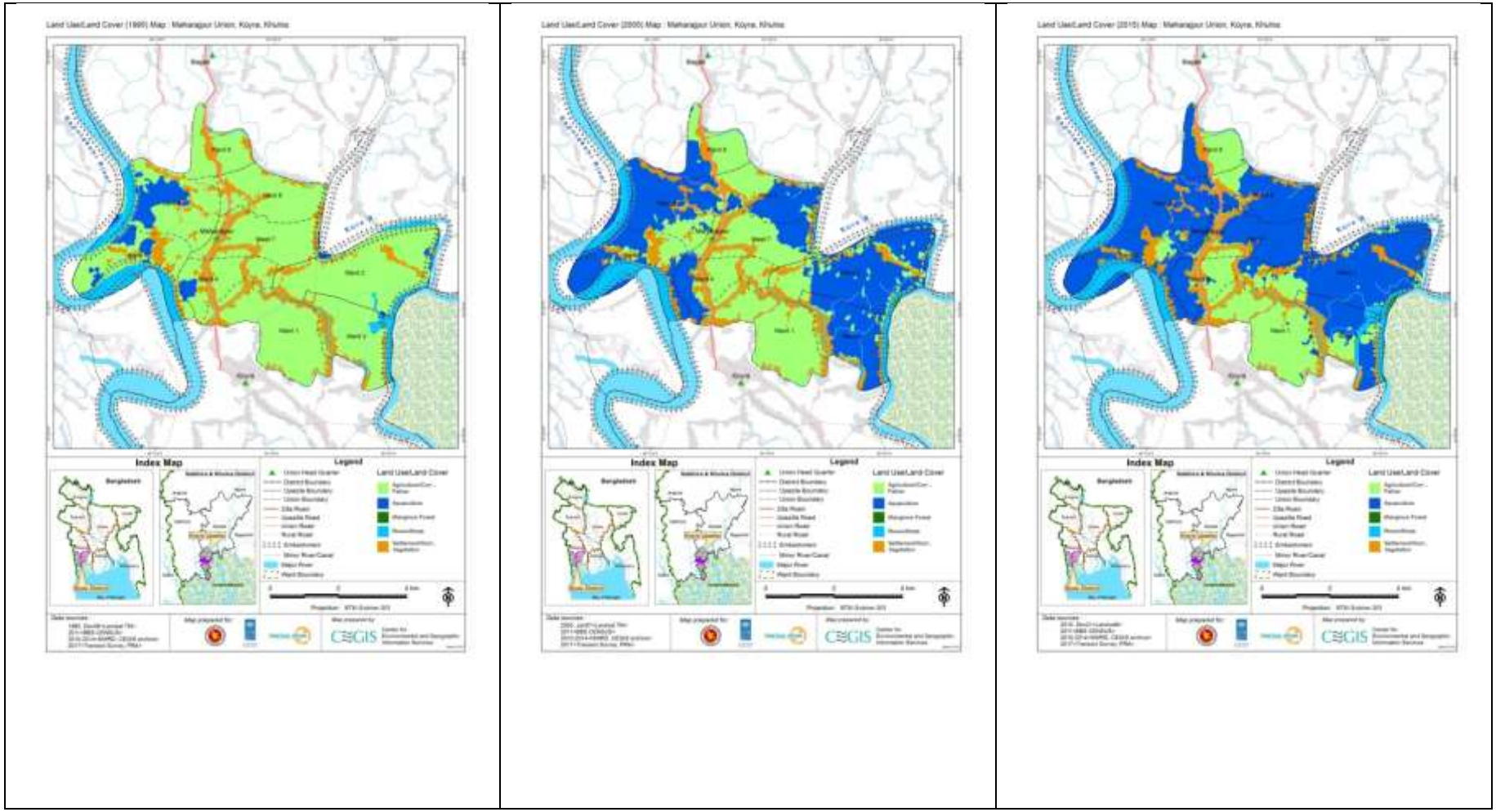


*Figure 02: Change in Land Use Pattern since 1995 in Moharajpur*

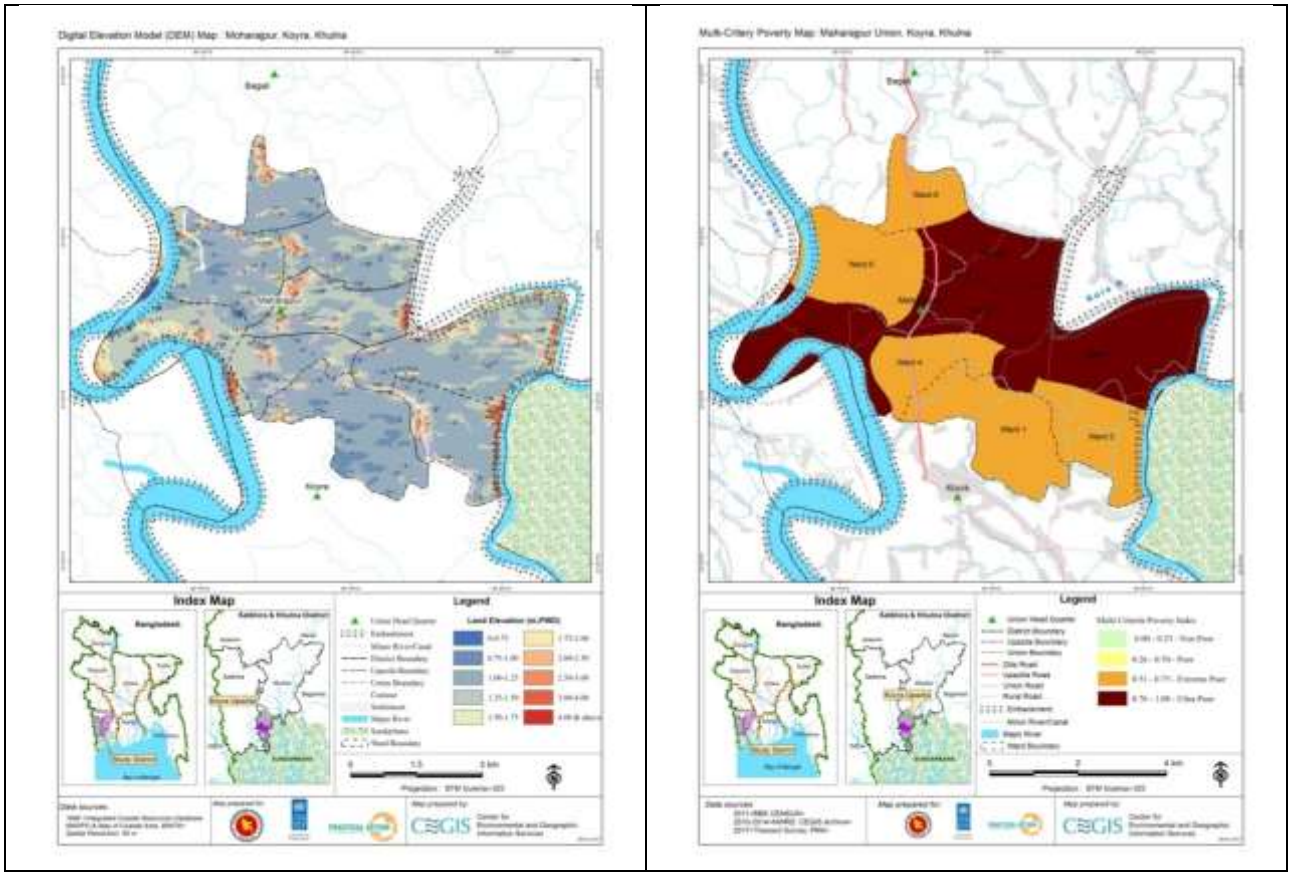


*Figure 03: Digital Elevation Map in Moharajpur*

**2. Existing Livelihoods**

PRA and GIS maps reveal that the major livelihoods that are currently practiced in this Union are paddy cultivation, agriculture day labour, and shrimp farming (see Figure 4 and Table 1). It is noteworthy to add that one single household can be engaged with up to four or five different income generating activities in maintaining their livelihoods. The women in ward 5,6, and 9 were identified as the wards most in need for the project support due to falling into the ultra-poor category and being particularly low-lying and, thus, vulnerable to soil and groundwater salinization processes (see figure 3).

*Table 1: Currently Practiced Livelihoods (based on PRA; red highlighted livelihoods were identified as being non-adaptive)*

| Ward_ Number | Agr. labour | Fishery | Business | Service | Other_OCC | Prawn | Sesame | Shrimp | Watermelon | Crab | Paddy | Mustard | Vegetable | Fishing | Fruit_ ORCH | Poultry | Collector from Sundarbans |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward # 2 | **60** | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 10 | 55 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 7 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 10 | **50** | 0 | 0 | 0 | 0 | 0 | 0 |
| Ward # 8 | **30** | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 0 | 10 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |

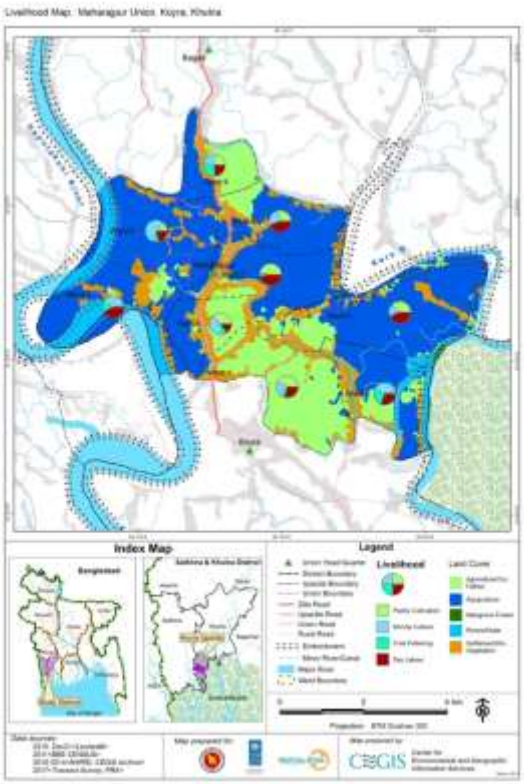


*Figure 04: Existing Livelihoods of Moharajpur*

**3. Proposed Climate Change Resilient Livelihood Strategies for the Union**

**3.1. Targeted Beneficiaries**

The target beneficiaries selected from this Union will include those individuals who currently practice a livelihood that will not only be severely affected by increasing salinity but can also be considered as being non-adaptive. These livelihoods include agriculture labourers, paddy farmers, and people cultivating water melon (see Table 1). The beneficiary selection process took into account the fact that each household is engaged in a portfolio of up to 5 different livelihood activities throughout the year plus the changing of production cycles. Thus, the highest percentage of the households practicing a non-adaptive livelihood in the ward was taken as a basis for identifying the targeted households (see Table 2). The project will therefore provide an alternative, adaptive and climate change resilient livelihood for one woman per household and twenty-five women will be clustered into one Women's Livelihood Group (WLG).

*Table 2: Targeted Households and Women*

| Ward No | Total HH | % Non-adaptive | Target HH | Targeted WLGs (≈ 25 women per group) |
|---|---|---|---|---|
| Ward # 2 | 739 | 60 | 443 | 18 |
| Ward # 7 | 624 | 50 | 312 | 13 |
| Ward # 8 | 582 | 30 | 175 | 7 |
| **Total** | **1945** | | **Total: 930** | **Total: 38** |

**3.3. Rational for Proposed Climate Change Resilient Livelihoods for the Union**

Considering its geographic and socio-economic characteristics and projected climate change impacts on the Union, the proposed climate change resilient livelihoods for this Union are homestead gardening, aqua-geoponics, plant nursery, and hydroponics (see Table 3).

*Table 3: Rational for Proposed Livelihoods*

| Livelihood Option | Rational for Selecting the Proposed Livelihood Option for this Union |
|---|---|

| | |
|---|---|
| Homestead gardening | Existing practices and moderate salinity in some area make vegetable cultivation feasible. The Union has plain and fertile arable land, meaning that vegetable cultivation within households, especially in combination with raised beds and other agricultural practices, can be sustainably practiced. |
| Aqua-geoponic | Owing to the high number of water bodies available in this Union and in order to cope with increasing soil salinization, there has been an increasing interest in the use of aqua-geoponics or soil-less techniques for producing greenhouse horticultural crops in the area. Aqua-geoponic systems are highly productive, require little to no fresh water for irrigation, and produce vegetables and fish that can be consumed at household level and/or sold at local markets. The beneficiaries, who will be trained in aqua-geoponics system, already have agricultural skills which can be built upon |
| Hydroponics | A good number of water bodies are available in this Union. There has been an increasing interest in the use of hydroponic or soilless techniques for producing horticultural crops in the area to cope with increasing soil salinization processes. The beneficiaries who will be trained in hydroponic systems already have skills in agriculture, which can be built upon. |
| Plant nursery | This Union provides adequate moderate saline and fertile land, and soils. Seeds and inputs for organic fertilisers are locally available. Women are also able to rely on their experience in agriculture farming. |

### 3.3. Proposed Value Chain Development and Market Linkages

The value chains for the proposed livelihood options are mostly well-established. The required inputs of seeds and fertilisers for homestead gardening and plant nursery are available at local markets at which surplus yields that are not consumed in the households can be sold. There are currently five prominent local markets in the Union with additional two crab depots and one fish depot available. Traders active in the Union have already reached out to buy and sell at district level markets. Thus, there will be no direct value chain development facilities financed through this project, but rather skills, training and market linkage facilitation will be otherwise provided.

### 3.4. Overview of Proposed Interventions and Cost Estimates

Table gives an overview of all direct project interventions and associated costs that are proposed for this Union.

*Table 4: Overview of Proposed Interventions and Cost of Interventions*

| Ward No. | Targeted population | Targeted HHs | Targeted WLGs | Proposed Interventions (figures stand for WLGs of 25 women) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Livelihoods / VLC Development | | | |
| | | | | Homestead gardening | Aqua-geoponics | Hydroponics | Plant nursery |
| 2 | 3,951 | 443 | 18 | 6 | | 10 | 2 |
| 7 | 3,073 | 312 | 13 | | 5 | 8 | |
| 8 | 2,900 | 175 | 7 | | | 7 | |
| **Total** | **9,924** | **930** | **38** | **6** | **5** | **25** | **2** |
| | | | Assets | 65,000 BDT | 232,875 BDT | 225,000 BDT | 376,000 BDT |
| | | | Inputs per production cycle | 41,850 BDT | 285,525 BDT | 100,000 BDT | 165,587 BDT |
| | | | **Total cost per LH** | **106,850 BDT** | **518,400 BDT** | **325,000 BDT** | **541,587 BDT** |
| | | | Cost for 1 production cycle (assets + inputs) | 641,100 BDT | 2,592,000 BDT | 8,125,000 BDT | 1,083,174 BDT |
| | | | **Total intervention costs for the union** | **12,441,274 BDT** | | | |