Evidence of Ecosystem Based Adaptation to Climate Change in Coastal Bangladesh

Samiya A. Selim, Ayesha Khanom, Joy Bhowmik and Mubashshira Rahman

**Center for Sustainable Development,
University of Liberal Arts Bangladesh
in association with
Climate-Resilient Ecosystems and Livelihoods (CREL)
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Cover photo: Focus group discussion at Chandpai, Mongla
above photo: Survey team conducting Focus Group Discussion at Nijhum Dwip, Hatiya

Climate-Resilient Ecosystems and Livelihoods (CREL) project
House 13/B Road 54, Gulshan
Dhaka 1212, Bangladesh

Winrock International
2101 Riverfront Drive
Little Rock, AR 72202-1748, USA

Center for Sustainable Development, University of Liberal Arts Bangladesh
House 56, Road 4/A, Dhanmondi,
Dhaka-1209 Bangladesh

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EXECUTIVE SUMMARY

The Bay of Bengal is among the most climate change affected regions, with massive salinity intrusion, river erosion, increasingly frequent extreme weather events. Bangladesh is considered to be one of the countries most vulnerable to climate change because of its flat and low lying topography, funnel shaped coastline challenged by its high population density. This is exacerbated by high levels of poverty and reliance of various livelihoods on climate sensitive sectors including agriculture, fisheries and water resources.

To tackle some of these issues, the Climate-Resilient Ecosystems and Livelihoods (CREL) project implemented by Winrock International and funded by USAID is designed to scale up and adapt successful co-management models to conserve ecosystems and protected areas (PAs) in Bangladesh, improve governance of natural resources and biodiversity, and increase resilience to climate change through improved planning and livelihoods diversification. Whilst there are CREL sites all across the country, this study evaluated CREL project based in coastal Bangladesh.

This study aimed to gather evidence to address gaps in ecosystem based adaptation (EbA) to climate change so that this can be fed into policy and management of effective implementation of EbA measures. It does this by evaluation of a number of CREL project activities based in the coastal areas of Bangladesh. The evaluation was done through primary and secondary data analysis. Firstly secondary data provided by CREL was analyzed from four CREL sites (three entirely mangrove forest sites and one coastal island site with mixed ecosystems of mangroves and intertidal mudflats), and seeing how well they aligned with and fit into the EbA framework and strategy. The second part consisted of primary data collection, in the form of focus group discussions and interviews in three sites, and seeing how beneficiaries of the project perceived project activities and how well these fit EbA interventions.

Results showed that several CREL activities met EbA criteria and utilized an ecosystem approach in diversifying alternate livelihoods to deal with the negative impacts of climate change. Some of these included poultry rearing, aquaculture and knitting. The project was also focused around natural resource management, and helped with knowledge generation and awareness of sustainable harvest, minimizing environmental impact, and protection of forests and wildlife.

However in some areas, we found lack of adoption of an ecosystem based approach, where the villagers are able to earn livelihood but still suffer from freshwater shortage and flooding due to poor roads. There were also several other limiting factors such as lack of land, education, power struggle, poor governance and lack of innovation that limited adoption of ecosystem based adaptation.

Overall, the findings from this study show that ecosystem based adaptation is prevalent in CREL activities but there are other factors that need to be taken into consideration for successful implementation of EbA in rural areas of Bangladesh. Limitations to adopting EbA strategies as seen in this study include: lack of land, assets and finances for vulnerable people to invest in adaptation strategies, land use conflict and community opposition. There were also knowledge gaps on innovations and technologies that can be used in implementing EbA. From our study we identified the following key issues that need to be addressed when designing future projects in remote areas of Bangladesh where a majority of people are poor and have limited resources:

- Addressing social and political issues e.g. land rights, power struggle, weak local governance.
- Focusing on transformation to sustainability, and enabling innovation in design and adaptation mechanisms.
- Social energy for collaborative ecosystem-based aquaculture and agriculture development with the poor

Abbreviations

BCCSAP –   Bangladesh Climate Change Strategy and Action Plan
CBA –   Community Based Adaptation
CBNRM -   Community Based Natural Resource Management
CMC –   Co-Management Committee
CNRS -   Centre for Natural Resource Studies
CODEC –   Community Development Center
COP -   Conference of the Parties
CREL -   Climate Resilient Ecosystem and Livelihoods
EbA -   Ecosystem based Adaptation
FGD –   Focus Group Discussion
IPCC –   Intergovernmental Panel for Climate Change
MoEF –   Ministry of Environment and Forest
NRM –   Natural Resource Management
UNFCC –   United Nations Framework Convention on Climate Change

Acknowledgements

CHAPTER 1 INTRODUCTION

1.1 Bangladesh, climate change and CREL

Coastal ecosystems provide a variety of ecosystem services which range from provisioning (e.g. fisheries) and regulatory (e.g. carbon sequestration), to supporting (e.g. coastal defense) and recreational (e.g. tourism) (Beaumont et al., 2007). At the same time these systems are being negatively impacted by both anthropogenic and natural disturbances which result in degradation of the ecosystem along with the ecosystem services and functions it provides (Ahammad et al., 2013).

According to the IPCC 4th assessment report, global mean surface temperature is projected to rise by 1.1 C-6.4 C by the end of the 21st century (IPCC, 2007) The shallow Bay of Bengal is among the most climate change affected regions on earth, with massive salinity intrusion, increasingly frequent extreme weather events and shifts in the composition, character and distribution of coastal ecosystems. Advancing tidal inundations and extreme weather events, coupled with mangrove deforestation, also caused by shrimp cultivation, are pushing the coastal salinity front further inland, with increasing biodiversity loss and carbon emissions (Ahmed et al., 2017.)

Scarcity of freshwater is one of the major impacts of climate change on the Bangladesh coast due to this increase in salinity from the above reasons mentioned, as well as trapping of storm surge waters (Irfannullah, 2016.) At the same time, the increased numbers of salt water shrimp farms in the Bangladesh coastal region also suggests increased salinity in formerly freshwater creeks and streams (Iftekhar and Islam, 2004).

Strategies are required that combine just and sustainable coastal production that includes the coastal poor and that appropriately value and use Bangladesh's mangroves and associated ecosystem service potentials. Poor coastal people at the frontline of climate change need feasible new production options in line with the changed coastal environment, to support their livelihoods.

Environmental crises in coastal and marine social-ecological systems affect the availability and quality of natural resources and ecosystem services, with severe consequences for ecosystem dependent coastal households and communities (Cinner et al. 2012; Pomeroy et al. 2006). In Bangladesh, coastal zones are strongly affected by continued sea-level rise and other climate change induced factors (DoE, 2015; Huq et al. 1999). The environmental change causes soil and river salinity to increase, gradually eliminating traditional coastal agriculture (Dasgupta et al. 20174 Forced to adjust their livelihood strategies, the frequently poor rural households adapt in different ways. Many resource users practice brackish or saline water shrimp farming as a compensatory livelihood for the loss of agriculture to salinization with well-recognized economic benefits, although it has also been associated with poverty generating issues (Amoako Johnson et al. 2016; Pouliotte et al. 2009).

At the same time, Bangladesh has been hailed as the 'adaptation' capital of the world and has been ahead of the game with preparation of the National Adaptation Programme of Action back in 2005 – the first ever strategic document to make such an organized effort on adaptation. During 2008-2010, the Government of Bangladesh took some unprecedentedly prompt actions in climate change policy and strategy formulation. In 2008, it formulated the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), and revised it in the following year (MoEF, 2009; Irfanullah, 2016.)

Rainwater harvesting has been implemented in several areas in the southwest region after the two major cyclones - Sidr (2007) and Aila (2009). Several water filtering technologies have been introduced as well such as pond sand filters. Floating gardens and diversified livelihoods have been other such initiatives taken. Water storage in crop fields, homestead gardening and incorporating the "Triple F Model" (simultaneous food, forestry and fish production) (Kibria, 2015) are some of the coastal adaptions taken for food production.

However, the same issues that have been plaguing the nation for more than 2 decades still persist. In his paper, Irfanullah (2016) identifies reasons why these adaptation solutions have not been successful and scaled up. He mentions that such participatory, community-led actions are not sustainable unless they are supported by public policies, strategies and plans, and implemented. Monitoring and evaluation was not integrated during project life cycles making it difficult to innovate and adapt if something does not work according to the initial plan. Innovation-Adaptation-Diffusion Theory is not followed. Nature based solutions are given but projects are rarely scaled up, due to several reasons such as poor governance and lack of long term sustainability in project design and implantation. Knowledge generation, sharing and management system is not built into the national efforts, hence a compromised learning cycle is repeated again in other parts of the country.

1.2 Ecosystem Based Adaptation

The concept of ecosystem-based adaptation (EbA) was first introduced into the United Nations Framework Convention on Climate Change (UNFCCC) negotiations at the fourteenth session of the Conference of the Parties (COP) to the UNFCCC in 2008. According to the Convention on Biological Diversity, EbA is defined as the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change as part of an overall adaptation strategy which increases the resilience and reduce the vulnerability of ecosystems and people. EbA is generating growing interest globally as a realistic and desirable adaptation option, particularly for developing and least developed countries. For EbA to be effective it should be planned and implemented at the local level. This allows for a direct link to local contexts and place-specific challenges. Furthermore, it enables effective adaptive management, and the embedding of climate change into local planning and implementation, including into service delivery, land use and infrastructure planning, and natural resources management (Bourne et al., 2016.)

EbA builds upon and uses approaches that already exist in the practices of biodiversity and ecosystem conservation, climate change adaptation and livelihood development. EbA draws from the related approaches of community based natural resource management (CBNRM), community-based adaptation (CBA), and climate change-integrated conservation strategies, but is unique in that it aims for the combined achievement of all three outcomes (Midgley et al. 2012).

Developing effective EbA responses essentially requires an integrated understanding of socio-ecological vulnerability and the ways in which ecosystems can assist local communities to adapt to climate change. There needs to be good understanding of the natural features of the ecosystem, such as the water ecological infrastructure and the biodiversity which underpins a range of ecosystem services. All this combined can support an ecosystem's ability to adapt to climate change. At the same time there needs to be good understanding of socioeconomic status and vulnerability and demand for natural resources and ecosystem services.

Communities dependent on environmental services and natural resources always have ecosystem, human and management/governance components to them (Berkes et al., 2016). We need to use a social-ecological framework to get a better understand of coupled human-nature system in ecosystem based adaptation and use an integrated approach that incorporates all the above multiple considerations.

1.3 Ecosystem Services in the study areas

The Sundarbans is the largest single tract of mangrove forest in the world, lying in the deltaic area of the Ganges and Brahmaputra Rivers on the Bay of Bengal, and comprising a complex network of meandering tidal channels, low silt and clay islands, and salt-tolerant bushy and tree vegetation (Shamik et al. 2018) The Sundarbans provides subsistence-based livelihoods for wood-cutters, fishers,

honey gatherers, and leaf and grass gatherers in surrounding villages. The mangrove trees and roots also act as a protective buffer from storm surges, seawater seepage and salinity intrusion along the coastline (Barber, 2007; Walters et al., 2008, Uddin et al., 2013). Golpata is a key plant resource (palm fronds) which supports the livelihoods of a large part of the population who live in the surrounding villages. Goran is another important resource mostly used as fuel wood, making charcoal, housing structures and making boundary fences. There are various other plant-based resources including reeds, catkin grass, *hental*, and *helipata* or *mailla* (mat making materials). The fisheries resources comprise a high diversity of fin fishes, shrimps, crabs and shrimp post larvae which are harvested from within and adjacent to the Sunderban Reserve Forest.

Planted mangrove forests provide similar services. In addition Hilsa fishing grounds are found along the entire coast and along the coastal river systems, with important areas (and Hilsa sanctuaries for spawning grounds close to both Tengagiri WS and Nijhum Dwip NP.

1.4 Organizational and Project Context

The Climate-Resilient Ecosystems and Livelihoods (CREL) project was designed to scale up and adapt successful co-management models to conserve ecosystems and protected areas (PAs) in Bangladesh, improve governance of natural resources and biodiversity, and increase resilience to climate change through improved planning and livelihoods diversification. The Project was implemented by Winrock International with BCAS, CNRS, CODEC, NACOM, TetraTech, and WorldFish.

CREL built on USAID's past investments to strengthen natural resource management (NRM) and livelihoods under the Management of Aquatic Ecosystems through Community Husbandry (MACH) project, the Nishorgo Support Program, and the Integrated Protected Area Co-management (IPAC) project. A key difference was a focus on building resiliency to climate risks for enhanced adaptation to climate change impacts for improved livelihoods and successful management of critical ecosystems in priority regions of the country. The four components of CREL aimed to develop:
  (1) Improved governance of natural resources and biodiversity;
  (2) Enhanced knowledge and capacity of key stakeholders;
  (3) Strengthened planning and implementation of climate-resilient natural resource management and adaptation; and
  (4) Improved and diversified livelihoods that are environmentally sustainable and resilient to climate change.

CREL addressed environmental, socioeconomic and policy issues that threaten biologically sensitive areas in Bangladesh and the people who depend on these areas for their livelihoods by scaling up proven methodologies that promote conservation and improve resilience to climate change. CREL aimed to increase capacity of individuals, communities and governments to adapt to and mitigate climate change impacts.

1.5 Study Objectives and Aims

The aim of this study is to gather evidence to address gaps in EbA literature that can feed into policy and management of effective implementation of EbA measures. It does this by evaluation of a number of CREL project activities based in the coastal areas of Bangladesh. The evaluation is done in two parts. The first part consist of analysing secondary data from four CREL sites (three entirely mangrove forest sites and one coastal island site with mixed ecosystems of mangroves and intertidal mudflats), and seeing how well they aligned with and fit into EbA framework and strategy. The second part consists of primary data collection, in the form of FGDs and interviews from three of these sites and seeing how beneficiaries of the project perceived project activities and how well these fit the definition of EbA interventions. The objective of the study is to learn about:

- Quantification of the multiplicity of co-benefits (disaster risk reduction, food security, water provisioning, etc.);
- Use of EbA in the project training and other activities;
- How different groups of people are affected by different interventions (e.g. from aquaculture training);
- Opportunities and challenges in scaling up or replicating in other similar environment/areas affected by climate change.

The framework for capturing knowledge of EbA interventions was adapted from Reid and Alam (2016), Colls et al., (2009) and UNFCCC (2011) and applied in the context of the project site activities and type of ecosystem.

CHAPTER 2 METHODOLOGY

2.1 Research design

Stage 1: Desk review and Design phase
The prime focus of the evaluation was to assess the degree to which the project activities on livelihoods training and natural resource management aligned with ecosystem based adaptation measures. The preparation and design of the evaluation comprised of a detailed desk review of project documents, monitoring and evaluation and performance indicator results; and secondary literature review of previous studies using EbA, highlighting which parts of EbA (in UN framework) were addressed in these papers. We then looked at synergies between EbA, CbA and NRM. Finally we did some field visits and conducted FGDs and interviews with some of the project beneficiaries of CREL.

Stage 2: Data Collection and Analysis
The data collection started once the research tools were finalized – we did a combination of Key Informant Interviews, Focus Group Discussions (FGDs) and questionnaire survey. Key informant interviews were conducted with managers, frontline staff, government representatives and other focal points who are involved with running the programs and delivering services. These interviews lasted between 45 minutes and one hour and were recorded and transcribed for analysis.

FGDs were conducted at the following CREL sites as shown in Figure 1. FGDs were conducted with beneficiaries who were chosen by project staff. FGDs lasted 1-1.5 hours. All recordings were transcribed for further analysis. The FGD questionnaire was developed under four themes – training, climate change knowledge, natural resource management and ecosystem based adaptation. However questions were left general and open-ended to allow for free flowing discussion. The focus of the FGDs was to gauge whether CREL's training had left any impact on the livelihoods of people; any connections between people's knowledge and perceptions on ecosystems, adaptation, and associated natural resources and ecosystem services; as well as to examine if people are being affected in terms of adaptive capacity and resilience power in all four sites.

Since it was beyond the scope of this research to acquire quantitative measures of these parameters, qualitative approaches were used to develop a broad overview of connections between these parameters. This research did not seek to quantify the particular ecosystem services observed. It rather details the number and diversity of trainings and different ecosystem services used by local communities. Likewise, ecosystem resilience is not measured directly. For the purposes of this research, a broad assessment of ecosystem resilience is made, looking at whether the ecosystem selected has undergone a major shift in its structure or function, as a result of human intervention as well as climate change, which has affected its ability to provide ecosystem services. Assessments about whether the trainings provided are linked to improvement in ecosystem services are largely qualitative, and are based on local community judgement on their journey through CREL project activities.

This research also looks at what kind of climate change related impacts ecosystems are experiencing and how this affects or could potentially affect adaptive capacity. This research takes a broad definition of natural resources, in which cultivated crops and vegetables are included.

Focus Group Discussions (FGDs) were conducted with women only in all the areas except for Nijhum Dwip. Conversations and observation also formed a core component of data gathered and used. In order to illustrate the key factors, FGDs were designed specifically to gather qualitative data on specific topics broadly covering the topics relating to:

- General potential people's affiliation with CREL program, focusing on the benefits they get through training provided by CREL

- The impact of climate change and its vulnerability in that study area
- People's perceptions on natural resource managements along with their behaviors and
- Approaches to ecosystem based adaptation focusing on aquaculture.

Once the interviews, focus group discussions and surveys were completed, the data was transcribed, categorized, systematized and synthesized.

Figure 1 Field Sites: Khulna and Nijhum Dwip

2.2 Study areas

Sundarbans Reserved Forest and Ecologically Critical Area. Two sites within this area were selected and one from Hatya Upazila:

> **Mongla** Upazila (sub-district), Khulna District, is about 11 miles (18 km) upstream on the Pusur River. Mongla lies about 60 miles (100 km) north of the seaward edge of the Sundarbans. In total six focus group discussions (FGDs) were done in Mongla to determine the impact of the training provided by CREL and how aligned it is with EbA approach.

> **Koyra** Upazila, Khulna District: here the study covered Bagali Moheswaripur, Koyra, and Uttar Bedkashi Unions. Three FGDs were conducted among the beneficiaries of CREL in Koyra Upazila to look into the usefulness of the training and its future based on people's perceptions and future needs.

Nijhum Dwip: Nijhum Dwip National Park is under Haitya Upazila, Noakhali District. The main island began to form in the 1950s, and during the 1970s and 1980s the higher parts of the island silted up to about the mean high water (MHW) line (+2.2 m public works datum) (Iftekhar et al., 2006). The National Park was declared in 2001 and covers 16,345 hectares (ha) of coastal ecosystem. Waters around the islands are brackish, with a tidal rise and fall of about l-2m. Mighty Bay of Bengal in the north of the island and all the three other sides are surrounded by Meghna. The inhabited part of the National Park is Nijhum Dwip proper which is divided into two parts by a canal: Kamalarpur (northern part) and Char Oshman (southern part) where most people live (Iftekhar et al., 2006).Six FGDs were conducted with CREL beneficiaries at Nijhum Dwip to find out how beneficial the training program has been and how aligned it was with EbA interventions.

CHAPTER 3 RESULTS

3.1 Secondary Data Analysis Results

This was analyzed from CREL's meta database (CRELlink database) using the framework of different EbA strategies. Table 1 describes the ecosystem where the study takes place. The sites in the Khulna region have some common geophysical features – they are separated from the forest by rivers, highly prone to cyclone and other natural disasters, the soil type is mostly sandy loam with present of slit. The landscape is plain and agriculture is the main occupation to local community. The main natural resources of this region are rivers, sea and forest (Tables 1 and 2) and natural resources found in the locality include various types of trees - Coconut, Tal, dates, Supari, Mango trees, Jambura, Boroi, Jackfruit, Chambol, Mahogany, betel leaf farm, Guava, Neem, Chhoila, Kewra, Khaer Babla, Ghewa, Harguzi. Animals, birds and reptiles reported by villagers from their villages and forest include fox (Patishial), Khatash, monitor lizard, Cow, Goat, Buffalo, Sheep, Dog, cobra, Darash, Ghugu, Kokil, crows, Tuntuni, eagles, Dhanesh, drongos, kites, Shyama, magpie-robin, bulbuls, Chatar, Tia, and mynas. Local people are also largely dependent on the timber resources of the forest for fuelwood, house construction and logs for fishing gear. Fishing activities are undertaken in the canals of the forest.

Nijhum Dwip is an island raised on the estuary of the Meghna channel in the mouth of the Bay of Bengal. The island proper (not counting other extensive areas of the National Parkl) is about 5-4 meters high from sea level and is formed of mostly sandy-loamy soil, and lacks uplands; 10% of the area is occupied as human habitation, 30% for cultivation and the rest is forest land. The island has been declared as unique eco-touristic spot because of its rich biodiversity and the perennial mangrove forest with wild animals like Spotted Deer, Wild Boar and Rhesus Macaque and for the ideal habitat for fish resources. The geographical and physical setting of the island provides unique ecological characteristics that support ideal feeding, breeding, nursing and spawning ground for many aquatic organisms, including commercially important fisheries.

Table 2 shows the different climate change impacts, vulnerability assessments and adaptation methods employed at the various sites,

Table 1: Description of Project Field Sites

Site	Area (sq. km.)	Population	Legal Status	Dependency on natural resources (%)	Main Natural Resources	Usage of Natural Resources
Dacope-Koyra	2767	36872	Reserved Forest, ECA	85	Rivers, sea, forest (various types of trees)	Timber for fuelwood, house construction, and fishing gears, fish from canals of forest
Munshigonj	Not Known	30588	Reserved Forest, ECA, Wildlife Sanctuary (Sundarban West)	62	Rivers, sea, forest (various types of trees)	Timber for fuelwood, house construction, and fishing gears, fish from canals of forest
Nijhum Dwip	163.4	> 30000	National Park	> 70	Mangroves, national park, Meghna river	Wood for household cooking, honey, fish, recreation
Chandpai	1461	17662	Reserved Forest	>65	Rivers, sea, forest (various types of trees)	Timber for fuelwood, house construction, and fishing gears, fish from canals of forest

Table 2:Climate Change Impacts, Vulnerability Assessment and Adaptation Methods

Site	Most Important Hazards	Most Vulnerable Sectors	CC Biophysical Effect	CC Livelihood Effect	Alternative Livelihoods in need of nurturing	CREL innovations undertaken
Dacope-Koyra	Cyclone, water surge, river erosion, increased salinity, high strong tide, crisis of drinking water	Health, water and sanitation	Salinity and high drought levels	Many agricultural lands turned into shrimp and fish farms	Wild crab fattening	"Tower method" and "sack method" to reduce soil salinity and protect from flooding (allows them to continue agriculture)
Munshigonj	Cyclone, water surge, river erosion, increased salinity, high strong tide	Fish cultivation affected by salinity, cyclone, river erosion	Salinity and high drought levels	Many agricultural lands turned into shrimp and fish farms	Wild crab fattening	"Tower method" and "sack method" to reduce soil salinity and protect from flooding (allows them to continue agriculture)
Nijhum Dwip	Cyclone, salt water intrusion, Water surge	Agriculture, fishing, accommodation, health and education	Salinity, river erosion	Losses of agricultural land, diseases in cattle and poultry, unable to do fresh water fish farming	Training on handicrafts e.g. nakshikantha, bamboo made furniture, tailoring, skilled veterinary practitioner	Provided training on modern fishing technique, veterinary medicine and vegetable production in barren land beside house, saplings to the local schools and mosques. Promoted social forestry and conservation of forest through building partnership with forest dept. Opened shop for seeds.
Chandpai	Salt water intrusion, river erosion, cyclone	Agriculture, fishing, industry	Salinity, river erosion	Loss of agricultural land , lack of access to fresh water, diseases in poultry		"Tower method" and "sack method" to reduce soil salinity and protect from flooding (allows them to continue agriculture)

Table 3 shows the distribution of trainings among the 10 major training areas for each site. The Training List section of the CREL website provided the number of trainings in each area for each site, which were then totaled. The proportion of total trainings made up by each major training area was then calculated as a percentage. It was found that the majority of trainings (67%) fell in the Climate Resilient Livelihoods training area.

Table 3: Distribution of training among the 10 major training areas up to September 2017

Major Training Area/Sites	Nijhum Dwip	Dacope-Koyra	Munshigonj	Tengra-giri	Total	Total (%)
Climate Change Adaption and Mitigation	28	33	44	19	124	5
Climate Change and NRM	6	15	38	29	88	4
Climate Resilient Livelihood	71	773	807	1	1652	67
Climate Resilient Livelihood (FELC Phase 1 completed)	11	81	76	0	168	7
Climate Resilient Livelihood (LSP)	0	7	7	0	14	1
Institutional and Financial Management	4	11	11	2	28	1
NRM and Bio-diversity conservation	28	23	10	7	68	3
Total	170	1106	1145	58	2479	100

Table 4 maps the major training areas against EbA Strategies. The EbA strategies used here were sourced from the UN's Framework Convention on Climate Change's "Ecosystem-based approaches to adaptation: compilation of information" document. The strategies were broken up into three broad categories and the major training areas were assigned to the one or more categories with criteria they satisfy. For example, Climate Change Adaptation and Mitigation includes trainings which assess the vulnerability of ecosystems as well as trainings that implement ecosystem-based adaptation methods, hence it falls under both EbA strategy (a) and (c) in the table. Climate Resilient Livelihoods was found to be the only major training area to fall under all three broad strategies.

**Table 4: Mapping of major training areas against EbA strategies**

EbA Strategies sourced from UN's Framework Convention on Climate Change's "Ecosystem-based approaches to adaptation: compilation of information"	Major Training Area
(a) Assessment of vulnerability: assessment and valuation (including accumulating knowledge on bioclimatic modeling, valuing the services of ecosystems and filling information gaps with regard to ecosystem functions)	Climate Change Adaption and Mitigation; Climate Resilient Livelihood
(b) Improvements in capacity, design and policy measures, including the following: (i) Capacity-building; (ii) Awareness-raising/education; (iii) Identifying and/or developing adaptation approaches; (iv) Promoting policy change; (v) Incorporating ecosystem-based approaches into relevant strategies (including adaptation strategies and plans, national biodiversity strategies, poverty reduction strategies, disaster risk reduction strategies, sustainable land management strategies and plans such as integrated water resource management plans, forest management plans and private-sector plans);	Climate Change and NRM; Climate Resilient Livelihood; Climate Resilient Livelihood (FELC -Phase 1 completed); Climate Resilient Livelihood (FELC -Phase 2 completed); Climate Resilient Livelihood (LSP); NRM and Bio-diversity management; Institutional and Financial Management
(c) Implementation of ecosystem-based adaptation measures, including the following: (i) Pilot and demonstration schemes; (ii) Natural resource management (including sustainable management, conservation and restoration of ecosystems); (iii) Establishment of protected areas and planning for conservation networks; (iv) Diversification of livelihoods; (v) Changing management practices, for example alternative agricultural approaches and water conservation practices	Climate Change Adaption and Mitigation; Climate Change and NRM; Climate Resilient Livelihood; Climate Resilient Livelihood (FELC -Phase 1 completed); Climate Resilient Livelihood (FELC -Phase 2 completed); Climate Resilient Livelihood (LSP); NRM and Bio-diversity management,

Since Climate Resilient Livelihoods (CRL) covered the bulk of the trainings as well as the broad EbA strategies, the trainings under this major training area were further analyzed to judge their fulfillment of EbA criteria. In Table 5, the three broad EbA strategies are broken down into eight criteria and 15 types of training are identified under CREL. From this table, as well as from the PVCAs conducted at each study sites, we can see that most of the training covered EbA criteria, except in two areas - "Promoting policy change" and "Incorporating ecosystem based approaches in sustainable land management strategies". A number of Participatory Climate Vulnerability Assessments carried out in Khulna also identified adaptation approaches and how this can be incorporated in disaster risk reduction.

Table 5: CREL training measured against EbA criteria

Training Type	Capacity Building	Awareness-raising/ education	Identifying and/or developing adaptation approaches	Promoting policy change	Incorporating eco-system based approaches in national biodiversity strategies	Incorporating eco-system based approaches in poverty reduction strategies	Incorporating eco-system based approaches in disaster risk reduction strategies	Incorporating eco-system based approaches in sustainable land management strategies
Aquaculture	yes	Yes	Yes		yes	yes		yes
Agriculture	yes	Yes			yes	yes		yes
Poultry Rearing	yes	Yes			yes	yes		
Duck Rearing	yes	Yes	Yes		yes	yes		
Cow Rearing	yes	Yes			yes	yes		
Goat Rearing	yes	Yes			yes	yes		
Market Linkage	yes		Yes			yes		
Pebble Group (Handicrafts)	yes					yes		
Self Confidence Training for Women	yes		Yes	Yes				
Ecotourism for Eco Tour Guide	yes	Yes	Yes		Yes	yes		yes
Pond Side Management		Yes	Yes					yes
Business Plan Development	yes		Yes					

Figure 2 give the breakdown of each training type under CRL by gender. All the CRL trainings for each site were sorted into 8 specific categories and a miscellaneous category which included the little training that did not fit into any of the 8 categories. Majority of the participants for all trainings in all sites were found to be female. "Market Linkage" training is the only one with majority male participants in all the sites it took place in.
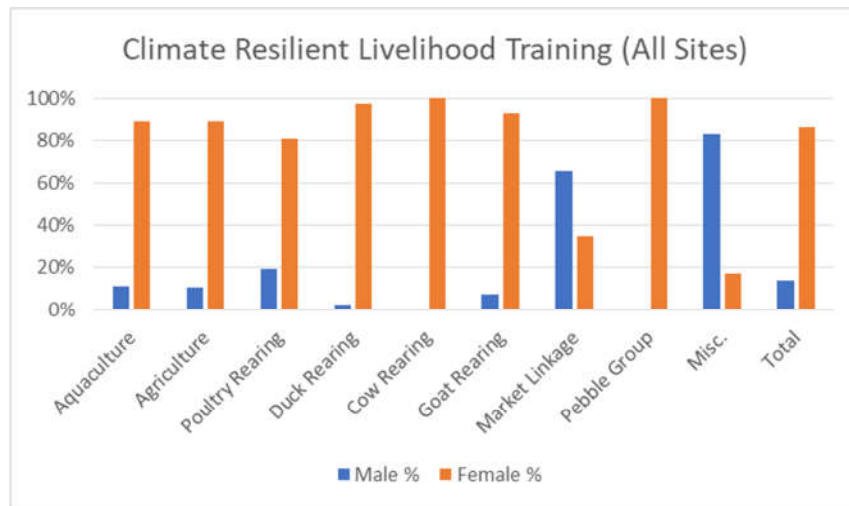
Figure 2 Different training provided under CRL categorized by gender

3.2 FGD PROGRAM IN CHANDPAI, MONGLA

FGDs conducted in Chandpai, Mongla upazila		
Upazila	**Total FGDs**	**Nature of Training**
Mongla	6	Poultry
		Aquaculture
		Mixed (Aquaculture, Poultry)

3.2.1 Training

In North Bazigor and North Kainmari villages of Mongla about 60 women aged from 26 to 45, living in these villages for more than 15 years, took part in six FGDs. According to the respondents, they have been acquainted with CREL for more than three years and under the supervision of CREL many of them have received several kinds of trainings according to individual needs. For example, in North Bazigor village salinity in soil and water is very high and it is difficult for the occupants of the village to grow any crops as well as to cultivate any fish. To grow rice seedlings people have to wait till the monsoon which dilutes salinity. As such, options were limited for them, so they were trained poultry rearing. They started rearing ducks and hens on their own, but they failed initially. Flu and other sicknesses were common amongst the chickens and ducks, and the women could not prolong the life span of their poultry for more than six months. According to the villagers sometimes the birds would die due to problems with unhygienic cages and also from the cold and being wet in the mud.

Box 1: Challenges reported by poultry farmers in Mongla before involvement with CREL	
Vaccine	"Our chickens used to die very frequently since we did not have idea about vaccination for chickens and ducks".
Feed	"We had a very common misbelief that we can feed our poultry normal food such as rice and fish bones and dry straw"
Poor Economic Returns	"Since death was very frequent, we could not sell eggs in bazar to earn extra money for our families."

The following are examples of benefits reported by CREL participants:

"For receiving the training from CREL now we are aware of different kinds of flues that poultries might get attacked by. Now we know what vaccinations need to use and for how long."

"In the poultry training of CREL we know what kind of foods will make the chickens and ducks healthy and protect them from dying. Through training we now know what percentage of dry straw has to be mixed with and how to prepare ideal food for the poultry."

"Previously we were not aware of the cleanliness of the cage where we used to keep the chickens or ducks. From the training now we have learned that it is better to keep them in a closed cage and to keep it clean so that they might not get attacked from any virus".

Besides learning and training on poultry rearing, the beneficiaries also were given training on selling their products in the market place and becoming entrepreneurs:

> *"In the past the chickens or ducks that we used to rear were not even enough for our family. Consequently, we had no option to make any extra money, but scenario has been changed after taking part in the poultry training by CREL. Now I can feed eggs to my children besides making profit".*

3.2.2 Respondents' encounters with climate change

Occupants of North Bajigor village responded that with time salinity problems in water and soil are soaring which result in degradation of soil quality and reduce agricultural productivity. Though previously people were not widely aware of the signs and consequences of climate and why it changes, they now have an idea about climate change from training provided by CREL. The villagers also now appreciate the benefits and importance of planting trees:

> *"I'm 35 now, but I did not see any salinity problem till I was 8-10 years old. But now with time I am encountering the harsh image of salinity making it difficult to grow crops or farm fishes. Fish die in the saline water and the plants don't bloom."*

Box 2 Climate change indicators and their effects	
Signs of Climate Change	**Problems encountered by the villagers due to the changing of climate**
Water level rise	"That never used to happen in this area before. Now we have water reaching up to our house doorways sometimes".
River Erosion	"Yes, that is happening too. As a result, the sides of the river banks are being lowered and our streets are becoming narrower".
Migration	Due to the very drastic change in climate in Mongla Upazila villagers are becoming unemployed. As a result, a substantial number of village people are moving to places like Dhaka, Chittagong, Barisal and Faridpur with a hope to earn money and support their family financially.

3.2.3 Perception on natural resource management

The largest mangrove forest Sundarbans is very near to North Bajigor village, and in the past, people used to visit the forest frequently in search of fish and 'Golpata'. They would make their livelihood from selling these items. Respondents said that now their visits to Sundarban have become less frequent, as now they understand that the forest maintains the overall ecology of the Khulna division. They have been taught that the forest is their *"maa" (*mother) that protects the villagers from natural casualties.

Box 3 Ecosystem- Based Adaptation In Alternate Livelihoods	
Questions	**Perceptions**
Which training do you prefer for this area?	*"We all mostly got poultry training. We can't farm fish here now anyway because of the salinity so we grow chickens. That training has been useful".*
Do you think growing chicken here is better than fish? Why?	*"Yes. If fish would survive then it would be profitable but fish farming does not work now because of the salinity".*
Do you think fish farming will become more popular in the future?	*"No it will not increase as long as there is salinity. The rise in water level is a problem for fish farming as well".*

3.2.4 Challenges

To the respondents the biggest challenge is the scarcity of sources of pure drinking water. Even though they were aware of initiatives for water collection such as pond sand filters and water storage tanks, the people who took part of the FGDs did not seem to want to take initiatives to organize such activities or suggest to their committee. Furthermore they wanted better access roads to their villages as at the moment, the roads were not developed and flooding happened often.

3.3 CREL PROGRAMME IN KOYRA UPAZILA

FGDs conducted in Koyra upazilla		
Upazilla	Total FGDs	Nature of Training
Koyra	3	Agriculture
		Fishing/Aquaculture

3.3.1 Training

All the respondents who participated in this FGDs are from the same village of Koyra and they are involved in CREL project. Majority of participants had been involved with CREL since 2013. Most of the women in this village got vegetable cultivation training. They mostly collect the vegetables seeds from government agriculture office. As part of the training, they learnt about different types of vegetables cultivation. After implementation of their training, they claim that now they are getting good quality of vegetables. Specifically, from CREL training, they learnt:
- Techniques of applying organic fertilizers
- Selection of good seeds

Previously, they grew local seeds, but after training they planted hybrid seeds that they collected from agriculture office and as a result, they get substantial yield from these seeds. They also learnt about how to go about buying the seeds, as well as advice and assistance from the sub-assistant agricultural officer who helped them to learn the names of different types of seeds and where to buy them in Mongla.

Apart from training on agriculture, few respondents have received training on aquaculture from CREL. In this training they have acquired knowledge on:
- Higher yielding strains of fish,
- breeding time,
- time to feed.

There are few other topics that the participants learned from the training provided from CREL:
- Climate change Adaptation

- Necessity of avoiding cutting trees from forest
- Establishment of hygienic latrine and its importance.

According to the respondents, "hybrid fish farming" (actually use of selectively bred strains of cultured fish) is very common in Koyra. Knowledge that the occupants have acquired through trainings includes how to identify what fish can coexist in the same ecosystem and would be good for aquaculture. For example, they learnt that Tilapia fish roe is good for mixing with fresh water prawn in pond aquaculture. They learnt that 'Rui' cannot be kept in same ecosystem as Golda and Bagda.

"There was a time when Tilapia fish's size was small but now hybrid fishes are big in size. The officer taught us that always notice on the movement of the fish roes. Roes that move much are good kind and roes that do not move much are less useful".

Whilst this is not directly related to ecosystem based adaptation, learning about the fish biology and pond ecology adds to knowledge generation around ecosystem management,

> **Box 4 Cultivating crops and fish in the same land**
> "Before freeing the fish roes in pond, the initial stage is pond irrigation so that the larger fish are taken out. It is necessary to cut out larger size fish for hybrid fishing cultivation since large fish eat the small fish. In winter season we have to remove and clean the ponds and the sides, so we can stock up the roes. Maintaining of time is very important in such dual cultivation. Firstly, we maintain the feeding and monitor cultivated vegetables. Secondly, we put the seeds in water then we put them in poly".

3.3.2 Natural Resource Management

Forest Conservation: *"Due to CREL project we have been able to understand the necessity and importance of protecting Sundarban. CREL has taught us that Sundarban rescues us from natural calamities like cyclones and floods. So we have to stop cutting down trees in Sundarban."*

Increase in local production: *"Before getting the training we were not able to sell any goods instead we had to buy them from local bazaar. Now after the training we have been able to grow more than before".*

Improvement in Livelihood: *Because of CREL we have learned how to cultivate fish and vegetables together in the same land. Without the training provided by CREL we would not able to learn the techniques. CREL has helped us in improving our lifestyle. Now we are making profit by selling goods and with the extra amount we are providing education to our children's".*

Crab cultivation and selling: *"Once we used to enter in Sundarban illegally. After CREL came, we learned about having ID card and getting permission legally from government. We collect crab from Sundarban and some villagers also cultivate the crabs caught from Sundarban in their own land but the number is not very high. Monthly we can sell crabs for 700-1000 taka per Kg".*

3.3.3 Challenges

Comparing to the respondents of Mongla, in Koyra the occupants are better acquainted with aquaculture, which they have learned from the CREL training. But there are some limitations and challenges faced which hampers successful implementation post training. According to respondents -
   a. Very few people opt this as their livelihood as it is very expensive to start up.
   b. The ways to increase the business are limited due to land shortage.

    c. They believe if they got further knowledge on aquaculture technology, then could have a prospering business in aquaculture.

    d. Overall, respondents believe the training should be more in-depth and have advanced levels.

3.4 CREL PROGRAMME IN NIJHUM DWIP

FGDs conducted in Nijhum Dwip		
Upazilla	**Total FGDs**	**Nature of Training**
Nijhum Dwip	6	Fish- Farming, Poultry, Environmental/ how to stay safe during natural calamities
		Agriculture and environmental
		Agriculture and Poultry mixed

3.4.1 Training

Nijhum Dwip is a small island under Hatiya Upazila which is situated in Noakhali District. Nijhum Dwip has 10 to 12 villages among which CREL is providing training to 6 to 7 villages. Uporbazaar, Agomoni, Muktijoddha bazaar, Dubairkhal, Shotoful are the villages where the FGDs had been done. Most of the respondents of the FGDs were male. All the respondents who took part in the FGDs mentioned that they are acquainted with CREL from last 3 to 4 years. In these time period, they have received training on poultry and rearing of livestock, mainly chickens and ducks. Besides, poultry training, few got training on agriculture while others got training on aquaculture.

The occupants of Nijhum Dwip who have received training from CREL claimed that because of the training their knowledge has increased and that impacted on their livelihood making them smoother than before. "*CREL has trained us with a complete knowledge about how trees provide us with oxygen and why it is very important for us*" stated one of the respondents. From the FGDs it has been brought up that now the villagers can measure and understand the sign of natural calamities and through CREL they have learned about some dos and don'ts during natural casualties. In the recent years they have gained knowledge about climate change and now they can feel and detect the effects occurring due to climate change.

Box 5 Perceptions of the People from FGDs: How much CREL Training helped you professionally?	
Groups	**Quotes**
FGD 1	*"Being a village policeman, government provides us minimum allowance and the villagers treat us with respect in society. Since we do not have to perform 24 hours of duty, we spend our free time in getting training from CREL. From the aquaculture training we are now able to cultivate fish in our pond collectively. Consequently we are able to earn an extra income now".*
FGD 2	*"The training has helped us to find a new source of extra income with which we are capable to reinvest in something else or save money for future for example getting our children married off."*
FGD 3	*"The training has helped us to find a new source of extra income with which we are able to reinvest in something else or save money for future".*

Box 5 Perceptions of the People from FGDs: How much CREL Training helped you professionally?	
Groups	**Quotes**
FGD 4	*"Even a couple of years ago women only used to cook food and stay home. They had no scope to get involved in productive tasks. But with the advent of CREL training, now women also work in their yard or outside of their home in planting of vegetables and taking care of chickens, ducks, and cows. The trainings have helped us to find a new source of extra income. We are able to send our children to school properly now to gather knowledge".*
FGD 5	*"The trainings have helped us to find a new source of extra income".*
FGD 6	*"The trainings have helped us to find a new source of extra income. Our lives were miserable before as most of us here at Nijhum Dwip are uneducated and we didn't know what could improve our lives so now after training we are earning enough for a better living".*

3.4.2 Climate Change Impacts

The most frequent or regular climatic problems in Nijhum Dwip are:
- ➢ Tidal bores
- ➢ Increase of salinity
- ➢ Unexpected heavy rainfall
- ➢ River bank erosion
- ➢ Cyclones
- ➢ Storms

"Tidal bore takes place due to climatic changes and enters our residence. Then again when salinity increases or river erosion takes place we face difficulties in fishing. Then it becomes quite difficult for us to earn a living. The extra income that we used to get despite of our professional jobs that seems to pause".

According to the villagers, tidal bores are a very frequent natural calamity that happens in this island. The above mentioned climatic events are causing a great amount of loss and damage for the inhabitants of Nijhum Dwip. A few respondents informed that they lost their family members, including children during these events. In this context, we believe that if calculated the value of economic loss and damage due to natural disasters would be a high amount. Moreover, there is other evidence of non-economic loss and damage. We found a few families who migrated from Hatiya to Nijhum Dwip and they changed their profession as well. Before they used to do farming, but now they are working as day laborer in big cities.

People living in Nijhum Dwip mostly migrated from Hatiya and almost all of them are the victims of river erosion. After losing their homes and land there, they shifted to this island at the very beginning of the formation of this island. But now this island is highly vulnerable due to intense natural hazards and people are migrating to the nearest small cities, or from one island to another, or in the case of some extremely poor people to big cities for livelihood diversification.

3.4.3 Natural Resource Management

People are more aware now about the fact that planting trees can help villagers attain shelter and protection from several natural calamities. The dwellers now have stopped cutting down trees and are very much dependent on forest resources. They realize that during floods or storms, they get buffer from the trees and this helps the island to survive. Currently planting trees works as a symbol of motivation to the villagers.

"Before we were dependent on forest because we did not have enough knowledge about the importance of trees for us. We did not have any source of income so we used to cut trees to sell the woods in the market. But now that we are aware of our mother nature we are no more dependent on cutting trees. We try our best to preserve it".

One problem that the villagers cannot ignore or adapt to is heavy rainfall. When it rains heavily they became unable to save their crops from being destroyed which brings a great loss for them financially. CREL's initiative of working together with Forest Department through social forestry helps to create a massive change among the dwellers. The beneficiaries who are involved in this program are now earning a little money as well by protecting forest from illegal loggers.

Box 6 Training, perception and key lessons learned	
Types of fishes/ crops respondents cultivate	Livestock: chickens, hens, cows Aquaculture: Rui, Kalibaush, other fish that are available Growing Seasonal vegetables
Changes in livelihood to adapt to the impacts of Climate Change through Training	
Perceptions	*"We are very much aware about sea and ocean from before so we have a good idea about how big the tidal bore is going to be. Sometimes we don't have enough money so we take help from the rich people. So even if the problem arises we somehow manage to find solution and adapt to the situation".* *"Yes training and change in livelihoods helped to adapt to these impacts of Climate Change".* *"CREL training has helped us to know about adaptation based on climate change".*
Key lessons learned through CREL Training	
Lessons	Climate change will continue to take place, even if it does so slowly Planting of more trees is needed Disseminating the knowledge gained through CREL training among others is necessary How to feed our livestock so that we can keep them healthy Spreading awareness on climate change Vegetable harvesting Taking care of animals How to utilize the money earned through farming and vegetable cultivation Look for alternate ways to earn extra income. Training on what to do during lightning and thunder What to feed the fishes and livestock and how to take care while they fall sick.

3.4.4. Challenges

Though with the help of CREL trainings the occupants of Nijhum Dwip were able to mitigate many of their problems and now are capable of earning a substantial amount of money, they still think that CREL should give emphasis on some certain points and improve their overall training for future agendas. The dwellers of Nijhum Dwip have discussed about some challenges that they faced after getting the training. Those include:

- **Financial Assistance:** The trainees claimed that it would be beneficial for them, if CREL could provide financial assistance after the training or before the training for business ventures. For them to carry on and use the knowledge gained from the training, they had to borrow money for starting of either fish farm/ harvesting/ poultry farm.
- **Infrastructural support:** Though CREL worked in the field of improving livelihood, villagers felt that logistical support for setting up a school/health center is also needed.

- **Selection of attendees:** During conducting FGDs some of the respondents informed about the biased selection process of getting chance to attend the training at Chittagong. The same person always got the chance for having different training and even after coming back they didn't share the information with the other beneficiaries.
- **Social norms**: Getting more women was a notable limitation for conducting the FGDs. In the family level, inhabitants of Nijhum Dwip strongly follow the social norms of religion due to lack of higher education (even secondary level), awareness, and poor access to resources/ information. There are strong social/family restrictions, e.g. women cannot go in front of any men who are unknown to them. This is why in some FGDs they failed to bring women. We also faced this problem during household surveys as well and the women used to hide inside the house or talked through veiled curtain. In some areas, this worked as a barrier to involving more women in CREL project activities.

## 3.5 Response from Stakeholders not in CREL Project

Our team (seven interviewers/students from ULAB) conducted 120 interviews with non-beneficiaries from eight villages located in these four coastal CREL project sites. Semi-structured questionnaires with open and close ended questions captured households' socio-economic status, level of education, access to land, means of employment and their knowledge and perception of climate change impacts as well as opportunities and challenges of implementing ecosystem based adaptation in aquaculture.

Due to extreme remoteness and lack of accommodation in the study sites, respondents were recruited opportunistically while walking through the villages and visiting tea stalls and shops. Collected data was analyzed through descriptive and inferential statistics. Mentioned by almost all interviewees (86%), salinity intrusion was seen as by far the most crucial issue in deleterious coastal environmental change (Table 6). This echoes with what CREL beneficiaries also mentioned as one of the biggest problems faced.

Table 6 Perceived environmental issues in the study area in south-west coastal Bangladesh

Deleterious Environmental Changes	Responses (120 respondents)	% reporting
Salinity	103	85.8
River Erosion	61	50.8
Water Logging	43	35.8
Extreme weather (i.e. more frequent cyclones)	34	28.3
Weather patterns (amount/ seasonality of rain)	29	24.2
Temperature changes	23	19.2

Adaptation to climate change is particularly urgent for those most dependent on the natural resources subject to change, i.e. the poorest rural coastal residents who have less access to other jobs and income sources. However in our study area, aquaculture was not really being practiced by several of the non CREL beneficiaries. Their reasons for not doing so are shown in Figure 3.
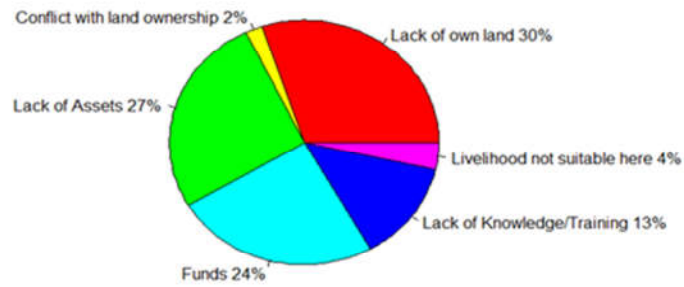
Figure 3 Reasons given for not cultivating fish (% of 120 respondents)

Lack of own land and lack of assets were mentioned by 30% and 27% respectively and this was also echoed by CREL beneficiaries on their limitations on implementing adaptation measures and alternate livelihoods. Furthermore non-CREL beneficiaries were under the impression that the only work NGOs do in these regions is on micro-credit programs and they do not provide long term benefits to communities.

4.1 Assessment of findings

According to report by UNFCC (2011) case studies from different parts of the world highlighted some key lessons that will lead to successful implementation of EbA (UNFCC, 2011). Some of these include involving local communities, reducing non-climate threats, building upon existing good practices in natural resource management and integrating EbA with wider adaptation strategies. We look at some of these lessons in the context of findings from this study:

- Reducing non-climate threats – As the project was focused around natural resource management, factors such as sustainable harvest, minimizing environmental impact, protection of forests and wildlife were very much part of the activities.
- Involving local communities – There was a strong element of building local leadership and creation of co-management bodies that include communities as well as CBOs as seen from project documents. However at the FGD level, beneficiaries stated that some were selected through connections to local leaders and there was selection bias and lack of participatory approach in involving local communities.
- Multi-partner strategy development – This was apparent in the project design where there were synergies arising from collaboration between local communities, conservationists, natural resource managers, and development practitioners. Initially there was a lot of resistance and challenges when trying to form partnerships with government bodies, but this too was resolved and there is now a working partnership between local communities and government (e.g. Forest Department).
- Building upon existing good practices in natural resource management – As CREL project was a follow on from Nishorgo and IPAC, this element was already there. There was application of an ecosystem approach for the integrated management of resources and this is very appropriate to the implementation of Ecosystem-based Adaptation
- Adopting adaptive management approaches - We found this to be lacking in some areas of the project, where certain problems were not addressed and the project implementation was not altered to adapt to these issues. One example would the greater focus on training women whereas men are struggling with income generation, and this caused discord amongst beneficiaries. Also in some areas, freshwater shortage was the biggest crisis but as this was not implemented in all the CREL sites, it could not be integrated into the specific villages where FGDs took place. Even though there were some pond renovation and pond sand filter done in a few places, there were challenges with construction and multiple demand on limited resources. There were also issues for the new CMC formed in Nijhum Dwip compared to older CMCs in other sites. But the co-management context is not a focal point in this study,
- Integrating Ecosystem-based Adaptation with wider adaptation strategies – This was evident in the study in some areas e.g. integrating NRM with livelihoods, but in other areas e.g. lack of integrating solutions for access to freshwater, with adaptation strategies on alternate income generation.
- Communicating and educating – Successful Ecosystem-based Adaptation depends on knowledge transfer, capacity building, integrating science and local knowledge and raising awareness about climate change impacts and the benefits and potential of sound ecosystem management. This was very much evident in the project that beneficiaries had received training on climate change impacts as well as disaster risk reduction.

The findings from this study show that several of these factors are prevalent in CREL activities but there are other factors that need to be taken into consideration for successful implementation of EbA in rural areas of Bangladesh. Limitations to adopting EbA strategies as seen in this study include: lack of land, assets and finances to invest in adaptation strategies, land use conflict and community opposition. There were also knowledge gaps on innovations and technologies that can be used in

adaptation, and finally communities showed dependency on donor agencies and NGOs to do the work for them.

It was possible to achieve two out of the four objectives in this study - use of EbA in project training and other activities was assessed, as well as improved understanding of how different groups of people are affected by different interventions (e.g. from aquaculture training). It was more difficult to quantify multiplicity of co-benefits (disaster risk reduction, food security, water provisioning) due to the limited scope and budget of this study. Further data would have to be collected on the different benefits from project outputs to be able to quantify whether these co-benefits have been achieved. Overall, some of the successful interventions and learning here can be scaled up and replicated in other similar environment/areas affected by climate change. Below we give some recommendations for further research and suggested improvement for future designing of development projects.

4.2 Recommendations

The six year CREL project learned a great deal from experience and was also able to draw on the long years of experience already accumulated from earlier projects Nishorgo and IPAC. Still, many issues require a more in-depth exploration and research to truly understand their implications in terms of piloting and upscaling ecosystem based adaptation practices in Bangladesh.

Some of these issues are:

- What are the challenges and opportunities for these to become self-driven sustainable entities?
- How can projects develop data-based evidence briefs to drive policy e.g. on informal markets, innovative infrastructure, land rights?
- What are global innovations in terms of information and communications technology tools for agile management and training?
- What digital apps can be used to reach and serve farmers and entrepreneurs?
- Which other NGO programmes are working on ecosystem based adaptation and natural resource management? Can there be a sharing of training tools rather than reinvention of the wheel?
- How can national and international NGOs collaborate with universities to carry out research on market value chains, climate change adaptation and other ways to synchronize conservation and development?

From our study we identified to following key issues that need to be addressed when designing future projects in remote areas of Bangladesh where a majority of people are poor and have limited resources:

- Addressing social and political issues e.g. land rights, power struggle, weak local governance.

- Focusing on transformation to sustainability, and enabling innovation in design and adaptation mechanisms.

- Social energy for collaborative ecosystem-based aquaculture and agriculture development with the poor.

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ANNEX 1 – Field Notes and Pictures

FGD in Koyra

District : Khulna
Upazila: Koyra
Village : 6 no Kheya Ghat, Koyra
People who have participated in this FGD all were from Koyra and they are related to CREL project . Most of the participants joined in CREL from 2013 till now . When we asked them what are the massive changes they have seen after CREL coming , they said, how to fishing , how to cultivate , which is an appropriate way to enter into the forest and which is not .Knowledge about CC these all are described by CREL .

CREL Training

Participants receive various kinds of training from CREL,
1. How adapt to climate change
2. How we can get safe drinking water
3. Avoid cutting trees from forest
4. Training on fishing
5. Hygiene Latrine making and its important everything were described through CREL project

Natural Resource Management

Dependency over forest has decreased last 4 or 5 years hugely. To make it happen CREL played a vital role . People in Koyra now are more concentrating on agriculture and fish cultivation. Even they are now much aware if they go into the forest in terms of biodiversity conservation and better management of forest .

Connection with Climate Change

In the question of CC, they said mostly temperatures are increasing , salinity , flood , river erosion , frequent storms and cyclones are main consequences of CC .

Ecosystem based adaptation to CC with focus on aquaculture and agriculture

Rivers are the most important sources of their live hood . Amount of salinity in the water has increased is quite shocking . Due to more salinity in the water , natural resources like fish , crab and other beneficial animals are vanishing from the river. CREL trying to give people a proper knowledge to use brackish water. Beside of that , floating garden , duck rearing , cage aquaculture these also trained through CREL .

FGDs in Mongla

District :Bagharhat
Upazila: Mongla
Village : West Alomguniya
People who have participated in this FGD all were from West Alomguniya and they are related to CREL project . After coming touch of CREL ,villagers saw a massive change in the village ,greatly in infrastructure.

CREL Training

Participants receive various kinds of training from CREL,
1. How adapt to climate change
2. How should we behave with the animals while we are in the forest
3. Not to cut trees
4. How we can grow more crops
5. As Salinity increasing in land and water, by using brackish water how we can cultivate fish and shrimp
6. Hygiene Latrine making and its important everything were described through CREL project
CREL training benefited us in many ways, like now we are incoming more money , saving our times and fund while we are cultivating fish and vegetables. Because CREL taught us proper cultivation process, how much fertilizer to be used and land preparing etc.

Moreover, through these years of relation with CREL, we never felt it was a challenge, the way CREL 's people treated us and their friendly approach made us a big CREL family.

Natural Resource Management

Dependency over forest has decreased last 5 years dramatically. To make it happen CREL played a vital role . People in Alomguniya now are more concentrating on agriculture and fish cultivation. Even they are now much aware if they go into the forest in terms of biodiversity conservation and better management of forest .

Connection with Climate Change

Actually , we are facing some big problems because of climate change . like salinity , flood , River Erosion , drought , High temperature during summer etc . Due to salinity in land we cannot cultivate more crops so that only shrimp and crab cultivation are going , but these are not making more job opportunity for us some people moving to Dhaka for earning . Though CREL giving us training for adapting to climate change , now situation slightly changed .

Ecosystem based adaptation to CC with focus on aquaculture and agriculture

Honestly saying we did not have any idea before CREL that aquaculture could be such important for us Day by day we are missing fishes and any other aqua resources in rivers so that income came very low CREL gave us training and instruction to how we can utilize brackish water and which fishes are suitable for this type of water, required medicines to have more fishes these all we got from CREL.