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Sustainability of Climate Change Adaptation Practices in South-Western Coastal Area of Bangladesh

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Abstract

In Bangladesh, South Western (SW) coastal area is the most vulnerable due to its geo-morphological characteristics and socio-economic conditions. Consequently, this study aims at find out the sustainable adaptation practices to climate change impacts through a series of field study along with questionnaire survey and reviewing the secondary literature. The study shows that near about 50 adaptation practices are exercised in SW coastal area of Bangladesh. Among these, growing local rice variety, rainwater harvesting, directly use of pond water through proper pond management, raising plinth, lowering use roof etc. are the more sustainable adaptation practices. On the other hand, homestead gardening, dyke nursery, cropping on raised mound, school cum cyclone shelter, purification of pond water trough traditional knowledge are the moderately popular and sustainable adaptation practices in terms of social, economic and environmental aspects. Furthermore, shrimp cultivation at homestead, fish-vegetables combined cultivation, purification of pond water through govt. supported filter, pond filter, bamboo made piling house etc. are the less sustainable one.

Keywords: climate change adaptation, Bangladesh, coastal areas, sustainability

1. Introduction

Global climate change has been one of the most talked about issues in recent times. Climate scientists declare that climate change is happening and is the biggest threat ever faced by the humanity (IPCC, 2007; Met Office, 2011). With this regard, Bangladesh is one of the most vulnerable countries to climate change due to a number of hydrological, geological and socio-economic factors. Furthermore, increased and longer periods of floods and erosion in monsoon, and rising sea level, increased drought due to reduced rainfall in winter and cyclones and tropical storms accelerate this situation (Chowdhury, 2011).

Through a careful multi-criteria analysis it was found that the South-Western coastal region of the country is the most vulnerable area to climate change impacts (BCAS-RA-Approtech, 1994). The future prediction shows that an increase in monsoon rainfall would increase flood vulnerability of the region. On the other hand, in dry-season, low and diminishing rainfall would enhance possibility for increasing drought vulnerability and salinity ingress along the coastal river systems (Alam et al., 1998; Ahmed et al., 1998a). Simultaneously, inundation of low-lying unprotected coastal areas, due to a combined effect of gradual subsidence and a rise in sea level, would enhance the possibility for saline water-logging throughout the southwestern region. World Bank (2000) reported that the above mentioned changes would have severe adverse impacts on coastal resources, water resources, agriculture, human health and biodiversity, with special reference to the south western region of Bangladesh.

As response to adverse effects of climate change, Bangladesh could consider both mitigation and adaptation which were highlighted in the UNFCCC. However, the country's greenhouse gases emission being very negligible compared to other developed countries, it was rather obvious that there had been increasing emphasis on adaptation. Moreover, the Bangladeshi has been widely known for their strong social will and mental strength for coping with climate-related extreme events. That is why, for a nation known for their fighting abilities, adapting to climate change has been a natural choice (Ahmed, 2010). Since climate change cannot be totally avoided and can more than exist, consequently, climate change adaptation brings immediate benefits and

opportunities foster the local community to go for adaptation practices in Bangladesh (Burton, 1996).

Following the signing of the UNFCCC, concerned research communities had begun to emphasize on adaptive responses, particularly on anticipatory and planned adaptation (Abramovitz et al., 2002; Adger, 2001). In view of growing needs for adaptation and people's strong willingness to respond to climate related hazards, the first ever project titled 'Reducing Vulnerability to Climate Change (RVCC)' was designed in 2002 and implemented until the beginning of 2005.

Within its limited resources, Government of Bangladesh has responded to the climate change problems conspicuously. Over the couple of years, both nationally and internationally, Bangladesh has been identified as one of the pioneers who started mainstreaming climate change into broader governance spectrum. Evidently, Bangladesh prepared National Adaptation Programme of Action (NAPA) in 2005; and subsequently in 2009 the country formulated most comprehensive climate action guidelines named Bangladesh Climate Change Strategy and Action Plan (BCCSAP). To operationalize the BCCSAP, Bangladesh has formed 'Climate Change Trust Fund (CCTF)' with its own resources. All the actions taken in response to climate change clearly signify the country's commitment to reduce vulnerability and secure the livelihood of its large population base. In addition to all of these, Media campaign (radio, TV, print media, round table discussion), setting up eco-clubs (village level clubs, sharing and learning sessions by experts, drama, cultural function), school program (a complete school curriculum on climate change, student initiatives, teacher's initiatives), folk media (*Pot* song, drama, *Baul* song), information collection and dissemination (booklets, paper clippings, monthly news letter, climate change cell, library), voice raising at grassroots level (credit group formation, water (*pani)* committee, posters) etc. are some activities for awareness raising about climate change adaptation in south western coastal area of Bangladesh (Ahmed, 2010).

1.1 Objectives of the Study

Overall objective of the study is to search the sustainability of existing adaptation practices to climate change in South-Western (SW) coastal area of Bangladesh.

Specific objectives of the study are:

1) To list down the existing adaptation practices to climate change in South-Western coastal area of Bangladesh.

2) To search the sustainable adaptation practices of climate change in SW coastal area of Bangladesh.

2. Concept of Adaptation

The tern adaptation comes from the word 'adapt meaning that making the current situations through altering the original one to more suitable. In other words, 'adaptation' can be defined as the process of adapting and the situations of being adjusted (Smit et al. 2000). Simply, climate change adaptation is denoted as the process of all adjustments in behavior or economic structure, including its short term and long term effects, by which the vulnerable people adaptation to climate change is the process through which people cut the adverse effects of climate change both on the human health and social welfare, and hence take the maximum opportunities that the ambient environment provides (Smit, 1993, Smit et al., 1996, Burton, 1992; Burton, 1997). IPCC (2007) defined adaptation as 'adjustment in natural or built environment in response to observed and predicted climatic stimuli or their negative effects, which moderates harm or exploits all the useful opportunities. Adaptation can be broadly categorized as anticipatory, autonomous and planned adaptation (Watson et al., 1996).

2.1 Concept of Sustainability

Ecologically, the term sustainability is defined as a system which can survive or persist (Costanza and Patten, *1995*). On the other hand, biologically, this refers to the avoidance of extinction, and living for the survival and reproduction. Economic point of view, it refers to avoiding major disruptions and collapses, hedging against instabilities and discontinuities. Simply, sustainability, at its base, is always concerns temporality, and, in particular, longevity. More formally, this aspect of sustainability can be thought of in terms of the system and it's component part's longevity (Costanza & Patten *1995*).

Table 1. Indicators of sustainability

Sustainability indicators	**Source**
-Social security system -Equal opportunities -Enabling of social innovation and work type construction -Safeguarding the basis for satisfying material needs -Full employment, social security, fair distribution of burdens between generations	Hans-Boeckler-Foundation 2001
-Basic supply -Independent security -Equal opportunities -Social resources	Jörissen et al. 1999
-Participation -Cultural diversity	Empacher and Wehling, 1999
Health, Social security, Social Integration, Gender equity, Justice	Littig, 2001
Environmental, economic, social and institutional	UNCSD, 2001
Social and policy relevance (economic viability, social structure, etc.). Analytical soundness and measurability. Suitable for different scales Encompass ecosystem processes and relate to process oriented modelling. Sensitive to variations in management and climate. Accessibility	Nambiar et al., 2001
Effectiveness, efficiency, equity and legitimacy	Adger, et al., 2005
Central concerns about sustainability—economic, social and environmental dimensions	Beg, et al., 2002

Table 2. Objectivity criteria of sustainability indicators

Indicators should	**Source**
Be accurate and bias free	UNCCD, 1994; Breckenridge et al, 1995
Be liable and consistent over space and time	Breckenridge et al, 1995; Abbot and Guijt, 1997; Rubio and Bochet, 1998
Assess trends over time	UNCCD, 1994; Breckenridge et al, 1995; Rubio and Bochet, 1998; UK Government, 1999
Provide early warning of detrimental change	Breckenridge et al, 1995; Rubio and Bochet, 1998; Zhen and Routray, 2003
Be representative of system variability	Breckenridge et al, 1995, Krugmann, 1996; UK Government, 1999
Provide timely information	UNCCD, 1994; Breckenridge et al, 1995; Abbot and Guijt, 1997
Be verifiable and replicable	UNCCD, 1994; Abbot and Guijt, 1997
Be scientifically robust and credible	Rubio and Bochet, 1998, UK Government, 1999
Be relevant to the local system/environment	Mitchell et al., 1995
Sensitive to system stresses or the changes it is meant to indicate	UK Government, 1999 and Zhen and Routray, 2003
Have a target level, baseline or threshold against which to measure them	UK Government, 1999 and Zhen and Routray, 2003

2.2 Frameworks on Sustainability

2.2.1 The Triple Bottom Line

The scientists and practitioners of "the triple bottom line" believe that sustainability decisions made not only on the basis of economic benefits but also on environmental protection and social equality. The three elements of the triple bottom lines economic, environmental and socials can be combined. Eco-efficiency refers to the optimizing economic and environmental goals whereas fair trade refers to economic activities conducted with particular attention to social consequences. On the other hand, environmental justice refers to social equity with respect to environmental protection (Elkington, 1998). However, a group of scientists opined that this 'The Triple Bottom Line' framework lack of a solid scientific foundation.

2.2.2 The Natural Step

The Natural Step defines a 'sustainable society' in different ways. Firstly, the nature is not capable to systematically increase the resources derived from the earth system. Secondly, natural environment is not subject to rise the concentrations of resources produced by the society. Thirdly, nature is susceptible to unchecked anthropogenic degradation due to meet the basic needs of human being (Nattrass & Altomare, 1999). In recent era, several current practices are unsustainable. Some examples include the increased combustion of fossil fuels which increases concentrations of atmospheric carbon dioxide; unregulated emissions of persistent organic and inorganic chemicals; radical change of forestland and water bodies; and a rapid growth of population.

2.2.3 The Ecological Footprint

The Ecological Footprint (EF) compares the environmental impact of specific actions to the limited earth's natural resources and the functions of ecosystem. The EF calculates a ratio of "how many earths" would be required to provide enough biologically productive land area to maintain the flows of resources and wastes in a sustainable manner, if everyone lived like a specific person or group of people (Wackernagel & Rees, 1996). The EF has been implemented across a wide range of units of analysis, including a consumer product (e.g., a personal computer, washing detergent); an individual company; an economic sector; specific regions and nations; and the entire earth system (Frey et al., 2000). Urban economists around the world have used the EF to evaluate the environmental impacts of commuting in Barcelona, Spain, as a function of transportation technology and residents' locations (Muniz & Galindo, 2001).

2.2.4 Graedel and Klee's Sustainable Emissions and Resource Usage

Graedel and Klee (Graedel and Klee, 2002) proposed a four-step process for measuring the sustainability in terms of natural resource use. These are: (i) calculation of the availability and supply chain of materials; (ii) allocation of consumption of this supply over a specific time scale and population; (iii) accounting for the recycling and for existing stockpiles including landfills; and (iv) consideration of this rate to be the maximum sustainable consumption rate and compare it to the current usage rate.

2.3 The Need for Adaptation Indicators

There is unequivocal evidence that climate change is happening and its' adverse impacts are experiencing by the global communities including Bangladesh. These impacts are expected to become more severe as changes in climate variability and weather extremes in the near future. A major challenge for policy makers at different scales of governance is to understand how, where and in what form of the projected impacts of climate change will occur. This task is complicated by a number of factors, not least being that the relationship between changes in climatic variables (e.g. changes in precipitation), impacts (e.g. increased flooding) and system response (e.g. adaptive capacity) is far from clear (Harley et al., 2008). There is therefore a need for all countries, developed and developing, to adapt to climate change. Adaptation offers an ample of opportunities to build resilience to climate change. Adaptation indicators are so useful for evaluating adaptation funding and policy interventions, future policy development, and disseminating adaptation techniques to the general public. All of these acts a substantial input for the politicians for the global climate change negotiations.

There is also a growing demand from the different stakeholders to share information on good climate change adaptation practices and hence to measure the progress and effectiveness of resource commitments (e.g. assessment and monitoring of long-term investments in infrastructure to accommodate the growing risks of weather and climate extremes). A further role for indicators is, therefore, as a communications tool to raise awareness in the policy community and among practitioners. For this reason, indicators should be as transparent as possible (Harley et al., 2008).

Adaptation indicators can be divided into two groups. These are *Process Based Indicators* and *Outcome Based Indicators.* A *process-based* approach can be defined as the key stages required in a process that would pint the best choice for the end point. In simple words, this is 'upstream' process that provides the enhanced capacity to handle a wide range of outcomes. Relevant indicators used in this process are needed to inform and justify the decisions taken and to contribute substantially to the policymakers to go ahead more strategically and proactively. On the other hand, an *outcome-based* approach can be defined as an explicit outcome of the adaptation practice i.e. improved drainage facility to cope with the excessive rainfall events. In other words, it also is called as 'downstream' approach that emphasize on the effectiveness of adaptation policies and legislation for a long run considering the future climate (Harley et al., 2008).

3. Methodology

3.1 Description of the Study Area

The southwest coastal region of Bangladesh (Figure 1) is under the scope of this study. The southwest coastal region of Bangladesh is an active part of Ganges Delta formed by alluvial soil carried in by the upstream flows. Most of the parts of this region (about 70% of the total landmass) are coastal wetlands by nature that are connected with many estuarine rivers of the Bay of Bengal. The region is protected from tidal surge by the Sundarbans mangrove forest. Cyclones, tidal surges, foods, repeated water-logging and land subsidence are common in this part of Bangladesh, shaping the live and livelihood patterns of the people living in the area. The southwest coastal region has been identified as one of the parts of the world most vulnerable to the effects of a rise in sea level caused by climate change.

3.2 Sampling Procedure

Among the six districts of South-Western coastal area, Khulna was selected purposively for this study. From Khulna district 2 Upazilas namely Koyra and Paikgacha were selected through simple random sampling. Koyra sadar, Amadi and Chandkhali union were selected from these Upazilas randomly. From these unions, five villages namely Koyra 5 no., Nonadighir par, Naksa, Harinager and Chandkhali were also selected following simple random sampling. Finally, a total of 100 households were selected randomly for this study. This overall sampling design follows the multi-stage sampling.

3.3 Data Collection

Both primary and secondary data were collected to conduct this study. During the field visit, Key Informant Interview (KII) and three focus group discussions (FGDs) were conducted at Koyra 5 no., Harinagar and Nana Dighir par (Munda community) with the members of the local forest people's associations coordinated by Unnayan Onneshan-The Innovators. In addition to this, open discussion was also made on the climate change adaptation in this area. A structured questionnaire containing social, economic and environmental aspect of existing adaptation practices was used to collect data.

3.4 Method of Calculating Sustainability of Climate Change Adaptation

There are three Multi Criteria Decision Making (MCDM) methodologies that could be used in criteria and indicators (C&I) assessment: (1) pairwise comparisons; 2) ranking and (3) rating. In a nutshell, the pairwise comparisons approach distills the complex C&I decision problem into a series of one-on-one judgment on the significance of each pair of indicator relative to one criterion. Ranking, on the other hand, is different from the pairwise comparison method in those C&I elements are not compared one-on-one. Instead, they are judged by their degrees of importance and are then given ranks accordingly. Finally, the rating method is like the ordinal ranking method in that all indicators are judged by their relative degrees of importance indicated by 'scores' instead of cardinal rank (Mendoza & Prabhu, 2000).

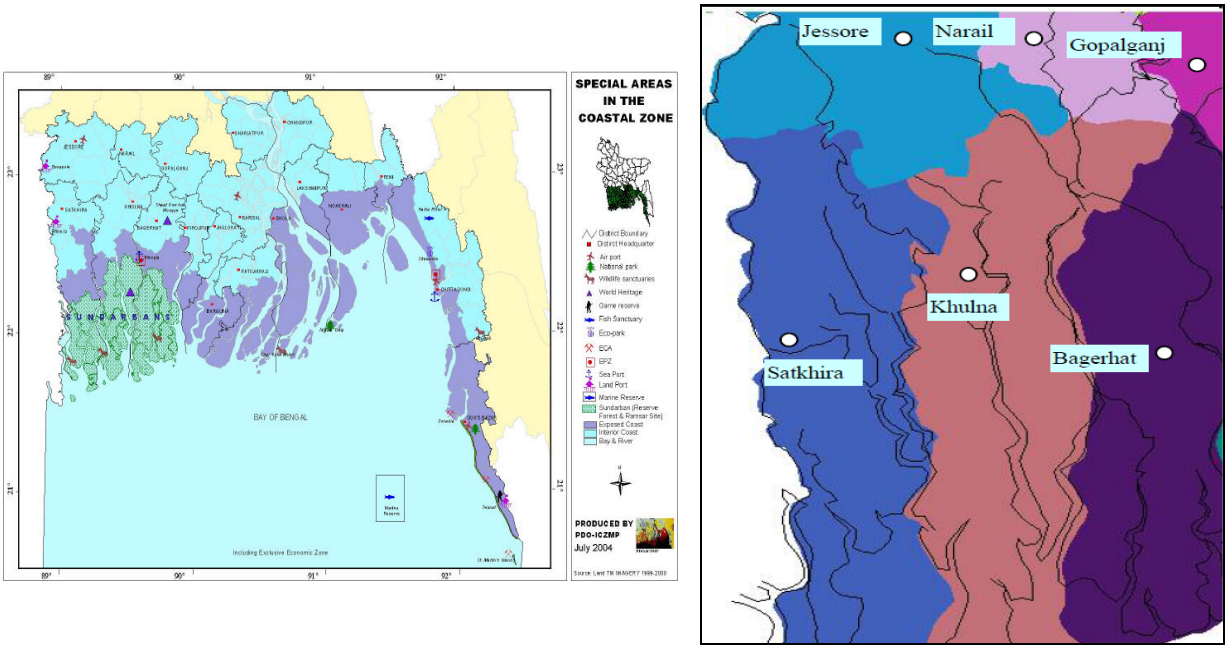


Figure 1. Map of the South-Western coastal area of Bangladesh (Source: PDO-ICZM)

In this study, rating method was used to calculate the sustainable adaptation practices. Although in this method, total scores are distributed by 100, but in this calculation, a total score of 10 used instead of 100. Scorings were used both of the social, economic and environmental aspects. The total average scores were taken into consideration for decisions about the sustainable adaptation practices.

4. Results and Discussion

4.1 List of Existing Adaptation Practices in SW Coastal Area of Bangladesh

The local people of South-Western coastal area are struggling against the adverse climate change impacts for a long time. Since it is not possible for that people to mitigate this effect, therefore, adaptation to climate change impacts is their natural choice. All the existing adaptation practices (Table 3) are categorized on the basis of sector-wise, seasonality and promoter-based (Table 4). We found that livelihood related adaptation was 29 (64.4%) while about 69% was wet seasonal adaptation (Figure 2a and 2b).

Table 3. Comprehensive list and description of climate change adaptation practices in southwestern Bangladesh

Name of Practice	Location	Brief Description	Nature of Adaptation	Objective
CMAS Culture	The practice scattered in Sarankhola Upazila of Bagerhat District , Koyra Upazila of Khulna District and Assasuni Upazila of Satkhira District	Combined cultivation of some mangrove plant species like Goalpata, Keora and a few aquatic species like Bagda Telapia, Perse, and Vetki etc. on fresh or brackish water swampy land	Livelihood (Crop cultivation)	Adaptation to cyclone, tidal surge and salinity
Grass Cultivation	Tala, Assasuni and Shymnagar (Gabura Union) Upazila of Satkhira District	Cultivation of Napier Grass (locally called Bajo Grass) alongside ponds and wetlands	Livelihood (Crop cultivation)	Adaptation to Salinity
Keora Nursery	Protabnagar Union of Assasuni Upazila under Satkhira District and scattered practice in Koyra Upazila of Khulna District	Collecting Keora seeds from the Sundarbans and growing Keora plants with much care for plantation in homestead surrounding fallow lands, low lands and dykes of agricultural lands.	Livelihood (Agriculture)	Adaptation to cyclone, tidal surge and very high salinity

Mele (Reed) Cultivation	Borodol Union of Assasuni Upazila, Khalishkhali and Khesra union of Tala Upazila under Satkhira District and Chadkhali Union of Paikgachha Upazila of Khulna District	Cultivation of Mele in salinity rich areas where cultivation of crops of fresh water variety is impossible	Livelihood (crop cultivation)	Adaptation to salinity, tidal flood and tidal surge
Dyke cropping	Dumuria and Koyra upazila of Khulna District, Fakirhat Upazila of Bagerhat District , Tala and Assasuni Upazila of Satkhira District	Growing vegetables and spices on the dykes of agricultural lands, shrimp ghers and homestead fish ponds	Livelihood (family income generation)	Adaptation to flood, waterlogging and salinity
Cage aquaculture	5 no. Koyra & 7 no. Uttar Bedkashi unions of Koyra Upazila of Khulna District	Small scale fish particularly *Bagda* farming in cages at household or community level at water bodies (rivers, *khals, beels*)	Livelihood (Fish farming)	Adaptation to breaking fish ponds banks by tidal and coastal flood.
Crab fattening	Paikgacha Upazila, 7 no. Uttar Bedkashi Union of Koyra Upazila of Khulna District and Atulia, Gabura and Buri Goalini unions of Shymnagar Upazila under Satkhira District	Collecting immature and soft crabs from the creeks of the Sundarbans and rearing in a pond to fat and to put on weight until they become marketable size (100 gm) and strong	Livelihood (crop cultivation)	Adaptation to Salinity
Hanging vegetables	Bagali and Koyra unions of Koyra Upazila, Dumuria Upazila and Paikgachha Upazila (Chandkhali Union) under Khulna District and Borodol Union of Assasuni Upazila under Satkhira District	Cultivation of vegetables like bottle-gourd, pumpkin, seam, sweet pumpkin in hanging earthen pots and baskets	Livelihood (Horticulture)	Adaptation to flooding and salinity
Hydroponics	Pirojpur District and Sarankhola Upazila under Bagerhat District	Growing vegetables on floating beds in waterlogged areas	Livelihood (Horticulture)	Adaptation to water logging and salinity
Poultry farming	Koyra Upazila of Khulna District, Shymnagar Upazila of Satkhira District and Sarankhola Upazila of Bagerhat District	After about one year of Aila, rearing of poultry/duck at household level started again to level up family income and to meet the family demand of protein	Livelihood (Seeking alternative options)	Adaptation to waterlogging and salinity intrusion
Cattle Raising	Assasuni Upazila of Satkhira District and Sarankhola Upazila of Bagerhat District	Raising cattle at household level to meet the need of protein and milk and to level up family income again started about one year after cyclone Aila	Livelihood (Agriculture)	Adaptation to coastal and tidal flooding and waterlogging
Shrimp-fish mixed cultivation	Tala Upazila of Satkhira District, Dumuria and Koyra upazila (particularly Amadi, Bagali and Koyra unions) under Khulna District	Shrimp-fish mixed cultivation in fresh water ponds and shrimp–fish mixed cultivation in saline water ponds both at household and community level	Livelihood (Seeking alternative option)	Adaptation to salinity and water logging
Apiculture	Shyamnagar Upazila of Satkhira District	Bee keeping and honey extraction	Livelihood	Alternative income generation
Goalpata Cultivation	Koyra and Amadi unions of Koyra Upazila, Paikgacha Upazila under Khulna District and Sarankhola and Mongla upazila of Bagerhat District	Cultivation of Goalpata in river side floodplain lands or homestead surrounding ditches and low lands	Livelihood	Adaptation to salinity, tidal flood and storm surge

Keora Cultivation	Koyra, Paikgachha (Suladana) and Dacope upazila of Khulna District	Cultivation of Keora tree in the dykes of farming lands and homestead surrounding brackish water swampy lands	Livelihood (alternative income generation)	Adaptation to salinity, tidal flood and storm surge
Growing local rice variety (BR 28) cultivation by crop calendar adjustment	Amadi and Bagali unions of Koyra Upazila and Paikgachha Upazila under the district of Khulna and Gabura Union of Shyamnagar Upazila under Satkhira District	Cultivating rice bypassing the flood season particularly during the overlapping periods of Kharif-1 & Kharif-2 (May to mid August) where flood usually occurs at late August.	Livelihood (food crop cultivation)	Adaptation to flood and waterlogging
Local rice variety (T Aus) cultivation by crop calendar adjustment	Amadi and Bagali unions of Koyra Upazila, Paikgachha Upazila and Dacope Upazila (Gupalpur Union) under Khulna District and Tala and Kolaroa Upazila of Satkhira District	Cultivating rice bypassing the flood season particularly during the overlapping periods of Kharif-1 & Kharif-2 (May to late August) where flood usually occurs at late August.	Livelihood (Food crop cultivation)	Adaptation to drought
Cropping on raised mound	Pirojpur District, Paikgachha Upazila of Khulna and Shymnagar Upazila of Satkhira	Growing different types of vegetables (guard, bitter guard, ladies fingers, chilies, cauliflowers, cabbages, radishes, etc) on raised mound	Livelihood (Horticulture, family income generation)	Adaptation to waterlogging and salinity
Homestead gardening	Amadi and Bagali unions of Koyra Upazila and Paikgachha Upazila under Khulna District and Borodol Union of Assasuni Upazila under Satkhira District have seen the practice.	Growing various types of vegetables (guard, bitter guard, ladies fingers, chilies, cauliflowers, cabbages, radishes, etc) on raised homestead yards	Livelihood (Family income generation)	Adaptation to waterlogging and salinity
Combined cultivation of fish and hanging vegetables	Amadi, Bagali and Koyra unions of Koyra Upazila, Chadkhali Union of Paikgacha Upazila under Khulna District and Borodol Union of Assasuni Upazila under Satkhira District	Cultivation of fish and vegetables on the same piece of swampy land. Hanging platform is constructed over the swampy land for vegetable cultivation. A corner of the plot is raised enough so that it is not inundated by normal coastal flooding to saw vegetables seeds.	Livelihood (Family income generation)	Adaptation to waterlogging and salinity
Purification of pond water using govt. supported filter	Harinagar Village of Amadi Union at Koyra Upazila of Khulna District	Govt. (Public Health Engineering Department-PHED) supported in installing concrete made water tank and water purifying filter by which pond water is easily purified to the extent that can be used for drinking and other household activities.	Water (purification and desalinization)	Adaptation to salinity in ground water and even in most of the surface water bodies
Purification of pond water using traditional knowledge	The pond water purification tool is also scattered in the whole coastal region. Example drawn from Harinagar Village of Amadi Union at Koyra Upazila of Khulna District.	Concrete made two tanks are used to purify water. The bottom of each tank is piled by a few layers. Each layer consists of two pieces of net, sand and stone pieces. Water is poured into a tank. After being purified to a considerable degree, the water is taken into another tank for further purification. Water that falls in drops through filter of the latter tank is directly used for drinking and household use	Water (water purification and desalinization)	Adaptation to salinity in ground water and even in most of the surface water bodies
Aman rice and fish(Bagda, Golda, Rui, and katla) combined	The adaptation technique practiced in Dumuria Upazila utilizing waterlogged area and Koyra (particularly in Amadi,	A corner of Aman rice cultivation plot is dug to five to six fit depth and fish fries are released for cultivation. Rice-fish combined cultivation also facilitates irrigation in the	Livelihood (Family income generation)	Adaptation to waterlogging at Dumuria Upazila and ground water salinity in Koyra

cultivation	Bagali and Koyra union) and Shyamnagar upazila harvesting rainwater	paddy field from the fish cultivation pond when necessary.		and Shyamnagar upazila
Rainwater harvesting in rectangular concrete tank	The practice more or less scattered across the whole coastal region. Evidence drawn from Harinagar Village, Amadi Union, Koyra Upazila in Khulna District.	Rainfall on building roof fed into a rectangular concrete tank at a corner of homestead yard and extracting water from the tank for use in drinking and household activities	Scarcity of water for household and drinking purposes	Adaptation to salinity in ground water and even in most surface water bodies.
Directly use of pond water in drinking and household activities through proper pond management	Almost a common practice found across the whole coastal region particularly in Shymnagar Upazila of Satkhira District, Koyra and Paikgacha upazila in Khulna District and Sarankhola Upazila of Bagerhat District. Example from Amadi, Bagali and Koyra unions of Koyra Upazila	Taking care and maintenance of Pond e. g. bank heightening, wedding out, removing unnecessary trees and plants from banks and taking extra-care so that intrusion of nothing can deteriorate the water quality and directly use the pond water in drinking and other household purposes.	Scarcity of water for household and drinking purposes	Adaptation to salinity in ground water and even in some surface water bodies
Rainwater harvesting through hanging canvas while raining	Harinagar and other villages of Amadi Union of Koyra Upazila	A rectangular shaped concrete tank built in an advantageous point of homestead yard is fed by rainwater that is harvested hanging canvas under the open sky when it is raining and purifying the water by filters installed in the tank.	Scarcity of water for household and drinking purposes	Adaptation to salinity in ground water and even in some surface water bodies
Pond Filter	Harinagar and other villages of Amadi Union of Koyra Upazila	Rectangular concrete tank set up on pond bank, taking water from pond, poured into tank, purifying by the filter of the tank and using water in household and drinking purposes	Scarcity of water for household and drinking purposes	Adaptation to salinity in ground water and even in some surface water bodies
Vegetables cultivation on raised mound with concrete wall	The practice scattered in different villages of Koyra Upazila. Has been a practice for long in Amadi Union and an emerging practice in 5 & 7 no. unions of the upazila.	Cultivation of different types of vegetables like red greens, radish and so forth raised mound with concrete made walls	Livelihood (Horticulture)	Adaptation to salinity, tidal surge and heavy erosion during rainy season
Fish vegetables combined cultivation	Throughout the whole Amadi and Bagali unions of Koyra Upazila. Evidence drawn from Naksha Village	Vegetables like bottle gourd, sweet pumpkin and creeper vegetable are cultivated in platform made of net and bamboo erected over fish cultivating pond.	Livelihood (New income generation)	Adaptation to salinity and tidal surge
Eter Paja (Household Level Brick-kiln)	Different villages of Amadi Union of Koyra Upazila	Bricks made of the soil derived from homestead fish pond floor and baked with bamboo and other domestic fuel materials.	Structural Strengthening house structure for improving resilience to natural disasters like cyclone	Adaptation to salinity, tropical cyclone and tidal surge
Gola (a granary, a storehouse for grain)	Different villages of Amadi Union of Koyra Upazila	Gola is a storehouse for grain particularly rice, it is separated from the main house. A circular shaped house made of concrete, bamboo and tin.	Structural	Adaptation to pest and insects

Goalghor (Cow-shed)	Naksha Village of Amadi Union at Koyra Upazila under Khulna District	Bricks covered floor, concrete columns and walls with so much ventilation and roofing with Goalpata	Structural	Adaptation to cyclone, tidal surge and salinity
School cum cyclone shelter	Throughout the whole coastal zones particularly in Koyra Upazila of Khulna District, Shymnagar Upazila of Satkhira District and Sarankhola Upazila of Bagerhat District	Two-storeyed modern complete buildings with empty ground floor to avert tidal surge.	Structural	Adaptation to cyclone, tidal surge and salinity
Bamboo made piling	Along the riverbanks of Kobodak in Amadi Union particularly at Masjidkur Village	Bamboo fence placed along the erosion points of river to protect bank erosion.	Structural	Adaptation to riverbank erosion
Bamboo cage	Along the riverbanks of Kobodak in Koyra Upazila. Evidence drawn from Masjidkur Village of Amadi Union of the Upazila	Bamboo made square-shaped structure full of brick-bats placed along erosion points of river to protect riverbanks.	Structural	Adaptation to riverbank erosion
Raising plinth	Almost in all coastal upazilas of Bangladesh, evidence from the whole Koyra Upazila	Plinth generally heightened from 3-6 feet high with mud (clay soil) collected from nearby pond.	Structural	Adaptation to tidal surge and coastal flooding
Lowering house roof (Low house)	Almost in all coastal upazilas of Bangladesh, evidence from the whole Koyra Upazila	House roof is lowered as much as possible to avoid the destructive force of strong wind in cyclone. The coastal houses are of so low-height that it is very difficult for the dwellers to stand straight on the floor	Structural	Adaptation to strong force of cyclone wind
Vegetables cultivation on the banks of homestead fish pond	Found throughout the whole Koyra Upazila, seen wide practice in its Amadi and Bagali unions	On the banks of the fish cultivation ponds at homestead, different types of vegetables like bean, bottle gourd, sweet pumpkin radish and red greens are grown.	Livelihood (New income generation)	Adaptation to tidal surge, salinity and land scarcity
Vegetables cultivation on homestead yard	Found throughout the whole Koyra Upazila, particularly seen wide practice in its Bagali and Koyra unions	On homestead yards, different types of vegetables like bean, bottle gourd, sweet pumpkin radish, red greens and creeper are grown.	Livelihood (Meeting domestic needs of vegetables & new income generation)	Adaptation to tidal surge, salinity and land scarcity
Shrimp cultivation at homestead	Found particularly at Koyra, 5 no. Koyra, Maharajpur and 7 no. Koyra unions of Koyra Upazila under Khulna District	On homestead yards, where Sidr and Aila critically hit, shrimp cultivation is practiced as alternative family income source.	Livelihood (post Aila generation of alternative family income)	Adaptation to tidal surge and salinity intrusion
Vegetables cultivation on raised mound at homestead	Found particularly at Koyra, 5 no. Koyra, Maharajpur and 7 no. Koyra unions of Koyra Upazila under Khulna District	In seriously affected areas (by Aila and Sidr), in many homesteads a part of homestead yard is raised enough to grow different types of vegetables	Livelihood (Alternative family income source)	Adaptation to tidal surge, salinity intrusion and saline waterlogging
Rainwater harvesting	In seriously (Sidr and Aila) affected areas of Khulna and Satkhira districts, examples from 5 no. Union of Koyra Upazila under Khulna District	Using coarse sheet of plastic paper over thatched roof to harvest rainwater, storing the rain water into concrete made circular shaped tanks and extracting the water from the tank after being purified by the filter installed in the tank.	Livelihood (Alternative family income source)	Adaptation to tidal surge, salinity contamination in surface water bodies and salinity in ground water

Disaster resilient stronger houses	Modinabad of Koyra Upazila Sadar Union under Khulna District	Concrete columns and plinth, roofing by Goalpata, fencing by bamboo, bran and *Gab* juice	House structure	Adaptation to cyclone and tidal surge
Sesame Cultivation	Harinagar, Hatiadanga, Palbari and Kinukati villages of Amadi Union under Koyra Upazila and Moukhali Village of Chadkhali Union under Paikgacha Upazila	Sesame cultivation in paddy fields instead of Boro Rice cultivation	(Livelihood) Crop cultivation	Adaptation to salinity in ground water
Sunflower Cultivation	Harinagar, Hatiadanga, Palbari and Kinukati villages of Amadi Union under Koyra Upazila and Moukhali Village of Chadkhali Union under Paikgacha Upazila	Sesame cultivation in paddy fields instead of Boro Rice cultivation	(Livelihood) Crop cultivation	Adaptation to salinity in ground water
Lentil (one kind of pulse)	Harinagar, Hatiadanga, Palbari and Kinukati villages of Amadi Union under Koyra Upazila and Moukhali Village of Chadkhali Union under Paikgacha Upazila	Sesame cultivation in paddy fields instead of Boro Rice cultivation	(Livelihood) Crop cultivation	Adaptation to salinity in ground water

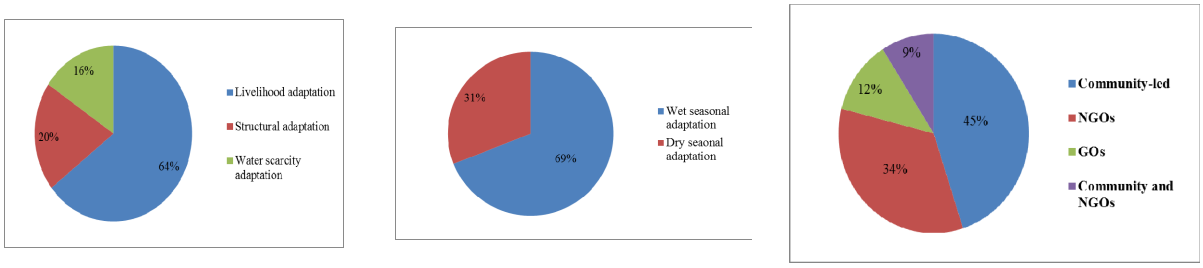
Table 4. Categorization of existing climate change adaptation practices in South-Western coastal area of Bangladesh

Name of the Adaptation practice	**Seasonality**		**Promoter**			
	DS	WS	LC	GOs	NGOs and LC	NGOs
Livelihood adaptation						
CMAS Culture		√	√			
Grass Cultivation		√	√			
Keora Nursery	√			√		√
Mele (Reed) Cultivation	√					√
Dyke cropping		√				√
Cage aquaculture		√				√
Crab fattening		√				√
Hanging vegetables		√				√
Hydroponics		√				√
Poultry farming		√				√
Cattle Raising		√				√
Shrimp-fish mixed cultivation		√				√
Apiculture	√					√
Goalpata Cultivation	√		√			
Keora Cultivation		√	√			
Growing local rice variety (BD 28) cultivation by crop calendar adjustment		√				√
Local rice variety (T Aus) cultivation by crop calendar adjustment	√		√			

Cropping on raised mound		√	√			
Homestead gardening		√				√
Combined cultivation of fish and hanging vegetables		√	√			
Fish vegetables combined cultivation		√	√			
Vegetables cultivation on raised mound with concrete wall		√			√	
Aman rice and fish(Bagda, Golda, Rui, and katla) combined cultivation		√			√	
Vegetables cultivation on the banks of homestead fish pond	√		√			
Vegetables cultivation on homestead yard	√				√	
Shrimp cultivation at homestead		√				√
Vegetables cultivation on raised mound at homestead		√				√
Sesame Cultivation	√		√			
Sunflower Cultivation		√	√			
Lentil (one kind of pulse)	√		√			
Adaptation to Water sector						
Rain water harvesting in rectangular concrete tank		√				
Directly use of pond water in drinking and household activities through proper pond management.	√		√			
Rain water harvesting through hanging canvas while raining		√				√
Pond Filter	√			√		
Purification of pond water using govt. supported filter	√			√		
Purification of pond water using traditional knowledge	√		√			
Rain water harvesting		√				√
Adaptation to structural sector						
Disaster resilient stronger houses		√	√			
Eter Paja (Household Level Brick-kiln)		√	√			
Gola (a granary, a storehouse for grain)	√		√			
Goalghor (Cow-shed)		√	√			
School cum cyclone shelter		√				
Bamboo made piling		√		√		
Bamboo cage		√		√		
Raising plinth		√				
Lowering house roof (Low house)		√	√			

Note: DS= Dry season, WS= Wet season, LC= Local community, GOs= Governmental organizations, NGOs= Non-Governmental Organizations

Source: CARE (RVCC Project), 2010; Satkhira Unnayan Sangstha (SUS), 2009 and Field Survey, 2012



a) b) c)

Figure 2. Categorization of existing adaptation practices in SW coastal area of Bangladesh

4.2 Sustainable Livelihood Adaptation

Although the local people are adapting various practices in association with governmental fund, donor agencies against water related impacts due to climate change, but all of them are not so popular and successful. The most successful adaptation practice should be socially acceptable, economically viable and environmentally sound. Considering these criteria, the more popular and sustainable adaptation practice for livelihood includes growing local rice variety (BD 28). This is because the practice is well accepted by the all type of community of this reason, initial and additional cost with respect of its derived benefits are very low. Besides this, there is no adverse impact of environment due to exercising this practice. On the other hand, dyke cropping, *Keora* nursing, homestead gardening, growing vegetables on raised mound etc. are some moderately sustainable livelihood adaptation practices. This study also found that fish vegetables combined cultivation, cage aquaculture, vegetables cultivation on raised mound with concrete wall etc. are some less and unpopular adaptation practices (Table 5).

4.3 Sustainable Adaptation Practices in Water Sector

Water is one of the most affected sectors by the adverse impacts of climate change in SW coastal area of Bangladesh. To adapt with this unfavorable condition, local community with the help of government has developed different adaptation practices. Among these practices, this study found that directly use of pond water through proper pond management and rain water harvesting are the more popular and sustainable adaptation practices for the drinking water purpose. The main reason of more sustainability are the very low initial investment and maintenance cost with respect to its perceived benefits. Social acceptance, applicability and environmental soundness are very high. On the other hand, rain water harvesting in rectangular concrete tank and purification of pond water using traditional knowledge are the moderately sustainable practice while Purification of pond water using govt. supported filter and pond filter are the less sustainable (Table 6).

4.4 Sustainable Adaptation in Structural Sector

This study found that raising plinth, lowering house roof (Low house) are the more popular and sustainable adaptation practices in structural sector. The very low initial and additional cost for its maintenance compared to its associated benefits, high social acceptance and environmental soundness are the main drivers for these more sustainable adaptation practices. On the other hand, Eter Paja (Household Level Brick-kiln), School cum cyclone shelter, Gola, Goalghor etc. are the moderately sustainable adaptation practices while bamboo made piling and bamboo case are the less sustainable practices (Table 7).

Table 5. Sustainability of livelihood adaptation practices in SW coastal area of Bangladesh

Name of adaptation practice	Sustainability Indicators (Achieved scores)				Sustainability
	Social	Economic	Environmental	Total average scores	
CMAS Culture	5.0	6.0	5.5	5.50	Less sustainable
Grass Cultivation	6.75	8.67	6.0	7.13	Moderately sustainable
Mele (Reed) Cultivation	6.5	8.67	6.0	7.05	Moderately sustainable
Crab fattening	5.75	6.67	4.5	5.64	Less sustainable
Sunflower Cultivation	5.25	7.33	5.0	5.86	Less sustainable
Lentil (one kind of pulse)	8.0	8.0	6.5	7.50	Moderately sustainable
Sesame Cultivation	6.25	8.0	5.5	6.60	Moderately sustainable
Growing local rice variety (BD 28)	8.25	8.67	7.5	8.14	More sustainable
Local rice variety (T Aus) cultivation by crop calendar adjustment	6.75	8.00	7.50	7.33	Moderately sustainable
Keora Nursery	5.75	7.33	5.5	6.11	Moderately sustainable
Cattle Raising	5.25	6.67	6.5	6.14	Moderately sustainable
Dyke cropping	8.25	8.00	7.5	7.92	Moderately sustainable
Cropping on raised mound	8.00	7.33	6.5	7.28	Moderately sustainable
Homestead gardening	7.75	8.00	7.00	7.58	Moderately sustainable
Combined cultivation of fish and hanging vegetables	6.00	8.00	7.5	7.17	Moderately sustainable
Aman rice and fish combined cultivation	5.00	6.67	6.00	5.90	Less sustainable
Shrimp cultivation at homestead	5.50	5.33	4.00	4.94	Less sustainable
Vegetables cultivation on raised mound at homestead	8.25	8.00	6.5	7.58	
Fish vegetables combined cultivation	4.75	6.00	6.5	5.75	Less sustainable
Vegetables cultivation on the banks of homestead fish pond	7.25	8.00	7.00	7.42	Moderately sustainable
Cage aquaculture	5.00	7.33	4.00	5.44	Less sustainable
Hanging vegetables	5.75	7.33	5.5	6.19	Moderately sustainable
Hydroponics	5.5	8.00	5.00	6.17	Moderately sustainable
Vegetables cultivation on raised mound with concrete wall	4.5	5.33	4.5	4.78	Less sustainable
Poultry farming	4.25	6.00	3.5	4.60	Less sustainable
Shrimp-fish mixed cultivation	3.75	6.00	3.5	4.42	Less sustainable
Keora Cultivation	5.25	6.00	7.5	6.25	Moderately sustainable
Vegetables cultivation on homestead yard	7.75	8.00	6.5	7.42	Moderately sustainable
Apiculture	6.00	8.67	6.5	7.10	Moderately sustainable
Goalpata Cultivation	5.00	8.67	7.5	7.10	Moderately sustainable

Note: Total average scores 8-10= more sustainable, 6-<8= moderately sustainable, 4-<6= less sustainable

Table 6. Sustainability of adaptation practices in water sector

Name of adaptation practice	Sustainability Indicators (Achieved scores)				
	Social	Economic	Environmental	Total average scores	Sustainability
Purification of pond water using govt. supported filter	4.5	5.33	5.5	5.11	Less sustainable
Purification of pond water using traditional knowledge	8.25	8.70	6.5	7.82	Moderately sustainable
Rain water harvesting in rectangular concrete tank	6.75	8.70	6.0	7.10	Moderately sustainable
Directly use of pond water through proper pond management	8.50	8.70	8.0	8.40	More sustainable
Rainwater harvesting through hanging canvas while raining	7.75	9.33	7.0	8.02	More sustainable
Pond Filter	5.75	6.67	8.0	6.81	Less sustainable
Rainwater harvesting	9.5	9.67	8.5	9.22	More sustainable

Note: Total average point 8-10= more sustainable, 6-<8= moderately sustainable, 4-<6= less sustainable

Table 7. Sustainable adaptation in Structural sector

Name of adaptation practice	Sustainability Indicators (Achieved scores)				
	Social	Economic	Environmental	Total average scores	Sustainability
Eter Paja (Household Level Brick-kiln)	6.00	5.33	7.5	6.28	Moderately sustainable
Gola (a granary, a storehouse for grain)	7.25	8.00	7.0	7.42	Moderately sustainable
Goalghor (Cow-shed)	5.75	7.33	5.5	6.20	Moderately sustainable
School cum cyclone shelter	7.50	8.00	6.5	7.33	Moderately sustainable
Bamboo made piling	5.75	4.00	5.5	5.08	Less sustainable
Bamboo cage	7.00	4.00	5.0	5.33	Less sustainable
Raising plinth	7.50	8.00	8.0	8.5	More sustainable
Lowering house roof (Low house)	8.00	8.67	7.5	8.10	More sustainable
Disaster resilient stronger houses	3.25	4.67	6.5	4.81	Less sustainable

Note: Total average point 8-10= more sustainable, 6-<8= moderately sustainable, 4-<6= less sustainable

4.5 Seasonal Sustainable Adaptation Practices

All of adaptation practices around the two seasons, i.e. wet and dry season are not in a similar sustainable level. Some of them are more sustainable and others are moderate and less sustainable. In wet season, growing local

rice variety cultivation by crop calendar adjustment, raising plinth, lowering house roof, direct rainwater harvesting and rain water harvesting through hanging canvas while raining etc. are the more sustainable adaptation practices while in the dry season (Table 8). Directly use of pond water in drinking and household activities through proper pond management. On the other hand, from the table, it is clear that the number of less sustainable of adaptation practices in wet season is comparatively higher than the dry season.

Table 8. Sustainable adaptation practices in different seasons

Seasonality	Name of Practice	Average scores	Sustainability
Wet season	CMAS Culture	5.50	Less sustainable
	Grass Cultivation	7.13	Moderate sustainable
	Aman rice and fish(Bagda, Golda, Rui, and katla) combined cultivation	5.90	Less sustainable
	Rainwater harvesting in rectangular concrete tank	7.10	Moderate sustainable
	Shrimp cultivation at homestead	4.94	Less sustainable
	Vegetables cultivation on raised mound at homestead	7.58	Moderate sustainable
	EterPaja (Household Level Brick-kiln)	6.28	Moderate sustainable
	School cum cyclone shelter	7.33	Moderate sustainable
	Bamboo made piling	5.08	Less sustainable
	Dyke cropping	7.92	Moderate sustainable
	Cage aquaculture	5.44	Less sustainable
	Crab fattening	5.64	Less sustainable
	Hanging vegetables	6.19	Moderate sustainable
	Hydroponics	6.17	Moderate sustainable
	Poultry farming	4.60	Less sustainable
	Cattle Raising	6.14	Moderate sustainable
	Shrimp-fish mixed cultivation	4.42	Less sustainable
	Goalghor (Cow-shed)	6.20	Moderate sustainable
	Bamboo cage	5.33	Less sustainable
	Raising plinth	8.5	More sustainable
	Lowering house roof (Low house)	8.10	More sustainable
	Keora Cultivation	6.25	Moderate sustainable
	Growing local rice variety (BR 28) cultivation by crop calendar adjustment	8.14	More sustainable

	Rainwater harvesting	9.22	More sustainable
	Disaster resilient stronger houses	4.81	Less sustainable
	Fish vegetables combined cultivation	5.75	Less sustainable
	Cropping on raised mound	7.28	Moderate sustainable
	Homestead gardening	7.58	Moderate sustainable
	Combined cultivation of fish and hanging vegetables	7.17	Moderate sustainable
	Vegetables cultivation on raised mound with concrete wall	4.78	Less sustainable
	Rainwater harvesting through hanging canvas while raining	8.02	More sustainable
Dry season	Purification of pond water using traditional knowledge	7.82	Moderate sustainable
	Apiculture	7.10	Moderate sustainable
	Goalpata Cultivation	7.10	Moderate sustainable
	Mele (Reed) Cultivation	7.05	Moderate sustainable
	Local rice variety (T Aus) cultivation by crop calendar adjustment	7.33	Moderate sustainable
	Purification of pond water using govt. supported filter	5.11	Less sustainable
	Directly use of pond water in drinking and household activities through proper pond management.	8.40	More sustainable
	Pond Filter	6.81	Moderate sustainable
	Gola (a granary, a storehouse for grain)	7.42	Moderate sustainable
	Vegetables cultivation on the banks of homestead fish pond	7.42	Moderate sustainable
	Vegetables cultivation on homestead yard	7.42	Moderate sustainable
	Lentil (one kind of pulse)	7.50	Moderate sustainable
	Sesame Cultivation	6.60	Moderate sustainable
	Keora Nursery	6.11	Moderate sustainable

4.6 Sustainable Promoter Based Adaptation Practices

Among the local community-led adaptation practices to climate change, directly use of pond water in drinking and household activities through proper pond management, raising plinth, lowering house roof (Low house) are the more sustainable (Table 9). Most of the other practices are moderate sustainable. This is because of their ecology based traditional knowledge and well-known bio-physical condition of this area. On the other hand,

growing local rice variety (BD 28) cultivation, rain water harvesting through hanging canvas while raining, rainwater harvesting are the more sustainable adaptation practices promoted by NGOs. By contrary, most of the governmental and government-NGOs adaptation practices are not more sustainable. Unfamiliar of local geo-physical context, very little knowledge about the cultural and traditional knowledge of the local communities are the main reasons behind the comparatively less sustainable adaptation practices promoted by them.

Table 9. Sustainable adaptation practices based on promoter

Category	Name of practice	Average scores	Sustainability
Promoted by local community	CMAS Culture	5.50	Less sustainable
	Grass Cultivation	7.13	Moderate sustainable
	Goalpata Cultivation	7.10	Moderate sustainable
	Keora Cultivation	6.25	Moderate sustainable
	Local rice variety (T Aus) cultivation by crop calendar adjustment	7.33	Moderate sustainable
	Cropping on raised mound	7.28	Moderate sustainable
	Combined cultivation of fish and hanging vegetables	7.17	Moderate sustainable
	Purification of pond water using traditional knowledge	7.82	Moderate sustainable
	Directly use of pond water in drinking and household activities through proper pond management	8.40	More sustainable
	Fish vegetables combined cultivation	5.75	Less sustainable
	Eter Paja (Household Level Brick-kiln)	6.28	Moderate sustainable
	Gola (a granary, a storehouse for grain)	7.42	Moderate sustainable
	Goalghor (Cow-shed)	6.20	Moderate sustainable
	Raising plinth	8.5	More sustainable
	Lowering house roof(Low house)	8.10	More sustainable
	Vegetables cultivation on the banks of homestead fish pond	7.42	Moderate sustainable
	Disaster resilient stronger houses	4.81	Less sustainable
	Sesame Cultivation	6.60	Moderate sustainable
	Lentil (one kind of pulse)	7.50	Moderate sustainable
	Sunflower Cultivation	5.86	Less sustainable

Promoted by NGOs	Keora Nursery	7.11	Moderate sustainable
	Mele (Reed) Cultivation	7.05	Moderate sustainable
	Dyke cropping	7.92	Moderate sustainable
	Cage aquaculture	5.44	Less sustainable
	Crab fattening	5.64	Less sustainable
	Hanging vegetables	6.19	Moderate sustainable
	Hydroponics	6.17	Moderate sustainable
	Poultry farming	4.60	Less sustainable
	Cattle Raising	6.14	Moderate sustainable
	Shrimp-fish mixed cultivation	4.42	Less sustainable
	Apiculture	7.10	Moderate sustainable
	Growing local rice variety (BD 28) cultivation	8.14	More sustainable
	Homestead gardening	7.58	Moderate sustainable
	Rainwater harvesting through hanging canvas while raining	8.02	More sustainable
	Shrimp cultivation at homestead	4.94	Less sustainable
	Vegetables cultivation on raised mound at homestead	7.58	Moderate sustainable
	Rain water harvesting	9.22	More sustainable
GOs	Purification of pond water using govt. supported filter	5.11	Less sustainable
	Pond Filter	6.81	Moderate sustainable
	School cum cyclone shelter	7.33	Moderate sustainable
Both Government and NGOs	Bamboo made piling	5.08	Less sustainable
	Bamboo cage	5.33	Less sustainable
	Rainwater harvesting in rectangular concrete tank	7.10	Moderate sustainable
Local community and NGOs	Vegetables cultivation on raised mound with concrete wall	4.78	Less sustainable
	Vegetables cultivation on homestead yard	7.42	Moderate sustainable
	Aman rice and fish (Bagda, Golda, Rui, and Katla) combined cultivation	5.90	Less sustainable

5. Conclusion

Although the South-Western coastal area of Bangladesh is the worst victim of climate change, the local communities have taken various adaptive measures against these impacts especially in livelihood, water and infrastructural sector. The main finding of this study shows that growing of local rice variety, purification of the pond water through proper pond management, rainwater harvesting, raising plinth, lowering the house roof etc

are some of the successful and popular adaption practices. However, the civil society, government officials should come forward to strengthen their adaptive capacity and helping to build self reliability. This study will offer an opportunity for the policy makers, donor agencies, government officials to rethink about formulating the adaptation strategies and policies regarding climate change affected people of South Western coastal area of Bangladesh.

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