



# Climate change adaptation practices to water sector in South-Western coastal area of Bangladesh

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Climate scientists, environmentalists, climate negotiators and policy makers around the world have recognized that Bangladesh is the worst victim of climate change. In Bangladesh, South Western coastal area is the most vulnerable due to its geo-morphological characteristics. Among the different sectors, water is seriously affected by climate change. However, people of this area has adapted with this impact by different ways. This study aims at find out the adaptation practices to water sector and their critical analysis through a series of field study along with questionnaire survey and reviewing the secondary literature. The present study shows that hanging vegetables, growing local rice variety, homestead gardening, purification of pond water trough traditional knowledge, directly use of pond water through its proper management, rain water harvesting are the most popular and successful adaptation practices in terms of social, economic and environmental aspects. Although the adaptation practices by the local community are praiseworthy, the dependency on donor agencies and non-governmental organizations are a new challenge for future adaptation practice.

## 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 (Edris Alam, 2017; Muhammad Rezaul Rakib and Md. Nurul Islam, 2017; Borhan Uddin et al. 2018). Furthermore, increased and longer periods of floods and erosion in monsoon, and rising sea level, increased drought due to reduced rainfall in winter and increased cyclones and tropical storms accelerate this situation (CEGIS, 2011).

It was revealed through a rigorous multi-criteria analysis that the South western region of the country would be the most vulnerable area (BCAS-RA-Approtech, 1994). The projected increase in monsoon rainfall would increase flood vulnerability of the region, while dry-season low-flow conditions-marked by already 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.

It was accorded in the literature that the above changes would have severe adverse impacts on coastal resources, water resources, agriculture, human health and biodiversity, with special reference to the south western region (World Bank, 2000).

As response to climate change impacts, Bangladesh could consider both mitigation and adaptation which were highlighted in the UNFCCC. However, the country's green house gases emission being small compared to 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).

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

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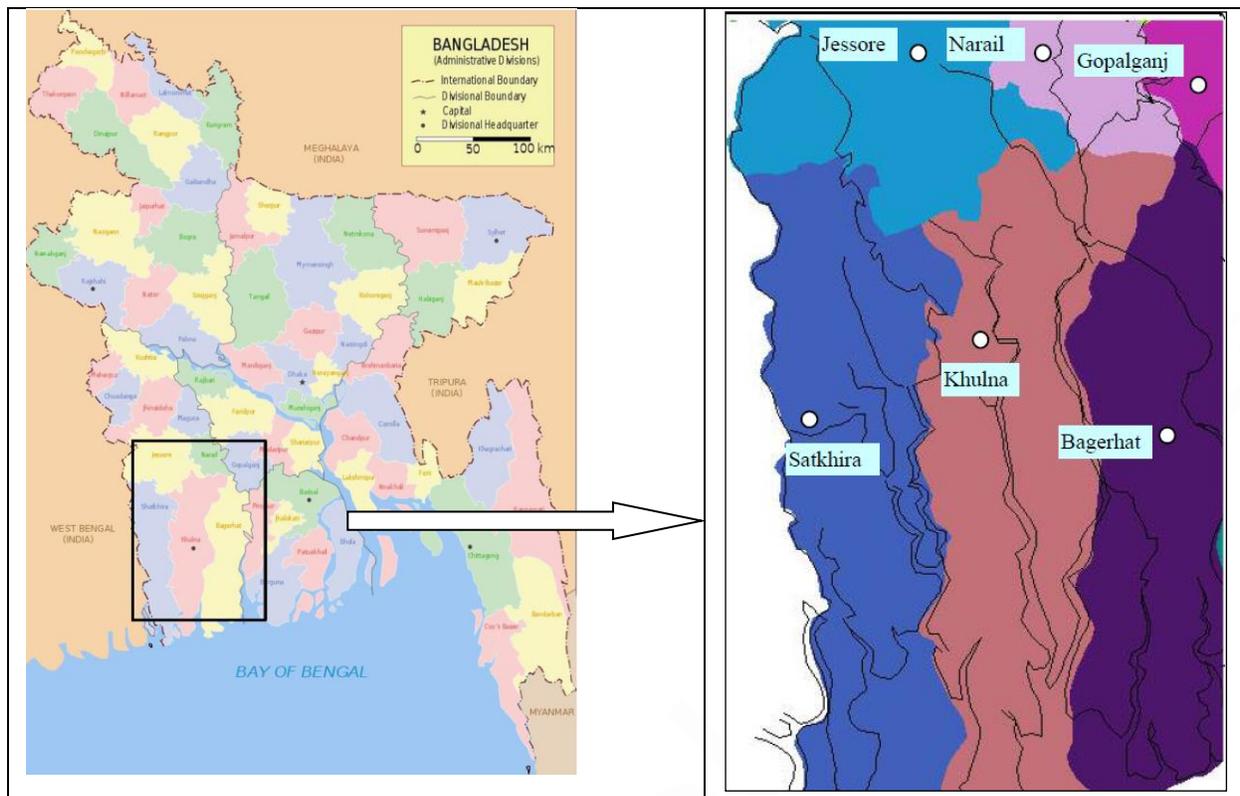


Figure 1 Map of study area

(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 (CTTF)' 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).

However, considering of all of these, this study aims at listing out the existing adaptation practices to climate change induced water related impacts and its critical analysis.

## METHODOLOGY

The southwest coastal region of Bangladesh (Figure 1) is under the scope of this study. 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 50 households were selected randomly for this study. This overall sampling design follows the multi-stage sampling.

During the field visit, Key Informant Interview (KII) and three focus group discussions (FGDs) were conducted with the members of the local forest people's associations coordinated by Unnayan Onneshan-The Innovators. In addition, open discussion was also made on the climate change adaptation to water sector in this area. A structured questionnaire containing social, economic and environmental aspect of existing adaptation practices was used to collect data.

## RESULTS AND DISCUSSION

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. Table 1 and Table 2 show the list of livelihood adaptation and potable water scarcity adaptation respectively.

### Most popular and successful Adaptation practice

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 most popular and successful adaptation practices in the study area include cultivation of hanging vegetables, growing of local rice variety, homestead gardening, purification of pond water using traditional knowledge, rain water harvesting are some of them (Table 3).

**Table 1** Livelihood adaptation practices against the adverse impacts of water induced problems

Name of Practice	Location	Brief Description
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
Cage aquaculture	5 no Koyra & 7 no Uttar Bedkashi unions of Koyra Upazila of Khulna District	Small scale fish particularly <i>Bagda</i> farming in cages at household or community level at water bodies (rivers, <i>khals</i> , <i>beels</i> )
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
Hydroponics	Pirojpur District and Sarankhola Upazila under Bagerhat District	Growing vegetables on floating beds in waterlogged areas
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
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.
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
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. In 4, 5 and 7 no unions of Koyra Upazila are freshly experiencing the increasing practice. Besides, the practice is scattered more or less across the whole coastal region	Growing various types of vegetables (guard, bitter guard, ladies fingers, chilies, cauliflowers, cabbages, radishes, etc) on raised homestead yards
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 sow vegetables seeds.
Aman rice and fish (Bagda, Golda, Rui, and katla) combined cultivation	The adaptation technique practiced in Dumuria Upazila utilizing waterlogged area and Koyra ( particularly in Amadi, Bagali and Koyra union) and Shyamnagar upazila harvesting rainwater	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 paddy field from the fish cultivation pond when necessary.
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

**Table 2** Climate change adaptation to potable water scarcity

Name	Location	Description
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.

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
Rain water 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
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.
Rain water 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.
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
Rain water 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.

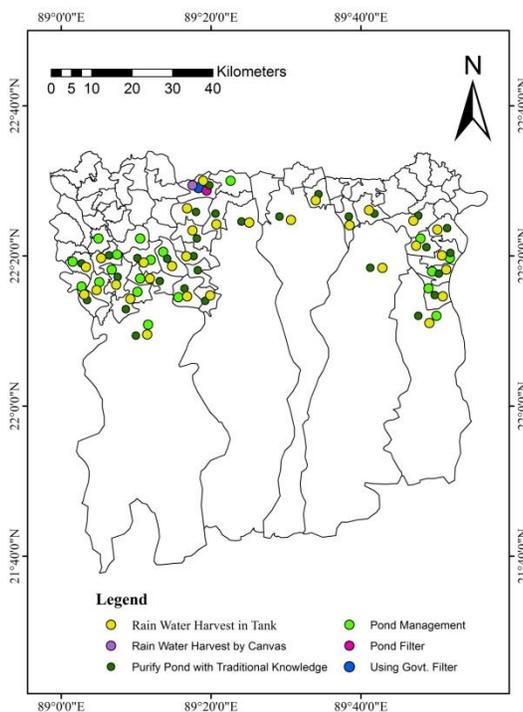


Figure 2 Geographical location of different water adaptation in SW area of Bangladesh

**Table 3** Social, economic and environmental aspects of climate change adaptation practices in water sector

Name of adaptation practice	Social acceptance				Economically profitable			Environmentally Sound	
	Duration of the practice (in year)	Implementing population practice (%)	Accepted by both man and woman	Easily implemented by the all communities	Initial cost of adaptation practice	Additional cost of implementation	Profitable considering its cost	Impact on environment by this practice	Environmental benefits by practicing this adaptation
Dyke cropping	4 yrs (64)	57 (49)	Yes (68)	Yes (50)	Low (50)	Very Low (62)	Low (50)	No (35)	Yes (60)
Cage aquaculture	4yrs (72)	45 (50)	Yes (55)	No (55)	Very Low (34)	Nil (42)	Low (45)	No (30)	No (35)
<b>Hanging vegetables</b>	5 yrs (61)	35(70)	Yes (60)	Yes (60)	Very Low (62)	Nil (50)	Low (65)	No (40)	No (55)
Hydroponics	6 yrs (55)	38(65)	Yes (40)	Yes (65)	Low (45)	Nil (45)	Medium (60)	No (40)	Yes (40)
Cattle Raising	3 yrs (45)	28(55)	No (65)	No (50)	High (72)	Medium (67)	High (45)	No (45)	No (45)
<b>Growing local rice variety (BR 28)</b>	>7 yrs (70)	85 (65)	Yes (60)	Yes (38)	Medium (63)	Medium (70)	High (80)	No (38)	No (50)
Cropping on raised mound	>7yrs (75)	56 (70)	Yes (55)	Yes (40)	Very Low (35)	Low (64)	Low (70)	No (40)	Yes (55)
<b>Homestead gardening</b>	>7yrs (70)	69 (55)	Yes (75)	Yes (50)	Very Low (40)	Low (48)	Low (65)	No (65)	Yes (60)
Combined cultivation of fish and hanging vegetables	4 yrs (45)	34 (48)	No (65)	No (60)	High (65)	Medium (38)	High (55)	No (70)	No (60)
<i>Aman</i> rice and fish combined cultivation	4 yrs (75)	29 (45)	Yes (40)	No (55)	High (60)	Medium (45)	High (60)	No (40)	No (35)
Vegetables cultivation on raised mound at homestead	>7yrs (60)	75 (80)	Yes (80)	Yes (40)	Very Low (32)	Very Low (45)	Low (70)	No (50)	Yes (40)
Purification of pond water using govt. supported filter	4 yrs (50)	30 (60)	Yes (75)	No (45)	High (45)	Low (40)	Medium (55)	No (50)	No (50)
<b>Purification of pond water using traditional knowledge</b>	>7yrs (45)	80 (45)	Yes (60)	Yes (60)	Very Low (50)	Very Low (60)	High (45)	No (55)	No (55)
Rain water harvesting in rectangular concrete tank	5yrs (72)	65 (60)	Yes (75)	No (45)	Medium(38)	Nil (50)	High (42)	No (65)	No (60)
<b>Directly use of pond water through proper pond management</b>	>7yrs (75)	80 (72)	Yes (45)	Yes (55)	Very Low (40)	Very Low (55)	High (38)	No (45)	Yes (75)
Rain water harvesting through hanging canvas while raining	> 7 yrs (70)	60 (55)	Yes (60)	Yes (50)	Very Low (65)	Nil (60)	High (66)	No (60)	No (60)
Pond Filter	5 yrs (45)	45 (60)	Yes (48)	Yes (46)	Medium (55)	Low (60)	Medium (75)	No (45)	No (70)
<b>Rain water harvesting</b>	>7yrs (50)	70 (45)	Yes (35)	Yes (37)	Very Low (60)	Nil (40)	High (68)	No (38)	No (60)

Notes: Figure within the parenthesis indicates the highest percentage of response from the questionnaire survey (n=50). In case of initial and addition cost, Very Low= BDT <1000, Low= BDT 1000-2000, Medium= BDT >2000 to 5000, High= BDT >5000. All of these categories were grouped considering the socio-economic condition of the study area. Again, in case of economic profit, low, medium and high was categorized on the basis of the increased level of money. Adaptation practice in bold font indicates the most successful practices.

## 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 water sector. The main finding of this study shows that cultivation of hanging vegetables, growing of local rice variety, homestead gardening, purification of the pond water using traditional knowledge, rainwater harvesting are some of the successful and popular adaption practices against the climate

induced impacts on water sector. 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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