A REVIEW OF GOOD ADAPTATION PRACTICES ON CLIMATE CHANGE IN BANGLADESH

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ABSTRACT

This paper discusses good adaptation practices for adapting to climate change in Bangladesh to reduce vulnerability of expected climate change. The analysis is based on national reviews of climate change adaptation practices, especially in Bangladesh. This review shows that Bangladeshi different communities and stakeholders are already using adaption practices related with climate risks. Good adaptation practices adopted by national and international NGOs in Bangladesh found quite fit for our environment. Tidal River Management (TRM), Green Afforestation Belt, Community Based Adaptation (CBA), floating agriculture, homestead vegetable gardening, caged-fish culture, raised flood-proof houses, elevated tube wells and latrines, diversified salt and flood tolerant crop varieties, etc. are some examples of good adaptation practices in Bangladesh.

Keywords: *Adaptation practices, TRM, climate change, vulnerability, CBA*

1. INTRODUCTION

Bangladesh is a deltaic country situated between the Himalyan Mountains in the north and the Bay of Bengal in the South. Because of its geographical position, there is little doubt that Bangladesh is likely to be one of the worst affected nations in the face of climate change (Harmeling, 2014). The country annually and inter-annually experience floods, cyclones, droughts, river bank erosions, salinity intrusions, tornados and other natural calamities that have adverse effect on agriculture, fishery, infrastructure, water and health (ADPC & BCAS, 2008).The country has been facing prolonged and repeated floods in the northern and central regions, severe cyclones, salinity increase in coastal areas, erratic rainfall and drought in northwest region (BCAS, 2008).The country has faced devastating Sidr in November 2007, Aila in April 2009, series of flood of 2004, 2007 and 2009, Nargis in 2010 and Mahasen in May 2013 (Ahmed , 2010 ; MOEF, 2009).

Among the least developed countries (LDC) in 2002; Care Bangladesh implemented Reducing Vulnerability to Climate Change (RVCC) project. RVCC project was the first climate change community adaptation project in the Southwest region of Bangladesh. The project piloted several options in context of salinity, flood, water logging and drought. Bangladesh was amongst the first LDCs to produce National Adaptation Programme for Action (NAPA) in 2005 under United Nations Framework Convention on Climate Change (UNFCCC) (MoEF-UNDP, 2005). NAPA suggested a range of adaptation practices for Bangladesh which was subsequently revised in 2009 (MoEF-UNDP, 2005). Technology Needs Assessment Report and National Capacity Self–Assessment (NCSA) was planned in 2009 (IUCN, 2009). In 2008-2009, the country has formulated the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) as a foundation of all activities regarding climate change including Climate Change Adaptation (CCA) (MOEF, 2009). There were several community based adaptation projects undertaken in Bangladesh by Practical Action Aid, Area Development Organization, Bangladesh Center for Advance Studies,

Comprehensive Disaster Management Programme, Food and Agriculture Organization of the United Nations in Bangladesh (FAO), International Union for Conservation of Nature (IUCN), Prodipan, Nabolok, RDRS Bangladesh and some other NGOs.

2. METHODOLOGY

The research mostly based on review of literatures, NAPA documents, case studies of national NGOs, annual activity report of projects , journal publications of adaptation practice on agriculture sectors, fisheries and livestock sectors and water management and the issues of adaption knowledge and technology. We also conducted content analysis of National Adaptation Programmes of Action (NAPA, 2005) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009). Among the reviewed literatures, focus was given on costal aquaculture, biodiversity management, general aspects of ecological based adaptation, coastal belt afforestation, water resource management, agriculture in coastal area, agriculture in drought prone area, rice and aquaculture, integrated farming, water borne diseases, vector borne disease, preparing a floating garden with water hyacinth, floating garden, community based adaptation, advocacy to climate change adaptation, coastline and flood defenses, St. Martin Island adaptation practices. Finally, the paper was divided into sectors like agriculture, fisheries and livestock, etc. as adaptation practices change.

3. RESULTS AND DISCUSSIONS

The analysis of selected publications on adaptation practices to climate change in Bangladesh show that there are a good number of adaptation practices in agriculture, fisheries and livestock, water, health and sanitation, infrastructure, biodiversity and forestry sectors. Those adaptations are practiced in drought prone vulnerable areas of North-West region, flash flood prone area of North-East and South-East region, flood plain area of North-Central, South-West and South-Central region and char land and coastal areas in Bangladesh. These practices have been found quite fitted in these climatic environments and have huge potential to mitigate the long term climatic risks of Bangladesh (Oxfam, 2011).

3.1 Adaptation Practices in Agriculture

Some good adaptation practices are identified in agriculture sectors against flood, drought and salinity. Saline tolerate rice varieties like Bina dhan - 8, Binadhan - 10, BRRIdhan - 47, BRRI dhan-55 are cultivated by more than one million farmers in Bangladesh. Bina dhan - 8 and Bina dhan-10 have been cultivated by farmers in Satkhira, Khulna and Bagerhat districts of south-west coastal region in Boro season. These varieties have the salt tolerate capacity to survive up to 10-12ds/m. Farmers cultivate BRRI dhan - 47 variety that requires less water and tolerance capacity to dry soil is quite high (Alam et al., 2013). BINA dhan - 8 varieties has salt tolerance capacity of EC8-10ds/m at mature stage and also are cultivated by farmers in those regions (DCRMA, 2011). BRRI dhan-51and-52 are submergence tolerant rice varieties and have submergence capacity at least for two weeks under water and are very popular in Sirajganj, Rangpur, Kurigram, Gaibandha and Lalmonirhat districts of Northern region. Farmers are happy with these submergence tolerant rice varieties. BRRI dhan-56 and -57 are short duration rice varieties and are cultivated in drought prone regions of the northern part of Bangladesh like Barind tract, Rajshahi, Chapainawabganj, Natore, Naogaon districts. They are also cultivated in southern region of Bangladesh. These varieties have also wide acceptance in Kushtia, Magura, Chuadanga and Jessore districts where rain seldom occur and both varieties have resistance to blast- a common rice disease in

Bangladesh. These varieties are good instruments for farmers to cope with the future effect of climate change.

The analysis of climate change adaptation practices in thirty agro-ecological Zones of Bangladesh and certain agriculture adaptation practices in selected publications revealed that vegetables in floating bed have huge potentials to mitigate coping problems against flood in south-western parts of Bangladesh (Oxfam, 2009). Floating bed is a popular practice in Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokhathi districts where land remain submerged most of the time in a year. Farmers are raising seedlings and producing vegetables, spices and more than thirty crops (AAS, 2012) using floating gardens. Cultivated vegetables in floating bed include okra (lady's finger), cucumber, bitterguard, khol rabi, pumpkin, water gourd, turmeric, ginger, karalla, arum, tomato, turturi and potato (Alauddin & Rhaman, 2013; UNFCCC, 2006).

Farmers and stakeholders are practicing sorjan system in saline tidal flooding areas through construction of embankment in Kolapara region. Shallow depth sorjans are suitable for the year round cultivation of vegetables and monsoon rice, where the sorjans with higher depths also allow rice-fish or rice-duck farming along with the year-round vegetables cultivation on raised beds. This sorjan system is very popular among the farmers in this coastal region of Patuakhali and annul net return from investment in sorjan system is very high (Sattar & Abedin, 2012).

Homestead gardening is a widely accepted practice in Bangladesh and mainly managed by women. It ensures food security and additional income by enhancing livelihoods of poor people. So, homestead gardening is considered as good adaptation practice and widely practiced in Nachole, Gomastapur, Porsha and Sapahar. Leafy vegetables such as kangkong, batisak, sweet tasting stem, amaranth (Ktora danta) are grown in homestead gardens. Homestead gardening is well adapted to low soil moisture and high temperature (FAO, 2008).

Permanent raised bed is an innovative and conventional practice in Nashipur and Rajshahi. Water-melon, okra, BARI Tamato-3 performed better in raised bed using mulching in Noakhali and Shatkhira coastal zone (FAO, 2008; Aladdin & Rahman, 2013).

Farmers are adopting high value cash cropping system in chars of the Teesta River in Lalmonirhat district and chars of the Ganges River in Rajshai district and chars of Chapinawabganj districts like cabbage (Atlas 70), cauliflower (Snow Star), onion (Taherpuri), groundnut (Dac-1) in Asriadah char in Rajshahi, Pakachar in Chapainawabganj district during Robi season and maize (NK 40 900M, 900 gold), country bean (LIV),white gourd (LIV), pumpkin (Baro mashi) varieties in Rajpur char, Folimari char, Holdibari char, Kalikapur char in Lalmonirhat district and Gorgori char in Rajshahi in Robi and Kharif season (AAS, 2012).

In coastal region, salinity is a major problem to cultivate agricultural crops. Farmers are using zero tillage potato cultivation using straw as mulch and zero tillage potato without straw. Zero tillage cultivation is better for production of potato in Nazirpur Upzila as livelihood adaptation to climate change. Zero tillage is also used for garlic cultivation in Natore district.

Two crop production cycles are also popular as nutrition requirement of crops is supplemented by each other cultivation like sunflower, chickpea and Khesari after the cultivation of T. Aman in coastal regions (Rashid et al., 2014). It is also accepted by coastal farmers to reduce food crisis.

Sunflower of variety Hi-Sun-33 is adopted as Rabi crop in coastal region of Jhalokathi for meeting up edible oil requirement as well as higher income and saving of foreign currency. BRAC has

undertaken a pilot study to popularize sunflower in coastal belt and to develop local market for this crop and also has established a mill for oil extraction (Rhaman, 2012).

Salt tolerant sugarcane variety ISWARDI-40, BINA sarisa-5 and BINA sarisa-6, sweet potato varieties like BARI SP-6 and BARI SP-7, BARI Mung-5 and 6, BARI Sweet Gourd-1 and 2, spinach, BARI Tomato-1, Knolkhol and beet are being cultivated as adaptive options in the coastal areas. Jute kenaf varieties HC-2, HC-95, CVL-1 are identified as potential adaptive practices in Satkhira and Patuakhali stations (BARC, 2012).

The eco-friendly pheromone trap technology is widely practiced in Baniachai, Habiganj district. To control crops pest, farmers are applying pheromone trap in brinjal and gourd cultivated fields. It is well established that use of pheromone trap is cost effective to pest control and very healthy and environmental friendly (Islam, 2012).

3.2 Adaptation Practice in Fisheries and Livelihoods

Communities and stakeholders of coastal, drought prone and hilly areas have achieved risk reduction adaptation practices in fisheries and livestock sectors quite well. It was indentified that adaptive practices like shrimp farming in Ghers during high salinity period (January-July) and freshwater carps farming during low salinity period (August-December) are well adapted and Bangladeshi and Chinese species or tilapia (*Oreochromis niloticca*, *O.mossambica*), *Lates calicarifer*, *Eleutheronema tetradactylum*, *Glossogobius giuries* and *Mystus menoda* are well accepted species. Moreover, salt resistant Aman paddy is cultivated in Shatkhira, Khulna, Bagherhat of south-west region and Cox's Bazaar, Chittagong of south-east region (Karim, 1986).

Crab fattening is increasingly accepted as livelihood practice for many families in the south-west coastal districts of Shatkhira, Bagerhat and Khulna. Such adaptation became favorable among coastal communities due to natural phenomenon like tidal inundation, water logging, saline water, available feed for crab, very profitable livelihood option, low investment and high demand in Dhaka market and abroad (Alam et al., 2013). A good number of farmers culture and fatten mud crab (*Scylla scrrata*) in gher of Chittagong region (Abdulla-Bin, 2013).

Fishermen culture mono-sex tilapia in cage system along the lower Meghna River in Chandpur and Rhamat Khali canal in Lakshimipur (Mustafa, 2013). Landless families also culture tilapia in cages along the Aandhamanik River in Patuakhali (www.shibleehatcheryandframsltd.blogspot.co.uk) and this practice is also running well in Shatkhira. Landless Adivasi householders and farmers are using cages for culture of genetically modified tilapia (*Oreochromis niloticus*) fingerlings in ponds in Kaharole Upzila of Dinajpur, Rajshai, Nilphamari, Panchaghar, Rangpur, Thakurgaon districts (Gupta et al., 2012).

Integrated rice-fish farming is in practice in Mymensing district by the local communities (Ahmed et al., 2011) and duck-fish-vegetables are popular in Dinajpur district. Farmers are satisfied with integrated rice-fish practice. It is effective for them for easy maintenance and good profit. Farmer's communities as well as stakeholders fatten fish using fish fattening technology in integrated farming system in Natore district (AAS, 2012).

The Community Based Adaptation to Climate Change through Coastal Afforestation (CBACC-CF) practice "Triple - F Livelihood" model for enhancing adaptation capacity of coastal communities in Hatiya of Noakhali district, Char Fassion of Bhola district and Bargun Sadar.

Different livelihood approaches in agriculture and fish cultivation, tree plantation and duck rearing are practiced considering salinity risks and fresh water scarcity in coastal areas (Alam et al., 2013).

3.3 Adaptation Practice in River Basin Management

One of the major findings of the review is the Tidal River Management (TRM) Adaptation Practice. A huge area in the southwest coastal region is to be the hardest hit by climate change induced sea level rise predicted by climate experts. TRM is a unique indigenous ecological knowledge of river management and collective effort of local communities to raise coastal land to a desired height. Bangladesh Water Development Board (BWDB) learned the concept in 1990s from the local communities and about 31.32 km^2 of land had been raised by local communities themselves in Beel Bhayna and Beel Dakatiya applying TRM. In Beel Jethua, belonging to the Kabodak river basin, local communities raised land by more than one and half metre, in one year, in a beel of 450 acres using this sediment management practice (Kibria & Mahmud, 2010). TRM practice in Bhayan Beel had helped to increase river flow and depth and to reduce the incidence of water logging (Oxfam, 2011). It has been revealed that TRM is the most effective method to raise land and make it cultivable, mitigate the water-logging crisis, increase the navigability of rivers, reduce salinity and protect coastal regions from sea level rise.

3.4 Adaptation Practice in Water and Sanitation

The coastal area, drought prone north and the north east and the south central floodplains are suffering from acute problems of safe water for drinking and irrigation. Now people are using Reverse Osmosis technique in Debhata, Kaliganj and Ashashuni Upazila for removing of slat of ponds .About 2000 households are using Pond Sand Filter in Shyamnagar of Shatkhira.

Gomestapur Upazila of Chapainawabganj district has no facilities of deep tubewell irrigation. In monsoon seasons, famers excavate mini-pond in their fields to store rainwater and use water from mini-ponds for supplemental irrigation. The majority of farmers in this area have adopted rice and mango intercropping, diversified drought tolerant crop variety like BARI Barely-6, BARI Chola-5, Mugbean lines BMX-011007, sugarcane, mango, jujube, pulse and oil crops.

Villagers of Sariakandi and Bogra are practicing flood proof raised tubewells and flood proof sanitary latrines (Practical Action Bangladesh, 2010). Households harvest rain water and store them in tank to ensure safe water for the people of Shatkira (CDMP-II). Marma women use Gravitational Flow System (GFS) for storing safe water in Bandarban (AF, 2014). In Chittagong hill tracts, GFS is an important adaptation practice for drinking water, small scale agriculture and horticulture and daily household purposes.

3.5 Adaptation Practices in Infrastructure

Structural adaptation practices in Sariakandi reduce disaster risk and poverty by construction of Jamuna Right Embankment and Spur in the Jamuna. In Sariakandi, Bogra, Gaibandha and Sriajganj districts, 135 homeless families have built cluster villages above high flood level. These houses reduce not only physical exposure of the families to disasters but also open the opportunity of economic activities increasing their resilience (Practical Action, 2010).

Chailia, disaster endurable house, embankment, flood/cyclone shelter, raising plinths are the major adaptation options to protect villages, houses and homesteads and livelihoods from the risks of climatic disaster particularly cyclone and flood in coastal and floodplain areas. Villagers of Shatkhira adopt bamboo and chailia for protection of village, disaster endurable houses, and

institutional grounds rising for flood shelter, raising plinths above the flood level (Source: CDMP).

Hoar areas of the north-eastern part of Bangladesh suffer from flash floods caused by sudden and early downstream water from the surrounding upstream rivers during the period from March to May. Flash floods take place more frequently and without any prediction. These floods cause quick damage to crops and property. Haors are important areas for Boro rice cultivation (a rice variety cultivated from December to May). This Boro cultivation is a largely mono-cropping agriculture system in haor areas. But the early flash floods often inundate standing crops and people lose their harvest from early flash floods. Low-height submersible embankments along the periphery of the haor are built by BWDB to protect the Boro from flash flood in many haor areas. The built submersible embankments protect the Boro paddy from initial inundation during early flash floods and thus help the farmers to protect their Boro from early flash flood. Construction of earthen embankment is a conventional practice for protecting people's lives and homes, agricultures and infrastructure (CARE, 2010; FE, 2 014).

Coastal green belt is one of the best adaptation practices to protect local, coastal and regional areas from storms, cyclone and tidal surges. It is essential to reduce the wind speed by planting appropriate tree species, which can withstand the high speed of wind and break the wind speeds. Naturally grown halophytic plants have the special adaptation for withstanding in the littoral zones with clayey alluvial soil, tides and strong salinity and winds. There are several palm species and swamp grasses having soil binding capacity to control erosion. They also reduce the speed of tidal surges (Alauddin and Rahman, 2013).

The inhabitants of the coastal zone are used to adapt and manage the frequent storms and cyclones by using their local knowledge and building their homes on raised floor, with low height and surrounded by highly protective coconut, areca nut and fishtail palm trees for breaking strong winds and surges. The forest department has started a mangrove plantation program outside protective embankments in order to protect life from cyclones and tidal surges.

3.6 Adaptation Practice in Health

Bangladesh has Community Clinic Services in ward level. They provide services during disaster period also. They provide seasonal disease information service to the community people. Radio Nalta in Kalignj of Shatkhira forecasts early warning system and climate resilience measures on public health for the coastal population. International Centre for Diarrhoeal Disease, Bangladesh (ICDDR, B) practices climate based cholera prediction model for Matlab, Chandpur which is a highly cholera (*Vibrio choleae*) epidemic area (CCC, 2009).

Vector borne malaria is one of the major public health concerns in Bangladesh. Out of 64 districts, 13 broader districts in the east and northwest are high risk zoon of vector born disease. Heed Bangladesh implement malaria control programme (MPC) in Jaintiapur Upzilla of Syhelt. It works in all 6 unions covering 25029 households and 152614 people. Householders are practicing long lasting insecticide treated nets and bed nets to control mosquito. Malaria control projects in high risk prone areas distributed stickers, poster and installed billboards in different places of working areas for awareness against malaria (Source;National Malaria Control Programme, Governments of the Peoples Republic of Bangladesh).

4. CONCLUSION:

Several good adaptation practices have been identified that can be tailored to the future changing climate in context of Bangladesh and can help in finding out future pathways on integration of best adaptation practices in ongoing as well as in future Climate Change Adaptation (CCA). Tidal River Management (TRM), Green Afforestation Belt, Community Based Adaptation (CBA), floating agriculture, homestead vegetable gardening, caged-fish culture, raised flood-proof houses, elevated tube wells and latrines, diversified salt and flood tolerant crop varieties, etc. are some examples of good adaptation practices in Bangladesh. The lessons learned so far could be replicated with modifications to be found from innovative research and applications in real field life.

ACKNOWLEDGMENT

The research leading to these results has received funding from the European Union Seventh Framework Programme FP7/2007-2013 under grant agreement no. 603864.

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