Submissions by Bangladesh on Adaptation Approaches, Strategies, Practices and Technologies for Adaptation

Type of adaptation action[1]	Title of adaptation action, including projects	Status of adaptation action - ongoing - under implementation - under development - under consideration	Needs in order to successfully implement the adaptation action	Concerns/ Barriers	Experiences/ Lesson learned	References i.e. publications, websites etc.
Scope of adaptation action ***Regional level***						
Approaches/ strategies	The 14th SAARC Summit, held in New Delhi during 3-4 April 2007 has adopted a decision to approach climate change as a regional concern. The immediate outcome is to organize a workshop this year where regional experts will identify coastal concerns and adaptation options. The prioritized options and actions	Under consideration	Regional workshop to draw relevant experts from member countries to develop specific actions to take up nationally and regionally. Additional resources and funds will need to be identified and secured to implement the adaptation actions.	Political commitment and support from key governments and the relevant international institutions.		Paragraph 13 of the New Delhi Declaration. Web address provided for full text

[1] Please be aware of the degree of adaptation within activities:

- Some activities are undertaken specifically to adapt to climate change, e.g. increased water storage capacity, development of new crop varieties.
- Some activities include a component of climate change adaptation, e.g. infrastructure replacement incorporating higher flood standards
- Some activities are not carried out for adaptation but have other objectives such as preserving biodiversity, however they can offer adaptation co-benefits, e.g. restored wetlands protect against storm surges.

	will be developed into projects for funding and implementation.					
Practices						
Technologies						
National level						
Approaches/ strategies	The Climate Change Cell, Department of Environment has developed a generic tool to operationalize mainstreaming and integration of climate risks management and adaptation. The objective of the country framework is establishing a mechanism that facilitates national development planning and implementation to integrate adaptation to climate change and climate risk management systematically and over time.	Under development. A National Workshop took place on 20 February 2007, and the resulting outcome is preparing a road map for Bangladesh to adopt this tool for mainstreaming across all sectors and at all levels.	The projects need to be developed further by host agencies, ministries. Available resources and funds are required to implement the projects.	Major concerns and barriers are described in the NAPA document Section 3.3.3 page 20.		*Climate Resilient Development – Country Framework to Mainstream Climate Risk Management and Adaptation,* published in November 2006 by Climate Change Cell, DoE, Bangladesh. Full text Available from website, or by requesting on email

	Bangladesh has also prepared its NAPA which outlines prioritized actions for adaptation and includes a list of projects for immediate implementation Concept notes on the 15 prioritized projects are contained in the report.	Under consideration. The document has been submitted with UNFCCC.				Web source provided
Practices						
Technologies						
Local (community) level						
Approaches/ strategies						
Practices						
Technologies						

Web link for 14th SAARC Summit New Delhi Declaration - www.priu.gov.lk/news_update/Current_Affairs/ca200704/20070405saarc_moves_implementation_phase.htm

Web link and email address of Climate Change Cell for the Country Framework on Climate Resilient Development www.climatechangecell-bd.org; info@climatechangecell-bd.org;

Web link for Bangladesh NAPA unfccc.int/resource/docs/napa/ban01.pdf

Sectoral level[2]						
Agriculture						
Approaches/ Strategies						
Practices						
Technologies						
Water resources						
Approaches/ Strategies						
Practices						
Technologies						
Health						
Approaches/ Strategies						
Practices						
Technologies						
Coastal zones (settlements)						
Approaches/ Strategies						
Practices						
Technologies						
Others (please provide information about other relevant sectors) North west-Barind Area (Drought prone and drought affected						
Approaches/ Strategies	Department of Agricultural Extension (DAE) with Food and Agriculture Organization on the UN , with support from Comprehensive					"Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agriculture Sector"

[2] The sectors below are given as examples. Please provide information on any other sectors which you consider important and have examples to share.

	Disaster Management Progra,mme of UNDP is implementing a project *Livelihood Adaptation to Climate Variability & Change in Drought-prone Areas of Bangladesh*					Case study report - Developing Institutions and Options for Livelihood Adaptation to Climate Variability and Change in Drought-prone Areas of Bangladesh, May 2006, The publication can be accessed from FAO website or a pdf version may be requested from the Climate Change Cell.
Practices						See Attached table -1
Technologies						See attached table-1

Table-1 Categories of adaptation options and their sources for drought risk management under the project Livelihood Adaptation to Climate Variability & Change in Drought-prone Areas of Bangladesh

Sl. No	Categories	Adaptation practice	Source
1.	Agronomic management	Seedbed method for T.*Aman* rice	Farmers and experts
2.		Manures and composting	Farmers
3.		Depth of transplanting for T.*Aman*	Farmers
4.		Weed control-reduce water seepage	Farmers
5.		Manual closing of soil cracks	Farmers
6.		Strengthening field bunds (Ail lifting)	Farmers
7.	Water harvesting	Re-excavation of traditional ponds	Farmers
8.		Re-excavation of khari canals	BMDA
9.		Canals	Farmers
10.		Water control structures	BMDA
11.		Miniponds	BMDA
12.		Supplemental irrigation	Farmers/ DAE
13.	Water resources exploitation	Shallow and deep tubewells	BMDA
14.	Water use efficiency	System of rice intensification	Experts
15.		Direct sown rice (drum seeder)	Experts
16.		Drought resistant rice varieties	Multiple sources
17. a)	Crop intensification	Green Manure – T.*Aman* system	Farmers
b)		*T. Aus* – Chini atap system	Farmers
c)		*T. aman* – Mustard/linseed system	BARI/ BRRI
d)		*T. aman* – Chickpea	BARI/ BRRI
e)		*T. aman* – Mung bean	DAE
d)		Famine reserve crops	Experts
18.	Alternate enterprise	Mango cultivation	Farmers
19.		Homestead gardens	BARI
20.		Mulberry intercropping in rice	BRRI
21.		Fodder cultivation	DoL
22.		Fish cultivation in miniponds	DoF
23.		Cottage industries	Community
24.		Manufacturing industries	Community
25.	Alternative energy source	Community based biogas and tree planting	Experts
26.	Post harvest practices	Seed storage for higher viability	Farmers

ADAPTATION TO CLIMATE CHANGE

Adaptation Possibilities: A brief Overview of Options

The implications of high intensity floods cannot be overemphasized in Bangladesh. Management of flood in future will remain a major challenge, especially in view of further densification in increasingly flood vulnerable lands (Ahmed *et al*., 1998a, Faruque and Ali, 2005). Creation of flood defense along the major rivers has been recommended by several authors (Alam *et al.*, 1998; Mahtab, 1989, Faruque and Ali, 2005). Community efforts to cope with floods can tremendously benefit from issuance of early warning. Improvement of current flood warning system and dissemination in people-friendly manner are thought to be highly potential adaptation option for future (Ahmed, 2005a). To enable this, one may contemplate further improvements in terms of modelling of monsoon rainfall throughout the GBM region and effective regional cooperation for on-time transfer of data from upstream areas along the GBM river systems as necessary pre-conditions for adaptation (Mirza and Ahmed, 2003).

Removal of impediments of drainage (dredging/re-excavation of choked rivers/khals; drainage canals), construction of drainage structures (culverts, bridges, and regulators), rehabilitation of structures such as roads, embankments etc. should be considered as adaptation measures towards facilitating drainage and reduce flood-related vulnerability (Ahmed *et al.*, 1998a, Ahmed, 2005a; Faruque and Ali, 2005). Pumping out water to remove water logging, especially in polder areas, has already been practiced, which will likely to be considered as an adaptation option for future (Faisal *et al*., 2003). In view of urban flooding, this option will remain as an important adaptation option despite the high cost of its implementation. In increasingly flood vulnerable areas (FVA), efforts should be made for flood proofing of infrastructure, as deemed necessary (Faruque and Ali, 2005). Similar to that of Multi-purpose Cyclone Shelters, flood shelters should be built in FVAs (Choudhury *et al*., 2003; GOB, 2005). In recent years, community-based flood management practices had shown high potential, which could also be considered as an important modality to adapt to climate change induced floods (Ahmad *et al*., 2004). A large number of small steps have been considered to advance community-based flood management, each of which deserves due consideration.

For drought management, making water available to offset moisture deficit appears to be the major adaptation modality (Karim, 1996). However, creation and recreation of water storage systems (ponds, *khals*, reservoirs etc.) – operated and maintained by vulnerable communities – needs to be given due emphasis (WB, 2000). Choice of low-water-consuming crops instead of paddy will reduce immense pressure on dwindling ground water aquifers (Ahmed, 2005b). Such an adaptation will not only help diversify crop agriculture, it will also counteract gradual lowering of piezoelectric surface of groundwater aquifer system (Ahmed, 2005a). Capacity building for advanced irrigation techniques could also be considered as an important adaptation option in order to conserve available water resources. Conjunctive use of water for irrigation, as highlighted in National Water Policy, might also be considered as an important adaptation option (Ahmed, 2004a). Resuscitation of surface water bodies including silted-up rivers and rivulets should be given due priority in order to maintain water bodies even during the dry season for irrigation purposes (Ahmed *et al*., 1998a). The proposed Ganges barrage is thought to offer huge potential for adaptation, especially for the entire Southwestern region (BUP, 2001; CEGIS, 2006). Regional cooperation towards ensuring augmentation of dry seasonal flows in international rivers has also been considered as an adaptation option (Ahmed, 2004a; Ahmed, 2005a).

Maintaining a sustained flow regime in coastal rivers throughout the dry season and flushing of brackish water zones with increased volumes of freshwater will help adaptation to increasing salinity ingress under climate change. Ahmed (2004a and 2005a) argued that, investing on a barrage on the Ganges River would profusely benefit the southwestern region of the country by pushing salinity front towards the bay. Indeed, CEGIS (2006) found this measure as highly

beneficial against ingress of salinity under climate change. It is also found that the option of having a barrage with proposed link canals to maintain a good flow regime along Betna-Bhairab, Gorai, and Madhumati systems would provide high dividend in terms of salinity control under climate change.
Deaths arising from cyclones and associated tidal bores (both human and livestock) could be minimized by maintaining the Cyclone Preparedness Programme, and further strengthening the programme by means of building new MCSs, killas and other facilities along the coastal zone (Mahtab, 1989; Ali, 1999). The dilapidated structures need to be replaced by new ones, whereas those requiring occasional repairs should be repaired to enhance capacity to save lives when needed. The polders which might be at risk of inundation due to rising sea levels and/or by invigorated tidal waves should be identified and rationalized, in order to enhance their efficiency towards safeguarding lives, crops, and properties (Ahmed, 2005a). NAPA for Bangladesh proposed community focused coastal afforestation as a priority adaptation measure to reduce climate hazards (GOB, 2005).

According to Ahmed (2004a), there exist a good number of policy elements in the current policy regime which offer good adaptation potentials. Efforts need to be made to analyse these options further and through institutional coordination, a few of these adaptation measures – as outlined earlier in this section – be implemented on a priority basis. The NAPA has forwarded a few prioritized programmes in water sector (GOB, 2005), which could be given high priority. This itself has been regarded as an institutional adaptation, which may be advanced further as well as mainstreamed by the development of a proposed 'climate change adaptation policy' (Ahmed, 2004a).

In addition to adaptation in water-resources sector, one must consider adaptation in agricultural sector. The gravity of the issue and its importance on people's livelihoods deserve special treatment, which is why the potential adaptation options in agriculture are discussed separately in the following section.

According to WB, the risk associated to human health in tropical developing countries is one of the salient risks of climate change (WB, 2000). Bangladesh's current vulnerability to outbreaks of cholera and other waterborne and diarrheal diseases such as dengue or dysentery needs to be given due importance in view of increasing risk potentials caused by climate change induced drainage congestion and standing water. Treating pathogen-laden water with a mixture of lime, bleaching powder and alum, as provided in Ahmad *et al*. (2004), should be given due importance to avoid large-scale outbreak of water borne diseases. Inadequate provisions for drinking water in saline affected regions adds to people's vulnerability, which needs to be given high priority towards designing national adaptation programmes (Ahmed, 2005a). Providing saline free drinking water should be considered as an immediate adaptation in view of current as well as future health risks (Ahmed, 2004b). The pressure on the availability and access to safe water, in particular during the dry period, and the increasing reliance on groundwater are an additional threat. RVCC project considered designation of community ponds to establish PDFs as an adaptation (RVCC, 2003). Moreover, sinking deep hand tubewells, subject to availability of groundwater sources, and building community/household based rainwater harvesting units in water scarce regions should be considered as adaptation measures, as promoted through the RVCC project (Ahmed and Schaerer, 2004).

Awareness needs to be increased among illiterate and poor people, especially along the drier western parts of the country, to combat heat-stress related health disorders. Improved cyclone as well as flood shelters, with increasing capacity and coverage, are likely to reduce overall death tolls in case of climate change induced high intensity disastrous events. Similarly, building relatively stronger houses by low-cost retrofitting along the cyclone-affected coastal regions could save lives as well as assets (RVCC, 2003). Safe use of carbolic acid would reduce susceptibility to snake bites in flooded regions. Use of oral rehydration saline for treating diarrheal patients will continue to save lives. Other major adaptation proposed for human health involves improving the health care system,

which is needed anyway to address the current human health situation. These improvements could significantly reduce the risks to human health from climate change (WB, 2000). Thus, the benefits of improving health care are likely to be even greater when avoided health impacts of climate change are accounted for.

Very little research has so far been undertaken to fully appreciate implications of climate change on ecosystems and biodiversity. However, it is suggested that ecosystems and biodiversity may be at greatest risk of all sectors sensitive to climate change (WB, 2000). Since the management of ecosystems is still relatively weak in its institutional realization and the institutions that are involved lack the capacity, adaptation to climate change for ecosystems and biodiversity warrant special institutional arrangements. Maintaining a sustained freshwater flow along the distributaries of the Ganges River, particularly in the dry season, has been recommended as a viable adaptation option

(Ahmed, 2004a). CEGIS (2006) considered two adaptation options[15]: the 'Ganges barrage option' and the option for 'augmentation of lean flow of River Gorai'. Modelling results provide ample evidence that both the options will be useful for adapting to increasing salinity along the Sundarbans.

Adaptation in Agriculture: Identifying Potential and Limitations

Crop agriculture in Bangladesh is highly susceptible to variations in the climate system. It is anticipated that crop production would be extremely vulnerable under climate change scenarios, and as a result, food security of the country will be at risk. Despite being highly vulnerable, very little efforts have so far been made to understand potential of agricultural adaptation in Bangladesh. Ahmed (2000) made an early attempt to analyse the adaptation potential of the country's crop agriculture in a warmer world. Faisal and Parveen (2004) examined food security aspect and implications of climate change, however adaptation potentials were not discussed. A brief account of adaptation types, based on IPCC typology of adaptation (UNEP, 1996), and limitations of a few adaptation options in agriculture are provided below.

Bear Crop Losses When potential loss of a standing crop is totally accepted by the growers, bearing crop losses is an adaptation option. It is however criticised that the option is rather theoritical, with limited applicability in Bangladesh (Ahmed, 2000). In practice, it is argued that, it is possible only when the cost of adaptation appears to be higher compared to the net crop loss. Such responses are often strategic and situation-specific.

Share Losses The anticipated crop losses may be shared among the stakeholders. Compensating the farmers for trying out agricultural activities under high threats of crop loss can be a potential mechanism for sharing loss. Provision of insurance against crop loss has worked well in advanced economies. Provision of government subsidies and remission of taxes for the farmers operating in susceptible croplands could be other possible options where some of the losses might be shared among the different stakeholders. Loss sharing strategies necessitate strong political will, adequate financial resources and careful planning. Loss sharing mechanisms can be a very local affair, and sometimes can even be extended to the worldwide family of humanity.

Modify the Threats to Crop Production This appears to be the mostly practiced option in Bangladesh. Vulnerability analysis may provide important lessons concerning the nature and extent of the threats to crop production under a given climate regime. In such cases, adequate precautionary measures might possibly modify the threats. Although most of the precautionary measures are anticipatory in nature, there might be some spontaneous measures as well.

Modifications may be approached either on an individual or a collective basis. Many such measures are technology-oriented and may require early investment for research and extension.

Development of drought and/or salinity tolerant varieties, switching to alternative cropping patterns with respect to altered agro-ecological zones etc. could modify the threat to a significant extent. Good extension programmes would help achieve awareness up to a desired level so that the farmers may respond to the threatening environmental factors. Adequate policy framework and market instruments (technology availability at subsidized rates, credit, etc.) coupled with social engineering processes could facilitate implementation of such measures.

Prevent Adverse Effects Some measures might consider preventing the losses in agricultural production. Preventive measures are anticipatory and might require large-scale investments. Building of large embankments to protect prime agricultural lands from excessive flooding may be cited as an example of preventive measure. Preventive measures often involve financial and institutional support of the government for planning and implementation.

Change Land Use In case it becomes extremely risky to continue agricultural activities under an altered climate scenario, an alternative land use might be considered as the next available option. If the suitability of Aus[5] paddy in pre-*Kharif* months (March-June) appears to be too low, the farmers should alter the land use and instead grow other suitable crops. However, such alterations should ideally lead to acceptable economic returns, optimizing social goods and services. In *beel* areas, growing *kachu* & *kachu-mukhee* (a local vegetable) appears to be better land use option than growing paddy with a risk of higher levels of inundation. In water logged areas, attempts have been made under the RVCC project to create floating gardens (i.e., hydroponics) by the use of water hyacinth and grow vegetables. The application of a indigenous practice through capacity building and extension allowed farmers of Jessore District to profitably change their land use and maintain livelihoods (Ahmed and Schaerer, 2004).

Change Location Change of location entails relocation of agricultural activities in areas that are not likely to be adversely affected. For Bangladesh, this appears to be a theoretical approach. Here access to land resources per capita is already high and there is hardly any unproductive land. Relocation, therefore, might not be socially accepted. Opting for relocation may necessitate long-term planning involving the farmers, farming communities and local governments. Planning for relocation has to be done through consultations among those involved. The farming communities that would have to accept such relocation in their areas should be compensated for lost opportunities. On the other hand, change of location may be a spontaneous adaptation (rather coping) measure in the highly vulnerable areas and people may become *climate change refugees*(UNEP, 1996). Table-2 highlights a few agricultural adaptation, according to the IPCC typology of Adaptation (Ahmed, 2000).

Table -2 Adaptation measures and requirements for crop cultivation under climate change in Bangladesh

Adaptation Measures	Requirements	Comment
Bear loss (no adaptation) - Loss of production - Loss of assets		Hypothetical, highly unlikely to take place.
Share losses - Crop insurance - Cooperative management - Governmental subsidies	Additional investment in terms of premium. Agreement for sharing the output. State allocation for offering subsidies. Adequate legal and institutional framework.	Provisions to be made. Political motivation is required.
Modify the threats - Preparedness (early warning) - Awareness and training - Investment for structural measures	- Research & extension - Extension, media campaign - Investments (anticipatory) - Crop calendar adjustment - Opting for less susceptible crops	Farmers are already practicing it, based on ancestral behaviour/ knowledge. Manifold opportunities are plausible, barrier removal and implementation could be less costly. High priority option.
Prevent adverse effects - Structural measures	- Large investment - Political motivation - Long-term planning	Investment intensive option. Financial constraints might hinder implementation process.
Change land use - Alternative cropping - Abandon crop agriculture	- Innovation through research, investment - Means of survival, skills for alternative employment	Unless alternative employment opportunities are created, it is not likely to be accepted socially.
Change location - Relocate to less vulnerable places	- Free cultivable land	Heavily constrained due to unavailability of fallow cropland.

Source: Modified from Ahmed, 2000.

The project titled Reducing Vulnerability to Climate Change (RVCC), implemented in six southwestern Districts of Bangladesh during 2002 till 2005, applied a few interesting adaptation measures in a bid to reduce vulnerability of communities to climate change by increasing people's coping capacity (RVCC, 2003; Schaerer and Ahmed, 2004). The agricultural adaptations worth special mention, due primarily to their simplicity and their overall social acceptance. Table-3 highlights the agricultural adaptation measures considered under the project.

Table 3: Strategic Approaches Considered for Agricultural Adaptation for RVCC Project

Strategy	Measure	Brief Description of Measure
Household level strategies in agriculture (crop, fishery, agro-forestry, & livestock)		
Increase food through agriculture	Drought tolerant crops/vegetables	Introduction of drought tolerant crops such as groundnuts, watermelon, etc.
	Floating gardens	Cultivation of vegetables on floating beds of water hyacinth (hydroponics)
	Low-cost irrigation	Demonstration of treadle pump and other simple technologies for irrigation
	Homestead gardening	Cultivation of vegetables and fruits on homestead plots for consumption and market
	Saline tolerant non-rice crops	Introduction of saline tolerant varieties of chili, mustard, maize and potato
Increase income through alternative livelihoods	Embankment cropping	Cultivation of beans, gourds, okra & other vegetables on embankments surrounding prawn *ghers* (ponds)
	Integrated farming systems	Using small area of land, small water body, and surrounding embankments to produce rice, fish and vegetables
	Cage aquaculture	Small-scale fish farming in cages, implemented in household ponds or common water bodies
	Prawn fish poly-culture	Prawn and fish culture in fresh-water *ghers* (ponds)
	Shrimp fish poly-culture	Shrimp and fish culture in salt-water *ghers* (ponds)
	Cattle rearing	Raising cattle for consumption and market
	Poultry rearing	Raising chickens to produce meat and eggs for consumption and market
	Crab fattening	Collection, rearing and feeding of crabs for a period of 15 days to increase their market value
	Duck rearing	Raising ducks to produce meat and eggs for consumption and market
	Goat rearing	Raising goats for consumption and market
	Pig rearing	Raising pigs for consumption and market
	Apiculture & honey processing	Beekeeping and processing of honey for market
	Nursery & homestead afforestation	Establishment of community nurseries and distribution (with handling instructions) of indigenous varieties of tree saplings (mango, coconut, *sofeda, korai*, guava, *mehaguni*, neem, *kewra*, etc.) to beneficiaries for homestead planting
	Saline tolerant tree plantation	Planting of saline tolerant fruit and timber trees for longer term income generation
	Mele (reed) cultivation	Cultivation of reeds that are used to produce mats that are widely used for sitting and sleeping on

Source: Modified from Schaerer and Ahmed, 2004.

Limitations of Agricultural Adaptation

It is reported that the existing institutions had inherent inefficiencies, lack of foresight in planning for the future, poor coordination among relevant institutions, poor information assimilation capacity and lack of trained and motivated personnel (Ahmed, 2000). As a result, those often proved to be ineffective. The central government could not successfully utilize the full potential of the local government and the latter could not assume the full responsibility of implementing local-level planning due to weaknesses in governance system. This made it difficult to implement development activities at the grassroots. All these are possible barriers to successful adaptation, which might have direct implications in agricultural sector.

People's lack of understanding might also be considered as a possible barrier. Lack of understanding on far-reaching implications of certain actions considered by one can jeopardize adaptation options taken by many. Resorting to alternative livelihood options could be of immense help if understood their merits properly and planned early. Capacity building might be a pre-requisite to enhance people's understanding.

Poverty might be identified as another potential barrier. Many people would not be able to take advantage of crop insurance due to acute poverty. It was argued that, in order to overcome the limitations of adaptation the first step should be to strengthen the institutions which would enable and facilitate the farming communities to go for adaptation measures (Ahmed, 2000). Weaknesses in the current legal framework were also considered to be a limitation. Weak institutional coordination, especially among large numbers of institutions dealing with agriculture and support facilities, might also be identified as a limitation. Strengthening of the agricultural extension services was recommended as an institutional adaptation towards safeguarding future agricultural activities.

Financing investments in agriculture may appear a major issue, especially amongst poor farmers (Warrick and Ahmad, 1996). Requirements for cash investment soon after a major flood event limit cultivation of cash crops such as vegetables (brinjal) and spices (chilli), as observed in Jamalpur District. Early investments in relatively highlands for seedbeds could not be possible, even though the benefits of doing so were known to the farmers of the same region (Choudhury *et al*., 2004). Lack of adequate credit facilities is reported as major constraints of coping in agriculture (Ericksen *et al.*, 1996; Asaduzzaman *et al.*, 2005).

Adaptation Measures as Prioritized in NAPA

By collating available information from literature and through four regional consultations, the NAPA document highlighted a few adaptation measures and prioritized them. The following are the adaptation measures which have received endorsement of the Government of Bangladesh through NAPA exercise. It is important to note that the proposed adaptation measures are primarily based on existing coping mechanisms and practices, as well as 'needs based suggestions' forwarded by national experts in relevant field/sector.

Intervention Type Measures

- Promoting adaptation to coastal crop agriculture to combat salinization through maize production under Wet Bed No-tillage Method and Sorjan systems of cropping in tidally flooded agro-ecosystem.
- Adaptation to agriculture systems in areas prone to enhanced flash flooding – North East and Central Region through no-tillage potato cultivation under water hyacinth mulch in wet sown condition, and Vegetable Cultivation on Floating Bed.

- Promoting adaptation to coastal fisheries through culture of salt tolerant fish especially in coastal areas of Bangladesh.
- Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.
- Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.
- Reduction of Climate Change Hazards through Coastal afforestation with community focus.
- Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.
- Enhancing resilience of urban infrastructure and industries to impacts of climate change including floods and cyclone.

Facilitating Type Measures

- Capacity building for integrating Climate Change in planning, designing of infrastructure, conflict management and landwater zoning for water management institutions.
- Exploring options for insurance and other emergency preparedness measures to cope with enhanced climatic disasters (e. g. flood, cyclones and drought).
- Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).
- Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.
- Climate change and adaptation information dissemination to vulnerable community to raise awareness.
- Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.
- Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.

4.4 Recommended Institutional Issues of Adapting to Climate Change

A number of institutional issues have been recommended by various authors in order to advance adaptation to climate change in Bangladesh (Ahmed *et al*., 1998a; Ahmed, 2004a; Ahmed, 2005a; Choudhury *et al*., 2004; Thomalla *et al*., 2005). Mainstreaming adaptation in development thinking and practices has been recommended as a priority (Ahmed and Haque, 2002; Huq *et al.*, 2003). Ahmed (2004a) revealed that the basic premise of adaptation to climate change has been grounded in the policy pronouncements; which needed to be formally recognized as another dimension of concern. Another institutional recommendation was to give climate change its due importance in decision-making processes.

It is necessary to understand that most of the climate change induced problems are likely to be exhibited in the form of water-related problems. Since climate change will have severe adverse impacts on agriculture and livelihoods and well being of the poor will most likely be at risk, a holistic policy approach should be considered.

It is recommended that, in order to mainstream adaptation to climate change, specific institutional guidelines need to be developed, which will provide for mechanisms on how inter-ministerial coordination will be achieved, how inter-ministerial policy conflicts will be resolved and who is supposed to mainstream adaptation to climate change, in which direction (Ahmed, 2005a). It is argued that, the current institutional authority revolves around two national institutions[3], leading to a potential impasse in terms of integrated and coordinated approach towards mainstreaming adaptation (Ahmed, 2004a). Removal of such institutional hindrance is therefore recommended. NAPA for Bangladesh is found to be in full conformity with the integrated approach of adaptation (GOB, 2005).

Ahmed (2004a) highlighted a few inter-sectoral policy conflicts, which might be counter productive towards implementing adaptation. It is recommended to establish an appropriate institutional regime, supplemented by the creation of a policy and regulatory regime. It is also recommended that the proposed Climate Change Policy should be housed and implemented under a supra-ministerial institutional platform, in order to facilitate its smooth functioning and to avoid unnecessary confusion. The proposed institution must be adequately empowered so that it can operate in cooperation with other relevant sectoral ministries[4]. To facilitate its functions, it may invite designated ministerial focal points to ensure coordination and cooperation among relevant line ministries. It is recommended that the pronouncement of the Coastal Zone Policy and the applications of generic guidelines provided in the Standing Orders on Disaster on horizontal and vertical integration may be revisited towards developing the proposed Climate Change Policy.

Recognizing that there exists a lack of awareness regarding all aspects of climate change, it is recommended that the government would consider steps towards enhancing awareness at all levels (WB, 2000; GOB, 2005). Building capacity through training appeared a useful mechanism to enhance human ability to adapt to a given climate condition (RVCC, 2003; Ahmed and Schaerer, 2004). Mainstreaming concerns of climate change would not take place without enhancing human capacity to analyze and respond. It is recommended that government officials, especially those dealing with water resources, agriculture, land-use, human health, coastal zone, fisheries and livestock should be provided with adequate training on climate change issues (Ahmed, 2004a). Climate change issues should also be an integral part of primary to tertiary level education, as advocated by RVCC (2003) and the NAPA for Bangladesh (GOB, 2005). RVCC has already initiated school-based educational programme on climate change, which should be integrated into national level curricula.

A major cross-cutting adaptation is to fill in the existing gaps in understanding on climate change (WB, 2000). The long-term water sector planning identified climate change as a gap[5] area and therefore no specific adaptation measures have been forwarded as such (WARPO-Halcrow *et al.*, 2004). It is recommended that such lack of understanding be removed on a priority basis during the time of revision of the plan (Ahmed, 2005b). It is recommended that the entire development regime would follow a planned approach, similar to that in water sector, and inter-sectoral coordination be ensured during implementation of programmes. Through the latter approach, it is anticipated that, the concerns of adaptation could be integrated into the plans and a climate resilient future therefore be established. NAPA for Bangladesh fully endorses such an institutional adaptation (GOB, 2005).

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[3] Ministry of Environment and Forest (MOEF), and Bangladesh Meteorology Department (BMD).

[4] The NAPA for Bangladesh, however, duly emphasized on an integrated approach and advocated for coordination.

[5] However, there exist a few programmes/components which would facilitate adaptation in water resources sector.

Recognizing that the major impacts of climate change will likely to be in water resources sector and national water resources are highly influenced by regional flow patterns, it is argued that efforts must be made to engage in regional cooperation on water (Ahmed, 2005a). Sharing of water in international rivers, especially during the lean flow period, should be a priority. Exchange of data from upstream areas to increase lead time for flood warning is a long-standing concern (BANCID, 1997), which need to be resolved with co-riparian countries. The micro-level planning exercises carried out under the RVCC project at Union levels should be replicated to identify key risks of climate change and to seek solutions that might be useful to reduce vulnerability of that area.

Several studies emphasized on the needs of involving 'environmental diplomacy' as an institutional adaptation mechanism (Ahmed, *et al*., 1998a; Huq *et al*., 1996; Asaduzzaman *et al*., 1996; Haque, 1996). Engaging in negotiations to draw adaptation financing have been recommended. In water sector, engaging in regional cooperation with a view to augment lean flows of international rivers has been recommended as an institutional adaptation (Ahmed, 2004a; Faruque and Ali, 2005). Considering legal measures have also been recommended by Freestone *et al*. (1996).

The civil society organizations have so far been proactive to raise public awareness and concerns regarding the country's special vulnerability to climate change. Bangladeshi researchers have been conducted research on climate change issues and projected the country's vulnerability at various international forums. The official GOB delegations have also played very important roles for raising concerns through official deliberations at SBSTA and COP. Continued engagement in negotiations and development of scientific background for adaptation should also be recognized as activities which would eventually facilitate institutional adaptation in the long run.