

...in store for us

FROM PAGE 8
inundated by rising seawaters. Such a speculative projection was made based on two major approximations; (a) the coastal plains are not protected and (b) the seawater front will follow the contour line. In reality, however, it is found that most of the plains in the coastal region are protected. Moreover, it is seen from the records that there is net gain of lands in coastal zone.

About 6000 km embankments have been constructed along the coastlines, banks of rivers and tidal estuaries to form polders. At present there are 108 polders and sub-polders in the greater Khulna, Barisal, Patuakhali, Noakhali and Chittagong districts in the coastal zone of Bangladesh. Several thousand drainage sluices are provided to remove accumulated rainfall run-off from the polders to the sea or adjacent rivers by gravity flow during low tide. Automatic flap gates are provided with the sluices to prevent saline water intrusion inside the polder during high tides.

Existing embankments provide protection against flooding from high tides but are not designed to prevent inundation by severe storm surges. In addition to protection of the regular inundations and saltwater intrusion, the embankments can reduce the tidal forces. This has an adverse effect on the drainage conditions (siltation due to reduced tidal volumes) and the ecosystems (water logging and stagnant waters). These negative effects have already been visible in parts of the coastal area such as Khulna, Barisal, Patuakhali and Noakhali regions.

Drainage congestion may become an even more serious threat than higher flood risks. Due to the siltation and poor maintenance of the drainage channel network in many parts of the coastal zone, drainage congestion is already a grave problem. The problem is expected to aggravate considerably.

Proper emphasis should be given to the fact that protection measures against inundation by embankments interrupt with the natural processes of land sedimentation and delta formation. This implies that subsidence and sea level rise will not be compensated by sedimentation and the risks of inundation and drainage congestion will be even greater in the future. These amplifying effects are particularly alarming and indicate that quite a different approach may be required to face the problems especially in the seaward parts of Bangladesh.

Unlike the densely populated seafront area, the Sundarbans is not protected and is heavily influenced by tidal effects. A rise in sea level will tend to inundate the mudflats of the forest and reduce the land area of the forest.

Increased salinity in ground and surface water: impacts on soil salinity and agriculture.—The effect of saline water intrusion is highly seasonal in Bangladesh. Saline intrusion reaches its minimum during the monsoon (June-October) when the GBM rivers discharge about 80 percent of the annual fresh water flow. In winter months the saline front begins to penetrate inland and the extent of affected areas rise sharply from 10 percent of the coun-

try in the monsoon to over 40 percent in winter. Climate change would further increase saline intrusion. Climate change-induced extreme weather events especially low flow conditions in winter will accentuate the saline intrusion in the coastal areas.

Increased coastal morphological dynamics (erosion and accretion): The morphological dynamism of deltaic Bangladesh is manifested in the coastal zone. The coastal areas have been experiencing natural erosion and accretion. Although current literature suggests that coastal land is in the process of slow accretion at the approximate rate of 8 km²/year during the past 210 years (Allison, 1998, Martin and Hart, 1997), much of this may be attributed to cross dams that have been built to reclaim land from the shallow continental shelves. Nevertheless, due to climate change induced alterations in thermal energy at the ocean-terrestrial interface and the expected changes in the inflow of riverine sediments, the dynamics of coastal morphology appears to be highly uncertain. Furthermore, new embankments for reclaiming additional land would affect the morphological dynamics of the coast.

Cyclones and Storm surges: From time immemorial, cyclones have been striking the delta causing extensive damages to the lives and properties of millions of people in the coastal districts of Bangladesh. In 1876, about 200,000 people were reportedly killed in Barisal by a cyclone. Another cyclone that hit in 1822 killed more than 70,000 people in Barisal and 95 percent population of the Hatiya Island. Considering the much lesser population during those times, the numbers of deaths give an indication of the severity of the cyclones. A cyclone in November 1970 hit the southern districts of Bangladesh forcing a 9 m high storm surge and killing approximately 300,000 people. The cyclone of 1991 caused loss of 138,000 lives. In more recent years, however, numbers of deaths caused by the cyclones with severe intensity have declined due to the growing successful institutional arrangements for disaster management and the fact that there are now over 2000 cyclone shelters spread along the coast which are being utilized during the cyclones. The most recent one is SIDR which was one of the most severe tropical cyclones which caused the losses of trees, crops, dueling houses and deaths of more than 3447 people. Climate change is expected to increase the intensity of cyclones and the penetration of storm surges further inland, causing higher damages.

Adaptation to Drainage Congestion: Physical adaptation requires mainly two steps: (i) bringing water from the land into the main drainage system; and (ii) drainage of water to the sea. Step (i) presently is done under gravity, mostly through regulators, which open during low tides. When higher water levels impede this process, pumping remains the main option. Step (ii) requires a well-maintained drainage network, and improvement of drainage system.



Increasing the drainage capacity of existing infrastructure, maintaining the out fall channels of hydraulic structures and providing new drainage structures in the locations where sedimentation process is less. Increased river/channels flow by diverting the Ganges river flow in the existing 24 big and small rivers under the proposed Ganges Barrage Project will reduce the drainage congestion and river siltation problems in the south-western region of Bangladesh. Pumped drainage seems a last, but expensive resort especially when the outside water levels become too high for drainage under gravity.

Institutional measures include guidelines to incorporate climate change in long term planning. Establishing proper O&M arrangements for the maintenance of drainage channels and infrastructure could be an effective approach. Establishment of water management associations, support of local water management including involvement of local institutions and development of appropriate design criteria for drainage infrastructure are other adaptation options that can be pursued.

Adaptation to Salinity Problem: Specific physical adaptations for the salinity problem should focus on increasing surface water flows from upstream, re-excavation of river networks, construction of cross dams/embankments to prevent saline water intrusion and increasing local storage of fresh water in the area.

Institutional adaptations for salinity include maintenance and operation of sluices and regulators, groundwater management, land use practice, extension services, and water saving techniques. The first two are management options. Improving maintenance and operation of sluices and other regulators to hold water in areas that are under increased stress from salinization is high in prior-

ity. In Bangladesh, there still remains a tendency to consider water as a common property. Groundwater management and regulatory operations should therefore incorporate and make use of the difference between the dry and wet seasons in Bangladesh.

Providing incentives to change agricultural practices so that agricultural demand for fresh water goes down can influence land use practice. Therefore, a cohesive approach is necessary with an intensification of extension services to promote changes in land use and farm management techniques. For example, there could be a door-to-door service in providing access to, and information of weather extremity tolerant crops to the farmers and change of cropping pattern in the coastal zone.

Adaptation to Increased Morphological Dynamics: Physical adaptations to the threat of increased erosion would include provision of mangrove greenbelts, cross dams and/or river training works. Mangrove greenbelts in the foreshore areas and along the coastal embankments, and cross dams at the same time enhance accretion. River training works, e.g., through bank protection or strong-holds are confined to the estuarine river branches. All these measures are effective. Cross dams and river training works and their long-term maintenance are basically costly. The high effectiveness and feasibility of mangrove greenbelts are well acknowledged. GOB has undertaken social afforestation program to restore the ecological balance and to mitigate environmental hazards in the coastal areas. Presently this is found very effective and community participation in this program is very high.

Institutional adaptations would aim at protecting the wetlands & mangroves and land use arrangements (including land tenure laws) & policies. The value of growing mangrove greenbelts is closely related to the effec-

tiveness, feasibility and sustainability of protecting mangroves in existing forest areas (through a combination of enforcement of existing legal provisions, and awareness raising among the coastal population). Protection of wetlands is assessed in a similar way, and wetlands can serve as a buffer against coastal storms and erosion. Another promising approach may be found through community-based adaptation where the community decides on how to share the limited common resources.

Although loss of land and the accretion of new lands are common phenomena in Bangladesh, at present, taking accreted land into culture for either forestry or agriculture falls under the jurisdiction of different ministries. The loss of land and relocation of displaced people needs to be addressed seriously. The mangrove belts could be managed in a much more flexible way. Reform of land tenure laws and policies, would give a sustainable adaptation base to climate change.

Adaptation to More Intense Natural Disasters in the Coastal Zones: It includes construction of new infrastructure such as cyclone shelters, coastal embankments and raised platforms, improved road communication networks, and improved technology of warning and signaling systems and mangrove greenbelts along the entire coastal zone. In addition to cyclone shelters for people, adequate provisions should be made for livestock, food grains and other perishable items. In the past, cyclone shelters for coastal cyclones have helped mitigate risks from cyclones. The size and adequacy of the shelters should be re-examined in the light of increased number of people at risk and the increased cyclone intensity as well. In recent years, over two thousand multipurpose cyclone shelters have been built in the coastal zones. Cyclone shelters are the safe heavens

for the people during storm surges and for other period these are used as schools and health/ community centers. For livestock and other perishable items, raised platforms (Land fill above the flood levels) of adequate numbers should be built, that can also be used on a multipurpose basis as play grounds, village markets etc.

Embankments need to be maintained on a regular basis. Actual maintenance of the existing coastal embankments is insufficient. A sizeable proportion of the existing coastal embankments is in bad condition, and is already being breached. Therefore maintenance of embankments is very essential. Under CERP (Coastal Embankment Rehabilitation Project) BWDB recently completed the construction/renovations of about 700 km sea-facing embankments (mechanically compacted). These embankments are found very effective against erosion due to wave rush-up and rush-down. The embankments are maintained well with community participation. For its role in saving lives and property, this has been slotted as a high priority future incremental action. For quick evacuation of people and livestock to the shelters and other safe places from the vulnerable areas during storm surges, road networks need to be improved. In considerations of climate change situation, drainage networks and structures are to be improved and new ones need to be constructed to drain out rapidly the surge water from the polders. It has been found that mangroves and forest belts act as effective barriers against winds and storm surges and facilitate accretion. New mangroves and forests in the fore shore areas, sides of embankment and around the homestead areas should be built. Such activities in Bangladesh need to be streamlined by ensuring people's participation in maintaining and benefit sharing.

Institutional adaptations include improving monitoring, forecasting and warning systems and evacuation procedures, adapting appropriate land use & development policy, and maintaining existing and future coastal infrastructures (embankments, drainage structures, cyclone shelters etc.). These responses relate to an improved emergency preparedness for cyclones and storm surges etc., and could reduce risks to health and property. Improvement of the monitoring and warning system of tropical cyclones and prediction of the associated storm surges would give more reliable advance warning about the landfall of cyclones. The research on these aspects should be strengthened. Dissemination system of the warning should be improved to alert the coastal residents about the severity of storms. The cyclone preparedness program may be further strengthened and the vulnerable people should be provided with appropriate training for self and community preparedness to face the disasters. Besides, the forestry and fisheries sectors will suffer severe impacts due to future scarcity of water and reduction of surface and ground water and soil moisture. The high floods and storm surges will wash out the fish and shrimp ponds. The biodiversity will be seriously affected by high temperature, drought as well flood conditions, more stronger cyclones and higher storm surges. From the above discussions, it may be concluded that the impacts of climate change have already knocked at our door and we must wake up and resist these impacts with all of our resources and give our best efforts to this end. The climate change and future impacts should be studied thoroughly to save our valuable lands, environment and ecology and keep our country suitable for living.

Dr. Md. Azizur Rahman is Water Resources Expert, DDC Ltd.

Dr. Md. Azizur Rahman is Water Resources Expert, DDC Ltd.

Dr. Md. Azizur Rahman is Water Resources Expert, DDC Ltd.