PREPARATION AND RESPONSE TO EMERGENCIES: FLOODS IN BANGLADESH

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ABSTRACT

Bangladesh is situated in deltaic and alluvial geographic terrain. A low lying country that faces sea and drains 92 percent of the snow melt from the vast Himalayan mountain range makes this area geographically one of the most vulnerable places for severe flood. Bangladesh experienced very big floods about once every 20 years. But recent experience shows that, during last 20 years worst floods happened in 1987, 1988, 1998 and 2004. So new patterns shows big flood recur 5 or 10 years. To protect some 240,000 km national, regional, district and rural roads with an asset value of approximately US$ 25 billion against such natural disaster, Government policies are drawn to identify the options for mitigation.

Three essential steps are categorized to be taken up simultaneously to achieve rational integrated road network preservation management from flood damage; (i) Development of policies to minimize damages in future, (ii) Investment in best possible way, (iii) Strengthening of Institutional Capacity. Amongst several issues, lessons from experience needed to be identified including resource constraint, socio-economic aspects, lack of preparedness to deal with the emergencies and drawing of a national level integrated mitigation plan.

A national workshop just after 2004 flood on 'Options for Flood Risk and Damage Reduction in Bangladesh' suggested mitigation/preventive measures to be adopted as national policies. Amongst other steps, Government of Bangladesh has earmarked emergency fund to meet such disasters. Departments responsible for road building network have developed ad-hoc plans to meet the flood emergency along with other agencies of the Government, i.e. arm forces, national volunteers, village defense parties etc. Flood shelters along with emergency facilities of air lifting for marooned people have been constructed in the vulnerable flood prone areas.

1. INTRODUCTION

Bangladesh is situated in South Asian subcontinent and the country has an area of approximately 147,000 sq km with a population of about 140 million. It is one of the most flood prone countries in the world. Due to its geographical and geomorphologic status, Bangladesh has to bear normal flood almost every year. But recent experience shows that frequency of devastating floods increases predominantly than ever before of known history. Four devastating floods in 1987, 1988, 1998 and 2004 within a span of 20 years had changed previous pattern.

There are two major road-building agencies in Bangladesh - Roads and Highways Department (RHD) and Local Government Engineering Department (LGED). RHD deals with main road network of the country like national, regional and district roads, and LGED

is responsible for mainly rural roads. RHD under Ministry of Communications (MOC), Government of Bangladesh (GOB) has huge assets in the form of roads, bridges, land, ferries, equipment and buildings, the combined value of which has been conservatively estimated at approximately US$ 7 billion (Taka 476 billion). Of this, the major chunk consists of about 21,684 kilometers of road with 3570 km National Highways, 4323 km Regional Highways, 13,791 km District Roads and about 11,000 bridges and culverts. This total asset value is the largest of any individual organization in Bangladesh, which probably exceeds the combined total of all private sector businesses operating in the country as a whole. Clearly, maintenance of these assets and protecting it against any disaster especially flood/tidal surge is a fundamental requirement, which is vital to the economy and being considered as one of the highest priorities.

Bangladesh is now standing on a stage to hunt for an appropriate technology as well as a compatible management technique to face floods taking both proactive and reactive measures. Following several disastrous recent floods in 1987, 1988, 1998, 2000 and in 2004, major international development partners and bilateral organizations were involved in assisting the road agencies to restore disrupted/affected road network to pre-flood condition within a short time frame. Several studies were carried out and strategies were developed on water and flood management and efforts were made to focus on flood strategies limiting disasters.

The situation calls for organized three dimensional efforts i.e., prevention of major floods; coping up with consequences of floods, and keeping road network well maintained in seasonal and localised floods.

2. BACKGROUND

Bangladesh has historical background of severe floods long before the Mughals and the British Empire being established in this delta of Bay of Bengal. The braided rivers and other low-lying southern plateau formed flood plain is the vulnerable area.
Flood is relatively high water flow that flushes through countryside over topping the natural and man made barriers inundating huge area. When it occurs flood causes colossal damage to lives, infrastructures, crops, and stalls the economy. When the affected area is over run by multiplying sheet of aggressive water flow all macro level solution to tackle the disaster had been thought even for hundreds of years, but such survey was conducted during British era and this delta was earmarked as a danger zone and suggestions were put forward for installing dams, construction of high embankments limited re-excavation and dredging of river channels etc. Special attention was given to the coastal belt where natural barriers like aforestation were planned along with sustaining coastal embankment.

During 329 years of Mughal ruling apart from building architectural monuments, very little records are available regarding floods. But some narration said that during rainy season whole of this southern Bengal was susceptible to flood and that was very much a common feature. As there have been little or no embankment or artificial bank and water could very easily spread over the whole plain.

From the Geomorphologic data 63% of Bangladesh is in flood plain area and over 90% area of the country, excepting the northeast and southeast corners, is less than 10m above sea level.

The rate of local relative sea level rise is 7mm/year around the coastal Bangladesh

resulting reduction in gradient of river flow exits. This is further aggravated by the siltation caused by an average 2 billion tons of sediment carried by the rivers steadily rising toward the sea level thus increasing the area of inundation.

The first comprehensive report on floods in Bengal from 1870 to 1922 by Prof. P.C. Mahalanabish shows that moderate floods have occurred once in two years, while severe floods occurred once in 6-7 years on an average.

After a major flood in northern Bengal in 1922, a Flood Committee report in 1927 inferred statistical analysis of occurrence of severe and catastrophic floods in every 7 years and 33-50 years respectively.

But after almost 60 years the pattern again changed the cycle and the country was hit by severe floods in 1987, 1988 and 1998 which led the Government to look for a plan and major studies were taken up in 1989 and those studies let the formulation of Flood Action Plan (FAP) in 1989.

3. CAUSES OF FLOOD

Generally mighty rivers of Bangladesh have their origin in Himalayas in Nepal and India. Incessant raining in the high lands, melting of glaciers in Himalayan plateau due to global warming, unplanned construction of water barriers in the upstream and climate change are the major causes identified up till now.

United Nations Environmental Programme (UNEP) study says (December 2002) each year in Bangladesh even in normal monsoon, 26,000 sq.km i.e. 18% of the country remains water logged. During severe floods, the affected area exceeds as high as 69% of the total area of the country. In an average 844,000 million cubic meter of water flow into the country during the humid period (May to October) through the three main rivers the Ganges, the Brahmaputra-Jamuna and the Meghna. This volume is 95% of the total annual inflow.

Road network in Bangladesh criss crosses flood plains. All national and regional roads were previously planned and designed for construction above highest flood level (HFL) with recurrence interval of 50 years and all feeders and rural roads were constructed over normal flood level (NFL). In 1987 flood, major part of all types of roads were submerged as the highest flood levels were constantly increasing over last three decades. Moreover the intensity and duration of the flood was more in the last three decades and the severity and damage to road infrastructures were also multiplying.

Main factors for causing floods in Bangladesh are:

i) General low topography of the country with major rivers draining through Bangladesh including congested river network system.
ii) Heavy monsoon rainfall in the upstream in the mainland.
iii) Synchronization of flood peaks of major rivers and influences of one over the other
iv) Snow-melt in the Himalayas and glacial displacement (natural or global warming)
v) River siltation / lateral river contraction / landslides
vi) Tidal and wind effects on slowing down the river outflow (backwater effect)

vii) Rate of sea level rise is faster than the rate of land aggradations
viii) Deforestation in the upstream regions of the rivers
ix) Tectonic anomalies those change in river flow/morphology.
x) Human intervention of the environment e.g. construction of facilities, commercial and residential units narrowing the available flood plain course, e.g. constructions along Buriganaga.

In Bangladesh, the definition of flood appears differently. During the rainy season when the water flow exceeds the holding capacity of rivers, canals, marshy land, low-lying areas, it inundates the whole area causing damage to habitation, crop and other properties. Broadly floods here are categorised as follows:

i) Monsoon floods from the major rivers. Water spilling over the banks of major rivers and their distributors causes extensive flooding in Bangladesh. During the monsoon, the major rivers generally rise slowly over the course of several weeks.

ii) Local flooding due to intense rainfall. Local flooding is caused by heavy monsoon rainfall within Bangladesh, which generates runoff volumes in excess of local drainage capacity, especially when the main rivers are at high levels.

iii) Flash floods in the eastern and northern rivers. These are characterized by a sharp rise followed by relatively rapid recession. The high velocity of the floodwater often damages crops and property.

iv) Floods due to storm surges in coastal areas. The coastal areas consist of large estuarine channels, extensive tidal flats, and low-lying islands. Storm surges generated by tropical cyclones cause widespread damage to life and property. Tropical cyclones, most likely to occur before and after the monsoon season (April-May and October–November, respectively), have not been known to coincide with monsoon flood peaks

4. ISSUES INVOLVED

The Issues Involved for Road Agency (RHD/LGED)

The issues involved for road agencies are essentially those related to damage to the infrastructure, preparedness for its prevention to the extent possible and addressing such damages in the best possible way in the least possible time.

(i) Damage to the Infrastructure

Prime targets for damage are road network, bridges, culverts, crops and habitation. The floodwater with high velocity across the road and through the existing drainage structures damages bridges/culverts and substantial part of road network.

(ii) Cost and Time Overrun in implementation of the ongoing projects, both GOB and externally financed

Major development work are effected due to flood and this requires additional time and cost to complete the project. During flood all works remain suspended

and in most cases the ongoing works are damaged or partly washed away causing serious impediment to all activities. In many cases the project area, workshops and Engineering facilities are also inundated during flood which requires repairs, reconstruction and improvement needing additional cost and time.

(iii) Additional funds required to restore / rehabilitate and reconstruct the damaged road infrastructure.

Capital fund are allocated for annual development program (ADP). But when severe flood occurs additional emergency funds are required beyond ADP for restoration/rehabilitation of damage roads, bridges and culverts.

(iv) Socio economic aspects

The flood induces sufferings of the road users and disrupts communications affecting the national economy. When roads are submerged under floodwater the pavement and bridges/culverts are damaged and road communication remain suspended until the roads are repaired/rehabilitated. As such the transportation of men and materials becomes extremely difficult. All social and economic activities are stalled and suffering of people become immense.

(v) Delay in urgent maintenance works.

Routine and periodic maintenance of the roads and bridges are the regular activities. When Roads are damaged by floodwater, road communication is disrupted and priority is given for immediate restoration of communication and post flood rehabilitation. The planned program of routine and periodic maintenance are affected due to priority works as well as for additional cost involved in the restoration and rehabilitation works.

(vi) Reduction Of Institutional Capacity

Due to damage of infrastructure and disruption of communications institutional capacity is affected. When roads, bridges/culverts, stackyards, are damaged by flood, they require repair and rehabilitation. Repairing and rehabilitation requires cost and ample institutional capability.

Addressing these Issues

Three essential steps are to be taken up simultaneously to achieve rational, integrated road network preservation management from flood damage.

(i) Development of policies to minimize flood damages in future

Construction of structures and facilities on flood passages and established waterways should be controlled. All major facilities should be constructed above highest flood level (HFL). For this purpose flood data for every year should be closely monitored and made available to all concerned.

(ii) Investment in best possible way

Address the damages as well as prevent future damage where possible e.g. raising of road levels above HFL and increasing openings of bridges and culverts.

(iii) Strengthening Of Institutional Capacity

Create adequate database for design of safe structures and risk assessment of all road infrastructures by the concerned road agencies (RHD/LGED).

5. LESSONS FROM PREVIOUS FLOODS AND SUBSEQUENT MITIGATION ACTIVITIES

The previous floods had affected the road infrastructure in varying degrees and agencies took possible measures within the available and mobilized resources to address the same. For better utilization of all future investments in the road sector it is necessary to identify and disseminate the knowledge acquired and lessons learnt in mitigating the flood situations so far.

i) The roads which have been raised above 1988 and1998 Flood Level, have suffered minimum damage in 2004-flood.

ii) The roads, which were inundated by floodwater, have been affected more when vehicles moved on submerged roads. There is less damage of roads where vehicle movements have been restricted when the roads were totally submerged. This approach thus should be examined as a policy on vulnerable roads.

iii) Bangladesh comprises a flat deltaic plain lying between 0 and 10 metre above mean sea level. Three mighty rivers Brahmaputra, Ganges and Meghna flow over the country with 230 tributaries and distributaries form the delta. Most of the rivers originate from Himalayan and India. Most of the rivers flow north to south direction and finally meet with Bay of Bengal. Accordingly roads those are constructed in north-south direction have experienced less damage than the roads alignment with east-west direction. So as best as possible, selection of road alignment should be made parallel to the river flow rather than across it.

iv) When a road is constructed along east-west direction, attention is to be given for drainage of water together with uninterrupted flow through rivers and canals. Before construction of the road, detail survey is to be done to calculate discharge from catchment area. Inadequate opening of bridges and culverts causes damage to both structures and approach roads. This causes afflux raising local flood level further and submerging more associated areas. Also the floodwater flowing at high velocity at the exits of bridges and culverts causes high scour on the down stream ground as well as abutment structures. So for the existing roads, additional drainage or release structures are to be provided in addition to the existing bridges and culverts. Normally there may be little or no flow through these culverts. But in flood seasons, these structures will act as a panacea for the road.

v) Moreover, existing bridges/culverts should be investigated and improved if necessary by proving extra span for adequate passage of water at peak flow stage.

vi) In a flood situation, there are three distinct consecutive stages. Initially flood comes

slowly or rapidly with rising of water level every day. Then a stage comes when water flows above danger level. This stage may prolong from couple of days or even may be couple of weeks. Finally, water starts recession. More attention is to be given during recession of floodwater. Damage like landslides occurs more when floodwater recedes. Provision of retaining structures like toe walls and flattening of embankment slopes in such situations should be explored.

vii) In northern and north-eastern region of Bangladesh, flood sometimes comes suddenly. Water flows with high velocity above danger level like an artificial sheet of water and wash away a section of road. This type of flood commonly known as flash flood generally can not be anticipated and is not possible to be prevented. However, causeway (Irish crossing) with cement-concrete topping in flash flood area would be a more economical solution depending on importance of the road.

viii) Bituminous pavement is more susceptible to water than cement-concrete pavement. Roadside market areas are more prone to damage during water logging due to absence of drainage and decay of organic substances. Such pavement sections survive better if done with cement concrete pavement.

ix) Damage to roads caused by water passing over the road surface could be reduced by providing asphalt concrete topping and hard shoulder. Asphalt concrete prepared by asphalt plant with controlled temperature and other parameters produce more durable pavement than usual road mixed carpeting.

x) Rising floodwater affects the side slope of the road embankment where erosion starts occurring due to wave action. So side slope should be protected by appropriate means e.g. concrete blocks, growing plants like vetiver (Kashphul), turfing etc. It is experienced from last few floods that, less damage occurred in side slopes, protected by growing plants. Damage of road embankment due to scour and wave action need to be prevented / protected by proper slope protection.

xi) Storm surge generated by tropical cyclones occurred two times within last 36 years - one on November 12, 1970 and other on April 29, 1991 took more than 1.6 million people. After those disasters, many cyclone centers have been constructed in coastal areas. In normal time, the centers are used as educational institutions.

xi) Flood affected people use high road embankments as shelter. This should be considered in planning of disaster management.

xii) Road embankment in flood prone area needs to be provided with cohesive blanket & turfing /plantation.

xiii) Drainage through natural channels needs to be augmented by desilting of drainage channels by dredging and excavations as applicable.

xiv) Coordination among agencies like RHD, LGED, Railways, City Corporations, Local Councils, Arm Forces, National Volunteers, Bangladesh Water Development Board and others to be augmented.

Strengths and Weakness, Relevant Policies, Regulations, Institutional Capacity

a. Strength

(i) Road agencies with their resources and countrywide networking has an organized set up to take up challenging tasks caused by flood.

(ii) Large fleet of ferry, which is being freed, with construction of more bridges can be redeployed at critical sections where communication is threatened or breached.

b. Weakness

(i) Road agencies need to be equipped for disaster management, especially for floods up to Division level by being allowed to keep reserve of:

- Portable steel bridge in flood prone areas for spanning damaged bridges or embankment breach along with skilled team for installation.

- Sufficient stockpile of rehabilitation materials like stone and brick aggregates, sheet piles, gunny bags, sands etc. before monsoon for emergency restoration of affected roads and bridges.

(ii) Institutional capacity of road agencies need to be strengthened by making available more resources and updating all databases for disaster management.

6. POLICIES AND INITIATIVES BY ROAD AGENCIES FOR DISASTER MITIGATION BEFORE, DURING AND AFTER FLOOD

The Office of the Chief Engineer, RHD/LGED and subordinate offices in accordance with the Standing Instructions regarding disaster mitigation issued by Disaster Management Bureau, Ministry of Disaster Management and Relief in January 1997 bear the following responsibilities in addition to the normal duties of planning and implementation of the works under their control.

During Normal Time

i) Instructions are issued to officials at all levels for maintenance of roads and for ensuring maintenance of uninterrupted communication on important corridors.
ii) Weak links in the road network are repaired and maintained satisfactorily during flood.
.iii) Like the bridges and culverts, roads and embankments also are strengthened so that they can withstand cyclone and high flood.
iv) The current plans are reviewed twice a year in light of past experience and the efforts for disaster preparedness are strengthened.
v) Instructions are issued to construct connecting links, temporary bridges and to maintain temporary ferry service if necessary.
vi) Arrangements are made for inspection and patrolling of important roads which are likely to be damaged by cyclone/upsurge/flood.
vii) All road construction equipments, portable steel bridge and materials are kept ready for urgent rehabilitation of roads.

During Cautionary and Warning Stage

i) A liaison Officer is usually appointed to maintain communications with the Ministry of Disaster Management and Relief.

ii) Vehicles and maintenance equipments are assembled at one place if necessary to be sent to important installations.

iii) Arrangements are made to save the infrastructure, construction materials, equipments and stores from damage.

iv) Alternative roads and diversions are planned for movement of vehicles if necessary.

During Disaster Stage

i) The Control room is kept in operation round the clock for all times.

ii) Constant communication is maintained with the control room of the Ministry of Disaster Management and Relief.

iii) Any important information received through own channel is communicated to Disaster Management Council and Disaster Management Bureau.

iv) Patrolling is intensified on important roads and bridges.

v) Arrangements are made for movement of vehicles on alternative routes and diversions in case of disruption of road communications.

vi) Appropriate steps are taken for safety of the ferries, stored equipments, and installations.

vii) Any other arrangement as deemed necessary is duly made.

During Rehabilitation Stage

i) The damaged / disrupted roads and bridges are repaired and rehabilitated.

ii) Alternative roads and diversions are constructed to restore communications to normalcy.

iii) Priority is allotted to movement of vehicles carrying relief workers, relief materials and other essential stores.

iv) All information and data on the nature and amount of damages are collected and transmitted in the form of a report to the Disaster Management Council / Ministry of Disaster Management and Relief and if necessary request is sent for additional funds to meet the emergency.

v) RHD carries on and maintain all efforts on temporary or permanent basis as applicable to keep road communication uninterrupted for relief of sufferings and socio-economic improvement of the affected persons.

7. CONCLUSIONS AND RECOMMENDATIONS FOR MITIGATION/PREVENTIVE MEASURES

i) National and International studies indicate that moderate flood have occurred in Bangladesh once in two years while severe floods occurred once in 6-7 years on an average. So flood hazard and land development maps are based on flood level and frequency of inundation as hydraulic parameter. Such maps need to be updated perennially for planning and Management of Roads & Bridges.

ii) Recurring floods cost in terms of human hardship and economic loss to a great extent. So institutional capacity has to be strengthened to estimate damages associated with flood events and evaluation for rehabilitation methods and policies.

iii) Policies should be adopted for reconstruction and rehabilitation of all national and regional Highways above highest flood level (HFL) phase wise on a priority basis.

iv) To minimize the pavement damages from flood, top layer of all roads pavement vulnerable to flood have to be provided with asphalt concrete (HMA) and hard shoulder, with protection similar to Irish crossings at location where flash flood is known.

v) To minimize the erosion of the road embankment and associated highly vulnerable road sections, slopes have to be protected with hard layers (C.C. blocks with geo-textile) and less vulnerable sections should be protected with flood resistant natural turf and plants like vetiver (Kashful).

vi) To minimize the damages of roads during flood, there may be legislation to stop the plying of all types of commercial vehicles in vulnerable road sections during flood period when roads are submerged under floodwater. This can be continued till the water level comes down reasonably.

vii) Legal instruments should be instituted to authorize appropriate authorities to prevent constructions that block the established waterways.

viii) In flash flood area, causeway (Irish Crossing) with cement concrete topping may be provided to reduce the damage.

ix) To face emergency situation, buffer stock of materials like bricks, stone, sand, gunny bags, sheet piles etc, to be kept ready.

x) Imprest stock of portable steel bridges and other equipment should be kept ready for immediate restoration of road communication during flood.

xi) To create database for assessment of impact by previous floods and interpret and interpolate such data for all design and construction activities in future.

xii) Agencies like RHD, LGED, Bangladesh Railway, Arm Forces, National Volunteers, Village Defense Parties and other local bodies should work in a synchronized coordination for implementation of the carefully drawn activities

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