Government of the People's Republic of Bangladesh

CONTINGENCY PLAN FOR EARTHQUAKE HAZARD
for Directorate of Relief and Rehabilitation (DRR)

Directorate f Relief and Rehabilitation (DRR)

Ministry of Food and Disaster Management

Directorate f Relief and Rehabilitation (DRR)

Government of the People's Republic of Bangladesh

Contingency Plan for Earthquake Hazard

Under Comprehensive Disaster Management Programme (CDMP)
Ministry of Food and Disaster Management
Earthquake and Tsunami Preparedness
CDMP/EC/4a/PC-1

UNDP Bangladesh

DFID Department for International Development

CDMP Comprehensive Disaster Management Programme

List of Abbreviations

ADB	Asian Development Bank
AFD	Armed Forces Division
AMI	Anjumane Mofidul Islam Bangladesh
Ansar & VDP	Bangladesh Ansar and Village Defence Party
BA	Biman Airlines
BDR	Bangladesh Rifles
BCAA	Bangladesh Civil Aviation Authority
BCG	Bangladesh Coast Guard
BDRCS	Bangladesh Red Crescent Society
BFRI	Bangladesh Forest Research Institute
BGSL	Bakhrabad Gas Systems Limited
BGMEA	Bangladesh Garment Manufacturers and Exporters Association
BIP	Bangladesh Institute of Planners
BIWTA	Bangladesh Inland Water Transport Authority
BKMEA	Bangladesh Knitwear Manufacturer and Exporters Association
BLRI	Bangladesh Livestock Research Institute
BMA	Bangladesh Medical Association
BMD	Bangladesh Meteorological Department
BP	Bangladesh Police
BPDB	Bangladesh Power Development Board
BR	Bangladesh Railway
BRTA	Bangladesh Road and Transport Authority
BRTC	Bangladesh Road and Transport Corporation
BSS	Bangladesh Sangbad Sangstha
BTMEA	Bangladesh Textile Mills Association
BTCL	Bangladesh Telecommunication Company
BTRC	Bangladesh Telecommunication Regulatory Commission
BTV	Bangladesh Television
BUET	Bangladesh University of Engineering & Technology
BWDB	Bangladesh Water Development Board
CAAB	Civil Aviation Authority Bangladesh
CBOs	Community-Based Organizations
CC	City Corporations
CCP	Bangladesh Centre for Communication Programs
CDA	Chittagong Development Authority
CDC	Communicable disease Control
CME	Centre for Medical Education
CMMU	Construction, Maintenance and Management Unit
CPA	Chittagong Port Authority
CPP	Cyclone Preparedness Programme
CWASA	Chittagong Water Supply and Sewerage Authority
DCC	Dhaka City Corporation
DESA	Dhaka Electricity Supply Authority
DESCO	Dhaka Electric Supply Company Ltd.
DFP	Department of Films and Publications
DG Fisheries	Directorate of Fisheries
DGoF	Directorate General of Food
DG Livestock	Directorate of Livestock
DGHS	Directorate General of Health Services
DMB	Disaster Management Bureau

DMC	Department of Mass Communication
DOA	Department of Architecture
DPHE	Bangladesh Department of Public Health Engineering
DRR	Directorate of Relief and Rehabilitation
DWASA	Dhaka Water Supply and Sewerage Authority
EMS	Earthquake Magnitude Scale
FAO	Food and Agricultural Organization
FBCCI	Federation of Bangladesh Chambers of Commerce
FSCD	Bangladesh Fire Service & Civil Defence
IAB	Institute of Architects Bangladesh
IFRC	International Federation of Red Cross and Red Crescent Societies
IOM	International Organization for Migration
IRC	International Rescue Committee
JICA	Japan International Cooperation Agency
GSB	Geological Survey of Bangladesh
HBRI	Housing & Building Research Institute
IAB	Institute of Architects Bangladesh
IEB	Institute of Engineers Bangladesh
IFRC	International Federation of Red Cross and Red Crescent
INGOs	International Non-Government Organizations
JGTDSL	Jalalabad Gas Transmission & Distribution Co. Limited
LGA	Local Government Agencies
LGD	Local Government Division
LGED	Local Government Engineering Department
LGRD	Local Government and Rural Development
LGRDC	Local Government Rural Development and Cooperatives
MinCom	Ministry of Commerce
MoC	Ministry of Communications
MoCAT	Ministry of Civil Aviation and Tourism
MoF	Ministry of Finance
MoFDM	Ministry of Food and Disaster Management
MoFL	Ministry of Fisheries and Livestock
MoHA	Ministry of Home Affairs
MoHFW	Ministry of Health and Family Welfare
MoHPW	Ministry of Housing and Public Works
MoI	Ministry of Information
MoL	Ministry of Land
NGOs	Non-Government Organizations
NHA	National Housing Authority
NIPSOM	National Institute of Preventive and Social Medicine
OHCHR	Office of the High Commissioner for Human Rights
PDB	Power Development Board
PetroBangla	It is a successor of Bangladesh Mineral Oil and Gas Corporation
PGCL	Power Grid Company of Bangladesh Ltd
PIB	Press Institute of Bangladesh
PID	Press Information Department
PSTN	Public switched telephone Network
PWD	Public Works Department
R&H	Roads and Highways
RAB	Rapid Action Battalion
REB	Rural Electrification Board
RAJUK	Rajdhani Unnyan Kortipakha
REHAB	Real Estate & Housing Association of Bangladesh
RHD	Roads and Highways Department

TGTDCL	Titas Gas Transmission and Distribution Co. Ltd
SoB	Survey of Bangladesh
UNDP	United Nations Development Programme
UN HABITAT	United Nations agency for human settlements
UNHCR	UN High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNRC	Resident Coordinator of United Nations
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
VDP	Village Defence Party
WFP	World Food Programme
WHO (DERG)	World Health Organization (Disaster Emergency Response Group)

Executive Summary

This Plan identifies the intended actions to be taken by the Directorate of Relief and Rehabilitation (DRR) in response to a damaging earthquake.

The overall goal of the project on **Contingency planning with regard to earthquake hazard** will be to develop a comprehensive geo-hazard risk reduction "Contingency planning" strategy that is linked to an easy implementation framework to be able to address the current needs and issues, which would be implacable at all the national, city and agency level and cover all the levels of disaster risk management from preparedness to response.

The project on Contingency planning with regard to earthquake hazard is comprised of two main activities:

- Activity I: Determine status of Contingency planning and design of interim contingency plan
- Activity II: Turn interim contingency plans into final versions (using maps for selected urban areas that highlight earthquake-vulnerable school/hospital/emergency response and control buildings etc.)

Planning requires the active participation of the stakeholders involved in implementation of the activities including in the planning stage. Time becomes more valuable once an emergency occurs, so planning before the emergency when workloads may be more flexible is very important. Earthquake happens without any early warning and although stakeholder community in Bangladesh is quite capable of responding to events such as floods, cyclones etc. there is a need for conducting Contingency planning in advance. One reason for conducting Contingency planning is because it will facilitate a ***rapid emergency response*** by allowing planners, in advance of an emergency to:

- Consider the likely consequences of an emergency before it occurs
- Identify the key resources, both human and physical, which may be available to respond to the emergency
- Identify the critical areas for immediate action
- Build and train the emergency response team in advance
- Define the general policies and approach to the emergency in advance

All of these measures allow constructive intervention immediately after the emergency. Team building is particularly useful, as the ability to act as a team may be critical to the success of the initial emergency response. Another benefit to Contingency planning is that, before an emergency, there is comparatively more time to consider all the aspects of problems that are likely to arise. Once the emergency has occurred, it may be very difficult to bring all of the players together. Agreement on policies in the Contingency planning stage may help clarify applicability and resolve contradictions that may occur. ***Rapid decision making*** on operational issues after an emergency is important because delays may cost lives.

The Contingency planning also serves as a tool for ***maintaining control over events or limiting the risk of loss of control***. Because of the scale of the problems that they pose, earthquakes sometimes provoke erratic or unpredictable responses. Well-intentioned but ill-equipped agencies may rush to help, leading some agencies to over-react to the emergency. The risk of inappropriate responses is much lower when clear plans are in place. The Contingency planning process also allows identification of projected needs that may arise as a result of an emergency and the resources that will be immediately available to meet those needs. One benefit of a realistic contingency plan is that it may encourage donors and others to provide the needed resources for enhancement of resource base of the agencies involved in plan implementation.

Although the objective of Contingency planning is usually the production of a contingency plan, many useful outputs of Contingency planning come from the ***process*** through which the plan is developed. Therefore, there are many advantages in a plan prepared by coming together of all major potential actors, agreeing on the broad policies and working groups filling the detail of the plan to a plan developed by an experienced emergency planner developing a contingency plan. It does not mean that the plan is not important. The plan is a measure of the quality of the process. A good planning process will produce a good plan. Even though the earthquake that occurs may be very different from the one planned for, the plan will still be useful. A good contingency plan ensures better preparedness for any emergency that may occur, even one that is very different from the scenario in the plan.

Earthquake Threat in Bangladesh and Identification of Risk Scenario related to Directorate of Relief and Rehabilitation (DRR)

1.1 Introduction

Over the past decades, urbanization in Bangladesh has been rapidly taking place without proper guidance. As a result many of the urban centers have developed haphazardly. These urban centers are fast growing and have a significant influence in the economic developments of the country. It is therefore essential to have a realistic understanding on the nature, severity and consequences of likely damage/loss that a possible event of earthquake could cause. A strong earthquake affecting a major urban center like Dhaka, Chittagong, or Sylhet may result in damage and destructions of massive proportions and may have disastrous consequences for the entire nation.

A low to moderate level of earthquake may cause Sevier damages to the life and property that may go beyond the existing capacity of the agencies like AFD within major cities, divisions as well as national level. Considering likely earthquake threat in Bangladesh, the Comprehensive Disaster Management Programme (CDMP) under the Ministry of Food and Disaster Management of the Government of Bangladesh (GoB), took initiative to develop likely scenarios of earthquake for Dhaka, Chittagong and Sylhet. This report presents the likely building collapse, debris generation, fire hazards and casualties during different level of earthquakes in these three cities and current preparations/ capacity by Armed Force Division (AFD) to cope with the situation.

1.2 Nature of Threats

Geographically Bangladesh is located close to the boundary of two active plates: the Indian plate in the west and the Eurasian plate in the east and north. In the past there where several earthquakes in the country that had caused severe damages to life and properties. Some of the major earthquakes around the region includes the 1548 earthquake, the 1664 earthquake, the 1762 earthquake, the 1869 Cachen earthquake (Ms 7.5), the 1885 Bengal earthquake (Ms 7.0), the 1897 Great Assam earthquake (Ms 8.1), and the 1918 Srimangal earthquake (Ms 7.6) (Earthquake in website “Banglapedia”; Oldham, 1883; Ambraseys, 2004; Bilham and Hough, 2006 etc). Following is a list of major earthquakes in and around Bangladesh.

Table 1.1 List of Major Earthquakes in Bangladesh

Year	Description of the Earthquake
1548	The first recorded earthquake was a terrible one. Sylhet and Chittagong were violently shaken, the earth opened in many places and threw up water and mud of a sulphurous smell.

1642	More severe damage occurred in Sylhet district. Buildings were cracked but there was no loss of life.
1663	Severe earthquake in ASSAM, which continued for half an hour and Sylhet district was not free from its shock.
1762	The great earthquake of April 2, which raised the coast of Foul island by 2.74m and the northwest coast of Chedua island by 6.71m above sea level and also caused a permanent submergence of 155.40 sq km near Chittagong. The earthquake proved very violent in Dhaka and along the eastern bank of the MEGHNA as far as Chittagong. In Dhaka 500 persons lost their lives, the RIVERS and *JHEEL*S were agitated and rose high above their usual levels and when they receded their banks were strewn with dead fish. A large river dried up, a tract of land sank and 200 people with all their CATTLE were lost. Two volcanoes were said to have opened in the Sitakunda hills.
1775	Severe earthquake in Dhaka around April 10, but no loss of life.
1812	Severe earthquake in many places of Bangladesh around May 11. The earthquake proved violent in Sylhet
1865	Terrible shock was felt, during the second earthquake occurred in the winter of 1865, although no serious damage occurred.
1869	Known as Cachar Earthquake. Severely felt in Sylhet but no loss of life. The steeple of the church was shattered, the walls of the courthouse and the circuit bungalow cracked and in the eastern part of the district the banks of many rivers caved in.
1885	Known as the Bengal Earthquake. Occurred on 14 July with 7.0 magnitude and the epicenter was at Manikganj. This event was generally associated with the deep-seated Jamuna Fault.
1889	Occurred on 10 January with 7.5 magnitude and the epicenter at Jaintia Hills. It affected Sylhet town and surrounding areas.
1897	Known as the Great India Earthquake with a magnitude of 8.7 and epicenter at Shillong Plateau. The great earthquake occurred on 12 June at 5.15 pm, caused serious damage to masonry buildings in Sylhet town where the death toll rose to 545. This was due to the collapse of the masonry buildings. The tremor was felt throughout Bengal, from the south Lushai Hills on the east to Shahbad on the west. In Mymensingh, many public buildings of the district town, including the Justice House, were wrecked and very few of the two-storied brick-built houses belonging to ZAMINDARS survived. Heavy damage was done to the bridges on the Dhaka-Mymensingh railway and traffic was suspended for about a fortnight. The river communication of the district was seriously affected (BRAHMAPUTRA). Loss of life was not great, but loss of property was estimated at five million Rupees. Rajshahi suffered severe shocks, especially on the eastern side, and 15 persons died. In Dhaka damage to property was heavy. In Tippera masonry buildings and old temples suffered a lot and the total damage was estimated at Rs 9,000.
1918	Known as the Srimangal Earthquake. Occurred on 18 July with a magnitude of 7.6 and epicenter at Srimangal, Maulvi Bazar. Intense damage occurred in Srimangal, but in Dhaka only minor effects were observed.
1930	Known as the Dhubri Earthquake. Occurred on 3 July with a magnitude of 7.1 and the epicenter at Dhubri, Assam. The earthquake caused major damage in the eastern parts of Rangpur district.
1934	Known as the Bihar-Nepal Earthquake. Occurred on 15 January with a magnitude of 8.3 and the epicenter at Darbhanga of Bihar, India. The earthquake caused great damage in Bihar, Nepal and Uttar Pradesh but did not affect any part of Bangladesh.
	Another Earthquake occurred on 3 July with a magnitude of 7.1 and the epicenter at Dhubri of Assam, India. The earthquake caused considerable damages in greater Rangpur district of Bangladesh.

1950	Known as the Assam Earthquake. Occurred on 15 August with a magnitude of 8.4 with the epicenter in Assam, India. The tremor was felt throughout Bangladesh but no damage was reported.
1997	Occurred on 22 November in Chittagong with a magnitude of 6.0. It caused minor damage around Chittagong town.
1999	Occurred on 22 July at Maheshkhali Island with the epicenter in the same place, a magnitude of 5.2. Severely felt around Maheshkhali island and the adjoining SEA. Houses cracked and in some cases collapsed.
2003	Occurred on 27 July at Kolabunia union of Barkal upazila, Rangamati district with magnitude 5.1. The time was at 05:17:26.8 hours.

Source: Earthquake in Bangladesh Sighted on :- http://www.scribd.com/doc/6956055/Earthquake-in-Bangladesh?autodown=doc ; Date of access: 8th June 2009

However, it seems that Bangladesh did not experience any large earthquake since 20th century for about 100 years. The 1918 earthquake is thought not to be a characteristic one, since the magnitude is small for the plate boundary fault. This may mean that Bangladesh has a high risk of large earthquake occurrence in near future. Several major active faults, e.g. the plate boundary fault (the northern extension of subduction fault) and the Dauki Fault, are inferred in Bangladesh. These faults must generate large earthquakes over M 8. However, the nature, detailed location, and the faulting history on these faults are not well known yet (Morino, 2009).

1.3 Potential Damage in different Scenarios of Earthquake

Three different scenarios have been developed to identify the possible damage to buildings and other infrastructures and also to find out the number of casualties. The three scenarios are taken as least, moderate and high intensities cases as assumed based on different magnitude of earthquakes. The following are the different scenarios and lost estimation in the cities of Dhaka, Chittagong and Sylhet.

Scenario Earthquakes

Dhaka city

1. Madpur Fault (7.5 Mw)
2. Plate Boundary Fault-2 (8 Mw)
3. Earthquake under the city (6.0 Mw)

Chittagong city

4. Plate Boundary Fault-1 (8.5 Mw)
5. Plate Boundary Fault-2 (8.0 Mw)
6. Earthquake under the city (6.0 Mw)

Sylhet city

7. Dauki Fault (8.0 Mw)
8. Plate Boundary Fault-3 (8.3 Mw)
9. Earthquake under the city (6.0 Mw)

Buildings Damage

Dhaka City Corporation Area

During an earthquake of 7.5 Mw originated from Madhupur fault, about 166,570 buildings will be moderately damaged. This is about 51.00 % of the total number of buildings in Dhaka city. Among these buildings, it is estimated that about 75,218 buildings could not be repaired. If the magnitude of the earthquake is 8.0 Mw, about 93,605 buildings will be at least moderately damaged which is about 29.00 % of the total number of buildings. During an earthquake originated from under the city at 6.0 Mw will moderately damage about 136,434 buildings and about 53,989 buildings will be damaged beyond repair.

Chittagong City Corporation Area

It is estimated that about 168,783 buildings will be damaged at 8.5 Mw Earthquake. This is about 93.00 % of the total number of buildings in the Chittagong city. During this time about 135,647 buildings will be damaged beyond repair. About 38,953 buildings will be at least moderately damaged at Mw 8.0 earthquake. The earthquake at Mw 6.0 will damage about 110,782 buildings which are about 61.00 % of the total number of buildings. At the same time an estimated 37,617 buildings will be damaged beyond repair.

Sylhet City Corporation Area

It is estimated that about 30,392 buildings will be damaged at 8.0 Mw earthquake. This is about 58.00 % of the total number of buildings in the Sylhet city. Among these, about 16003 buildings will be damaged beyond repair. About 7230 buildings will be at least moderately damaged at Mw 8.3 earthquake. The earthquake at Mw 6.0 will damage about 21960 buildings which are about 42.00 % of the total number of buildings. At the same time an estimated 4537 buildings will be damaged beyond repair.

Collateral Hazards

There might be several secondary hazards due to earthquake which may affect structures as well as damage to human life responsible for huge economic losses in the country. These collateral hazards include fire, debris generations etc. The following are the possible fire hazards and debris generation that may appear due to earthquake in Dhaka, Chittagong and Sylhet cities.

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires at the same time, lack of water and sufficient manpower and also due to inaccessible roads, the fire in the city could be out of control. For fire hazard scenario development, Monte Carlo simulation model was used. The number of ignitions and amount of burnt areas was estimated using this method.

Dhaka City Corporation Area

During an earthquake of 7.5 Mw originated from Madhpur Fault, there will be 920 ignitions that will burn about 4.12 sq. mi 9.04 % of the city area. It is estimated that the fires will displace about 701,134 people and burn about 1,577 (millions of dollars) of building value. Similarly an earthquake originated from Plate boundary fault-2 will be responsible for 918 ignitions that will burn about 4.08 sq. mi 8.95 % of the city area. It is also estimated that the fires will displace about 726,606 people and burn about 1,665 (millions of dollars) of building value. The earthquake if originated from under the city of 6.0 Mw will be responsible for 920 ignitions that will burn about 4.22 sq. mi 9.26 % of the city and the fires will displace about 730,857 people and burn about 1,563 (millions of dollars) of building value.

Chittagong City Corporation Area

In Chittagong during an earthquake of 8.5 Mw originated from Plate boundary fault-1, there will be 699 ignitions that will burn about 6.54 sq. mi 11.49 % of the city area. It is also estimated that that the fires will displace about 315,408 people and burn about 441 (millions of dollars) of building value. On the other hand an earthquake originated from Plate Boundary fault-2 at 8.0 Mw will be responsible for 648 ignitions that will burn about 5.87 sq. mi 10.31 % of the city. It is also estimated that the fires will displace about 312,052 people and burn about 433 (millions of dollars) of building value. The earthquake if originated from under the city of 6.0 Mw will be responsible for 699 ignitions that will burn about 6.24 sq. mi 10.96 % of the city. The model also estimates that the fires will displace about 314,421 people and burn about 437 (millions of dollars) of building value.

Sylhet City Corporation Area

In Sylhet, during an earthquake of 8.0 Mw originated from Dauki fault, there will be 770 ignitions that will burn about 1.79 sq. mi 19.85 % of the city area. It is also estimated that that the fires will displace about 79,608 people and burn about 171 (millions of dollars) of building value. On the other hand an earthquake originated from Plate Boundary fault-3 at 8.3 Mw will be responsible for 769 ignitions that will burn about 2.22 sq. mi 24.62 % of the city. It is also estimated that the fires will

displace about 98,905 people and burn about 221 (millions of dollars) of building value. The earthquake if originated from under the city of 6.0 Mw will be responsible for 770 ignitions that will burn about 2.17 sq. mi 20.06 % of the city. The model also estimates that the fires will displace about 96,967 people and burn about 204 (millions of dollars) of building value.

Debris Generation

The amounts of debris that will be generated by the earthquake are categorized into two general types:

a) Brick/Wood

b) Reinforced Concrete/Steel.

This classification is made because of the different types of material handling equipment required to handle and remove the debris.

Dhaka City Corporation Area

During an earthquake of 7.5 Mw originated from Madhpur Fault, a total of 30,599 million tons of debris will be generated. Out of this amount, Brick/Wood comprises 22.00% and Reinforced Concrete/Steel with 78%. If the debris tonnage is converted to an estimated number of truckloads to remove, 1,223,960,000 truckloads are required (@25 tons/truck). Similarly an earthquake originated from Plate boundary fault-2 will generate a total of 19,147.00 million tons of debris of which Brick/Wood comprises 19.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 765,880,000 truckloads (@25 tons/truck). The earthquake originated from under the city of 6.0 Mw, will be responsible for generation of a total of 21,059.00 million tons of debris. Out of this amount, Brick/Wood comprises 23.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 842,360,000 truckloads (@25 tons/truck) to remove it.

Chittagong City Corporation Area

During an earthquake of 8.5 Mw originated from Plate boundary fault-1, a total of 13,350.00 million tons of debris will be generated. Out of this, Brick/Wood comprises 32%, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 534,000,000 truckloads (@25 tons/truck) to remove it. On the other hand an earthquake originated from Plate Boundary fault-2 at 8.0 Mw will be responsible for 2,079.00 million tons of debris of which Brick/Wood comprises 29%, with the

remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 83,160,000 truckloads (@25 tons/truck) to remove it. The earthquake if originated from under the city of 6.0 Mw, will generate an estimated 5,423.00 million tons of debris. Out of the total amount, Brick/Wood comprises 31% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 217,160,000 truckloads (@25 tons/truck) to remove the debris generated by this earthquake.

Sylhet City Corporation Area

During an earthquake of 8.0 Mw originated from Dauki fault, a total of 18,93.00 million tons of debris will be generated. In this amunt, Brick/Wood comprises 27%, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 75,720,000 truckloads (@25 tons/truck) to remove it. On the other hand an earthquake originated from Plate Boundary fault-2 at 8.3 Mw will be responsible for the generation of 256.00 million tons of debris of which Brick/Wood comprises 25%, and the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 10,240,000 truckloads (@25 tons/truck) to remove it. The earthquake if originated from under the city of 6.0 Mw, will generate an estimated 949.00 million tons of debris. Out of the total amount, Brick/Wood comprises 25% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 37,960,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake

Economic Loss

Earthquake may make substantial economic losses to economy through damaging different infrastructures. These losses include structural, non-structural, different materials inside a building, transportation, utility services etc. Following is the detail of possible economic loss estimated based on different earthquake scenarios in Dhaka, Chittagong and Sylhet cities.

Structural, non structural and content loses due to building damage

Dhaka City Corporation Area

There will be significant losses due to the damage of building and other infrastructures if there is earthquake in Dhaka. During an earthquake with magnitude 7.5 Mw originated from Madhupur fault, the country has to bear a

economic loss of about 1025 million USD for structures. Economic loss to the structure will be 649.30 and 687.79 million USD respectively during the earthquake at 8.0 Mw from plate boundary Fault-2 and an earthquake originated from under the city at 6.0 Mw.

Similarly the loss of Non-Structural items will be 3608, 2166 and 2562 million USD respectively for the earthquakes at 7.5 Mw originated from Madhupur fault, at 8.0 Mw from plate boundary Fault-2 and an earthquake originated from under the city at 6.0 Mw. Building contain loss will be 1369, 798 and 989 million USD respectively for the three earthquakes as described sequentially.

The estimated loss due the damage of building and other infrastructures in Dhaka city for different earthquake scenario has been shown in the following table.

Table 1.2 Building-Related Economic Loss Estimates (Millions of dollars) in Dhaka City Corporation Area

Dhaka : Case 1							
Category	**Area**	**Single Family**	**Other Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Capital Stock Loses							
	Structural	*2.52*	*515.57*	*423.33*	*34.59*	*49.23*	*1,025.25*
	Non_ Structural	*7.02*	*2,562.89*	*704.91*	*149.53*	*183.62*	*3,607.97*
	Content	*1.73*	*680.18*	*457.01*	*110.49*	*110.75*	*1,360.17*
Dhaka : Case 2							
Capital Stock Loses							
	Structural	*1.22*	*311.26*	*287.92*	*18.91*	*29.99*	*649.30*
	Non_ Structural	*3.50*	*1,524.00*	*445.66*	*83.91*	*108.79*	*2,165.85*
	Content	*0.91*	*389.31*	*283.39*	*61.16*	*63.01*	*797.78*
Dhaka : Case 3							
Capital Stock Loses							
	Structural	*1.70*	*376.80*	*254.94*	*20.49*	*33.87*	*687.79*
	Non_ Structural	*4.74*	*1,910.68*	*421.78*	*99.51*	*125.53*	*2,562.24*
	Content	*1.25*	*537.92*	*292.98*	*75.73*	*80.96*	*988.85*

Source: Hazus calculation based on database, engineering geology and seismic hazard

Chittagong City Corporation Area

An earthquake in Chittagong with magnitude 8.5 Mw originated from Plate Boundary Fault-1, will bring economic loss to structural, non-structural and building contain that costs respectively 677, 20001 and 310 million USD. Similarly there will be loss of 98, 249 and 40 million USD respectively for structural, non-structural and house content during an earthquake at 8.0 Mw from plate boundary Fault-2.

The earthquake originated from under the city at 6.0 Mw may bring economic loss of about 264, 712 and 123 million USD respectively for structural, non-structural and building contain.
The estimated loss due the damage of building and other infrastructures in Chittagong city for different earthquake scenario has been shown in the following table.

Table 1.3 Building-Related Economic Loss Estimates (Millions of dollars) in Chittagong City Corporation Area

Chittagong : Case 1							
Category	**Area**	**Single Family**	**Other Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Capital Stock Loses							
	Structural	*161.82*	*219.82*	*252.72*	*23.54*	*19.33*	*677.23*
	Non_ Structural	*521.86*	*938.70*	*350.91*	*123.69*	*66.78*	*2,0001.93*
	Content	*0.00*	*0.00*	*184.91*	*89.21*	*36.52*	*310.64*
Chittagong : Case 2							
Capital Stock Loses							
	Structural	*24.19*	*27.30*	*39.05*	*4.71*	*2.29*	*97.54*
	Non_ Structural	*66.03*	*118.27*	*38.85*	*18.99*	*7.05*	*249.19*
	Content	*0.00*	*0.00*	*21.92*	*13.89*	*4.11*	*39.92*
Chittagong : Case 3							
Capital Stock Loses							
	Structural	*67.13*	*76.40*	*102.00*	*11.31*	*6.74*	*263.57*
	Non_ Structural	*192.50*	*322.73*	*121.74*	*53.61*	*21.56*	*712.14*
	Content	*0.00*	*0.00*	*68.90*	*40.40*	*13.57*	*122.88*

Source: Hazus calculation based on database, engineering geology and seismic hazard

Sylhet City Corporation Area

An earthquake in Sylhet at 8.0 Mw originated from Dauky Fault, will bring economic loss to structural, non-structural and building contain that costs respectively 86, 263 and 88 million USD. Similarly there will be loss of 11, 28 and 11 million USD respectively for structural, non-structural and house content during an earthquake at 8.3 Mw from plate boundary Fault-3. The earthquake originated from under the city at 6.0 Mw may bring economic loss of about 37, 100 and 40 million USD respectively for structural, non-structural and building contain.

The different types of loses for different scenarios earthquake for Sylhet city has been given in the following table.

Table 1.4 Building-Related Economic Loss Estimates (Millions of dollars) in Sylhet City Corporation Area

Sylhet : Case 1							
Category	**Area**	**Single Family**	**Other Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Capital Stock Loses							
	Structural	*43.49*	*15.12*	*22.79*	*1.02*	*3.46*	*85.89*
	Non_ Structural	*129.52*	*77.97*	*36.99*	*4.79*	*13.85*	*263.12*
	Content	*34.90*	*19.87*	*21.36*	*3.46*	*8.42*	*88.01*

Sylhet : Case 2							
Capital Stock Loses							
	Structural	*3.98*	*2.35*	*3.80*	*0.10*	*0.55*	*10.79*
	Non_ Structural	*8.94*	*11.09*	*5.03*	*0.49*	*1.85*	*27.39*
	Content	*3.46*	*2.99*	*3.09*	*0.37*	*1.23*	*11.14*
Sylhet : Case 3							
Capital Stock Loses							
	Structural	*18.83*	*6.29*	*9.75*	*0.48*	*1.55*	*36.89*
	Non_ Structural	*47.26*	*30.16*	*14.80*	*2.19*	*5.55*	*99.96*
	Content	*15.52*	*8.78*	*9.56*	*1.67*	*3.87*	*39.40*

Source: Hazus calculation based on database, engineering geology and seismic hazard

Economic Loss in Transportation and Utility Service Sector

There will be huge economic losses in transport and Utility services sectors during the earthquake of different magnitudes. Transport sector covers the infrastructures like highways, railways, bus and ferry. While utility services cover water supply, waste water treatment system, gas supply network, electric supply and communication systems. The following are the economic losses estimated in transportation and utility service sectors.

Dhaka City Corporation Area

In Dhaka an earthquake of 7.5 Mw originated from Madhupur fault, will bring economic loss of 97, 4.2, 0.9 and 0.1 million USD respectively for highway, railway, bus and ferry sector. Similarly for scenario 2, an earthquake with magnitude 8.0 Mw, there will be 38, 2, 0.5 and 0.1 million USD economic losses for highway, railways, buses and ferry respectively. For scenario 3, an earthquake under the city, the economic loses will be 32, 2.4, 0.8 and 0.1 million USD for the respective four sectors. The detail estimated economic loses has been given in the following table.

Table 1.5 Transportation System Economic Losses in Dhaka City Corporation Area (in million of dollars)

System	*Component*	*Scenario 1*			*Scenario 2*			*Scenario 3*		
		Inventory Value	***Economics Loss***	***Loss Ratio (%)***	***Inventory Value***	***Economics Loss***	***Loss Ratio (%)***	***Inventory Value***	***Economics Loss***	***Loss Ratio (%)***
Highway	*Segments*	*1,479.39*	*95.43*	*6.45*	*1,479.39*	*36.73*	*2.48*	*1479.39*	*31.41*	*2.12*
	Bridges	*26.53*	*1.24*	*4.66*	*26.53*	*0.86*	*3.23*	*26.53*	*0.56*	*2.09*
	Subtotal	***1,505.90***	***96.70***		***1,505.90***	***37.60***		***1505.90***	***32.00***	
Railways	*Segments*	*66.52*	*2.04*	*3.07*	*66.52*	*0.76*	*1.15*	*66.52*	*0.46*	*0.07*
	Facilities	*9.20*	*2.11*	*22.92*	*9.20*	*1.24*	*13.50*	*9.20*	*1.96*	*21.33*
	Subtot	***75.70***	***4.20***		***75.70***	***2.00***		***75.70***	***2.40***	

	al									
Bus	*Facilities*	*3.68*	*0.93*	*25.37*	*3.68*	*0.53*	*14.53*	*3.68*	*0.76*	*20.73*
	Subtotal	***3.70***	***0.90***		***3.70***	***0.50***		***3.70***	***0.80***	
Ferry	*Facilities*	*0.80*	*0.14*	*17.78*	*0.80*	*0.10*	*12.51*	*0.80*	*0.15*	*18.26*
	Subtotal	***0.80***	***0.10***		***0.80***	***0.10***		***0.80***	***0.10***	
	Total	***1586.10***	***101.90***		***1,586.10***	***40.20***		***1586.10***	***35.30***	

Source: Hazus calculation based on database, engineering geology and seismic hazard

The aggregate of the economic loss in these four sectors would be 40 and 35 million USD respectively during the earthquake of 8.0 Mw from plate boundary Fault-2 and the earthquake originated from under the city at 6.0 Mw. Similarly for three different scenarios economic loss in utility system would be respectively 59, 39 and 45 million USD (please see table……. for detail).

The economic loses for utility systems like portable water, waste water, natural gases, electrical power and communication for different earthquake scenario has been presented in the following table.

Table 1.6 Utility System Economic Losses in Dhaka City Corporation Area (in million of dollars)

System	*Component*	*Scenario 1*			*Scenario 2*			*Scenario 3*		
		Inventory Value	***Economics Loss***	***Loss Ratio (%)***	***Inventory Value***	***Economics Loss***	***Loss Ratio (%)***	***Inventory Value***	***Economics Loss***	***Loss Ratio (%)***
Portable Water	*Pipelines*	*13.10*	*1.61*	*12.32*	*13.10*	*0.80*	*6.13*	*13.10*	*0.84*	*6.38*
	Facilities	*140.20*	*20.58*	*14.68*	*140.20*	*10.18*	*7.26*	*140.20*	*16.86*	*12.02*
	Subtotal	***153.28***	***22.19***		***153.28***	***10.99***		***153.28***	***17.69***	
Waste Water	*Pipelines*	*2.90*	*3.18*	*111.13*	*2.90*	*1.98*	*69.15*	*2.90*	*1.85*	*64.86*
	Facilities	*60.60*	*5.33*	*8.79*	*60.60*	*4.13*	*6.81*	*60.60*	*5.10*	*8.42*
	Subtotal	***63.48***	***8.51***		***63.48***	***6.10***		***63.48***	***6.96***	
Natural Gas	*Pipelines*	*7.70*	*0.43*	*5.66*	*7.70*	*0.20*	*2.58*	*7.70*	*0.21*	*2.80*
	Facilities	*7.00*	*1.28*	*18.35*	*7.00*	*0.49*	*6.94*	*7.00*	*0.90*	*12.91*
	Subtotal	***14.66***	***1.72***		***14.66***	***0.68***		***14.66***	***1.12***	
Electrical Power	*Facilities*	*75.80*	*15.60*	*20.59*	*75.80*	*16.37*	*21.61*	*75.80*	*9.77*	*12.90*
	Subtotal	***75.76***	***15.60***		***75.76***	***16.37***		***75.76***	***9.77***	
Communication	*Facilities*	*81.00*	*11.24*	*13.88*	*81.00*	*5.20*	*6.42*	*81.00*	*9.47*	*11.69*
	Subtotal	***81.00***	***11.24***		***81.00***	***5.20***		***81.00***	***9.47***	
	Total	***388.18***	***59.25***		***388.18***	***39.35***		***388.18***	***45.00***	

Source: Hazus calculation based on database, engineering geology and seismic hazard

Chittagong City Corporation Area

In Chittagong an earthquake of 8.5 Mw originated from Plate Boundary fault-1, will bring economic loss of 166, 14 and 0.7 million USD respectively for highway, railway and bus sector.

Table 1.7 Transportation System Economic Losses in Chittagong City Corporation Area (in million of dollars)

System	Component	Scenario 1			Scenario 2			Scenario 3		
		Inventory Value	**Economics Loss**	**Loss Ratio (%)**	**Inventory Value**	**Economics Loss**	**Loss Ratio (%)**	**Inventory Value**	**Economics Loss**	**Loss Ratio (%)**
Highway	*Segments*	*725.67*	*164.49*	*22.67*	*725.67*	*11.81*	*1.63*	*725.67*	*23.85*	*3.29*
	Bridges	*6.56*	*1.23*	*18.84*	*6.56*	*0.08*	*1.24*	*6.56*	*0.20*	*3.05*
	Subtotal	***732.20***	***165.70***		*732.20*	*11.90*		***732.20***	***24.00***	
Railways	*Segments*	*98.20*	*9.09*	*9.25*	*98.20*	*0.18*	*0.19*	*98.20*	*0.51*	*052*
	Facilities	*7.36*	*4.88*	*66.25*	*7.36*	*0.52*	*7.03*	*7.36*	*2.19*	*29.74*
	Subtotal	***105.60***	***14.00***		***105.6***	***0.70***		***105.60***	***2.70***	
Bus	*Facilities*	*1.55*	*0.71*	*45.53*	*1.55*	*0.25*	*15.88*	*1.55*	*0.47*	*30.63*
	Subtotal	***1.60***	***0.70***		***1.60***	***0.20***		***1.60***	***0.50***	
	Total	***839.30***	***180.40***		***839.30***	***12.80***		***839.30***	***27.20***	

Source: Hazus calculation based on database, engineering geology and seismic hazard

Table 1.8 Utility System Economic Losses in Chittagong City Corporation Area (in million of dollars)

System	Component	Scenario 1			Scenario 2			Scenario 3		
		Inventory Value	**Economics Loss**	**Loss Ratio (%)**	**Inventory Value**	**Economics Loss**	**Loss Ratio (%)**	**Inventory Value**	**Economics Loss**	**Loss Ratio (%)**
Portable Water	*Pipelines*	*3.60*	*2.47*	*68.38*	*3.60*	*0.25*	*6.94*	*3.60*	*0.61*	*16.74*
	Facilities	*69.60*	*24.76*	*35.60*	*69.60*	*5.87*	*8.44*	*69.60*	*14.96*	*21.51*
	Subtotal	***74.31***	***28.31***		***74.31***	***0.13***		***74.31***	***15.65***	
Natural Gas	*Pipelines*	*0.40*	*0.00*	*0.00*	*0.40*	*0.00*	*0.00*	*0.40*	*0.00*	*0.00*
	Facilities	*22.00*	*10.52*	*47.82*	*22.00*	*1.57*	*7.14*	*22.00*	*5.00*	*22.75*
	Subtotal	***22.81***	***11.43***		***22.81***	***1.58***		***22.81***	***5.07***	
Electrical Power	*Facilities*	*33.40*	*15.94*	*47.80*	*33.40*	*1.47*	*4.42*	*33.40*	*8.33*	*24.98*
	Subtotal	***33.35***	***15.94***		***33.35***	***1.47***		***33.35***	***8.33***	
Communication	*Facilities*	*19.00*	*9.53*	*50.16*	*19.00*	*0.77*	*4.05*	*19.00*	*4.27*	*22.45*
	Subtotal	***19.00***	***9.53***		***19.00***	***0.77***		***19.00***	***4.27***	
	Total	***150.15***	***66.07***		***105.15***	***9.97***		***150.15***	***33.39***	

Source: Hazus calculation based on database, engineering geology and seismic hazard

The aggregate of the economic loss in these three sectors would be 13 and 27 million USD respectively during the earthquake of 8.0 Mw from plate boundary Fault-2 and the earthquake originated from under the city at 6.0 Mw. Similarly for three different scenarios economic loss in utility system would be respectively 66, 10 and 34 million USD (please see table …….. for detail).

Sylhet City Corporation Area

In Sylhet, an earthquake of 8.0 Mw originated from Dauki fault, will bring economic loss of 181, 10 and 0.2 million USD respectively for highway, railway and bus sector.

Table 1.9 Transportation System Economic Losses in Sylhet City Corporation Area (in million of dollars)

System	Component	Scenario 1			Scenario 2			Scenario 3		
		Inventory Value	Economics Loss	Loss Ratio (%)	Inventory Value	Economics Loss	Loss Ratio (%)	Inventory Value	Economics Loss	Loss Ratio (%)
Highway	Segments	178.35	6.78	3.80	178.35	1.27	0.71	178.35	2.49	1.40
	Bridges	2.55	0.41	15.90	2.55	0.16	6.20	2.55	0.21	8.31
	Subtotal	**180.90**	**7.20**		**180.90**	**1.40**		**180.90**	**2.70**	
Railways	Segments	6.99	9.20	2.84	6.99	0.01	0.15	6.99	0.03	0.36
	Facilities	3.44	1.20	34.76	3.44	0.35	10.18	3.44	0.92	26.79
	Subtotal	**10.40**	**1.40**		**10.40**	**0.40**		**10.40**	**0.90**	
Bus	Faclities	0.16	0.06	34.88	0.16	0.02	10.25	0.16	0.04	26.81
	Subtotal	**0.20**	**0.10**		**0.20**	**0.00**		**0.20**	**0.00**	
	Total	**191.50**	**8.60**		**191.50**	**1.80**		**191.50**	**3.70**	

Source: Hazus calculation based on database, engineering geology and seismic hazard

Table 1.10 Utility System Economic Losses in Sylhet City Corporation Area (in million of dollars)

System	Component	Scenario 1			Scenario 2			Scenario 3		
		Inventory Value	Economics Loss	Loss Ratio (%)	Inventory Value	Economics Loss	Loss Ratio (%)	Inventory Value	Economics Loss	Loss Ratio (%)
Portable Water	Pipelines	0.50	0.92	168.15	0.50	0.16	29.12	0.50	0.31	57.87
	Facilities	2.40	0.34	14.47	2.40	0.27	11.66	2.40	0.31	13.07
	Subtotal	**2.90**	**1.26**		**2.90**	**0.43**		**2.90**	**0.63**	
Natural Gas	Pipelines	0.40	0.30	72.13	0.40	0.04	8.60	0.40	0.10	23.93
	Facilities	1.00	0.23	23.17	1.00	0.05	5.06	1.00	0.17	16.83
	Subtotal	**1.42**	**0.53**		**1.42**	**0.09**		**1.42**	**0.27**	
Electrical Power	Facilities	14.30	3.66	25.71	14.30	0.76	5.34	14.30	2.39	16.75
	Subtotal	**14.26**	**3.66**		**14.26**	**0.76**		**14.26**	**2.39**	
Communication	Facilities	23.00	5.48	23.84	23.00	1.53	6.65	23.00	3.88	16.86
	Subtotal	**23.00**	**5.48**		**23.00**	**1.53**		**23.00**	**3.88**	
	Total	**41.58**	**10.95**		**41.58**	**2.81**		**41.58**	**7.16**	

Source: Hazus calculation based on database, engineering geology and seismic hazard

The aggregate of the economic loss in these three sectors would be 1.8 and 3.7 million USD respectively during the earthquake of 8.3 Mw from plate boundary Fault-3 and the earthquake originated from under the city at 6.0 Mw. Similarly for three different scenarios economic loss in utility system would be respectively 10.95, 3 and 7 million USD (please see table…… for detail).

Potential Casualties in different Scenarios of Earthquake

In order to take necessary preparation by different agencies, during earthquake, the numbers of people that will be injured and killed by the earthquake have been

estimated into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimations are made for two times of day: 2:00 AM and 2:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum and the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum. Following are the description on the casualties in the city of Dhaka, Chittagong and Sylhet in different time on different scenarios.

Dhaka City Corporation Area

Night time

During an earthquake at 7.5 Mw originated from Madhupur fault at night time, about 18 thousand people will be killed immediately after the earthquake. About 9 thousand people will require hospitalization and can become life threatening if not promptly treated, about 50 thousand people will require hospitalization but are not considered life-threatening and about 150 thousand people will require medical attention like first aid or some kind of treatment. Similarly about 2 thousand people will be killed, one thousand need to be hospitalized on a critical condition, seven thousand need to be hospitalized on moderate injuries and about 24 thousand people will require medical attention if there is an earthquake at 8.0 Mw from plate boundary Fault-2. During an earthquake originated from under the city at 6.0 Mw, about 13 thousand people will die immediately, about seven thousand people will need to be hospitalized on a critical condition, about 38 thousand people will require taking admission in hospital with moderate injuries and about 110 thousand people will require medical attention.

Table 2.11 Casualties in Dhaka during different cases in Different Time

Time and Case	Level of casualties			
	Level 1	***Level 2***	***Level 3***	***Level 4***
2 AM				
Case 1	*152,307*	*50,905*	*9,028*	*17,884*
Case 2	*23,965*	*6,952*	*1,139*	*2,251*
Case 3	*110,753*	*37,265*	*6,671*	*13,216*
2 PM				
Case 1	*137,582*	*45,810*	*8,221*	*15,892*
Case 2	*32,021*	*9,433*	*1,572*	*3,021*
Case 3	*91,863*	*30,759*	*5,586*	*10,804*

Source: Hazus calculation based on database, engineering geology and seismic hazard

Day time

An earthquake at 7.5 Mw originated from Madhupur fault at day time, will kill about 16 thousand people immediately after the earthquake. About 8 thousand people will require hospitalization and can become life threatening if not promptly treated, about 46 thousand people will require hospitalization but are not considered life-threatening and about 137 thousand people will require medical attention like first aid or some kind of treatment. Similarly about 3 thousand people will be killed, one thousand five hundred need to be hospitalized on a critical condition, nine thousand five hundred need to be hospitalized on moderate injuries and about 32 thousand people will require medical attention if there is an earthquake at 8.0 Mw from plate boundary Fault-2. During an earthquake originated from under the city at 6.0 Mw, about 10 thousand people will die immediately, about five thousand five hundred people will need to be hospitalized on a critical condition, about 30 thousand people will require taking admission in hospital with moderate injuries and about 92 thousand people will require medical attention.

Chittagong City Corporation Area

Night time

During an earthquake at 8.5 Mw originated from Plate Boundary Fault-1 at night time, about 15 thousand people will be killed immediately after the earthquake. About 7 thousand people will require hospitalization and can become life threatening if not promptly treated, about 46 thousand people will require hospitalization but are not considered life-threatening and about 141 thousand people will require medical attention like first aid or some kind of treatment. Similarly about 2 thousand people will be killed, two thousand three hundred need to be hospitalized on a critical condition, fourteen thousand need to be hospitalized on moderate injuries and about 45 thousand people will require medical attention if there is an earthquake at 8.0 Mw from plate boundary Fault-2. During an earthquake originated from under the city at 6.0 Mw, about 5 thousand people will die immediately, about two thousand people will need to be hospitalized on a critical condition, about 14 thousand people will require taking admission in hospital with moderate injuries and about 46 thousand people will require medical attention.

Table2.12: Casualties in Chittagong during different cases in Different Time

Time and Case	Level of casualties			
	Level 1	***Level 2***	***Level 3***	***Level 4***
2 AM				
Case 1	141,391	46,335	7,436	14,545
Case 2	16,968	5,430	905	1,780
Case 3	45,778	14,343	2,328	4,571
2 PM				
Case 1	130,068	44,785	7,919	15,370
Case 2	14,923	4,875	858	1,660
Case 3	41,863	13,662	2,392	4,639

Source: Hazus calculation based on database, engineering geology and seismic hazard

Day time

An earthquake at 8.5 Mw originated from Plate Boundary Fault-1 by day time, will kill about 15 thousand people will be killed immediately after the earthquake. About 7 thousand people will require hospitalization and can become life threatening if not promptly treated, about 46 thousand people will require hospitalization but are not considered life-threatening and about 130 thousand people will require medical attention like first aid or some kind of treatment. Similarly about one thousand six hundred people will be killed, nine three hundred need to be hospitalized on a critical condition, five thousand need to be hospitalized on moderate injuries and about 15 thousand people will require medical attention if there is an earthquake at 8.0 Mw from plate boundary Fault-2. During an earthquake originated from under the city at 6.0 Mw, about 5 thousand people will die immediately, about two thousand people will need to be hospitalized on a critical condition, about 14 thousand people will require taking admission in hospital with moderate injuries and about 42 thousand people will require medical attention.

Sylhet City Corporation Area

Night time

During an earthquake at 8.0 Mw originated from Dauki Fault at night time, about 42 people will be killed immediately after the earthquake. About 21 people will require hospitalization and can become life threatening if not promptly treated, about 136 people will require hospitalization but are not considered life-threatening and about 442 people will require medical attention like first aid or some kind of treatment. Similarly about 2 people will be killed, one need to be hospitalized on a critical condition, five to be hospitalized on moderate injuries and 20 people will require medical attention if there is an earthquake at 8.3 Mw from plate boundary Fault-3. During an earthquake originated from under the city at 6.0 Mw, about 8 people will die immediately, about four people will need to be hospitalized on a critical condition, about 25 people will require taking admission in hospital with moderate injuries and about 86 people will require medical attention.

Table 2.13 Casualties in Sylhet during different cases in Different Time

Time and Cases	Level 1	Level 2	Level 3	Level 4
2 AM				
Case 1	442	136	21	42
Case 2	20	5	1	2
Case 3	86	25	4	8
2 PM				
Case 1	398	123	20	38
Case 2	18	5	1	1
Case 3	79	23	4	8

Source: Hazus calculation based on database, engineering geology and seismic hazard

Day time

An earthquake at 8.0 Mw originated from Dauki Fault, during day time, will kill about 38 people immediately after the earthquake. About 20 people will require hospitalization and can become life threatening if not promptly treated, about 123 people will require hospitalization but are not considered life-threatening and about 398 people will require medical attention like first aid or some kind of treatment. Similarly about one people will be killed, one need to be hospitalized on a critical

condition, five need to be hospitalized on moderate injuries and about 18 people will require medical attention if there is an earthquake at 8.3 Mw from plate boundary Fault-3. During an earthquake originated from under the city at 6.0 Mw, about 8 people will die immediately, about four people will need to be hospitalized on a critical condition, about 23 people will require taking admission in hospital with moderate injuries and about 79 people will require medical attention.

General Aspects of Agency Level Plan

2.1 Legal Provisions, Authority and National Level DM Functions of the Agency

Organizational Setup of the Ministry of Food and Disaster Management: Under the Ministry of Food and Disaster Management, Directorate of Relief and Rehabilitation (DRR) assists in formulating as well as implementing policies with regard to disaster management. DRR is responsible for executing and monitoring various food assisted programmes including Food for Work (FFW), Test Relief, Bridge and Culverts (FFW), Risk Reduction Programme, Relief and Rehabilitation programme, Vulnerable Group Feeding (VGF) & Vulnerable Group Development (VGD), Food Security Enhancement Initiative (FSED) Programme, and Construction of Flood/Cyclone shelters Programme.

2.2 The Major roles assigned to the agency in relation to National Earthquake Contingency Plan

The agency level responsibility of DRR with regards to Earthquake Risk Management is to ensure management of situation of mass casualties and treatment of victims as a result of Earthquakes and major aftershocks and as a result of co-lateral hazards. The main roles assigned to DRR in relation to National Earthquake Contingency Plan are to ensure:

- To undertake loss estimation and damage assessment for planning for long term recovery after earthquake disaster.
- Short term recovery planning and coordination for restoration of utilities, lifelines etc
- Planning for Reconstruction, Rehabilitation and long term recovery
- Relief Operations and welfare of victims after disaster events
- Maintenance of Camps for displaced
- Execution of Rehabilitation schemes
- Assistance for Contingency Plan Development
- Assistance for DM plan preparation of Union, Thana and District levels

2.3 The support roles assigned to agency under National Earthquake Contingency Management Plan

A strong National Earthquake Contingency Plan is considered to be a one that is built on a foundation for DRR that promotes:

- To prepare a framework for integrated response efforts by formulating a well coordinated Incident Command System (ICS) for risk reduction of potential earthquake hazards.
- EOC development and reporting structure
- ICS system development at various levels
- Command, Control, Coordination arrangement among first responder organizations

- Readiness reporting

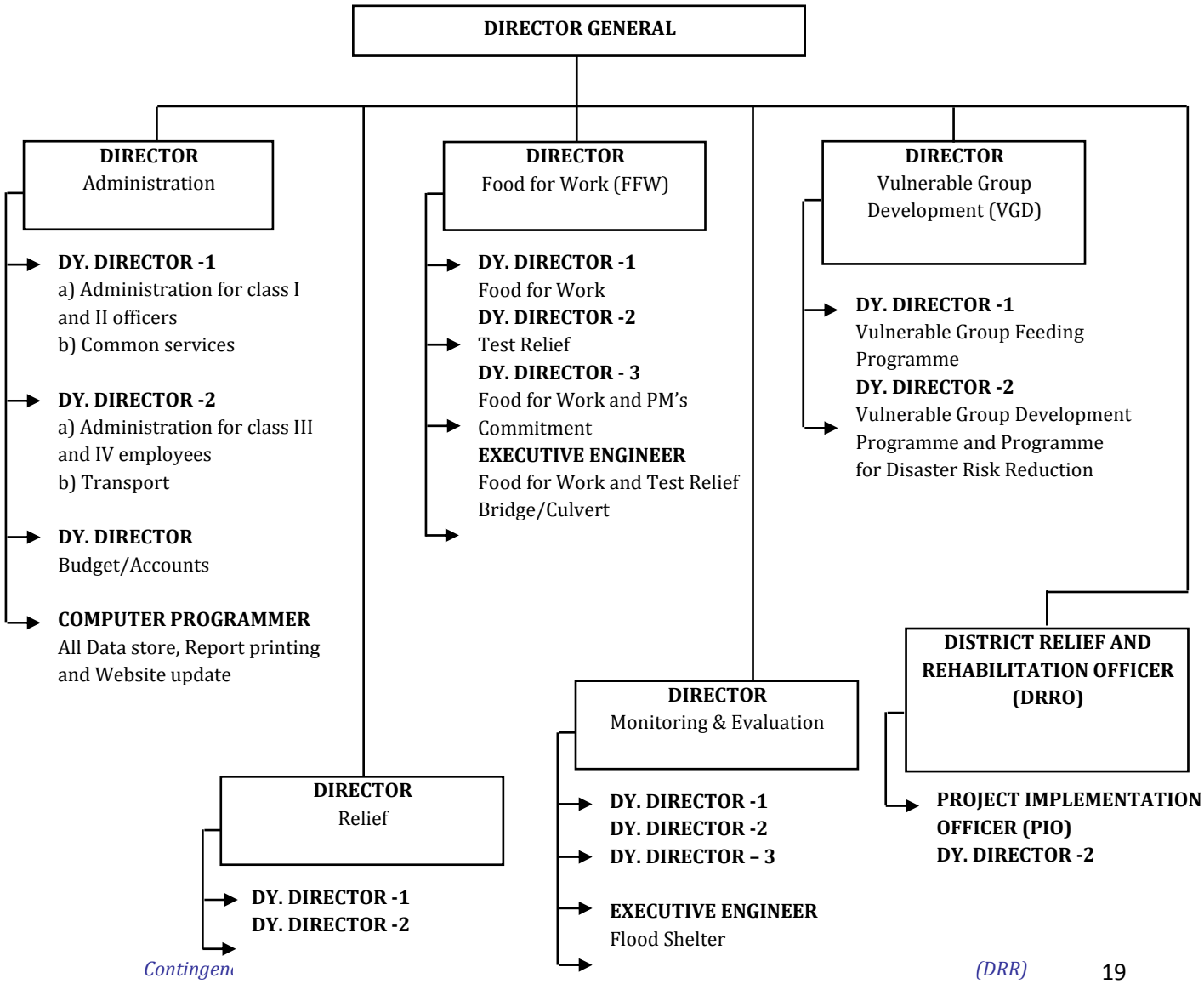
2.4 Agency level Objectives in fulfilling the assigned roles under National Earthquake Contingency Plan

The agency level responsibility of DRR with regards to Earthquake Risk Management is to ensure the welfare of victims of earthquake disaster and management of camps for displaced as a result of Earthquakes and major aftershocks to.

- Minimize the inconvenience to displaced
- Provide shelter, food and other welfare items
- Maintain the accepted levels of humanitarian assistance to victims of earthquake disaster in partnership with Government agencies, city authorities, NGOs, INGOs, Donor agencies

2.5 Agency level structure for Command, Control and Coordination within the organization and with outside agencies

The Organogram of the Directorate of Relief & Rehabilitation (DRR) is given in the following.



Command, Control and Coordination mechanism for DRR with regard to relief distribution is as follows:

Overall Supervision: Director General, DRR
Focal Point: Director of Relief, DRR
Management support: Director (Admin), Director (Monitoring & Evaluation)

The DRR implements its Disaster Management-Oriented decisions in different levels. More specifically, at District level, the District Relief and Rehabilitation Officer (DRRO) and the Project Implementation Officer (PIO) perform the all functions in their respective areas under the supervision of the Deputy Commissioner (DC) and Thana Nirbahi Officer (TNO).

2.6 Plan Implementation Strategies by the Agency

The following strategies are to be adopted in plan implementation:

- Setting up a strong organizational framework to identify and assess earthquake hazards, analyze vulnerability, assess risk and loss estimation with regards to relief and rehabilitation;
- Plan & development of institutional capabilities to translate earthquake risk reduction into Preparedness and Response Plans;
- Establish a consistent, participatory approach to the management of earthquake emergency responses;
- Propose a mechanism to integrate Disaster Management concept into the Operational Plans of Health Service Providers at all levels;
- Undertake training and education programs on all phases of Disaster Management for all levels to build the capacity of professionals;
- Develop a mechanism to improve the relationships with non-government organizations to address mitigation, preparedness, response and recovery phase effectively;
- Transfer knowledge and state of the art of technologies necessary to support institutional operations and implement operation plans;

2.7 Plan Limitations

- The Earthquake Contingency plan will not, and cannot, address all circumstances (e.g. long-term recovery plans)
- The Plan assumes that the line agencies will have Mandatory provisions and national capacity to deal with assigned tasks. Mandatory provisions for line agencies, ministries, and local governments. District authorities can be granted through a gazette notification but Lines of authority need to be finalized and communicated to all levels.
- The Earthquake Contingency Plan requires similar planning at all levels of government and by a number of key ministries and line departments. While respective agencies need to have dedicated champions to undertake planning and implementation; Ministry of Food & Disaster Management will have a difficult task in coordinating and providing technical assistance.

- DRR may need additional resources in terms of qualified manpower, technical as well as financial resources to undertake assigned tasks under the Earthquake Contingency Plan.
- The Earthquake Contingency Management process will take some times to become fully functional as an integrated system.
- The Plan assumes that the Emergency Operations Center is to be established on priority basis to have service functions for a 24/7 schedule with duty officers in place with clearly identified notification protocols.
- The Plan cannot ensure that emergency assistance to communities will arrive in time following a rapid on-site disaster unless the government will have emergency declarations in time. It will depend on efficient reliable and accurate emergency management system, which depends on application of advanced state of the art technology.
- Capable and committed staff with appropriate financial resources, facilities, equipment and supplies is required to implement an effective, long-term program based on the plan.

2.8 Intended Users of the Plan within the agency

The direct users of the agency level Earthquake contingency plan will be the management personnel of Directorate of Relief and Rehabilitation (DRR) in order to provide humanitarian assistance during earthquake emergencies.

In addition to DRR, the others including line Ministries, Departments, City Authorities, NGOs/ INGOs, electronic and paper Media, Community based Organizations (CBOs), Civil Society Organizations (CSOs), Academia, Development Partners will be the passive users of the plan as they will be providing support services for plan implementation with regard to emergency relief distribution and other welfare activities. The ultimate beneficiaries would be the communities at risk to bring normalcy within a fastest possible time.

Functional Response Roles and Responsibilities Assigned for the Agency

3.1 Emergency Response Tasks under Respective Functional Groups- Preparedness and Mitigation Phase (normal time activities)

To ensure this Contingency planning as a forward planning process, it is obvious to agree upon specific scenarios and objectives. An effective Potential Response System has to be put in place in order to prevent, or better respond to, an emergency or critical situation. In this regard, DRR needs to accomplish the following activities well-before the earthquake event.

Contingency planning by Directorate of Relief and Rehabilitation (DRR):

- Develop contingency plans for earthquake risk
- Conduct necessary training and capacity building for plan update
- Carry out periodic reporting to authorities on readiness of the DMB for responding to earthquake events

Emergency Services:

- Conduct scenario based Need Assessment survey of emergency services for earthquake prone urban areas and report to authorities

Welfare, Food and Nutrition:

- Develop methodology for conducting need assessment survey of welfare items, food and nutrition.
- Build capacity of staff for conducting damage analysis and need assessment survey
- Develop a database of agencies who can assist the government in welfare and supply of Information collection and supply of food and nutrition
- Develop methodology for Quality assurance for food and nutrition
- Establish regional ware houses for store of government supplies of welfare items food and supplementary items
- Ensure government resources for buying additional welfare items food and supplementary items
- Develop guidelines for setting up welfare camps by all agencies
- Developing guidelines for rehabilitation of physically handicapped disabled & vulnerable groups

Mass Media Communications and Public Information:

- Develop and disseminate information/guidelines on maintaining of welfare camps, distribution of welfare items and food
- Create general awareness in earthquake risk and community level preparedness

Water and Sanitation:

- Develop guidelines with water and sanitation group for minimum sanitation levels to be maintained in welfare camps

Recovery:

- Assist Developing a transfer strategy for intermediate recovery stage to permanent recovery stage
- Assist Development of procedures for Management of destitute and orphans
- Assist in Promotion of social security systems (insurance schemes, micro credit, etc.)
- Develop programs for livelihood recovery in earthquake prone areas

3.2 Emergency Response Tasks under Respective Functional Groups – Response phase (activities during and soon after the disaster events)

Contingency planning by Directorate of Relief and Rehabilitation (DRR):

- Compliance with plan arrangements and reporting on the DMB involvement in contingency plan implementation

Emergency Services:

- Conduct rapid Need Assessment survey of food and welfare for earthquake affected areas and report to authorities

Welfare, Food and Nutrition Group:

- Conduct needs assessment survey of welfare items, food and nutrition.
- Networking with Various stakeholders (funding agencies, NGOs & INGOs for improved coordination relief material distribution)
- Network with Ministries, departments, district authorities, Un Agencies ,NGOs & INGOs for distribution of relief material welfare items
- Conduct surveys for Quality assurance for food and nutrition
- Supply of food and supplementary items through government departments, district authorities for distribution to victims
- Routine stocking of food items in affected areas and distribution
- Observe compliance of guidelines for setting up welfare camps by all agencies
- Identification of physically handicapped disabled for special treatment

Mass Media Communications and Public Information Group:

- Assist authorities for communications with media in relation to welfare of victims

Water and Sanitation Group:

- Assist authorities to maintain sanitation facilities within welfare camps set up for victims

Recovery Group:

- Select potential beneficiaries to be included in programs for Management of destitute and orphans

3.3 Emergency Response Tasks under Respective Functional Groups – Recovery phase (activities following a disaster event)

Contingency planning by Directorate of Relief and Rehabilitation (DRR):

- Compliance with plan arrangements and reporting on the DMB involvement in contingency plan implementation

Emergency Services:

- Support the authorities to provide emergency services in earthquake affected areas

Welfare, Food and Nutrition Group:

- Assist in coordination with Ministries, departments, district authorities ,NGOs & INGOs for distribution of relief material distribution)
- Network with Ministries, departments, district authorities, Un Agencies ,NGOs & INGOs for distribution of relief material welfare items
- Conduct surveys for Quality assurance for food and nutrition
- Supply of food and supplementary items through government departments, district authorities for distribution to victims
- Routine stocking of food items in affected areas and distribution
- Periodic visits to welfare camps and M&E of compliance of guidelines for setting up welfare camps by all agencies
- Establishing counseling centre

Mass Media Communications and Public Information Group:

- Assist authorities for communications with media in relation to welfare of victims

Water and Sanitation Group:

- M&E of sanitation facilities

Recovery Group:

- Assist authorities to implement the transfer strategy for intermediate recovery stage to permanent recovery stage
- Undertake actions for Management of destitute and orphans
- Assist in activation of social security systems (insurance schemes, micro credit, etc.)
- Undertake livelihood recovery programs after earthquake event in affected areas

Operating Procedure Guidelines

4.1 Planning assumptions

- The agency level responsibility of DRR with regards to Earthquake Risk Management is to ensure welfare of Affected people in terms of provision of relief supply(food, cloths, welfare items etc, temporary shelter for displaced etc management of evacuation camps set up to house displaced people due to earthquake disaster within Bangladesh. There are many urban areas vulnerable to earthquake hazard as per the seismic zonation of Bangladesh and likelihood of a serious earthquake is inevitable. It is expected that there will be a large number of deaths as well as casualties, displaced, etc in most of the highly urbanized areas and main cities such as Dhaka, Chittagong, and Sylhet. This determines the level of response capacity of the DRR should possess during any Earthquake disaster situation.
- Operating procedures for mobilizing community participation during various stages of Earthquake disaster response is stated in the National Contingency Plan for Earthquakes. The DRR is required to study these and adopt appropriate measures to ensure that community participates substantially in first responder activities assigned to DRR under National Earthquake Contingency Plan.
- For effective preparedness, the DRR must have an Earthquake Contingency plan or Earthquake disaster response procedures clearly defined, in order to avoid confusion and improve efficiency in cost and time.
- Orientation and training for Earthquake Contingency plan and procedures accompanied by simulated exercises, will keep the department prepared for such eventualities. Special skills required during emergency operations need to be imparted to the officials and the staff. Select personnel can be deputed for training as "NODAL OFFICER - DRR", "Officer-in-charge – DRR at District level and "Officer-in-charge – DRR at City level" at the district and city levels respectively.
- To the extent possible, preparedness measures as recommended in the National Earthquake Contingency Plan should be undertaken to improve the departmental capacity to respond to an earthquake disaster.

4.2 Normal time activities

- Assess preparedness level of the DRR and report the same as per the format given to National EOC every six months.
- Conduct scenario based Need Assessment survey of emergency services for earthquake prone urban areas and report to authorities. Prepare a list of welfare items that will be needed during earthquake emergency so that

such information can be provided for Flash Appeals launched by UNDP and other International donor agencies.

- Develop methodology for conducting need assessment survey of welfare items, food and nutrition and conduct training for Officials who will be involved in such assessments.
- Build capacity of DRR staff for conducting damage analysis and need assessment survey
- Develop a forum of Agencies who can assist the government in welfare and supply and establish a reporting mechanism by such agencies (NGOs, INGOs, Donor agencies).Develop a database of resources available with agencies that can assist the government in welfare items, temporary shelter and supply of food and nutrition items.
- Develop methodology for Quality assurance for supply of food and nutrition during earthquakes
- Establish regional warehouses to store government supplies of welfare items food and supplementary items in High Earthquake risk areas and outside.
- Ensure government resources for buying additional welfare items food and supplementary items
- Developing guidelines for rehabilitation of physically handicapped disabled & vulnerable groups
- Develop and disseminate information/guidelines on maintaining of welfare camps, distribution of welfare items and food
- Develop guidelines with institutions involved in water and sanitation for minimum sanitation levels to be maintained in welfare camps
- Create general awareness in earthquake risk and community level preparedness especially to have a household level earthquake packs for survival for 02 days

4.3 Activities on receipt of notice of Activation if National Earthquake Contingency Plan

- Within the affected City/district/electoral ward, all DRR personnel will be made available to the Response Commander. If more personnel are required, then out-of-station officers or those on leave may be recalled.
- All personnel required for Earthquake Response should work under the overall supervision and guidance of Response Commander
- Establish radio communications with National Emergency Operations Centre, district control rooms and DRR departmental offices within the affected areas.
- All district/city level officials of the department would be asked to report to the pre-agreed location/DRR office
- Appoint one personnel as “NODAL OFFICER – DRR” at the National level

- Appoint one personnel each as "Officer-in-charge – DRR" at the City/District level
- Review precautionary measures, procedures of operations through daily review with relevant senior staff, to improve the Response services by officials of DRR and make arrangements for necessary back up support if needed
- Assist Government, donor agencies, UNDP in providing damage assessment reports and need analysis reports on daily basis for launching Flash appeals by them.
- Assist the authorities to make arrangements for stand by Resources (man-power, material, equipment)
- Fill department vehicles and park them in protected area
- Check emergency tool kits, supplies, assembling any additional welfare items as needed.
- Review the total extent of the damage to FSCD buildings, equipment, installations
- Review the total extent of the damage and fire outbreaks within major cities by a reconnaissance flight, if possible to understand the needs of setting up welfare camps
- Dispatch emergency response teams of DRR to affected areas but unattended.

Readiness Checklist

5.1 Readiness Checklist and Reporting Formats

The Preparedness Checklist and Reporting Template for DRR with regard to Earthquake hazard is given below:

(To be filled by the Nodal Officer of M&E Department and submitted through the DRR to the National EOC at the end of May and November every year)

Preparedness Measures taken	Details / Remarks
The department is familiar with the National earthquake disaster contingency plan and responsibilities given to DRR	
Orientation and training for Earthquake Contingency plan and procedures undertaken within DRR. Each relevant officer understands earthquake disaster response procedures he has to follow during earthquake event.	
Special welfare items and provisions required during Earthquake emergency operations that DRR posses(fill the number) ▪ No of warehouse facilities in earthquake affected areas ▪ No of Emergency supplies kits in hand for distribution to affected people ▪ No of temporary shelter facilities ▪ No of mobile kitchens ▪ No of water purification plants	
Special welfare items and provisions required during Earthquake emergency operations belong to other agencies and that other agencies have reported to DRR ▪ No of warehouse facilities in earthquake affected areas ▪ No of Emergency supplies kits in hand for	

distribution to affected people ▪ No of temporary shelter facilities ▪ No of mobile kitchens ▪ No of water purification plants	
Reviewed and updated: ▪ Preparedness measures and procedures that DRR should undertake. ▪ The vulnerability assessment of buildings of DRR ▪ The precautions to be taken to protect equipments and material belong to DRR, in case of earthquake. ▪ Post earthquake disaster recovery procedures to be followed by DRR. ▪ No of DRR critical Buildings and facilities were strengthened to have high standard of safety	
An officer has been designated as Nodal Officer for Earthquake Disaster Response ▪ Name ▪ Designation ▪ Contact details	
Additional Sources of supply of materials, manpower, equipment required to support DRR in Earthquake response operations have been identified.	

Reported By:

Designation: DRR Signature: Date

Agency Level Actions for Training & Capacity Building of Staff, Awareness Creation, Reporting, Pre-positioning of Emergency Facilities, Resource Mobilization for Purchase of Equipments

6.1 Assessment of Existing Capacity (Man power, Equipment and Material)

The DRR divides its Infrastructural Network into the following levels:

National Level:

The total Manpower of the Directorate at the Head Office, District and Upazila level are as follows:-

Sl	Name of Post	No. of Sanctioned Post
1.	Director General	01
2.	Director	05
3.	Deputy Director	13
4.	Executive Engineer	02
5.	Computer Programmer	01
6.	Assistant Director	11
7.	Assistant Engineer	02
8.	Project Implementation Officer	16
9.	Class-III employee	99
10.	Class-IV employee	44
	Total	***194***

District Office:

Sl	Name of Post	No. of Sanctioned Post
1.	District Relief and Rehabilitation Officer	68
2.	Class-III employee	294
3.	Class-IV employee	160

Upazila Office:

Sl	Name of Post	No. of Sanctioned post
1.	Upazila Project Implementation Officer	200
2.	Upazila Project Implementation	302
3.	Class-III employee	486

District level:

For execution of the projects and implementation of Directorate's activities there are committees at district, Upazila and union level.

District FFW/TR Coordination Committee:

Sl	Member of Committee	Designation
1.	Deputy Commissioner	Chairman
2.	Superintendent of Policies (SP)	Member
3.	Dy. Director, Agriculture Extension Department	Member
4.	Upazila Nirbahi Officer (All)	Member
5.	Chairman Pourashava	Member
6.	District Control, Food	Member
7.	Executive Engineer, LGED	Member
8.	District Fisheries Officer	Member
9.	District Education Officer	Member
10.	District Relief & Rehabilitation Officer(DRRO)	Member Secretary

District Steering Committee:

Sl	Member of Committee	Designation
1.	DC	Chairman
2.	Upazila Nirbahi Officer(UNO)	Member
3.	Superintending of Police	Member
4.	Chairman (All)	Member
5.	CEO/Secretary, City Corporation.	Member
6.	District Controller, Food	Member
7.	Deputy. Director, Agriculture Extension	Member
8.	Dist Fisheries officer	Member
9.	District Education officer	Member
10.	Executive Engineer , LGED	Member
11.	District Relief & Rehabilitation Officer(DRRO)	Member Secretary

Union and Upazila Level:

Upazila FFW/TR Coordinator Committee:

Sl	Member of Committee	Designation
1.	Upazila Nirbahi Officer	Chairman
2.	Upazila Engineer	Member
3.	Upazila Agriculture Officer	Member
4.	Upazila Fisheries Officer	Member
5.	Upazila Public Health Engineer	Member
6.	Upazila Food Controller	Member
7.	Upazila Rural Development Officer	Member
8.	Upazila Accounts Officer	Member
9.	Upazila Social Welfare Officer	Member
10.	Sub Assistant Engineer (Public Health)	Member
11.	UP Chairman (All)	Member
12.	Project Implementation Officer (PIO)	Member Secretary

6.2 Gap Analysis (Man power, equipment and material)

Followings are the key elements identified to enhance the emergency preparedness for a sustainable response.

Table: Gap Analysis Matrix for DRR

Type of gap	Description
General gaps	• Difficulties for compliance to standing orders since Earthquake aspect is not covered adequately in the SOPs. Some of the Standard Operation Procedures which will be drafted for agency level plan operations have to be incorporated in to General SOP of Bangladesh.
Management gaps	• The DRR personnel will be called upon to provide services Relief and welfare services in case of emergencies. But there is no clear coordination and command structure in place especially to coordinate with NGOs, INGOs, and Donor agencies. It will become a difficult task for discharge of services without a proper management structure for obtaining such services during earthquakes.
Gaps in Mandatory provisions	• Absence or lack of Mandates for DM related functions; DRR participate in the process of supply of relief assistance because of organization missions, concern for safety, community responsibilities etc. But due to procedural setbacks the Government aid supplies will arrive with certain delay. In certain countries there is a provision for calamity funds to be used by sub-national level authorities but due to decentralized process relief assistance can not be provided in the same speed

	as the NGOS. This has to be regularized.
Gaps in Planning	• It is necessary to introduce a Damage Assessment and need analysis (DANA) methodology. • Regular process should be introduced to coordinate with NGOs (especially INGOs which have large stocks of Relief and welfare items) for inventorying and database management.
Gaps in man-power and capacity building	• The available man-power under DRR will not be enough to handle operations during large scale Earthquakes. There is a need for training of other government staff to serve in DRR in case of such emergency. • Financial resources for addressing the Shortage of skilled manpower for specialized Emergency Relief supply & related services during earthquakes • Resource concerns for skill enhancement in planning and capacity building of DRR staff in Damage Assessment and Need Analysis (DANA) should be addressed.
Gaps in Temporary shelter facilities	• At the moment the schools, mosques other religious places, government buildings are being used as temporary shelter for victims. But in case of earthquakes most of them might get destroyed and there is a need for procurement of adequate temporary shelter for evacuation of larger population in urban areas in particular. Suitable open areas need to be located and arrangements should be made in advance for other services for setting up camps for displaced people. • Financial resources for addressing the Shortage of Temporary shelter facilities should be addressed.
Gaps in Monitoring and Evaluation	• The DRR need to develop a comprehensive data base on all the resources in hand. Arrangements should be made in place for replenishment soon after utilizing the available items during disaster events. • The DRR need to have an inventory of items that should be obtained from donor countries so that just after earthquakes a clear plash appeals could be provided to UN agencies
Gaps in Provision of technical services	• The methodology for rapid assessment of Damage Assessment and Need Analysis (DANA) has to be developed in order to have consistency in such surveys conducted by H/office and field officers (District officials -DRROs, Upazila level officials -PIOs etc).This can be done through capacity building and simulation exercises. • Methodology should be developed for Quality assurance and Quality checks of welfare items and that need to be shared with all DRR Executives. • Standards should be developed for Welfare camp maintenance and shared with Executive staff of DRR.

6.3 Process for addressing the gaps

Capacity Assessment of DRR: A capacity assessment of DRR has to be conducted to see the possibility of addressing the Relief and Rehabilitation needs of a large

scale earthquake. A recent Cyclone Sydr has provided a good opportunity to test out the response capacity of DRR.The lessons learned in such an events can be used for enhancement of the existing capacity of DRR.A comprehensive assessment is needed for identifying areas of improvement and it will be useful to identify probable scenarios due to earthquakes in order to carry out an analysis of the existing capacity of DRR.

Methodology development for conducting assessments: Often DRR needs to carry out Damage Assessment and Need Analysis surveys after the disaster events. In order to have consistent and comprehensive methodology developed and utilized in future disaster events, services of a suitable consultant should be obtained for methodology development, training and conducting analysis. The methodology can be based on the methodology used in one of the SAARC countries and that should be modified to suit the situation in Bangladesh. The Gujarat State Disaster Management Authority has developed such a methodology and that may be one of the methodologies that can be studied.

Training and capacity building: In order that all the field level staff conduct the Assessment maintaining a consistent level of performance it is suggested to have routine Capacity building programs for DRR staff. In a large scale emergency such as Earthquakes it will be necessary for DRR staff to manage Relief and Recovery operation in coordination and collaboration with many other government and non-government institutions. Therefore it is advisable to impart such training to other institutions also for possible assistance during large scale disaster events.

Developing standards for Welfare camps, welfare items, food stocks etc.: The International humanitarian community has developed standards for various operations during disaster events and post disaster period. It is necessary to compile such standards and provide field operation manuals for DRR staff and other stakeholder institutions. It is necessary to translate such material in to Bangla language.

Develop forums for better coordination with NGOs, INGOs, and Donor agencies: It is necessary to have a better coordination mechanism as well as a reporting mechanism about the readiness of responder institutions to respond to large scale disasters. This will include developing databases of stocks (of food, welfare items etc), preparation of inventory of materials & equipment such as temporary shelter, shelter material, latrines, water purification plants, generators, and man-power. There should be a continuous reporting process and routine review process to have an analysis of status. In order to achieve this sort of objectives better to organize a standing committee of responder institutions responsible for relief supply, welfare of displaced people etc and have routine meetings to share the level of readiness and to take up appropriate solutions for improvements.

6.4 Action Plan for Enhancement of Capacity

Present capacities of DRR in Disaster Management are largely centered on emergency response and post-disaster recovery; there is a need for a comprehensive geo-hazard risk reduction "Contingency planning" strategy that is linked to an easy implementation framework to be able to address these issues.

Ensuring clear delineation of contingency plan preparation and implementation within local government and institutional structures is vital. This is high time to take immediate step towards longer-term investment and effective implementation. Ensuring that appropriate spatial planning at all levels of implementation is needed to ensure disaster preparedness is considered early on in the decision planning process. This should review existing response mechanism and address the simplification of procedures, future planning and immediate response actions with regard to earthquake hazard.

A clearer view on current public and private sector disaster Contingency planning strategies needs to be compiled. Focus needs to be placed on as wide a business cohort as possible, including (though not exclusive to) food and water supply, and other humanitarian assistance. In addition, consideration should be given to gender, children and disability issues post geo-hazard disaster episode.

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Glossary of Terms

Building Codes Ordinances and regulations controlling the design, construction, materials, alteration and occupancy of any structure to insure human safety and welfare. Building codes include both technical and functional standards.

Capacity A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster.

Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.

Capacity Building Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk.

In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society.

Cluster A "cluster" is essentially a "sectoral group" and there should be no differentiation between the two in terms of their objectives and activities; the aim of filling gaps and ensuring adequate preparedness and response should be the same. (IASC Guidance Note on Using the Cluster Approach Nov 2006)

Cluster Approach The Cluster Approach aims to strengthen humanitarian response capacity and effectiveness in five key ways: i) ensuring sufficient global capacity is built up and maintained in key gap sectors/areas of response; ii) identifying predictable leadership in the gap sectors/areas of response; iii) facilitating partnerships and improved inter-agency complementarity by maximizing resources; iv) strengthening accountability; and 5) improving strategic field-level coordination and prioritization in specific sectors/areas of response by placing responsibility for leadership and coordination of these issues with the competent operational agency. (IASC Guidance Note on Using the Cluster Approach Nov 2006)

Cluster Leads A "cluster lead" is an agency/organization that formally commits to take on a leadership role within the international humanitarian community in a particular sector/area of activity, to ensure adequate response and high standards of predictability, accountability & partnership. (IASC Guidance Note on Using the Cluster Approach Nov 2006)

Disaster A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient

	capacity or measures to reduce the potential negative consequences of risk.
Disaster Risk Management	The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.
Disaster Risk Reduction (disaster reduction)	The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development. *The disaster risk reduction framework is composed of the following fields of action, as described in ISDR's publication 2002 "Living with Risk: a global review of disaster reduction initiatives", page 23:* • *Risk awareness and assessment including hazard analysis and vulnerability/capacity analysis;* • *Knowledge development including education, training, research and information;* • *Public commitment and institutional frameworks, including organisational, policy, legislation and community action;* • *Application of measures including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;* • *Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities.*
Earthquake	An earthquake is a series of vibrations on the earth's surface caused by the generation of elastic (seismic) waves due to sudden rupture within the earth during release of accumulated strain energy.
Emergency Management	The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. *Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.*
Emergency	Consists of all activities taken in anticipation of a crisis to expedite effective emergency response. This includes contingency planning,

Preparedness	but is not limited to it: it also covers stockpiling, the creation and management of standby capacities and training staff and partners in emergency response. (Source: ODIHPN Contingency Planning Review Paper 2007)
First Responder	The term 'first responder' refers to those agencies/ individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as well as emergency management, public health, clinical care, public works, and other skilled support personnel (such as equipment operators) that provide immediate support services during prevention, response, and recovery operations. *Source: Homeland Security Act of 2002 (6 U.S.C. 101, Washington, U.S.A.)*
Geographic information systems (GIS)	Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer programmes for capturing, storing, checking, integrating, analysing and displaying data about the earth that is spatially referenced. *Geographical information systems are increasingly being utilised for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.*
Hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. *Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.*
Hazard Analysis	Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour.
Land-use Planning	Branch of physical and socio-economic planning that determines the means and assesses the values or limitations of various options in which land is to be utilized, with the corresponding effects on different segments of the population or interests of a community taken into account in resulting decisions. *Land-use planning involves studies and mapping, analysis of environmental and hazard data, formulation of alternative land-use decisions and design of a long-range plan for different geographical and administrative scales.* *Land-use planning can help to mitigate disasters and reduce risks by discouraging high-density settlements and construction of key*

	installations in hazard-prone areas, control of population density and expansion, and in the siting of service routes for transport, power, water, sewage and other critical facilities.
Mitigation	Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.
Natural Hazards	Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. *Natural hazards can be classified by origin namely: geological, hydrometeorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.*
Planning Assumptions	The key elements of a scenario that form the basis for developing a contingency plan (for example, projected caseloads) (Source: IASC Contingency Planning Guidelines 2001)
Preparedness	Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.
Prevention	Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters. *Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a "culture of prevention".*
Recovery	Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. *Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.*
Relief / Response	The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.
Resilience / Resilient	The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Retrofitting (or upgrading)	Reinforcement of structures to become more resistant and resilient to the forces of natural hazards. *Retrofitting involves consideration of changes in the mass, stiffness, damping, load path and ductility of materials, as well as radical changes such as the introduction of energy absorbing dampers and base isolation systems. Examples of retrofitting includes the consideration of wind loading to strengthen and minimize the wind force, or in earthquake prone areas, the strengthening of structures.*
Risk	The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. *Conventionally risk is expressed by the notation Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.* *Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes. (Source: ISDR)*
Risk Assessment/Analysis	A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. *The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.*
Scenario	An account or synopsis of a possible course of events that could occur, which forms the basis for planning assumptions (for example, a river floods, covering a nearby town and wiping out the local population's crop) (Source: IASC Contingency Planning Guidelines 2001)
Scenario-building	The process of developing hypothetical scenarios in the context of a contingency planning exercise. (Source: IASC Contingency Planning Guidelines 2001)
Seismic Hazard	Seismic hazard in the context of engineering design is defined as the predicted level of ground acceleration which would be exceeded with 10% probability at the site under construction due to occurrence of earthquake anywhere in the region, in the next 50 years.
Sustainable	Development that meets the needs of the present without

development compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. (Brundtland Commission, 1987).

Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction.

Vulnerability The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.