Government of the People's Republic of Bangladesh

CONTINGENCY PLAN FOR EARTHQUAKE HAZARD
for Armed Forces Division (AFD)

Armed Forces Division (AFD)

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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 Armed Force Division (AFD) 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 levels 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.

This draft plan identifies the intended actions to be taken by the Armed Forces Division (AFD) in response to a damaging earthquake. This report contains six sections. Section 1 includes a general discussion regarding earthquake threat in Bangladesh and identification of risk scenario related to the agency's functions. In Section 2 general aspects of agency level plans have been discussed. In Section 3, functional response roles and responsibilities assigned for AFD have been identified. In Section 4, operating procedure guidelines for AFD has been developed. In Section 5, a readiness checklist has been proposed for AFD. In Section 6, agency level actions for training & capacity building of staff, awareness creation, reporting, pre-positioning of emergency facilities, and resource mobilization for purchase of equipments have been identified.

Earthquake Threat in Bangladesh and Identification of Risk Scenario

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.

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.

Table1.1 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 *JHEELS* 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: Banglapedia, 2007

However, it seems that Bangladesh did not experience any large earthquake since 20th century for about 100 years. The 1918 earthquake is 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).

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

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

Sylhet city

1. Dauki Fault (8.0 Mw)
2. Plate Boundary Fault-3 (8.3 Mw)
3. 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 Earthquakes. 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 Earthquakes. 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 amount, 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.

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 : 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.

Table : 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 : 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.**

Possible availability of hospital beds after an earthquake

During scenario development, available hospital beds and other facilities in the three cities are considered. Based on available facilities, following is a likely scenario of hospitals to cope with the situation.

Dhaka

In Dhaka there are about 59,849 hospital beds available for use. On the day after an earthquake of 7.5 Mw, it is estimated that only 26,171 hospital beds (44%) will be

available for use by patients already in the hospital and those injured by the earthquake. After one week, 57% of the beds will be back in service. By 30 days, 73% will be operational. After an earthquake at 8.0 Mw only about 28,265 hospital beds (47%) are available for use by patients already in the hospital and those injured by the earthquake. During this situation after one week, about 63% of the beds will be back in service and by 30 days, 80% will be fully operational. In least case during an earthquake at 6.0 Mw about 38,489 hospital beds (64%) will be available for use by patients already in the hospital and those injured by the earthquake during first day. After one week, 78% of the beds will be back in service. By 30 days, 88% will be operational.

Chittagong

Currently in Chittagong there are about 21,664 hospital beds available for use. On the day after an earthquake at 8.5 Mw, only 1,814 hospital beds (8%) will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 15% of the beds will be back in service. By 30 days, 20% will be operational. After an earthquake at 8.0 Mw, about 15,680 hospital beds (72%) will be available for use by patients already in the hospital and those injured by the earthquake on the first day. Gradually after one week, 83% of the beds will be back in service and by 30 days, 92% will be operational. After and earthquake at 6.0 Mw , the model estimates that only 8,774 hospital beds (41%) will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 53% of the beds will be back in service. By 30 days, 72% will be operational.

Sylhet

Currently in Sylhet there are about 5237 hospital beds available for use. On the day after an earthquake at 8.0 Mw, only 1,629 hospital beds (31%) will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 39% of the beds will be back in service. By 30 days, 50% will be operational. After an earthquake at 8.3 Mw, about 3568 hospital beds (68%) will be available for use by patients already in the hospital and those injured by the earthquake on the first day. Gradually after one week, 81% of the beds will be back in service and by 30 days, 93% will be operational. After and earthquake at 6.0 Mw , the model estimates that only 5,237 hospital beds (43%) will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 56% of the beds will be back in service. By 30 days, 77% will be operational.

General Aspects of the Plan

2.1 Legal Provisions, Authority and national level DM Functions

Armed Forces Division acted very credibly in responding to major disaster events in the past and is ready to perform the required duties in any type of emergency at any time. Other than Bangladesh Fire Service this organization can be kept alert to perform any duty on 24/7 alert level all through out the year.

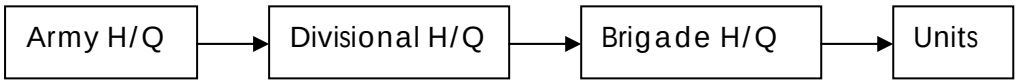
The authority for Army units to go to field is provided under the legal provisions of the constitution under common law of the country and it is called **"employment of Military in aid to civil power"**

This law can be applied for any type of emergency situation whether it is a man-made event or natural calamity.

Before mobilizing the units the unit commanders will have their own evaluation of the situation and also provided with other information from possible external sources (national and international)

The AFD will be given early warning to prepare for emergency response duties by Military High authority during which they have to keep ready man-power, equipment and other resources. This warning period may be few hours or even a day depending on the nature of the event (for example in case of Cyclones AFD gets a longer period to show readiness as Meteorological Agencies normally can make available advance information on the possible cyclone track).They will wait until they get the clearance to proceed to areas of need from Army HQ and deployment order comes usually after the event.

The order normally flows



Broad Objectives:

- Ensure Safety and security of Victims during disaster events
- Search and Rescue(S&R) operations
- Response actions such as distribution of food, water, medicines and first aid assistance,
- Support the actions by Govt. agencies to ensure the welfare of victims
- Security for critical facilities
- Post disaster immediate Recovery actions
- Assistance for Rehabilitation of most essential Infrastructure

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

The agency level responsibility of AFD 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 AFD in relation to National Earthquake Contingency Plan are to ensure:

- S&R
- First aid & First Medical Response to provide emergency medical treatment
- Triage, stabilization of victims before treatment
- Fire safety & rescue
- Security arrangements, Maintenance of law and order

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 AFD 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 Objectives in fulfilling the assigned roles under National Earthquake Contingency Plan

The agency level responsibility of AFD with regards to Earthquake Risk Management is to ensure management of Earthquake Emergency situations as a result of Earthquakes, major aftershocks or resulting collateral hazards such as Fire outbreaks, spill of hazardous material, breach of dams, embankments, landslides, liquefaction etc and

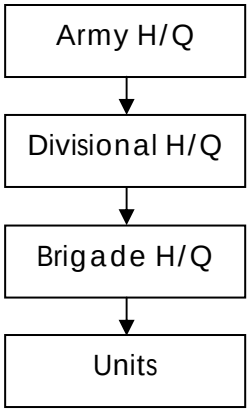
- Minimize the deaths, injuries
- Minimize the property losses
- Reduce the interruptions to services, utilities, lifelines facilities
- Maintain law and order situation within the affected areas of earthquakes

2.5 Structure for Command, Control and Coordination within the organization and with outside agencies

Armed Forces Division is composed of Principal Staff Officer's Office, four Directorates and an Administrative Company. The Directorates are:

- Operations and Plans Directorate (O & P)
- Training Directorate (Trg)
- Civil and Military Relation Directorate (CMR)
- Administration and Logistics Directorate (A&L)

The Organogram of the Armed Force Division (AFD) is given in the following.



Command, Control and Coordination mechanism for AFD with regard to Disaster Management are as follows:
Overall Supervision: Principal Staff Officer, AFD
Focal Point: General Staff Officer-1, AFD
Management support: Commanding officers of all relevant formations of Bangladesh Army, Navy and Air Forces
Monitoring: General Staff Officer-1, AFD

2.6 Plan Implementation Strategies

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.
- AFD 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

The direct users of the agency level Earthquake contingency plan will be the management personnel of Armed Forces Division (AFD), including all relevant formations of Bangladesh Army, Navy and Air Forces, in order to save human-lives and minimize mass casualties due to earthquake.

In addition to AFD, the others such as 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. The ultimate beneficiaries would be the communities at risk to bring normalcy within a fastest possible time.

Functional Response Roles and Responsibilities

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, AFD needs to accomplish the following activities well-before the earthquake event.

Contingency planning:

- Develop contingency plans for earthquake risk for AFD to cover all high risk areas
- Conduct necessary training and capacity building for AFD officials for plan update
- Carry out periodic reporting to authorities on readiness of the AFD for responding to earthquake events

Operations Response:

- Participate in EOC operations and reporting of readiness
- Setting up earthquake Incident Command Systems with relevant agencies where necessary (establishment, training and capacity building)
- Develop guidelines for AFD Logistic supply, management and deployment of resources
- Operation surveillance Training for AFD teams selected for mobilizing in earthquake events

Emergency Services:

- Capacity building for creating special units in AFD for Search and rescue from collapsed buildings, infrastructure
- Capacity building of medicolegal procedure for Identification and tagging of dead bodies with health group
- Capacity building procedure for Restricting or preventing entry to damaged buildings and conduct training on INSARAG
- Capacity building on handling situations of release of Chemical, Biological and toxic harmful waste during earthquakes.
- Procurement of necessary tools and equipment for Urban S&R operations and get the civil authorities to develop inventories of such equipment available for use during earthquakes
- Obtain details on warehouses for emergency supplies under government institutions

Urban Crisis Planning:

- Vulnerability assessment of Critical buildings of Armed Forces division and measures to reduce the vulnerability.
- Collect maps for urban areas and identify with city authorities areas suitable for evacuation of victims
- Collect maps and other information related to pre-positioned essential facilities to be used during earthquakes(bore holes for water supply, tools for USER , equipments , fire hydrants etc)

Immediate Recovery:

- Participate in training programs on procedures for sector based Assessment of loss and damage
- Participate in training programs on recovery planning after earthquake event

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

Contingency planning:

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

Operations Response:

- Facilitate EOC operations
- Mobilize earthquake Incident Command System where necessary under the command of AFD
- Facilitate coordination of Logistic supply management
- Networking with organizations under ICS
- Logistic supply management
- Coordinate surveillance Operations

Emergency Services:

- Mobilize special units for Search and rescue from collapsed buildings, infrastructure
- Assist health teams tagging of dead bodies and locating missing during the earthquake
- Undertake actions for Restricting or preventing entry to damaged buildings with assistance from project groups
- Deploy special teams to handle release of Chemical, Biological and toxic harmful waste during earthquakes.
- Mobilizing necessary tools and equipment for Urban S&R operation
- Facilitate emergency supply distribution and ensure safety of victims

Urban Crisis Planning:

- Rapid damage assessment of buildings of Armed force division, for prevention of further damage due to aftershocks
- Facilitate evacuation to suitable open areas and assist in setting up camps.
- Mobilize access to pre-positioned essential facilities
- Ensue safety and security in evacuation areas and prevent actions for uprising due to various reasons
- Restrict access to damaged areas

Health & Emergency Medical Care:

- Assist transportation of injured to hospitals
- Assist setting up of temporary hospitals in suitable locations
- Assist in providing emergency medical care to displaced persons.

- Deploy special teams to handle victims due to release of Chemical, Biological and toxic harmful waste during earthquakes.
- Provide first aid to displaced and injured where necessary

Welfare, Food and Nutrition:

- Liaise with relevant govt. Institutions, line departments, district authorities to ensure welfare of victims and food supply
- Assist other stakeholder institutions such as NGOs and INGOs for Supply of food and supplementary items to displaced

Mass Media Communications and Public Information:

- Facilitate media coverage by media institutions on reporting disaster events
- Facilitate public information dissemination related to emergency declaration, announcements & warnings on after shocks

Water and Sanitation:

- Observe the emergency water supply needs and communicate to relevant stakeholders
- Close Surveillance in epidemic outbreak in affected areas due to problems connected with water and sanitation and make remedial actions

Transport:

- Assist transport authorities to restore the transportation systems to reach critical areas for S&R teams and supply of relief

Immediate Recovery:

- Assist in rapid assessment surveys

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

Contingency planning:

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

Operations Response:

- Facilitate EOC operations
- Evaluation of performance of earthquake Incident Command System and recommend improvements
- Facilitate coordination of Logistic supply management and deployment
- Facilitate Deployment of resources
- Facilitate Deployment of resources
- Coordinate surveillance Operations

Emergency Services:

- Mobilize special units for Search and rescue from collapsed buildings, infrastructure
- Assist health teams tagging of dead bodies and locating missing during the earthquake
- Undertake actions for Restricting or preventing entry to damaged buildings with assistance from project groups

- Undertake post disaster surveillance of situations of release of Chemical, Biological and toxic harmful waste during after shocks of earthquakes.
- Mobilizing necessary tools and equipment for Urban S&R operation
- Facilitate emergency supply distribution and ensure safety of victims

Urban Crisis Planning:

- Rapid damage assessment of buildings of Armed force division, for prevention of further damage due to aftershocks
- Facilitate provision of basic services to camps for displaced.
- Mobilize access to pre-positioned essential facilities
- Ensue safety and security in evacuation areas and prevent actions for uprising due to various reasons
- Facilitate access to damaged areas for restoration of services by service agencies

Health:

- Assist transportation of injured to hospitals
- Assist setting up of temporary hospitals in suitable locations
- Assist in providing emergency medical care to displaced persons.
- Deploy special teams to handle victims due to release of Chemical, Biological and toxic harmful waste during earthquakes.
- Provide first aid to displaced and injured where necessary

Welfare, Food and Nutrition

- Liaise with relevant govt. Institutions, line departments, district authorities to ensure welfare of victims and food supply
- Assist other stakeholder institutions such as NGOs and INGOs for Supply of food and supplementary items to displaced

Planning of Utilities:

- Assist Utility agencies to restore and rehabilitate supply of power, water, gas, to critical agencies(hospitals, AFD, Police, evacuation camps so on) and in waste disposal

Mass Media Communications and Public Information:

- Facilitate media coverage by media institutions on reporting disaster events
- Facilitate public information dissemination related to emergency declaration, announcements & warnings on after shocks

Water and Sanitation:

- Observe the emergency water supply needs and communicate to relevant stakeholders
- Close Surveillance in epidemic outbreak in affected areas due to problems connected with water and sanitation and make remedial actions

Transport:

- Assist transportation authorities to commence rehabilitation of damaged transport infrastructure and facilities, rail roads, main roads, ports, airports etc

Immediate R

- Provide resource inputs for restoring the normalcy after earthquakes
- Provide resource inputs for recovery especially restoration of services to buildings belongs to AFD

Operating Procedure Guidelines

4.1 Planning assumptions

- The agency level responsibility of Armed Force Division (AFD) with regards to Earthquake Risk Management is to ensure Management of Earthquake Emergency situation by provision of Command and Control for all Response activities. During normal times actions should be taken to study the Agreed actions listed in the National level Plan and arrangements should be made to cover comprehensively all such actions during Agency level planning by the concerned sub-agencies under the AFD.
- The level of preparedness at any given time determines the level of response capacity of the AFD during any Earthquake disaster situation. The maintenance of standards of services, verification of effectiveness through simulations and conduct of regular stock taking of the readiness during normal times should be conducted and reported regularly. This ensures the response capacity of the AFD to any earthquake disaster situation
- Operating procedures for mobilizing the support and participation of all other First Responder organizations during various stages of Earthquake disaster response is stated in the National Contingency Plan for Earthquakes. The relevant officials of AFD in lead positions are required to study these and adopt appropriate measures to ensure Command Control and Coordination under the leadership of AFD in first responder activities during earthquakes.
- In order to clarify the Command Control procedure during Earthquake emergencies necessary Incident Command training should be organized for selected officials attached to First responder organizations in major cities with high seismic risk such as Dhaka, Chittagong, Sylhet
- For effective preparedness, the AFD must have an Earthquake Contingency plan prepared or disaster response procedures clearly defined for major cities with high seismic risk such as Dhaka, Chittagong, Sylhet etc, 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 AFD prepared for such eventualities. Special skills required during emergency operations(such as Urban search & Rescue, First Medical response, Collapse Building search & Rescue etc) need to be imparted to the officials and the staff of AFD. The equipment and tools required should be procured or databases of such equipment available with other agencies should be made available to AFD by DMB.
- Selected personnel of Army, Air Force, Navy, Para-military forces in Districts, Pourashava, major cities with high seismic risk such as Dhaka, Chittagong, Sylhet etc, can be designated as "NODAL OFFICERS-AFD", Officer –in-charge-AFD-District and "Officer-in-charge – AFD-City level" respectively for effective Command, Control and Coordination during earthquake events.

- To the extent possible, preventive measures as recommended in the National Earthquake Contingency Plan should be undertaken to improve the capacity to respond of AFD to an earthquake disaster.

4.2 Normal time activities

- Develop Agency level contingency plans for earthquake risk especially plans to cover Districts, Pourashava, major cities with high seismic risk such as Dhaka, Chittagong, Sylhet etc
- Assess preparedness level of the AFD and report the same as per the format given to National EOC every six months.
- Undertake Routine Capacity building of AFD cadre in special Search and rescue operations, Medical First Responder functions and station them within Earthquake high risk areas.
- Making arrangements to have simulations and drills, refresher courses to retain the capacity for special Emergency Response operations & USER operations.
- Participate in National EOC operations and reporting of readiness periodically
- Setting up earthquake Incident Command Systems where necessary (establishment, training and capacity building)especially to cover major cities with high seismic risk such as Dhaka, Chittagong, Sylhet etc
- Assist DMB in Development and dissemination of guidelines for Logistic supply management , Deployment of resources Operation surveillance during earthquakes
- Assist health authorities in Development of medico-logical procedure for Identification and tagging of dead bodies with health group
- Develop and disseminate procedure for Restricting or preventing entry to damaged buildings and conduct training on INSARAG
- Procurement of necessary tools and equipment for Urban S&R operations and get the civil authorities to develop inventories of such equipment available for use during earthquakes
- Obtain details on warehouses for emergency supplies under government institutions
- Make arrangements for Vulnerability assessment of buildings, critical facilities, infrastructure of armed force division.
- Collect maps for urban areas and identify with city authorities areas suitable for evacuation of victims
- Collect maps and other information related to pre-positioned essential facilities to be used during earthquakes(bore holes, tools , equipments , fire hydrants etc)
- Participate in training programs on procedures for sector based Assessment of loss and damage
- Participate in training programs on recovery planning after earthquake event

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

- Within the affected City/district/electoral ward, AFD will undertake the Command, Control and Coordination of response activities with the

leadership of Response Commander -NODAL OFFICER-AFD. All other relevant AFD 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 from First Responder Organizations should work under the overall supervision and guidance of Response Commander
- Establish radio communications with National Emergency Operations Centre, district control rooms and AFD offices within the division.
- Review precautionary measures, procedures of operations through daily review with relevant senior staff, to improve the Response services by Response Commander -NODAL OFFICER-AFD and make arrangements for necessary back up support if needed
- Assist the authorities to make arrangements for stand by Resources (man-power, material, equipment) through the assistance of EOC and DMB
- Response Commander -NODAL OFFICER-AFD will make arrangements for raid assessment of buildings for suitability for occupation, special care and services to agencies and critical facilities such as
    - AFD
    - FS&CD
    - Hospitals
    - Water Supply/electricity/gas authorities
    - Police stations
    - Telecommunications buildings
    - DMB and DRR

  Within his area of Command and control
- If necessary acquire the machinery ,vehicles, equipment etc and park them in protected area for utilization of search and rescue operations as needed
- Check emergency tool kits, assembling any additional equipment needed for utilization of search and rescue operations as required
- Review the total extent of the damage to AFD buildings, equipment, installations
- Review the total extent of the damage and fire outbreaks within major cities by arranging a reconnaissance flight, if possible.
- On the recommendations of the Response Commander "Officer-in-Charge – Power Supply/Gas supply/water supply" of the relevant institutions in the affect istrict staff of the relevant institutions to disconnect the main supply for the affected area
- Dispatch special professional search and rescue teams, emergency response teams, medical response teams of AFD to affected areas but unattended.

Readiness Checklist

5.1 Readiness Checklist and Reporting Formats

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

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

Preparedness Measures taken	Details / Remarks
The AFD staff is familiar with of the Earthquake Contingency plan of AFD	
Orientation and training for Earthquake Contingency plan and procedures undertaken. Each relevant officer understands earthquake disaster response procedures he has to follow during earthquake event.	
Special skills required during Earthquake emergency operations imparted to the officials and the staff. AFD posses to date following professionals First responders • No of Master Instructors for CSSR • No of master Instructors for MFR • No of specially trained FSCD cadre of First Responders for CSSR and MFR	
Reviewed and updated: ▪ Precautionary measures and procedures. ▪ The vulnerability assessment of buildings, critical facilities, infrastructure ▪ The precautions to be taken to protect equipments and material have been undertaken. ▪ Post earthquake disaster procedures to be followed.	
No of AFD Buildings were strengthened to have high standard of safety	

Seismic hazard maps of following districts/porushava/city authorities have been collected and relevant Nodal Officers are familiar with evacuation areas, places of pre-positioning of earthquake emergency supplies, equipment, resources etc. *1.* 2. 3.	
An officer has been designated as Nodal Officer for Earthquake Disaster Response NODAL OFFICER-AFD for each city, district located in the high seismic hazard area as follows; Name, designation and contact details of the officers are as follows;	
Additional Sources of supply of materials, manpower, equipment required to support AFD in Earthquake response operations have been identified.	

Reported By:

Designation: AFD Signature: Date

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)

Need to be incorporated.

6.2 Gap Analysis (Man power, equipment and material)

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

Issue	Description	Recommendation
Sharing resources with civil administration	There is no system in place for acquiring private resources (equipment, supplies manpower etc) by armed force under normal civil law even when there is a severe need to help victims.	Regulations should be introduced or provisions under **"employment of Military in aid to civil power"** should be amended so that AFD will be able to use equipment available with other agencies in case of emergencies.
Lack of coordination with civil administration	Not necessarily government agencies or civil society agencies follow orders from the AFD under normal civil law during placement of govt. Officers under military commander or in other type of resource allocation, distribution etc..	There is a need for creating Mandatory provisions for establishing a Command and Coordination structure in place during special situations created under "employment of Military in aid to civil power" for civilian officials to work under the command of AFD and for use of other govt. resources

Issue	Description	Recommendation
	This is no Command/Control/ coordination between AFD and different stakeholder institutions for optimization of resource distribution when AFD takes over the command and control for managing disaster events.	Regular process should be introduced to coordinate with NGOs (especially INGOs which have large stocks of Relief and welfare items) and government responder organizations to get assistance of AFD in distribution of relief and welfare items. More often that will be handled by AFD(due to its potential for quick mobilization for distribution of such items and its resource base)
Lack of proper methodologies for damage /need assessment	AFD officials are usually called upon to undertake rapid assessments soon after the disaster events. AFD does not follow any standard methodology for damage and need assessment and assessments are made very arbitrarily	It is necessary to introduce the Damage Assessment and Need analysis (DANA) methodology used by Govt.
Lack of proper training	Capacity building is an essential need to respond to special situations arising from Earthquake and AFD needs to set up training of special USER groups(such as Collapse Building Search and Rescue(CSSR), Medical First Responder Training(MFR),urban search and rescue(USER), evaluation of safety of buildings, training on INSARAG - Unified System used for identification of structures as per International S&R Advisory Group guidelines (UN-OCHA etc)	Institutions in AFD's training curricula can be done through integrating PEER type of training in AFD academies or introducing some special courses for AFD officials. Need to create an Instructor and master Instructor base in AFD for conducting such training.

Issue	Description	Recommendation
Lack of database and need for accessing data bases of other organizations	No comprehensive data base is available to AFD.	The AFD need to develop a comprehensive data base on all the resources in hand for mobilizing the same in case of large scale disaster event like earthquake.
	AFD may not have access to the databases of other govt. agencies	Necessary access should be given to AFD into databases maintained by Govt. responder institutions
No methodology for vulnerability assessment	AFD professionals do not have any standard methodology for vulnerability assessment for buildings and other critical infrastructures	The methodology for rapid assessment of Vulnerability of Buildings need to be introduced to AFD Engineers and measures should be undertaken to conduct vulnerability assessment of buildings and critical infrastructure belong to AFD and located in high hazard zone.
Lack of Incident Command System	AFD will be required to undertake key role in many operations pre, during and after any disaster event. While doing this AFD will be required to interact with many government and non-govt. organizations. At present there is no Incident Command System in	There should be an Incident Command System in place at all levels. This is needed to be developed during pre-disaster period to ensure Command and Control of AFD so that

Issue	Description	Recommendation
	place at any level.	everybody under such Command and Control (civilian govt. officers) understand the role and expectations while serving in calamity situations. Otherwise it is difficult to carry out M&E operations for performance and to provide an efficient service during emergencies.

6.3 Process for addressing the gaps

Enhanced capability of the health sector to effectively address health risks to emergencies through:

- Development of an integrated emergency health management mechanism that covers areas of risk assessment, health intelligence, capacity building, public awareness as well as effective emergency response capability;
- Using "public health and hazard mapping" as a useful operational tool for health risk assessment of the hazard prone areas;
- Development of technical guidelines, and surveillance standards in order to promote best health practice during humanitarian crisis situation;
- Capacity building for rapid health needs assessment following any emergency in order to ensure that the most vulnerable population benefit from the humanitarian health relief Programme.

6.4 Action Plan for Enhancement of Capacity

- Establishment of core group at periphery level including all stakeholders (DMB, CDMP, LGRD/Civil Admin./Fire Service & Civil Defence/Army/NGOs/CBOs and other relevant ministries)
- Enhanced the national capacity of disaster mitigation in respect of planning and responding to disasters, like Earthquakes and Tsunamis by preparing Earthquake/Tsunami Response Plan
- Conduct and assess field based survey to find out vulnerability of the area for their capacity building by table-talk & simulation exercise.
- Establishment of Field/Mobile Hospital

- Provide more training – capacity building and regular Mock drill for preparedness for any impending disasters and post-disaster health care management.
- Distribute emergency life- savings drugs for maintaining buffer stock in order to organize case management in emergency situations for Upazila and district level as preparedness for disaster
- Provision of emergency transport like country boat, speed boat, emergency ambulance etc and increase reserve fund for emergency response
- Ensurin stics like life-jacket, rain-coat, umbrella, gum boot, and others essential materials during response activities.

Bibliography

ADB (1991), *Disaster Mitigation in Asia and the Pacific*, Asian Development Bank, Manila, Philipines

ADPC (2000), *Standard Operation Procedures of Urban Disaster Management in the Municipality of Bandung*, Bangkok 10400, Thailand

Ali, A. (1999), *Ghurnijhar* (Cyclone). Dhaka, Bangla Academy, Bangladesh

Ansary, M.A. and Ali, M.(2004), *Seismic risk of Dhaka city and role of the insurance community*, Insurance Journal of Bangladesh, No. 55, pp. 5-34.

Ansary, M. A.(2004), *Seismic loss estimation of Dhaka for an earthquake of intensity vii*, Oriental Geographer, No. 48 (1), pp. 1-16

Ansary, M.A. (2003), *Status of earthquake risk mitigation in Bangladesh* (Paper presented at the 3rd WSSI Workshop on EQS, Bangkok).

Banglapedia (2007), *Earthquake*, Asiatic Society of Bangladesh

BBS (2003), *Statistical Year Book 2003*, Bangladesh Bureau of Statistics, Bangladesh

BNBC (1993), *Bangladesh National Building Code 1993*, Ministry of Housing and Public Works, Bangladesh

Carney, D. (1998). *Sustainable Rural Livelihoods: What Contributions Can We Make?* Department for International Development, London

CEGIS (2001*), Application of Agroecological Zones Database in Drought Management and Water Availability Assessment, Environment and GIS Support Project*, Ministry of Water resources, Government of Bangladesh, Dhaka.

City of Pasadena (1997), *Comprehensive Emergency Management Plan*, California, USA

Choudhury, Jamilur Reza (2005), *Options for Urban Disaster Risk Management : The Bangladesh Experience*, Paper presented at the National Workshop on "Options for Urban Disaster Risk Management in Bangladesh" organized by the Comprehensive Disaster Management Programme, MoFDM, on 28th May, 2005 at Hotel Lake Shore, Dhaka.

DMB (2006), *Disaster Risk Management Profile*, Ministry of Food and Disaster Management, Dhaka, Bangladesh

GoB (1999), *Standing Orders on Disaster*, Ministry of Disaster Management and Relief and Disaster Management Bureau, Bangladesh

GoB (2008), *Draft Disaster Management Act, 2008*, Disaster Management Bureau

GoB (2005), *Disaster Management Strategic Plan 2005*, Disaster Management Bureau, Ministry of Food and Disaster Management, Bangladesh

GoB (2008), *National Plan for Disaster Management 2007-2015*, Ministry of Food and Disaster Management, Bangladesh

GoB(….), *National Disaster Management Policy*, Disaster Management Bureau and Ministry of Food and Disaster Management, Bangladesh

GoB (2008), *Super Cyclone SIDR: Impacts and Strategies for Interventions*, Ministry of Food and Disaster Management, Bangladesh

GoI (2001), *National Disaster Response Plan, Department of Agriculture and Cooperation*, Ministry of Agriculture, Government of India, October, 2001

GoI (2007), *National Disaster Management Guidelines: Management of Earthquakes*, National Disaster Management Authority Government of India

Gupta H. K., Rajendran, K. and Singh, H. N.,(1986), *Seismicity of the northeast India region part I: the data base*, Journal of Geological Society of India, Vol. 28, pp. 345-365.

ESCAP (1995), *The State of the Environment in Asia and the Pacific*, ESCAP, Bangkok

FEMA (2005), *ICS-200: ICS for Single Resources and Initial Action Incidents*. September, 2005

FEMA (2002), Getting Started Building Support for Mitigation Planning.

Ferdausi, M.(2005), *Bangladesh Country Perspective on Emergency Preparedness*, Ministry of Food and Disaster Management, Bangladesh

IASC (2007), *Inter Agency Contingency Planning Guidelines For Humanitarian Assistance*, Inter-Agency Standing Committee

IFRCS, (2007), *Disaster response and contingency planning guide*, International Federation of Red Cross and Red Crescent Societies, Geneva, Switzerland

Islam, Nazrul (1996), *DHAKA: From City to Megacity: Perspectives on People, Places*, Planning and Development Issues, Bangladesh

Mohit et al (2002). *Delineation of Flood Damaged Zones of Dhaka City Based on the 1998 Flood by Using GIS,* Engineering Concerns of Flood. Bangladesh University of Engineering and Technology (BUET), Bangladesh

NSET (1999), *The Katmandu Valley Earthquake Risk Management Action Plan*, Nepal

Pacific Disaster Center (2006), *Disaster Risk Management Profile, Dhaka Bangladesh* (http://emi.pdc.org/cities/CP_Dhaka-July2006.pdf)

Richard C. (2007), *Contingency planning and humanitarian action*, A Review of Practice. HPN Network Paper No. 59, March *2007*

Sharfuddin, M. (2001), *Earthquake Hazard Analysis for Bangladesh*. M.Sc. Engg. Unpublished Thesis, BUET, Dhaka

UNHCR (2000), *Contingency Planning*, Geneva, Switzerland

UNHCR and NDCC (2003), *Contingency Planning for Emergencies*, Geneva, Switzerland

Weinstock, Dr. Joseph A., (2005), *New Directions of Asian Development Bank in Reducing Disaster*, Asian Development Bank, Japan

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.