OVERVIEW OF EARTHQUAKE PREPAREDNESS

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Earthquake Preparedness

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- Fire Safety Division, Safety Organization of the Philippines
- Past President, Philippine Society of Mechanical Engineers, Metro South Chapter
A weak to violent shaking of the ground produced by the sudden movement of rock materials below the earth’s surface.
TYPES OF NATURAL EARTHQUAKES

1. Tectonic
   - earthquakes produced by sudden movement along faults and plate boundaries

2. Volcanic
   - earthquakes produced by movement of magma beneath volcanoes
Distribution of Active Faults and Trenches in the Philippines
At least 20 earthquakes per day
4 – 5 felt earthquakes per week
PHILIPPINE DESTRUCTIVE EARTHQUAKES

- M8.3 02 Jul 1954 Bacon, Sorsogon (13/101)
- M7.5 01 Apr 1955 Lanao (291/713)
- M7.3 02 Aug 1968 Casiguran (270/600)
- M7.3 07 Apr 1970 Baler (15/200)
- 17 Aug 1976 Moro Gulf (3,739/8,000)
- 16 July 1990 Luzon (1,283/2,786)
- 15 November 1994 Mindoro (78)
Two ways of describing the strength of an earthquake

1. **Intensity**
   - Perceived strength of an earthquake based on relative effect to people and structures; generally higher near the epicenter.

2. **Magnitude**
   - Based on instrumentally derived information and correlates strength with the amount of total energy released at the earthquake's point of origin.
Strength --- Intensities

PHIVOLCS EARTHQUAKE INTENSITY SCALE

I. SCARCELY PERCEPTIBLE
- No noticeable effects.
- No damage.

II. SLIGHTLY FELT
- Felt by a few people.
- Small objects may move.
- No damage.

III. WEAK
- Felt by many people.
- Water in containers may move.
- No damage.

IV. MODERATELY STRONG
- Felt by most people.
- Water in containers may break.
- Damage to poorly constructed buildings.

V. STRONG
- Damage to well-built buildings.
- Damage to poorly constructed buildings.
- Major earthquake.

VI. VERY STRONG
- Damage to well-built buildings.
- Total destruction of buildings.
- Major earthquake.

VII. DESTRUCTIVE
- Total destruction of buildings.
- Entering panic stage.

VIII. VERY DESTRUCTIVE
- Total destruction of buildings.
- Mass evacuation.

IX. DEVASTATING
- Total destruction of buildings.
- Mass evacuation.

X. COMPLETELY DEVASTATING
- Total destruction of buildings.
- Mass evacuation.

PHIVOLCS:
- Philippine Institute of Volcanology and Seismology
- Department of Science and Technology (DOST)
<table>
<thead>
<tr>
<th>Magnitude Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earthquake with $M$ below 1 are only detectable when an ultra sensitive seismometer is operated under favorable conditions.</td>
</tr>
<tr>
<td>2</td>
<td>Most earthquakes with $M$ below 3 are the &quot;hardly perceptible shocks&quot; and are not felt. They are only recorded by seismographs of nearby stations.</td>
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<tr>
<td>3</td>
<td>Earthquake with $M$ 3 to 4 are the &quot;very feeble shocks&quot; and only felt near the epicenter.</td>
</tr>
<tr>
<td>4</td>
<td>Earthquakes with $M$ 4 to 5 are the &quot;feeble shocks&quot; where damages are not usually reported.</td>
</tr>
<tr>
<td>5</td>
<td>Earthquakes with $M$ 5 to 6 are the &quot;earthquakes with moderate strength&quot; and are felt over the wide areas; some of them cause small local damages near the epicenter.</td>
</tr>
<tr>
<td>6</td>
<td>Earthquake with $M$ 6 to 7 are the &quot;strong earthquakes&quot; and are accompanied by local damages near the epicenters. First class seismological stations can observe them wherever they occur within the earth.</td>
</tr>
<tr>
<td>7</td>
<td>Earthquake with $M$ 7 to 8 are the &quot;major earthquakes&quot; and can cause considerable damages near the epicenters. Shallow-seated or near-surface major earthquakes when they occur under the sea, may generate tsunamis. First class seismological stations can observe them wherever they occur within the earth.</td>
</tr>
<tr>
<td>8</td>
<td>Earthquake with $M$ 8 to 9 are the &quot;great earthquakes&quot; occurring once or twice a year. When they occur in land areas, damages affect wide areas. When they occur under the sea, considerable tsunamis are produced. Many aftershocks occur in areas approximately 100 to 1,000 kilometers in diameter.</td>
</tr>
<tr>
<td>9</td>
<td>Earthquakes with $M$ over 9 have never occurred since the data based on the seismographic observations became available.</td>
</tr>
</tbody>
</table>
What to do **BEFORE** an earthquake

The key to effective disaster prevention is planning.

- Determine if site is along an active fault and/or prone to liquefaction or landslide.

- **Use proper structural design and engineering practice** when constructing a house or building.

- **Evaluate structural soundness of buildings and important infrastructures**; strengthen or retrofit if found necessary.
What to do **BEFORE** an earthquake

Familiarize yourself with your place of work and residence

- Identify relatively strong parts of the building where you can take refuge during an earthquake:
  - door jambs
  - elevator shafts
  - sturdy tables

- Learn to use fire extinguishers, first aid kits, alarms and emergency exits. These should be accessible/conveniently located and properly marked.
What to do **BEFORE** an earthquake

Prepare your place of work and residence for the event

+ Strap heavy furniture to walls to prevent sliding or toppling.
+ Store breakable items, harmful chemicals and flammable materials in lower most shelves and secure firmly.
+ Turn off gas tanks when not in use.
+ Keep heavy materials in lower shelves.
+ Check stability of hanging objects.
+ Maintain an earthquake survival kit.
Earthquake Survival Kits
First-Aid Kits

- Gauze Pads and Roller Gauze (assorted sizes)
- Activated Charcoal
- Antiseptic Ointment
- Syrup of Ipecac
- American Red Cross First Aid Kit
- Adhesive Tape
- Cold Pack
- Plastic Bags
- Disposable Gloves (assorted sizes)
- Band-Aids (assorted sizes)
- Hand Cleaner
- Small Flashlight and Extra Batteries
- Triangular Bandage
- Blanket
- Scissors and Tweezers
What to do **DURING** an earthquake

**If inside a structurally sound building, stay there!**

+ **Protect your body from falling debris** by bracing yourself in a doorway or by getting under a sturdy desk or table.
What to do **DURING** an earthquake

**If outside, move to an open area**

- Get away from power lines, posts, walls and other structures that may fall or collapse.
- Stay away from buildings with glass panes.
What to do **DURING** an earthquake

If along the shore and you feel an earthquake, strong enough to make standing difficult.

+ Run away from the shore toward higher ground
What to do **DURING** an earthquake

If on a mountain, or near a steep hill slope, move away from steep escarpments which may be affected by landslides.
What to do **DURING** an earthquake

When driving a vehicle, pull to the side of the road and stop

+ Do not attempt to cross bridges or overpasses which may have been damaged.
What to do AFTER an earthquake

If inside an old, weak structure, take the Fastest and safest way out!

+ Get out calmly in an orderly manner. Do not rush to the exit.
+ Use the stairs. Do not use elevators.
+ Check yourself and others for injuries
What to do **AFTER** an earthquake

**Check surroundings**

- Clean up chemical spills, toxic flammable materials to avoid any chain of unwanted events.
- Check for fire and if any, have it controlled.
- Check water and electrical lines for defects. If any damage is suspected, turn the system off in the main valve or switch.
What to do AFTER an earthquake

If you must evacuate your residence, leave a message stating where you are going.

+ Take with you your earthquake survival kit, which should contain all necessary items for your protection and comfort.
What to do AFTER an earthquake

Help reduce the number of casualties from the earthquake:

+ Don’t enter partially damaged building, strong aftershocks may cause these to collapse.

+ Gather information and disaster prevention instruction from battery-operated radios.

+ Obey public safety precautions.
What to do **AFTER** an earthquake

Unless you need emergency help:

+ **Do not use your telephone to call relatives and friends.** Disaster prevention authorities may need the lines for emergency communications.

+ **Do not use your car and drive around areas of damage.** Rescue and relief operations need the road for mobility.
What to do AFTER an earthquake

Unless you need emergency help:

+ Do not use your telephone to call relatives and friends. Disaster prevention authorities may need the lines for emergency communications.

+ Do not use your car and drive around areas of damage. Rescue and relief operations need the road for mobility.
Earthquake Drill Procedure:

1. **ALARM PHASE:**
   Continuous ringing of siren/bell for one minute which means ongoing earthquake.

2. **RESPONSE PHASE:**
   Stay where you are unless imminent danger is noticeable. Move to a safer place with caution.

**DO** the DUCK, COVER and HOLD
3. **EVACUATION PHASE:**

After the alarm/siren stops (meaning the shaking stops) drill participants should then start to evacuate the building.

The evacuees proceed through predetermined routes and evacuees (unit occupants) should then gather outside in a designated evacuation area.
Earthquake Drill Procedure:

4. **ASSEMBLY PHASE:**
   At the assembly area, groups from each floor must stay together.

5. **HEADCOUNT PHASE:**
   During the head count phase every section head/leader must determine if everyone is present or accounted for.
Earthquake Drill Procedure:

6. **EVALUATION:**

- After the headcount there should be an evaluation.

- The evaluators identify the snags in the drill.

- The problem areas or potential problem areas to rectify these problem for future earthquake drill or in actual earthquake scenario.
When is the time to evacuate???

✓ After a very strong earthquake with observed or felt intensity of VI or higher in the area.

✓ As need arises or as declared by authorities.
Form a **Disaster Management Committee (SDMC)** composed of several teams with specific tasks and designate an over-all coordinator.

- **First Aid Team**
- **Fire – Safety Team**
- **Communication Team**
- **Evacuation Team**
- **Over-all coordinator**
- **Site Security Team**
METRO MANILA AND THE ACTIVE VALLEY FAULT SYSTEM
The **Marikina Valley Fault System**, also known as the **Valley Fault System (VFS)**, is a dominantly **dextral** strike-slip fault system in Luzon, Philippines. It extends from Dingalan, Aurora in the north and runs through the provinces of Nueva Ecija, Bulacan and Rizal and the Metro Manila cities of Quezon, Marikina, Pasig, Makati, Paranaque, Taguig and Muntinlupa, and the provinces of Cavite and Laguna that ends in Canlubang.¹
West Valley fault
The west segment, known as the *West Valley Fault (WVF)* is one of the two major fault segments of the Valley Fault System which runs through the cities of Marikina, Pasig and Muntinlupa of 100 kilometers when the fault moves. It moves in a dominantly dextral strike-slip motion. The West Fault is capable of producing large scale earthquakes on its active phases with a magnitude of 7 or higher.

East Valley fault
The eastern segment, known as *East Valley Fault (EVF)* moves in an oblique dextral motion within 10 kilometers.
A 7.2-magnitude earthquake generates 3.98 petajoules or same as the energy in:

- 63.5 Hiroshima atomic bombs
- 951.5 kilotons of TNT (a measurement of energy released in explosions)
- 796,214 average lightning flashes
- 30.16 million gallons of gasoline
- 1.90 billion sticks of dynamite

That seismic energy is also equal to 1,105.56 gigawatt hours, or 1.5% of the Philippines’ total generated power in 2012.

WEST VALLEY FAULT

Metro Manila

Quezon City:
• Bagong Silangan
• Bagumbayan
• Batasan Hills
• Blue Ridge B
• Libis
• Matandang Balara
• Pansol
• White Plains
• Ugong Norte
• Loyola Heights
• Pasong Putik Proper (Pasong Putik)
• Payatas
**Marikina City:**
- Barangka
- Industrial Valley
- Malanday
- Tumana

**Pasig City:**
- Bagong Ilog
- Ugong

**Makati City:**
- East Rembo
- Pembo
- Rizal
- Comembo

**Taguig City:**
- Bagumbayan
- Bagong Tanyag
- Upper Bicutan
- Central Bicutan
- Lower Bicutan
- Maharlika Village
  - Pinagsama
- North Signal Village
- Central Signal Village
- South Signal Village
- Ususan
- South Daang Hari
Muntinlupa City:
• Alabang
• Bayanan
• Buli
• Cupang
• Poblacion
• Putatan
• Sucat
• Tunasan

Outside Metro Manila
Bulacan:

• San Jose Del Monte City:
  • San Isidro
  • Ciudad Real
  • San Roque

• Norzagaray:
  • San Lorenzo

• Doña Remedios Trinidad:
  • Camachin
  • Kabayunan
  • Sapang Bulak
  • Bayabas
  • Camachile
  • Pulong Sampalok
Laguna:

• San Pedro:
  • Calendola
  • Gsis
  • Sampaguita Village
  • San Antonio
  • San Vicente
  • Riverside
  • United Bayanihan

• Biñan:
  • Biñan (Poblacion)
  • Malamig
  • San Francisco (Halang)

• Sta. Rosa:
  • Sto Domingo

• Cabuyao:
  • Casile

• Calamba:
  • Canlubang
Cavite:

• Gen. Mariano Alvarez:
  • San Jose

• Carmona:
  • Bancal
  • Cabilang Baybay
  • Lantic
  • Mabuhay

• Silang:
  • Carmen
  • Inchican
EAST VALLEY FAULT

Rizal

• San Mateo:
  • Ampid I
  • Dulongbayan II
  • Guinayang
  • Guitnangbayan II
  • Malanday
  • Maly
  • Santa Ana

• Rodriguez (Montalban):
  • Burgos
  • Macabud
  • San Jose
  • San Isidro
  • San Rafael (Rosario)
What is the Earthquake Scenario in Metro Manila and nearby Provinces?
LATEST DAMAGING EARTHQUAKE IN METRO MANILA

- M 7.3 Casiguran, Aurora Earthquake, 02 August 1968
- Ruby Tower in Manila collapsed - 268 killed, 260 injured
EARTHQUAKE GENERATORS IN METRO MANILA AND VICINITY
THE VALLEY FAULT SYSTEM

- West Valley Fault (WVF) movement mainly horizontal

- WVF moved 4 times in past 1400 years; movement interval ~ 400 years

- Last major earthquake from Valley Fault in 1658
EARTHQUAKE-RELATED HAZARDS

Faulting (Ground) Rupture → Ground Shaking → Liquefaction

Tsunami → Fire → Landslide
Valley Fault System

- **East Valley Fault**
  - 10 km (M6.2)
  - Municipalities of Rodriguez and San Mateo, Rizal

- **West Valley Fault**
  - 100 km (M7.2)
  - Bulacan ((Doña Remedios Trinidad, Norzagaray and San Jose Del Monte City)
  - Rizal (Rodriguez)
  - Quezon City, Marikina City, Makati City, Pasig City, Taguig City and Muntinlupa City

- **Laguna** (San Pedro City, Biñan City, Sta. Rosa City, Cabuyao City and Calamba City)

- **Cavite** (Carmona, General Mariano Alvarez and Silang)
The Valley Fault System (VFS) in Greater Metro Manila Areas Atlas

- 33 map sheets
- Metro Manila
  - 1:5,000 (22 map sheets)
- Laguna and Cavite
  - 1:10,000 (10 map sheets)
- Bulacan and Rizal
  - 1:50,000 (1 map sheet)
GROUND SHAKING IN GREATER METRO MANILA (West Valley Fault Earthquake)
(Risk Analysis Project, 2013: PHIVOLCS, GA supported by AusAID)
INTENSITY VIII (VERY DESTRUCTIVE)
GROUND SHAKING

1995 Kobe Earthquake
BUILDING AND CASUALTY ESTIMATES (1)
FOR METRO MANILA FROM A M7.2 WEST VALLEY FAULT EARTHQUAKE

Residential Building (1,325,896)
- Damage
  - Heavy: 168,300 (12.7%)
  - Partly: 339,800 (25.6%)

Public Buildings
- Damage
  - Heavy: 8-10%
  - Partly: 20-25%

10-30 Storey Building
- Damage
  - Heavy: 11%
  - Partly: 27%

30-60 Storey
- Damage
  - Heavy: 2%
  - Partly: 12%

Population (9,932,560)
- Casualty
  - Dead: 33,500 (0.3%)
  - Injured: 113,600 (1.1%)

Additional Deaths by Fire: 18,000

Metro Manila Earthquake Impact Reduction Study, 2004 - JICA, PHIVOLCS, MMDA
### BUILDING AND CASUALTY ESTIMATES (2)
FOR METRO MANILA FROM A WEST VALLEY FAULT EARTHQUAKE

<table>
<thead>
<tr>
<th></th>
<th>M7.2</th>
<th>M6.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Floor Area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in Complete to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collapsed Damage (sqm)</td>
<td>88,142,000</td>
<td>65,407,000</td>
</tr>
<tr>
<td>in Slight to Extensive</td>
<td>172,924,000</td>
<td>162,799,000</td>
</tr>
<tr>
<td>Damage (sqm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Fatalities</strong></td>
<td>31,000</td>
<td>23,000</td>
</tr>
<tr>
<td><strong>Total Injuries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Serious</td>
<td>14,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Serious</td>
<td>112,000</td>
<td>85,171</td>
</tr>
<tr>
<td>Slight</td>
<td>385,000</td>
<td>302,000</td>
</tr>
<tr>
<td><strong>Total Economic Losses</strong></td>
<td>2,269,000</td>
<td>1,773,000</td>
</tr>
</tbody>
</table>

Risk Analysis Project, 2013 - PHIVOLCS, UP-ICE, GA (AusAID)
LIQUEFACTION

Dagupan 1990
Subsidence of bridge column

Dagupan 1990
Subsidence of building, roads

Mindoro 1994
Fissuring of roads

La Union, 1990
Damage to buried pipes, tanks
LIQUEFACTION POTENTIAL
M7.2 West Valley Fault Earthquake

Localities prone to liquefaction

a) water-saturated (shallow water table), low-lying

b) Have loose (unconsolidated), sand or silt deposits

- river banks, abandoned rivers, flood plains
- coastlines
- swamps
- reclaimed land

(READY for GMMA Project, 2013)
FIRE AFTER THE EARTHQUAKE
M7.2 West Valley Fault Earthquake

- Fire outbreak by electrical short circuit; toppling of lamps, candles
- Explosion of petroleum, gas tanks may cause spreading of fire

Maximum Burnt Number

- 500 - 1,000
- 200 - 500
- 100 - 200
- 50 - 100
- 20 - 50
- 1 - 20

(MMEIRS, 2004)
POSSIBLE ISOLATION DUE TO EARTHQUAKE IMPACTS
(West Valley Fault Scenario)

- **West**
  - Fire, Building Damage
- **North**
  - Bridge Damage
- **South**
  - Bridge Damage
- **East**
  - Building Damage, Bridge Damage

(MMEIRS, 2004)
Estimated Tsunami Height in Manila Bay:
• 3.5 meters (mean sea level)
• 5.5 meters (+ 2m from tide)

Arrival Time:
• > 1 hour
Are we ready and prepared?

Is Metro Manila ready for a 7.2 Magnitude earthquake?
What do we have to do???

• Reminders for everybody!!!!
Family Readiness

- Create a family Earthquake plan
- Know the safe spot in each room
- Know the danger spots
- Decide where your family will reunite if separated
- Keep a list of emergency phone numbers
- Develop a survival kit for work, car, and home
Home Preparedness

• Learn how to shut off gas, water, and electricity
• Check chimneys, roofs, and wall foundations for stability
• Secure heavy furnishings
• Secure water heater and appliances
• Keep heavy objects on lower shelves
• Maintain emergency food, water, medicine, first aid kit, tools, and clothing
Emergency Supplies

- **First Aid supplies**
  - Band-Aids
  - antibiotic ointment
  - latex gloves
  - cold/hot packs
  - ace bandages
  - arm sling
  - Tylenol or Advil
  - diarrhea medication

- **Equipment**
  - work gloves
  - shovel
  - tents
  - sleeping bags
  - ready to eat foods
  - clothing
  - radio, flashlights
  - CASH
Emergency Food

- Camp or backpacking stove
  - propane tank
- Canned foods
  - manual can opener
- MRE’s
- Granola bars
- Energy bars
Safe Drinking Water

- **Store a supply of water**
  1 and 5 gallon containers
do not store on concrete

- **Purifying tap water**
  8 drops bleach per gal of water
  add bleach when storing
  or, boil for 10 minutes

- **Water from water heater**
  turn off gas or electric
  turn off cold water supply
  once cooled, drain at bottom

- **Other sources**
  toilet storage tank
  melted ice cubes
  water trapped in pipes
During an Earthquake

• Stay away from windows, bookcases, file cabinets, heavy mirrors, and other heavy objects that could fall
• Duck under a desk or sturdy table
• Watch for falling plaster or ceiling tiles
• Stay undercover until the shaking stops, and hold onto your cover
• If the desk or table you are under moves… move with it
• If in your car, stop, but not on a bridge, or under trees or a power line
• If outside, stay outside, and move to an area clear of overhead trees, power lines, or objects that could fall from a structure
• Don’t forget about aftershocks
After The Earthquake

- Be prepared for aftershocks, plan for cover when they occur
- Check for injuries, give first aid as necessary
- Remain calm, try to reassure others
- Wear shoes to avoid injury from broken glass
- Check for fire and take appropriate actions
- Check gas, water, and electric lines
- Tune to emergency broadcast system on radio
WHAT TO PACK IN A SURVIVAL KIT

OTHER NEEDS

- Duct tape
- Safety pins
- Whistle
- Baking soda
  Can be used as deodorizer and cleanser
- Petroleum jelly
- Ziplock to secure gadgets or documents
- Large garbage bag
  Can be used as a waterproof container for survival kit items. It can also be used as a poncho, a makeshift tent, or as an earth pad.
- Basic tools like tire bar or vice grips for cars and pliers, screw driver, and hammer for the house
- Blanket
- Some clothing
- Transistor or windup radio
- Flashlight and extra batteries
- Pocket knife
- Lighters or waterproof matches
- Candles in containers
- Jacket, umbrella, and rain boots
- Disposable plates
- Rope, gloves, and goggles for rescue
- Tarps

SOURCE: MARTIN AGUDA, DISASTER RISK REDUCTION ADVOCATE AND EMERGENCY MANAGEMENT
WHAT TO PACK IN A SURVIVAL KIT

ESSENTIAL DOCUMENTS

STORE IMPORTANT DOCUMENTS IN A SEALED PLASTIC ENVELOPE
- Birth certificates
- School diplomas
- Land titles

SCAN THE DOCUMENTS
store it in a CD, hard drive, or USB

LIST OF EMERGENCY CONTACT NUMBERS

SOURCE: MARTIN AGUDA, DISASTER RISK REDUCTION ADVOCATE AND EMERGENCY MANAGEMENT
WHAT TO PACK IN A
SURVIVAL KIT

HEALTH & SANITATION

- TOOTHBRUSH & TOOTHPASTE
- SHAMPOO
- SOAP
- WET WIPES
- VITAMINS
- MEDICINE (prescription medicine that will last for several days)
- ANTIBIOTICS
- INSECT REPELLENT

SOURCE: MARTIN AGUDA, DISASTER RISK REDUCTION ADVOCATE AND EMERGENCY MANAGEMENT
WHAT TO PACK IN A SURVIVAL KIT

**FOOD**

- **WATER**
  1 gallon/day per person x No. of people in the household

- **WHITE CLOTH/COFFEE FILTER**
  To filter particles from water

- **EASY-TO-OPEN GOODS**
  Like canned goods and packaged food

- **BLEACH/IODINE**
  Can be used as emergency disinfectant for drinking water.
  *To disinfect, add 4 drops of bleach/iodine for every liter of water. Set aside for 30 minutes before consuming.

- **CRACKERS**

- **COFFEE**

- **MILK**

- **HIGH-ENERGY PACKAGED FOOD**
  Like peanut butter, crackers, or caramel-flavored candies

- **MILK FOR CHILDREN**

- **PET FOOD**
  (If family will tag along pet)

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*Source: Martin Aguda, Disaster Risk Reduction Advocate and Emergency Management*
Be Safe Rather Than Be Sorry!
END OF PRESENTATION

Thank you for listening