Understanding Earthquake Hazards

Robelyn Z. Mangahas

Science Research Specialist I / Geologist

September 18, 2017

Pacific Plaza Condominium Corporation

Philippine Institute of Volcanology and Seismology
Department of Science and Technology

Outline

① Background on earthquake and tectonic setting of the Philippines

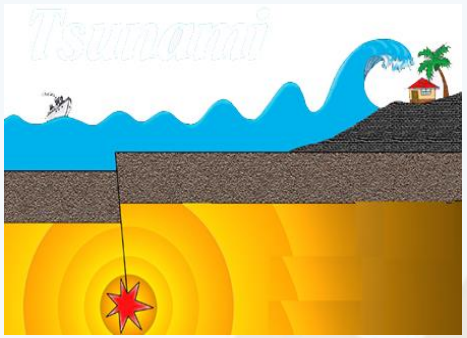
② Earthquake hazards and risks

③ Preparedness

Philippine Hazardscape

The Philippines is prone to many natural hazards.

Earthquake



Tsunami

Volcanic eruption

Typhoon

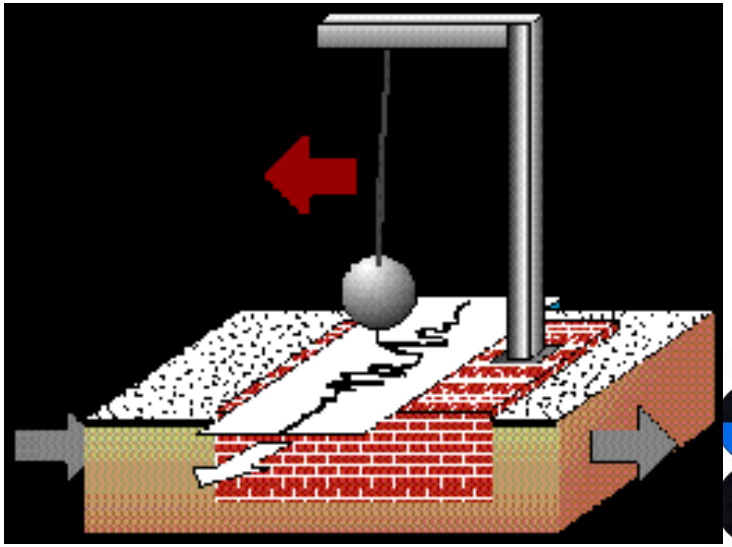
Storm surge

Flood

Landslide

EARTHQUAKE

A weak to violent shaking of the ground produced by the sudden movement of rock materials below the earth's surface.

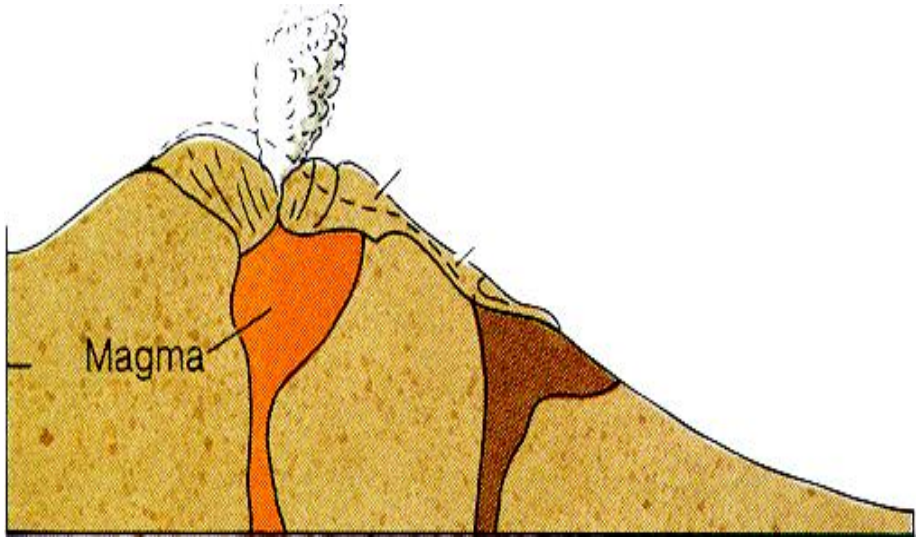


DOST

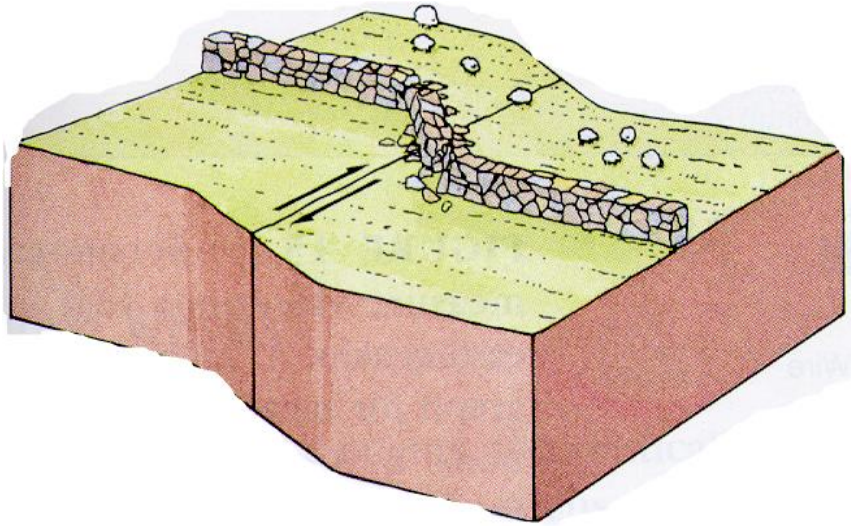
PHIVOLCS

Earthquakes

1. **Volcanic**
- earthquakes produced by movement of magma beneath volcanoes or by eruptions

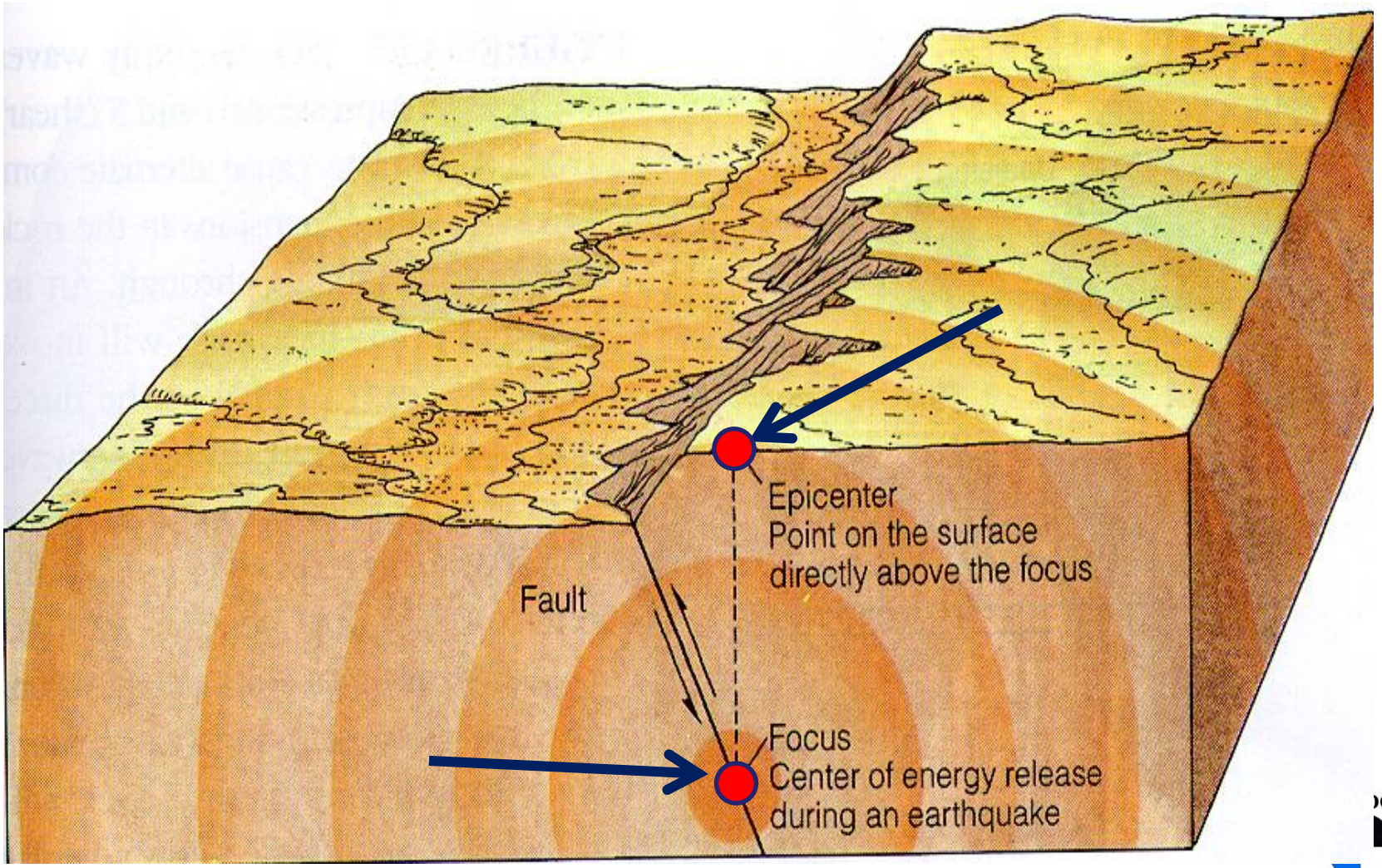


2. **Tectonic**
- earthquakes produced by sudden movement of rocks along faults and plate boundaries



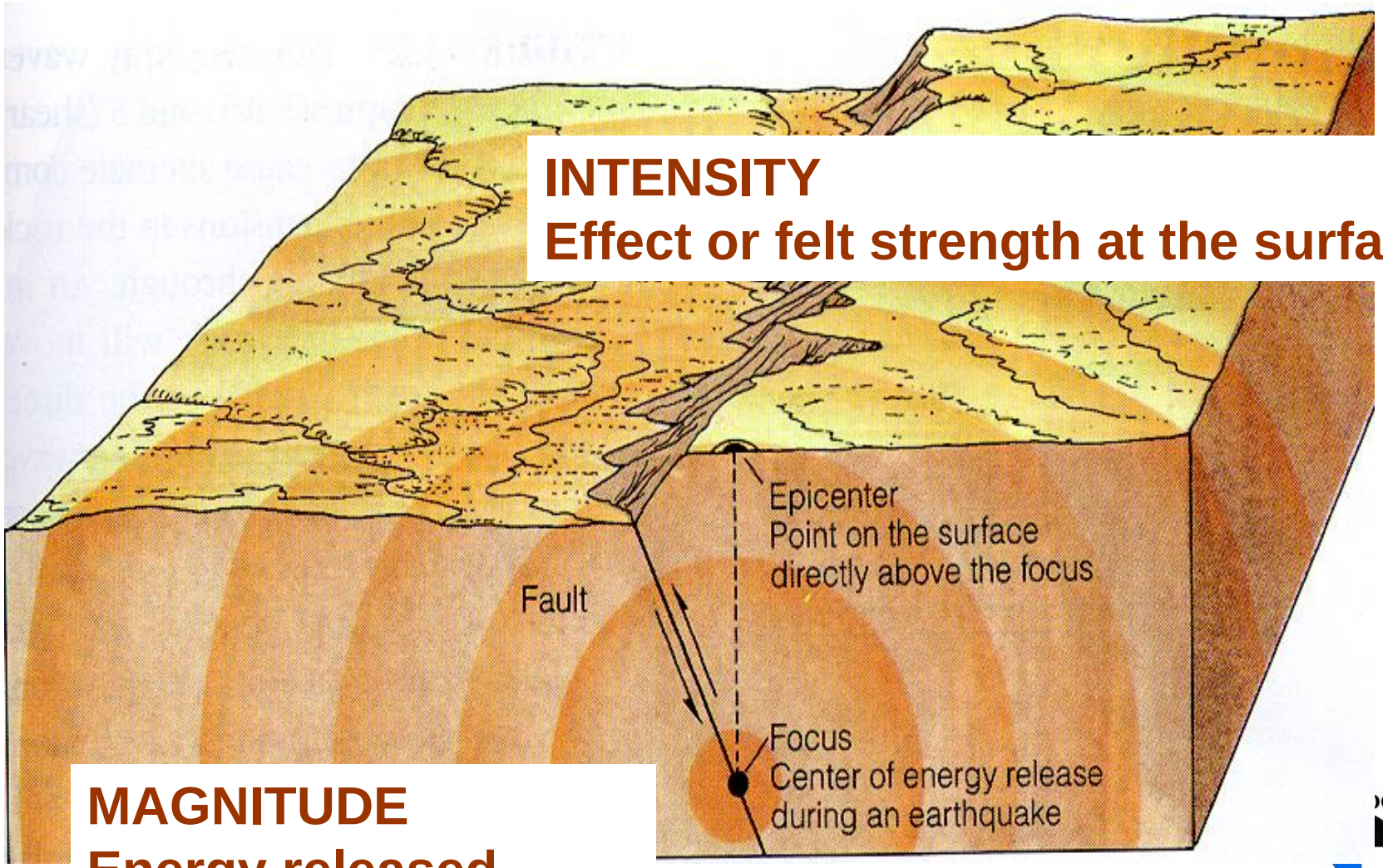
PHIVOLCS

LOCATION OF AN EARTHQUAKE:



PHIVOLCS

STRENGTH OF AN EARTHQUAKE: MAGNITUDE VERSUS INTENSITY



INTENSITY
Effect or felt strength at the surface

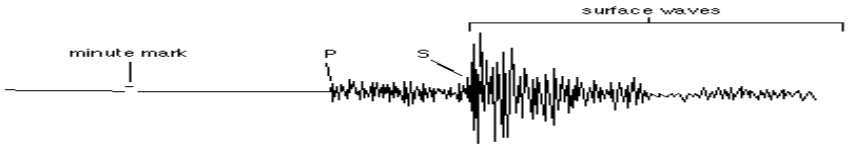
MAGNITUDE
Energy released during earthquake.

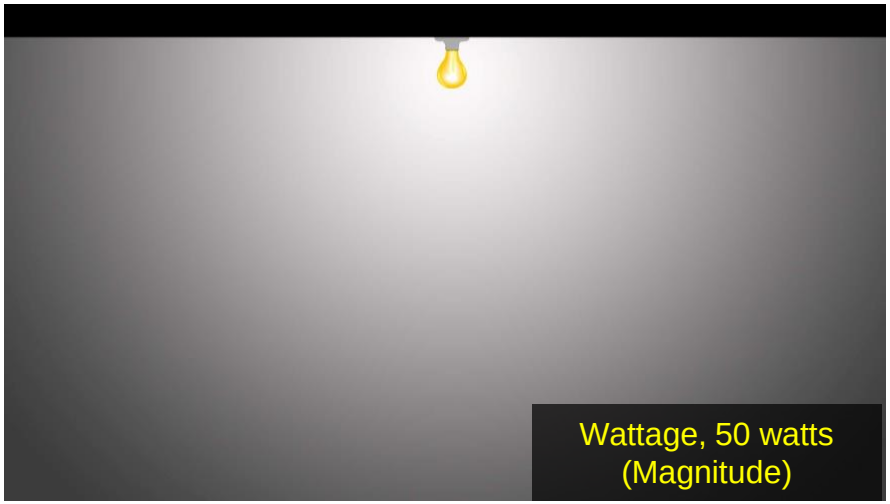
PHIVOLCS

DESCRIBING THE STRENGTH OF AN EARTHQUAKE

MAGNITUDE

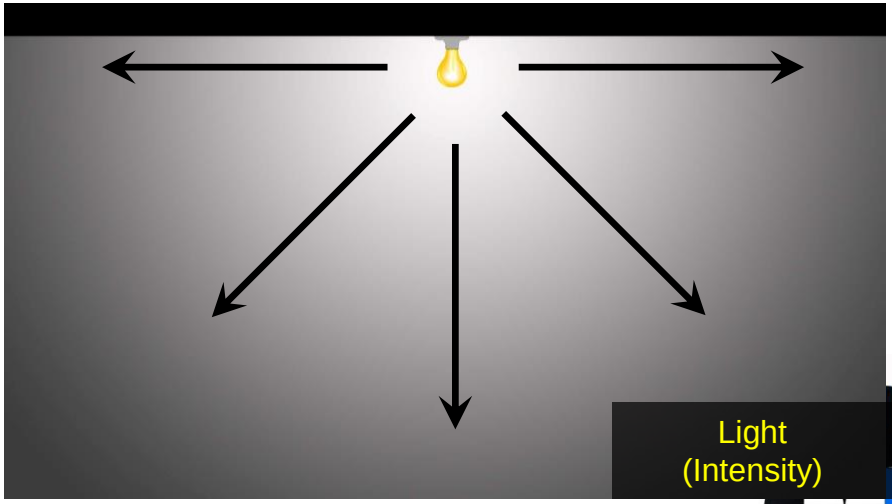
Total amount of energy released.
Based on instrumentally derived information.





INTENSITY

Estimate of the effects of an earthquake on people, structures and environment. Generally higher near the epicenter.



PHIVOLCS

PHIVOLCS Earthquake Intensity Scale

I – Scarcely perceptible
II – Slightly felt
III – Weak
IV – Moderately strong
V – Strong
VI – Very strong
VII – Destructive
VIII – Very destructive
IX – Devastating
X – Completely devastating

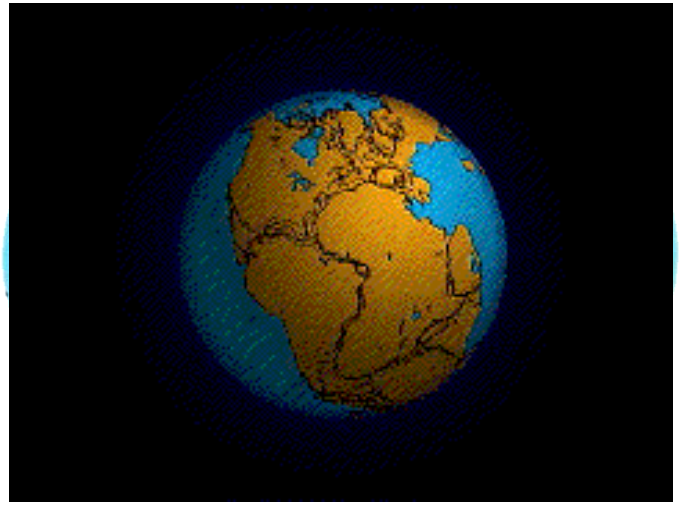
DAMAGING

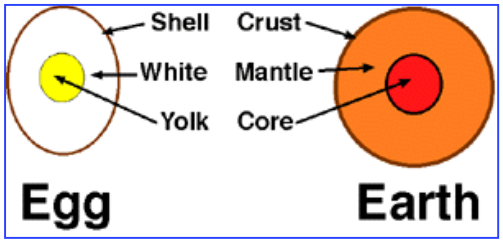
DOST PHIVOLCS

PHIVOLCS

Why earthquakes occur?

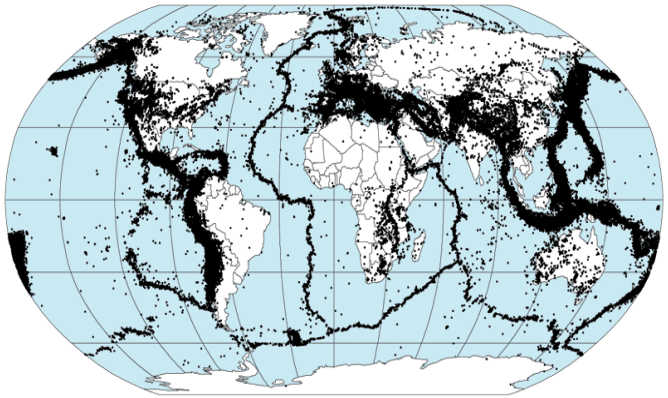
Plate Tectonics

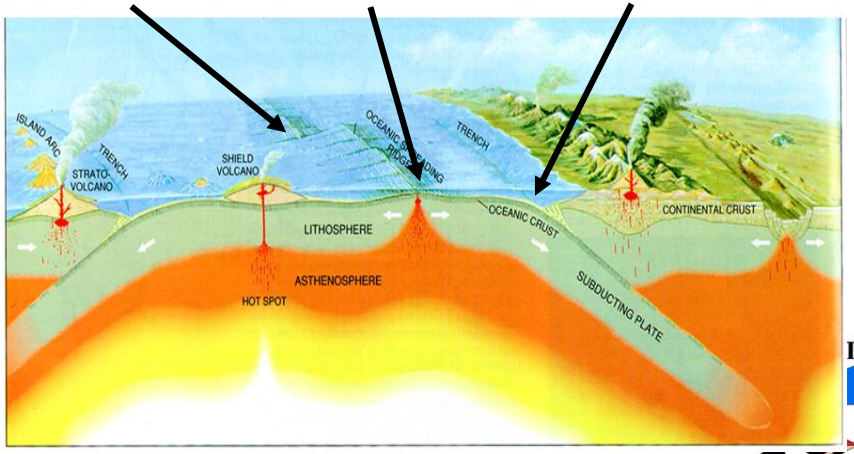




TRANSFORM DIVERGENT CONVERGENT

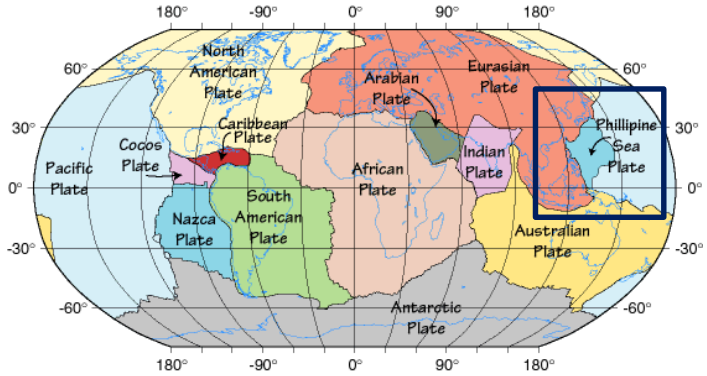
Preliminary Determination of Epicenters
358,214 Events, 1963 - 1998

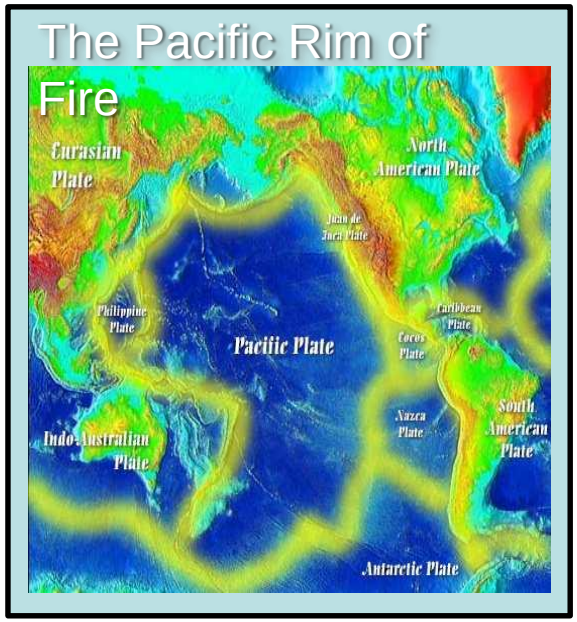


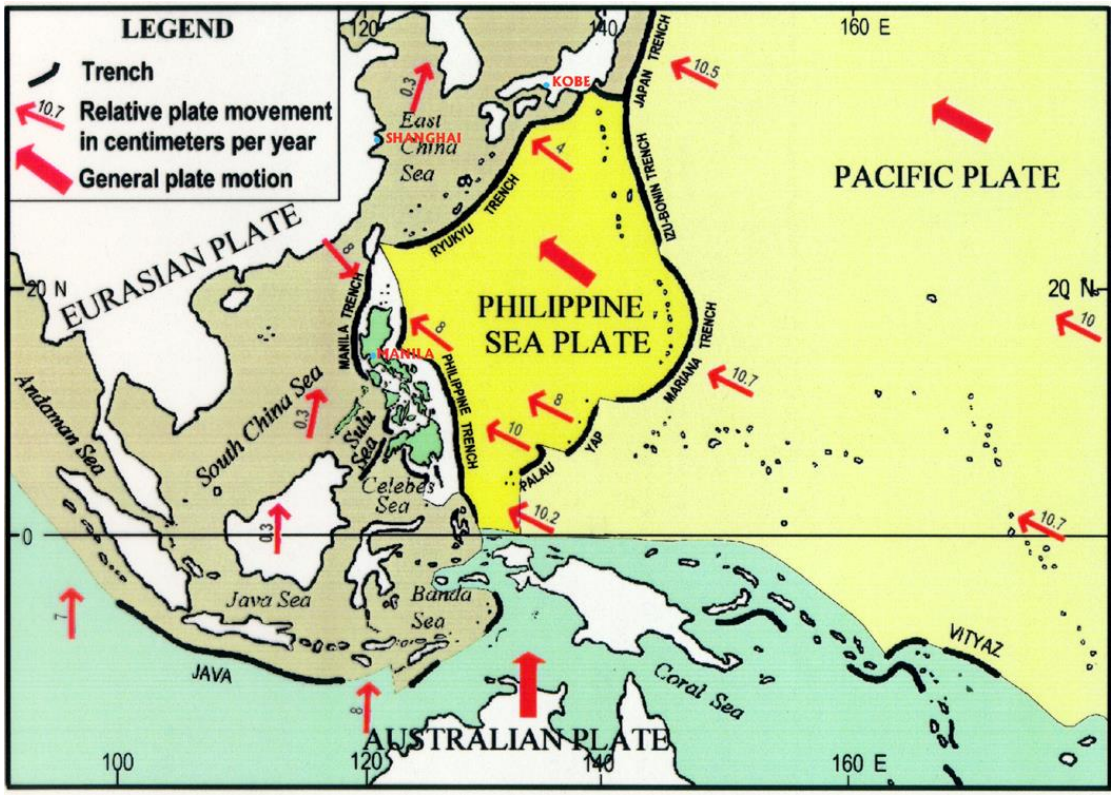


PHIVOLCS

Tectonic Settings of the Philippines



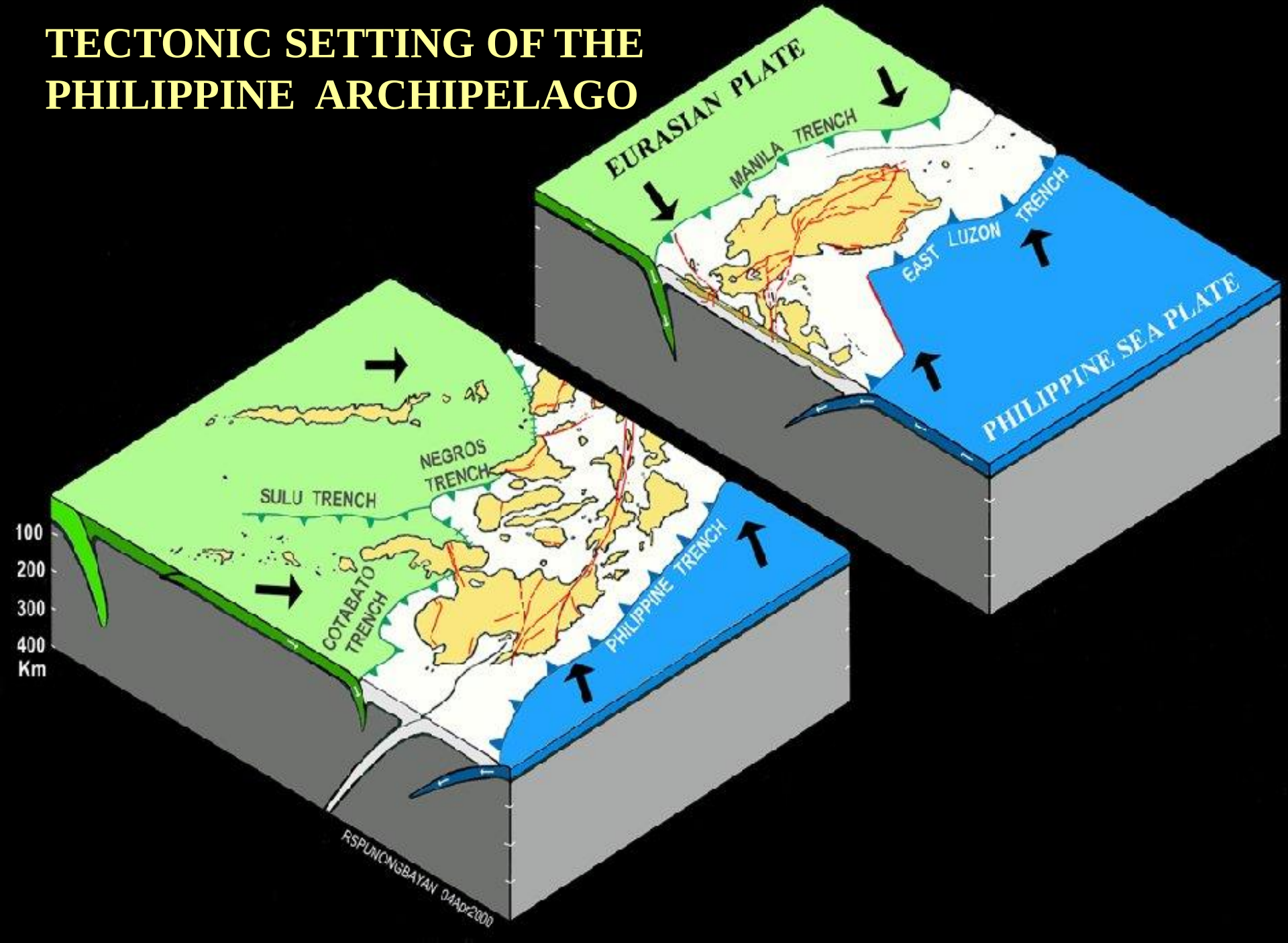




The Pacific Rim of Fire - a region of high volcanic and seismic activity that surrounds the majority of the Pacific Ocean Basin. This region is essentially a horseshoe of geologic activity that includes volcanoes, earthquakes, deep see trenches, and major fault zones.

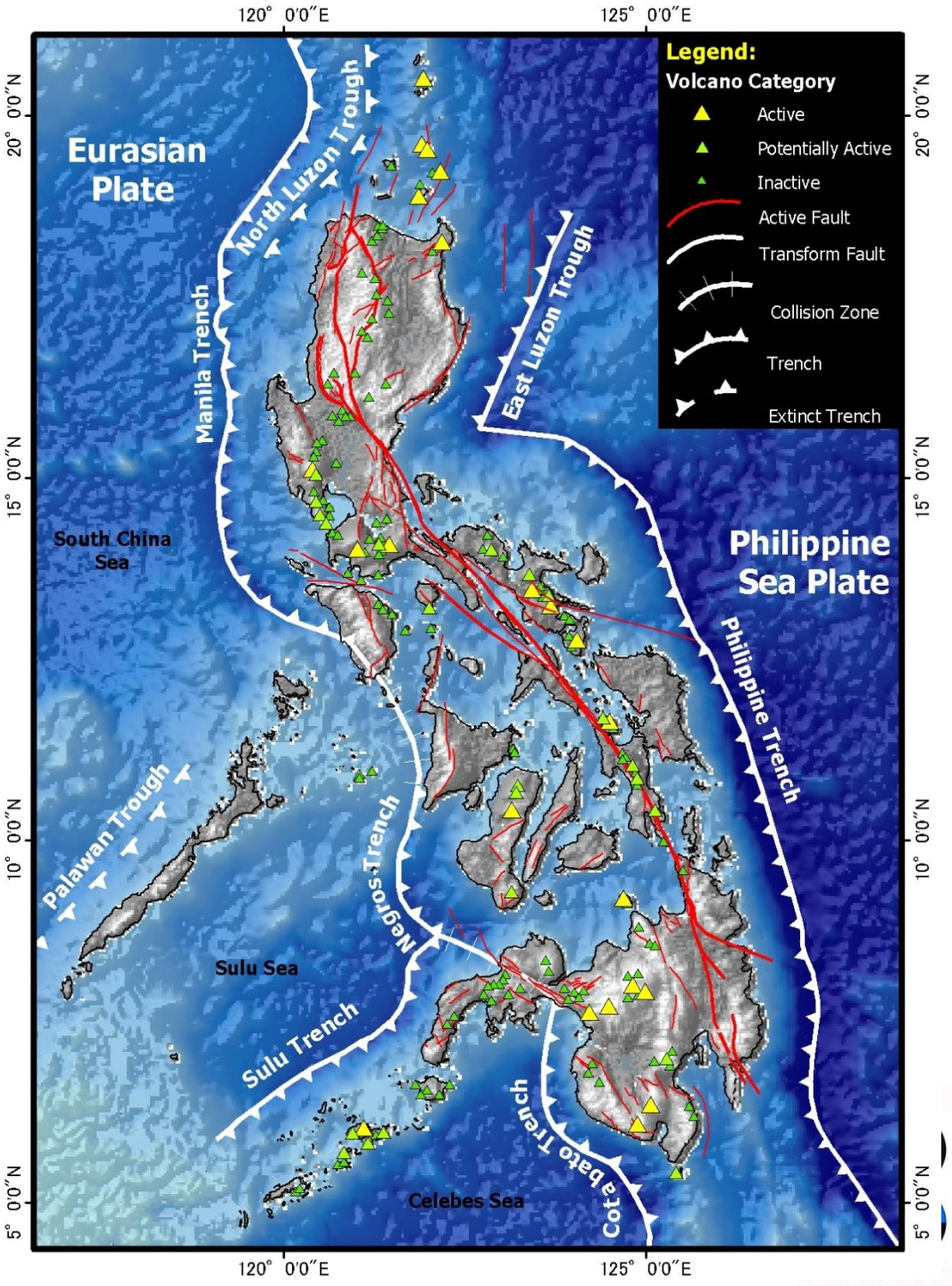
DOST PHIVOLCS

TECTONIC SETTING OF THE PHILIPPINE ARCHIPELAGO



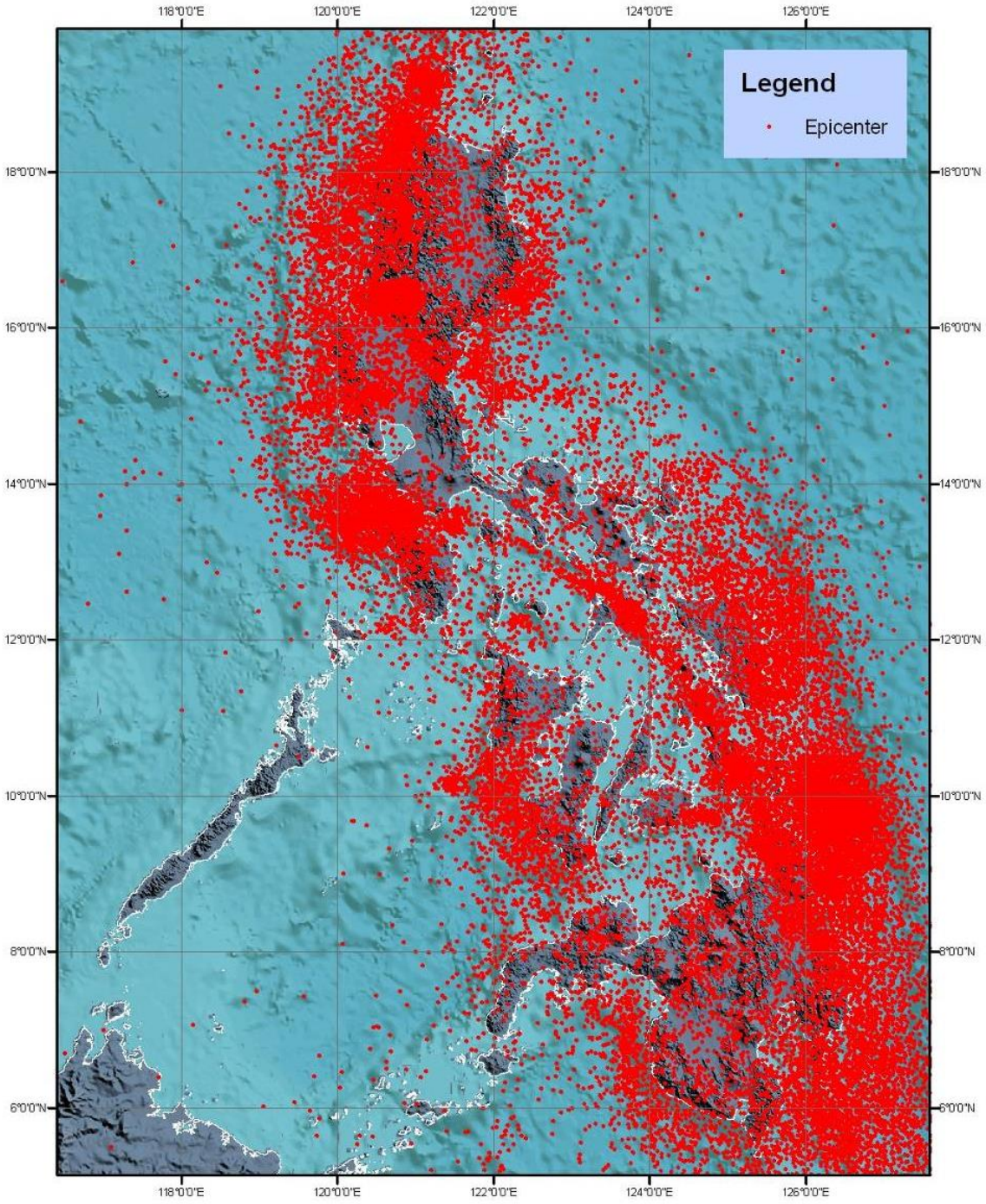
EARTHQUAKE SOURCES

- Philippine Trench
- East Luzon Trough
- Manila Trench
- Palawan-Mindoro Collision Zone
- Negros Trench
- Zamboanga-Western Mindanao Collision Zone
- Philippine Fault Zone and its many branches
- Many Active Faults (e.g. Valley Fault System, Lubang, Tablas, Casiguran and Mindanao Faults)



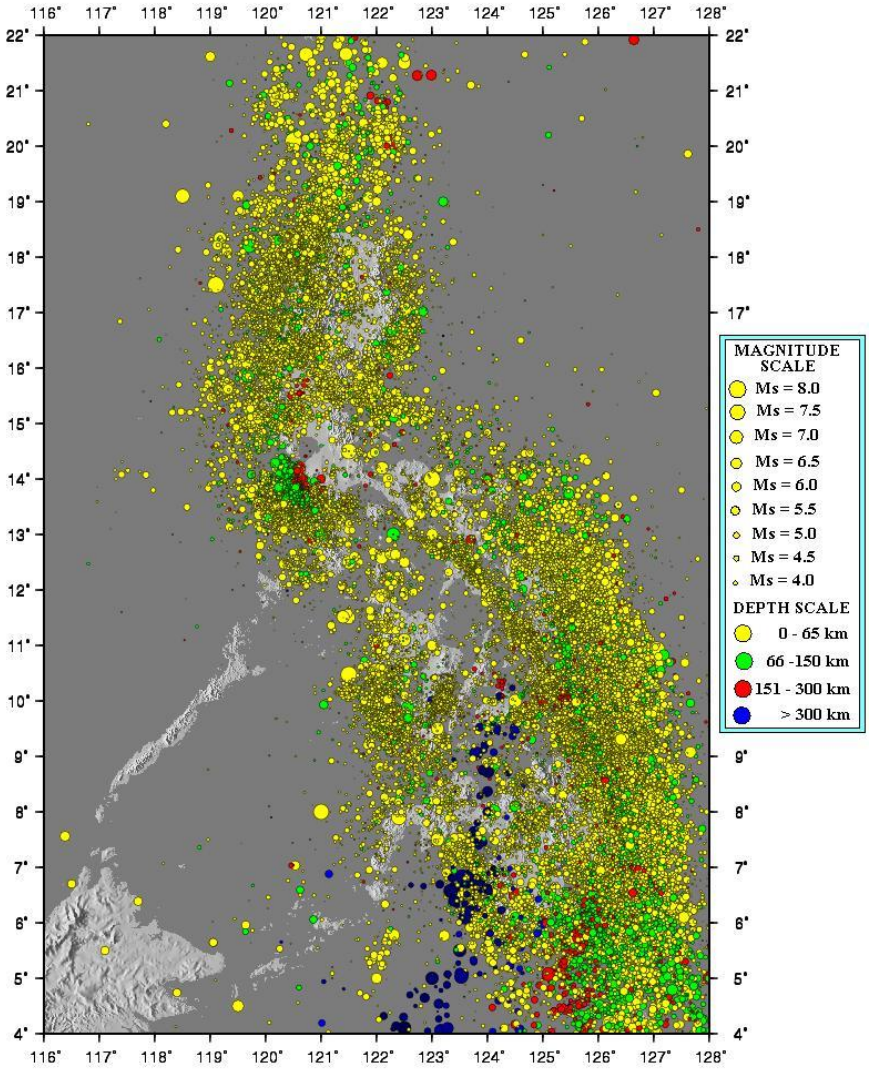
Philippine Seismicity

- an average of 20 earthquakes recorded per day
- 4-5 felt earthquakes per week
- 5000 plotted earthquakes per year
- 90 destructive earthquakes for past 400 years



EARTHQUAKE ACTIVITY IN THE PHILIPPINES

(~90 destructive earthquakes for past 400 years)



Seismicity Map of the Philippines
1907-2012

M7.8 1990 Luzon Earthquake

M6.9 2012 Negros Or Earthquake

DOST
PHIVOLCS

M7.2 2013 Bohol Earthquake

Affected Bohol and Cebu

Casualties:

- Dead - 222
- Missing - 8
- Injured - 976

Houses damaged:

- Total - 14,512
- Partial - 58,490

Roads, bridges, seaports damaged

2017 EVENTS

February 10

Magnitude 6.7 Surigao del Norte Earthquake

April 8

Magnitude 6.0 Batangas Earthquake

April 16

Magnitude 5.2 Lanao del Norte Earthquake

July 12

Magnitude 6.5 Leyte Earthquake

DOST
PHIVOLCS

DEPARTMENT OF SCIENCE AND TECHNOLOGY

PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY

EARTHQUAKE INFORMATION NO. : 4

PHIVOLCS Bldg, C.P. Garcia Avenue, U.P.- Diliman, Quezon City, PHILIPPINES
Tel.: 426-1468 Fax: 927-1087

Date/Time	:	**11 Aug 2017 - 01:28:24 PM**
Location	:	**13.95°N, 120.49°E - 020 km S 45° W of Nasugbu (Batangas)**
Depth of Focus (Km)	:	**178**
Origin	:	**TECTONIC**
Magnitude	:	**Ms 6.3**

DOST
PHIVOLCS

Reported Intensities	:	Intensity IV - Nasugbu, Calatagan & Balayan, Batangas; Calapan, Sablayan & Mamburao, Occidental Mindoro; Calapan and Naujan, Oriental Mindoro; Manila; Paranaque City; Pasig City;Taguig City; Pasay City; Rosario, Maragondon, Noveleta & Dasmarinas, Cavite; Floridablanca, Pampanga; Olongapo City; Subic & Iba, Zambales; Alaminos City, Pangasinan; Boac, Marinduque; Binan, Laguna Intensity III - Puerto Galera, Oriental Mindoro; Abra de Ilog and San Jose, Occidental Mindoro; Tagaytay City; Canlubang & Calamba, Laguna; Indang & Alfonso Cavite; Bocaue, Malolos, Obando & Balagtas, Bulacan; Dagupan City; Dau, Pampanga; Lingayen and Bolinao, Pangasinan; Bagac, Bataan; Baguio City; Pateros; Quezon City; Makati City; San Juan City; Marikina City; Cainta & San Mateo, Rizal; Lucban, Quezon Intensity II - Magsaysay, Occi. Mindoro; Sta Rosa, Laguna; Gasan, Marinduque; Magalang, Pampanga; Sto. Tomas and Tanauan City Batangas Intensity I - Talisay, Batangas; Pantabangan, Nueva Ecija; Meycauayan, Bulacan; Atok, Benguet
11.20g 2017_0811_0528_M63D178_B4F		
		Instrumental Intensities: Intensity IV: Calapan City, Or. Mindoro Intensity III; Quezon City; San Juan City; Guagua City; Cabanatuan City; Dagupan City; Bacoor City; Tagaytay City; San Idelfonso, Calumpit & Malolos, Bulacan; Las Pinas City; Puerto Galera, Or. Mindoro Intensity II: Pasig City; Muntinlupa Cit; Talisay City, Batangas; Magalang, Pampanga; Baler, Aurora; Lucban, Quezon; Gasan, Marinduque; San Juan, Occ. Mindoro; Mulanay & Alabat, Quezon Intensity I - Infanta, Quezon; Baguio City

PHIVOLCS

Strong earthquakes can affect Metro Manila and vicinity

Latest Damaging Earthquake in Metro Manila

14-A THE MANILA TIMES Saturday, August 3, 1968

Earthquake leaves death and destruction in Manila

PRESIDENT MARCOS visits site of disaster on Dimaiuo Jose and Teodora Alonzo sts. as workmen on crane start digging through the ruins in a race to save hundreds of people trapped inside the Ruby Tower building. The President declared a state of emergency in the face of widespread damage caused by yesterday's earthquake all over the island of Luzon.

ALSO THERE to look into the progress of rescue work is the First Lady, Mrs. Imelda R. Marcos. Behind her may be seen the upper floors of the six-story building which collapsed like an accordion crushing residents inside.

A WOMAN is carried in a stretcher by soldiers as onlookers watch from the street below. As of 8 last night, some 150 persons trapped in the fifth and sixth floors had been rescued. Work continued on into the night.

A DOCTOR goes down firemen's ladder with a baby rescued from top floor of Ruby Tower. It was among the first to be brought down by rescuers.

VICTIM trapped under a concrete wall is comforted by Manila Times publisher Joaquin P. Roces, who was among the first volunteers to arrive at the scene. Her leg was pinned by the concrete wall later lifted by rescuers.

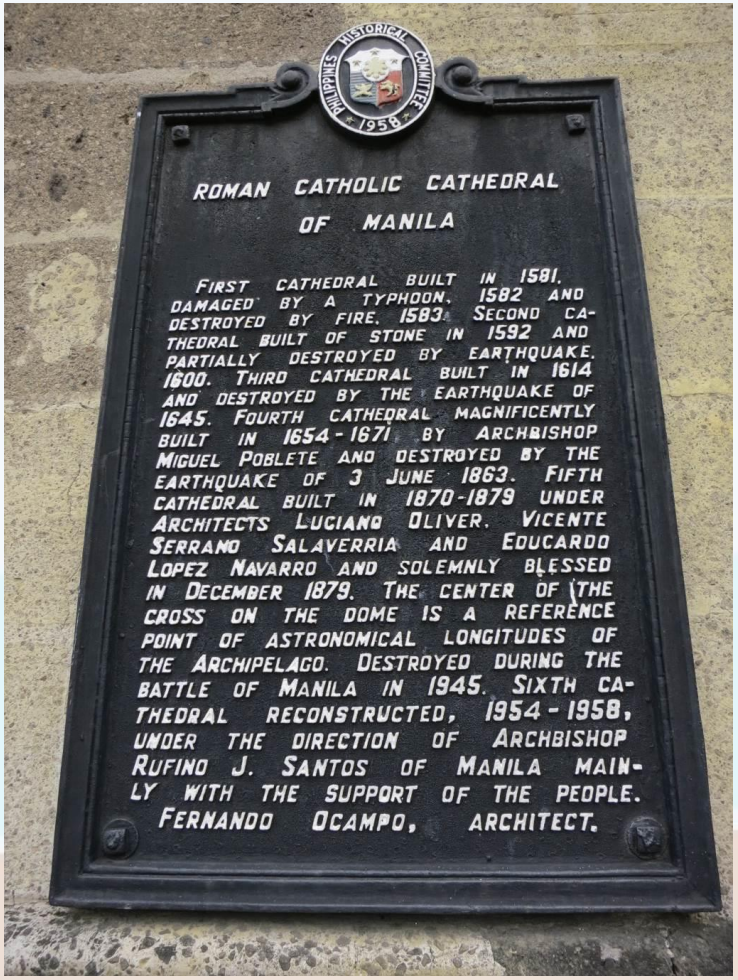
ELSEWHERE in Manila, several buildings like the Tuason building on the Escolta, suffered cracks and other extensive damage caused by the earthquakes. Some 70 buildings all over Manila were damaged. Most suffered broken glass panes and cracked walls.

P20 MILLION worth of cargo go up in smoke in Shed C of Pier 9 in the second of two fires that hit the South Harbor early yesterday morning. The first, at 3:20 a.m., destroyed bales of raw cotton in one hatch of the m/s Genevieve Lykes docked at Pier 5. This second one broke out at 3:30 a.m. in Pier 9 right after the earthquake. Both fires were caused by snapped electric wires.

- M 7.3 Casiguran, Aurora Earthquake, 02 August 1968
- Ruby Tower in Manila collapsed – 268 killed, 260 injured

Historical Church with Earthquake Accounts

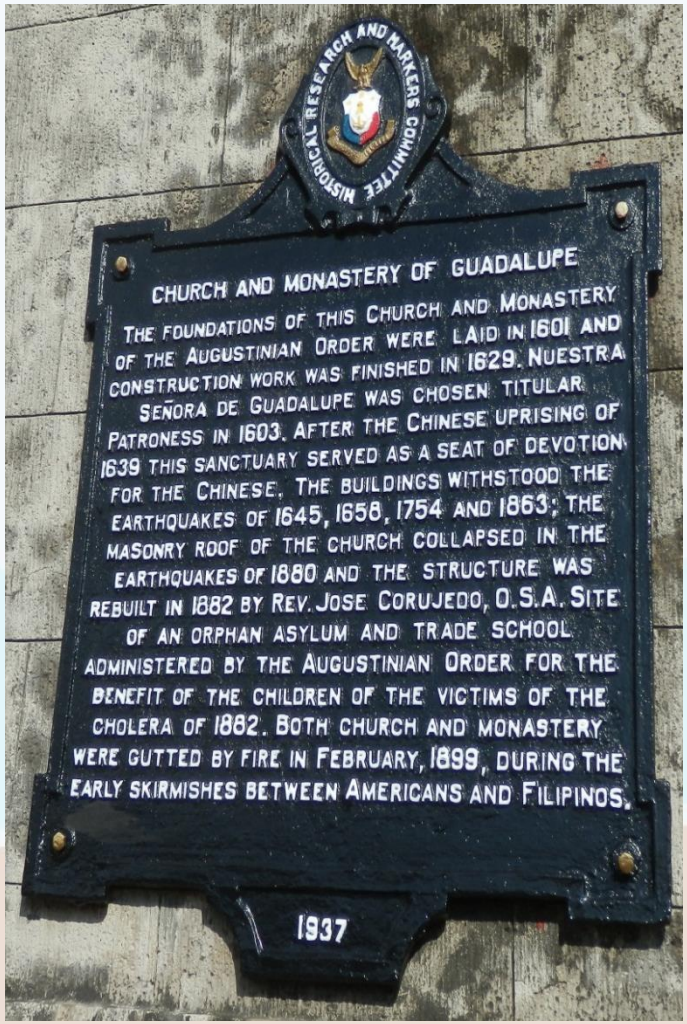
Manila Cathedral



- “partially destroyed by earthquake of 1600”
- “destroyed by the earthquake of 1645”
- “destroyed by the earthquake of 3 June 1863”

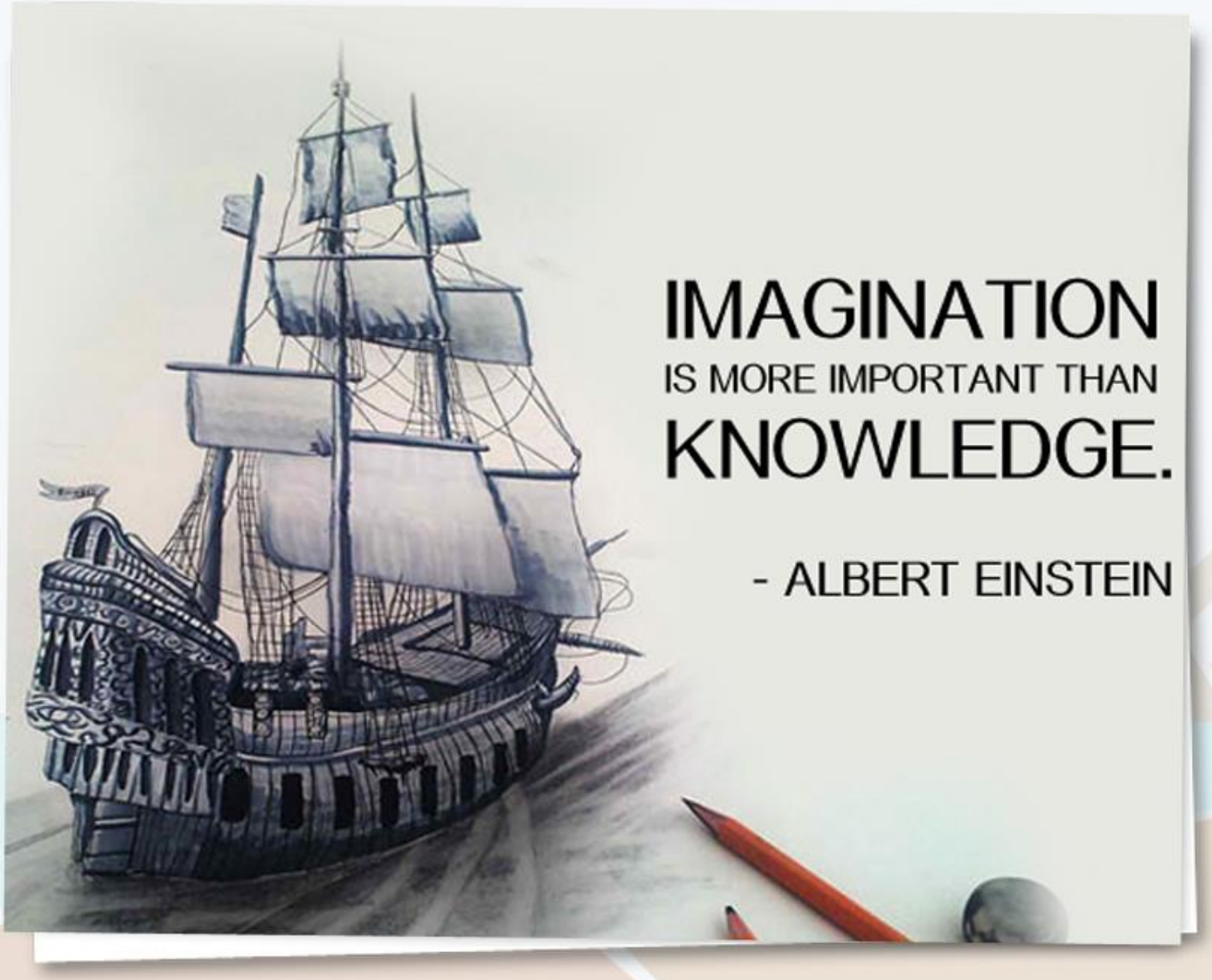
Historical Church with Earthquake Accounts

Church and Monastery of Guadalupe



- “withstood the earthquakes of 1645, 1754, and 1863”
- “the masonry roof of the Church collapsed in the earthquake of 1880”

What are the hazards associated with earthquakes?

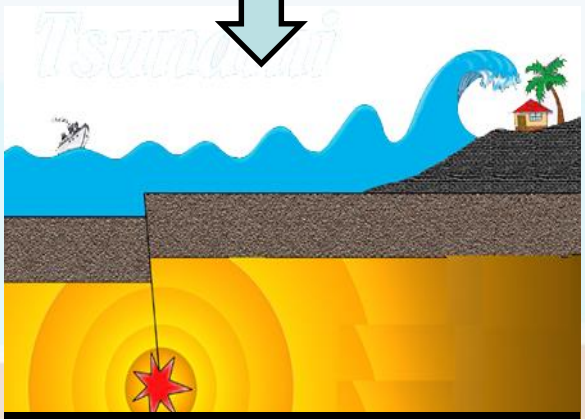

IMAGINATION
IS MORE IMPORTANT THAN
KNOWLEDGE.
- ALBERT EINSTEIN

Earthquake-Related Hazards

Faulting (Ground) Ruptu

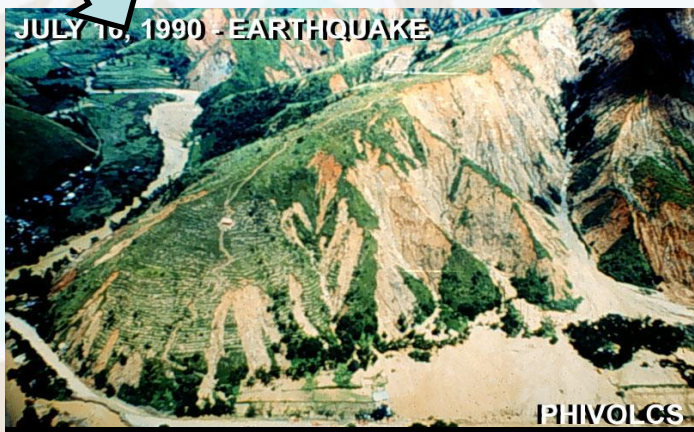
Ground Shaking

Liquefaction



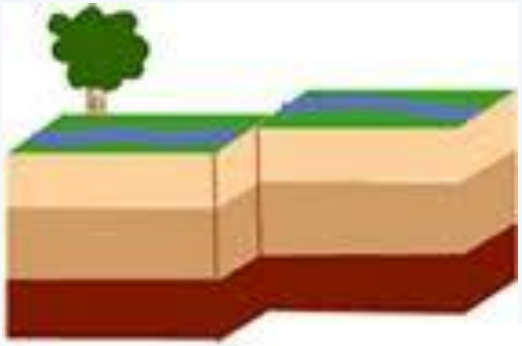
Tsunami

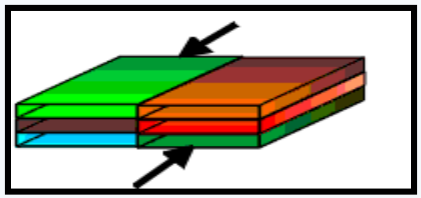
Fire



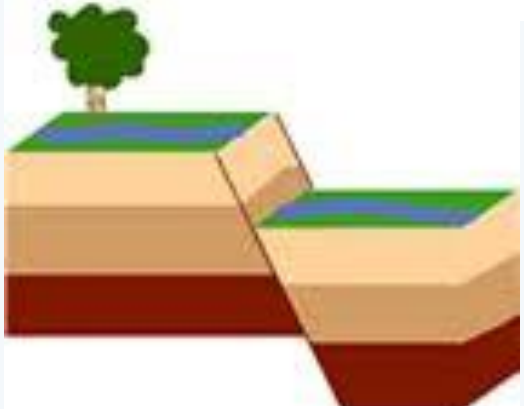
Landslide

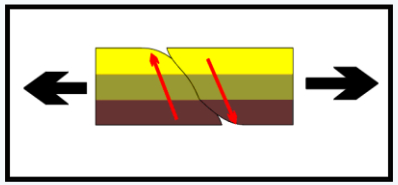
1. FAULTS



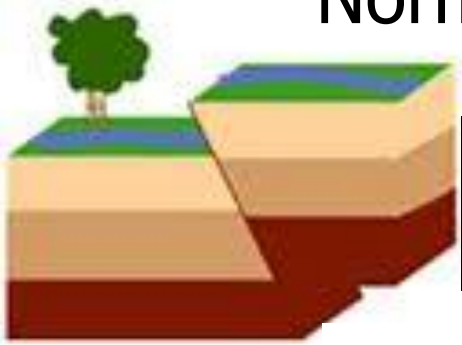


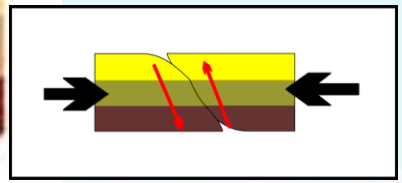
Strike Slip





Normal





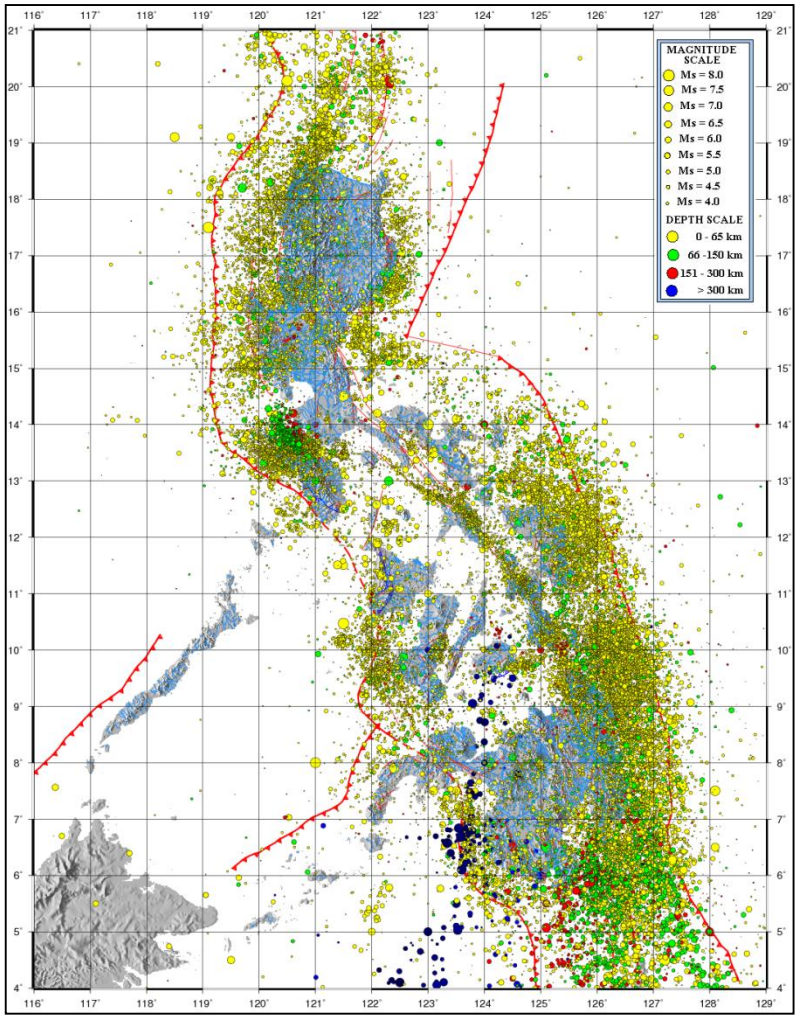
Thrust or Reverse

- fractures where rock movement has taken place and earthquakes have been produced

- **active faults** are those that moved in the last 10,000 years

How do we know if a fault is active?

1) Earthquakes



2) Study of landforms associated with active faulting

Landforms associated with ground rupture

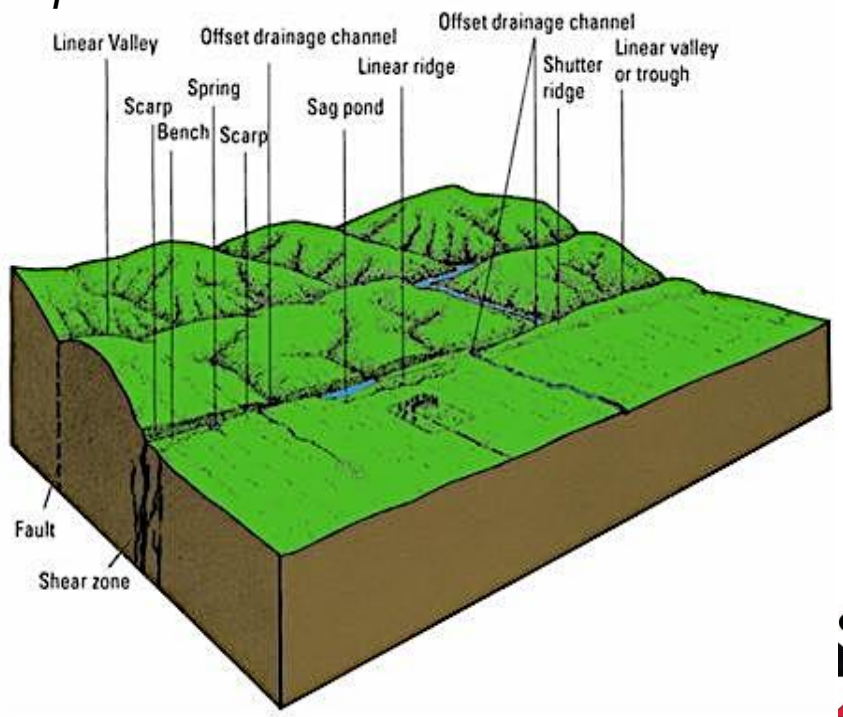
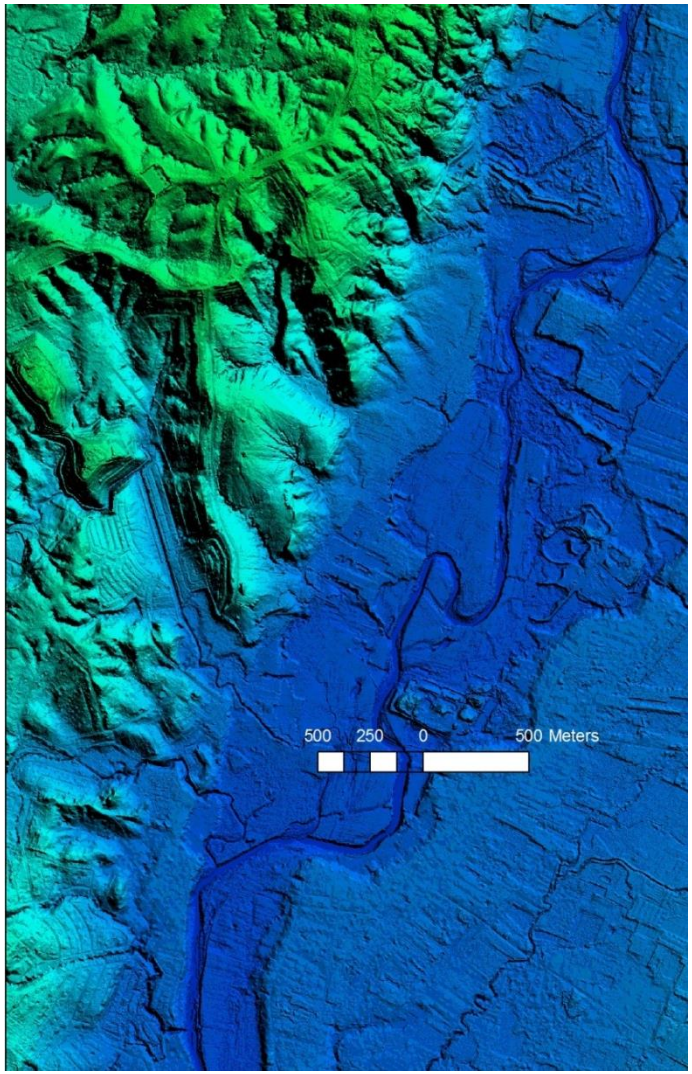


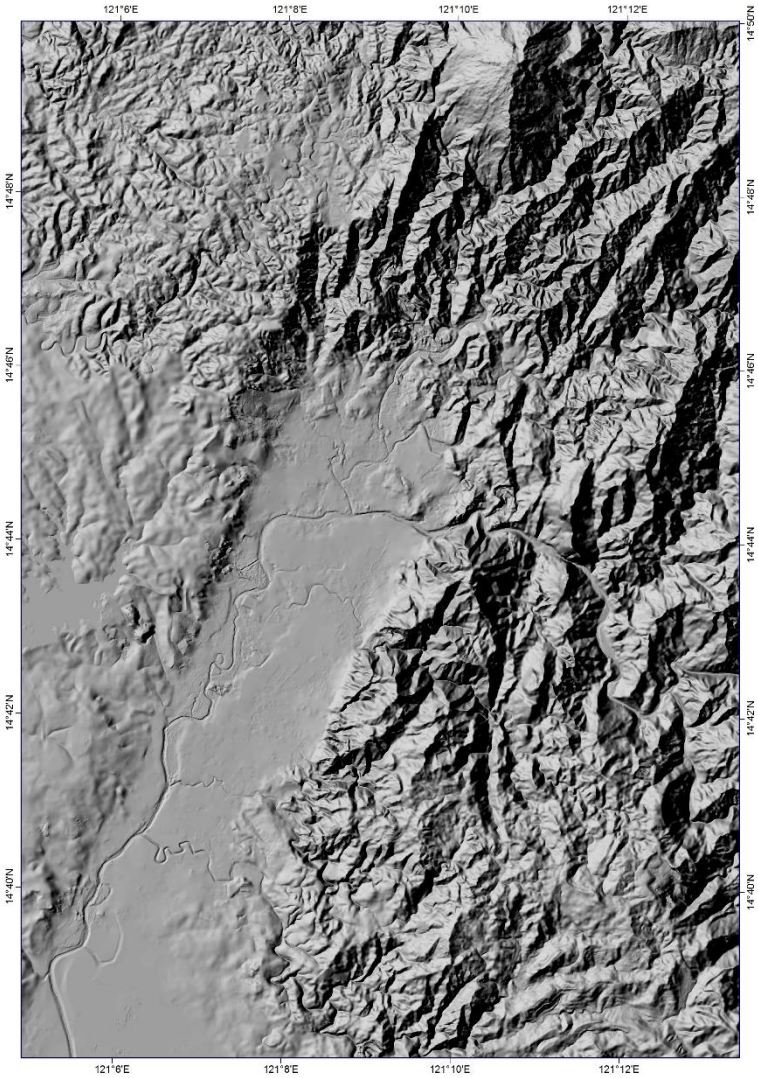
Image source: Strike-slip geomorphology
Wesson & others [1975], modified by Burbank & Anderson [2000])

OST
PHIVOLCS

INTERPRETATION OF DIGITAL ELEVATION MODEL AND DIGITAL SURFACE MODEL



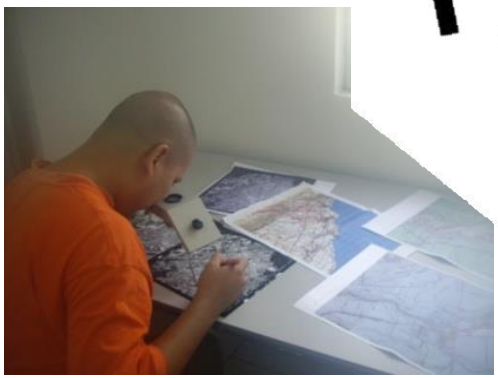
LiDAR Digital Elevation Model of northern part of Quezon City

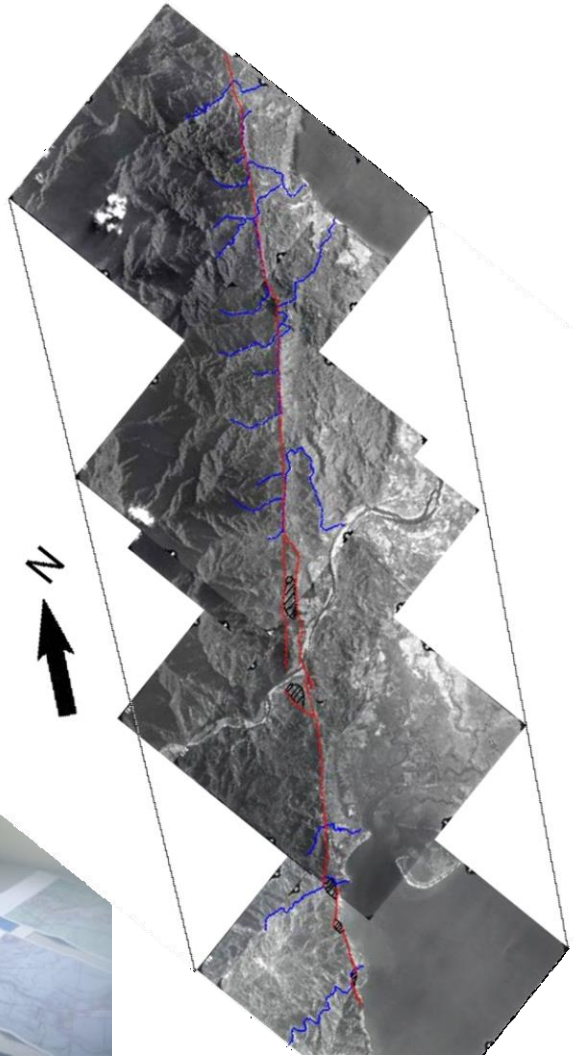


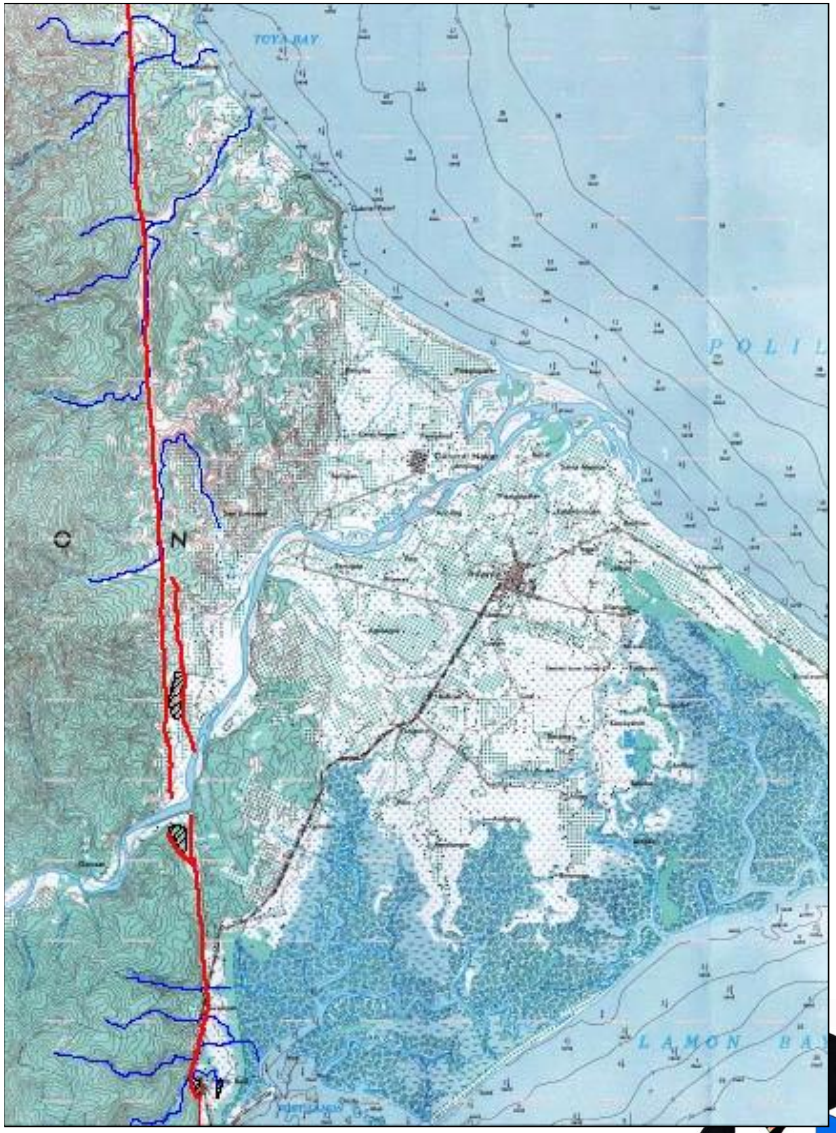
IFSAR-derived Digital Elevation model showing expression of Valley Fault System in Rizal Province

DOST
PHIVOLCS

INTERPRETATION
OF AERIAL PHOTOGRAPH & TOPOGRAPHIC MAP



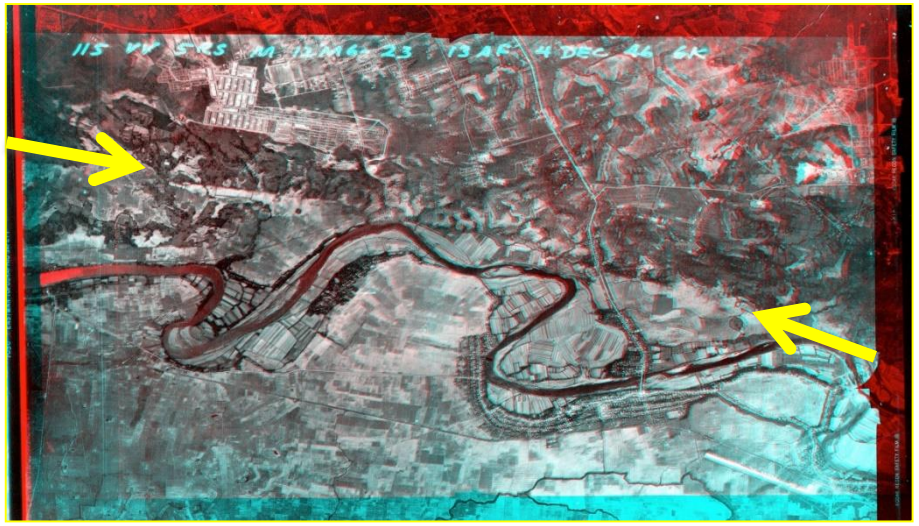




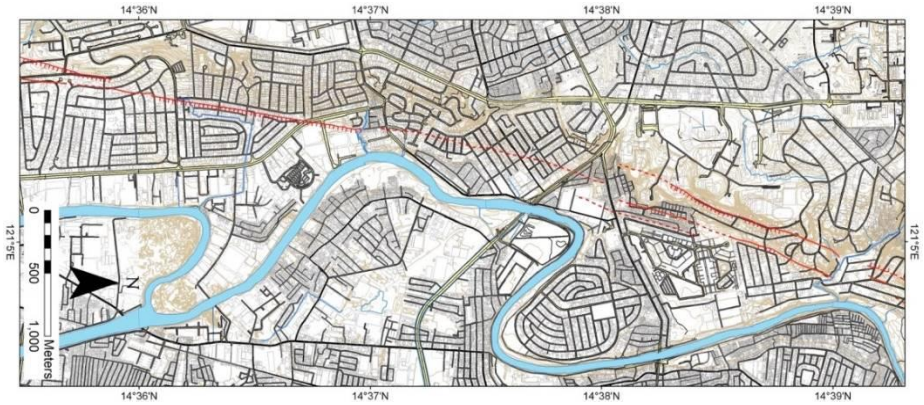
Detailed airphoto interpretation of
PFZ: Infanta Fault (T. Bacolcol & others)

PHIVOLCS

Aerial photograph interpretation of West Valley Fault in Marikina and Quezon City. (After KL Papiona and MIT Abigania, 2013)



1946 Aerial Photograph



1:5,000 Topomap

DOST PHIVOLCS

Field validation

- Series of peer reviews (Internal and External)

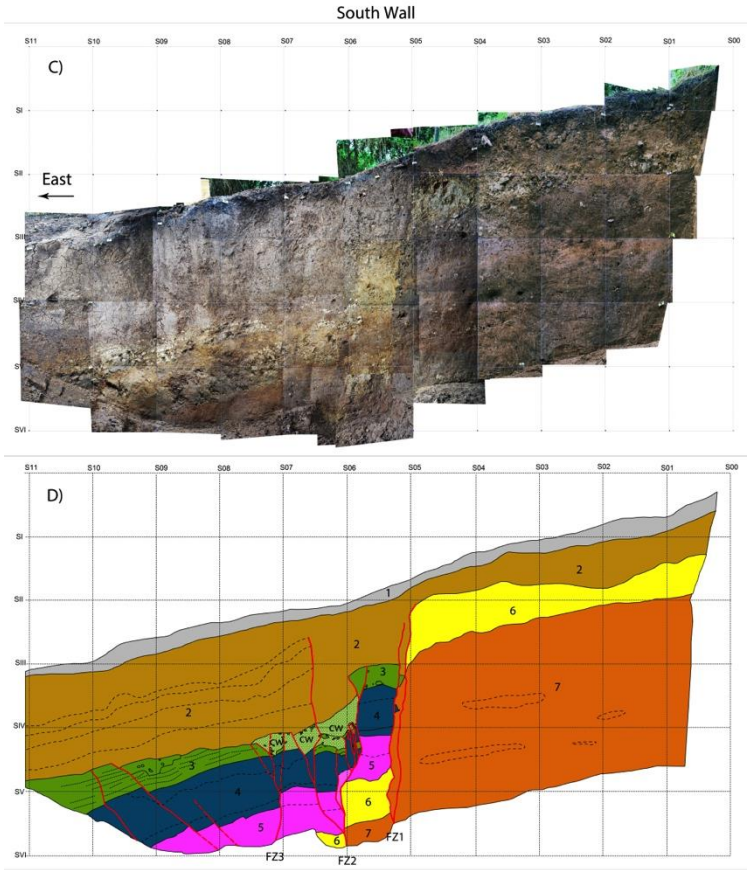
PHIVOLCS

Paleoseismology -Study of past earthquakes along a fault

TRENCHING –is a method of paleoseismic study where the known trace of the fault is excavated to understand:

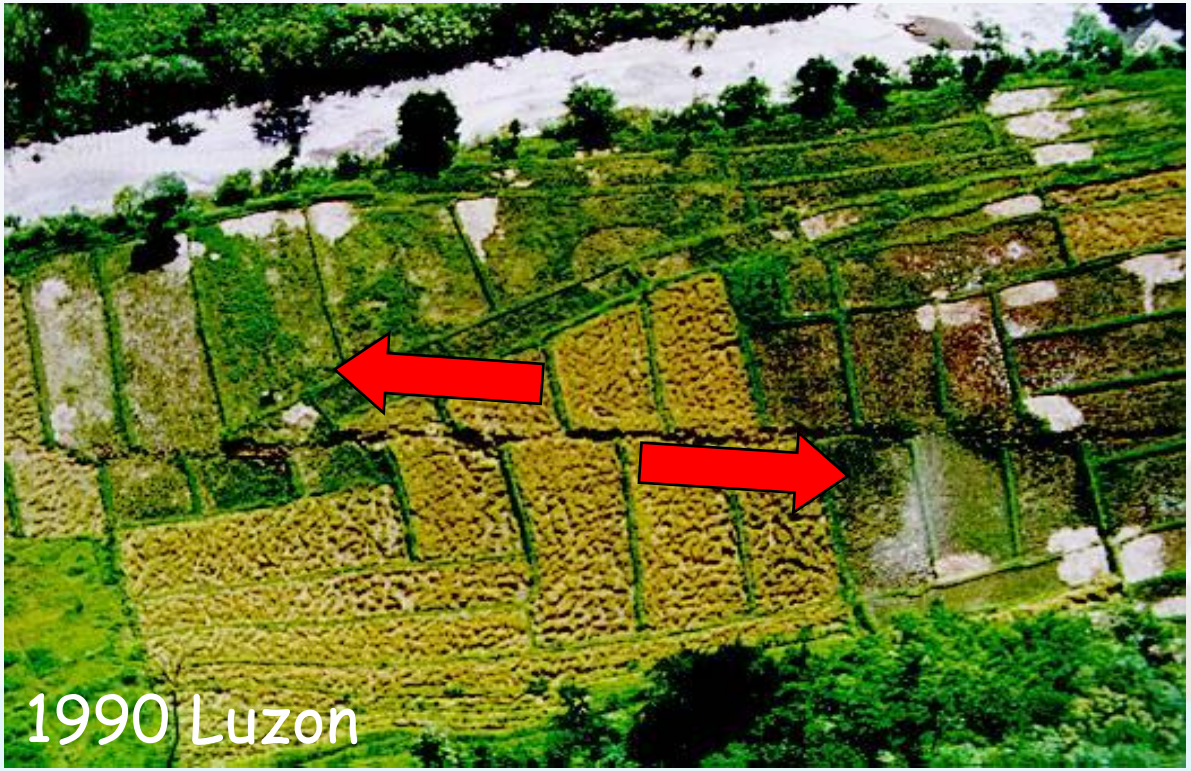
1. the characteristic movement and slip of the fault
2. how big is the size (magnitude) of a potential earthquake
3. when did and when will (frequency) the potential earthquake will occur

Location of the trench across the WVF



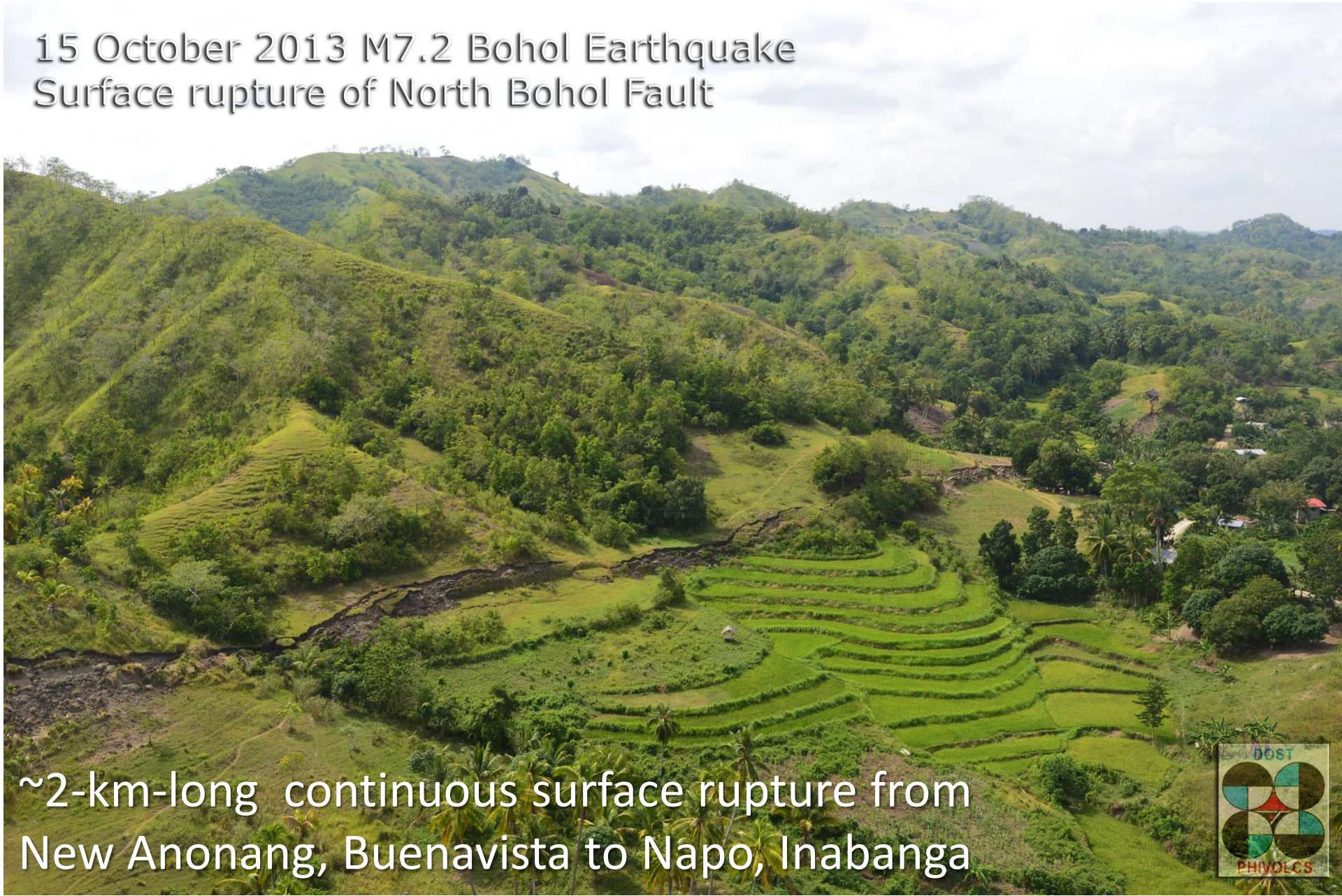
Fault (Ground) Rupture

July 16, 1990 Luzon earthquake



- creation of new or the renewed movements of old fractures, oftentimes with the two blocks on both sides moving in opposite directions

DOST PHIVOLCS


15 October 2013 M7.2 Bohol Earthquake
Surface rupture of North Bohol Fault
~2-km-long continuous surface rupture from
New Anonang, Buenavista to Napo, Inabanga
DOST
PHIVOLCS

Surface rupture in Inabanga

North Bohol Fault

"The Great Wall of Bohol"

Surface Rupture
2017 M6.7 Surigao Del Norte Earthquake

- Philippine fault – Surigao segment
- Total surface rupture mapped onland: ~4.3 km in Surigao City (Brgy. Ipil) and Municipality of San Francisco (Brgys. Poblacion, Honrado and Macopa)
- Max. horizontal displacement: 60 cm
- Max. vertical displacement: 40 cm

DOST
PHIVOLCS

Surface Rupture
2017 M6.7 Surigao Del Norte Earthquake

Surface rupture that passes under the Anao-aon Bridge

Horizontal displacement: 15 cm
Vertical displacement: 42 cm.
Downthrown side: west
Brgy. Poblacion, San Francisco

DOST
PHIVOLCS

Surface Rupture 2017 M6.7 Surigao Del Norte Earthquake

Transected chapel in Brgy. Ipil, Surigao City

Two parallel traces forming a depression

DOST
PHIVOLCS

Surface Rupture
2017 M6.7 Surigao Del Norte Earthquake

Undamaged house less than 5 m from the surface rupture in Brgy. Poblacion, San Francisco

DOST
PHIVOLCS

Surface Rupture
2017 M6.5 Leyte Earthquake

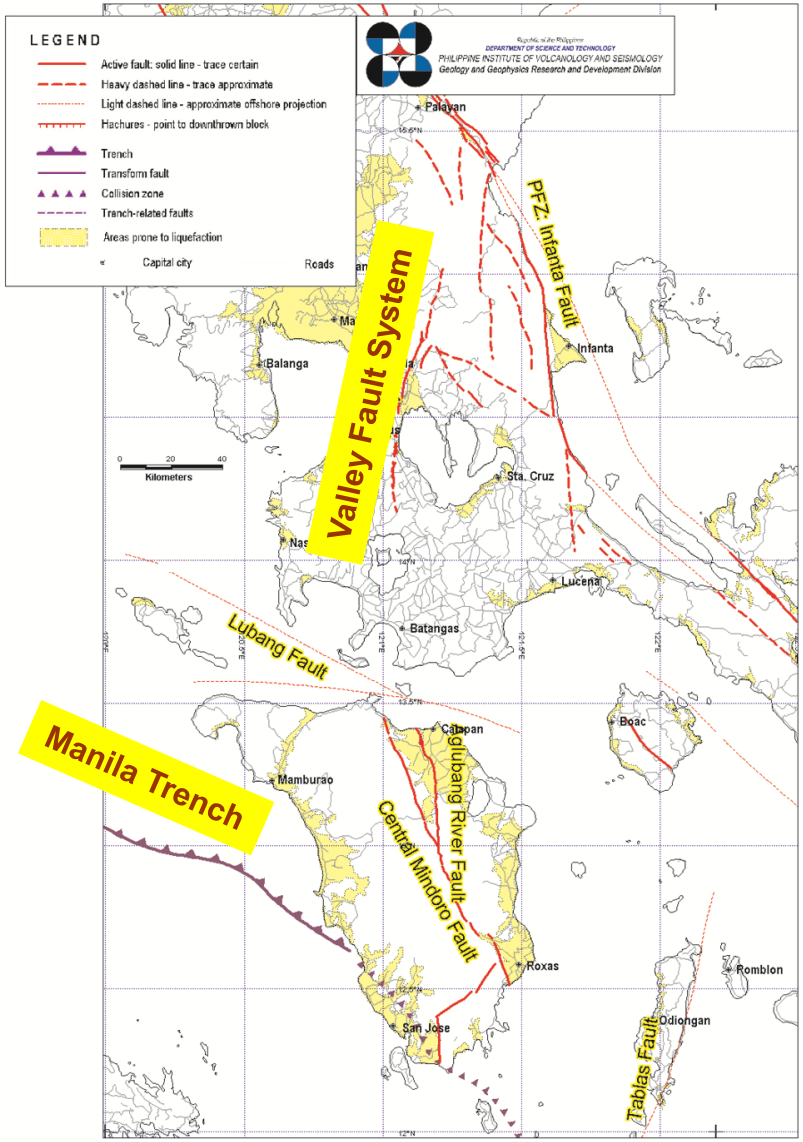
Brgy. Tongonan, Ormoc City

PHIVOLCS

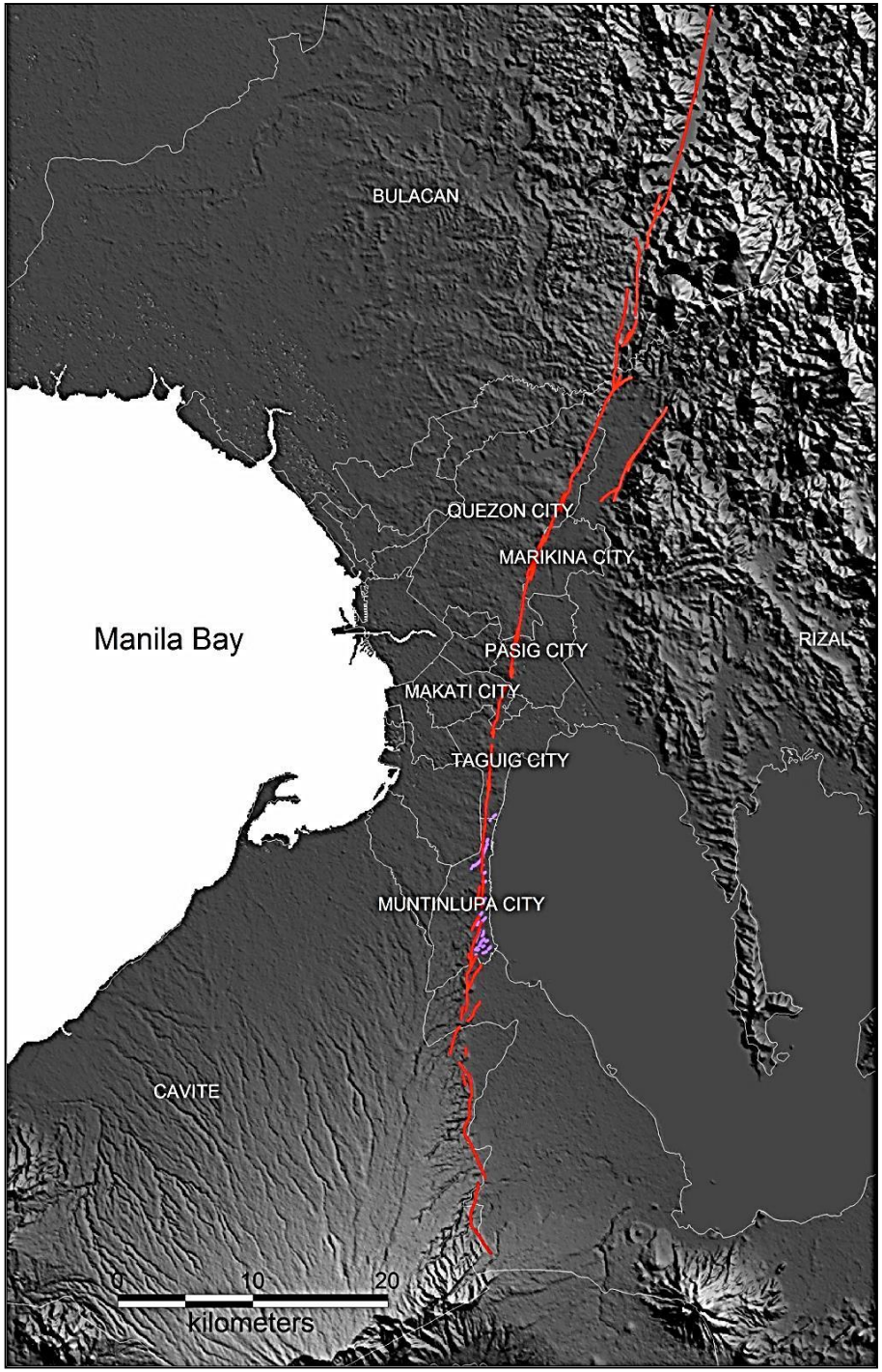
Brgy. Hiluctogon, Kananga

DOST
PHIVOLCS

Earthquake Generators in Metro Manila and Vicinity



DOST
PHIVOLCS

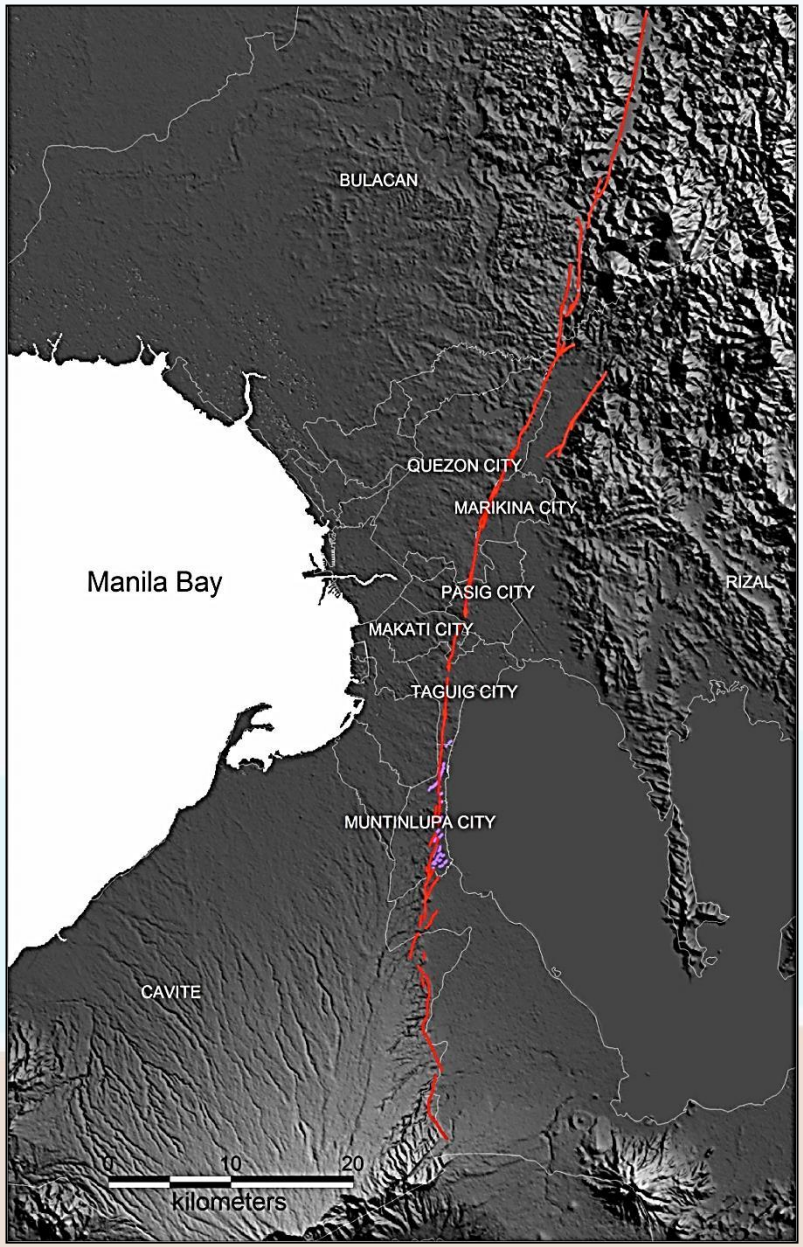


Valley Fault System

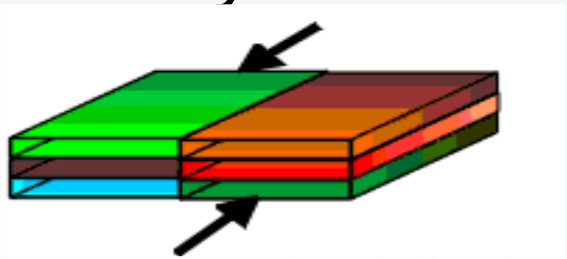
- East Valley Fault
  - 10 km (M6.2)
  - Municipalities of Rodriguez and San Mateo, Rizal
- West Valley Fault
  - 100 km (M7.2)
  - Bulacan (Doña Remedios Trinidad, Norzagaray and San Jose Del Monte City)
  - Rizal (Rodriguez)
  - Quezon City, Marikina City, Pasig City, Makati City, Taguig City and Muntinlupa City
  - **Laguna** (San Pedro City, Biñan City, Sta. Rosa City, Cabuyao City and Calamba City)
  - **Cavite** (Carmona, General Mariano Alvarez and Silang)

DOST
PHIVOLCS

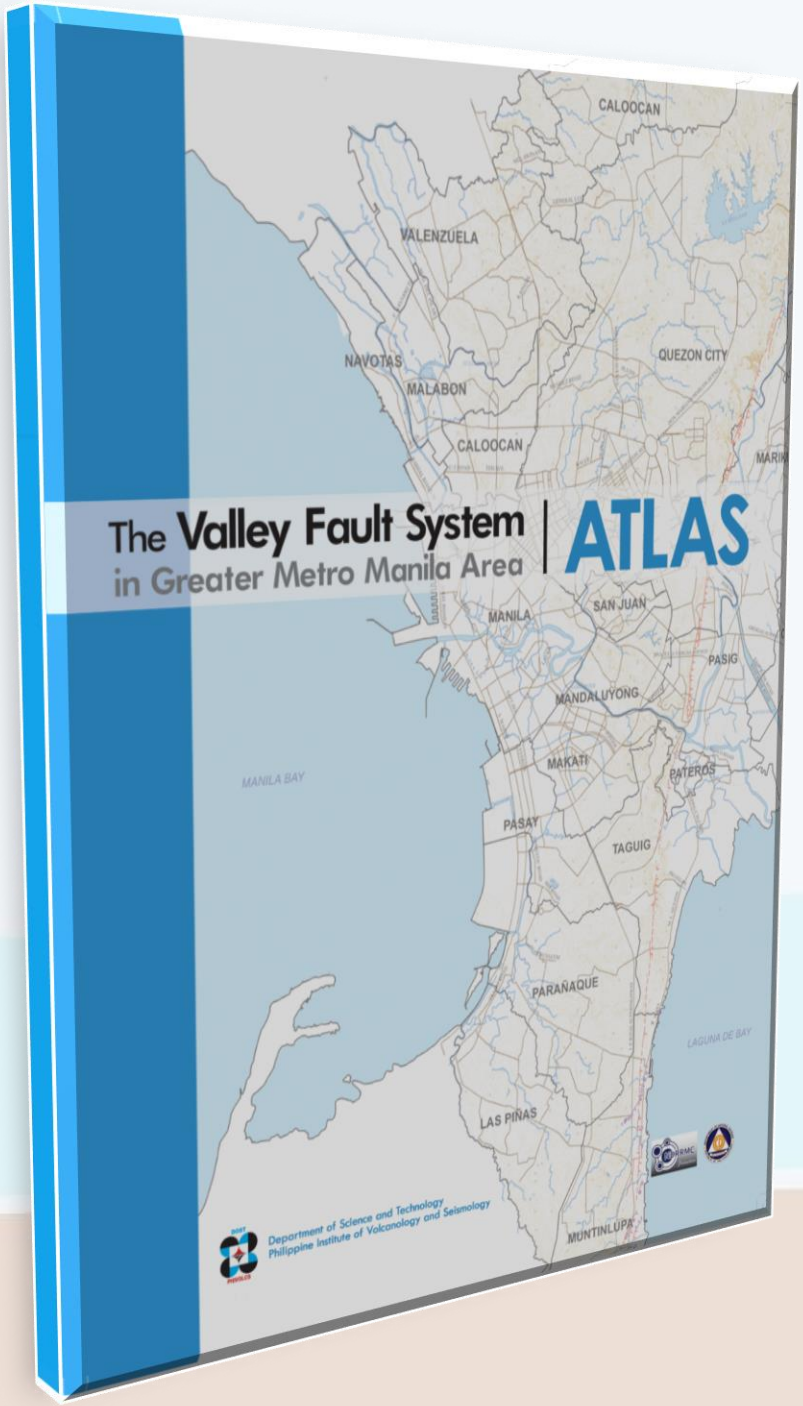
The Valley Fault System



- West Valley Fault (WVF) movement mainly horizontal



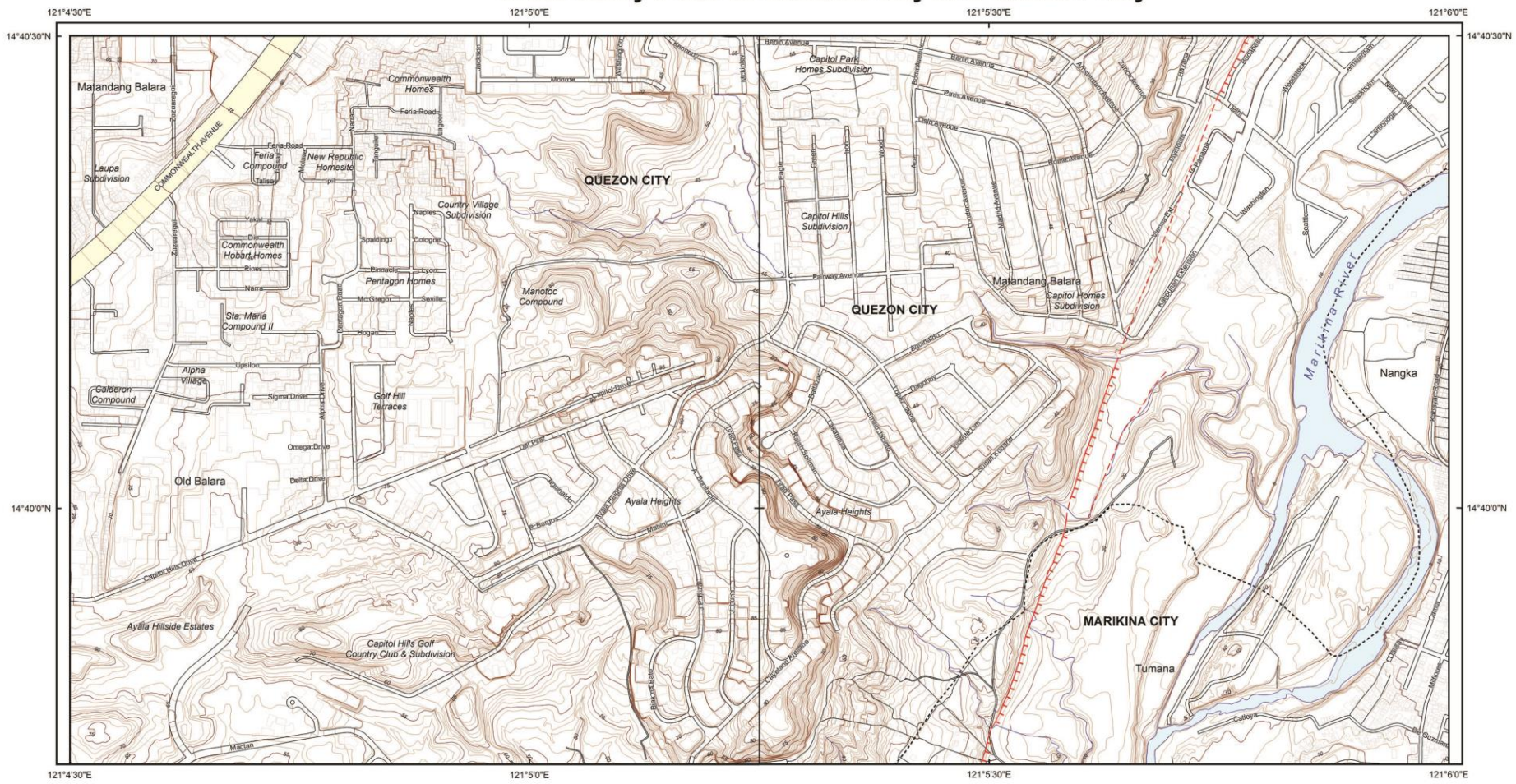
- WVF moved 4 times in past 1400 years; movement interval ~ 400-600 years
- Last major earthquake from Valley Fault in 1658



The Valley Fault System Atlas in Greater Metro Manila Area

3230 III 7 C
1:5,000

West Valley Fault in Marikina City and Quezon City



Active Faults

- Solid line - trace is certain; hachures indicate downthrown area
- Dashed line - trace is approximate
- Dotted line - trace is concealed

Explanation

The Valley Fault System, consisting of the West Valley Fault and the East Valley Fault, was mapped by the Philippine Institute of Volcanology and Seismology using available data, such as aerial photographs, satellite imageries, topographic maps, earthquake epicenters and previous publications, and verified by field surveys. Some geomorphic features identified from aerial photographs may not be observable on the ground at present due to land modification. The recommended minimum buffer zone, or zone of avoidance, against ground rupture hazard is at least 5 meters as reckoned from both sides of the fault trace or from the edge of the deformation zone.

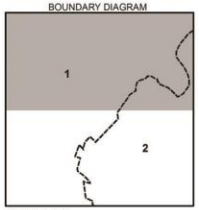
Base map are National Mapping and Resource Information Authority 1:5,000 planimetric maps (2004) and Metro Manila Street Map (2010).

Legend

- Roads
- Contour lines
- Administrative boundaries
- Building footprints
- Major roads
- Water bodies

Disclaimer:
Administrative boundaries are approximate (Risk Analysis Project, 2013).

BOUNDARY DIAGRAM



City / Municipality
1. Quezon City
2. Marikina City

INDEX TO ADJOINING SHEETS

3230 III 7 A	3230 III 7 D	3230 III 8 A
3230 III 7 B	3230 III 7 C	3230 III 8 B
3230 III 12 A	3230 III 12 D	3230 III 13 A

Shaded portion pertains to areas covered by the maps shown in these pages

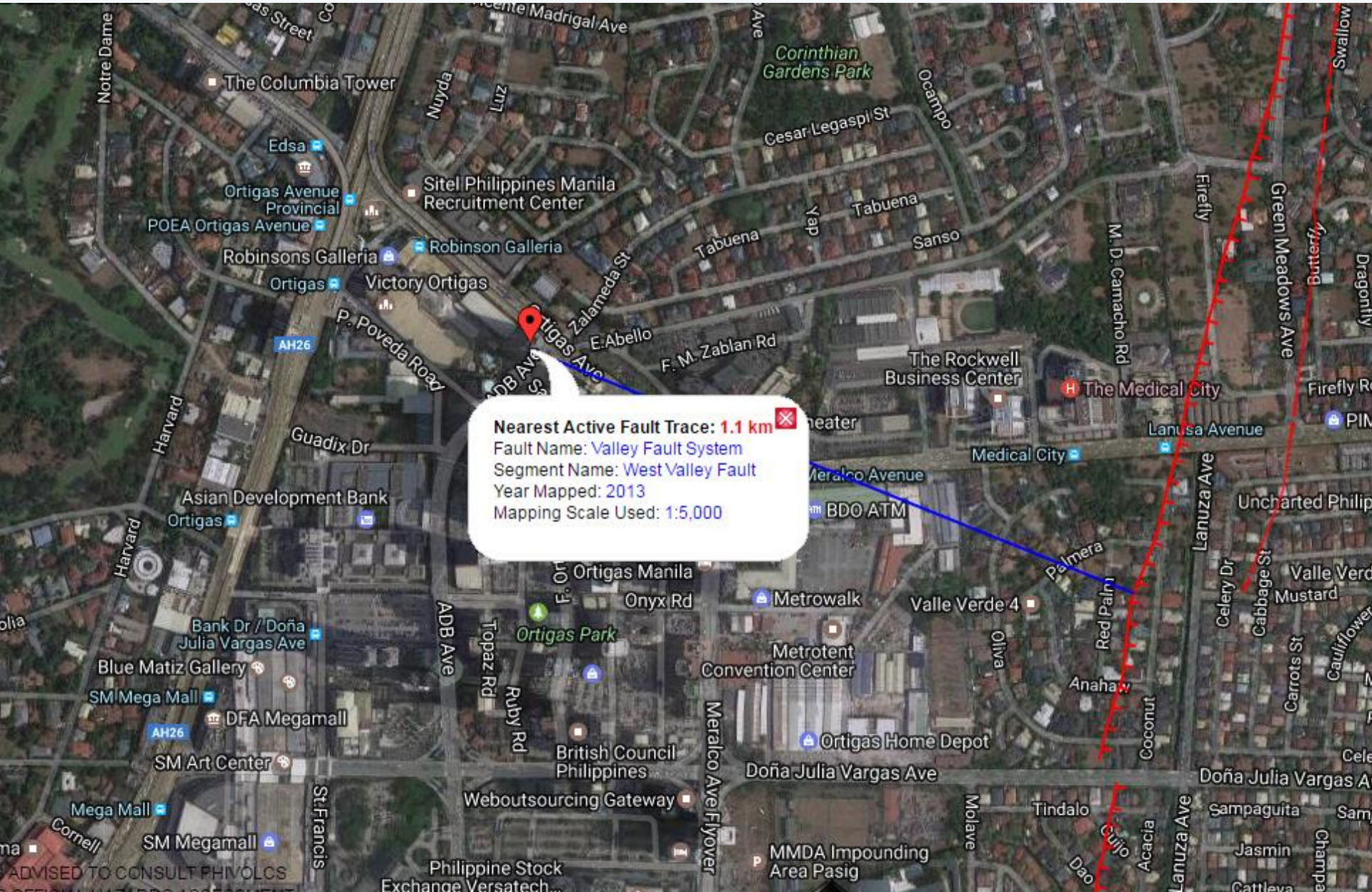
N
W E

0 100 200 300 400 500
Meters

Spheroid.....Clarke 1866
Projection.....Transverse Mercator
Horizontal Datum.....Philippine Reference System 1992 (PRS92)
Vertical Datum.....Mean Sea Level
Contour Interval.....1 meter

DOST
PHIVOLCS
Department of Science and Technology
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY
PHIVOLCS Building, C.P. Garcia Avenue
U.P. Campus, Diliman, Quezon City
Tel. No. : +63 2 426-1468 to 79 Telefax: +63 2 929-8366
June 2014

faultfinder.phivolcs.dost.gov.ph



Avoiding Effects of Ground Rupture

- Avoid construction of structures on top of an active fault
- House or building should be at least 5 meters away from the trace of the fault

3-meter fault scarp of the North Bohol Fault in Brgy. Anonang, Inabanga

Buffer Zone

Explanation

Active Faults:

Solid Line - trace certain

Dashed Line - trace approximate

Dotted Line - trace concealed

Hachures indicate downthrown area

Note: Recommended minimum buffer zone from the fault is at least 5 meters as reckoned from both sides of the fault trace or from the edge of the deformation zone. Mapping is based on available data (aerial photographs, field survey, etc.). Some geomorphic features, interpreted from aerial photographs indicating active fault traces, may not be observable in the field due to land modification. Base map is from National Mapping and Resource Information Authority (NAMRIA) 1:5,000 planimetric maps (2004).

- *PHIVOLCS recommends a minimum of at least 5 meters buffer zone from each side of the fault trace or from the edge of the deformation zone.*
- Also refer to as **fault avoidance zone**
- **No structure or building should be built within the buffer zone.**

DOST PHIVOLCS

- Ano maaaring gawin sa buffer zone?
  - Low-use facility
    - Green space, playing fields, gardens, parks, garage, parking lot

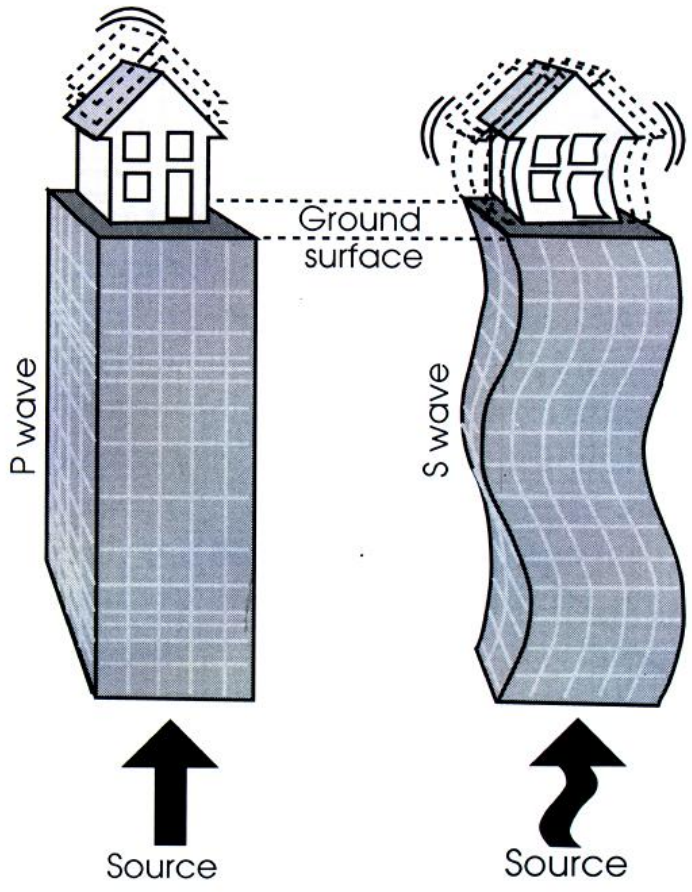
DOST
PHIVOLCS

Buffer Zone

2008 M 7.9 Sichuan Earthquake

Bailu school, looking northeast in direction of rupture
Photo credit to Dr. Gary Gibson

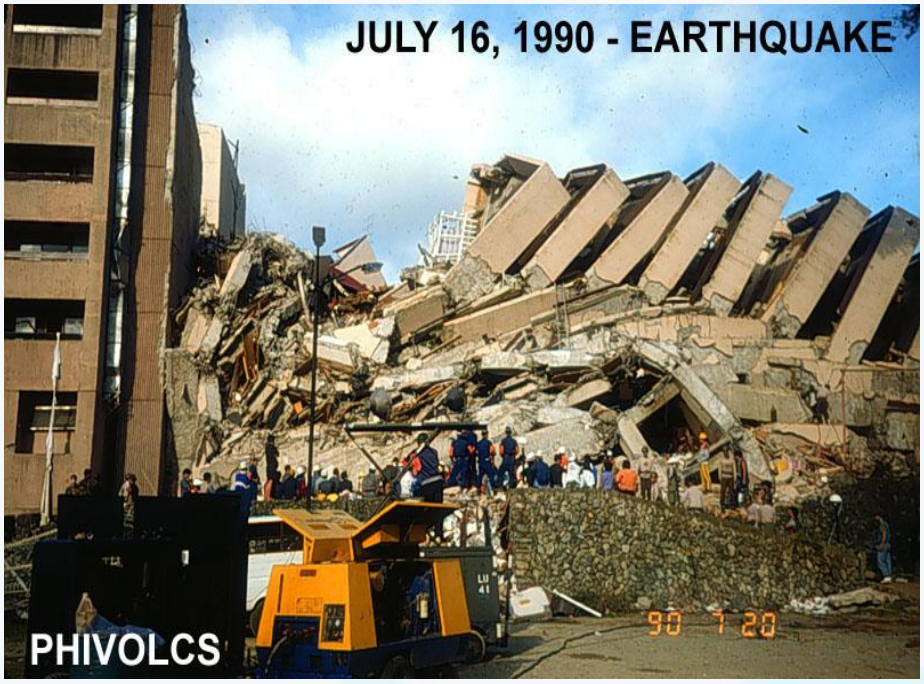
2. Ground Shaking



Primary (P-) and Secondary (S-) waves. P-waves are transmitted as a compressional disturbance, while S-waves are transmitted as a transverse disturbance.

- Up and down;
  - first felt by people near the epicenter
  - not felt by people far from epicenter
- Sideways;
  - felt after up and down by people near epicenter
  - first felt by people far from epicenter

Ground Shaking Effects



Building Collapse

Falling Objects

Sagbayan

DOST
PHIVOLCS

Tubigon

DOST PHIVOLCS

A once two-storey house with first floor pressed under the second floor

PHIVOLCS

PHIVOLCS Earthquake Intensity Scale

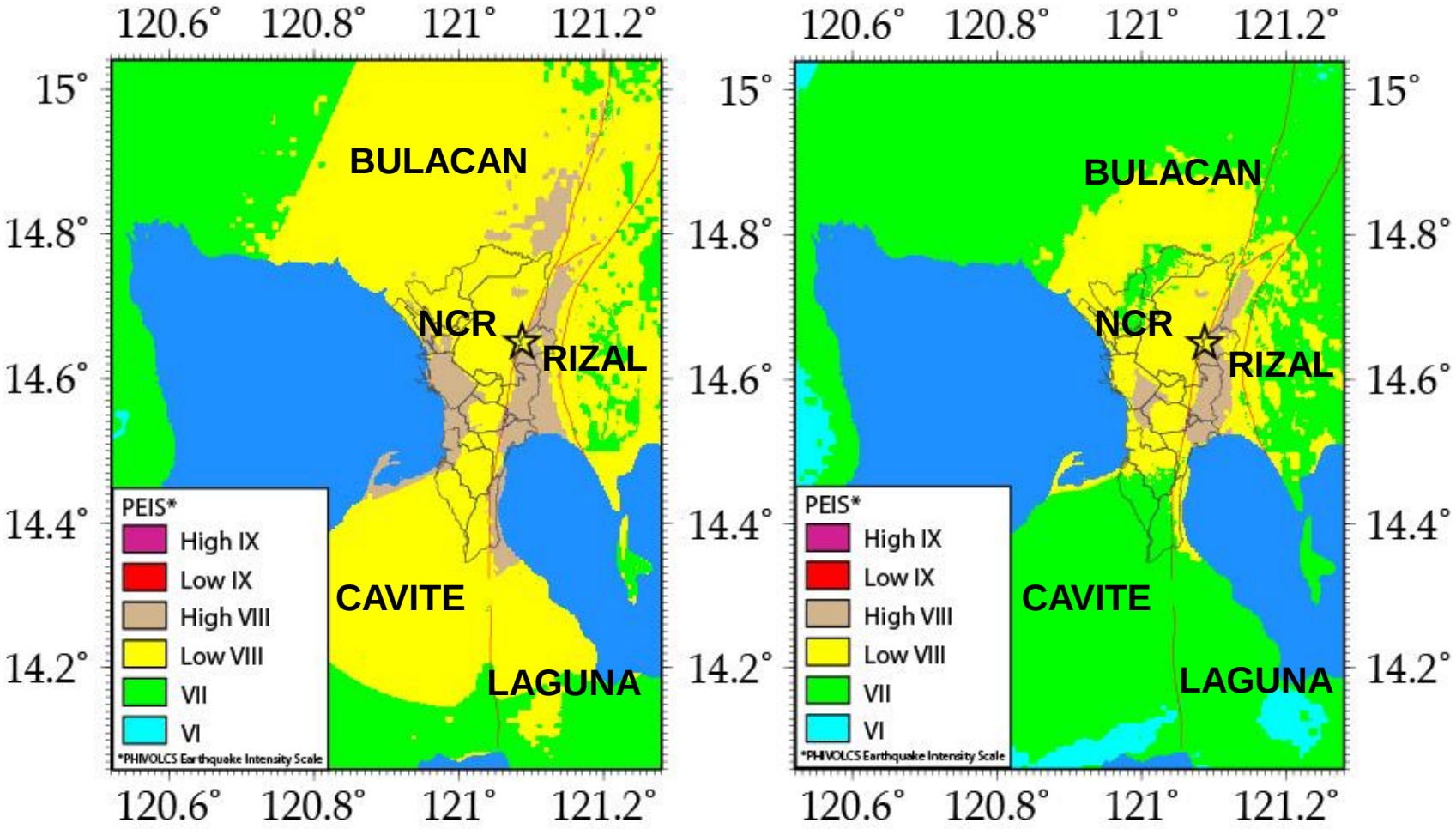
I – Scarcely perceptible
II – Slightly felt
III – Weak
IV – Moderately strong
V – Strong
VI – Very strong
VII – Destructive
VIII – Very destructive
IX – Devastating
X – Completely devastating

DAMAGING

Ground Shaking in Greater Metro Manila

(West Valley Fault Earthquake)

(Risk Analysis Project, 2013: PHIVOLCS, GA supported by AusAID)



M7.2 **M6.5**

DOST PHIVOLCS

INTENSITY VIII (Very Destructive)

Ground Shaking

1995 Kobe Earthquake

Building and Casualty Estimates

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

Lifeline Damage Estimates

for Metro Manila from a M7.2 West Valley Fault Earthquake

Bridge 213 (with detail inventory and stability analysis 189) Flyover 80 (with detail inventory and stability analysis 38)	Large possibility of falling-off	Bridge	7
		Flyover	0
	Moderate possibility of falling-off	Bridge	2
		Flyover	0
Water Supply Distribution Pipes Total 4,615km		Break of pipes or joints	4000 points
Electric Power Transmission and Distribution Line Total 4,862km		Cut of cables	30 km
PLDT Telephone Aerial Cable 9,445 km Underground Cable 3,906 km		Cut of cables	95 km

DOST
PHIVOLCS

Building and Casualty Estimates

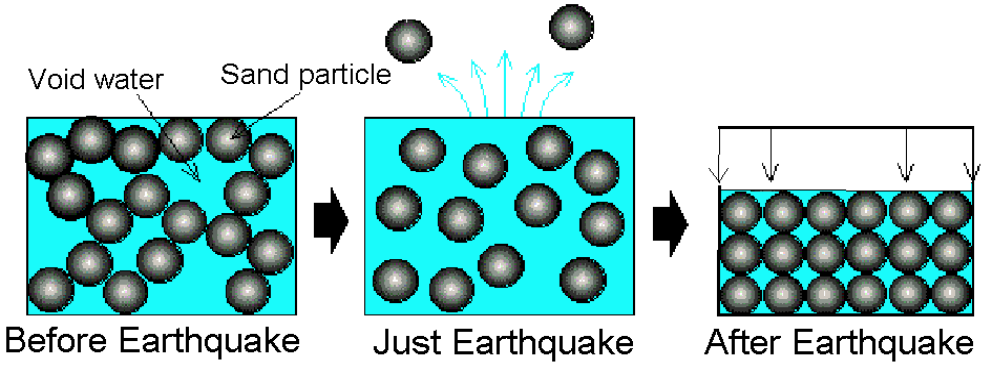
for Metro Manila from a West Valley Fault Earthquake

		M7.2	M6.5
Total Floor Area in Complete to Collapsed Damage (sqm)		88,142,000	65,407,000
Total Floor Area in Slight to Extensive Damage (sqm)		172,924,000	162,799,000
Total Fatalities (Death)		31,000	23,000
Total Injuries	Very Serious	14,000	10,000
	Serious	112,000	85,171
	Slight	385,000	302,000
Total Economic Losses (millions of PhP)		2,269,000	1,773,000

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

DOST
PHIVOLCS

Liquefaction



- Loose, water-rich sediments behave like liquid during strong ground shaking.
- Sediments are rearranged into a more compact state.

DOST
PHIVOLCS

DOST
PHIVOLCS

Liquefaction Effects

Subsidence of bridge column

Subsidence of building, roads

Fissuring of roads

Damage to buried pipes, tanks

DOST
PHIVOLCS

LIQUEFACTION HAZARD
M7.2 West Valley Fault Earthquake

Localities prone to liquefaction

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

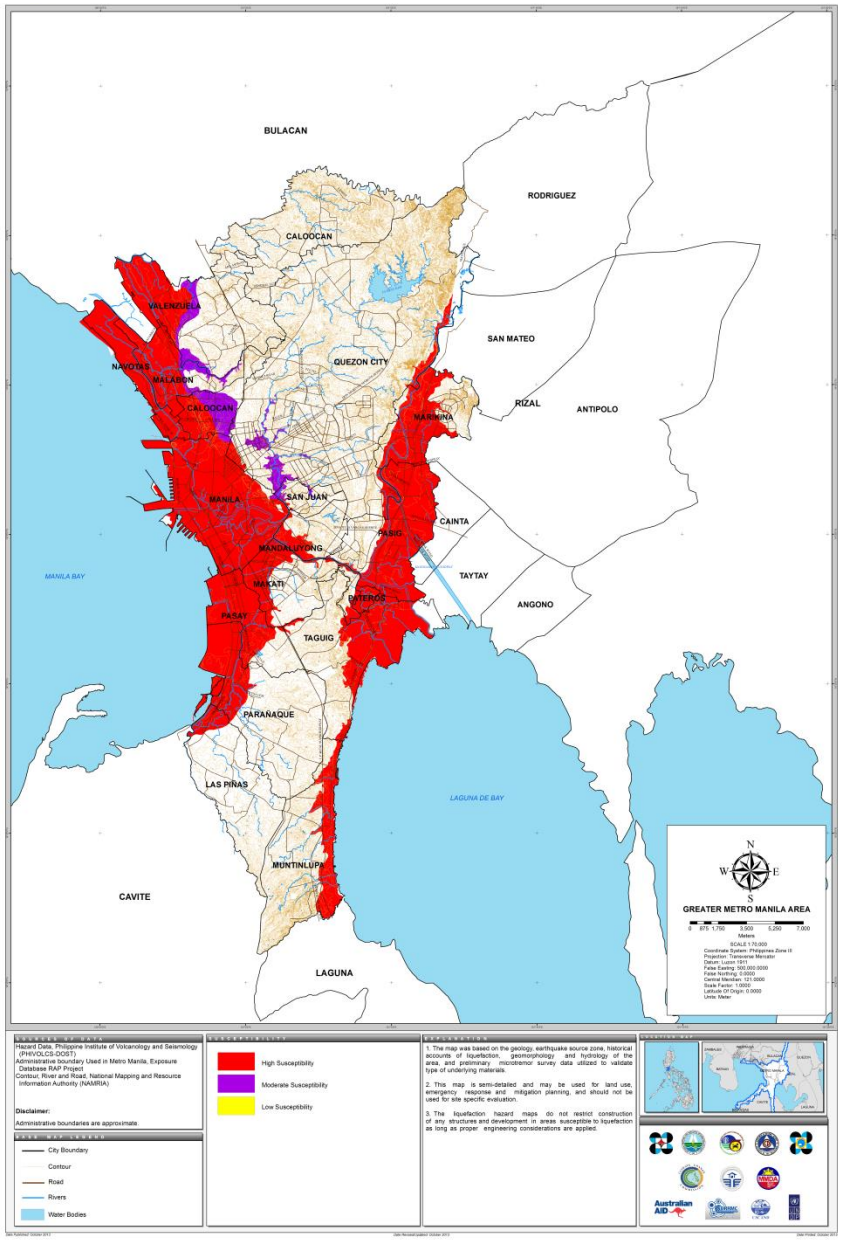
b) Have loose (unconsolidated), sand or silt deposits

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

DOST
DOST
PHIVOLCS

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)

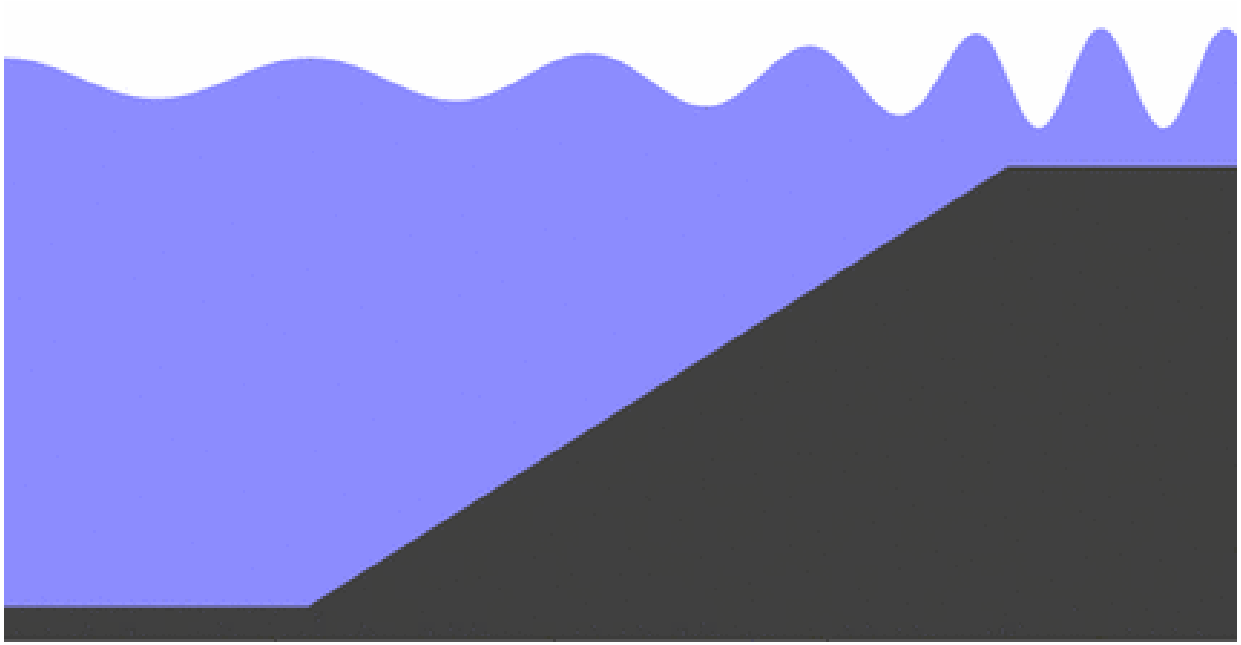
Tsunami

Sea waves, small to large, resulting from disturbance of seawater by undersea earthquakes, landslides, and volcanic eruptions, and meteor impact

March 11,2011 Japan Tsunami

From Kyodo News

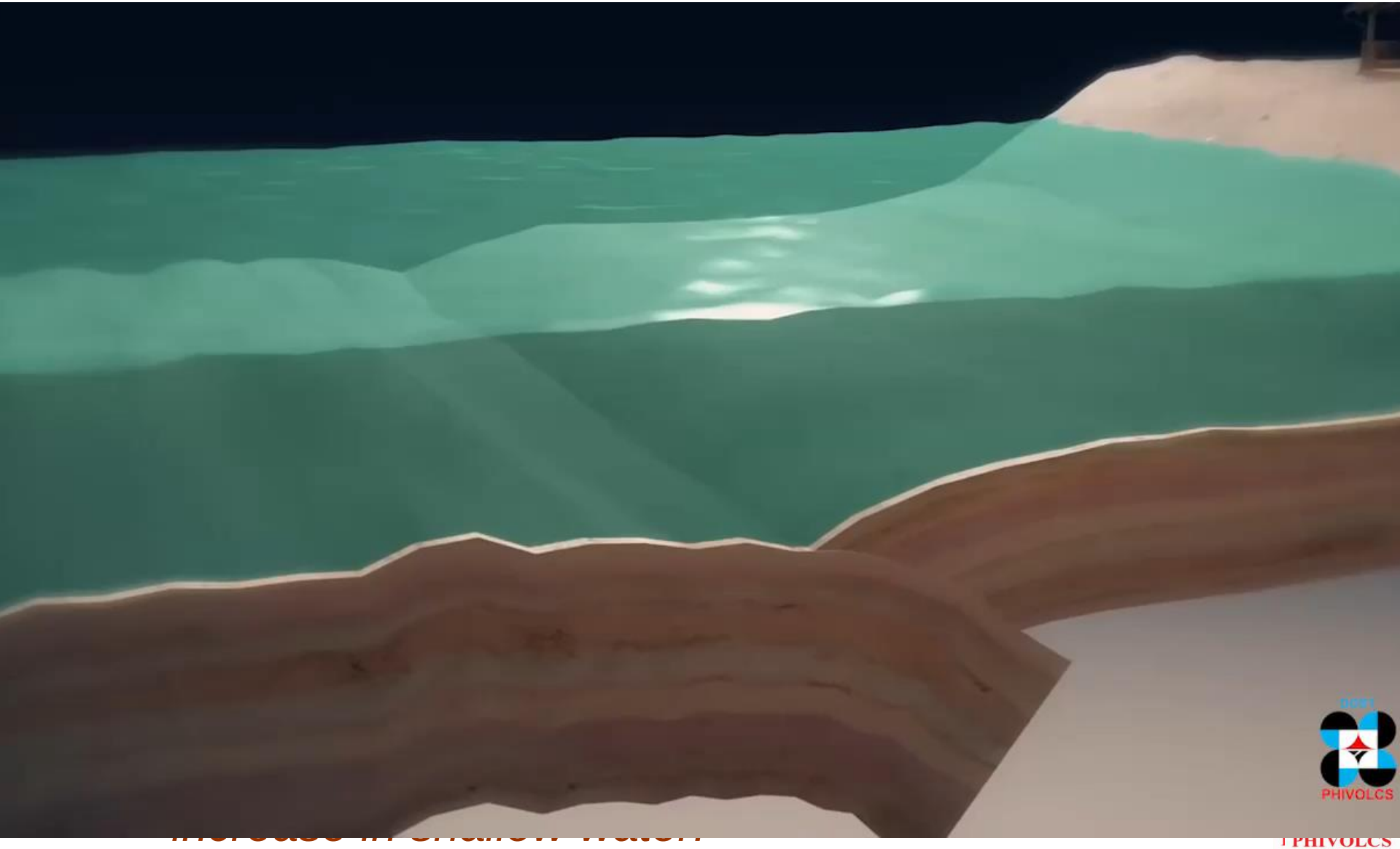
Tsunami Propagation



A *tsunami* moves faster in deeper *water* and slower in shallower *water causing their amplitudes to greatly increase in shallow water.*

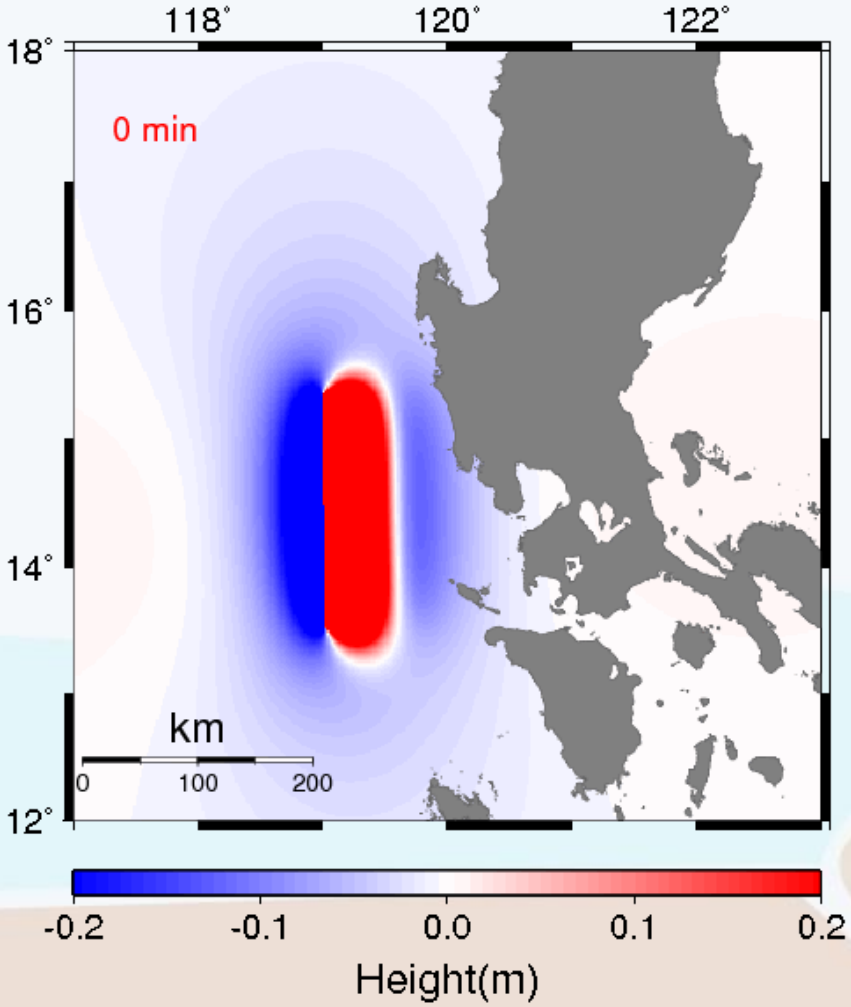
DOST
DOST
PHIVOLCS

Tsunami Propagation



Tsunami Scenario

M8.3 Earthquake from Manila Trench



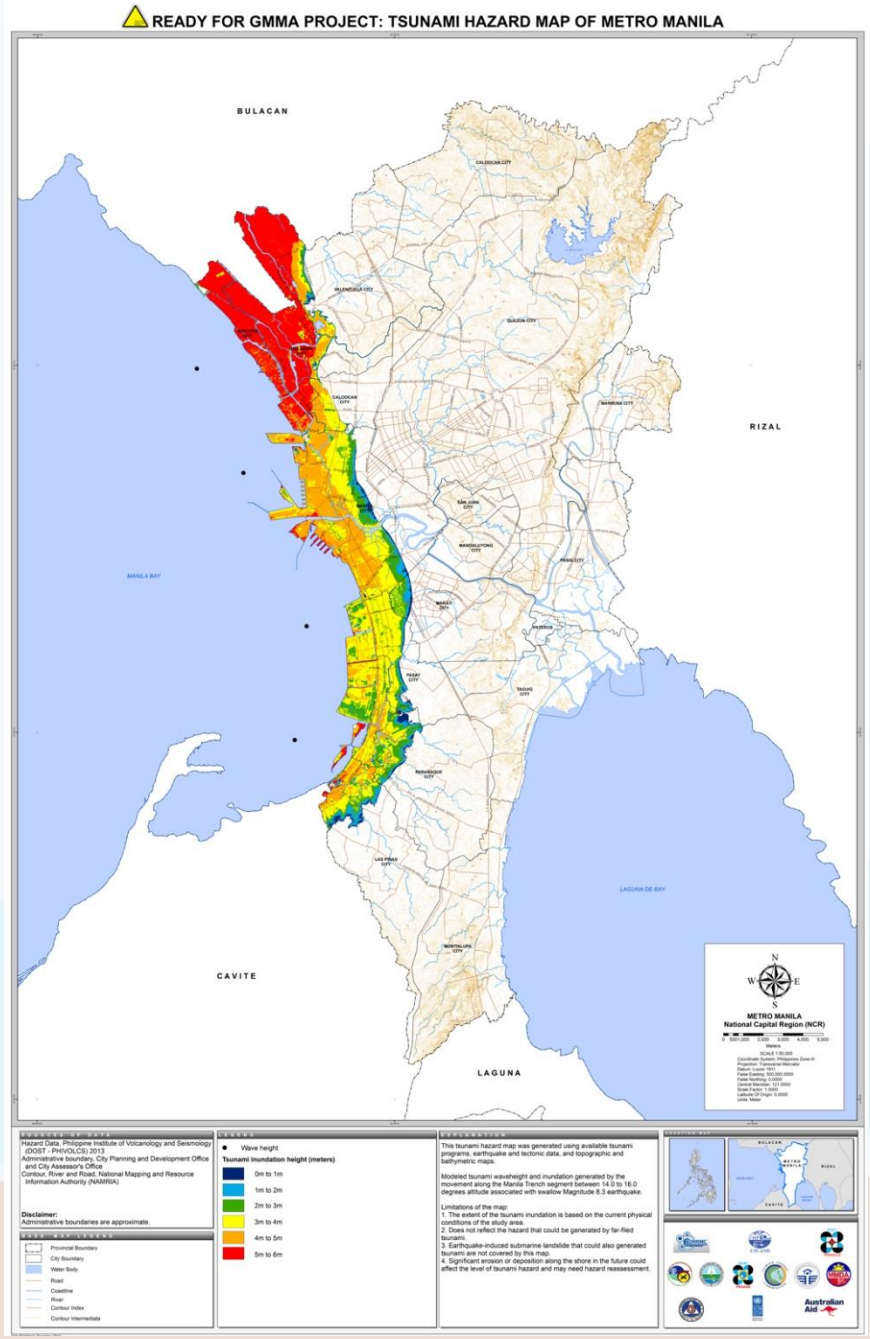
Estimated Tsunami Height in Manila Bay:

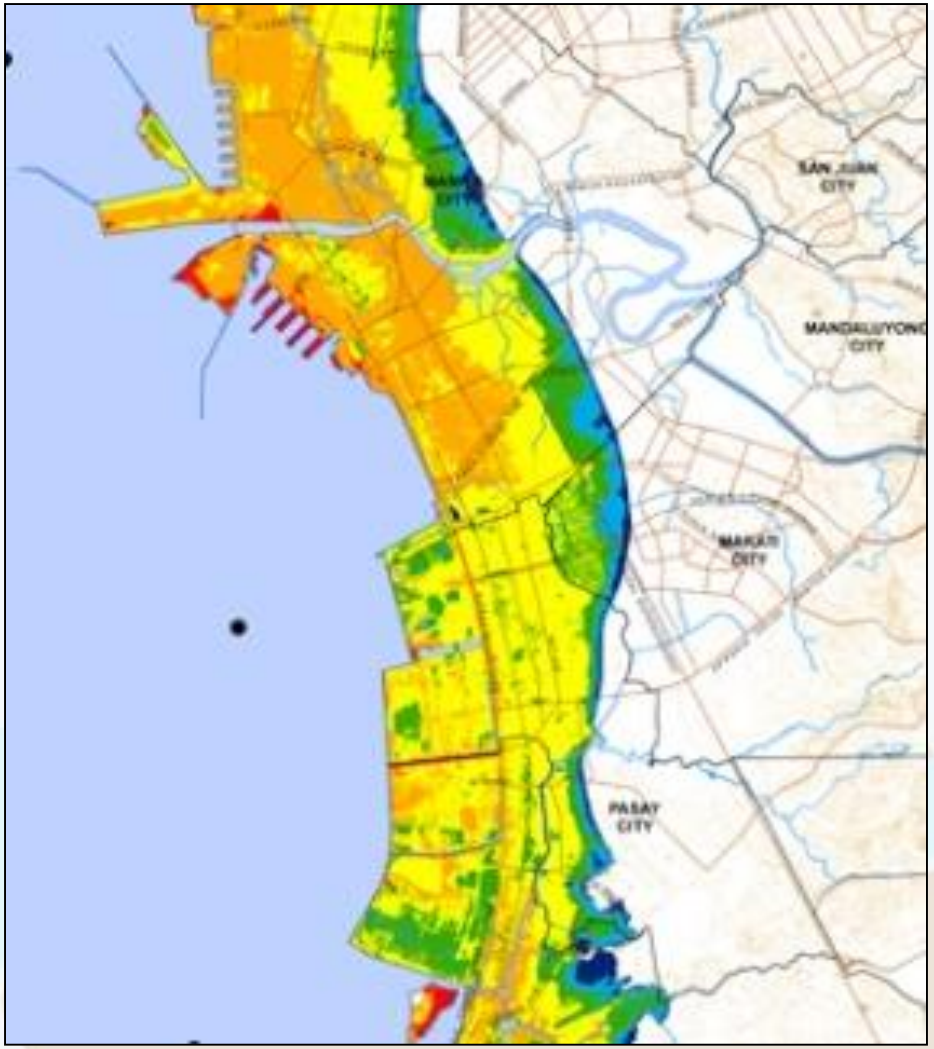
- 3.5 meters (mean sea level)
- 5.5 meters (+ 2m from tide)
- 2.7 km inundation

Arrival Time:

- ~ 1 hr

Tsunami Hazard





Fire Hazard

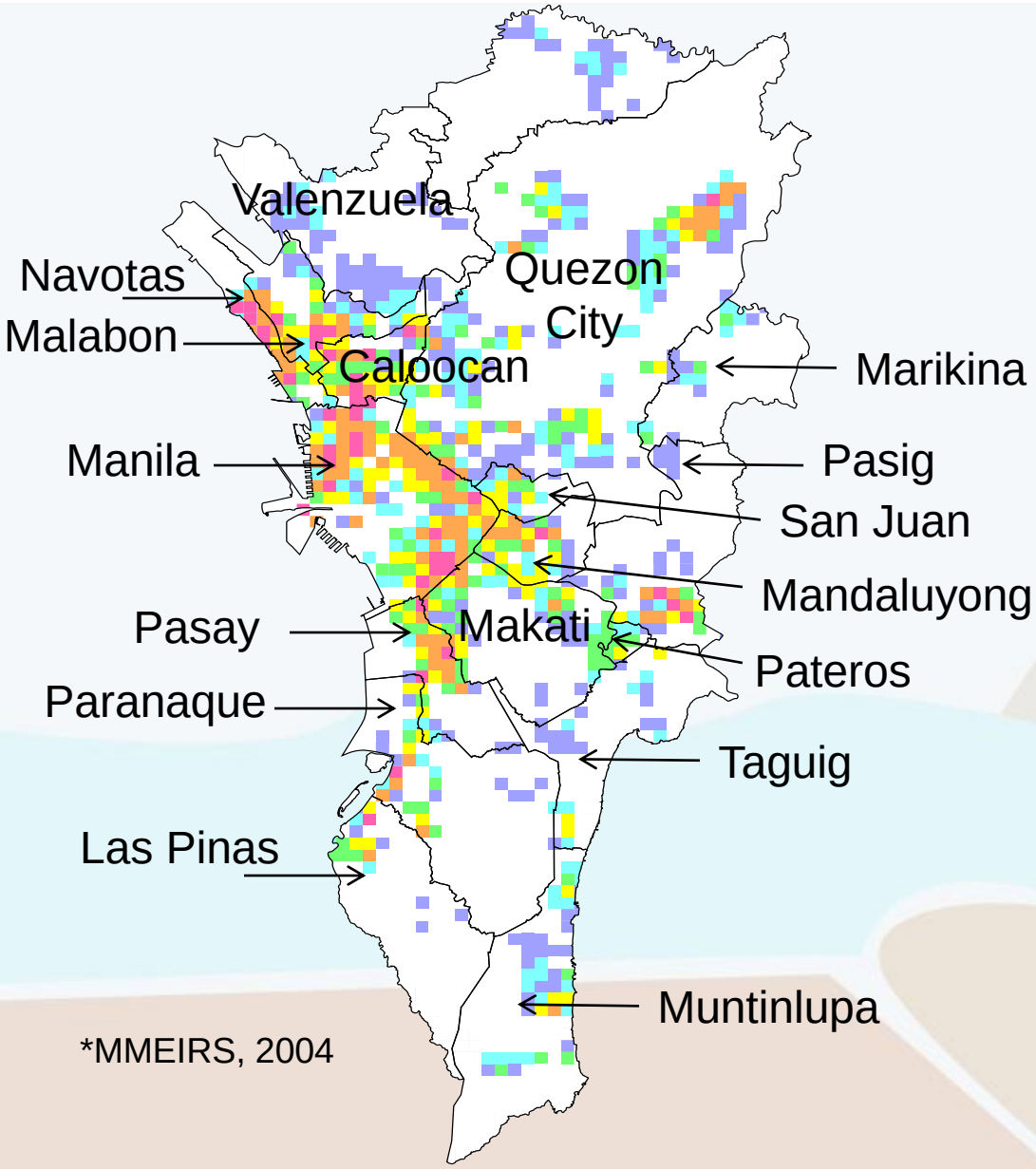
- Indirectly caused by earthquake.
- Fires can be sparked from power or gas lines or other flammable facilities that are damaged during earthquakes.

2011 M 9.0 Off the coast of Tohoku, Japan

DOST
PHIVOLCS

Fire after the Earthquake

M7.2 West Valley Fault Earthquake



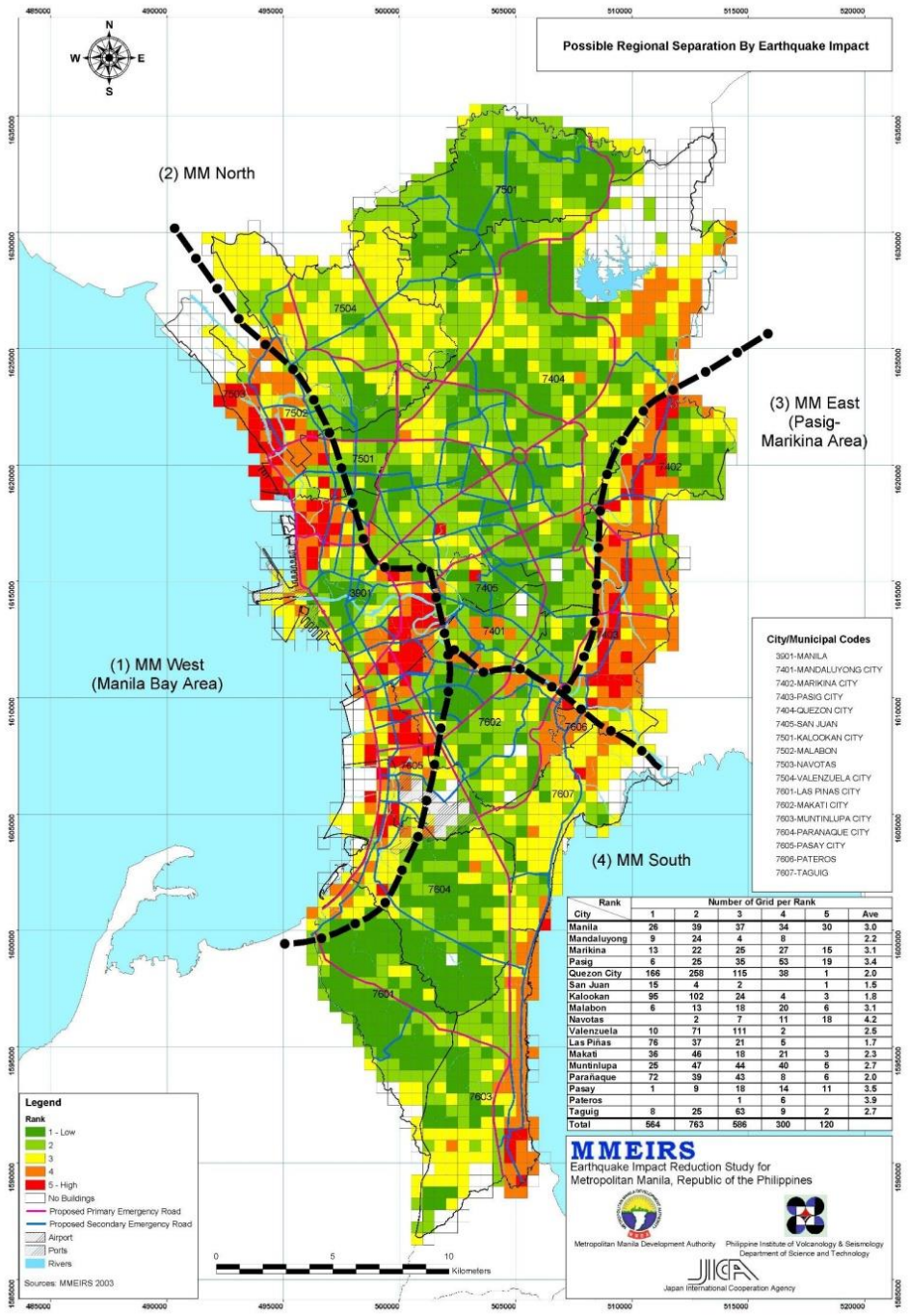
*MMEIRS, 2004

- 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)



Rank / City	Number of Grid per Rank 1	2	3	4	5	Ave
Manila	26	39	37	34	30	3.0
Mandaluyong	9	24	4	8		2.2
Marikina	13	22	25	27	15	3.1
Pasig	6	25	35	53	19	3.4
Quezon City	166	258	115	38	1	2.0
San Juan	15	4	2		1	1.5
Kalookan	95	102	24	4	3	1.8
Malabon	6	13	18	20	6	3.1
Navotas		2	7	11	18	4.2
Valenzuela	10	71	111	2		2.5
Las Piñas	76	37	21	6		1.7
Makati	36	46	18	21	3	2.3
Muntinlupa	25	47	44	40	5	2.7
Parañaque	72	39	43	8	6	2.0
Pasay	1	9	18	14	11	3.5
Pateros			1	6		3.9
Taguig	8	25	63	9	2	2.7
Total	564	763	586	300	120	

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)

What can be done about earthquake?

- **When** exactly a strong earthquake would occur **cannot be predicted at present**.
- **Where** earthquakes would be generated **can be determined.**
- Maximum Size (**magnitude**) of an earthquake that can be generated by a fault **can be estimated.**
- **Effect** of an earthquake **can be assessed and evaluated.**
- **Damaging effect** of an earthquake **can be prevented or minimized.**

DOST
PHIVOLCS

EARTHQUAKE PREPAREDENESS GUIDE

EARTHQUAKE PREPAREDNESS

- **Prior to the event**
  - Awareness, Education
  - Establishment of evacuation procedures, refuge sites, drills
  - Plan for efficient and effective response: standard operating procedures, contingency plans
  - Evaluation of site and building safety
  - Implementation of building code and proper land use **(safe location, safe construction)**

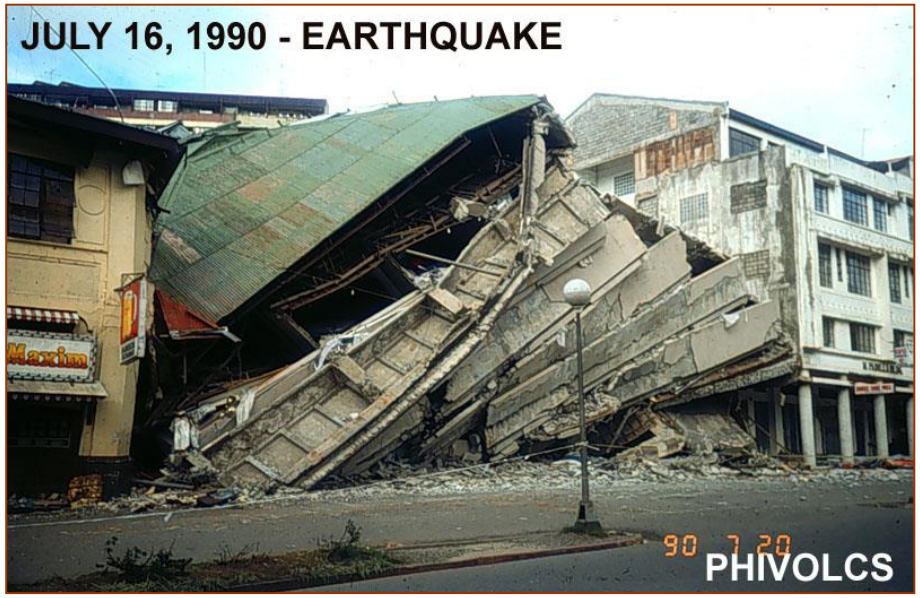
DOST
PHIVOLCS

Land Use and Building Codes

Location

Don’t build on top of an active fault and buffer zone of at least 5 meters on both sides of the fault trace

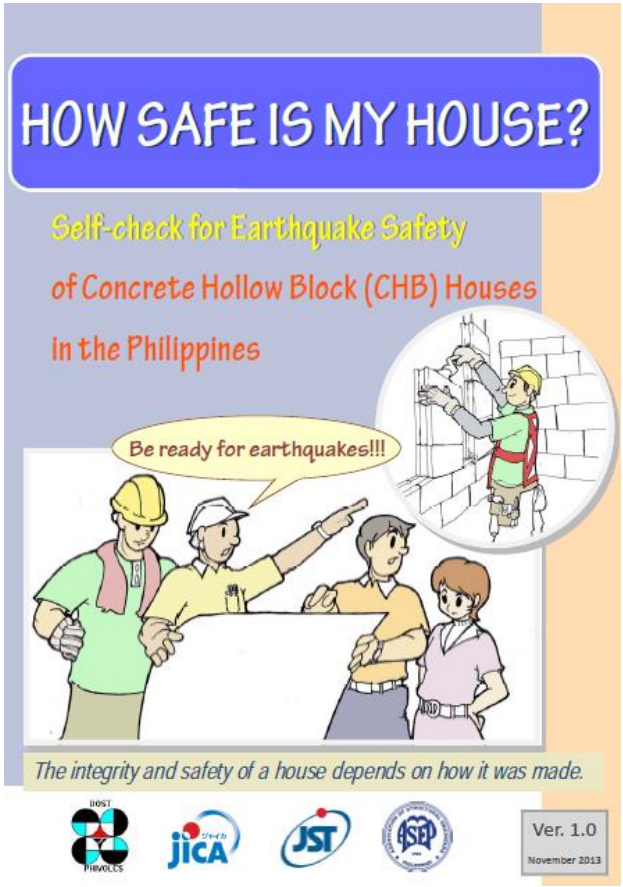
Design and Construction



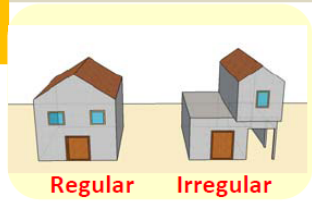
Follow the National Building Code

DOST
PHIVOLCS

House Safe is My House: Self-check for Earthquake Safety (12 pt questionnaire)



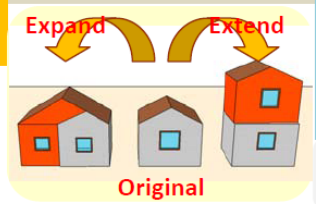
QUESTION 4 — **What is the shape of my house?**



Items		point
A: Regular (symmetrical, rectangular or box-type)	-	1
B: Irregular or complicated.	-	0
C: It is not clear or unknown.	-	0

This checks the shape of your house which influences behavior during strong ground shaking. .

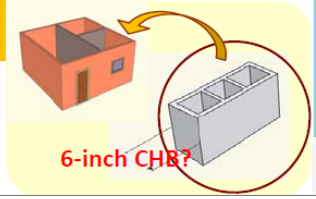
QUESTION 5 — **Has my house been extended or expanded?**



Items		point
A: NO or YES but supervised by a civil engineer/architect.	-	1
B: YES, but not supervised by a civil engineer/architect.	-	0
C: It is not clear or unknown.	-	0

This checks if additional construction was properly executed and correctly attached to the original structure.

QUESTION 6 — **Are the external walls of my house made of 6-inch (150mm) thick CHB?**



Items		point
A: YES, it is 6-inch CHB.	-	1
B: NO, it is thinner than 6-inch.	-	0
C: It is not clear or unknown.	-	0

This checks if the standard size of at least 6" thick CHB was used.

Score — **Please sum up the points of question 1 to 12.**

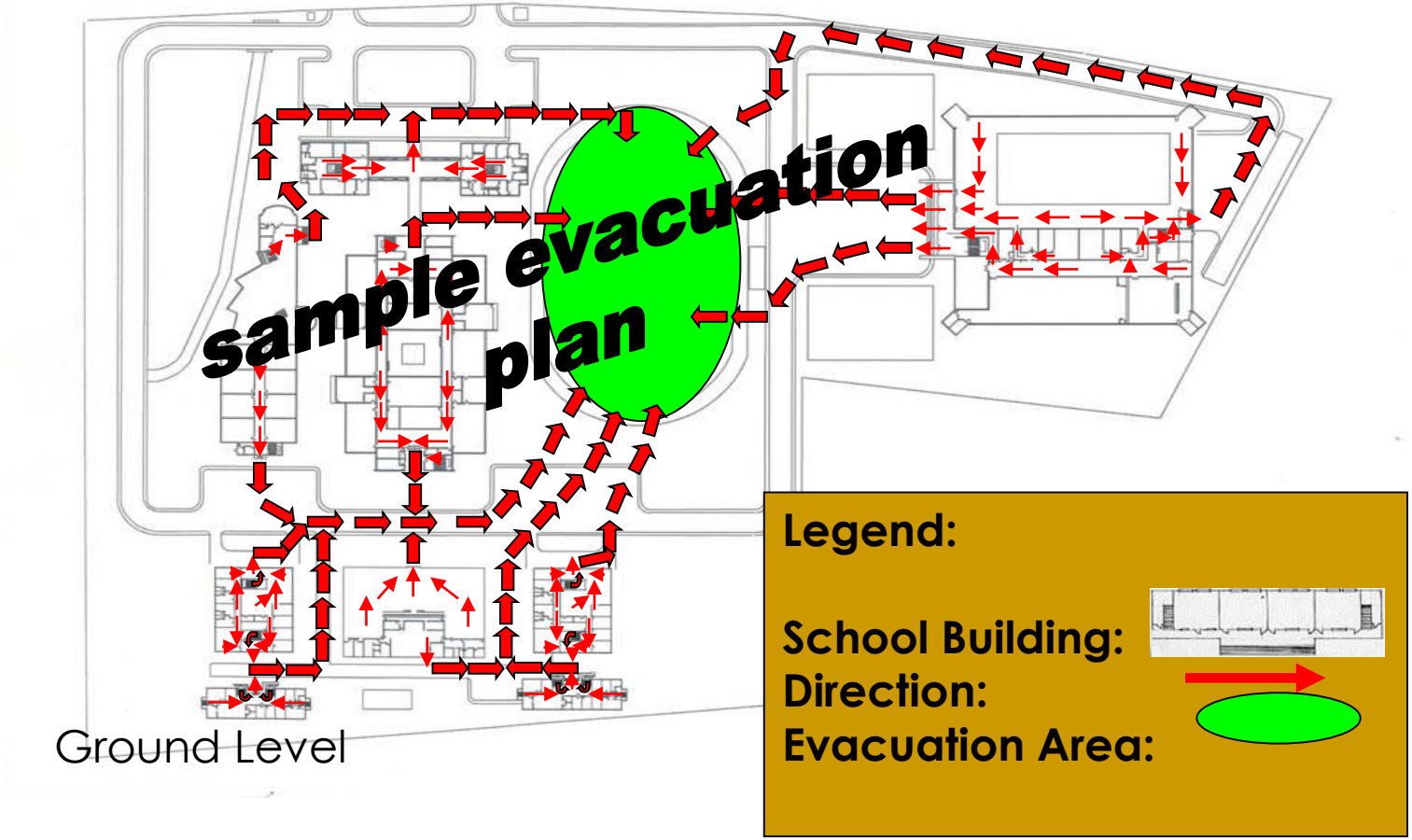
Total	Evaluation and Next steps
11 - 12 points	Though this seems safe for now. Please consult experts for confirmation.
8 - 10 points	This requires strengthening, please consult experts.
0 - 7 points	This is disturbing! Please consult experts soon.

DOST PHIVOLCS

What to do Before

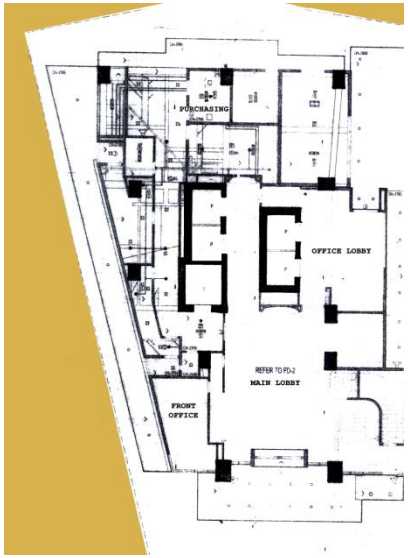
- **Prepare an evacuation and response plan and conduct drill**

- Determine alternative evacuation routes and evacuation area



DOST PHIVOLCS

What to do Before
FAMILY AWARENESS AND PREPAREDNESS



- **Determine roles** before, during and after a hazardous event
- **Know safe and dangerous spots** and what to do during an event
- **Know response procedures** during earthquakes, fire, first aid
- **Familiarize with evacuation plan** and the responses after the event
- **Prepare emergency bags/kits**

DOST
PHIVOLCS

Before an earthquake

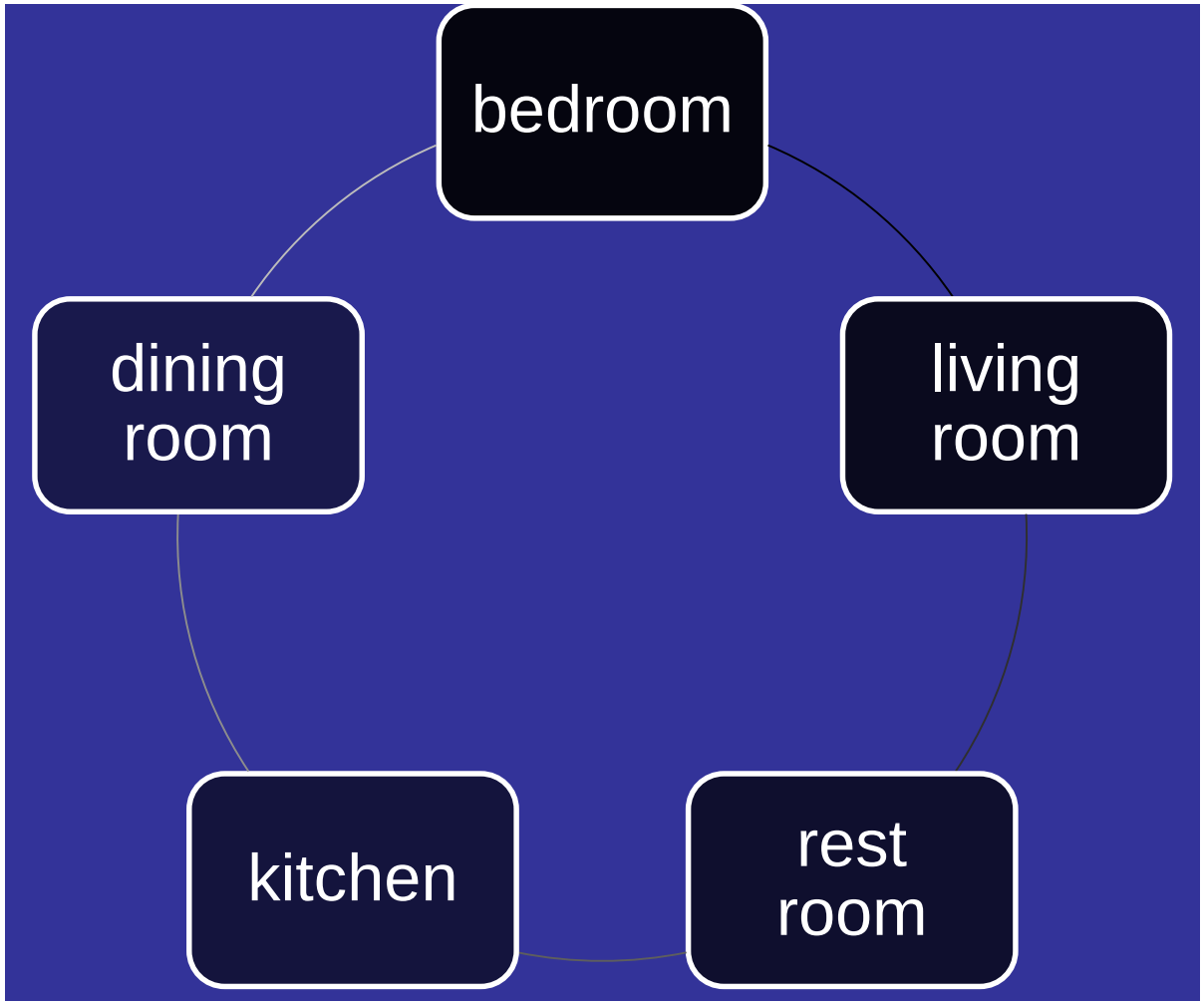
- Prepare an **emergency kit/earthquake survival kit**
  - First Aid Kit
  - Water Purification Tablets
  - AM/FM Radio
  - Water & High-energy Food
  - Tools & Ropes
  - Candles & Flashlights
  - Blankets
  - Tissue Paper & Waste Bags
  - Pencil and Paper
  - Whistle

PHIVOLCS

FAMILY PREPAREDNESS

Draw your risk: Imagine your home

1. DRAW 5 rectangles



DOST PHIVOLCS

2. DRAW where are the major part/furniture in each room

living room

bedroom

dining room

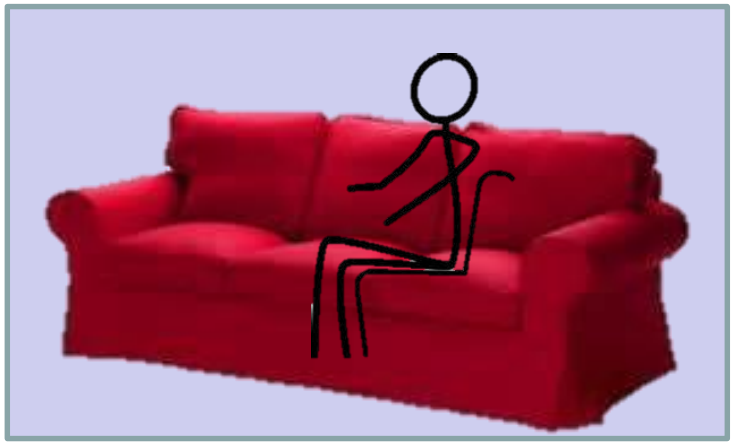
kitchen

restroom

DOST

PHIVOLCS

3. DRAW yourself where you usually stay in each room



DOST
PHIVOLCS

Activity 1: Draw your risk

4. **Identify potential hazard**: look around you, identify all unsecured objects that might fall during shaking (represent as symbols/shapes)

2.1 cabinets/shelves

2.2 refrigerator

2.3 hanging objects (frames, ceiling fan, chandeliers)

2.4 objects on open shelves and table tops (collectibles)

fixed

movable

DOST PHIVOLCS

Activity 2a: Create a family disaster preparedness plan

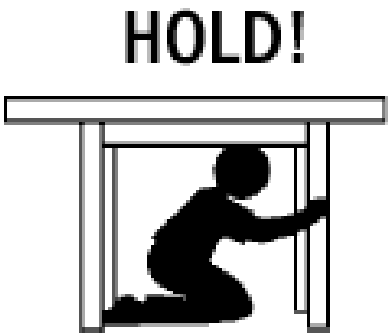
Plan **now** to be safe **during** an earthquake

1. Practice “Duck, Cover, and Hold”
2. Identify **safe spots** in every room (sturdy table)
3. Learn how to protect yourself from falling debris

DOST PHIVOLCS

During the earthquake

- Person closest to the door should open it, if possible
- Do the Drop (Duck), Cover and Hold Approach
  - Duck under a sturdy table and hold on to it.
  - If there is no sturdy table,
- Go to safe spot and protect your head and neck with your arms.



PHIVOLCS

Activity 2b: Create a family disaster preparedness plan

Plan **now** to respond **after** an earthquake

1. Identify safe emergency exits
2. Identify safe temporary refuge
3. Teach everyone in your household how to get rescuers attention if trapped (whistle or knocking)
4. Identify special needs (gender, age, differently-abled, health)
5. Know who in your neighborhood is trained in first-aid and medical practitioners
6. Know the locations of utility shutoffs and keep needed tools nearby (gas, water, electricity)

DOST
PHIVOLCS

Activity 2c: Create a family disaster preparedness

Plan **now** to communicate and recover **after** an earthquake

1. Locate a **safe place** outside your home for your family to meet after the shaking.
2. Identify "**someone**" whom every member of your family can contact after a disaster, he/she should be away from the area affected.
3. Provide all family members with a list of **important contact numbers.**
4. Identify a **place or a house** where you can stay if your house will be damaged.
5. Ask copy of your children's **school disaster preparedness plan.**

DOST PHIVOLCS

After the earthquake

Be prepared for aftershocks. Once the shaking stops, **take the fastest and safest way out of the building**.

- Get out in an orderly manner. Do not rush.
- Bring the emergency/survival kits
- Watch out for falling objects
- Follow the designated route
- Don’t use elevators, use stairs
- Assist persons who need help

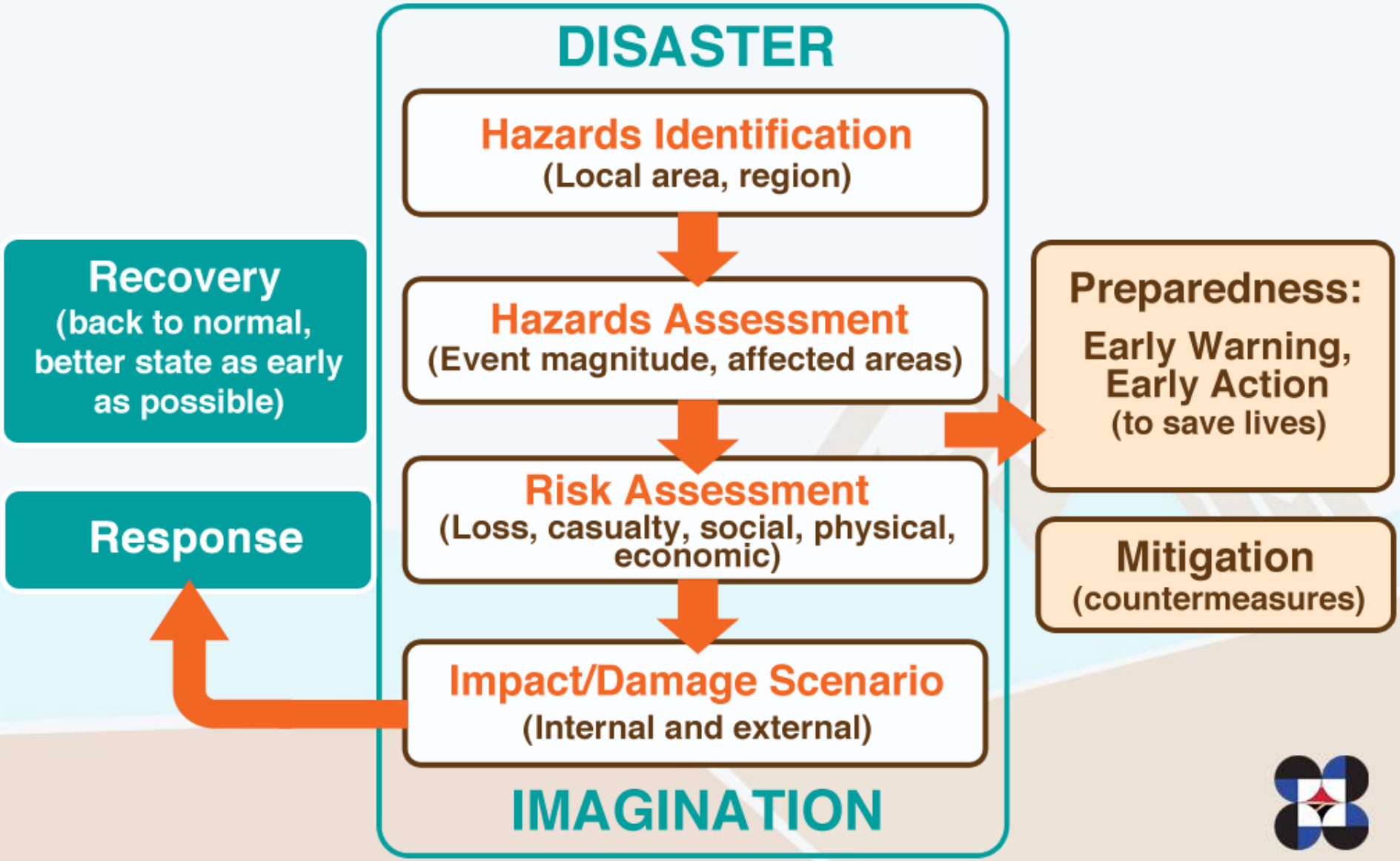
DOST
PHIVOLCS

After the earthquake

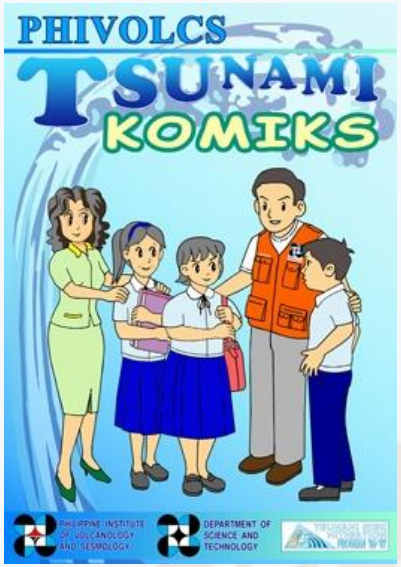
- **Conduct head count** at the evacuation area
- **Check** yourself and others for **injuries**
- Check water and electrical lines for damages
- Check for spills of chemical, toxic and flammable materials
- Check for fires and control if possible
- **Do not enter damaged buildings**
- **Leave a message or note** if you need to leave your place of residence
- **Do not use telephones** unless necessary
- **Keep updated** of instructions and information **from battery operated radios**

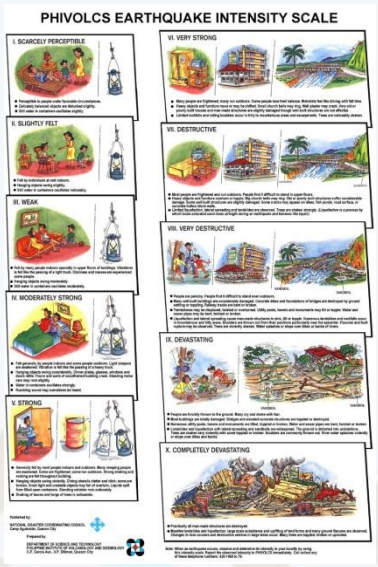
PHIVOLCS

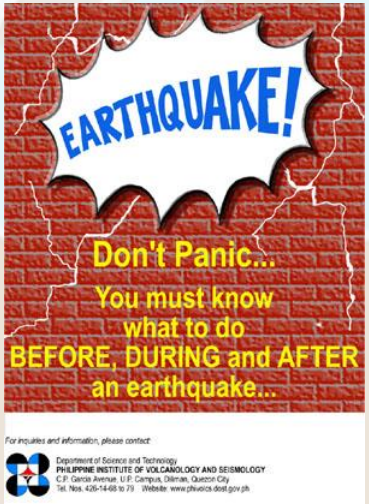
ACTIONS FOR DISASTER RISK MANAGEMENT



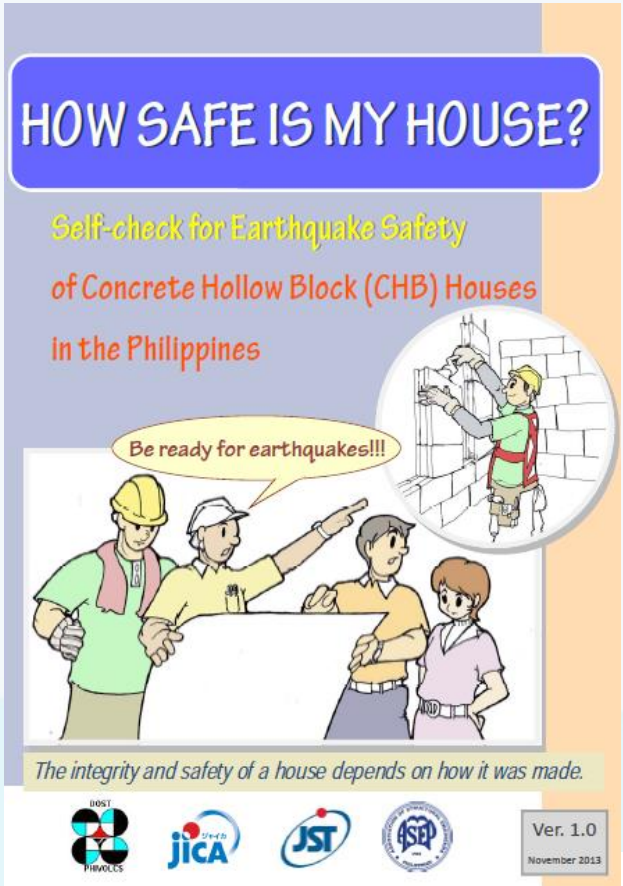
EARTHQUAKE AND TSUNAMI INFORMATION MATERIALS



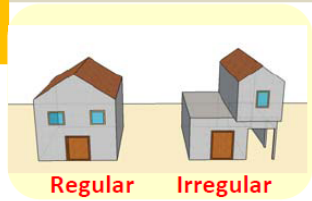




HOW SAFE IS MY HOUSE: SELF-CHECK FOR EARTHQUAKE SAFETY



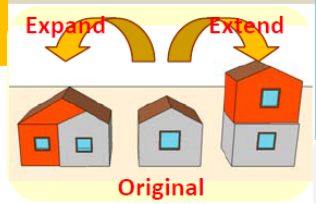
QUESTION 4 — What is the shape of my house?



Items		point
A: Regular (symmetrical, rectangular or box-type)	-	1
B: Irregular or complicated.	-	0
C: It is not clear or unknown.	-	0

This checks the shape of your house which influences behavior during strong ground shaking. .

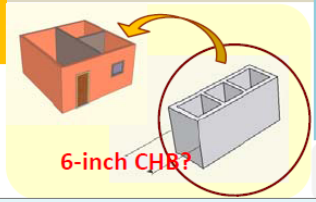
QUESTION 5 — Has my house been extended or expanded?



Items		point
A: NO or YES but supervised by a civil engineer/architect.	-	1
B: YES, but not supervised by a civil engineer/architect.	-	0
C: It is not clear or unknown.	-	0

This checks if additional construction was properly executed and correctly attached to the original structure.

QUESTION 6 — Are the external walls of my house made of 6-inch (150mm) thick CHB?



Items		point
A: YES, it is 6-inch CHB.	-	1
B: NO, it is thinner than 6-inch.	-	0
C: It is not clear or unknown.	-	0

This checks if the standard size of at least 6" thick CHB was used.

Score — Please sum up the points of question 1 to 12.

Total	Evaluation and Next steps
11 - 12 points	Though this seems safe for now. Please consult experts for confirmation.
8 - 10 points	This requires strengthening, please consult experts.
0 - 7 points	This is disturbing! Please consult experts soon.

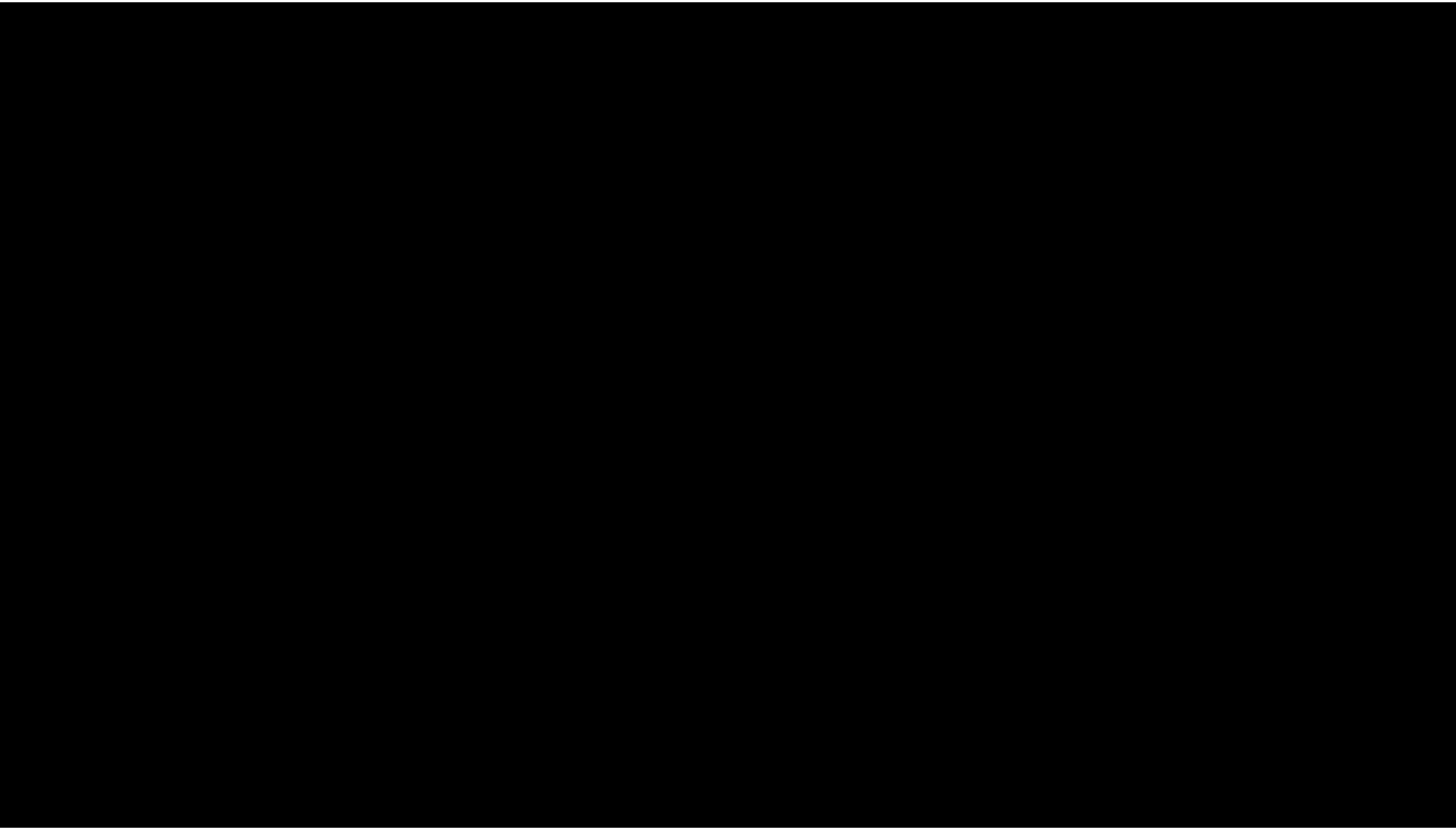
Ground rupture of the 10 February 2017 M6.7 Surigao del Norte Earthquake

DOST

PHIVOLCS

DOST

PHIVOLCS



DOST

PHIVOLCS

KEY MESSAGES

- The Philippines is prone to extreme natural events, such as strong earthquakes and tsunamis.
- A large earthquake from the West Valley Fault can significantly affect Metro Manila and vicinity. A large earthquake from the Manila Trench can generate a tsunami that can affect the coastal areas of the metropolis.
- **Be involved. Disaster preparedness is everyone's business. You can be a victim if you do not prepare.**

DOST

PHIVOLCS

www.phivolcs.dost.gov.ph

PHIVOLCS Building, CP Garcia Ave., UP Campus, Diliman, Quezon City

Tel: (02) 426 1468 to 79 Fax: (02) 929 8366

Follow us on:

twitter.com/phivolcs_dost

www.facebook.com/pages/Philippine-Institute-of-Volcanology-and-Seismology-PHIVOLCS-DOST

DOST

PHIVOLCS