

MAGNITUDE 7.2: EFFECTS TO LIFELINES (POWER)

6th E-Power Mo: Developing Energy
Resilient Philippines
June 26, 2018

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PHIVOLCS-DOST



Kobe, Japan, 1995

quake rocks Leyte, kills one, causes blackout

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yesterday,
The NGCP said it is still assessing the extent of the damage to its transmission facilities in the Visayas region.
Codilla, meanwhile, said authorities recorded a six-yard damage in the power plant, but he

Power outages cripple Leyte, nearby areas after 6.5 quake

Large parts of the Visayan region remained without power days after a 6.5-magnitude quake shook the Leyte and nearby provinces and killed two people, authorities said yesterday.
Power plant facilities in the central island of Leyte, which provide electricity for the island and neighboring regions, sustained damage when the quake struck on Thursday, the Department of Energy (DoE) statement said.
The geothermal plants, near the quake's epicenter, were damaged by both the tremors and resulting



earthquake).
Meanwhile, the EDC, in a press release yesterday, said their Leyte power plants were still shut down while assessment of the full extent of damage was ongoing.
The EDC president, who has been at the site since Friday, was with the Energy secretary when the latter inspected the facilities.
The press release said that "barring any unforeseen issues, EDC could have about 317 MW of power restored to Leyte within the next 10 days."
"Meanwhile, repair of the

A8

NEWS

No power for 1 week in quake-hit areas

By **Rommel W. Domingo**
@RonWDomingoINQ

Energy officials on Friday said that the power outage in the provinces of Bohol, Samar, Biliran and

left leaning by the quake, but workers were able to prevent its high-voltage lines from touching the ground.
She said the Ormoc-Tongonan line could still deliver elec-

Town Grocery, who said presence of mind and prayers kept her alive.
"I was not scared. All I could think about at that time was my family," she told the reporter

the second floor and a roof deck on the third floor.
When the quake struck at 4:06 p.m. on Thursday, most of the people were able to run outside moments before the

OUTAGES PERSIST IN QUAKE-HIT AREAS

By **Joel Zurbano**

LARGE parts of central Philippines and resulting landslides, the department said

Development Corp. (EDC), which accounts for close to 1,000 megawatts, had tripped to the tumbler.
The plants consisted of the 1,100-MW Upper Mahiao, 232.5-MW Malitbog, 180-MW Magdang and 51-MW Optimum plants. They were being about 460 megawatts when the quake EDC said in a statement.
Now, all of the plants are down and we are evaluating the damage," it said.
P112.5-MW Palinpinon 1 and 60-MW Palinpinon 2 are in Negros, operated by Green Core Geothermal. Also tripped.
Secretary Alfonso G. Codilla said the quake's epicenter was in the geothermal fields that include the 112.5-MW Tongonan plant.
The power situation in the affected provinces is changing because of the demand by the loss of the capacity of affected plants.
Secretary Cyn...

"We don't have power. We don't have water. Where will we turn to?" said Anabelle Magancia, 45, a resident of Ubujaan District.
Bohol Light advised the public to conserve batteries and water.
"Power restoration for Bohol may take long. Please take precautions to prevent fire, conserve water and remove plugs from outlets," it said.
Gomez said the earthquake triggered landslides in the barangays of Cabaon-an, Cabintan, Tongonan and Gaas.
A 19-year-old mother, Rhissa Rosales, was killed when she was hit by debris in Cabaon-an. Her 6-month-old baby survived.
At least 37 people were wounded and two school buildings in Barangays Lim-au and Rizal were damaged in Kananga.

her, plunging the place into darkness.
She could hear Omolon, whom she personally knew from a neighboring barangay.
"It was dark. There was no air. It was so hot," she said. "I knew she was near but couldn't see her because it was dark and there was debris between us."
Superales told Omolon to try to get her phone inside her bag near her cash register. Omolon got hold of it and Superales told her to call her brother, PO2 Rodol Superales, to ask for help.
Superales relayed instructions to rescuers on how to find them through Omolon until they finally dug a hole through the debris and pulled her and the others out of the rubble.
"It was God's will that I survived. Maybe he still has plans for me. Whatever his plans are, I still don't know," said Superales, the eldest of five siblings.

tively shallow depth, which often can cause greater surface damage. The US Geological Survey measured it at 6.5 kilometers deep while the Philippine Institute of Volcanology and Seismology said it was 2 kilometers and caused by movement of the Philippine Fault.
"The center of the earthquake was in mountainous villages so we will only get a clearer picture of the impact once we reach these areas," said Minna Marasigan, spokesperson for the National Disaster Risk Reduction and Management Council.
The quake struck in a region that was devastated in 2013 by Super typhoon "Yolanda" (international name: Haiyan) which left more than 7,300 people dead or missing, leveled entire villages and displaced more than 5 million villagers.
The Philippines sits on the Pacific "Ring of Fire," where earthquakes and volcanic eruptions are common. A 7.7-magnitude quake killed nearly 2,000

ing two deaths and 72 injuries.
Much of Leyte and the surrounding islands of Samar and Bohol were without power on Saturday as repairs were still being conducted, energy undersecretary Wimpy Fuentes said.
"In three to 10 days, we will see a tremendous improvement in ensuring that there will be basic electrical service available," he said on ABS-CBN television.
Vegetable seller Cheryl Anne Acidera, 25, in Tacloban City, recalled running out of her school in terror when the quake struck.
"We all ran out to the plaza so nothing would fall on us," she told AFP, add-

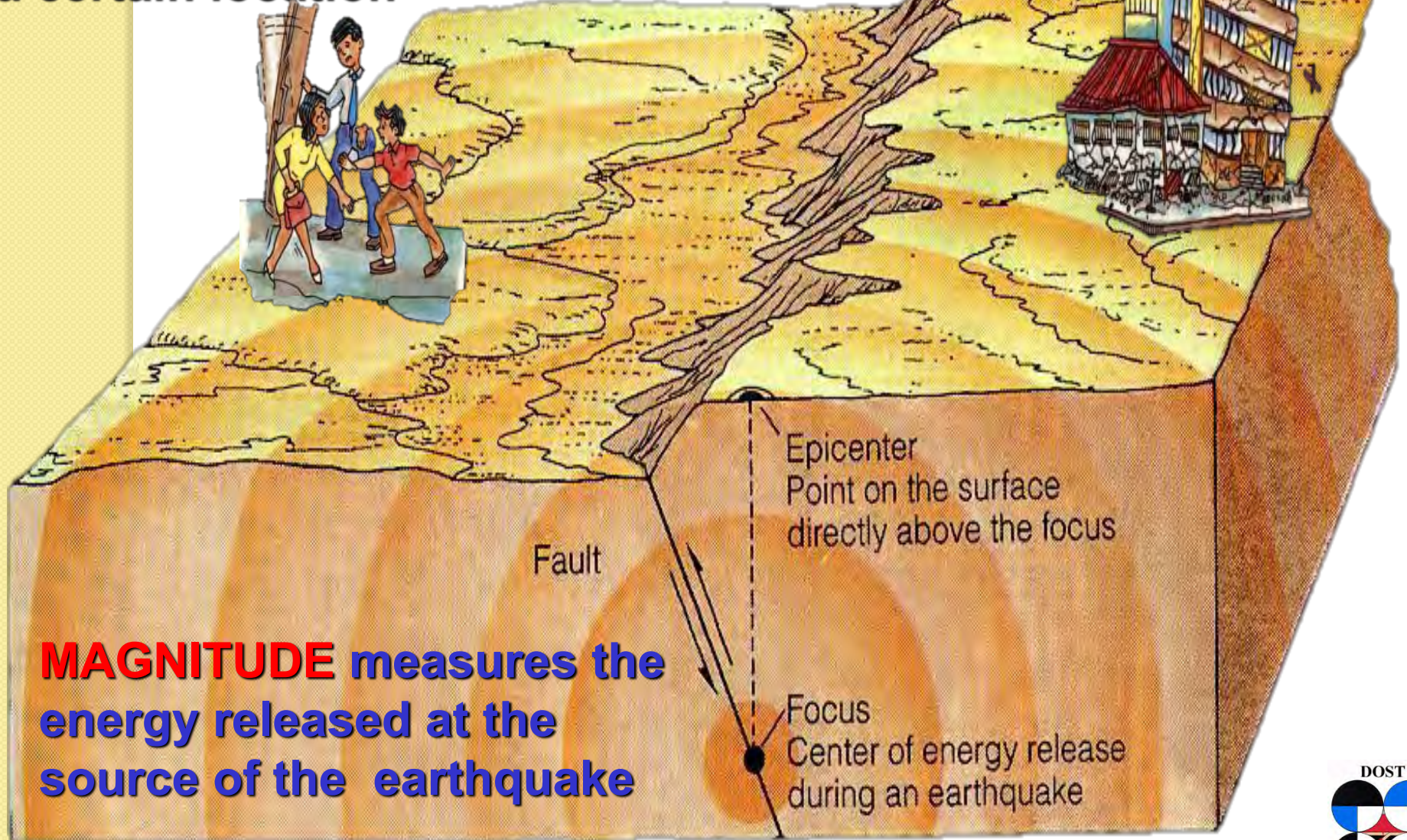
Still no power in parts of Leyte, Samar, Bohol

LARGE parts of the central Philippines remained without power days after a 6.5-magnitude quake shook the region and killed two people, authorities said yesterday.

Power plant facilities in the central island of Leyte, which provide electricity for the island and neighboring regions, sustained damage when the quake struck on Thursday, an energy department statement said.
The geothermal plants, near the quake's epicenter, were damaged by both the tremors and resulting landslides, the department said.
Leyte, home to some 1.75 million people, bore the brunt of the quake, record-

ing that some of her companions fainted.
The Philippines lies on the so-called Ring of Fire, a vast Pacific Ocean region where many earthquakes and volcanic eruptions occur.
In February, a 6.5-magnitude quake killed eight people and left more than 250 injured outside the southern city of Surigao.
The following month a 5.9-magnitude tremor killed one person.
Before the Surigao disasters, the last fatal earthquake to hit the Southeast Asian nation was a 7.1-magnitude quake that left more than 220 people dead and destroyed historic churches in the central islands in October 2013. AFP

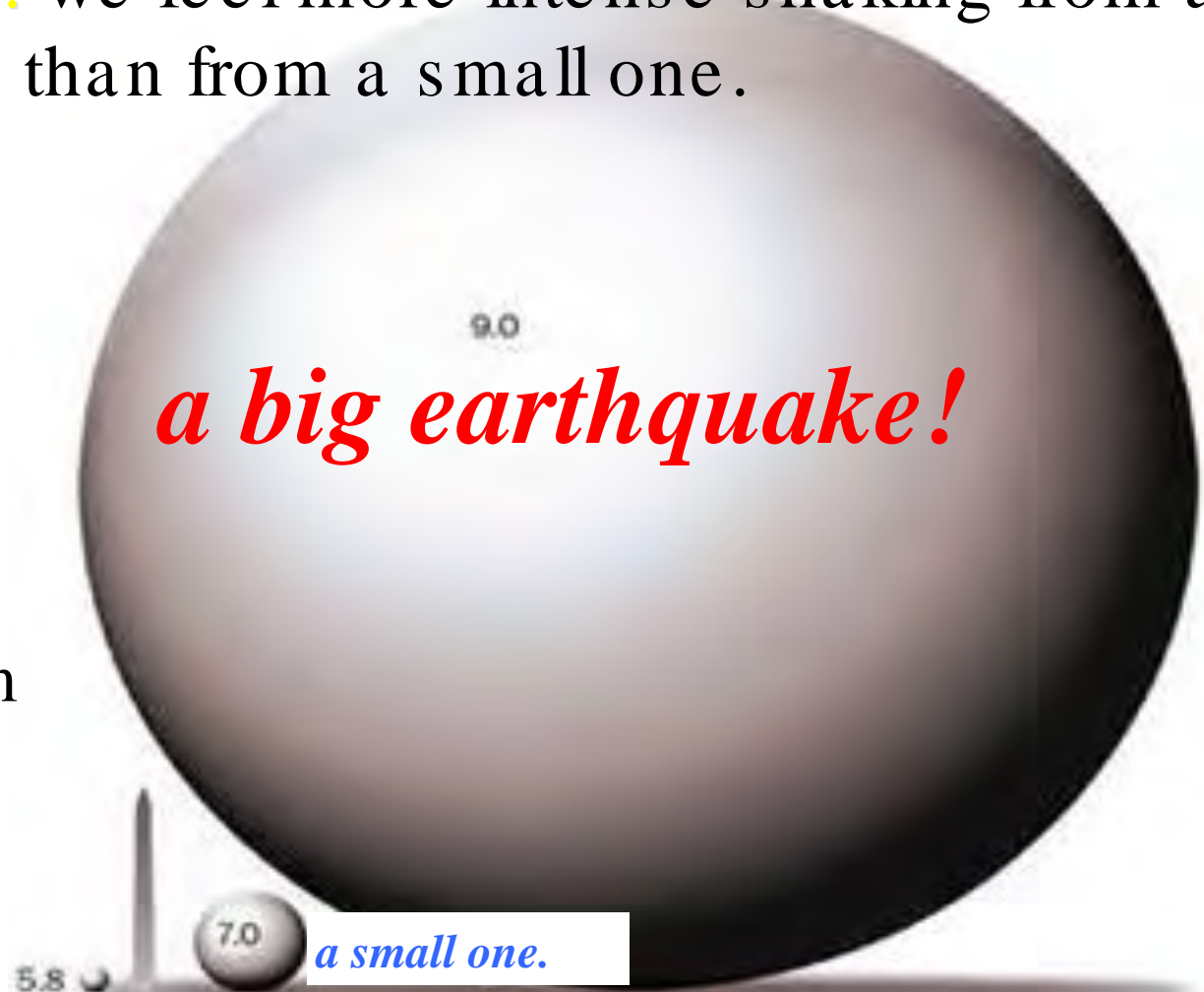
INTENSITY measures the strength of shaking produced by the earthquake at a certain location



MAGNITUDE measures the energy released at the source of the earthquake

Factors that primarily determine what we feel in an earthquake

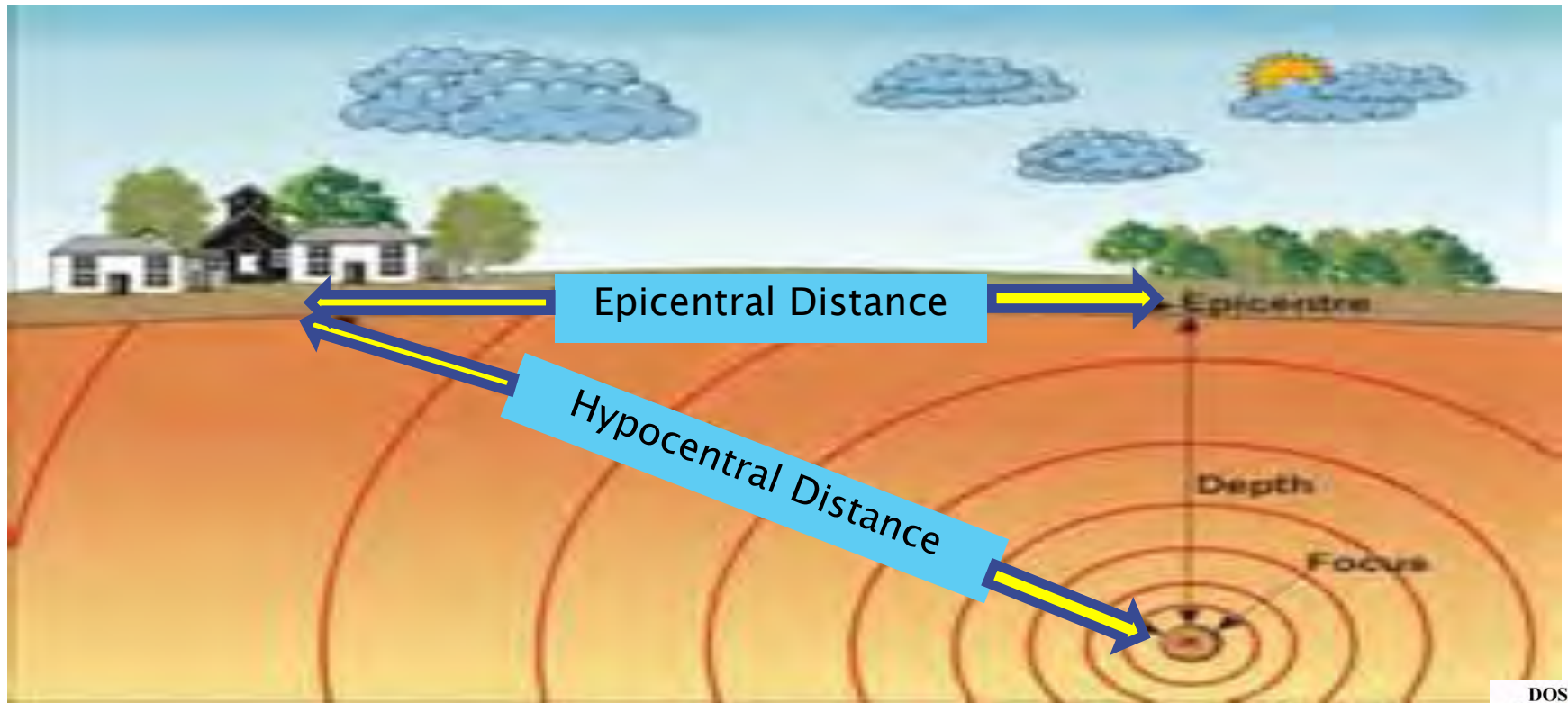
Magnitude: we feel more intense shaking from a big earthquake than from a small one.



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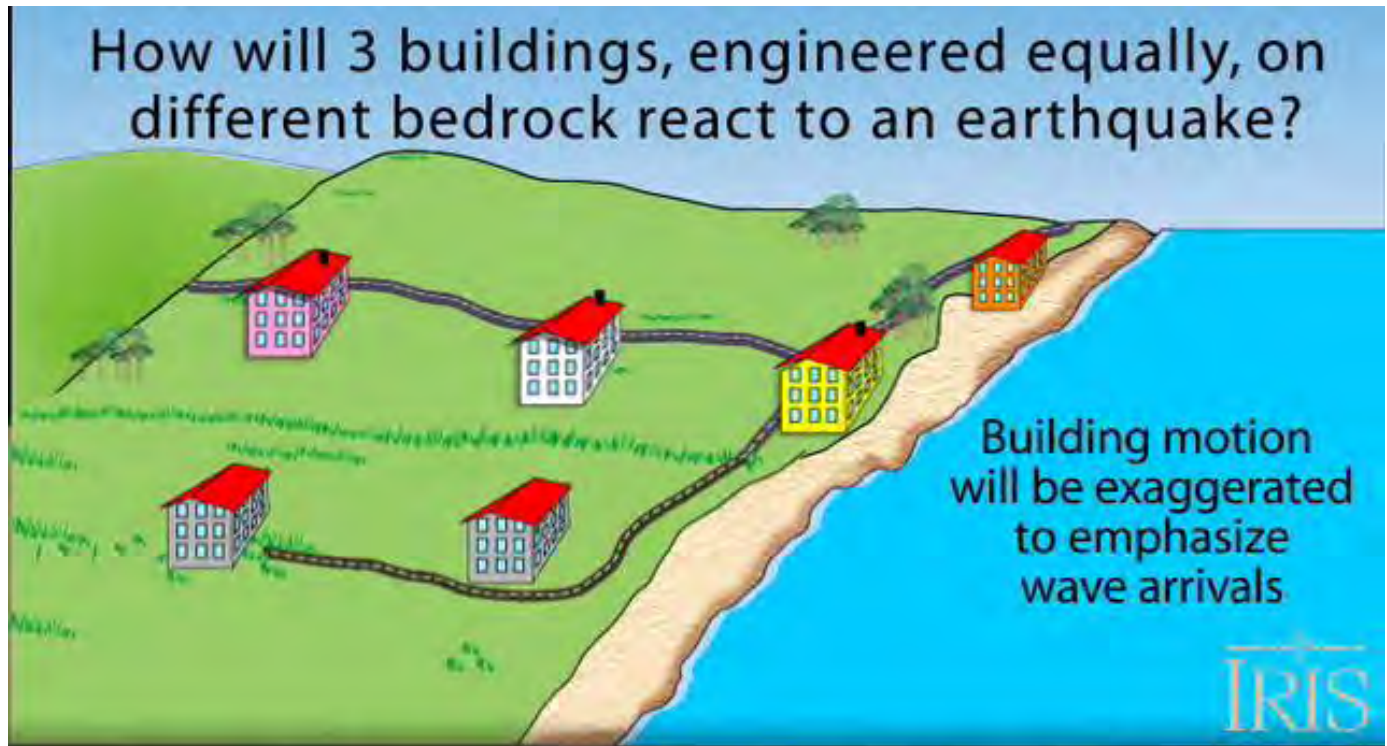
Factors that primarily determine what we feel in an earthquake

Distance from the fault: earthquake waves die off as they travel through the earth so the shaking becomes less intense farther from the fault.



Factors that primarily determine what we feel in an earthquake

Local Soil Conditions: A soft, loose soil will shake more intensely than hard rock at the same distance from the same earthquake.




Two variables affect damage during earthquake:

- 1) Intensity of shaking (*felt motion, not magnitude*)
- 2) engineering

PHIVOLCS Earthquake Intensity Scale

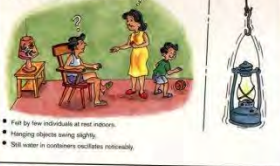
PHIVOLCS EARTHQUAKE INTENSITY SCALE

I. SCARCELY PERCEPTIBLE




- Perceptible to people only under favorable circumstances.
- Delicately balanced objects are disturbed slightly.
- Still water in containers oscillates slightly.

II. SLIGHTLY FELT




- Felt by few individuals at rest indoors.
- Hanging objects swing slightly.
- Still water in containers oscillates noticeably.

III. WEAK




- Felt by many people indoors especially in upper floors of buildings. Vibration is felt like the passing of a heavy truck.
- Dishes and mirrors are experienced by some people.
- Hanging objects swing noticeably.
- Still water in containers oscillates moderately.

IV. MODERATELY STRONG



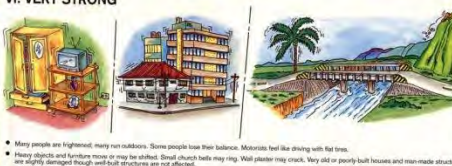
- Felt generally by people indoors and some people outdoors. Light objects are awakened.
- Vibration is felt like the passing of a heavy truck.
- Hanging objects swing considerably. Dinner plates, glasses, windows and doors rattle. Floors and walls of weak framed buildings crack. Standing water can be seen to slosh.
- Water in containers oscillates strongly.
- Rumbling sound may sometimes be heard.

V. STRONG




- Generally felt by most people indoors and outdoors. Many sleeping people are awakened. Some are frightened, some run outdoors. Strong shaking and rattling are felt throughout building.
- Hanging objects swing violently. Dining utensils rattle and clink, some are broken. Small, light windowed objects may fall or overturn. Liquids spill from their open containers. Steady shaking of doors and hinges of trees is noticeable.

VI. VERY STRONG




- Many people are frightened, many run outdoors. Some people lose their balance. Motorists feel like driving with fat tires.
- Many objects and furniture move or may be tilted. Small church bells may ring. Wet plaster may crack. Very old or poorly built houses and non-made structures are slightly damaged though well-built structures are not affected.
- Limited rockfall and falling buildings occur in hilly to mountainous areas and encampments. Trees are noticeably shaken.

VII. DESTRUCTIVE




- Most people are frightened and run outdoors. People find it difficult to stand in upper floors.
- Many objects and furniture overturn or topple. Old or poorly built structures suffer considerable damage. Some well-built structures are slightly damaged. Some cracks may appear on walls, bath pans, food service, or concrete hollow block walls.
- Limited topographic lateral spreading and landslides occur in mountainous and hilly areas.

VIII. VERY DESTRUCTIVE




- People are terrified. People find it difficult to stand on outdoors.
- Many well-built buildings are considerably damaged. Concrete slabs and foundations of bridges are damaged by ground settling in slipping. Railway tracks are bent or broken.
- Sandblows may be displaced, heaved or overturned. Utility poles, towers and masts may be bent, twisted or broken.
- Liquefaction and lateral spreading cause non-made structures to sink, tilt or topple. Numerous landslides and mudflows occur in mountainous and hilly areas. Buildings are thrown out from their positions particularly near the epicenter. Persons and fuel-carrying may be observed. Trees are violently shaken. Water splashes or spouts from dikes or banks of rivers.

IX. DEVASTATING



- People are hurled to the ground. Many cry and shriek with fear.
- Most buildings are totally damaged. Bridges and elevated concrete structures are toppled or destroyed.
- Numerous utility poles, towers and masts are tilted, toppled or broken. Water and sewer pipes are bent, twisted or broken.
- Landslides and liquefaction with lateral spreading and mudflows are widespread. The ground is illustrated into considerable. Trees are shaken very violently with some toppled or broken. Dikes are commonly thrown out. Rain water splashes violently or spouts from dikes and banks.

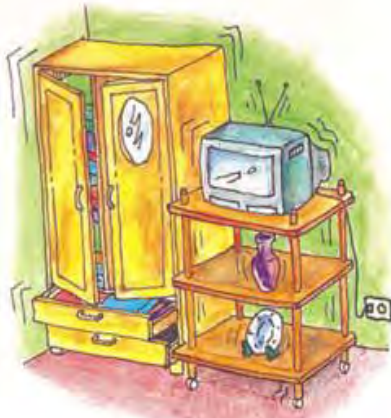
X. COMPLETELY DEVASTATING



- Practically all non-made structures are destroyed.
- Massive landslides and liquefaction, open slope subsidence and gapping of land forms and many ground fissures are observed. Changes in river courses and destructive tsunamis in large lakes occur. Many trees are toppled, broken or uprooted.

- 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

VI. Very Strong



- * Many people are frightened; many run outdoors. Some people lose their balance. Motorists feel like driving with flat tires.
- * Heavy objects and furniture move or may be shifted. Small church bells may ring. Wall plaster may crack. Very old or poorly built houses and human-made structures are slightly damaged though well-built structures are not affected.
- * Limited rock falls and rolling boulders occur in hilly to mountainous areas and escarpments. Trees are noticeably shaken.

VII. Destructive



- * Most people are frightened and run outdoors. People find it difficult to stand in upper floors.
- * Heavy objects and furniture overturn or topple. Big church bells may ring. Old or poorly built structures suffer considerable damage. Some cracks may appear on dikes, fish ponds, road surfaces, or concrete hollow block walls.
- * Limited liquefaction, lateral spreading and landslides are observed. Trees are shaken strongly. (Liquefaction is a process by which loose saturated sand loses strength during an earthquake, and behaves like liquid.)

VIII. Very Destructive



- * People are panicky. People find it difficult to stand even outdoors.
- * Many well-built buildings are considerably damaged. Concrete dikes and foundations of bridges are destroyed by ground settling or toppling. Railway tracks are bent or broken.
- * Tombstones may be displaced, twisted or overturned. **Utility posts, towers and monuments may tilt or topple. Water and sewer pipes may be bent, twisted or broken.**
- * Liquefaction and lateral spreading cause man-made structures to sink, tilt or topple. Numerous landslides and rock falls occur in mountainous and hilly areas. Boulders are thrown out from their positions particularly near the epicenter. Fissures and fault rupture may be observed. Trees are violently shaken. Water splashes or slops over dikes or banks of rivers.

IX. Devastating



- * People are forcibly thrown to the ground. Many cry and shake with fear.
- * Most buildings are totally damaged. Bridges and elevated concrete structures are toppled or destroyed.
- * Numerous utility posts, towers and monuments are tilted, toppled or broken. Water and sewer pipes are bent, twisted or broken.
- * Landslides and liquefaction with lateral spreading and sand boils are widespread. The ground is distorted into undulations. Trees are shaken very violently with some toppled or broken. Boulders are commonly thrown out. River water splashes violently or slops over dikes and banks.

People

	I	II	III	IV	V	VI	VII	VIII	IX	X
Perceptible only under favorable circumstances	Felt by few at rest indoors	Felt by many indoors specially in upper floors.	Felt generally by people indoors and some people outdoors.	Generally felt by most people indoors and outdoors. Some run outdoors.	Many run outdoors. Some lose balance	Most run outdoors. People find it difficult to stand in upper floors	People find it difficult to stand even outdoors	People find it difficult to stand even outdoors	People are forcibly thrown to the ground.	
		Dizziness and nausea are experienced by some.	Light sleepers are awakened.	Many sleeping people awakened. Some are frightened	Many people are frightened;	Most are frightened	People are panicky	Many cry and shake with fear.		
		Vibration is felt like the passing of a light truck.	Vibration is felt like the passing of a heavy truck.	Strong shaking and rocking are felt throughout the building.	Motorists feel like driving with flat tires.					

**WHAT IS THE “BIG ONE” IN
METRO MANILA?**

**MAGNITUDE 7.2
PEIS VIII**

Metro Manila and vicinity were affected by several major earthquakes in the past



Ruby Tower (Manila)

- ◆ M7.3 Casiguran, Aurora Earthquake
- ◆ 02 August 1968
- ◆ Ruby Tower in Sta. Cruz Manila collapsed
- ◆ 268 killed, 260 injured



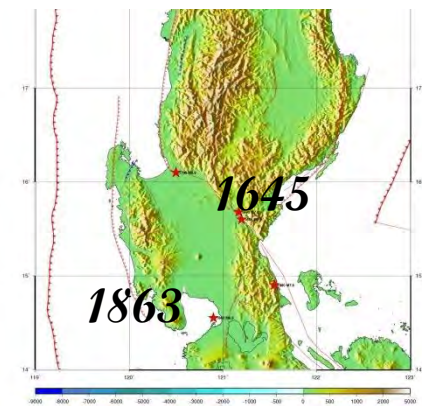
Some Historical Churches in the Philippines with earthquake accounts



“partially destroyed by earthquake, 1600”

“destroyed by the earthquake of 1645”

“destroyed by the earthquake of 3 June 1863”



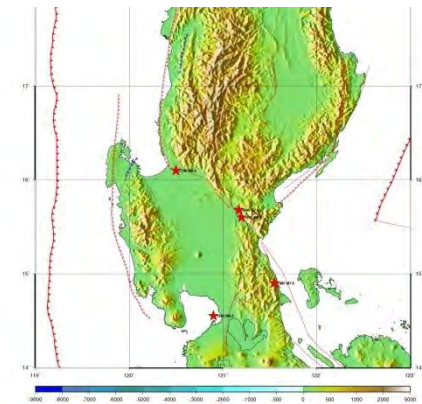
Some Historical Churches in the Philippines with earthquake accounts



CHURCH AND MONASTERY OF GUADALUPE
THE FOUNDATIONS OF THIS CHURCH AND MONASTERY OF THE AUGUSTINIAN ORDER WERE LAID IN 1601 AND CONSTRUCTION WORK WAS FINISHED IN 1629. NUESTRA SEÑORA DE GUADALUPE WAS CHOSEN TITULAR PATRONESS IN 1603. AFTER THE CHINESE UPRISING OF 1639 THIS SANCTUARY SERVED AS A SEAT OF DEVOTION FOR THE CHINESE. THE BUILDINGS WITHSTOOD THE EARTHQUAKES OF 1645, 1658, 1754 AND 1863; THE MASONRY ROOF OF THE CHURCH COLLAPSED IN THE EARTHQUAKES OF 1880 AND THE STRUCTURE WAS REBUILT IN 1882 BY REV. JOSE CORUJEDO, O.S.A. SITE OF AN ORPHAN ASYLUM AND TRADE SCHOOL ADMINISTERED BY THE AUGUSTINIAN ORDER FOR THE BENEFIT OF THE CHILDREN OF THE VICTIMS OF THE CHOLERA OF 1882. BOTH CHURCH AND MONASTERY WERE GUTTED BY FIRE IN FEBRUARY 1899 DURING THE EARLY SKIRMISHES.

“withstood the earthquakes of 1645, 1658, 1754, and 1863”

“the masonry roof of the Church collapsed in the earthquakes of 1880”



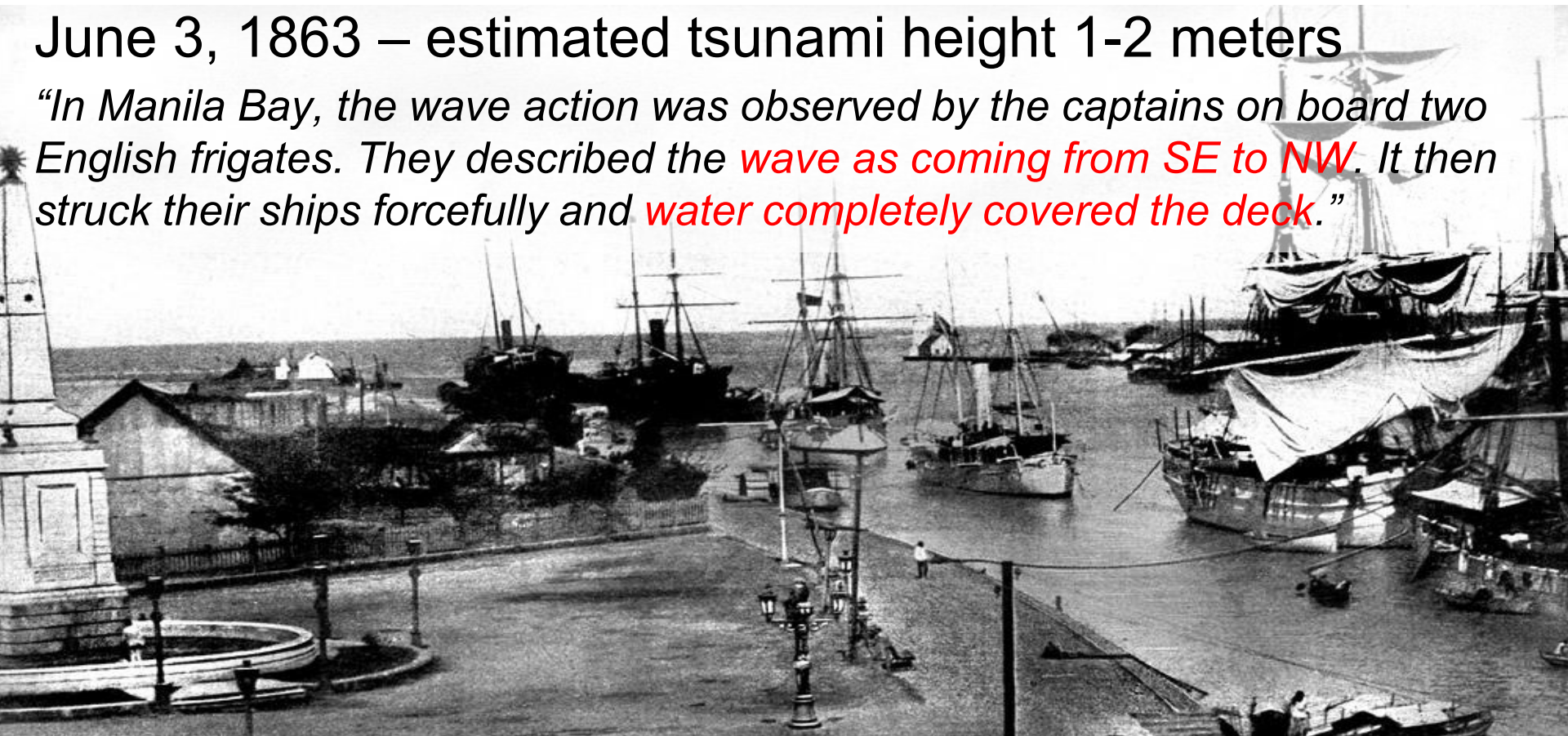
HISTORICAL TSUNAMIS

November 9, 1828 – estimated tsunami height 1 meter

*“At the port (of Manila), people on board ship felt the shocks strongly as if they struck a hard object. The **river level rose quickly after the quake** to rainy day water level and **inundated lowlands** near its banks.”*

June 3, 1863 – estimated tsunami height 1-2 meters

*“In Manila Bay, the wave action was observed by the captains on board two English frigates. They described the **wave as coming from SE to NW**. It then struck their ships forcefully and **water completely covered the deck**.”*



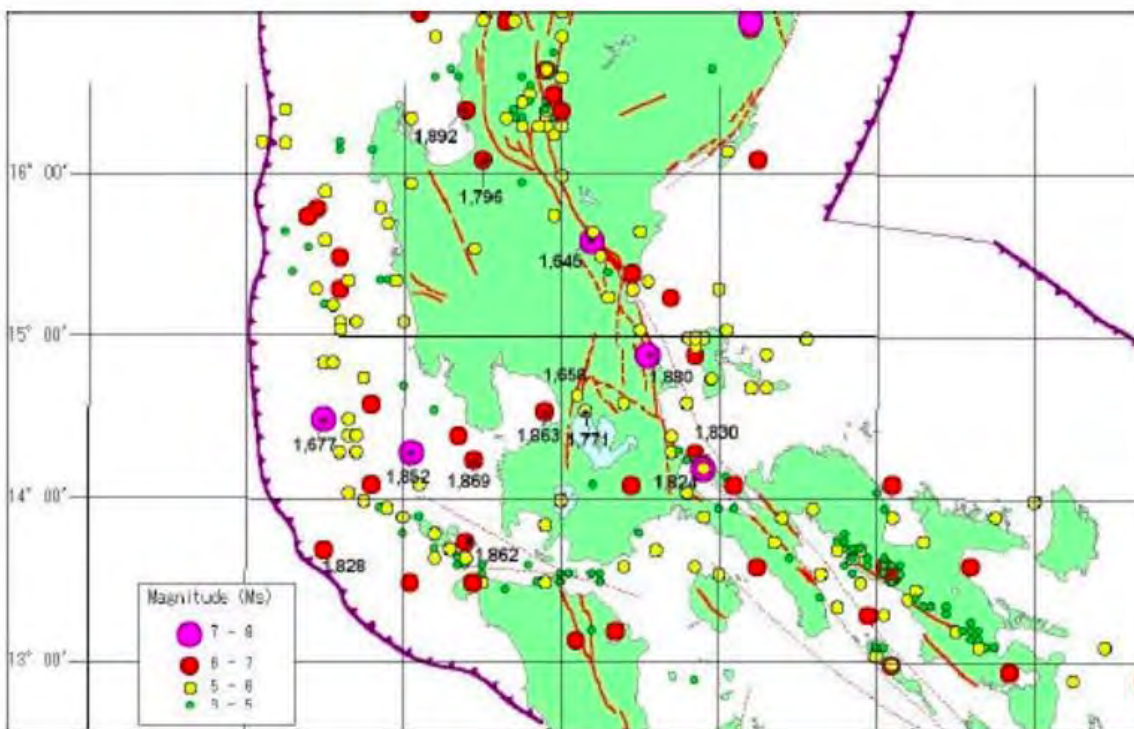


Figure 2.1.4 Distribution of Historical Earthquakes from 1608 to 1895

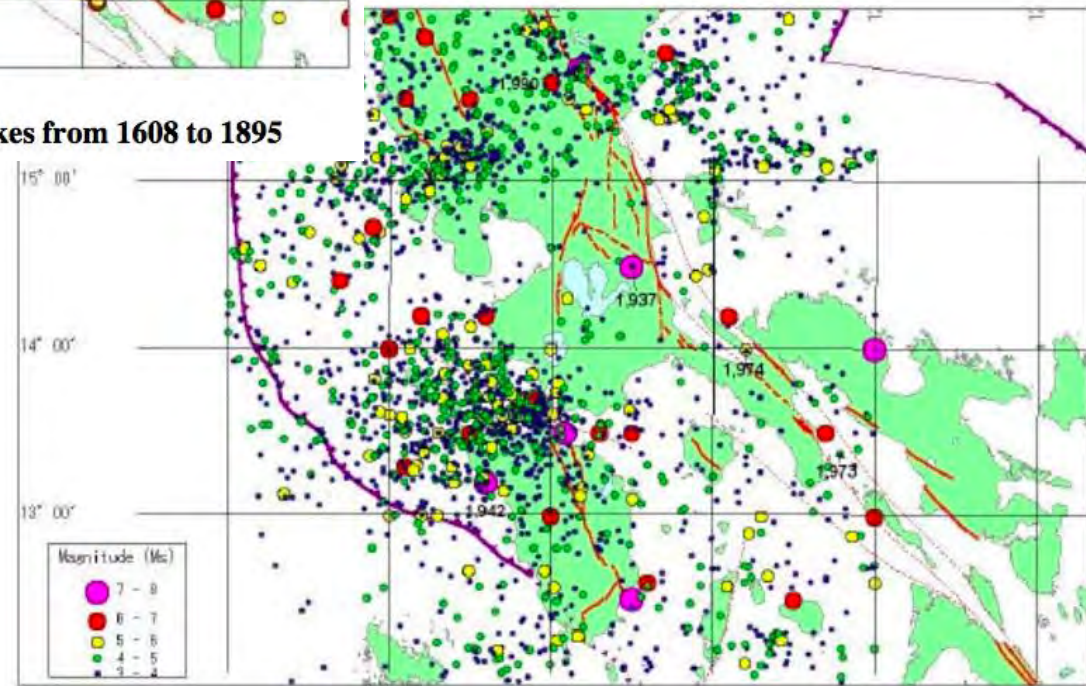


Figure 2.1.5 Distribution of Instrumentally Recorded Earthquakes from 1907 to 2002

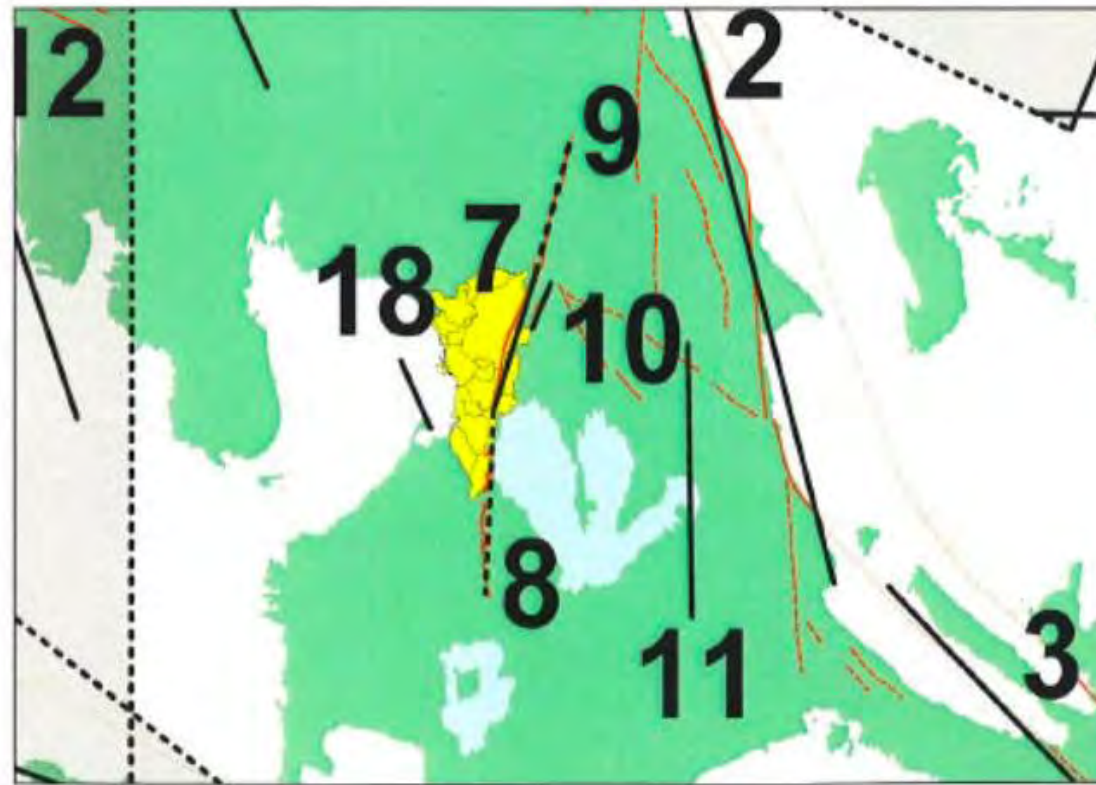
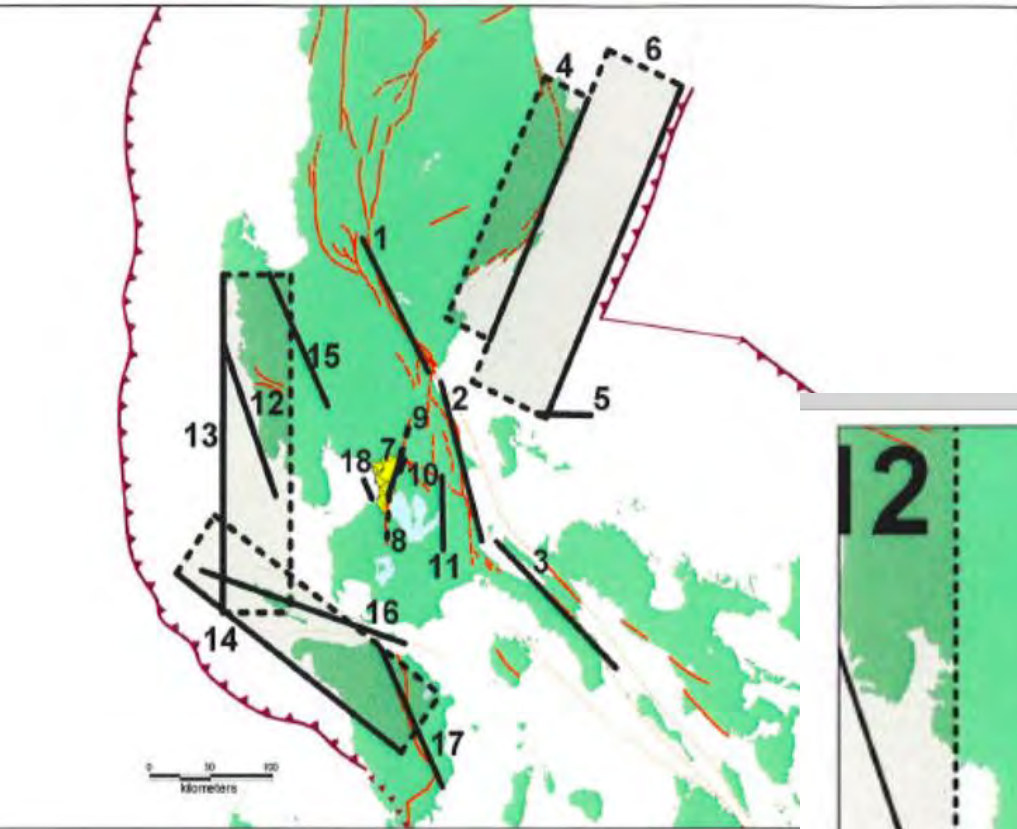
Table 2.1.1 Destructive Earthquakes that Affected Metropolitan Manila and Estimated PGA

Year	Month	Day	Ms	Distance(km)	PGA(gal)
1589					
1599	6	21		4.1	
1601	1	1			
1603					
1635					
1645	11	30	7.9	116.3	81.0
1658	8	19	5.7	12.5	202.6
1664	7	19			
1665	7	19			
1674					
1677	12	7	7.3	163.8	27.9
1728	11	28		18.9	
1767	11	13		41.1	
1770	12			41.1	
1771	2	1	5.0	14.1	113.2
1796	11	5	6.9	179.2	16.5
1824	10	26	7.4	103.2	69.8
1828	11	9	6.6	190.3	11.1
1830	1	18	6.3	94.2	34.3

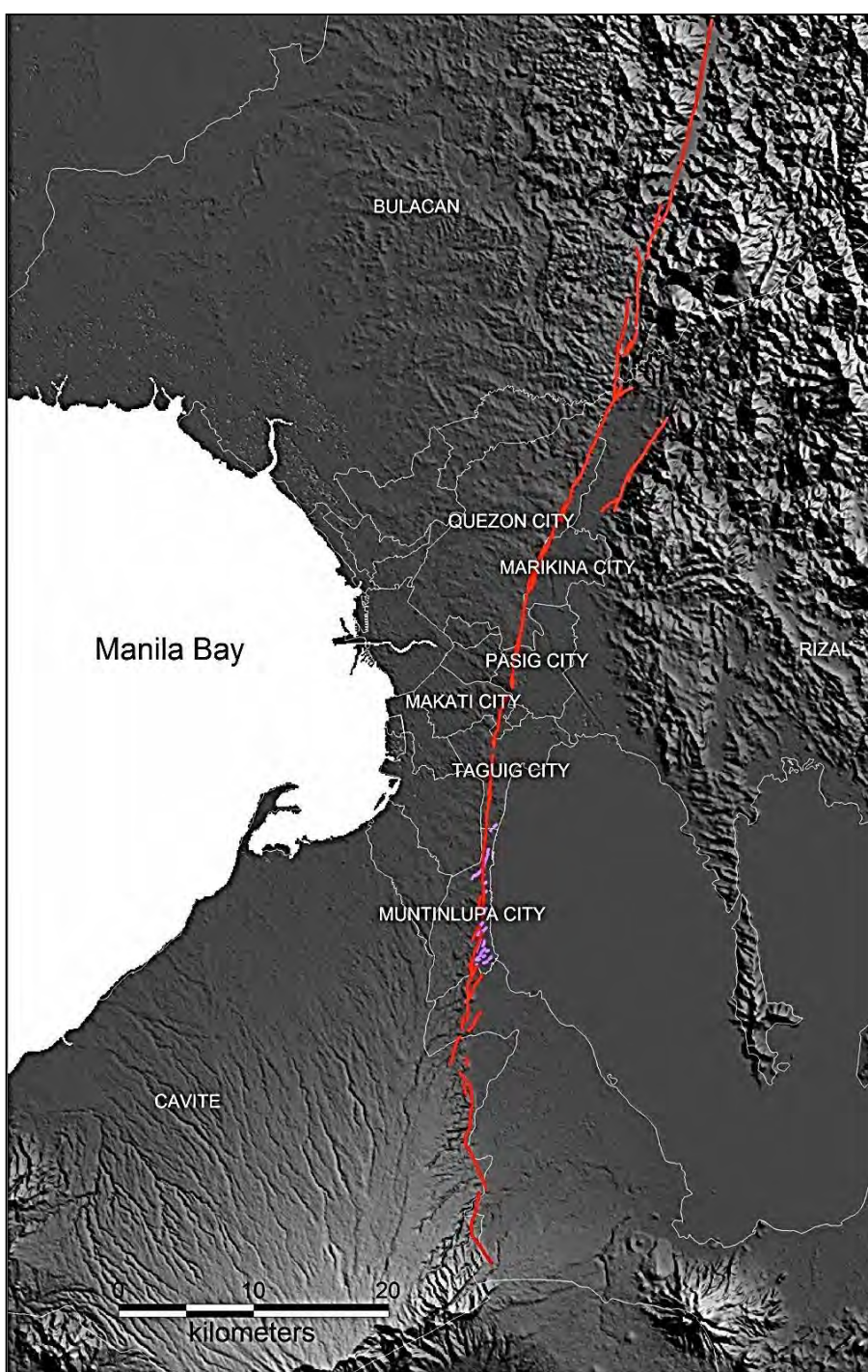
Year	Month	Day	Ms	Distance(km)	PGA(gal)
1833	11	7			
1852	9	16	7.6	108.7	74.0
1862	3	4	6.1	113.0	21.2
1863	6	3	6.5	13.1	298.3
1869	10	1	6.6	70.9	66.8
1880	7	18	7.6	67.8	139.8
1892	3	16	6.6	214.2	8.2
1937	8	20	7.5	52.2	174.7
1942	4	8	7.5	118.9	59.6
1968	8	2	7.3	224.6	13.2
1970	4	7	7.3	152.2	32.5
1970	4	12	7.0	123.8	38.0
1972	4	26	7.2	153.8	29.4
1973	3	17	7.3	232.5	12.1
1974	2	19	6.1	139.0	14.3
1977	3	19	7.0	282.2	5.3
1990	7	16	7.8	124.6	67.8
1994	11	14	7.1	119.1	44.1
1999	12	12	6.8	203.2	11.2

Source: PHIVOLCS and Study Team

Scenario Earthquake Fault Models for Hazard Estimation



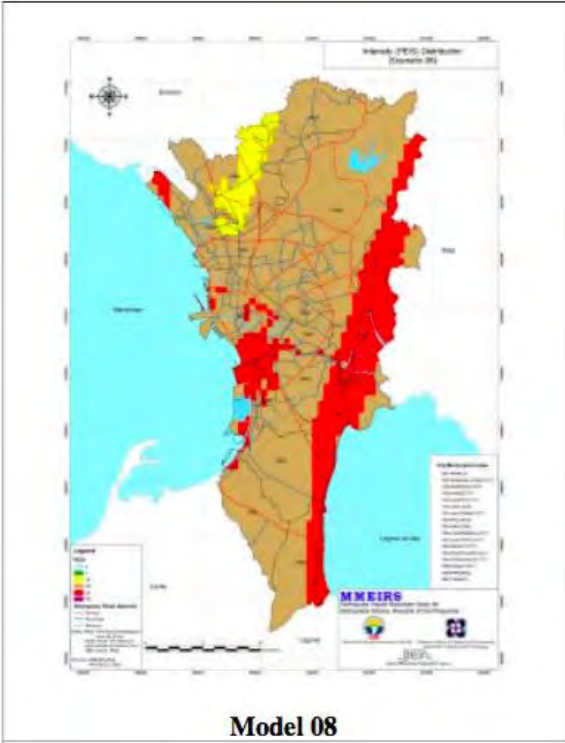
VALLEY FAULT SYSTEM



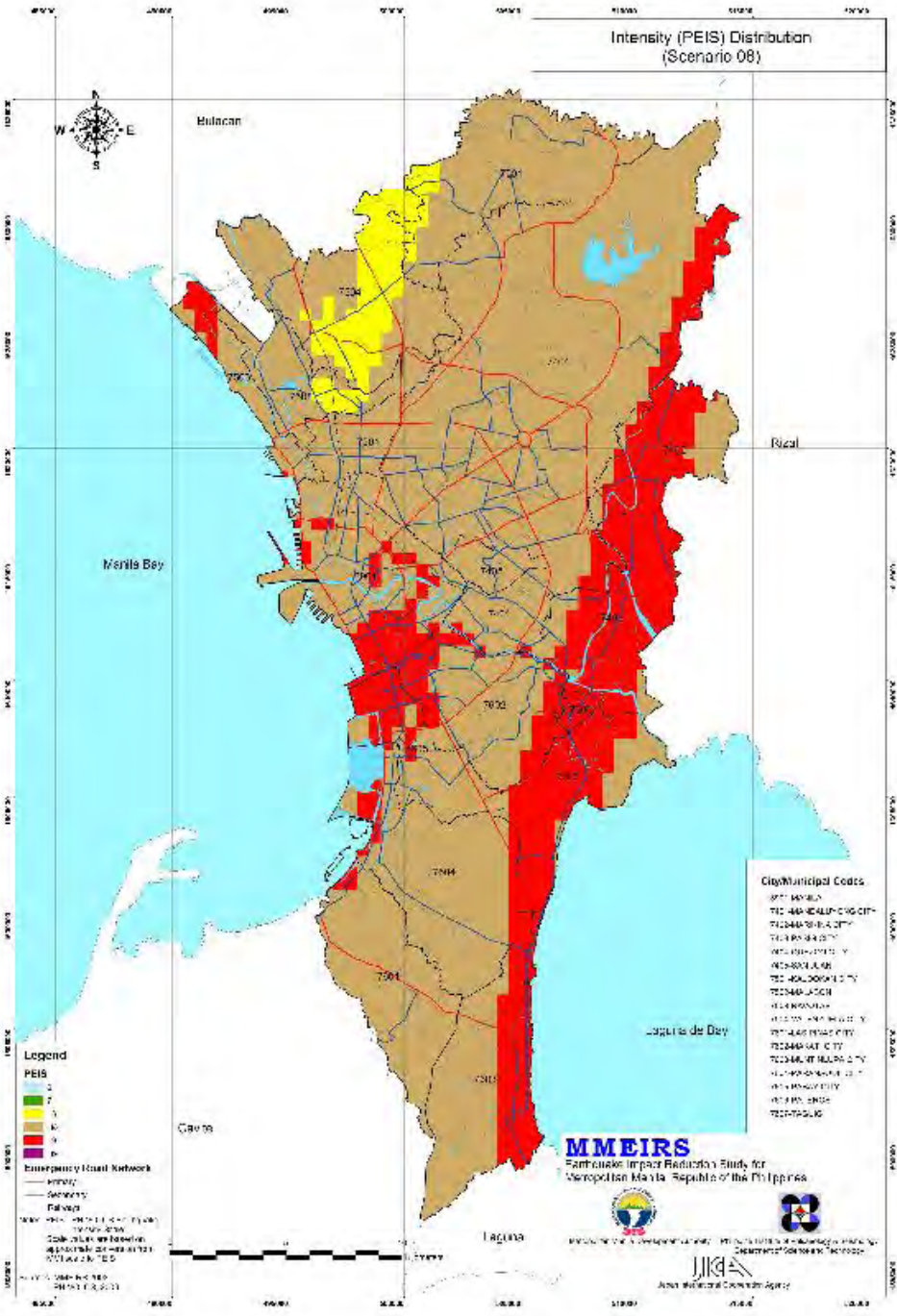
- ✦ East Valley Fault (EVF)
 - ✦ ~10 km long
- ✦ West Valley Fault (WVF)
 - ✦ ~100 km long
- ✦ WVF moved 4 times in past 1400 years; movement interval ~ 400 yrs
- ✦ Last major earthquake from the Valley Fault was in 1658



Distribution of Seismic Intensity, PEIS



Intensity (PEIS) Distribution
(Scenario 08)



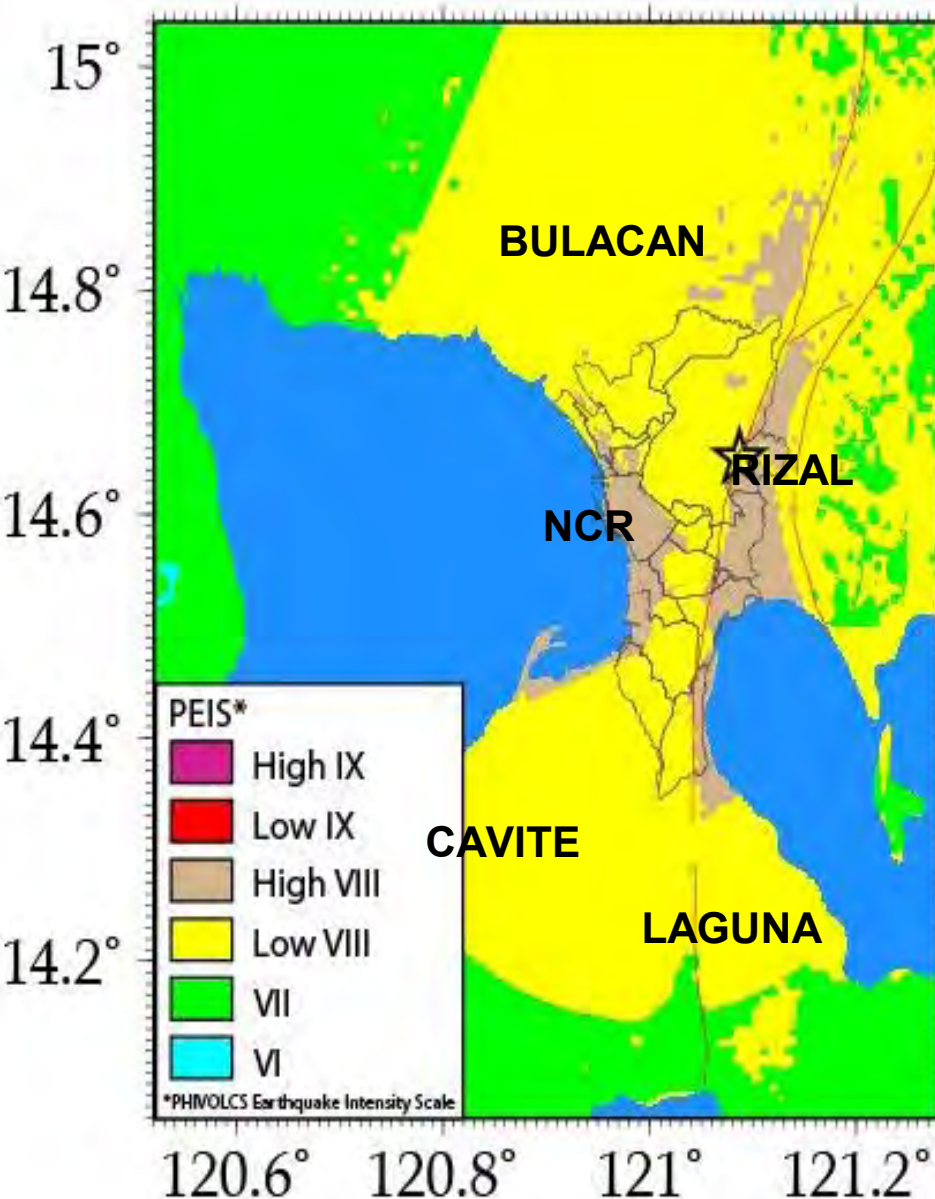
INTENSITY VIII (PEIS)

- ◆ People cannot stand even outdoors
- ◆ Many well-built buildings are considerably damaged
- ◆ Concrete dikes and foundations of bridges are destroyed
- ◆ Railway tracks are bent or broken
- ◆ **Utility posts, towers and monuments may tilt or topple**
- ◆ Water and sewer pipes may be bent, twisted or broken
- ◆ Liquefaction and lateral spreading
- ◆ Numerous landslides and rock falls occur in mountainous and hilly areas
- ◆ Fissures and fault rupture



GROUND SHAKING HAZARD

M7.2 West Valley Fault Earthquake



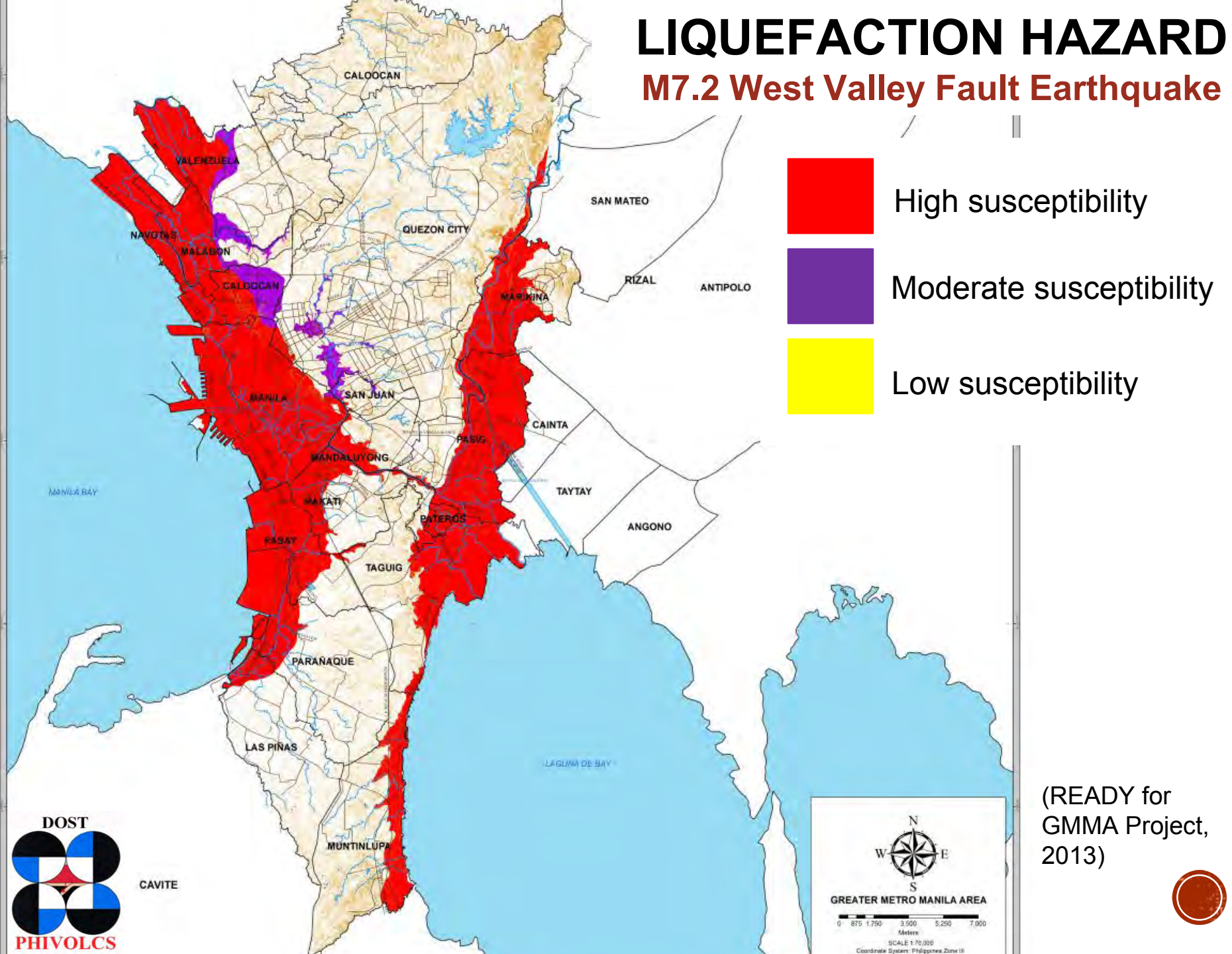
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LIQUEFACTION HAZARD

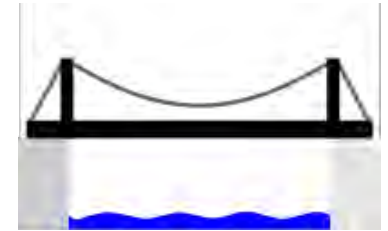
M7.2 West Valley Fault Earthquake



Effects: Damages on Lifelines



Water



Bridges



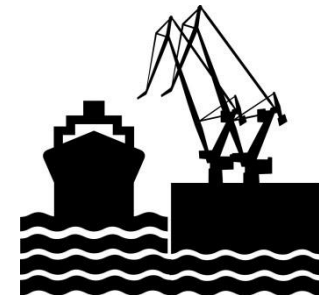
Power



Roads



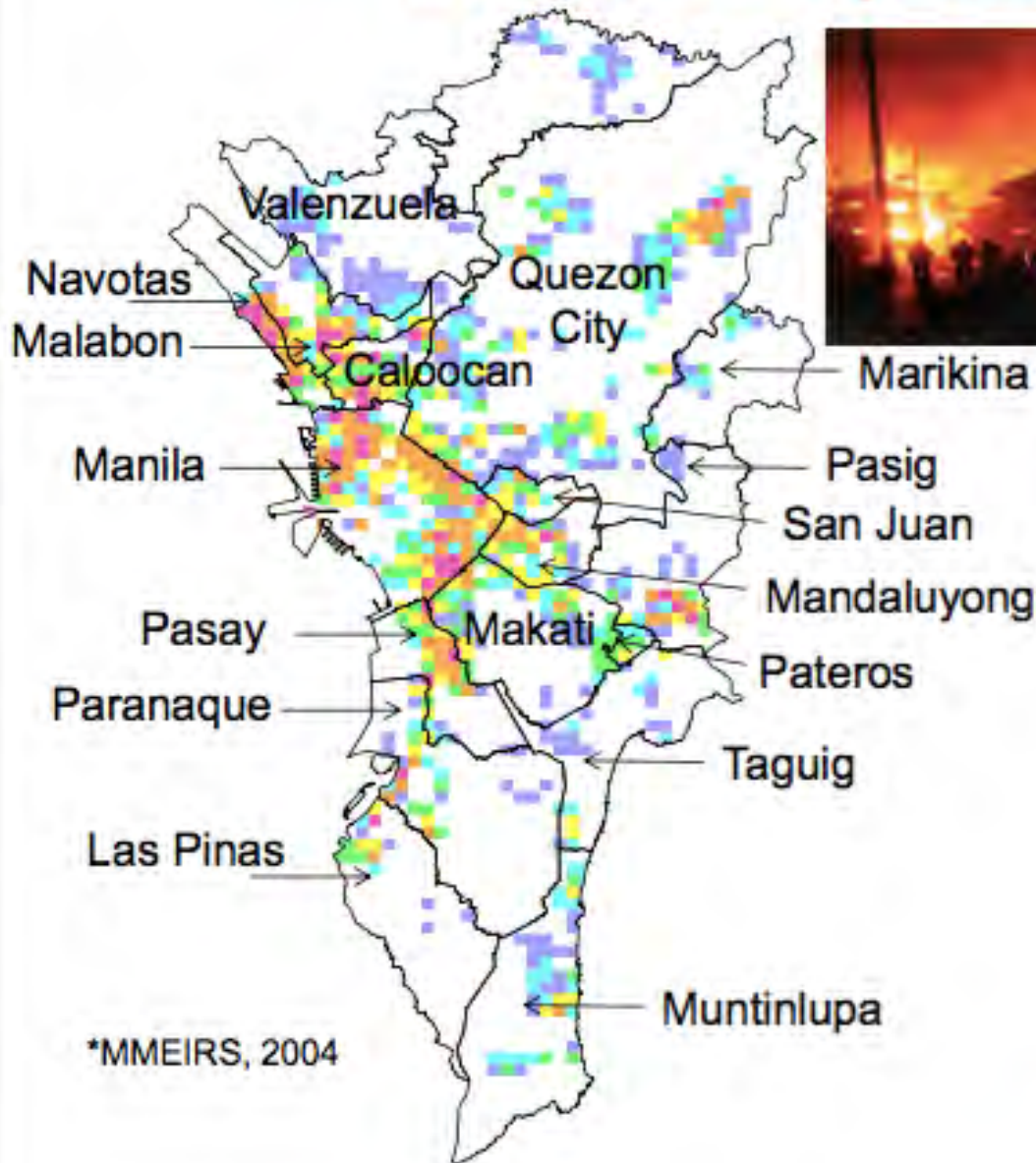
Telecommunication



Ports

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



(MMEIRS, 2004)

2.4 Infrastructure and Lifeline Damage

Scenario Earthquake	Model		Model 08	Model 13	Model 18	
	Magnitude		7.2	7.9	6.5	
Bridge 213 (with detailed inventory and stability analysis 189) Flyover 80 (with detailed inventory and stability analysis 38)	Large possibility of falling-off	Bridge	7	0	0	
		Flyover	0	0	0	
	Moderate possibility of falling-off	Bridge	2	0	2	
		Flyover	0	0	0	
Water Supply Distribution Pipes Total 4,615km		Break of pipes or joints	4000 points	0 points	200 points	
Electric Power Transmission and Distribution Line Total 4,862km		Cut of cables	30 km	0 km	4 km	
PLDT Telephone Aerial Cable 9,445 km Underground Cable 3,906 km		Cut of cables	95 km	0 km	11 km	
Public Purpose Buildings (Hospital 177, School 1412, Fire Fighting 124, Police 43, MMDCC Organizations and 17 LGU City and Municipal Halls 53)		Heavily Damaged	8 - 10 %	0 - 0.2%	0 - 1 %	
		Partly Damaged	20 - 25 %	0 - 0.3%	2 - 3 %	
Mid-rise and High-rise Buildings	10-30 stories building	981	Heavily Damaged	11 %	0.3 %	2.3 %
			Partly Damaged	27 %	2.8%	9.2 %
	30-60 stories building	119	Heavily Damaged	2 %	0 %	0%
			Partly Damaged	12 %	0.1%	0.5%

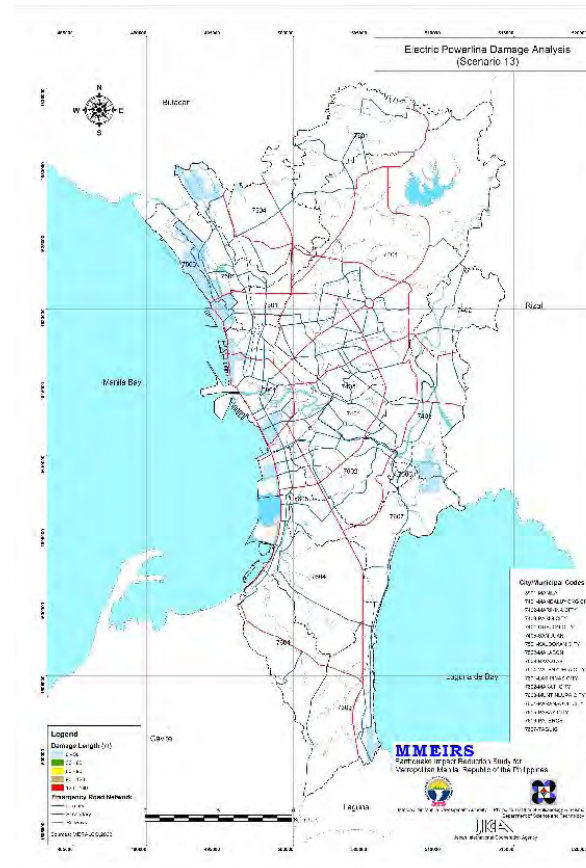
Electric Power Transmission and Distribution Line Total 4862km

Cut cables:

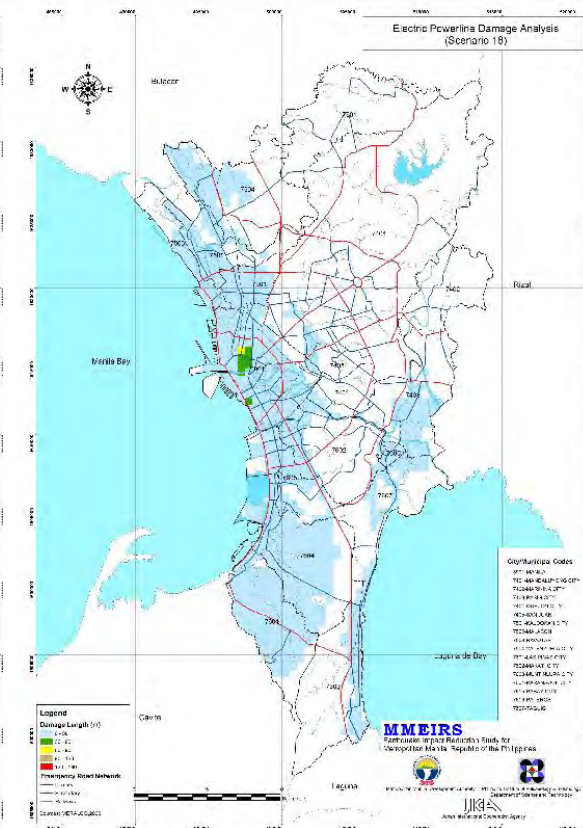
Model 08: 30km

Model 13: 0km

Model 18: 4km



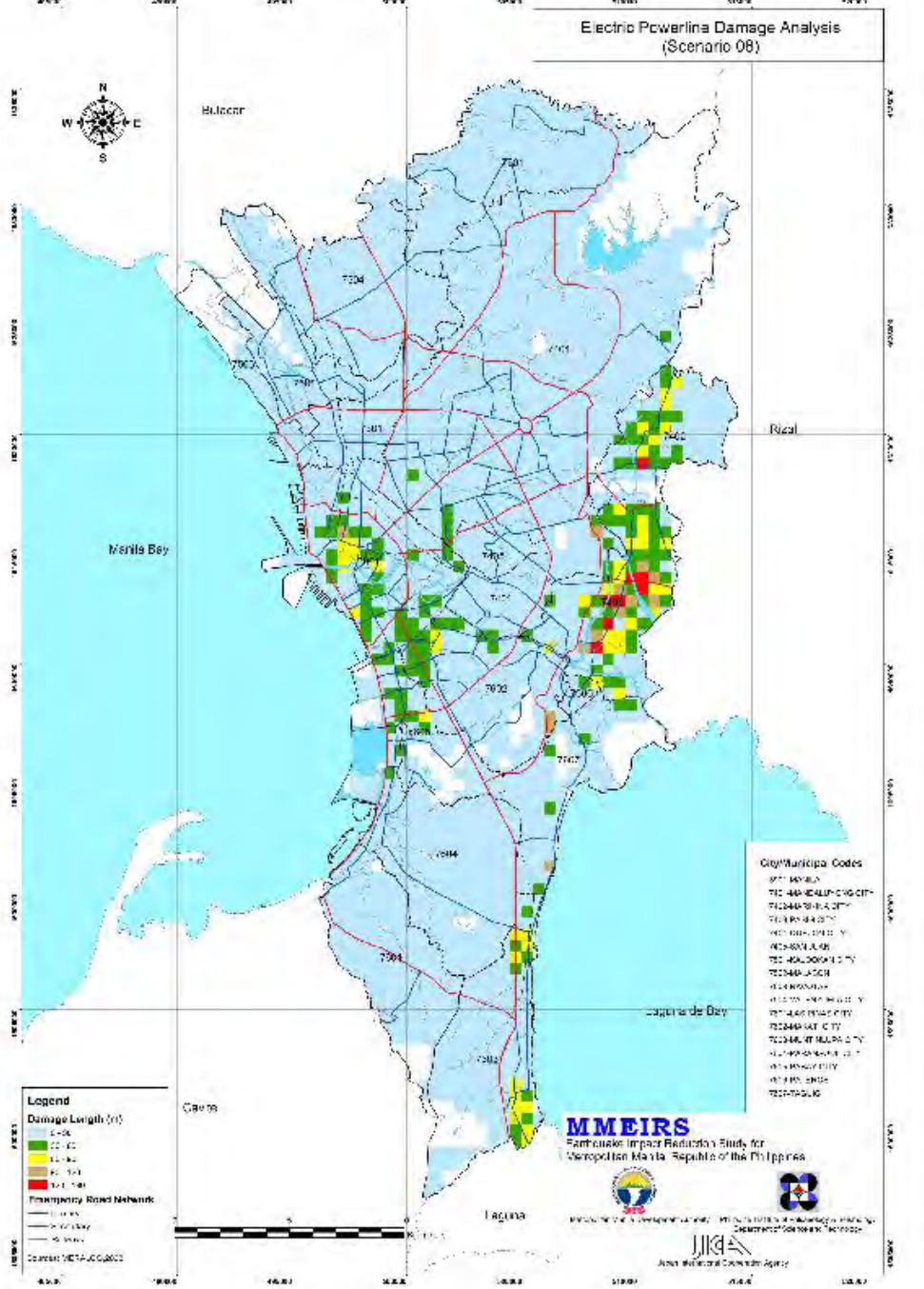
Model 13



Model 18

Electric Powerline Damage Analysis

Model 08



Legend

Damage Length (m)



Priority Road Network



Source: MCEP-CO-002

Fire and Lifeline Damage Scenario

	0-1 hour	1-24 hours	1-3 days	3-7days	7days after
Outbreak of Fire	<ul style="list-style-type: none"> Total 500 fire outbreak by electricity short circuit 70 in Manila, 60 Quezon, 50 in Pasig Fire from Factories, Hospitals, Residential Kitchens Petroleum leakage from storage tank LPG leakage from storage tank 	<ul style="list-style-type: none"> Explosion of LPG and petroleum and tanks by spreading of fire around Magnification of fire spreading 		<ul style="list-style-type: none"> New fire outbreaks occur by short circuit c resuming of power supply 	
Spread of Fire	<ul style="list-style-type: none"> Not occurred yet 	<ul style="list-style-type: none"> Fire hydrants incapable Fire engine unreachable to the fire areas because of congested or debris-blocked roads Fire fighting system incapable 100,000 (7%) residential building in 1,700 hector area burned out Heavy smoke causes respiratory illnesses 			<ul style="list-style-type: none"> Fire almost extinguished
Water Supply	<ul style="list-style-type: none"> Failure of water supply caused by damage to water supply pipe at 4,000 points 	<ul style="list-style-type: none"> Failure of water supply over the whole city 		<ul style="list-style-type: none"> Damages to Angat reservoir and water purification plant causes stopping of water supply for long term 	
Electricity Supply	<ul style="list-style-type: none"> Electric transmission facilities, electric transformer substation on the fault is damaged Total 30km snapping of cables Many snapping of cables caused by building collapse 	<ul style="list-style-type: none"> Power failure over the whole city Damaged area expands by spread of fire 	<ul style="list-style-type: none"> Partially recovering in area of building damage is not severe 	<ul style="list-style-type: none"> Damages to transformer substation is not recovered Power failure continues over the whole city 	
Telephone	<ul style="list-style-type: none"> Total 100km snapping of cables Many snapping of cables caused by building collapse Cellular phone broken off as results of damages to base transceiver station Telephone and cellular phone service is congested and out of use 	<ul style="list-style-type: none"> Telephone services suspended over the whole city Suspended area expands by spread of fire 	<ul style="list-style-type: none"> Partially recovering applying emergency backup generators Limitation of available fuel for the generator Limited time of telephone 		

Electricity Supply 0 to 1 hour

- Electric transmission facilities, electric transformer substation on the fault is damaged
- Total 30km snapping of cables
- Many snapping of cables caused by building collapse

Electricity Supply 1 to 24 hours

- Power failure over the whole city.
- Damaged area expands by spread of fire.

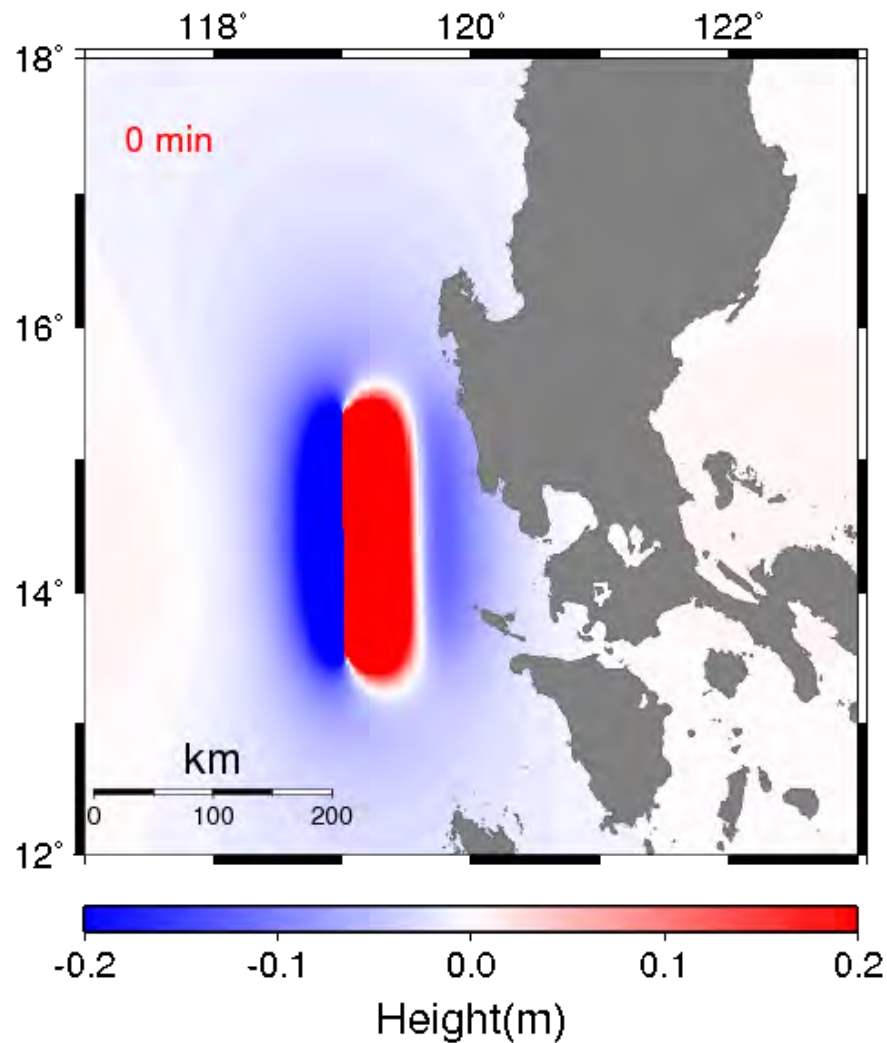
Electricity Supply 1 to 3 days

- Partially recovering in area of building damage is not severe.

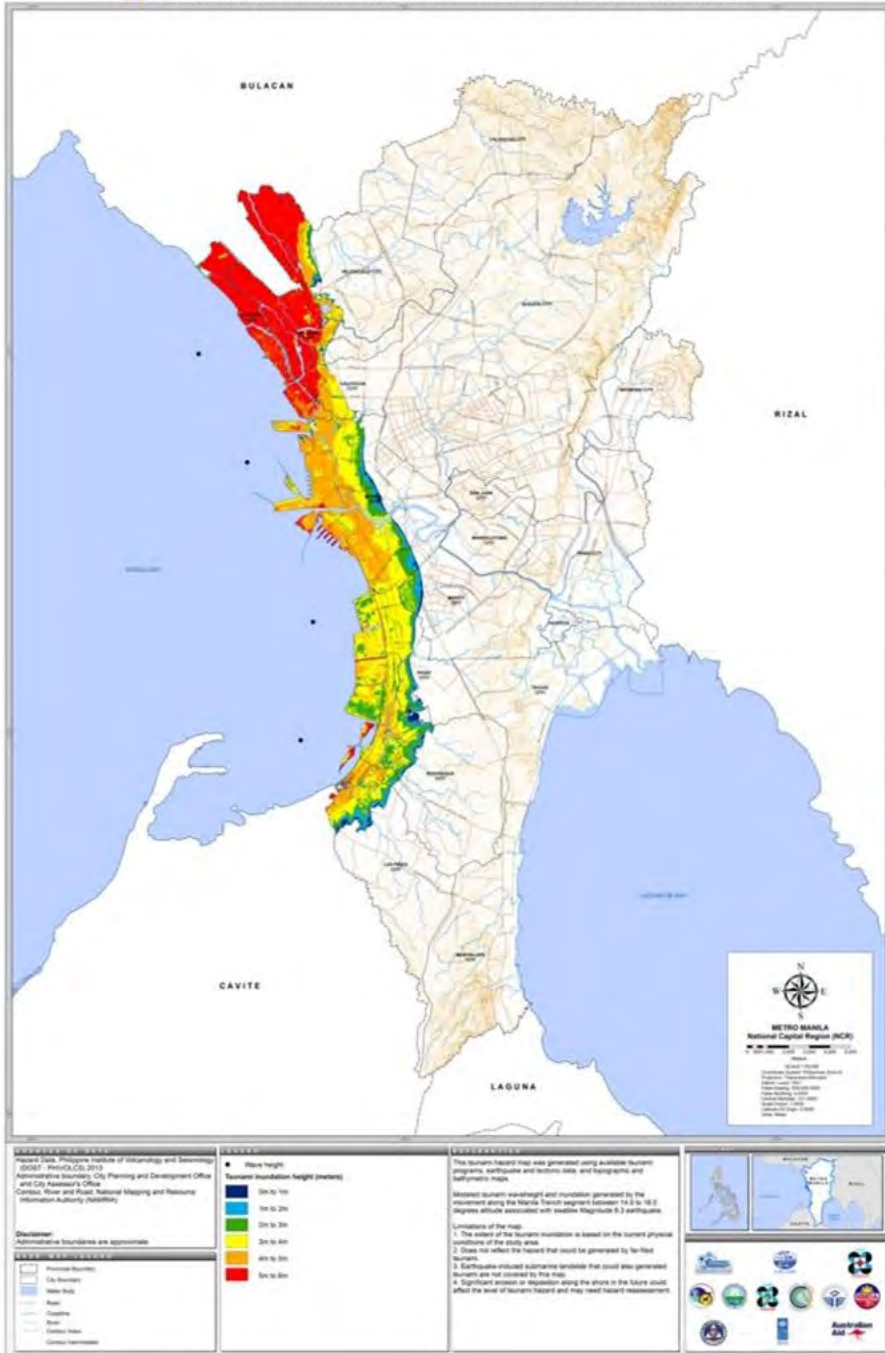
Electricity Supply 3 to 7 days

- Damages to transformer substation is not recovered
- Power failure continues over the whole city.

Tsunami Scenario: Manila Trench Source



Tsunami Hazard Map of Metro Manila



Estimated Tsunami Height in Manila Bay:

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

Arrival Time:

- ≥ 1 hour

The Impact of the recent Earthquake and Tsunami on the Japanese Energy Industry

March 2011

ABSTRACT

The horrendous disaster that occurred in the afternoon of March 11 has shaken the world with some tragic and horrific outcomes, all seemingly caught on camera. Firstly, a gigantic offshore Category 9.0 earthquake caused damage to North East Honshu. Then the resultant tsunami, that to date has tragically claimed thousands of lives and devastated everything and anything that got in its way.

Subsequently, there is the “energy” impact of these natural disasters – explosions and radiation leakage at the Fukushima Daiichi power plant, damage to refineries (reportedly some 1.7 mbd of capacity had initially shut down), damage to petrochemical plants (reportedly over 3 mta ethylene capacity closed) and closure of other power generation facilities (nuclear, gas, coal and oil).

Japanese industry recovered relatively quickly after the 1995 Kobe Earthquake that claimed

The Impact of the recent Earthquake and Tsunami on the Japanese Energy Industry

March 2011

- ABSTRACT**
- Infrastructure impact
 - Refinery impact
 - Impact on imports

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Japanese industry recovered relatively quickly after the 1995 Kobe Earthquake that claimed

INFRASTRUCTURE IMPACT

Petroleum products are mainly delivered to end-users by coastal tankers and by road trucks, as

REFINERY IMPACT

Japan has some 30 domestic refineries with a combined capacity of some 5mbd, boasting the

IMPACT ON IMPORTS

In order to restore power to the devastated area and to other areas that are currently rationed, much effort is being placed on increasing the output from undamaged non-nuclear power stations.

For example, TEPCO is in the process of restarting a number of mothballed oil-fired units. *(Note - TEPCO has also now restarted five gas power units (totalling 1.3GW) by shortening maintenance shutdowns and plans to bring another 1.0GW gas stations on by the end of March. Meanwhile, Tohoku Electric has restarted its 250MW Hachinohe oil-fired unit after a nine-day closure forced by the earthquake and is increasing capacity at other undamaged gas-fired stations.)*

To facilitate this, Japan is in the market for:

- a) Additional supplies of Australian and Indonesian coal
- b) Extra LNG cargoes. It is reported that any unfixed European shipments have already been diverted to Japan⁶. Japan has 40 dedicated LNG terminals
- c) Supplementary supplies of suitable oil that can be used as direct feed in their oil fired or dual fired power stations

To the latter end, given the damage to a significant amount of refining capacity and the lack of indigenous production of ISEO (*Japanese refineries tend to run mainly sour crudes mainly from the*

Hazard Maps

PHIVOLCS produces maps showing areas prone to earthquake or volcanic hazards.

These are made available to users either as printed output or digital data.

Hazard Maps

For use in:

- Evacuation
- Emergency response
- Rehabilitation
- Planning location of settlements, facilities
(comprehensive land use and development plans)

Earthquake

Ground Shaking
Hazard Map -
probability of
occurrence of
ground shaking over
a given time period
of seismic hazard
and related
uncertainties

THE PHILIPPINE EARTHQUAKE MODEL



A Probabilistic Seismic Hazard Assessment
of the Philippines and of Metro Manila

Hazard and risk information through web and mobile application – PHIVOLCS FaultFinder

- The **PHIVOLCS FaultFinder**, is a web-based and mobile phone (android) application to locate the nearest active fault from a specified location or the named barangay. This application facilitates easy access to quality data for disaster preparedness, land use, risk assessment and in real-estate.

The PHIVOLCS FaultFinder

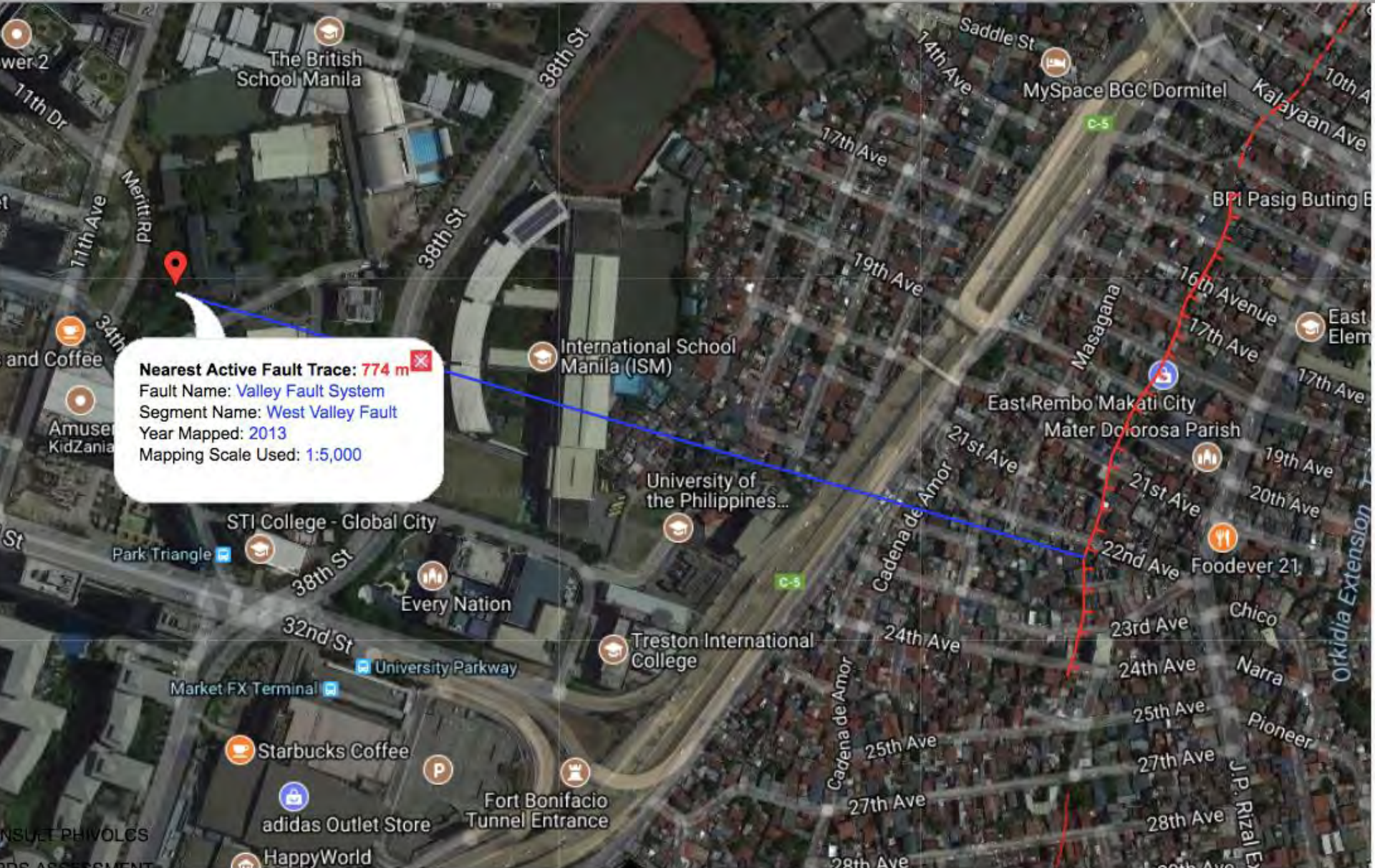
Valley Fault System (VFS)

Other Fault Systems

URL: <http://faultfinder2.phivolcs.dost.gov.ph>

Nearest Active Fault Trace: 2.9 km
Fault Name: Valley Fault System
Segment Name: West Valley Fault
Year Mapped: 2013
Mapping Scale Used: 1:5,000

DOST
PHIVOLCS



Surface Rupture



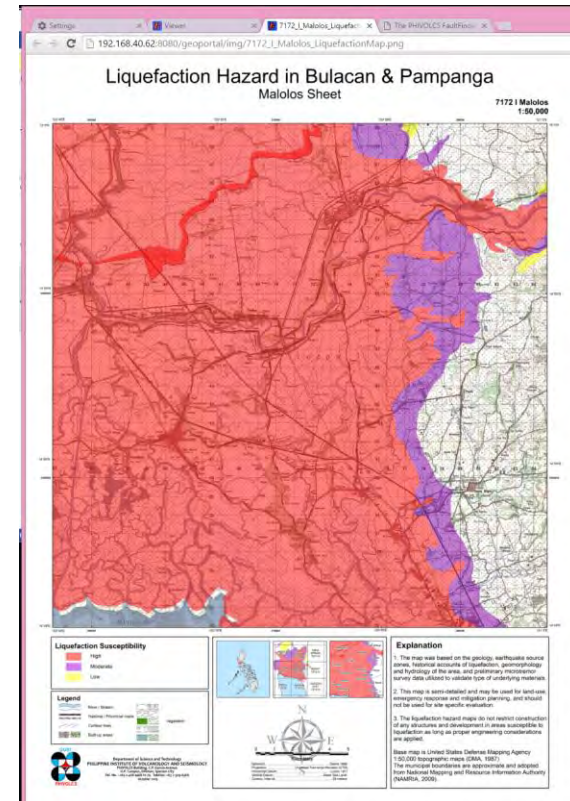
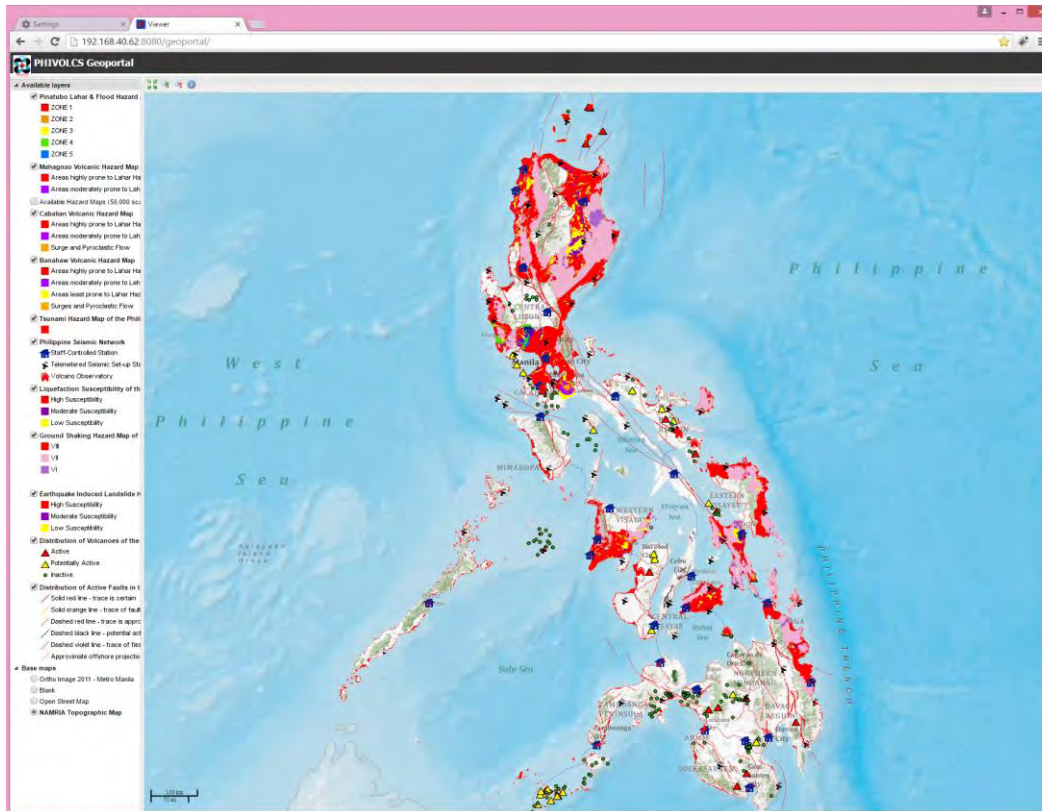
MITIGATION MEASURE:

No construction of houses, schools, buildings and critical facilities **on top** of an active fault.

*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.*

Hazard and risk information through web application – PHIVOLCS Geo-Portal

- The **PHIVOLCS Geo-Portal**, a web-GIS based portal, enables the public to view and collate hazard and risk maps.

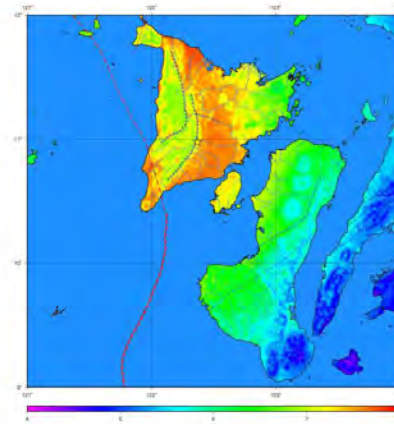


URL: <https://gisweb.phivolcs.dost.gov.ph/hazardmap>

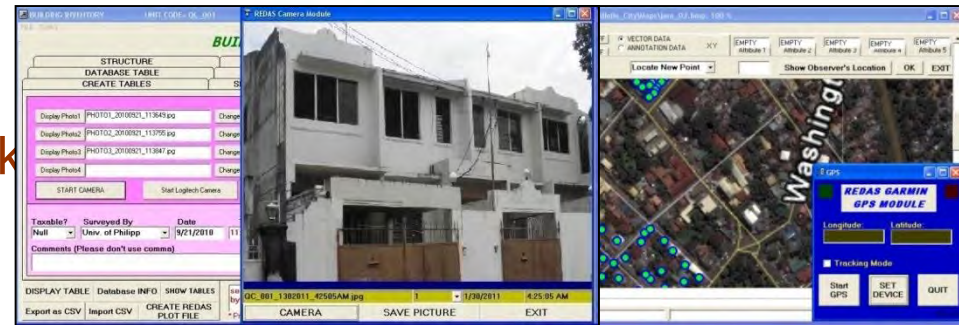
Hazard and Impact Assessment Software

Rapid Earthquake Damage Assessment System

- **Hazard assessment module**
- tools for assessing earthquake hazards; preparing scenarios
- static maps of various hazards (geological, hydro-meteorological) can be integrated



- **Exposure data base module**
- contains database of elements at risk which can be updated by local government



- **Impact assessment module**
- can estimate damage to buildings, casualty, economic loss



* being shared with local governments, national agencies, academic partners

Structural Mitigation Construction of Earthquake Resistant Buildings & Structures

Factors to consider:

- Good design
- Quality construction materials
- Good workmanship

Restoration of Leyte power station completed

THE National Grid Corporation of the Philippines (NGCP) said it has finally energized its Ormoc High Voltage Direct Current (HVDC) Converter Station last week and is now fully engaged to allow power sharing between the Luzon and Visayas grids. NGCP said its maintenance teams completed the restoration of the Ormoc HVDC Converter Station which had been severely damaged by the magnitude 6.3 earthquake last July. Restoration work involved moving several heavy equipments from different NGCP facilities to replace damaged ones such as converters.

"NGCP is pleased to report that with this energization, the Visayas grid can now be powered from Luzon, the unavailability of earthquake-affected geothermal plants. It assures the public that to conduct similar restoration activities, reliable power transmission, the company said in a statement.

Thirteen electric cooperatives serving a total of 186 cities and municipalities from Bohol, Leyte and Samar were affected by a power dis-



Power fully restored in 3 quake-hit Visayas provinces – DoE

Power has been fully restored in Leyte, Samar and Bohol provinces, which were recently hit by a magnitude 6.5 earthquake, the Department of Energy (DoE) announced yesterday.

Energy Secretary Alfonso Cusi commended DoE personnel and industry participants who helped restore electricity in the three provinces four days earlier than the July 31 deadline.

"However, the task to build a stronger and more resilient energy system lies ahead. Our hosting of the Asian Cooperation Dialogue in Bohol next week will help us learn more and do more," Cusi said in a news release.

System operator, the National Grid Corp. of the

Philippines, meanwhile reported to the DoE that the newly transferred 150-megavolt ampere Transformer 2 at the Ormoc Substation was successfully energized at about 9 p.m. last Wednesday and was loading electricity on Friday.

This means that another 135 megawatts (MW) can be delivered to Leyte, Samar and Bohol.

A combined power generation capacity of 330 MW will be delivered to the three islands in anticipation of its projected 291-MW projected peak demand. A total of 270 MW will be traversing the Ormoc Substation, 40 MW will come from the Tongonan Geothermal Power Plant, and 20 MW from various embedded sources. **PNA**

DoE vows to restore power in quake-hit areas in 1 week

THE Department of Energy (DoE) and energy stakeholders are aiming to restore electricity within three to seven days in quake-affected areas in the Visayas.

"I am hopeful that we can see a tremendous improvement in the delivery of energy services within three to seven days," Energy Secretary Alfonso Cusi said in a statement on Saturday.

Cusi conducted an aerial and ground inspection of various power plants, including geothermal facilities that suffered damage from the magnitude 6.5 quake that hit the region on Thursday.

These plants included the 180-megawatt (MW) Majanandog Geothermal Power Plant (GPP), 230-MW Malitbog GPP, 120-MW Tongonan GPP, and 120-MW Upper Majiao GPP.

These facilities have seven other optimizing plants with an additional generation capacity of 50 MW.

The quake that hit Jaro town in Leyte led to the deaths of two people, while 72 others were reported injured.

Blackouts hit Bohol and Samar islands as well as southern Leyte, where a number of structures collapsed.

Leyte plants still shut

Energy Development Corp. (EDC) President Richard Tantoco briefed Cusi on the status of its power plants.

As of 10:00 a.m. on Saturday, all of EDC's Leyte power plants were still shut down amid an assessment of the full extent of damage. The Tongonan facility's office was damaged along with the plant and its transformer.

Out of the potential 120-MW capacity, EDC aims to restore at least 40 MW within seven to eight days, an additional 40 MW by September 1, and another 40 MW within 50 days, officials said.

The Tongonan GPP is directly connected to the 138-kilovolt (kV) transmission line operated by the National Grid Corp. of the Philippines.

The upper Majiao plant, meanwhile is expected to resume operations within five to seven days to bring 132-MW facility back to the grid.

For the Malitbog power plant, Units 1 and 2 are expected to resume operations within the next seven to 10 days, bringing around 150 MW of power back online. Unit 3, however, will remain shut down because of damage sustained by its cooling tower.

Access to the Majanandog plant remains difficult and the extent of the damage that hit the plant has yet to be assessed.

The Malitbog GPP, meanwhile, can deliver around 150 MW by July 11 to several areas in Samar and Ormoc City as it only reported minor damage.

The Malitbog, Majanandog and Majiao GPPs deliver electricity through a marshalling station, which was likewise damaged by the earthquake.

"We are still working to clear landslide debris. Barring any unforeseen issues, EDC could have about 317 MW of power restored to Leyte within the next 10 days," Tantoco said.

"Meanwhile, repair of the marshalling station has commenced and we expect it to be operational in three to five days. Aside from transmitting power from our plants, these repairs will also allow the connection of the station to the 230-kV line to Luzon," he said.

"Our team of contractors has been mobilized to work 24/7, safety considerations permitting, to complete the assessment and accelerate return to service," he added.

VOLTAIRE PALAÑA

KEY MESSAGES

- A large earthquake from the WVF can significantly affect Metro Manila and vicinity. A large earthquake from the Manila Trench can generate a tsunami that can affect the coastal areas.
- Preparedness, mitigation as well as response activities must be based on appropriate hazard and impact scenarios.
- DRRM tools like Business Continuity Plans should address not only the safety of the employees but also their families.
- Preparedness is importantly taking ACTIONS. Let us collectively make our communities safer and resilient to disasters.



Earthquake & Tsunami (24/7):

Tel. Numbers

- ▶ +632 929-9254
- ▶ +632 426-1468 loc 124 / 125

Fax number

- ▶ +632 927-1087

Volcano (24/7):

Tel. Numbers

- ▶ +632 426-1468 loc 127

Telefax number

- ▶ +632 927-1095

IEC materials:

- ▶ +632 426-1468 loc 128
- ▶ +632 927-4524

Contact Us:

www.phivolcs.dost.gov.ph



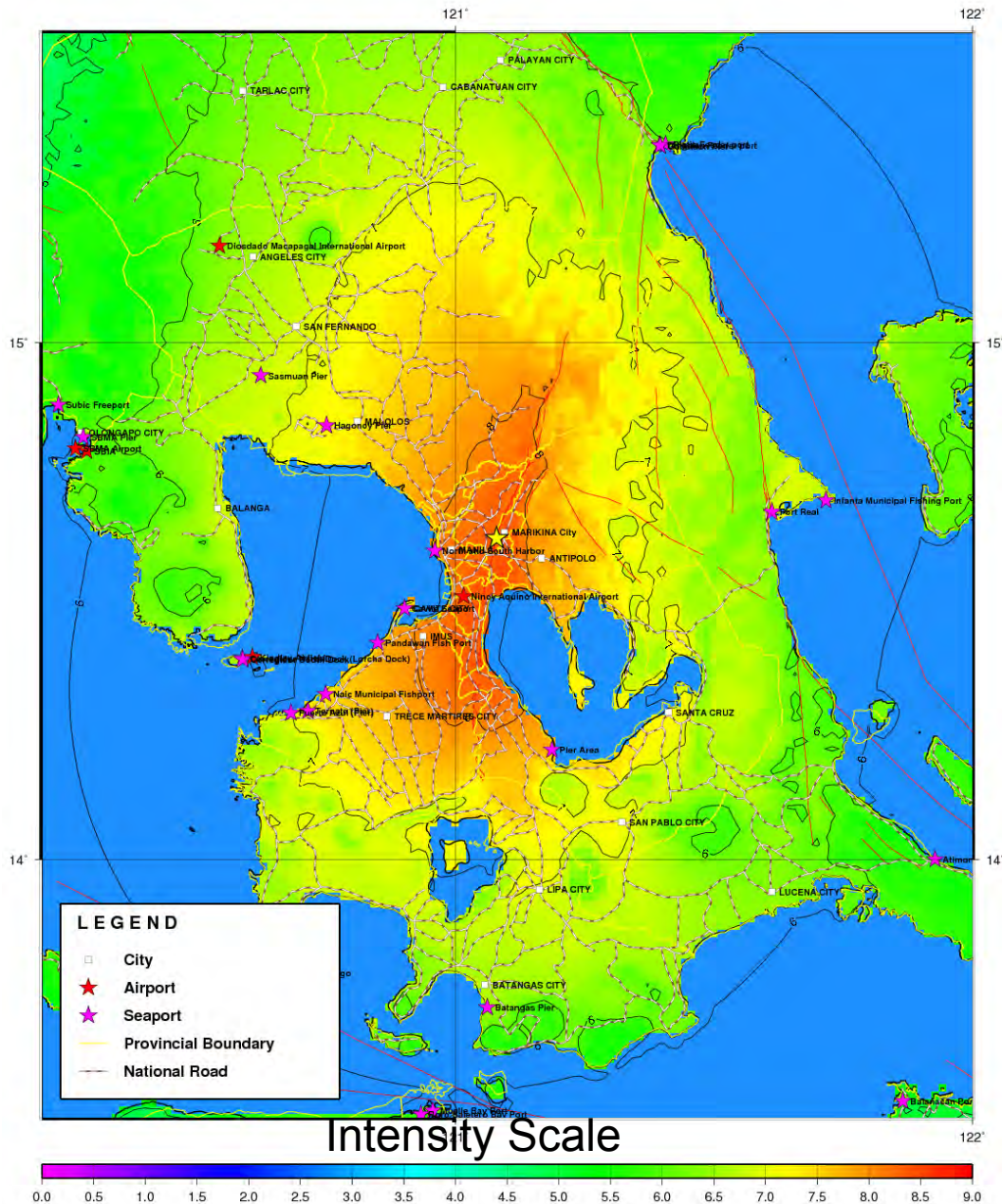
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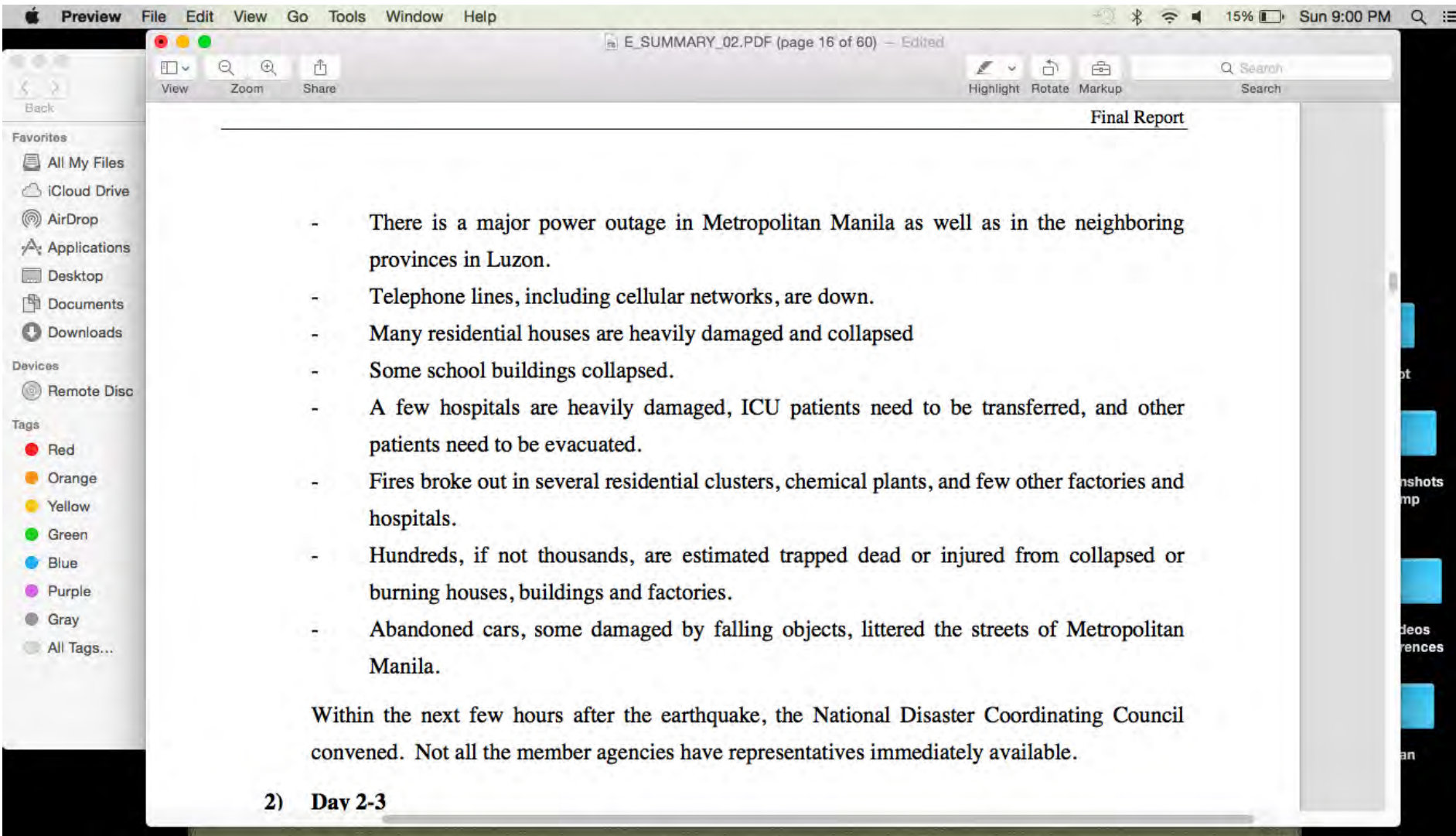
/PHIVOLCS

faultfinder.phivolcs.dost.gov.ph

Earthquake Scenario: West Valley Fault



Source: West Valley Fault
Magnitude 7.2



- There is a major power outage in Metropolitan Manila as well as in the neighboring provinces in Luzon.
- Telephone lines, including cellular networks, are down.
- Many residential houses are heavily damaged and collapsed
- Some school buildings collapsed.
- A few hospitals are heavily damaged, ICU patients need to be transferred, and other patients need to be evacuated.
- Fires broke out in several residential clusters, chemical plants, and few other factories and hospitals.
- Hundreds, if not thousands, are estimated trapped dead or injured from collapsed or burning houses, buildings and factories.
- Abandoned cars, some damaged by falling objects, littered the streets of Metropolitan Manila.

Within the next few hours after the earthquake, the National Disaster Coordinating Council convened. Not all the member agencies have representatives immediately available.

2) Day 2-3