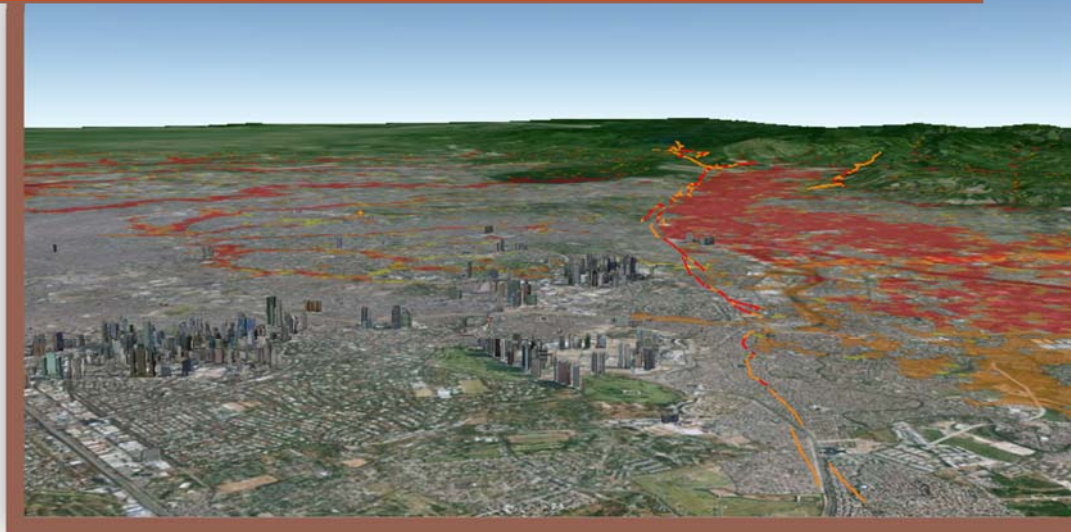


# Natural and Anthropogenic Hazards in Metro Manila



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## Introduction

Metro Manila is subject to numerous hazards including strong earthquakes (with associated surface rupture, liquefaction, tsunamis, fire and security risk), flooding, typhoons, a minor landslide risk and volcanic eruptions from nearby provinces. These hazards, particularly the earthquake risk, should be taken extremely seriously.

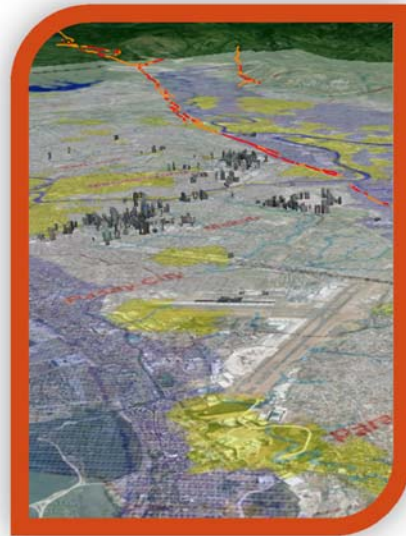
Flooding and typhoons are frequent, cause disruption and may result in loss of life. They should be taken seriously, but life usually moves on quickly after these events. Powerful earthquakes represent the single greatest threat to Manila. Strong earthquakes have not been experienced in Manila by the vast majority of people alive today. This should be taken as a warning, but often creates complacency. Strong earthquakes have regularly occurred in the past and one can expect a strong earthquake in our lifetimes. Maybe tomorrow, maybe in a year, maybe in 40 years.

By being aware of the natural hazards we can prepare. We can avoid danger areas as much as possible. A great deal of mapping has been carried out. One can overlay flood risk, fault lines, liquefaction prone areas, post-quake fire prone areas, predicted shake maps, tsunamis prone and landslide prone areas. Many of these hazards stack one on top of the other. Certain areas are prone to most of these hazards and certain areas, a broad central belt, are much less hazardous. Of course, strong shaking will still be experienced in all areas, but with properly designed buildings one is far more likely to get through the disaster. One should choose very cautiously where to set up home in Manila. Understand the risks in your locality and plan for them.

Attention should be paid to choosing the right kind of building to live in or reviewing and retrofitting existing buildings to ensure safety. Drills should be practised and plans should be made at home, school and work. We should all have at least 10 days to 2 weeks of supplies to help ourselves in terms of food, water, shelter, medicine, torch light and even rescue tools such as jacks and crowbars. Aid will likely be slow coming, probably non-existent for most people. By helping yourself and your community you become part of the solution and not another statistic.

All of the threats in Manila are manageable so long as they are respected and taken very seriously. Many thousands will die unnecessarily in the next large earthquake due to poor design and construction, construction in unsuitable areas, electrical fires and lack of fire safety equipment, poor reactions and lack of preparation. We have a good developing understanding of the risks and therefore the consequences will be down to how we behave and react to the problems. React now – don't wait until it's too late!

*Image Credit: A. Whymark using data from Google Earth, PHIVOLCS-DOST and the Mines and Geoscience Bureau.*



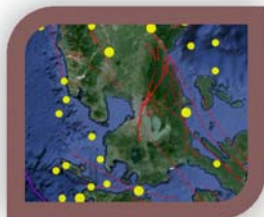
## Contents

|   |           |
|---|-----------|
| <b>Introduction</b> .....                                 | <b>1</b>  |
| <b>Contents</b> .....                                     | <b>2</b>  |
| <b>Executive Summary</b> .....                            | <b>3</b>  |
| Summary of Natural Hazards .....                          | 3         |
| Summary of Anthropogenic Hazards .....                    | 4         |
| <b>Natural Hazards</b> .....                              | <b>5</b>  |
| Fault Lines (Earthquake).....                             | 5         |
| Liquefaction (Earthquake).....                            | 8         |
| Tsunamis (Earthquake).....                                | 9         |
| Landslides (Earthquake and Meteorological).....           | 11        |
| Volcanic Eruptions.....                                   | 13        |
| Flooding (Meteorological).....                            | 14        |
| Typhoon (Meteorological) .....                            | 16        |
| <b>Anthropogenic Hazards</b> .....                        | <b>17</b> |
| Fire (Earthquake).....                                    | 17        |
| Security (Earthquake).....                                | 18        |
| Lack of Preparation (Earthquake and Meteorological) ..... | 19        |
| Know what to do in an earthquake .....                    | 20        |
| Choosing a place to live .....                            | 21        |
| Items to have in case of emergency .....                  | 22        |
| Building Design and Maintenance (Earthquake).....         | 23        |
| PHIVOLCS Information Sheets .....                         | 25        |

*Cover Image Credit: A. Whymark using data from Google Earth, PHIVOLCS-DOST and National Operational Assessment of Hazards (NOAH).*



## Summary of Natural Hazards in Metro Manila



**Fault Lines (Earthquake):** There are many fault lines in the Philippines, a number of which have historically caused significant damage in Metro Manila. Due to proximity, the Valley Fault System poses the greatest risk. The West Valley Fault runs directly through Metro Manila, exhibiting a distinctive scarp slope. Avoid areas directly on top of the fault line and review closely offset areas as the trace may be inferred or have multiple scarps.



**Liquefaction (Earthquake):** The underlying soil is an extremely important factor. You may be far from the epicentre, but at greater risk due to underlying geology. If your house is on soft un-compacted muddy sediment found in low lying areas or on reclaimed land, the shaking may be amplified and liquefaction may occur. The Pasig River mouth, Antipolo, Cainta and Pasig are all areas at increased risk. Good foundations and solid structures reduce the risk.



**Tsunamis (Earthquake):** Shortly after an earthquake one should prepare for a tsunamis if living in a coastal area. Although the risk is relatively low in Metro Manila, historically two 1-2 metre high tsunamis have been recorded in Metro Manila. It is believed that earthquake triggered tsunamis have the potential to be up to 5.5 metres in height in Manila Bay.



**Landslide (Earthquake & Meteorological):** The landslide risk is low for much of Metro Manila due to topography, but certain areas with slopes and along the fault line may be at risk during an earthquake. Landslides can also be induced by heavy rainfall.



**Volcanic Eruptions:** The Philippines is largely volcanic. There are no active volcanoes in the immediate vicinity of Metro Manila, but the second most active volcano in the Philippines, Taal Volcano in Tagaytay, is just 55 km from the international airport (NAIA). Volcanic eruptions are usually predictable weeks ahead and one should follow instruction. Within Metro Manila this hazard is more likely to be an inconvenience, particularly in aviation and in air quality.



**Flooding (Meteorological):** Flooding is a significant issue within Metro Manila, particularly in the rainy season between May and November. Localised flooding is common during thunder storms. Significant flooding is often associated with slow moving tropical depressions or storms. Indeed these often cause greater damage and loss of life than typhoons within Manila. One should carefully evaluate a property for flood risk prior to renting or buying.



**Typhoons (Meteorological):** On average, 9 typhoons make landfall in the Philippines each year and 1 or 2 will impact Metro Manila. Typhoons most frequently occur in July to November, peaking August to September, but may occur any time of the year. Whilst Manila is somewhat sheltered by being on the westerly side, very strong and damaging winds are still recorded. In some instances, associated flooding and storm surges become an issue.

## Summary of Anthropogenic Hazards in Metro Manila



**Fires (Earthquake & Meteorological):** Following a large earthquake there is a very high risk of fire with high numbers of casualties anticipated. High density informal settlements with poor wiring, oil lamps and candles in use are of particularly high risk. Water mains may be cut. Many routes will be inaccessible to the fire trucks. Many fire trucks will be out of action. Plan an escape route to an open area. Do not try to save belongings.



**Security (Earthquake):** Following a large earthquake, law and order may rapidly break down and looting of malls will be commonplace. Security guards may be absent as they attend to their families. High rises, gated subdivisions and well fenced / walled properties may offer a fair degree of protection. One would be advised to utilize friendly community and not to explore or travel unnecessarily. Do not loot: Gun ownership is common.



**Lack of Preparation (Earthquake & Meteorological):** In a disaster, government and aid organizations are over-run. If you get help then you are lucky, the probability is that you will have to be very patient. Don't add to the problem, give yourself a helping hand by keeping 10 days to 2 weeks of supplies in stock and have a basic kit to survive temporarily. Prepare a plan, prepare your supplies and prepare your home and your home fixtures to increase survivability.



**Building Design and Maintenance (Earthquake):** Your work place and residence should be of safe design. Contrary to popular belief it is the high rise buildings that will be the safest due to proper design and ability to flex. Mid-rise and low-rise buildings are at higher risk. One should consider factors such as property age - is it pre-1992? Is it architect designed? Is it on a slope? Is it a simple shape? Has it been modified or floors added? Does it feel solid and constructed well? Is it well maintained? Does it have an open storey / lanai / garage? A structural engineer (ideally with original plans) can evaluate the need for a seismic retrofit. It's ten times cheaper to retrofit than to rebuild and it may save your life!

### Image Credits:

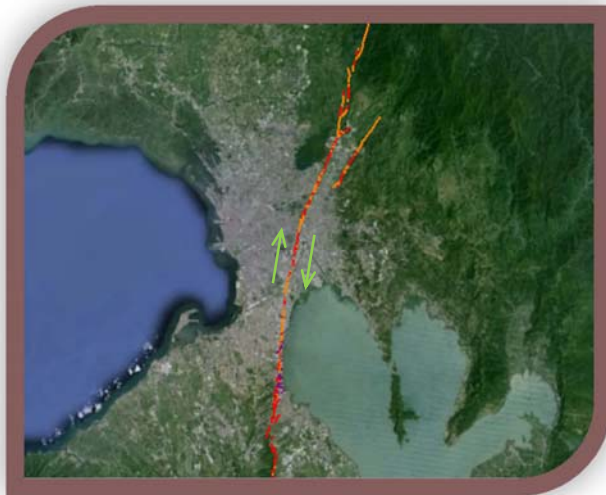
- 1) A. Whymark, utilising data from the The Valley Fault System in Greater Metro Manila Area Atlas (2015) PHIVOLCS-DOST.
- 2) The Marina District of San Francisco suffered from relatively intense shaking and liquefaction in the 1989 Loma Prieta earthquake. U.S. Geological Survey photograph.  
[http://geomaps.wr.usgs.gov/sfgeo/liquefaction/image\\_pages/osc\\_loma5.html](http://geomaps.wr.usgs.gov/sfgeo/liquefaction/image_pages/osc_loma5.html)
- 3) <https://pixabay.com/en/wave-water-sea-tsunami-giant-wave-11061/> Free for commercial use / No attribution required.
- 4) Photograph courtesy of the U.S. Geological Survey. Source:  
<http://landslides.usgs.gov/learning/images/foreign/ElSalvadorslide.jpg> The USGS home page is <http://www.usgs.gov>
- 5) Mayon Volcano, Philippines. Author Credit: Top1963 / Tryfon Topalidis.  
[https://commons.wikimedia.org/wiki/File:Mayon\\_0052.jpg](https://commons.wikimedia.org/wiki/File:Mayon_0052.jpg)
- 6) MANILA (Sept. 17, 2007), United States Navy Photograph, ID 090927-N-0120R-002
- 7) Typhoon Haiyan at peak intensity and approaching the Philippines on November 7, 2013. Author: NASA, LAADS Web, HDF File processed by Supportstorm. <https://ladsweb.nascom.nasa.gov>
- 8) Foto van J. ter Huurne. Released into the public domain (by the author).  
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- 9) <https://pixabay.com/en/chaos-regulation-chaos-theory-485491/> Free for commercial use / No attribution required.
- 10) <https://pixabay.com/en/panic-man-screaming-running-person-149063/> Free for commercial use / No attribution required.
- 11) Tilted Victorian home at Howard and 17th Streets in the Mission District of San Francisco showing liquefaction-related damage from the 1906 earthquake. Photograph by G.K. Gilbert of the U.S. Geological Survey.  
[http://geomaps.wr.usgs.gov/sfgeo/liquefaction/image\\_pages/tilted\\_victorian.html](http://geomaps.wr.usgs.gov/sfgeo/liquefaction/image_pages/tilted_victorian.html)

## Fault Lines (Earthquake)

### The Risk:

There are many fault lines in the Philippines, a number of which have historically caused significant damage in Metro Manila. One can expect a destructive earthquake in Manila every  $\pm 80$  years (Miuraa *et al.*, 2008 after Daligdig & Besana, 1993), last one being in 1937. Due to proximity, the Valley Fault System poses the greatest risk. The West Valley Fault runs directly through Metro Manila, exhibiting a distinctive scarp slope. It is thought to have last moved in 1658 (this is the best case scenario as some authors attribute the 1658 quake to the East Valley Fault). The West

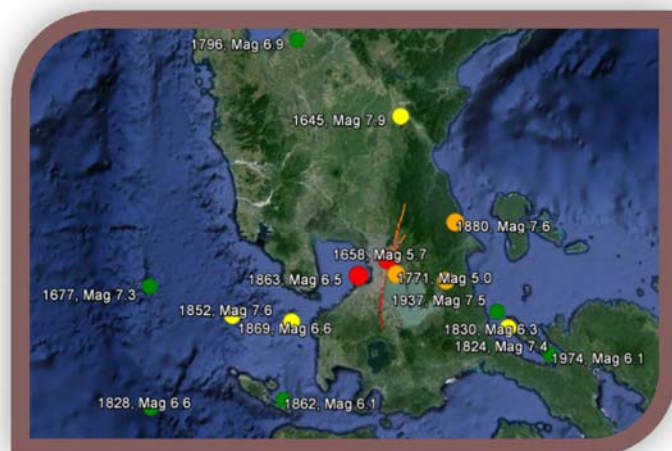
Valley fault is interpreted to move every 400-600 years (Nelson, 2000), with many authors favouring a  $\pm 400$  year cyclicity. As such, a quake from the West Valley Fault within our lifetimes is very realistic. Further unmapped faults may exist.



*Left: A map of the Valley Fault System. Note that in reality the East Valley Fault extends further to the northeast, being part of a larger system. The two faults are likely joined at depth. Arrows indicate movement. Credit: A. Whymark, with data from Google Earth and The Valley Fault System in Greater Metro Manila Area Atlas (2015) PHIVOLCS-DOST.*

Proximity to the West Valley Fault may result in higher peak ground acceleration and stronger shaking. However, proximity to the fault is only one factor. One may be close to the fault and on solid rock (in this case, west of the West Valley Fault) and experience less damage than a house built on soft un-compacted muddy sediments at some distance away, such as at the mouth of the Pasig River. Everywhere in Metro Manila will experience strong ground shaking, not just those areas near the fault.

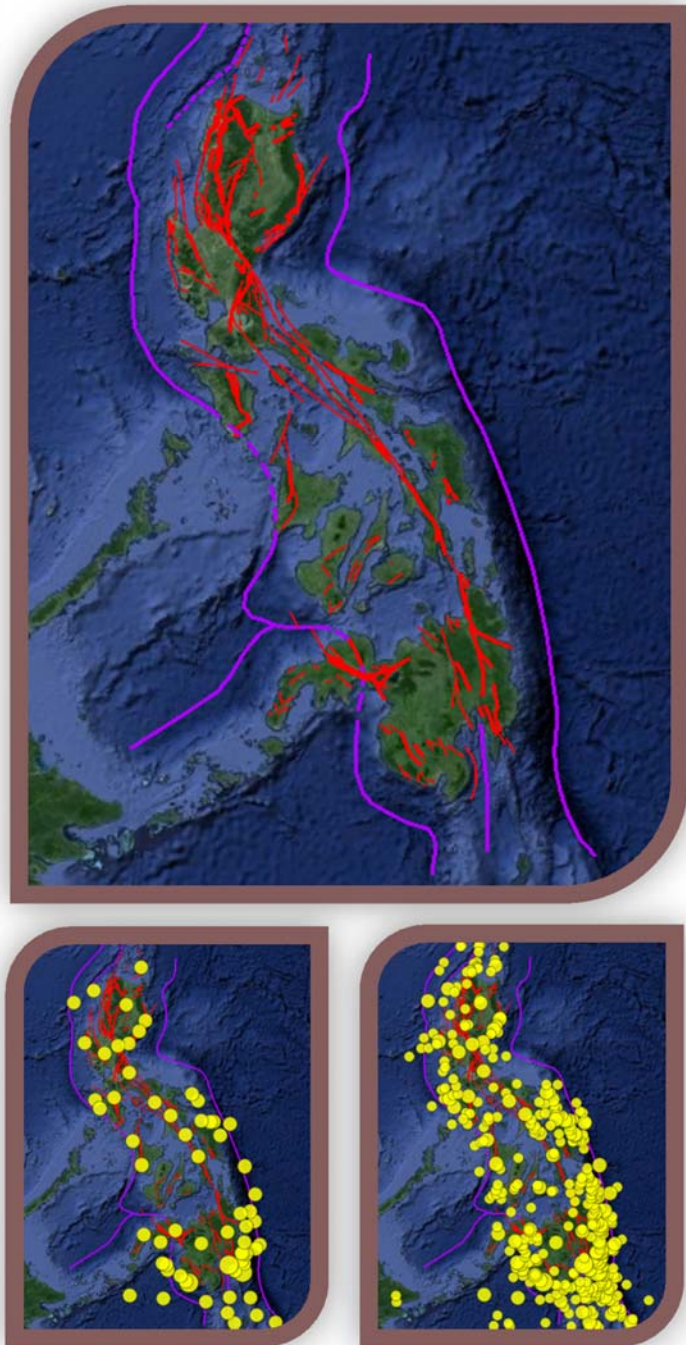
*Right: A map showing previous earthquake epicentres that have resulted in light (green) to heavy (red) ground shaking in Metro Manila. The red and orange line is the Valley Fault System. Credit: A. Whymark utilising data from Google Earth, PHIVOLCS-DOST and Earthquake Impact Reduction Study for Metropolitan Manila in the Republic of the Philippines (2004).*



It is very important not to build directly on top of the fault. No amount of structural engineering can save a building constructed directly on top of the fault line. Details of the West Valley Fault can be found in PHIVOLCS 'Valley Fault System Atlas'. The PDF copy will provide the most accurate map. Overlays on satellite images are always subject to minor discrepancies. These maps are reasonably accurate, very accurate in places, but in some cases you could argue the fault is metres or tens of metres away or that multiple unmapped historic ruptures exist within a broader 200-300 metre band. In some places a single line is drawn and it is said not to build within 5 metres. It is safer to give these faulted areas a wider berth. If you are on a sloping or 'rippled' area immediately adjacent to the mapped fault line then beware. A safer option is to try and be 300 metres away from the mapped fault line, but on a case-by-case basis being closer will pose no greater risk (especially on flat high ground).

The surface rupture of a fault is simply a reflection of a deep seated fault line many kilometres below ground. It is advisable not to build anywhere on the scarp slope as new ruptures may not precisely follow historic surface ruptures. This scarp slope is also more prone to landslides and houses built on multiple levels on a slope are more subject to collapse if not properly designed.

*Right: Fault distribution in the Philippines. Bottom Left: Magnitude 7 or greater earthquakes from 1910 to 2015. Bottom Right: Magnitude 6 or greater earthquakes from 1910 to 2015. Credit: A. Whymark utilising data from Google Earth and Earthquake Impact Reduction Study for Metropolitan Manila in the Republic of the Philippines (2004).*



### What to do:

- Do not rent, buy, build on, or work in a building directly on top of the mapped Valley Fault System lines. These buildings may be un-survivable. If within tens of metres be cautious - you may wish to consult a structural geologist.
- The safest option is to be at least 300 metres away from the mapped fault line.
- If on the higher (up-thrown) side you are more likely to be in a safer position, although landslide may remain a threat.
- Be aware that everywhere in Metro Manila is prone to violent ground shaking. Some of the most severe shaking will be in liquefaction prone areas far from the fault line. Proximity to the fault is only one factor and less important than underlying geology.
- Earthquakes are survivable with properly engineered structures.



*Top Right: A modern surface rupture / scarp from Bohol 2013. Credit: Jeremy Rimando.*



*Bottom Right: Multiple historic surface ruptures / scarps on the West Valley Fault. Credit: A. Whymark.*

### Resources:

- Valley Fault System Atlas: [http://www.PHIVOLCS.dost.gov.ph/index.php?option=com\\_wrapper&view=wrapper&Itemid=500043](http://www.PHIVOLCS.dost.gov.ph/index.php?option=com_wrapper&view=wrapper&Itemid=500043) and <http://www.ndrrmc.gov.ph/index.php/13-disaster-risk-reduction-and-management-laws/1457-the-valley-fault-system-atlas>
- Valley Fault trace on Google Maps: [http://www.nababaha.com/marikina\\_valley\\_fault.htm](http://www.nababaha.com/marikina_valley_fault.htm)
- Distance from Fault Line: <http://tremors.instigators.io/>
- Presentation: <http://carlospromulo.org/wp-content/uploads/2015/02/Ms.-Toni-Yulo-Loyzaga.pdf>
- Presentation: <http://carlospromulo.org/wp-content/uploads/2015/02/Dr.-Renato-Solidum.pdf>
- Presentation: <http://carlospromulo.org/wp-content/uploads/2015/05/Metro-Manila-Earthquake.pdf>
- Earthquake Impact Reduction Study: [http://ndrrmc.gov.ph/attachments/article/1472/Earthquake\\_Impact\\_Reduction\\_Study\\_Volume\\_1.PDF](http://ndrrmc.gov.ph/attachments/article/1472/Earthquake_Impact_Reduction_Study_Volume_1.PDF)  
[http://ndrrmc.gov.ph/attachments/article/1472/Earthquake\\_Impact\\_Reduction\\_Study\\_Volume\\_2.PDF](http://ndrrmc.gov.ph/attachments/article/1472/Earthquake_Impact_Reduction_Study_Volume_2.PDF)  
[http://www.mbc.com.ph/engine/wp-content/uploads/2014/03/Forum-2013-12-Solidum\\_web.pdf](http://www.mbc.com.ph/engine/wp-content/uploads/2014/03/Forum-2013-12-Solidum_web.pdf)

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1. Miuraa H, Midorikawab S, Fujimotoc K, Pachecod BM, Yamanakae H. 2008. Earthquake damage estimation in Metro Manila, Philippines based on seismic performance of buildings evaluated by local experts' judgments. *Soil Dynamics and Earthquake Engineering* 28, 764–777.
2. Daligidig JA, Besana GM. 1993. Seismological hazards in Metro Manila. In: *Proceedings of the natural disaster prevention and mitigation in metropolitan Manila area*. UNCHS (Habitat) Project INT/90/70, p. 9–41.
3. Nelson AR, Personius SF, Rimando RE, Punongbayan RS, Tungol N, Mirabueno H, Rasdas A. 2000. Multiple Large Earthquakes in the Past 1500 Years on a Fault in Metropolitan Manila, the Philippines. *Bulletin of the Seismological Society of America*, 90, 1, pp. 73–85.



## Liquefaction (Earthquake)

### The Risk:

Areas sitting on soft muddy un-compacted sediments, such as reclaimed land or adjacent to a river mouth, are subject to liquefaction and more intense ground shaking. If the buildings are properly designed, good foundations and a rigid structure, they should be able to withstand an earthquake. Unfortunately, these areas are likely to exhibit by far the worst destruction. The 1995 Kobe Earthquake in Japan experienced similar liquefaction resulting in building collapse: Over 6,000 people died.

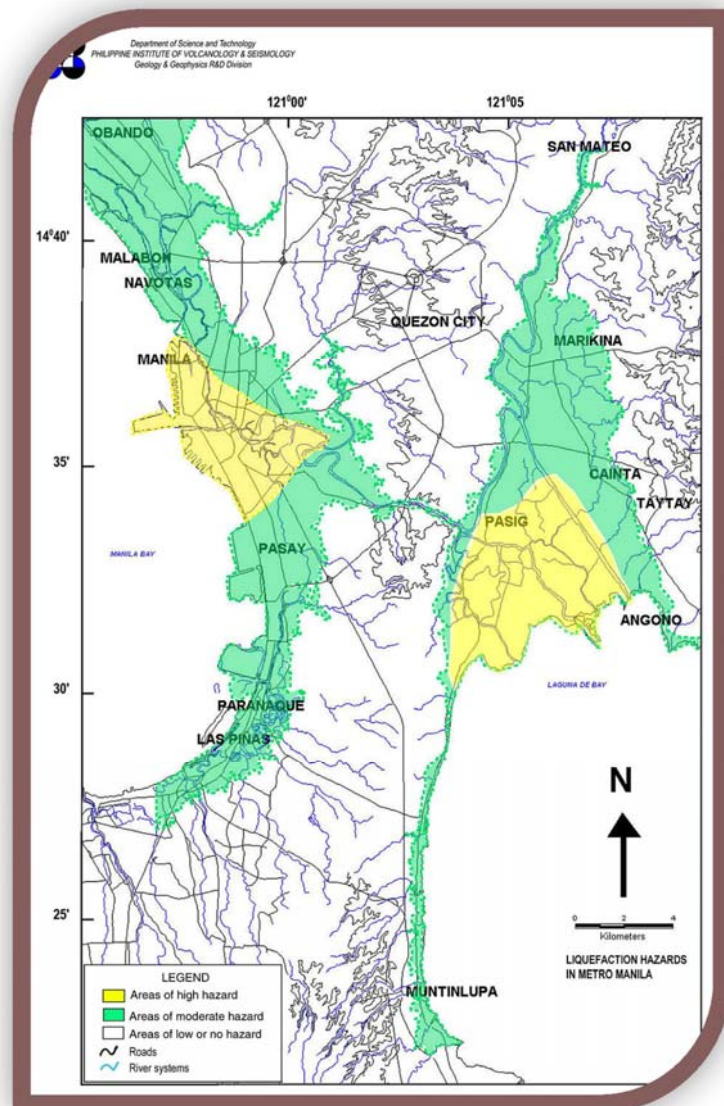
*Left: Liquefaction risk in Metro Manila. Yellow being high hazard and green being moderate hazard. Following an earthquake, these areas are likely to be the most severely damaged areas in Manila. Credit: PHIVOLCS-DOST.*

### What to do:

- Preferably avoid living or working in areas at high risk of liquefaction.
- If you need to be in these areas review the building design. A rigid building with proper foundations will survive.
- Expect and prepare for the worst in these areas.

### Resources:

- Liquefaction Maps:  
[http://www.PHIVOLCS.dost.gov.ph/index.php?option=com\\_content&view=article&id=418&Itemid=500026](http://www.PHIVOLCS.dost.gov.ph/index.php?option=com_content&view=article&id=418&Itemid=500026)



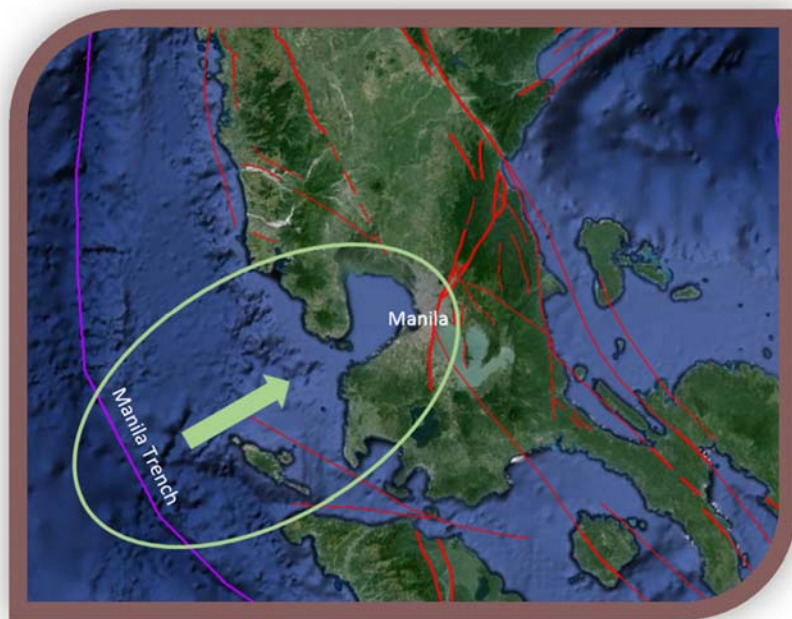
## Tsunamis (Earthquake)

### The Risk:

According to Renato Solidum, director of PHIVOLCS “Metro Manila and its vicinity will be isolated should the Manila Trench move and cause a tsunamis as high as 5.5 metres”. If a tsunamis is generated it would likely hit Manila within a short time (possibly as little as 10 minutes and likely under 1 hour) of the quake hitting. Manila is at lower risk compared to Pacific coastal areas in the Philippines, but due to population density a tsunamis would be devastating.

Historically, in 1828 and in 1863 tsunamis up to 2 metres in height were recorded in Manila Bay.

*Right: Positioning of the Manila Trench. Credit: A. Whymark, Google Earth, Rimando & Kneupfer (2006), PHIVOLCS-DOST.*

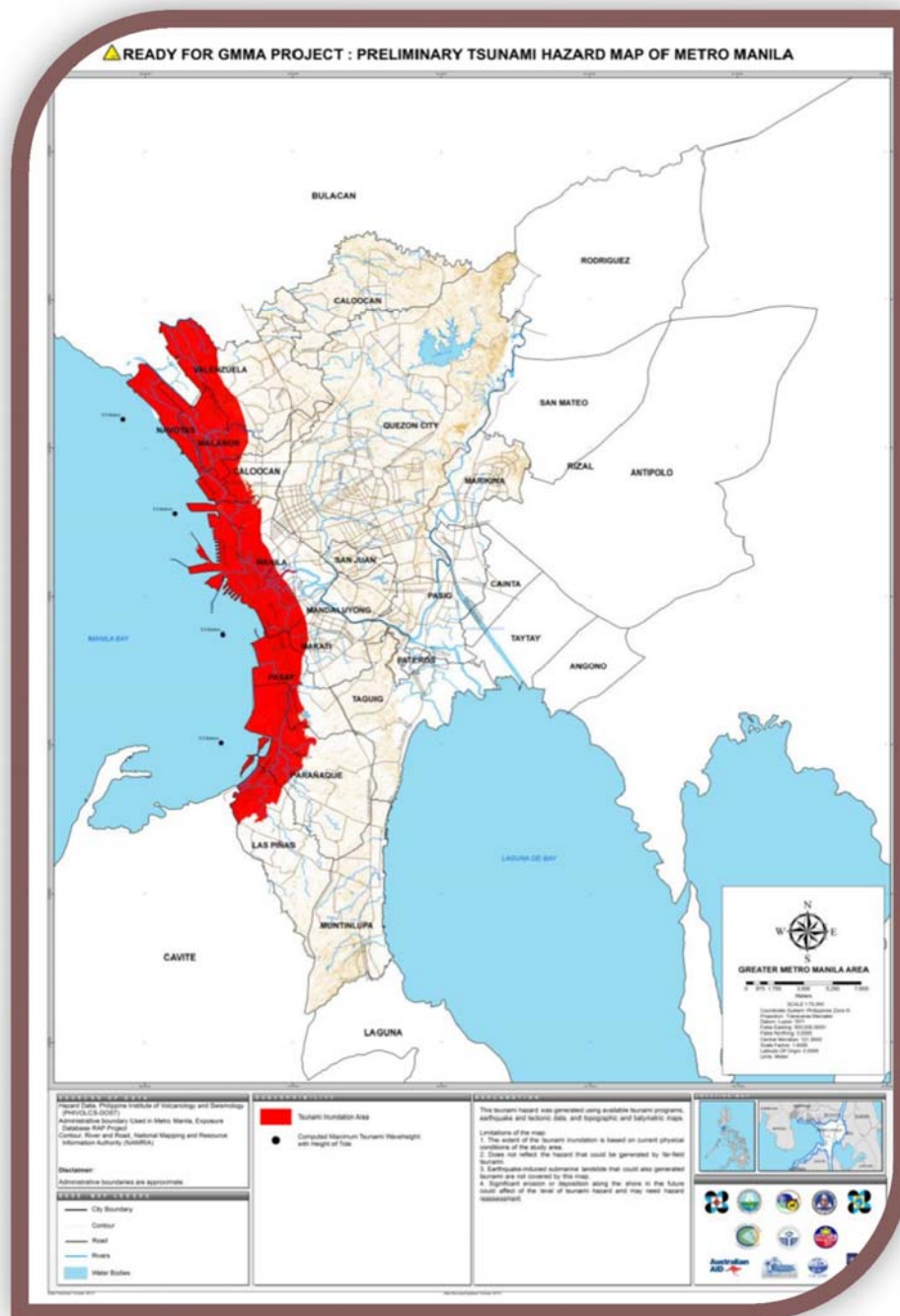


Asteroid impact generated tsunamis pose a further risk, these are much rarer but potentially much more catastrophic events. The Pacific

seaboard is at greatest risk due to the Pacific Ocean representing a large target. Metro Manila, being on the western side, is at a much reduced risk.

### What to do:

- In the event of significant ground shaking immediately move away from the coast and low lying areas, to higher ground or to higher floors in solid concrete structures that appear to be in good shape after the initial quake. Wait for the all clear.
- A tsunamis will likely arrive within the hour and could arrive in a matter of minutes, so do not delay in finding safety.
- High rise buildings in Manila Bay and along Pasig River will likely offer the quickest route of escape as traffic is usually bad and considerable distances must be covered to reach higher ground. If the building seems structurally sound after the earthquake then it's probably your best option. Move to the fifth floor or higher.



Above: Preliminary tsunamis hazard map of Metro Manila. Credit: Philippine Institute of Volcanology and Seismology (PHIVOLCS-DOST) and Solidum R. U. (2015) Earthquake Hazards and Risk Scenario for Metro Manila and Vicinity: the Need for Whole of Society Preparedness.

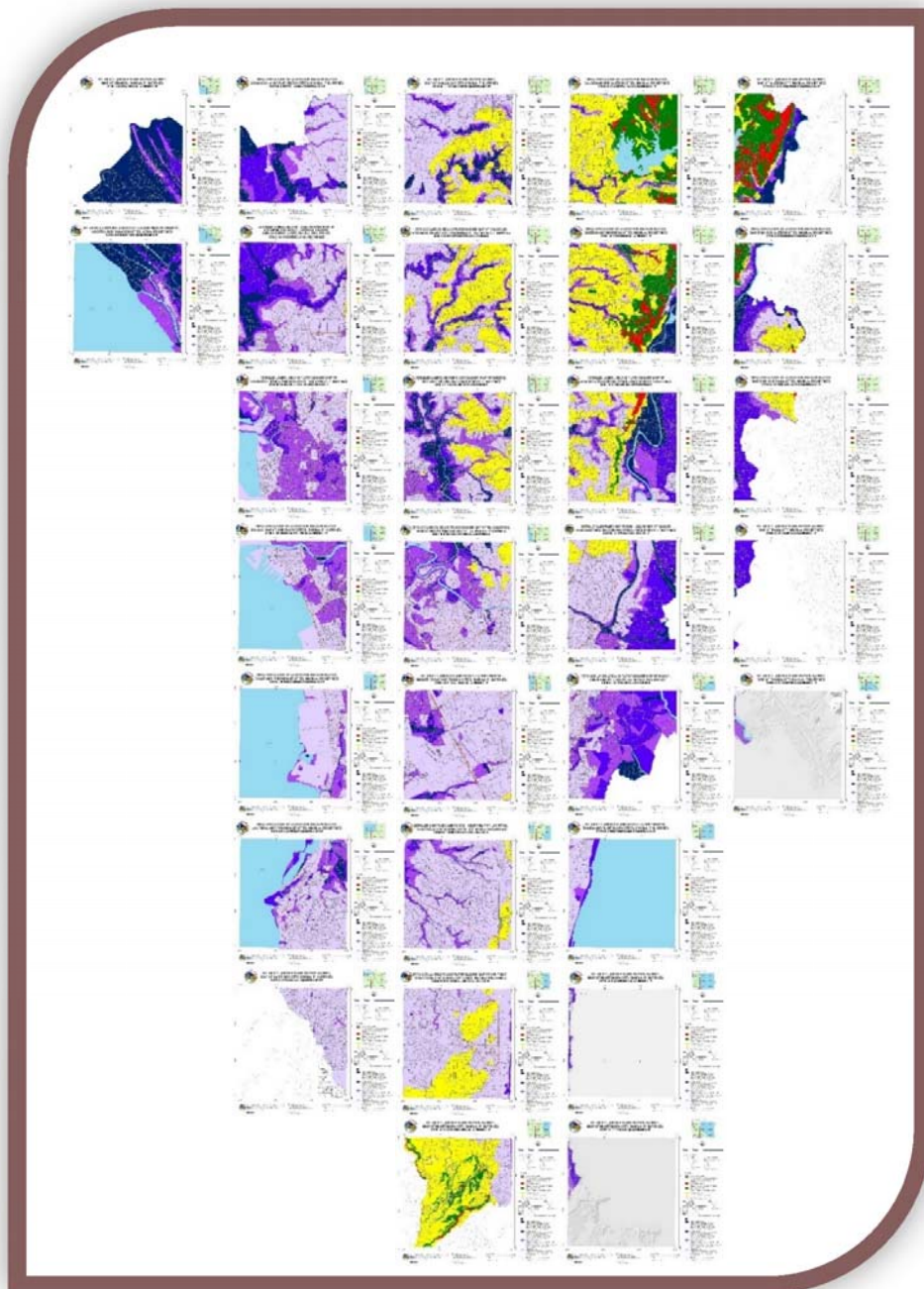
### Resources:

- Tsunamis Modelling in Manila Bay:  
<http://www.preventionweb.net/english/professional/maps/v.php?id=10603>
- Presentation: <http://carlospromulo.org/wp-content/uploads/2015/05/Metro-Manila-Earthquake.pdf>

## Landslides (Earthquake & Meteorological)

### The Risk:

Below: Landslide and Flood Risk Maps from the Mines and Geoscience Bureau. Yellow indicates low landslide risk, green is moderate landslide risk and red is high landslide risk. Flooding is indicated in dark purples and blues. Credit: Mines and Geoscience Bureau.



Due to the generally flat topography in Metro Manila, the earthquake induced landslide risk is relatively low for the most part. Risk is higher along the Valley Fault scarps and in any areas with a higher gradient. The Mines and Geoscience Bureau have produced landslide and flood maps which can be found online.



Landslides can be induced by heavy rains which add weight and lubricate the soils. They can also be induced by ground shaking from an earthquake. Risk may be increased if an earthquake occurred in the wet season.

*Left: An earthquake induced landslide during the 2001 El Salvador quake. Credit: Photograph courtesy of the U.S. Geological Survey. The USGS home page is <http://www.usgs.gov>*

### What to do:

- Consult the maps and understand the risks. Landslides are predictable, timings are not.
- If you are at high risk then consider relocating.
- Following an earthquake, be aware that aftershocks may cause further landslides.

### Resources:

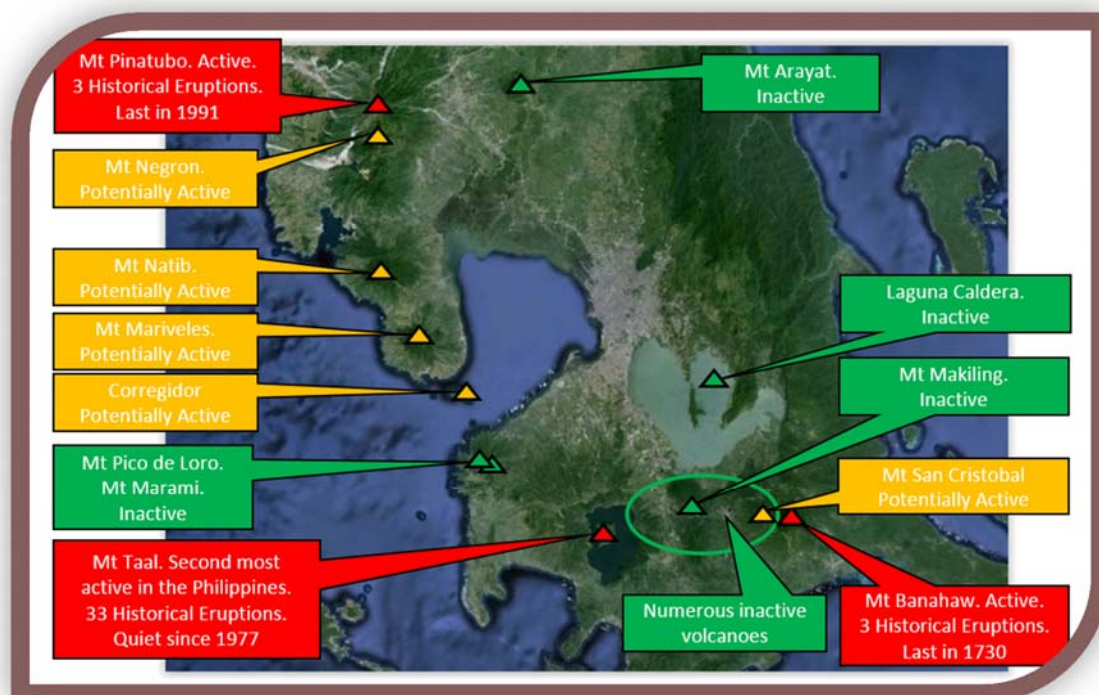
- Click on the 'Geohazard Map Visualization on Google' and log in for the most detailed maps. <http://www.mgb.gov.ph/lhmp.aspx>
- Easily accessible maps are found on <http://www.nababaha.com/>

## Volcanic Eruptions

### The Risk:

There are numerous volcanoes within the general area of Manila.

Probably the greatest threat to Manila is Taal Volcano in Tagaytay. It is unlikely to cause major problems in Metro Manila. The ash may result in closure of the International NAIA Airport. The ash may also be a nuisance and reduce air quality. Taal Volcano is closely monitored and one would likely receive a few weeks warning of a possible eruption with Taal Volcano Island being evacuated.



Above: Volcanoes in the vicinity of Metro Manila. Credit: A. Whymark utilising data from Google Earth and PHIVOLCS-DOST.

### What to do:

- Follow instruction – if an area is declared a no-go zone or you are told to evacuate parts of Tagaytay (a popular retreat for those living in Manila) then please respect these limits and avoid dangerous sight seeing.
- If ash is present in the air use dust masks and stay indoors.
- Flights may be re-routed. Clark is a secondary hub and may be usable. Boats are functional for internal transportation, weather permitting.

### Resources:

- For volcano alert levels and advisories visit <http://www.PHIVOLCS.dost.gov.ph/>

## Flooding (Meteorological)

### The Risk:

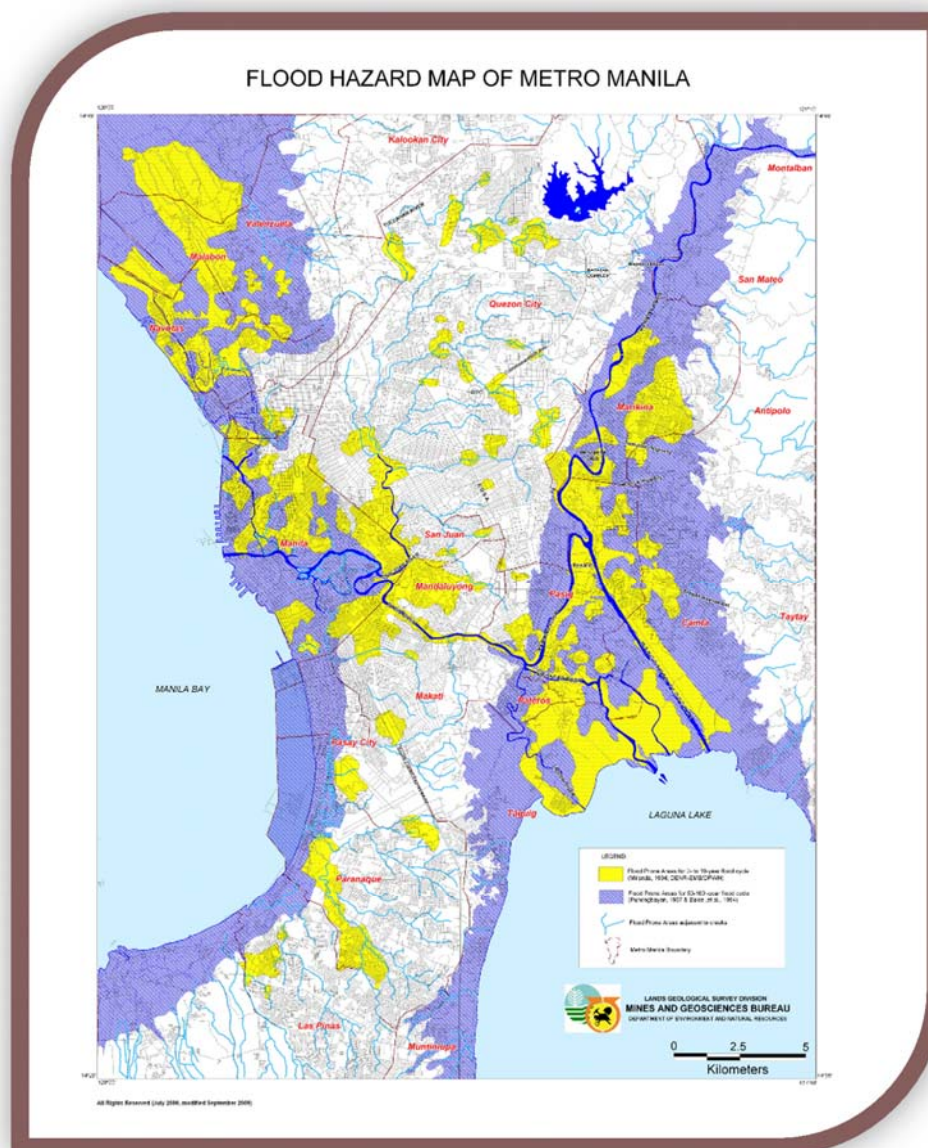
Large areas of Manila are subject to flooding. In fact some areas will flood after almost every thunderstorm and the inhabitants will have raised level properties or raised barriers in front of doors. Localised flooding is an inconvenience, but occasionally a slow moving tropical depression, tropical storm or typhoon will cause severe and sometimes deadly flooding within Metro Manila. Flooding is most common in the wet season from May to November.

*Right: Flooding in Manila (Sept. 17, 2007). Credit: United States Navy Photograph, ID 090927-N-0120R-002*



### What to do:

- Always research a possible home in terms of flooding to avoid an unpleasant surprise. Utilise the NOAA maps and ask neighbours.
- Where possible, do not live in properties subject to flooding.
- In the future weather may become more extreme with global increases in temperature, therefore review the worst case flood scenario and assume it may become more frequent.
- Take heed of government warnings and avoid unnecessary travel.
- Do not drive into water of unknown depth.
- Take extra precaution if near a stream. These act as open sewers and may smell in dry periods and may contaminate adjacent land with sewerage in times of flooding.
- Do not be tempted to play in flood waters. Leptospirosis in the water may enter through eyes, mouth, nose, or any open cuts in the skin. Rats are displaced during flooding and may spread disease.
- Flash flooding has occurred in the past. Have a route up to safety – a second or third floor or roof access. Have sufficient food and water to survive at least 3-4 days trapped if you are in a high risk area.
- Properties subject to flooding may be on softer sediments or on artificially raised land and therefore more prone to earthquake damage if foundations are insufficient. Use flooding as a cue to check liquefaction susceptibility.



Above: Overview of flooding in Metro Manila. Yellow areas are the most flood prone, purple less so. Note how the NNE-SSW trace of the West Valley Fault is very evident on this map with the down-thrown block to the east being more flood prone with river channels paralleling the fault trace. Note also a less prominent NNW-SSE linear feature crossing at Taguig. Credit: Mines and Geoscience Bureau from [http://www.preventionweb.net/files/24897\\_metromanilafloodhazardmap40kvl1.jpg](http://www.preventionweb.net/files/24897_metromanilafloodhazardmap40kvl1.jpg)

### Resources:

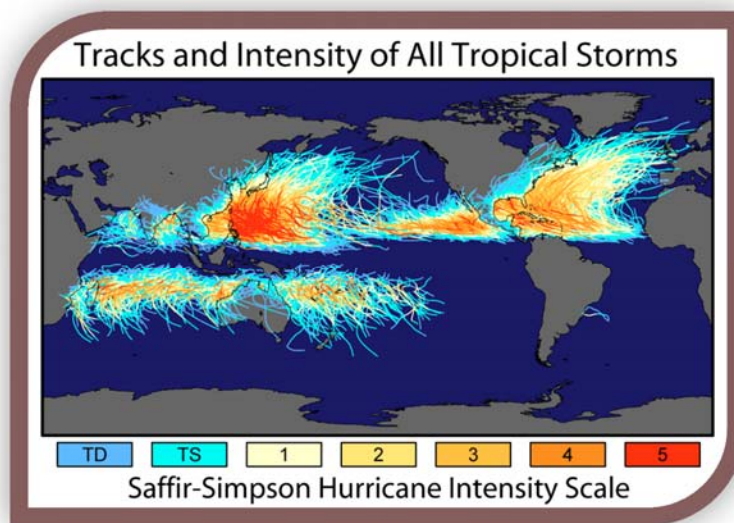
- The most accurate and detailed flood maps can be found at <http://noah.dost.gov.ph/> and <http://www.nababaha.com/>
- For information on a current situation visit <http://web.pagasa.dost.gov.ph/>, note that this site is often down when there is heavy traffic, but PAGASA also has a Facebook page and information will be broadcast on news and radio channels. Dam levels are also indicated on this site.



## Typhoon (Meteorological)

### The Risk:

The northern and central parts of the Philippines are amongst the most prone places in the world to experience typhoons (known as Hurricanes and Cyclones elsewhere). Fortunately Metro Manila is somewhat sheltered by land masses to the east. That said, even weak typhoons are damaging and some very strong typhoons do hit Metro Manila. On average, 19 typhoons hit the Philippines each year and a couple normally impact Metro Manila. Typhoons can occur any time of the year, but are more frequent in the wet season, mainly July to November, peaking August to September.



*Left: Global tracks and intensity of tropical typhoons, showing the Philippines to be of particularly high risk. Image Credit: NASA.*

### What to do:

- Pay attention to track forecasts and storm signal warnings.
- Prepare. Ensure stocks of food and water. Charge emergency lights (buy in advance – they sell out before a storm).
- If necessary move away from the coast. Move into a solid concrete building.
- Do not travel by boat if a typhoon is a possibility.
- During the storm do not go out on a look-see (on foot or by car). Trees and branches may fall on you, as may tiles, windows and stone cladding in built-up areas.
- Things get back to normal within a day or so, but you may have no power for a week in subdivisions.
- Consider buying a generator well in advance if you cannot live without power. Research carefully the size you need before spending any money (do not impulse buy).

### Resources:

- Monitor the typhoon on <http://web.pagasa.dost.gov.ph/>. This site is often down in times of heavy traffic. Another great source of information is <http://www.typhoon2000.ph/> which will give you access to satellite images and storm tracks from various government agencies. <http://www.tropicalstormrisk.com/> is useful for storm track and strength and gives you the heads up before the typhoon enters the Philippine Area of Responsibility.

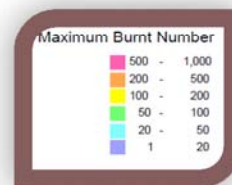
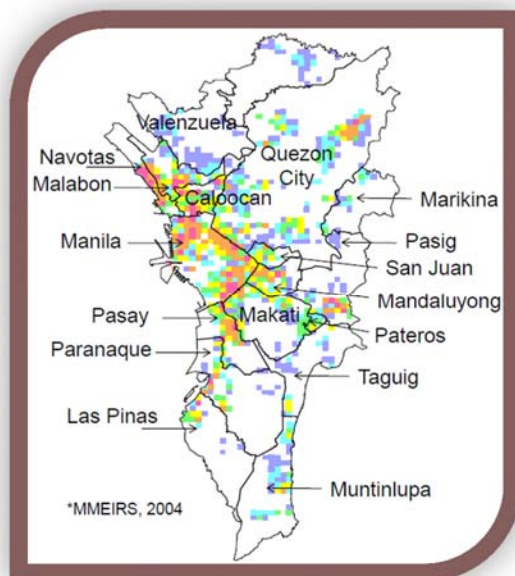
## Fire (Earthquake & Meteorological)

### The Risk:

In the aftermath of a large earthquake, Manila will burn. The greatest risk will be to liquefaction prone, high density, informal settlements with plenty of ignition sources, burnable materials and poor access. Up to 500 simultaneous fires will burn out of control as roads are inaccessible, water

mains are burst and fire trucks buried in rubble. Whole blocks will be destroyed and around 18,000 further lives may be lost.

Fires are not uncommon in Manila and are often associated with electrical short circuits during flooding.



Right: Fire outbreak map (Model 08), following a 7.2 magnitude earthquake in Metro Manila. Credit: Earthquake Impact Reduction Study for Metropolitan Manila in the Republic of the Philippines (2004) and Solidum R. U. (2015) Earthquake Hazards and Risk Scenario for Metro Manila and Vicinity: the Need for Whole of Society Preparedness.

### What to do:

- Ensure you have adequate fire escapes (and window grill escapes) and ensure they are never locked.
- Ensure your home and work place have ABC fire extinguishers positioned near exits.
- Have a very minimum of one smoke alarm in your house, which is tested monthly.
- Plan where to meet up with family in the event of fire – designate an open area.
- Turn off gas and power after an earthquake.
- Check electrical wiring in advance. In the Philippines joining cables with tape and not proper connectors is commonplace. These wires easily work loose and may short circuit.
- Save yourself, do not attempt to save property or valuables.
- Do not use candles or oil lamps following an earthquake (except wide out in the open) due to risk of aftershocks. Use battery or solar torches instead.

### Resources:

- Earthquake Impact Reduction Study: [http://ndrrmc.gov.ph/attachments/article/1472/Earthquake\\_Impact\\_Reduction\\_Study\\_Volume\\_1.PDF](http://ndrrmc.gov.ph/attachments/article/1472/Earthquake_Impact_Reduction_Study_Volume_1.PDF)  
[http://ndrrmc.gov.ph/attachments/article/1472/Earthquake\\_Impact\\_Reduction\\_Study\\_Volume\\_2.PDF](http://ndrrmc.gov.ph/attachments/article/1472/Earthquake_Impact_Reduction_Study_Volume_2.PDF)
- Presentation: <http://carlospromulo.org/wp-content/uploads/2015/05/Metro-Manila-Earthquake.pdf>

## Security (Earthquake)

### The Risk:

The aftermath of disaster can bring out both the best and worst in people. Following Typhoon Yolanda (Haiyan) a breakdown in law and order was witnessed. In Metro Manila this is unlikely to happen in response to a typhoon or flood event, but is a prime example of how one might expect the aftermath of a large earthquake to unfold. One can expect shops and malls to be looted, not just for food, but also for high end goods. Private homes are likely to be less prone to mass looting. Isolated incidents of rape and violence may also occur.

### What to do:

- Be prepared. Have an emergency bag or simply routinely overstock your cupboards with 10 days to 2 weeks of food. You should have no need to go near a shop or mall.
- Do not explore, especially at night. You may get caught up in a bad situation.
- Avoid impersonal shops and malls. Residential areas will probably be less prone to large scale looting.
- Do not loot and avoid crowds of looters. Shooting incidents can realistically be expected.



- If you are caught up in a crowd, try to blend in, go with the crowd and in the same direction until you can get to the edge and find an escape route.
  - Do not be a have-a-go hero or lecture someone. Risking yourself to save property is not worthwhile. Possessions are always secondary to any person's life.
  - Stick with a group of friends, neighbours or colleagues. If you are in a secure condominium, compound or subdivision then stay there and avoid the temptation to explore.
- To protect from being looted invest in barriers, fences, security locks and window grills in advance. Sand bags can be used for re-building barriers (as well as flood control). Move valuables out of sight. A dog, a gun sticker or even a cut-out cardboard person can be a deterrent. If you look like a harder target or less appealing than your neighbours, you are less likely to be looted. Groups of homeowners patrolling may also deter isolated looters, but you should not take the law into your own hands.
  - Have comprehensive home insurance.

### Resources:

- Information: <http://survivalife.com/2014/09/17/7-tips-for-surviving-a-mob-of-looters-2/>
- Information: <http://www.colorado.edu/hazards/o/archives/2007/mar07/mar07.pdf>

## Lack of Preparation (Earthquake & Meteorological)

### The Risk:

In the aftermath of a catastrophic event, government and aid organisations will be extremely thin on the ground. Furthermore, supply routes may be inaccessible. With forward planning you will be able to help yourself and your family, freeing up agencies to help those truly in need. Aim for self help and mutual help within your local community.

### What to do:

- BEHAVIOUR
  - Arrange a post-quake meeting point for your family in a safe and open area like a park.
  - Have a single relative out of town that everyone can contact to relay messages.
  - Practise earthquake drills and know what to do at home, work, school and in a car.
  - Have a medium-term plan on where to go following a large Earthquake, once the road network is re-established – maybe you have family in the provinces?
- SUPPLIES
  - Always have at least 10 days to 2 weeks of food in the house. Buy new food when you have 2 weeks supply left, not when you run out.
  - Always have at least 10 days to 2 weeks supply of baby milk / food and essential medicines.
  - Have 10 days to 2 weeks supply of water at home and a basic water purification kit. If an earthquake hits try and gather and store as much water as possible as pipes may be broken.
  - Consider having a full bug out bag (example items to be found on the next page).
  - Consider storing basic rescue tools (example items to be found on the next page).
  - Have at least 1 torch (solar power or batteries is ideal). Avoid candles / open flames.
- HOME SAFETY REVIEW
  - Review your house for a seismic retrofit. It costs one tenth to retrofit compared to rebuilding and it can save your life.
  - Review the positioning of hazardous objects and ensure tall furniture is secured to walls.
  - Ensure adequate unlocked escape routes in the event of fire or earthquake.
  - Always have at least one smoke alarm and ABC fire extinguisher in the house.
  - Quake Alarms (physical or phone app) may wake you and give a few seconds warning.
  - Know how to shut off electricity, gas and water.
  - Review home security (fences, gates, grills, etc.) but ensure escape is not blocked.
  - Get earthquake insurance – it's probably your best investment.



### Know what to do in an earthquake:

In the event of an earthquake you should know precisely what to do.

- You have rehearsed your earthquake drill.
- You have checked and have confidence in the structure you are in.
- You have secured furniture and loose objects.



**In a Building:** The DROP, COVER and HOLD ON method is recommended. If possible move away from windows and falling hazards when the shaking starts and, if you can, turn off gas and extinguish open flames. In an earthquake you need to protect your head from falling ceilings, furniture and objects. The sturdier the furniture the better, but you will likely have little choice. You can also grab a pillow or chair cushion to protect your head. Plan ahead by keeping water and a torch under your bed or desk.

The 'Triangle of Life' offers an alternative method, but is not recommended. It is said that by being next to, rather than under, a sturdy piece of furniture there will be a survivable space should the building collapse. Unfortunately you may well be killed by the china display cabinet falling on your head and chances are your building wasn't going to collapse anyway.

Avoid the temptation to rush outside as falling masonry, tiles and windows can kill. If you are inside, stay inside and do not move rooms, simply DROP, COVER and HOLD ON where you are.

If you are in a modern packed stadium, cinema, theatre, nightclub or mall then do not rush for the exit. You may be trampled or crushed. Simply DROP, COVER and HOLD ON. Protect your head and neck as best as possible. Go under something or between chairs. Leave in an orderly manner after the quake. Do not use lifts / elevators. Historic public buildings, including old churches, will be more prone to collapse and one should calmly but quickly evacuate these if possible.

**Outdoors:** Stay in the open. Stay away from buildings and electrical lines. Drop to the floor.

**In a Vehicle:** Stop the car immediately in an open area if possible, put on hand brake and hazard lights. If on an open road or on a skyway then stay in the vehicle with your seatbelt fastened. If beneath a skyway you may wish to vacate your vehicle and move to an open area. Stay away from

buildings and falling debris. If not safe to vacate then curl up and get in the foot well. If electrical lines fall on the car then stay in the vehicle. If you drive home, do so slowly and cautiously.

**In a high risk area:** If downstream from a dam move to higher ground. The dam may be compromised.

If by the coast, immediately move to higher ground or higher floors in solid buildings as a tsunamis may follow within a short time.

If in a landslide prone area then move to safer ground, aftershocks may cause more landslides.

Expect aftershocks. Vacate dangerous areas and buildings.



*Credit: U.S. Geological Survey photograph.*

### Choosing a place to live

If you are looking for a safe place to live in Manila, examination of the flood hazard maps or liquefaction maps gives the big picture. Avoid low lying areas that flood, flooding is frequent in Manila and can be both hazardous and inconvenient. These same strongly flood prone areas will fair badly in earthquakes due to strong ground shaking brought on by liquefaction of the soft underlying sediments. These most heavily damaged areas will also have the majority of the earthquake related fires. Many of the same low lying areas, particularly in the Manila Bay area are subject to earthquake tsunamis and typhoon storm surges.

Aim to live on relatively higher ground, but avoid slopes which often correspond to landslide risk areas and proximity to the fault line. It would be advisable to be 300 metres from the mapped fault line in order to be certain you are in a safer area. If closer, you should evaluate risk with geomorphological analyses of the extent of the deformation zone and historic scarps.

The safer areas are the higher ground forming a broad central swathe to the west of the West Valley Fault. This area encompasses much of Las Pinas, Paranaque, Makati, Fort Bonifacio, Mandaluyong, Ortigas, San Juan, Quezon City and Kalookan City. These areas typically have solid rock or firm soil foundations and buildings will fare better despite proximity to the fault line.

The safest structures to be in are the modern high rise buildings with 30-60 floors. Modern buildings should be to current code. In low rise housing, one needs to evaluate the property and retrofit if needed. Modern architect designed and retrofitted buildings should be safe.

The most likely Scenario for a proximal earthquake would be either along the East Valley Fault or the northern part of the West Valley Fault from Quezon City, Marikina and up to Taguig. This northern segment is locked and has a very pronounced scarp slope. The surface rupture may extend further south through Muntinlupa, but to the south the scarp slope becomes less pronounced and in places the fault is creeping, which relieves stresses.

## Items to have available in case of emergency:



### Sustenance

- Non-perishable packaged or canned food (e.g. canned tuna, sweetcorn, beans, spam, corned beef, high energy snack items like nuts). Always have two weeks supply in your cupboard and rotate. Rice, pasta, oatmeal, noodles are also functional and easy to keep in stock, but bear in mind these use a lot of water to prepare. Make it a habit to always have 10 days to 2 weeks supply of food in the house. Never run out before re-stocking.
- Any special foods and supplies for babies, the disabled or the elderly. You won't be able to buy baby milk, so keep some ready and rotate every few months.
- Plastic eating utensils, paper cups and plates.
- Manual can opener.
- A gallon of water per person per day – you may have a storage tank – don't waste this water. (Filter water using cloth / paper towel / coffee filter, boil for 1-3 minutes, cool).
- Water purification kit or unscented liquid bleach (Filter using cloth / paper towel / coffee filter, add 6-8 drops per gallon / 4.5 litres / 8 pints of water. Wait 30 min. Water should have a slight chlorine odour. If not then repeat and stand for 15 min. If no odour then discard. If odour too strong let water sit for a few hours).

### Medical & Hygiene

- First aid kit and handbook (maybe even do a first aid course).
- Essential medication required. Paracetamol and diarrhoea tablets should be kept.
- Toilet paper, basic toiletries, soap, diapers and feminine hygiene items.
- Paper towels / wet wipes.
- Alcohol Disinfectant.
- Dust masks

### Shelter

- Two tarps (used billboard tarpaulin / lona / trapal), 8 feet by 10 feet or camping tents.
- Large pop-up canopy tent for community gathering point (optional).
- Mosquito net.
- Coils of rope and wire; Duct tape.
- Flashlight, with spare batteries. Modern solar powered lamps are ideal. Candles should be used with extreme caution and outside only due to aftershocks creating fire risks.
- Heavy-duty aluminium foil.
- Knife or razor blades, scissors.
- Camping stove, fuel and saucepan.
- Portable radio and battery.
- Matches in waterproof container.
- Large and small plastic bags / bin bags.
- Water and fuel containers.
- Generator (optional).
- ABC Fire extinguishers.

### Communication / Documents

- Paper, pens, markers for signs/posters.
- Telephone numbers – your phone may not work.
- Road maps if required
- Important documents or copies (passport, insurance, financial, etc.). Consider digitising.
- Cash and small change. Big bills will be useless and ATM's will not function.

### Rescue and Construction Tools

- Work gloves.
- Small tool kit including hammer and nails.
- Larger tools: Machete or axe; Shovel; Crowbar; Bolt Cutters.
- Car Jacks – Bottle Jacks are cheap and used to lift concrete slabs. We should all keep a couple.

## Resources:

- Metro Manila Preparation: <http://www.bepreparedmetromanila.com/>
- Metro Manila Earthquake Drill: <http://www.metromanilashakedrill.com/>
- Earthquake preparedness: <http://earthquake.usgs.gov/learn/preparedness.php>
- Earthquake preparedness: <http://www.seattletimes.com/seattle-news/get-ready-to-rumble-a-guide-to-earthquake-preparedness/>
- Earthquake preparedness: <http://www.fema.gov/media-library/assets/documents/7877>
- Earthquake preparedness: <http://www.utah.gov/beready/earthquakePreparedness.html>

## Building Design and Maintenance (Earthquake)

### The Risk:

**Structure:** Within the Philippines buildings have to contend with typhoons, flooding and earthquakes. This poses a unique problem for building design. An open story design to cope with flooding or a heavy roof to cope with typhoons, may not be the best design in an earthquake. It is therefore absolutely critical to live in properly designed or retrofitted buildings.

In the event of a 7.2 magnitude earthquake this is the expected building damage:

|                              |               |                 |
|------------------------------|---------------|-----------------|
| Residential Building Damage  | Heavy - 12.7% | Partly - 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%    |

Source: Metro Manila Earthquake Impact Reduction Study, 2004 – JICA, PHIVOLCS, MMDA.

**So, to dispel the myth, modern high rise buildings in Metro Manila are by far the safest buildings to be in when an earthquake strikes. Additionally, most modern high rises are on solid rock of the up-thrown block, which is the safest place to be. Low floors in high-rise condominiums are probably optimal as lifts will be out of action following a quake.**

Mid-rise buildings in Metro Manila should be taken on a case-by-case basis. Most are architect designed, which is advantageous. Modern builds are likely to be the safest. Older buildings may not be up to the current code.

Low-rise buildings, for the most part houses, are variable in design. They may not have been architect designed or reviewed from a seismic perspective. Modern constructions are more likely to be up to code.

**Fixtures:** The fixtures should be precisely that – FIXED! Furniture and heavy items turn into projectiles in an earthquake. This is why the DROP, COVER and HOLD ON method is recommended. You should be protecting your head from falling ceilings, bookcases and objects. By forward planning you can not only reduce the hazard to yourself, but also save your valuables and treasured heirlooms!

*Right: Furniture and heavy objects fall during a large earthquake. It is important to secure items. During an earthquake practice DROP, COVER & HOLD ON method. Credit: 清水区震度5強-写真共有サイト「フォト蔵」, [https://commons.wikimedia.org/wiki/File:Shizuoka\\_earthquake\\_struck\\_room\\_20090811.jpg](https://commons.wikimedia.org/wiki/File:Shizuoka_earthquake_struck_room_20090811.jpg)*





## What to do:

**Structure:** To evaluate your home or a potential home ask questions like:

- Was it architect designed?
- When was it built – pre-1992?
- Has it been seismically evaluated or retrofitted?
- Is the house well maintained, any old cracks?
- Is it a regular shape? Does it have over-hangs?
- Is it built on a slope?
- Does it have wide open areas such as Lanai or garage with no walls between columns?
- Has it had extra floors added?
- Are the walls 4 inches or 6 inches thick?
- Are unsupported walls more than 3 m wide?
- Am I on soft river sediment or solid soil / rock?
- Does the house feel solid and constructed well?



Use these questions to get a feeling for the construction, but at the end of the day the only way to be certain is to have a seismic review of the property done. You ideally need full architect drawings so that rebar, foundations, etc. can be reviewed. **A seismic retrofit is ten times cheaper than rebuilding your home and it may save your life!**

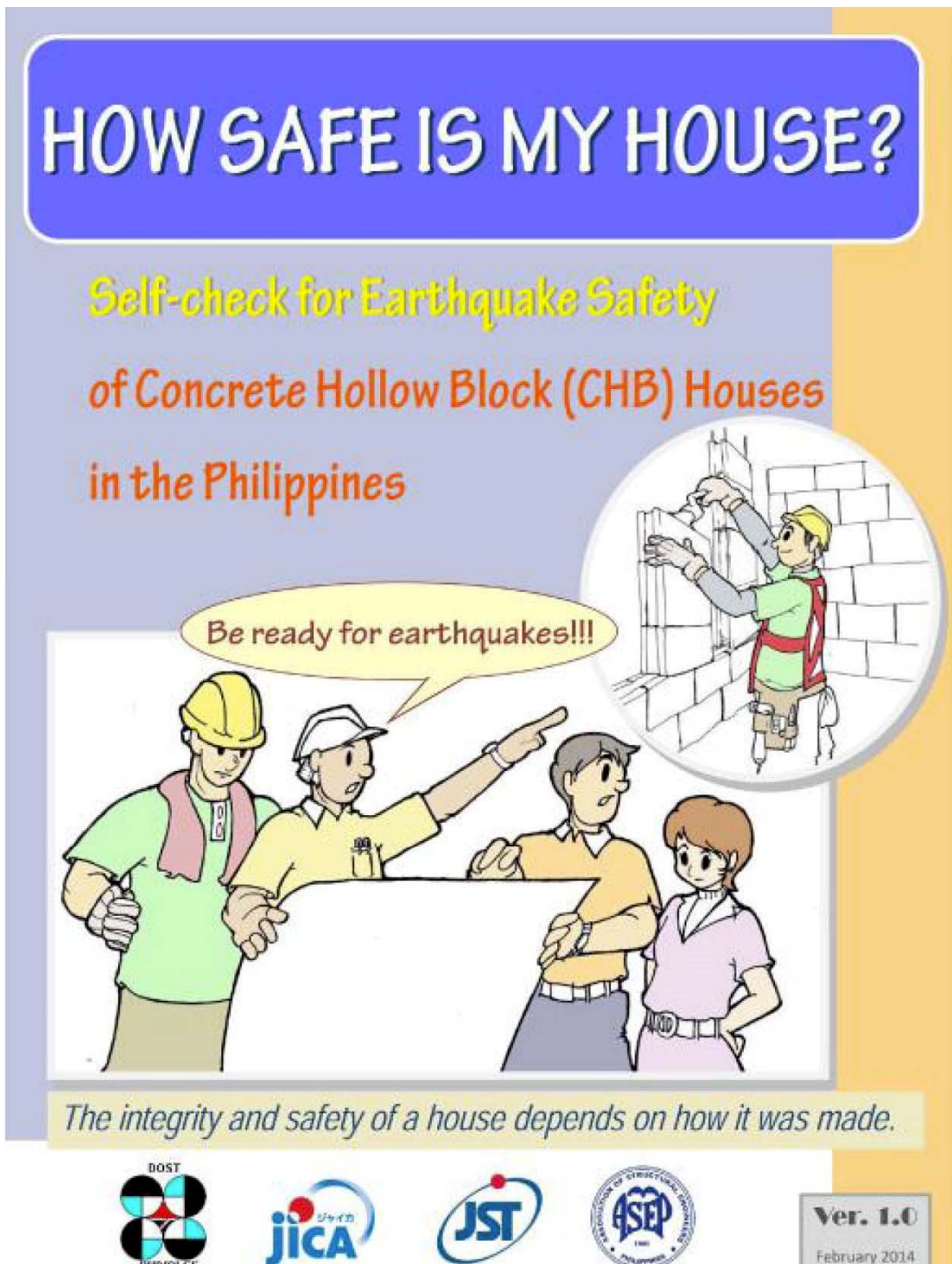
*Above Right: Tilted Victorian home at Howard and 17th Streets in the Mission District of San Francisco showing liquefaction-related damage from the 1906 earthquake. Photograph by G.K. Gilbert of the U.S. Geological Survey. [http://geomaps.wr.usgs.gov/sfgeo/liquefaction/image\\_pages/tilted\\_victorian.html](http://geomaps.wr.usgs.gov/sfgeo/liquefaction/image_pages/tilted_victorian.html)*

**Fixtures:** If you are happy with the structure then turn your attention to the interior:

- Secure tall cupboards, bookcases and heavy furniture to walls with L-brackets.
- Heavy objects should be placed close to ground level.
- Use blu-tack, museum putty, velcro or invisible nylon cord to secure display items.
- Ensure picture and mirror hooks are secure.
- Make sure that cupboards, especially food cupboards close or lock securely so the contents are not thrown out. Shelves can be fitted with bars to prevent falling objects.
- Ensure ABC fire extinguishers are to hand and positioned near an exit route.
- Window films can stop windows from shattering (or use masking tape for aftershocks).
- Evaluate electrical wiring – loose wires may be a fire hazard.
- Keep hallways and escape routes free of objects that may hamper your exit if they fall.
- Brace water tanks and consider flexible hoses. This is your main water supply.
- Ensure there is nothing around your bed that may fall and injure you.

## Resources:

- Checking your house: [http://satreps.PHIVOLCS.dost.gov.ph/images/jica\\_materials/2\\_questionnaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/images/jica_materials/2_questionnaire_chb_english_ver1_0_january20_2014.pdf)
- Preparation: <http://www.wikihow.com/Prepare-for-an-Earthquake>
- Preparation: <http://www.getprepared.gc.ca/cnt/rsrscs/pblctns/rthqks-wtd/index-en.aspx#s4>



ABOVE: A PHIVOLCS-DOST Publication 'How Safe is my House?' Page 1.

[http://satreps.PHIVOLCS.dost.gov.ph/images/jica\\_materials/2\\_questionnaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/images/jica_materials/2_questionnaire_chb_english_ver1_0_january20_2014.pdf)

**OBJECTIVE OF THE TEST**

This "House self-check" serves to understand and evaluate the integrity of your house and its vulnerability to strong earthquakes. The initial result will verify whether your house was properly built and have followed appropriate construction procedures and recommended measures or if it will require necessary strengthening.

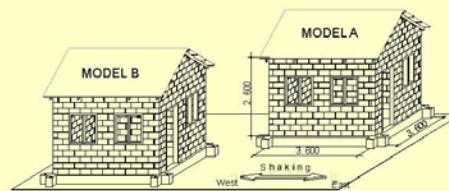
**TARGET USERS / HOUSE TYPE**

This evaluation is initially intended for 1 to 2-storey Concrete Hollow Block (CHB) houses, including those residences with small shops, offices, garages and the like. It will help the house owners of this type to evaluate their houses by themselves and to understand the likely behavior of their houses during a strong earthquake.

**Full scale shaking table test of CHB Houses**

A full-scale shaking table experiment on CHB masonry structures was conducted in Japan to showcase two types of CHB houses. One model represented a code-compliant CHB house (Model A) and the other represented the more common residential CHB house (Model B) in the Philippines. The aim of the test was to better understand the vulnerability of its different parts and sections, the failure pattern and the overall behavior of similar structures during large earthquakes.

For the Philippine CHB houses, the application of mortar is another crucial construction activity that should be given equal importance as with appropriate reinforcements. Mortar should be properly applied and compacted requiring proper mixing, pouring and curing to produce homogeneous fill and bond.



| Specification              | Model A   | Model B  |
|----------------------------|---|--|
| CHB Wall                   | 6" (400x200x150 mm)   | 4" (400x200x100 mm)  |
| Vertical Steel Bars        | 10 millimeter diameter spaced at 40 centimeter                        | 6 millimeter diameter spaced 90 centimeter                           |
| Horizontal Steel Bars      | 10 millimeter diameter spaced at 60 centimeter or laid every 3 layers | 6 millimeter diameter spaced at 60 centimeter or laid every 3 layers |
| Mortar Mix (Cement : Sand) | 1:4 Compacted   | 1:4 Not compacted  |
| Roof Frame / Roofing       | Wood / G.I. Sheets  | Wood / G.I. Sheets   |

**Request and notes to those who distribute this material.**

This method in evaluating CHB Houses was developed as an easy and manageable test for laymen to promote inexpensive yet practical performance evaluation of residential houses against earthquakes and to subsequently disseminate information and strategies for strengthening. It aims to help the house owners enhance their awareness and acquire relevant information by doing the evaluation themselves. This test shall lead to a more detailed assessment with assistance from building experts for what the house owners need to know about their house, allay their fears and confusion and learn what to do thereafter.

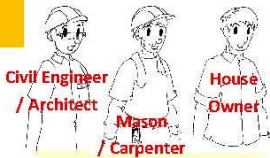
This earthquake disaster awareness material was prepared by the Philippine Institute of Volcanology and Seismology (PHIVOLCS) of the Department of Science and Technology (DOST) in collaboration with the Association of Structural Engineers of the Philippines (ASEP) under the Japan International Cooperation Agency (JICA) - Japan Science and Technology (JST) Project on the " Enhancement of Earthquake and Volcano Monitoring and Effective Utilization of Disaster Mitigation Information in the Philippines".

It is strictly prohibited to change the contents in any way.

ABOVE: A PHIVOLCS-DOST Publication 'How Safe is my House?' Page 2.

[http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica\\_materials/2\\_questionnaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica_materials/2_questionnaire_chb_english_ver1_0_january20_2014.pdf)

**QUESTION 1 Who built or designed my house?**




| Items  | point |
|--|-------|
| A: Built or designed by a licensed civil engineer/architect. | - 1   |
| B: Not built by a licensed civil engineer/architect.         | - 0   |
| C: It is not clear or unknown.                               | - 0   |

This question refers to the person who supervised the building of the house.

---

**QUESTION 2 How old is my house?**




| Items                          | point |
|--------------------------------|-------|
| A: Built in or after 1992.     | - 1   |
| B: Built before 1992.          | - 0   |
| C: It is not clear or unknown. | - 0   |

This checks if your house was built under more recent earthquake-resistant building standards.

---

**QUESTION 3 Has my house been damaged by past earthquakes or other disasters ?**

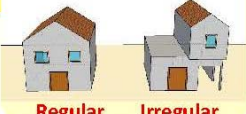


| Items                          | point |
|--------------------------------|-------|
| A: NO or YES but repaired.     | - 1   |
| B: YES but not yet repaired.   | - 0   |
| C: It is not clear or unknown. | - 0   |

This checks if the house sustained structural damage and had undergone repair works.

---

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

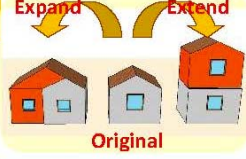


| Items   | point |
|---|-------|
| A: Regular (symmetrical, rectangular, box-type, simple) | - 1   |
| B: Irregular/Complicated.                               | - 0   |
| C: It is not clear or unknown.                          | - 0   |

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

---

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

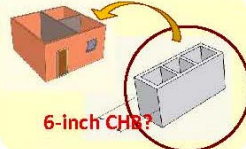


| Items  | point |
|--|-------|
| A: NO or YES but supervised by a civil engineer/architect. | - 1   |
| B: YES, but not supervised by a civil engineer/architect.  | - 0   |
| C: It is not clear or unknown.                             | - 0   |

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

---

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



| Items                             | point |
|-----------------------------------|-------|
| A: YES, it is 6-inch              | - 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.

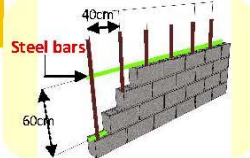


Enhancement of Earthquake and Volcano Monitoring and Effective Utilization of Disaster Mitigation Information in the Philippines

ABOVE: A PHIVOLCS-DOST Publication 'How Safe is my House?' Page 3.

[http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica\\_materials/2\\_questionaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica_materials/2_questionaire_chb_english_ver1_0_january20_2014.pdf)

**QUESTION 7** **Are steel bars of standard size and spacing used in walls ?**

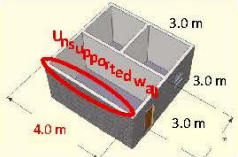


| Items   | point |
|---|-------|
| A: YES (10mm diameter, tied and spaced correctly) . | - 1   |
| B: NO, fewer and smaller than 10mm.                 | - 0   |
| C: None or Unknown.                                 | - 0   |

This checks if standard size and spacing of steel bars were used as reinforcement.

---

**QUESTION 8** **Are there unsupported walls more than 3 meters wide?**




| Items   | point |
|---|-------|
| A: NONE, all unsupported walls are less than 3m wide.       | - 1   |
| B: YES, at least one unsupported wall is more than 3m wide. | - 0   |
| C: It is not clear or Unknown.                              | - 0   |

This checks if the wall is properly supported from falling down.

---

**QUESTION 9** **What is the gable wall of my house made of ?**




| Items  | point |
|--|-------|
| A: Light materials, properly anchored CHBs, no gable wall. | - 1   |
| B: Not properly anchored CHBs, Bricks, Stone.              | - 0   |
| C: It is not clear or Unknown.                             | - 0   |

This checks if the gable wall is properly supported by sufficient steel bars or by a lintel beam.

---

**QUESTION 10** **What is the foundation of my house?**




| Items                               | point |
|-------------------------------------|-------|
| A: Reinforced concrete.             | - 1   |
| B: Stones or unreinforced concrete. | - 0   |
| C: It is not clear or Unknown.      | - 0   |

This checks if the foundation is properly constructed to support the walls.

---

**QUESTION 11** **What is the soil condition under my house?**




| Items                          | point |
|--------------------------------|-------|
| A: Hard (rock or stiff soil).  | - 1   |
| B: Soft (muddy or reclaimed) . | - 0   |
| C: It is not clear or Unknown. | - 0   |

This checks if the house was built over a stable or stabilized ground.

---

**QUESTION 12** **What is the overall condition of my house?**



| Items                          | point |
|--------------------------------|-------|
| A: Good condition.             | - 1   |
| B: Poor condition.             | - 0   |
| C: It is not clear or Unknown. | - 0   |

This describes the overall physical state of the house and checks defect or any deterioration.

---

Your information \_\_\_\_\_  
 Name: \_\_\_\_\_ Address: \_\_\_\_\_

ABOVE: A PHIVOLCS-DOST Publication 'How Safe is my House?' Page 4.

[http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica\\_materials/2\\_questionnaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica_materials/2_questionnaire_chb_english_ver1_0_january20_2014.pdf)

|                     |   |   |
|---------------------|---|---|
| <b>Score</b>        | <b>Please sum up the points of question 1 to 12.</b>      |   |
|                     | <b>Total</b>  | <b>Evaluation and Next steps</b>  |
|                     | <b>11 - 12 points</b>                                     | ➔ <b>Though this seems safe for now, please consult experts for confirmation.</b> |
|                     | <b>8 - 10 points</b>                                      | ➔ <b>This requires strengthening, please consult experts.</b>                     |
| <b>0 - 7 points</b> | ➔ <b>This is disturbing! Please consult experts soon.</b> |   |

**COMMENTARY AND RECOMMENDATION FOR SAFER CHB HOUSES**

The National Building Code, the National Structural Code of the Philippines and the Full Scale Shaking Table Test for CHB Houses emphasizes adherence to design standards and proper construction implementation for CHB type of structures in the Philippines. The walls of CHB houses play a vital function as the main support of the structure. The code prescribes the use of at least 6" (150mm) thick CHB reinforced with vertical and horizontal steel bars with a minimum diameter of 10 millimeters spaced at 40 centimeters and 60 centimeters on center respectively. It also highly recommends that all CHB cells and joints are filled and compacted with mortar using the correct mix of 1 part of cement to 4 parts (1:4) of washed river sand.

This safety evaluation tool intends to provide more understanding and guidance whether your CHB house conformed with the minimum construction standard.

- It is assumed that building construction standards were most likely observed if authorized people took charge of the construction.
- It rates the chance that your house was built compliant to the recent earthquake-resistant building standards similar to special seismic detailing introduced in 1992.
- If damaged by previous earthquakes and disasters and not repaired, the structure is weakened making it vulnerable to a partial or total collapse during a strong ground shaking.
- The shape of the house influences its behavior during strong ground shaking. Box-type or rectangular-shaped houses behave better than those with irregular or unsymmetrical configurations.
- It is assumed that supervised expansion or extension leads to safer and stronger structures.
- The use of standard 6" CHB for external walls produces more stable and stronger structures. This was realized in the Full Scale Shaking Table Test conducted for CHB houses on two models on Feb 2011 in Tsukuba, Japan. Avoid using sand and gravel taken from the shorelines and beaches as materials for CHB, mortar, plaster and concrete mix for foundation for they are known to corrode the steel bars over time resulting to thinner diameter and loss of bond.
- Steel bars embedded in CHB walls, concrete columns, floors and foundation resist the impact of ground shaking. The use of the standard 10 millimeters diameter steel bars spaced at 40 centimeters from side to side and properly connected and tied to steel bars laid every 3 layers of CHB (~60 centimeters) prevent collapse of walls during earthquakes.
- Walls wider than 3 meters span without any perpendicular walls or supports are susceptible to collapse in a strong ground shaking.
- The shaking table test for CHB Houses exhibited that the unanchored gable part of the wall show larger horizontal movement during strong ground shaking. It is recommended that well-reinforced and well-anchored CHBs or light materials be used for the gable wall.
- Reinforced concrete wall foundation resists shaking, slipping and tilting better than stone-foundations.
- Rock or stiff-soil provides better support. Soft soils usually amplify strong ground shaking and tend to spread and subside the ground which may worsen damage to structure. For houses on slopes, tie beams or continuous wall foundation prevent uneven settlement during strong ground shaking.
- It is important to observe the state of our house over time. Regular house maintenance must be done to prevent deteriorations like sagging roof, chipped-off plasters and cracks on walls.



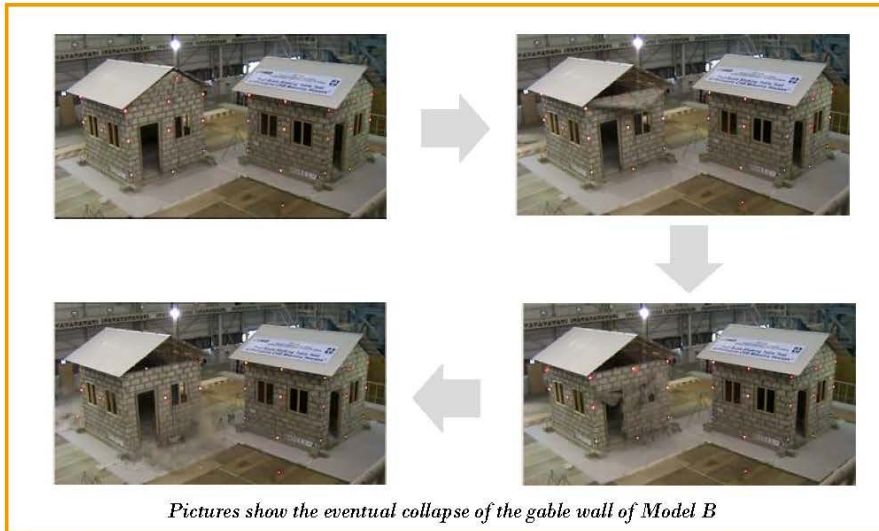
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ABOVE: A PHIVOLCS-DOST Publication 'How Safe is my House?' Page 5.

[http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica\\_materials/2\\_questionnaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica_materials/2_questionnaire_chb_english_ver1_0_january20_2014.pdf)

**COMMENTARY AND RECOMMENDATION FOR SAFER CHB HOUSES**

Full Scale Shaking Table Test of CHB Houses, February 2011 in NIED Tsukuba, Japan



*Pictures show the eventual collapse of the gable wall of Model B*



*Picture shows the collapsed gable part of the back wall of model B*

It is highly recommended however, that the state of your house must be consulted to the proper authorities. The Engineers/Experts of your Local Government Unit may have recommended methods using affordable or low-cost materials to strengthen your house (specifically its walls) in order to protect it from collapse, and to minimize possible falling debris during strong earthquake ground shaking.




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ABOVE: A PHIVOLCS-DOST Publication 'How Safe is my House?' Page 6.

[http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica\\_materials/2\\_questionnaire\\_chb\\_english\\_ver1\\_0\\_january20\\_2014.pdf](http://satreps.PHIVOLCS.dost.gov.ph/imaqes/jica_materials/2_questionnaire_chb_english_ver1_0_january20_2014.pdf)



## PHIVOLCS EARTHQUAKE INTENSITY SCALE (PEIS)

|   |   |
|---|---|
| <h3>I. SCARCELY PERCEPTIBLE</h3>  <ul style="list-style-type: none"> <li>Perceptible to people only under favorable circumstances.</li> <li>Delicately balanced objects are disturbed slightly.</li> <li>Still water in containers oscillates slightly.</li> </ul>   | <h3>VI. VERY STRONG</h3>  <ul style="list-style-type: none"> <li>Many people are frightened; many run outdoors. Some people lose their balance. Motorists feel like driving with flat tires.</li> <li>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 man-made structures are slightly damaged though well-built structures are not affected.</li> <li>Limited rockfalls and rolling boulders occur in hilly to mountainous areas and escarpments. Trees are noticeably shaken.</li> </ul>   |
| <h3>II. SLIGHTLY FELT</h3>  <ul style="list-style-type: none"> <li>Felt by few individuals at rest indoors.</li> <li>Hanging objects swing slightly.</li> <li>Still water in containers oscillates noticeably.</li> </ul>  | <h3>VII. DESTRUCTIVE</h3>  <ul style="list-style-type: none"> <li>Most people are frightened and run outdoors. People find it difficult to stand in upper floors.</li> <li>Heavy objects and furniture overturn or topple. Big church bells may ring. Old or poorly built structures suffer considerable damage. Some well-built structures are slightly damaged. Some cracks may appear on dikes, fish ponds, road surface, or concrete hollow block walls.</li> <li>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.)</li> </ul>   |
| <h3>III. WEAK</h3>  <ul style="list-style-type: none"> <li>Felt by many people indoors specially in upper floors of buildings. Vibration is felt like the passing of a light truck. Dizziness and nausea are experienced by some people.</li> <li>Hanging objects swing moderately.</li> <li>Still water in containers oscillates moderately.</li> </ul>  | <h3>VIII. VERY DESTRUCTIVE</h3>  <ul style="list-style-type: none"> <li>People are panicky. People find it difficult to stand even outdoors.</li> <li>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.</li> <li>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.</li> <li>Liquefaction and lateral spreading cause man-made structures to sink, tilt or topple. Numerous landslides and rockfalls occur in mountainous and hilly areas. Boulders are thrown out from their positions particularly near epicenter. Fissures and fault rupture may be observed. Trees are violently shaken. Water splashes or flows over dikes or banks of rivers.</li> </ul> |
| <h3>IV. MODERATELY STRONG</h3>  <ul style="list-style-type: none"> <li>Felt generally by people indoors and some people outdoors. Light sleepers are awakened. Vibration is felt like the passing of a heavy truck.</li> <li>Hanging objects swing considerably. Dinner plates, glasses, windows and doors rattle. Floors and walls of wood framed building creak. Standing motor cars may rock slightly.</li> <li>Water in containers oscillates strongly.</li> <li>Rumbling sounds may sometimes be heard.</li> </ul>                                    | <h3>IX. DEVASTATING</h3>  <ul style="list-style-type: none"> <li>People are forcibly thrown to the ground. Many cry and shake with fear.</li> <li>Most buildings are totally damaged. Bridges and elevated concrete structures are toppled or destroyed.</li> <li>Numerous utility posts, towers and monuments are tilted, toppled or broken. Water and sewer pipes are bent, twisted or broken.</li> <li>Landslides and liquefaction with lateral spreading and sandbolts 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 flows over dikes and banks.</li> </ul>  |
| <h3>V. STRONG</h3>  <ul style="list-style-type: none"> <li>Generally felt by most people indoors and outdoors. Many sleeping people awakened. Some are frightened; some run outdoors. Strong shaking and rocking are felt throughout building.</li> <li>Hanging objects swing violently. Dining utensils clatter and clink; some are broken. Small, light and unstable objects may fall or overturn. Liquids spill from filled open containers. Standing vehicles rock noticeably.</li> <li>Shaking of leaves and twigs of trees is noticeable.</li> </ul> | <h3>X. COMPLETELY DEVASTATING</h3>  <ul style="list-style-type: none"> <li>Practically all man-made structures are destroyed.</li> <li>Massive landslides and liquefaction, large scale subsidence and uplifting of landforms and many ground fissures are observed. Changes in river courses and destructive seiches in lakes occur. Many trees are toppled, broken or uprooted.</li> </ul>  |



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#### REPORT AN EARTHQUAKE

Text only 0918-9248354  
 Text/Call 0905-3134077  
 or call (02) 426-1468 to 79 local 124/125; (02) 929-9254

For text, send: NAME / DATE AND TIME OF EARTHQUAKE / LOCATION AT THE TIME OF EARTHQUAKE / INTENSITY RATING

ABOVE: A PHIVOLCS-DOST Publication 'PHIVOLCS Earthquake Intensity Scale (PEIS)'.



# EARTHQUAKE!!!

(Are you prepared?)

Do you know that about 20 earthquakes are recorded daily in the Philippines? Most of these earthquake however, are unfelt and can only be detected by an instrument called *seismograph*. Earthquakes cannot be prepared, but we can prepare for them.

Always remember these basic things to do before, during and after a strong earthquake:

## BEFORE

The key to effective disaster prevention is planning:



- Know the earthquake hazards in your area.
- Follow structural design and engineering practices when constructing a house or building.
- Evaluate the structural soundness of the buildings and houses; strengthen or retrofit if necessary.

Prepare your homes, workplace or schools:

- Strap or bolt heavy furniture/cabinets to the walls.
- Check the stability of hanging objects like ceiling fans and chandeliers.
- Breakable items, harmful chemicals and flammable materials should be stored properly in the lowermost secured shelves.
- Always turn off the gas tanks when not in use.



Familiarize yourself with the exit routes and places where fire extinguishers, first aid kits, alarms, and communication facilities are located. Learn how to use them beforehand.

Prepare a handy emergency supply kit with first aid kit, canned food and can opener, water, clothing, blanket, battery-operated radio, flashlights and extra batteries.

Conduct and participate in regular earthquake drills.



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 June 2009

## DURING

STAY CALM.

When you are **INSIDE** a structurally sound building or home...**STAY THERE!**

Do the **"DUCK, COVER and HOLD"**.



- If possible quickly open the door for exit.
- Duck under a sturdy desk or table, and hold on to it, or protect your head with your arms.
- Stay away from glass windows, shelves, cabinets and other heavy objects.
- Beware of falling objects. Be alert and keep your eyes open.

If you're **OUTSIDE**...move to an open area!

- Stay away from trees, powerlines, posts and concrete structures.
- Move away from steep slopes which may be affected by landslides.
- If you're near the shore and feel an earthquake, especially if it's too strong, move quickly to higher grounds. Tsunamis (giant sea waves) might follow.



If you're in a moving vehicle, **STOP and get out!** Do not attempt to cross bridges, overpasses, or flyovers which may have been damaged.

## AFTER

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

- Don't...
  - ...use elevators.
  - ...enter damaged buildings.
  - ...use telephones unless necessary.
  - ...PANIC.

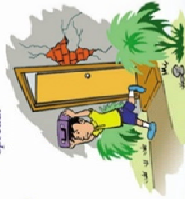
Check...

- yourself and others for injuries.
- water and electrical lines for damages.
- for spills of chemical, toxic and flammable materials.
- and control fires which may spread.



If you need to evacuate your residence, leave a message stating where you are going and bring your emergency supply kit.

Keep updated on disaster prevention instructions from battery-operated radios.



ABOVE: A PHIVOLCS-DOST Publication 'Earthquake! Are You Prepared?'