HAZARD FACT SHEET:

The possibility of earthquakes and tsunamis in Viet Nam

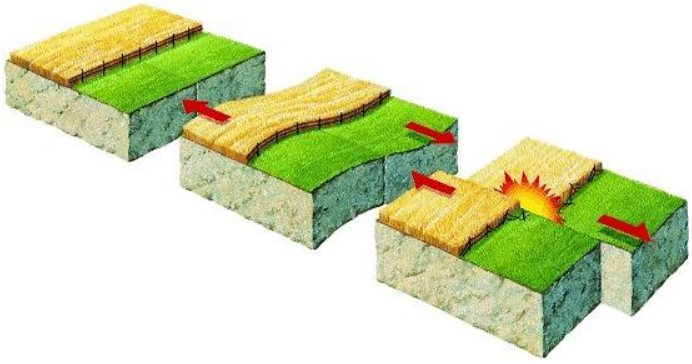
One of the objectives of the UN Program Coordination Group on Natural Disasters and Emergencies (UN PCG NDE)[1] is to collect information on known and potential hazards and vulnerabilities in the country, develop regular disaster Situation Reports (SitReps) and ensure timely distribution of information to the appropriate focal points within the Government and other humanitarian stakeholders in Viet Nam, the region and globally. This factsheet aims to provide background information and raise awareness on the possibility of earthquakes and tsunamis in Viet Nam.

PART A. CAUSES AND EFFECTS OF EARTHQUAKES AND TSUNAMIS

EARTHQUAKES

- Shaking, trembling or displacement of the earth surface due to seismic waves or other phenomena of volcanic or tectonic origin.[2]

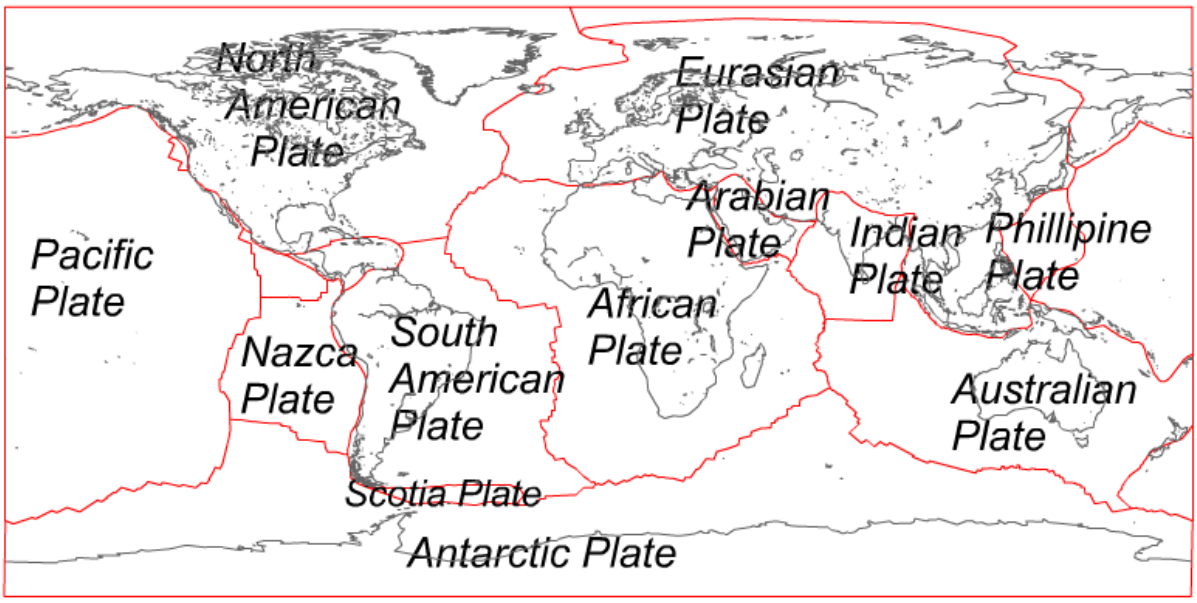
- Movements within the Earth's crust cause stress or energy to build up at points of weakness, and rocks to deform. When the stress finally exceeds the strength of the rock, the rock fractures along a fault, often at a zone of existing weakness within the rock. The stored energy is suddenly released as an earthquake. These cause intense vibrations, or seismic waves, spread out from the initial point of rupture, like ripples on a pond. These waves which can travel large distances in all directions, make the ground shake. Near the epicentre, the waves can be very large, making them extremely destructive.



- Most of **the earthquake activity in the world** is concentrated in a number of distinct earthquake belts. For instance, around the edge of the Pacific Ocean, the so-called 'ring of fire', or in the middle of the Atlantic Ocean. The outer shell of the Earth is made up of a number of rigid segments called tectonic plates. These plates are continually moving at rates of a few centimetres per year. At the boundaries between the plates, where they are moving together, apart or past each other, tremendous stresses build up – these are where most earthquakes occur.[3]

- Earthquakes are measured in terms of magnitude and intensity. The size or **magnitude** of an earthquake refers to the amount of energy released and is measured in Arabic numerals through the Richter scale. On the Richter scale, magnitude is expressed in whole numbers and decimal fractions, scaling from less than 2.0 (minor earthquake) to maximum 10.0+ (massive earthquake). **Intensity** measures the strength of shaking produced by the earthquake at a certain location. It is determined from effects on people, human structures, and the natural environment and does not only depend on the size but also on the depth of

the quake, the distance to the epicentre and the geological conditions of the location. It is measured in Roman numerals (intensity I or 'not felt' to XII or 'completely devastating') through various similar scales like MM(I), EMS-98 and MSK-64.[4]



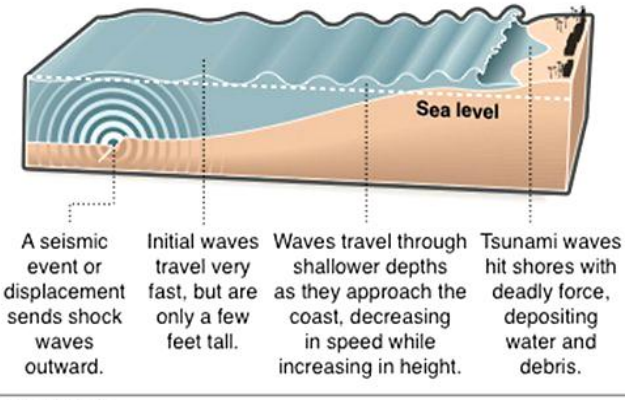
- The **major effects of earthquakes** are. damage to human beings (casualties and impact on public health), physical damage (collapsed infrastructure due to earthquake, fires, dam and dyke failures, landslides and flooding), shortage of water or contaminated water supply, and often massive social disruption.

TSUNAMIS

- Waves generated by large and sudden submarine earth movements, earthquakes, volcanic eruptions or landslides.[5]

- When a tsunami is generated, its speed in the open sea can reach several hundred kilometres per hour, reaching distant coastlines in a relatively short time. Tsunamis can travel virtually unnoticed through open ocean because the wave height may be only 30cm. Tsunamis slow down as they approach the shoreline but their height increases. Because of their relatively large wavelength, tsunamis may travel far inland, and due to the short period between waves, they cause flooding faster than tidal waves and storm surges. The enormous capacity to erode the landscape and destroy buildings makes tsunamis highly destructive both in terms of mortality and economic loss.[6]

Tsunami waves travel rapidly in the deep ocean, but their destructive power comes from the towering heights attained as they approach the coast.

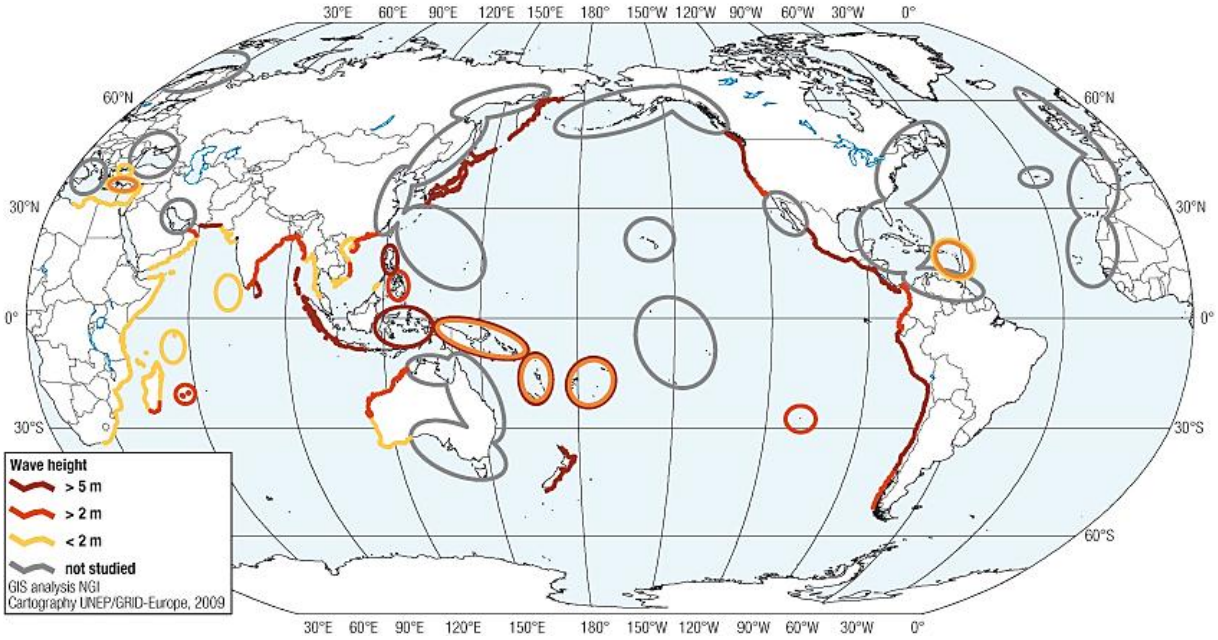


SOURCE: USGS

- Tsunamis are relatively infrequent with only 5 to 10 events reported globally per year, but as demonstrated in the Indian Ocean in 2004 and more recently in Japan 2011, they can be devastating. The map below shows the **distribution of tsunami hazard globally**.

- The **major effects of tsunamis** are: damage to human beings (casualties and impact on public health), physical damage (major damage to structure and infrastructure caused by flood, or withdrawal of the wave from shore), water supply contaminated by salt water, debris or sewage, lost crops and food supplies (harvests, food stocks, livestock, farm implements, and fishing boats), land may become infertile due to salt water incursion, and also cause severe disruption of transport, communications and logistics.

Map showing global tsunami hazard areas



PART B. EARTHQUAKES AND TSUNAMIS IN VIET NAM

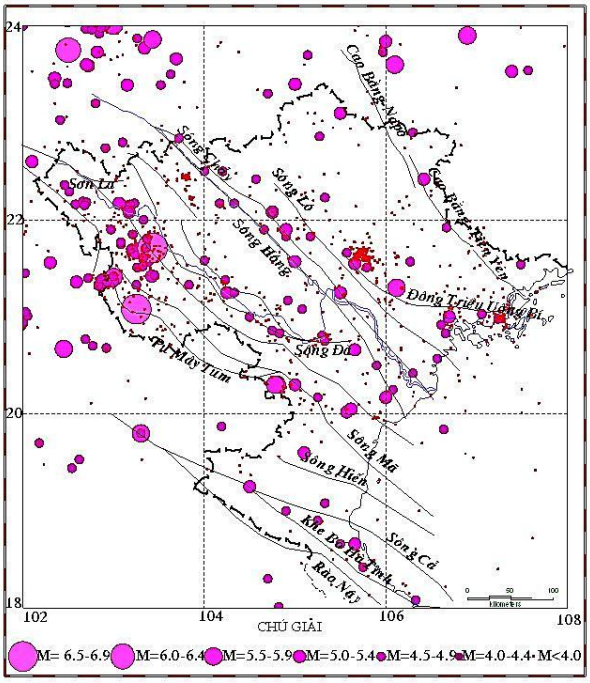
THE POSSIBILITY OF EARTHQUAKES IN VIET NAM

- Viet Nam is located on the Southeast section of the Eurasian plate, between the Indian plate, the Philippine plate and the Australian plate. The country is not located on the edge of any of these plates which makes it **much less vulnerable to earthquakes than other countries in the region**.

- The northern region of Viet Nam has **low to moderate seismicity** but some fault systems, such as the Red River (Sông Hồng), the Mã River (Sông Mã) and the Lai Châu - Điện Biên area.

- These fault lines likely have lengths of several hundred kilometres and slip rates in the range of 0.5 to 2mm a year[7]. Fault segments of this length can potentially generate earthquakes from 5.7 to 7 magnitude.[8]

- Historically, from 1900 till 1995, 2 earthquakes with magnitude 6.7-6.8 and intensity VIII-IX (on



Map showing the historical seismicity of Northern Viet Nam with the major fault lines

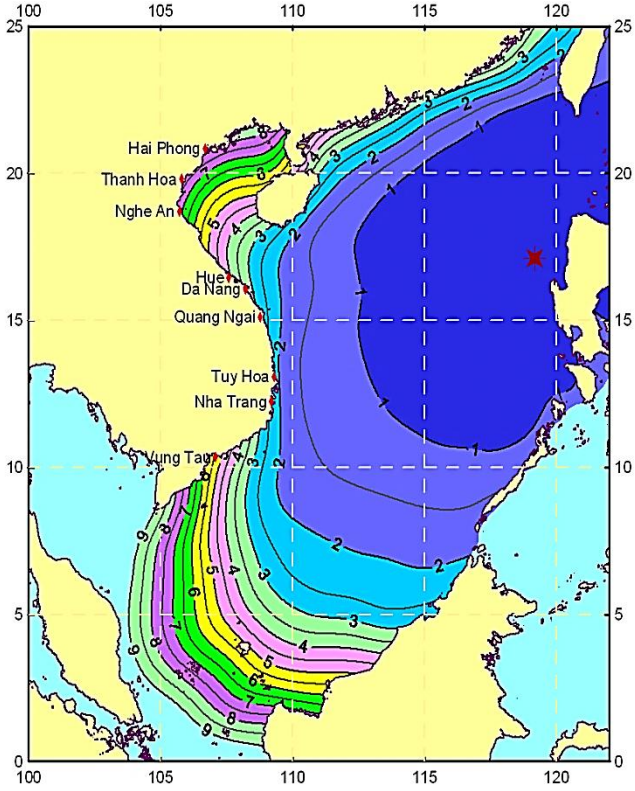
the MSK-64 scale); 2 earthquakes with magnitude 5.6-6.0 and intensity VII-VII; 13 earthquakes with magnitude 5.1- 5.5 and intensity VII and more than 100 earthquakes with magnitude 4.6-5.0 and intensity VI-VII have occurred in Viet Nam.[9] The most recent earthquakes of magnitude 6.7 and 6.8 have occurred in Điện Biên Phủ (November 1935) and Tuần Giáo (June 1983) respectively.

THE POSSIBILITY OF TSUNAMIS IN VIET NAM[10]

- The **probability** of a tsunami in Viet Nam is **very low**. However, although a damaging tsunami has so far not yet been registered since records started, the central coastal provinces can potentially be affected by a tsunami.[11] Three most likely sources of earthquakes have been defined that could trigger tsunamis reaching the Vietnamese coast. These are earthquakes measuring 8 on the Richter scale along the Manila fault, earthquakes over 8 occurring North of the Luzon Island of the Philippines and those originating the south of Taiwan and earthquakes over magnitude 8.8 along the Ryukyu fault, Japan.

- The **central coast from Đông Hà (Quảng Trị) to Phan Rang (Ninh Thuận)** could potentially be the most affected by a tsunami. Other coastline province to the North and the South are not expected to be affected seriously by a similar tsunami.

- It is anticipated that it would take about two to three hours for tsunami waves generated by a very strong earthquake along the Manila fault to reach the Vietnamese coastline as is shown in the figure on the right.



Map showing anticipated time for tsunami waves caused by a very strong earthquake along the Manila fault

- It is estimated that **270,000 people** in Viet Nam live in areas potentially affected by tsunamis.[12]

- Estimated **potential** tsunami heights, based on scenario with earthquake along the Manila fault, earthquakes most likely to cause tsunamis in Viet Nam are shown in the following table:[13]

Earthquake magnitude	Hoang Sa archipelago	Truong Sa archipelago	Thua Thien – Hue to Da Nang	Quang Nam to Quang Ngai	Binh Dinh to Ninh Thuan	Binh Thuan to Ba Ria – Vung Tau
8 Richter	2.5m	1m	Less than 1m	1-2m	1m	Less than 1m
8.4 Richter	4m	2m	Over 1m	2-4m	1.5-2m	1m
8.6 Richter	8-9m	4-6m	3-5m	7-10m	3-5m	1.5m

EARTHQUAKE AND TSUNAMI RISK MANAGEMENT INITIATIVES IN VIET NAM[14]

- The **Institute of Geophysics** (IGP) of the Viet Nam Academy of Sciences and Technology (VAST) is the sole agency responsible for all work related to seismology in the country. IGP undertakes research and studies on earthquakes and tsunamis.

- The Government issued Decision 264/2006/QD-TTg instructing the Institute of Geophysics to establish and operate **earthquake and tsunami gauging stations for early warning**. The Institute of Geophysics has now established a forecasting system for earthquakes with 5 seismograph stations at strategic locations. A further 6 stations are planned for completion by 2015. A tsunami early warning system is also planned including 30 stations by 2015 with 8 stations already equipped.

- The Government has also issued Decision 78/2007/QD-TTg on **preparedness and response to earthquakes and tsunamis**. 25 scenarios have been developed for tsunamis and applied to coastal provinces under this Decision.

- In response to the events in Japan, the **Ha Noi** People's Committee has issued an **earthquake plan** to ensure timely earthquake warnings and the implementation of safety measures.[15]

- The Institute of Geophysics has conducted a number of earthquake and tsunami **risk assessment studies** at the national level.

- A national level **zoning of earthquake vulnerable areas** has been completed by the Ministry of Construction. Technical requirements for the construction of earthquake-proof buildings have also been issued by the Ministry but further studies need to be conducted to examine their suitability to the Vietnamese context.

- Pilot initiatives to improve **regional cooperation** on tsunami monitoring and warning systems exist through the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (**RIMES**). It is an international and intergovernmental institution, owned and managed by its Member States, including Viet Nam, for the generation and application of early warning information.[16]

WHAT TO DO WHEN AN EARTHQUAKE HAPPENS?

BEFORE	DURING	AFTER
▪ Prepare a Disasters and Emergencies Supplies Kit for your home, workplace, and car containing basic food, flashlights and spare batteries, first aid kit and manual, fire extinguishers, clothing, essential medicine, etc. ▪ Know how to turn off the gas, electricity, and water at main switches and valves. ▪ Know where you should go for protection when your house starts to shake. Be aware of evacuation centers and evacuation routes. ▪ Check the quality of crucial infrastructure and buildings and strengthen or reinforce when needed. ▪ Community education and training in earthquake	**If you are indoors** ▪ Take cover under a solid desk, table, or bench, or against an interior wall, and hold on ("drop, cover, and hold on" method). ▪ Stay away from glass, windows, outside doors and walls, and possible falling debris. ▪ Stay inside until the shaking stops and it is safe to go outside. ▪ Be aware that electricity may go out or that fire alarms or sprinklers may turn on. ▪ Do not use elevators. **If you are outdoors** ▪ Stay there ▪ Move away from buildings, trees, streetlights, and utility wires to an open space. **If you are in a moving car**	▪ If anyone has stopped breathing, give mouth-to-mouth resuscitation. Stop any bleeding injury by applying direct pressure to the wound. ▪ Do not move seriously injured people unless they are in immediate danger of further injury. ▪ For minor injuries, use a Red Cross or other First Aid manual. For more severe injuries consult a doctor prior to moving an injured person ▪ Head to the nearest evacuation center. If you're not injured, assist children, pregnant women, elderly, disabled and the minor injured if possible.

preparedness and response. ▪ Organize community or office emergency response exercises. ▪ Train your family members, friends and colleagues to escape or save themselves if an earthquake happens. ▪ If possible, arrange bedding or a place for elderly or disabled people near to an exit, so that they can be evacuated quickly	▪ Stop immediately but safely, pull to the side of the road and stay in the car. ▪ Avoid stopping near or under buildings, trees, overpasses, and utility wires. ▪ Do not attempt to drive across bridges or overpasses that have been damaged. ▪ Proceed cautiously after the earthquake has stopped, watching for road and bridge damage. **If you are trapped under debris** ▪ Do not light a match. ▪ Do not move around or kick up dust. ▪ Cover your mouth with a handkerchief or clothing. ▪ Tap on a pipe or wall so that rescuers can find you. Use a whistle if available. Shout only as a last resort as shouting can cause inhaling of dangerous amounts of dust.	▪ Keep a battery-powered radio with you so you can listen for emergency updates and news reports. ▪ Be aware of possible tsunamis if you live in a coastal area. When local authorities issue a tsunami warning, assume that a series of dangerous waves is on the way. Move inland to higher ground as quickly as possible. (*see next section*) ▪ Wear shoes in areas near fallen debris or broken glass. ▪ If capable, participate in clearing roads and debris, rebuilding houses and public buildings

WHAT TO DO WHEN A TSUNAMI HAPPENS?

BEFORE	DURING	AFTER
▪ Learn the tsunami warning signs like a big earthquake, any unusual change in sea level (sea level may drop before waves come), or a roaring noise. ▪ Know close by high, safe areas and evacuation routes to these areas to run to in case of a tsunami. ▪ Prepare a Disasters and Emergency kit *(see previous section).* ▪ Prepare buoyancy items to use as life buoy or life vests and keep them ready in easy to reach places. ▪ Learn how to swim. ▪ Know how to turn off the gas, electricity, and water at main switches and valves. ▪ Community education and training in tsunami preparedness and response. ▪ Organize community or office emergency response exercises. ▪ Train your family members, friends and colleagues to escape or save themselves if a tsunami	**If you're aware of any of the warning signs:** ▪ Run to a high and safe area immediately (on high ground, over 15m, at least 1km from the coast). ▪ No hesitation: Do not wait to be told or until you see the wave. Do not try to save any belongings from your houses. ▪ Follow the evacuation route to the nearest high and safe place ▪ If possible and within close reach, try to take your Disasters and Emergencies kit. ▪ If you cannot run away to a safe place, climb a strong nearby tree or go to the top of a building. ▪ Stay at the safe area for several hours since more waves may come. ▪ Do not stay in a car as it can be carried away by the waves. **If you are on a boat out at sea** ▪ Do not return to the coast, stay out in the open sea until the waves have ceased. **If you are on a boat at a harbor and**	▪ Help the people injured or trapped in building and if possible give first aid to those injured ▪ Find the nearest medical assistance ▪ Head to the nearest evacuation center. If you're not injured, assist children, pregnant women, elderly and disabled people. ▪ Once the condition is safe, go home and check if any damage has affected your house ▪ Check food and drinking water stocks. Food and water affected by flood water should not be consumed anymore as it is probably contaminated and will be a risk for your health ▪ Participate in cleaning up the environment, and restoring people's lives where possible ▪ If capable, participate in clearing roads and debris,

happens. ▪ If possible, arrange bedding or a place for elderly or disabled people near to an exit, so that they can be evacuated quickly. ▪ Establish early warning systems or familiarize yourself with the existing early warning in your locality. ▪ Plant or maintain mangrove or appropriate trees along the coastal areas or build barriers such as breakwaters. ▪ Make buildings along the coast tsunami-proof.	**there is no time to take it out to the sea** ▪ Leave the boat and run to a safe place **If you are caught by a tsunami wave** ▪ Swim as strongly as you can ▪ Find something that floats, climb on it and hang on to it as strongly as you can	rebuilding houses and public buildings

ENDNOTES

[1] The primary purpose of the PCG NDE is to ensure coordination of UN assistance to the Government of Viet Nam (GoV) in respect to disaster risk management (DRM) including: disaster preparedness, mitigation, response, early recovery rehabilitation and reconstruction. Particularly in relation to the event of a disaster, the PCG-NDE serves to ensure that a prompt, effective and concerted response by the UN system is made at the country level in coordination with and to complement national efforts. The PCG NDE operates as a joint working mechanism co-owned by the Government and the UN and is co-convened by the Ministry of Agriculture and Rural Development (MARD) and the United Nations Development Program (UNDP). The PCG NDE consists of nominated staff from the Disaster Management Center (DMC) as the designated body on behalf of MARD and UN Agencies (UNDP, UNICEF, FAO, WHO, IOM, UNFPA, UNESCO, UN HABITAT and UNIFEM), working together in the area of DRM.

[2] Centre for Research on the Epidemiology of Disasters (CRED), http://www.cred.be/

[3] The British Geological Survey, http://www.bgs.ac.uk/

[4] MM stands for Modified Mercalli Intensity scale, EMS-98 for European Macroseismic Scale and MSK-64 for Medvedev-Sponheuer-Karnik scale. For more information on the difference and comparison between the magnitude and intensity of an earthquake: U.S. Geological Survey, http://earthquake.usgs.gov/learn/topics/mag_vs_int.php

[5] Centre for Research on the Epidemiology of Disasters (CRED), http://www.cred.be/

[6] UNISDR, *2009 Global Assessment Report on Disaster Risk Reduction, Risk and Poverty in a Changing Climate*. United Nations International Strategy for Disaster Risk Reduction.

[7] These findings are based on preliminary research, historical data and extrapolations from similar locations done by the Viet Nam Institute of Geophysics. However, further research is needed to know the exact magnitude and interval occurrence of potential quakes in Viet Nam. Research: Tran Thi My Thanh, Graeme H. McVerry (2009). Pilot Seismic Hazard Study for Northern Viet Nam Investigating Fault Modeling. Institute of Geophysics, Hanoi, Viet Nam. Nguyen Dinh Xuyen, Tran Thi My Thanh, Seismicity and Seismic Hazard Assessment in Viet Nam. Institute of Geophysics, Hanoi, Viet Nam.

[8] The magnitudes mentioned here are converted from the surface wave magnitude (M_S) scale used in the research from Thanh and Graeme (note 7). M_S differs from the local magnitude (M_L) scale or Richter scale. For this factsheet we chose to use the more commonly used Richer scale through the formula $M_L = (M_S + 3.2)/1.45$, as suggested by Vladimír Tobyáš and Reinhard Mittag (1991). *Local magnitude, surface wave magnitude and seismic energy*. Studia Geophysica et Geodaetica, Volume 35, Number 4, 354-357. http://www.springerlink.com/content/lv140444x5m01362/

[9] Data provided by the Viet Nam Institute of Geophysics.

[10] Tran Thi My Thanh, Le Huy Minh, Le Tu Son, (2009). *Tsunami Hazard, Risk and Preparedness for Viet Nam*. Institute of Geophysics.

[11] Similar as with earthquakes, these findings are based on preliminary research, historical data and extrapolations and needs further research and refining.

[12] Figure 2.30 'Number of people living in areas potentially affected by tsunamis' in: UNISDR, *2009 Global Assessment Report on Disaster Risk Reduction, Risk and Poverty in a Changing Climate*. United Nations International Strategy for Disaster Risk Reduction. (p.47)

[13] *Could a tsunami really hit Vietnam?* 30th October 2009.
http://www.monre.gov.vn/v35/default.aspx?tabid=675&CateID=57&ID=75126&Code=OZMDV75126

6.5 Richter scale quakes can cause tsunamis, says geophysics expert. 21st March 2011.
http://www.monre.gov.vn/v35/default.aspx?tabid=675&CateID=57&ID=98091&Code=B8YAT98091

[14] Disaster Management Center, Ministry of Agriculture and Rural Development (2010), *Viet Nam National progress report on the implementation of the Hyogo Framework for Action (2009-2011) – interim*, last updated 22 September 2010.

[15] *Hanoi issues quake plan*. 15th March 2011.
http://www.monre.gov.vn/v35/default.aspx?tabid=675&CateID=57&ID=97744&Code=YQIFM97744

[16] RIMES evolved from the efforts of 26 countries in Africa and Asia, in the aftermath of the 2004 Indian Ocean tsunami, and was established on 30 April 2009 to establish a regional early warning system, within a multi-hazard framework, which generates and communicates early warning information, and builds capacity to prepare for and respond to trans-boundary hazards. RIMES regional facility for early warning, established with support from the Danish International Development Agency (DANIDA) and the Tsunami Regional Trust Fund administered by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), is located at the campus of Asian Institute of Technology, Thailand. For more information: http://www.rimes.int.

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