# Tsunami

## NATURAL HAZARDS IN THE PACIFIC - FACT SHEET 3

SOPAC

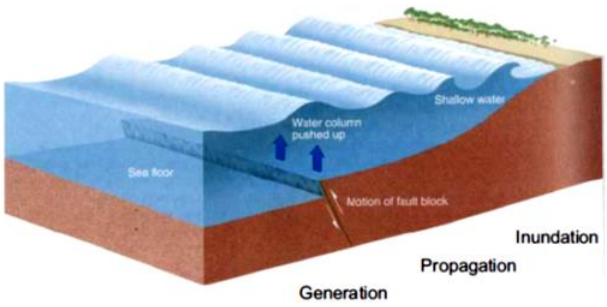
Reducing Vulnerability of Pacific ACP States

The most tragic and devastating tsunami in recent history occurred on 26th December 2004 just off the Indonesian province of Bande Aceh. Waves up to 30 m high battered the coastlines of Indonesia, Thailand, India, Sri Lanka and the Maldives, leaving about 300,000 people dead or missing. Whilst destructive tsunamis such as this are relatively infrequent, tsunami are common in the Pacific Ocean and can affect all of the Pacific island countries. This is because the Pacific basin is surrounded by the "Ring of Fire", a series of tectonic plate boundaries associated with high earthquake and volcanic activity.

Artist's impression of a Tsunami

### What is a Tsunami?

A tsunami (a Japanese word meaning "harbour wave") is a series of waves, travelling at speeds of over 800 km/h in the deep ocean and often going unnoticed. They travel harmlessly until they reach the shallow water of a coastline where they slow down and steepen, cresting to heights of more than 10 m and can crash with devastating force across the shore, flooding low-lying areas and causing death and severe destruction.

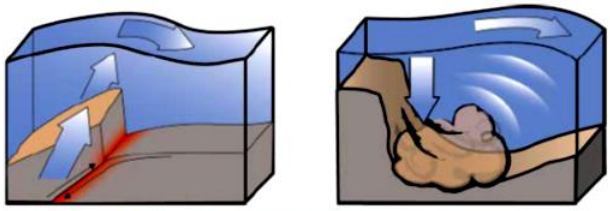



Any disturbance that shifts a large volume of water away from its normal position can generate a tsunami. The most common cause of a tsunami is an offshore earthquake, which can cause the sea floor to abruptly lift or subside. This can disturb the overlying water column and possibly lead to a tsunami.

**EXAMPLE:** The 2004 Indian Ocean tsunami was caused by an earthquake as was the 2002 Port Vila, Vanuatu tsunami and the 1999 Pentecost Island, Vanuatu tsunami.

Similarly, a submarine volcanic eruption creates an upward force that lifts the water column above the volcano leading to the generation of a tsunami. A submarine landslide can also generate a tsunami from the sudden down-slope movement and the slumping of sea floor sediments. These landslides are most often the result of an earthquake and are occasionally due to a volcanic eruption. In addition, coastal landslides and volcanic cone collapses that send tons of debris spilling into the water can also result in tsunami.

**EXAMPLE:** Earthquakes triggered the submarine landslides that caused the 1998 Aitape, Papua New Guinea and the 1953 Suva, Fiji tsunami.



Earthquake and landslide caused tsunamis

**EXAMPLE:** In 1958 a huge landslide Lituya Bay, Alaska, generated an enormous tsunami 525 m high and in Ritter, Papua New Guinea, a major volcanic cone collapse caused a tsunami 12-15 m high, wiping out a number of villages in western New Britain, Papua New Guinea.

### Tsunami Hazards

**Coastal inundation and erosion.** Tsunami can severely impact coastal areas, completely inundating low-lying coastal areas, destroying buildings, damaging infrastructure, flattening trees, churning up soil and even washing away entire villages. The inundation can also cause severe coastal erosion and affect areas upstream from the coast since tsunami waves can travel up rivers and streams from the ocean.

**Wave speed/force.** Tsunami waves travel at 36-54 km/h in shallow water, faster than most people can run. This enormous momentum means that the force of the waves can move large rocks weighing several tons, along with boats and other debris. People can be caught up in the wave and tossed about, choking on seawater and suffering injuries due to the debris.

**Debris.** During major tsunami, fatalities and damage result not only from the force of the waves themselves, but also from the accompanying debris churned up as the wave surges across the shore, such as broken glass, torn metal, parts of buildings and uprooted trees.

EXAMPLE: 17 July 1998. Three catastrophic tsunami waves hit the coast of Aitape, Papua New Guinea, penetrating up to 1 km inland, devastating villages. Along the 25 km strip from Sissano to Malol, wave heights reached between 10 and 15 m. Over 2000 lives were lost. This picture shows the sand spit where Arop Village once stood.

Image source: US National Geophysical Data Center

**Backwash.** Another danger from Tsunami waves is that they bring a large volume of seawater onto the land. When the water flows back out it may carry people out to sea.

**Wrap around.** Tsunamis tend to align themselves parallel to the shoreline so they wrap around headlands, sand spits and even whole islands, so that it can be just as dangerous on coasts not facing the tsunami source.

Wrap around effect.

## Tsunami Warning

The Pacific Tsunami Warning Centre (PTWC) in Hawaii detects and provides warnings of potentially damaging Pacific wide tsunami.

## For further information please see the following links:

**International Tsunami Information Centre (ITIC):**
http://www.tsunamiwave.info
**Pacific Tsunami Warning Centre (PTWC):**
http://www.prh.noaa.gov/ptwc

While warnings of far-source / ocean-wide tsunami can be given well in advance of the tsunami arriving, unfortunately, warnings cannot be given about a near-source tsunami because it can reach shore within 10-20 minutes of the earthquake or eruption that caused it. This was the case with the 17 July 1998 event in Aitape, Papua New Guinea.

**KEY POINTS TO REMEMBER:**

Tsunami can strike any coastline in the Pacific — warnings apply to YOU. For tsunami survival remember the following three warning signs:

1. An earthquake
2. Any unusual change in sea level
3. A ROARING noise

Upon noticing the warning signs:

- RUN to a safe place
- Do not wait to be told
- Do not wait until you see the wave — that is too late because the wave travels faster than you can run.

YOU ARE SAFE FROM THE WAVE AS LONG AS YOU ARE SEVERAL KILOMETERS FROM THE WATER'S EDGE OR ARE ON HIGH GROUND.

What you can do before, during and after a tsunami

**PREPARE FOR A TSUNAMI**

- Since tsunamis often happen suddenly, everyone in the community must know the warning signs. An earthquake in your area is a natural tsunami warning sign, as is a noticeable rise or fall of coastal water and a roaring sound as the tsunami rushes towards shore.
- Coastal communities and schools should plan for tsunami — prepare a safe area and escape paths (more than one) so that people can reach the safe area quickly. The safe area should be on high ground or at least a few kilometers from the coast.
- Have disaster supplies on hand — torch and battery radio both with extra batteries, emergency food and water, can opener, basic medicines, money and sturdy shoes.
- Develop an emergency communication plan and post-disaster meeting place in case family members are separated during a tsunami.

**DURING A TSUNAMI**

- Listen to your radio or television for emergency information – if you hear a tsunami warning or if you become aware of any of the warning signs, evacuate and seek higher ground immediately.
- Do not stay in low-lying coastal areas after an earthquake has been felt. If the earthquake occurs just offshore, there will be very little time for response so head for higher ground as quickly as possible.
- Never go to the shore to watch a tsunami. If you can see it you are too close to escape.
- If you are in a boat offshore, do not return to shore — the vessel is safe in the open ocean.
- During a tsunami emergency, police and other emergency organizations will try to save your life. Give them your fullest cooperation.
- A tsunami is not a single wave – it is a series of waves, so stay out of danger areas (coastal and low-lying regions) for at least 2-3 hours.

**AFTER A TSUNAMI**

- Listen to your radio for advice and updates.
- Help trapped or injured people.
- Stay out of damaged buildings. When returning to your home, enter it with caution – check for gas leaks, electrical shorts and live wires.
- A small tsunami at one point on the shore can be extremely large a few kilometers away. Don't let the modest size of one make you lose respect for them all.

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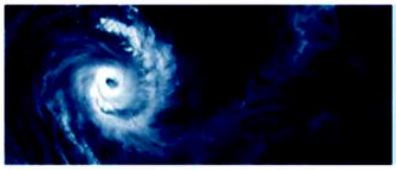
# Tropical Cyclones

NATURAL HAZARDS IN THE PACIFIC - FACT SHEET 1

SOPAC

Reducing Vulnerability of Pacific ACP States

Tropical cyclones (also known as typhoons or hurricanes) affect nearly all Pacific island countries and are the most frequent hazard to affect the region, with around 7- 8 cyclones occurring every year. As a result of climate change cyclone frequency has doubled in the last decade. The cyclone season in the southern hemisphere runs from October to May and in the northern hemisphere from May to October but some cyclones do occur outside the season.



Satellite view of a tropical cyclone.

Image source: US National Geophysical Data Center www.ncdc.noaa.gov

## What is a Tropical Cyclone?

A tropical cyclone is a violent rotating windstorm that develops over warm tropical waters warmer than 26.5 °C and located between 5° and 15° latitude.

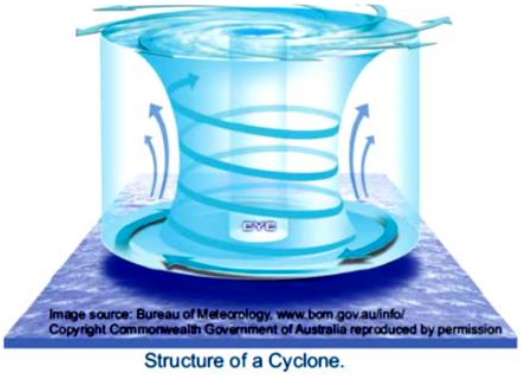


Image source: Bureau of Meteorology, www.bom.gov.au/info/
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Structure of a Cyclone.

Cyclones begin as thunderstorms, which due to the Earth's spin revolve clockwise in the southern hemisphere and anticlockwise in the northern hemisphere.

These storms rise up to 10 km into the atmosphere and can be up to 2000 km across. As the cyclone becomes organised, a calm clear area called the 'eye' forms at its centre. The eye is typically 10-50 km wide and is surrounded by a dense ring of cloud known as the eye wall, which marks the belt of strongest winds.

Tropical cyclones can persist for many days and follow unpredictable paths, however in the South Pacific they usually move southeast. The warmth of the tropical waters provides the energy to fuel cyclones. As a result, they tend to weaken and dissipate as they move over significant island landmasses or cooler waters further south, forming rain depressions.

## Tropical Cyclone Hazards

Strong winds can continue for hours, days even, causing widespread damage to buildings, infrastructure and vegetation and causing loss of life. Wind speed levels of a tropical cyclone are:

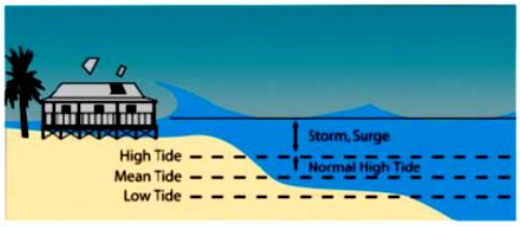
| | |
|---|---|
| Gale force winds: | 63-87 km/h |
| Storm force winds: | 88-117 km/h |
| Hurricane force winds: | 117+ km/h |

**Torrential rains** can result in widespread flash flooding and river flooding. Up to 600 mm and more of high intensity rain can be produced in one day. These rains can also trigger landslides in hilly areas, which may already be sodden due to previous rains.

**EXAMPLE:** Although Cyclone Dani skirted past Fiji in 1999, it brought with it torrential rains that caused severe flash flooding, devastating western Viti Levu and killing seven people.

**Storm surges and waves** created by low atmospheric pressure and strong cyclonic winds blowing over long distances. A storm surge is a raised dome of seawater about 60-80 km wide and 2-5 m higher than normal sea level. As the cyclone makes landfall, storm surge and waves inundate coastal areas. At the coast, storm surge and waves are the greatest threat to life and property and also cause severe coastal erosion. In low-lying atolls, a surge may inundate the whole island.

Further **Saltspray** and **Lightning** can cause considerable damage to crops, forests and infrastructure.


**EXAMPLE:** When Cyclone Bebe hit Funafuti in Tuvalu in 1972, it caused a 4 m surge that swept entirely across the islet causing total devastation. In 2004, Cyclone Heta brought huge storm waves crashing over 20 m high cliffs at the Alofi coast of Niue.

**EXAMPLE:** Cyclone Heta smashed up a four tonne coral boulder and deposited it up a 20m cliff in Nauru. All houses in its path were destroyed.

**EXAMPLE:** Storm surge, Cook Islands during Cyclone Heta. This cat. 5 cyclone affected Samoa, Tonga, Niue and the Cook Islands in January 2004.

Image source: Geoff Mackley

## Cyclone Warning

There is a well established network of cyclone warning centres throughout the region. Places like the Regional Specialised Meteorological Centre (RSMC) in Nadi monitor, track and name tropical cyclones as well as provide warning services to Pacific island countries. Similar services are provided for Papua New Guinea and Solomon Islands by the Australian Bureau of Meteorology's Tropical Cyclone Warning Centres. French-speaking countries are looked after by Meteo-France and American affiliated states by the National Oceanic Atmospheric Administration (NOAA).

## For more information about tropical cyclones and warning systems see the following links:

**Regional Specialised Meteorological Centre-Nadi:**
http://www.met.gov.fj/about_RSMC.htm
**Brisbane Tropical Cyclone Warning Center:**
http://www.bom.gov.au/weather/qld/cyclone/
**US Navy Joint Typhoon Warning Centre**
http://www.npmoc.navy.mil/jtwc.html

CYCLONE SEVERITY: SAFFIR-SIMPSON HURRICANE SCALE

| Cate-gory | Wind Speed (km/h) | Damage | Storm Surge (m) |
|---|---|---|---|
| 1 | 119-153 | Minimal: No real damage to buildings. Coastal road flooding and minor pier damage. | 1-1.5 |
| 2 | 154-177 | Moderate: Damage to roof, window, door. Piers, shrubs damaged, trees felled. Coastal and low-lying escape routes flood. Craft break moorings. | 1.5 - 2.5 |
| 3 | 178-209 | Extensive: Structural damage to houses, utility buildings. Shrubs stripped, large trees felled. Low-lying escape routes cut off. Terrain less than 1.5 m above sea level flooded. Coastal evacuation. | 2.5 - 3.5 |
| 4 | 210-249 | Extreme: Extensive curtainwall failures, roofing failures on small houses. Extensive damage - doors, windows. Low-lying escape routes cut off. Major damage to lower floors of nearshore structures. Terrain lower than 3 m above sea level may flood. Massive evacuation up to 10 km inland. | 3.5 - 5.5 |
| 5 | >250 | Catastrophic: Complete roof failures, some complete building failures, utility buildings blown away. Severe and extensive window and door damage. Low-lying escape routes cut off. Major damage to lower floors of all structures less than 4.5 m above sea level. Massive evacuation up to 16 km inland. | > 5.5 |

## What you can do before, during and after a cyclone

**PRE-SEASON PREPARATIONS**

- Be aware of Cyclone Warning Systems.
- Check your house for structural weaknesses.
- Identify the safest room in your house.
- Clear your property of loose objects/material that could blow about during extreme winds. Trim tree branches away from windows and power lines.
- In case of a storm surge warning know the nearest safe high ground and the safest access route to it.
- Prepare an emergency kit for the family containing a portable radio with spare batteries, torch, fuel lamp, candles, matches, water containers, canned food with opener, spare clothes, masking tape for windows and plastic bags.
- Clear all drains and waterways on the property.
- Ensure houses have proper provision for earthing lightning.

**UPON HEARING A CYCLONE WARNING**

- Listen to your radio for further information.
- Fill water containers and fuel car (if you have one).
- Store or tie down all loose objects in the house.
- Batten down roof. Fix any loose parts of the house.
- Close off shutters. If you live in a flood-prone area take flood precautions.
- Ensure all the members of your family are present; keep children away from swollen drains and waterways.
- If your house is not structurally safe, prepare to move to the nearest evacuation centre.
- Collect firewood and keep in a dry place.

**DURING THE CYCLONE**

- Disconnect all electrical appliances but listen to your battery radio for further information.
- Open louvres on side away from wind to reduce the pull force of the wind on the roof.
- Remain calm, stay indoors but clear of doors and windows. Remain in the strongest part of the building.
- Only use the telephone for very urgent calls.
- If the building breaks up, protect yourself with rugs or mattresses under a strong table/bench or hold onto a solid fixture (e.g. a water pipe).

**BEWARE THE EYE OF THE STORM:**

If the cyclone eye passes over a sudden lull in winds occurs and may last up to 2 hours. The other side of the cyclone then hits and winds resume with equal strength but blowing from the other direction. It is vitally important to remain in shelter during and after the eye passes.

**AFTER THE CYCLONE WIND STORM HAS PASSED**

- Don't go outside until officially advised it is safe.
- Do not attempt to drive and don't allow children to roam around outside.
- Beware of fallen power lines, damaged buildings, trees or flooded waterways.
- Listen to your radio for advice and updates.

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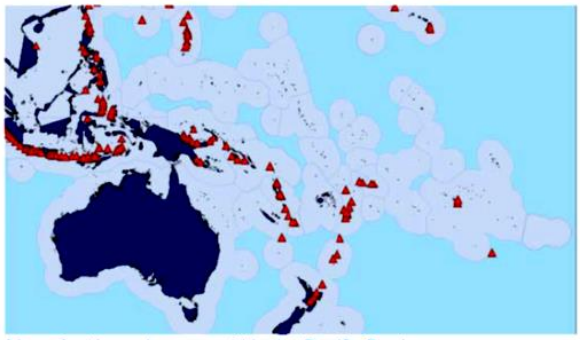
# Volcanoes

## NATURAL HAZARDS IN THE PACIFIC - FACT SHEET 5

SOPAC

Reducing Vulnerability of Pacific ACP States

The Pacific Rim is often called the "Ring of Fire" due to the large number of volcanic eruptions that occur along its plate boundaries. Volcanic eruptions are the greatest single cause of natural hazard induced deaths in the Pacific, having caused over 3500 fatalities in the last 100 years.



Map of active volcanoes within the Pacific Region.

### What is a Volcano?

A volcano is a mountain formed by erupted lava, rock fragments and ash. Volcanic eruptions occur when magma (molten rock) from inside the Earth rises to the surface along plate boundaries or at weak points within the plates called hotspots. There are many different types of volcanoes associated with different eruption types.

| Volcano Type | Characteristics | Example | Picture |
|---|---|---|---|
| Shield Volcano | Gently sloping, shield shaped volcano built by non-violent lava eruptions. | Giluwe, PNG |  |
| Cinder Cone Volcano | Small cone shaped volcano usually found on other volcanoes or in cone fields. Built by small explosive eruptions blowing lava into the air, which fragments and falls as cinders. | Cone on Mauna Kea, Hawaii |  |
| Com-posite Volcano | Steep volcano built by alternating layers of gentle lava flows and explosive eruption products usually found along destructive plate boundaries. | Manam volcano, PNG |  |
| Lava Dome | Dome shaped pile of lava created by individual flows of thick, sticky lava. | Bamus, PNG |  |
| Caldera | Large crater shaped basin, formed during large, violent eruptions, when either the summit is blown away or the volcano collapses into the emptied magma chamber. | Billy Mitchell Volcano, PNG |  |

Image sources: 1. PNG Rabaul Volcanic Observatory, 2. Vic Camp, San Diego State University, 3. Micheal Bonte, 4. PNG Rabaul Volcanic Obersvatory, 5. PNG Rabaul Volcanic Obersvatory.

### Eruption Frequency and Variability

Small eruptions are much more frequent and usually less disastrous than large, violent eruptions, which can take several thousand years to build up gas pressure before exploding. The explosivity of eruptions depends on the composition of the magma and the amount of water present. If more silica is in the magma it is less fluid and fewer gas bubbles can escape from it, leading to more violent eruptions. However, if water is present during the eruption, even highly fluid magma can erupt explosively - these hydrovolcanic eruptions lead to violent steam explosions, fragmenting the magma into fine-grained ash.

1

Image source: Cronin, Massey University NZ

2

Image source: Rabaul Volcanic Observatory, PNG

1. Huge eruption column of a violent, large eruption at Lopevi, Vanuatu.
2. Hot ash flows are amongst the deadliest volcanic hazards, as shown here in Manam, PNG in 1996. In 1951 nearly 3,000 people were killed by hot ash flows at Lamington volcano, PNG.

### Volcanic Hazards

**Hot ash flows** are the most dangerous hazard because they are fast-moving (up to 240 km/h) avalanches of hot (up to 800°C) ash, rock fragments and gas. They flow down the flanks of the volcano during explosive eruptions and tend to follow valleys, destroying everything in their path.

**Lava flows** can reach far distances and are capable of destroying all in their path, although they are usually fairly slow moving and thus not really life threatening.

**Volcanic gases** such as poisonous sulphur and carbon monoxide are emitted during eruptions. Acid rain damages crops and vegetation and carbon monoxide is lethal to animals and people.

**Volcanic bombs** (lava fragments larger than 64 mm across) blasted during eruptions can damage buildings and start fires.

**Ash falls** can rain down during eruptions burying people, crops and livestock and causing buildings to collapse.

**Ash clouds** pose a serious risk to air traffic.

**EXAMPLE:** In September 1994, two volcanoes, Vulcan and Tavurvur erupted and buried the town of Rabaul, PNG under millions of tonnes of ash and made 80,000 people homeless.

## Secondary Effects

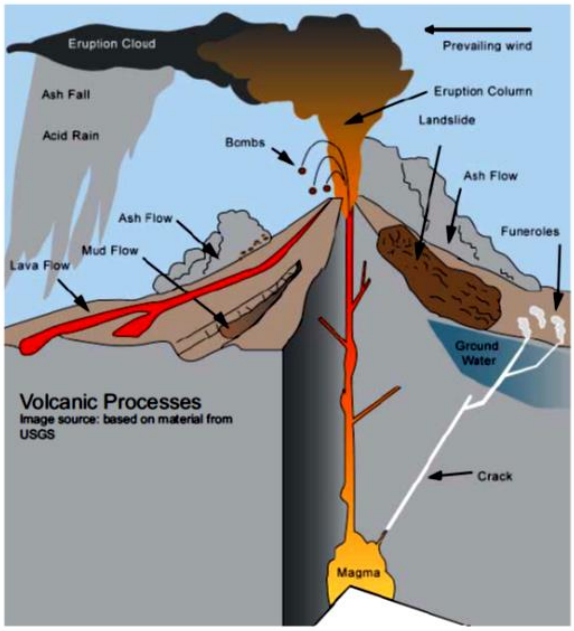
**Landslides** on steep, unstable flanks can have disastrous impacts. For example during the 1985 eruption in Colombia 23,000 people were killed by a fast moving mudflow of ash and water.

**Tsunamis** can be triggered by violent submarine eruptions or major volcanic landslides entering the sea.

**Earthquakes** can be caused by the intrusion or release of magma.

**Fires** can be caused by hot ash, bombs or lava.

**World's climate** is affected by the gases and particles forced high into the atmosphere during eruptions.

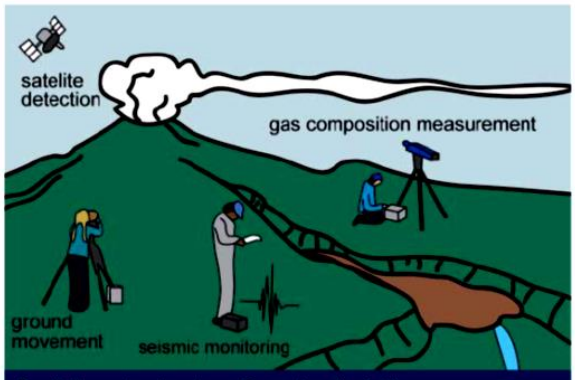



Volcanic Processes
Image source: based on material from USGS

## Volcano Warning

Effective management of volcanic activity and good prediction saves lives. Volcano monitoring is designed to detect and measure changes within a volcano caused by magma moving beneath it. A combination of observing stations, expert teams and a well educated and aware community is crucial to avoiding disasters during eruptions. An alert system should outline crucial emergency response actions for the different stages of volcanic activity.

However, Pacific island countries suffer from both many dangerous volcanoes and a lack of resources and often require outside help to properly monitor and assess their volcanoes.




Predicting volcanic crises: Ground and satellite sensors can detect earth tremors, ground distortion due to rising magma, changes in temperature and composition of steam and gas emissions.
Image source: based on material from USGS

**For more information, see the following links.**

**Observatories:**

- RVO-PNG: http://www.mineral.gov.pg/volcObs/volcanObs.htm
- DGMWR–Vanuatu: observatoire@vanuatu.com.vu
- USGS - Hawaii: http://hvo.wr.usgs.gov
- IGNS – NZ: http://www.geonet.org.nz
- DVAAC-AUS: http://www.bom.gov.au/info/vaac

**Educational:**

- http://www.geology.sdsu.edu/how_volcanoes_work/

## What you can do before, during and after a volcano

Volcanic eruptions are preceded by signs, some of which are not detected by instruments, nor observed by a volcanologist. The following are some points that should be taken into account to effectively respond to a volcanic eruption.

**PREPARE FOR AN ERUPTION**

- Make evacuation plans. If you live in a known volcanic hazard area, plan a route out and have a backup route in mind.
- Always keep an emergency kit in your home. Include water, food, necessary medicine, a reliable torch with fresh batteries and spares, portable radio, first aid kit, emergency phone numbers.
- Report any and all unusual physical changes around volcanoes e.g. the drying up of vegetation, rumbling sounds, earthquakes, landslides and other possible abnormalities.

**2. DURING THE ERUPTION**

- Listen to the radio for information and advice. Pay attention to warnings, which include evacuation notices.
- Escape from area as quickly as possible.
- Find shelter, but NOT in a building with low-pitched or flat roof, if heavy ash is falling.
- Avoid basements and closed spaces where gases may accumulate.
- Wear protective clothing over head and body if you have to move in an ash shower.
- Breathe through a handkerchief.
- Always carry a flashlight, even during the daytime.

**3. MITIGATION MEASURES**

- Establish permanent danger zones (4 to 6 km radius circle) around the summit of active volcanoes.
- Educate population about volcano risks.
- Improve warning and evacuation systems.

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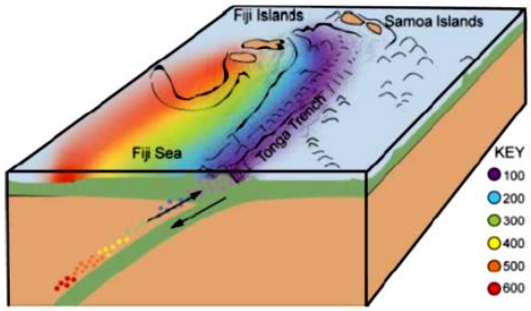
# Earthquakes

NATURAL HAZARDS IN THE PACIFIC - FACT SHEET 2

SOPAC

Reducing Vulnerability of Pacific ACP States

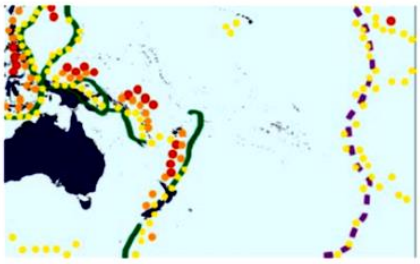
81% of the world's largest earthquakes occur at the edge of the Pacific, which is known as the "Pacific Ring of Fire" because it is renowned for earthquakes, volcanic eruptions and tsunamis. These hazards are caused by the movement of the Earth's tectonic plates, especially when one plate is dragged under another at what is known as a convergent margin.




The Tonga Trench, an ocean-ocean convergent margin.

## What is an Earthquake?

As plates collide and grind over or past each other, stress builds up locally within the rock until the rock breaks along lines of weakness (faults). An earthquake is the vibration of the earth due to the energy released as the rock breaks. Additionally some earthquakes can be caused by volcanic activity or underground collapse. Both shallow (0-70 km deep) and deep (down to 700 km) earthquakes are associated with oceanic subduction zones such as the Tonga trench connecting New Zealand, Tonga and Samoa and the New Hebrides trench, which connects Vanuatu, Solomon Islands and Papua New Guinea. Regionally, these countries and Fiji are at greatest risk from earthquakes.




Earthquake location map: Pacific Ring of Fire

## Earthquake Hazards

Earthquakes, both deep and shallow, can release huge amounts of energy and so can be extremely damaging to Pacific island countries.

**EXAMPLE:** The earthquake in East New Britain, Papau New Guinea in 2000 cost the country 14 million Kina in infrastructure and property damage and affected 100,000 people.

**Ground shaking** is caused by energy waves known as seismic waves hitting the surface of the earth. They cause the ground to shake up and down, back and forth and from side to side. This causes damage to buildings, roads, dams and reservoirs, buried pipelines, infrastructure, and overhead cables, leading to dangers from collapsing buildings, falling debris, uneven ground, landslides, flooding and fires.

Ground shaking occurs at different intensities according to distance from and magnitude of the earthquake. The larger and shallower the earthquake and the closer to the centre of it you are, the more intense the ground shaking.


**EXAMPLE:** A powerful Ms 7.3 earthquake struck Port Vila, Vanuatu 2002.
First picture shows the damaged Teouma Bridge.
Second picture shows a bungalow damaged by rock fall.

**Surface faulting** is where an earthquake causes the ground surface to permanently split apart along a fault within the ground rock and soil. Faulting tends to occur when the earthquake is very shallow (0-10 km deep) and strong.

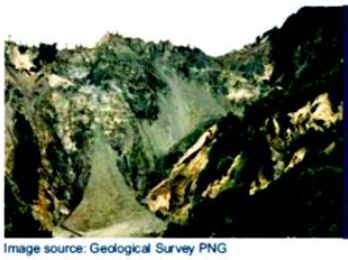
**Liquefaction** is where the vibrations of the ground cause the soil to behave like a liquid. It happens on mainly sand and mud/clay soils – the soil flows, acting like quicksand, and results in failure of building foundations. It is an especially dangerous effect in urban areas.

**EXAMPLE:** In 2002 a Ms 7.4 earthquake caused liquefaction of unconsolidated sediments, destruction of houses and water supply of islands offshore Wewak, PNG due to the remarkable uplift of 30-40 cm along faults.

**Secondary Hazards.** In addition, earthquakes can trigger secondary hazardous events such as **health problems** due to interrupted water supply or broken sewage disposal systems, **landslides**, **tsunamis**, **seiches**, **fires** (due to gas leaks and broken live electricity wires) and **flooding**.

## Modified Mercalli Earthquake Intensity Scale

I. Instrumental. Not felt except by a very few under especially favourable conditions detected mostly by Seismography. (2)
II. Feeble. Felt only by a few persons at rest, especially on upper floors of buildings. (2)
III. Slight. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing cars may rock. Vibration similar to the passing of a truck. (3)
IV. Moderate. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rock noticeably. (3)
V. Rather Strong. Felt by nearly everyone; many awakened. Some dishes, windows broken. Un-stable objects overturned. Pendulum clocks may stop. (4)
VI. Strong. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. (5)
VII. Very Strong. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures. (5)
VIII. Destructive. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of factory stacks, columns, monuments, walls. Heavy furniture overturned. (6)
IX. Ruinous. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. (7)
X. Disastrous. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bend greatly. (7)
XI. Very Disastrous. Few (masonry) structures remain standing. Bridges destroyed. Rails bend greatly. (8)
XII. Catastrophic. Damage total. Lines of sight and level are distorted. Objects thrown into the air. (8)



EXAMPLE: Several earthquakes in 1993/4 in the Finisterre Range, PNG caused massive and widespread landsliding resulting in damming of streams with subsequent flooding and huge sediment problems.

Image source: Geological Survey PNG

## Earthquake Warning

Currently there are no effective prediction or warning systems to provide advance warning that an earthquake is about to happen. Thus, it is vitally important that you are aware of what to do should one occur.

## For more information, see the following links:

**US Federal Emergency Management Agency:**
http://www.fema.gov/hazards/earthquakes
**US Geological Survey:** http://earthquake.usgs.gov

## What you can do before, during and after an earthquake

**PREPARE FOR AN EARTHQUAKE**

Always keep an emergency kit in your home. Include water, food, necessary medicines, a reliable torch with fresh batteries and spares, portable radio, first aid kit, emergency phone numbers.

**DURING AN EARTHQUAKE**

If you are inside:

- Drop, cover and hold.
- Stay inside — do not attempt to run outside. However, be prepared for aftershocks and evacuate if necessary. Listen to your radio for information and advice.
- Take cover under strong support like an internal door frame, table, desk or bed. Stay away from windows, overhead fittings, shelves containing heavy objects etc.
- If in a high-rise building, stay away from windows and outer walls. Never use the elevator.
- If in a crowded public place, try not to panic. Do not attempt to barge at the door.

If you are outdoors:

- Keep well clear of buildings, power lines, trees etc. and stay in the open. Do not attempt to seek shelter in a building.
- If you are in a vehicle, pull off the road to a clear area and stop the car.
- Beware of fallen power lines, damaged roads and bridges.

**AFTER AN EARTHQUAKE**

- Check people for injuries and apply first aid. Call the ambulance and do not move the seriously injured unless they are in immediate danger.
- Do not use the telephone unless it is absolutely necessary.
- Do not use your vehicle unless there is an emergency.
- Do not enter damaged buildings.
- Turn off cooking stoves. Do not light matches until you have checked for gas or fuel leaks.
- Turn utility off at source if you have water leaks or damaged electrical wires or sewerage lines.
- Check food and water supplies.
- Stay calm and lend a hand to others if possible.

**Earthquakes are sudden, striking with little or no warning. Be prepared in case it happens!**

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