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TSUNAMI

Is Not a Tidal Wave

Presented by Todd R. Adams

For vitae information click here

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TSUNAMI

The word tsunami is of Japanese origin. It roughly translates to mean “harbor wave”. To that extent, it could be applied to just about any wave, but it is not. The name was given to a very dangerous wave, more accurately called a seismic wave.

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TSUNAMI

Through much of my 40 years on Earth, I, like many other people, referred to tsunamis and other large waves as tidal waves. I attribute this to a couple of reasons. One is a lack of scientific knowledge in the area of ocean sciences. The other is perpetuation of the “tidal” wave by the media, to include the motion picture industry and the news. The media inaccuracy could fall back to reason number one or they just think the viewer/listener isn’t smart enough to except the accurate name.

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TSUNAMI

The Indonesian tsunami on December 26, 2004 was referred to as a tidal wave in some, not all, newspaper, TV, and radio reports. This is especially bothersome to me, since I spent nearly 18 years in radio and television. Accuracy is something taught in journalism school.

While every profession has its own terminology, I think we in the sciences should make every effort to communicate science in a non-science way to make it palatable by the general public while maintaining accuracy.

Alright, I'll get off my soap box now and talk a little about waves.

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OCEAN WAVES

- Disturbances that move through or over the surface of the ocean with speed dependent on the properties of the water
- Ocean wave
  - A wave is a pattern of raising and falling water level that is transmitted along the sea surface.
  - Waves transmit energy away from an initial disturbance without the physical transport of water.
  - Actual patterns are complex and are typically studied by using ideal waves.
  - Progressive waves that move energy from one place to another. Energy moves in a definite direction.

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OCEAN WAVES ENERGY SOURCES

- Winds – primary source
- Earthquakes
- Undersea landslides
- Undersea volcanoes
- Gravity between Earth, Sun, and Moon
- Atmospheric pressure changes
- Movement of ships

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WAVE CHARACTERISTICS

There are many types of waves. In order to understand the tsunami, we must first look a the characteristics of waves and the different types of waves.

Wind Waves

Tidal Waves

Seismic Waves

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WAVE CHARACTERISTICS

The name of the wave is given to it based on what causes the wave. This "cause" is called a *disturbing force*. A *disturbing force* is what initiates a wave. Some disturbing forces include; wind, seismic activity, and gravitational pull from the moon and sun. Because waves have different disturbing forces, all waves are not the same.

Something also tries to return the water flat, toward the surface. This is called a *restoring force*. In small capillary waves, this is called cohesion. In larger waves, gravity is the restoring force.

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WAVE DEFINITIONS

<u>Wavelength</u> is the horizontal measurement from crest to crest or trough to trough.

<u>Crest</u> is the highest raised part of the wave from average sea level.

<u>Trough</u> is the valley between the crests (lowest part; depression).

<u>Wave height</u> is the vertical difference from the lowest part of the trough to the highest part of the crest.

<u>Wave period</u> is the time for two consecutive crests or two consecutive troughs to pass a given point.

<u>Wave speed</u> is wave length divided by wave period.

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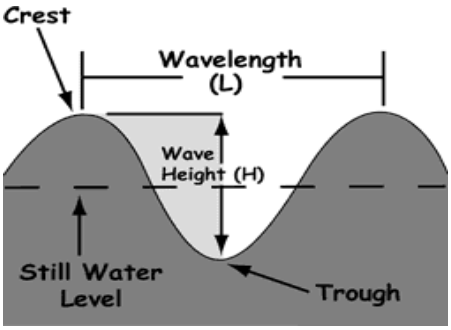
WAVE DIAGRAM



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SHALLOW WATER WAVES

- **Water depth<1/20 of the wavelength**
- **Interaction with bottom alters the wave characteristics**
- **As depth decreases more wave alterations**
- **At depths between ½ and 1/20 of the wavelength the orbitals flatten**
- **Wave period remains the same**
- **Waves interacting with the bottom slow down**
- **Wave lengths shorten**
- **Wave heights increase**
- **Wave speed is related to depth –the shallower, the slower the speed**
- **As waves "feel bottom" friction with the bottom causes circular pattern to become elliptical and ultimately change to a back and forth motion.**

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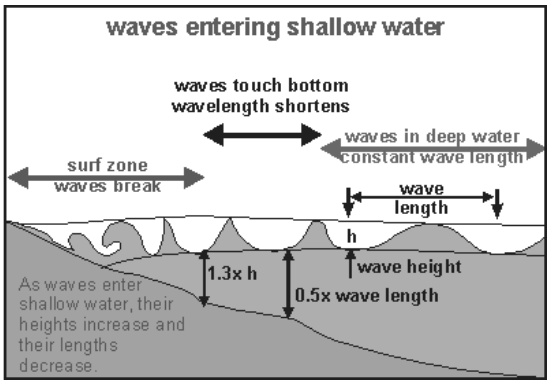
SHALLOW WATER WAVES



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WIND WAVES

Wind driven waves are the most common waves experienced in coastal / lake areas. They are caused by the friction of the wind blowing over the water and the force of gravity pulling down.

Factors affecting wind driven waves include:

- Wind speed
- Wind duration
- Fetch – the distance over which the steady wind blows

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WIND WAVES

Specific wave characteristics are produced by:

- Strength (speed) of wind
- How long wind blows (duration)

Strong winds blowing for long periods of time produce waves with the greatest heights, lengths, periods, and speeds.

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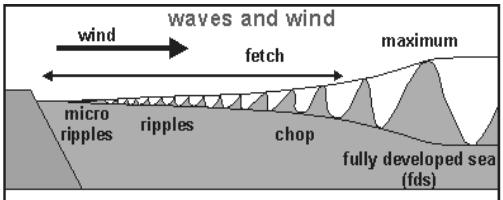
WIND INFLUENCE ON WAVES



As waves develop, they offer more surface area for the wind to press against (wind stress). Depending on both fetch and time, the size of the waves increases quadratically to a maximum. The energy imparted to the sea increases with the fourth power of the wind speed! As waves develop, they become more rounded and longer and they travel faster. Their maximum size is reached when they travel almost as fast as the wind. A 60 knot storm lasting for 10 hours makes 15 m high waves in open water.

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TIDAL WAVES

A tidal wave is quite common also. Remember, the cause of a wave is where the wave gets its name. So, tidal waves are caused by tides. Tides are caused by the gravitation pull of the moon, Earth and sun.

The larger the wavelength of a wave the more unnoticed it goes in open water. The tidal wave is half the circumference of the Earth, so, all that is noticed is the rise of the tide itself.

Though, in some places on Earth, the right combination of tidal range and geologic make up of the area can cause large waves*, swift currents and whirlpools.

***One such wave is called a tidal bore. More information is available on tidal bores at the National Geographic webpage.**

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SEISMIC WAVES

This is the tsunami! The cause is seismic activity, usually underwater earthquakes or underwater landslides. Though, above water landslide can also cause a tsunami.

In either case, a land mass is moved, displacing water. When I teach "coastal hazards" to students, I relate it to their doing a cannonball in a swimming pool. Their body displaces water, causing it to rush rapidly outwards, creating waves.

An excellent animation of this at this Public Broadcasting System website.

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TSUNAMIS – SEISMIC WAVES

- Caused by earthquakes, landslides, and volcanic eruptions
- Long wavelengths and periods; low height
- Wavelengths are so long tsunamis are actually shallow water waves in an ocean basin
- As tsunamis approach coastlines the bottom interaction results in a rapid decrease in speed and wavelength causing a rapid, potentially dangerous increase in wave height
- Not noticeable at sea because troughs and crests are so far apart
- May travel as fast as 600 miles/hour
- May produce breakers >100 feet high

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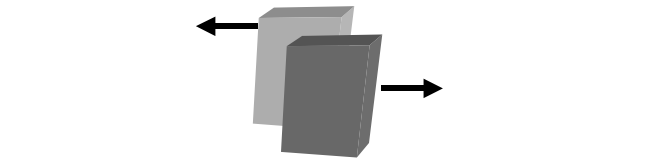
SEISMIC WAVES continued

Not all earthquakes cause tsunamis. Some earthquakes, where the land slides horizontally, have negligible water displacement.



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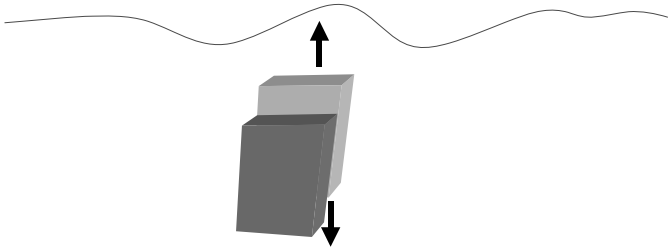
SEISMIC WAVES continued

Even some earthquakes, where the land slides vertically, have little water displacement. An earthquake magnitude should be at least a 6.5 on the Richter scale to cause concern about a tsunami.



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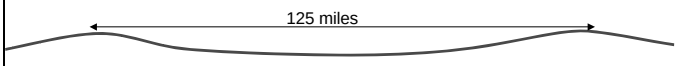
SEISMIC WAVES continued

The tsunami has a long wavelength, about 125 miles between crests. Therefore, the seismic waves can go almost unnoticed, at speeds of 600 mph, in deep open water.



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SEISMIC WAVES continued

Noticing a seismic wave is the job of NOAA, the National Oceanic and Atmospheric Administration.

Currently only a few detection devices known as DARTs, Deep-ocean Assessment and Reporting of Tsunamis, exist in the Pacific Ocean. After the Indonesian tsunami, the U.S. government decided to upgrade our detection system, to include the Atlantic and Caribbean Sea.

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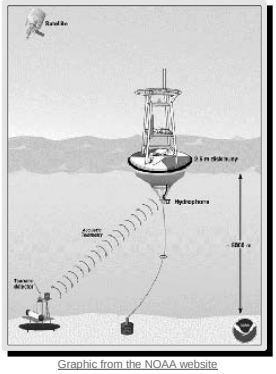
DART

Deep-ocean Assessment and Reporting of



Graphic from the NOAA website

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DART

Deep-ocean Assessment and Reporting of Tsunamis.

This is how the detection system works.

Sea floor based detection devices detects seismic activity.

When a earthquake is detected, a scale is activated that weighs the water. Tsunamis weigh more than regular waves. When a tsunami passes over the scale, a signal is sent to the attached buoy that contains satellite communications equipment.

Data is sent to the Tsunami Warning Center in Hawaii to be analyzed. Then, the Tsunami Warning Center advises the emergency management (also known as civil defense) agencies. Emergency management officials use sirens, door to door notification, and media to warn the public.

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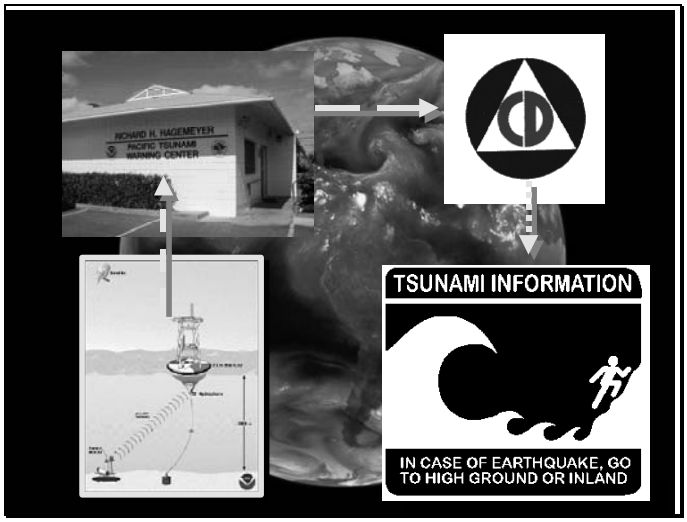

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Pacific Tsunami Warning Center in Hawaii

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FEMA

The Federal Emergency Management Agency is the federal counterpart to state, county and city emergency management/civil defense programs.

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Public Notification of Tsunamis

It should be noted that not all countries have an emergency management system as elaborate as the United States. In the case of Indonesia, they have little in the way of an organized emergency preparedness and warning system. This lack of notification likely contributed to the nearly 150,000 deaths from the December 26th tsunami.

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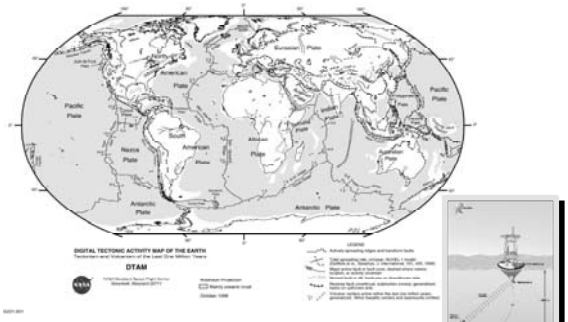
DART

Deep-ocean Assessment and Reporting of Tsunamis.

Below is a map indicating areas of tectonic activity.



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TSUNAMI DESTRUCTION

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TSUNAMI DESTRUCTION

www.digitalglobe.com/images/tsunami/meluaboh

Visit the web site given above for aerial photos that reveal the terrestrial damage and land loss.

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TSUNAMI

References:

Garrison, Tom. 2002. Oceanography, An Invitation to Marine Science. Wadsworth/Thompson Learning, Pacific Grove, CA.

Segar, Douglas A. 1998. Introduction To Ocean Sciences. Wadsworth Publishing Company, Belmont, CA.

Web sites:

http://oceanworld.tsunami.edu/students/waves/wavesw3.htm

www.bigelow.org/virtual/handson/waves.html

www.fema.gov/hazards/tsunamis/tsunamif.shtm

www.ndbc.noaa.gov/educate/waves.shtml

www.ndbc.noaa.gov/Dart/dart.shtml

http://news.nationalgeographic.com/news/2005/02/0222_050222_tidalbore.html

www.onr.navy.mil/focus/ocean/motion/waves/waves4.htm

http://www.pbs.org/wnet/savageearth/animations/tsunami/index.html

www.prh.noaa.gov/ptwc/