Implementation of tsunami education outreach website in HTML and JavaScript format

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Abstract

A website about tsunamis has been developed for educational purposes oriented to a broad audience and to students as a reference site. This site has been created with the general public in mind; consequently technical words or complex equations were avoided for a better understanding. The tsunami website has been created in English and Spanish in that way more people will be able to read it and learn about tsunamis. This site contains information about tsunamis, characteristics, causes, frequently asked questions, stories and photos, it also contains more detailed information about recent and stronger tsunami events that will be of interest to tsunami researchers. The programming languages used for the creation, development and design of the tsunami website were html and JavaScript. Investigation and research have been made for the creation of the tsunami website. The sources of such investigations were taken from books and other websites about tsunamis.

Introduction

The phenomenon called tsunami is a series of water waves generated by any disturbance associated with seismic activity, explosive volcanism, a submarine landslide, a meteorite impact with the ocean, or in some cases meteorological phenomena. A tsunami represents a vast volume of seawater in motion, the source of its destructive power. These waves can be generated in oceans, bays, lakes or reservoirs.
Tsunamis can savagely attack coastlines, causing devastating property damage and loss of life. The idea of this website is through education and awareness people will understand the dangers of the tsunamis and will be prepared for them.

Website organization
(Figure 1)

1. Tsunami Information

Tsunamis are frequently called “tidal waves”, but this term is not correct as tsunamis are unrelated to the tides. Tides result from the imbalanced, extraterrestrial, gravitational influences of the moon, sun and earthquake-related generation mechanism.
A tsunami is a series of waves most commonly caused by violent movement of the sea floor. A tsunami can be generated by any disturbance that displaces a large water mass from its equilibrium position. In some ways a tsunami resembles the ripples that radiate outward from the spot where a stone has been thrown into water, but a tsunami can occur on an enormous scale. The movement at the sea floor that causes the tsunami can be produced by different types of violent geologic activity: earthquakes, underwater landslides or much less frequently by volcanic eruptions or meteorite impacts.

Causes of tsunamis

- Earthquake generated tsunamis
  The most common cause of tsunami is seismic activity. Over the past two millennia, earthquakes have produced 82.3% of all tsunami in the Pacific Ocean.
  Two thirds of damaging tsunamis in the Pacific Ocean region have been associated with earthquakes with a surface magnitude of 7.5 or more. The majority of these earthquakes have been teleseismic events affecting distant coastlines as well as local ones.
  Most tsunamis occur in the Pacific Ocean, because the Pacific basin is surrounded by a zone of very active features in the earth’s crust: deep ocean trenches, explosive volcanic islands, and dynamic mountain ranges. Frequent earthquakes and volcanic eruptions make the rim of the Pacific basin the most geologically active region on earth, this place is called the ring of fire.

- Landslides
  Probably the second most common cause of tsunamis is land sliding. A tsunami may be generated by a landslide starting out above sea level and then plunging into the sea, or by a landslide occurring entirely underwater. Landslides are produced when slopes or deposits of sediment become too steep and the material fails under the pull of gravity. Once unstable conditions are present, slope failure can be caused by storms, earthquakes, rain, or merely continued deposition of material on the slope. Certain environments are particularly susceptible to the production of landslide-generated tsunamis. River deltas and steep underwater slopes above

submarine canyons, for instance, are likely sites for landslide-generated tsunamis. Another type of area prone to landslide-generated tsunamis are fjords.

- Volcanic Eruptions
  Although volcanic tsunamis are much less frequent than those associated with earthquakes, they are often highly destructive.
  In historical times, there have been at least 92 major tsunamis produced by volcanic action. About 25 percent of these were produced by earthquakes accompanying eruption, another 25 percent produced by pyroclastic flows impacting the water, about 20 percent were generated by submarine explosions, about 10 percent by caldera collapse, and the remaining 20 percent by various types of volcanic landslides. Volcanoes have caused 4.6% of tsunami and 9.1% of the deaths attributable to this hazard.
  A survey of volcanic tsunamis indicates that the most violent and destructive tsunamis produced by volcanoes are due to pyroclastic flows impacting the sea, or to large volcanic landslides.

<u>Tsunami characteristics</u>
Tsunami waves are very different from other ocean waves.
Ordinary waves, which are in fact caused by the wind blowing over the water, affect only the surface of the ocean. These waves don't have a very high depth and never travel at more than 60 miles per hour and are usually much slower. Wind waves are rarely longer than 1,000 feet from crest to crest (wavelengths). Tsunami waves, on the other hand, could easily keep pace with a Boeing 747 with speeds that can exceed 700 kilometers per hour (500 miles per hour or more) in the deep ocean. Tsunami waves also have much greater wavelengths and are often an incredibly long 100 miles between crests.

A popular misconception is that there is only one giant wave in a tsunami. On the contrary, a tsunami may consist of 10 or more waves forming what is called a "tsunami wave train". The individual waves follow one behind the other, anywhere from 5 to 90 minutes apart.

Tsunamis evolve through three overlapping but quite distinct physical processes**:**

- **Generation** is the process by which a seafloor disturbance, such as movement along the fault reshapes the sea surface into a tsunami. (Figure 2)
- **Propagation** of the tsunami transports seismic energy away from the earthquake site through undulations of the water. Researchers apply linear wave theory, which assumes that the height itself does not affect the wave's behavior. The theory predicts that the deeper the water and the longer the wave, the faster the tsunami. (Figure 3)

- **Inundation** of dry land. Capable of inundating or flooding, hundreds of meters inland, the fast-moving water associated with the inundating tsunami can crush homes and other coastal structures. (Figure 4)

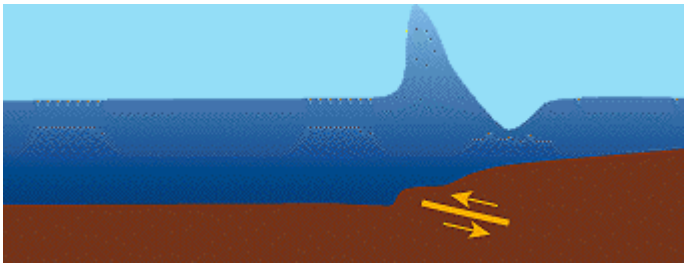

Figure 2. – Generation: disturbance of the seafloor

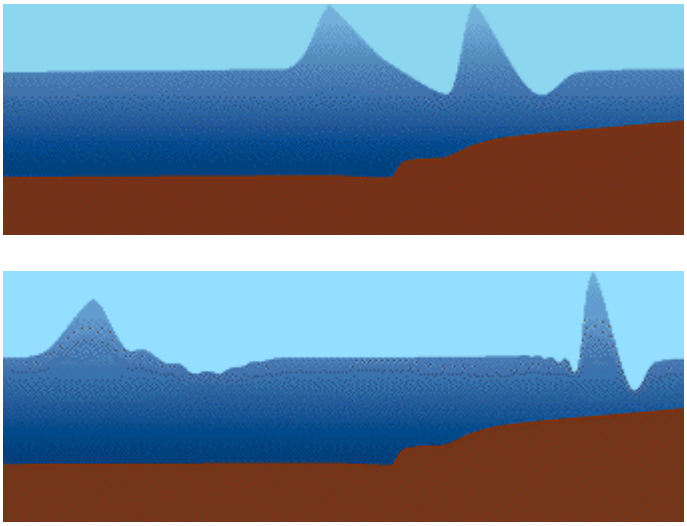

Figure 3. - Propagation: transports seismic energy away from the earthquake site through undulations of the water

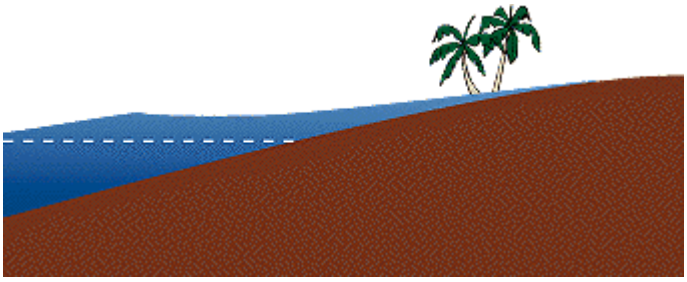

Figure 4. - Inundation of dry land; it washed up everything that is in its way.

2. Worldwide tsunamis

Tsunamis have been reported since ancient times. They have been documented extensively especially in Japan because it is precariously situated near the colliding margins of four tectonic plates, also they are very frequent in the Mediterranean areas and along the west coast of South America, especially in Peru and Chile, that are one of the most tsunami-prone coasts in the world. About four out five tsunamis happen within the “ring of fire”.
The only regions that have generated remote-source tsunamis affecting the entire Pacific Basin are the Kamchatka Peninsula, the Aleutian Islands, the Gulf of Alaska, and the coast of South America. Hawaii, because of its location in the center of the Pacific Basin, has experienced tsunamis generated in all parts of the Pacific.

2.1 World Map: location of the most destructive tsunamis in the world (Figure 5)

Figure 5. – Most worldwide destructive tsunamis

July 12, 1993: Okushiri Island, Japan

A large earthquake with a magnitude of 7.8, centered about 15-30 km offshore in the Sea of Japan, struck the Okushiri region of Hokkaido. Five minutes later, waves ranging from 5 to 10 meters in height crashed on the closest shores destroying fishing villages and killing 239 people. Field survey documented the maximum wave height to be 31.7 meters in a small valley on Okushiri Island.

The loss of lives in this event was a great tragedy, but it is clear that both warning technology and community education greatly reduced the number of casualties. The Japan Meteorological Agency issued timely and accurate warnings, and many residents saved themselves by fleeing to high ground immediately after the main shock – even before the warming. Okushiri clear demonstrated that the impact of tsunamis can be reduced. This event has also become the best-documented tsunami disaster in history.

July 17, 1998: Papua New Guinea

On July 17, 1998 an earthquake with magnitude of 7.1 struck the north central coast of Papua New Guinea. Following the earthquake a large tsunami also struck the region killing more than 2,200 people. Waves reached a maximum of 15 meters in height. Surprisingly, a relative small earthquake spawned waves usually limited to much larger quakes. This apparent discrepancy between earthquakes strength and tsunami intensity has prompted speculation among scientists that the seismic vibrations may have triggered other seafloor disturbances, such as underwater landslide or an explosion of gas hydrates, that helped to create a much larger tsunami.

Dec. 12, 1992: Flores, Indonesia

The islands that make up the Indonesia Archipelago span a zone where three huge tectonic plates collide: the Indo-Australia plate, the Asian plate and the Pacific plate all converge and thrust against one another, producing some of the largest and most frequent quakes on earth. On December 12, 1992 an earthquake of magnitude 7.5 generated a local tsunami along the North Coast of the island of Flores in the Indonesian Archipelago, which killed more than 1,000 people and destroyed thousands of houses. The tsunami wave train consisted of at least three waves, with the second one often being the largest. The first wave, which came in as a wall, was preceded by a general withdrawal of water and arrived on the shores of Flores Island within two minutes after the initial shock and reached the

north shore within five minutes. Submarine landslides triggered by the earthquake may explain many of the tsunami's features including the small number of waves in the wave train and the larger run-up heights and shorter arrival times eastwards. Waves reached a maximum of 26 meters in height. This tsunami is only one of three that occurred in the twentieth century with run-up exceeding more than 20 m.

June 23, 2001: Peru

On June 23, 2001 southern Peru was rocked by a powerful earthquake of moment magnitude 8.4, the largest earthquake recorded worldwide in 35 years. The quake, centered near the Peruvian coastal city of Ocoña just north of Camaná. Many cities and towns in the region sustained heavy damage. The terrible earthquake also generated a tsunami. The tsunami was observed in many coastal areas of the Pacific including Peru, Chile, Hawaii, and Japan. Hardest hit was the region around Camaná, Peru, where approximately 26 people died as a result of the tsunami with roughly 70 still missing.
Maximum run-up measurements exceeded 7 meters in some locations, with greater than one kilometer of inundation distance in others. The powerful surges destroyed hundreds of homes, hotels and restaurants in La Punta, a popular resort area located along a narrow strip of beach immediately south of Camaná. Thankfully, the tsunami occurred during the southern hemisphere winter, when the beach front communities were largely deserted.

2.2 Table with the major tsunamis in the world from 1990 – 2002

Location	Date	Earthquake Magnitude	Maximum Height (m)	Death Toll
Nicaragua	Sept. 2 1992	Ms = 7.2	10.7	170
Flores, Indonesia	Dec. 12 1992	Ms = 7.5	26.2	1713
Okushiri Island, Japan	12-Jul-93	Ms = 7.6	31.7	239
East Java, Indonesia	2-Jun-94	Ms = 7.2	14	238
Shikotan, Kuril Islands	Oct. 4, 1994	Ms = 8.1	10	10
Mindoro, Philippines	Nov. 14, 1994	Ms = 7.1	7	71
Jalisco, Mexico	Oct. 9, 1995	Ms = 7.9	10.9	1
Sulawesi Island, Indonesia	Jan. 1, 1996	Ms = 7.7	3.4	24
Irian Java	Feb. 17, 1996	Ms = 8.0	7.7	108
Chimbote, Peru	Feb. 21, 1996	Ms = 7.5	5	2
Kronotskiy Cape, Kamchatka	Dec. 14, 1997	Ms = 7.7	8	--
Aitape, Papua New Guinea	17-Jul-98	Ms = 7.1	15	2,202
Sea of Marmara, Turkey	Aug. 17, 1999	Ms = 7.8	2.5	?
Pentecost Island, Vanuatu	Nov. 26, 1999	Ms = 7.3	5	5
Southern Peru	June 23, 2001	Ms = 8.4	7	26
Wewak, Papua New Guinea	Sept. 9, 2002	Ms = 7.8	5	?

Summary

Tsunamis have killed more than 50,000 people and are responsible for several hundred million dollars in property damage in the past century. This is a great and destructive phenomenon that cannot be diminished neither underestimated, that's why the worldwide web is a very good way to teach and prevent the people about tsunamis. People will understand the dangers of the tsunami; they will be prepared when it's coming and escape from it.

References

National Geophysical Data Center NOAA, "Geologic Hazards Photos, Volume 3: Landslides, Tsunamis and Volcanoes"

Edward Bryant Tsunami, "The Underrated Hazard"

Walter C. Dudley and Min Lee, "Tsunami!"