




**Hawaii Hazards Awareness & Resilience Program**


Produced by  
Hawaii State Civil Defense



**HAWAII HAZARDS AWARENESS & RESILIENCE PROGRAM:**

**GOAL:** To enhance community resilience to multiple hazards through a facilitated education and outreach program that promotes hazard understanding and awareness, and offers tools and information resources to guide mitigation, preparedness, response and recovery.

2



**TSUNAMI BASICS**

Module 1: Hazard Awareness


**Contents**

- What is a Tsunami?
- Tsunami Impacts
- Tsunami Events in Hawaii
- Where to Get More Information?

3


Module 1: Hazard Awareness

**WHAT IS A TSUNAMI?**



**Tsunami Myths**

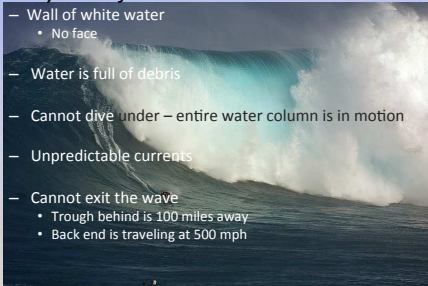
- A monstrous wall of water that rises up out of the sea to engulf a unsuspecting ship or coastal community... Like you see in the movies!



6

## Tsunami Myths

- **Can you surf a tsunami?**



- Wall of white water
  - No face
- Water is full of debris
- Cannot dive under – entire water column is in motion
- Unpredictable currents
- Cannot exit the wave
  - Trough behind is 100 miles away
  - Back end is traveling at 500 mph

7

## What is a Tsunami?

- Pronounced: *Tsoo-nah-mee*
- Japanese word meaning ‘harbor wave’
- Also known as a ‘seismic sea wave’
- You may hear a tsunami erroneously referred to as a ‘tidal wave.’
- A series of traveling waves of extremely long length and period, usually generated by disturbances associated with earthquakes occurring below or near the ocean floor. (IOC, UNESCO)

8

## Terms & Definitions

- **Inundation**
  - The horizontal distance inland that a tsunami penetrates, generally measured perpendicularly to the shoreline. (IOC, UNESCO)
- **Runup**
  - The difference between the elevation of the maximum tsunami penetration (inundation line) and the sea level at the time of the tsunami. (IOC, UNESCO)
- **Tsunami Evacuation Zones**
  - Areas that might be affected by a tsunami, beyond which people must be evacuated to avoid harm from tsunami waves.

9

## Illustration of Tsunami Terms

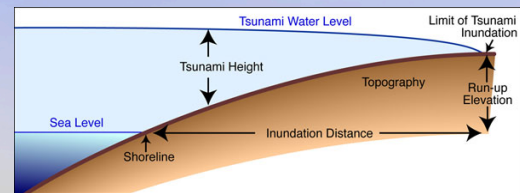


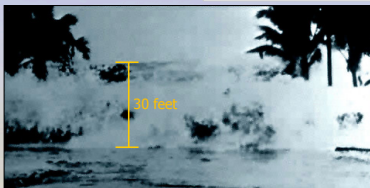
Image source: USGS, Illustration by Bruce Jaffe

10

Hat Rai Lay Beach, Thailand  
December 26, 2004



Agence France Presse  
Tourists try to rush to safety before the tsunami in the Hat Rai Lay Beach in Thailand.  
The water had receded before the deadly wave struck.



Hilo, Hawaii  
April 1, 1946

11

## Tsunami Causes

Tsunami events result from a sudden displacement of water caused by:

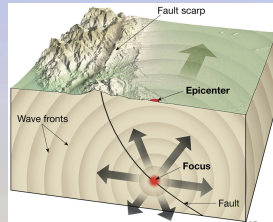
- **Earthquakes**
  - Movement of the plates along the sea floor
  - Most destructive tsunamis are associated with earthquakes of magnitude 7.5 and higher (USGS)
    - Sumatra – December 2004
    - Chile – May 1960
- **Landslides**
  - Displacement of a large amount of sediment/material usually triggered by an earthquake
    - Alaska – April 1946
- **Submarine Volcanic Eruptions**
  - Catastrophic eruption of undersea volcanoes
    - Krakatoa – August 1883

12

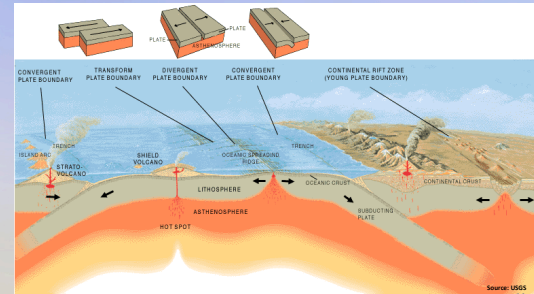
## Tsunami Causes (Continued)

Tsunami waves are typically triggered by shallow earthquakes (with a focus depth of 12 miles or less).

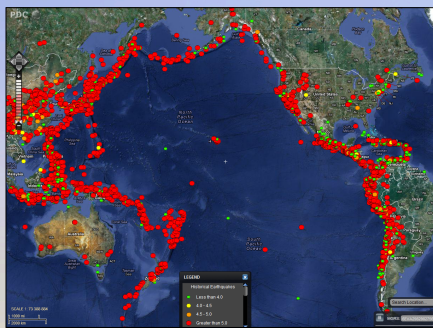
- The earthquake *focus* is the point within the earth where seismic waves originate.
- The earthquake *epicenter* is the point at the earth's surface directly above the focus.



## Plate Boundaries



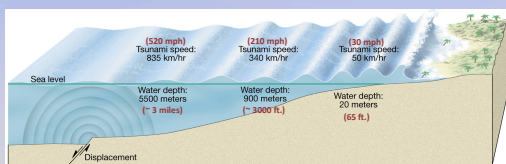
## Pacific Ring of Fire



## Tsunami Characteristics

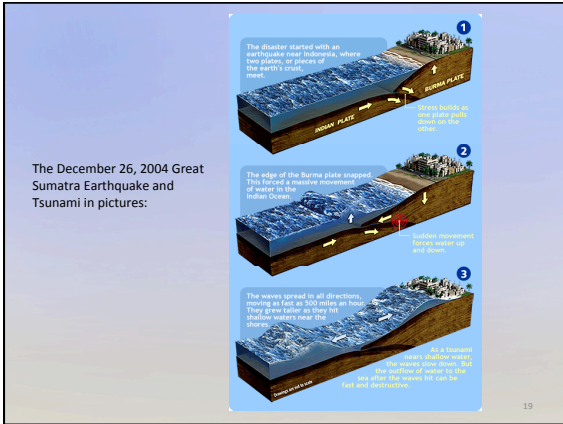
- In the open ocean
  - Height is usually < 3 feet
  - Extremely long wavelength: > 60 miles
  - Travel at great speeds: ~ 500+ mph (jet plane)
- In shallow coastal waters
  - Runup can reach heights over 100 feet
  - Inundation can be several miles

## Illustration of a Tsunami



## Tsunami Characteristics (Continued)

- Tsunami bore waves
  - A steep, turbulent, rapidly moving tsunami wave front, typically occurring in a river mouth or estuary. (IOC, UNESCO)
- A tsunami may have *MORE THAN ONE* wave!
  - Multiple waves
  - First may not be the largest
  - Time between waves could be 10 to 60 minutes.



## Distant vs. Local Tsunami

- Distant Tsunami or Teletsunami
  - A tsunami originating from a far away source (> 620 miles or 1000 km away).
  - Arrival of first wave expected within *hours*.
- Local Tsunami
  - A tsunami originating from a nearby source, with destructive effects confined to coasts within 62 miles (100 km) of the source.
  - Arrival of first wave expected within *minutes*.

20

Module 1: Hazard Awareness

## TSUNAMI IMPACTS

21

## Tsunami Impacts

- Loss of life to unsuspecting observers unable to outrun fast-moving, steadily rising floodwater carrying debris.
- Destruction of coastal resources
  - Permanent changes to beaches and coastal features.
- Salinization of land in the inundation area
  - Agricultural land rendered useless.
- Partial or complete damage to infrastructure
  - Built environment (homes and other structures).
  - Roads, bridges, etc.
- Can trigger cascading effects
  - Example: Japan tsunami, March 11, 2011.

22





## Learning Check

1. What is a tsunami?
2. What causes a tsunami to occur?
3. What are some of the impacts of a tsunami?
4. What is the difference between a local tsunami and a teletsunami?

26

Module 1: Hazard Awareness

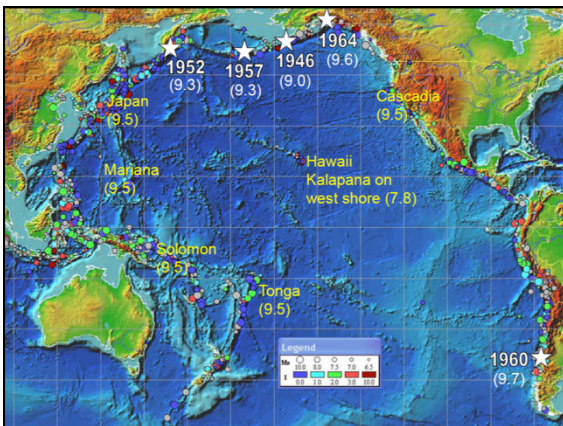
## TSUNAMI EVENTS IN HAWAII

## Tsunami Travel Times to Hawaii

*Approximate Travel Times For Distant Tsunami Events:*

Japan	7 hours
Alaska	5 hours
S. Pacific	7 hours
Chile	14 hours
U.S. West Coast	5 hours

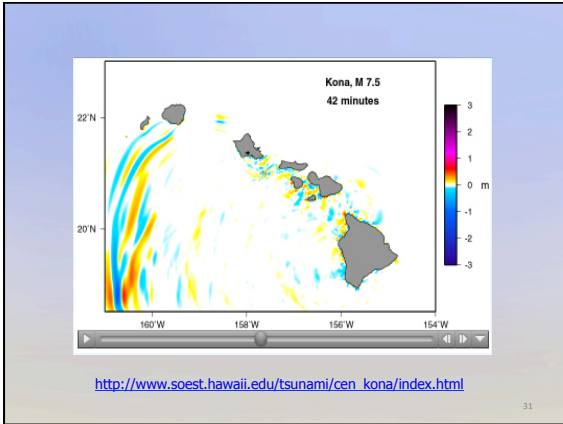
28



## Local Tsunami Events

- May be caused by earthquake or submarine landslides.
- Danger is greater due to the limited warning time.
  - Minutes, not hours before arrival of first wave.
- Most significant local event for Hawaii:
  - November 29, 1975
  - Runup to 40 feet
- The animation on the next slide shows how quickly a locally generated tsunami can travel through the Hawaiian Islands.

30



## Hawaii's Tsunami History

- Thirteen (13) significant tsunami events from 1819 to 2000
  - Most generated by earthquakes
- More people killed by tsunamis than by any other natural disaster in Hawaii.
- Statistics from 1900 to 1998:
  - Tsunami deaths
    - ~221 people (~159 of these occurred in the 1946 event).
  - Hurricane deaths
    - 7 people

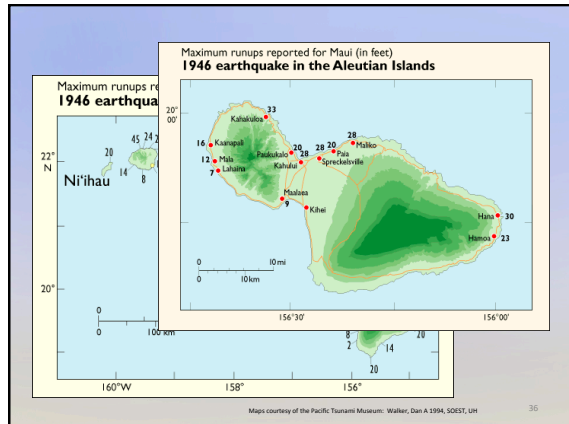
## Hawaii's Tsunami History

- Two Major Tsunamis:
  - April 1, 1946 – Alaska – M 8.1 earthquake
  - May 22, 1960 – Chile – M 9.5 earthquake
- Other Events (smaller waves):
  - March 27, 1964 – Alaska M 9.2
  - Nov 29, 1975 – Local M 7.2
  - May 7, 1986 – Alaska M 8.0
  - February 26, 2010 – Chile M 8.8
  - March 11, 2011 – Japan M 9.0

## April 1, 1946 – Distant Tsunami

- Tsunami generated from M 8.1 earthquake event in Aleutian Islands, Alaska.
- 159 people lost their lives.
- 30 foot wave in Hilo Harbor.
- Deadliest tsunami to hit Hawaiian Islands.

Image courtesy of the Pacific Tsunami Museum



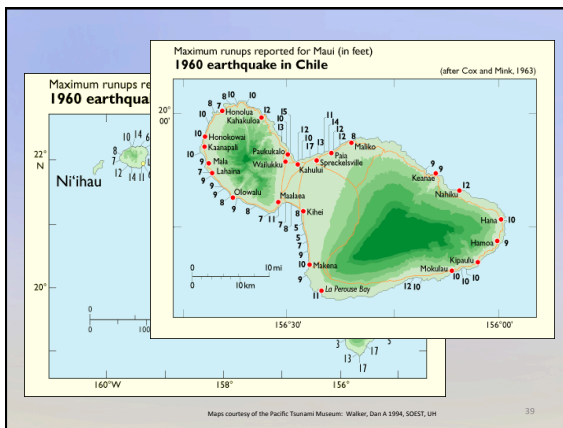
### May 22, 1960 – Distant Tsunami

- Tsunami generated from earthquake event in Southern Chile
  - Magnitude 9.5 – largest earthquake ever measured
  - First wave arrived 15 hours after earthquake
- 61 people killed
- 282 injured
- 35 foot wave in Hilo Harbor

37



38

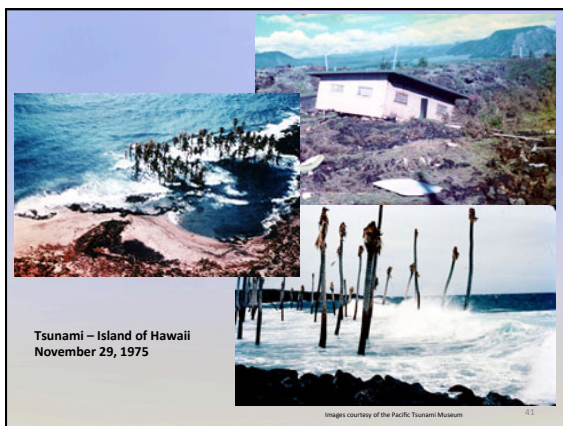


39

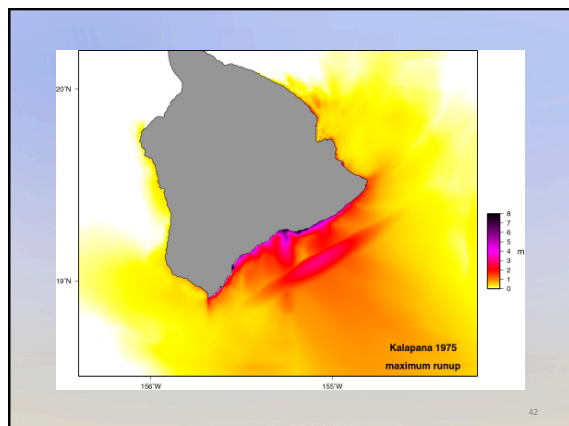
### November 29, 1975 – Local Tsunami

- Caused by two earthquakes
  - First 3 miles inland of Kamoamoa Villages in Volcano Park
    - Magnitude 5.7
  - Second less than an hour later – 2 miles offshore of Wahaula heiau
    - Magnitude 7.2
  - Caused 10 foot submarine landslide
- 5 waves (5 to 26 feet)
  - First hit Halape 30 seconds after second earthquake
  - 2 died; 19 injured in campground
  - 47 foot runup at Keauhou
  - 26 foot runup at Halape (1.9 miles to SW)
- Second most destructive tsunami to be recorded in Hawaii.

40



41

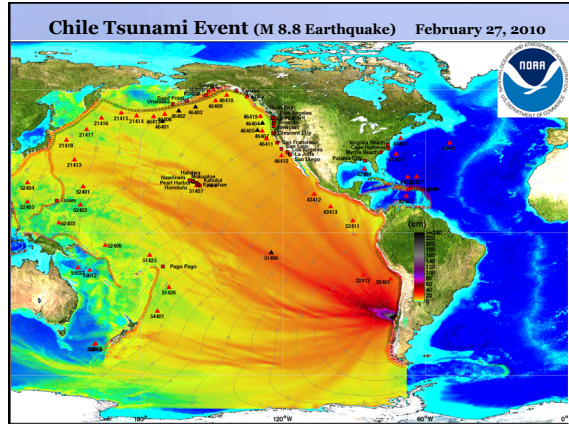


42

### February 27, 2010 – Distant Tsunami

- Tsunami generated from earthquake event in Southern Chile
  - Mag 8.8
  - First wave arrived 15 hours after earthquake
- No loss of life in Hawaii
- Runup
  - Tide fluctuations and disturbances in harbors
  - No significant inundation (low tide)
  - 3.2 foot wave recorded in Kahului, Harbor
- No damage

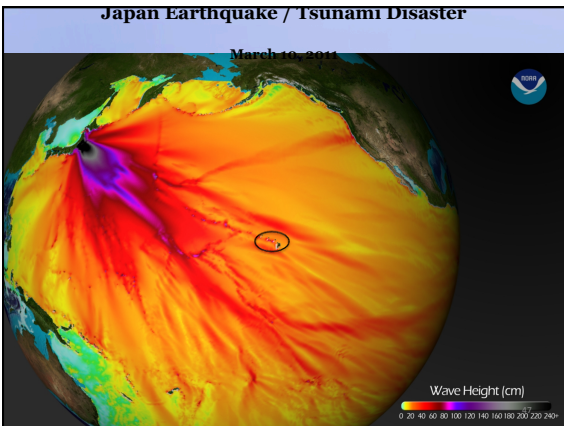
43



### March 10, 2011 – Distant Tsunami


- Tsunami generated from earthquake event in Japan
  - Mag 9.0
  - First wave arrived 7 hours after earthquake
  - No loss of life in Hawaii
  - Runup
    - Estimated at 7 to 11 feet on Maui and Big Island
    - 5.7 foot wave measured by tide gauge in Maui
    - 2.3 foot wave measure by tide gauge in Hilo
  - Millions in damages to boat harbors and coastal infrastructure on Oahu, Maui, Molokai and Big Island.

45







 **Learning Check**

1. When was Hawaii's most deadly tsunami, and from where did it originate?

51

Visit the Tsunami Awareness Program (TAP) Website: <http://tap.pdc.org>

**FOR MORE INFORMATION**



52

**For More Information**

- Hawaii State Civil Defense
  - [www.scd.hawaii.gov](http://www.scd.hawaii.gov)
- Pacific Tsunami Warning Center
  - <http://ptwc.weather.gov/>
- International Tsunami Information Center
  - <http://www.prh.noaa.gov/ttic/>
- Pacific Disaster Center
  - <http://www.pdc.org>
- NOAA's Pacific Marine Environmental Lab
  - <http://www.pmel.noaa.gov/tsunami/>
- City and County of Honolulu Department of Emergency Management
  - <http://www1.honolulu.gov/dem/index.htm>
- Maui County Civil Defense Agency
  - <http://www.co.maui.hi.us/index.aspx?nid=70>
- Hawaii County Civil Defense Agency
  - <http://www.hawaiicounty.gov/civil-defense/>
- Kauai Civil Defense Agency
  - <http://www.kauai.gov/civildefense>

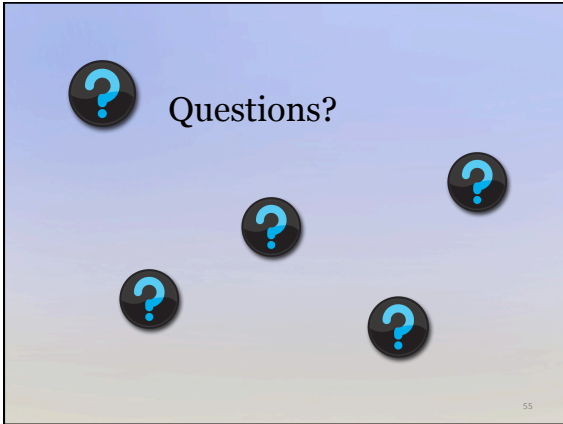
53

**For More Information (Continued)**

- NOAA NWS TsunamiReady
  - [www.tsunamiready.noaa.gov](http://www.tsunamiready.noaa.gov)
- USGS Tsunami and Earthquake Research
  - <http://walrus.wr.usgs.gov/tsunami/>
- Pacific Tsunami Museum
  - <http://www.tsunami.org/>






54



## MAHALO

The Hawaii Hazards Awareness & Resilience Program (HHARP) is the result of a collaborative partnership between Hawaii State Civil Defense and the Pacific Disaster Center.

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Phone: (808) 733-4300



56