

# The Pacific Tsunami Museum

Through Stories, We Remember... and Learn

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Pacific Tsunami Museum

Funded by the U.S. Department of Education



## Table of Contents

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- 3** Aloha Kakou
- 5** The Pacific Tsunami Museum
- 7** Tsunamis in Native Hawaiian Culture
- 9** April Fool's Day, 1946
- 13** A Day of Tragedy and Survival at Laupāhoehoe
- 16** Be Ready for the Next Tsunami
- 17** Tsunami Science
- 25** The 1960 Earthquake and Tsunami

**Cover:** Wall mural painted by Elfie Wilkins and students, Lena Higa and Ruth Iwata for the Pacific Tsunami Museum. The mural depicts an aerial view of Laupāhoehoe Point prior to 1946.

People run from a 1946 tsunami wave in Hilo, Hawai'i. Cicilio Licos photo/Bishop Museum and Pacific Tsunami Museum.

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# Aloha Kakou

## Introduction



Donna Saiki  
Director, Pacific Tsunami Museum

The threat of a tsunami is an ever-present reality to all who live on the Hawaiian Islands in the middle of the Pacific Ocean. We at the Pacific Tsunami Museum believe that through tsunami awareness and education, no one in Hawaii should ever again die due to a tsunami.

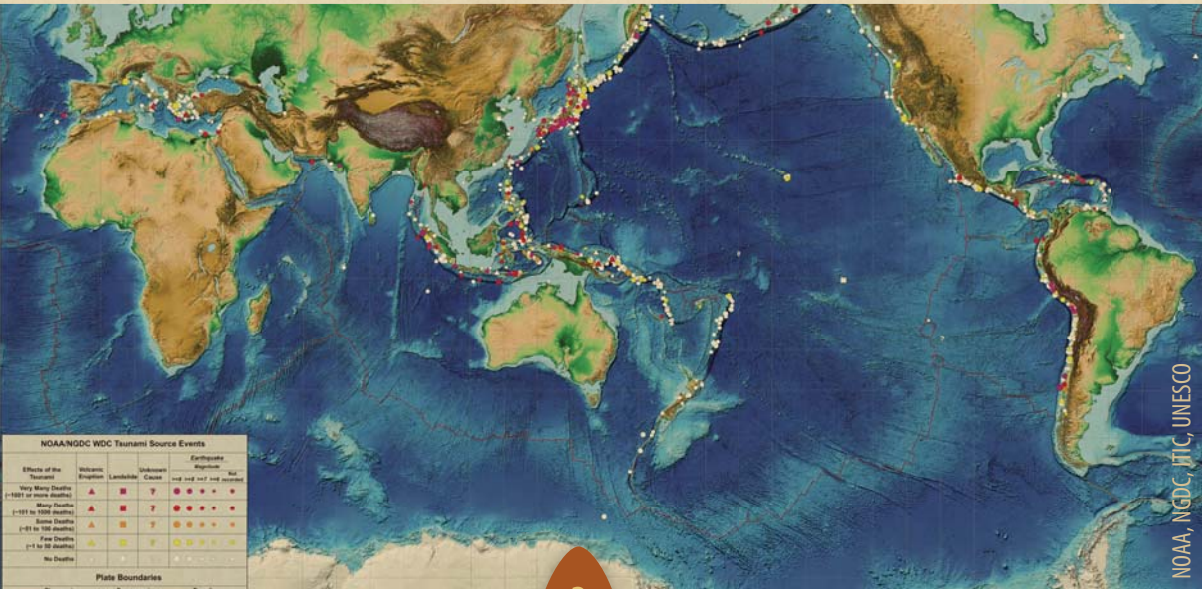
Our primary goal, to promote public tsunami awareness and education for the people of Hawai‘i and the Pacific Region, is met through a blend of science, history and personal accounts. In preserving the social and cultural history of our tsunamis, we also serve as a testament to the perseverance of communities to rebuild their lives.

To quote Rudyard Kipling, “If history were taught in the form of stories, it would never be forgotten.” The museum strives to help people remember the past and teach them to take action when the next tsunami comes, because there will be a next one.

This booklet is part of a tsunami education curriculum that incorporates Hawaiian history and cultural knowledge with the latest scientific information and strives to reach teachers and students, especially those in tsunami-prone communities across the state. Through stories, the museum strives to help people remember the past and teach them to take action when the next tsunami comes, because there will be a next one.

Donna Saiki  
Director,  
*Pacific Tsunami Museum*

The threat of a tsunami is an ever-present reality to all who live on the Hawaiian Islands, and all coastal communities around the Pacific are vulnerable to tsunamis. Over 90% of all earthquakes and 80% of tsunamis are generated in the Pacific Ocean.





# The Pacific Tsunami Museum

**Mission Statement:** *Through education, no one in Hawai'i should ever again die due to a tsunami.*

The Pacific Tsunami Museum in Hilo, Hawai'i provides tsunami education to residents and visitors. The museum fosters community skill-building and tsunami education dissemination and serves as a hub for community leaders and emergency managers to strengthen their own tsunami mitigation, education and preparedness activities.

Visually-rich exhibits tell the histories of tsunamis in the Pacific Basin, share survivors' stories and describe tsunami science and warning system technology. The tsunami history of Hilo has contributed much to the scientific study of

tsunamis, and the lessons of perseverance and recovery have inspired the museum to fulfill its mission to preserve and share the stories of survivors and through them educate the community.

Outreach programs include working with downtown Hilo businesses to help them become better prepared for the next tsunami, creating a tsunami education blueprint for coastal communities, preparing exhibits for museums in Kodiak, Seward, and Valdez, Alaska, and museums as far away as Thailand and India, and working with schools to educate administrators and teachers about the dangers

of tsunamis.

At the museum, friendly staff welcome all visitors, including class and groups. Volunteer docents relate the stories of Hilo and Laupāhoehoe and give museum visitors insight into how Hawai'i's communities have been shaped by tsunami waves.

Tsunami photographs, maps, oral histories, scientific papers, documents, videos, and artifacts are archived in the Pacific Tsunami Museum, a repository for materials that promote an understanding of and appreciation for tsunamis.

## Pacific Tsunami Museum Founded in 1993

Jeanne Branch Johnston and tsunami researcher Walter C. Dudley co-founded the museum in 1993. Jeanne, a survivor of the 1946 tsunami, felt compelled to warn others of the danger of tsunamis. She approached Walter with the idea, telling him she wanted to record the oral histories of survivors and use these stories to educate others about the dangers of tsunamis, and together they co-founded the museum a few months later. Ironically, the first meeting planned for the new museum board of directors was scheduled for October 4, 1994, but was postponed because of a tsunami warning, the first since 1986.

In 1998, artist Diane McGregor donated her painting entitled, *Tsunami II*, a 54 x 36 inch oil on canvas, to the Pacific Tsunami Museum's permanent collection. No side of an island is safe, because tsunami waves may come from any direction and wrap completely around an island.

## Tsunami Story Festivals

In 2002, the museum organized its first Tsunami Story Festival. Each year, featured stories showcase the resilience of Hilo residents and tsunami survivors. Preserving the stories and accounts of things said and done in the past helps us make thoughtful decisions for the future and helps raise awareness that our proximity to the coast makes us vulnerable to tsunamis. When the next one occurs, we'll be ready!



## Kai E'e

The Hawai'i Tsunami Education Curriculum: Kai E'e is a place-based and culturally relevant education program for Hawaiians and Pacific Islanders. The program includes teacher training by scientists, cultural knowledge-bearers and educators, hands-on, project-based lessons for students in grades 4, 6, 8 and 9, an online course for teachers focused on the science of tsunamis that includes indigenous knowledge, interactive multimedia activities and visualizations, access to selected online museum resources, and informal consultation to help schools enhance their existing tsunami evacuation preparedness plans and procedures.

The Pacific Tsunami Museum is located at 130 Kamehameha Avenue in Hilo, Hawai'i in an historic bank building overlooking the bay.

## Tsunami Education, Preparation and Recovery Project

During the Tsunami Education, Preparation and Recovery Project for Downtown Hilo, an innovative partnership between the museum and the Hawai'i County Department of Planning, the museum prepared a blueprint for coastal communities to educate businesses about tsunamis.

## Tsunami Observer Program

From June 2006 to May 2010, the Pacific Tsunami Museum coordinated the Tsunami Observer Program, funded by NOAA and sponsored by Hawaii State Civil Defense, training volunteer tsunami observers to safely record all important data associated with a tsunami event, including video recording waves inundating the coastline, measuring wave runup heights and inundation distance inland, gathering information from eyewitnesses and recording building damage as part of a post-tsunami field survey.

## International Outreach

Tsunami education and mitigation initiatives abroad include conference presentations for teachers, community members and local officials, collecting stories and interviews from survivors of the 2004 tsunami in Sumatra, Thailand, India, Sri Lanka and the Maldives, the 2006 tsunami in Java, and the 2009 tsunami in Samoa and American Samoa, networking and training local officials to carry out tsunami evacuation drills, meeting with tsunami researchers, faculty and graduate students in India and Thailand, and installing tsunami safety exhibits and interactive kiosks.

## Walking Tour

The Pacific Tsunami Museum offers a self-guided walking and driving tour of historical tsunami sites. The tour takes place within the Big Island's eastside tsunami corridor, which stretches from Laupāhoehoe peninsula down to the popular strip of beaches in Keaukaha.

# Tsunamis

## in Native Hawaiian Culture

Tsunamis appear in the oral literature of Native Hawaiians in connection with volcanic activity in mo'olelo (stories) and mele (chants). In Hawai'i, tsunamis can be generated locally by large earthquakes, submarine volcanic activity, or by landslides triggered by even a modest-sized earthquake. Recent locally-generated tsunamis occurred in 1868 and in 1975. Tsunamis can also come from across the ocean. Tsunamis can also come from across the ocean.

The relationship between tsunamis and volcanic eruptions is documented in the traditional mo'olelo of Kaikahinali'i and her daughter Pele's migration to the islands. Pele's father, Kānehoalani, is the sun, and both parents are involved with the migration and Pele's manifestations. Pele is the deity embodied in the fire, lava, and earthquakes of volcanic activity, and her dramatic effects on the ocean can be interpreted as a tsunami resulting from volcanic activity.

The story begins with Kaikahinali'i, mother of Pele, who helps Pele to travel to Hawai'i before there was water in the ocean. Pele pours out water from her head at Kanaloa (Kaho'olawe Island), and the following mele, composed by Pele's brothers, Kamohoali'i and Kahuilaokalani, describes what happens to the sea and the land during this and probably other later tsunamis.

Tsunamis are embodied by the deities Kaikahinali'i and Pele. Propelled by Kaikahinali'i during her migration, Pele carried her favorite sister, Hi'iaka, with her to Hawai'i, in the form of an egg.



Stan Rillon

# Kaikahinali'i Chant

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The sea, oh the sea  
The sea is breaking  
Breaking at Kanaloa  
The sea inundates the land, reaching the cliffs  
The calmness of the ocean is gone  
The sea breaks in doubles  
The sea breaks in triples  
A sea carried on the back of Pele  
The sea turns downward, breaking the earth  
The sea is rising, rising to Kīlauea  
A sea supporting the five layers of Pele  
The sea of Pele is overwhelming  
Consumed in the breast of Pele  
The roar is tumultuous at the sea of Papalauahi  
The sea rises up to Akanikōlea  
The sea reaches the edges of Wahinekapu  
The sea of Pele, of the goddess  
Descend, deepen the revelation!

*translated by Pualani Kanaka'ole Kanahele*

# He Mele Kaikahinali'i

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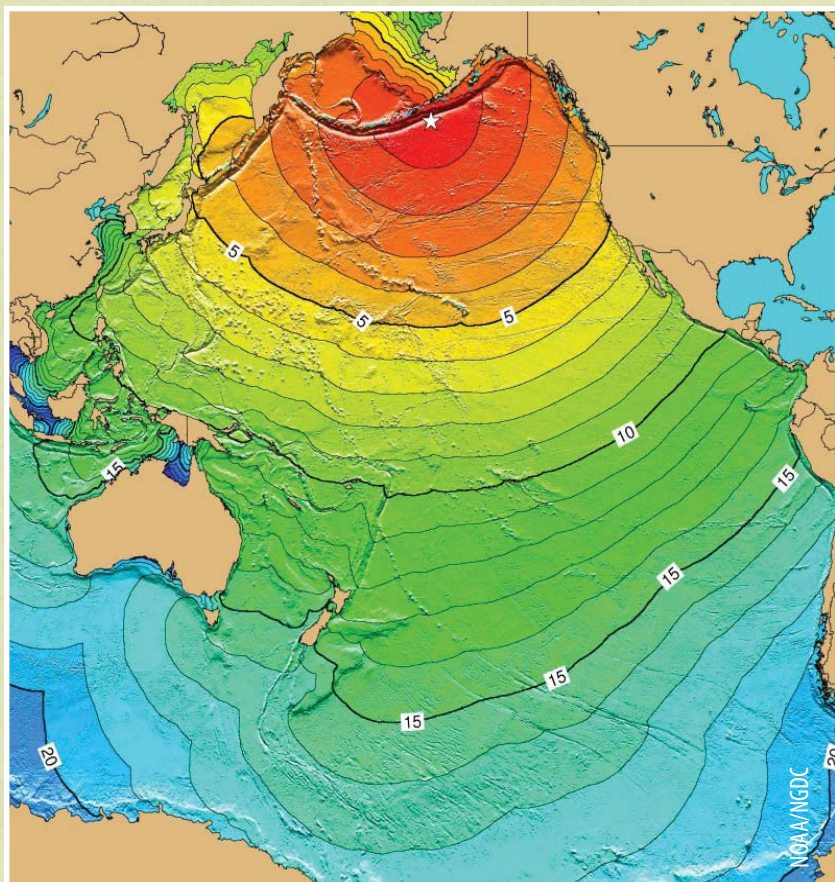
He kai ē, he kai  
Popo'i akula ke kai  
Popo'i akula i Kanaloa  
Aia i nā pali ka ilina a ke kai  
Hala a'ela ka maha a ke kai  
Ha'i kualua ke kai  
Ha'i kuakolu ke kai  
He kai hā'awe i ke kua o Pele  
Huli iholā ke kai, wāhi i ka honua  
Ke amo lā ke kai, amo i Kīlauea  
He kai kālele i ka lima o Pele  
Ho'omakua maila ke kai a Pele  
Kai hi'i i ke alo o Pele  
Wawā ka leo o ke ka i Papalauahi  
Pi'i a'ela ke kai i luna o Akanikōlea  
Holo ke ka i nā kī o Wahinekapu  
Kai a Pele, a ke akua  
'Eli'eli e kau mai!

# April Fool's Day, 1946

## Ocean-wide tsunami devastates Hawai'i

*I was going to work at about 6:30 a.m. I was living on Wainaku and Ohai Street in Puueo. When I was reversing my car out, friends were walking up the street and yelled at me, "Steamy, tidal wave, tidal wave." And I yelled back, "April Fool's." And the lady says, "Real, real." And I said yeah, "April Fool's."*  
—Bob Chow, Police Officer

The April 1, 1946 tsunami was caused by a magnitude 8.1 earthquake in Alaska, near Unimak Island in the Aleutians, and it caused damage around the Pacific. Less than five hours after the earthquake struck Alaska, the first of eight destructive tsunami waves reached Hawaiian coastlines around 7 a.m., just as people were heading to work. Hawai'i's Big Island suffered the greatest impact: in Hilo 96 people were killed (the death toll statewide was 159), and Hilo's business district and the residential areas of Shinmachi and Waiākea were destroyed. Total property damage was \$26 million in Hawai'i, \$250,000 in Alaska, and \$10,000 in California. This tsunami led to the development of tsunami time travel charts and an official tsunami warning system.



Tsunami time travel map indicates first wave travel time from earthquake epicenter in Alaska. Contours are in one-hour intervals.

Downtown Hilo at the corner of Shipman and Kamehameha Avenue. The street is covered with water from the 1946 tsunami. The train station across the street was completely destroyed. Remaining tracks can be seen in the background.



# During the tsunami

## The power of the waves

*And then all of the sudden, somewhere around 7 a.m., there was this roar. What is this roar? And then, it starts. It is coming from the oceanside down there. So I go over and look. And I can see here coming are the waves over the breakwater.*

## What is this roar? And then, it starts. It is coming from the oceanside...

*And every time one of the big waves come in, it goes out, there is a gaping hole in the breakwater, where all the big breakwater stones have been just washed right out into the bay itself. And, it looked like a kid with his teeth knocked out: there is one gone here; next wave, there is one gone there, and so on.*

—Martin Pence, county judge

Waves from the April 1, 1946 tsunami advance up Waianuenue Avenue at the corner of Kamehameha Avenue in Hilo's business district.

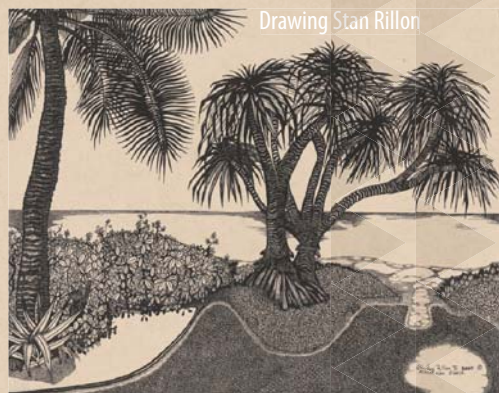
## Inside a tsunami wave

*Before I could think of anything, the house broke or ripped like a toothpick and I had only a tiny second or less to hold my breath. Then, I was inside going with the wave. I only could open my eyes a little but that little was plenty enough. Then I could only see the brownish black water with lumber all around me. I held my breath as long as I can. Then I started to puff out the air little by little and, before I knew it, the water receded and I was under a high pile of debris.*

—George Okino, student

## If not for the hala tree

*But right at that corner right by the Front Street there was a store. The first Keaukaha Store. And it was owned by this family, Kuamoa. That's all I know them by, Kuamoa, elderly people. So, we was on the hill looking back when the wave came in, just looking at their home. The home*



Drawing Stan Rillon

*just kinda like a balloon, the waters fill that home up and just blew that whole thing apart. And you know something, it was a miracle because way after, I mean that afternoon you see those two people are elderly people, the wife is invalid. The husband could walk. You know that after we check around we finally found those two up in the hala tree. The wife was up there. How she got up there? So there's no answer, she got up there and the husband was down below. But they hung on to that hala tree and they lived through that tidal wave but their store was just demolished.*

—Samson Kela



## Ship loaded with dynamite cut free

The receding ocean sounded like a monstrous vacuum cleaner. Two ships were moored at Hilo Pier, the SS *Brigham Victory* carrying 50 tons of dynamite and the volatile blasting caps that could set them off. Antone Correa Aguiar worked at the Hilo Wharf for the Hawaii Consolidated Railroad Company, along with his son Herbert. When the first wave came in, the workers got scared and started to run. One of them yelled, “Hey, somebody got to turn the power off from the wharf.” Herbert thought his father was running right behind him, but Antone had run back to turn it off. Just before being engulfed by the second wave, he managed to set the line free, allowing the ship to pull away just in time. His body was found three days later in Reed’s Bay.

The ship’s crew watches as a wave overwhelms Pier 1 at Kuhio Wharf. Photos taken by Steward Wayne Rasmussen on the *Brigham Victory* by the Hilo docks about 7:20 a.m.



Pacific Tsunami Museum, Rebecca Lyman Enskine Collection, Courtesy of Linda Enskine

Antone Correa Aguiar, left, cuts the cable to the ship *Brigham Victory*, freeing it from the dock. His body was recovered later at Reed’s Bay.



Pacific Tsunami Museum, Rebecca Lyman Enskine Collection, Courtesy of Linda Enskine

# The aftermath



Men row a boat in the flooded streets in Shinmachi, a residential area in Hilo, after the 1946 tsunami. A high water mark is visible in the background.

Hakalau Sugar Mill before the tsunami

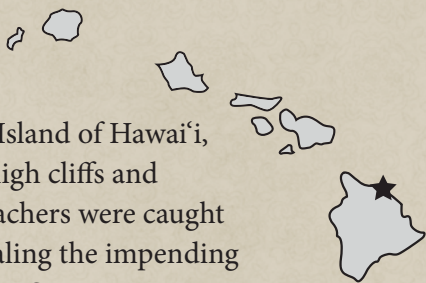


Damage to Hilo's business district on Kamehameha Avenue at the foot of Haili Street looking from the sea toward the town. The powerful waves toppled buildings, rearranged rail lines, moved boulders and crushed cars.

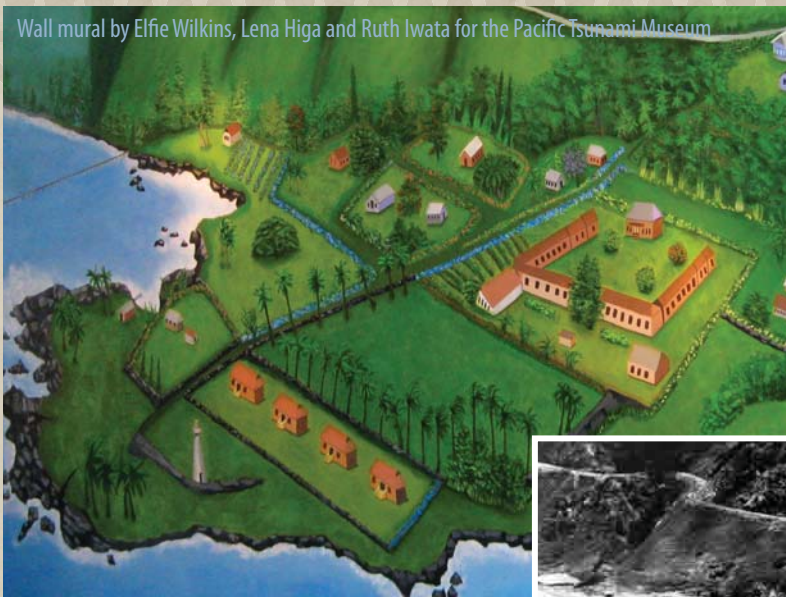


# A day of tragedy and survival

## at Laupāhoehoe



Laupāhoehoe, an idyllic low-lying point north of Hilo on the Big Island of Hawai'i, was particularly vulnerable to the 1946 tsunami. Surrounded by high cliffs and secluded, the area was home to a thriving school. Students and teachers were caught unprepared and did not recognize the natural warning signs signaling the impending tsunami that killed 24 people and destroyed cottages and buildings. Survivors ran away, were washed inland or pulled from the sea, and lived to tell their stories.



Wall mural depicting an aerial view of Laupāhoehoe point prior to 1946. The mural was painted by Elfie Wilkins and students, Lena Higa and Ruth Iwata for the Pacific Tsunami Museum.

Aerial view of Laupāhoehoe point prior to 1946. Note four teachers' cottages near the ocean.



Laupāhoehoe point after 1946.



# A student's story: A makeshift raft

Herbert Nishimoto was 15 at the time of the tsunami and grew up in Ninole and Hakalau.

## **I found a mattress and some logs and I made a raft from the log.**

After being swept out to sea, Herbert cobbled together a makeshift raft and picked up two other survivors, Takashi Takemoto from Honohina and Asa Asayuki or Koniyuki from Ookala. After two failed rescue efforts and drifting in the current overnight, the boys were eventually helped ashore in North Kohala.

*I found a mattress and some logs and I made a raft from the log. Found an axe handle and used that as a hammer to nail the log. And some cord and tied it, put some wood on it.*

*Oh, I found a Crisco bottle floating, so I grab all the Crisco and rubbed it all over my body, my head my ears, all over my body, oiled myself. Then I floated out and next thing I know I found two other boys, they were one year younger than I was. One was on a door and one was on a barrel, half-sunk barrel. And they*

*were extremely exhausted and so I told them "Hey come on over, swim over."*

*They couldn't, and we were only about 20 feet away. So I said, well, I've got a long piece of log, was a tongue and groove, must have floated from one of the buildings, was about 12-15 feet.*

*So I pushed it out to him for him to grab but he couldn't even reach for it. And I was afraid of losing the log and I felt kind of exhausted. So had the nail so I make sure the thing was stuck to the raft, and I went out, swam to him and grabbed him. Once I got one guy in, then the other guy was easy. He was on the door, so slowly [I] put the plank to him, he grabbed it and I brought both of them in.*



Pacific Tsunami Museum

**Herbert Nishimoto, a Laupāhoehoe student, survived the 1946 tsunami and saved two others.**

**Aerial view of Laupāhoehoe after the April 1, 1946 tsunami. Note foundations of four teachers' cottages.**

# A teacher's story: Caught in the waves



MARSUE MCGINNIS, Laupāhoehoe school teacher who was rescued about nine hours after being swept out to sea by the April 1 tidal wave, awaits the arrival of her mother from Claremont, Calif. Mrs. Irma McGinnis changed her plans at the last moment and was not aboard the Constellation when it departed for Hawaii today. She may come to the islands Thursday. Miss McGinnis is recuperating in the Laupāhoehoe Sugar Co. hospital.

Pacific Tsunami Museum

In 1946, after WWII, Marsue McGinnis was a newly arrived teacher at Laupāhoehoe School, welcomed warmly into the community. She and three other teachers, Helen Kingseed, Dorothy Drake and Fay Johnson, arrived together, shared a cottage, and were thrilled to be working in this lovely place. Marsue said, “It was very difficult to teach—you happen to glance outside see this horse, see the waterfalls, see the hibiscus, and the blue, blue ocean.”

Initially the teachers felt excitement and curiosity on the day of the tsunami. This later turned to terror as one

by one they were taken by the waves. After witnessing the deaths of her fellow teachers, Marsue was washed out to sea where she was rescued later in the day.

A newspaper clipping reports Laupāhoehoe teacher Marsue McGinnis' condition after the 1946 tsunami.

*I was hanging on to the roof and so was Fay and I remember Helen Kingseed was right beside me and I put my arm under hers, but she was just swooshed right out, and I never saw her again. And so Fay and I just kinda climbed up on the roof and the roof was floating and rushing toward the school and we got up on the cone of the roof and we were riding that and then it started to suck out again. And so then almost as fast as we were washed in, we were rushed out. And I remember looking over to my left, and the garage was no longer there, but [a] car was just turned end on end like a Tootsie Toy...So our only hope was while it was sucking out again, to climb down off the roof. And we were out there, you know there was seaweed and rocks and [it] was quite a ways. And we got just part of the way and the tidal wave hit again. And so that was it.*

*...And I thought this is it, this is the end and I, I went down. And it didn't matter how good a swimmer I was, except that I took a breath instinctively and all bubbles and I could feel myself being on the rocks and I, I'm, I'm dead.*

*Well I was down there and lo and behold, there was a lot of bubbles and everything. I remember coming up again and taking another breath... and I went down again. Second time I came up I was right by the lighthouse, at the top of the lighthouse. But it was quite high and I came up at the top of it and my thought was I got to get away from these rocks. I was surrounded by rubbish, parts of boards, you know everything, plants, trees everything, coconut. And I clung on to this several boards that were still nailed together and kinda paddled around...*

*So, I kinda bowed down and then I noticed that my shoes were both gone and I had tied them. My socks were gone... Thank God I had this huge man's shirt, you know...So I buttoned up the shirt...and then pretty soon along came a door. A floating door. So I got onto that and let my other rubbish go, it was pretty good.*

# Be Ready for the Next Tsunami !

## Know

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- A tsunami is like a fast rising flood, an advancing wall of water and strikes with devastating force.
- A tsunami moves faster than any person can run.
- A tsunami is a series of waves that may continue for hours. The first wave may not be the largest or the most dangerous.

A tsunami may occur if you:

- Feel a strong earthquake
- Observe a rapid unexpected rise or fall in sea level, a surge or retreat of the water
- Hear a loud roaring sound coming from the ocean

## Act

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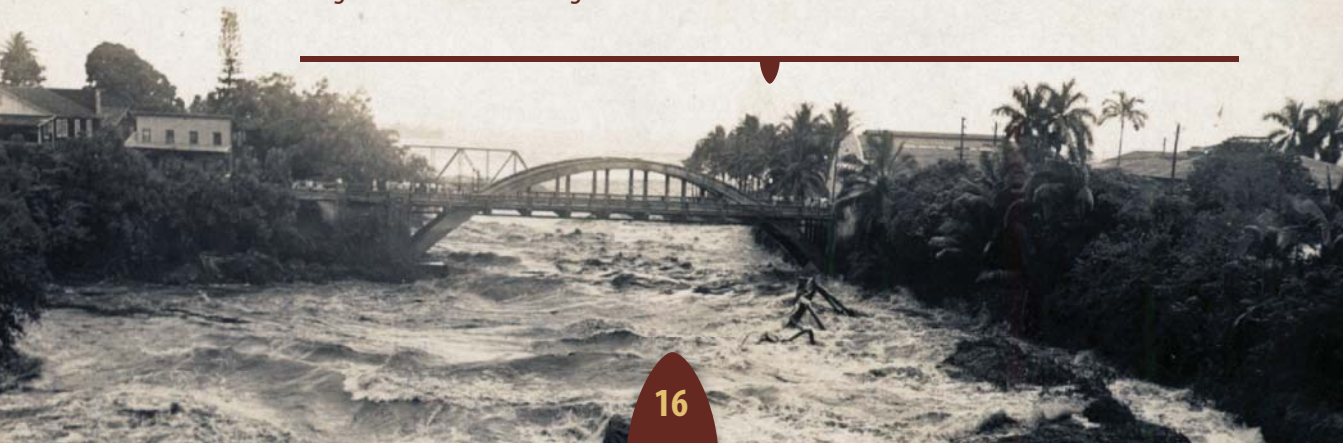
- Keep calm
- Immediately move inland to higher ground
- Heed official, unofficial or natural warnings
- Stay away from the beach until officials issue an “all clear”
- If you are unable to quickly move inland, high multi-story, reinforced concrete buildings may provide a safe refuge on the third floor and above

## Remember

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- The only warning you may have is an earthquake
- Tsunamis can reach the coast within minutes of an earthquake
- Know the tsunami history and flooding elevation of the area where you work, live or visit
- Share what you know with friends and family
- Ke’e nalu! Don’t surf tsunamis!

The 1946 tsunami travels up the Wailuku River in Hilo, Hawai’i. Rivers are not safe from tsunamis. In Hawaiian, “Wailuku” means “destroying water.” The river experiences violent surges from the sea during tsunamis and from cloudbursts over Mauna Kea.



# Tsunami Science

## Why Study Tsunamis?

Devastating tsunami events of the recent past indicate that we still have a lot to learn about tsunamis. Tsunami researchers share the responsibility of working with communities and local and state agencies to improve warning systems, evacuation procedures and tsunami education.

Tsunami research ranges from the study of tsunami causes, how they travel and how they interact with landforms and coastlines, to the impacts tsunamis have on coastal communities and survivors and more. Researchers study the physics of tsunamis, and through the examination of geologic evidence, they study tsunamis of the recent and distant past. Whether developing new technologies to help monitor seismic activity and alert us to an impending tsunami, creating models to improve understanding of how fast tsunamis travel, testing tsunami warning systems, or taking measurements of tsunami runup heights to create better evacuation maps, tsunami scientists share their knowledge to help us prepare for the next tsunami and save lives.

To gain a basic understanding of tsunamis, it is important to understand what a tsunami is, how tsunamis are generated, how they propagate, or travel, and how tsunami waves inundate coastal areas.



Tsunami deposits from long ago provide opportunities to better understand future tsunami dangers. Tsunami researcher Kruawun Jankaew stands in a soil profile pit .5 kilometers inland on Phra Thong Island, Thailand. Layered evidence is sediment from four Indian Ocean tsunamis. Over time, natural processes buried marine sediments that tsunami waves transported and deposited inland.

# What is a Tsunami?



The word tsunami comes from Japanese. Formerly, tsunamis were often called tidal waves; however, tsunamis are not caused by the tides, nor are they single-wave events. A tsunami is a series of waves caused by a massive displacement of water most often caused by an undersea disturbance, such as an earthquake, landslide or volcanic activity. On average two tsunamis per year inflict damage near coastal areas somewhere in the world. Destructive, ocean-wide tsunamis occur on average about every 15 years.

Hawai‘i, with its active volcanoes, seismic activity, and steep island slopes, is at risk for local tsunamis generated by landslides, earthquakes, or volcanic activity, as well as ocean-wide tsunamis (tele-tsunamis), originating from locations such as Alaska, Japan or Chile.

“Tsunami” is Japanese for “harbor wave.” A tsunami, a series of waves caused by an undersea disturbance such as an earthquake, landslide or volcanic eruption, can cause great destruction along low-lying, often highly populated, coastal areas.

## Take Action, Move to Higher Ground!

Observing sudden changes in the environment, especially the ocean, may indicate an impending tsunami. In the event of these natural warnings, informal warnings called out by friends or neighbors, or if official

warnings are given through sirens, low-flying aircraft, emergency broadcast systems, television, radio or telephone calls or texts, take immediate action, and move to higher ground.

# Nature's Tsunami Signs

For those who live or travel near the coast, it is essential to observe the normal patterns of the ocean to better understand when something unusual is about to occur. If you notice any of nature's tsunami warning signs, don't wait for an official warning. Take action immediately and move to higher ground if you notice:

- An earthquake: swaying buildings and trees or trembling ground
- Water suddenly surging inland
- An unusually low or receding waterline
- Eerie silence along a coast instead of the usual sound of surf
- Sucking, hissing, bubbling and boiling may be heard as rocks, pebbles and water are drawn out to sea
- Unusual bubbles in the water
- Exposed seafloor for hundreds of feet



Lori Dengler

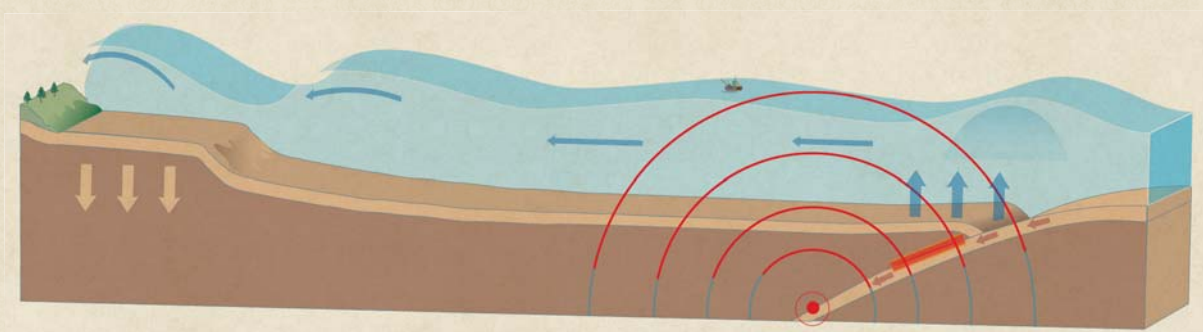
Earthquakes can be natural warnings that a tsunami may have been produced. If you live close to the epicenter of an earthquake, there may not be enough time for officials to issue an official tsunami warning. If you notice any of the natural tsunami warnings listed, take action and move to higher ground.

## 'Olelo No'eau, Hawaiian Words of Wisdom

Hawaiian	English translation	An interpretation
<i>Mimiki ke kai, ahuwale ka papa leho</i>	<i>When the ocean recedes during a tsunami, the rocks where the cowries hide are exposed.</i>	<i>Secrets will spill out on the day of wrath.</i>

# Tsunamis Caused by Earthquakes

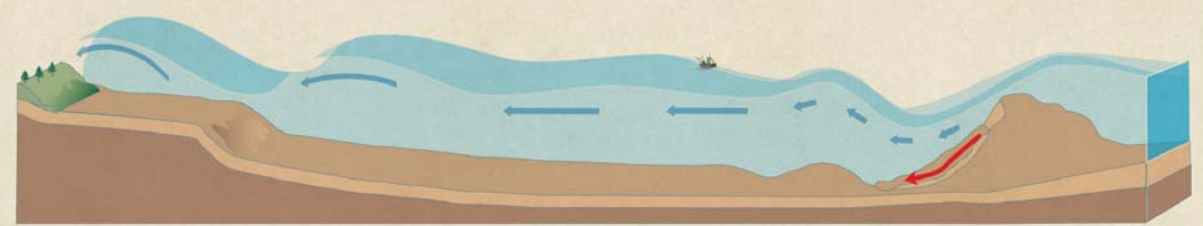
Most tsunamis are caused by earthquakes. Earthquakes generate tsunamis when they cause a sudden uplift in the seafloor or change the shape of the seafloor by triggering landslides. Undersea earthquakes often result when tectonic plates collide: as one plate is subducted, or forced below another, pressure builds over time, until the energy is released, producing an earthquake. As the upper plate bounces back into place, a great volume of water can be displaced, producing massive tsunami waves. In the Pacific Ocean, earthquakes generate 83% of tsunamis.



An undersea earthquake may produce a tsunami when a large amount of water is displaced by the movement of the tectonic plates.

# Tsunamis Caused by Landslides

Tsunamis may be produced by land sliding into the ocean from above sea level or by landslides occurring completely under water. The large volume of water that is suddenly displaced produces a tsunami. So-called surprise tsunamis are those generated by landslides caused by small earthquakes that may not alert emergency managers to tsunami danger. A massive slope failure may produce a tsunami with greater local runup than a tsunami generated by an earthquake.

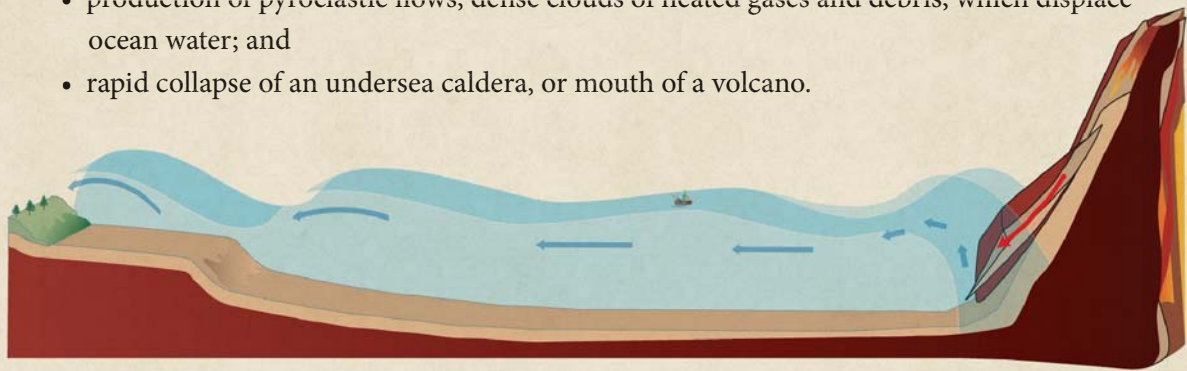


Tsunamis caused by landslides provide little to no warning.

# Tsunamis Caused by Volcanic Activity

Volcanic activity can generate local tsunamis through:

- an undersea explosion;
- production of pyroclastic flows, dense clouds of heated gases and debris, which displace ocean water; and
- rapid collapse of an undersea caldera, or mouth of a volcano.



Volcanic landslides occur above ground or below the water, and if they displace water, they may cause a tsunami.

## Tsunamis and Pele

A group of Hawaiian chants that describe major volcanic eruptions begin with the word “hulihia,” which means overturned, overthrown, and upheaved. The chants include references to volcanic activity, including earthquakes, tsunamis and pyroclastic flows. The chants include references to volcanic activity, such as earthquakes and pyroclastic flows, and tsunamis.

In one of the chants is a list of criteria by which Pele, the volcano deity, declares her power, including the warning of her departure (through the sounds of eruption), declaration of her power to restore life on land and to cut into the ocean (potentially causing a tsunami or creating new land), and the warning or law to stay away when the land has become hot with volcanic activity. These edicts or decrees, known as *kānāwai*, are described by the Hawaiian scholar and cultural practitioner Pualani Kanakaʻole Kanahele as the critical criteria for existing, by which Pele abides.

Hawaiian	English translation	An interpretation
<i>He kihoʻihoʻi kānāwai</i>	<i>A law for quick restoration</i>	<i>Infusion of new life</i>
<i>He kai ʻokia kānāwai</i>	<i>A sea-separating edict</i>	<i>Respect boundaries and limits</i>
<i>He kuaʻa kānāwai</i>	<i>A decree of the burning back</i>	<i>When the land is hot: Keep off!</i>

The 1868 earthquake and tsunami devastated settlements along the South Kona coast on Hawai'i's Big Island and is commemorated here and in the popular and haunting mele La 'Elima. Children who were led to safety in caves were thought to be among the victims, but were rescued five days after the tsunami. Locally-generated tsunamis may be among the most dangerous, as emergency managers may not have time to issue official warnings. In the event of a strong earthquake, seek higher ground immediately. Local tsunamis may be generated by earthquakes, landslides or volcanic activity.



# Tsunami Waves

Comparing wind-generated waves and tsunami waves is useful for understanding the force, scope and potential danger of large tsunamis. From the location of origin, tsunami waves travel in all directions through the entire water column, from the bottom of the ocean to the top. Some tsunamis may be barely noticeable in size, while others generate powerful waves that can devastate coastal areas. The energy of tsunami waves is much greater than most wind-generated waves.

**Never  
surf a Tsunami!**

Tsunamis are characterized by very long wavelengths that travel across the open ocean very quickly. The speed of tsunami waves depends on the depth of the ocean: the deeper the ocean, the faster the waves travel, sometimes as fast as 890 kilometers per hour (~550 mph), or about the same speed as a jet airplane.

Tsunami waves are also characterized by having small amplitudes spread over a great distance in deep water, so that on the open ocean a tsunami might go unnoticed by a ship that experiences nothing more than a gentle rise and fall.

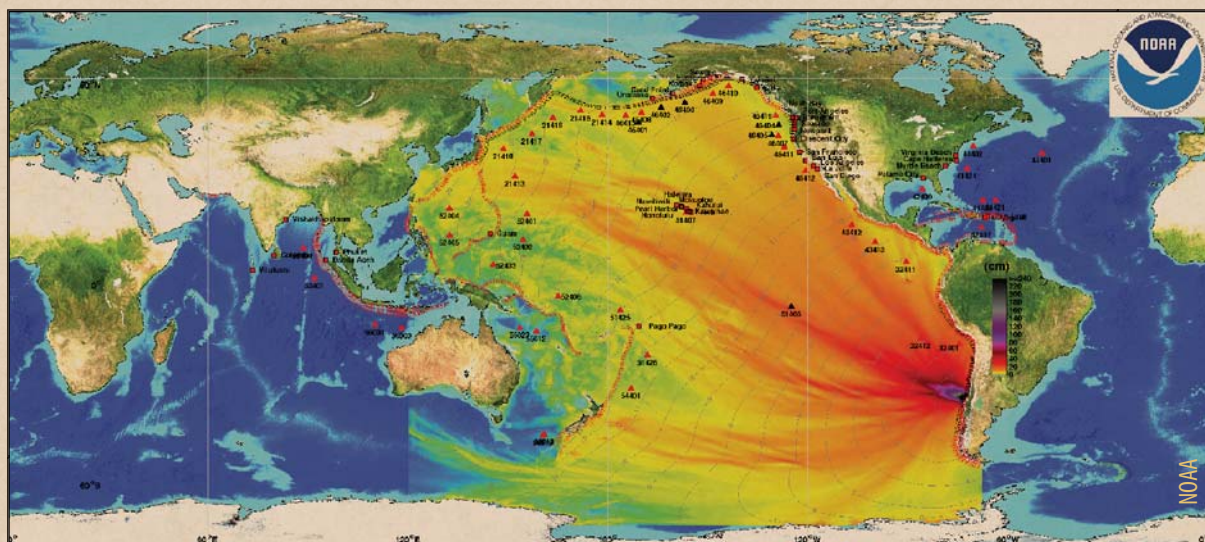


Wind-generated waves affect the surface of the ocean, but the water beneath remains undisturbed. In contrast, tsunami waves travel through the entire water column.

## Tsunami Monitoring and Warnings

Emergency managers and other officials need better tools to help them make the necessary decisions to warn citizens of impending tsunamis. Instruments and modeling technology have improved tsunami detection and forecasting, helping officials issue appropriate warnings. UNESCO and the Intergovernmental Oceanographic Commission (IOC) carry the responsibility of planning and coordinating tsunami warning

systems worldwide. When an undersea earthquake occurs, scientists at tsunami warning centers, such as the Pacific Tsunami Warning Center and the West Coast and Alaska Warning Center, receive data from strategically located instruments and have to decide whether or not to issue an official warning to local emergency managers and coastal communities.



The MOST (Method of Splitting Tsunami) model, successfully and thoroughly tested, is a numerical model that simulates three tsunami processes: earthquake tsunami generation, wave propagation across the ocean and tsunami inundation. The energy propagation pattern of the February 27, 2010 Chilean tsunami, generated by a magnitude 8.8 earthquake, was calculated using the MOST forecast model and accurately predicted that Hawai'i would not experience severe impacts. Compare this energy pattern with the 1960 tsunami wave amplitude plot on page 25. The earthquake that generated the 1960 tsunami was the largest in recorded history, a magnitude 9.5.

Using data from observational instruments such as the DART buoys (Deep-ocean Assessment and Reporting of Tsunamis), developed by the Pacific Marine Environmental Laboratory and the National Oceanic and Atmospheric Administration's Center for Tsunami Research, tsunami models compute complex calculations that take different natural processes into account. Tsunami models make use of data including the size, location and depth of an earthquake, the depth of the ocean as determined by bathymetric measurements, the distance to a given location, the shape of the coastline in impact zones and historic tsunami wave runup heights. Data and models of past tsunamis help

scientists estimate wave arrival times, wave heights and approximate inundation areas of an impending tsunami.

In Hawai'i tsunamis have killed more people than all other natural disasters combined. Some communities have been highly successful at educating their population about what to do in the event of a tsunami, saving countless lives. Collective memory, native knowledge and survivor knowledge passed down through generations, tsunami museums and coordinated education efforts and evacuation drills all contribute to an informed population that will know what to do during the next tsunami.

# 1960 Earthquake and Tsunami

## "Isle's Agony Unbelievable"

On May 22, 1960, the largest earthquake ever recorded by instruments, a magnitude 9.5, occurred in Chile, sending massive destructive tsunami waves 6,600 miles across the ocean. The tsunami reached Hilo, Hawai'i in the early morning hours of May 23, about 15 hours after it originated.

An official warning system was in place and sirens sounded, but many residents chose not to evacuate. Memories of the 1946 tsunami had faded, a new generation of young people was coming of age, and after two minor tsunamis in 1952 and 1957, a feeling of complacency may have set in. Drawn by the powerful force of curiosity, people went down to the bay to await the tsunami, and 61 people lost their lives.

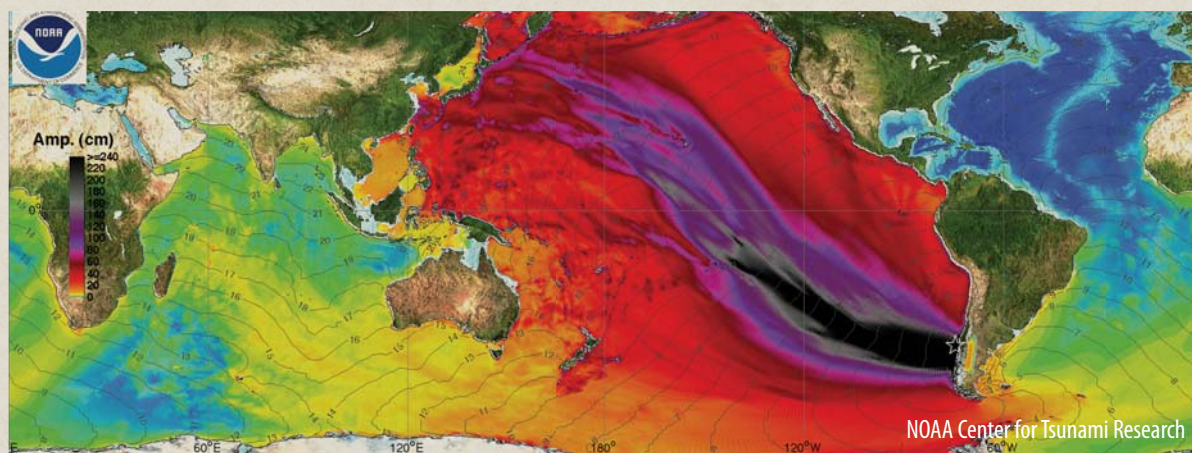
Unlike the Aleutian tsunami of 1946, where Hilo Bay had funneled the waves into downtown, the tsunami waves from Chile wrapped around the island and were reflected off the coast north of Hilo, coming into the bay as a bore, a steep, turbulent, rapidly moving wave front. The areas of Waiākea and Shinmachi were destroyed with property damage estimated as high as \$50 million.

Survivors' stories provide information about why people choose not to evacuate, helping officials dispel misinformation through education. Fusayo Ito did not evacuate because her house was located in the area where she had fled to safety during the 1946 tsunami and where waves had not previously reached. Mrs. Ito's story serves as a reminder that each tsunami event is unique and that all warnings should be taken seriously.



The Honolulu Advertiser reports on casualties and damage a day after the tsunami. A headline reads, "Isle's Agony Unbelievable," and articles report on rescue team efforts and list the names of the known dead.

Filled colors show modeled maximum wave amplitude across the Pacific Ocean. Wave amplitude measures the height of the wave from peak or trough to the undisturbed sea level in centimeters. Black contours show computed tsunami wave arrival time.



1960 Chile tsunami (earthquake magnitude Mw 9.5) Maximum amplitude plot -- for comparison with Feb 27, 2010 Chile tsunami event

# The Power of Curiosity



Richard and Bernard Waltjen near the time of the 1960 tsunami.

Like many curious people in Hilo, Hawai'i, brothers Richard and Bernard Waltjen, ages 16 and 19, heard about the impending tsunami on May 22, 1960, hopped in a fast car they thought they could escape in if necessary (a '48 Ford business coupe),

**And I seen that wave come over my right shoulder, it hit that boat that we were trying to save and just shattered it...**

and drove down to the waterfront to take a look. Before the third and biggest wave hit, they noticed fish

floating upside down, watched the water coming in and going out a little further each time, and tried to save a boat. As the third wave approached, Bernard ran to his car, considered the situation, and said, "No, I don't think so," and ran as fast as he could to safety. Richard climbed a light post thinking he would be safe up high. Below, Richard tells the story of his adventure and how in the end he was reunited with his brother. The next day they found the Ford crushed under three houses.

*And then we seen this boat, it broke its mooring and it started floating by us. And somebody said, "Hey! Let's save the boat! Somebody go get a rope." So a car pulled up with ropes, and we managed to get it on the boat and brought the boat close to shore. Well I've seen the guy with the camera, he said, "Hey! You guys pose for the camera," you know, so we all smiled and posed for the camera, and then at that moment the street light started blinking, going off and on, and we started yelling, "Hey! We can't see! Give us light!"*

*And then I happened to get off the boat, and when I looked under the boat, there was nothing, it was just like in the picture, hanging on its side, and I yelled to everybody, "Hey, the wave is coming! Let's go!" I of course ran to this post, this electric light post, and I climbed up. Well, I got further up and I could watch it. And from*

*my vantage point, I could watch people running, cars pulling up, people getting out of their cars and run, you know. To my right was the bridge and I could see people on the bridge. There was a policeman on the bridge trying to direct traffic, trying to chase people away, and I never did see him again.*

*But during that time my post started shaking, started going back and forth, rocking back and forth. And I could feel tension on the post, so I jumped off the post onto this building, this roof that was a restaurant at that time, Café 100. So I jumped on there, and just after I landed on the roof, the post broke, and it landed next to me with sparks flying all over and I just hung on to this roof.*

Curious Hilo residents wait at the Suisan market waterfront for the arrival of the 1960 tsunami forecasted to arrive around midnight. The clock in the background reads 12:12. The third and most destructive tsunami wave arrived just after 1:00 am. Someone said sharks were seen swimming in the water in the foreground. James Hamasaki, a former County Supervisor, used this photo to bring to light his concern about the complacency of citizens who did not heed the tsunami warning.

*And at that moment, the wave hit the power plant. When the wave hit the power plant, the whole sky lit up like lightning. I mean it just lit up bright. And all I could say was, “God, help me please,” and I hung on to the roof.*

*And I seen that wave come over my right shoulder, it hit that boat that we were trying to save and just shattered it, picked me up and took me in. And I’m going in, and I could see everything, because the power plant was still electrocuting, you know. So I could see this house in front of me, and I saw in my mind—it said to grab the windowsill and spring myself in it. So I’m on this roof, I’m going in. I stand up and I grab this windowsill, and as I attempt to jump, there’s nothing under me and I’m just dangling.*

*And at the same time, the wave hits this house, and it pushes at me, and I start spinning around with this building, and it takes me in, and I’m hanging on. It takes me in, and as I go, the water seems to be calming down. And I see something floating by, so I swim to it. And it was a canoe, like, on its side and I hung on to it, and it took me in, all the way in for about another ten minutes.*

*And then the water started settling down and I waited, and waited. And then it got ground, and I think it was about chest-high deep of water. I stood up and then I waited, and the water started going out again. And I started walking towards where the blue lights were, all the cops.*

*So when I got there, I told the people there, you guys had seen anybody? My brother and I had the same kind of shirt, was this blue, white glitter shirt. So I asked them, I said, “Is there a guy who had a shirt like this over here?” And they said, “Oh! Yeah, yeah, your brother is up here! God when he sees you he’s going to die, because, because we’re all worried!” And then we see each other, “Oh! My god we thought you were gone,” you know, it’s like, “Wait till your sister hears about this. She’s going to kill you,” you know.*

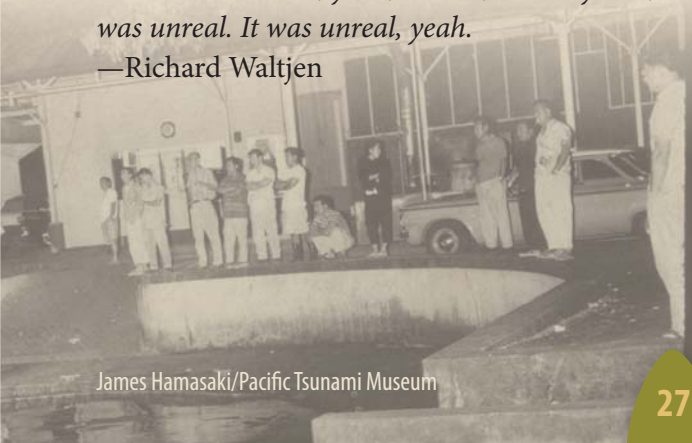
*And then all the cops and everybody was asking me what happened and I just was telling them what I went through, and everybody just couldn’t believe that, you know.*

*This thing just wiped out this whole town. I mean, this place was a whole town. When you look back at it there was just nothing, everything was flat, you know, and I just walked off of that.*

*So we didn’t have his car, naturally. We had to catch a ride home and then the next day when we came back down we found his car under three houses, yeah, so that, that day was, it was unreal. It was unreal, yeah.*

—Richard Waltjen

*Just before fleeing from the third wave of the 1960 tsunami, the Waltjen brothers and four others pull on ropes to secure a boat as the water goes out.*



James Hamasaki/Pacific Tsunami Museum



Hawaii Tribune Herald Collection/Pacific Tsunami Museum



Howard Pierce Collection/Pacific Tsunami Museum

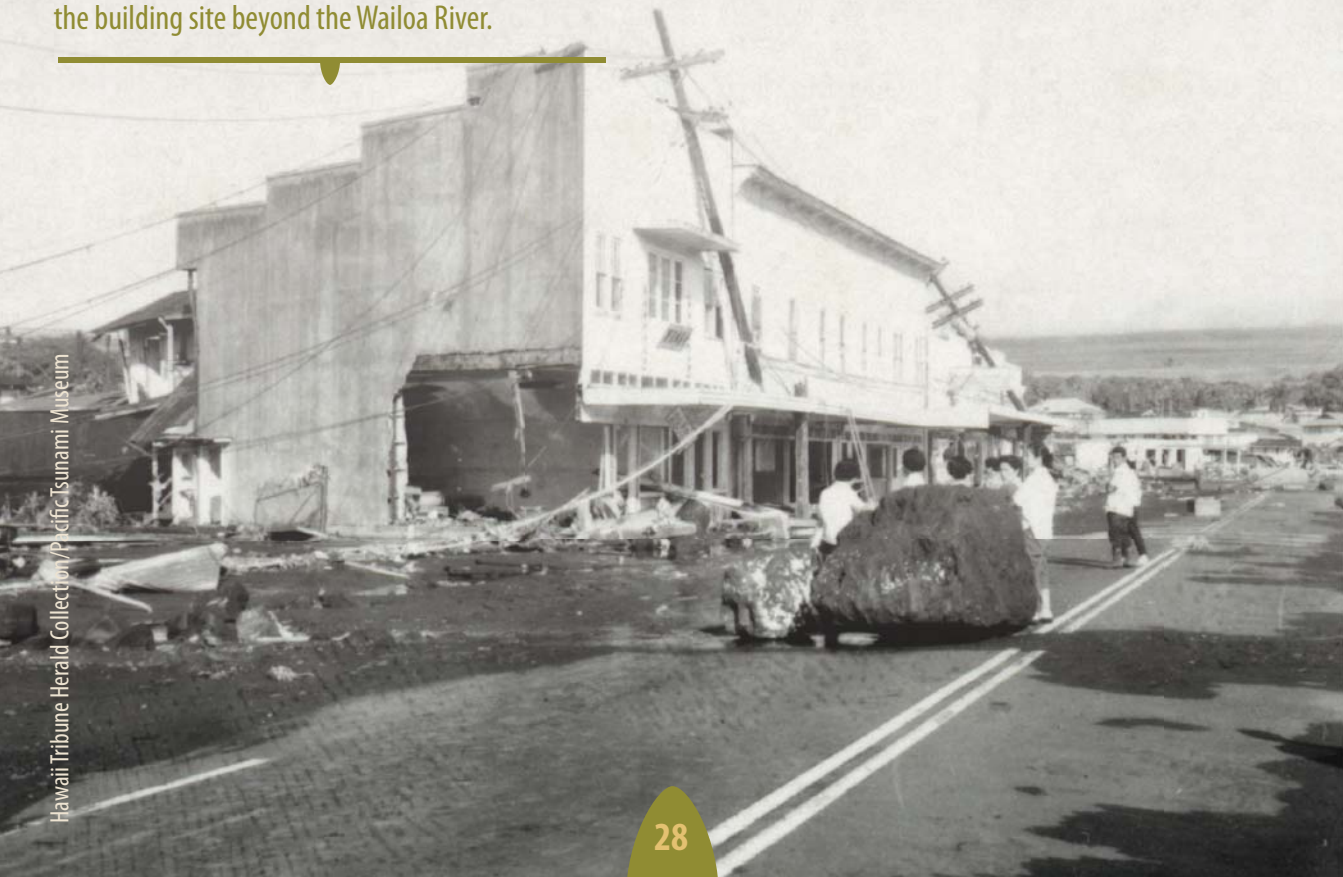
Showing the cheerful resilience of Hilo residents, women clean shoes in front of a shoe store on Kamehameha Avenue next to Helen's Fabric Shoppe after the 1960 tsunami.

The Waiākea clock lies in the rubble, stopped at 1:04, the time the tsunami swept through Hilo during the early morning of May 23, 1960.



Hawaii Tribune Herald Collection/Pacific Tsunami Museum

A boulder from the breakwater sits in the middle of Kamehameha Avenue in downtown Hilo after the 1960 tsunami. The run-up height was more than 35 feet near the Wailoa Motors building, located at that time on Kamehameha Avenue. Inundation distance was marked by 22-ton boulders from the 10-foot-high bayfront seawall that were carried as far as 600 feet inland across Mo'oheau Park. Pieces of the Hawaii Planning Mill were later found 1,500 feet away from the building site beyond the Wailoa River.



Hawaii Tribune Herald Collection/Pacific Tsunami Museum



Aerial of the damage along Hilo Bay Front following the 1960 tsunami. Mo'ohau Bandstand in the right hand corner; AMFAC Grocery Warehouse in the middle foreground.

Parking meters bent by the force of the 1960 tsunami waves. Two people contemplate the disaster in Waiākea in Hilo. Damage to property included 229 dwellings and 308 businesses and public buildings.



# "I'll never see a human being again"



Fusayo Ito, a docent at the Pacific Tsunami Museum

Mrs. Ito did not evacuate when the warnings sounded on May 22, 1960. She had built her house on high ground away from the ocean, near a place where she sought safety from the 1946 tsunami and where waves hadn't previously reached.

At 1:04 a.m., she was caught by a thirty-five foot wave, and described the moment as follows: "And then the floor gave away and the house started to go into pieces, I guess, and I just zoom, went down with the house. And fall right down in the crack, and I got caught on that. So I tried to climb up, but I couldn't. I got stuck. And the house was 'creak, creak, creak' cracking around, and the house just collapsed on me and I fainted."

After some time passed, she woke up disoriented in the water. She said, "And I look up and I saw the stars, I saw the stars and I just got frightened. I thought I was still in the house. You know when I fainted I thought I was still in the house, but no I was outside already. And that's the first time I cried."

As Mrs. Ito floated on a window screen, she somehow crossed the river, floated past the Ironworks, Cow Palace, past the park and Wainuku mill and Waiākea pond, down to the wharf, and eventually out to sea. Everything was dark because the power plant had exploded. Several times she thought she would be able to stand and walk away only to find she could not reach the bottom: "Cause the wreckage I cannot see the water, just all covered with the wreckage. So it's just like a floor. So I thought I can walk and run away. But I put my feet down, reach the bottom I cannot. I cannot reach the bottom. So I thought 'Oh, I'm still in the water.'"

Out at sea, she saw two lighthouses and then finally just the sky and ocean. During the long night until the Coast Guard saved her, she thought of her only daughter and cried. She prayed to Buddha, and became peaceful. "I pray

the whole time," she said, "And I was quiet and I wasn't even afraid of the ocean. The ocean was beautiful. I look in the sky, everything beautiful. And I didn't even struggle. I was safe. I was safe. I was sure I would never come back to this world again. Never see a human being again. So, I closed my eyes. I relaxed and just hung on. But, it was nice, I looked up in the sky I wasn't scared anymore. I was with my Lord Buddha. I pray. I was calm yeah. I didn't think nothing, not even my daughter already."

When the Coast Guard pulled her out, she started to cry again. She said, "And the doctor in the Coast Guard told me, 'You're safe, so don't cry. We'll take good care of you.' But I couldn't stop, I just cried, cried, cried. Cause I thought, 'I never will see a human being again, because I never will come back to this world.'"

Mrs. Ito was reunited with her daughter, but suffered from nightmares and feared the sound of water. It took many months before she could return to the downtown Hilo area. Finding catharsis in sharing her story, in the 1990's she went to the Pacific Tsunami Museum once a week to share her tale with spellbound audiences of visitors.



Richard Tada

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In 1960 post-tsunami Hilo, a man collects clothing from piles of debris in front of Hilo Quality Cleaners and Chevron station, Kimiville, on Kumu Street.

## References

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Dudley, W. C., & Lee, M. (1998). *Tsunami!* (2nd ed.). Honolulu, HI: University of Hawai'i Press.

Emerson, N.B. 1915. Pele and Hiiaka: a myth from Hawaii. Retrieved from University of California Digital Library, uploaded 2010, [http://archive.org/stream/pelehiikamythfr00emeriala/pelehiikamythfr00emeriala\\_djvu.txt](http://archive.org/stream/pelehiikamythfr00emeriala/pelehiikamythfr00emeriala_djvu.txt)

Fornander, A. (1916-17/edited 1998). "The flood in Hawaii in the Olden Times." Collection of Hawaiian antiquities and folk-lore. Vol. 5, Pt 3 (p522-527). Honolulu: Bishop Museum Press. Retrieved January 26, 2012 from Ukulau: the Hawaiian Electronic Library <http://www.ulukau.org/elib/cgi-bin/library?e=d-0fornander5-000Sec--11en-50-20-frameset-book--1-010escapewin&a=d&p2=book>

Kanahele, P. K. (2011). *Ka Honua Ola: 'Eli 'eli Kau Mai. The Living Earth: Descend, Deepen the Revelation*. Honolulu: Kamehameha Publishing.

Tsunami brochure. (n.d.). Retrieved April 19, 2012 from Tsunami Ready National Weather Service website: <http://www.tsunamiready.noaa.gov/>



*A tsunami can be measured in inches or hundreds of feet. It can take countless lives in an instant. It almost took mine. Be safe. Respect the ocean.*

## *Felipe Pomar*

—World Champion surfer Felipe Pomar survived an earthquake-generated local tsunami while surfing in Peru in 1974.

World Champion surfer Felipe Pomar, surfing a regular wind-generated wave in the photo, ...

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*1965  
World Surfing Champion*

*Robert Beck*