



TSUNAMI NEWSLETTER



International Tsunami Information Center

This month, in addition to summaries on the tsunami in Algeria and tsunami warning system news from the Richard H. Hagemeyer Pacific Tsunami Warning Center and ITIC, we feature articles on several projects which have improved tsunami warning capabilities in the United States for the State of Hawaii. These are the recent publication of updated and recompiled runup maps for the State by Dr. Daniel Walker, and an automated tsunami alert system developed by the Pacific Disaster Center that provides rapid notifications to emergency officials. We also pay tribute to Dr. Doak C. Cox, who passed away in April, 2003. Dr. Cox was instrumental in creating Hawaii's first tsunami evacuation maps and dedicated himself to collecting historical data on the effects of Hawaii tsunamis. His work provided a base for evaluating tsunami hazards and testing tsunami models. Dr. Cox also served as the Hawaii State Tsunami Advisor for decades, and was a founding member of the Hawaii State Earthquake Advisory Board.

SUMMARY OF EARTHQUAKES IN THE PACIFIC Occurring April-May 2003

With surface wave or moment magnitude (M_w) greater than or equal to 6.5 and a depth no greater than 100 km, or an event for which a Tsunami Information Bulletin (TIB) or Regional Watch Warning (RWW) was issued. Epicenter and M_w from USGS National Earthquake Information Center (NEIC, G); preliminary M_s from PTWC (P) at time of action; M_w and depth from Harvard (H).

DATE	TIME (UTC)	LOCATION	LAT	LONG	DEPTH (km)	M_w	M_s	PTWC ACTION	ACTION TIME (UTC)	Damaging Tsunami ?
4-May	13:15	Kermadec Islands	30.625 S	178.315 W	45	6.7 (G,H)	6.7	TIB	13:43	NO
26-May	9:25	Near East Coast of Honshu, Japan	38.901 N	141.446 E	62	7 (G,H)	6.6	TIB	9:45	NO
26-May	19:23	Halmahera, Indonesia	2.406 S	128.811 E	35	6.9 (H) 6.8 (G)	6.7	TIB	19:45	NO

ALGERIAN EARTHQUAKE

The following event description is summarized from information sources available at the 21 May 2003 Algerian Earthquake web site http://www.emsc-csem.org/Html/ALGER_210503.html hosted by the European Mediterranean Seismological Centre.

A strong shallow earthquake occurred at 1844 UTC on 21 May 2003 (Harvard Mw 6.8, depth of 16.4 km; USGS epicenter of 36.97°N, 3.668°E) in the province of Boumerdes about 50 km east of the capital city of Algiers. The earthquake caused over 2500 casualties and 10,000 injuries, with 200,000 left homeless and 20,000 dwellings lost; preliminary economic costs are as high as USD \$1.5 billion. Observed tsunami waves of up to 3-m height with a mean period of 10-12 minutes were reported on the southeastern coast of Majorca and Menorca, and in Ibiza in the Spanish Balearic Islands located about 250 km north of the epicentral region. The waves caused significant damage to hundreds of vessels in harbors and ports. On the Algerian coast in the epicentral region, eyewitness accounts report a 100-m recession of the sea in coastal sections of Algiers and Boumerdes, and fishermen in the port of Zemmouri-El-Bahri, reported a drop in water depth to less than 1 m with several boats ending up resting on the sea bottom before the water returned.

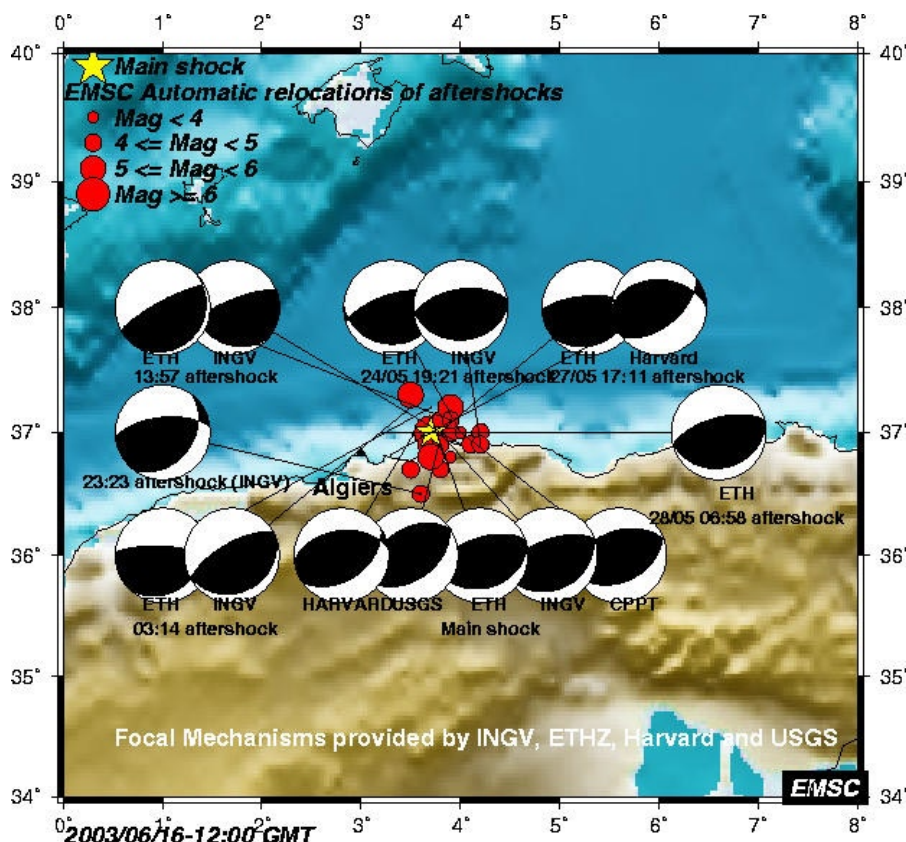


Figure 1. Earthquake focal mechanisms showing thrust faulting for the main shock and relocated aftershocks, as determined by the Istituto Nazionale di Geofisica e Vulcanologia (INGV), Federal Institute of Technology Zurich (ETHZ), Harvard University, and the U.S. Geological Survey (USGS). The distribution and character of historical seismicity, along with other geological and geophysical data, suggest that the faulting occurred along the southeast-dipping, low-angle thrust plane at depths of less than 20 km.

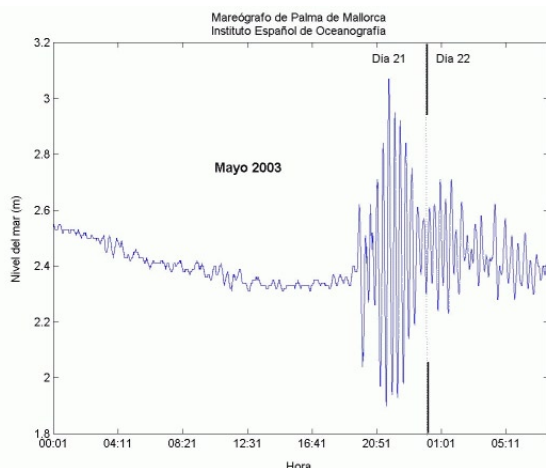


Figure 2. Tide gage record in Palma, Majorca showing peak-to-trough amplitude of 1.2 m, courtesy of María Jesús García (Instituto Español de Oceanografía, IEO).

Underwater telephone cables were severed by the earthquake and/or tsunami cutting communications between Europe and Asia, the Middle East, and the Pacific.

Preliminary simulations of the Balearic tsunami have been conducted by Hélène Hébert (CEA - DASE/ Laboratoire de Detection et de Geophysique, LDG, <http://www.emsc-csem.org/Doc/HEBERT/index.html>) and Jose Borrero (Tsunami Research Group, University of Southern California, <http://www.usc.edu/dept/tsunamis/ALGERIA/>). Computed tsunami arrival times at ports were estimated to be 20-60 minutes after tsunami generation.

PTWC NEWS**Modifications to Products and Procedures of the Pacific Tsunami Warning Center**

Effective June 21, 2003, the Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC) made the following changes to its international tsunami warning and information products, and the procedures used for issuing those products:

1. The earthquake magnitude reported in the bulletins and used in criteria for determining the type of bulletin to issue is now the moment magnitude, M_W , instead of the Richter surface wave magnitude, M_s . M_W values are similar to M_s values for most shallow earthquakes. However, M_W is a more accurate scale for very large earthquakes and for slowly rupturing earthquakes that have an enhanced tsunamigenic potential. M_W is also the standard magnitude now used by most seismic observatories.
2. Tsunami Information Bulletins (TIB) continue to be issued for shallow Pacific earthquakes with magnitudes between 6.5 and 7.5, inclusive. However, a TIB supplement will now be issued if data from nearby sea level gauges indicate a local tsunami was generated. A TIB will now also be issued for certain large Pacific region earthquakes that do not pose a tsunami threat to the Pacific Basin because they are inland or deep or located in a marginal sea.
3. A Spanish-language version of the Tsunami Information Bulletin, formerly sent to a few locations in South America, will be replaced by the English-language version. This change is being made to eliminate the potential for confusion when PTWC staff make changes to pre-scripted language of the English version to accommodate a particular situation, but are unable to compose similar changes in the Spanish version.
4. A non-expanding regional warning, limited in areal extent to 1000 km from the earthquake epicenter, will be issued for shallow Pacific earthquakes with magnitudes between 7.6 and 7.8, inclusive.
5. An expanding regional tsunami warning and watch, formerly issued for shallow Pacific earthquakes with magnitudes of 7.6 or greater, will now only be issued for magnitudes of 7.9 or greater.
6. A number of additional warning points have been added. Warning points are locations used to determine if an area should be in a warning or watch based either on that point's distance from the epicenter or on the time remaining until the estimated arrival of the first tsunami wave at that point. The additional warning points are needed to improve the coverage and accuracy of warning and watch areas. Estimated arrival times will continue to be provided in bulletins for all warning points within warning and watch areas.
7. A few format changes have been made to the bulletins. Notable is that the earthquake parameters are now in a tabular rather than narrative form. In addition, the geographic coordinates of warning points are now provided whenever estimated arrival times for those points are listed in the bulletins.

The purpose of these changes is to help reduce the problem of over-warning, to provide more comprehensive and accurate warning and watch areas, and to otherwise make the bulletins more informative and effective. These changes are largely the result of recommendations made and approved at the Eighteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific (ITSU-XVIII). Questions or comments regarding these changes should be directed to:

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PTWC NEWS, *continued*

During May, 2003, PTWC Senior Electronics Technician Richard Nygard made repairs and performed maintenance to the sea level station in Majuro, Marshall Islands. The station was installed in August, 2002, but began malfunctioning soon afterward. The station is located on a pier at a tunafish packing plant (Figure 1), and is maintained by the US National Weather Service Office (WSO), Majuro (Figure 2). A new Handar 555 Data Collection Platform (DCP, Figure 3) and Garmin GPS clock were installed, and transmission communications were confirmed with PTWC prior to completion. Water level is measured using two Druck PTX-1830, 20 psi sensors located in a stilling well that was originally established by the University of Hawaii Sea Level Center.



Figure 2. Rich Nygard (PTWC) with Majuro WSO Officer-in-Charge Atran Lakabung at station. Stilling well (bottom) and DCP enclosure (top) seen between them.



Figure 1. DCP enclosure mounted on pole at edge of pier; GOES flat antenna and 20-watt solar panel mounted at top.

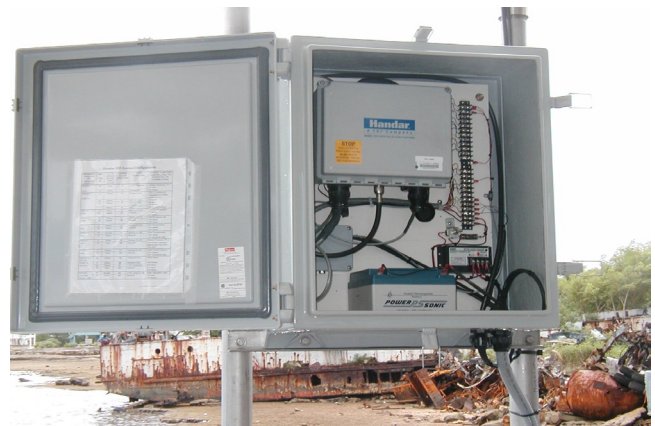


Figure 3. Handar 555 DCP, cabling, solar regulator, and 12-volt battery are mounted in weatherproof enclosure.

ITIC NEWS

Figure 1. Lorca examines rocks deposited in river channel by mud lahar from Volcán de Fuego. The 3,763-m high stratovolcano has erupted 61 times during since 1524, making it is one of Central America's most active volcanoes.

Hemispheric Consultation on Early Warning Systems

Dr. Laura Kong, ITIC Director, and Mr. Emilio Lorca from Chile's Tsunami Warning System (SHOA), represented the tsunamis as part of a global hazards panel at a Hemispheric Consultation on Early Warning Systems in Antigua, Guatemala from 3-5 June 2003. Altogether, about 90 individuals representing 22 countries attended the sessions. This consultation was part of the preparations leading to the Second International Early Warning Conference (EWCII) which will take place in Bonn, Germany, 15-19 October 2003. The objective of the regional consultation was to identify existing early warning systems, responsible persons/organizations, as well as other relevant aspects of early warning systems such as the financial aspects, investment costs, and sustainability. The regional consultation also identified shortfalls and future needs such as data, information, knowledge, skills, and resources. The

ITIC NEWS, *continued*

meeting was hosted by Guatemala and was supported by the Government of Germany, through Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), under the auspices of the United Nations and promoted by the Inter-Agency Secretariat of the International Strategy for Disaster Reduction and UNDP.

During the meeting, Kong and Lorca also met with Dr. Wilfried Strauch, ITSU Nicaragua contact and Director for Geophysics at Instituto Nicaragüense de Estudios Territoriales (INETER), Dr. Antonio Arenas, Director of Servicio Nacional de Estudios Territoriales in El Salvador, Dr. Marino Protti, Professor, Observatorio Vulcanológico y Sismológico de Costa Rica (OVSICORI) in Costa Rica, and

Ing. Gerónimo Giusto, Executive Secretary of Centro de Coordinación para la Prevención de los Desastres Naturales en América Central (CEPREDENAC), to discuss greater participation in ICG/ITSU activities. The group agreed to initiate the development of a Pacific Coast Regional Tsunami Warning System for Central America, and identified critical data and communication needs for implementation. As Nicaragua has recently been most involved in ICG/ITSU activities, Dr. Strauch volunteered to lead the effort to make a cooperative proposal from the Pacific-coast Central American countries to CEPREDENAC in July, 2003, and together, they hope to be able to present their plan for discussion at ICG/ITSU XIX this October.



Figure 1. Left to Right: Emilio Lorca, Chile National Tsunami Warning System, Dr. Laura Kong, ITIC Director, and Wolfgang Stiebens, GTZ.,

NESDIS Data Users Workshop and Unified Global Tsunami Historical Database Initiative

ITIC Director Dr. Laura Kong represented international and national tsunami data users at the US National Environmental Satellite, Data & Information Service (NESDIS) Data Users Workshop held 11-12 June 2003 at the NESDIS National Geophysical Data Center (NGDC) in Boulder, CO. In addition to the catalogs of tsunami events and runups first compiled in the 1970s by the World Data Center (WDC) for Solid Earth Geophysics through NGDC, NESDIS also supports the Tsunami Warning System by providing communications from remote data platforms through NOAA's Geostationary Operational Environmental Satellite (GOES). As a panelist in the Government User Panel, Dr. Kong emphasized the critical need for accurate and comprehensive historical data that is easily and quickly accessible electronically. She also reiterated the concern that many international customers may only have limited bandwidth Internet connections, and that it was therefore important to support the development of offline applications, and to maintain traditional hard copy distribution capabilities. The Workshop was attended by

nearly 200 people representing data providers, application developers, contractors, and public and private data users.

During the week, ITIC Director Dr. Laura Kong also met with NGDC Acting Director Dr. Christopher Fox, NGDC Deputy Director David Clark, WDC-SEG Acting Director Susan Mclean, and the NGDC Tsunami Program Manager Paula Dunbar, to discuss a plan to develop a unified global historical tsunami database. The proposal effort involved Dr. Viacheslev (Slava) Gusiakov, who provided significant input via electronic mail. The collaborative proposal between NGDC, Novosibirsk Tsunami Laboratory (NTL), Russian Academy of Sciences, and ITIC calls for merging two previously separate databases, the WDC/NGDC and NTL HTDB, and establishes data quality standards and procedures for updating and collecting new event data. The proposal has been distributed electronically to International and National Tsunami points-of-contact, and a discussion meeting is planned for the week of 7 July during the International Union Geodesy and Geophysics meeting in Sapporo, Japan.

IN MEMORIAM:

DOAK CAREY COX
JANUARY 16, 1917 - APRIL 21, 2003

By Jacquelin Miller - with lots of help from Charlotte Kato, John Harrison, Peter Rappa, George Curtis and other friends and colleagues.

I first met Doak Cox in 1964 on a cold, snowy night in Washington DC, when my husband, Gaylord Miller, brought him home for dinner. Doak had been at Harvard finishing his Ph.D. and was stopping by Washington to put the finishing touches on the development of the first joint agreement between the U.S. Department of Commerce and the State of Hawaii/University of Hawaii to establish the Joint Tsunami Research Effort (JTRE). Little did I ever imagine how much the next almost 40 years of my life would be influenced by this "distinguished visitor" in the long, well padded, and very large overcoat who proceeded to crawl around on the floor playing a "big bear" to the delight of our two small daughters. A few months later our family arrived in Hawaii on Friday, June 11, 1965, where Gaylord had been hired as the director of the new JTRE. Being "fresh off the boat," we did not know that June 11th was Kamehameha Day and that the banks would be closed. We arrived with almost zero cash (before the days of credit cards!) and no way to cash a check. Since Doak was the only person we knew in Hawaii, he kindly loaned us money to get us through the weekend. Hence began my long and incredibly fulfilling association with Dr. Doak Cox.

Doak was born on January 16, 1917, in Wailuku, Maui but spent much of his childhood on the island of Kauai where his father was a civil engineer for the McBride Sugar Plantation. He graduated from the University of Hawaii with a B.S. degree in Physics and Mathematics in 1938, before moving to the mainland for graduate work at Harvard University, where he received his M.A. degree in Geology in 1941. While a student at Harvard, he met and married Marjorie Greiner, a math student at Radcliffe College. Following completion of his degree, he was employed by the U.S. Geological Survey as a field geologist for their strategic minerals investigation program generated by the war. From 1941-45, he was in charge of fluorspar investigations in several western states, as well as Cuba. Doak had many good stories to tell about this period in his life. In 1946, he was offered a position with the Hawaiian Sugar Planters Association (HSPA) to direct their Geology Department. Doak worked for the HSPA from 1946 to 1960 and was directly involved with the statewide development of water resources and conservation in Hawaii. During this time, he also participated in a number of hydrological investigations in the Marshall Islands, serving as a hydrologist for the Pacific Science Board Arno Expedition in 1950 and contributing to other expeditions to the Marianas Islands and Western Samoa.

Doak's interest in tsunamis began on April 1, 1946, following the devastating tsunami in Hawaii. While working as a hydrologist for the HSPA, he conducted the first modern post-tsunami survey. The 1946 tsunami was generated by an Aleutian earthquake, and Doak realized that the hazards of such tsunamis could be significantly reduced if there was an adequate warning system. His efforts resulted in the establishment of the Seismic Sea Wave Warning System, which later became the Pacific Tsunami Warning System.

In 1954, while he was employed by the HSPA, Doak was asked to serve on the initial planning committee for a proposed Geological Institute for the State of Hawaii. This committee was instrumental in developing the administrative and directional framework, which led to the establishment of the

Hawaii Institute of Geophysics (HIG) at the University of Hawaii. Doak was not only one of the proponents for the establishment of HIG, but a "founding father", who served as executive secretary of the committee until HIG was formally established.

In 1960, Doak was very busy. He was invited to spend a quarter as a visiting professor of Groundwater Geology at Stanford University. This was his entry into the academic community. He left the HSPA and officially joined the University of Hawaii faculty where he was appointed to the rank of Professor in the Department of Geology and Geophysics and was put in charge of the Tsunami Research Program at the Hawaii Institute of Geophysics. He held this position until the subsequent establishment of JTRE in 1964. In the 1960's tsunamis were one of the most significant geophysical hazards in Hawaii. There were five major Pacific basin-wide tsunamis between 1946 and 1964, so tsunami research had a clearly perceived social, as well as scientific, significance.

In addition to his other activities in the early 1960's, Doak was responsible for drafting the original agreement between the State of Hawaii and the U.S. Department of Commerce to establish the Joint Tsunami Research Effort (JTRE) on the Manoa campus. With the establishment of JTRE, the University of Hawaii was recognized nationally and internationally as a leading tsunami researcher. Furthermore, JTRE served as the prototype for the cooperative institutes to be sponsored by National Oceanic and Atmospheric Administration (NOAA). There are now eight such institutes in the United States, one of which, The Joint Institute for Marine and Atmospheric Research (JIMAR) at the University of Hawaii, is a direct outgrowth of JTRE. Doak also helped draft the Memorandum of Understanding establishing JIMAR, and he chaired the search committee for a new director for JIMAR following Gaylord's death in 1976.

Although Doak turned the lead of the Tsunami Research Program over to JTRE following its establishment in 1964, he continued his own research on tsunamis. He studies their sources, frequencies of occurrence, run-up, and particularly analysed historical data on earthquakes and tsunamis in the Pacific. During the early 1960's he had edited the report on the Alaskan Earthquake for the National Academy of Science, and in 1965, accepting many of his published papers as a thesis, Harvard University awarded him the long delayed Ph.D. During a sabbatical leave in 1966, as a visiting professor at Nagoya University in Japan he consulted with other tsunami experts. He also served as the official Tsunami Advisor to the State Office of Civil Defense from 1962 to 1967. In this capacity, he was called upon to assist Civil Defense in determining if a tsunami warning and evacuation order should be issued (in the event of a distantly generated earthquake). He was also called upon to present continuous live television reporting during tsunami alerts to guide the public in evacuation routes and provide historical run-up data-- all from memory!

In addition to his work on tsunamis, Doak established a Natural Hazards Group at UH Manoa to bring scientists from many different departments together to share ideas on natural hazard research. A sabbatical in 1981 found him delved into natural disasters at the Natural Hazards Research and

IN MEMORIAM, DOAK COX, *continued*

Applications Information Center of the University of Colorado at Boulder. Doak made a significant study of the storm surge associated with Hurricane Iwa. This study generated wide interest in the problems of storm surges near island chains, which until then had received little attention. Upon Doak's retirement from the University in 1985, Dr. Dennis Moore, Director of JIMAR, commented on Doak's accomplishments with the following:

During his entire tenure at U.H. Manoa, Dr. Cox has contributed outstanding research and service in the tsunami and tsunami hazard mitigation area. This has been an area of high social relevance, and his efforts represent an outstanding contribution to the University of Hawaii and the State.

As if his tsunami reports were not enough, Doak served on the organizing committee for the UH Manoa Water Resources Research Center in 1964 and was appointed the first director of WRRC. Many of the current goals of the WRRC were set in place under Dr. Cox's initial leadership as Director.

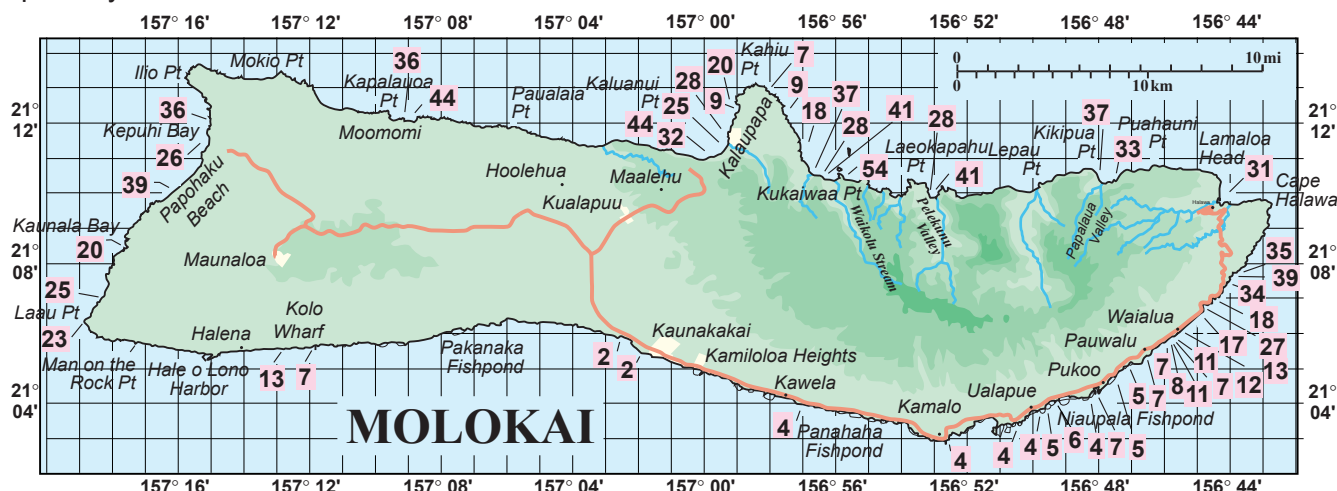
Following the establishment and initial operation of the WRRC, Doak's expertise was again sought out by the University to meet the rapidly growing need for responsible environmental management. His knowledge, legendary facility with the pencil, and communication skills, soon led to the recognition by the legislature of the need to develop the legislative framework and procedures for wise environmental planning and management. The result was the passage, in

1970, of Act 246, which established the Governor's Office of Environmental Quality Control, the Environmental Council and the Environmental Center of the University of Hawaii. Again Doak's leadership abilities were tapped, and he was appointed Director of the UH Environmental Center. Under Doak's direction, the Environmental Center achieved broad statewide recognition for its impartial and reasoned responses to environmental issues, and his personal research on tsunamis continued as a major focus of the Center's research efforts. Doak's service to the University included more than two decades of nearly continuous service on the Faculty Senate. He was a faculty senator from 1964 through 1985, with only brief absences when he was away on sabbaticals. He also served on the Chancellor's ad hoc committee on Academic Planning where he accepted the most demanding task of secretary of the ad hoc Committee On Administrative Structure. Following retirement from the University in 1985, Doak's keen awareness of State needs and institutions led him to initiate efforts with State Civil Defense to establish a unique advisory organization for matters relating to seismic hazards in the State. The Hawaii State Earthquake Advisory Board (HSEAB), founded in 1990, was a direct result of his efforts, and Doak served several years as a charter member. Largely as a result of Doak's advice, this group continues to meet quarterly, as an advisory adjunct to the Hawaii State Civil Defense agency. The efficacy of the HSEAB has been recognized nationally, and its approach to hazard mitigation is widely replicated in other states.

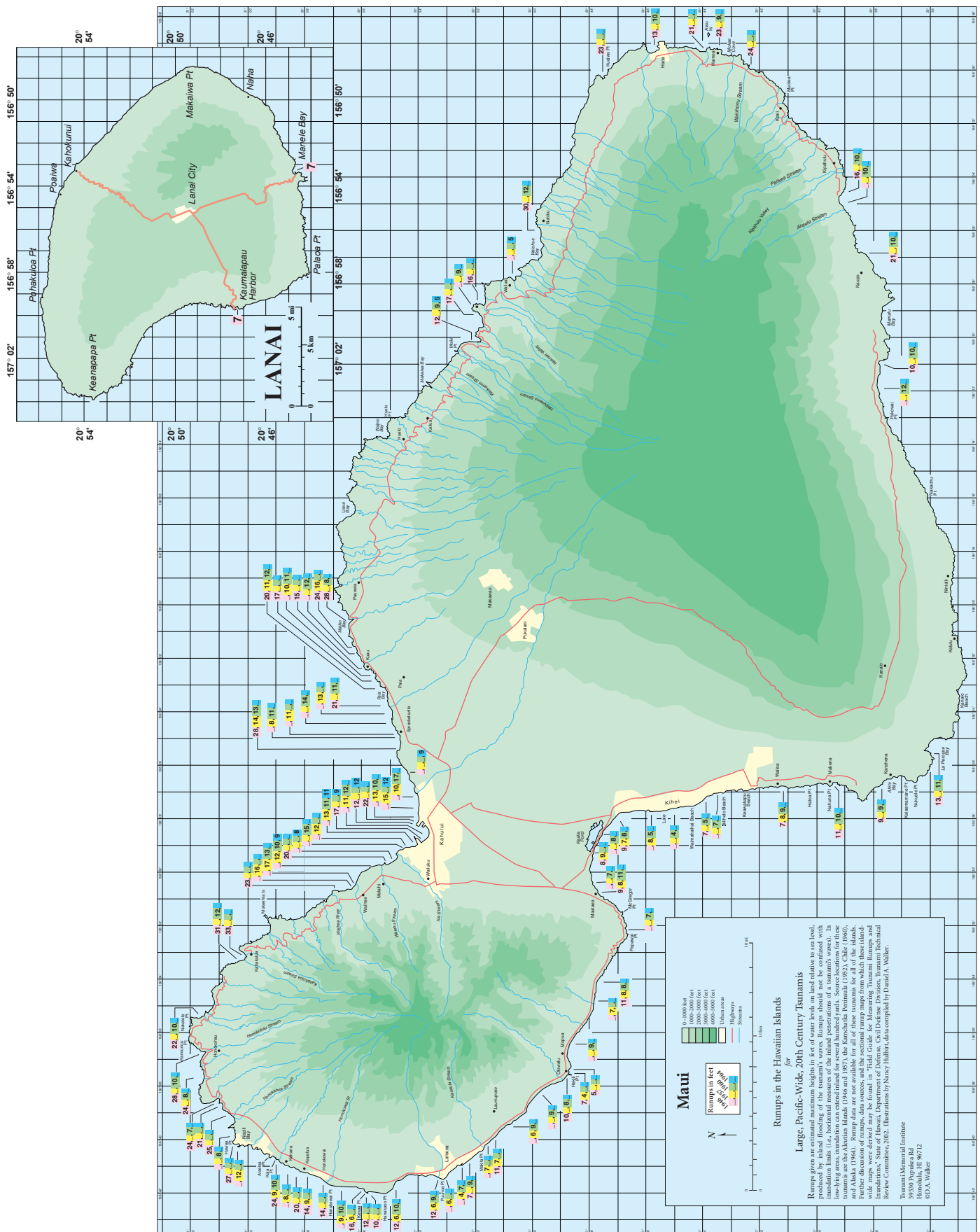
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RUN-UPS IN THE HAWAIIAN ISLANDS

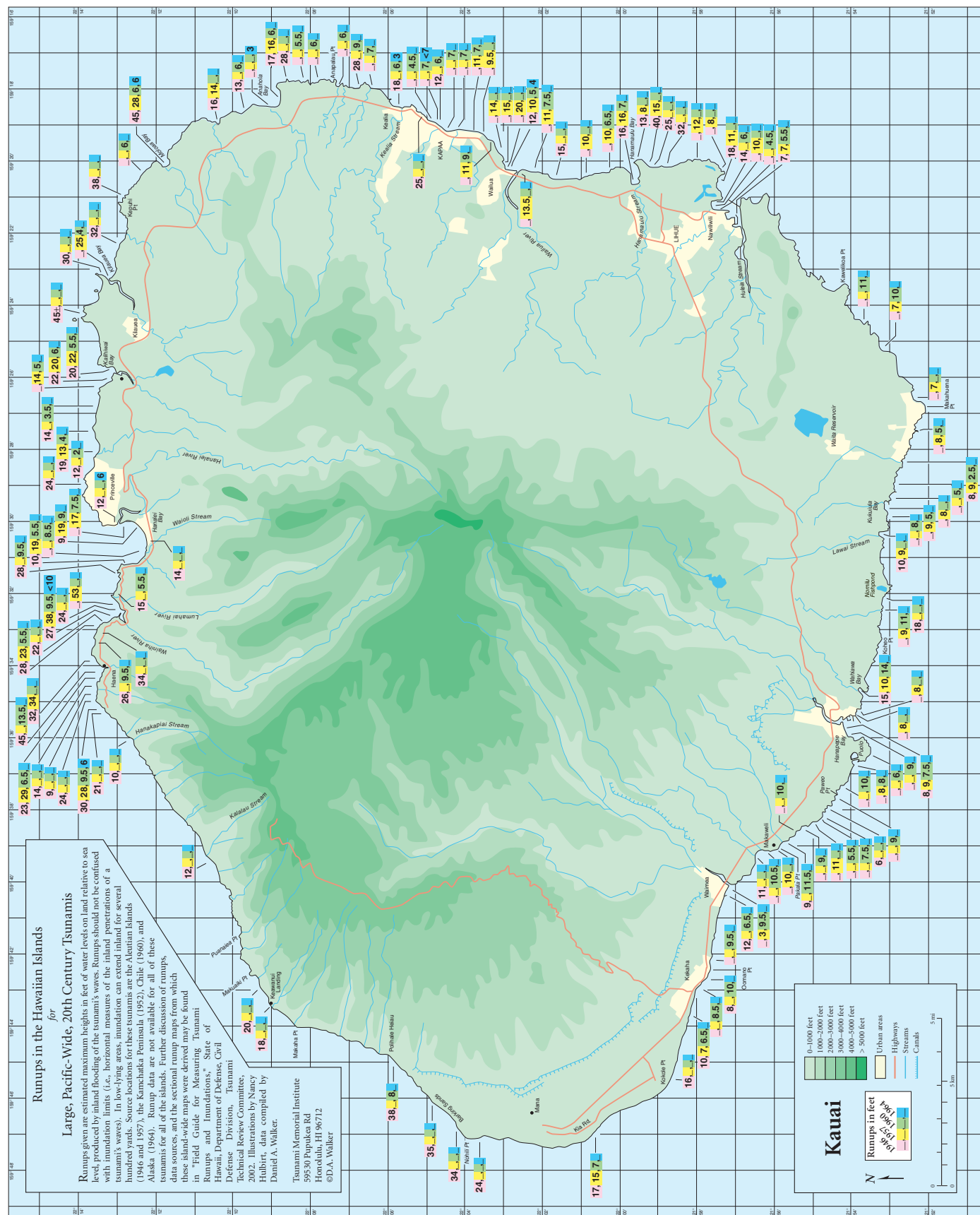
The following maps show run-ups for large, Pacific-wide, 20th Century tsunamis as measured on the Hawaiian Islands. The runups are the estimated maximum heights in feet of water levels on land relative to sea level, produced by inland flooding of the tsunami waves. Runups should not be confused with inundation limits (i.e., horizontal measures of the inland penetrations of a tsunami waves). In low-lying areas, inundation can extend inland for several hundred yards. Source locations for these tsunamis are the Aleutian Islands (1946 and 1957), the Kamchatka Peninsula (1952), Chile (1960), and Alaska (1964). Runup data are not available for all of these tsunamis for all of the islands. Further discussion of runups, data sources, and the sectional runup maps from which these island-wide maps were derived may be found in Field Guide for Measuring Tsunami Runups and Inundations, State of Hawaii, Department of Defense, Civil Defense Division, Tsunami Technical Review Committee, 2002. Illustrations by Nancy Hulbirt, data compiled by Dr. Daniel A. Walker.



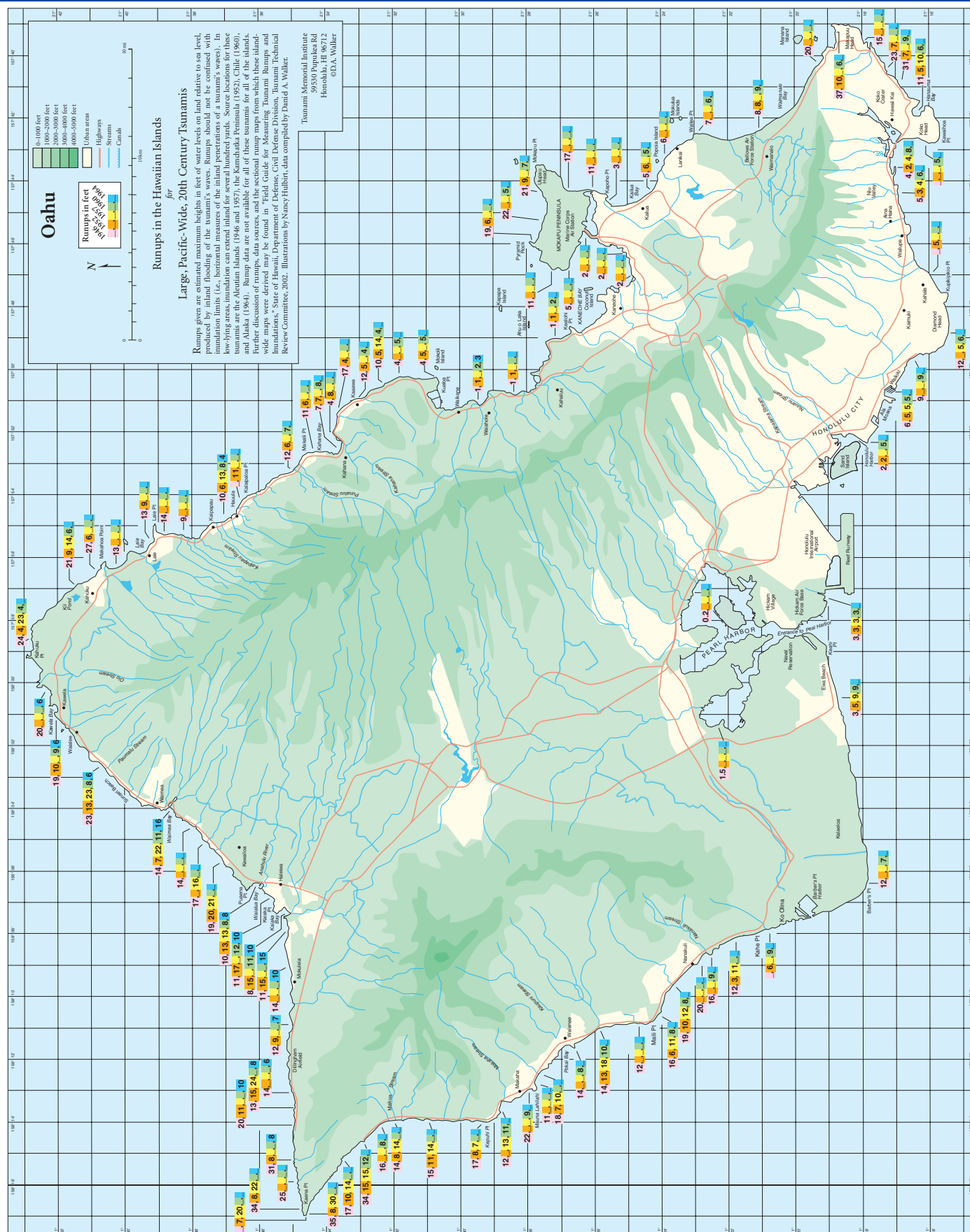
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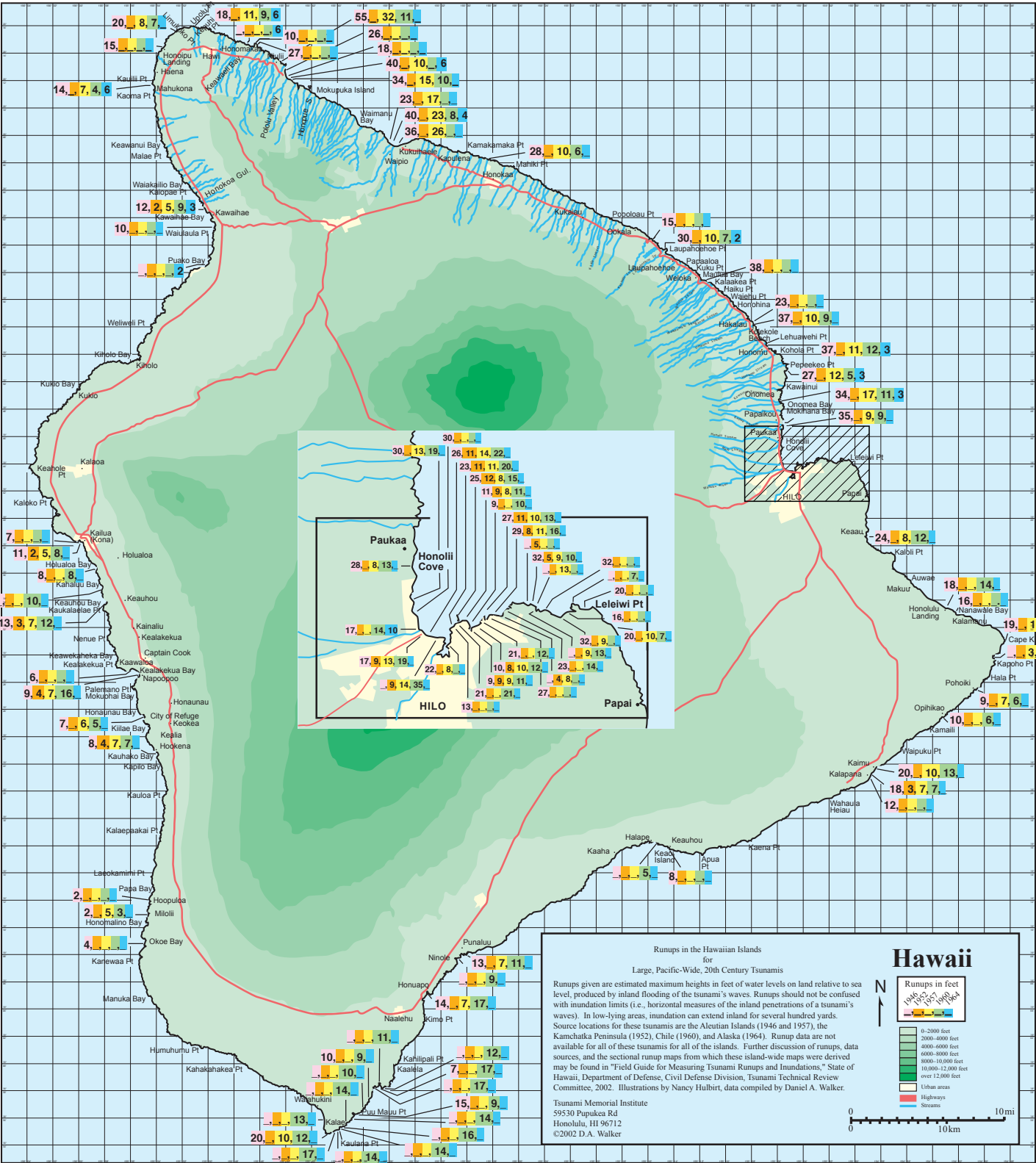
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RUN-UPS, *continued*



RUN-UPS, continued



TSUNAMI MODELLING OF LANDSLIDE SOURCES WORKSHOP

contributed by Dr. Gerard Fryer, University of Hawaii

Forty scientists from eight countries participated in the workshop, *Model Validation and Benchmarking for Tsunami Generation by Submarine Mass Failure*, in Honolulu, Hawaii, May 30-31, 2003. The workshop, organized by Dr. Stephan Grilli of the University of Rhode Island, was funded by the U.S. National Science Foundation and held in conjunction with the 13th International Offshore and Polar Engineering Conference. The goal of the workshop was to review the state of the art in modeling and to define benchmark problems for validating numerical models of submarine mass failures.

The workshop began with descriptions of historical slump and landslide-generated tsunamis, presentations of different numerical algorithms for modeling tsunamis, presentation of results from wave tank experiments, and descriptions of theories for slope failure and sediment flow. After the formal presentations, participants divided into two working groups. Hydrodynamicists and ocean engineers discussed future directions in modeling and in validating models with wave tank experiments, while geologists and geotechnical experts discussed future field experiments and the choice of major landslides as benchmarks for further geological investigation. Dialogue in both groups was spirited, and animated discussions continued after the two groups presented their deliberations to the full meeting.

The single most contentious issue was the speed at which very large landslides travel. Slope failure models all predict very high speeds for large landslides (approaching 200 m/s down long slopes), which would result in very efficient tsunami generation. Many participants, however, could not accept such high speeds, especially as they are unsupported by historical data. It was agreed that uncertainties, including consideration of the appropriate physics and assumptions, about scaling up numerical and laboratory experiments must be resolved, and that future geophysical investigations should focus on major landslides for which slide motion and especially slide speed can be hindcast or determined by other means.

IN MEMORIAM, DOAK COX, *continued*

Doak was frequently called on as an expert witness by the judiciary on numerous cases involving water rights and water resource developments on a statewide basis. He was highly sought after for these cases because of his reputation for consistently reflecting an exemplary image of competency and fairness.

Doak held many honorary positions. He was active with the Hawaiian Academy of Sciences for over 50 years and was the only person to serve twice as president of that organization (1958-59 and 1984-85). He was an honorary life member of the Academy and received the Academy's first Lifetime Achievement Award in 2002. He served as president of Sigma Xi, Chairman of the Board of Hanalei School, President of the Oratorical Society of Honolulu, President of the Conservation Council of Hawaii, and President of the Memorial Society and Treasurer of Honolulu Friends Meeting. In 1960-62, he was a Councilor of the American Association for the Advancement of Science. He held the position of Secretary of the Tsunami Committee of the International Union of Geology and Geophysics from 1960-1966. From 1964-72, he was an Alaska Earthquake Committee member and Chair of the Oceanography Panel for the National Academy of Sciences. In 1971, he was the Hawaii Conference Chairman of the International Association of Water Pollution Control. Because of his personal competence, reputation, and demonstrated leadership, he was appointed to the State of Hawaii Governor's State Water Commission from 1977-1979. He also was a member of the Hawaii Water Commission from 1980-81. Doak was a charter member of the Conservation Council and was an active member of the board and select committees since its establishment in Hawaii. In April 1985, he received the prestigious award for Conservation Achievement given by the

National Wildlife Federation and the Conservation Council of Hawaii. Doak was an Emeritus Geophysicist and Senior Fellow of the Joint Institute for Marine and Atmospheric Research and of the graduate faculty of Geology and Geophysics and a Research Affiliate of the Environmental Center from 1985 till his death. Doak's many accomplishments were formally recognized in 1985 by his receipt of the Governor's Award for distinguished service to the University and State of Hawaii. This award was given:

...to recognize an individual who has excelled and provided leadership of an extraordinary nature, in a multiplicity of fields and endeavors. Throughout his long and productive work efforts, his exceptional perception and personal expertise have provided guidance over a broad spectrum of academic, governmental and societal issues that has resulted in significant long term benefits both to the State of Hawaii and the world.

A complete set of Doak's many publications are available at the University of Hawaii, Hamilton Library and at the Environmental Center.

I had the good fortune to work closely with Doak at both the Water Resources Research Center and the Environmental Center for nearly 15 years and to benefit from his expertise and friendship for nearly 40. He was a tremendous positive influence on my life and the lives of all those with whom he came in contact. His reasoned, objective and non-judgmental analyses of complex resource management issues were extraordinary and legendary. Deciphering his multifarious pages of hand written notes on the yellow tablets was a challenge to all, but met admirably by Winnie Miura and Charlotte Kato. We all learned from his example and our lives were better for his teachings.

AUTOMATED TSUNAMI ALERT SYSTEM FOR HAWAII WITH APPLICATIONS FOR OTHER TSUNAMI-PRONE NATIONS

by Jim Buika ¹, Stanley Goosby ², Raymond Isawa ³, Dr. Laura Kong ⁴, Juliana Lo ⁵, and Brian Yanagi ⁶

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(The following is based on a paper submitted to the 7th US/Japan Workshop on Urban Earthquake Hazard Reduction sponsored by the Earthquake Engineering Research Institute and the Japan Institute of Social Safety Science, March 25-28, 2003, Kihei, Maui, Hawaii. Summary by Dr. Laura Kong.)

The Pacific Disaster Center, Hawaii (PDC) has deployed an Automated Tsunami Alert System that reliably provides Hawaii's emergency officials with critical tsunami travel-time information for tsunamis that may be generated when earthquakes of magnitude 7.5 or greater occur. The prototype was developed in partnership with state, federal, and local disaster management agencies, including the Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC), which operates the Hawaii Regional Tsunami Warning System for the State of Hawaii, the University of Hawaii, the Hawaii State Civil Defense Agency, and the four local county Civil Defense Agencies of Oahu, Maui, Kauai, and Hawaii. The system improves emergency officials' awareness of a potential tsunami in three ways: 1. automatically delivering the official PTWC tsunami bulletins via pager and cell phone to emergency managers; 2. automatically posting the official tsunami bulletins to PDC's operational-oriented web site; and 3. posting to the Internet tsunami travel times to Hawaii using a PDC modeling capability (Figure 1).

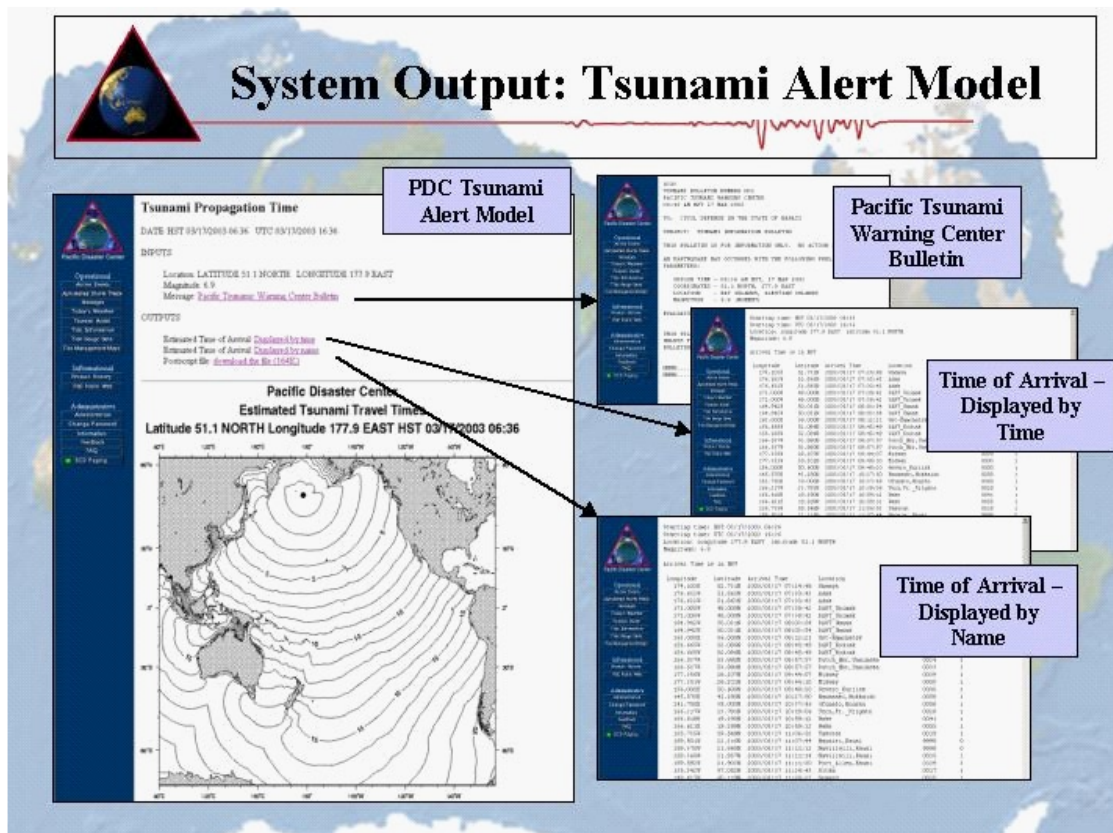


Figure 1. Tsunami Alert System requires as input tsunami bulletin information from PTWC and produces automated tsunami notification alerts to emergency managers' cell phones, pagers, and email, and outputs a model run to PDC's web site displaying estimated tsunami travel times (in hours) across the Pacific Ocean for emergency management purposes.

AUTOMATED TSUNAMI ALERT SYSTEM, *continued*

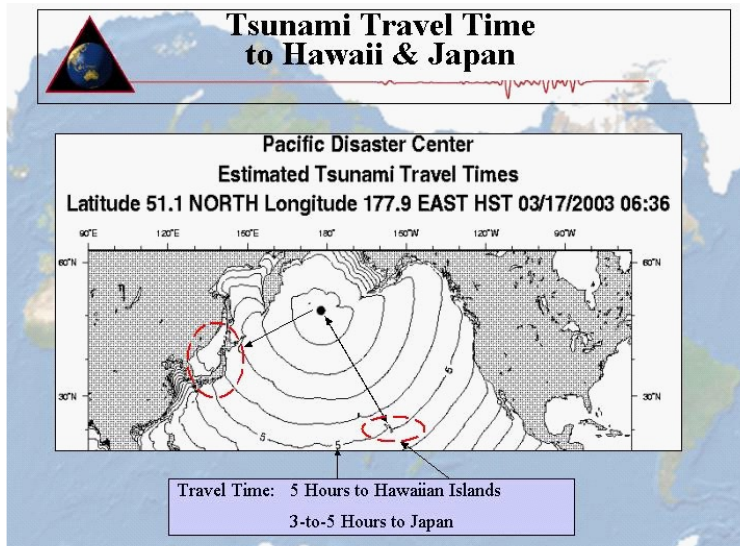


Figure 2. Tsunami Travel Time Model Result for recent March 17, 2003 Alaskan Rat Island earthquake, magnitude 6.9. Model estimates a tsunami travel time of five hours from earthquake to Hawaii and 3-5 hours to Japan. Contour interval = 1 hour.

The time a tsunami develops to the time it reaches Hawaii's shores ranges from a few minutes to more than 12 hours, depending on whether it is generated by an offshore landslide or an earthquake across the Pacific. For emergency managers, the *Automated Tsunami Alert System* provides rapid and uniform notification of tsunami advisory, watch, warning, and cancellation bulletins to more than 30 Hawaii State Civil Defense personnel and county emergency managers on a 24/7 basis anywhere within pager or cell phone range. This facilitates rapid emergency management decisions and actions for response purposes, thus providing officials with the maximum amount of preparation time. Following any alert from the *Automated Tsunami Alert System*, first responders communicate with Hawaii State and County Tsunami Science advisors and other responders to analyze the situation, and can go to PDC's web site to view automatic model runs estimating tsunami travel times to Hawaii (Figure 2).

Automated Tsunami Alert System

The *Automated Tsunami Alert System* has five subsystem modules, including:

1. **Data Capture and Processing Module:** The system is triggered by the receipt of a PTWC tsunami bulletin. The bulletin, containing earthquake source data, are received via electronic mail on a dedicated private communication network between the Pacific Tsunami Warning Center, Honolulu and PDC. Data are then automatically processed to read earthquake epicenter, location, and magnitude. In case of a potential tsunami situation (i.e., earthquake magnitude greater than 7.5, or 5.5 or greater for Hawaii earthquakes), the event information is analyzed and forwarded to other subsystems for automatic notifications and an automatic travel-time model run.
2. **Notification Module:** People are notified using electronic mail, pager, and cell phone. A standard email package running Simple Mail Transport Protocol (SMTP) is used to send alerts via emails, and a paging package uses a modem to transmit a message to the recipient's paging service using Telelocator Alphanumeric Protocol (TAP). The alert system also sends text messages to text-capable cellular phones and pagers. The pager message contains the earthquake origin time, epicenter, magnitude, and estimated arrival time to Hawaii.
3. **Database Module:** PDC maintains and manages a contact database of user accounts, including user name, cell phone number, pager phone, email address, and carrier's Short Message Service (SMS) gateway computer modem number.
4. **HTTP Server Module:** This Internet portal displays tsunami bulletins, warnings, watches, and travel time maps in hypertext format. The module provides a front-end interface for administering the user database and a simple web-to-pager program for sending critical alerts. Information on recent tsunami events of interest to researchers is also available. For emergency management situational awareness purposes, the PDC automatically indexes the twenty latest warning messages from various sources to the password-protected "EMOPS" (Emergency Operations) web page. Besides tsunami warning messages, the Twenty Latest Warning Messages includes cyclone warnings originated from the Joint Typhoon Warning Center, Pearl Harbor, Hawaii, USA and earthquake information originated from the National Earthquake Information Center, Golden, Colorado, USA.
5. **Tsunami Travel Time Model Module (TWATCH):** This module is automatically triggered by tsunami bulletins to generate a map depicting epicenter of the earthquake and the modeled graphical representation of travel times away from the source location if a tsunami had been generated. Model run results are posted to the PDC EMOPS website as a travel-time contour map for the Pacific Basin.

AUTOMATED TSUNAMI ALERT SYSTEM, *continued*

A tsunami alert generated from a Papua New Guinea magnitude 7.7 earthquake on Sunday, September 8, 2002 is a good example of the benefit of the *Automated Tsunami Alert System* to emergency managers. Although no tsunami reached Hawaii, behind the scenes, emergency officials were able to utilize information from the *Automated Tsunami Alert System*. On the morning of the quake, some emergency managers in Hawaii were notified of the tsunami potential from the distant earthquake within seconds of the tsunami bulletin being issued by the Pacific Tsunami Warning Center, Honolulu. Upon receiving the automatic alert, emergency officials began monitoring the situation that could have led to further response and actions, if required, to prepare for the possible event. The System has never been tested for locally generated earthquakes in the Hawaiian Islands, in part because no such events have occurred since the System's implementation.

Future Developments - Application for other Tsunami-prone Nations

PDC developed and deployed the *Automated Tsunami Alert System* in 1999 at the request of Hawaii State Civil Defense and the four county emergency services offices. Today, within the State, the alert system also broadcasts hurricane, weather, and earthquake bulletins from Federal warning centers to emergency staff pagers or cell phones operational in Hawaii. The alert system also provides a foundation for broadcasting additional hazard bulletins in the future, such as flash floods and volcano alerts. PDC is studying ways to enhance this automated alert capability to assist international inquiries interested in similar technology applications. To apply the *Automated Tsunami Alert System* outside of the Hawaii, the host country must address at least three critical issues. These three critical issues are data capture, system maintenance, and institutional capacity and coordination.

1. **Data Capture** - Data capture is a critical component in the alert system. Therefore, application outside of Hawaii requires more fact finding to define communications methods for receiving PTWC data at other agencies, as well as design of a mechanism to ingest this critical information into PDC's alert system.
2. **System Maintenance** – For any application outside of Hawaii, the host country must identify a responsible agency for maintenance and upgrade of the alert system. The host country must consider responsibilities for backup of its operating system, collection of tsunami data, and running of the modeling program, and database.
3. **Institutional Capacity and Coordination** - Any successful implementation of the *Automated Tsunami Alert System* in other tsunami-prone nations in the Pacific will require full partnership and coordination with all appropriate international, national, and local scientific and government agencies. These partners must address a host of implementation issues such as 1) availability of a host warning organization, 2) establishment of interagency coordination policies, procedures, and protocols, and 3) availability of necessary communications and Internet infrastructure.

For most Pacific nations and for the United States island jurisdictions of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, the PTWC will generate tsunami warnings when there are distant tsunamis that are potentially dangerous. The PTWC does not have responsibilities for local or regional tsunami warning. These warnings are the jurisdiction and responsibility of the various states, nations or island jurisdictions. Nations could use the *Automated Tsunami Alert System* for its national or local tsunami warning system, in which case the tsunami warnings would be generated by the nations themselves using their own data (e. g., seismic networks to locate and estimate the size of regional or local earthquakes, and their own threshold criteria for triggering a tsunami alert). For example, the American Samoa, Guam, and the Commonwealth of Northern Mariana Islands all have U.S. National Weather Service weather-related offices, which have telecommunications infrastructures for message and information dissemination.

Note: The Pacific Disaster Center's mission is to provide applied information research and analysis support for the development of more effective policies, institutions, programs and information products for the disaster management and humanitarian assistance communities of the Asia-Pacific region. Since 2002, the East-West Center has been the managing partner of the Pacific Disaster Center. The Pacific Disaster Center is a public-private partnership sponsored by the PDC Program Office (ASD/C3I). The content of the information does not necessarily reflect the position or policy of the U.S. Government and no official government endorsement should be inferred.

For other automated services available to emergency managers and the public, visit the PDC website at <http://www.pdc.org> or contact Jim Buika, Director; Customer Applications Support and Training, <1> 808-891-7913. For general information on this System, or other tsunami warning technologies, please contact Dr. Laura Kong, ITIC Director.

CONFERENCES

International Seminar/Workshop on Tsunami In Memory of the Krakatau Eruption-120 Years Ago *Tsunami and the lessons learned from large Tsunamis*

August 26 – 29, 2003, Jakarta and Anyer Indonesia

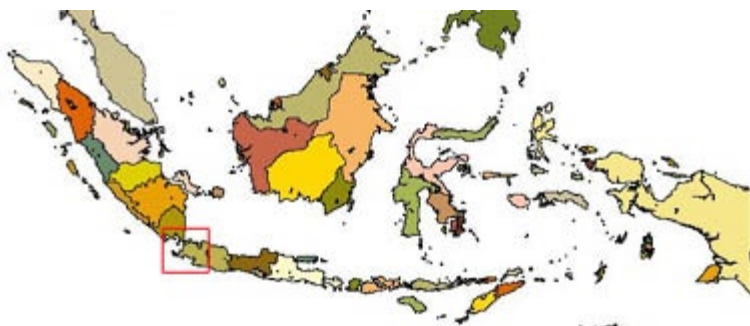
To remember the great eruption of Krakatau, 120 years ago, on August 27, 1883 and awaken the people around the tsunami- and earthquake- prone area to the potential tsunami hazard, Meteorological and Geophysical Agency (BMG) and Department of Marine Affairs and Fishery (DKP) of Indonesia are organizing a seminar and workshop in Indonesia. This occasion is in cooperation with ICG/ITSU, IUGG Tsunami Commission and several related governmental entities in Indonesia.



- Agenda:**
- August 26. Opening remarks and seminar; the policies of Indonesian government in regards to disaster management. (Jakarta)
 - August 27. General seminar. Discussion on the scientific value of research to the public and begin the workshop on tsunami early warning systems. (Anyer)
 - August 28. Lessons learned from large tsunami seminar; local case studies in earthquake and tsunami hazard reduction including a national workshop on monitoring, and early warning systems. (Anyer)
 - August 29. Tour to Krakatau complex; to inspect the current conditions surrounding the volcano.

Objectives

1. To strengthen links among key agencies who are responsible for the earthquake monitoring, tsunami and disaster management in their countries. (Seminar)
2. To share experiences and expertise on tsunami disasters. (Seminar)
3. To introduce to the Indonesian government the links between the scientific value of earthquake in general or tsunami in specific and national plan. (Workshop)
4. To evaluate the progress of the tsunami monitoring system in each countries. (Workshop)
5. To evaluate the knowledge of the people around the earthquake and tsunami prone area to the disaster. (Workshop)
6. To initiate the establishment of tsunami warning system in the Indian Ocean and southwest Pacific.



Important dates:

July 17th Third circular; announcement for acceptance, complete agenda, etc.

August 2nd Deadline for full paper submission.

Detailed information is available on the website:
<http://www.bmg.go.id/krakatau/>

Contacts:

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Email: gegar@lycos.com

CONFERENCES, *continued***ITSU-XIX**

The Nineteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-XIX) will be held in the Wellington Convention Center in Wellington, New Zealand on September 29 through October 3, 2003. This meeting is organised by the Intergovernmental Oceanographic Committee of UNESCO for the signatory countries involved in the Pacific Tsunami Warning System. The meeting includes reports by the Committee Chairman, the ITIC Director, and the PTWC Geophysicist-in-Charge. Other business includes evaluation of the program, proposals for future projects and applications of new technologies, completion of the budget for 2004-2005 and the election of new officers. Presentations will be made on the various training and educational products sponsored by ITSU. A summary report will be drawn up for adoption on the final day of the session. This is a closed session addressing the governance and operation of the Warning System, however, it is possible for observers to attend. This can be arranged through Sara Williams at MCDEM (E-mail: sara.Williams@dia.govt.nz). All inquiries regarding ITSU/XIX should be addressed to Mr. Peter Pissierssens, Head, Ocean Services (E-mail p.pissierssens@unesco.org)

More information about the session can be found at the ITSU website at <http://ioc.unesco.org/itsu>. ITSU-XIX will be followed by a IUGG/ITSU Workshop (see next page). More about New Zealand and making accommodations can be found on the Internet at <http://www.naturalhazards.net.nz/tsunami/wellyinfo.html>

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

Nineteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-XIX)
Wellington, New Zealand, 29 September – 3 October 2003

PROVISIONAL TIMETABLE

	Monday 29 September	Tuesday 30 September	Wednesday 1 October	Thursday 2 October	Friday 3 October
09:00- 10:30	09h30-11h30: Powhiri function	4.1 ITSU Training Programme	6.1 Far East Tsunami Warning System	8. Proposals for future projects	14. Adoption SR
10:30 – 11:00		coffee	Coffee	coffee	coffee
11:00 – 12:30	11h30-12h00: BREAK 12h00-14h30: 1. Opening 2. Organization of the Session 3.1 Report of the Chair 3.2 National Reports	4.2 Training Courses 4.3 Public Education 4.4 Other	6.2 IAS Tsunami Warning System 6.3 Other regions	9. Evaluation of the ITSU programme 10. Other business	14. Adoption SR
12:30 – 14:00		lunch	lunch	lunch	Lunch
14:00 – 15:30	3.3 ITIC Director's Report 3.4 PTWC Director's Report 3.5 Sea Level enhancements	5.1 Tsunami Newsletter 5.2 Tsunami Information Kit	7.1 Cooperation with IUGG 7.2 Cooperation with ISDR 7.3 WDC-A	11. Programme and Budget 2004-2005 12. Dates and Place for ITSU-XX	14. Adoption SR 15. Closure
15:30 – 16:00	coffee	coffee	coffee	coffee	Coffee
16:00 – 17:30	3.6 WG Signs & Symbols 3.7 Report HTDB/PAC 3.8 Recent technol.dev.	5.3 Tsunami Glossary 5.4 ITSU web sites	7.4 Cooperation with GLOSS 7.5 Other	13. Election of Chair and Vice-Chair	
17:30 – ...	RECEPTION	Sessional Working Groups	Sessional Working Groups		

CONFERENCES, *continued*

The International Workshop

"Tsunamis in the South Pacific--Research towards preparedness and mitigation"

25-27 September 2003

Wellington Convention Center, Wellington New Zealand

The workshop is planned as a two-day international conference for discussing a wide range of tsunami research related to understanding tsunami hazards, and developing tsunami warning and mitigation measures. The focus will be on aspects important for the Southwest and Central Pacific region, although other presentations are welcome. The Workshop will be followed on Saturday, September 27, 2003 by an optional one-day field trip to the nearby coast where a series of raised beaches attest to dramatic responses to past large earthquakes, the most recent being the tsunamigenic M8+ earthquake in 1855.

The objectives of the workshop are; 1) to present and review tsunami observations and preparedness in the Southwest and Central Pacific area; 2) to analyze the regional features of tsunami generation, propagation and impact from both local and remote sources; 3) to exchange national experiences on tsunami mitigation measures, and 4) to formulate recommendations on the actions required for tsunami disaster reduction.

Convened by:

Viacheslav Gusiakov (Russia)

François Schindelé (France)

Gaye Downes (New Zealand)

Roy Walters (New Zealand)

Local Contact:

Ms. Gaye Downes

Institute of Geological and Nuclear Sciences, Ltd.

PO BOX 30-368

Lower Hutt, New Zealand

Organized jointly by the IUGG Tsunami Commission (IUGG/TC) and the International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), in co-operation with the Institute of Geological & Nuclear Sciences and the National Institute of Water and Atmospheric Research (New Zealand), in Wellington, New Zealand and held in conjunction with ITSU-XIX.

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Workshop Website:

<http://www.naturalhazards.net.nz/tsunami/programme.html>

Located in Honolulu, the International Tsunami Information Center (ITIC) was established on November 12, 1965, by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In 1968, the IOC formed the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU).

The present 25 Member States are: Australia, Canada, Chile, China, Colombia, the Cook Islands, Costa Rica, the Democratic People's Republic of Korea, Ecuador, Fiji, France, Guatemala, Indonesia, Japan, Mexico, New Zealand, Nicaragua, Peru, Philippines, the Republic of Korea, Samoa, Singapore, Thailand, the Russian Federation, and the United States of America.

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