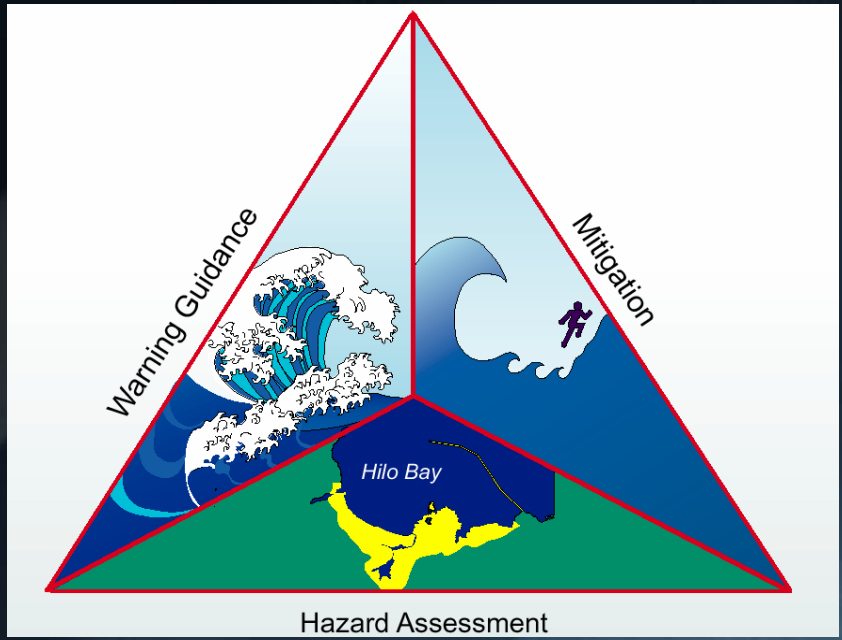
National Tsunami Hazard Mitigation Program



David Green
National Oceanographic and Atmospheric Administration,
Tsunami Program Manager

Sub-Committee for Disaster Reduction,
September 14, 2006, Washington D.C.

Outline

- Program Overview
- End-to-end System
- NTHMP Hazard Assessment
- Observations & Detection
- Communications
- Warnings to Forecasts
- Readiness to Resilience

NOAA Tsunami Program

Mission: Save Lives and Protect Property

Objective: *Establish durable end-to-end forecast, warning, and mitigation systems for tsunami and related coastal hazards*

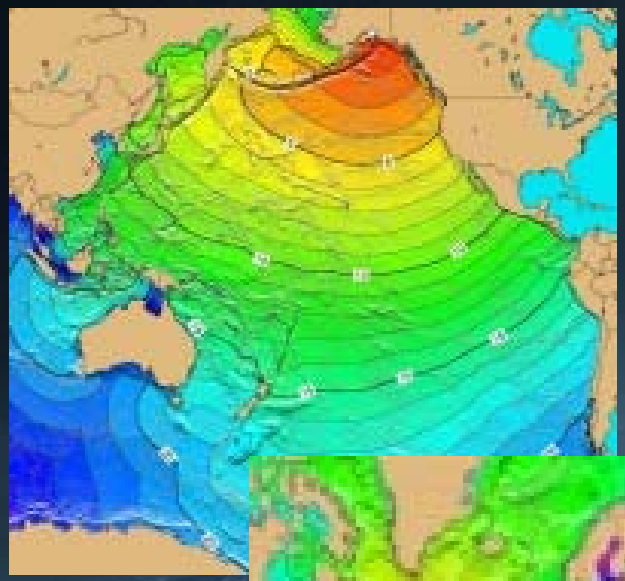
by strengthening

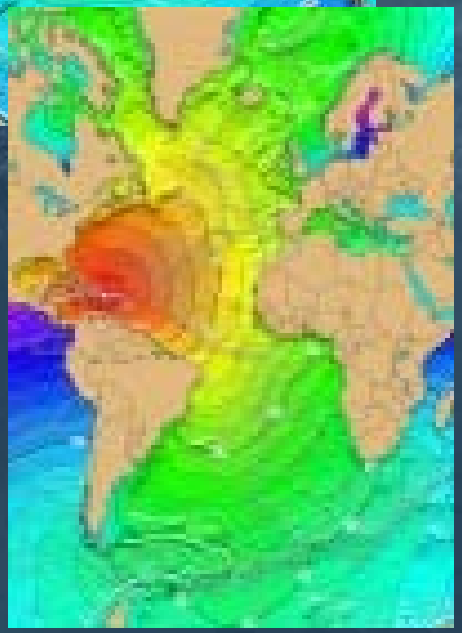
- ✓ **Hazard Assessment**
- ✓ **Warning Guidance**
- ✓ **Preparedness**
- ✓ **Mitigation**
- ✓ **Research**
- ✓ **International Coordination**

The Threat

- Tsunamis are infrequent high impact events that can cause a considerable number of fatalities, inflict major damage and cause significant economic loss to large sections of the U.S. coastlines.
  - Since the beginning of the 20th century, tsunami events have caused more than **800** deaths and over **$200** million dollars in damage to the U.S. coastal states and territories
  - Approximately 53% of the U.S. population now live in coastal communities and are at risk for impacts from a destructive tsunami

March 28, 1964 Prince William Sound, Alaska

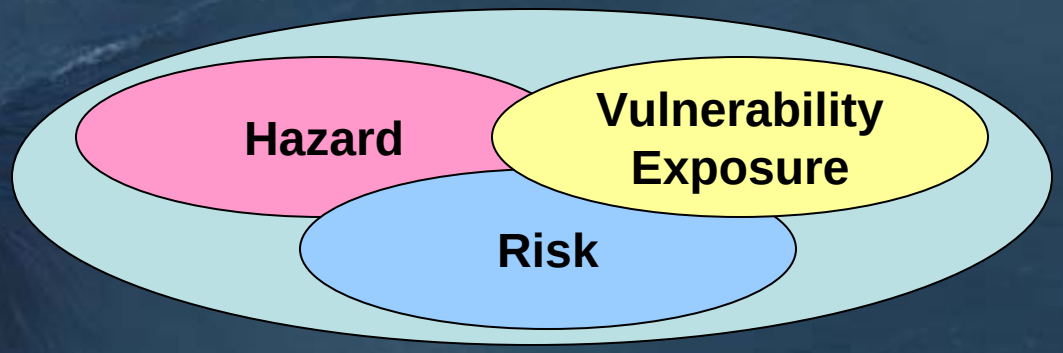




October 11, 1918 Puerto Rico

Integrated Risk

- **Hazard** - the probability of occurrence of a potentially damaging tsunami-related phenomenon including tsunami, earthquake, volcano, undersea landslide, or inundation within a specified period of time
- **Exposure -** the people, homes, commerce, industry, etc. that are in the tsunami inundation zones
- **Vulnerability** - the degree of loss resulting from the occurrence of the phenomenon
- **Risk** derived from hazard, exposure and vulnerability to estimate expected number of casualties, direct economic losses and indirect economic losses due to business interruption from tsunamis



Partners in Risk Reduction

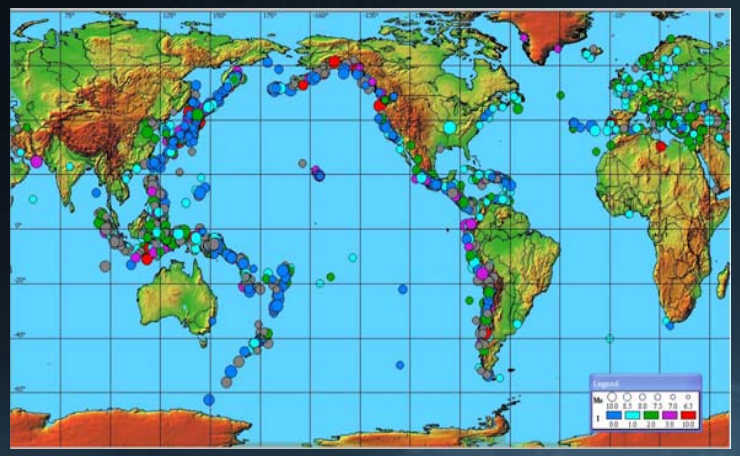
- NOAA is the lead agency for providing tsunami forecasts and warnings and coordinating the National Tsunami Hazard Mitigation Program (NTHMP) with USGS, FEMA, and NSF
  - but many other federal, state, and local agencies have important roles in preparedness, response and recovery.

How Agencies Contribute

- NOAA
  - NWS – warnings, DART, TsunamiReady
  - NOS – bathy/topo, ocean explor., sea level, coastal service and community resilience,
  - NESDIS – hazard assessment, data and grids/DEMs
  - OAR/PMEL – research, modeling and mapping
- USGS
  - sources, hazard assessment, bathy/topo
- FEMA
  - exposure, vulnerability, bathy, loss estimation models
- NSF
  - hazard assessment, socio-economic, modeling, generation
- NIST
  - building standards
- NASA
  - GPS,…

Strategies

- **Support a Global Framework**
  - *Global Earth Observing System of Systems* (GEOSS)
    - UNESCO Intergovernmental Oceanographic Commission (IOC)
    - World Meteorological Organization (WMO)
    - International Strategy for Disaster Reduction (ISDR)



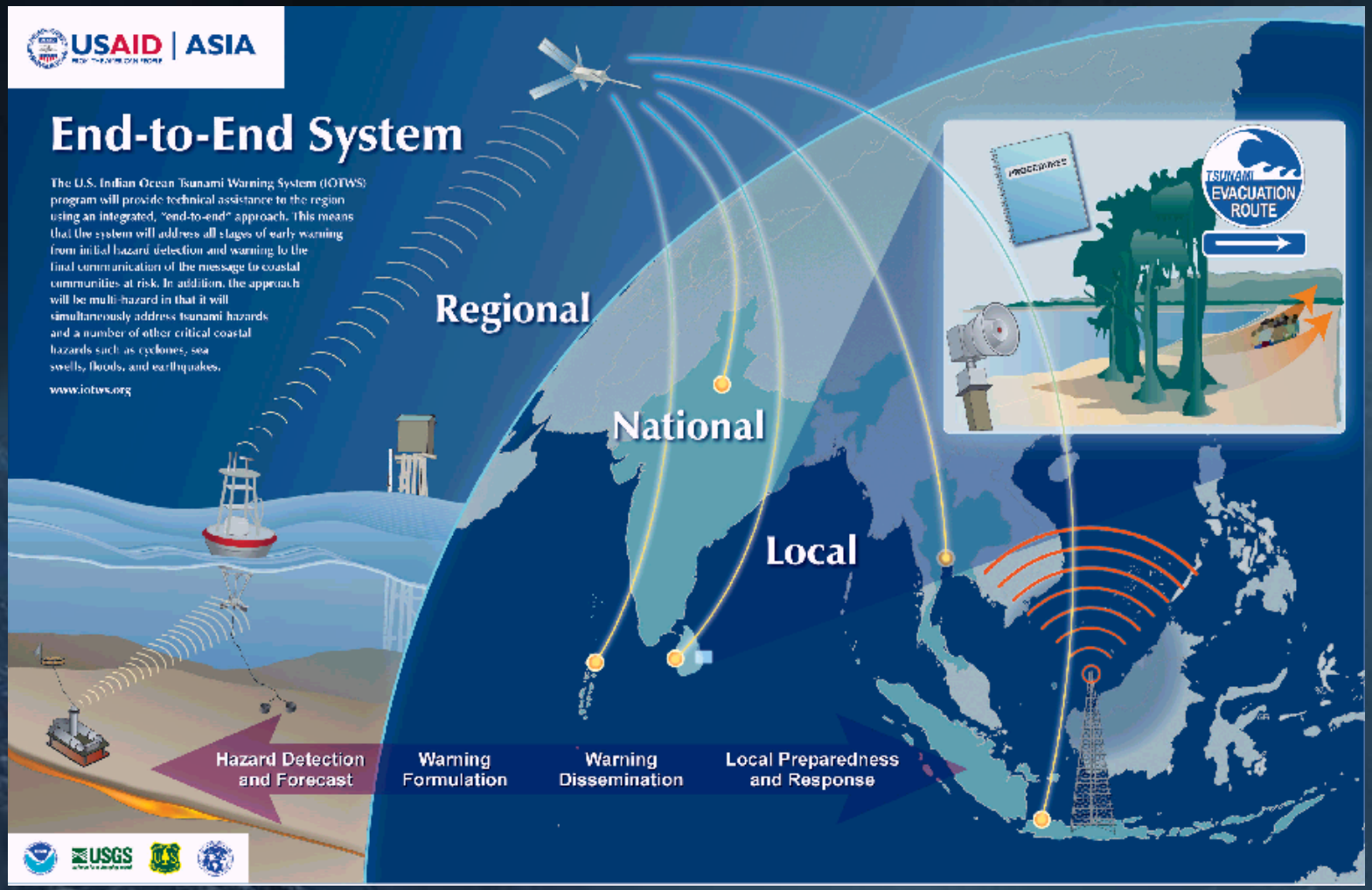
Tsunami Sources in the world
(2180 events from 1628BC to 2005)

- **Work at Regional, National and Local levels**

- **Develop Capacity and Sustainability**

End-to-end System

Linking Hazard monitoring, Observations, Data, and Analysis to Early Warnings and Mitigation



Coastal Community Resiliency

- Unique partnership for the Core Team
  - US Federal Govt. (NOAA OAR and Pacific Services Center)
  - Academia (University of Rhode Island – Coastal Resources Center)
  - International NGO (Asian Disaster Preparedness Center)
  - Private Sector (Tetra Tech, Inc.)

- Working with numerous International agencies, organizations and NGOs to develop a sustainable program to promote Coastal Community Resiliency

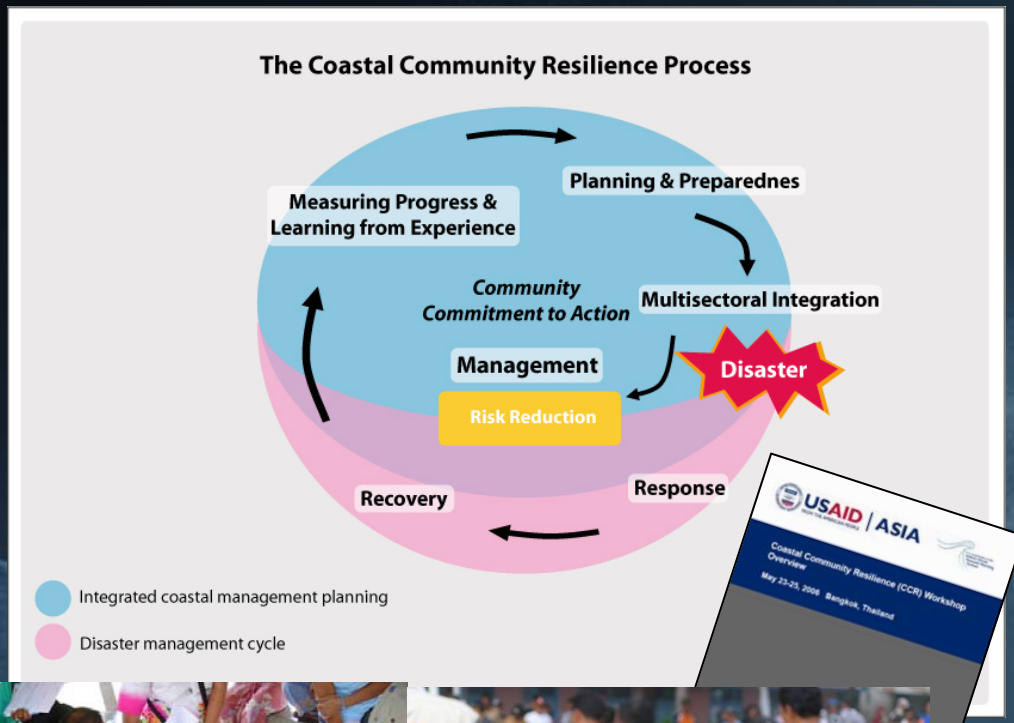
NOAA Pacific Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

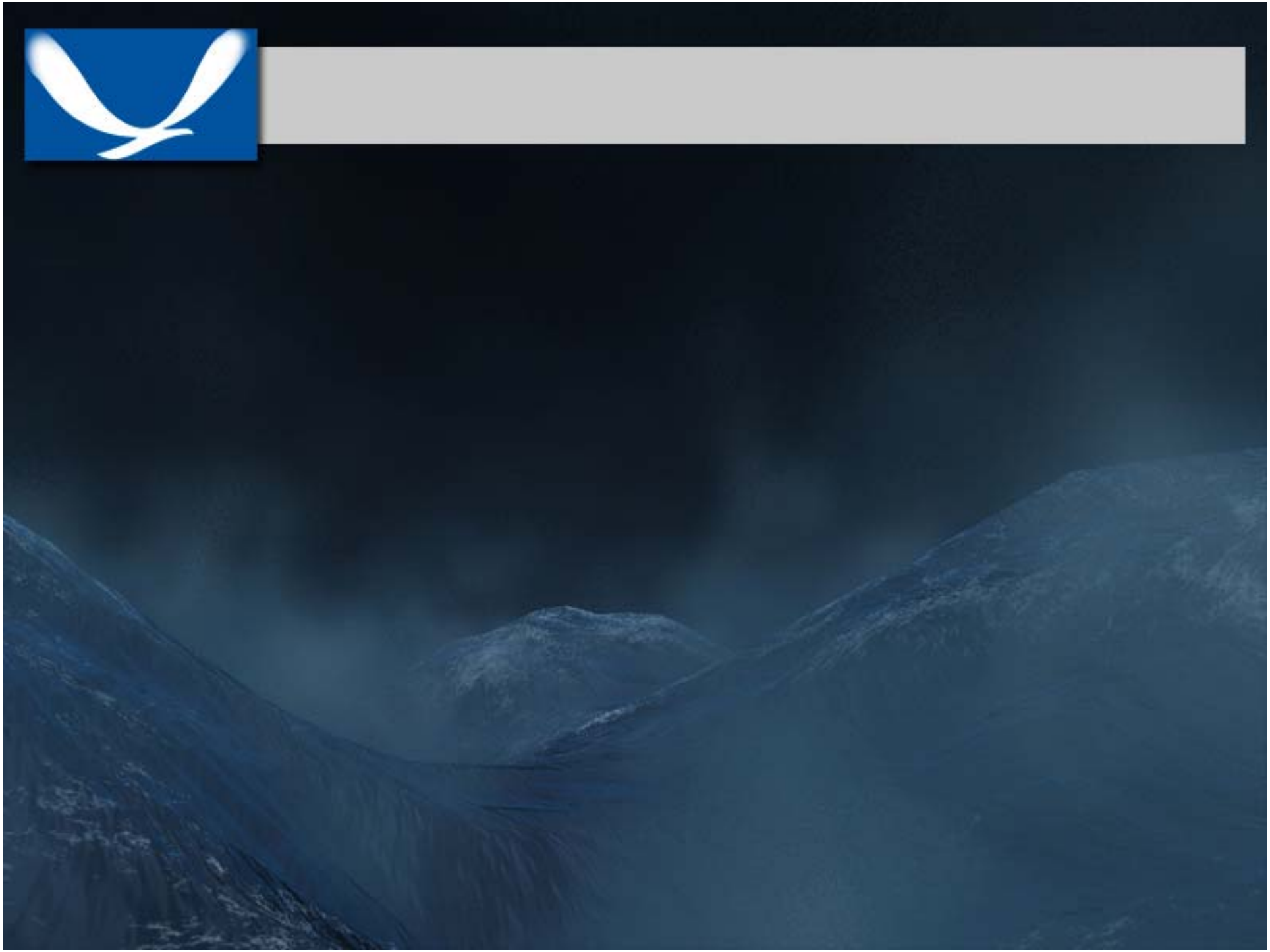
U.S. Contribution to the Indian Ocean Tsunami Warning System

USAID | ASIA
FROM THE AMERICAN PEOPLE

CCR Framework Foundation

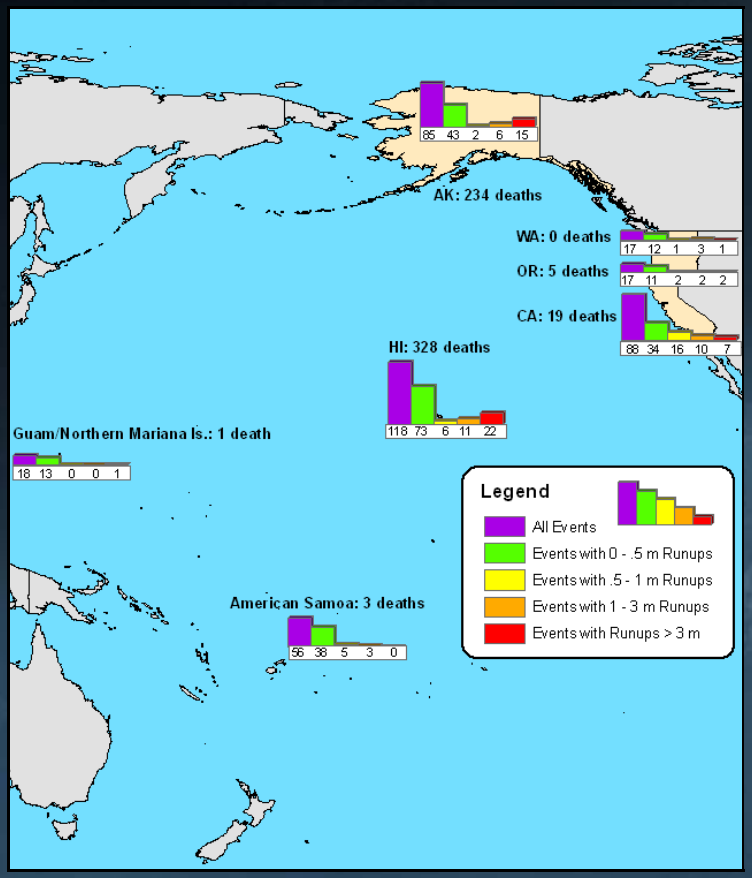
Resilient coastal communities" understand coastal hazards, take deliberate and coordinated actions to reduce vulnerability, and have appropriate and practiced contingency plans to respond to disaster events.





Hazard Assessment

NGDC Based Tsunami Qualitative Tsunami Hazard Assessments		
Region	**Hazard based on runups**	**Hazard based on deaths & damage**
Atlantic Coast	Very low to low	None to very low
Gulf Coast	None to very low	None to very low
Caribbean	High	Very high or severe
West Coast	High	High
Alaska	Very high or severe	Very high or severe
Hawaii	Very high or severe	Very high or severe
Western Pacific	Moderate	Low to moderate



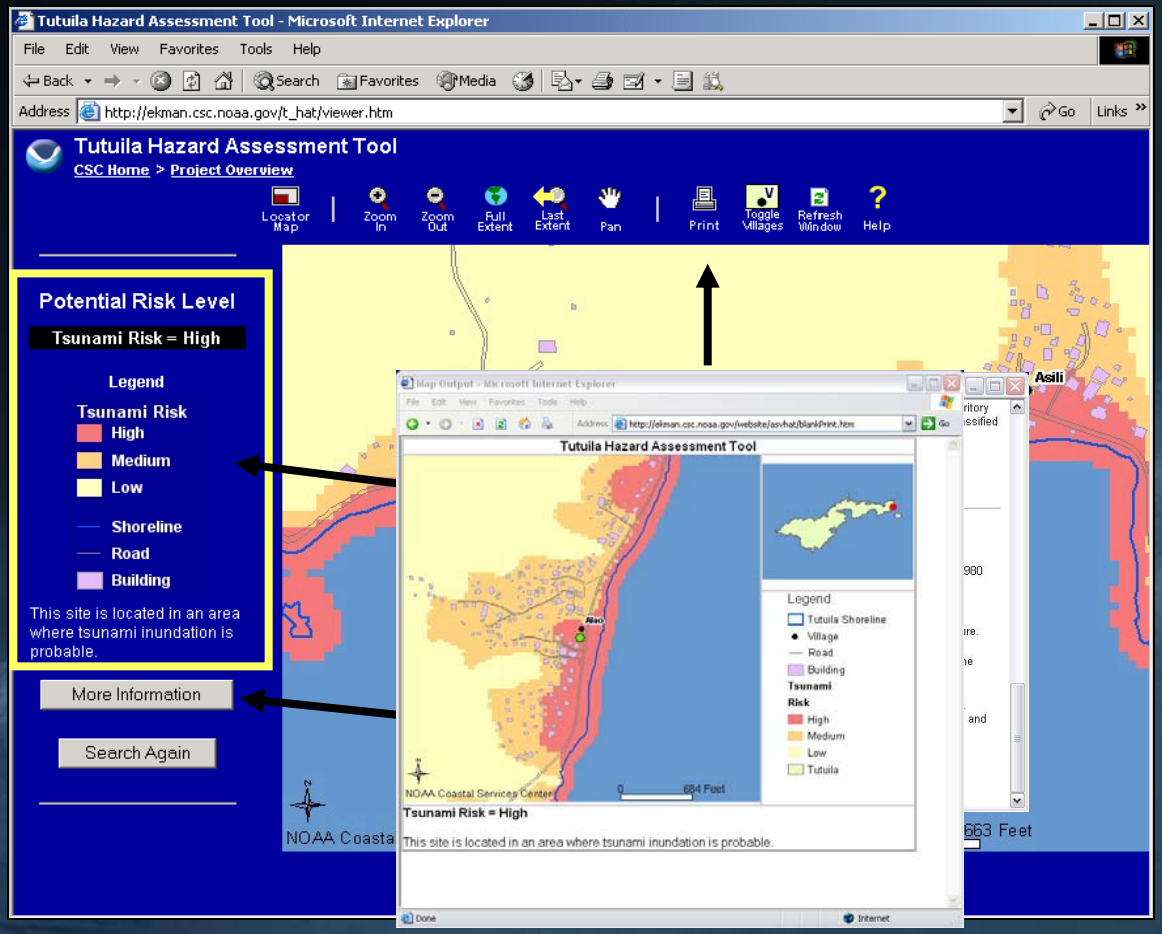
Map showing total number of tsunami events, and total number of events causing runup heights from 0m to greater than 3 m for states and territories in the Pacific Ocean.

Awareness and Assessment Tools

- NOAA/CSC and PSC are developing a manual/guidebook for developing Hazard Awareness and Assessment Tools – ArcIMS template or Open Source version

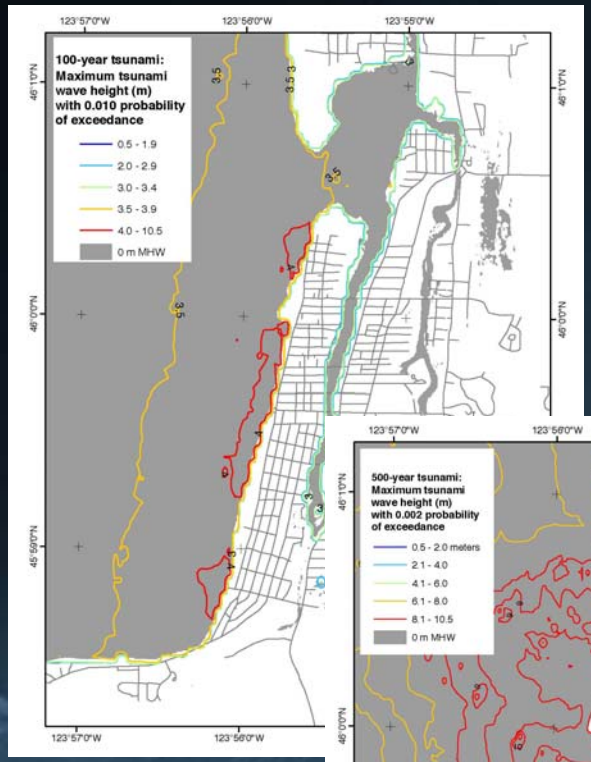
- Working with FEMA to promote the use of similar tools to all communities throughout the US

- Working with USAID, United Nations International Strategy for Disaster Reduction, and others to promote the use of similar tools throughout the world

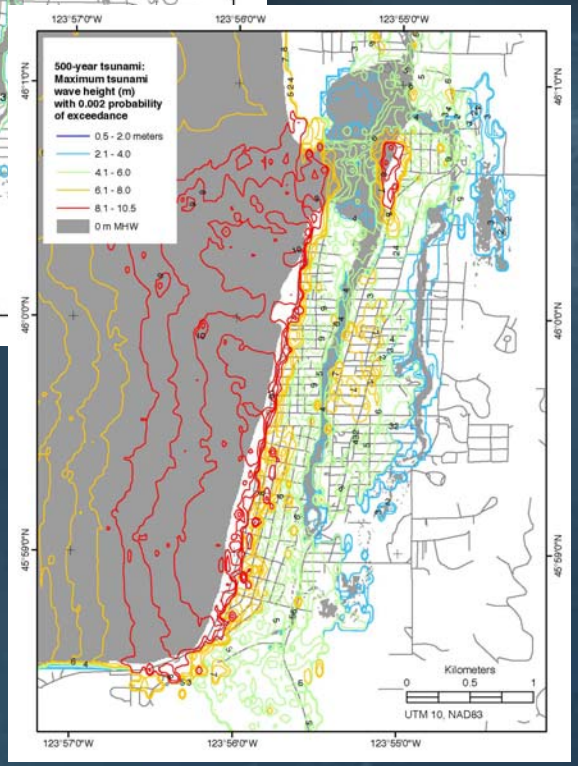


Hazard Maps

- **Probabilistic Tsunami Hazard Assessment—**
  - ***Seaside, Oregon Tsunami Pilot Study—Modernization of FEMA Flood Hazard Maps***



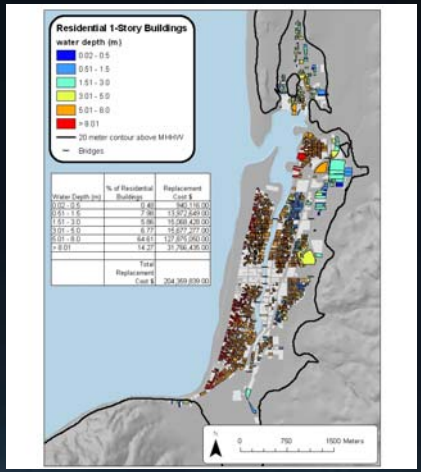
100-year tsunami map



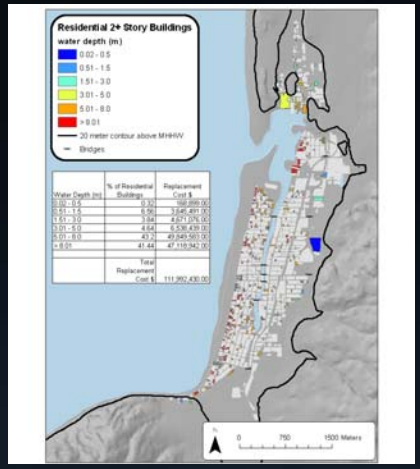
500-year tsunami map

FEMA, USGS, and NOAA, in collaboration with the University of Southern California, Middle East Technical University, Portland State University, Horning Geoscience, Northwest Hydraulics Consultants the Oregon Department of Geological and Mineral Industries

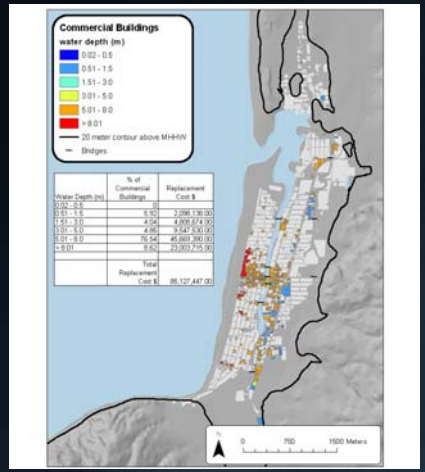
Vulnerability Maps



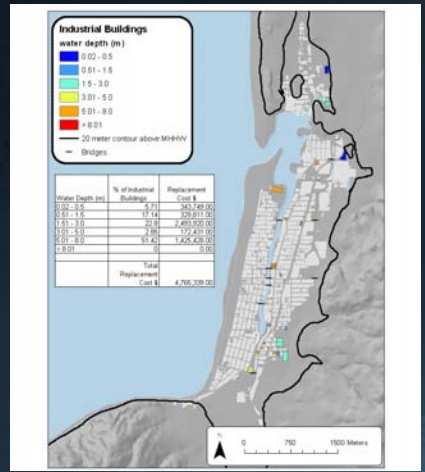
1-story **Residential** buildings in the tsunami inundation zone



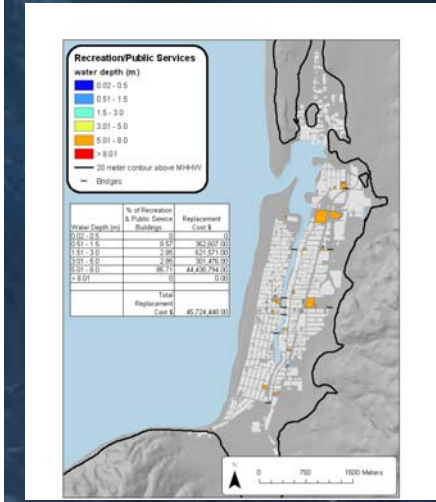
2-story **Residential** buildings in the tsunami inundation zone



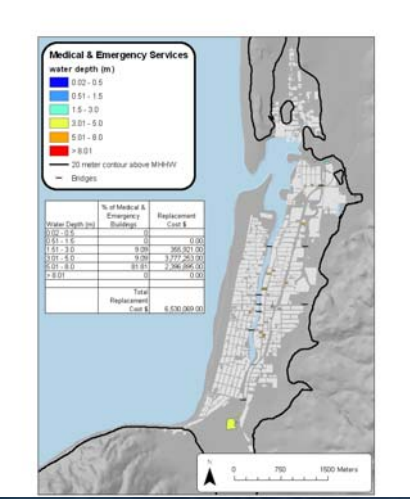
Commercial buildings tsunami inundation zone



Industrial buildings in the tsunami inundation zone



Recreational and public service buildings in the tsunami inundation zone



Medical and emergency services buildings in the tsunami inundation zone

- ***Vulnerability or degree of loss resulting from the occurrence of tsunamis due to exposure and fragility***
  - ***Seaside, Oregon Tsunami Pilot Study—Modernization of FEMA Flood Hazard Maps***

Data provided with FEMA's HAZUS loss estimation software and Clatsop County, Oregon, tax assessment data were used as input to the model.

Assessment – Key Elements

- **Collection, analysis and quality assurance** of all data related to U.S. tsunami events
- **Assessment of frequency, severity and uncertainty** of tsunami sources
- **Acquisition, quality assurance**, and archive of bathymetric and near-shore topographic data
- Development of **tsunami inundation forecast tools**
- **Inundation mapping and modeling** of all U.S. coastal areas

GAO Report

- Government Accountability Office (June 5, 2006) "**U.S. Tsunami Preparedness: Federal and State Partners Collaborate to Reduce Potential Impacts, But Challenges Remain**."

  http://www.gao.gov/new.items/d06519.pdf

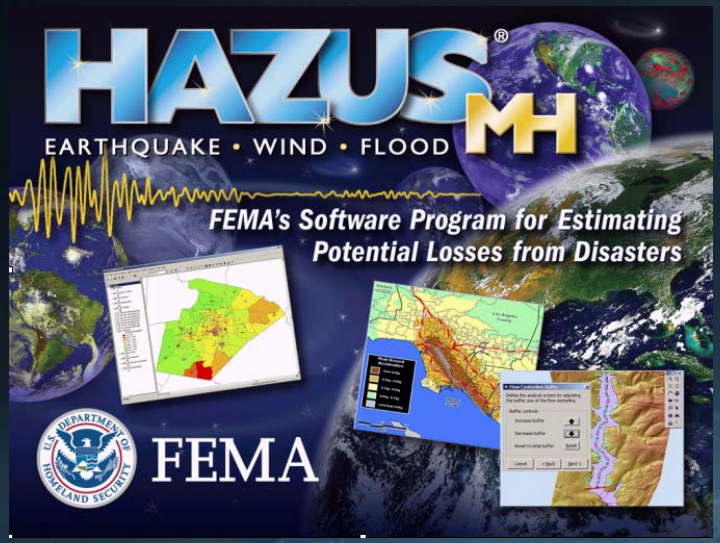
  – *While the National Oceanic and Atmospheric Administration (NOAA) has the technology to detect the formation of a tsunami and issue warnings fairly quickly, the states lack comprehensive information regarding potential human, structural, and economic impacts that could result from a tsunami wave.*

Hazard Loss Estimation

- Risk assessment, planning and analysis tool to
  - **Identify** and characterize hazards,
  - **Inventory** assets and evaluate vulnerable areas
  - **Assess** readiness and preparedness
  - **Estimate** exposure and losses from specific events
  - **Organize** resource allocations
  - **Plan** mitigation options
  - **Estimate** recovery

Hazard Loss Estimation

- HAZUS*
  - Analysis tool for estimating direct and induced damage, and direct and indirect losses
  - Implemented through
    - GIS Technology
    - Nationwide databases
    - Standardized methodologies



* Developed under contract with National Institute of Building Sciences

For more information http://www.fema.gov/plan/prevent/hazus

GAO Report

- For many parts of coastal Alaska, California, Hawaii, Oregon and Washington - as well as Puerto Rico and the U.S. Virgin Islands - ***reliable assessments of potential tsunami impacts have not yet been completed.***
- ***Limited progress on the creation of inundation maps that show the extent of coastal flooding for these regions,***
- ***Lack of standardized computer software for estimating the likely human, structural, and economic damages from tsunamis***

GAO Recommendations

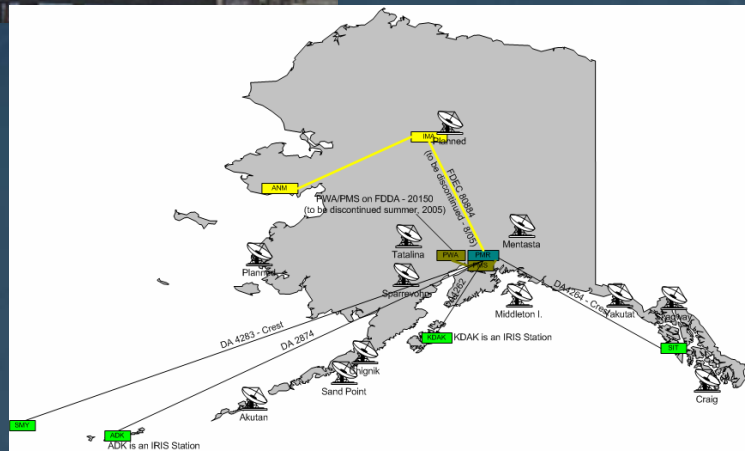
- ***Loss Estimation:*** *Create standardized tsunami loss estimation software – NOAA, FEMA and USGS*
- ***Outreach and Education:*** *Raise public awareness, through school and community programs, of how to respond to* ***tsunami*** *warnings – Federal, State and Local governments and others*
- ***Evacuation Plans:*** *Improve evacuation routes – Local Governments*
- ***Communications:*** *Build emergency communications infrastructure that would be protected from potential* ***tsunami*** *damage. – Local Government*
- ***Strategic Plans:*** *Create a long-range strategic plan and define specific performance measures so that the success of the National* ***Tsunami*** *Hazard Mitigation Program (NTHMP) can be assessed - NOAA*

Observation and Detection

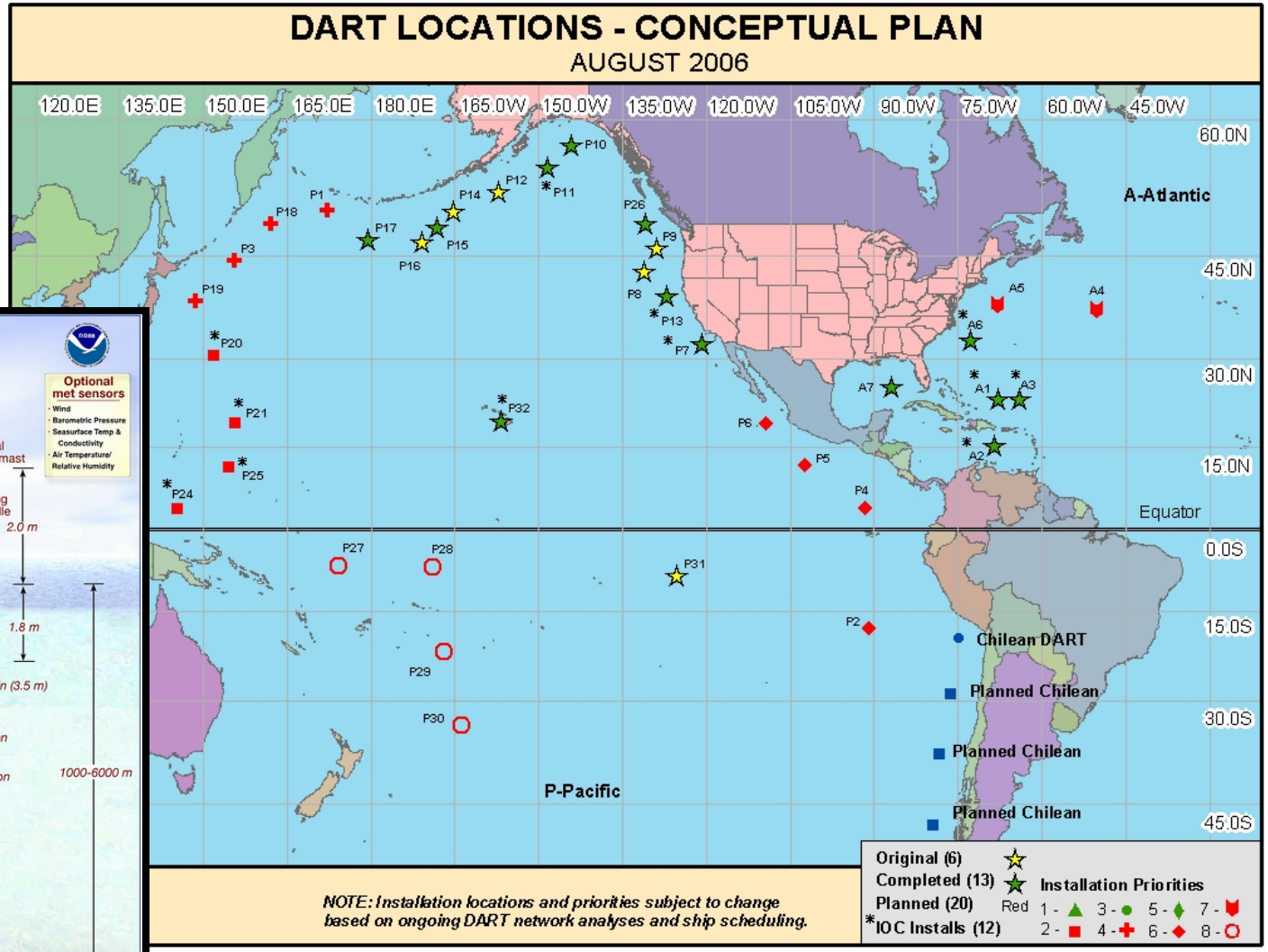
- **DART Stations**
- DART = *Deep Ocean Assessment and Reporting of Tsunamis*
  - 32 Pacific and 7 Atlantic/Caribbean

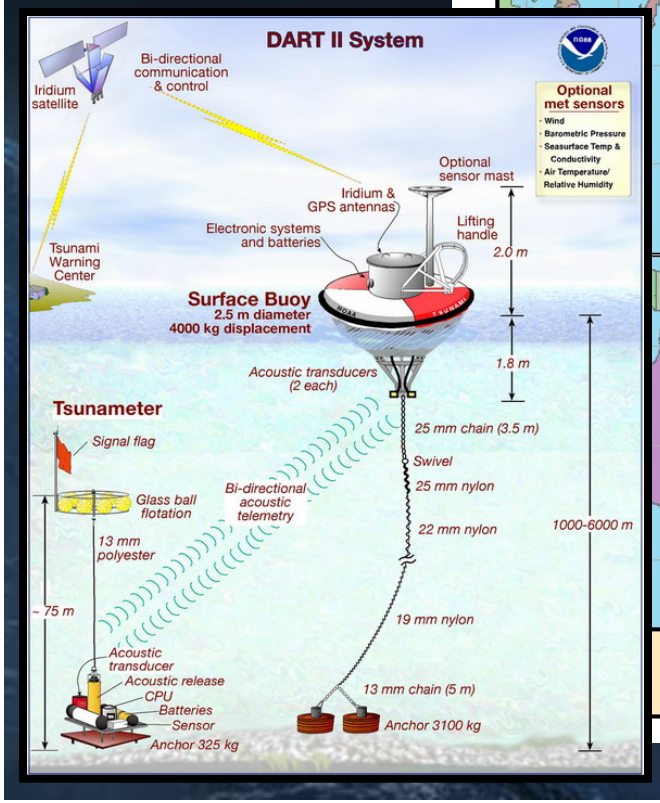
- **Sea Level Stations**
  - Upgrade 33 Pacific Data Collection Platforms to real time
  - Install 16 new stations

- **Seismic Network**
  - Expand and upgrade seismic network in HI
  - USGS expanding 9 stations Caribbean



Deep Ocean

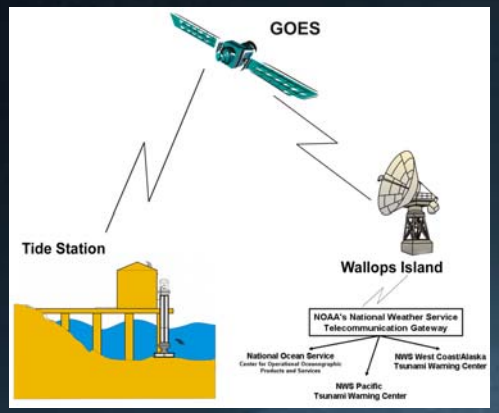

DART LOCATIONS - CONCEPTUAL PLAN
AUGUST 2006
120.0E
135.0E
150.0E
165.0E
180.0E
165.0W
150.0W
135.0W
120.0W
105.0W
90.0W
75.0W
60.0W
45.0W
60.0N
45.0N
30.0N
15.0N
Equator
0.0S
15.0S
30.0S
45.0S
A-Atlantic
P-Pacific
Chilean DART
Planned Chilean
Planned Chilean
Planned Chilean
Original (6)
Completed (13)
Planned (20)
*IOC Installs (12)
Installation Priorities
Red
1 -
2 -
3 -
4 -
5 -
6 -
7 -
8 -
NOTE: Installation locations and priorities subject to change based on ongoing DART network analyses and ship scheduling.

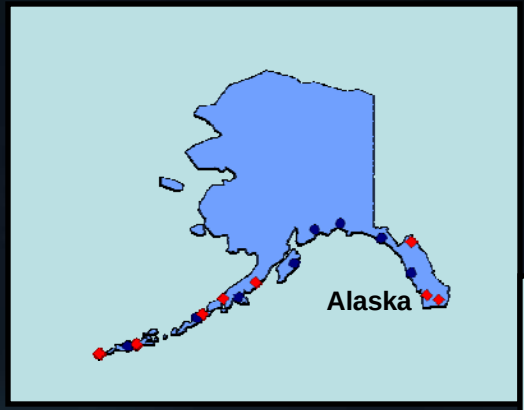

DART II System
Iridium satellite
Bi-directional communication & control
Optional met sensors
Wind
Barometric Pressure
Seasurface Temp & Conductivity
Air Temperature/ Relative Humidity
Optional sensor mast
Iridium & GPS antennas
Electronic systems and batteries
Lifting handle
2.0 m
Tsunami Warning Center
Surface Buoy
2.5 m diameter
4000 kg displacement
1.8 m
Acoustic transducers (2 each)
Tsunameter
Signal flag
25 mm chain (3.5 m)
Swivel
25 mm nylon
Glass ball flotation
Bi-directional acoustic telemetry
22 mm nylon
1000-6000 m
13 mm polyester
~ 75 m
19 mm nylon
Acoustic transducer
Acoustic release
CPU
Batteries
Sensor
Anchor 325 kg
13 mm chain (5 m)
Anchor 3100 kg

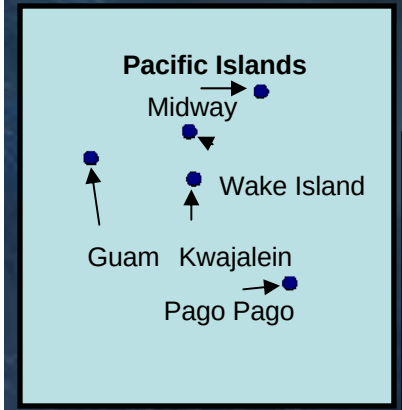
Near Shore

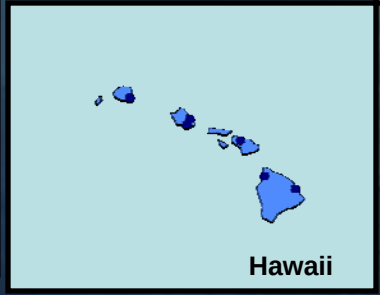
Sea Level Stations

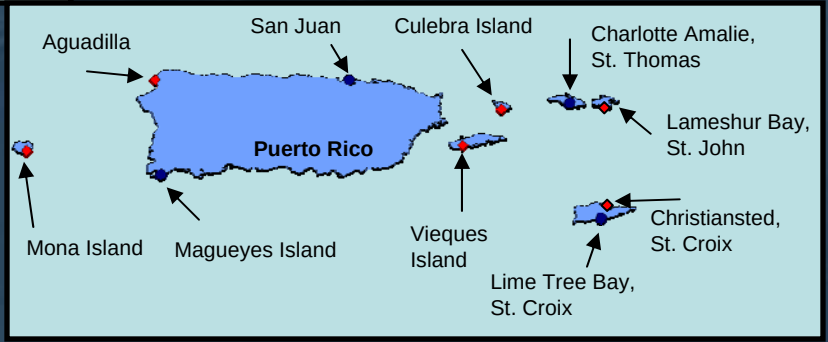
- Current Tsunami Tide Stations
- Expanded Tsunami Tide Stations



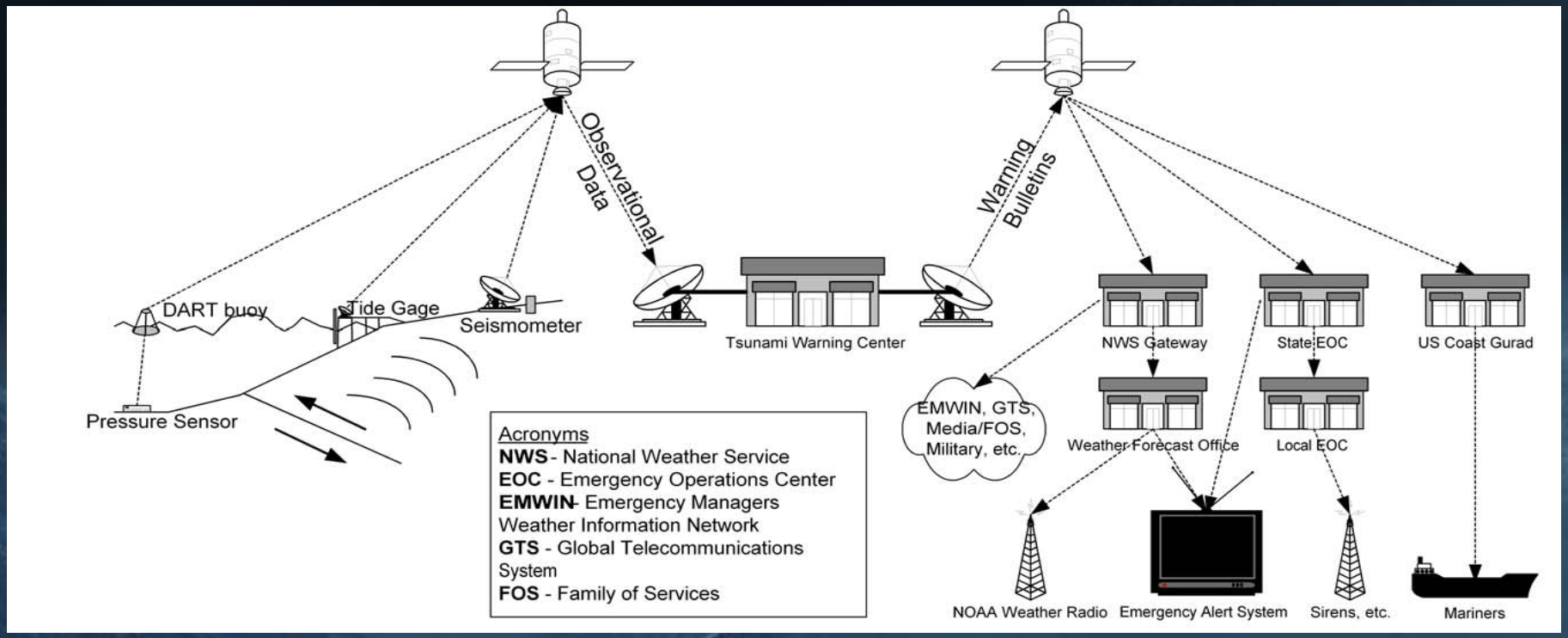








Communications



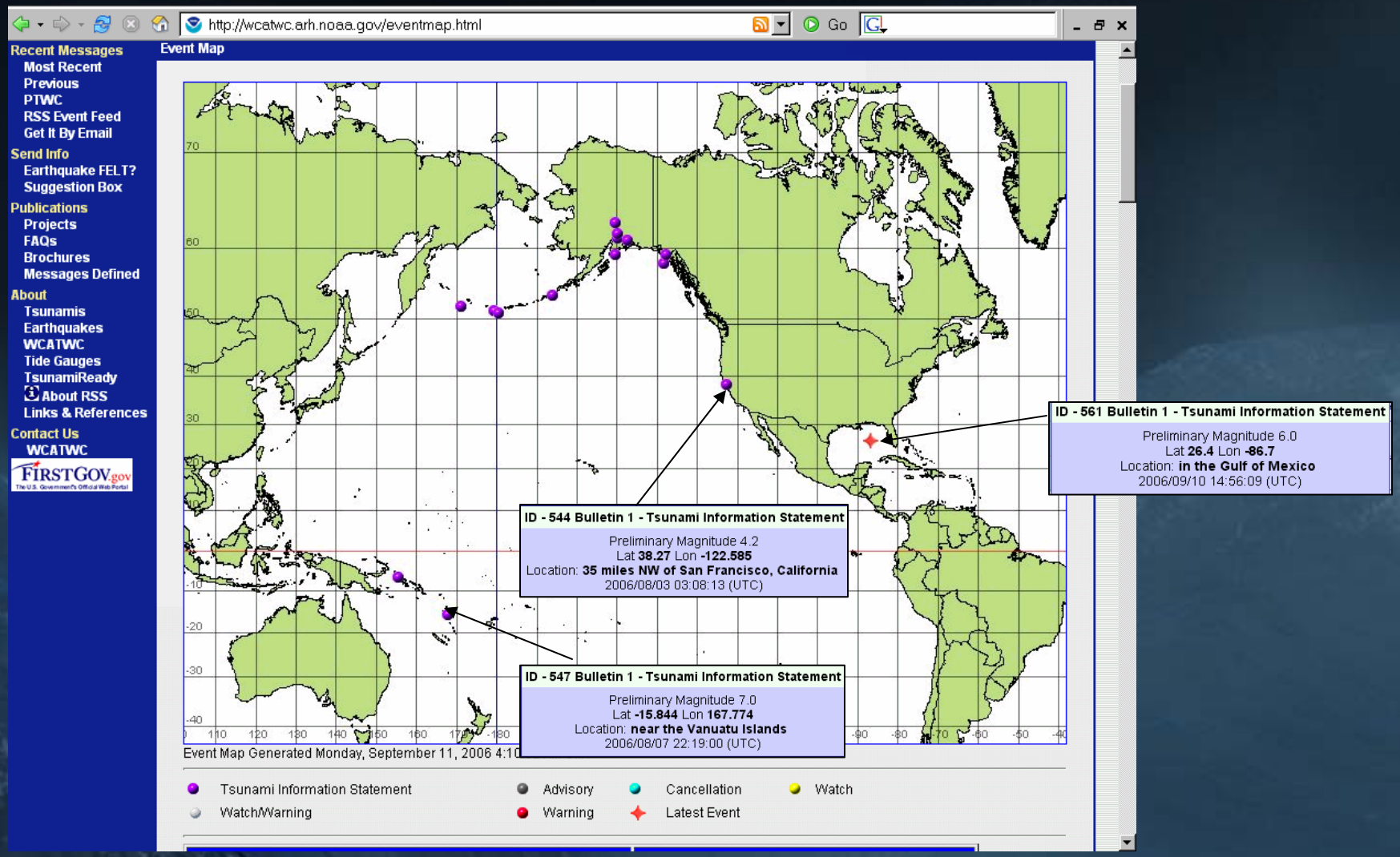
Warning Guidance

Tsunami Warning Center Operations

- Expanded to 24x7 staffing and broader areas of responsibility
- WC/ATWC = **West Coast / Alaska Tsunami Warning Center** serving continental US, Canada, PR and USVI
- PTWC = **Pacific Tsunami Warning Center** serving HI and all Pacific and Caribbean basin, and interim to Indian Ocean

- **Warning**
  - **The highest level of tsunami alert.**
- **Watch**
- **Advisory**
- **Information Bulletin**
- **Information Message**

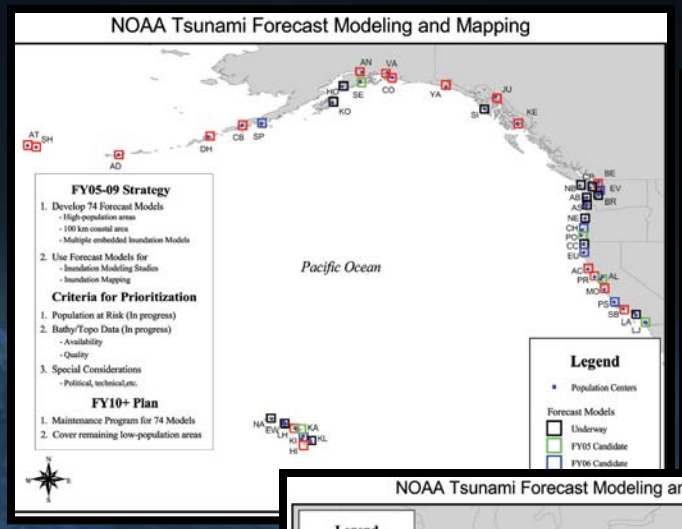
Warning Guidance

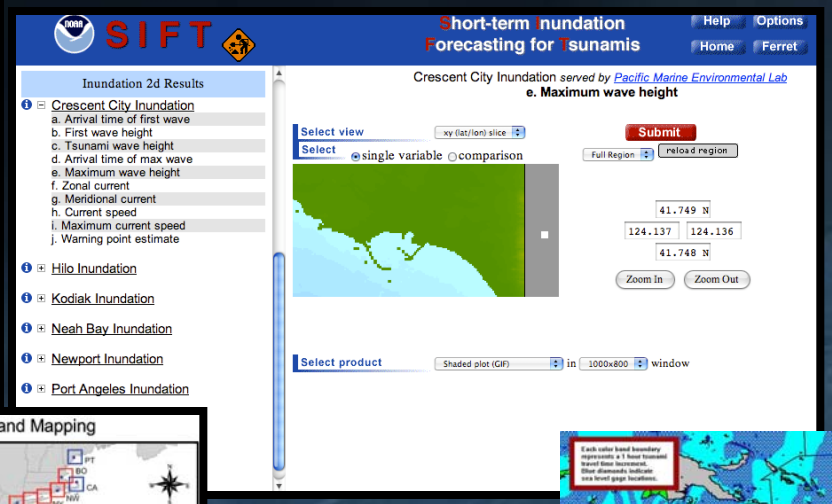


From Warnings to Forecasts

Dynamic 4D Inundation Models and Maps

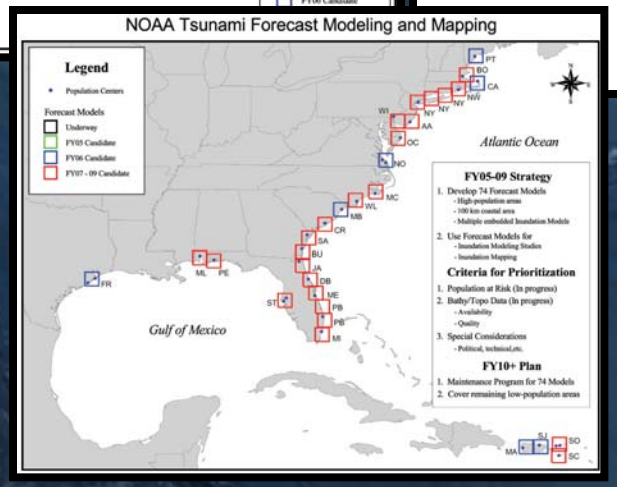
- site-specific forecasts simulate tsunami generation, propagation and inundation impact for at risk communities



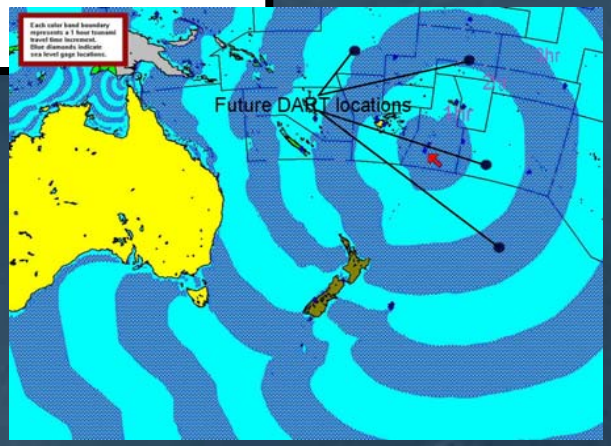


SIFT

(Short-term Inundation Forecasting for Tsunamis)

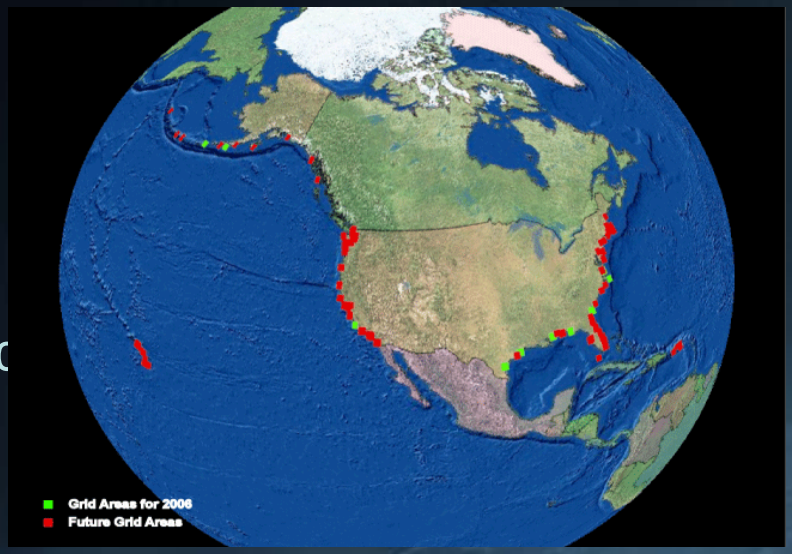


Graphical Products

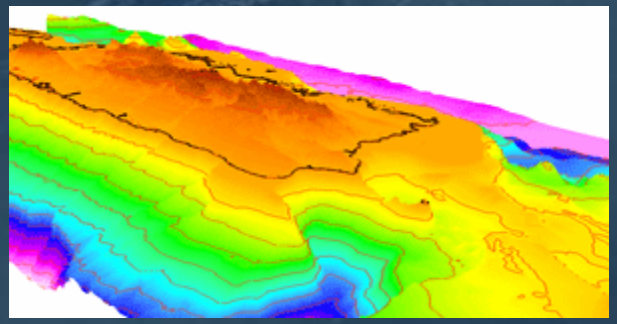


Inundation Grids

- **<u>High resolution digital elevation models</u>** (DEMs)
  - Combined bathymetric-topographic data*, DEMs are part of the tsunami forecast system SIFT
  - Used by NOAA with the Method of Splitting Tsunami (MOST) model to simulate tsunami generation, propagation, and inundation.



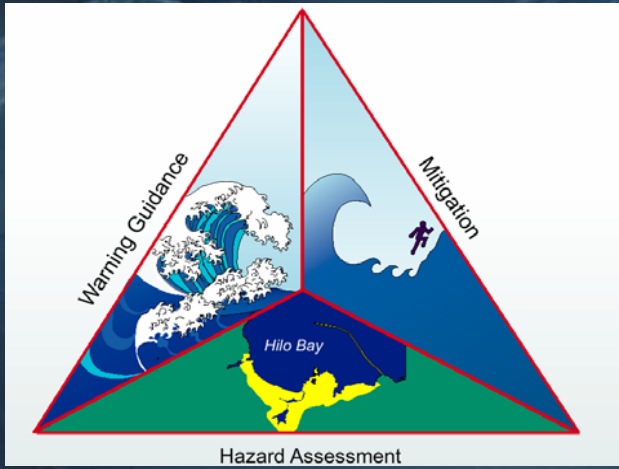
http://www.ngdc.noaa.gov/mgg/inundation/



* NOAA, USGS, USACE, FEMA, and other federal, state, and local government agencies, academic institutions, and private companies.

Mitigation

- National Tsunami Hazard Mitigation Program (NTHMP)
  - NOAA, USGS, NSF, FEMA
  - 28 States, Commonwealths, & Territories
    - Mapping and evacuation planning
    - Outreach and education



23 Ocean/Gulf States, 5 Commonwealths & Territories

Atlantic Ocean states(14)
Maine
New Hampshire
Massachusetts
Rhode Island
Connecticut
New Jersey
New York
Delaware
Maryland
Virginia
North Carolina
South Carolina
Georgia
Florida

Pacific Ocean states (5):
California
Oregon
Washington
Alaska
Hawaii

Gulf of Mexico states (5):
Florida
Alabama
Mississippi
Louisiana
Texas

Commonwealths (2)
Puerto Rico
Northern Mariana Islands

Territories (3)
US Virgin Islands
American Samoa
Guam

NTHMP Status

- Through FY06 NTHMP-funded members (OR, WA, CA, HI, AK, PR, and USVI) are completing the following tasks (varies by state):
  - Maintaining Tsunami Evacuation signs
  - Working to resolve issues from the June 14, 2005 tsunami warning
  - Conducting tsunami workshops
  - Participated in *Pacific Peril 2006*
  - Continued development of educational material to convey tsunami issues to businesses, schools and residents
  - Develop tsunami inundation and evacuation models

NTHMP Mitigation Plans

- **Promote tsunami resilient communities**
  - Development of model mitigation measures and encourage communities to adopt construction, critical facilities relocation or protection, evacuation guidance, and land-use planning practices to reduce the impact of future tsunamis
- **Increase outreach to all tsunami communities**
  - Include all demographics of the at-risk population, to raise awareness, improve community preparedness, and encourage the development of tsunami response plans

Extending HAZUS

- **Development of a Tsunami Risk Assessment Model within HAZUS**
  - Utilize existing flood grid analysis and earthquake source modeling capabilities, and an inventory system for importing and managing national data on demographics and the numbers, types and locations of buildings, and essential facilities
  - Evaluate tsunami impact using either the NOAA models, e.g. MOST (Model of Splitting Tsunami), other numerical models, or existing tsunami hazard and risk maps that have been produced

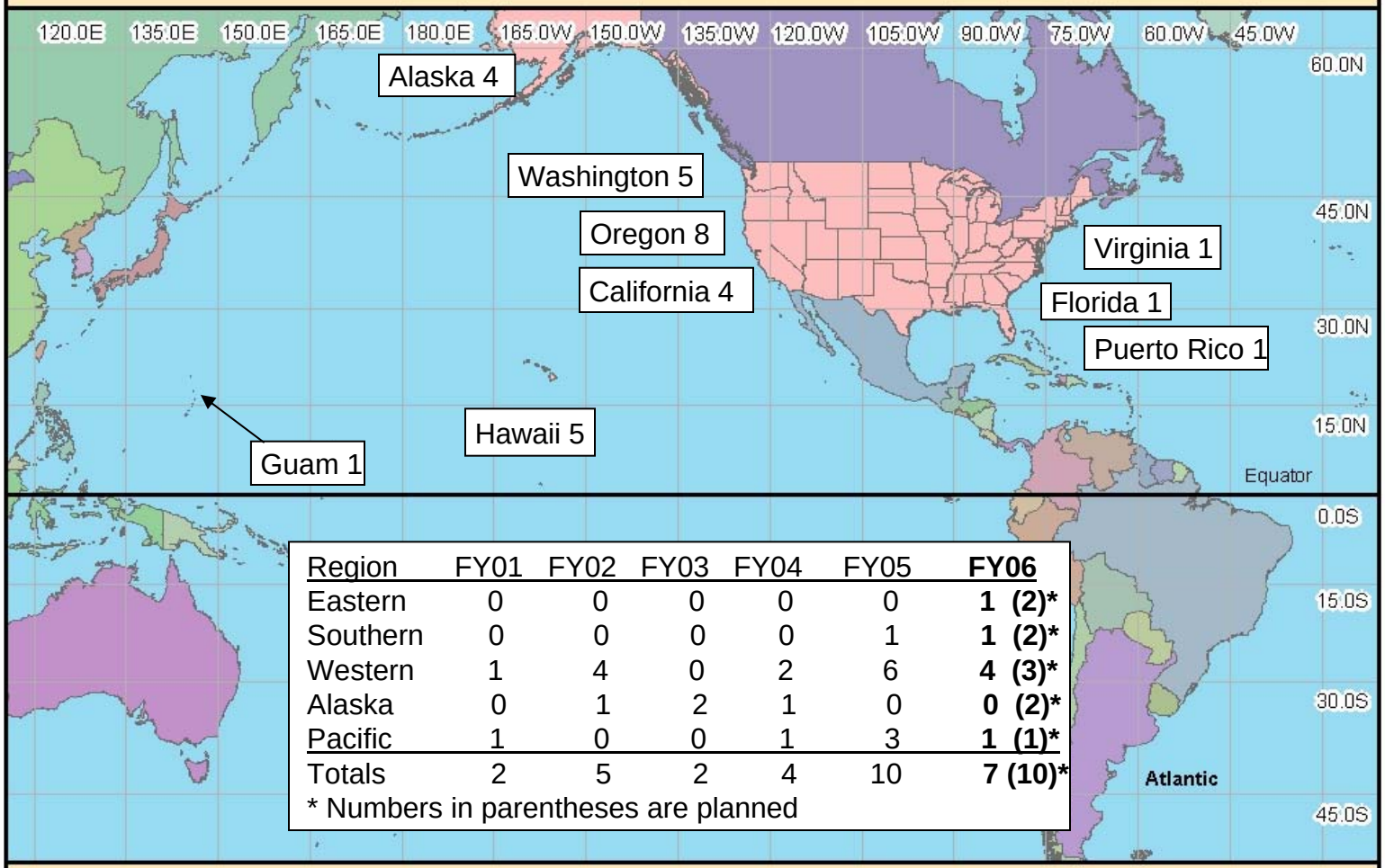
Preparedness and Response

- **Why does America need TsunamiReady?**
  - Detection and warnings alone are not sufficient to meet the mission
  - Preparedness and response must be learned, practiced, and owned locally
  - Continuous education and outreach to requires partnerships
  - Achievements should be recognized!

www.stormready.noaa.gov/tsunamiready

TsunamiReady Status

30 communities



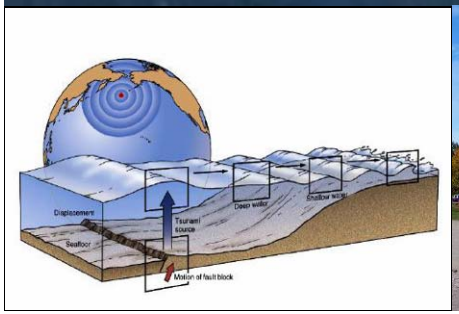
Region	FY01	FY02	FY03	FY04	FY05	**FY06**
Eastern	0	0	0	0	0	**1 (2)***
Southern	0	0	0	0	1	**1 (2)***
Western	1	4	0	2	6	**4 (3)***
Alaska	0	1	2	1	0	**0 (2)***
Pacific	1	0	0	1	3	**1 (1)***
Totals	2	5	2	4	10	**7 (10)***

* Numbers in parentheses are planned

As of: September 1, 2006

Preparedness and Response

- **Challenges in getting America TsunamiReady**
  - Establishing and maintaining a sense of urgency
  - Creating and leveraging partnerships
  - Developing socially and culturally relevant plans
  - Communicating and educating
  - Empowering local stakeholders for broad-based action
  - Scientifically based and continuously improved
  - Availability of data and information, e.g. inundation maps
  - Building capacity toward community resilience



TsunamiReady
NATIONAL WEATHER SERVICE

Preparedness and Response

- **NOAA NWS efforts to overcome these challenges…**
  - Increase coordination
  - Bolstering education and outreach
  - Optimize resources
  - Leverage other resources
  - Enhance private sector partnerships

Program Status Sept 06

- **DART deployment**

  19 of 39 (39% complete)
- **Facilities expansion**

  Complete
- **Warning operations expansion**

  24x7 staffing complete at both WC/ATWC and PTWC
- **Seismic Network upgrade**

  4 of 8 in HI & AK (50% complete)
- **Sea live (tide station) expansion**

  14 of 16 new and 30 of 33 upgrades (90% complete)
- **TsunamiReady**

  30 TsunamiReady communities
- **Forecast Mapping/Modeling**

  15 of 26 (58%) full operations;

  15 of 75 (20%); Ongoing
- **Long Term Archive**

  Ongoing: 200 Gb new data added, 530 Gb new to add

For Further Information

http://www.tsunami.noaa.gov/
www.tsunami.gov

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