

# Earthquake and Tsunami activities of the United States Geological Survey

## Presentation to the Ring of Fire Delegation

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USGS Earthquake Hazard Program  
August 28, 2010



# So many earthquakes... too many earthquakes?

## News Release

April 14, 2010

Dr. Michael Blampied  
Clarice Nassif Ransom

703-648-6696  
703-648-4299

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[cransom@usgs.gov](mailto:cransom@usgs.gov)

## Is Recent Earthquake Activity Unusual? Scientists Say No.

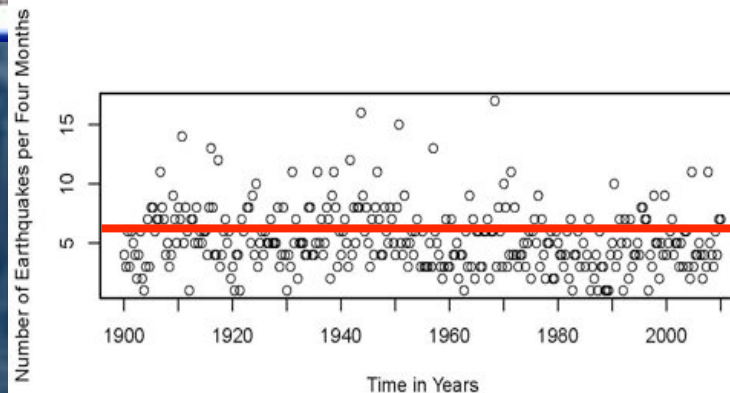
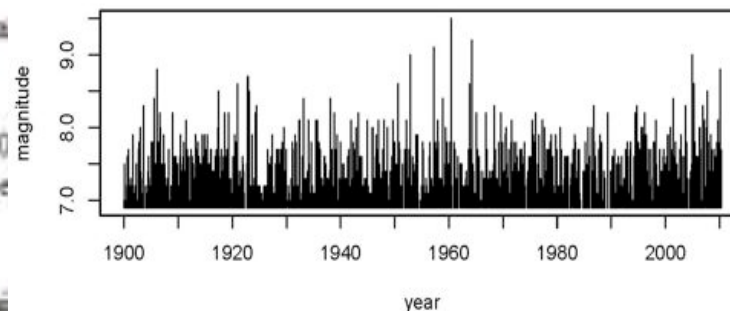


China's tragic magnitude 6.9 earthquake on April 13 and the recent devastating earthquake many wondering if this earthquake activity is unusual.

Scientists say 2010 is not showing signs of unusually high earthquake activity. Since 1900 earthquakes — the size that seismologists define as major — have occurred worldwide at a rate of about 18 per year, with considerable variability from year to year.

With six major earthquakes striking in the first four months of this year, 2010 is well within the range of 2009, to April 14, 2010, there have been 18 major earthquakes, a number also well within the range of 2009.

Real Data: Centennial and PDE Catalogs



# USGS statutory roles and responsibilities

- USGS has the delegated federal responsibility to provide notification and warnings for **earthquakes**, **volcanoes**, and **landslides**.
- In addition, USGS seismic networks support NOAA in carrying out its **tsunami** warning responsibility; USGS streamgages and storm surge monitors support NOAA's **flood** and **severe weather** (including **hurricane**) warnings; our geomagnetic observatories support **solar storm** forecasts.
- USGS geospatial information supports response operations for **wildfire** and many other hazards.



# The mandate of the National Earthquake Hazard Reduction Program

- Develop effective measures for earthquake loss reduction;
- Promote their adoption;
- Improve the understanding of earthquakes and their effects on communities, buildings, structures, and lifelines.



FEMA

NIST

National Institute of  
Standards and Technology

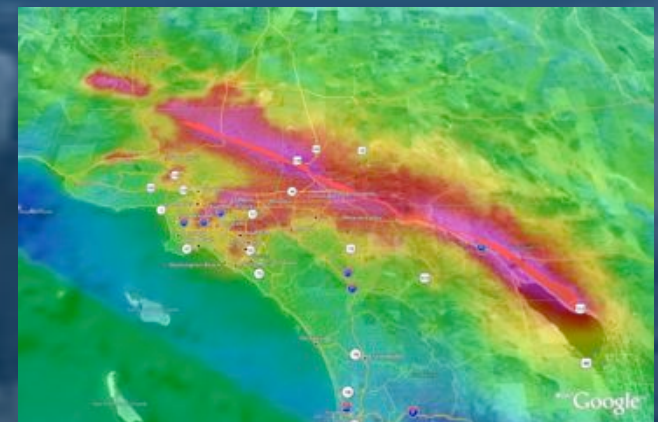
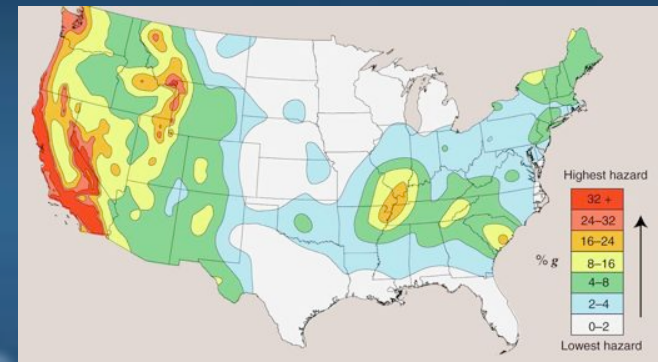


USGS  
science for a changing world

national **earthquake** hazards reduction program

# The USGS role in NEHRP

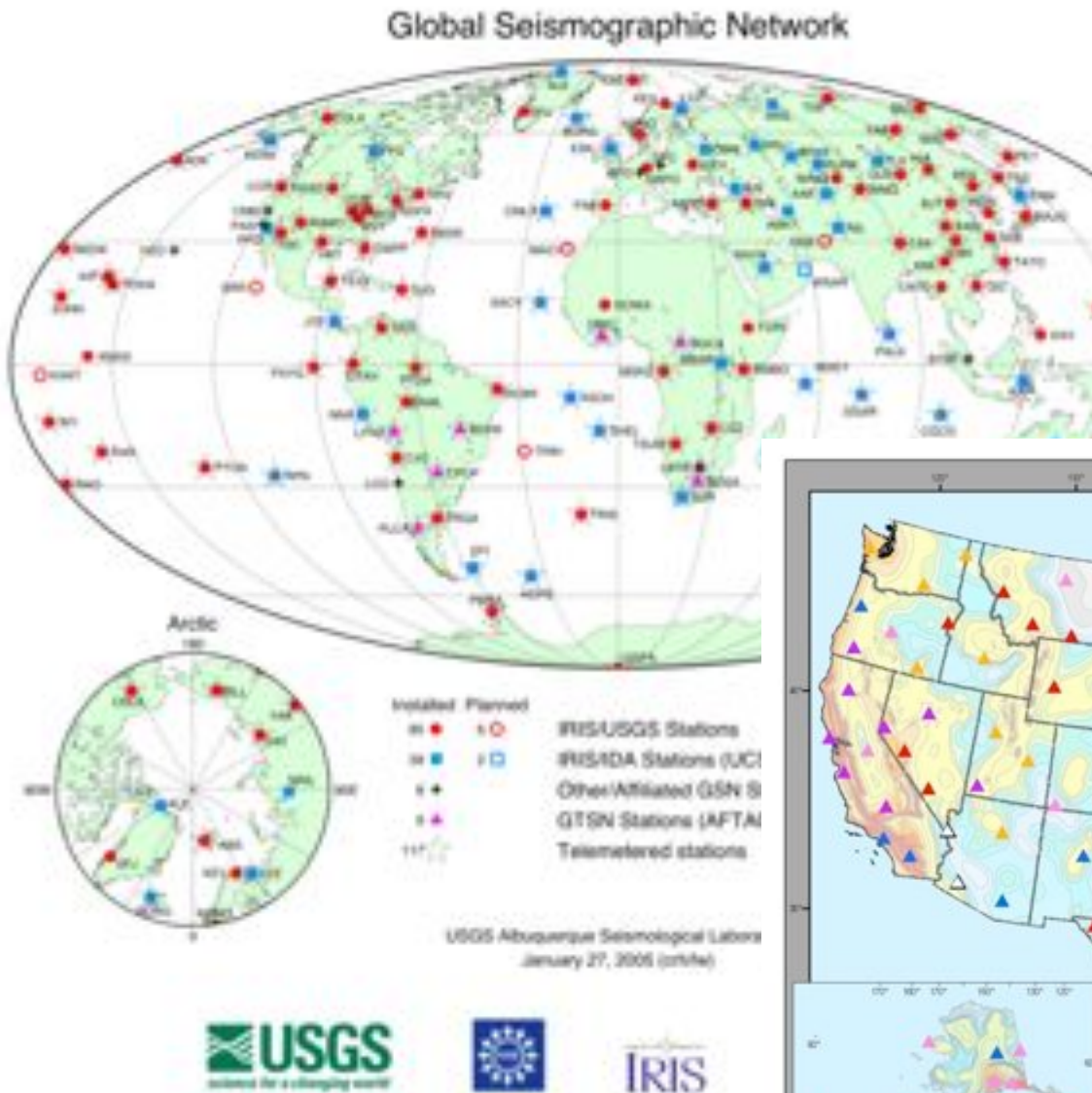
- Provide earthquake monitoring and notifications,
- Assess seismic hazards, and
- Conduct targeted research needed to reduce the risk from earthquake hazards nationwide.



# USGS provides rapid information on earthquakes worldwide



**USGS National Earthquake Information Center, Golden, Colorado**



# USGS Earthquake Notification System

Over  
175,000  
users



The screenshot shows the USGS Earthquake Notification System (ENS) website. The browser title is "USGS Earthquake Hazards Program - Earthquake Notification Service: Customizable Alerts". The page features the USGS logo and navigation links for "Home", "Earthquake Center", "Regional Information", "Learning & Education", "Research & Monitoring", and "Additional Resources". A sidebar on the left lists various resources such as "Latest Earthquakes", "EQ Notification Service", "Feeds & Data", "Animations", "Recent Earthquakes", "Historic Earthquakes", "Top 10 Lists & Maps", "Significant EQs", "Earthquake Search", "EQ Summary Posters", "Scientific Data", "About EQ Maps", "Did You Feel It?", "Energy & Broadband Solutions", "Fast Moment Tensors", "Media Info", "PAGER", "Seismogram Displays", and "ShakeMaps". The main content area includes a description of the system, a link to "Introduction to ENS - What you need to know", a "Manage Your Account" form with fields for "Username" (waidjd) and "Password" (\*\*\*\*\*), and a "Register for a New Account" button. Below the form is a "Login" button and a link to "See recent events processed". A footer section contains links for "About Us", "Contact Us", "Site Map", and "Site Search", along with "Accessibility", "FOIA", "Privacy", and "Policies and Notices". The page footer also includes the U.S. Department of the Interior | U.S. Geological Survey information, the URL <http://earthquake.usgs.gov/eqcenter/ens/index.php>, contact information for the Web Team, and the page last modified date: March 07, 2006 11:28:22 AM. Logos for "FIRST GOV" and "TAKE PRIDE IN AMERICA" are also visible.

<http://earthquake.usgs.gov/ens/>

# ENS can be customized to suit your needs

The screenshot displays the USGS Earthquake Notification Service (ENS) website interface. The main heading is "Earthquake Notification Service: Customizable Earthquake Alerts". Below this, there are tabs for "My Notification Profiles" and "My Account". The central content area shows "Earthquake Notification Profiles Associated with waldjd's Account".

Two profiles are visible:

- Continental US (Custom region):**
  - Depth: 0.00 to 800.00km
  - Networks: CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR
  - Geographic Bounds: polygon
  - Day Mag: 4
  - Night Mag: 4.5
  - Day Begins: 08:00
  - Day Ends: 22:00
  - Address 1: 3036386000@vtext.com (short)
  - Address 2: wald@usgs.gov (long)
- World (Custom region):**
  - Depth: 0.00 to 800.00km
  - Networks: CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR
  - Geographic Bounds: rectangle
  - South Latitude: -90.000
  - North Latitude: 90.000
  - East Longitude: 180.000
  - West Longitude: -180.000
  - Day Mag: 5.7
  - Night Mag: 6.1

The right sidebar contains user information for "waldjd", including "Log Out", "Recent Events Sent to Me", "Map of Recent Events", "My Email Addresses" (listing 3036386000@mmode.com and 3036386000@vtext.com), "Add New Email Address", "Add New Profile" (with options for Predefined, Rectangle, Circle, and Polygon profiles), and "Admin Functions" (Recent Events List, Recent Events Map, Admin Page).





# ENS can be customized to suit your needs

The image displays two overlapping windows from the USGS Earthquake Notification Service (ENS) website. The background window shows the main user interface for a user named 'waldjd'. The foreground window is a 'Map Input' dialog for defining a polygon boundary on a map of the western United States.

**USGS Earthquake Notification Service: Customizable Earthquake**

Welcome waldjd!  
Log Out  
Recent Events Sent to Me  
Map of Recent Events  
My Email Addresses  
3036386000@mmode.com (short)  
3036386000@vtext.com (short)  
wald@usgs.gov (long)  
Add New Email Address  
Add New Profile  
Predefined Profile  
Rectangle Profile  
Circle Profile  
Polygon Profile  
Admin Functions  
Recent Events List  
Recent Events Map  
Admin Page

**USGS ENS Map Input**

Click on the map to define your polygon boundary. You may have up to 50 points in your polygon. Click 'Done' when finished.

Back up one point | Number of points: 7

Done

USGS ENS Map Input

Map | Satellite | Hybrid

Depth: 0.00 to 800.00km  
Networks: CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR  
Geographic Bounds: polygon  
Day Mag: 4  
Night Mag: 4.5  
Day Begins: 08:00  
Day Ends: 22:00  
Address 1: 3036386000@vtext.com (short)  
Address 2: wald@usgs.gov (long)  
DELETE PROFILE | EDIT PROFILE

Depth: 0.00 to 800.00km  
Networks: CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR  
Geographic Bounds: rectangle  
South Latitude: -90.000  
North Latitude: 90.000  
East Longitude: 180.000  
West Longitude: -180.000  
Day Mag: 5.7  
Night Mag: 6.1

# ShakeMap: A tool for rapid post-earthquake response, coordination, and situational awareness



California Governor Schwarzenegger pointing to ShakeMap at his press conference following the 2008 M5.4 Chino Hills earthquake that hit LA.

 A screenshot of the USGS Earthquake Hazards Program website. The page title is "USGS Earthquake Hazards Program - Event Northridge". It features a navigation menu on the left, a central map showing ShakeMap intensity contours for the 1999 Northridge earthquake, and a table of shaking intensity levels at the bottom right.
 

Very Strong	Severe	Violent	Extreme
Moderate	Moderate-Heavy	Heavy	Very Heavy
5-6.4	6.5-6.9	7.0-7.4	>7.5
IV	V	VI	VII

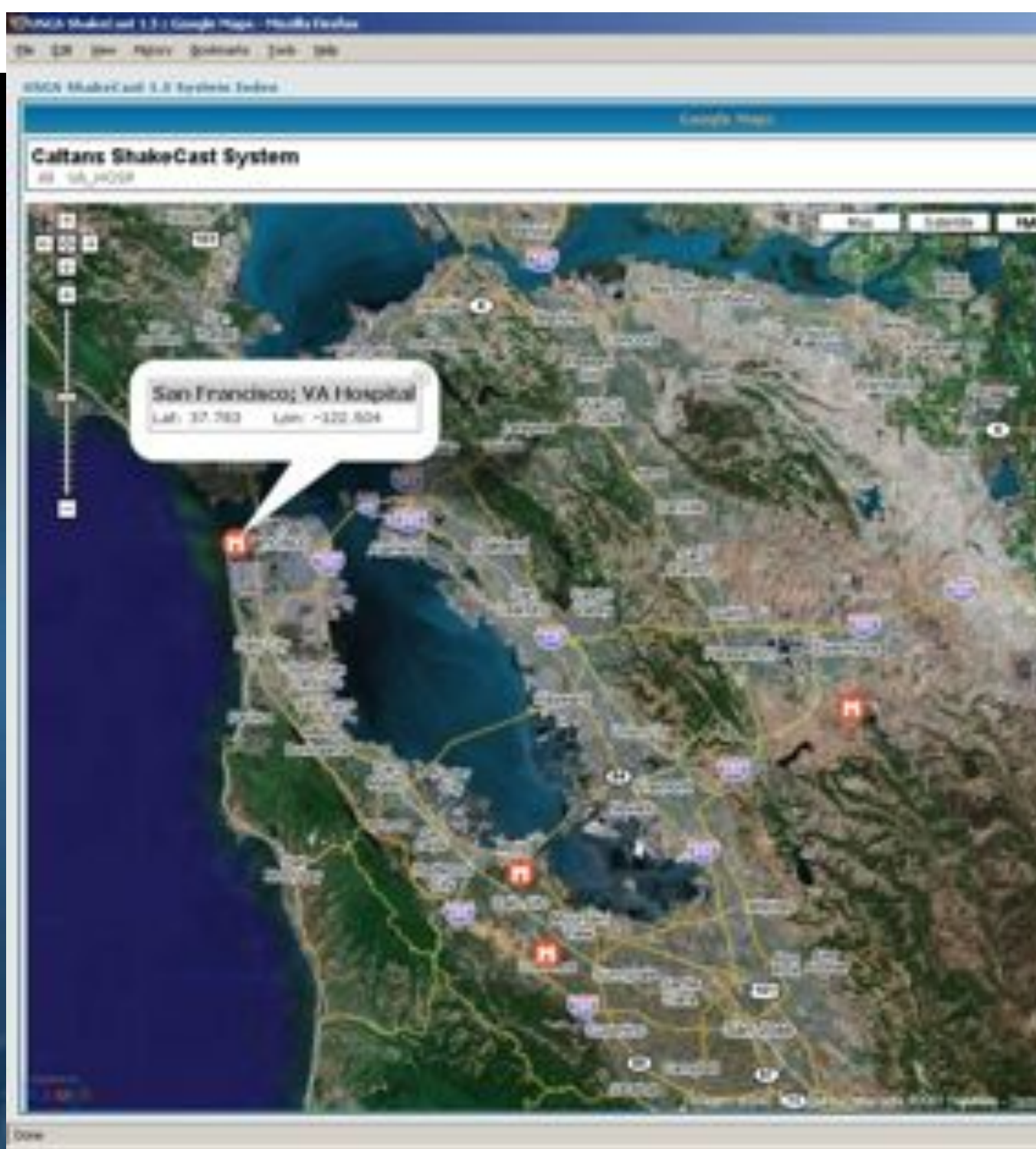


# ShakeCast



Automated  
notifications to  
operators of  
critical facilities

 USGS



# ShakeCast



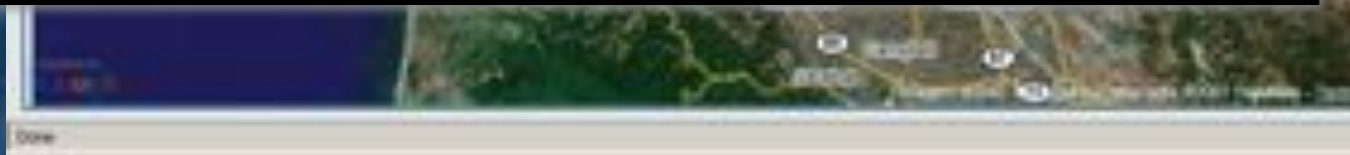
Automated notifications to operators of critical facilities



## Facility Damage Estimates from ShakeMap

Bridges presented in the table below are sorted in order of potential damage level.

Bridge Name	Bridge No	Dist-Cty-Rte-PM	Damage Level	Value	Exceedance Ratio
Pisgah Overhead	54 0689L	08-SBD-040-R37.41	RED	47.6856	1.163
Pisgah Overhead	54 0689R	08-SBD-040-R37.44	RED	47.6856	1.163
Lavic Road OC	54 0734	08-SBD-040-R41.91	YELLOW	56.4714	0.867
Ash Hill Wash	54 0758L	08-SBD-040-R54.75	GREEN	25.5495	0.887
Ash Hill Wash	54 0758R	08-SBD-040-R54.77	GREEN	25.5495	0.887
Argos Wash	54 0737L	08-SBD-040-R43.84	GREEN	48.8524	0.053
Argos Wash	54 0737R	08-SBD-040-R43.84	GREEN	48.8524	0.053



# Situational awareness available in 20 minutes

## Prompt Assessment of Global Earthquakes for Response



**M 6.9, SOUTHERN QINGHAI, CHINA**

Origin Time: Tue 2010-04-13 23:49:37 UTC

Location: 33.27°N 96.83°E Depth: 10 km



**PAGER  
Version 2**

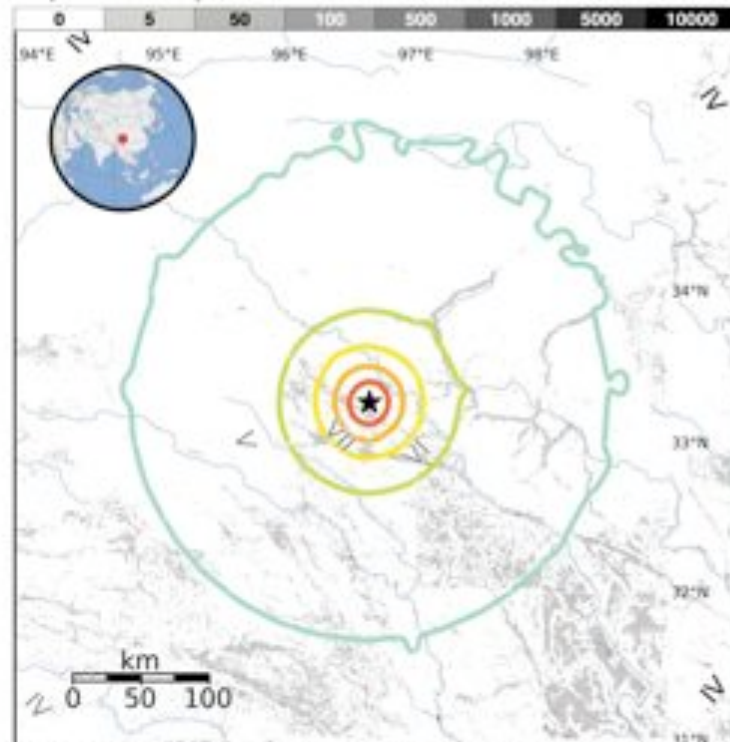
Created: 37 minutes, 54 seconds after earthquake

### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	540k*	237k	48k	9k	5k	3k	0	
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme	
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

\*Estimated exposure only includes population within the map area

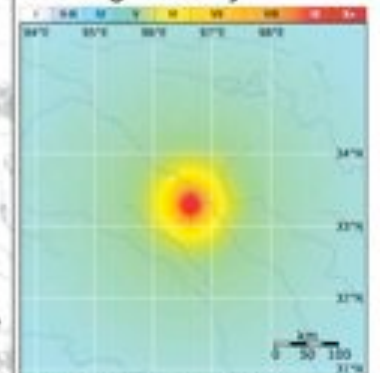
### Population Exposure



### Selected City Exposure

MMI City	Population
bold cities appear on map (k = x1000)	

### Shaking Intensity



Overall, the population in this region resides in structures that are highly vulnerable to earthquake shaking, though some resistant structures exist. On June 15, 1982 (UTC), a magnitude 5.6 earthquake 338 km Southeast of this one struck China, with estimated population exposures of 1,000 at intensity VII and 2,000 at intensity VI, resulting in a reported 11 fatalities.



# Situational awareness available in 20 minutes

## Prompt Assessment of Global Earthquakes for Response



**M 6.9, SOUTHERN QINGHAI, CHINA**  
 Origin Time: Tue 2010-04-13 23:49:37 UTC  
 Location: 33.27°N 96.63°E Depth: 10 km



**PAGER Version 2**

Created: 37 minutes, 54 seconds after earthquake

### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	540k*	237k	48k	9k	5k	3k	0	
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme	
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

\*Estimated exposure only includes population within the map area



**Summary Alert** ● **Orange**



**M 6.9, SOUTHERN QINGHAI, CHINA**  
 Origin Time: Tue 2010-04-13 23:49:37 UTC (07:49:37 local)  
 Location: 33.27°N 96.63°E Depth: 10 km

**PAGER Version 2**

Created: 38 minutes, 39 seconds after earthquake



### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	540k*	233k	50k	9k	6k	3k	0	
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme	
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

\*Estimated exposure only includes population within the map area.

**Population Exposure**

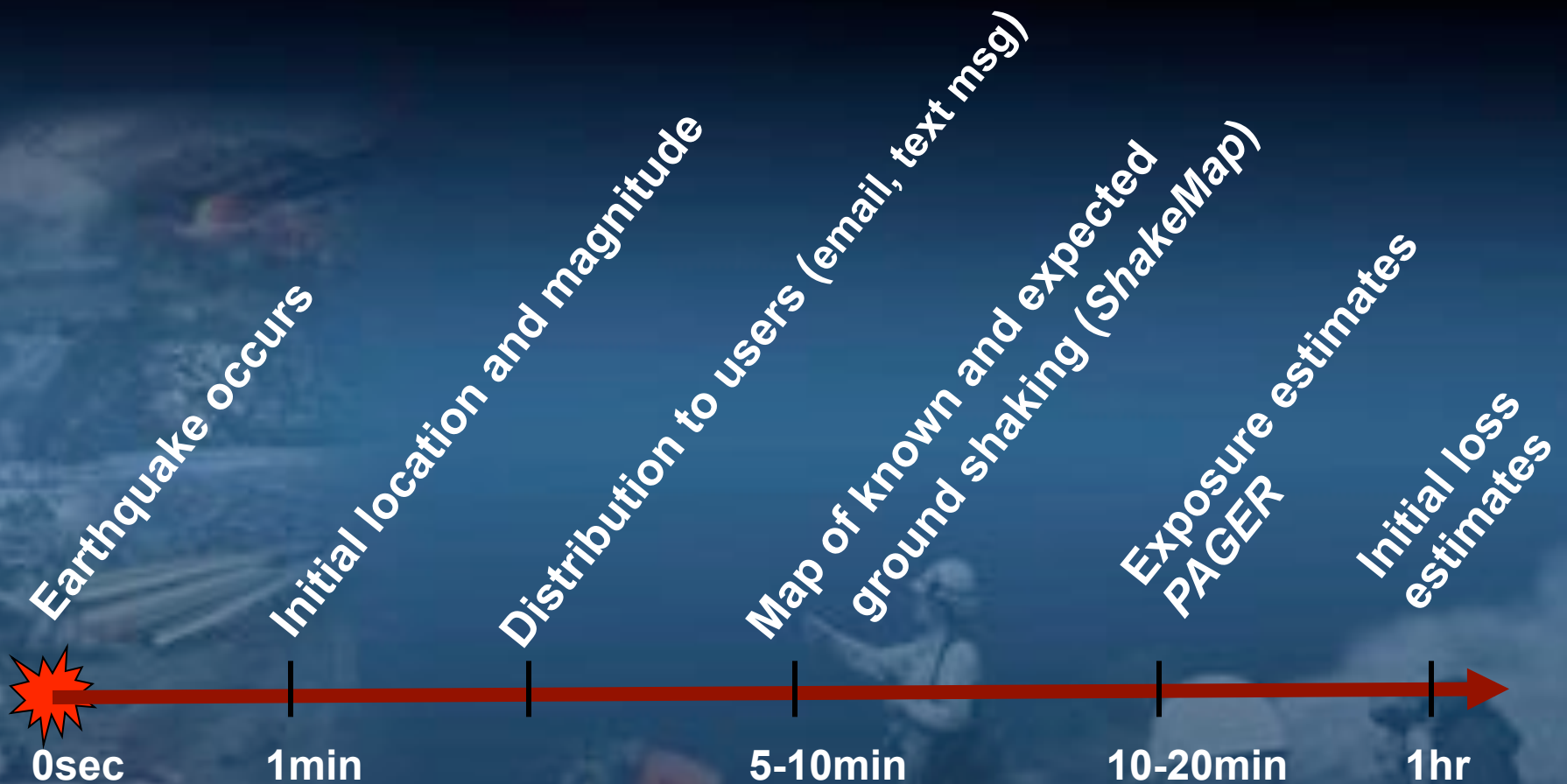
population per ~1 sq. km from Landsat

**Structures:**

Overall, the population in this region resides

**Beta-test product:  
LossPAGER**

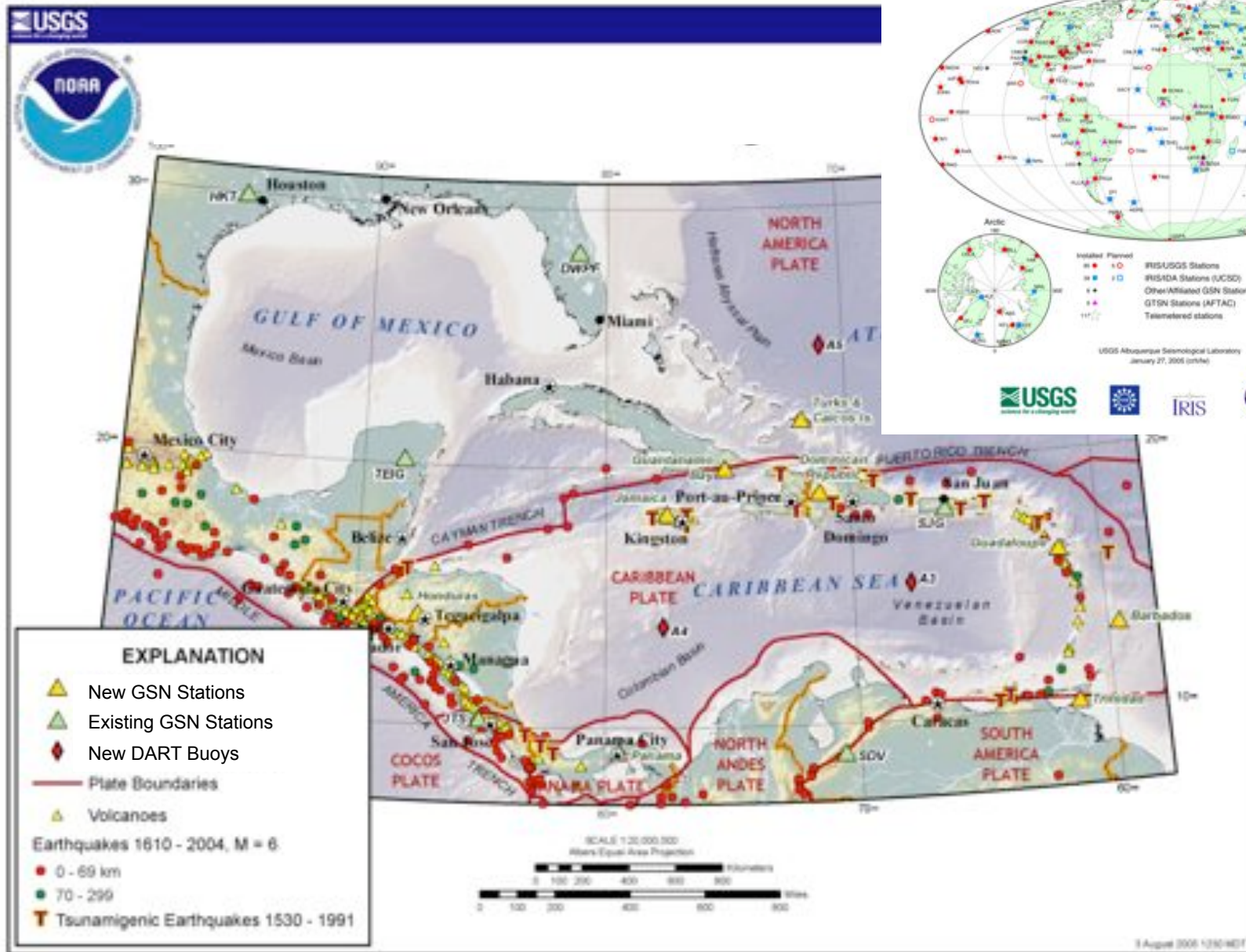
# An earthquake information timeline (domestic earthquake)



 USGS



# NOAA-USGS Post-Sumatra tsunami warning initiative





# Earthquake Disaster Assistance Team

- Cooperative program of the USGS and USAID's Office of Foreign Disaster Assistance (OFDA)
- Purposes:
  - Support OFDA's response activities to earthquake disasters in developing nations.
  - Make USGS experts or scientific services available to assist local geological agencies, when requested.
  - Conduct rapid assessment of earthquake, tsunami, and landslide hazards and impacts.
  - Provide advice and training to build capacity in monitoring, hazard asmt., microzonation, etc.
- Can also support mitigation and capacity-building projects.

# Earthquake Disaster Assistance Team

Teams deployed following recent earthquakes:

- Padang, Sumatra M7.6, September 2009
- Karonga, Malawi M6.0, December 2009
- Port au Prince, Haiti M7.0, January 2009





# HELP for HAITI

The President speaks on the urgent situation after the earthquake in Haiti and the government's response. Read his remarks and learn how to contribute to the relief effort.

[Learn More](#)

- 1
- 2
- 3
- 4



Map courtesy of USGS

## A NEW FOUNDATION



**The President's Plan for Health Insurance Reform**  
Cut through the rhetoric on health insurance reform. Read the essentials of the President's plan, and watch a video with highlights of his speech to Congress.

[Learn More](#)

◀ BACK | NEXT ▶

## SEARCH the SITE

## PHOTO of the DAY



## THE BLOG

January 13, 2010 at 9:53 AM EST

## FEATURED LEGISLATION

Ryan White HIV/AIDS Treatment

# PAGER

Prompt  
Assessment of  
Global  
Earthquakes  
for  
Response

Rapidly estimated that  
over 2 million people  
were exposed to  
violent shaking



## M 7.0, HAITI REGION

Origin Time: Tue 2010-01-12 21:53:10 UTC

Location: 18.46°N 72.53°W Depth: 13 km



PAGER  
Version 8

Created: 1 day, 20 hours after earthquake

### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	5,887k*	7,261k	1,049k	571k	314k	2,246k	332k	
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme	
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

\*Estimated exposure only includes population within the map area.

### Population Exposure



### Selected City Exposure

MMI City	Population
X Grand Ouve	5k
IX Port-au-Prince	1,235k
IX Carrefour	442k
IX Pignonville	108k
IX Delmas 73	353k
IX Croix des Bouquets	5k
VI Miragoane	6k
V Verrettes	49k
III Santo Domingo	2,202k
III Guantanamo	273k

bold cities appear on map (k = x1000)

### Shaking Intensity



Overall, the population in this region resides in structures that are vulnerable to earthquake shaking, though some resistant structures exist. On June 24, 1984 (UTC), a magnitude 6.7 earthquake 329 km East of this one struck the Dominican Republic, with estimated population exposures of 320,000 at intensity VII and 2,964,000 at intensity VI, resulting in 5 reported fatalities. Recent earthquakes in this





USGS Home  
Contact USGS  
Search USGS

# Earthquake Hazards Program

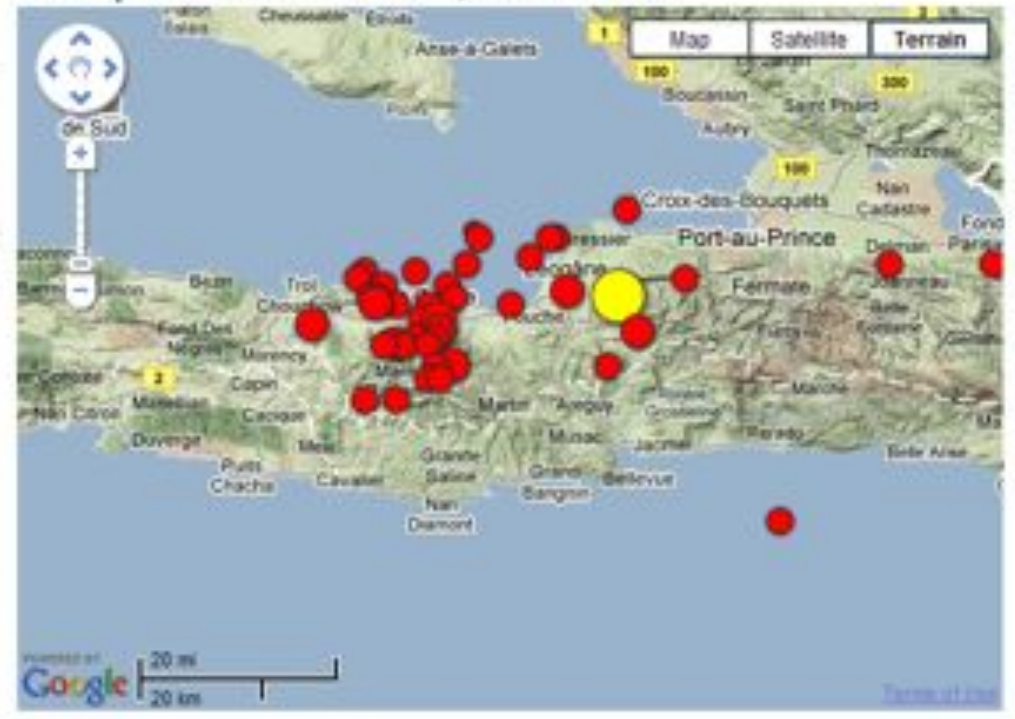
- EARTHQUAKES**
- HAZARDS
- LEARN
- PREPARE
- MONITORING
- RESEARCH

- Past**
- Past 8-30 days
  - Significant Earthquakes
  - Earthquake Lists & Maps
  - Search for an Earthquake
- Present**
- Real-time - CA/NY
  - Real-time - USA
  - Real-time - Worldwide
  - About Earthquake Maps
  - WML / RSS Feeds & Data
  - Earthquake Notifications
  - Seismogram Displays
  - Earthquake Animations
  - Did You Feel It?
  - ShakeMaps
  - PAGER
  - EQ Summary Posters
- Future**
- Earthquake Scenarios
  - Prediction
  - Probabilities
- Location**
- Info by State
  - Info by Country/Region

## Aftershock Mapping

### Aftershock Map - Mainshock and 42 Aftershocks

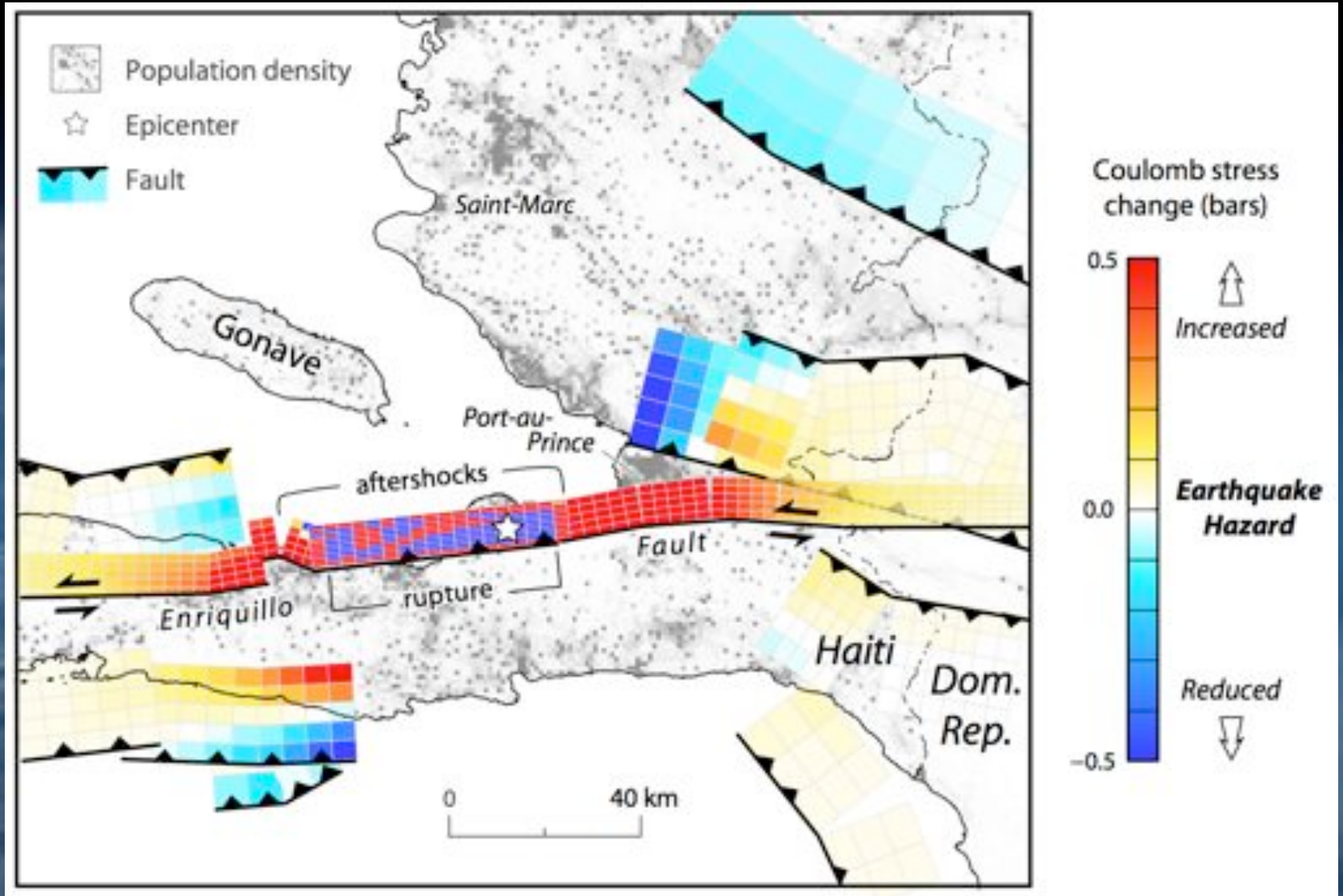
Last Updated: 04 March 2010, 00:08:59 UTC



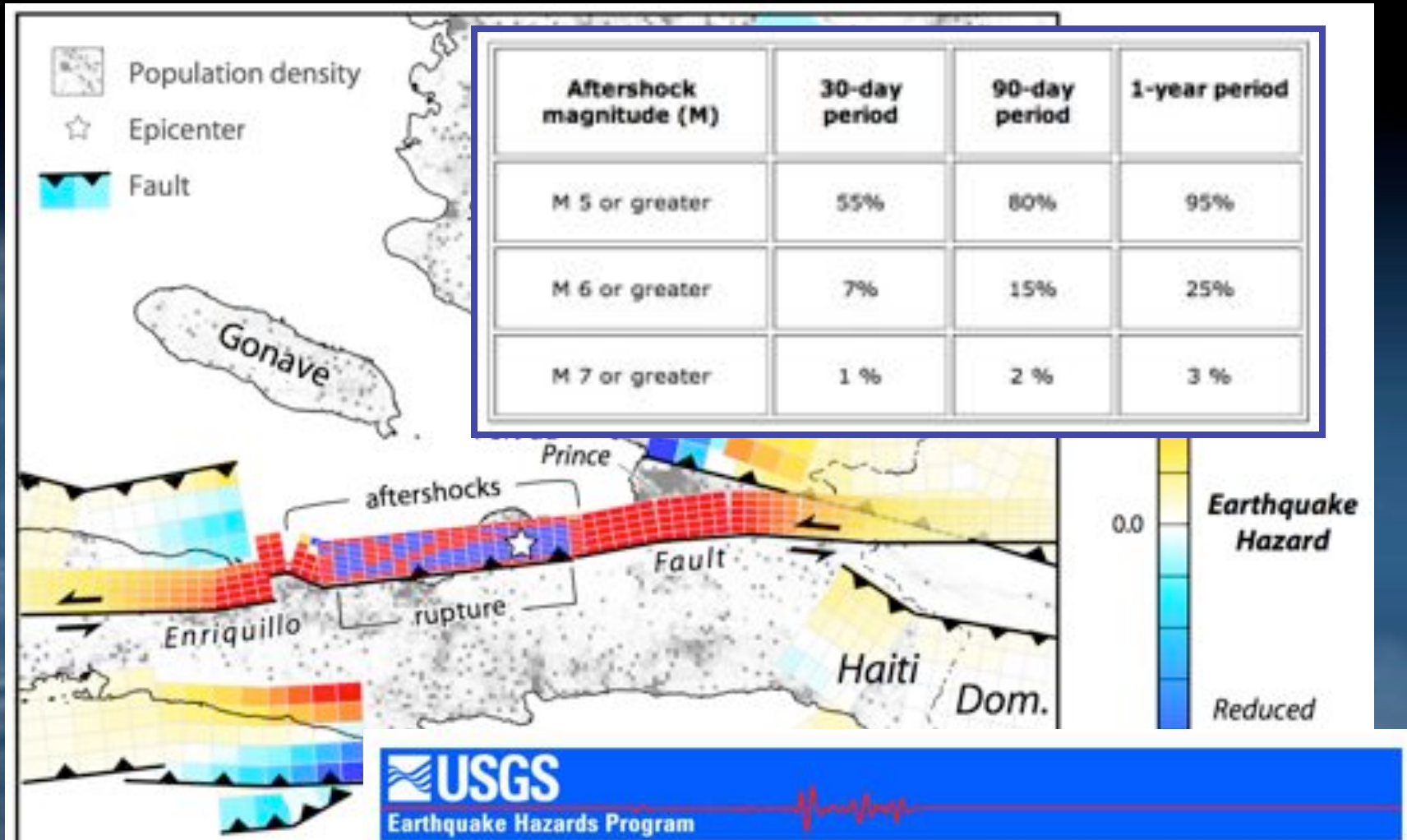
### Legend



# Stress increase on Enriquillo & adjoining faults



# Stress increase on Enriquillo & adjoining faults



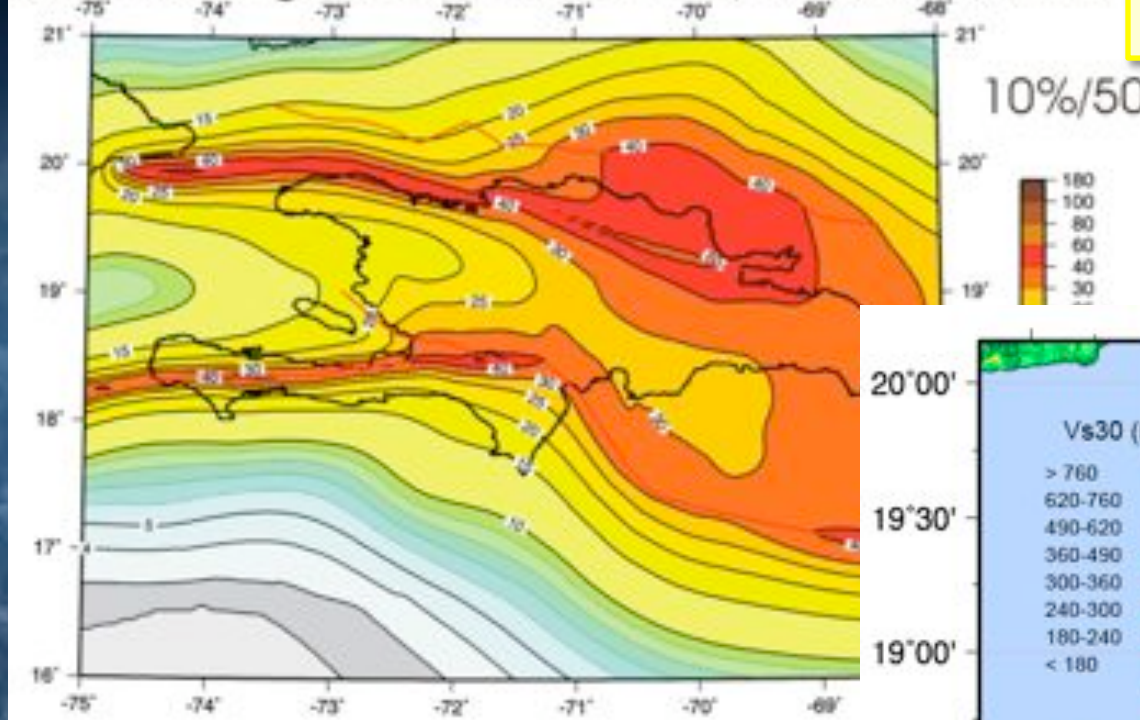
Information summary distributed in English, French, Spanish and Creole

Risk tranblemanntè ak mezu sékirité nan Péyi Dayiti ak tout zòn Karayib-la  
 Komuniké Sant enspéksyon jéolojik Étaizini  
 28 janvyé 2010

Èchèl Richtè, sé yon manyè pou mezuré puisans yon tranblemanntè.  
 Yon lòt mo pou di puisans yon tranblemanntè, sé mayltud.  
 Yon lòt mo pou di tranblemanntè, sé séyis, ou byen kataklis tou, ki pi jénéral.

# USGS/USAID Earthquake Disaster Assistance Team: Improved seismic hazard analysis

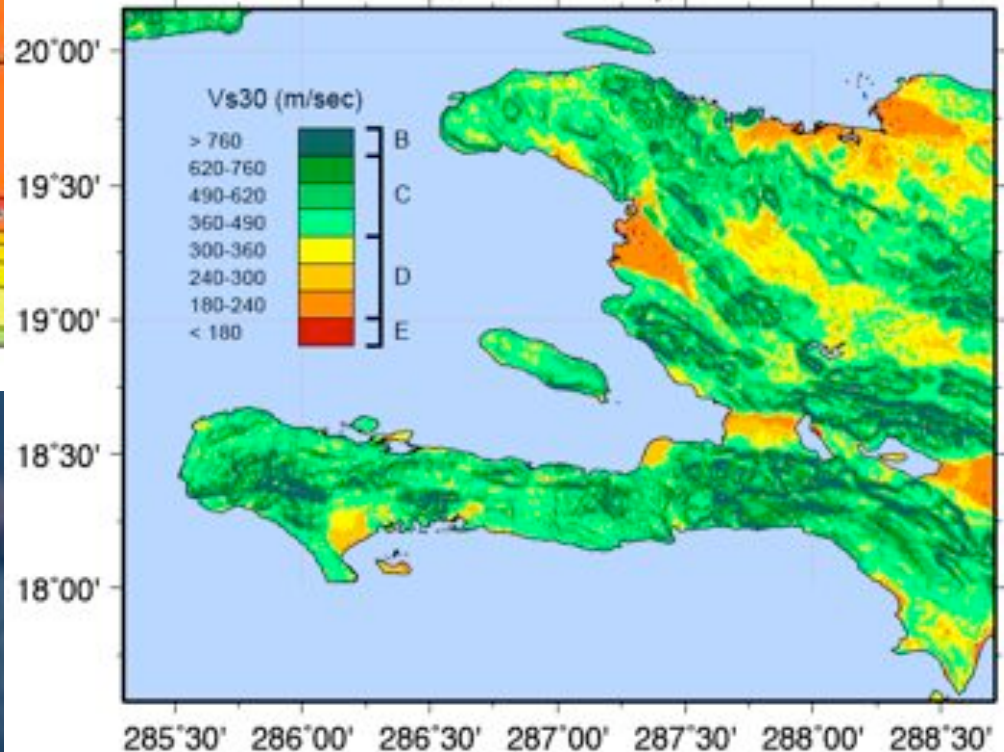
USGS working seismic hazard maps March 5, 2010



Shaking hazard

Shallow seismic wave speed

Vs30 (30-m shear velocity) m/s





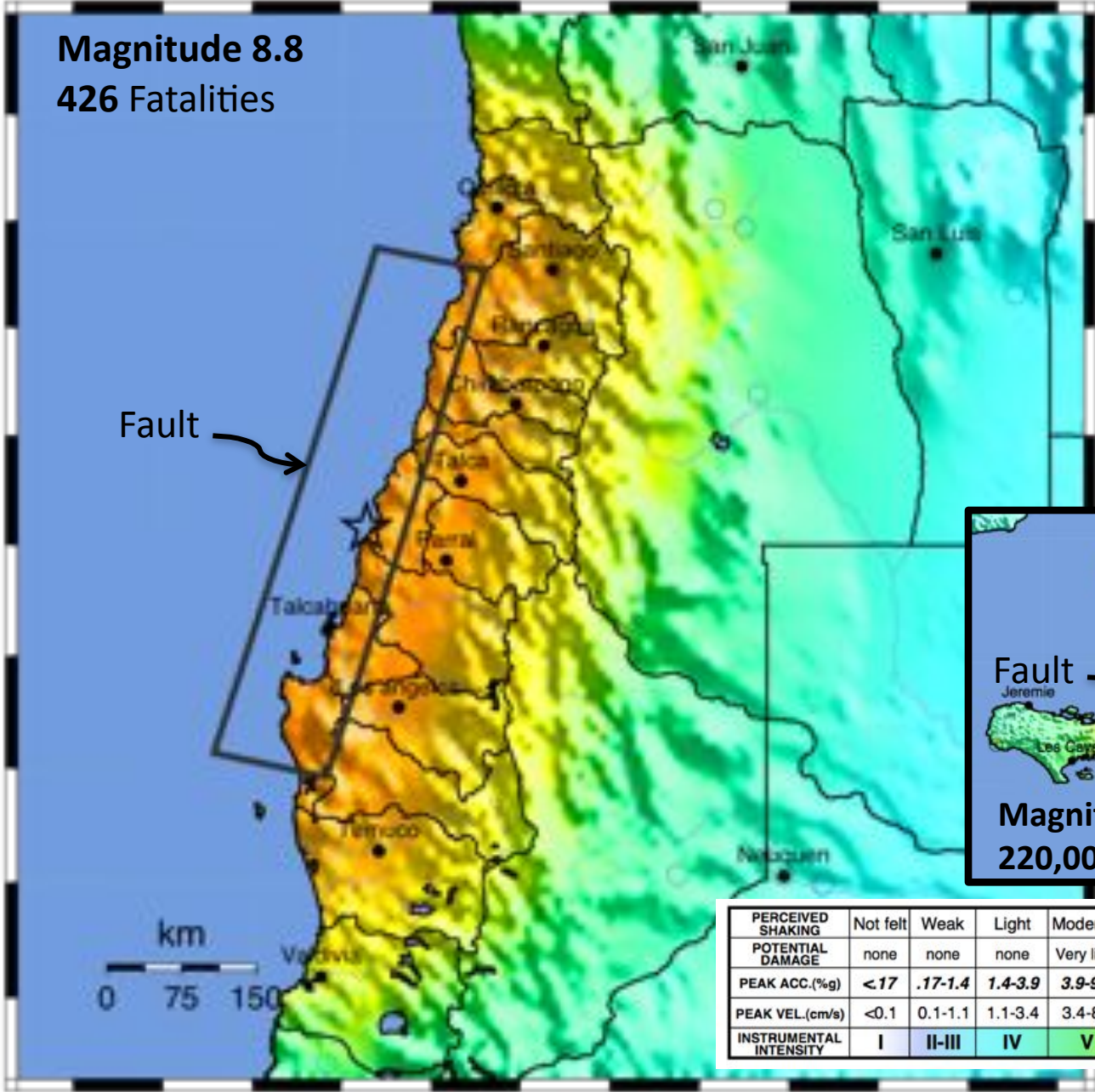
# USGS ShakeMap : OFFSHORE MAULE, CHILE

Sat Feb 27, 2010 06:34:14 GMT M 8.8 S35.85 W72.72 Depth: 35.0km ID:2010ffan

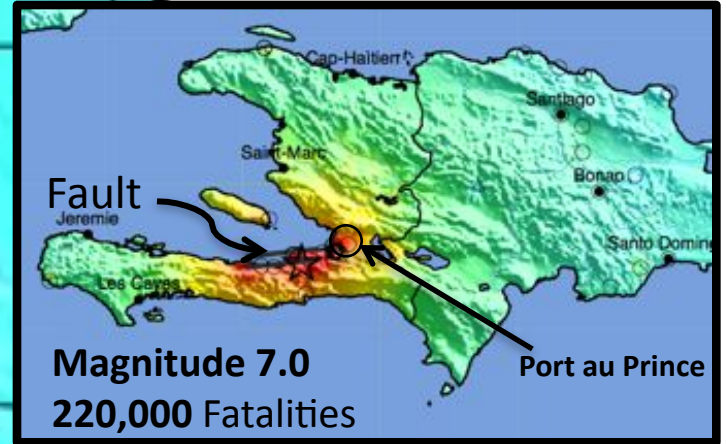
**Magnitude 8.8**  
**426 Fatalities**

**USGS ShakeMap  
Estimated Shaking  
Intensities**

**Same Map Scale!**



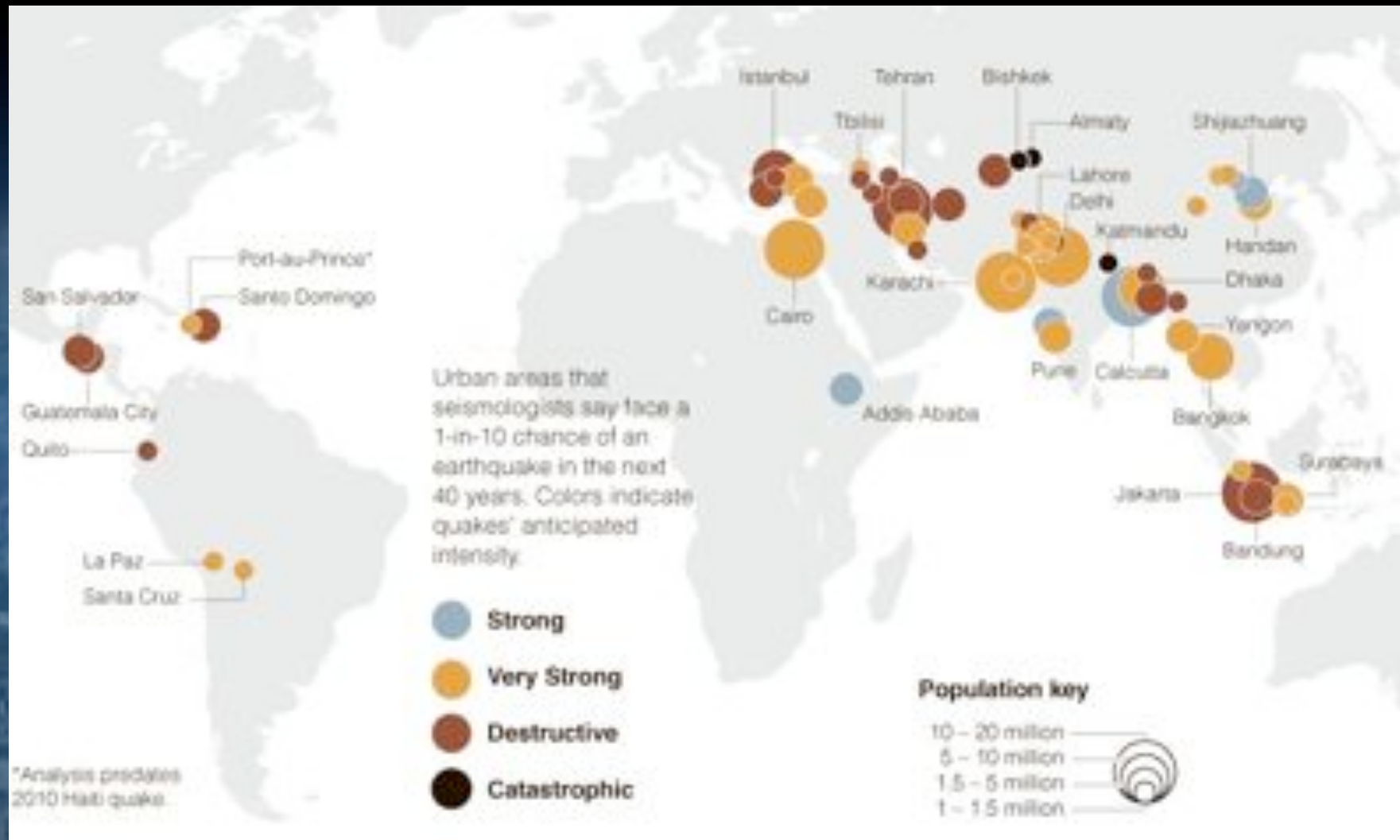
Haiti, Jan 10, 2010



**Magnitude 7.0**  
**220,000 Fatalities**

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

# Cities at risk: There will be more bulls-eyes



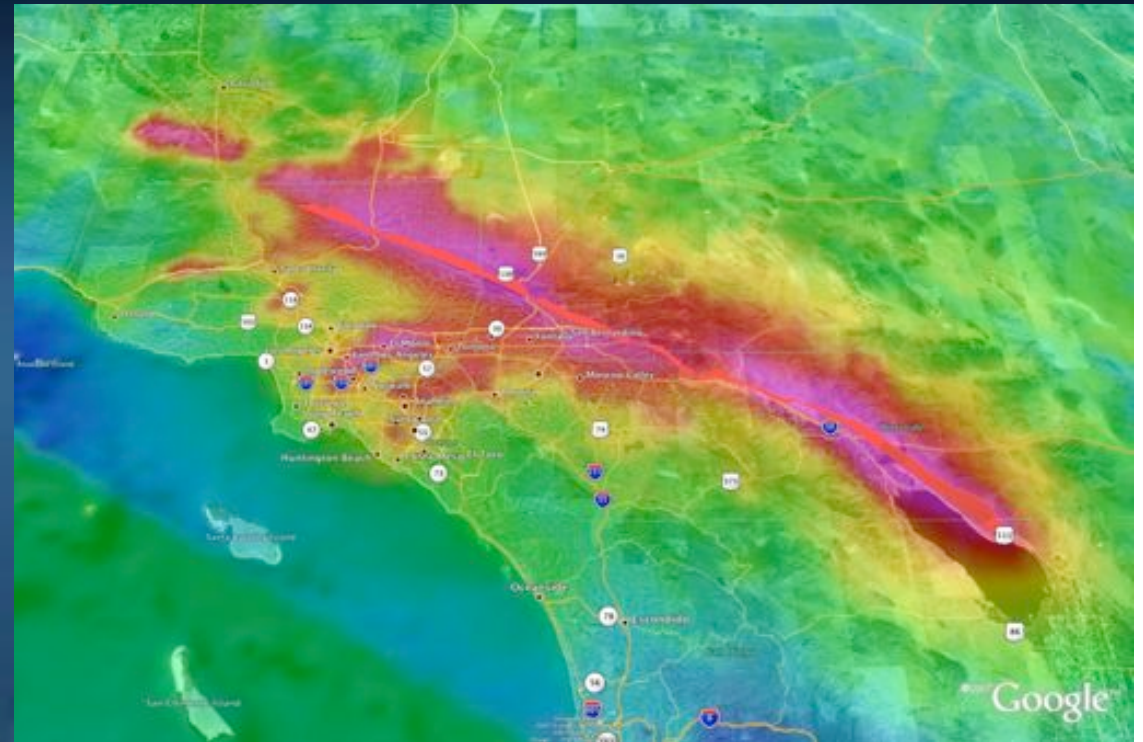
Graphic courtesy of *The New York Times*  
Data from Columbia University Earth Institute

# San Andreas ShakeOut Scenario

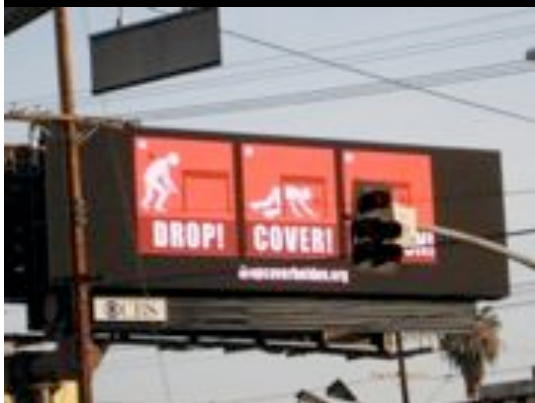
The Great  
Southern California  
**Shake  
Out**

- Top request of emergency managers
- Rallying point for community

- San Andreas 'Big One' simulated magnitude-7.8 earthquake; multi-hazard scenario
- Initiation near Bombay Beach, rupturing to the northwest
- Disruption of critical lifeline infrastructure (freeway, internet, power and gas lines) along surface rupture
- Strong shaking throughout region, including urban areas



# California-wide public preparedness drill



# The Great California Shake Out

October 15, 2009

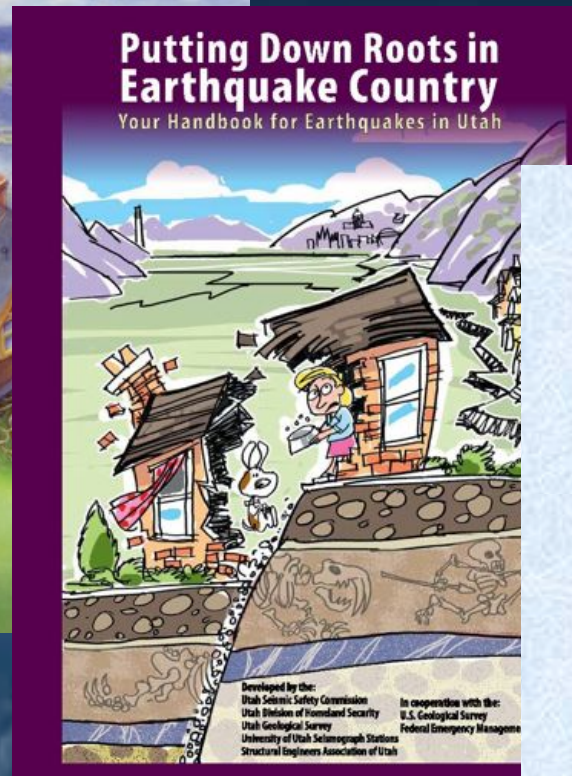
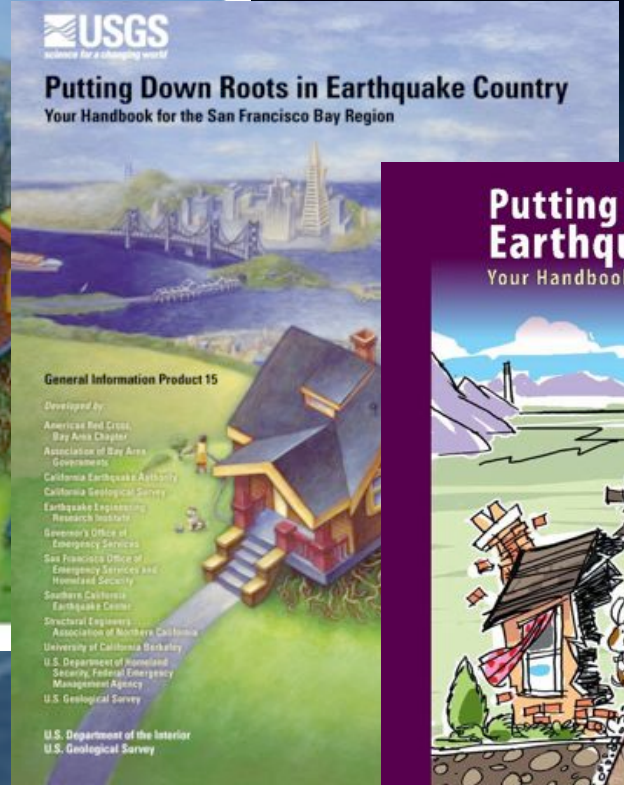
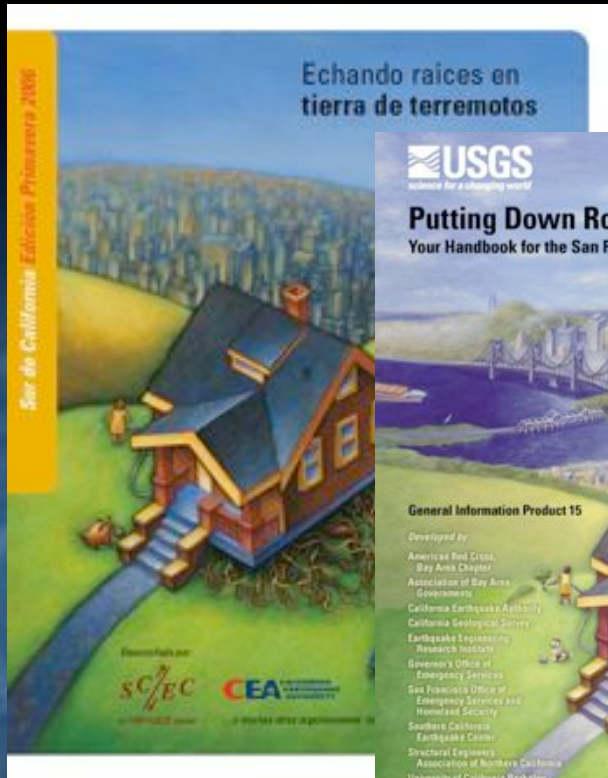


an NSF + USGS center

Earthquake Country **Alliance**  
We're all in this together.



# Putting Down Roots in Earthquake Country



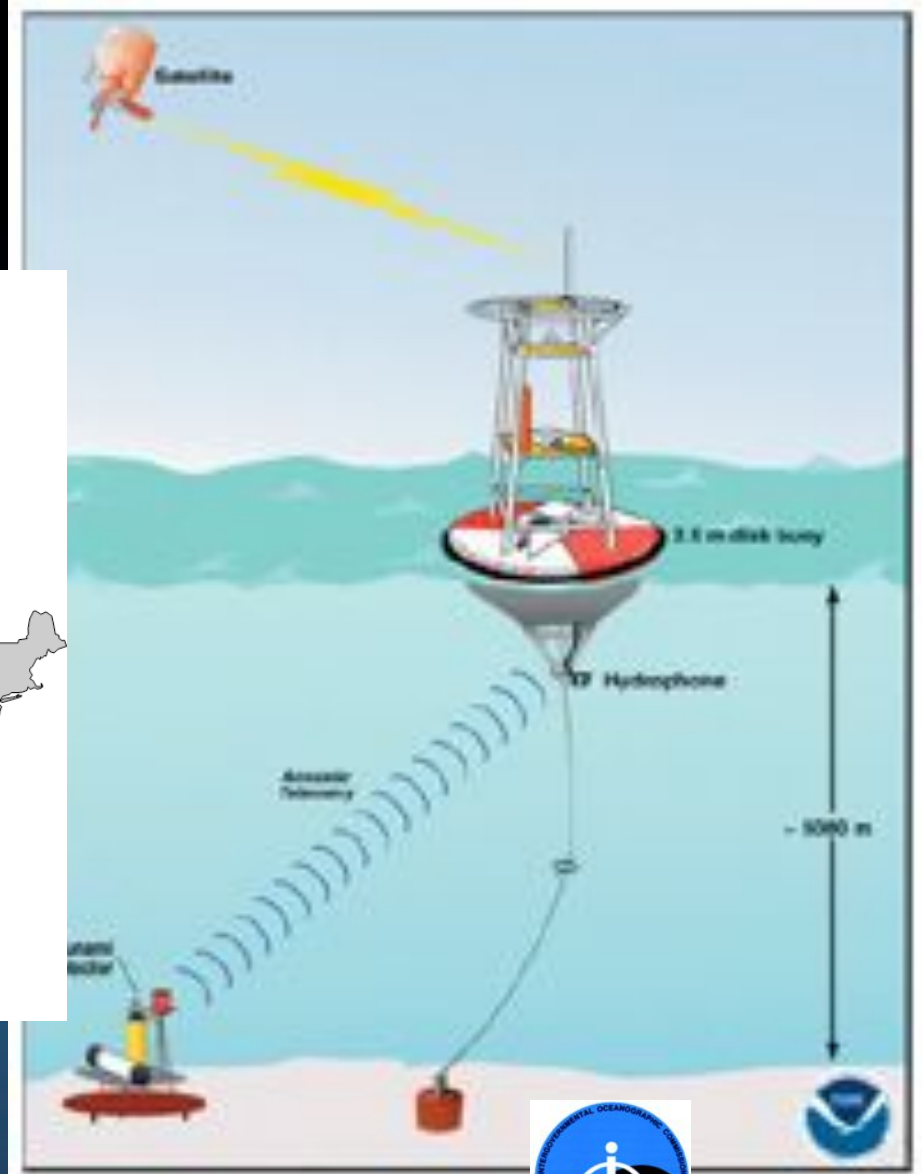
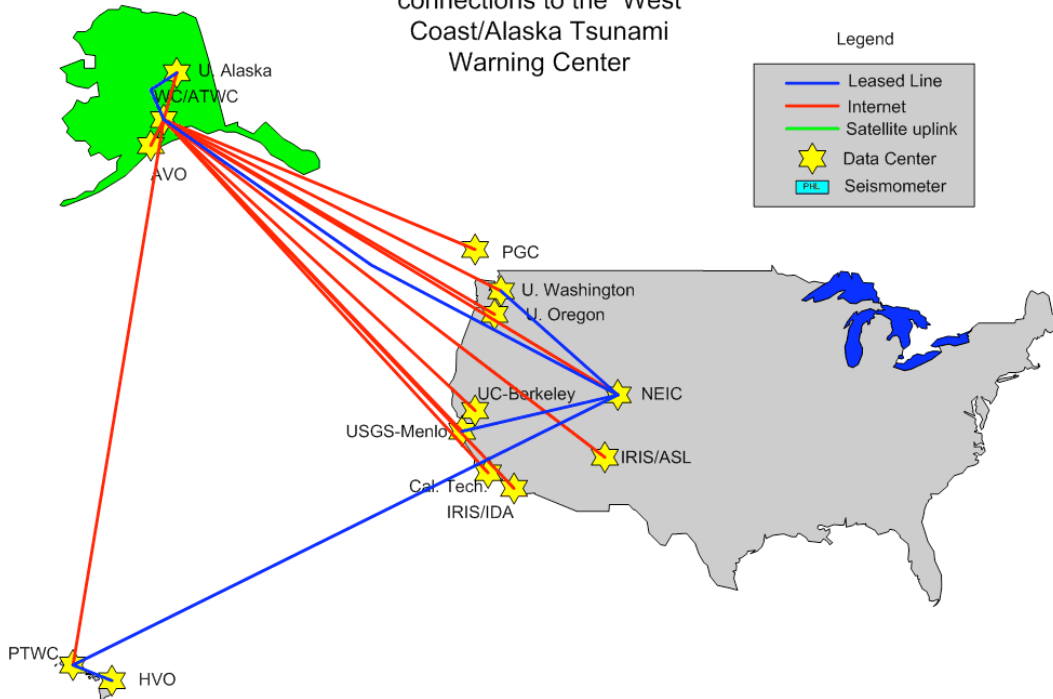
**Putting Down Roots for the Central US (coming soon)**



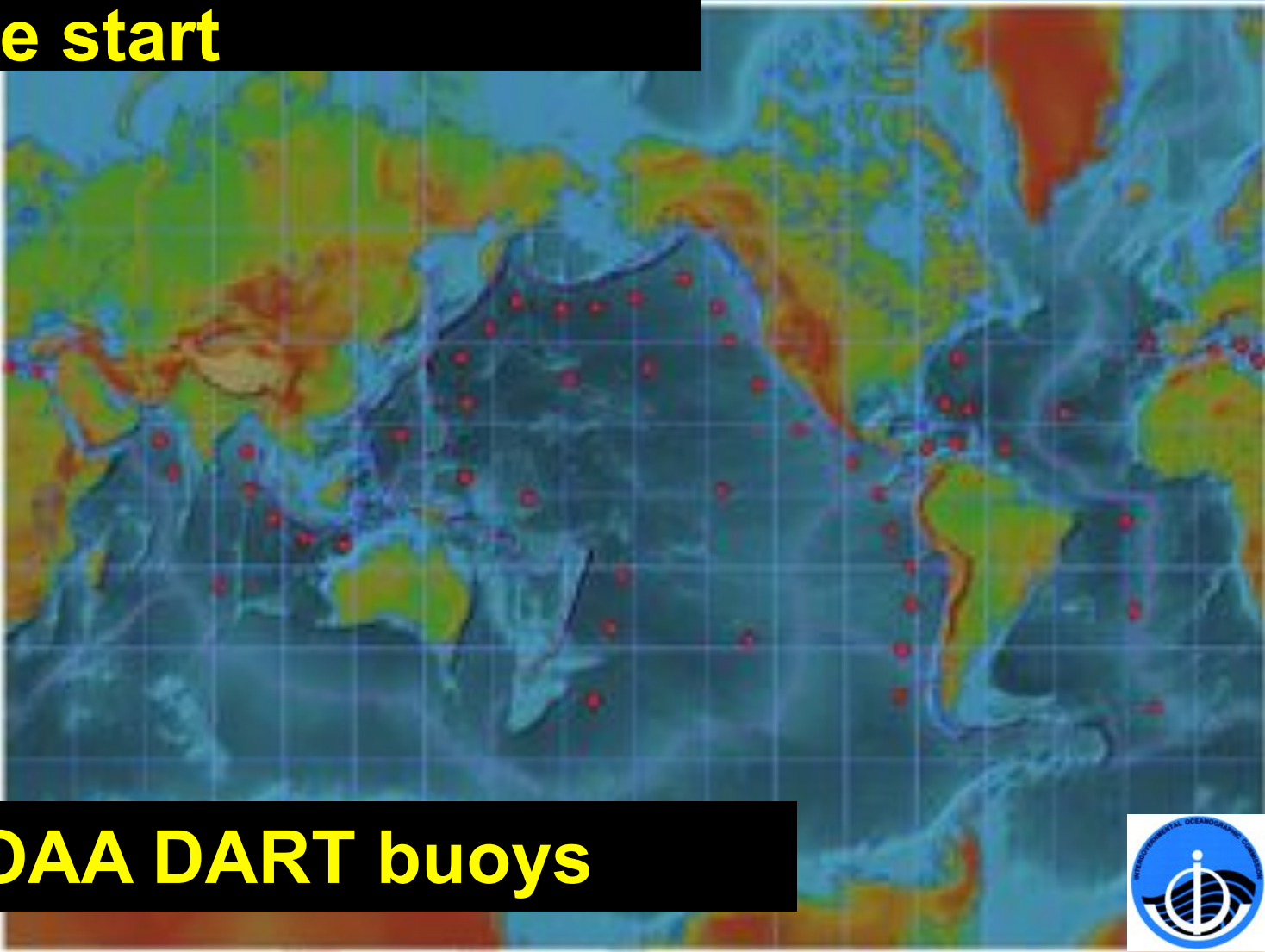
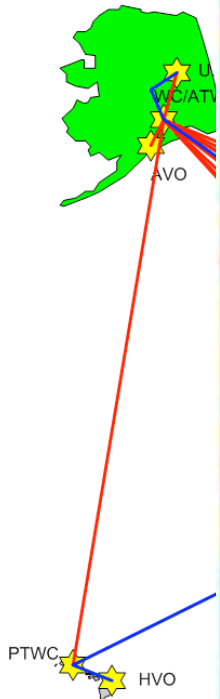
Utah Seismic Safety Commission  
American Red Cross, Pacific Gas & Electric and many more...

# For tsunamis, seismic is the start

Seismic Data Centers with connections to the West Coast/Alaska Tsunami Warning Center



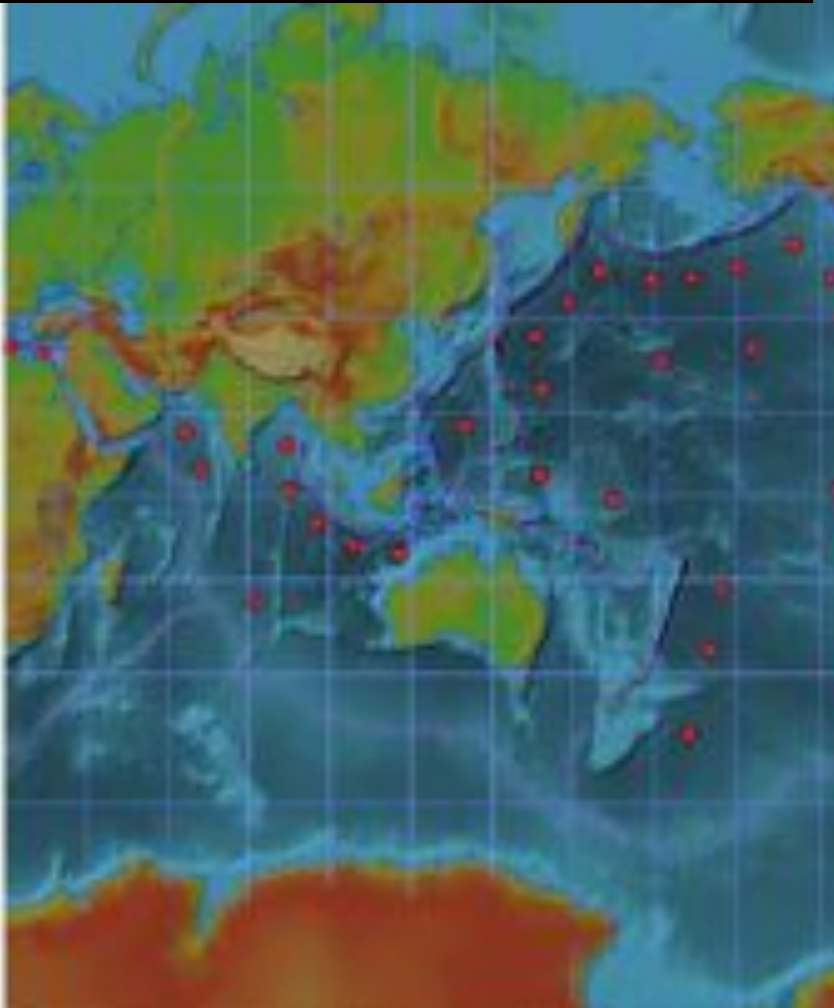
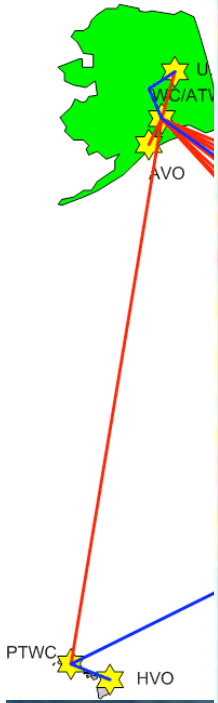
**For tsunamis, seismic is the start**



**NOAA DART buoys**



**For tsunamis, seismic is the start**



**The beach is the finish**



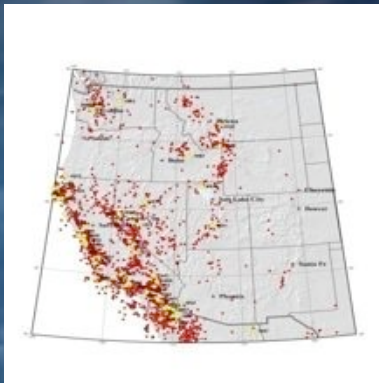
**All Hazard Alert Broadcast system installed at Ocean Shores, Washington.**

Credit: Washington Emergency Management



# National seismic hazard assessment inputs

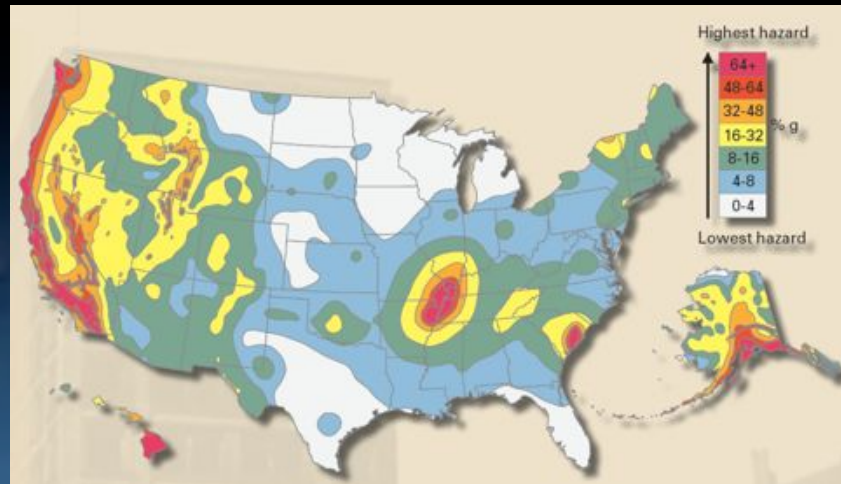
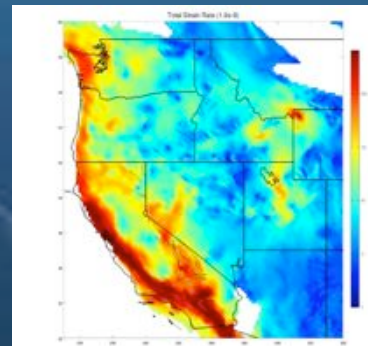
Seismicity



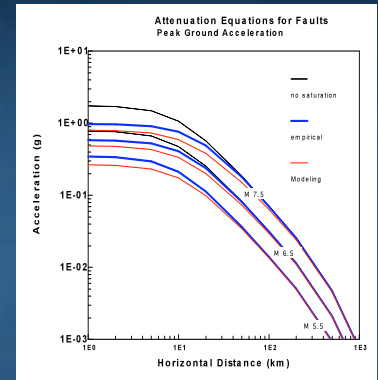
Quaternary Faults



Geodetics

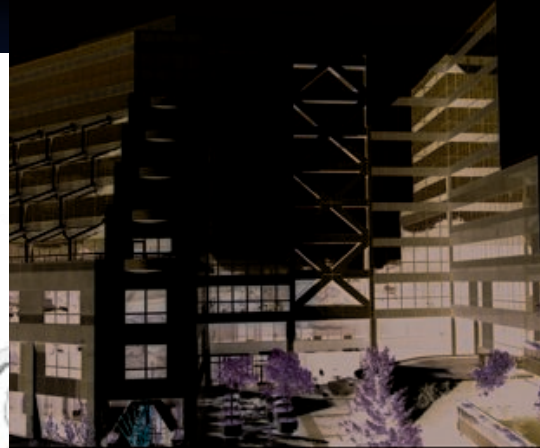
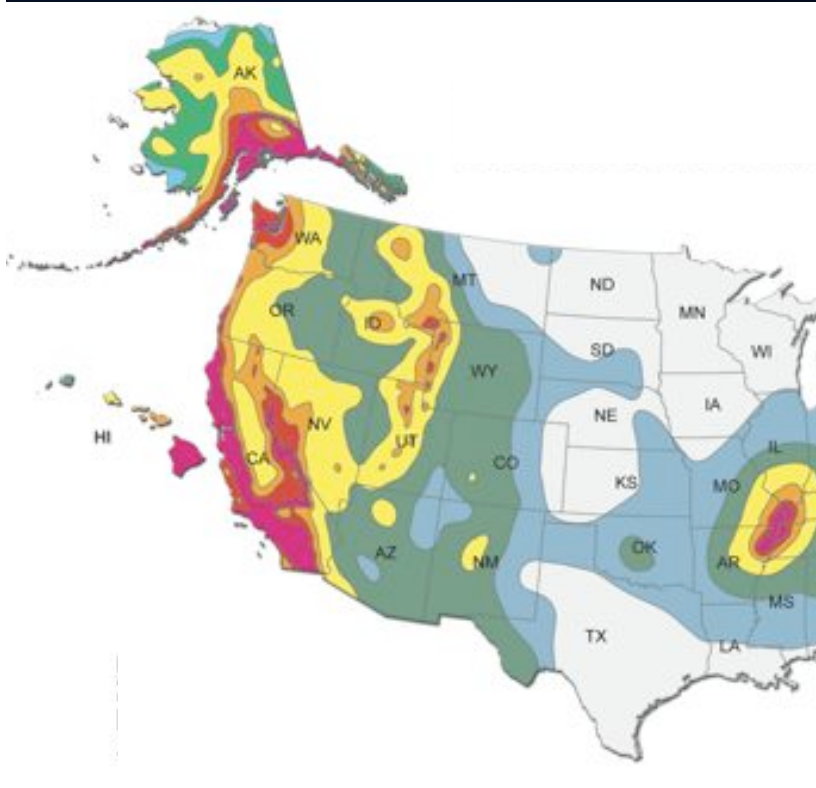


Attenuation Relations



Inputs are derived from regional geology, seismology, and crustal structure studies

# Translating USGS national hazard maps into model building codes



## NEHRP Recommended Seismic Provisions

for New Buildings and Other Structures

FEMA P-750 / 2009 Edition



USGS



Seismic element of NEHRP Provisions and Int'l Building Code based on the USGS national seismic hazard map

For more information on recent earthquakes,  
earthquake hazards,  
and USGS earthquake monitoring,  
research and hazards assessments, see:

[\*http://earthquake.usgs.gov\*](http://earthquake.usgs.gov)

 USGS

