Automated Methods for Personal Risk Management

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Forecasting vs. Prediction

Context	Characteristic	Alternatively
Prediction	A statement that can be validated or falsified with 1 observation	Prediction is characterized by a search for reliable precursors
Forecast	A statement for which multiple observations are required to determine a confidence level	Forecasting is characterized by a computation of probabilities

Types of Forecasts

- Fault-based forecasts
  - Focuses on individual faults
  - Needs information on fault properties, recurrence intervals, and other geologic data
  - Must make assumptions about fault-to-fault jumps of slip and other physical processes to calculate forecasts
  - Large logic tree
  - Assumptions must be made about fault slip segmentation
- Area-based forecasts
  - Focuses on earthquake activity in defined area
  - Needs seismicity data from catalogs
  - Uses the Gutenberg-Richter relation
  - Uses small earthquakes counts to forecast large earthquakes
  - Fault slip segmentation issues are considered automatically

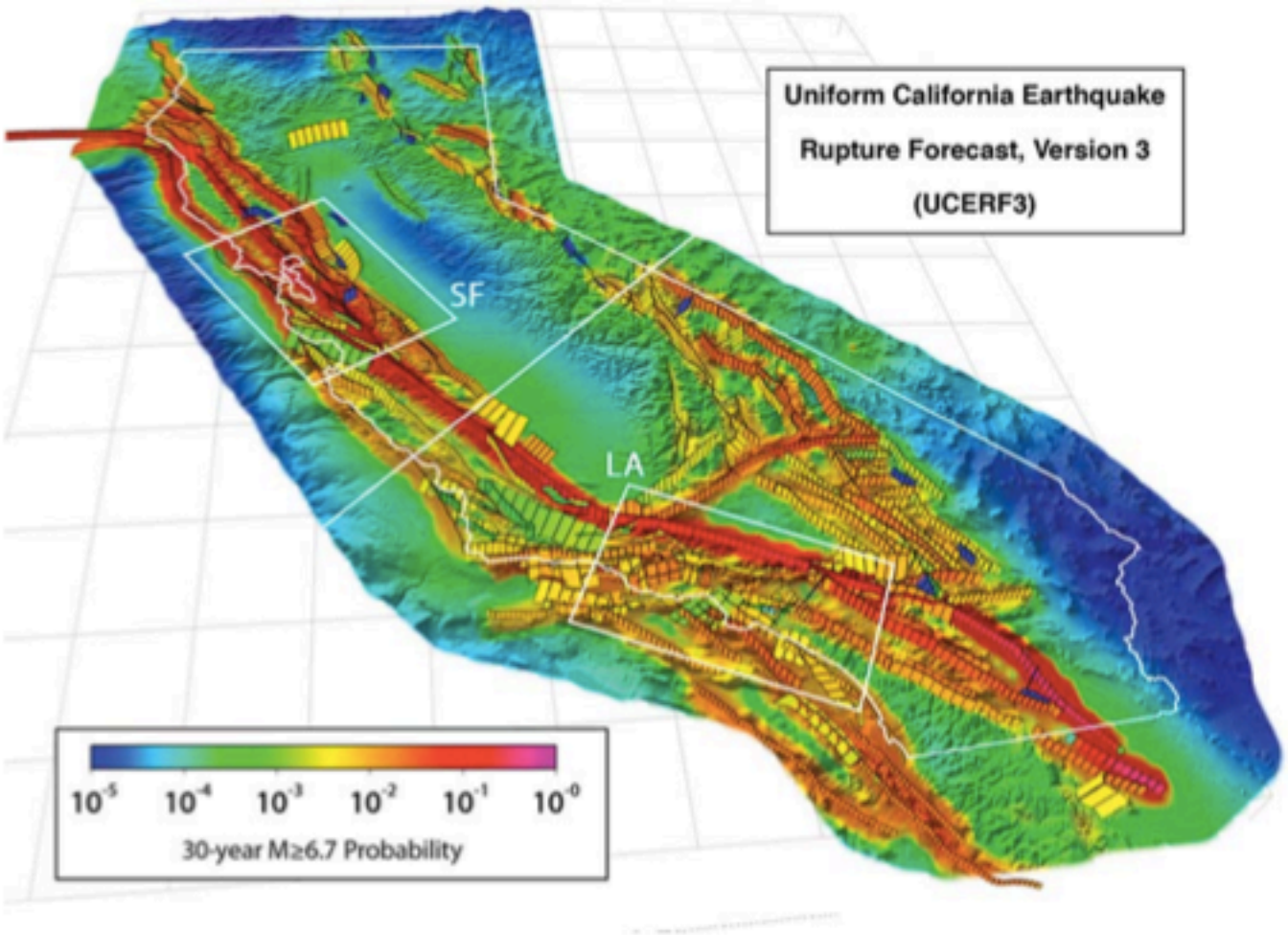

Figure 1. Three-dimensional perspective view of the third Uniform California Earthquake Rupture Forecast (UCERF3). The small black rectangular elements represent the 2606 fault subsections used in the forecast (for one of the two fault models, FM3.1). The along-strike length of each subsection is equal to half the down-dip width, and supraseismogenic ruptures are defined as two or more contiguous subsections. Colors depict the mean participation probability, the likelihood that each point will experience one or more $M \geq 6.7$ earthquakes in the 30 years following 2014 (for which participation means that some point on the rupture surface is within about 5 km). The entire colored area represents the UCERF model region, which comprises California and a buffer zone (referred to as All CA in the text). The white boxes define the San Francisco (SF) Bay and Los Angeles (LA) regions, respectively, and the white line crossing the state is our definition of northern versus southern California (referred to as N. CA and S. CA, respectively, in the text). The influence of the Cascadia megathrust is not shown on this map.

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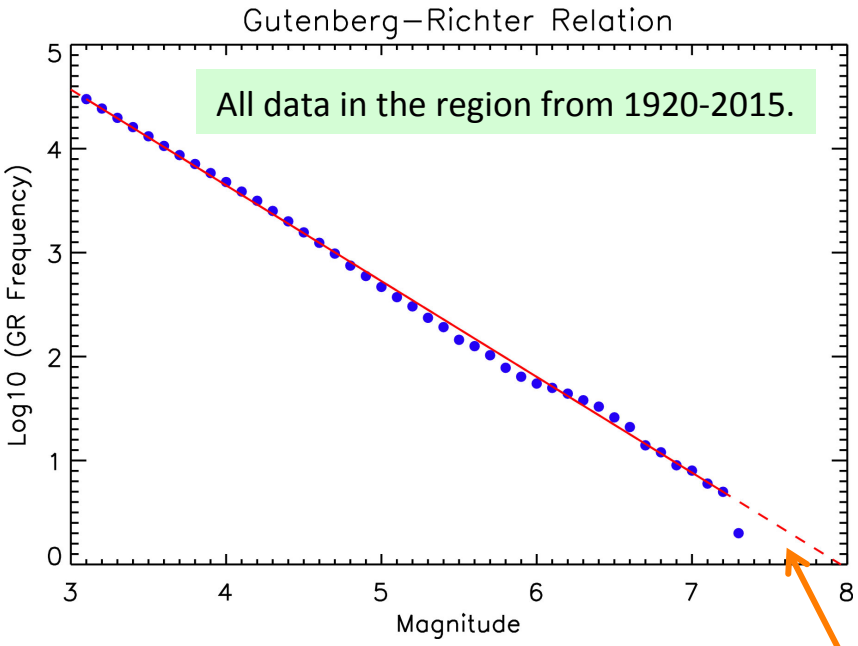
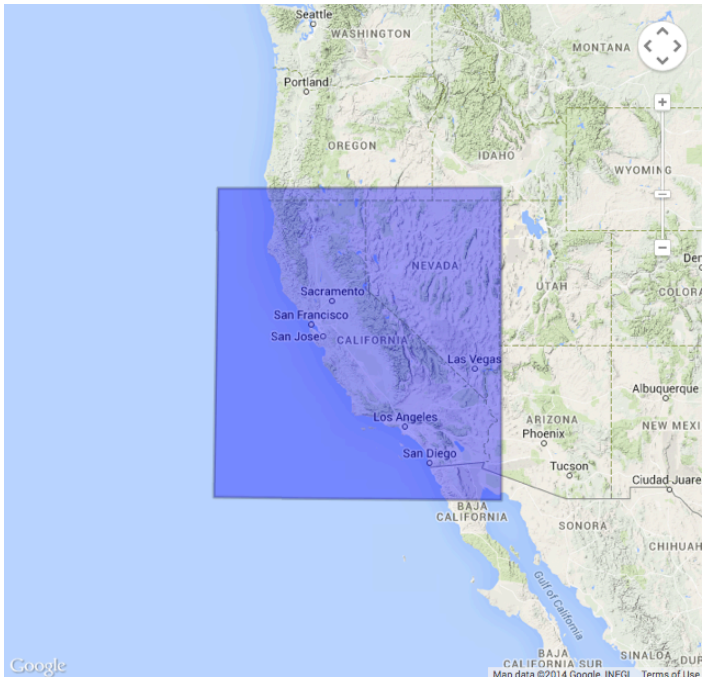
Large Region & Long Time

California-Nevada, 1920 to 4/1/2015





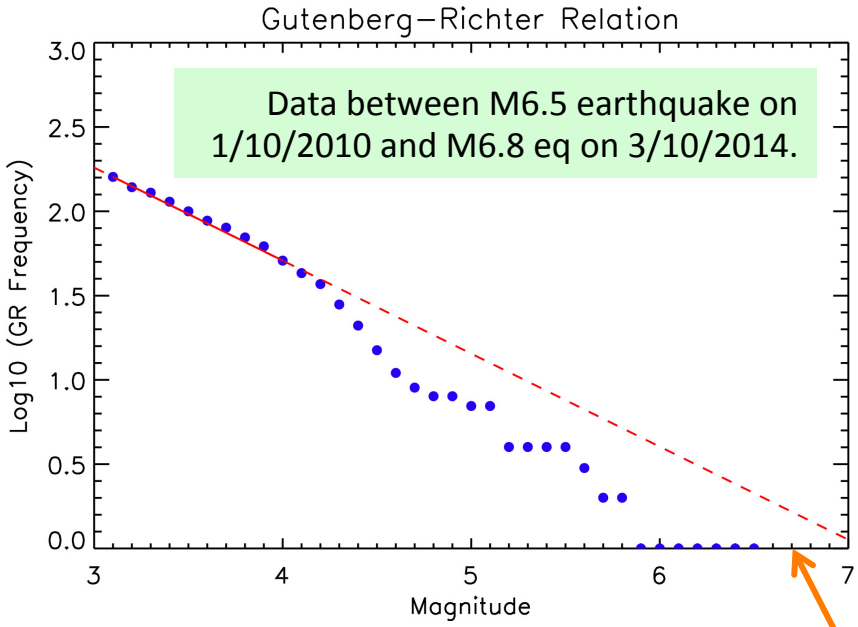
California-Nevada Region.

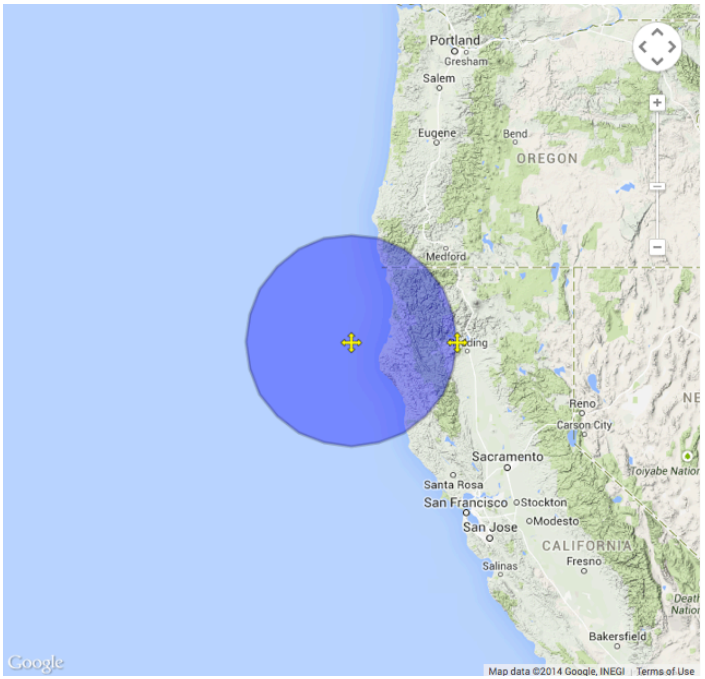
Scaling line has b=0.93

GR Relation indicates a deficit of earthquakes M>7.2, and that an M~8 earthquake is needed to complete the scaling relation.

Small Region & Short Time

North Coast, CA, 200 km Radius Circle, 1/10/2010 to 3/10/2014





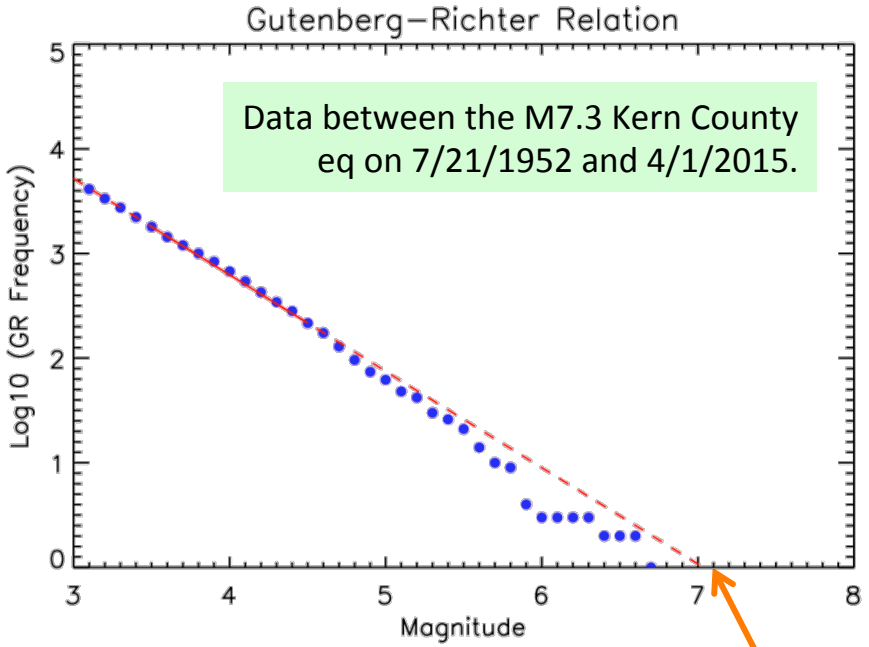
California-North Coast Region.
Earthquakes within 200 km radius of
40.67° N , -125.01° W.

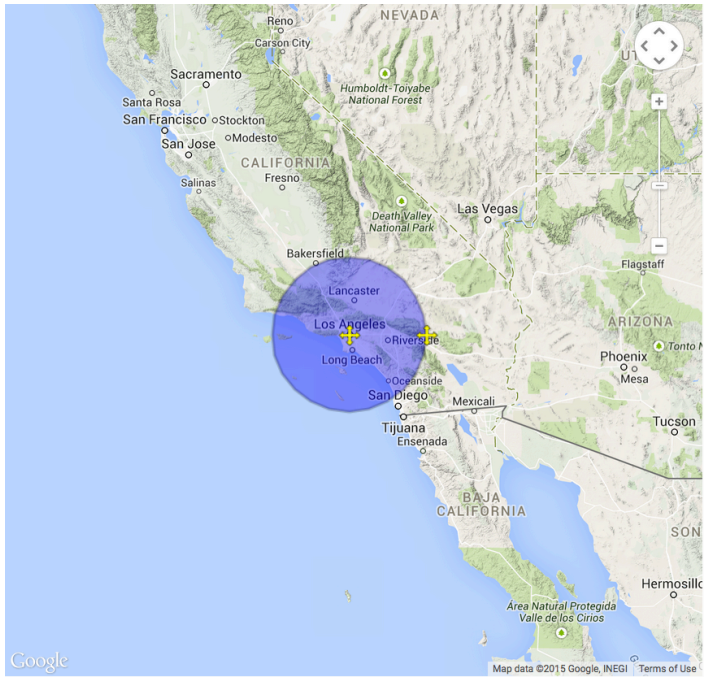
Scaling line has b = 0.53

GR Relation indicates a deficit of earthquakes M>4.0, and that an M~7 earthquake is needed to complete the scaling relation.

Small Region & Short Time

Los Angeles, CA, 160 km Radius Circle, 7/21/1952 to 4/1/2015





California-North Coast Region.
Earthquakes within 160 km radius of Los Angeles at 34.05° N , -118.25° W.

Scaling line has b = 0.91

GR Relation indicates a deficit of earthquakes M>5.5, and that an M~7 earthquake is needed to complete the scaling relation.

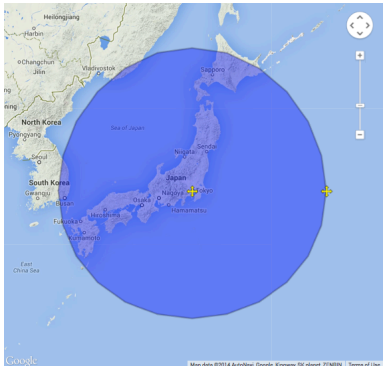
“Filling in” the Gutenberg-Richter Relation

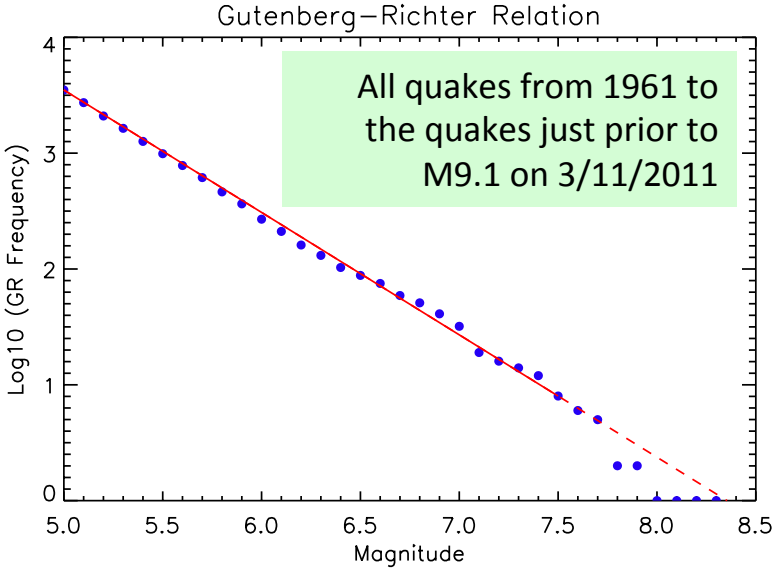
Statistics Before and After 3/11/2011

Radius of 1000 km Around Tokyo

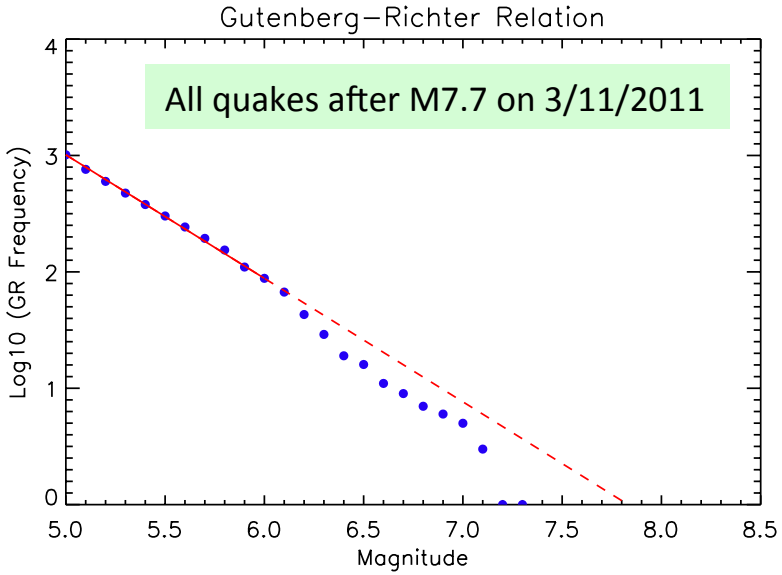
Data accessed 6/26/2014

b=1.01 +/- 0.01





“Normal” statistics



Deficit of large events

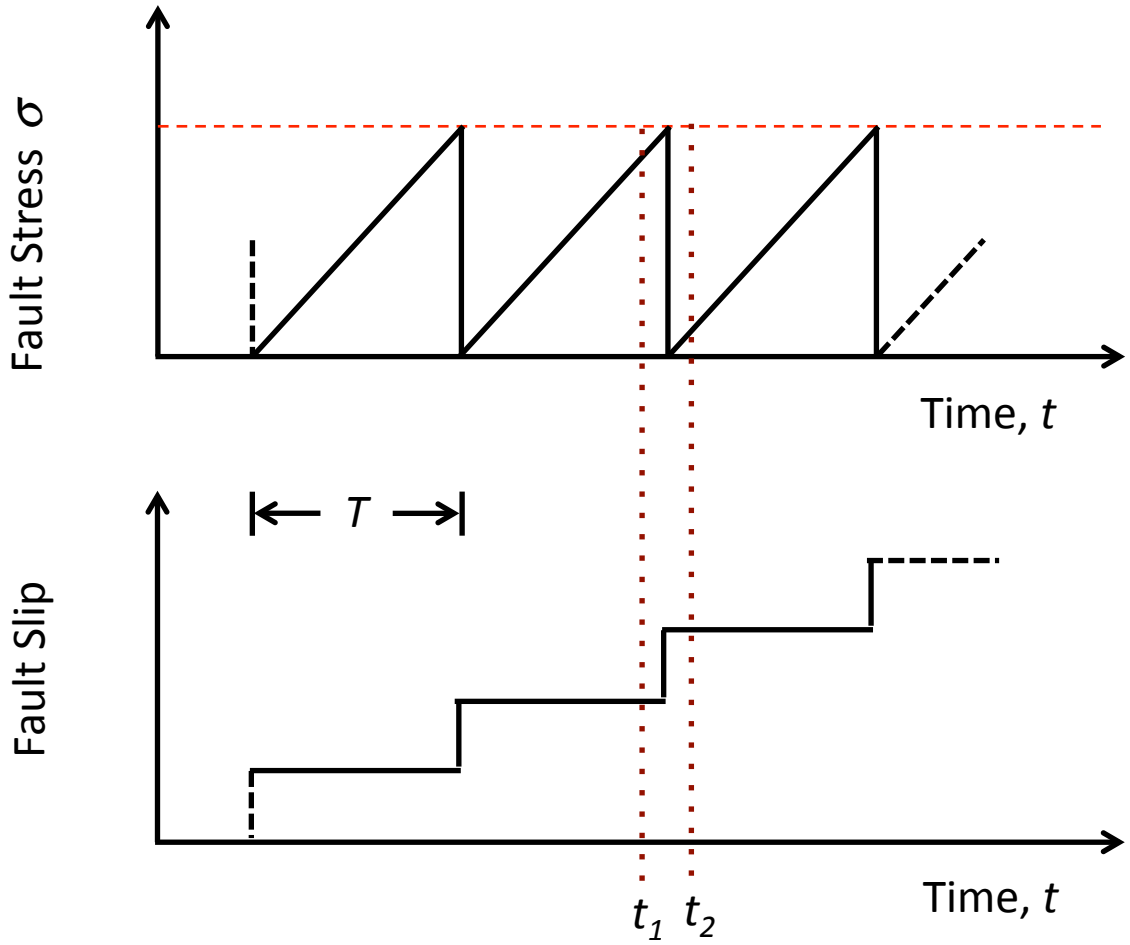
New Forecast Model: Natural Time Weibull (NTW)

- Count number of small earthquakes since the last large earthquake
- Deficit of large earthquakes relative to scaling line implies future large earthquake
- Use a standard probability model (e.g., Weibull) to quantify probabilities
- Select best parameters in probability model based on backtesting
- Account for finite correlation length between events

NTW Model displays the elastic rebound effect

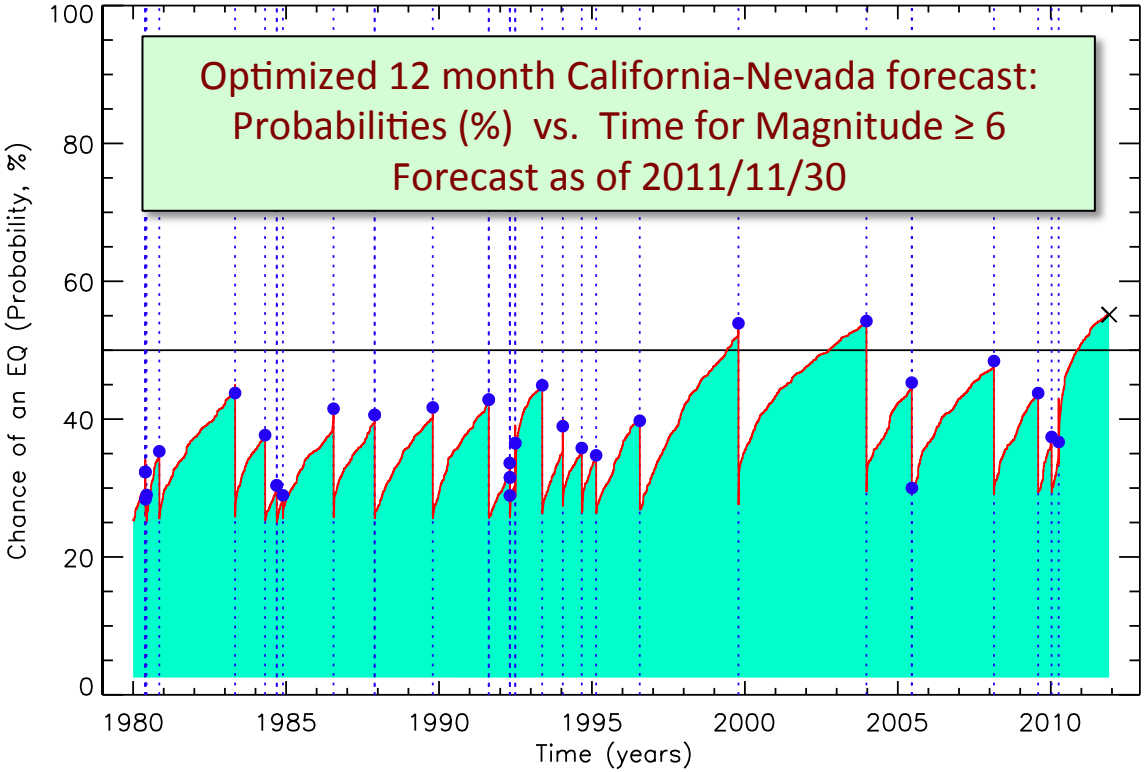
Idealized Model of Elastic Rebound on a Fault:

H.F. Reid (1910)

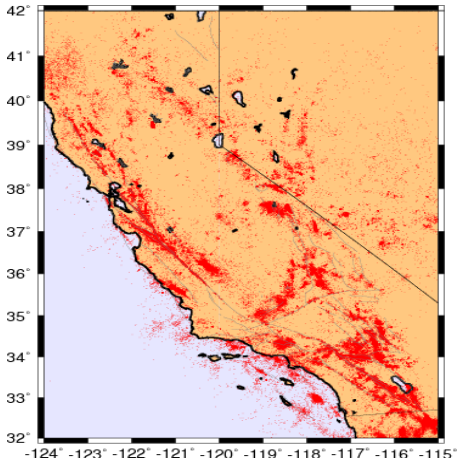


California-NV Forecast

Optimized 12 month California-Nevada forecast:
Probabilities (%) vs. Time for Magnitude ≥ 6
Forecast as of 2011/11/30

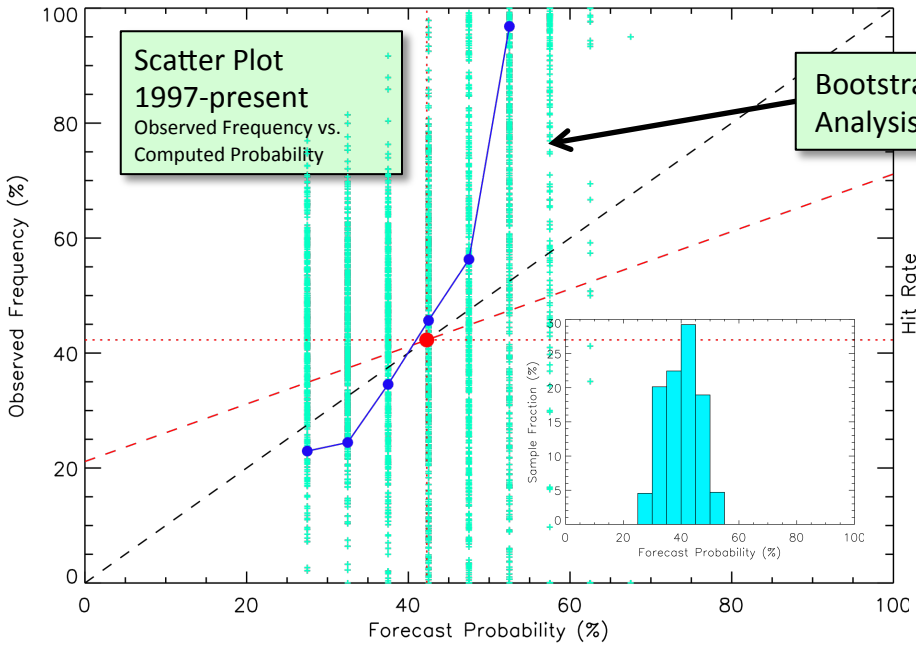


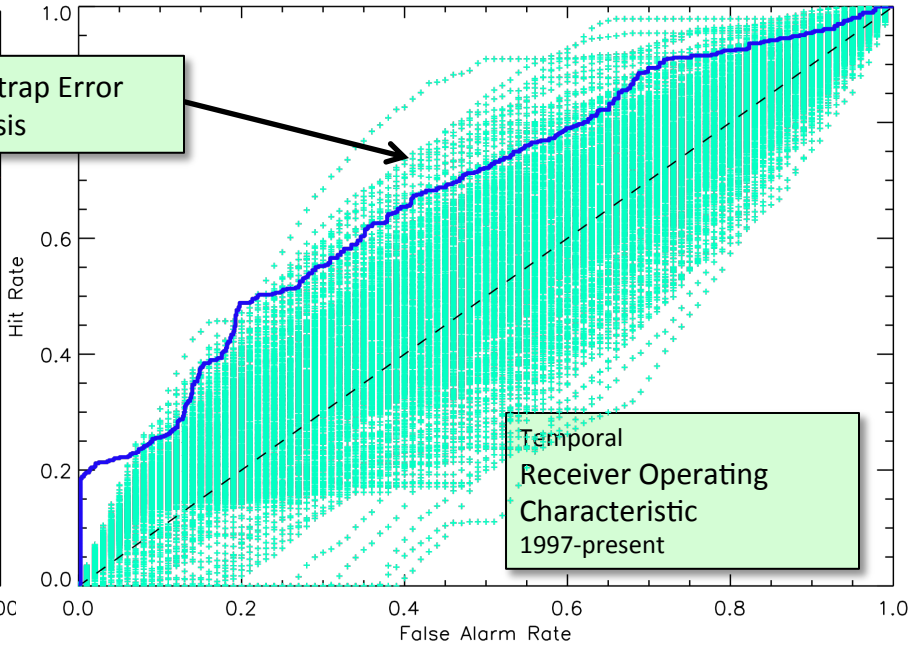
Optimal forecasts via backtesting, using common validation and verification testing procedures.



Scatter Plot
1997-present
Observed Frequency vs.
Computed Probability

Bootstrap Error Analysis



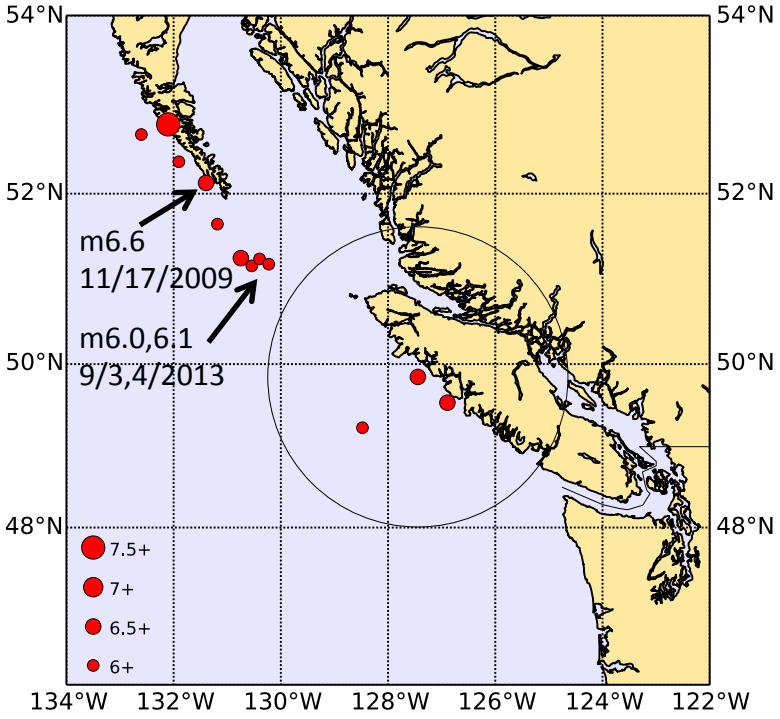


Temporal
Receiver Operating Characteristic
1997-present

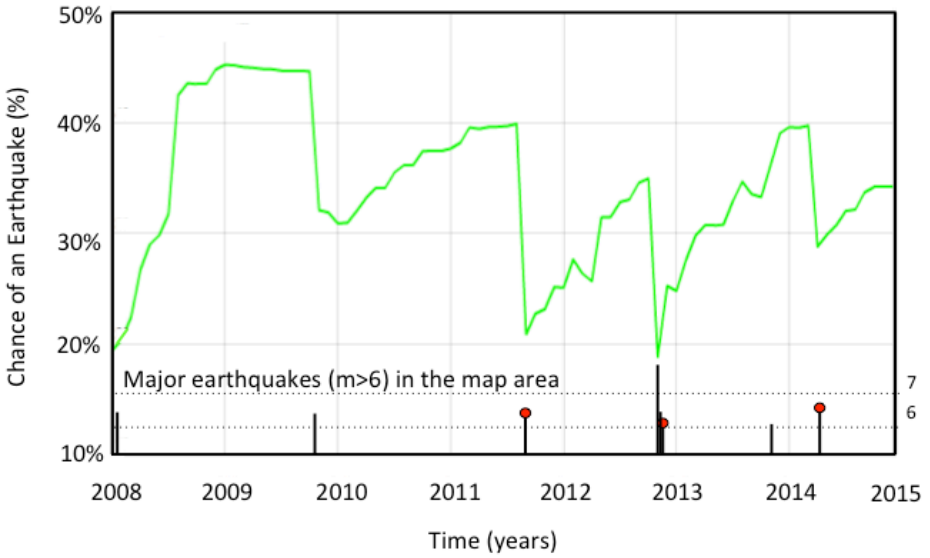
Example: Vancouver Island Earthquakes

Latest Significant Event was M6.6 on 4/24 /2014

JR Holliday et al, PAGEOPH (2014)



Chance of M>6 earthquake in circular region of radius 200 km for next 1 year.
Data accessed 12/02/2014



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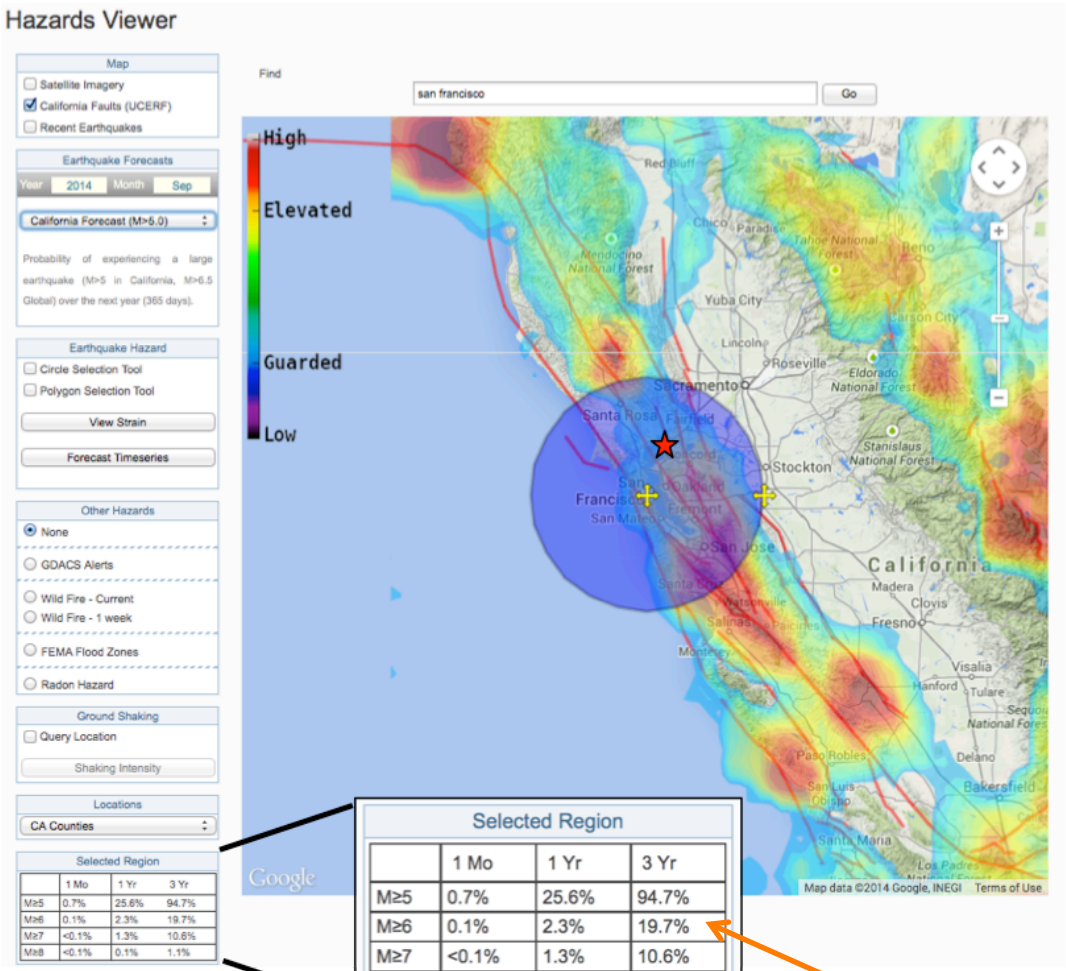
Probabilities can change rapidly

Napa earthquake forecast: 9/30/2014



M>6, 3 Years: 19.7%

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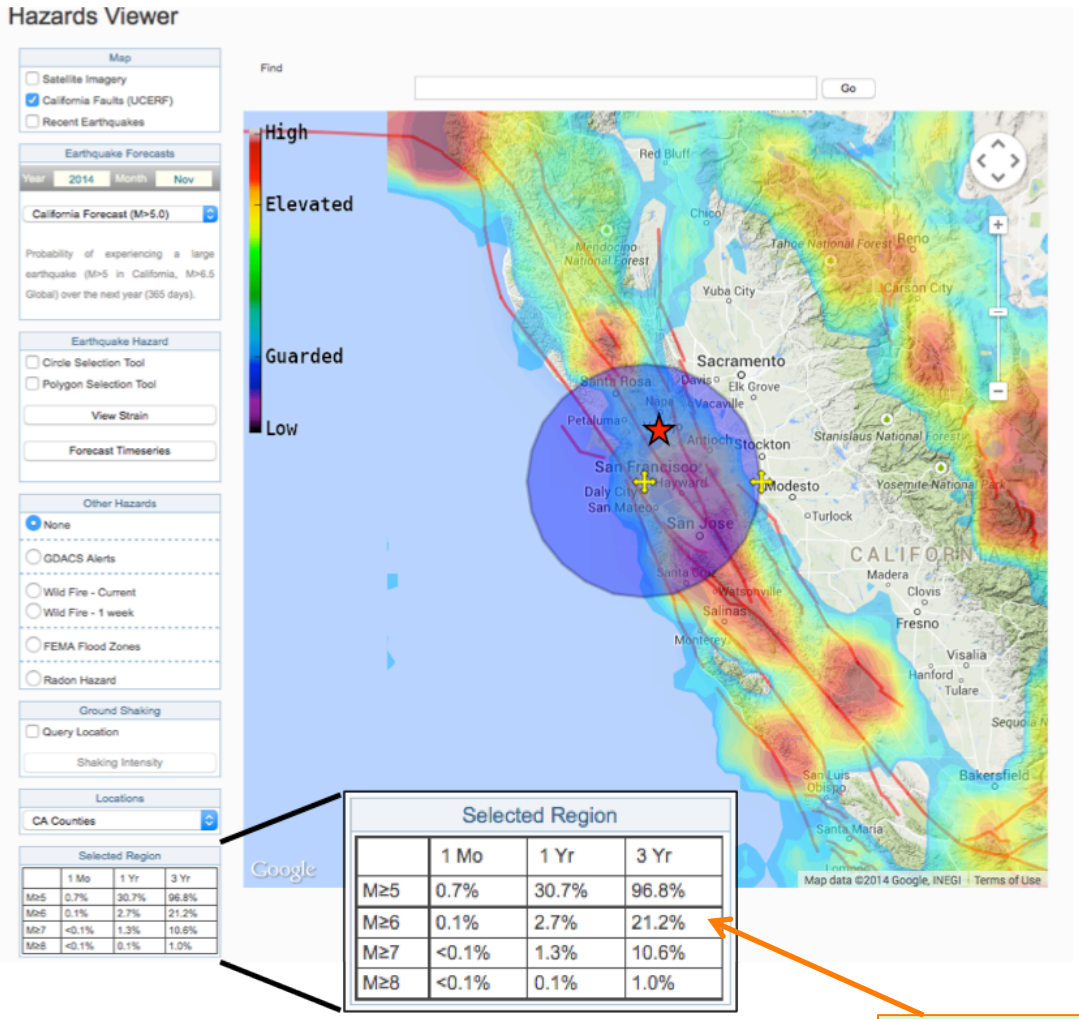
Probabilities can change rapidly

Napa earthquake forecast: 11/25/2014



M>6, 3 Years: 21.2%

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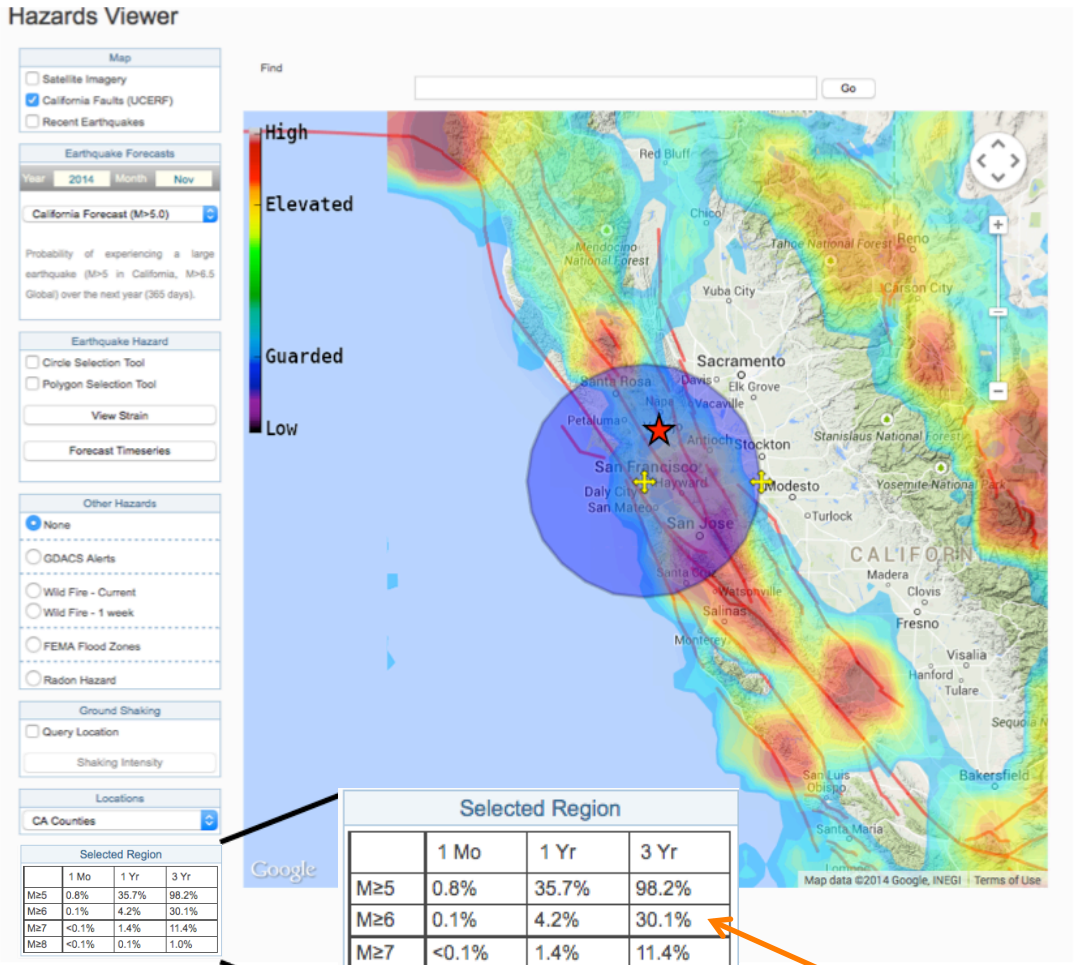
Probabilities can change rapidly

Napa earthquake forecast: 4/19/2015



Selected Region

	1 Mo	1 Yr	3 Yr
M≥5	0.8%	35.7%	98.2%
M≥6	0.1%	4.2%	30.1%
M≥7	<0.1%	1.4%	11.4%
M≥8	<0.1%	0.1%	1.0%

M>6, 3 Years: 30.1%

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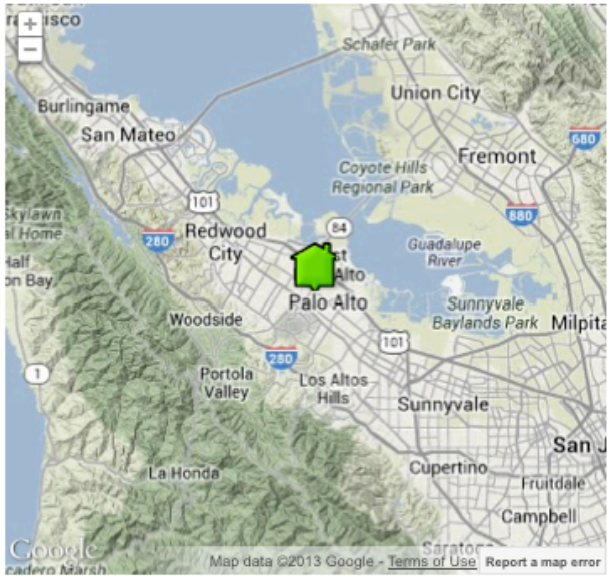
Home Damage Estimator

Calculate estimated damage to your home due to strong earthquakes in three easy steps.

Damage Factor: 0.0000

Step 1: Locate House

Drag the green house marker to your home's location or enter your street address in the search box below.



Address: 498 Fulton Street, Palo Alto, CA 94301

Search

Step 2: Describe House

Step 3: Place Sample Earthquake

Create Report

1. First, locate your house. You can do this by holding down on the green house marker in "Step 1" and dragging it to your home's location. You can also enter your street address in the search box.
2. Next, describe your house. You can do this by filling out the table in "Step 2". Initial guesses at appropriate values are supplied by Zillow.com.
3. Finally, place a sample earthquake to check for possible damage. You can do this by holding down on the red earthquake marker in "Step 3" and dragging it close to your home's location. The closer you place the earthquake, the more damage you'll see. You can also select a magnitude for the sample earthquake.

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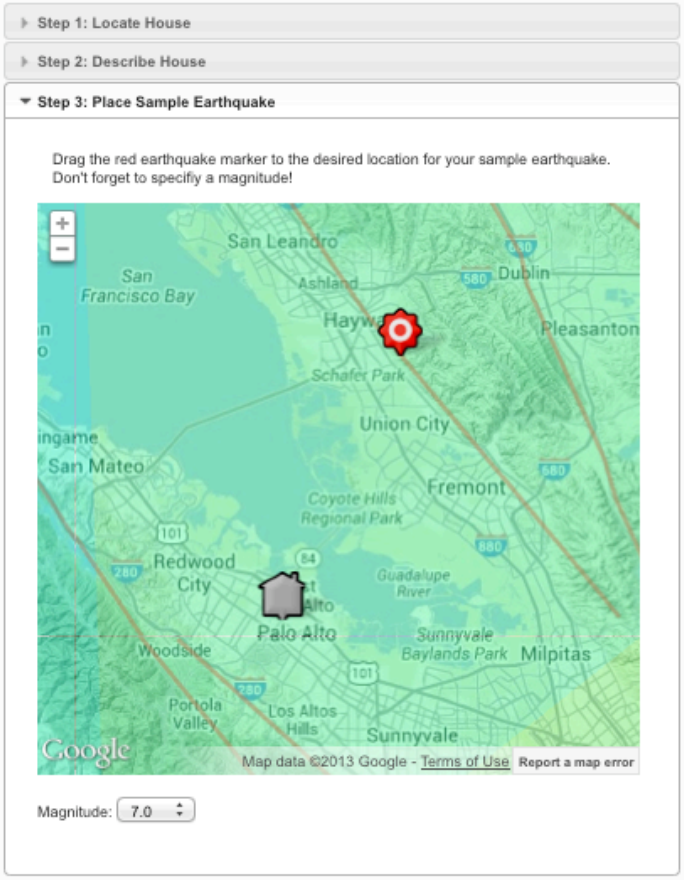
Damage Factor: 0.1432



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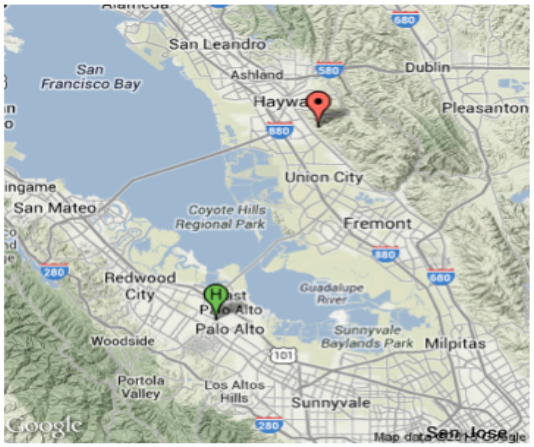
Risk Assessment For User Generated Home Values

Report Generated: Fri Jul 05 2013 14:18:41 GMT-0700 (PDT)

Your test earthquake produced a simulated peak ground acceleration (PGA) of 18.658%g at your home location. Given your description, the damage factor (DF) for this event is 0.1432. This means on average you would experience $87,000 in damage (assuming a home value of $605,972).



Address:	498 Fulton Street, Palo Alto, CA 94301
Earthquake Location:	37.642°N, -122.050°E
Magnitude:	7.0
Estimated PGA (%g):	18.658
Damage Factor:	0.1432
Estimated Damage:	$87,000

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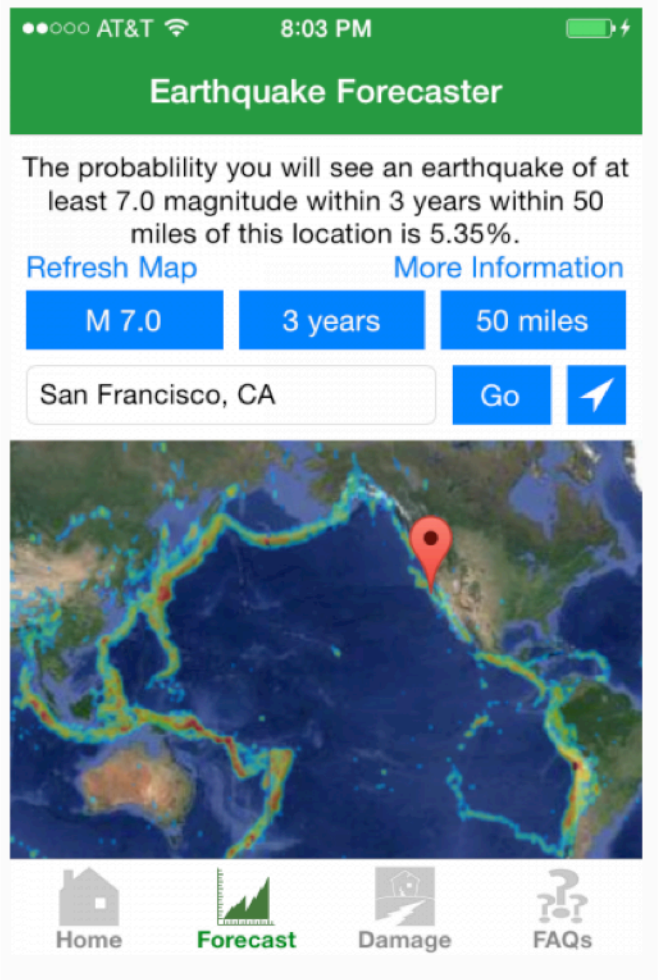
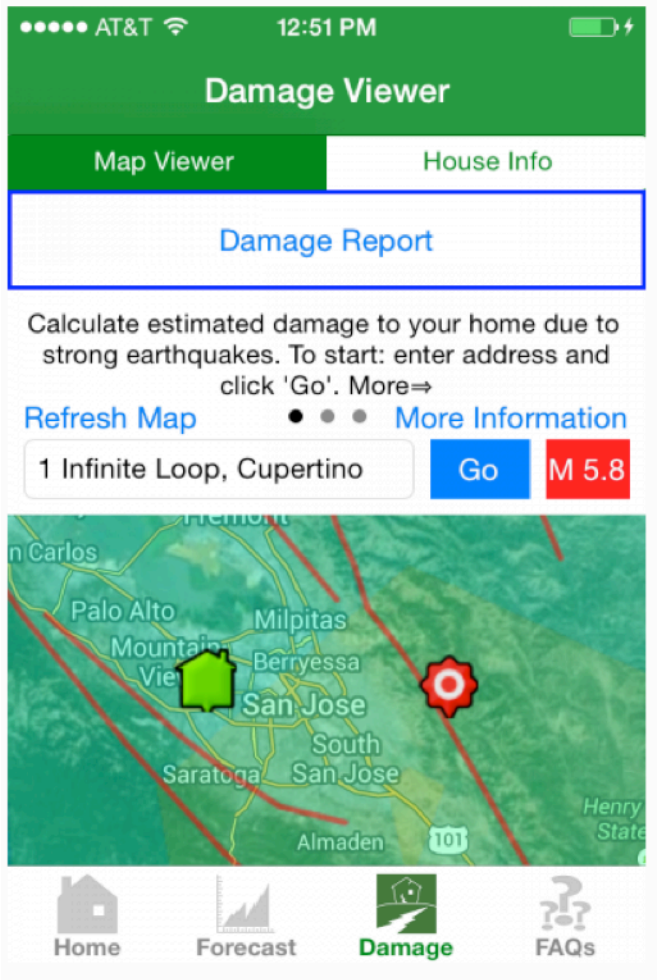
QuakeWorks Mobile App (iOS)





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