

Estimation of Short Term Shelter Needs – FEMA Earthquake HAZUS Model

Techniques & Results

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Planning for Estimated Shelter Needs

- Social Services Agency request for assistance.
- Required to plan for shelter capacity.
- Future earthquake location and severity is not certain.
- The need to plan capacity is certain.



HAZUS PARAMETERS



- HAZUS contains DEFAULT parameters which can be used in a standardized methodology to determine the estimated short term shelter needs.
- HAZUS model has pre-defined ground-motion estimates that can be used or you can add refined scenarios from the USGS.
- No adjustment of parameters was made for our study.

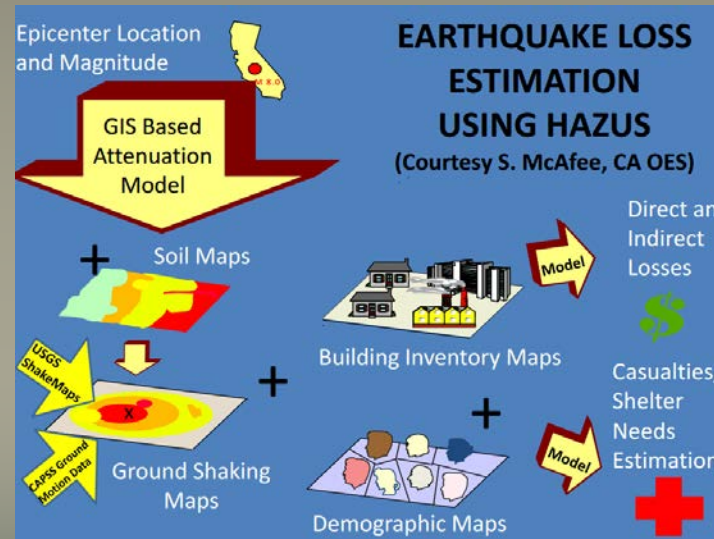
SCENARIOS



- Historic Epicenter Event
- Source event
- Arbitrary event
- Probabilistic Hazard
- User-supplied Hazards
- USGS Shake Map



- Historic Epicenter Event
- Arbitrary event
- USGS Shake Map



SCENARIOS



USGS ShakeMap Scenario		
Category	Magnitude	Scenario
USGS1	7.1	N. San Andreas; Santa Cruz Mountain
USGS1	7.2	N. San Andreas Peninsula
USGS1	6.9	Hayward-Rodgers Creek; Hayward S
USGS1	6.9	Calaveras North
USGS1	7	Hayward-Rodgers Creek; Hayward N + S
USGS2	7.9	N. San Andreas; Offshore + North Coast + Peninsula + Santa Cruz Mountain
USGS2	7.5	N. San Andreas; Peninsula + Santa Cruz Mountain
USGS3	7.3	HRC+HS+HN+RC
USGS3	7.8	SAF+SAP+SAN+SAO
USGS3	7.9	SAF+SAS+SAP+SAN+SAO

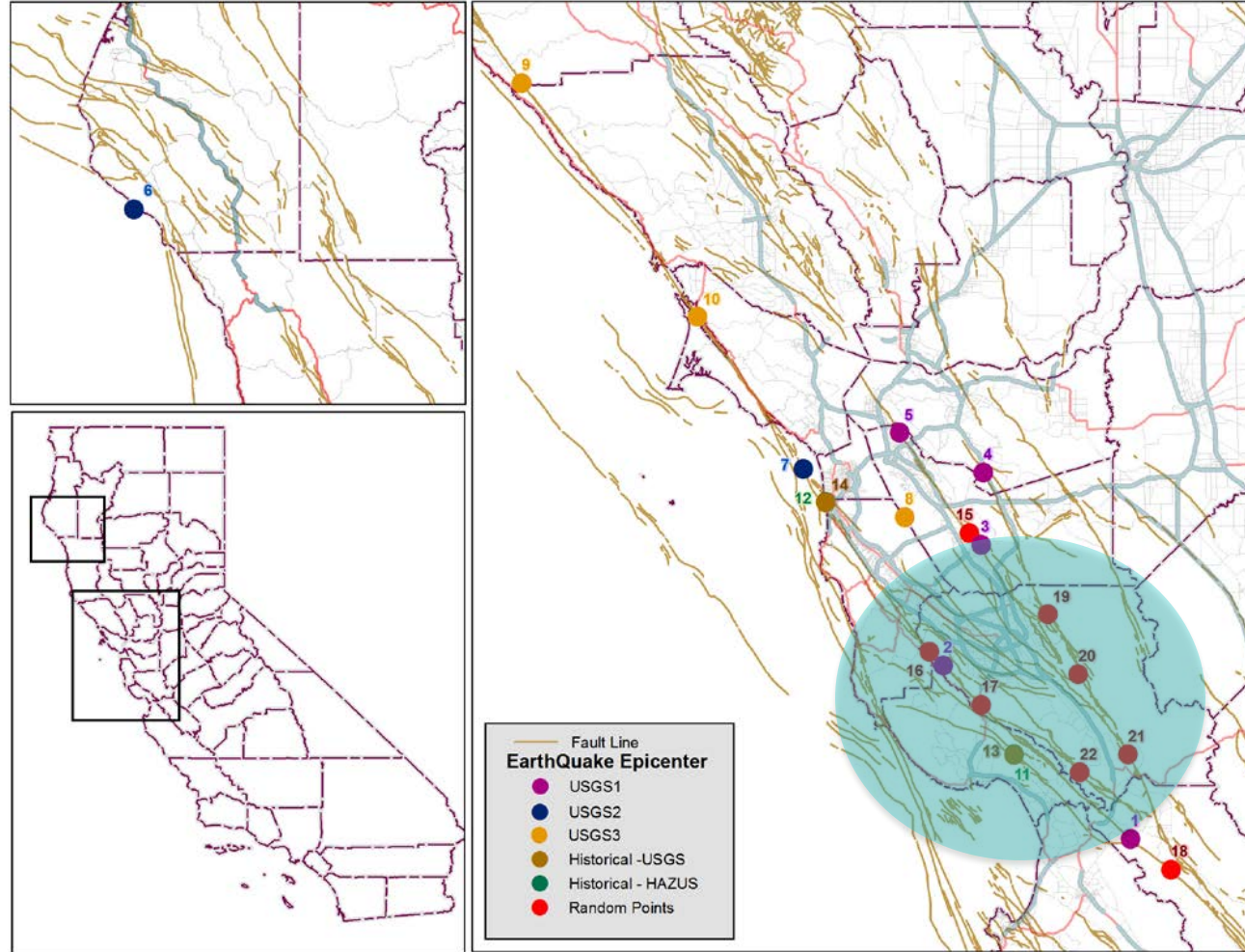
We choose many scenarios to do the sensitivity analysis and could compare with different results.

Historical- Hazus Scenario		
Category	Magnitude	Scenario
Historical - HAZUS	6.89	N. San Andreas; Santa Cruz Mountain
Historical - HAZUS	7.8	N. San Andreas Peninsula
Historical - HAZUS	6.89	Hayward-Rodgers Creek; Hayward S
Historical - HAZUS	7.8	Calaveras North

Random Scenario		
Category	Magnitude	Scenario
Random	8	Hayward Fault
Random	6.8	N. San Andreas; Santa Cruz Mountain
Random	7.8	San Andreas Fault - Middle
Random	7.5	San Andreas Fault - South
Random	7.2	Calaveras Fault
Random	7.4	Calaveras Fault
Random	7.8	Calaveras Fault South
Random	6	Sargent Fault



SCENARIOS



SCENARIOS / RESULTS

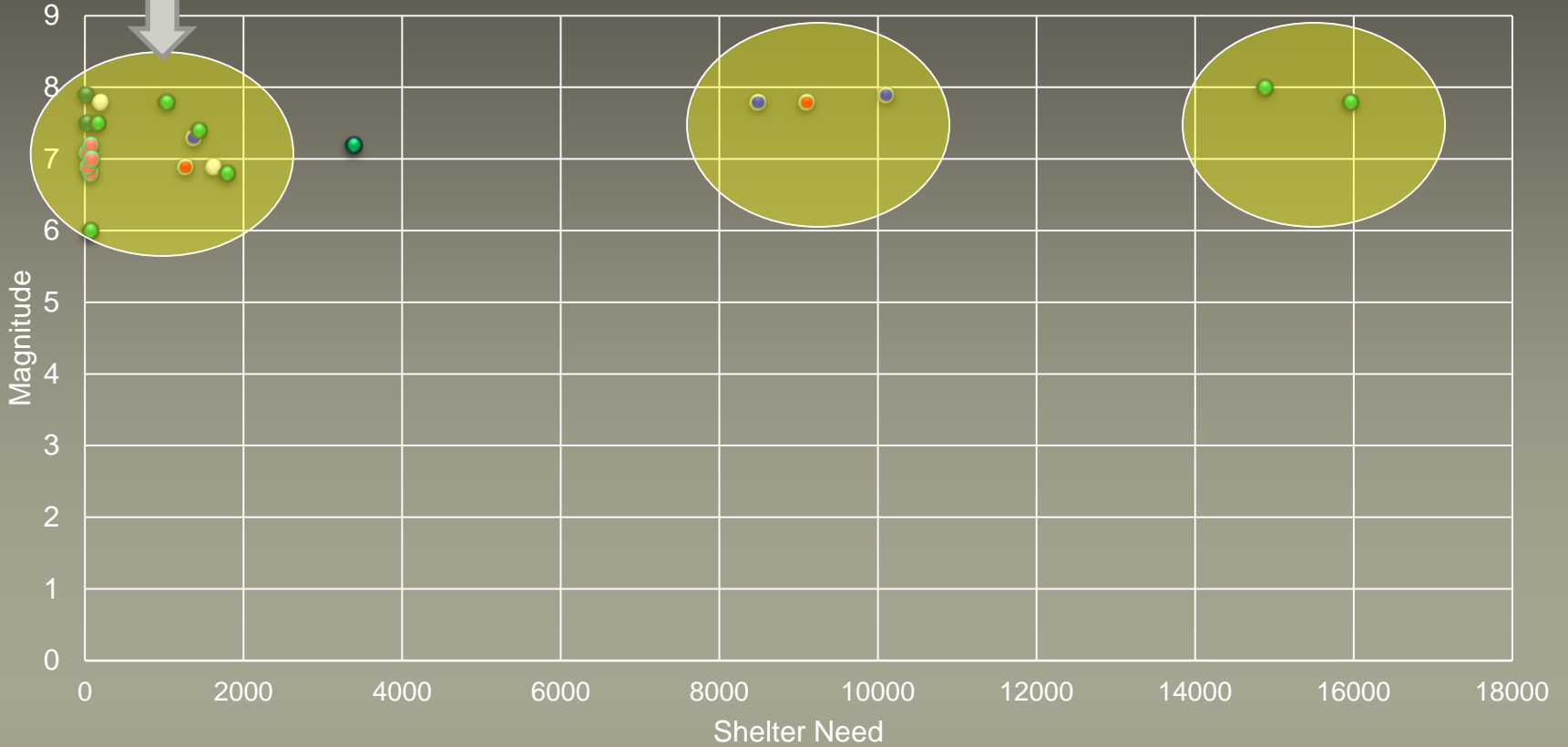
	Category	Magnitude	Name	Latitude	Longitude	Depth	Shelter Needs	Comment Reference
1	Top Five	7.1	N. San Andreas; Santa Cruz Mountain	36.8187	-121.498	12km	73	(1)
2	Top Five	7.2	N. San Andreas Peninsula	37.2728	-122.113	11km	202	(1)
3	Top Five	6.9	Hayward-Rodgers Creek; Hayward S	37.5872	-121.981	9Km	142	(1)
4	Top Five	6.9	Calaveras North	37.7763	-121.981	9Km	100	(1)
5	Top Five	7	Hayward-Rodgers Creek; Hayward N + S	37.8793	-122.257	8Km	173	(1)
6	Other Five	6.4	Calaveras Central	37.4359	-121.798	7km	31	(1)
7	Other Five	6.5	Calaveras Central + South	37.4268	-121.789	7km	51	(1)
8	Other Five	6.5	Monte Vista-Shannon	37.3106	-122.12	3km	456	(1)
9	Other Five	7	Zayante-Vergeles	36.8048	-121.551	10km	16	(1)
10	Other Five	7	Greenville	37.5099	-121.546	12km	3	(1)
11	Historical - HAZUS	6.89	Lomapieta1989_historic	37.04	-121.88	10Km	2,607	(2)
12	Historical - HAZUS	7.8	CA1906_historic	37.7	-122.5	10Km	709	(3)
13	Historical -USGS	6.89	Lomapieta1989_shakemap	37.04	-121.88		1,711	(2)
14	Historical - USGS	7.8	CA1906_shakemap	37.7	-122.5		8,128	(3)
15	Random	8	Hayward Fault	37.62	-122.03	10Km	15,275	
16	Random	6.8	San Andreas Fault - North	37.31	-122.16	10Km	2,463	
17	Random	7.8	San Andreas Fault - Middle	37.17	-121.99	10Km	16,241	
18	Random	7.5	San Andreas Fault - South	36.99	-121.66	10Km	406	
19	Random	7.2	Calaveras Fault	37.41	-121.77	10Km	4,314	
20	Random	7.4	Calaveras Fault	37.25	-121.67	10Km	1,842	
21	Random	7.8	Calaveras Fault South	37.04	-121.5	10Km	1,858	
22	Random	6	Sargent Fault	36.99	-121.66	10Km	123	



Majority of the scenarios are for 0 to 2000 shelter need

RESULTS

Shelter Need Calculated by Hazus



● USGS1 ● USGS2 ● USGS3 ● Historical - HAZUS ● Historical - USGS ● Random

● Three Clusters (0 to 2000, 8000 to 10000 & 14,000 to 16,000 population)

Model Adjustments

Contractor Parameter Adjustments & Results



- They updated the Hazus default general building stock data with the County's tax assessor data.
- They added NEHRP soils and liquefaction susceptibility data to the analysis.

Scenario	Number of Persons Requiring Short- Term Shelter
100-Year Shaking from Earthquakes	9,185
500-Year Shaking from Earthquakes	34,220
San Andreas ShakeMap Scenario	3,742
Calaveras ShakeMap Scenario	805
Hayward ShakeMap Scenario	4,403

Compare Contractor Parameter Adjustments & Results with county's default parameter For 100 & 500 probabilistic hazard



Scenario	Number of Persons Requiring Short- Term Shelter (by Tetra Tech)	Number of Persons Requiring Short- Term Shelter (by SCC employee)	Difference
100-Year Shaking from Earthquakes	9,185	5,480	3,705 (67.60%)
500-Year Shaking from Earthquakes	34,220	20,316	13,904 (68.43%)

MODEL VALIDATION



- No known location where estimated short-term shelter outputs are compared to actual shelter needs.
- Literature review and inquiries of Red Cross identified the following two U.S. events:
 - Northridge 1994
 - Napa 2014
- Are there other data points available?
- Has FEMA published empirical comparisons?

MODEL VALIDATION



1994 Northridge Earthquake

“Sheltering organizations had opened 23 congregate shelters by 9:00am on January 18 with 3,600 evacuees provided support in one night and 6,000 meals served. By the end of the second night, peak demand for shelter space was over 20,000 people and exceeded shelter capacity by approximately 13,000. On January 20, demand for shelter space still exceeded capacity by about 4,000. It was not until January 21 that shelter capacity exceeded the demand.”

Non-Traditional Shelter Case Studies, American Red Cross, December 31, 2011 accessed on December 22, 2014 at: http://catastrophicplanning.org/products/NTS_Case_Studies.pdf

Estimated Shelter Demand – HAZUS data	Estimated Shelter Demand – USGS shaking intensity	Experienced Shelter Demand – American Red Cross
Deterministic: Historical Epicenter 5672	“NorthRidge”	
12,983	16,906	20,000+

MODEL VALIDATION



2014 Napa

Six mobile homes at Napa Valley Mobile Home Park burned to the ground, officials said. Thirty-three buildings in the city of Napa were red-tagged as of 5 p.m., and numerous others were yellow-tagged, which means people were being granted only limited access.

Los Angeles Times August 24, 2014 accessed at: <http://www.latimes.com> on 4/7/2017

Estimated Shelter Demand – HAZUS data	Estimated Shelter Demand – USGS shaking intensity	Experienced Shelter Demand – American Red Cross
	Shakemap nc72282711	Per Red Cross utilization database
N/A	285	72

CONCLUSION / LIMITATIONS



- Can HAZUS be used without modification to estimate Short-Term Shelter Needs?
- Is there more work to do to catalog estimated versus actual needs?
- What are required modifications, if any, to HAZUS model inputs?

Question?

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