Earthquake

An earthquake occurs within the U.S. resulting in direct economic losses greater than $100 Million.

Data Summary

Table 1 shows the minimum, average, and maximum values for frequencies and impacts of national level earthquakes. Note that the low and high likelihoods do not correspond to the low and high impacts. In addition, low and high impacts are not necessarily correlated with each other between different impact categories.

Table 1

Category	Description	Metric	Low	Best	High
Health and Safety	Fatalities	Number of Fatalities[1]	0	370	8,900
	Injuries and Illnesses	Number of Injuries or Illnesses[1]	0	8,700	210,000
Economic	Direct Economic Loss	U.S. Dollars (2011)[1]	$110 Million	$8.7 Billion	$105 Billion
Social	Social Displacement[2]	People Displaced from Home ≥ 2 Days[3]	160	27,000	2 Million
Psychological	Psychological Distress	Qualitative Bins		See text	
Environmental	Environmental Impact	Qualitative Bins[4]		High[5]	
LIKELIHOOD	Frequency of Events	Number of Events per Year[6]	0.11	0.27	2

Event Description and Analytical Methods

For planning purposes, a national-level earthquake is defined as an earthquake producing direct economic loss in excess of $100 million dollars. The historical record of U.S. earthquakes during the 105-year time period from 1906 to 2011 was used estimate the interarrival rates/frequencies and impacts for earthquakes exceeding the $100 million threshold. To provide an accurate assessment for current year planning, historic damage estimates have been updated to estimate impacts for a 2011 base year. Economic and health & safety impacts, derived directly from historic record, are updated based on changes in populations, building structures, and

[1] Low, best, and high estimates for fatalities, injuries and illnesses, and direct economic loss are the historical minimum, average, and maximum for each impact type in the event set. Extremal events for one impact type may but generally do not correspond to those for other impact types.
[2] See discussion in text.
[3] See Social Displacement section in this summary sheet for details.
[4] The United States Environmental Protection Agency (EPA) convened an ad hoc group of environmental experts representing the fields of environmental science, ecological risk, toxicology, and disaster field operations management to estimate environmental impacts for this event. The comments and rankings presented in this Risk Summary Sheet have not undergone review by the EPA and only represent the opinions of the group. Estimates pertain to the potential for adverse effects on living organisms associated with pollution of the environment; they are grouped into high, moderate, low, and de minimus (none) categories. Experts provided both first and second choice categories, allowing the experts to express uncertainty in their judgments as well as reflect the range of potential effects that might result depending on the specifics of the event. The first choice represents the 'best' estimate.
[5] Earthquakes were given a best estimate of 'High' with a second best estimate of 'Moderate'. Experts assessed that the debris, devastation, and resulting chemical/contaminant releases which may be caused by an earthquake would have the potential to impact large areas.
[6] Historical lowest, average, and maximum number of events per year (calculated from interarrival times).

infrastructure. In total, 27 earthquakes[7] exceeding the $100 million threshold are aggregated in the findings of this report. The full list of national level earthquakes is located in Table 4.

Table 1 reports the maximum, average, and minimum frequency with which such earthquakes occurred in the United States, as well as the maximum, average, and minimum fatalities, injuries, and direct economic losses associated with earthquakes in the set. The oldest event included is the 1906 San Francisco earthquake and the most recent is the 2003 Paso Robles/San Simeon earthquake.

To obtain impact estimates, normalized fatality and economic loss estimates for United States historic earthquakes reported by Vranes and Pielke (2009) were used.[8] Normalization of impacts from historic record to present day values is performed by estimating changes in impact levels due to changes in population densities, community wealth, mitigation factors, and inflation. For most historic events, the present day community, with modern day structures and infrastructure, has a greater financial value than the community at the time of an event. Population densities have also changed. As the population increases, so too do the fatality and injury estimates for a given event. These increases, however, are offset, at least partially, by improving mitigation strategies. Improved building codes and emergency response substantially decrease the impacts caused by modern earthquakes. The impact estimates reported by Vranes and Pielke (2009) take into account the changes in mitigation strategies, population densities and wealth profiles when normalizing loss estimates to a 2005 base year. Because of the substantial changes in mitigation factors over the historical time period analyzed, a mitigation strategy was used in the normalization routine to relate loss rates to the year an event occurred. Three alternative mitigation rates were published by Vranes and Pielke (2009): no mitigation, a 1% per annum loss mitigation rate and a 2% per annum loss mitigation rate. The 2% mitigation rate was shown to have a lower correlation when compared to damage estimates normalized by magnitude and inflation[9] than the 1% mitigation rate; therefore, the 1% mitigation rate was chosen as the best available impact normalization factor available for the purposes of this analysis. In other words, the normalized losses were reduced by 1% for each year since the event occurred. The CPI deflator was used to convert reported economic loss estimates from 2005 to 2011 dollars; for fatality estimates, the 2005 base year was maintained. For more detailed information on the normalization routine and raw event data used in this report, please refer to Vranes and Pielke (2009).

Normalized estimates were not available for injuries. To estimate injuries, a linear model was generated that relates normalized fatalities to injuries based on the ratio of injuries to fatalities for a New Madrid event as reported by Elnashai, *et al*.[10] The linear model produces a multiplier that models the correlation between fatalities and injuries. Based on the New Madrid event estimates, a multiplier of 23.5 injuries per fatality was utilized in this report.

Low, best and high estimates were developed in the following manner from the normalized impact estimates and historic record. For fatalities, injuries and economic loss, the low estimate is the smallest impact for events that exceed $100 million. For economic loss, $107 million

[7] The April 1946 earthquake near Unimak Island, Hawaii resulting in a tsunami causing twelve fatalities and $200 million in inflation-adjusted property damage was excluded from the set to avoid double-counting with the Tsunami event.
[8] Vranes, K. and Pielke, R. (2009). Normalized Earthquake Damage and Fatalities in the United States: 1900-2005. *Natural Hazards Review* 10(3): 84-101.
[9] Ibid, p. 90.
[10] Elnashai, A.S., Jefferson, T., Cleveland, L. J., and Gress, T. (2009) Impact of New Madrid Seismic Zone earthquakes on the Central USA, Vol. 1. 2009 Mid-America Earthquake Center: University of Illinois. Available online at https://www.ideals.illinois.edu/handle/2142/14810. Accessed September 28, 2011.

(1992 Ferndale/Fortuna/Petrolia, California earthquake) is the smallest normalized historic loss that exceeded $100 million. Six historic events exceeding the economic threshold did not result in any fatalities and, consequently, were not estimated to cause any injuries resulting in a minimum for both fatalities and injuries of zero. For event frequency, the low estimate is derived from the greatest time gap, t_{max}, between two events. The greatest gap occurs between the 1906 San Francisco and the 1915 El Centro earthquakes. This nine year time lapse between national level earthquakes results in an interarrival frequency of 0.11, or $1/t_{max}$.

The best estimate is the average impact for events that exceed $100 million. The average economic impact is $8.7 billion per event. On average, 370 fatalities occur per event. An average of 8,700 injuries per event is using the multiplier technique described above. The average time between national level events is 3.7 years, resulting in 0.27 events expected per year. An estimate of the average annual loss for each impact type (e.g., fatalities per year or economic loss per year) can be obtained by multiplying the average frequency by the average impact in a category. The average annual fatality and economic losses for the set of 27 historic events analyzed are approximately 100 fatalities per year and approximately $2.3 billion per year. The average annual economic loss estimate computed using this subset of events is 50% less than FEMA's average annual loss estimate of $5.3 billion for the full set of earthquake hazards, computed using HAZUS modeling.[11] More information about the FEMA average annual loss estimate is provided below.

The meanings of the high estimates for impact and frequency differ. For impacts, the high estimates reflect the largest losses seen within the set of national level event earthquakes, i.e., those above the $100 million economic loss threshold. The high fatality estimate, for example, is the normalized estimate for the 1906 San Francisco earthquake of approximately 9,000 fatalities if it were to happen in the present day; this is the highest normalized fatality estimate for the events included in the analysis. A high estimate of 210,000 injuries per event is using the multiplier technique described above. The high estimate for frequency is the maximum number of times an earthquake resulting in losses greater than $100 million has occurred in a calendar year, or 2 times per year.

It is important to note that the frequency estimates reported here differ from probabilities. The frequency of a national-level earthquake can be greater than one, while a probability cannot. Additionally, while the average estimates for impacts and frequency are correlated and approximate the average annual loss when multiplied together, the maximum and minimum historical values for impact and frequency are uncorrelated and do not have meaning when multiplied together.

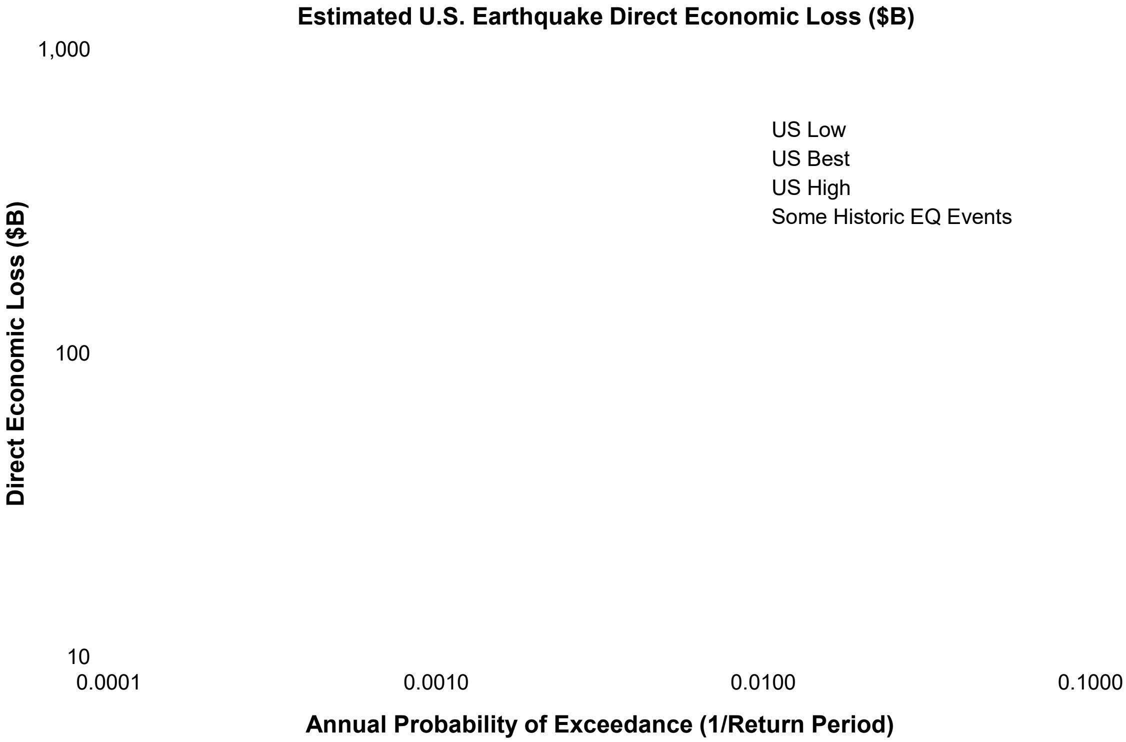
Expected Loss versus Return Period

Major earthquakes are commonly evaluated based on return period and expected loss. The return period vs. loss is an important perspective when evaluating historic data. The 105-year range used for impacts in Table 1 does not provide a record of all possible impacts. Low frequency events have the capacity to eclipse the greatest damage reports from historic events. Earthquake modeling can be used to estimate losses for events with limited historical precedence in the modern era. Figure 1 relates modeled earthquake economic losses to the annual probability of

[11] FEMA Publication 366: Hazus-MH Estimated Annualized Earthquake Losses for the United States, April 2008.

exceedance.[12] It is important to note that this is a modeled estimate, not actualized measured events.

Figure 1: Probability of Exceeding Direct Economic Losses



Social Displacement Estimates

For the purposes of the SNRA, social displacement was defined as the number of people forced to leave home for a period of 2 days or longer. Note that there are limitations to this measure of social displacement, as the significant differences between temporary evacuations and permanent displacement due to property destruction are not captured.

Social displacement estimates for national-level earthquakes were constructed from multiple data sources. The high estimate was provided by subject matter experts at FEMA and informed by experience with Hazus modeling as well as studies such as the analysis by Elnashai *et al*. (2009) of the number of people displaced from their homes and/or without electricity for greater than 3 days due to an earthquake in the New Madrid Seismic Zone.[13] The order of magnitude of the SNRA high estimate for the number of people displaced from home for 2 days or greater was validated for this earthquake event by a subject matter expert affiliated with the National Consortium for the Study of Terrorism and Responses to Terrorism (START), who noted that "displacement in millions due to fires, damaged critical infrastructure, damaged residential areas" was plausible for the scenario of a 7.8 magnitude earthquake occurring on the San Andreas fault in the Los Angeles metropolitan area studied by the U.S. Geological Survey

[12] Source: Modeling done by FEMA HAZUS contract support for the SNRA project team.
[13] Elnashai, A.S., Jefferson, T., Cleveland, L. J., and Gress, T. (2009) Impact of New Madrid Seismic Zone earthquakes on the Central USA, Vol. 1. 2009 Mid-America Earthquake Center: University of Illinois; at: https://www.ideals.illinois.edu/handle/2142/14810. Accessed on: September 28, 2011.

(USGS).[14] As a further validation point, note that displacement due to a 1906 San Francisco earthquake repeating itself in modern times were reported by Kircher *et al*. (2006) to be approximately 400,000-600,000 people due to damaged residences.[15] The latter estimates are likely to underestimate the SNRA social displacement metric because the study did not account for the effects of fires or damage to transportation and utility systems on displacement.

Low and best estimates for social displacement were constructed in an ad-hoc manner by examining published reports of displacement in the recent U.S. historic earthquake record. The low estimate is the minimum of the social displacement estimates reported below, and the best estimate is the average value of the social displacement estimates reported below. This approach, while resulting in crude estimates, was chosen so that the low and best estimates were a reflection of the best available recent historic data. The low estimate reflects the observed occurrence of earthquakes which cause more than $100M in losses while having relatively minor impact on human populations. The best estimate begins to approach the same order of magnitude of social displacement as observed from the two most costly U.S. earthquakes of the past 40 years (the 1981 Loma Prieta earthquake and the 1994 Northridge earthquake).

Table 2: Social Displacement Estimates

Date	Earthquake Name/Location	Displacement Estimate	Source
10/1/1987	Whittier, Los Angeles, Calif.	9,000	16
10/18/1989	Loma Prieta, SF Bay Area, Calif.	32,500	17
6/28/1992	Landers, Calif.	750	18
1/17/1994	Northridge, Calif.	120,000	19
2/28/2001	Seattle area, Wash.	400	20
12/22/2003	San Robles, Calif.	160	20

Note that the best estimate of social displacement is not necessarily correlated to the best estimate of frequency reported in Table 1. Also note that historic estimates reported in the table above are likely underestimates of social displacement as defined for the SNRA, because they are predominantly based upon permanent destruction of housing and may not include temporary displacement.

Psychological Distress

Psychological impacts for the SNRA focus on *significant distress* and *prolonged distress*, which can encompass a variety of outcomes serious enough to impair daily role functioning and quality

[14] USGS Circular 1324. (2008). The ShakeOut Earthquake Scenario – A Story that Southern Californians are Writing; at: http://pubs.usgs.gov/circ/1324/c1324.pdf. Accessed September 28, 2011.
[15] Kircher, C.A., Seligson, H.A., Bouabid, J., and Morrow, G.C. (2006). When the Big One Strikes Again – Estimated Losses due to a Repeat of the 1906 San Francisco Earthquake. *Earthquake Spectra* 22(82): 8297-8339.
[16] Whitter Daily News (2011). Whitter Narrows Earthquake: 20 Years Later. Article date 9/28/2011. At http://www.whittierdailynews.com/earthquake (accessed March 2013).
[17] U.S. Geological Survey (1998). The Loma Prieta, California Earthquake of October 17, 1989 - Building Structures. USGS Professional Paper 1552-C; http://pubs.usgs.gov/pp/pp1552/pp1552c/pp1552c.pdf (accessed March 2013). Notes 13,000 uninhabitable housing units; assumed 2.5 people per household.
[18] John A. Martin & Associates (unknown date). The Landers/Big Bear Earthquakes of June 28, 1992. At http://www.johnmartin.com/earthquakes/eqshow/lan_0000.htm (accessed March 2013).
[19] USGS (1998), *op cit*. Notes 48,000 uninhabitable housing units; assumed 2.5 people per household.
[20] EM-DAT, number of "total affected". EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be, Université Catholique de Louvain, Brussels (Belgium). Accessed on September 28, 2011. The number of "total affected" includes injuries, people needing immediate assistance for shelter, and people needing immediate assistance, including displacements and evacuations. The inclusion of injuries in this metric makes it imperfect for use in the SNRA; it is used for earthquake events when better estimates of displacement could not be found.

of life. An index for significant distress was created that reflected empirical findings that the scope and severity of an event is more important than the type of event. The equation for this index uses the fatalities, injuries, and displacement associated with an event as primary inputs; a factor elicited from subject matter experts weights the index for differing psychological impact based on the type of event, but as a secondary input.[21] The numerical outputs of this index formula were used to assign events to bins of a risk matrix for a semi-quantitative analysis of psychological risk in the SNRA.

Environmental Impacts

The United States Environmental Protection Agency (EPA) convened an ad hoc group of environmental experts representing the fields of environmental science, ecological risk, toxicology, and disaster field operations management to estimate environmental impacts for this event. Estimates are based on the following assumptions:

- Experts were elicited to provide estimates in the environmental impact category based on assumptions. Actual environmental/ecological harm that occurs as a result of the events described in a given scenario may vary considerably, and will depend on numerous variables (e.g., chemical or biological agent, contamination extent, persistence, toxicity—both chronic and acute toxicity—and infectivity).
- EPA defined environmental consequence (impact)[22] as the potential for adverse effects on living organisms associated with pollution of the environment by effluents, emissions, wastes, or accidental chemical releases; energy use; or the depletion of natural resources.
- Experts identified the best estimate for environmental impacts as "moderate." Debris, devastation, and chemical or contaminant releases from damaged facilities have the potential to impact large areas.

Assumptions

The SNRA project team used the following assumptions to estimate health and safety impacts caused by an earthquake event:

- Earthquake mitigation has improved by 1% annually.
- A linear multiplier of fatalities is sufficient for estimating the injuries associated with earthquakes to the desired precision of the SNRA (i.e., within an order of magnitude).
- The SNRA project team used the following assumptions to estimate direct economic impacts caused by an earthquake event:

[21] The Significant Distress Index is calculated from these inputs using a formula proposed by subject matter experts consulted for the SNRA project: $N_{SD} = C_{EF} \times (5\ Fat + Inj + \frac{1}{2} D)$, where N_{SD} represents the number of persons significantly distressed, C_{EF} is the expert assessed Event Familiarity Factor, *Fat* is the number of fatalities, *Inj* is the number of injuries and/or illnesses, and *D* is the number of persons displaced (Social Displacement). In words, this formula suggests that there are 5 significantly distressed persons for each life lost; 1 for each person injured; and 1 for each 2 people displaced. This formula was constructed to reflect the empirical finding that the most severe stressor of a disaster is losing a loved one, followed by injury, followed by displacement. Uncertainty was captured by applying the index formula to the low, best, and high estimates of these three human impact metrics.

The Event Familiarity Factor is intended to capture the extent to which the event entails an ongoing threat with uncertainty regarding long term effects, is unfamiliar, or that people dread, exacerbating psychological impacts. This factor, ranging from 1.0 for familiar events to 1.3 for unfamiliar events, was provided by subject matter experts for each national-level event included in the SNRA: earthquakes were given a C_{EF} of 1.1.

The numerical estimates calculated from this formula are reported in Appendix G. The semi-quantitative risk matrix is discussed in the Findings (Psychological Distress Risk).

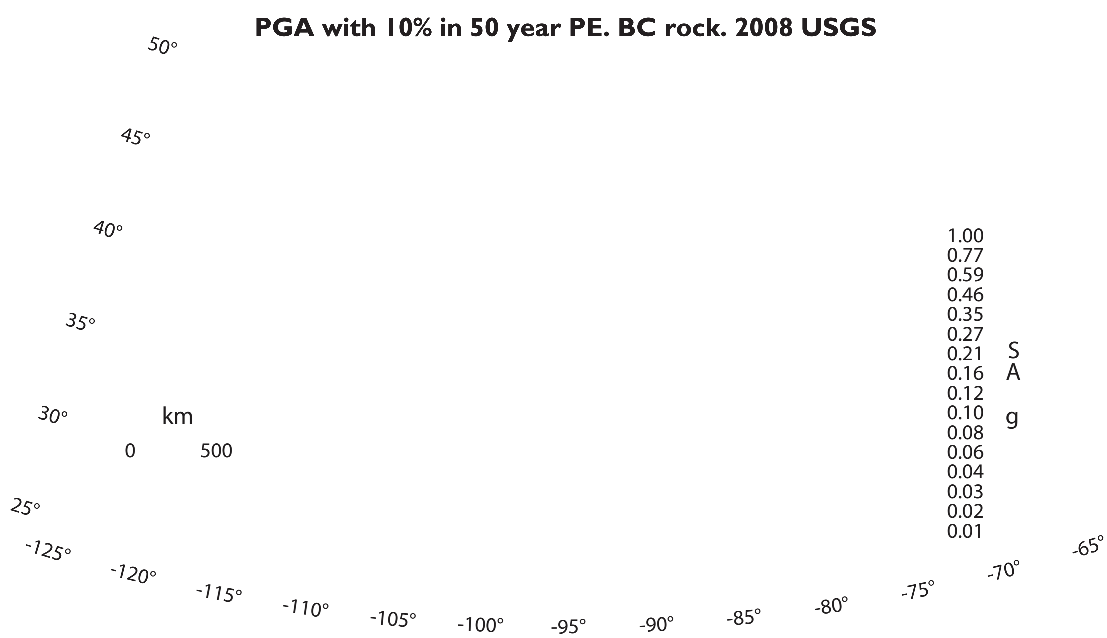
[22] The 2011 SNRA referred to impacts as 'consequences' because of prior usage in quantitative risk assessment (Kaplan and Garrick [1981, March], On the quantitative definition of risk: *Risk Analysis* 1(1) 11-32). Except where it will cause confusion, 'impact' is used synonymously in this document because of pre-existing connotations of the word 'consequence' within FEMA.

- Indirect losses included in historic records do not significantly bias direct economic loss estimates.
- Correcting for inflation only from 2005-2011 does not significantly bias direct economic estimates. (Published normalized economic losses incorporating population, wealth, and mitigating factors were only available through 2005.)

Potential Mitigating Factors

The following key factors can mitigate the potential impacts caused by earthquakes: population and wealth/assets density, land use, construction type and quality, adherence to building codes in design, level of preparedness and awareness in dealing with disasters, and the potential/extent for liquefaction.

Figure 2: Peak Acceleration With 10 Percent Probability of Exceedance in 50 Years



Additional Relevant Information

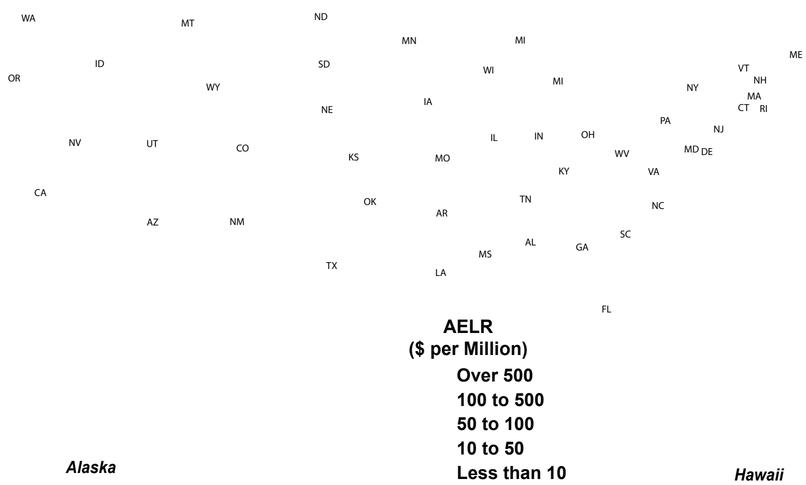
Figure 2 shows, from a national perspective, the probability that ground motion would reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the USGS Geologic Hazards Team.

As shown in Figure 2, the areas with the highest probability of seismic impacts in the U.S. are in western California, with moderate probability across larger areas of the western U.S., the Midwest, and around Charleston, SC.

In 2008, FEMA estimated average annualized losses from earthquakes for the entire nation by state. The estimated average annualized loss (AAL) addresses risk by estimating the probability of loss occurring in the study area (largely a function of building construction type and quality). By annualizing estimated losses, the AAL factors in historic patterns of frequent, smaller events with infrequent but larger events to provide a balanced presentation of risk. The AAL analysis yielded an estimate of the national AAL of $5.3 billion per year. This estimate does not include lifeline infrastructure losses or indirect (long-term) economic losses, and is therefore, a minimum estimate of the potential losses. Moreover, the estimate represents a long-term average and actual losses in any single year may be much larger or smaller.

The annualized loss ratio (ALR) represents the AAL as a fraction of the replacement value of the local inventory. The ALR gauges the relationship between average AAL and replacement value. This ratio can be used as a measure of vulnerability in the areas and, because it is normalized by replacement value, it can be directly compared across different geographic units such as metropolitan areas or counties.

Figure 3: Hazus-MH Annualized Earthquake Loss Ratios (AELR) by State



Source: FEMA, April 2008[23]

Figure 3 depicts the resulting state ALRs from this study, which helps to illustrate a national perspective of those areas more vulnerable to potential earthquake impacts. The states shown in dark red (Alaska, Washington, Oregon, California, Nevada and Utah) have the highest expected ALRs among all states and therefore have a higher likelihood of experiencing earthquake losses in any given year. Florida, North Dakota, Minnesota, Iowa, Wisconsin and Michigan have the lowest ALRs and are therefore least likely to experience earthquake losses when compared with the rest of the nation.

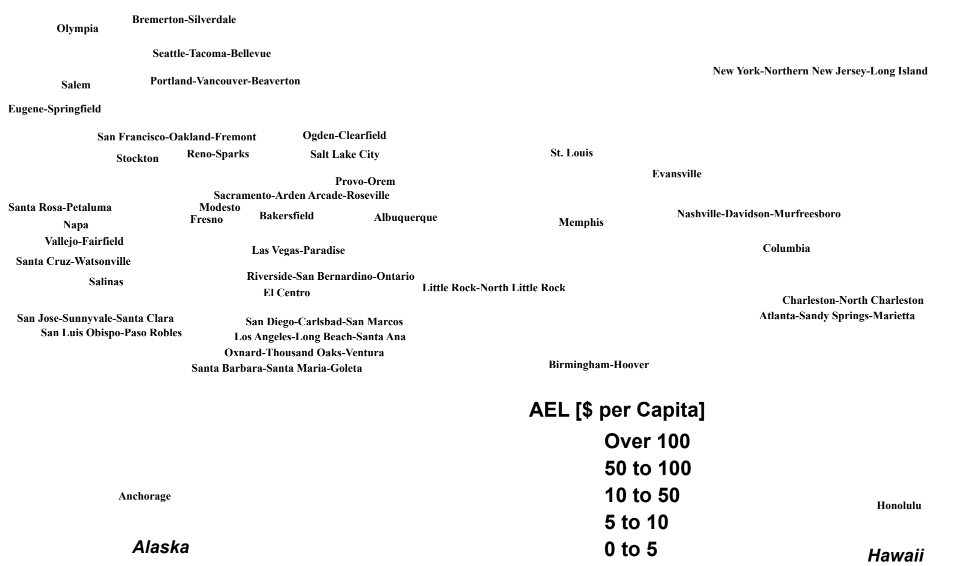
Figure 4 shows the annualized earthquake losses (AEL) by metropolitan area. Table 3 shows the top 7 metropolitan areas vulnerable to earthquake losses, as ranked using AEL. Of these 7 vulnerable areas, 5 are located in California.

[23] FEMA Publication 366: Hazus-MH Estimated Annualized Earthquake Losses for the United States, April 2008.

Table 3: Top 7 Metropolitan Areas Vulnerable to Earthquake Losses

1	Los Angeles-Long Beach-Santa Ana, CA	1,312.3
2	San Francisco-Oakland-Fremont, CA	781.0
3	Riverside-San Bernardino-Ontario, CA	396.5
4	San Jose-Sunnyvale-Santa Clara, CA	276.7
5	Seattle-Tacoma-Bellevue, WA	243.9
6	San Diego-Carlsbad-San Marcos, CA	155.2
7	Portland-Vancouver-Beaverton, OR-WA	137.1

Figure 4: Hazus-MH Annualized Earthquake Loss (AEL) by Metropolitan Area



Source: FEMA, April 2008[23]

Table 4: Earthquakes with 2011 damage estimates in excess of $100 million. Year, location, and current year (2011) damage estimates highlighted in blue.

ACC	4/18/1906	1906	San Francisco	CA	6901	3,000	524,000,000	8,941,736,986	$104,905,367,626	24,062	8,896
EM-DAT	6/22/1915	1915	El Centro	CA	6025	6	1,000,000	14,598,047	$131,076,352	33	13
EM-DAT	10/11/1918	1918	Mona Passage	PR	72000	116	29,000,000	261,566,935	$1,943,953,812	331	138
NGDC-s	4/21/1918	1918	San Jacinto/Riverside County	CA	6065	0	200,000	1,803,910	$193,990,095		0
EM-DAT	6/29/1925	1925	Santa Barbara	CA	6083	13	8,000,000	74,247,020	$1,371,950,746	98	44
ACC	3/11/1933	1933	Long Beach	CA	6902	116	39,250,000	495,767,829	$7,565,220,534	737	358
NGDC-s	10/31/1935	1935	Helena	MT	30049	2	6,000,000	70,378,531	$512,380,253	6	3
NGDC-s	10/19/1935	1935	Helena	MT	30049	3	11,250,000	132,000,000	$960,000,000	9	5
EM-DAT	5/19/1940	1940	El Centro/Imperial Valley	CA	6025	9	6,000,000	69,000,000	$392,000,000	12	6
ACC	4/13/1949	1949	Puget Sound/Olympia	WA	53067	8	52,500,000	359,951,841	$3,403,585,667	41	24
NGDC-s	11/18/1949	1949	Terminal Island	CA	6902	0	9,000,000	61,706,030	$414,893,442		0
NGDC-s	8/15/1951	1951	Terminal Island	CA	6902	0	3,000,000	18,982,899	$109,913,608		0
ACC	8/22/1952	1952	Kern County/Bakersfield	CA	6029	2	20,000,000	124,417,934	$662,071,491	6	4
ACC	7/21/1952	1952	Kern County/Bakersfield	CA	6029	14	55,000,000	342,149,318	$1,820,696,601	44	26
EM-DAT	8/18/1959	1959	Hebgen Lake	MT	30031	28	26,000,000	140,472,170	$706,863,603	85	54
NGDC-s	3/28/1964	1964	Prince William Sound/Anchorage	AK	2099	131	540,000,000	2,735,575,437	$11,213,495,628	332	220
ACC	4/29/1965	1965	Seattle	WA	53999	7	20,250,000	100,744,986	$299,194,941	13	9
NGDC-s	10/2/1969	1969	Santa Rosa	CA	6097	1	8,000,000	36,000,000	$120,000,000	2	2
ACC	2/9/1971	1971	San Fernando	CA	6902	65	539,500,000	2,092,109,007	$5,083,948,997	114	81
NGDC-s	10/15/1979	1979	Imperial Valley	CA	6025	0	30,000,000	67,881,448	$129,806,214		0
ACC	10/1/1987	1987	Whittier/Los Angeles	CA	6902	8	354,000,000	542,215,449	$795,888,336	10	9
hybrid	10/18/1989	1989	Loma Prieta/San Francisco	CA	6901	62	5,750,000,000	8,206,000,000	$10,485,000,000	71	60
ACC	6/28/1992	1992	Landers/Yucca Valley	CA	6071	3	100,000,000	129,782,948	$202,144,394	4	3
ACC	4/25/1992	1992	Ferndale/Fortuna/Petrolia	CA	6023	0	66,000,000	85,656,746	$106,971,740		0
ACC	1/17/1994	1994	Northridge/Los Angeles	CA	6902	60	47,350,000,000	58,814,639,537	$78,235,199,499	69	62
ACC	2/28/2001	2001	Seattle/Tacoma/Olympia	WA	53999	1	2,000,000,000	2,189,728,415	$2,378,245,427	1	1
ACC	12/22/2003	2003	Paso Robles/San Simeon	CA	6079	2	300,000,000	316,390,574	$328,283,332	2	2

[24] Original source cited by Vranes and Pielke (2009), *op. cit.*, from which this table was taken.