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Estimated Annualized Earthquake Losses for the United States

By

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Agenda

- Background
- Study Objectives and Scope
- Analyzing Earthquake Risk
- Study Limitations
- Results of the Study
- Findings and Applications

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Background

- Progressive increase in damage and loss caused by earthquakes worldwide due to:
  - Growth in earthquake prone areas
  - Vulnerability of older building structures
- Rising concern for regions with low earthquake hazard, but at high risk due to dense concentrations of buildings that do not meet seismic building code standards (e.g., New York).

Study Objective and Scope

- To asses the level of seismic risk in the United States using two inter-related metrics:
  - Annualized Earthquake Loss (AEL)—Measures losses in any single year.
  - Annualized Earthquake Loss Ratio (AELR)—Addresses seismic risk in relation to the value of the buildings in the study area.

Study Objective and Scope

- This study also addresses:
  - Casualties Estimates– Key to medical response planning and identifying potential lifesaving measures.
  - Estimating Shelter Requirements—Useful for measuring the effects of building codes and other mitigation measures to reduce damage to buildings and lessen the need for post-disaster shelter.
  - Debris Estimates—Useful for preparing removal and disposal plans, and for scaling requirements for urban search and rescue operations.

Analyzing Earthquake Risk

- Earthquake risk involves measuring the likely damage and the costs of earthquakes within a specified geographic area over certain periods of time.
- A comprehensive risk analysis assesses various levels of hazard and the consequences to structures and people.
- This study uses a *probabilistic* hazard analysis.

Analyzing Earthquake Risk

- The following parameters in HAZUS-MH MR2 were used to estimate average annualized loss:
  - Geotechnical parameters – 2002 USGS National Seismic Hazard Maps for eight return periods, NEHRP soil type D.
  - Building inventory – 2000 U.S. Census for residential buildings, 2002 Dun & Bradstreet for non-residential buildings and 2005 R.S. Means for building replacement values.

Analyzing Earthquake Risk

- The analysis involved a five step process
  1. Specify probabilistic hazard data
  2. Compute building damage and loss
  3. Compute the AEL
  4. Compute the AELR
  5. Compute the annualized casualties, debris, and shelter requirements

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Study Limitations

- Estimates provided are not determinations of total risk, e.g., damage to lifelines and other facilities, as well as, indirect economic losses are not included in the study.

- Uncertainties are inherent in computing losses using estimated values at the census tract level in conjunction with variables such as magnitude and frequency of future events and variations in attenuation of strong ground motion.

- Annualized risk averaged over many years may appear small and not reveal the high risk due to a single event.

Results of the Study

- National Level
  - Estimated AEL of $5.3 billion per year.
- State and County Level
  - Relatively high earthquake loss ratios exist in:
    - Western U.S. (including Alaska and Hawaii)
    - Central U.S. states (New Madrid Seismic Zone)
    - The Charleston, SC area
    - Some parts of New England

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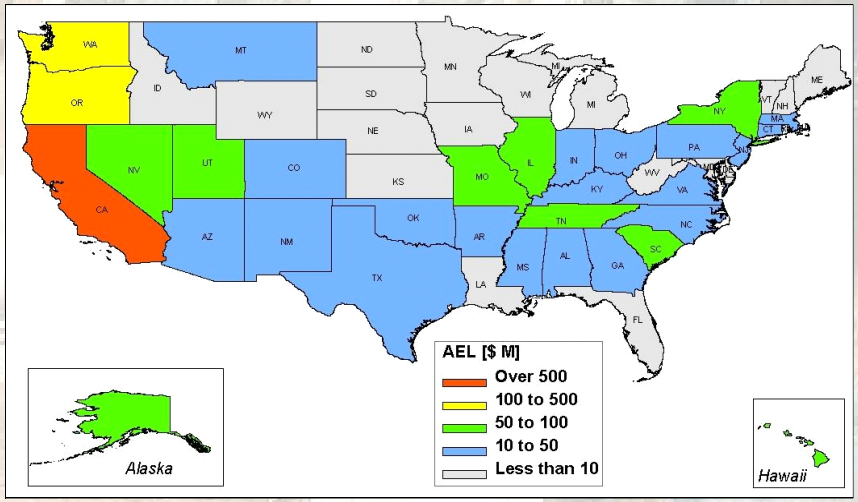
Results of the Study

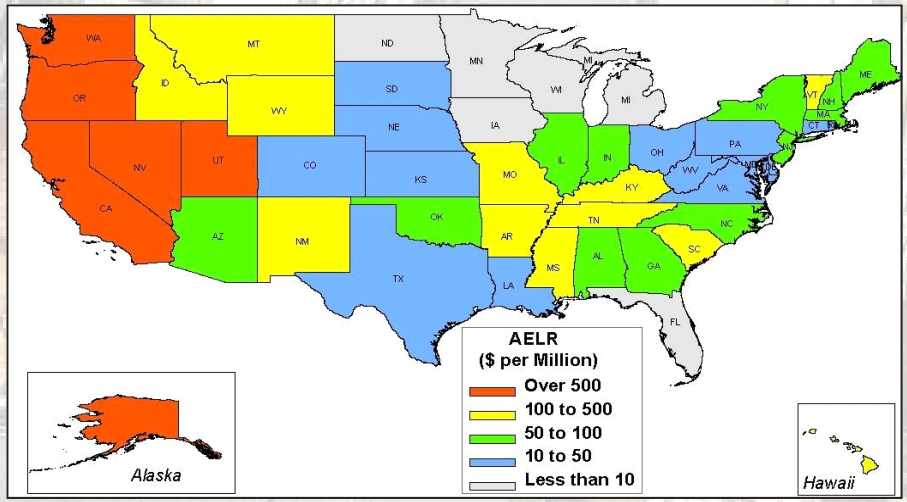
- State and County Level
  - The majority (77 % or $4 billion) of the annualized losses occur in California, Oregon and Washington, with 66% ($3.5 billion) concentrated in California.
  - States with low hazard and high value building inventories (e.g., New York) can have annualized losses comparable to states with greater hazard but smaller building inventories (e.g., Nevada).

Results of the Study

- States and Counties



Annualized Earthquake Losses by State



Annualized Earthquake Loss Ratios by State

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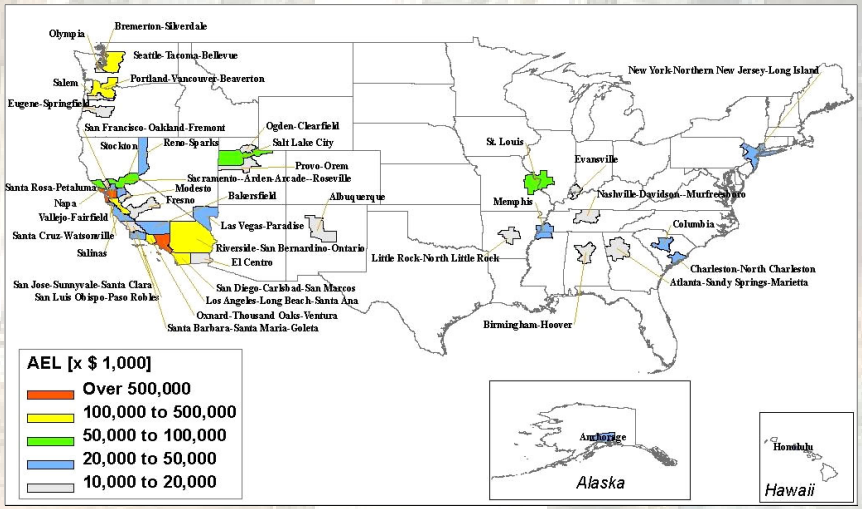
Results of the Study

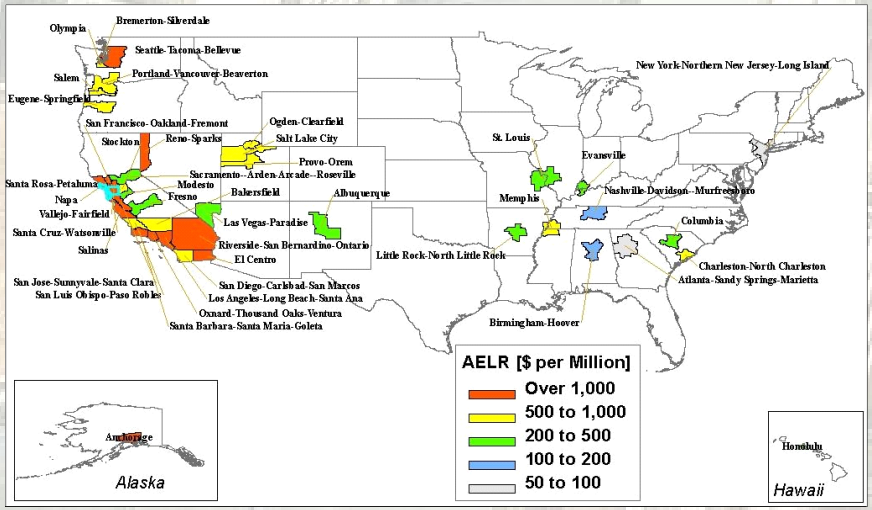
- Metropolitan Area Level
  - 43 metropolitan areas, led by Los Angeles and San Francisco, have estimated annualized losses of $10 million or greater.
  - These 43 metropolitan areas account for 82% of the total annualized losses in the U.S.
  - Los Angeles alone accounts for 25% of total annualized losses in the U.S.
  - When losses are expressed as a fraction of total building value, the cities of Napa, CA, Anchorage AK, and Reno NV have notably high rankings.

Results of the Study

- Metropolitan Area Level



Metropolitan Areas with Annualized Earthquake Losses Greater than $10 million



Annualized Earthquake Loss Ratios for Metropolitan Areas with Annual Loss Greater than $10 million

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Results of the Study

- Socio-Economic Level
  - Ability to correlate population density and annualized loss

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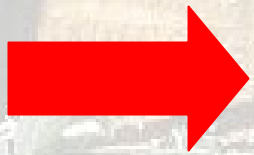
  - Ability to examine annualized loss in terms of casualties, shelter and debris



Better policies, programs and strategies to minimize socio-economic losses from earthquakes

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Results of the Study

- Socio-Economic Level
  - The analysis of the annualized loss in relation to the 2000 population distribution revealed that areas with high rankings include:
    - Areas with high seismic hazard and high building exposure (e.g., L.A. and San Francisco).
    - Areas with high seismic hazard and low building exposure (e.g., Hawaii and Alaska).
  - CA, OR, WA, AK and HI have the highest seismic risk when measured on a per capita basis at the state level.

Results of the Study

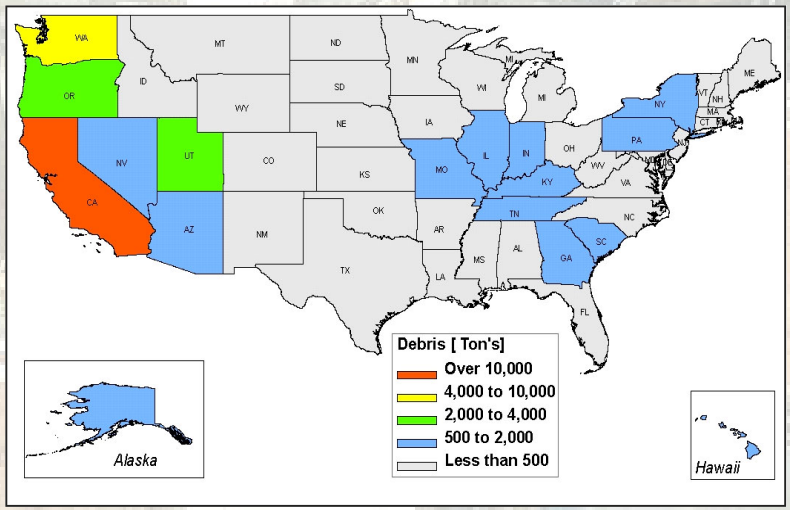
- Annualized Estimates of Casualties
  - The majority of injuries are minor (non life-threatening) and occur during daytime events.
  - California's daytime minor casualties (1891) are over 6 times higher than the second-ranked state, Washington (260).
  - While California and western states are highest, the casualty rates drop off considerably in the lower-ranking states.

Results of the Study

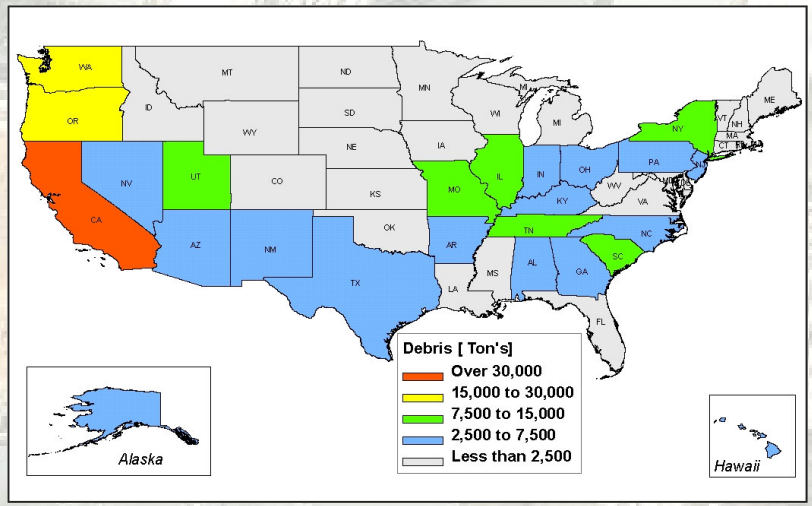
- Annualized Estimates of Short-Term Shelter Requirements
  - People requiring shelter in California (1313), Washington (123), and Oregon (77) together account for nearly 75 percent of the U.S. total. California alone accounts for nearly 60 percent
  - New York remains the top ranked state in the East with 3 persons per million potentially requiring shelter.

Results of the Study

- Estimates of debris were conducted for 250-year, 500-year and 1,000-year return periods.



Debris Estimate 250-year Return Period



Debris Estimate 1000-year Return Period

- The analysis shows a large increase in debris estimates for the 1,000-year return period.

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Results of the Study

- Compared to the previous AAL study published by FEMA in 2001, there has been an AEL increase of 21% (from $4.4B to $5.3B), but when adjusted for inflation there is actually a small decrease in AEL of approximately $3M.

Findings

- Although greatest on the West Coast, seismic risk exists in other areas of the U.S.
- While an increase in the USGS probabilistic seismic map values will translate to an increase in risk, an increase in building inventory will not always translate to a proportional increase in seismic risk.
- Earthquake risk continues to be highest in urban areas, most notably in California and on the West Coast.

Applications

- The findings of the study can be used to support analysis, decision making and risk reduction, including:
  - Improving the understanding of seismic risk in the U.S.
  - Supporting the adoption and enforcement of seismic building code provisions.
  - Comparing seismic risk with other natural hazard risks.
  - Supporting disaster response and recovery planning.