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National Assessments of Societal Exposure to Natural Hazards in the United States

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Application

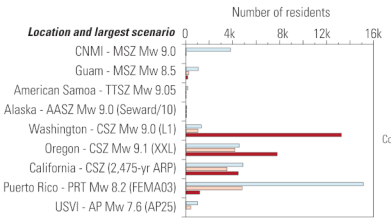
Natural hazards are substantial threats to the safety, economic well-being, and resources of United States (U.S.) communities. National assessments of societal exposure to natural hazards provide managers, planners, and policy makers at multiple scales with insights on where targeted studies, preparedness and mitigation plans, and outreach efforts may be warranted. The United States Geological Survey (USGS) has recently completed several national studies of societal exposure to natural hazards that can support local, county, state, territorial, and Tribal risk-reduction planning. Each of the following examples include published journal articles and USGS data releases.

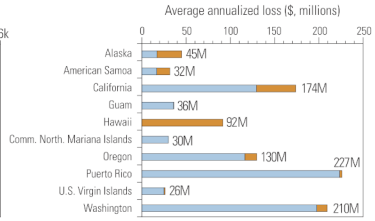
U.S. population exposure, evacuation potential, and losses from earthquake-generated tsunamis

Why: All U.S. coastal communities are threatened by distant tsunamis that could arrive hours after generation by an earthquake or other sea disturbance. Some communities are threatened by local tsunamis that could arrive in minutes after generation by a nearby earthquake or other sudden-onset event. Estimating exposure and evacuation potential supports targeted outreach, training, and mitigation strategies to save lives.

What:

Earthquake-generated Tsunami Sources	Estimated Exposure, Evacuation Time, and Fatalities	Estimated Building Losses	Estimated Scenario Return Period	Estimated Average Annualized Losses
- 102 scenarios - Alaska-Aleutian SZ - Tonga Trench SZ - Mariana SZ - East Philippines SZ - Ryukyu–Kyushu–Nankai - Cascadia SZ - Puerto Rico Trench - Many Caribbean sources	- 2020 Census resident counts - National Structure Inventory - Pedestrian-evacuation models - Departure delays (0, 5, 10 min) - Value of a statistical life = $12.5M	- HAZUS loss estimation - Various analytical levels based on hazard data availability	- Subject matter expert guidance - Probabilistic analysis (CA) - Geologic and geodetic data - Gutenberg-Richter law and Global Earthquake Model (GEM) - Convergence rates and GEM	- Block level calculations - Riemann sum trapezoidal approach to approximate area under the loss-exceedance probability curve

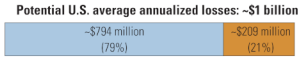


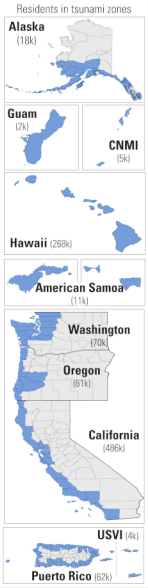


Number of residents who may have insufficient time to evacuate before tsunami arrival but may be able to because of risk-reduction strategies

- Reducing departure delays from 10 minutes to 5 minutes
- Reducing departure delays from 5 minutes to 0 minutes
- Reducing population exposure through land use changes or improving evacuation potential with structural strategies

Potential U.S. average annualized losses: ~$1 billion



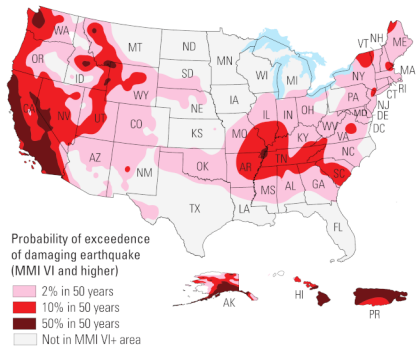


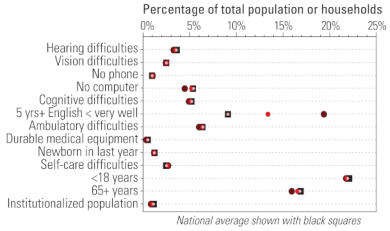
Earthquake-hazard exposure of U.S. residents with potential access and functional needs

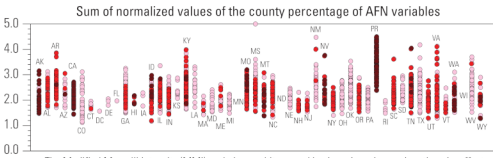
Why: Early earthquake warning (EEW) alerts and observed ground shaking may be less effective and actionable for people with potential access and functional needs

What: Geospatial, county-level index of 13 demographic variables based on the C-MIST framework of access and functional needs overlaid with USGS National Seismic Hazard Model to identify potential immediate challenges in:

Accessing information	*due to individual disabilities*	Hearing or vision difficulty
	due to technology gaps	No phone, no computer
Understanding information	*due to individual disabilities*	Cognitive difficulty
	due to language gaps	5+ yrs speak English < "very well"
Acting on information	*due to movement limitations*	Ambulatory or self-care difficulty Durable medical equipment Parents with newborns
	due to caregiver reliance	< 18 yrs, 65+ yrs, institutionalized







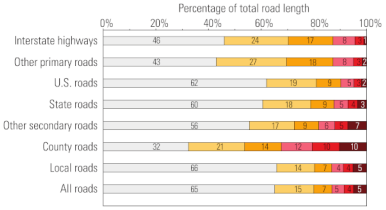
The Modified Mercalli Intensity (MMI) scale is an arbitrary ranking based on observed earthquake effects using Roman numerals that range from imperceptible shaking (I) to catastrophic destruction (X).

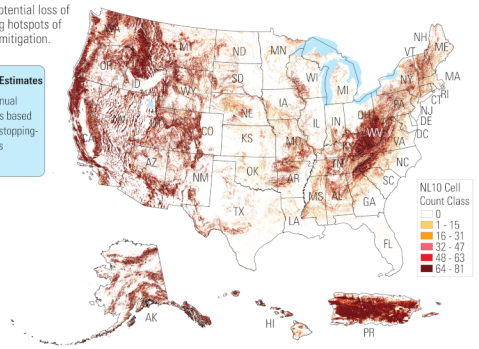
U.S. road exposure and traffic volumes in areas susceptible to landslides

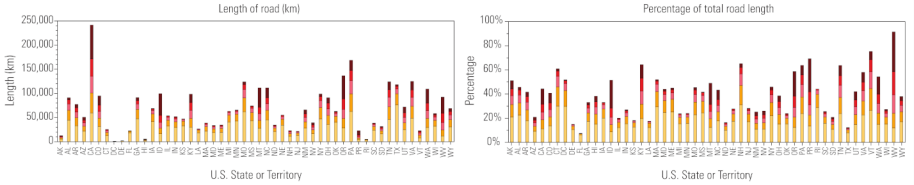
Why: Landslides are substantial threats to the U.S. road network, in terms of potential loss of life and disruptions to quality of life and economic productivity. Identifying hotspots of high exposure and high traffic volumes support county, state,and federal mitigation.

What:

Landslide Susceptibility	U.S. Road Exposure	Traffic Volume Estimates
- CONUS, AK, HI, PR - 90m grid cell based on 10m DEM - # of 10m cells that meet slope/relief thresholds	- National Transportation Data - GIS-based analysis - Total length, % of total length - Reported for states/counties - By road type	- Hourly and annual - Affected zones based on estimated stopping-zone distances





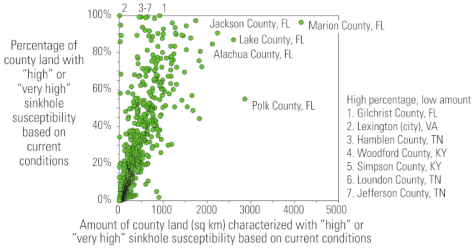


Sinkhole susceptibility in karst and pseudokarst areas of the conterminous U.S.

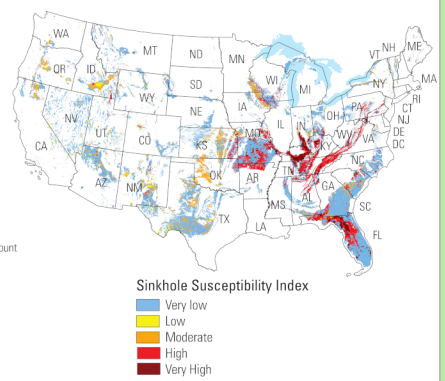
Why: Sinkholes are substantial threats to U.S. communities in areas of karst and pseudo-karst geology. Ground failures can cause loss of life, road damage, and building collapse. There is currently no national sinkholes hazards program.

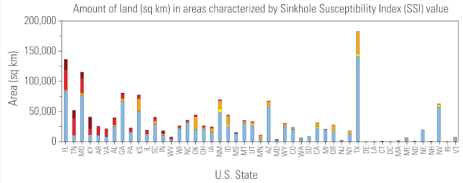
What:

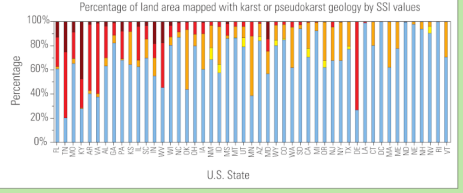
Closed-depression density mapping	Sinkhole susceptibility mapping	Exposure analysis
- High performance computing - 10m DEMs for CONUS	- 90m maps: Current, 2070 conditions - Closed-depression density, geology, soils, precipitation, developed land	- Land by area - State and county



High percentage, low amount
1. Gilchrist County, FL
2. Lexington (city), VA
3. Hamblen County, TN
4. Woodford County, KY
5. Simpson County, KY
6. Loundon County, TN
7. Jefferson County, TN







For More Information

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Landslides: Wood N, Jones J (2025) Variations in road exposure and traffic volumes in the United States in areas susceptible to landslides. International Journal of Disaster Risk Reduction, 124: 105567
Sinkholes: Wood N, Doctor D, Alder J, Jones J (2023) Current and future sinkhole susceptibility in karst and pseudokarst areas of the conterminous U.S., Frontiers in Earth Science, 11: 1207689
Tsunamis: Wood N, Peters J, Sheehan A, Bausch D (2025) National population exposure and evacuation potential in the U.S. to earthquake-generated tsunami threats. International Journal of Disaster Risk Reduction, 123: 105511
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Pedestrian Evacuation Analyst - https://www.usgs.gov/software/pedestrian-evacuation-analyst-tool

U.S. Department of the Interior
U.S. Geological Survey