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Loss-Estimation Modeling of Earthquake Scenarios for Each County in Nevada Using HAZUS-MH

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One of the first pieces of information needed in disaster planning, preparedness, and response is a general estimate of potential damage and costs of an event, such as an earthquake. Nevada has a relatively high level of earthquake hazard, but that hazard is not evenly distributed throughout the state. The characteristics of the population, infrastructure, and societal resources vary dramatically across the state as well. In order to understand the potential consequences of earthquakes in Nevada, we have run an earthquake loss-estimation model (Level 1 of the Federal Emergency Management Agency's HAZUS-MH computer program) for each county seat. A fault that is a likely source of an earthquake was selected near each community. How often such an earthquake may occur, a parameter that varies from thousands to tens of thousands of years, was not considered in this study. In all cases we do not know when the next earthquake will occur, only that it will happen sometime. The earthquake scenario allows us to see what could happen when an earthquake does occur nearby.

HAZUS-MH is a standardized, nationally recognized software program that was designed for the Federal Emergency Management Agency to estimate losses from potential earthquakes and other disasters. It is used for exercises, planning efforts, and disaster declarations. HAZUS-MH estimates losses at three levels of accuracy, Levels 1, 2, and 3.

Level 1: A rough estimate based solely on data from national databases included in the HAZUS-MH software distribution. The national databases that come with HAZUS-MH include Census 2000 demographic data, building stock estimates, earthquake fault data, historical earthquake information, and national transportation and infrastructure data layers.

Level 2: A more accurate estimate based on professional judgment and detailed information on local geology, more up-to-date demographic data, and greater detail on the buildings and other infrastructure within the community that are input into HAZUS-MH at the local level.

Level 3: The most accurate estimate based on detailed engineering and geotechnical input into HAZUS-MH that develops into a customized methodology designed to the specific conditions of a community.

This report summarizes HAZUS-MH Level I analyses, which use the default national data set within the computer model. Level 1 analyses are crude, order-of-magnitude estimates that should be used for risk communication, conceptual preparation, and generalized planning (e.g., on a state level or for a disaster mitigation plan). For more detailed disaster or mitigation planning, a Level 2 or 3 analysis is needed. All county scenarios in this report were run using the WUS shallow crustal event-extensional attenuation function, an option within HAZUS-MH that is applicable in Nevada.

Table 1 lists the counties and county seats analyzed in this study. Table 2 shows the results of the HAZUS-MH runs for each county seat. This table shows both county-specific damage estimates as well as regional estimates. As expected, the potential losses vary dramatically across the state. Earthquakes considered range in magnitude from 6.5 to 7.5, the general range of historical damaging earthquakes in Nevada. Possible economic losses range from about $280,000 in Goldfield to $8.8 billion in Las Vegas.

Keep in mind these are only crude, order-of-magnitude estimates. That is, any given number may be off by a factor of as much as 10, although HAZUS runs for real earthquakes in recent years have been within a factor of two. Significant potential economic losses, on the order of tens of millions of dollars, are indicated for most communities in Nevada. Potential major building damage per event ranges from four buildings (in the Goldfield region) to 30,000 buildings (in the Las Vegas area). Unfortunately, an accurate inventory of building stock is not available for the Level 1 analysis and statistical estimates are usually used. Fatalities are extremely difficult to predict because they are dependent on time of day, what buildings or structures people are in, and how people behave. These factors can vary wildly and dramatically affect the number of casualties listed for a potential earthquake. There is no record of anyone being killed during a historical Nevada earthquake, but this is going to be a hard record to keep in the future. Possible fatalities in future earthquakes range from none to as many as 800 people. The number of people needing shelter, a critical issue in some weather situations in Nevada, ranges from none to 11,000. The different levels of potential earthquake consequences require different levels and types of preparedness across the state, and it is this needed visualization that makes these county seat scenarios of immediate value for the local communities and for state contingency planning.

Table 2 also includes, in the last two fields, the probability of experiencing an earthquake of a given size or greater over a 50-year period within 50 kilometers (31 miles) of the county seat. These data come from maps that were generated using the U.S. Geological Survey PSHA (Probabilistic Seismic Hazard Analysis) Model, which is presented at http://eqint.cr.usgs.gov/eq/html/eqprob.html. The actual maps that the values were taken from can be viewed online at www.nbmg.unr.edu/eqprob/eqprob.htm.

The attached reports include, for each county, a HAZUS-MH produced Pga (peak ground acceleration) ground motion map that shows the location of the selected scenario event for each county; a one-page summary estimating anticipated damages that would occur if the earthquake struck in the early afternoon; and a detailed summary listing the population, building stock, and infrastructure inventory that is at risk and the various impacts that the designated earthquake might have on these resources. The county Pga ground motion maps, located at the beginning of each county section, show the maximum acceleration (a measure of the intensity of shaking) that would be expected during the course of the earthquake, generally decreasing with distance from the hypocenter (initial rupture point of the earthquake). The hotter or redder colors on the map are the areas of strongest shaking from the scenario earthquake, and the cooler colors (blue, green, and gray) are areas of less shaking.

It is important to understand that while the summaries contained in this report are county specific, i.e., only showing the impacts that an earthquake will have on a single county; large earthquakes generally have regional effects that can cover many counties. So, in addition to the individual county summaries contained within this report, there are several regional summaries depicting the multi-county effects of an earthquake from a regional perspective. These include multi-county scenarios for events in Douglas County, Storey County, Washoe County and Carson City. The multi-county scenarios are located immediately following the single county scenario for each of the respective counties. Table 2 provides a quick comparison of the expected losses in the county alone versus the multi-county region.

"A Guide to Using HAZUS for Mitigation" is located at the end of this report. This guide, produced by the National Institute of Building Sciences for the Federal Emergency Management Agency, will help you understand and interpret the various types of information that HAZUS-MH produces. It also identifies various ways that communities can use this information for earthquake mitigation planning.

Table 1: List of Nevada County Seats.

CARSON CITY - STATE CAPITAL
CLARK COUNTY - Las Vegas
CHURCHILL COUNTY – Fallon
DOUGLAS COUNTY – Minden
ESMERALDA COUNTY – Goldfield
HUMBOLDT COUNTY – Winnemucca
LYON COUNTY - Yerington
WHITE PINE COUNTY – Ely
NYE COUNTY - Tonopah
ELKO COUNTY – Elko
EUREKA COUNTY – Eureka
LANDER COUNTY - Battle Mountain
LINCOLN COUNTY – Pioche
MINERAL COUNTY – Hawthorne
PERSHING COUNTY – Lovelock
STOREY COUNTY - Virginia City
WASHOE COUNTY - Reno

Table 2: Summary of loss-estimation output for earthquake scenarios that may affect counties in Nevada, using FEMA's HAZUS model.

County	County Seat	Earthquake Scenario Magnitude	Economic Loss (estimated in multi-county region) In billions of $	Building-Related Economic Loss (estimated in county alone)	Buildings with Major Damage (estimated in multi-county region)	Buildings with Major Damage (estimated in county alone)	Fatalities (estimated in multi-county region)	Fatalities (estimated in county alone)	Number of People Needing Public Shelter (estimated in multi-county region)	Number of People Needing Public Shelter (estimated in county alone)	Earthquake Magnitude (for comparison with probabilities)	Estimated Probability of Occurring within 50 years within 50 km (1)
Carson City	Carson City	6.5	0.6 to 2.2	$665 million	~3,900	~2,800	30 to 110	20 to 100	170 to 700	140 to 600	6.5 6.0	50-55% ~70%
Churchill	Fallon	6.5	0.0 to 0.2	$85 million	~400	~400	< 20	1 to 3	10 to 50	10 to 50	6.5 6.0	20-25% 30-40%
Clark	Las Vegas	6.6	4.4 to 17.7	$8.8 billion	~30,000	~30,000	200 to 800	200 to 800	3,000 to 11,000	3,000 to 11,000	6.5 6.0	<5% 10-20%
Douglas	Minden	7.1	0.6 to 2.5	$471 million	~3,600	~1,300	30 to 120	10 to 50	150 to 600	50 to 190	7.0 6.5 6.0	10-12% 50-60% 60-70%
Elko	Elko	6.5	0.1 to 0.4	$224 million	~900	~900	10 to 40	10 to 40	40 to 150	40 to 150	6.5 6.0	6-8% 10-15%
Esmeralda	Goldfield	6.7	< 0.1	$280 thousand	~4	~2	none	none	none	none	6.5 6.0	5-10% 20-30%
Eureka	Eureka	7.2	< 0.1	$4.1 million	~100	~50	none	none	none	none	7.0 6.5 6.0	<0.5% 4-6% 10-15%
Humboldt	Winnemucca	6.5	0.0 to 0.1	$56 million	~600	~600	< 20	1 to 3	10 to 30	10 to 30	6.5 6.0	5-10% 15-20%
Lander	Battle Mountain	7.5	0.0 to 0.1	$74 million	~1,200	~1,200	< 20	3 to 6	10 to 20	10 to 20	7.5 7.0 6.5 6.0	0.1-0.2% ~1.5% ~10% 15-20%
Lincoln	Pioche	6.5	< 0.1	$5.6 million	~40	~40	none	none	none	none	6.5 6.0	2-3% 6-10%
Lyon	Yerington	6.9	0.0 to 0.2	$88 million	~800	~800	< 20	1 to 3	10 to 30	10 to 30	7.0 6.5 6.0	12% 40-45% ~60%
Mineral	Hawthorne	7.5	0.0 to 0.2	$78 million	~700	~700	< 20	2 to 4	10 to 40	10 to 40	7.5 7.0 6.5 6.0	<0.5% 10-12% 30-40% ~60%
Nye	Tonopah	7.0	< 0.1	$440 thousand	~140	~1	none	none	none	none	7.0 6.5 6.0	<1% 5-10% 20-30%
Pershing	Lovelock	7.3	0.0 to 0.1	$61 million	~800	~800	< 20	2 to 4	10 to 20	10 to 20	7.5 7.0 6.5 6.0	~0.1% 1-2% ~10% 10-20%
Storey	Virginia City	6.5	0.6 to 2.5	$8.5 million	~3,500	~70	20 to 90	none	200 to 800	none	6.5 6.0	50% 65-70%
Washoe	Reno	6.9	1.9 to 7.6	$2.9 billion	~12,000	~8,200	120 to 500	80 to 300	800 to 3,000	600 to 3,000	7.0 6.5 6.0	12-15% ~50% 65-70%
White Pine	Ely	6.8	0.0 to 0.2	$79 million	~400	~400	< 20	1 to 4	10 to 30	10 to 30	7.0 6.5 6.0	<0.5% 1.5-2% 4-6%

(1) Please refer to http://www.nbmg.unr.edu/eqprob/eqprob.htm for details on earthquake probabilities estimated by the U.S. Geological Survey.