The Damage and Economic Cost of Historical Nevada Earthquakes

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Earthquakes have shaken Nevada repeatedly through history, and with a small and sparse population until recently, the State has escaped deaths from earthquakes, although not injuries. Earthquakes have repeatedly caused damage in Nevada, however, and this damage and particularly its associated costs were the subject of this study.

Accountable estimates of the cost for historical earthquakes were made; *accountable estimates* are cost estimates based on damage reports. These estimates are preliminary and are principally derived from reviewing newspaper articles and reports, tabulating the damage, estimating the cost of the damage, and adding up the results. Costs are estimated in three ways: 1) using reported and estimated costs at the time of the event, 2) using a reported cost of similar damage from another earthquake that was close in time, or 3) using the cost to fix damage estimated in 2003 dollars and adjusted to the time of the earthquake. The costs of the historical earthquakes were adjusted to 2003 values for comparison and perspective. A earthquake simulation program, HAZUS, was used to explore what it would cost if these historical earthquakes occurred today, with more people, buildings, and infrastructure.

Estimating damage and replacement costs is difficult to do without making numerous assumptions. The first assumption is that the reported effects and/or costs are accurate. Multiple accounts of damage are used when possible to increase the confidence in what effects occurred. I have the general impression that most earthquake effects and damage are unreported (hopefully most of the larger damage is reported). With some of the effects that occurred, it is not hard to imagine additional similar damage in other buildings or houses. In some cases there may have been some local under-reporting of damage as not to scare away financial investors in local mines. After the first day or so, newly discovered damage is usually not news and is usually not reported in the newspapers. An additional assumption employed is that a reported cost can be taken, and multiplied by the number of other reported incidents; this must be done judiciously because there would be variations in cost. In some cases, incurred damage was not replaced or rebuilt, and in many cases, capable owners repaired the damage themselves and no costs were reported. The latter point has two perspectives: 1) that no cost was directly incurred (but there were indirect costs from manual labor, supplies required, and business revenues lost), 2) in a 2005 setting, few business owners could undertake rebuilding their buildings themselves, so when converting to modern costs, assume 2003 damage costs for these situations. If there was reported damage, I assigned a cost to it.

The costs of the earthquakes studied and the conversions to 2003 dollars are shown in Table 1. HAZUS estimates for selected earthquakes are also given in Table 1. The total accountably estimated cost of major historical earthquakes to Nevada in 2003 dollars is $7,333,000. This value is likely an underestimation because of unreported damage. Further research would reveal more damage from these earthquakes, and the process of estimating cost could be improved, but it is unlikely large

differences (>20%) in the total estimated cost would result. The final value is buffered by the limited population affected by these earthquakes. In contrast, the HAZUS estimate for seven of these earthquakes is over $1.5 billion. This difference can be starkly seen considering a single earthquake, the 1887 Carson City Earthquake. The 1887 earthquake caused almost $200,000 (2003 values), whereas the HAZUS estimate for this earthquake is nearly $700 miullion, over an order of magnitude different.

In most ways Nevada's historical earthquakes are not directly comparable to earthquakes that might occur today. Population was dramatically less back then and there were many fewer buildings, highways, homes, and so forth. Today people build in areas that can shake more violently, such as on young sediments, drained to be inhabitable, that were swamps in the olden days. Building construction was poor in earlier days, and building types were commonly the most vulnerable to shaking (stone and brick), but they were generally small, single-story structures, some buttressed against each other lining a street (these buildings tend to survive better than the ones on the ends). There were no large utilities with massive infrastructures and unavoidable seismic vulnerabilities. There were no paved highways and fewer bridges. Houses were not filled to the brim with stuff that could fall and break. There were no computers playing important roles in peoples lives that could be shaken down. Nevada is vastly more vulnerable to earthquakes than it was in the past. Only effective mitigation efforts can prevent serious earthquake disasters in Nevada.

Table 1 Nevada's Historical Earthquakes and Their Cost

Earthquake	Original Costs[1]	2003 Costs[2]	HAZUS est.[3]
1868 Virginia Range Eq.	$300 min.	$3,750	
1869 Virginia Range Eq.	$3,245	$42,143	$620M
1875 Eureka Eq.	$40	$645	$840,000
1887 Carson City Eq.	$6,700-$10,700	$198,148	$689M
1894 Virginia City Eq.	$1,100	$22,917	
1896 Carson City Eq.	$170 min.	$3,542	
1897 Virginia City Eq.	$260 min.	$5,532	
1910 Tonopah Junction Eq.	$40	$741	$2M
1914a (Feb.) Reno Eq.	$156	$2,889	
1914b (April) Reno Eq.	$612	$11,333	
1914c (April) Virginia City Eq.	$122	$2,259	
1915 Pleasant Valley Eq.	$6,632	$120,582	$236M
1932 Cedar Mountain Eq.	$3,885	$52,500	$25M
1933 Wabuska Eq.	$478	$6,732	
1934 Excelsior Mtn. Eq.	$635	$8,699	
1954a,b Rainbow/Stillwater Eqs.	$750,000	$5,136,986	
1954c,d Fairview Pk.-Dixie V. Eqs.	$250,000	$1,712,329	
1966 Caliente Eq.	$0	$0	$390,000
1994 Double Spring Flat Eq.	$805	$1000	
Total	>$1,029,180	$7,332,727	$1,573,000,000

1 These estimates are preliminary and are likely too low.

2 Most of these values were estimated converting the cost to 2003 values by using the change in the value of the dollar (calculations by Dr, Robert Sahr at Oregon State University, Corvallis) between the time of the earthquake and 2003.

3 These are ballpark estimates based on earthquake simulations. Uncertainties in these estimates arise from incomplete inventories and earthquake models.