Simulation of Seismic-Wave Propagation Through the Lake Tahoe Basin, Calif.-Nevada: A Scenario Approach to Probabilistic Shaking Hazard

Gretchen C. Schmauder1,2, John N. Louie1,3, Satish Pullmananappalli2, Kyle Gray1, Kevin McBean1, Alexa McBean1, & Graham M. Kent1

1. Nevada Seismological Lab. and Dept. Geol. Sci. & Engin., Univ. of Nevada 0174, Reno NV 89557 USA; louie@seismo.unr.edu
2. Optim SDS, 200 S. Virginia St. Suite 560, Reno, NV 89501 USA; gretchens@optimsds.com
3. Visiting VUW

1) Finding Earthquake Source Faults: Marine CHIRP Under Lake Tahoe; Dense LiDAR Under Trees

Time-history plot (modified from Maloney et al., 2013, UC San Diego) showing both direct and indirect evidence for faulting in the Tahoe basin, including turbidite deposits near, or possibly resulting from failure of, the Stateline-North Tahoe fault.

Watershed Sciences airborne Light Detection and Ranging (LiDAR) imagery over 232,000 acres in the Tahoe basin. At least 6 late LiDAR returns per sq. meter. Ground model has 2.5 cm elevation accuracy.

Assembled Basin Thickness
Assembled Geotech Vs
200-m Grid Upper-Zone Vs
NSZ WTPF So. Rupture
NSZ 0.3 m A.R.E. Map

2) Gravity and ReMi™ Assess Wave Trapping in Basins and Geotechnical Amplification

Separate Bedrock and Basin gravity like Saltus, Jochens, Blakely of USGS

3) Probabilistic Mapping with ShakeZoning Scenario Predictions Using Physics and Geology

How to Turn Scenarios into Probabilistic Maps

Frankel et al. (2007) add up Annual Rates of Exceedance (ARE) to get probability with:

\[ f(\mu \geq \mu_i) = \sum_{M=0}^{\infty} r_{(M, source)}(\mu_i \geq \mu_i) \cdot p_{(M, source)} \]

where \( r_{(M, source)} \) is the annual rate of occurrence for an earthquake with magnitude \( M \) at source location \( j \).

Quick Summation of AREs

\[ ARE(\mu \geq \mu_i, \text{site}) = \sum_{M=0}^{\infty} r_{(M, site, source)}(\mu_i \geq \mu_i) \cdot p_{(M, site, source)} \]

with \( ARE(\mu \geq \mu_i, \text{site}) \) the total annual rate of exceedance of ground motion \( \mu_i \) (0.30 m/s PGV) at site i on the map. \( p_{(M, site, source)} \) the NSZ-computed PGV at site i for source scenario j and the annual rate of scenario source j.

<table>
<thead>
<tr>
<th>Fault</th>
<th>Average Rate, /yr</th>
<th>Maximum Rate, /yr</th>
<th>Minimum Rate, /yr</th>
<th>Number of Scenarios</th>
<th>Scenario Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTPPF</td>
<td>1/4.500</td>
<td>1/3.500</td>
<td>1/5.400</td>
<td>3</td>
<td>0.00007/year</td>
</tr>
<tr>
<td>SNTF</td>
<td>1/14.500</td>
<td>1/13.500</td>
<td>1/19.400</td>
<td>2</td>
<td>0.00001/year</td>
</tr>
<tr>
<td>IVF</td>
<td>1/17.500</td>
<td>1/15.000</td>
<td>1/20.000</td>
<td>1</td>
<td>0.00005/year</td>
</tr>
</tbody>
</table>

1. Nevada Seismological Lab. and Dept. Geol. Sci. & Engin., Univ. of Nevada 0174, Reno NV 89557 USA; louie@seismo.unr.edu
2. Optim SDS, 200 S. Virginia St. Suite 560, Reno, NV 89501 USA; gretchens@optimsds.com
3. Visiting VUW