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Directivity-Based Probabilistic Seismic Hazard Analysis for the State of California: Report 3, Datasets & Tools

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A report on research conducted with support from the California Energy Commission, Pacific Gas & Electric Company and California Department of Transportation

Report GIRS-2023-06

DOI: 10.34948/N3G01Q

University of California, Los Angeles (headquarters)

March 2023

Natural Hazards Risk & Resiliency Research Center

B. John Institute for the Risk Sciences

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September 2023

ABSTRACT

An independent state-wide probabilistic seismic hazard analysis (PSHA) was conducted for California including, for the first-time, the directivity effects of ground motions. This PSHA study and the resulting mean hazard curves, ground motions, and deaggregation results are input for the larger seismic risk analysis and resiliency study conducted for the natural gas infrastructure system including transmission lines and storage facilities throughout the state of California.

A total of 19,316 sites based on a grid spacing of 0.05 by 0.05 degrees longitude and latitude were used in the seismic hazard analysis. At each site location, PSHA was conducted for multiple Vs30 values including the site-specific Vs30 value estimated from three-dimensional velocity structure maps in California. Hazard results are also provided for site-specific estimates of basin depth parameters where these estimates are deemed reliable.

This report is the third in a series of three reports on documentation of the directivity-based state-wide PSHA study for California. The first report (Al Atik, et al, 2022) described the input seismic source and ground motion models. The second report (Al Atik, et al, 2023) described the implementation of *near-field directivity effects* on the ground motion for the state-wide hazard study. This third report describes the data collected and processed from the hazard analysis and development of a user-interactive web tools, which allow the user to generate hazard results with and without directivity effects at any location in California and for any Vs30 site condition between 180 and 1,100 m/sec.

Two web-based tools were developed to provide access to the data. The Directivity-Based Intensity-Measure Interactive Maps provide the geographic distribution of intensity measures with an overlay of the fault sources and geographic features. The Directivity-Based PSHA Interactive Tool interpolates the study data to provide Uniform-Hazard Spectra with and without directivity at a user-specified location, Vs30, and return period. The tool also provides the directivity adjustment factor, defined as the ratio between with-directivity and without-directivity PSA. By using this tool, you may either use the with-directivity PSA values directly, or you may use the directivity-amplification factors and apply them to no-directivity PSA values obtained from your own PSHA analysis. These tools, as well as the data tables can be access from: https://www.risksciences.ucla.edu/nhr3/california-directivity.

ACKNOWLEDGMENTS

Support for this research project was provided by the California Energy Commission, Pacific Gas & Electric Company, and California Department of Transportation. The support of these organizations is greatly appreciated.

The opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the study sponsors, the Natural Hazards Risk and Resiliency Research Center, or the Regents of the University of California.

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1. Introduction

A state-wide probabilistic seismic hazard analysis (PSHA) was performed for California. The state-wide PSHA includes, for the first time, the effects of directivity of ground motion. A total of 19,316 sites based on a grid spacing of 0.05 by 0.05 degrees longitude and latitude were used in the analysis. These sites were selected to cover the entire state, as shown in Figure 1.1, and extend slightly beyond the state boundaries.

A project-specific version of HAZ-45 (HAZ-45-CEC) was developed to perform the PSHA for this study. The hazard analysis was performed for peak ground velocity (PGV) and for 22 spectral periods ranging from 0.01 sec (assumed to be equivalent to peak ground acceleration, PGA) to 10 sec. For each site, PSHA was performed for a range of site conditions with travel-time averaged shear-wave velocity in the top 30 m of the profile (Vs30) values of 180, 300, 400, 500, 760, and 1,100 m/sec. These six Vs30 values were selected to allow for a reasonable approximation of the hazard results for any Vs30 value between 180 and 1,100 m/sec not explicitly used in the study based on interpolation of the results obtained at neighboring Vs30 values. In addition, the PSHA was performed for each site for the site-specific estimate of Vs30 obtained from proxy models developed for California. Site-specific basin depth estimates were evaluated for the selected sites and used along with the site-specific Vs30 values to calculate the hazard for sites where site-specific basin depths estimates were deemed reliable.

Directivity-Based PSHA was also performed at all sites for the case of Vs30 = 760m/s. As presented in the companion reports, the directivity-based PSHA was also performed at all other Vs30, except for the site-specific value, for a number of sites located in the North-West region of California.

This report is the third in a series of three reports for the documentation of the directivity-based state-wide PSHA study for California (Al Atik, et al, 2022 and 2023). The first report described the input seismic source and ground motion models. The second report described the implementation of near-field directivity effects on the ground motion for the state-wide hazard study. This third report describes the data collected and processed from the hazard analysis and development of a user-interactive web tool. The web tool, which allows the user to generate hazard results with and without directivity effects at any location in California and for any Vs30 site condition between 180 and 1,100 m/sec.

Two web-based tools were developed to provide access to the data. The Directivity-Based Intensity-Measure Interactive Maps provide the geographic distribution of intensity measures with an overlay of the fault sources and geographic features. The Directivity-Based PSHA Interactive Tool interpolates the study data to provide Uniform-Hazard spectra with and without directivity at a user-specified location, Vs30, and return period. The tool also provides the directivity adjustment factor, defined as the ratio between with-directivity and without-directivity PSA. By using this tool, you may either use the with-directivity PSA values directly, or you may use the directivity-amplification factors and apply them to no-directivity PSA values obtained from your own PSHA analysis.

The data processing presented in this report consists of three parts. The HAZ-45 program generates a set of output ASCII files that are formatted to be read by a human, not a computer. These first-set files were read in a systematic way and processed to be able to be interpreted by a computer algorithm into a second set of data that is stored in a systematic manner and easy to read programmatically. The third set of data comprises post-processed data that is easy to interpret, such as intensity-measure maps and graphs.

The web-based tools, as well as the data tables can be access from: https://www.risksciences.ucla.edu/nhr3/california-directivity.

1.1 Site Parameters

Figure 1.2 shows the location of the crustal sources in California developed in the Uniform California Earthquake Rupture Forecast Version 3 (UCERF3) model (Field et al., 2014) seismic sources used in the seismic hazard analysis.

Even though the PSHA analyses were performed on 19,316 sites in California, only 18,338 are located on land. Figure 1.3 shows the selected sites that are located on land, along with their site ID, as well as the UCERF-3 fault sources. This figure is a good reference to determine the location of individual sites and which sites are closest to the fault sources.

A map of the site-specific estimates of Vs30 for the 18,338 sites in California are shown in Figure 1.4. The site-specific Vs30 values are provided in the electronic appendix to this report. These site-specific Vs30 estimates range from 177 to 1,115 m/sec and were used along with default Z1.0 and Z2.5 estimates in the PSHA analysis. The use of site-specific basin depth estimates is discussed in the first companion report. Figure 1.5 and Figure 1.6 show the site-specific values of Z1 and Z2.5 values, respectively, for sites in which these values were estimated with confidence. A total of 4,419 out of the 19,316 sites in California had confident estimates of site-specific basin depth parameters. The list of site-specific Z1 and Z2.5 values is provided in the electronic appendix to this report.

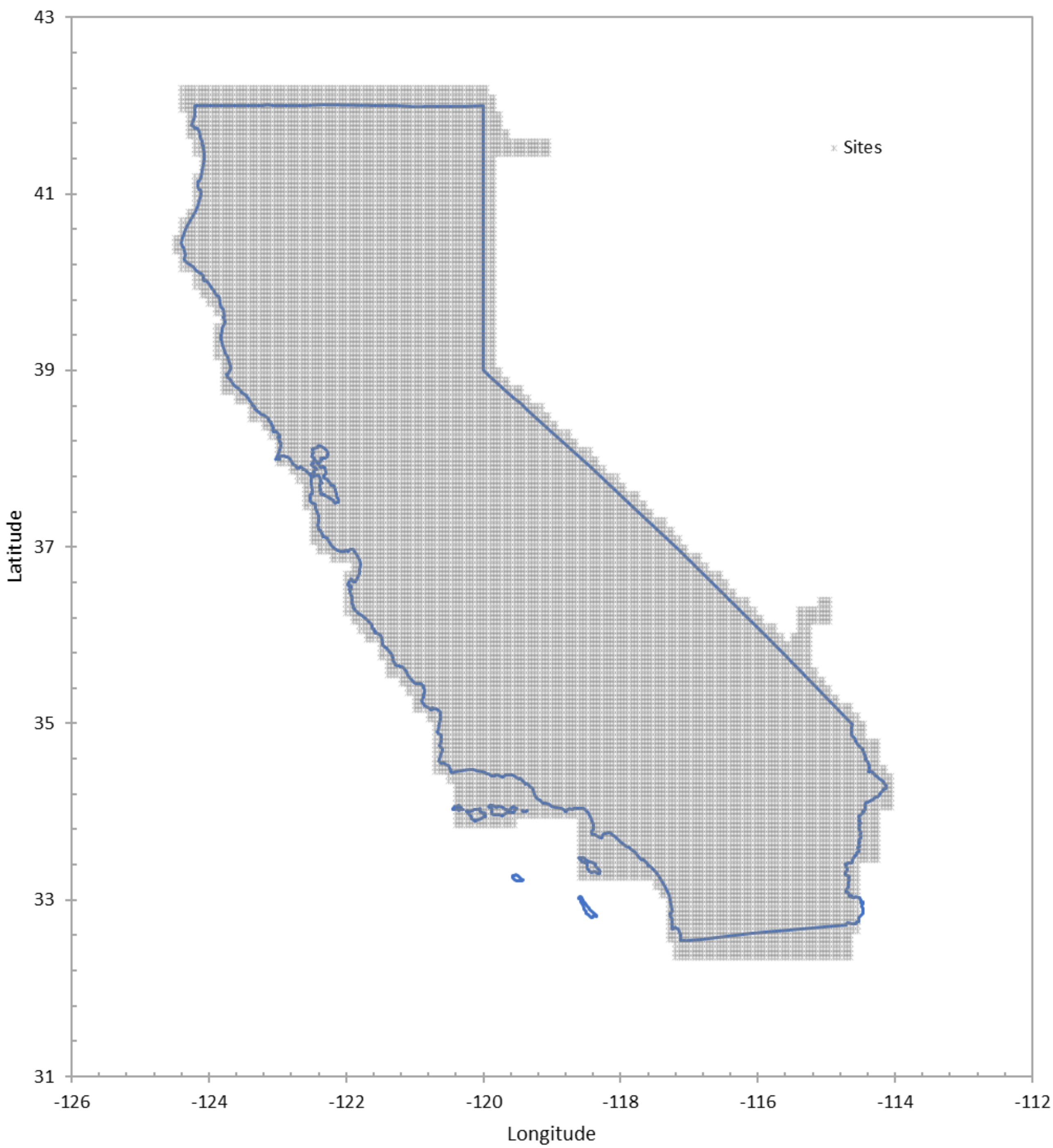


Figure 1.1. Selected site locations.

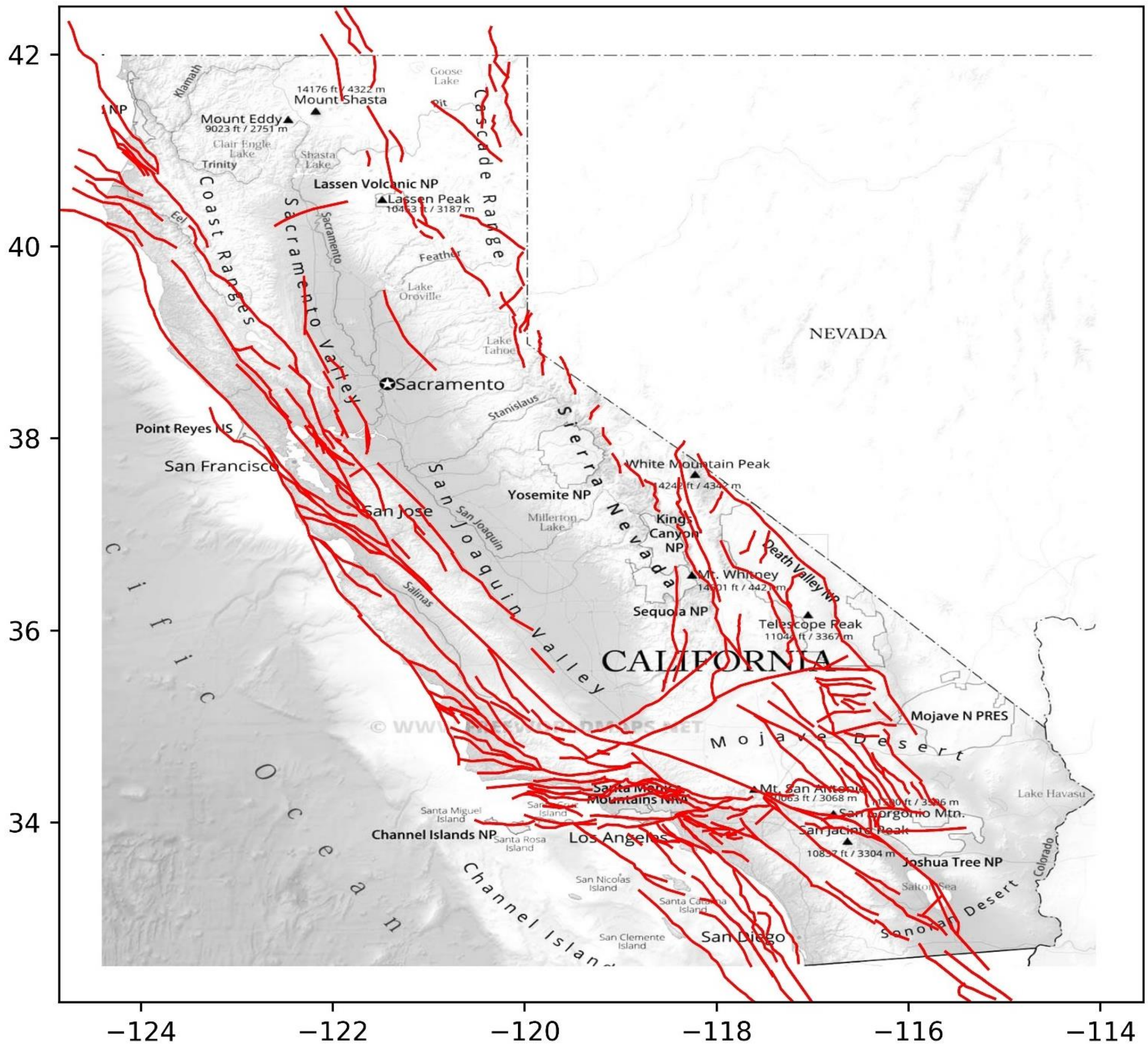


Figure 1.2. UCERF3 fault traces map for the state of California.

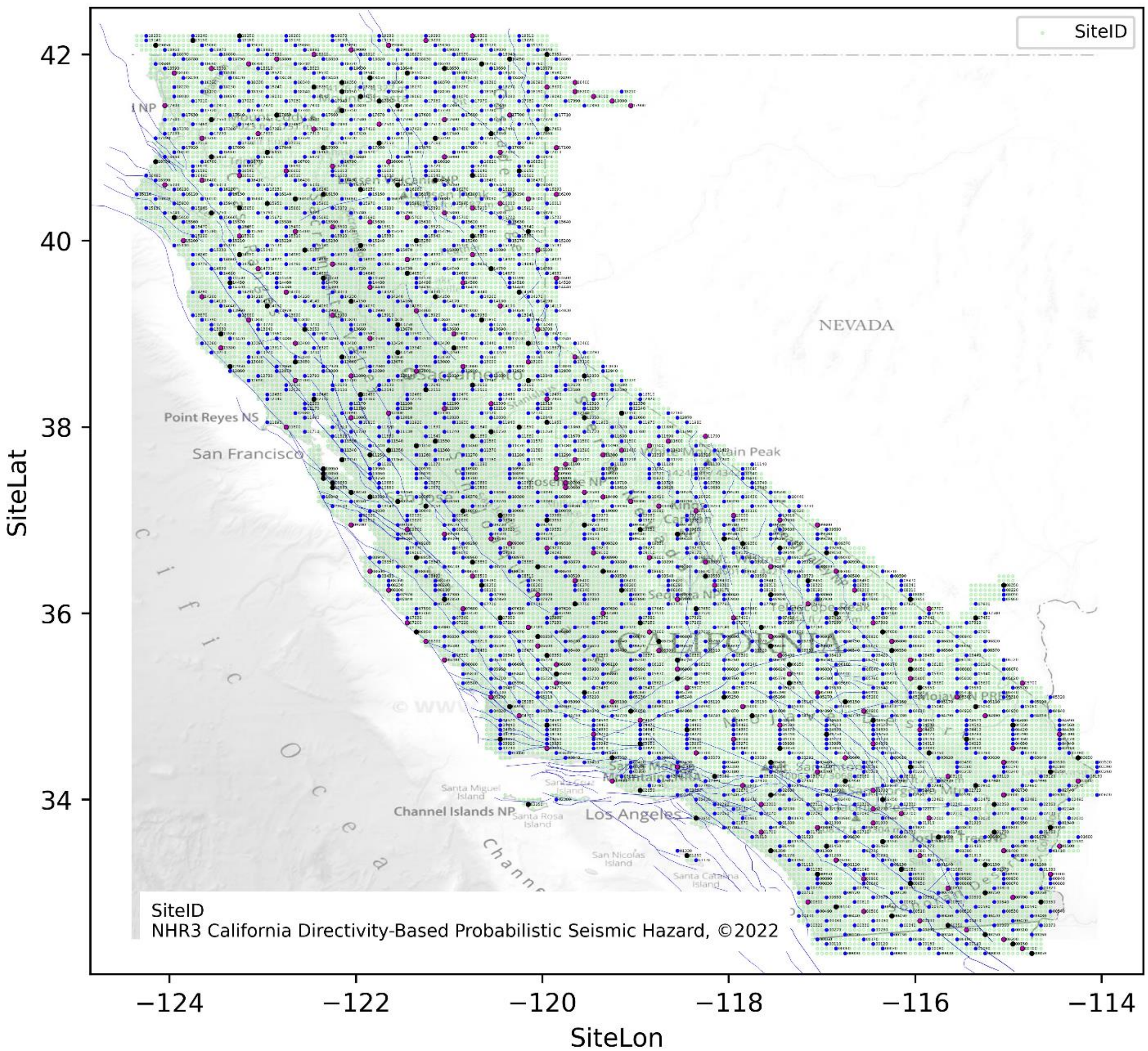


Figure 1.3. Site locations on land (green circles) for the hazard analysis. Black lines show the UCERF3 fault traces. The site labels are provided in intervals of 10 in blue circles, 50 in black circles and 100 in magenta circles.

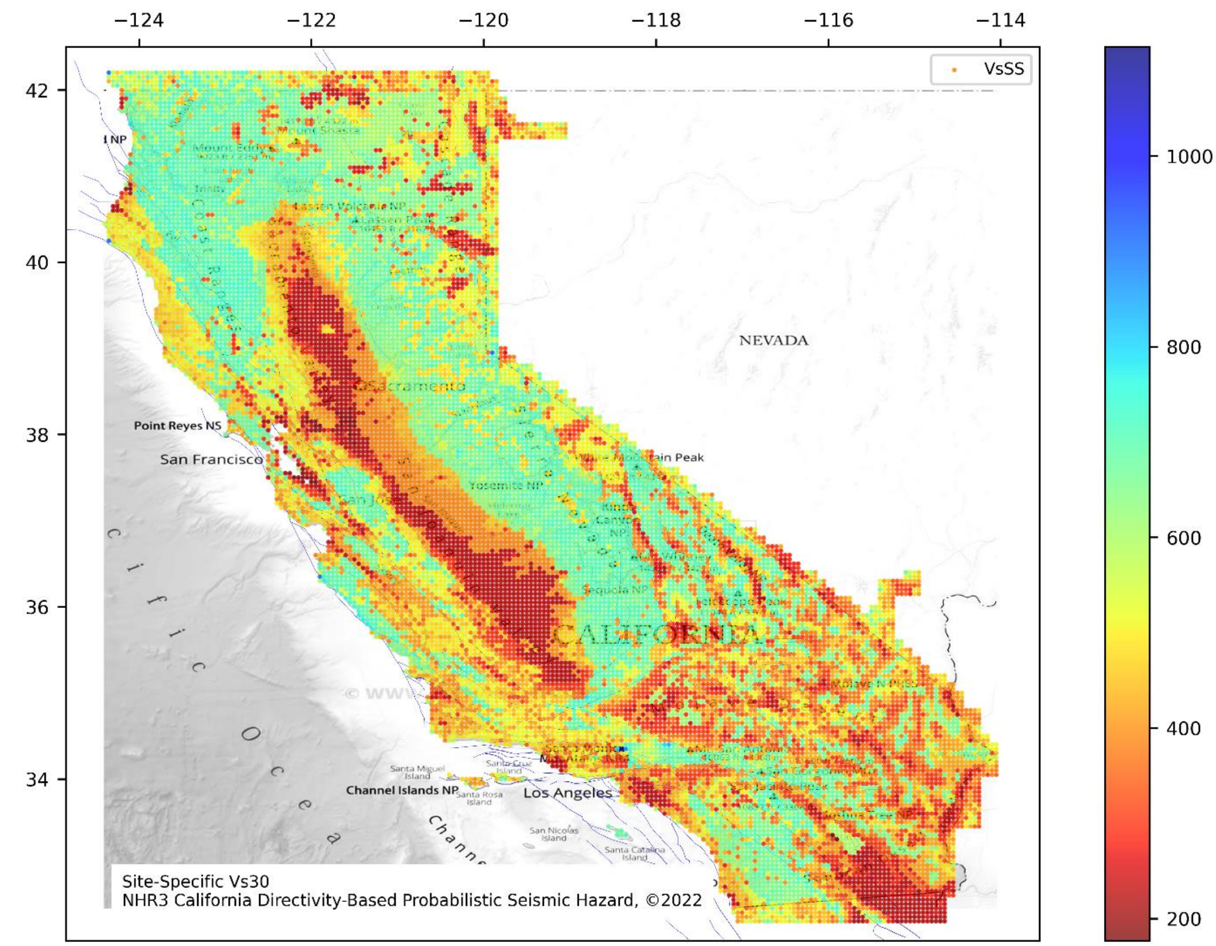


Figure 1.4. Site-Specific Vs30 (VsSS) m/s for all sites on land, obtained from proxy models developed for California.

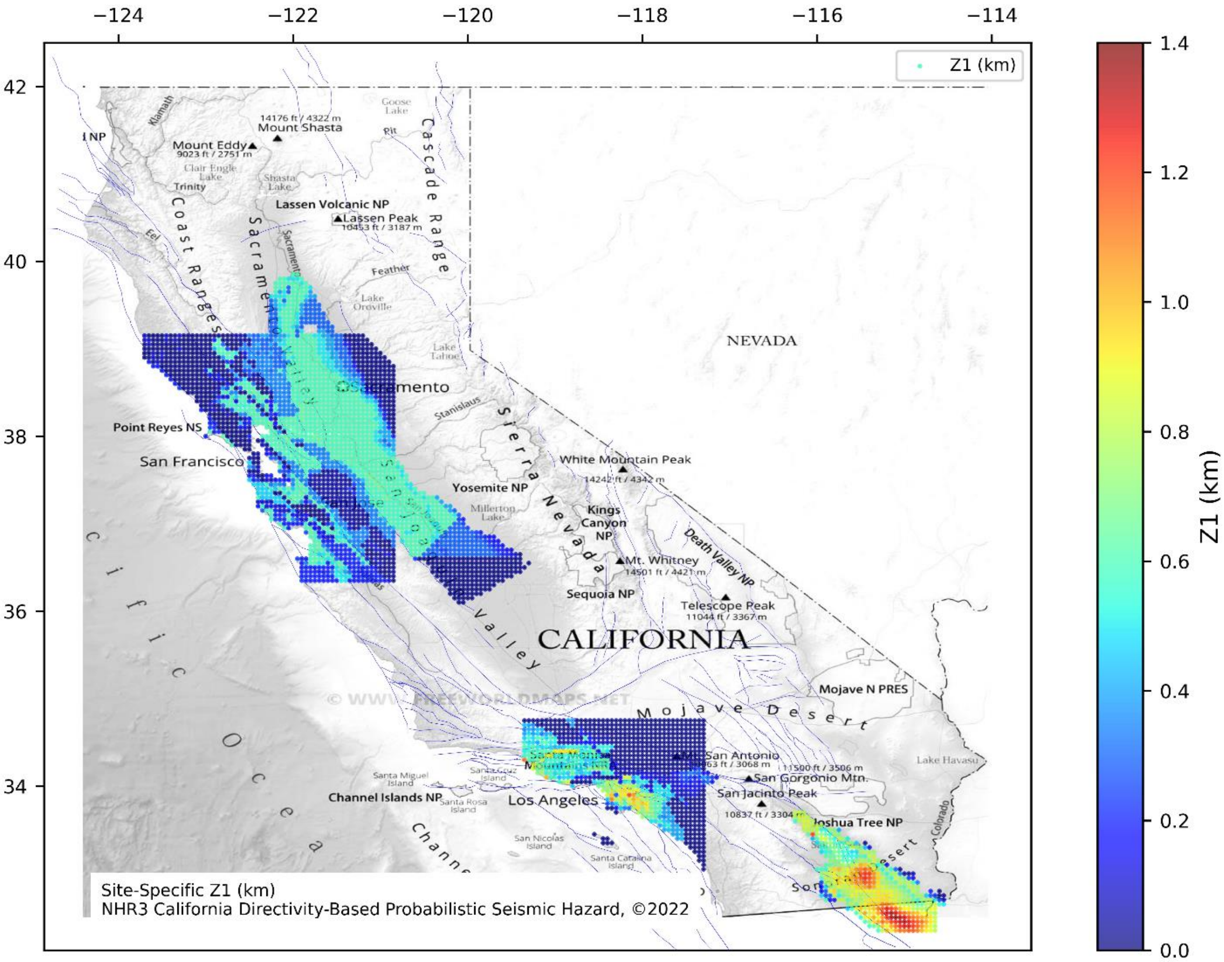


Figure 1.5. Estimated site-specific basin depth term Z1 (km) at select locations, where available.

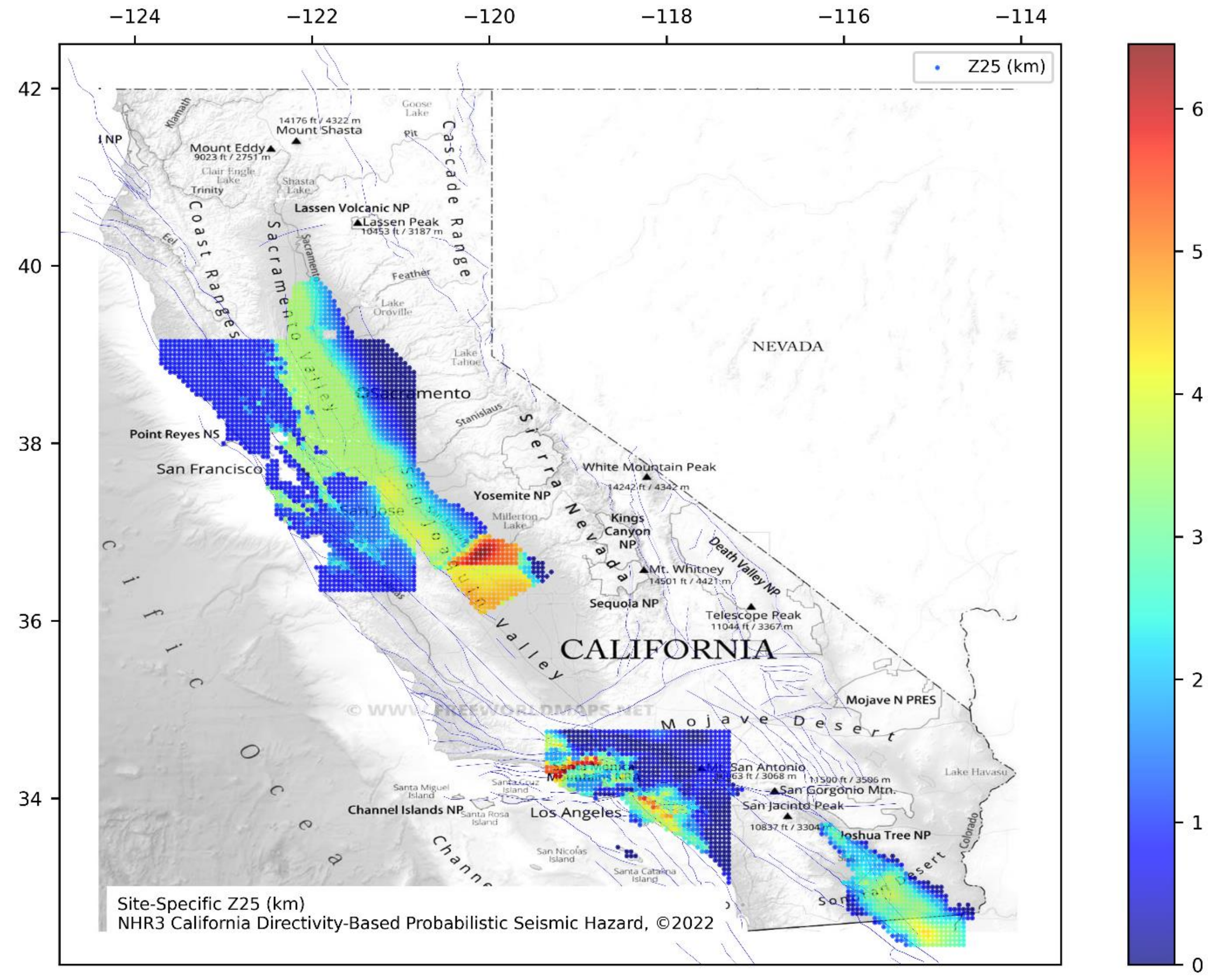


Figure 1.6. Estimated site-specific basin depth term Z2 (km) at select locations, where available.

1.2 Directivity-Amplification Factor

As described in the companion reports, a PSHA that considered directivity effects was performed at all sites for the case of VS760, while a PSHA that did not consider directivity effects was performed for all sites and Vs30 cases. Using the results of these analyses, the Directivity-Amplification Factor was defined as the ratio of PSA considering directivity to the PSA not considering directivity at a set of user-defined return periods.

Once computed for the case of VS760, the Directivity-Amplification Factor was used to estimate the directivity-based PSA for all other Vs30 cases by multiplying the no-directivity PSA computed for a particular Vs30 (180-1100m/s) by the Directivity-Amplification Factor. As a conservative measure, a lower bound of 1.0 was set for the Directivity-Amplification Factor used in these calculations.

As presented in the companion report, additional directivity-based PSHA were performed at a set of sites in the North-West region of California for all Vs30 cases and a new set of

Directivity-Amplification Factors were computed for each Vs30 and stored in the datasets. While these values are used in the site-specific tool, all tables and maps for directivity are based on the VS760-based Directivity-Amplification Factor.

1.3 Spectral Periods

As presented in the companion report, the directivity-based PSHA was performed only for spectra periods of 0.5sec and higher. In the datasets presented in the report, it is assumed that the directivity and no-directivity PSHA results for the lower periods are equal and a Directivity-Amplification Factor of 1.0 was assigned to these cases.

1.4 Directivity Models

As presented in the companion reports, the directivity-based PSHA computed a weighted average directivity model. All directivity-based data (PSA and Directivity-Amplification Factor) presented in this report are based on this model. However, the hazard-analysis results for each individual directivity model presented in the companion report, was also processed and presented in this report. The Directivity-Amplification Factors for each directivity model were computed and included in the datasets contained in this report.

1.5 Geographic-Distribution Data

In addition to being grouped by site, the Uniform-Hazard Spectra data were further post-processed and grouped by intensity measure, resulting in tables and maps to quantify the geographic distribution of such quantities. These PSA values with and without directivity, as well as the directivity-amplification factors for the individual directivity models are such intensity measures. All directivity models – weighted average and individual directivity models – were processed. One table for each Vs30, spectral period, and return period was produced for each intensity measure. These tables were produced in csv format. These data were further plotted in a map (jpg file) to enable better visualization and reporting of the data. Interactive maps in HTML format were also created for each dataset.

2 Processing of PSHA Results

This chapter provides details on the different types of data processing that were performed. The data itself is presented in the next chapter.

2.1 Data Format

Because of the significant size of the data, the collected data were saved to a series of HDF5 files (Hierarchical Data Format) which store the data in compressed binary format. HDF5 format is widely used in the scientific and computer-science community. HDF5 file stands for Hierarchical Data Format 5. It is an open-source file for storing large amounts of data. As the name suggests, it stores data in a hierarchical structure within a single file. An HDF5 file is a container for two kinds of objects: datasets, which are array-like collections of data, and groups, which are folder-like containers that hold datasets and other groups. The most fundamental thing to remember when using HDF5 is that groups work like dictionaries, and datasets work like NumPy arrays. The benefits of using HDF5 are as follows:

- Heterogeneous Data Storage: HDF5 files can store many different types of data within the same file. One HDF5 can replace many CSV/table files.
- Supports Data Slicing: extracting portions of the dataset as needed for analysis. Unlike a JSON file, you do not need to upload the entire file to memory.
- Can be accessed via many interpreters (Matlab, Python, R, etc.) (= Open Format)
- Because it uses a hierarchical data structure, it is self-documenting.

Figure 2.1 shows a schematic of the HDF5 data structure. This data structure is very similar to the JSON format. However, pure JSON can only be stored in ASCII format and the entire JSON dictionary must be loaded to memory. HDF5 format saves the data in its original binary format. For example, numpy arrays in python are stored as numpy arrays. This format results in more efficient memory and programmatic access management.

Because the HDF5 is binary, it cannot be easily viewed via a text editor. However, a simple script can be written to query the keys and attributes of the data. All data processing was performed in Python.

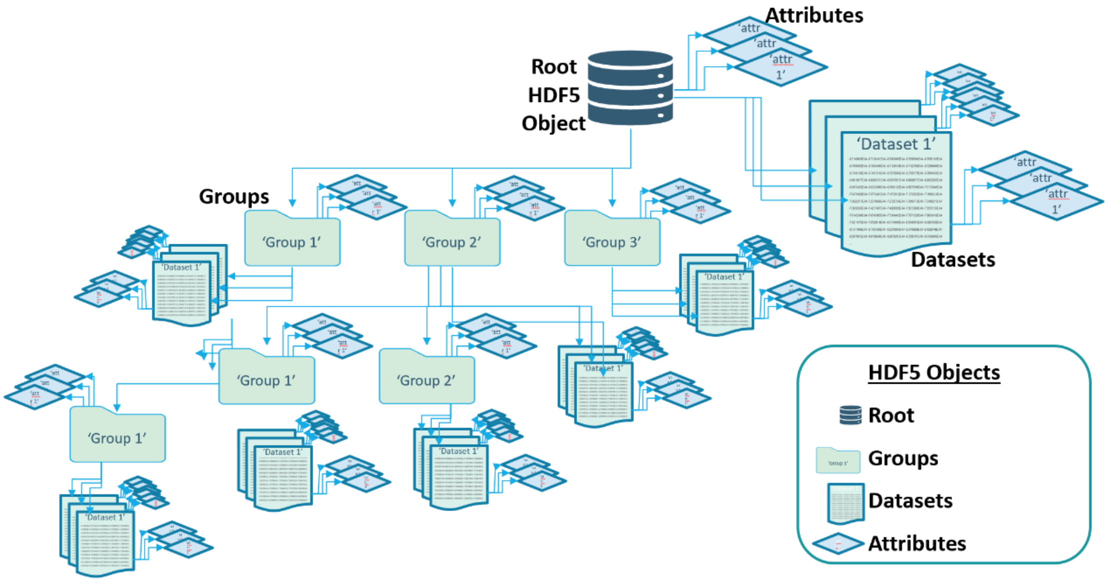


Figure 2.1. Schematic of HDF5 data structure

2.2 Hazard-Analysis Results: Raw Output Data

A project-specific version of HAZ-45 (HAZ-45-CEC) was developed to perform the PSHA for this study. The hazard analysis was performed for peak ground velocity (PGV) and for 22 spectral periods ranging from 0.01 sec (assumed to be equivalent to peak ground acceleration, PGA) to 10 sec. For each site, PSHA was performed for a range of site conditions with travel-time averaged shear-wave velocity in the top 30 m of the profile (Vs30) values of 180, 300, 400, 500, 760, and 1,100 m/sec. In addition, the PSHA was performed for each site for the site-specific estimate of Vs30 obtained from proxy models developed for California. Site-specific basin depth estimates were evaluated for the selected sites and used along with the site-specific Vs30 values to calculate the hazard for sites where site-specific basin depths estimates were deemed reliable.

Because HAZ-45 performs the hazard analysis for each case (site location, Vs30, directivity case), it generated a set of output files for each case, for a total of over 160,000 individual data sets. Each dataset contained approximately 100 files, depending on the Vs30 cases and the number of periods considered (directivity analysis was performed only on longer periods). HAZ-45 generates 8 types of files, of these the following were processed:

- *.out3: (one file per period, including PGV). This file contains the hazard-curve data generated for each fault group (e.g., fault sources or gridded seismicity groups) as well as the total weighted annual rate of exceedance, the annual Poisson probability, and the corresponding mean Magnitude, Distance, and Epsilon values. Shown in Figure 2.2.
- *.out6: (one file per period, including PGV). This file contains the annual probability of exceedance for each ground-motion model used at the site. For the case where directivity is considered, it also contains the annual probability of exceedance for each directivity model. Shown in Figure 2.3.
- *.out7. (One file per period, including PGV). This file contains the annual probability of exceedance for each fault source. Shown in Figure 2.4.
- *-UHSoutput.txt. HAZ-45 outputs one UHS-out file for each case. This file contains a series of output tables:
    - Table of 23 user-defined periods. The user-defined spectral periods are given in Table 2.1.
    - Table of user-defined annual frequency of exceedance, along with the corresponding probability of exceedance and return period. The user-defined return periods are given in Table 2.2.
    - Table of PSA (g) at each user-defined annual rate of exceedance (which corresponds to a specific return period) and each user-defined spectral period. These are the Uniform-Hazard Spectra (UHS) table. Shown in Figure 2.5.
    - Tables of mean Magnitude, Distance and Epsilon (Magnitude Bar, Distance Bar, Epsilon Bar) corresponding to the UHS table. Shown in Figure 2.5.

- Deaggragation Data Tables for each Spectral Period, Epsilon Bin Range (-20-20) and hazard level (AEP or Return Period). Each table contains the fractional contribution of different magnitude and distance bins. Shown in Figure 2.6.

Table 2.1. List of spectral periods used in this study. Peak ground acceleration (PGA) is assumed to be equivalent to the period of 0.01 sec. Hazard was also conducted for peak ground velocity (PGV), which uses a value of -1 in the hazard program.

Spectral period (s)	0 (or 0.01, PGA), 0.02, 0.03, 0.04, 0.05, 0.075, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5, 0.75, 1, 1.5, 2, 3, 4, 5, 7.5, 10, -1 (PGV)

Table 2.2. List of Annual Frequency of Exceedance, corresponding probability of exceedance and return period used in this study.

Annual Frequency of Exceedance (/yr)	1.97E-02,1.01E-02,2.11E-03,1.05E-03,1.00E-03,4.04E-04,2.00E-04,1.00E-04
Annual Probability of Exceedance (/yr)	1.95E-02,1.00E-02,2.11E-03,1.05E-03,1.00E-03,4.04E-04,2.00E-04,1.00E-04
Return Period (yr)	50.862,99.499,474.561,949.118,999.5,2474.911,5000,10000

```
      6       0          Number of faults, fault cases
Fault Name                       nFlt System Number Rupture Dist   BJF Dist  Campbell Dist nWidth nMaxmag Max Mag  Wts.  Fault Type   HWFlag    Vs


---------------------------------------------------------------------------------------------------------------

 SITE 1 COORDINATES:  -117.200   32.350
    1  nAtten
  Attenuation:     1      0.0100
   20  nAmp
 AMP:                                       pSeg al_Wt  MinDis    0.001000    0.001600    0.002600    0.004300    0.007000    0.011300    0.018300    0.029800
  Site00001-Flts-select                    1.000 1.000     3.0   0.1449E+00  0.1381E+00  0.1239E+00  0.1005E+00  0.7307E-01  0.4790E-01  0.2899E-01  0.1699E-01
       Site00001-Grd-SS                    1.000 1.000     1.0   0.4339E+00  0.3420E+00  0.2455E+00  0.1579E+00  0.9358E-01  0.5132E-01  0.2588E-01  0.1205E-01
    Site00001-Grd-RV-HW                    1.000 1.000     1.0   0.1430E+00  0.1125E+00  0.8173E-01  0.5411E-01  0.3350E-01  0.1942E-01  0.1048E-01  0.5278E-02
    Site00001-Grd-RV-FW                    1.000 1.000     1.0   0.1420E+00  0.1114E+00  0.8056E-01  0.5303E-01  0.3260E-01  0.1873E-01  0.9993E-02  0.4958E-02
    Site00001-Grd-NM-HW                    1.000 1.000     1.0   0.6657E-01  0.5057E-01  0.3395E-01  0.1970E-01  0.1024E-01  0.4772E-02  0.1947E-02  0.6828E-03
    Site00001-Grd-NM-FW                    1.000 1.000     1.0   0.6608E-01  0.4996E-01  0.3331E-01  0.1915E-01  0.9824E-02  0.4495E-02  0.1791E-02  0.6091E-03
  Wt_Total_Events/yr                       0.000 0.000     0.0   0.9965E+00  0.8045E+00  0.5989E+00  0.4044E+00  0.2528E+00  0.1466E+00  0.7908E-01  0.4058E-01
  Poisson_Prob:                            0.000 0.000     0.0   0.6308E+00  0.5527E+00  0.4506E+00  0.3326E+00  0.2234E+00  0.1364E+00  0.7603E-01  0.3976E-01
  M_bar                                    0.000 0.000     0.0   0.567E+01   0.573E+01   0.582E+01   0.591E+01   0.602E+01   0.612E+01   0.621E+01   0.628E+01
  D_bar                                    0.000 0.000     0.0   0.155E+03   0.148E+03   0.138E+03   0.128E+03   0.116E+03   0.102E+03   0.862E+02   0.680E+02
  Eps_bar                                  0.000 0.000     0.0  -0.185E+01  -0.147E+01  -0.113E+01  -0.826E+00  -0.586E+00  -0.406E+00  -0.293E+00  -0.241E+00
```

Figure 2.2. Screenshot of HAZ-45 .out3 sample file.

```
1    1    1  0.5840E+01  0.4807E+01  0.3684E+01  0.2519E+01  0.1610E+01  0.9366E+00  0.5043E+00  0.25
1    1    2  0.5582E+01  0.4484E+01  0.3355E+01  0.2237E+01  0.1398E+01  0.7963E+00  0.4198E+00  0.20
1    1    3  0.6071E+01  0.5117E+01  0.4018E+01  0.2819E+01  0.1843E+01  0.1096E+01  0.6023E+00  0.31
1    1    4  0.6007E+01  0.5011E+01  0.3893E+01  0.2710E+01  0.1764E+01  0.1030E+01  0.5356E+00  0.24
1    1    5  0.5761E+01  0.4691E+01  0.3562E+01  0.2421E+01  0.1538E+01  0.8720E+00  0.4380E+00  0.19
1    1    6  0.6225E+01  0.5315E+01  0.4228E+01  0.3016E+01  0.2009E+01  0.1207E+01  0.6487E+00  0.31
1    1    7  0.6161E+01  0.5224E+01  0.4119E+01  0.2881E+01  0.1848E+01  0.1047E+01  0.5291E+00  0.24
1    1    8  0.5935E+01  0.4915E+01  0.3778E+01  0.2566E+01  0.1598E+01  0.8770E+00  0.4305E+00  0.19
1    1    9  0.6358E+01  0.5514E+01  0.4457E+01  0.3209E+01  0.2120E+01  0.1239E+01  0.6455E+00  0.30
1    1   10  0.5819E+01  0.4826E+01  0.3725E+01  0.2541E+01  0.1589E+01  0.8805E+00  0.4420E+00  0.20
1    1   11  0.5572E+01  0.4513E+01  0.3395E+01  0.2247E+01  0.1365E+01  0.7349E+00  0.3601E+00  0.16
1    1   12  0.6041E+01  0.5126E+01  0.4056E+01  0.2850E+01  0.1835E+01  0.1047E+01  0.5393E+00  0.25

1    0    1  0.1190E+01  0.9928E+00  0.7712E+00  0.5331E+00  0.3413E+00  0.1955E+00  0.1011E+00  0.48
1    0    2  0.1190E+01  0.9928E+00  0.7712E+00  0.5331E+00  0.3413E+00  0.1955E+00  0.1012E+00  0.48
1    0    3  0.1190E+01  0.9928E+00  0.7712E+00  0.5331E+00  0.3413E+00  0.1955E+00  0.1011E+00  0.48
1    0    4  0.1190E+01  0.9928E+00  0.7712E+00  0.5331E+00  0.3413E+00  0.1955E+00  0.1011E+00  0.48
1    0    5  0.1190E+01  0.9928E+00  0.7712E+00  0.5331E+00  0.3413E+00  0.1955E+00  0.1011E+00  0.48
```

Figure 2.3. Screenshot of HAZ-45 .out6 sample file.

```
---------------------------------------------------------------------------------------------------------------

 SITE 1 COORDINATES:  -117.200   32.350
    1  nAtten
  Attenuation:     1      0.0100
   20  nAmp
 AMP:                                       pSeg al_Wt  MinDis    0.001000    0.001600    0.002600    0.004300    0.00700
  ParentID:   341                          1.000 1.000   334.9   0.1515E-03  0.1509E-03  0.1484E-03  0.1392E-03  0.1192E-
  ParentID:    49                          1.000 1.000   315.9   0.1358E-03  0.1348E-03  0.1314E-03  0.1223E-03  0.1049E-
  ParentID:   286                          1.000 1.000   287.9   0.3543E-03  0.3494E-03  0.3389E-03  0.3190E-03  0.2860E-
  ParentID:   301                          1.000 1.000   221.0   0.1027E-01  0.9300E-02  0.7159E-02  0.4290E-02  0.2169E-
  ParentID:   282                          1.000 1.000   200.2   0.2537E-02  0.2455E-02  0.2194E-02  0.1665E-02  0.1044E-
  ParentID:   294                          1.000 1.000   179.5   0.1049E-03  0.1046E-03  0.1032E-03  0.9851E-04  0.8878E-
  ParentID:   283                          1.000 1.000   182.4   0.3299E-02  0.3249E-02  0.3055E-02  0.2546E-02  0.1750E-
  ParentID:   250                          1.000 1.000   188.4   0.2104E-03  0.2080E-03  0.1972E-03  0.1657E-03  0.1134E-
  ParentID:   119                          1.000 1.000   185.4   0.1416E-03  0.1404E-03  0.1369E-03  0.1304E-03  0.1226E-
  ParentID:   295                          1.000 1.000   176.7   0.2148E-02  0.2119E-02  0.2028E-02  0.1829E-02  0.1526E-
  ParentID:   284                          1.000 1.000   180.8   0.8546E-03  0.8463E-03  0.8124E-03  0.7227E-03  0.5811E-
  ParentID:   901                          1.000 1.000   195.1   0.2213E-04  0.2202E-04  0.2161E-04  0.2066E-04  0.1931E-
  ParentID:   289                          1.000 1.000   173.2   0.1071E-03  0.1071E-03  0.1067E-03  0.1057E-03  0.1034E-
  ParentID:   401                          1.000 1.000   156.4   0.1862E-03  0.1861E-03  0.1857E-03  0.1842E-03  0.1803E-
  ParentID:   293                          1.000 1.000   142.0   0.1042E-02  0.1041E-02  0.1034E-02  0.9985E-03  0.9002E-
```

Figure 2.4. Screenshot of HAZ-45 .out7 sample file.

Testing Levels :		0.019661	0.010050	0.002107	0.001054	0.001001	0.000404	0.000200	0.000100
Return Period(yr):		50.862	99.499	474.561	949.118	999.500	2474.911	5000.000	10000.000
	Period (sec)								
1	0.010	0.069904	0.106263	0.244631	0.336538	0.343300	0.486598	0.619821	0.770703
2	0.020	0.070877	0.107945	0.249456	0.343272	0.350276	0.499122	0.635114	0.792637
3	0.030	0.077896	0.119185	0.277095	0.380023	0.388220	0.561018	0.712412	0.898719
4	0.040	0.087724	0.135217	0.318832	0.435398	0.445384	0.641356	0.828658	1.031728
5	0.050	0.098049	0.151396	0.360284	0.496670	0.508715	0.732140	0.948847	1.185735
6	0.075	0.125601	0.194552	0.464197	0.642328	0.656928	0.959162	1.238478	1.565981
7	0.100	0.143362	0.221937	0.532283	0.731953	0.749369	1.088282	1.423716	1.777077
8	0.150	0.156772	0.240685	0.575537	0.799012	0.818819	1.184158	1.546558	1.934166
9	0.200	0.150971	0.230490	0.548939	0.756551	0.774884	1.121595	1.470313	1.831150
10	0.250	0.139443	0.211509	0.498174	0.682060	0.697906	1.013590	1.314034	1.655795
11	0.300	0.128283	0.193757	0.448334	0.616340	0.630111	0.919362	1.180425	1.504246
12	0.400	0.107920	0.161203	0.370541	0.514470	0.526196	0.757222	0.981404	1.236664
13	0.500	0.091783	0.137192	0.317837	0.435066	0.445382	0.645581	0.844985	1.060178
14	0.750	0.064177	0.096100	0.223322	0.309125	0.316719	0.461098	0.602517	0.764938
15	1.000	0.046157	0.069449	0.163325	0.228076	0.233305	0.345498	0.449522	0.576712
16	1.500	0.028772	0.043759	0.104702	0.146580	0.150024	0.222578	0.291341	0.372603
17	2.000	0.020187	0.031221	0.076905	0.107551	0.110256	0.163387	0.216293	0.274882
18	3.000	0.012124	0.019224	0.049445	0.070005	0.071846	0.107240	0.141928	0.182136
19	4.000	0.008374	0.013594	0.036383	0.052463	0.053744	0.081464	0.107335	0.138574
20	5.000	0.006206	0.010333	0.029043	0.041977	0.043135	0.065598	0.087661	0.113371
21	7.500	0.003697	0.006426	0.019151	0.028242	0.028989	0.044576	0.059736	0.076739
22	10.000	0.002442	0.004383	0.013718	0.020271	0.020848	0.031982	0.042751	0.054817
23	-1.000	5.223123	8.088039	19.386177	26.682859	27.307693	39.696819	51.715790	64.653000

Magnitude Bar Results:

1	0.010	6.54	6.63	6.69	6.69	6.69	6.68	6.66	6.64
2	0.020	6.54	6.62	6.68	6.68	6.68	6.66	6.65	6.63
3	0.030	6.54	6.61	6.67	6.67	6.67	6.66	6.65	6.63
4	0.040	6.51	6.59	6.65	6.65	6.65	6.64	6.63	6.62
5	0.050	6.49	6.58	6.64	6.64	6.64	6.63	6.62	6.60
6	0.075	6.46	6.53	6.58	6.58	6.58	6.58	6.57	6.55
7	0.100	6.42	6.50	6.55	6.55	6.55	6.55	6.54	6.52
8	0.150	6.43	6.50	6.58	6.59	6.59	6.59	6.59	6.58
9	0.200	6.47	6.55	6.65	6.67	6.67	6.68	6.69	6.68
10	0.250	6.52	6.62	6.72	6.74	6.74	6.76	6.77	6.77
11	0.300	6.56	6.67	6.78	6.81	6.81	6.83	6.84	6.84
12	0.400	6.67	6.76	6.92	6.96	6.96	6.98	6.99	6.99
13	0.500	6.71	6.83	7.01	7.05	7.06	7.09	7.11	7.11
14	0.750	6.81	6.94	7.16	7.21	7.21	7.24	7.26	7.27
15	1.000	6.88	7.02	7.24	7.30	7.30	7.35	7.36	7.37
16	1.500	7.00	7.16	7.40	7.46	7.47	7.51	7.53	7.54
17	2.000	7.06	7.24	7.49	7.55	7.55	7.60	7.62	7.63
18	3.000	7.17	7.35	7.61	7.66	7.66	7.70	7.71	7.72
19	4.000	7.24	7.42	7.68	7.74	7.74	7.77	7.78	7.79
20	5.000	7.28	7.47	7.72	7.77	7.77	7.81	7.82	7.83
21	7.500	7.37	7.54	7.78	7.83	7.84	7.88	7.90	7.90
22	10.000	7.39	7.57	7.80	7.85	7.85	7.89	7.91	7.93
23	-1.000	6.98	7.15	7.36	7.40	7.41	7.44	7.46	7.46

Distance Bar Results:

1	0.010	46.016	37.406	22.925	17.887	17.726	14.307	12.176	10.704
2	0.020	45.752	37.180	22.760	17.823	17.653	14.031	12.035	10.512
3	0.030	45.026	36.646	22.631	18.145	17.930	13.637	12.035	10.144
4	0.040	45.332	36.454	22.111	18.255	17.969	13.974	11.773	10.414
5	0.050	45.462	36.744	22.170	18.071	17.709	14.133	11.776	10.559
6	0.075	43.883	35.729	21.980	17.850	17.632	13.736	11.966	10.382
7	0.100	44.052	35.322	21.157	17.688	17.407	13.808	11.501	10.479
8	0.150	44.626	36.038	21.526	17.573	17.222	13.995	11.707	10.644
9	0.200	46.096	37.196	22.397	18.724	18.400	14.843	12.343	11.278
10	0.250	48.156	38.770	23.755	20.087	19.811	15.718	13.563	11.878
11	0.300	50.242	40.375	25.765	21.331	21.092	16.493	14.621	12.416
12	0.400	53.839	44.951	28.846	23.331	23.001	18.978	16.149	14.318

Figure 2.5. Screenshot of HAZ-45 *-UHSoutput.txt. HAZ-45 sample file, Uniform Hazard Spectra Table.

```
 Deaggregation Results for Spectral Period:
              0.010

 Epsilon Bin Range:
            -20.000    29.600

       Hazard Level:
     AEP         RP (yr)
  0.01966113      50.862

Ground Motion Level =    0.06990

                       5.00 - 5.50   5.50 - 6.00   6.00 - 6.50   6.50 - 7.00   7.00 - 7.50   7.50 - 8.00   8.00 - 8.50   8.50 - 9.60
     0.000     5.000   0.1323E-01    0.5651E-02    0.2191E-02    0.1848E-02    0.7242E-03    0.4552E-04    0.0000E+00    0.0000E+00
     5.000    10.000   0.1908E-01    0.1413E-01    0.6560E-02    0.1681E-02    0.3943E-03    0.6351E-05    0.0000E+00    0.0000E+00
    10.000    20.000   0.6449E-01    0.4972E-01    0.1970E-01    0.8161E-02    0.6859E-02    0.2873E-01    0.4450E-02    0.0000E+00
    20.000    30.000   0.4219E-01    0.3778E-01    0.4599E-01    0.1852E-01    0.1991E-01    0.1359E-02    0.0000E+00    0.0000E+00
    30.000    50.000   0.2821E-01    0.4751E-01    0.3584E-01    0.1369E-01    0.8492E-02    0.3291E-02    0.0000E+00    0.0000E+00
    50.000    75.000   0.8752E-02    0.2412E-01    0.4055E-01    0.3013E-01    0.3030E-01    0.8676E-01    0.6173E-01    0.1414E-04
    75.000   100.000   0.1494E-02    0.6011E-02    0.2352E-01    0.1694E-01    0.2072E-01    0.3567E-01    0.1363E-02    0.0000E+00
   100.000   125.000   0.1874E-03    0.1074E-02    0.4328E-02    0.8853E-02    0.1028E-01    0.1321E-01    0.1313E-03    0.0000E+00
   125.000   150.000   0.2270E-04    0.1595E-03    0.8959E-03    0.2614E-02    0.7506E-02    0.7538E-02    0.1103E-03    0.0000E+00
   150.000   175.000   0.2456E-05    0.2437E-04    0.1365E-03    0.4897E-03    0.1247E-02    0.1207E-02    0.1789E-04    0.0000E+00
   175.000   200.000   0.2553E-06    0.3187E-05    0.2449E-04    0.7432E-04    0.5576E-03    0.1547E-03    0.6073E-05    0.0000E+00
   200.000   300.000   0.0000E+00    0.8025E-06    0.5975E-05    0.3364E-04    0.3336E-03    0.1547E-03    0.1406E-04    0.0000E+00
   300.000   800.400   0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00    0.0000E+00    0.2039E-05    0.7290E-04
```

Figure 2.6. Screenshot of HAZ-45 *-UHSoutput.txt. HAZ-45 sample file, Deaggregation Data Table

2.3 Data Collection: Combining All Results

In this first phase of data processing, the individual HAZ-45 ASCII files were read line by line in Python, interpreted, and saved to lists, numpy arrays and dictionaries in HDF5 files. In this first processing steps the data are grouped by output type:

- Hazard Curves (out3)
- Uniform-Hazard Spectra (UHS-out)
- Deaggregation Data (UHS-out)
- Ground-Motion Model Hazard Curves (out7)
- Directivity-Model Hazard Curves (out7)
- Fault-Source Hazard Curves (out6)

These data were processed for all sites, site classes, and directivity models.

The data for each output set is stored in the hierarchical manner represented by the graphic in Figure 2.7, depending on the type of data being stored. The first level of the stored data is the site label. To keep the data files at a manageable size, the HDF5 files were broken down into 78 files with each containing 250 sites each, except for the last file. The filenames were defined so that the user can easily identify, or compute, which file contained a particular site. For example, the hazard-curve file for the first set of sites is named:
SourceHazardData_SourceHazard_250sitesInFile_Site00001toSite00250.hdf5

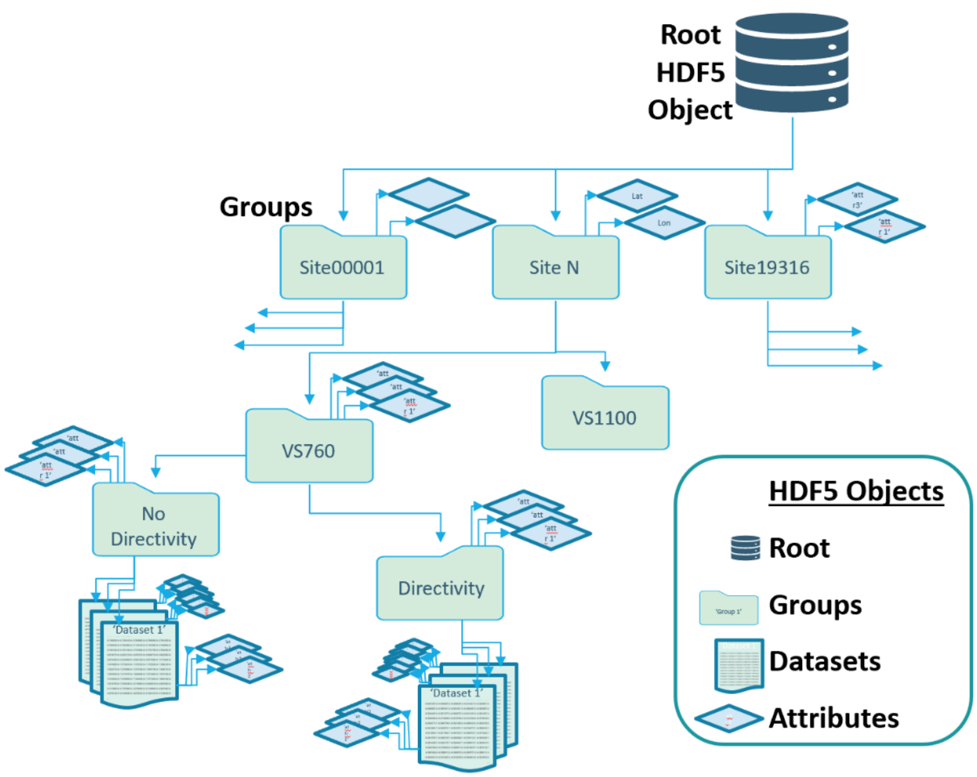


Figure 2.7. Graphic representation of HDF5 file for State-Wide PSHA

2.4 Data Post-Processing: Computing Derivative Values

Once the HAZ-45 output data was collected into HDF5 that were accessible programmatically, these data were post-processed to compute derivative values, such as the directivity-amplification factor: the ratio between the spectral acceleration considering directivity and that of not considering directivity. This post-processing was performed on the weighted-average directivity model as well as the individual directivity models. This directivity-amplification factor was computed for both the Uniform-Hazard Spectra and the Hazard Curves. Please note that the directivity-amplification factor was computed only for the return-period range for which it was validated in the PSHA study: for the return periods given in Table 2.2.

As was presented in the companion reports, with the exception of a particular region, the PSHA was performed for all sites only for the case of Vs30 = 760 m/s. As a result, the directivity-amplification factor was computed for all sites only for the case of Vs30=760 m/s. This ratio was then used to compute the directivity-based Uniform-Hazard Spectra PSA values at all sites for Vs30 other than 760 m/s. In this calculation, a lower bound of 1.0 was imposed on the directivity-amplification factor.

For completeness, the Vs30-specific directivity-amplification factor was also computed for the sites where the directivity-based PSHA was performed at different Vs30s.

2.5 Site-Specific Data Plots

A series of curves were plotted for each site and Vs30. Hazard Curves (annual probability of exceedance vs. amplitude, one curve per spectral period) and Uniform-Hazard Spectra (amplitude vs. spectral period, one curve per return period) were plotted for the following quantities (amplitudes):

- PSA with no directivity
- PSA with weighted directivity model
- Directivity-Amplification Factor (with unity lower bound)
- Directivity-Amplification Factor with no lower bound.

Deaggregation curves were also plotted for each site, Vs30, spectral period, and return period. These plots, however, were produced only for the case of no directivity.

2.6 Geographic-Distribution Tables & Maps: Grouping Data by Metric

To quantify the geometric distribution of the different quantities, such as PSA with and without directivity, as well as the directivity-amplification factor, the data were regrouped by quantity instead of site. Grouping the data in this manner enables the generation of maps where the data may be overlain with geographic features as well as geographically-distributed systems, such as seismic-fault systems and pipelines.

The quantities contained in these data are the PSA with and without directivity, as well as the directivity amplification factors, for both the weighted-average directivity model and the individual directivity models. One file is generated for each combination of Vs30, Spectral Period, and Return Period.

The data were produced in three different formats:

1. Geographic-distribution tables. These tables were generated in both comma-separated format (.CSV) and in HDF5 files, for ease of access. Individual CSV files can be uploaded directly to MS Excel and plotted using their 3D Maps add-on.
2. Geographic-distribution map images in JPG format. The individual-site quantities are displayed via colored circles. These images, such as the one shown in Figure XXX, are high-resolution images that can be included in a report. The UCERF-3 Faults are also shown in these maps.
3. Interactive geographic-distribution maps in HTML format. The individual-site quantities are displayed via colored circles. The UCERF-3 faults, as well as the portion of the California Natural Gas Pipeline provided to the researchers by the CEC, are included in these maps. These maps have the following capabilities:
    a. Zoom in/out of figure.
    b. Click on a site to display additional quantities, such as Hazard Curves and Uniform-Hazard Spectra
    c. Visualize UCERF-3 sources (turn on/off).
    d. Click on a UCERF-3 fault line to display properties of that fault segment.
    e. Visualize California Natural Gas Pipeline (turn on/off).
    f. Click on a pipeline segment for additional data on the segment.

    These interactive maps, and their supporting data, are stored in an AWS server for ease of access via a web portal.

2.7 Interactive Geographic-Distribution Maps

While static maps in .jpg format are useful for publication, an interactive map allows you to visualize more data at different levels of detail. Interactive geographic distribution maps (in HTML format) were produced for the Uniform-Hazard Spectra Values: PSA with and without directivity, as well as the Directivity-Amplification Factor. The amplification factors for the individual directivity models were also mapped. These maps were made available via a web server.

3 Datasets: Site Data

This Chapter presents the different datasets that were produced from post-processing of the PSHA. Different users may be interested in accessing the data at different levels. The data are either stored in csv files or in HDF5 binary files. Because HDF5 is a hierarchical data format, the file content becomes self-documenting. A sample of each file is provided in Appendix A.

To access the HDF5 the user can open the file in any language that provides access to such files (e.g., python, R, Matlab) and query the keys, attributes and values at each level. The commands used to perform these queries are interpreter-dependent but are equivalent.
To manage the size of the HDF5 files, data that is grouped by site was broken up into 78 files with at most 250 sites in each file. The filename indicates the type of data stored in the file as well as the number of sites and the first and last site in that file. For example, SourceHazardData_SourceHazard_250sitesInFile_Site00001toSite00250.HDF5 contains data about hazard sources for 250 sites, starting with Site00001 and ending with Site00250.

3.1 Hazard-Curve Data: Initial Collection and Processing (.out3 output)

This dataset contains the first level of output from the PSHA by collecting all the PSHA-analysis *.out3 output for all sites and VS30s. The hierarchical data are grouped by:

1. Site Label (Site00001-Site19316)
2. Vs30 (Vs180-Vs1100 + Vs180_Dir-Vs1100_Dir, where applicable)
3. Spectral Period (PGV,0.01-10sec)

For each of the above cases, the values for each amplitude in “AmpList” is tabulated for the individual fault cases (presented in companion report), as well as the weighted annual rate of exceedance (Wt_Total_Events_per_yr), Poisson Probability, etc., as shown in Table 11.1.

3.2 Hazard-Curve Data: Hazard Levels Only (.out3 output)

This dataset is a subset of the Hazard-Curve Data. It only contains the hazard levels (PSA) used for each case, as shown in Table 11.2. These data are used in processing the directivity model data because the hazard levels are not output with the .out6 data.

3.3 Hazard-Curve Data: Directivity Amplification Factor (.out3 output)

This dataset uses the data for the case of no directivity and directivity at each Vs30 where directivity was considered in the PSHA and computes the directivity-amplification factor, as shown in Table 11.3. This ratio is computed by interpolating the without- and with-directivity cases at the user-specified return periods: Return Periods (yr) ['50.862','99.499','474.561','949.118','999.500','2474.911','5000.000','10000.000']. Two sets of directivity-amplification factors are provided: with and without a unity lower bound.

For each case (SiteLabel, Vs30, and Spectral Period) you have the Hazard Curves (annual rate of exceedance vs amplitude) for the following cases:

- No-Directivity PSA (annual rates computed in the No-Directivity PSHA)
- For each Vs30 where directivity effects were considered (all sites have it for VS760, some also for other VS30s):
    - Directivity PSA (annual rates used in the Directivity PSHA)
    - No-Directivity PSA (annual rates used in the Directivity PSHA)
    - Directivity-Amplification Factor with a lower bound of 1.0. (At the user-defined annual rates)
    - Directivity-Amplification Factor with no lower bound (at the user-defined annual rates)

It is worth noting that Site15022 is one of the sites for which a directivity-based PSHA was performed at all VS30s. As a result, as shown in the contents of Table 11.3, for the case of VS1100 two directivity models are used: one is based on the directivity-based PSHA at **VS1100** and the other is based on the directivity-based PSHA at **VS760**.

3.4 Hazard-Curve Data: All, No-Directivity PSA, With-Directivity PSA, and Directivity-Amplification Factors at all Sites, VS30s, and Periods (.out3 output)

This dataset combines the data for the case of no directivity and directivity all Vs30 cases, as shown in Table 11.4. For the Vs30 cases where directivity was not considered in the PSHA, the With-Directivity PSA was computed by multiplying the No-Directivity PSA with the Directivity-Amplification Factor computed for VS760 (with a lower bound of 1.0). For periods where the directivity-effects were not considered, an amplification factor of 1.0 was used.

3.5 Uniform-Hazard Spectra Data: Initial Collection and Processing (*UHSoutput.txt output)

This dataset contains the first level of output from the PSHA by collecting all the PSHA-analysis *UHSoutput.txt output related to the UHS for all sites and VS30s. The hierarchical data are grouped by:

- SiteLabel (Site00001-Site19316)
    - Vs30 (Vs180-Vs1100 + Vs180_Dir-Vs1100_Dir, where applicable)
        - Return Period (50-10,000yr)

This dataset contains all data pertinent to a Uniform-Hazard Spectrum, as shown in Table 11.5.

3.6 Uniform-Hazard Spectra Data: Deaggregation Data (*UHSoutput.txt output)

This dataset contains the first level of output from the PSHA by collecting all the PSHA-analysis *UHSoutput.txt output related to deaggregation for all sites and VS30s. The hierarchical data are grouped by:

- SiteLabel (Site00001-Site19316)
  - Vs30 (Vs180-Vs1100 + Vs180_Dir-Vs1100_Dir, where applicable)
    - Spectral Period (0.01-10sec, PGV)
      - Return Period (50-10,000yr)

This dataset contains all data pertinent to Deaggregation, as shown in Table 11.6.

3.7 Uniform-Hazard Spectra Data: Directivity Amplification Factor (*UHSoutput.txt output)

This dataset uses the data for the case of no directivity and directivity at each Vs30 where directivity was considered in the PSHA and computes the directivity-amplification factor, as shown in Table 11.3. Because the UHS for the two cases correspond to the same return periods, the directivity-amplification factor was simply computed by taking the ratio of the two PSA at the same return period and spectral period. Two sets of directivity-amplification factors are provided: with and without a unity lower bound.

For each case where directivity was considered (SiteLabel, Vs30_directivity, and Return Period) you have the Uniform-Hazard Spectra (PSA vs spectral period) for the following cases:

- Directivity-Amplification Factor with a lower bound of 1.0. (At the user-defined annual rates)
- Directivity-Amplification Factor with no lower bound (at the user-defined annual rates)

It is worth noting that Site15022 is one of the sites for which a directivity-based PSHA was performed at all VS30s, as shown in the contents of Table 11.7.

3.8 Uniform-Hazard Spectra Data: All -- No-Directivity PSA, With-Directivity PSA, and Directivity-Amplification Factors at all Sites, VS30s, and Periods (*UHSoutput.txt output)

This dataset combines the data for the case of no directivity and directivity all Vs30 cases, as shown in **Table 11.8**. For the Vs30 cases where directivity was not considered in the PSHA, the With-Directivity PSA was computed by multiplying the No-Directivity PSA with the Directivity-Amplification Factor computed for VS760 (with a lower bound of 1.0). For periods where the directivity-effects were not considered, an amplification factor of 1.0 was used.

The data are grouped by:

- SiteLabel
  - Vs30
    - Return Period

For each case the data are grouped into two parts:

- Directivity
    - For each Vs30 for directivity (all sites have VS760, some more)
        - PeriodList – Spectral Periods
        - DirectivityRatioList: Directivity-Amplification Factor with a 1.0 lower bound
        - DirectivityRatioList_noLB: Directivity-Amplification Factor with no lower bound
        - UHSDirectivity: PSA considering directivity
- noDirectivity
    - UHSnoDirectivity: PSA NOT considering directivity

3.9 Deaggregation Data (*UHSoutput.txt output)

This dataset contains the remainder of the contents of the Uniform-Hazard Spectra data. For each Site and Vs30, it tabulates the contribution of Magnitude and Distance bins to the hazard at each Return Period and Spectral Period, as shown in Table 11.9. The deaggregation data yields very large files.

3.10 Ground-Motion-Model Hazard Curves (*.out6 data)

The HAZ-45 .out6 file contains the hazard-curve data for the individual ground-motion models. The .out6 file only contains the annual rate of exceedance for each model. These rates were then combined with the corresponding PSA amplitude given in the .out3 file for the directivity case.

This dataset is broken down into 78 files, each containing the data for 250 sites. The data are grouped by SiteLabel, Vs30, and Spectral Period. At each spectral period the hazard curves are tabulated by PSA (columns) and ground-motion model (rows), as shown in Table 11.10. The ground-motion models are identified by integer numbers that are defined in the hazard-analysis input.

3.11 Directivity-Model Hazard Curves (*.out6 data)

For the cases where directivity was included in the PSHA, the HAZ-45 .out6 file also contains the hazard-curve data for the individual directivity models considered, even if not used in computing the weighted average. The following directivity models were included in the output and are presented in the companion report:

- BS13
- BSS20
- CS13
- BS13_FaultNormal
- BS13_FaultParallel

The .out6 file only contains the annual rate of exceedance for each model. These rates were then combined with the corresponding PSA amplitude given in the .out3 file for the directivity case.

This dataset is broken down into 78 files, each containing the data for 250 sites. The data are grouped by SiteLabel, Vs30, and Spectral Period. At each spectral period the hazard curves are tabulated by PSA (columns) and directivity model (rows), as shown in Table 11.11Table 11.10. The ground-motion models are identified by integer numbers that are defined in the hazard-analysis input.

3.12 Directivity-Model PSA and Directivity-Amplification Factor Hazard Curves and Uniform-Hazard Spectra (*.out6 data)

The directivity-model PSA hazard curves were further processed to compute the hazard curves for the directivity-amplification factor. This quantity was computed by interpolating the spectral-period-specific hazard curves of each ground-motion model at the return periods defined by Table 2.2. These values were divided by the corresponding PSA values (spectral period, return period) with no-directivity. These data were further regrouped to produce Uniform-Hazard Spectra: PSA or directivity-amplification factor vs Spectral Period at different return periods.

This dataset is broken down into 78 files, each containing the data for 250 sites. The data are grouped by SiteLabel and Vs30. For each case the data are grouped by Hazard Curves or Uniform-Hazard Spectra, as shown in Table 11.12.

3.13 Parent-Fault Hazard Data (*.out7 data)

In the .out7 file, HAZ-45 reports the hazard curve for each parent-fault source: the annual rate of exceedance for the individual fault sources at each PSA amplitude used in the PSHA, as well as the weighted total contribution of the fault sources. The minimum distance between the site and each fault source is also provided.

This dataset is broken down into 78 files, each containing the data for 250 sites. The data are grouped by SiteLabel, Vs30, and Spectral Period, as shown in Table 11.13. Each site has a unique number of fault sources – the representative one in Table 11.13 has 139, given by the size of the SourceList variable. Each site may also have a unique number of PSA values, given by the size of the AmpList variable shown in the table. As a result, the HazardData table is a table where the columns are defined by the AmpList and the rows are defined by the SourceList. The total rate of these fault sources is given by the variable Wt_Total_Events_per_yr_Parent. Please note that this is not the total annual rate of exceedance at a site, since it does not include other sources, such as the gridded seismicity.

3.14 Parent-Fault Hazard Ratio Data (*.out7 data)

The Parent-Fault Hazard data was further processed by computing the ratio of the annual rate of each fault source by the total the parent-fault sources (Wt_Total_Events_per_yr_Parent). This ratio is the partial contribution of each Parent Fault to the total contribution of the fault sources to the total hazard.

This dataset is broken down into 78 files, each containing the data for 250 sites. The data are grouped by SiteLabel, Vs30, and Spectral Period, as shown in Table 11.14.

4 Directivity-Based PSHA Results

4.1 Hazard Curves

Hazard Curves (annual frequency of exceedance vs amplitude for different spectral periods) were plotted for each Site and Vs30. Each plot contains the hazard curves for all spectral periods, including PGV. The total number of Hazard-Curve figures is a total of 183,977 figures (32GB). The following data were plotted as hazard curves:

- PSA with and without directivity using the Vs30=760 m/s directivity-amplification factor – all sites (Figure 4.1)
- PSA with and without directivity using the Vs30-specific directivity-amplification factor – select sites (Figure 4.2)
- Directivity-Amplification Factor with a 1.0 lower bound (Figure 4.3)
- Directivity-Amplification Factor with no lower bound (Figure 4.4)

While the range of the annual frequency of exceedance for the case of no-directivity PSA spans the same range as the PSHA, the range of the annual frequency of exceedance of the other cases only spans the range for which it was validated: between 50 and 10,000 yr return period. For all sites, the above quantities were computed using the directivity-based PSHA for the case of VS760, resulting in 9 plots per site, as shown in Table 4.1.

Additional hazard curves were plotted for the sites where a directivity-based PSHA was performed at VS30s other than 760m/s. These additional plots are included in the dataset and have the specifying label, resulting in a total of 24 plots per site. Site 15023 is used in the figures because it is one of these sites, as shown in Table 4.2.

As is seen in the figures, directivity effects were computed only for spectral periods at and above 0.5 seconds. The no-directivity case can be used for periods below this threshold (directivity-amplification factor = 1.0).

Table 4.1. Uniform-Hazard Spectra Plot Filenames: Representative site where PSHA with directivity was performed only at VS760

PSA	NHR3_California_DirectivityPSH_Site15018_Vs1100_Spectra.jpg NHR3_California_DirectivityPSH_Site15018_Vs180_Spectra.jpg NHR3_California_DirectivityPSH_Site15018_Vs300_Spectra.jpg NHR3_California_DirectivityPSH_Site15018_Vs400_Spectra.jpg NHR3_California_DirectivityPSH_Site15018_Vs500_Spectra.jpg NHR3_California_DirectivityPSH_Site15018_Vs760_Spectra.jpg NHR3_California_DirectivityPSH_Site15018_VsSS_Spectra.jpg
Directivity-Amplification Factor	NHR3_California_DirectivityPSH_Site15018_Vs760_DirRatio.jpg NHR3_California_DirectivityPSH_Site15018_Vs760_DirRatioNoLB.jpg

Table 4.2. Uniform-Hazard Spectra Plot Filenames: Representative site where PSHA with directivity was performed at all Vs30

PSA	NHR3_California_DirectivityPSH_Site15023_Vs1100_Spectra.jpg NHR3_California_DirectivityPSH_Site15023_Vs1100_Spectra_Vs1100DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_Spectra.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_Spectra_Vs180DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_Spectra.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_Spectra_Vs300DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_Spectra.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_Spectra_Vs400DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_Spectra.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_Spectra_Vs500DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs760_Spectra.jpg NHR3_California_DirectivityPSH_Site15023_VsSS_Spectra.jpg
Directivity-Amplification Factor	NHR3_California_DirectivityPSH_Site15023_Vs1100_DirRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs1100_DirRatioNoLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_DirRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_DirRatioNoLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_DirRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_DirRatioNoLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_DirRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_DirRatioNoLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_DirRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_DirRatioNoLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs760_DirRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs760_DirRatioNoLB.jpg

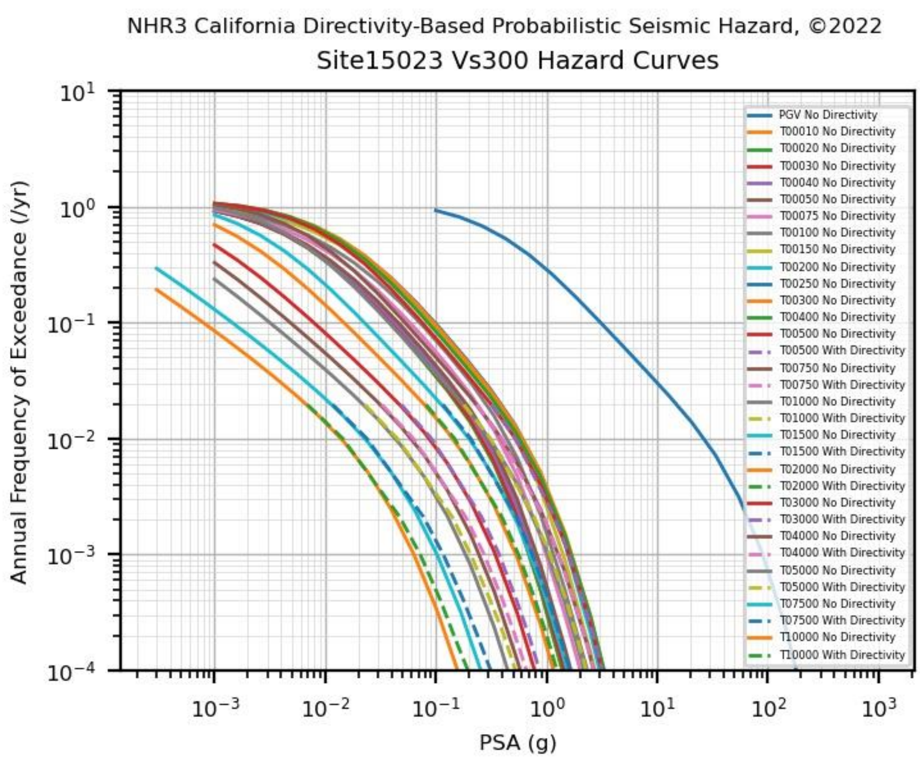


Figure 4.1. NHR3_California_DirectivityPSH_Site15023_Vs300_HazardCurves.jpg

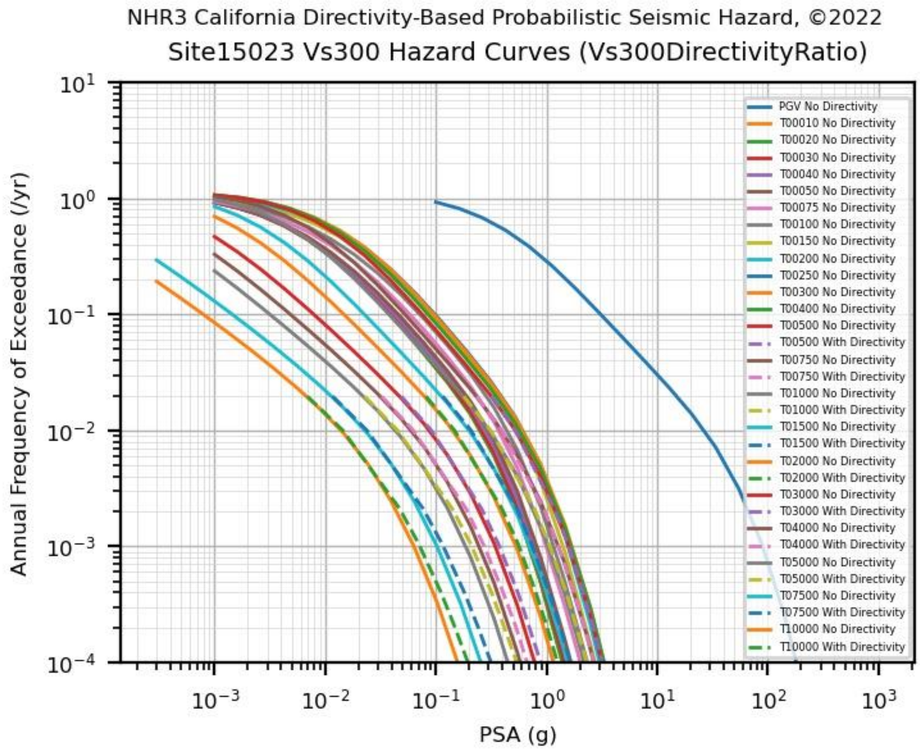


Figure 4.2.
NHR3_California_DirectivityPSH_Site15023_Vs300_HazardCurves_Vs300DirectivityRatio.jpg

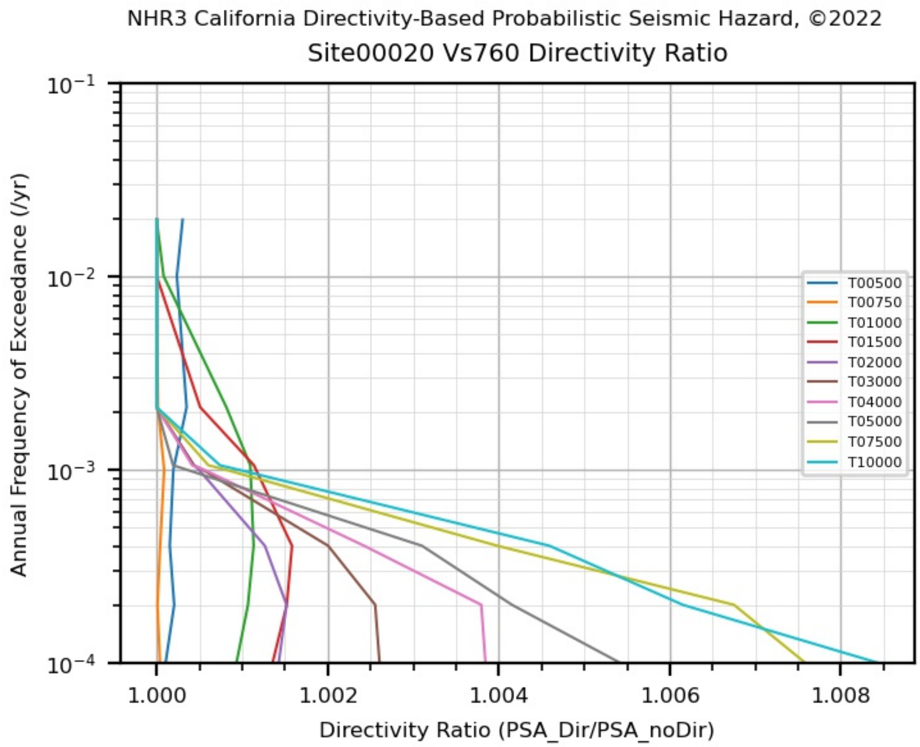


Figure 4.3. NHR3_California_DirectivityPSH_Site00020_Vs760_DirectivityRatio.jpg

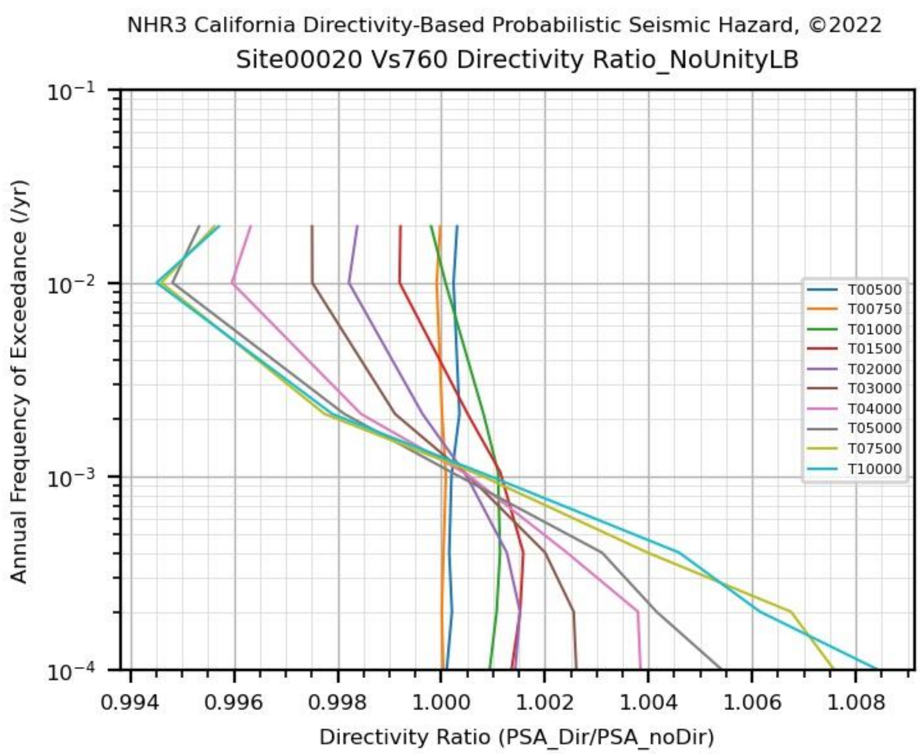


Figure 4.4.
NHR3_California_DirectivityPSH_Site00020_Vs760_DirectivityRatio_NoUnityLB.jpg

4.2 Uniform-Hazard Spectra

In a manner consistent with the hazard curves, the Uniform-Hazard Spectra (amplitude vs spectral period for different return periods) were plotted for each Site and Vs30. PGV was not plotted. The total number of Uniform-Hazard Spectra figures is a total of 183,977 figures (32GB). The following data were plotted as hazard curves:

- PSA with and without directivity using the VS760 directivity-amplification factor – all sites (Figure 4.5)
- PSA with and without directivity using the Vs30-specific directivity-amplification factor – select sites (Figure 4.6)
- Directivity-Amplification Factor with a 1.0 lower bound (Figure 4.7)
- Directivity-Amplification Factor with no lower bound (Figure 4.8)

For all sites, the above quantities were computed using the directivity-based PSHA for the case of VS760, resulting in 9 plots per site, as shown in Table 4.3.

Additional hazard curves were plotted for the sites where a directivity-based PSHA was performed at VS30s other than 760m/s. These additional plots are included in the dataset and have the specifying label, resulting in a total of 24 plots per site. Site 15023 is used in the figures because it is one of these sites, as shown in Table 4.4

As is seen in the figures, directivity effects were computed only for spectral periods at and above 0.5 seconds. The no-directivity case can be used for periods below this threshold (directivity-amplification factor = 1.0).

Table 4.3. Hazard-Curve Plot Filenames: Representative site where PSHA with directivity was performed only at VS760

PSA	NHR3_California_DirectivityPSH_Site15018_Vs1100_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15018_Vs180_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15018_Vs300_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15018_Vs400_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15018_Vs500_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15018_Vs760_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15018_VsSS_HazardCurves.jpg
Directivity-Amplification Factor	NHR3_California_DirectivityPSH_Site15018_Vs760_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15018_Vs760_DirectivityRatio_NoUnityLB.jpg

Table 4.4. Hazard-Curve Plot Filenames: Representative site where PSHA with directivity was performed at all Vs30

PSA	NHR3_California_DirectivityPSH_Site15023_Vs1100_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15023_Vs1100_HazardCurves_Vs1100DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_HazardCurves_Vs180DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_HazardCurves_Vs300DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_HazardCurves_Vs400DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_HazardCurves_Vs500DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs760_HazardCurves.jpg NHR3_California_DirectivityPSH_Site15023_VsSS_HazardCurves.jpg
Directivity-Amplification Factor	NHR3_California_DirectivityPSH_Site15023_Vs1100_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs1100_DirectivityRatio_NoUnityLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs180_DirectivityRatio_NoUnityLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs300_DirectivityRatio_NoUnityLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs400_DirectivityRatio_NoUnityLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs500_DirectivityRatio_NoUnityLB.jpg NHR3_California_DirectivityPSH_Site15023_Vs760_DirectivityRatio.jpg NHR3_California_DirectivityPSH_Site15023_Vs760_DirectivityRatio_NoUnityLB.jpg

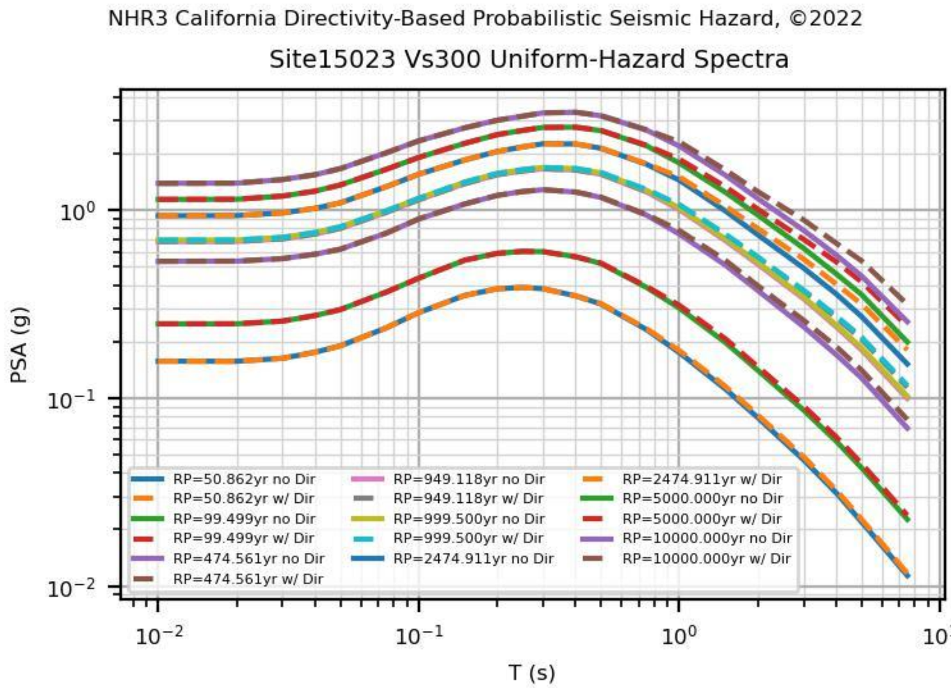


Figure 4.5. NHR3_California_DirectivityPSH_Site15023_Vs300_Spectra.jpg

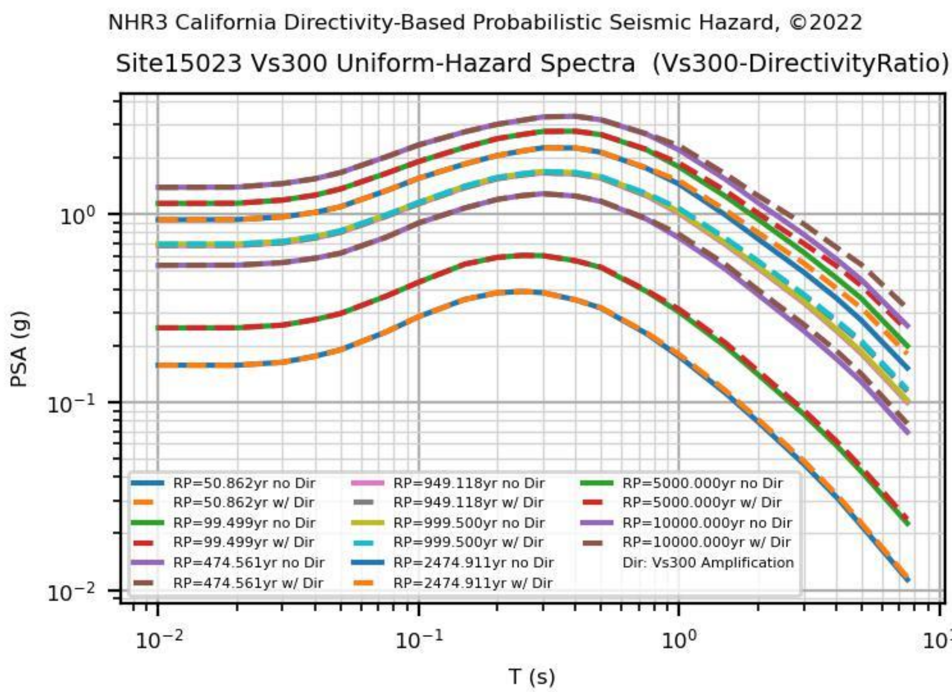


Figure 4.6.
NHR3_California_DirectivityPSH_Site15023_Vs300_Spectra_Vs300DirectivityRatio.jpg

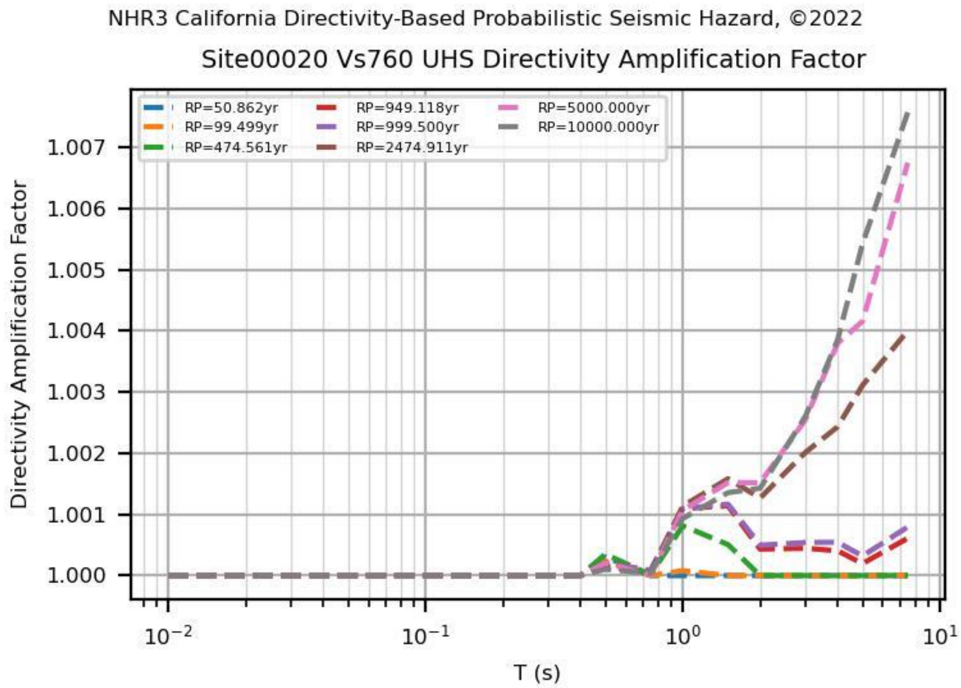


Figure 4.7. NHR3_California_DirectivityPSH_Site00020_Vs760_DirRatio.jpg

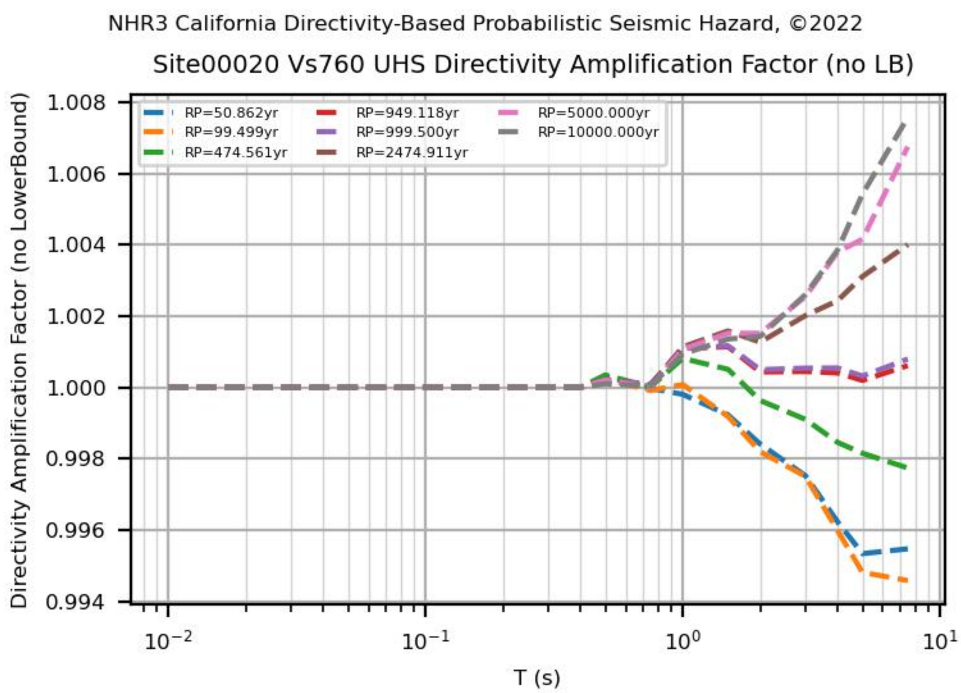


Figure 4.8. NHR3_California_DirectivityPSH_Site00020_Vs760_DirRatioNoLB.jpg

4.3 Deaggregation Data Plots

The deaggregation data is plotted in a single figure and is generated for each Site, Vs30 and Spectral Period. Each file contains 8 plots, one for each return period, as shown in Figure 4.9. Because one figure is generated for each site, oscillator period, and Vs30, the large dataset results in over 2 million files.

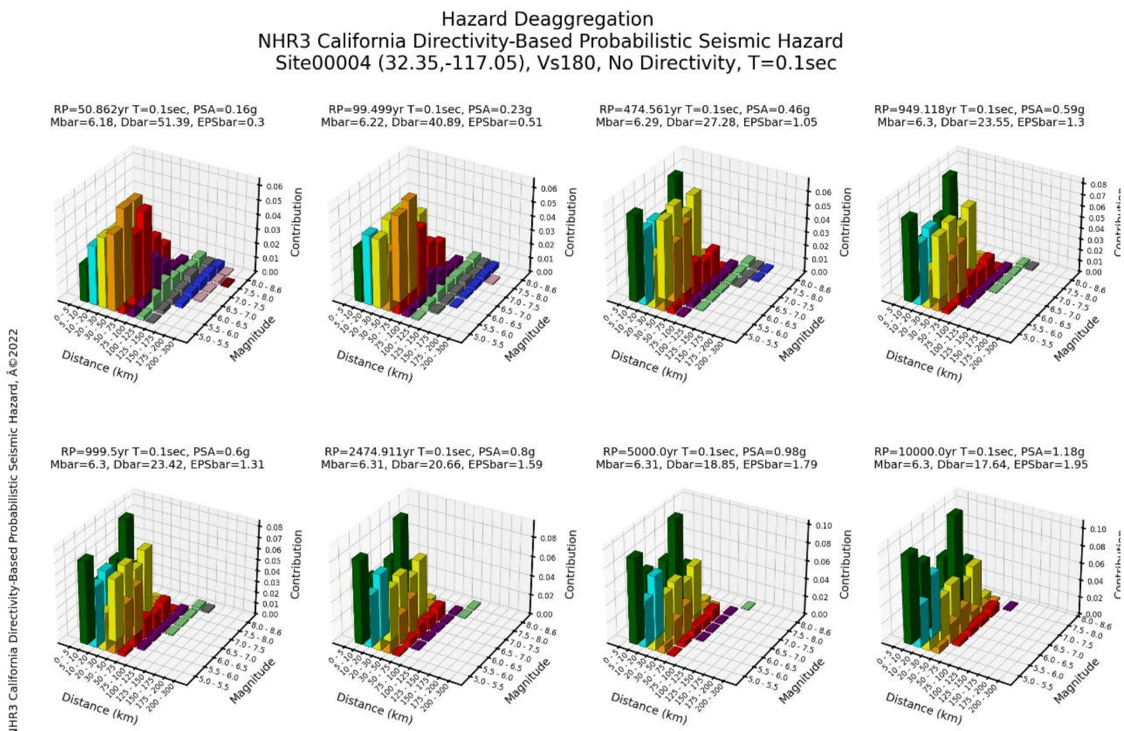


Figure 4.9. NHR3_California_DirectivityPSH_Site00004_Vs180_Deaggr_T0pt1.jpg

5 Geographic-Distribution Tables

To quantify the geometric distribution of the different quantities, such as PSA with and without directivity, as well as the directivity-amplification factor, the data were regrouped by quantity instead of site: a single quantity (column) is tabulated in a single file for all site (rows). Grouping the data in this manner enables the generation of maps where the data may be overlain with geographic features as well as geographically-distributed systems, such as seismic-fault systems and pipelines.

The quantities contained in these data are the PSA with and without directivity, as well as the directivity amplification factors, for both the weighted-average directivity model and the individual directivity models. One file was generated for each combination of Vs30, Spectral Period, and Return Period for each quantity.

There are two types of datasets in this group. The first group contains the entire hazard curve or uniform-hazard spectrum in a pair of cells. For the case of the Hazard Curves, one cell contains a list of annual rate of exceedance, the other contains a list of PSA values – one row per combination of SiteLabel (+Lat, Lon), Vs30, Vs30_Dir, and Spectral Period. For the case of Uniform-Hazard Spectra, one cell contains a list of Spectral Period, the other contains a list of PSA values – one row per combination of SiteLabel (+Lat, Lon), Vs30, Vs30_Dir, and Return Period. These datasets are presented in the first four sections of this chapter. These files are useful when the user is interested in searching for the entire hazard curve or UHS at all/select sites. This group of datasets contains a total of 29 files.

The second group of datasets is useful for ease of plotting the geographic distribution of a single datum: e.g. the directivity PSA at all sites for a particular Vs30, SpectralPeriod, and Return Period. As a result, this dataset contains over 9000 files.

5.1 Geographic-Distribution Tables – Hazard Curves

The geographic-distribution tables (.csv files) were generated from the processed Hazard-Curve data. Each table/file has the following content:

- SiteLabel
- Site Location: Site Latitude and Longitude
- VS30Case: site Vs30
- VS30Dir: Vs30 used for the directivity analysis. All sites have VS760, some sites have additional VS30s. This column does not exist for the base case of the No-Directivity case
- Period (s): Spectral period for Hazard Curve
- Quantity: Label for datum being reported in this table. This label is also repeated in the header of the data column. It is included in the row for completeness, in case different tables are concatenated. The Directivity-Amplification Factor was computed by taking

the ratio of the PSA with directivity divided by the PSA without directivity, both taken at the same annual rate

- AnnualRateOfExceedance (/yr): Bracketed list of N values of annual rate of exceedance. The PSHA output with and without directivity have the same amplitude and different rates. Because the directivity-amplification factor for the hazard curves is computed from the With-Directivity and No-Directivity PSA at the same annual rate (return period), the No-Directivity data was interpolated at the same annual rate as the analysis with Directivity and saved to a table/file.
- Datum: Bracketed list of N values being tabulated in this file. The header of this column specifies the quantity of the datum, it is different for each file.

The hazard-curve files are listed in Table 5.1. A sample of each file is also given within the table. Please note that the first period shown is 2 seconds: directivity was included in the PSHA for periods greater than or equal to 0.5sec only. This dataset contains 5 files.

Table 5.1. Geographic-Distribution Tables – Hazard Curves

a. PSA with No Directivity

- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_NoDirectivity.csv

	A	B	C	D	E	F	G	H
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis							
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/							
3	SiteLabel	Latitude	Longitude	Vs30Case	Period_s	Quantity	AnnualRateOfExceedance (/yr)	PSA_noDir (g)
21	Site00001	32.35	-117.2	Vs1100	2	PSA (g) No Directivity	[3.3870e-01,2.2530e-01,1.3870e-	[1.0000e-03,1.6000e-03,2.6000e-
22	Site00001	32.35	-117.2	Vs1100	3	PSA (g) No Directivity	[2.0110e-01,1.2920e-01,7.6710e-	[1.0000e-03,1.6000e-03,2.6000e-
23	Site00001	32.35	-117.2	Vs1100	4	PSA (g) No Directivity	[1.3580e-01,8.4970e-02,4.9180e-	[1.0000e-03,1.6000e-03,2.6000e-
24	Site00001	32.35	-117.2	Vs1100	5	PSA (g) No Directivity	[9.7940e-02,6.0200e-02,3.4370e-	[1.0000e-03,1.6000e-03,2.6000e-
25	Site00001	32.35	-117.2	Vs1100	7.5	PSA (g) No Directivity	[1.0450e-01,6.7560e-02,4.1050e-	[5.0000e-04,8.0000e-04,1.3000e-
26	Site00001	32.35	-117.2	Vs1100	10	PSA (g) No Directivity	[6.7700e-02,4.2800e-02,2.5730e-	[5.0000e-04,8.0000e-04,1.3000e-
27	Site00001	32.35	-117.2	Vs180	-1	PSA (g) No Directivity	[1.2780e+00,1.1270e+00,9.2690e-	[1.0000e-01,1.6240e-01,2.6370e-

b. PSA with No Directivity – interpolated at the same annual rate as the With-Directivity case

- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_NoDirectivity_DirRate.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30Dir	Period_s	Quantity	AnnualRateOfExceedance (/yr)	PSA_noDir (g)
21	Site00001	32.35	-117.2	Vs1100	Vs760	2	PSA (g) No Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[1.1606e-02,1.7909e-02,4.7951e-
22	Site00001	32.35	-117.2	Vs1100	Vs760	3	PSA (g) No Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[7.4332e-03,1.1729e-02,3.2276e-
23	Site00001	32.35	-117.2	Vs1100	Vs760	4	PSA (g) No Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[5.2882e-03,8.5073e-03,2.3992e-
24	Site00001	32.35	-117.2	Vs1100	Vs760	5	PSA (g) No Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[4.0374e-03,6.6227e-03,1.9210e-
25	Site00001	32.35	-117.2	Vs1100	Vs760	7.5	PSA (g) No Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[2.4802e-03,4.2738e-03,1.2996e-
26	Site00001	32.35	-117.2	Vs1100	Vs760	10	PSA (g) No Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[1.6561e-03,2.9660e-03,9.5389e-
27	Site00001	32.35	-117.2	Vs180	Vs760	-1	PSA (g) No Directivity	[1.2780e+00,1.1270e+00,9.2690e-	[1.0000e-01,1.6240e-01,2.6370e-
28	Site00001	32.35	-117.2	Vs180	Vs760	0.01	PSA (g) No Directivity	[1.2170e+00,1.0730e+00,8.8630e-	[1.0000e-03,1.6000e-03,2.6000e-
29	Site00001	32.35	-117.2	Vs180	Vs760	0.02	PSA (g) No Directivity	[1.2130e+00,1.0670e+00,8.8000e-	[1.0000e-03,1.6000e-03,2.6000e-

c. PSA with Directivity – Weighted directivity model

- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_WithDirectivity.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30Dir	Period_s	Quantity	AnnualRateOfExceedance (/yr)r	PSA_Dir (g)
21	Site00001	32.35	-117.2	Vs1100	Vs760	2	PSA (g) With Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[1.1670e-02,1.8122e-02,4.9884e-
22	Site00001	32.35	-117.2	Vs1100	Vs760	3	PSA (g) With Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[7.4786e-03,1.1877e-02,3.3746e-
23	Site00001	32.35	-117.2	Vs1100	Vs760	4	PSA (g) With Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[5.3184e-03,8.6106e-03,2.5100e-
24	Site00001	32.35	-117.2	Vs1100	Vs760	5	PSA (g) With Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[4.0591e-03,6.6968e-03,2.0071e-
25	Site00001	32.35	-117.2	Vs1100	Vs760	7.5	PSA (g) With Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[2.4917e-03,4.3162e-03,1.3484e-
26	Site00001	32.35	-117.2	Vs1100	Vs760	10	PSA (g) With Directivity	[1.9661e-02,1.0050e-02,2.1070e-	[1.6629e-03,2.9918e-03,9.8147e-
27	Site00001	32.35	-117.2	Vs180	Vs760	-1	PSA (g) With Directivity	[1.2780e+00,1.1270e+00,9.2690e-	[1.0000e-01,1.6240e-01,2.6370e-
28	Site00001	32.35	-117.2	Vs180	Vs760	0.01	PSA (g) With Directivity	[1.2170e+00,1.0730e+00,8.8630e-	[1.0000e-03,1.6000e-03,2.6000e-

d. Directivity-Amplification Factor – Weighted directivity model

- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio_noLB.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30Dir	Period_s	Quantity	AnnualRateOfExceedance (/yr)	PSA_Dir/PSA_noDir Ratio
21	Site00001	32.35	-117.2	Vs1100	Vs760	2	PSA_Dir/PSA_noDir Ratio	[1.9661e-02,1.0050e-02,2.1070e-	[1.0055e+00,1.0119e+00,1.040
22	Site00001	32.35	-117.2	Vs1100	Vs760	3	PSA_Dir/PSA_noDir Ratio	[1.9661e-02,1.0050e-02,2.1070e-	[1.0061e+00,1.0126e+00,1.045
23	Site00001	32.35	-117.2	Vs1100	Vs760	4	PSA_Dir/PSA_noDir Ratio	[1.9661e-02,1.0050e-02,2.1070e-	[1.0057e+00,1.0121e+00,1.046
24	Site00001	32.35	-117.2	Vs1100	Vs760	5	PSA_Dir/PSA_noDir Ratio	[1.9661e-02,1.0050e-02,2.1070e-	[1.0054e+00,1.0112e+00,1.044
25	Site00001	32.35	-117.2	Vs1100	Vs760	7.5	PSA_Dir/PSA_noDir Ratio	[1.9661e-02,1.0050e-02,2.1070e-	[1.0046e+00,1.0099e+00,1.037
26	Site00001	32.35	-117.2	Vs1100	Vs760	10	PSA_Dir/PSA_noDir Ratio	[1.9661e-02,1.0050e-02,2.1070e-	[1.0041e+00,1.0087e+00,1.028
27	Site00001	32.35	-117.2	Vs180	Vs760	-1	PSA_Dir/PSA_noDir Ratio	[1.2780e+00,1.1270e+00,9.2690e-	[1.0000e+00,1.0000e+00,1.000

5.2 Geographic-Distribution Tables – Directivity-Model Hazard Curves

Tables of the geographic distribution of Directivity-Model-specific Hazard curves were generated in a manner similar to that of the PSHA hazard curves. In this case, one file was generated for each directivity model. Two sets of files were generated for each Directivity Model: one set tabulates the PSA values, the other the directivity-amplification factor, which was computed as the ratio between the PSA with directivity and PSA without directivity, evaluated at the same annual Spectral Period and annual rate of exceedance.

The files are listed in Table 5.2, along with a sample screenshot for each case. This dataset contains 10 files.

Table 5.2. Geographic-Distribution Tables – Directivity-Model Hazard Curves

a. PSA with Directivity – Individual Directivity Models

- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio_DirModel_BS13.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio_DirModel_BS13_FaultNormal.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio_DirModel_BS13_FaultParallel.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio_DirModel_BSS20.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_DirectivityAmpRatio_DirModel_CS13.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30_DirR	Period (s)	Quantity	AnnualRateOfExceedance	PSA_Dir (g)BS13
4	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.5	PSA_g_WithDirectivity b'BS13'	[1.1900e+00,9.9280e-	[1.0000e-03,1.7000e-
5	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.75	PSA_g_WithDirectivity b'BS13'	[1.0400e+00,8.3940e-	[1.0000e-03,1.6000e-
6	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1	PSA_g_WithDirectivity b'BS13'	[8.6950e-01,6.6480e-	[1.0000e-03,1.6000e-
7	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1.5	PSA_g_WithDirectivity b'BS13'	[6.1130e-01,4.3750e-	[1.0000e-03,1.6000e-
8	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	2	PSA_g_WithDirectivity b'BS13'	[4.3460e-01,2.9990e-	[1.0000e-03,1.6000e-
9	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	3	PSA_g_WithDirectivity b'BS13'	[2.5180e-01,1.6680e-	[1.0000e-03,1.6000e-
10	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	4	PSA_g_WithDirectivity b'BS13'	[1.6740e-01,1.0730e-	[1.0000e-03,1.6000e-
11	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	5	PSA_g_WithDirectivity b'BS13'	[1.1750e-01,7.3380e-	[1.0000e-03,1.6000e-

b. Directivity-Amplification Factor – Individual Directivity Models

- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_WithDirectivity_DirModel_BS13.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_WithDirectivity_DirModel_BS13_FaultNormal.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_WithDirectivity_DirModel_BS13_FaultParallel.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_WithDirectivity_DirModel_BSS20.csv
- NHR3_California_DirectivityPSH_HazardCurveTable_AllSites_PSAg_WithDirectivity_DirModel_CS13.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30_DirRatio	Period (s)	Quantity	AnnualRateOfExceedance (/yr)	PSA_Dir/PSA_noDir Rati
4	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.5	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.1900e+00,9.9280e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
5	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.75	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.0400e+00,8.3940e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
6	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1	PSA_Dir/PSA_noDir Ratio b'BS13'	[8.6950e-01,6.6480e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
7	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1.5	PSA_Dir/PSA_noDir Ratio b'BS13'	[6.1130e-01,4.3750e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
8	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	2	PSA_Dir/PSA_noDir Ratio b'BS13'	[4.3460e-01,2.9990e-	[1.0, 1.0, 1.0, 1.0, 1.0001
9	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	3	PSA_Dir/PSA_noDir Ratio b'BS13'	[2.5180e-01,1.6680e-	[1.0, 1.0, 1.0, 1.000151, 1
10	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	4	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.6740e-01,1.0730e-	[1.0, 1.000984, 1.000146
11	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	5	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.1750e-01,7.3380e-	[1.0, 1.0, 1.000209, 1.000
12	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	7.5	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.1860e-01,7.7320e-	[1.0, 1.000142, 1.0, 1.0, 1
13	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	10	PSA_Dir/PSA_noDir Ratio b'BS13'	[7.5810e-02,4.8120e-	[1.0, 1.0, 1.00033, 1.001

5.3 Geographic-Distribution Tables – Uniform-Hazard Spectra

Tables of the geographic distribution of Uniform-Hazard Spectra were generated in a manner like that of the PSHA hazard curves. Two sets of files were generated: one set tabulates the PSA values, the other the directivity-amplification factor, which was computed as the ratio between the PSA with directivity and that without directivity, evaluated at the same annual rate of exceedance. Each table/file has the following content:

- SiteLabel
- Site Location: Site Latitude and Longitude
- VS30Case: site Vs30
- VS30Dir: Vs30 used for the directivity analysis. All sites have VS760, some sites have additional VS30s. This column does not exist for the base case of the No-Directivity case
- ReturnPeriod: Return Period corresponding to UHS
- Quantity: Label for datum being reported in this table. This label is also repeated in the header of the data column. It is included in the row for completeness in case different tables are concatenated. The Directivity-Amplification Factor was computed by taking the ratio of the PSA with directivity divided by the PSA without directivity, both taken at the same annual rate
- Period (s): Bracketed list of N values of Spectral Periods.
- Datum: Bracketed list of N values being tabulated in this file. The header of this column specifies the quantity of the datum, it is different for each file.

The tables are listed in Table 5.3, along with a sample screenshot for each case. This dataset contains 4 files.

Table 5.3. Geographic-Distribution Tables – Uniform-Hazard Spectra

a. PSA with No Directivity

- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_NoDirectivity.csv

	A	B	C	D	E	F	G	H
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis							
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/							
3	SiteLabel	Latitude	Longitude	Vs30Case	ReturnPeriod (yr)	Quantity	Period (s)	PSA_noDir (g)
4	Site00001	32.35	-117.2	Vs1100	50.862	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.042029, 0.042828, 0.04772, (
5	Site00001	32.35	-117.2	Vs1100	99.499	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.067701, 0.069164, 0.077662,
6	Site00001	32.35	-117.2	Vs1100	474.561	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.192077, 0.197572, 0.224486,
7	Site00001	32.35	-117.2	Vs1100	949.118	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.28874, 0.298049, 0.342413, (
8	Site00001	32.35	-117.2	Vs1100	999.5	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.297499, 0.307241, 0.351899,
9	Site00001	32.35	-117.2	Vs1100	2474.911	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.467407, 0.485212, 0.563435,
10	Site00001	32.35	-117.2	Vs1100	5000	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04 ,	[0.624867, 0.648112, 0.756491,
11	Site00001	32.35	-117.2	Vs1100	10000	Uniform-H	[0.01 , 0.02 , 0.03 , 0.04	[0.801847, 0.838935, 0.980557

b. PSA with Directivity – Weighted directivity model

- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_WithDirectivity.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30_Dir	ReturnPeriod (yr)	Quantity	Period (s)	PSA_Dir (g)
4	Site00001	32.35	-117.2	Vs1100	Vs760	50.862	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.042029, 0.042828, 0.0477
5	Site00001	32.35	-117.2	Vs1100	Vs760	99.499	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.067701, 0.069164, 0.0776
6	Site00001	32.35	-117.2	Vs1100	Vs760	474.561	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.192077, 0.197572, 0.2244
7	Site00001	32.35	-117.2	Vs1100	Vs760	949.118	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.28874, 0.298049, 0.34241
8	Site00001	32.35	-117.2	Vs1100	Vs760	999.5	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.297499, 0.307241, 0.3518
9	Site00001	32.35	-117.2	Vs1100	Vs760	2474.911	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.467407, 0.485212, 0.5634
10	Site00001	32.35	-117.2	Vs1100	Vs760	5000	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.624867, 0.648112, 0.7564
11	Site00001	32.35	-117.2	Vs1100	Vs760	10000	Uniform-Hazard PSA (g) With Directivity	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[0.801847, 0.838935, 0.9805

c. Directivity-Amplification Factor – Weighted directivity model

- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmplificationRatio.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmplificationRatio_noLB.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30_Dir	ReturnPeriod (yr)	Quantity	Period (s)	PSA_Dir/PSA_noDir Ratio
4	Site00001	32.35	-117.2	Vs1100	Vs760	50.862	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
5	Site00001	32.35	-117.2	Vs1100	Vs760	99.499	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
6	Site00001	32.35	-117.2	Vs1100	Vs760	474.561	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
7	Site00001	32.35	-117.2	Vs1100	Vs760	949.118	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
8	Site00001	32.35	-117.2	Vs1100	Vs760	999.5	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
9	Site00001	32.35	-117.2	Vs1100	Vs760	2474.911	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
10	Site00001	32.35	-117.2	Vs1100	Vs760	5000	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
11	Site00001	32.35	-117.2	Vs1100	Vs760	10000	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.
12	Site00001	32.35	-117.2	Vs180	Vs760	50.862	Directivity-Amplification Ratio	[0.01 , 0.02 , 0.03 , 0.04 , 0.05	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.

5.4 Geographic-Distribution Tables – Directivity-Model Uniform-Hazard Spectra

Tables of the geographic distribution of Directivity-Model-specific Uniform-Hazard Spectra were generated in a manner similar to that of the Directivity-Model PSHA hazard curves. Two sets of files were generated: one set tabulates the PSA values, the other the directivity-amplification factor, which was computed as the ratio between the PSA with directivity and that without directivity, evaluated at the same Spectral Period and Return Period.

The files are listed in Table 5.4, along with a sample screenshot for each case. This dataset contains 10 files.

Table 5.4. Geographic-Distribution Tables – Directivity-Model Uniform-Hazard Hazard Spectra

c. PSA with Directivity – Individual Directivity Models

- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_WithDirectivity_DirModel_BS13.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_WithDirectivity_DirModel_BS13_FaultNormal.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_WithDirectivity_DirModel_BS13_FaultParallel.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_WithDirectivity_DirModel_BSS20.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_PSAg_WithDirectivity_DirModel_CS13.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30_DirR	Period (s)	Quantity	AnnualRateOfExceedance	PSA_Dir (g)BS13
4	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.5	PSA_g_WithDirectivity b'BS13'	[1.1900e+00,9.9280e-	[1.0000e-03,1.7000e-
5	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.75	PSA_g_WithDirectivity b'BS13'	[1.0400e+00,8.3940e-	[1.0000e-03,1.6000e-
6	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1	PSA_g_WithDirectivity b'BS13'	[8.6950e-01,6.6480e-	[1.0000e-03,1.6000e-
7	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1.5	PSA_g_WithDirectivity b'BS13'	[6.1130e-01,4.3750e-	[1.0000e-03,1.6000e-
8	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	2	PSA_g_WithDirectivity b'BS13'	[4.3460e-01,2.9990e-	[1.0000e-03,1.6000e-
9	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	3	PSA_g_WithDirectivity b'BS13'	[2.5180e-01,1.6680e-	[1.0000e-03,1.6000e-
10	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	4	PSA_g_WithDirectivity b'BS13'	[1.6740e-01,1.0730e-	[1.0000e-03,1.6000e-
11	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	5	PSA_g_WithDirectivity b'BS13'	[1.1750e-01,7.3380e-	[1.0000e-03,1.6000e-

d. Directivity-Amplification Factor – Individual Directivity Models

- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmpRatio_DirModel_BS13.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmpRatio_DirModel_BS13_FaultNormal.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmpRatio_DirModel_BS13_FaultParallel.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmpRatio_DirModel_BSS20.csv
- NHR3_California_DirectivityPSH_SpectraTable_AllSites_DirectivityAmpRatio_DirModel_CS13.csv

	A	B	C	D	E	F	G	H	I
1	NHR3 California Directivity-Based Probabilistic Seismic Hazard Analysis								
2	https://www.risksciences.ucla.edu/nhr3/cal-directivity-psha/								
3	SiteLabel	Latitude	Longitude	Vs30Case	Vs30_DirRatio	Period (s)	Quantity	AnnualRateOfExceedance (/yr)	PSA_Dir/PSA_noDir Rati
4	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.5	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.1900e+00,9.9280e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
5	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	0.75	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.0400e+00,8.3940e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
6	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1	PSA_Dir/PSA_noDir Ratio b'BS13'	[8.6950e-01,6.6480e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
7	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	1.5	PSA_Dir/PSA_noDir Ratio b'BS13'	[6.1130e-01,4.3750e-	[1.0, 1.0, 1.0, 1.0, 1.0, 1.0
8	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	2	PSA_Dir/PSA_noDir Ratio b'BS13'	[4.3460e-01,2.9990e-	[1.0, 1.0, 1.0, 1.0, 1.0001
9	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	3	PSA_Dir/PSA_noDir Ratio b'BS13'	[2.5180e-01,1.6680e-	[1.0, 1.0, 1.0, 1.000151, 1
10	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	4	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.6740e-01,1.0730e-	[1.0, 1.000984, 1.000146
11	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	5	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.1750e-01,7.3380e-	[1.0, 1.0, 1.000209, 1.00
12	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	7.5	PSA_Dir/PSA_noDir Ratio b'BS13'	[1.1860e-01,7.7320e-	[1.0, 1.000142, 1.0, 1.0, 1
13	Site00001	32.35	-117.2	Vs760_Dir	Vs760_Dir	10	PSA_Dir/PSA_noDir Ratio b'BS13'	[7.5810e-02,4.8120e-	[1.0, 1.0, 1.00033, 1.001

6 Geographic-Distribution Maps

The geographic distribution of data and intensity measures was plotted on a set of 9,813 maps in jpg format. Colormaps were used to represent each quantity. The following data were mapped:

- Site ID (Figure 1.1)
- Site-Specific Vs30 (Figure 1.4)
- Site- Specific Z1.0 (Figure 1.5)
- Site- Specific Z2.5 (Figure 1.6)
- UCERF-3 Fault Sources (Figure 1.2)

At each Vs30, Return Period, and Oscillator period, the following intensity measures were mapped, a sample figure is provided for each below:

- PSA with No Directivity (Figure 6.1)
- PSA with Directivity, Weighted Model, Vs-760 directivity-adjustment factor (Figure 6.2)
- PSA with Directivity, Weighted Model, Vs30 directivity-adjustment factor (where available) (Figure 6.3)
- PSA with Directivity, CS13 model (Figure 6.4)
- PSA with Directivity, BS13 model (Figure 6.5)
- PSA with Directivity, BSS20 model (Figure 6.6)
- PSA with Directivity, BS13-FaultNormal Component model (Figure 6.7)
- PSA with Directivity, BS13-FaultParallel Component model (Figure 6.8)
- Directivity-Adjustment Factor, Weighted Model (Figure 6.9 Vs30=760m/s, Figure 6.10 Vs30=180m/s)
- Directivity-Adjustment Factor with no lower bound, weighted model (Figure 6.11)
- Directivity-Adjustment Factor, CS13 model (Figure 6.12)
- Directivity-Adjustment Factor, BS13 model (Figure 6.13)
- Directivity-Adjustment Factor, BSS20 model (Figure 6.14)
- Directivity-Adjustment Factor, BS13-FaultNormal Component model (Figure 6.15)
- Directivity-Adjustment Factor, BS13-FaultParallel Component model (Figure 6.16)

For completeness, the PSA with directivity was mapped for all periods, but for periods less than 0.5 seconds the values mapped are equal to those without directivity. Directivity adjustment factors, as well as directivity-model-specific with-directivity PSA were mapped only for periods at or above 0.5sec.

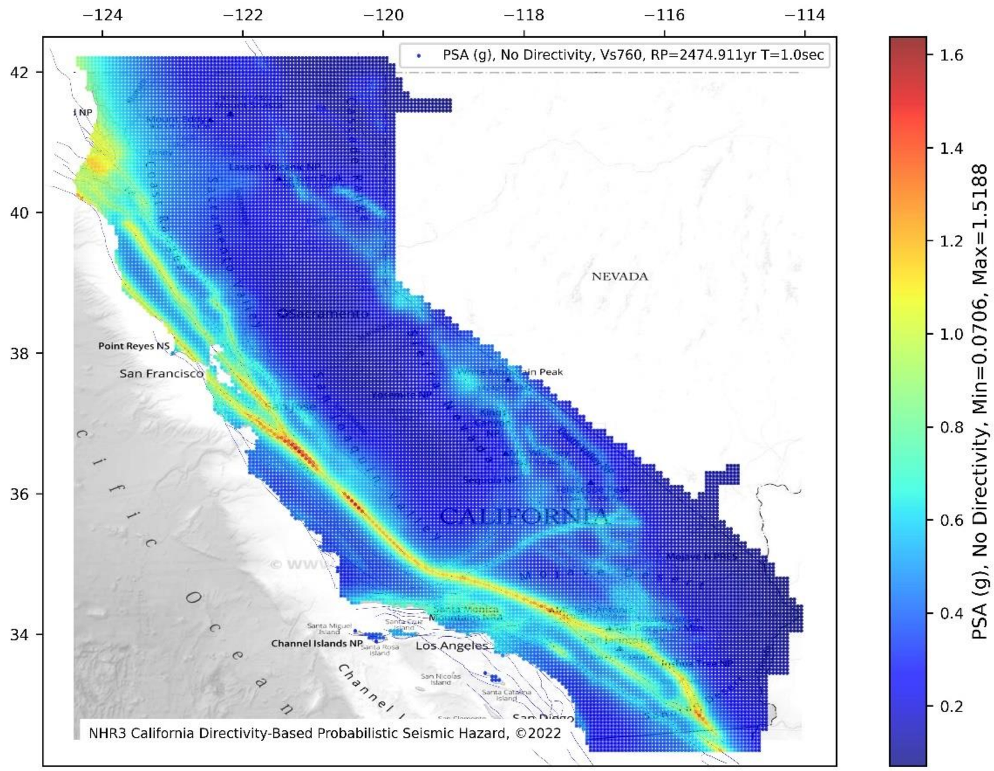


Figure 6.1. PSA with No Directivity

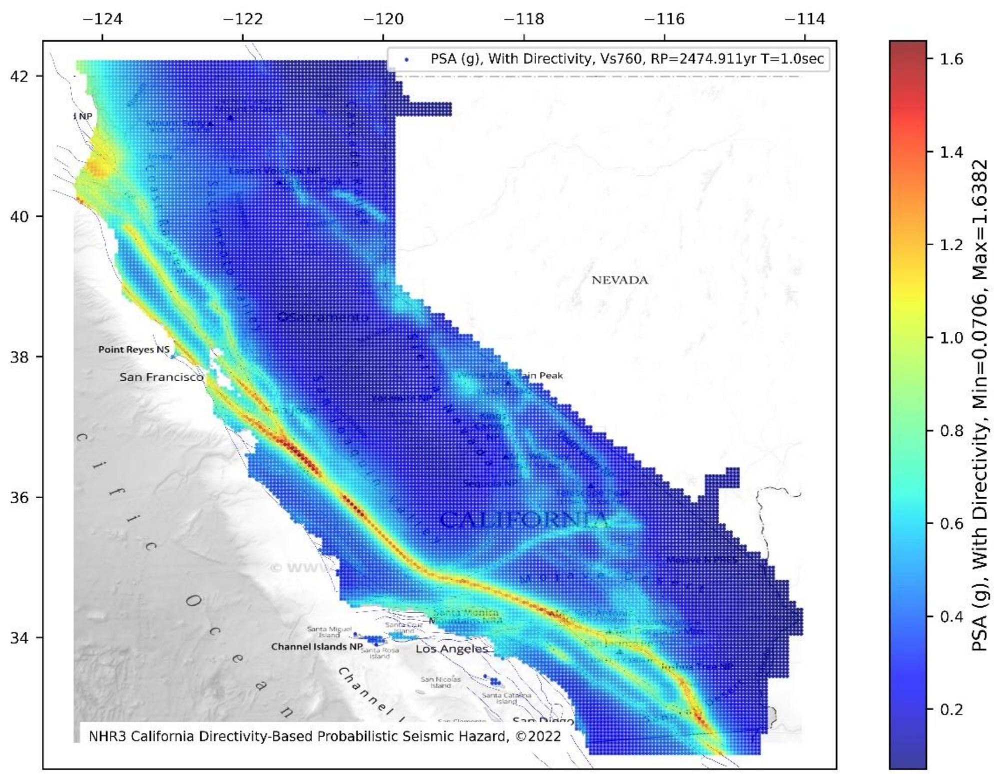


Figure 6.2. PSA with Directivity, Weighted Model, Vs-760 directivity-adjustment factor

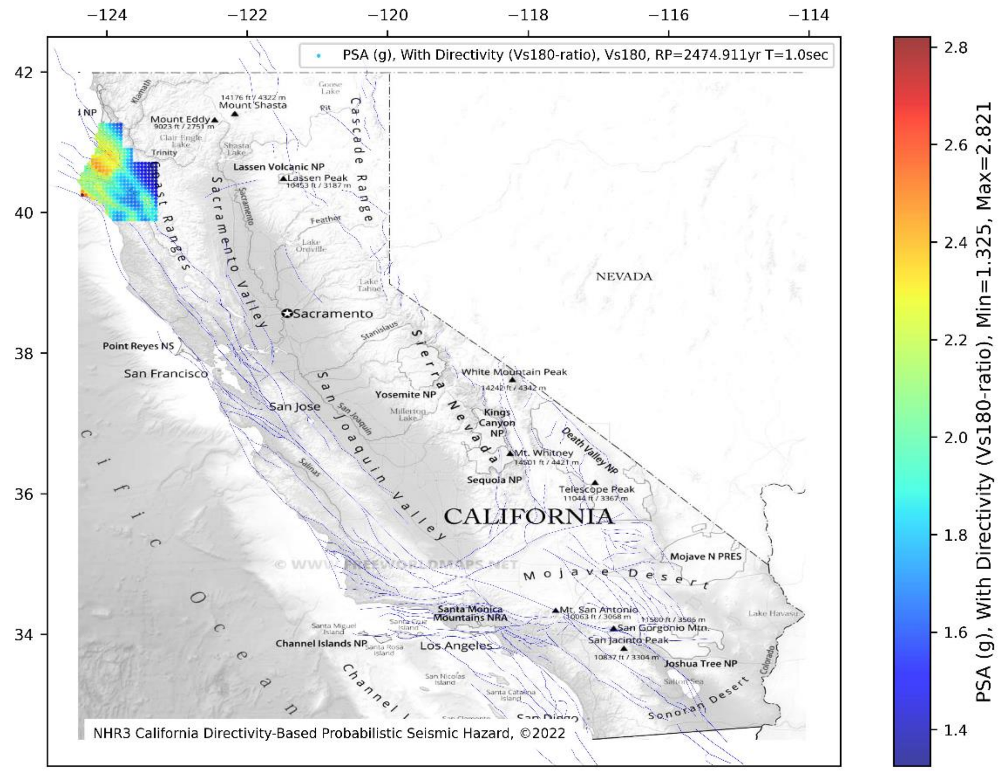


Figure 6.3. PSA with Directivity, Weighted Model, Vs30 dir-adjustment

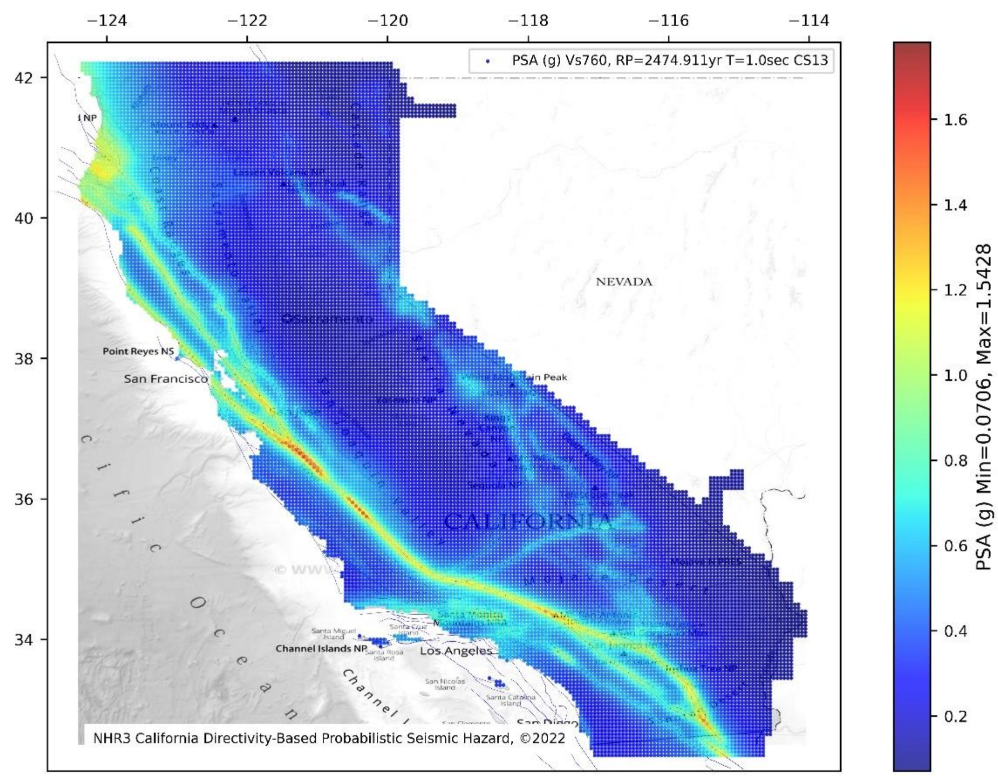


Figure 6.4. PSA with Directivity, CS13 model

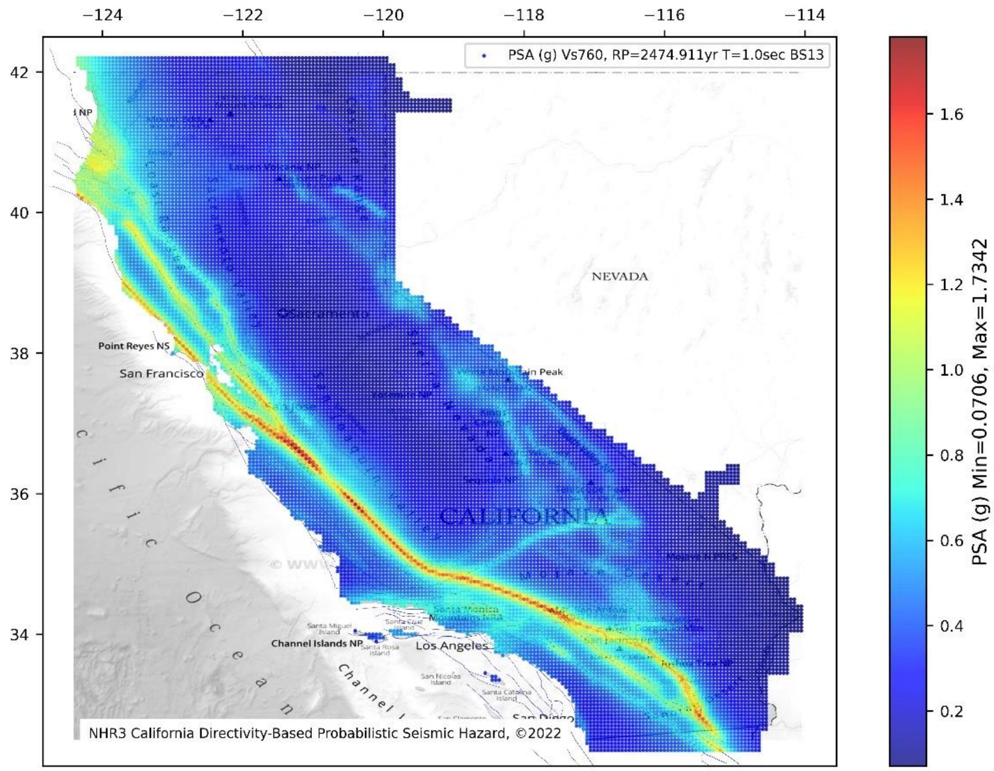


Figure 6.5. PSA with Directivity, BS13 model

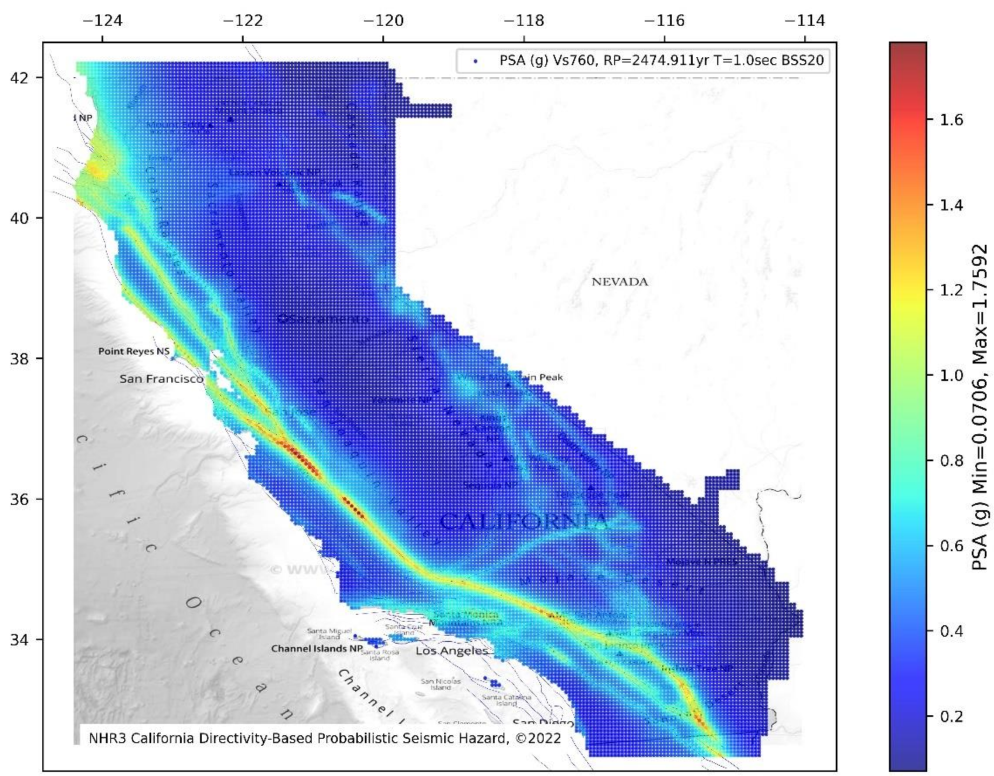


Figure 6.6. PSA with Directivity, BSS20 model

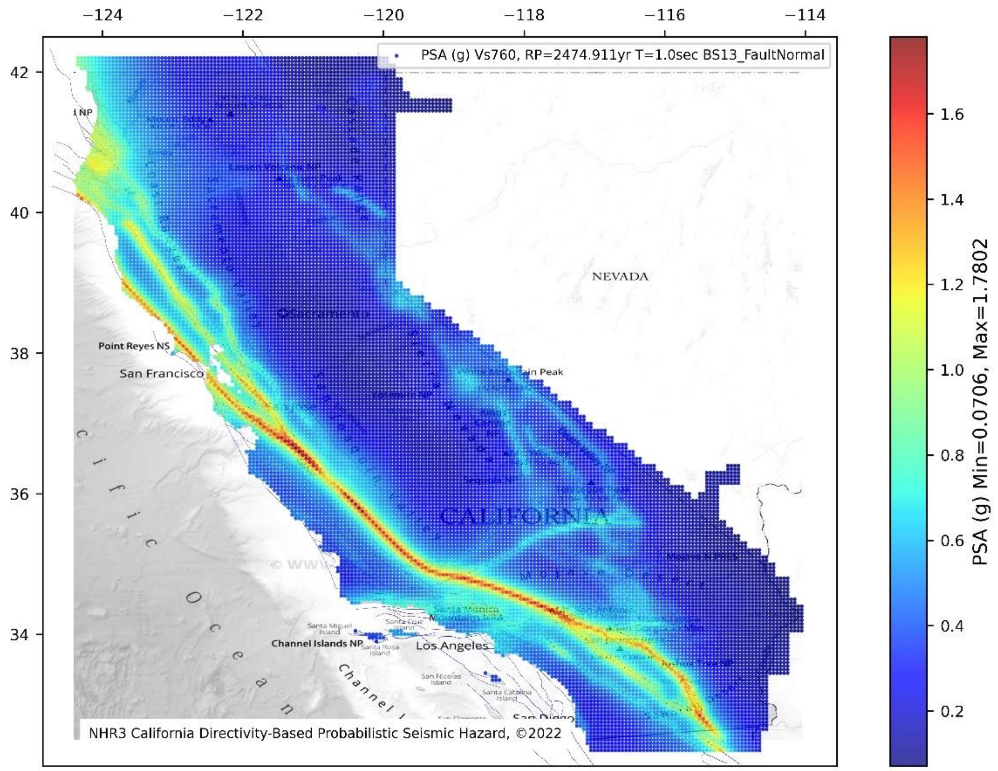


Figure 6.7. PSA with Directivity, BS13-FaultNormal Component model

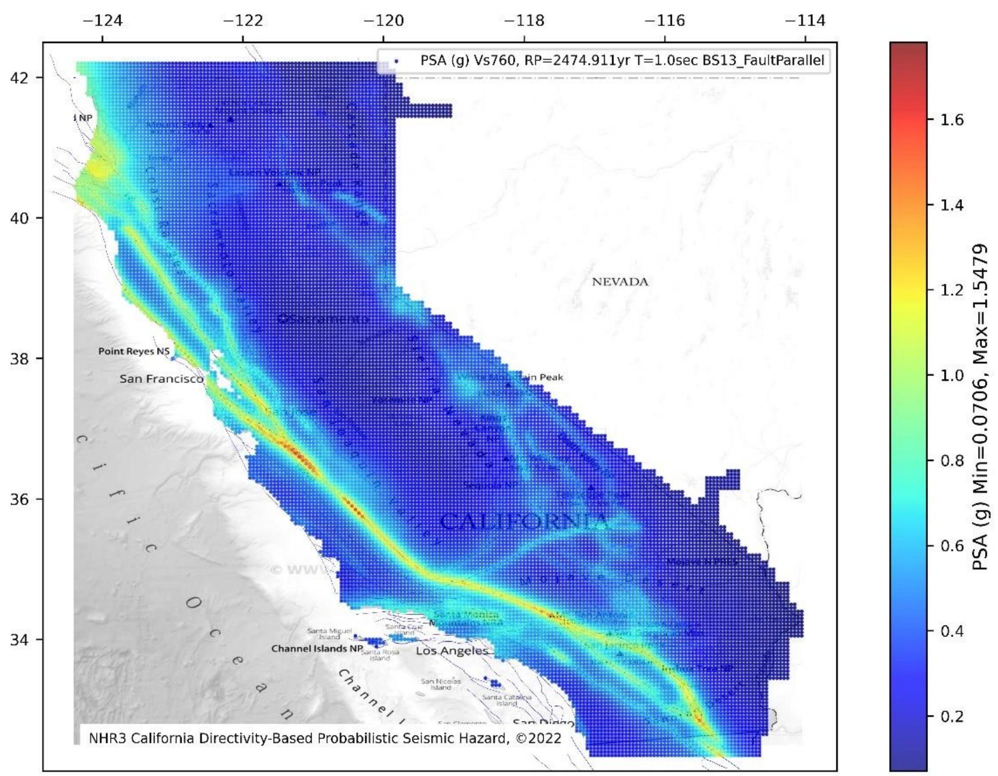


Figure 6.8. PSA with Directivity, BS13-FaultParallel Component model

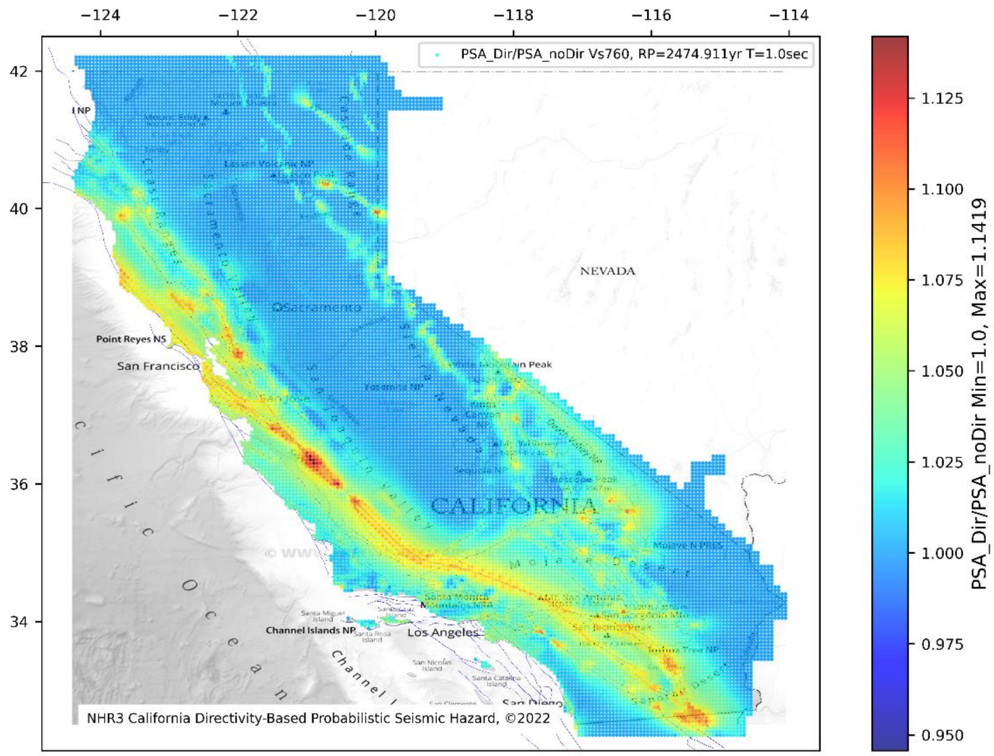


Figure 6.9. Directivity-Adjustment Factor, Weighted Model

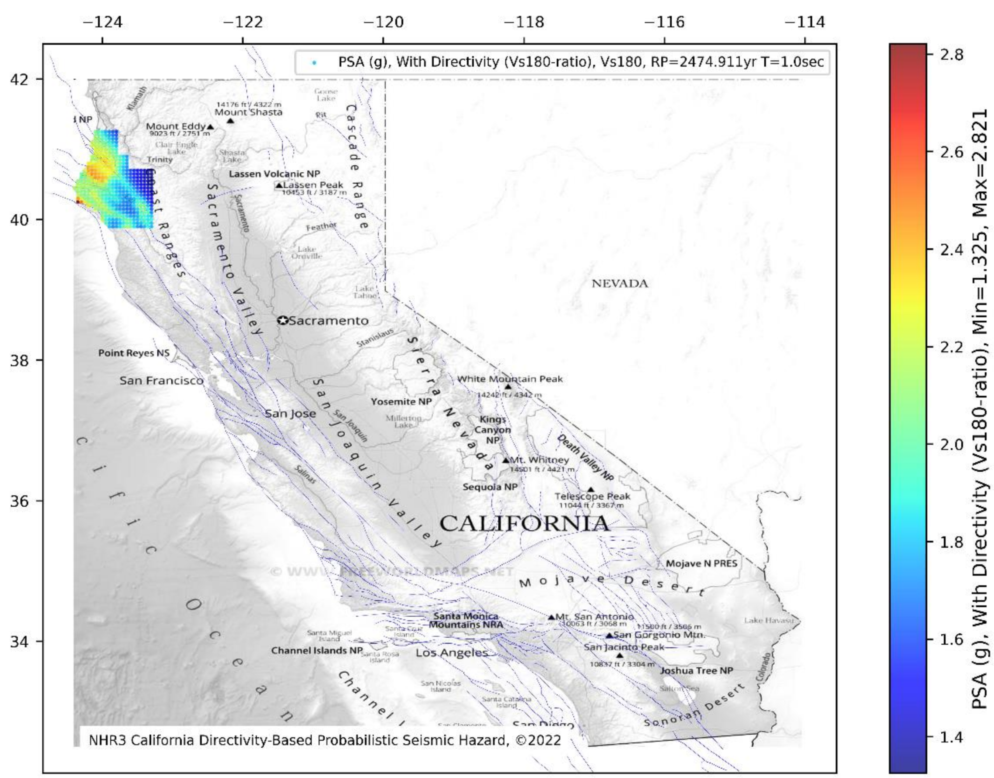


Figure 6.10. Directivity-Adjustment Factor, Weighted Model (Vs30<>760m/s)

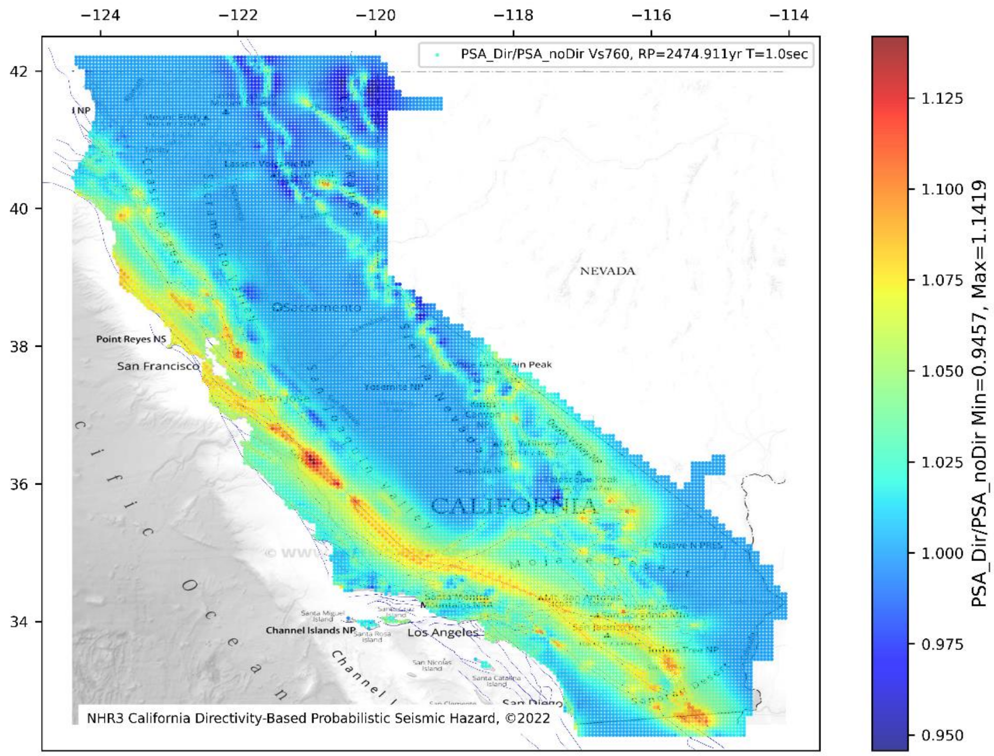


Figure 6.11. Directivity-Adjustment Factor with no lower bound, weighted model

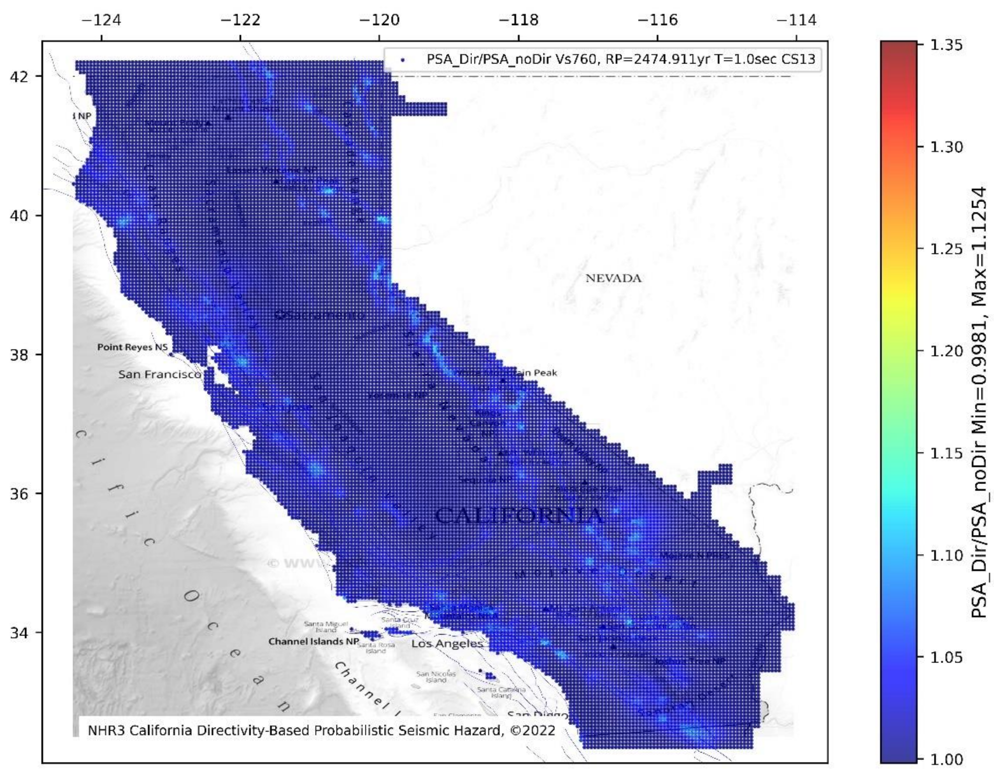


Figure 6.12. Directivity-Adjustment Factor, CS13 model

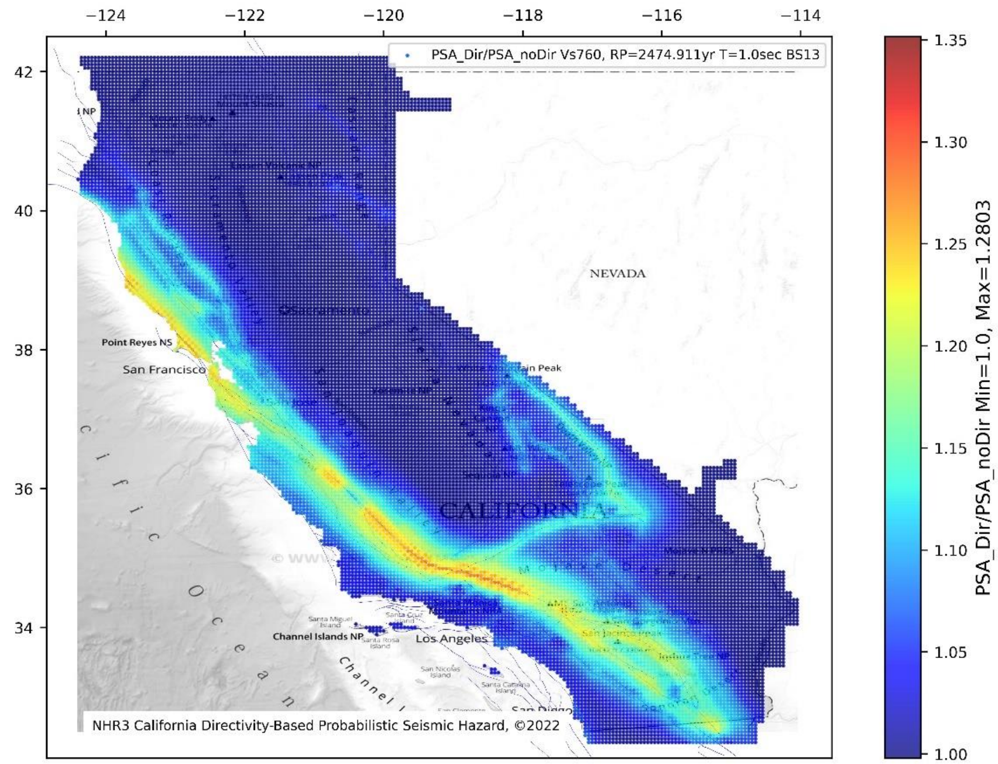


Figure 6.13. Directivity-Adjustment Factor, BS13 model

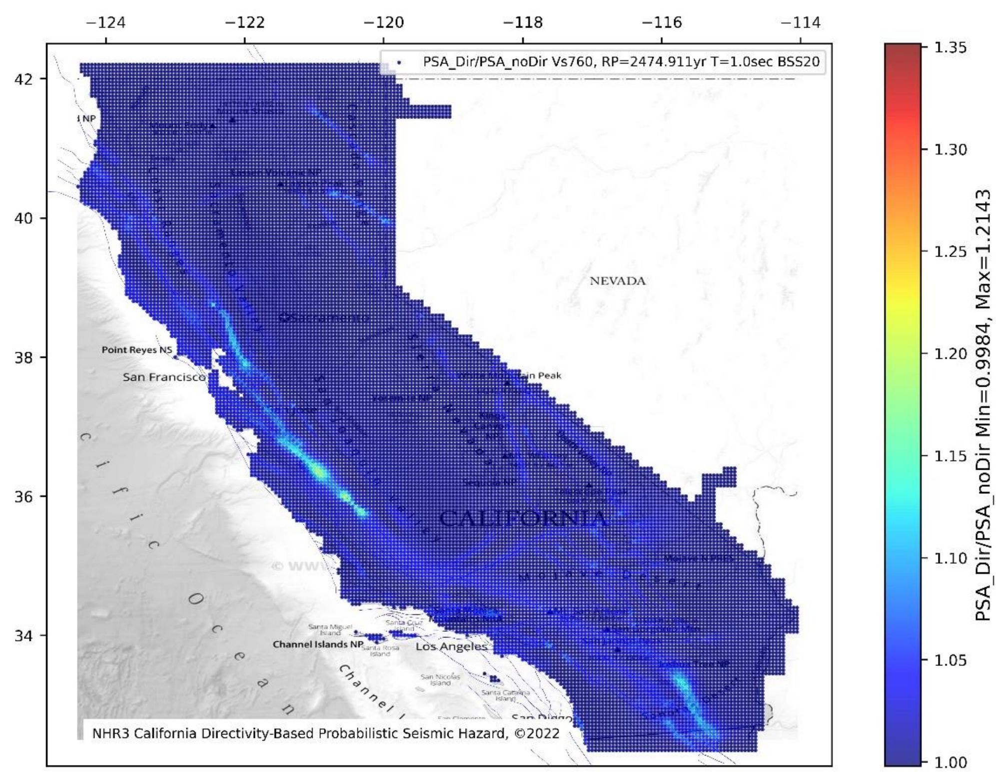


Figure 6.14. Directivity-Adjustment Factor, BSS20 model

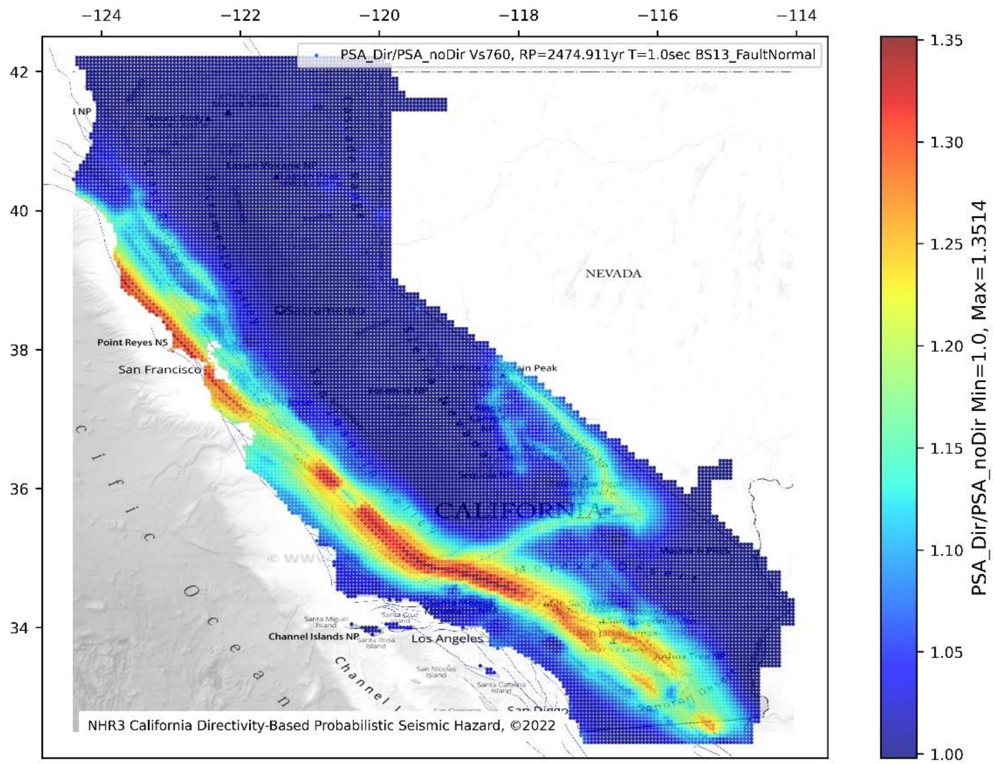


Figure 6.15. Directivity-Adjustment Factor, BS13-FaultNormal Component model

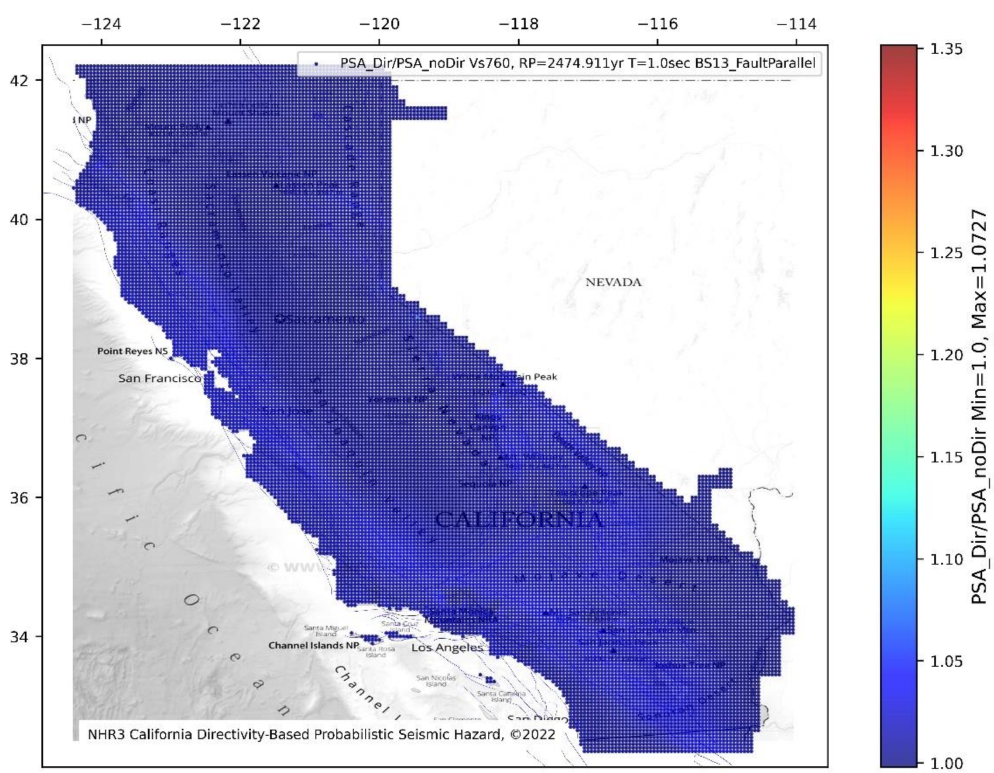


Figure 6.16. Directivity-Adjustment Factor, BS13-FaultParallel Component model

These data have been plotted on a map of California so that the user may identify geographic features. The UCERF-3 fault sources have also been included in the maps. The maps have been produced to a high-enough resolution that the user may enlarge the image and visualize important details and locations in the map, as shown in the detail given in Figure 6.17.

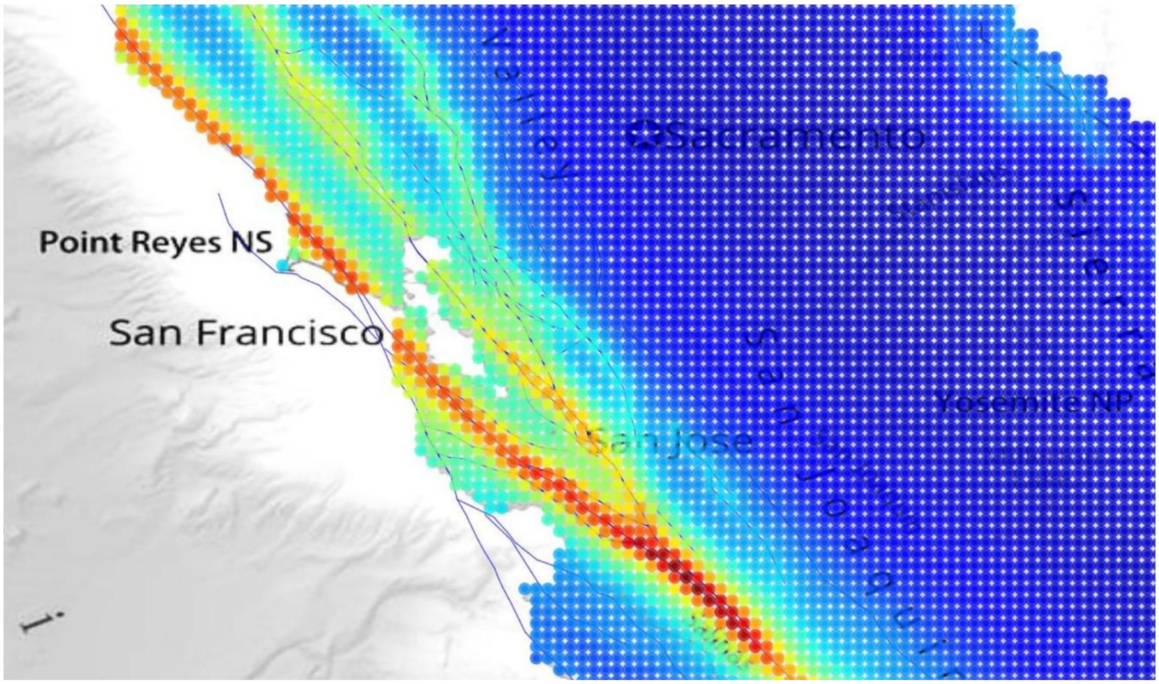


Figure 6.17. Enlarged detail of intensity-measure map.

7 Directivity-Based Probabilistic Hazard in California: Interactive Maps

A web portal has been established to enable access to the data and tools presented in this report. A dataset of interactive maps in .html format has also been produced and assembled into an interactive web portal. In addition to displaying the data via colormaps, JavaScript code has been added to enable the user to select the intensity measures of interest and interact with the map by zooming in/out, panning, and clicking on the sites themselves, as shown in Figure 7.1.

The first time they visit the web site, we recommend that the first time the user read the instructions by clicking on the “Instructions & Notes” button. This toggle button opens and closes the instructions menu.

Via pull-down menus, the user can select the Oscillator Period, the data they would like to visualize (input data or intensity measures), the site-class Vs30 and the return period. Every time the user makes a new selection, the map in the web-portal frame is updated automatically. The user also has the option to access the map in a full web page instead of the frame, thus allowing for comparison of different cases.

When a directivity-based intensity measures is being displayed the tool automatically limits the oscillator-period selection to the periods where directivity was considered in the PSHA (>=0.5sec), as shown in Figure 7.2. When the no-directivity PSA is selected for the map, the user is automatically provided a wider selection of periods, as shown in Figure 7.3.

The same colorscale was used for different IM to enable comparisons. For example, the same colorscale was used for the PSA with and without directivity, as shown in Figure 7.2 and Figure 7.3. The same colorscale was used for the recommended Directivity-Adjustment factor (with a lower bound value of 1) and the Weighted-Model Directivity-Adjustment factor, where no lower bound was imposed, as shown in Figure 7.4 and Figure 7.5. The pink-shaded regions in the second figure indicate regions of de-amplification due to the computed directivity-adjustment factor.

The same colorscale is used for directivity-adjustment factors of the individual directivity so that they may be compared with each other. Please note that this colorscale is different from that of the weighted-average directivity-adjustment factor, as this would decrease the resolution of the latter figures. All directivity-adjustment-factor map colorscales have been defined such that the value of 1.0 falls at the dark-blue values and values below 1.0 are pink, as is shown in Figure 7.6.

When the user overs over an individual site marker, basic information is displayed on the map, as shown in Figure 7.7. This information is useful to identify the location of the study sites.

When the user clicks on an individual site marker, a popup object opens up with more information about the site, as well as hazard data for that site, as shown in Figure 7.8. In this pop-up box the user can access the following data:

- Site location and data
- Intensity-measure value
- Plot of Uniform-Hazard Spectra with and without directivity
- Plot of Hazard Curves with and without directivity

- Hazard-Deaggregation plots: Magnitude-Distance Bins
- Hazard-Deaggregation plots: Hazard by source type
- Hazard-Deaggregation plots: Hazard by fault source
- Tabulated values of Uniform-Hazard spectra with and without directivity
- Tabulated values of Directivity-Adjustment factors (with and without lower bound)

The user may also visualize, interactively, the site data, such as site-specific Vs30 (Figure 7.9), Z1.0 (Figure 7.10), Z2.5 (Figure 7.11), as well as the UCERF-3 Fault Source (Figure 7.12). More information about a fault is provided when the user clicks on it, as shown in Figure 7.13. Additional data is also accessible in additional layers that can be turned on by the user: the Natural-Gas pipelines in California (provided by CEC), and the CEC storage facilities, as shown in Figure 7.14. Additional background-map layers are also available via the layer controls in the map.

In addition to having the basic zooming options (via mouse and map buttons), the maps have helpful navigation/visualization tools. The user can add a marker by clicking on the add-marker button and entering the marker label and coordinates, as shown in Figure 7.15.

By clicking on the distance button on the lower-left corner of the map and following the direction in the pop-up window, the user can measure distances between markers, as shown in Figure 7.16.

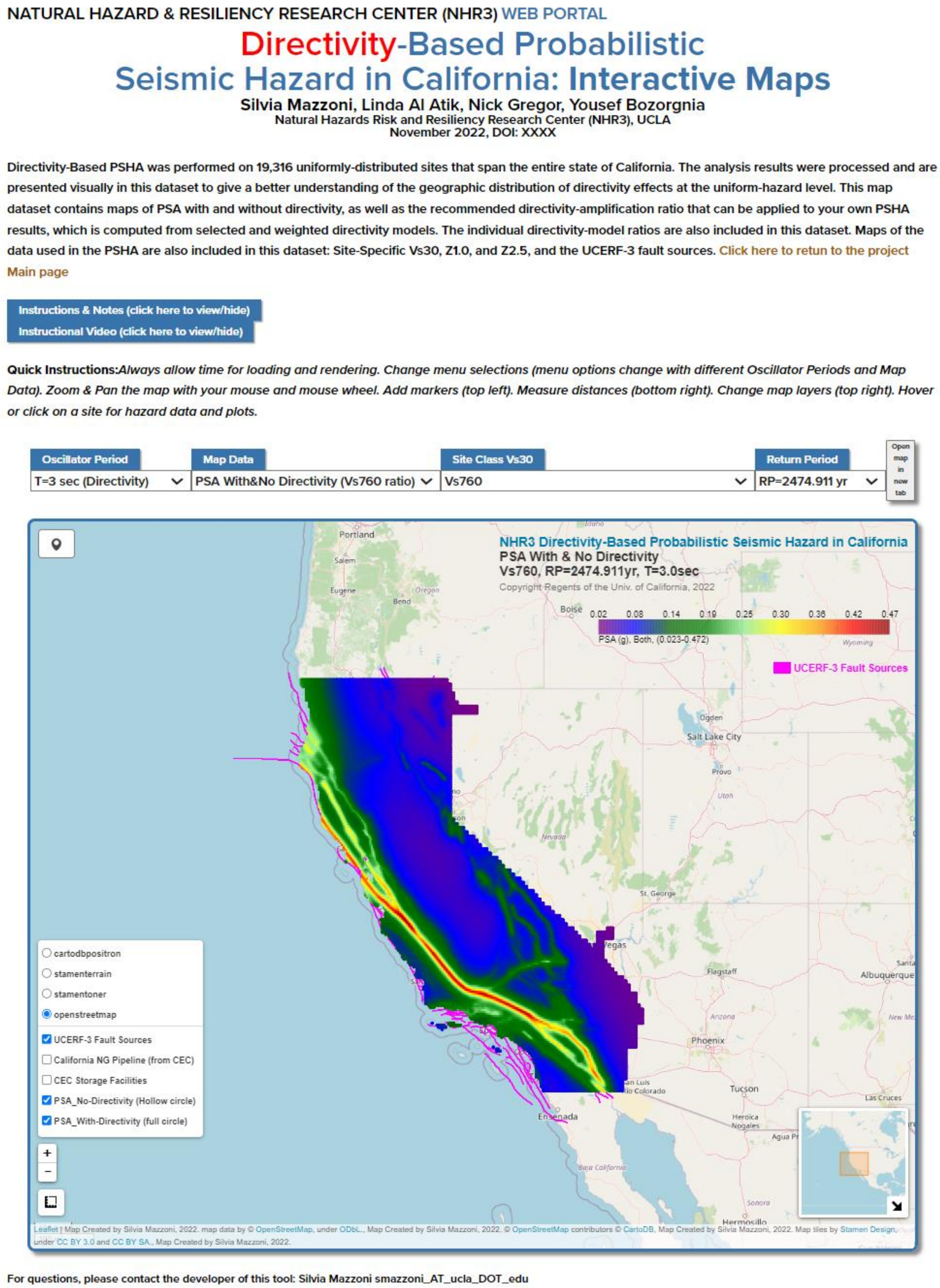


Figure 7.1. Directivity-Based Probabilistic Seismic Hazard in California: Interactive Maps Web Portal.

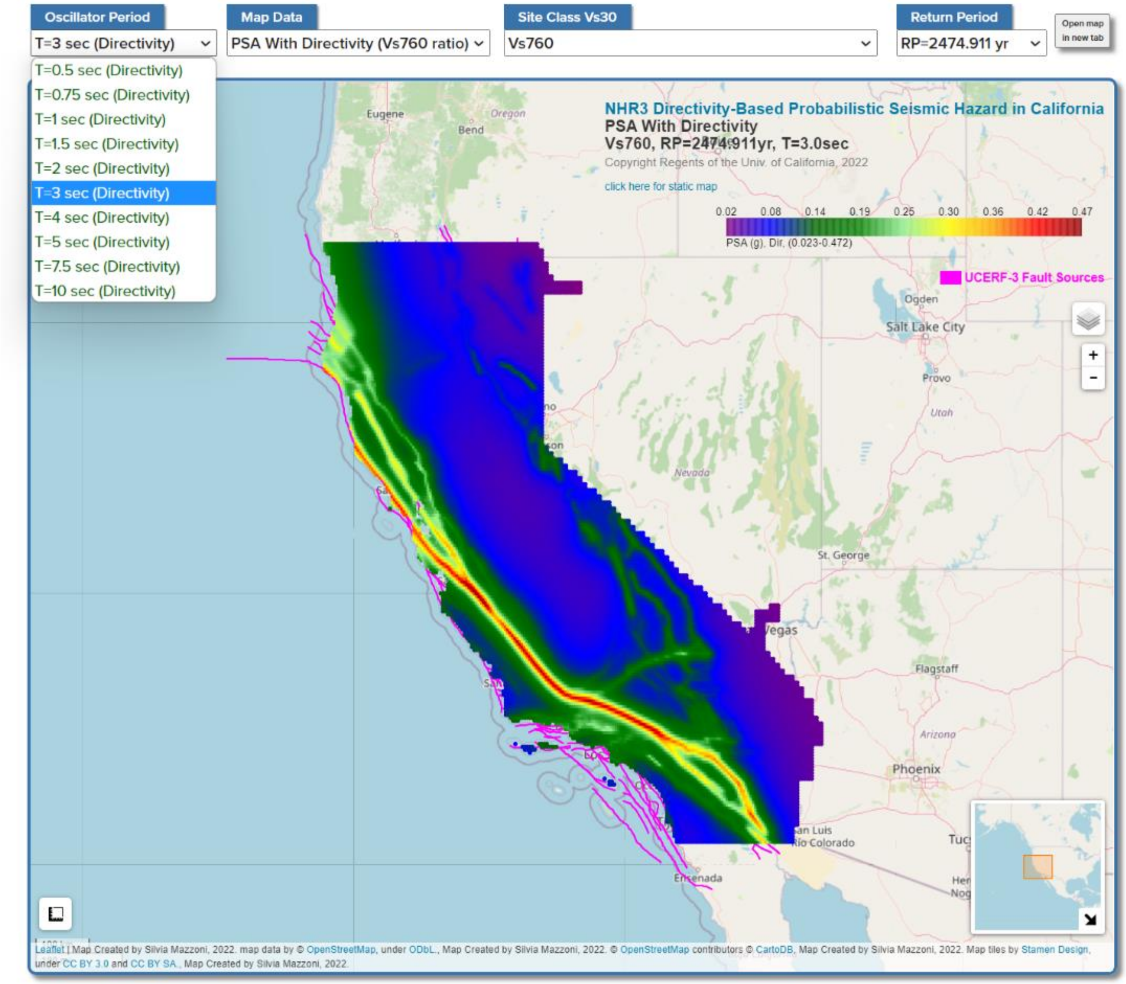


Figure 7.2. Oscillator-Period Options for directivity-based IM

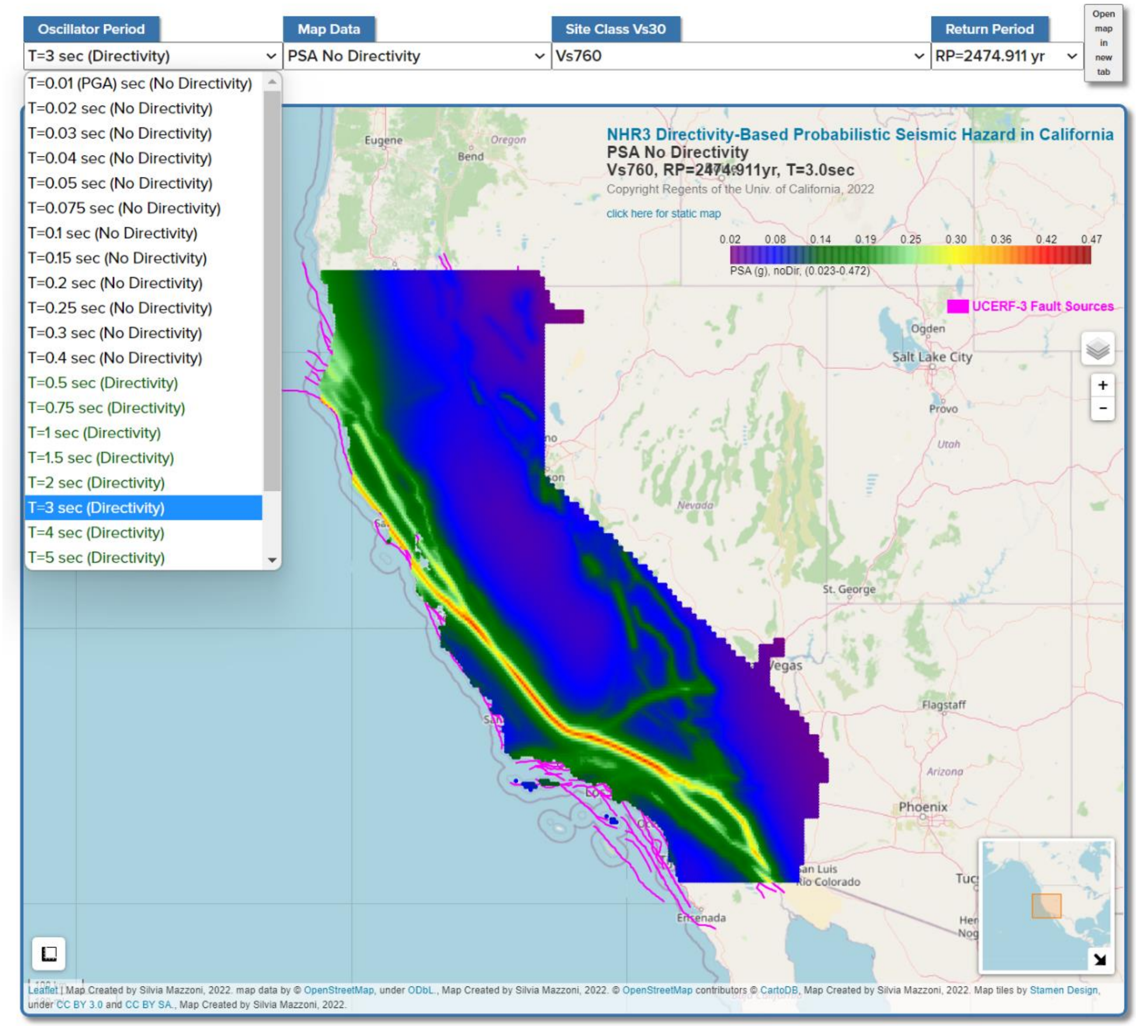


Figure 7.3. Oscillator-Period Options for no-directivity PSA

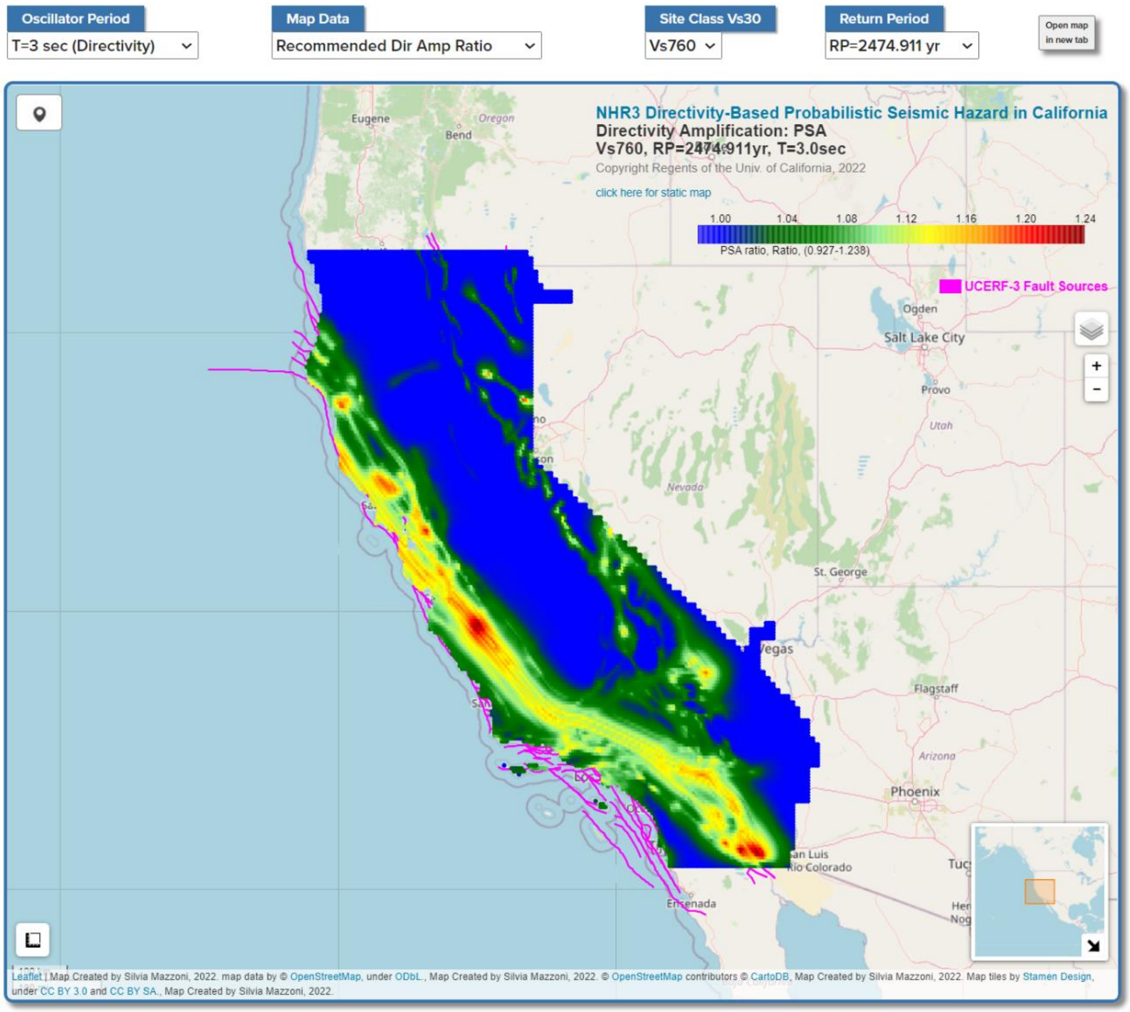


Figure 7.4. Recommended Directivity-Adjustment Factor (with lower bound)

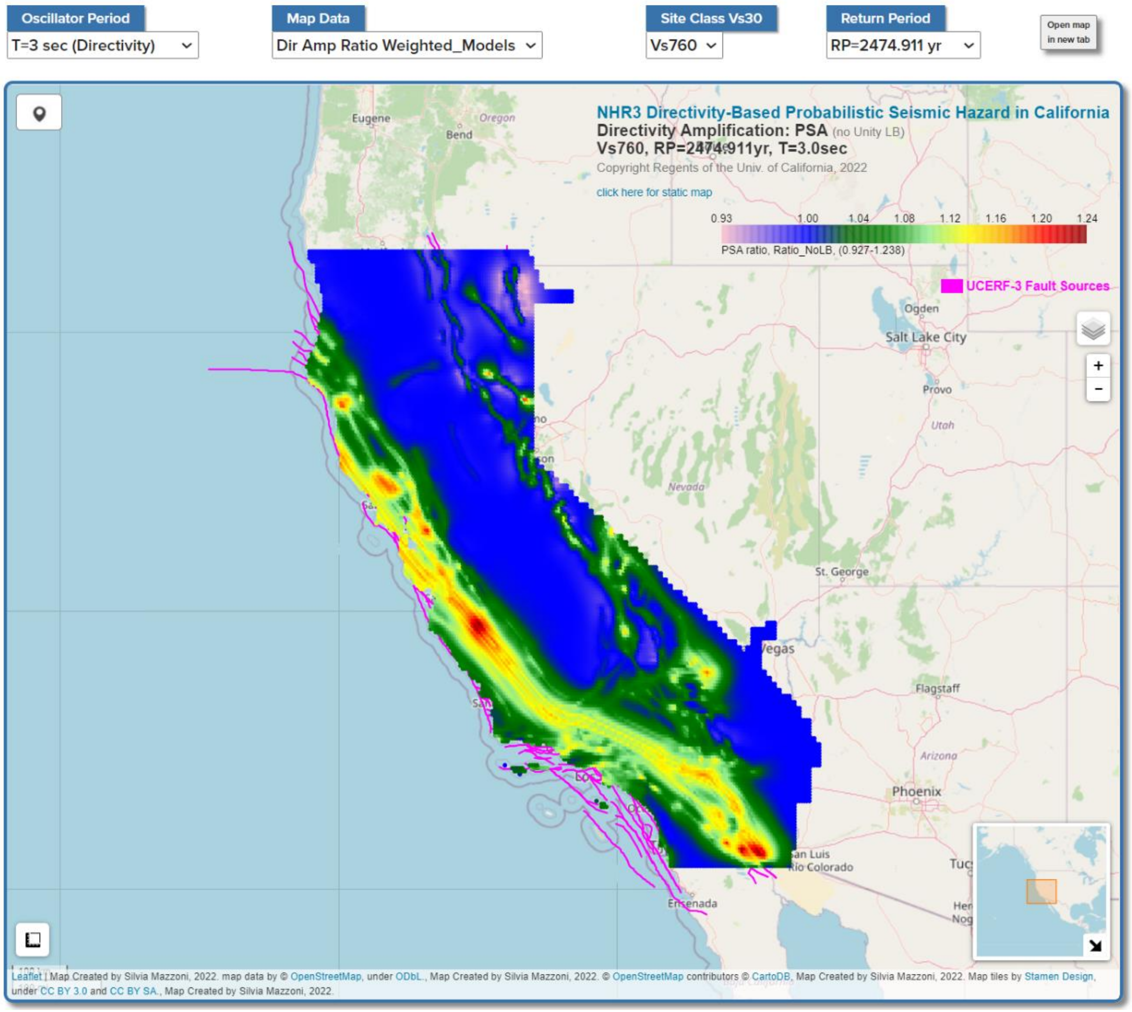


Figure 7.5. Computed Directivity-Adjustment Factor (no lower bound)

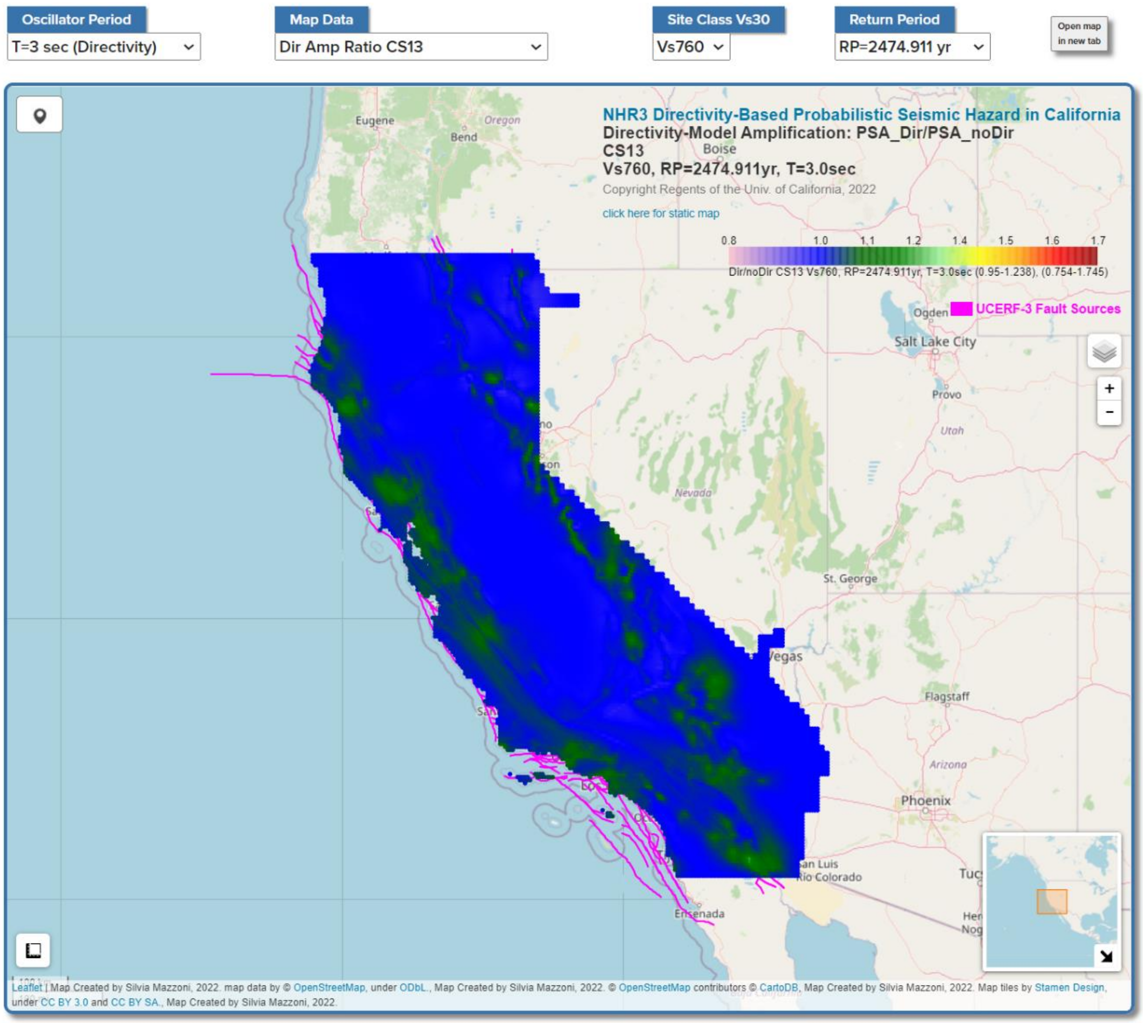


Figure 7.6. Directivity-Adjustment Factor: CS13

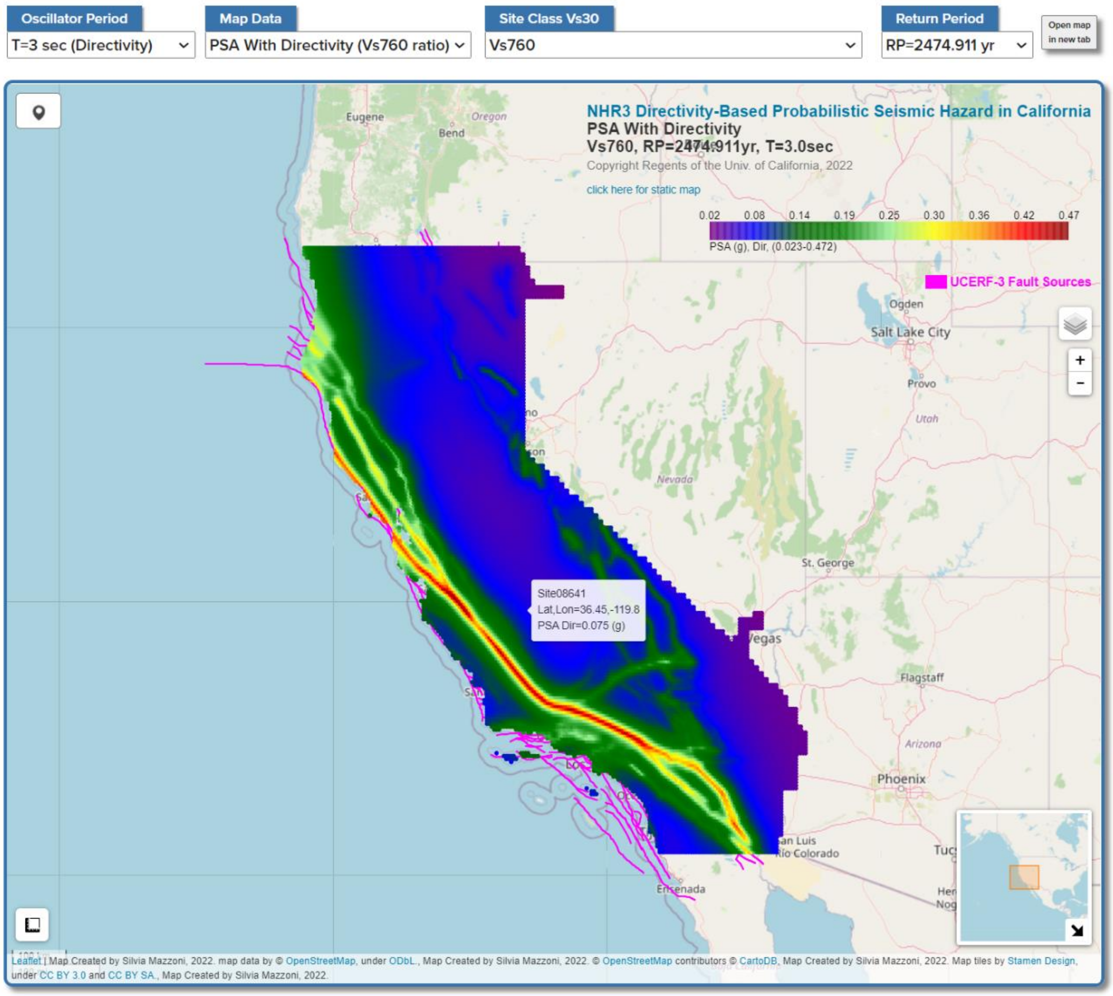


Figure 7.7. Site-Data hovering

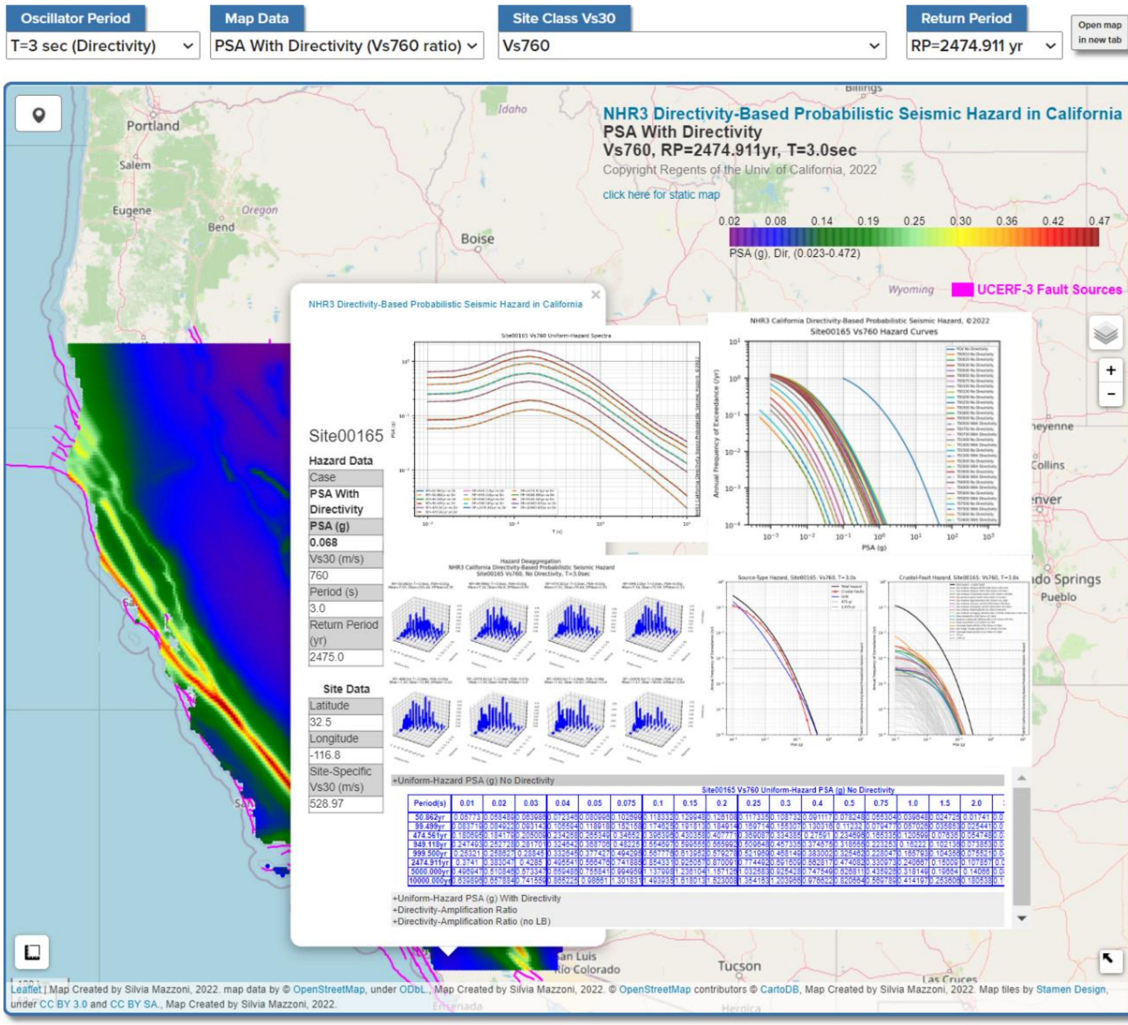


Figure 7.8. Site Data pop-up box

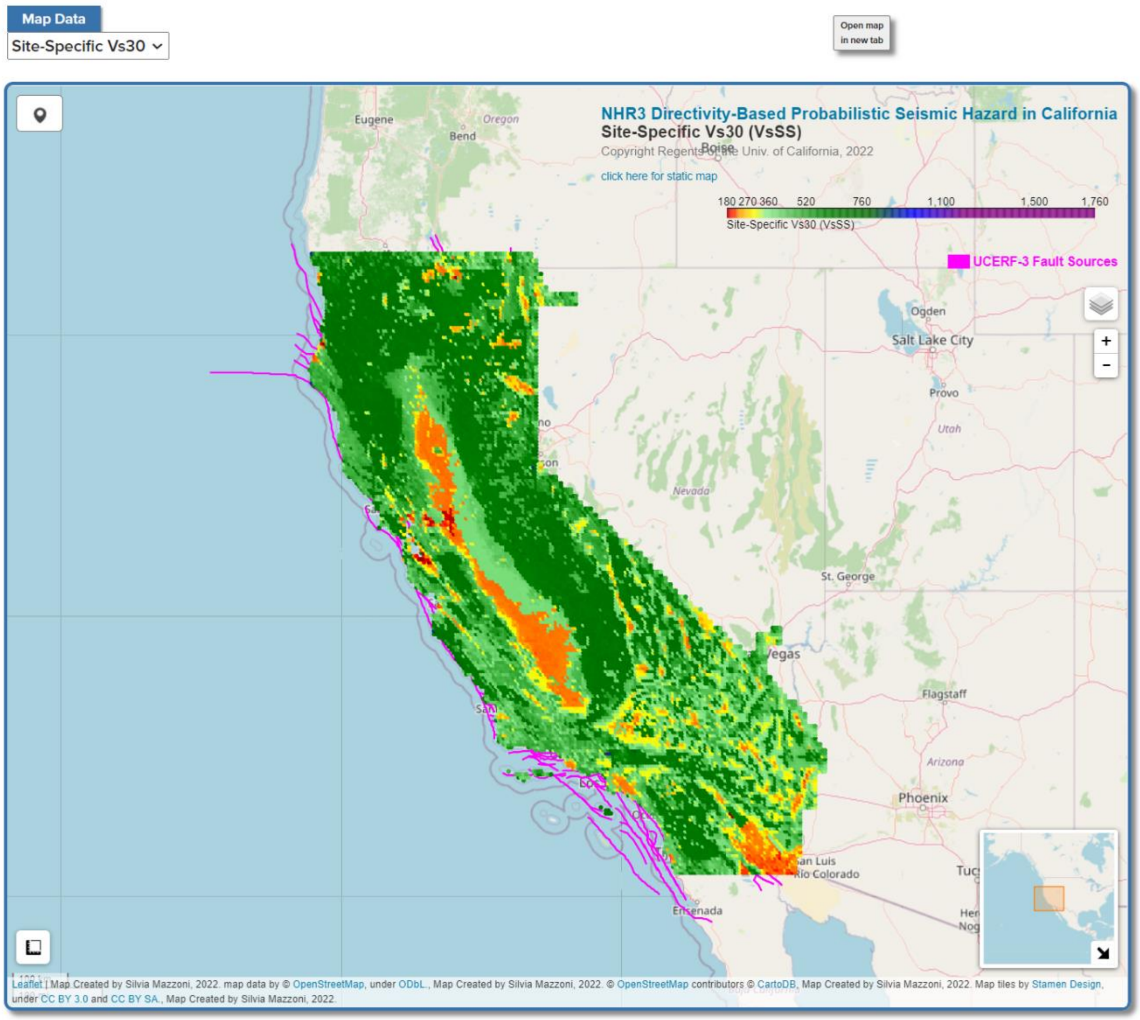


Figure 7.9. Interactive map of site-specific Vs30.

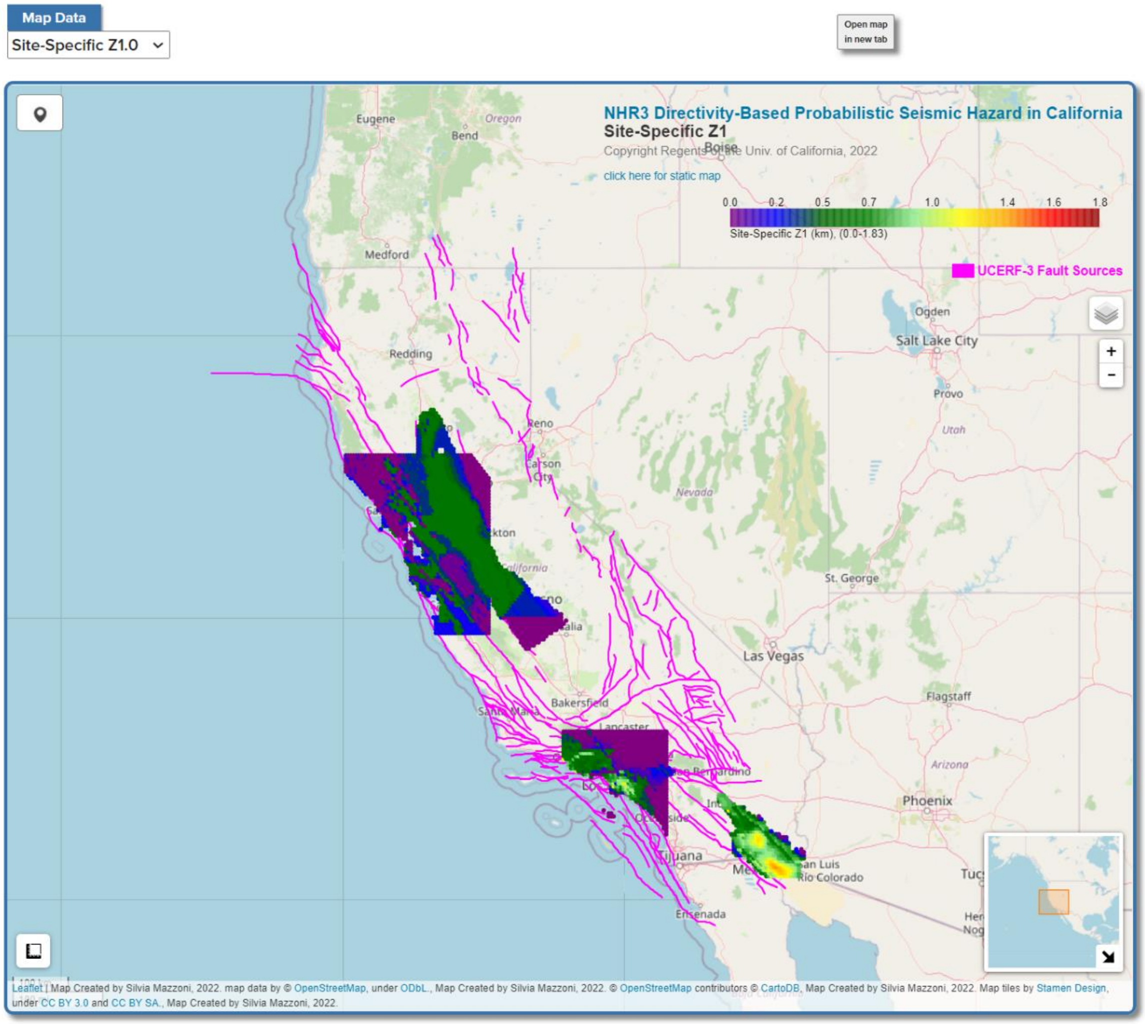


Figure 7.10. Interactive map of site-specific Z1.0.

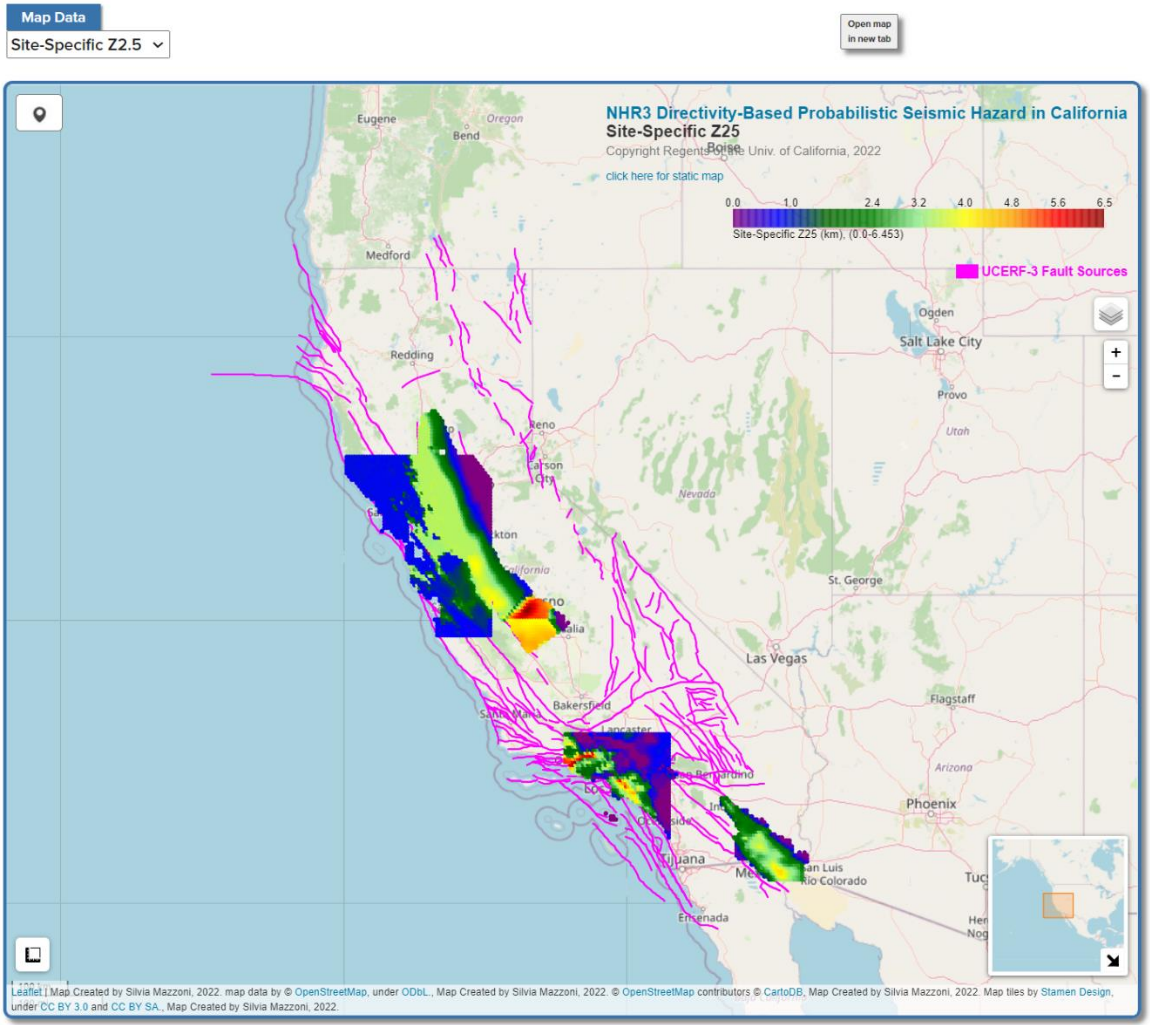


Figure 7.11. Interactive map of site-specific Z2.5.

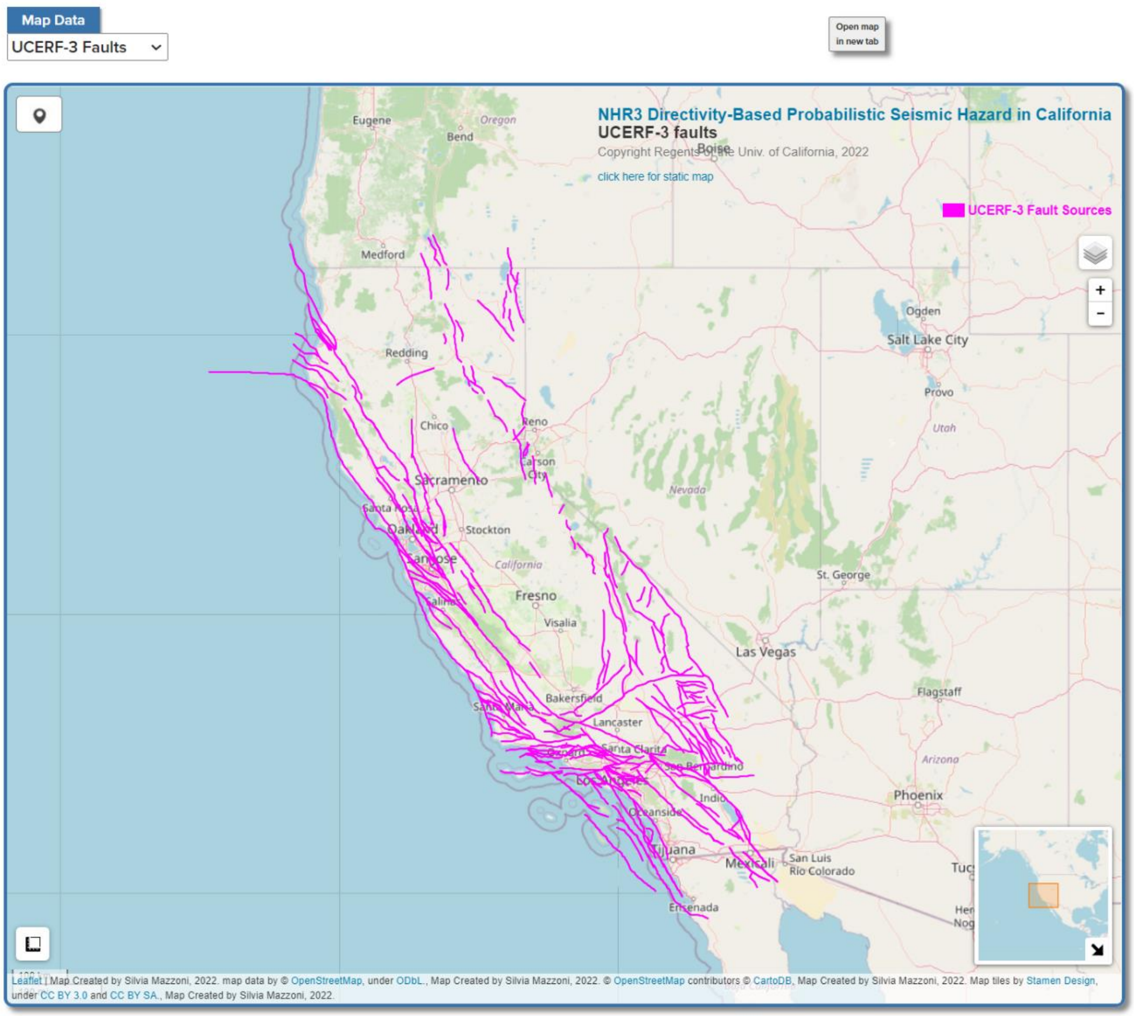


Figure 7.12. Interactive map of UCERF-3 Fault Sources.

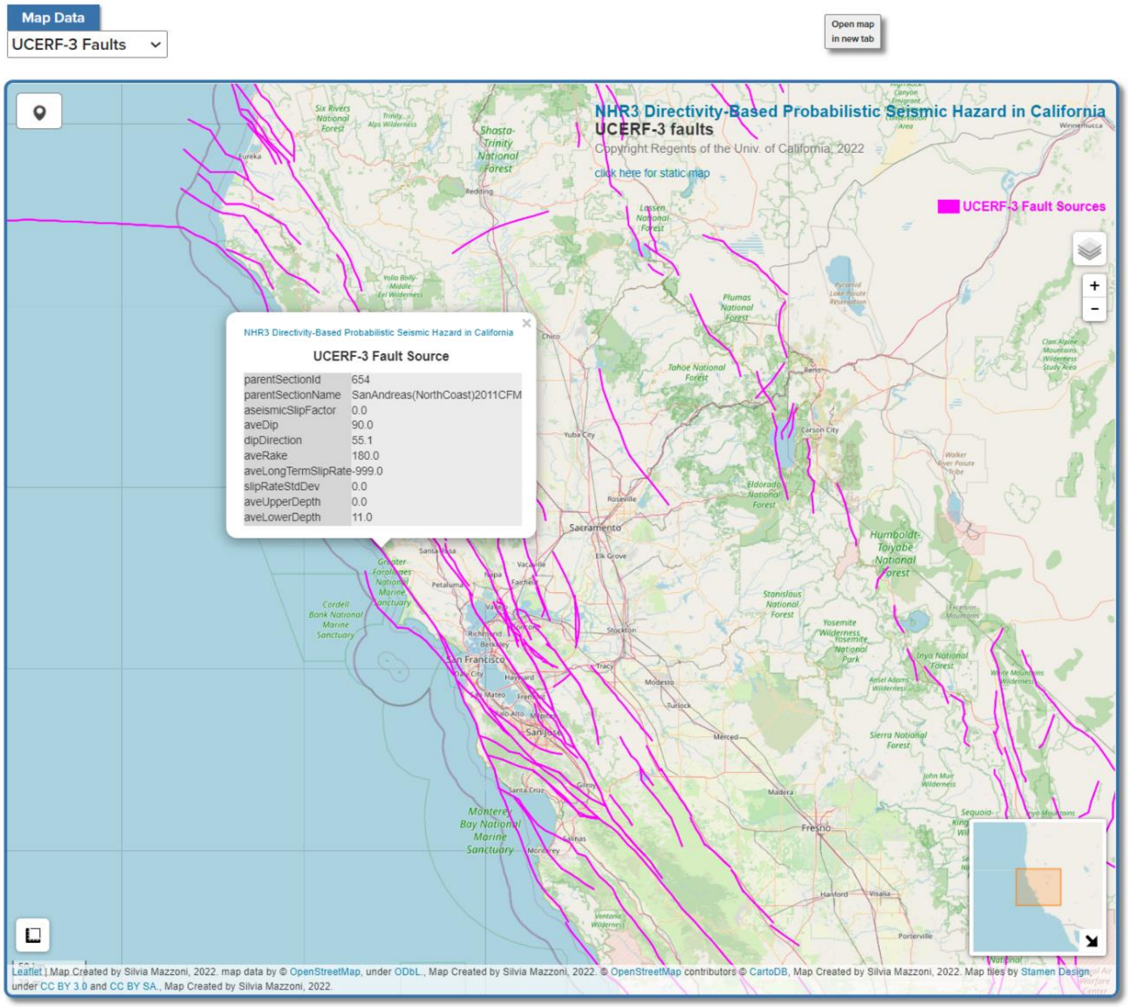


Figure 7.13. Interactive map of UCERF-3 Fault Sources: clicking on a fault.

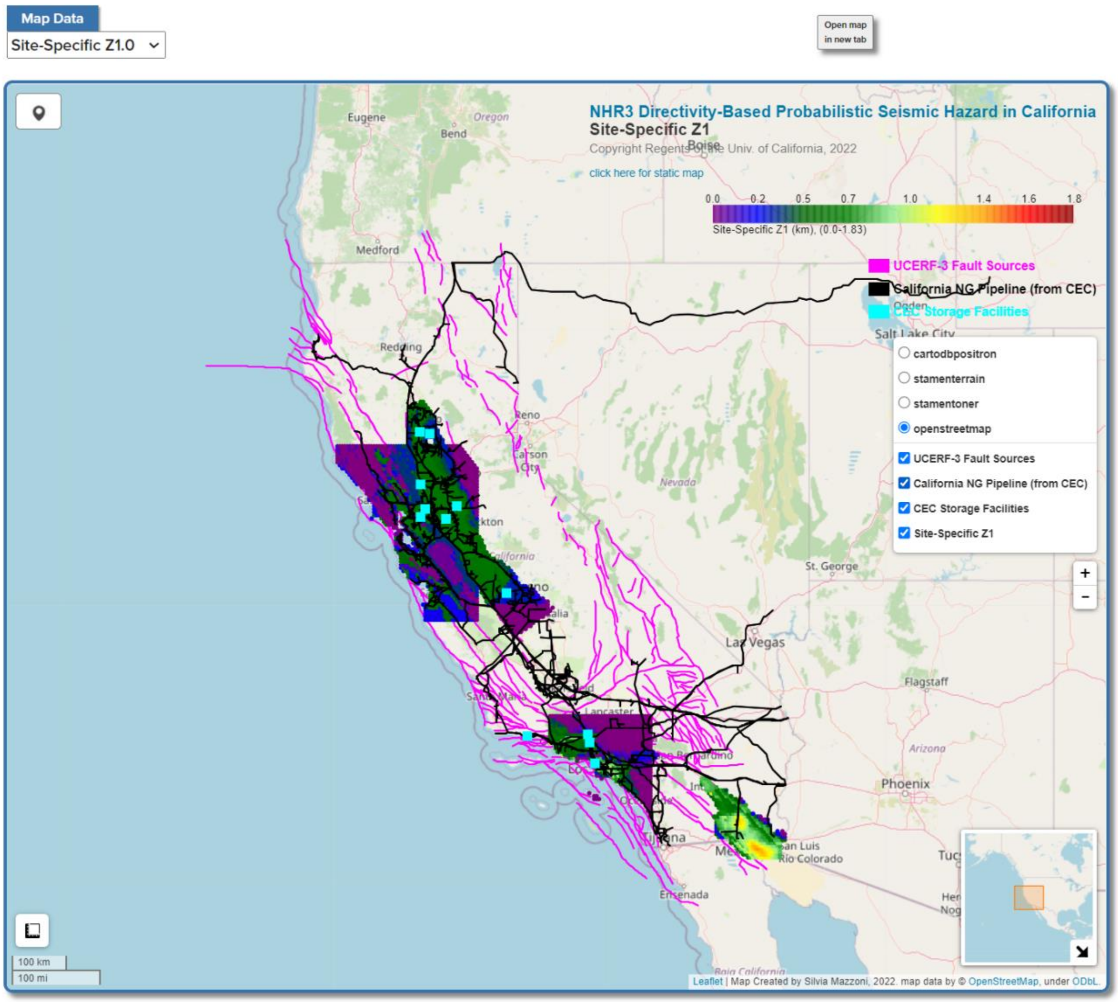


Figure 7.14. Additional-data layers.

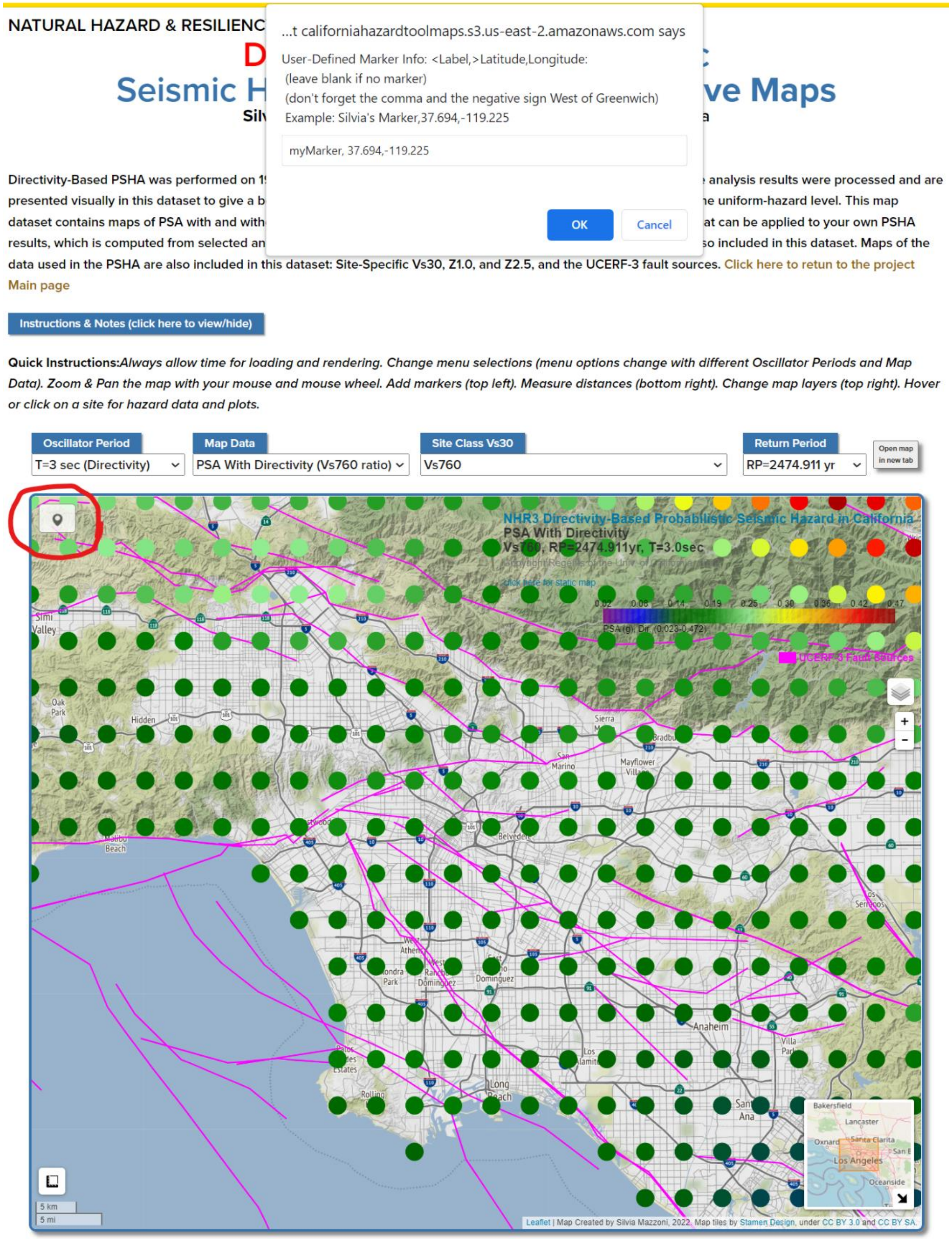


Figure 7.15. Add-marker option (click on button circled in red in the figure, and enter data in the pup-up window).

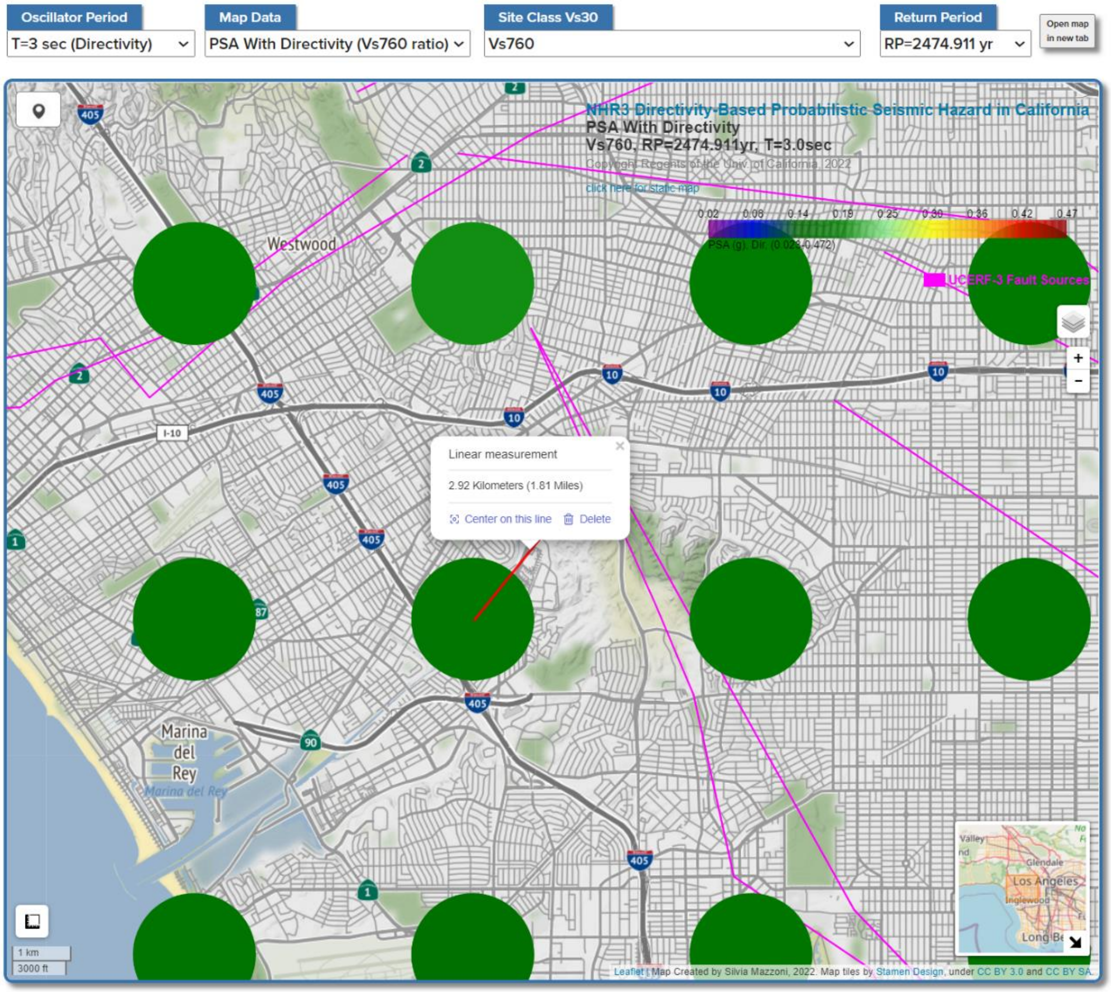


Figure 7.16. Add distance metrics option (click on lower-left button in the figure and enter data in the pup-up window).

8 Directivity-Based PSHA Interactive Tool

The Directivity-Based PSHA Interactive Tool is an on-line web tool that interpolates the state-wide PSHA results to provide uniform-hazard spectra for PSA with and without directivity, as well as for the directivity adjustment factor, at a user-specified location, Vs30, and return period. The tool's opening page is shown in Figure 8.1, and it can be accessed via the project's web site: https://www.risksciences.ucla.edu/nhr3/california-directivity. A description of the data is given in that main page and detailed instructions on how to use the tool and information about the required input are given in the instructions block on the tool's landing page. We recommend the user review these instructions the first time they access the web site.

As shown in Figure 8.1, the primary input parameters are the site location and Vs30. If the user-defined location and Vs30 do not fall on a study site, the web tool computes the Uniform-Hazard Spectra with and without directivity at the user site by interpolating the data from the nearest sites and Vs30. If the site is aligned with the study sites in either longitude or latitude, the two nearest sites are used, otherwise the four nearest sites are used in the interpolation. The tool performs interpolations on the no-directivity PSA and the directivity-adjustment factor separately.

Once it determines the location(s) of the nearest site(s), the program interpolates the no-directivity PSA values for all periods at each site for the user-defined Vs30. This Vs30 interpolation is performed in log space.

Once the PSA values are computed at each site for the same Vs30, when the user site does not fall on a study site, two no-directivity uniform-hazard spectra are computed: a spatially-weighted average spectrum, and an envelope spectrum. The spatially-weighted average is computed by assigning a relative weight to each nearby site equal to the inverse of the distance from the user-defined site and adding them up. The envelope spectrum is computed by taking the maximum no-directivity PSA of the nearby sites for each period. The envelope spectrum is, by definition, the more conservative estimate of the hazard at the user site. When 4 sites are used in the interpolation, the web tool computes the coefficient of variation of PSA between the four sites for the case of Vs30=760m/s, return period=2475, averaged over the period range of 0.1-2 seconds. When this COV is greater than or equal to 0.06, the program automatically selects the envelope spectrum as the baseline no-directivity UHS, while it selects the spatially-weighted average if the value of 0.06 is not exceeded, as shown in Figure 8.2. The web tool, however, does allow the user to select either of these UHS or the one from any of the other sites to be the baseline line no-directivity spectrum that will be adjusted to account for directivity, as shown in the pop-up menu Figure 8.3. Once the user makes a new selection the tool recomputes the with-directivity spectra based on this selection.

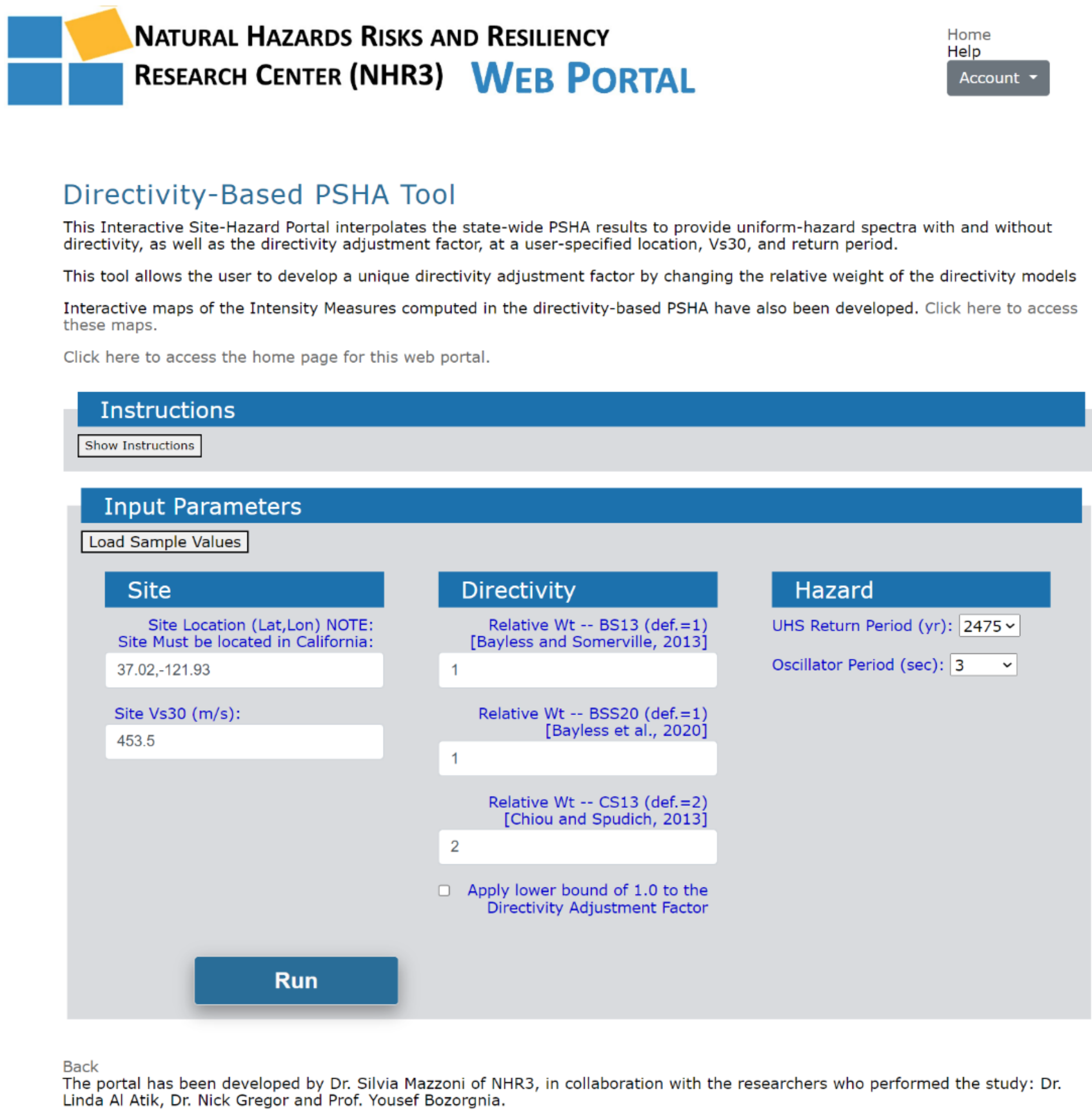


Figure 8.1. Main page for Directivity-Based PSHA Web Tool.

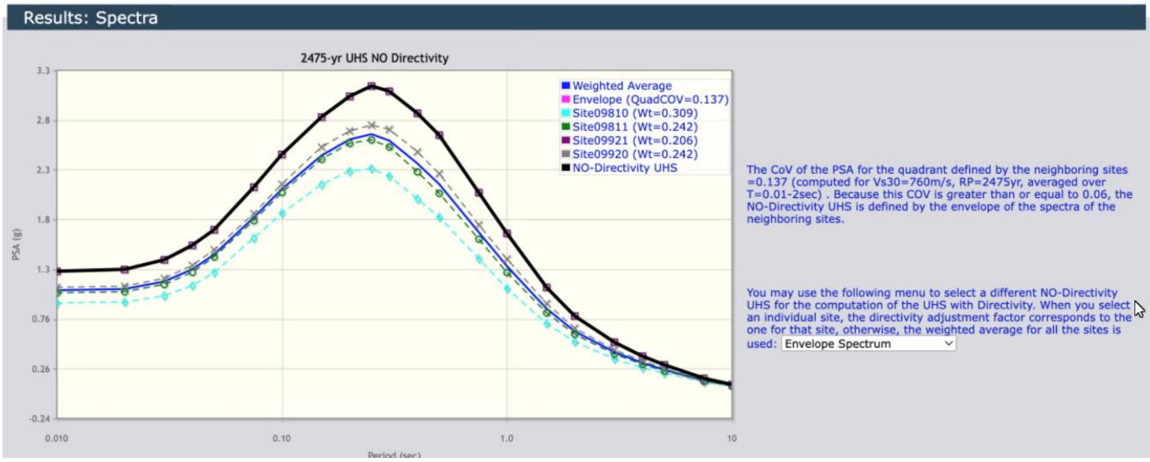


Figure 8.2. No-Directivity UHS computed by Interactive PSHA Web Tool.

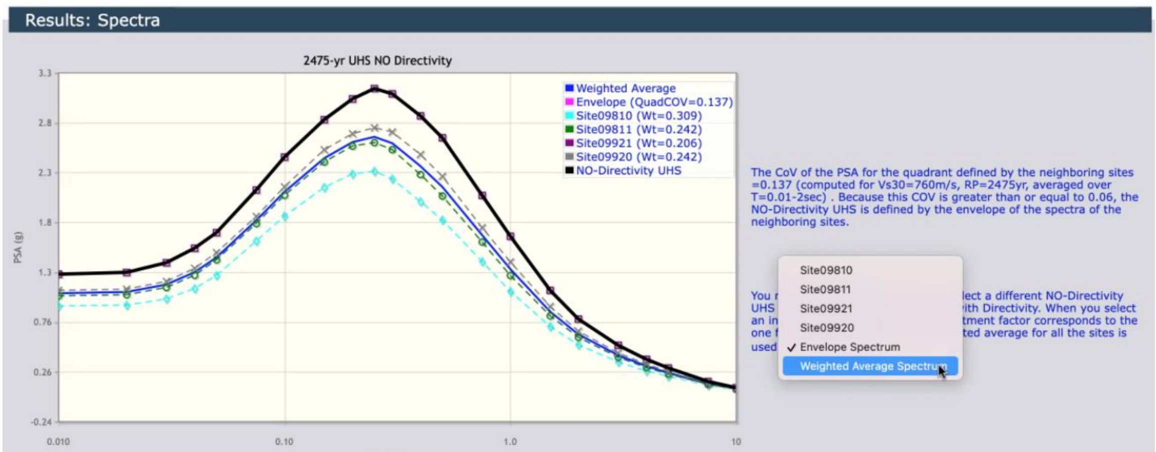


Figure 8.3. User selection for No-Directivity UHS in Interactive PSHA Web Tool.

The directivity-adjustment factor for each directivity model, on the other hand, is computed for each site at Vs30=760m/s, unless it is available for other Vs30, in which case it is interpolated at the user-defined Vs30. The directivity-adjustment factor at the user-defined site is then computed from the spatially-weighted average of each neighboring site, where the weight is proportional to the inverse of the distance between each study site and the user-defined site. This factor is used whether the user selects the envelope of the weighted average for the baseline no-directivity UHS. When the user selects a study-site for the no-directivity UHS, the tool uses the directivity-adjustment factors for that site.

As shown in Figure 8.1, the relative weights of the individual directivity models are defined by the user – the values used by the project study presented in the companion reports are provided as default values. These values are used to compute the weighted-average directivity-adjustment factor that is used by the program to compute the with-directivity PSHA Uniform-Hazard Spectrum at the user site, as shown in Figure 8.4. The user also has the option to set a lower bound of 1.0 for the directivity-amplification factor. The directivity-adjustment factors, as well as their corresponding UHS, are also displayed graphically, as shown in Figure 8.4.

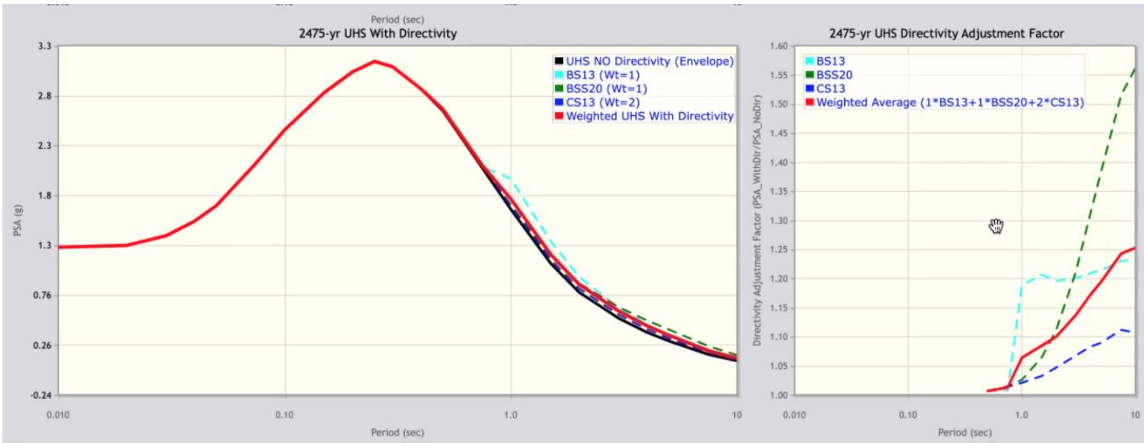


Figure 8.4. With-Directivity UHS in Interactive PSHA Web Tool.

The user can iterate on the relative weights of the directivity models. However, to select new values for the other input parameters, the user needs to start a new project, as shown in Figure 8.5.

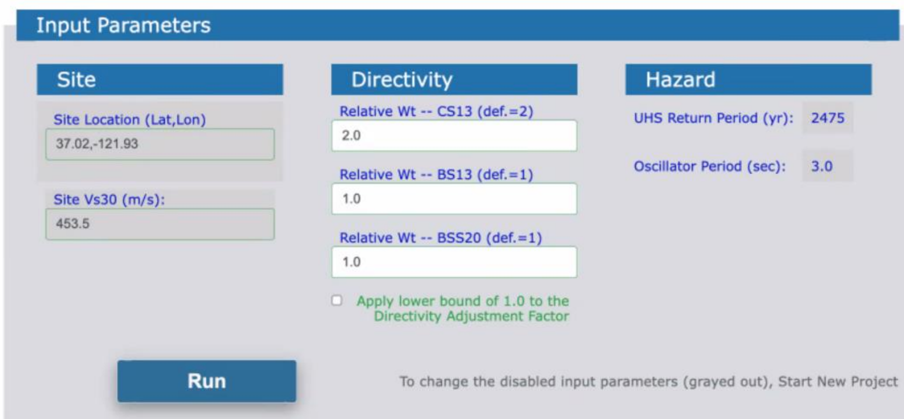


Figure 8.5. Updating input parameters in Interactive PSHA Web Tool.

To enable the user to select the most appropriate input parameters and baseline no-directivity spectra, the Interactive PSHA Web Tool provides two interactive maps, as shown in Figure 8.6. The first map shows the location of the user-defined site, as well as the UCERF-3 fault sources, overlaid on top of a google map so that the user may visualize the geographic features in the area. If the user-defined site does not correspond to a study site, the two or four nearby sites used for interpolation are also shown in the map. The second interactive map displays the statewide intensity measure defined by the user input. The user may add their site location to this map and compute distances. Both interactive maps provide data when the user hovers over a marker or clicks on it.

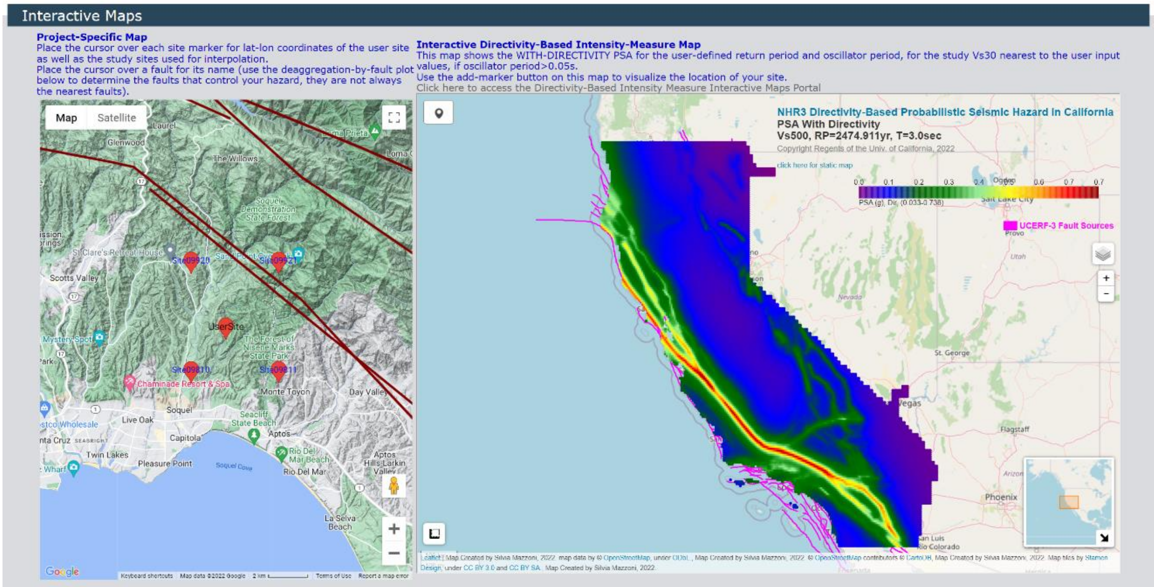


Figure 8.6. Interactive maps in PSHA Web Tool.

The Interactive PSHA Web tool also provides numerical-results tables of the data it computes and presents in the graphs. The user may either copy the results and paste them elsewhere or may download a .csv file containing all the input parameter and output values. The layout of the data tables is shown in Figure 8.7.

Numerical Results

Site Data -- User Input:

Site Location (Lat,Lon):	37.02,-121.93
Site Vs30 (m/s):	453.5
UHS Return Period (yr):	2474.911
Oscillator Period (sec):	3.0
Apply lower bound of 1.0 to the Directivity Adjustment Factor (1=yes,0=no):	0

Site Data:

Site-Quadrant UHS PSA-COV (avg over 0.01-2sec): 0.137 -- NO-Directivity Envelope UHS is used when this quantity>=0.06, NO-Directivity Weighted Average UHS is used otherwise

Interpolation-Quadrant Data:

Corner-Site Label:	Site09810	Site09811	Site09921	Site09920
Corner-Site Latitude:	37.0	37.0	37.05	37.05
Corner-Site Longitude:	-121.95	-121.9	-121.9	-121.95
Corner-Site VsSS:	475.35	480.79	495.4	455.25
Corner-Site Geometric Weight:	0.309	0.242	0.206	0.242
Corner-Site Vs30 Interpolation list:	"Vs400", "VsSS"	"Vs400", "VsSS"	"Vs400", "VsSS_ZSS"	"Vs400", "VsSS"
*Corner-Site Z1.0 (km) for each Vs30 used in interpolation:	0.361, 0.268	0.361, 0.262	0.361, 0.244	0.361, 0.293
*Corner-Site Z2.5 (km) for each Vs30 used in interpolation:	1.265, 1.038	1.265, 1.025	1.265, 1.02	1.265, 1.091
Corner-Site Directivity-Amp Vs30:	Vs760	Vs760	Vs760	Vs760

*Click here to access the interactive maps of the estimated site-specific Vs30 values for the study sites: Vs30 Interactive Map
** Site-Specific Z values were estimated for a limited number of sites.
For the sites where the estimated site-specific Z values were available, the analysts did not allow the Z values used in the PSHA analysis to be shallower than the default value associated with the site-specific Vs30:
Z_psha = max {mapped Site-Specific Estimated Z where available, Vs-30 estimated default Z}.
Click on the following links to access the interactive maps of the estimated site-specific Z1.0 and Z2.5 values for the study sites: Z1.0 Interactive Map and Z2.5 Interactive Map

UHS NO Directivity:

UHS Period (s):	0.01	0.02	0.03	0.04	0.05	0.075	0.1	0.15	0.2	0.25	0.3	0.4	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	7.5	10.0	PGV (cm/s)
Site09810	0.921	0.929	0.991	1.095	1.226	1.572	1.822	2.11	2.245	2.272	2.195	1.967	1.783	1.366	1.066	0.714	0.53	0.358	0.267	0.213	0.123	0.078	107.246
Site09811	1.022	1.033	1.106	1.228	1.383	1.747	2.031	2.366	2.525	2.56	2.489	2.239	2.024	1.562	1.226	0.821	0.606	0.406	0.303	0.238	0.135	0.085	124.267
Site09921	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.608	2.03	1.62	1.077	0.789	0.526	0.385	0.298	0.162	0.1	165.981
Site09920	1.077	1.089	1.167	1.298	1.456	1.819	2.116	2.488	2.649	2.709	2.666	2.44	2.221	1.706	1.362	0.915	0.667	0.449	0.337	0.261	0.146	0.091	140.098
Weighted Average NO-Directivity UHS (g):	1.048	1.06	1.135	1.258	1.407	1.778	2.064	2.402	2.564	2.617	2.553	2.323	2.115	1.631	1.29	0.863	0.635	0.426	0.317	0.248	0.139	0.088	131.308
Envelope NO-Directivity UHS (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.608	2.03	1.62	1.077	0.789	0.526	0.385	0.298	0.162	0.1	165.981
NO-Directivity UHS (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.608	2.03	1.62	1.077	0.789	0.526	0.385	0.298	0.162	0.1	165.981

***NOTE**: Recommended UHS NO Directivity: Envelope Spectrum -- Quadrant average PSA-COV>=0.06*

Directivity Adjustment Factors:

Directivity-Model Period (s):	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	7.5	10.0
Directivity-Model BS13 (Wt=1.0):	1.007	1.008	1.188	1.207	1.196	1.201	1.209	1.215	1.23	1.234
Directivity-Model BSS20 (Wt=1.0):	1.007	1.015	1.026	1.065	1.111	1.213	1.311	1.385	1.516	1.562
Directivity-Model CS13 (Wt=2.0):	1.007	1.014	1.021	1.033	1.047	1.068	1.083	1.09	1.112	1.107
Weighted Directivity Amplification Ratio:	1.007	1.013	1.064	1.085	1.1	1.138	1.172	1.195	1.243	1.253

UHS With Directivity:

UHS Period (s):	0.01	0.02	0.03	0.04	0.05	0.075	0.1	0.15	0.2	0.25	0.3	0.4	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	7.5	10.0	PGV (cm/s)
UHS NO Directivity (Envelope) (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.608	2.03	1.62	1.077	0.789	0.526	0.385	0.298	0.162	0.1	165.981
Directivity-Model BS13 (Wt=1.0) (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.046	1.925	1.3	0.944	0.632	0.465	0.362	0.199	0.123	165.981
Directivity-Model BSS20 (Wt=1.0) (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.06	1.662	1.147	0.877	0.638	0.505	0.413	0.246	0.156	165.981
Directivity-Model CS13 (Wt=2.0) (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.058	1.654	1.113	0.826	0.562	0.417	0.325	0.18	0.111	165.981
Weighted UHS With Directivity (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.056	1.724	1.168	0.868	0.598	0.451	0.356	0.201	0.125	165.981

Download Project Results

Figure 8.7. Data Tables in Interactive PSHA Web Tool.

The seismic-hazard deaggregation data for the study sites used in the interpolation by the Interactive PSHA Web Tool are also provided by the tool for the case of no directivity, as shown in Figure 8.8. The deaggregation data consists of three graphs: Magnitude-Distance bins, source-type hazard curves, and Crustal-fault hazard curves. When more than one site is used, the user may visualize each site by clicking on the tab corresponding to each site, as shown in Figure 8.8.

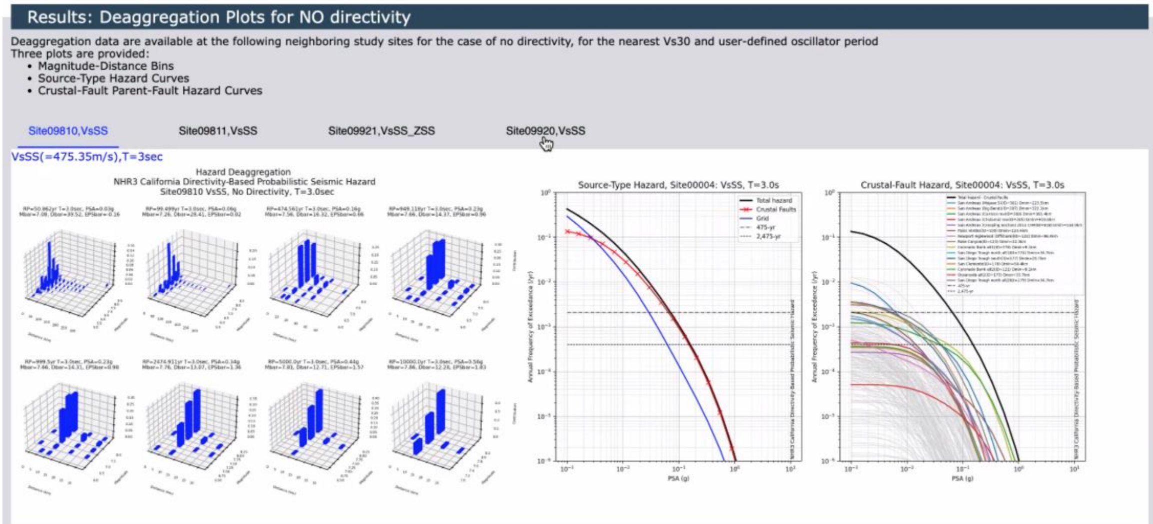
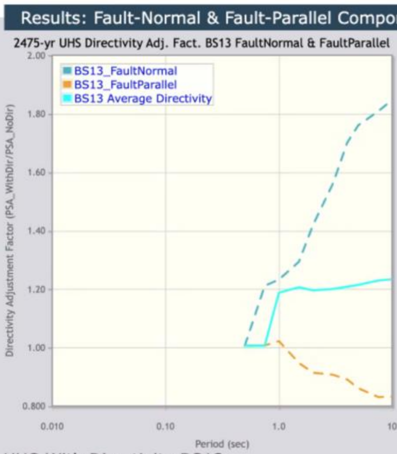


Figure 8.8. Deaggregation data in Interactive PSHA Web Tool.

The Interactive PSHA Web Tool also provides the Fault-Normal and Fault-Parallel component data from the BS-13 model, as presented in the companion reports. As shown in Figure 8.9, the tool provides tabulated values of the adjustment factors for these components as well as the UHS values.

Results: Fault-Normal & Fault-Parallel Components for BS-13



BS-13 Fault-Normal & Fault-Parallel Directivity Adjustment Factors:

Directivity-Model Period (s):	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	7.5	10.0
Directivity-Model BS13_FaultNormal:	1.007	1.212	1.233	1.294	1.42	1.562	1.701	1.76	1.808	1.847
Directivity-Model BS13_FaultParallel:	1.007	1.008	1.023	0.948	0.915	0.908	0.892	0.862	0.832	0.833
Directivity-Model BS13 Average Directivity:	1.007	1.008	1.188	1.207	1.196	1.201	1.209	1.215	1.23	1.234

UHS With Directivity BS13:

UHS Period (s):	0.01	0.02	0.03	0.04	0.05	0.075	0.1	0.15	0.2	0.25	0.3	0.4	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	7.5	10.0
UHS NO Directivity (Envelope) (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.608	2.03	1.62	1.077	0.789	0.526	0.385	0.298	0.162	0.1
Directivity-Model BS13 Average Directivity (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.046	1.925	1.3	0.944	0.632	0.465	0.362	0.199	0.123
Directivity-Model BS13_FaultNormal (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.46	1.997	1.394	1.12	0.822	0.655	0.524	0.293	0.185
Directivity-Model BS13_FaultParallel (g):	1.239	1.257	1.354	1.5	1.656	2.084	2.414	2.79	2.998	3.102	3.049	2.828	2.626	2.046	1.657	1.021	0.722	0.478	0.343	0.257	0.135	0.083

Figure 8.9. Fault-Normal and Fault-Parallel Component Data in Interactive PSHA Web Tool.

9 Summary

The directivity-based state-wide PSHA study has produced a vast amount of valuable data. The objective of this phase of the project, summarized in this report, was to ensure that these data would be accessible in a productive manner.

The web tools have been developed in such a manner that the user may use the complete dataset or just parts of it. The output of PSHA results have been separated into two main quantities: Directivity-based PSA and Directivity-Adjustment factors. The user is able to compute the with-directivity PSA values at any California location, for any Vs30 and return periods. Directivity-adjustment factors can be obtained from the interactive web tools and be applied directly to the user-defined spectrum to computed PSA with directivity.

The Web Tools, as well as the data tables, can be accessed via the Dataset main page: https://www.risksciences.ucla.edu/nhr3/california-directivity.

10 References

Al Atik, L, N. Gregor, Y. Bozorgnia. S. Mazzoni (2022). Directivity-Based Probabilistic Seismic Hazard Analysis for the State of California: Report 1, No-Directivity Baseline Case. Civil and Environmental Engineering Department and Natural Hazards Risk and Resiliency Research Center, University of California, Los Angeles.

Al Atik, L, N. Gregor, Y. Bozorgnia. S. Mazzoni (2023). Directivity-Based Probabilistic Seismic Hazard Analysis for the State of California: Report 2. Civil and Environmental Engineering Department and Natural Hazards Risk and Resiliency Research Center, University of California, Los Angeles.

11 Appendix A. Dataset Tables: sample file content and format

11.1 Hazard-Curve Data: Initial Collection and Processing (.out3 output)

Table 11.1. Hazard-Curve Data: Initial Collection and Processing

First Filename	SourceHazardData_SourceHazard_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	SourceHazardData_SourceHazard_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78
Sample File Content	-- sample key: Site15022 ->Vs1100:<HDF5 group "/Site15022/Vs1100" (23 members)> ->PGV:<HDF5 group "/Site15022/Vs1100/PGV" (11 members)> +attr: FaultCases 0 +attr: NFaults 60 +attr: Period -1.0 +attr: PeriodLabel -1.0 +attr: SiteLatitude 39.9 +attr: SiteLongitude -123.95 +attr: iProb 1 +attr: nAmp 20 +attr: nAtten 1 ->AmpList:<HDF5 dataset "AmpList": shape (20,), type "<f4"> ->D_bar:<HDF5 dataset "D_bar": shape (20,), type "<f4"> ->Eps_bar:<HDF5 dataset "Eps_bar": shape (20,), type "<f4"> ->HazardData:<HDF5 dataset "HazardData": shape (60, 20), type "<f4"> ->M_bar:<HDF5 dataset "M_bar": shape (20,), type "<f4"> ->MinDisList:<HDF5 dataset "MinDisList": shape (60,), type "<f4"> ->Poisson_Prob:<HDF5 dataset "Poisson_Prob": shape (20,), type "<f4"> ->SourceList:<HDF5 dataset "SourceList": shape (), type "|O"> ->Wt_Total_Events_per_yr:<HDF5 dataset "Wt_Total_Events_per_yr": shape (20,), type "<f4"> ->al_WtList:<HDF5 dataset "al_WtList": shape (60,), type "<f4"> ->pSegList:<HDF5 dataset "pSegList": shape (60,), type "<f4">

11.2 Hazard-Curve Data: Hazard Levels Only (.out3 output)

Table 11.2. Source-Hazard Data – Hazard-Levels Only

First Filename	SourceHazardData_HazardLevelsOnly_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	SourceHazardData_HazardLevelsOnly_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5

Number of Files	78
Sample File Content	-- sample key: Site15022 ->Vs1100:<HDF5 group "/Site15022/Vs1100" (23 members)> ->PGV:<HDF5 group "/Site15022/Vs1100/PGV" (1 members)> +attr: FaultCases 0 +attr: NFaults 60 +attr: Period -1.0 +attr: PeriodLabel -1.0 +attr: SiteLatitude 39.9 +attr: SiteLongitude -123.95 +attr: iProb 1 +attr: nAmp 20 +attr: nAtten 1 ->AmpList:<HDF5 dataset "AmpList": shape (20,), type "<f4">

11.3 Hazard-Curve Data: Directivity Amplification Factor (.out3 output)

Table 11.3. Source-Hazard Data – Directivity Amplification Factor

First Filename	SourceHazardData_SourceHazardDirectivityRatio_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	SourceHazardData_ SourceHazardDirectivityRatio_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78
Sample File Content	-- sample key: Site15022 ->Vs1100:<HDF5 group "/Site15022/Vs1100" (10 members)> ->T00500:<HDF5 group "/Site15022/Vs1100/T00500" (3 members)> ->Dir:<HDF5 group "/Site15022/Vs1100/T00500/Dir" (2 members)> ->Amp:<HDF5 dataset "Amp": shape (20,), type "<f4"> ->Rate:<HDF5 dataset "Rate": shape (20,), type "<f4"> ->DirectivityAmpRatio:<HDF5 group "/Site15022/Vs1100/T00500/DirectivityAmpRatio" (5 members)> ->AmpDir:<HDF5 dataset "AmpDir": shape (8,), type "<f8"> ->AmpNoDir:<HDF5 dataset "AmpNoDir": shape (8,), type "<f8"> ->DirRatio:<HDF5 dataset "DirRatio": shape (8,), type "<f8"> ->DirRatio_NoUnityLB:<HDF5 dataset "DirRatio_NoUnityLB": shape (8,), type "<f8"> ->Rate:<HDF5 dataset "Rate": shape (8,), type "<f8"> ->noDir:<HDF5 group "/Site15022/Vs1100/T00500/noDir" (2 members)> ->Amp:<HDF5 dataset "Amp": shape (20,), type "<f4"> ->Rate:<HDF5 dataset "Rate": shape (20,), type "<f4">

11.4 Hazard-Curve Data: All, No-Directivity PSA, With-Directivity PSA, and Directivity-Amplification Factors at all Sites, VS30s, and Periods (.out3 output)

Table 11.4. Source-Hazard Data – All: noDir and Dir

First Filename	SourceHazardData_SourceHazardAllDirNoDir_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	SourceHazardData_SourceHazardAllDirNoDir_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78
Sample File Content	-- sample key: Site15022 ->Vs1100:<HDF5 group "/Site15022/Vs1100" (2 members)> ->**Vs1100**:<HDF5 group "/Site15022/Vs1100/Vs1100" (23 members)> +attr: DirectivityPeriodLabelList ['T00500', 'T00750', 'T01000', 'T01500', 'T02000', 'T03000', 'T04000', 'T05000', 'T07500', 'T10000'] ->PGV:<HDF5 group "/Site15022/Vs1100/Vs1100/PGV" (9 members)> ->Amp_Directivity:<HDF5 dataset "Amp_Directivity": shape (20,), type "<f4"> ->Amp_Directivity_NoUnityLB:<HDF5 dataset "Amp_Directivity_NoUnityLB": shape (20,), type "<f4"> ->Amp_NoDirectivity:<HDF5 dataset "Amp_NoDirectivity": shape (20,), type "<f4"> ->Amp_NoDirectivity_DirRate:<HDF5 dataset "Amp_NoDirectivity_DirRate": shape (20,), type "<f4"> ->DirRatio:<HDF5 dataset "DirRatio": shape (20,), type "<f8"> ->DirRatio_NoUnityLB:<HDF5 dataset "DirRatio_NoUnityLB": shape (20,), type "<f8"> ->Rate_Directivity:<HDF5 dataset "Rate_Directivity": shape (20,), type "<f4"> ->Rate_NoDirectivity:<HDF5 dataset "Rate_NoDirectivity": shape (20,), type "<f4"> ->Rate_Ratio:<HDF5 dataset "Rate_Ratio": shape (20,), type "<f4"> …… ->**Vs760**:<HDF5 group "/Site15022/Vs1100/Vs760" (23 members)> +attr: DirectivityPeriodLabelList ['T00500', 'T00750', 'T01000', 'T01500', 'T02000', 'T03000', 'T04000', 'T05000', 'T07500', 'T10000'] ->PGV:<HDF5 group "/Site15022/Vs1100/Vs760/PGV" (9 members)> ->Amp_Directivity:<HDF5 dataset "Amp_Directivity": shape (20,), type "<f4"> ->Amp_Directivity_NoUnityLB:<HDF5 dataset "Amp_Directivity_NoUnityLB": shape (20,), type "<f4"> ->Amp_NoDirectivity:<HDF5 dataset "Amp_NoDirectivity": shape (20,), type "<f4"> ->Amp_NoDirectivity_DirRate:<HDF5 dataset "Amp_NoDirectivity_DirRate": shape (20,), type "<f4"> ->DirRatio:<HDF5 dataset "DirRatio": shape (20,), type "<f8"> ->DirRatio_NoUnityLB:<HDF5 dataset "DirRatio_NoUnityLB": shape (20,), type "<f8"> ->Rate_Directivity:<HDF5 dataset "Rate_Directivity": shape (20,), type "<f4"> ->Rate_NoDirectivity:<HDF5 dataset "Rate_NoDirectivity": shape (20,), type "<f4"> ->Rate_Ratio:<HDF5 dataset "Rate_Ratio": shape (20,), type "<f4">

11.5 Uniform-Hazard Spectra Data: Initial Collection and Processing (*UHSoutput.txt output)

Table 11.5. Uniform-Hazard Spectra Data: Initial Collection and Processing

First Filename	UHSData_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	UHSData_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78

<table>
<tr><td>Sample File Content</td><td>-- sample key: Site15022
->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (12 members)>
+attr: InputFilename Site15022/HazRuns/Vs1100/Run_UHS.txt
+attr: NHazardLevels 8
+attr: Nperiods 23
+attr: UHSdataFilename \Output_UHS_Processed/Site15022/Vs1100\Vs1100\Site15022-Vs1100-noDir-UHSoutput.txt
+attr: Version ***Version45.1***
->**AEFList**:<HDF5 dataset "AEFList": shape (8,), type "<f4">
->**AEPList**:<HDF5 dataset "AEPList": shape (8,), type "<f4">
->**AllData**:<HDF5 dataset "AllData": shape (), type "|O">
->**DistanceBar_Data_atRP**:<HDF5 group "/Site15022/Vs1100/DistanceBar_Data_atRP" (23 members)>
+attr: ReturnPeriods ['50.862' '99.499' '474.561' '949.118' '999.500' '2474.911' '5000.000' '10000.000']
->**-1.0**:<HDF5 dataset "-1.0": shape (8,), type "<f4">
...
->**10.0**:<HDF5 dataset "10.0": shape (8,), type "<f4">
->**EpsilonBar_Data_atRP**:<HDF5 group "/Site15022/Vs1100/EpsilonBar_Data_atRP" (23 members)>
+attr: ReturnPeriods ['50.862' '99.499' '474.561' '949.118' '999.500' '2474.911' '5000.000' '10000.000']
->**-1.0**:<HDF5 dataset "-1.0": shape (8,), type "<f4">
…
->**10.0**:<HDF5 dataset "10.0": shape (8,), type "<f4">
->**HazardCurves**:<HDF5 group "/Site15022/Vs1100/HazardCurves" (23 members)>
+attr: ReturnPeriods ['50.862' '99.499' '474.561' '949.118' '999.500' '2474.911' '5000.000' '10000.000']
->-1.0:<HDF5 dataset "-1.0": shape (8,), type "<f4">
…
->10.0:<HDF5 dataset "10.0": shape (8,), type "<f4">
->**MagnitudeBar_Data_atRP**:<HDF5 group "/Site15022/Vs1100/MagnitudeBar_Data_atRP" (23 members)>
+attr: ReturnPeriods ['50.862' '99.499' '474.561' '949.118' '999.500' '2474.911' '5000.000' '10000.000']
->-1.0:<HDF5 dataset "-1.0": shape (8,), type "<f4">
…
->10.0:<HDF5 dataset "10.0": shape (8,), type "<f4">
->**PeriodList**:<HDF5 dataset "PeriodList": shape (23,), type "<f4">
->**RP_yrList**:<HDF5 dataset "RP_yrList": shape (8,), type "<f4">
->**ResponseSpectra**:<HDF5 group "/Site15022/Vs1100/ResponseSpectra" (8 members)>
+attr: PeriodList [0.01 0.02 0.03 0.04 0.05 0.075 0.1 0.15 0.2 0.25 0.3 0.4 0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10. -1.]
->10000.000:<HDF5 dataset "10000.000": shape (23,), type "<f4">
…
->999.500:<HDF5 dataset "999.500": shape (23,), type "<f4">
->**ReturnPeriods**:<HDF5 dataset "ReturnPeriods": shape (), type "|O">
->**TestingLevels**:<HDF5 dataset "TestingLevels": shape (8,), type "<f4"></td></tr>
</table>

11.6 Uniform-Hazard Spectra Data: Deaggregation Data (*UHSoutput.txt output)

Table 11.6. Uniform-Hazard Spectra Data: Deaggregation Data

<table>
<tr><td>First Filename</td><td>DeaggrData _250sitesInFile_Site00001toSite00250.HDF5</td></tr>
<tr><td>Last Filename</td><td>DeaggrData_250sitesInFile_Site19251toSite19316.HDF5</td></tr>
<tr><td>File Format</td><td>HDF5</td></tr>
<tr><td>Number of Files</td><td>78</td></tr>
<tr><td>Sample File Content</td><td>-- sample key: Site15022
->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (23 members)>
+attr: DeaggregationInputFile Site15022/HazRuns/Vs1100/Run_UHS.txt
+attr: InputFilename Site15022/HazRuns/Vs1100/Run_UHS.txt
+attr: NHazardLevels 8
+attr: UHSdataFilename \Output_UHS_Processed/Site15022/Vs1100\Vs1100\Site15022-Vs1100-noDir-UHSoutput.txt
+attr: Version ***Version45.1***
->**-1.0**:<HDF5 group "/Site15022/Vs1100/-1.0" (8 members)>
->**10000.0**:<HDF5 group "/Site15022/Vs1100/-1.0/10000.0" (3 members)>
+attr: AEP 0.0001
->**DeaggregationTable**:<HDF5 dataset "DeaggregationTable": shape (13, 8), type "<f8">
+attr: DeaggregationTableColumns MagnitudeBins
+attr: DeaggregationTableRows DistanceBins
->**DistanceBins**:<HDF5 dataset "DistanceBins": shape (13,), type "|O">
->**MagnitudeBins**:<HDF5 dataset "MagnitudeBins": shape (8,), type "|O">
->**2474.911**:<HDF5 group "/Site15022/Vs1100/-1.0/2474.911" (3 members)>
+attr: AEP 0.00040406
->**DeaggregationTable**:<HDF5 dataset "DeaggregationTable": shape (13, 8), type "<f8">
+attr: DeaggregationTableColumns MagnitudeBins
+attr: DeaggregationTableRows DistanceBins
->**DistanceBins**:<HDF5 dataset "DistanceBins": shape (13,), type "|O">
->**MagnitudeBins**:<HDF5 dataset "MagnitudeBins": shape (8,), type "|O"></td></tr>
</table>

11.7 Uniform-Hazard Spectra Data: Directivity Amplification Factor (*UHSoutput.txt output)

Table 11.7. UHS Data – Directivity Amplification Factor

First Filename	UHSpsaDataRatio_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	UHSpsaDataRatio_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78

Sample File Content	-- sample key: Site15022 ->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (8 members)> ->10000.000:<HDF5 group "/Site15022/Vs1100/10000.000" (3 members)> ->DirectivityRatio:<HDF5 dataset "DirectivityRatio": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->DirectivityRatio_noUnityLB:<HDF5 dataset "DirectivityRatio_noUnityLB": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->PeriodList:<HDF5 dataset "PeriodList": shape (10,), type "<f4"> ->2474.911:<HDF5 group "/Site15022/Vs1100/2474.911" (3 members)> ->DirectivityRatio:<HDF5 dataset "DirectivityRatio": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->DirectivityRatio_noUnityLB:<HDF5 dataset "DirectivityRatio_noUnityLB": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->PeriodList:<HDF5 dataset "PeriodList": shape (10,), type "<f4"> …. ->999.500:<HDF5 group "/Site15022/Vs1100/999.500" (3 members)> ->DirectivityRatio:<HDF5 dataset "DirectivityRatio": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->DirectivityRatio_noUnityLB:<HDF5 dataset "DirectivityRatio_noUnityLB": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->PeriodList:<HDF5 dataset "PeriodList": shape (10,), type "<f4"> ->**Vs180**:<HDF5 group "/Site15022/Vs180" (8 members)> ->10000.000:<HDF5 group "/Site15022/Vs180/10000.000" (3 members)> ->DirectivityRatio:<HDF5 dataset "DirectivityRatio": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->DirectivityRatio_noUnityLB:<HDF5 dataset "DirectivityRatio_noUnityLB": shape (10,), type "<f4"> +attr: PeriodList [0.5 0.75 1. 1.5 2. 3. 4. 5. 7.5 10.] ->PeriodList:<HDF5 dataset "PeriodList": shape (10,), type "<f4"> ->2474.911:<HDF5 group "/Site15022/Vs180/2474.911" (3 members)>

11.8 Uniform-Hazard Spectra Data: All -- No-Directivity PSA, With-Directivity PSA, and Directivity-Amplification Factors at all Sites, VS30s, and Periods (*UHSoutput.txt output)

Table 11.8. Source-Hazard Data – All: noDir and Dir

First Filename	UHSpsaDirectivityAll _SourceHazardAllDirNoDir_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	UHSpsaDirectivityAll _SourceHazardAllDirNoDir_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78

Sample File Content	-- sample key: **Site15022** ->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (8 members)> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] +attr: ReturnPeriods ['50.862' '99.499' '474.561' '949.118' '999.500' '2474.911' '5000.000' '10000.000'] ->**10000.000**:<HDF5 group "/Site15022/Vs1100/10000.000" (2 members)> ->**Directivity**:<HDF5 group "/Site15022/Vs1100/10000.000/Directivity" (2 members)> ->**Vs1100**:<HDF5 group "/Site15022/Vs1100/10000.000/Directivity/Vs1100" (4 members)> ->**DirectivityRatioList**:<HDF5 dataset "DirectivityRatioList": shape (23,), type "<f8"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**DirectivityRatioList_noLB**:<HDF5 dataset "DirectivityRatioList_noLB": shape (23,), type "<f8"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**PeriodList**:<HDF5 dataset "PeriodList": shape (23,), type "<f4"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**UHSDirectivity**:<HDF5 dataset "UHSDirectivity": shape (23,), type "<f8"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**Vs760**:<HDF5 group "/Site15022/Vs1100/10000.000/Directivity/Vs760" (4 members)> ->**DirectivityRatioList**:<HDF5 dataset "DirectivityRatioList": shape (23,), type "<f8"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**DirectivityRatioList_noLB**:<HDF5 dataset "DirectivityRatioList_noLB": shape (23,), type "<f8"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**PeriodList**:<HDF5 dataset "PeriodList": shape (23,), type "<f4"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**UHSDirectivity**:<HDF5 dataset "UHSDirectivity": shape (23,), type "<f8"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.] ->**noDirectivity**:<HDF5 group "/Site15022/Vs1100/10000.000/noDirectivity" (1 members)> ->**UHSnoDirectivity**:<HDF5 dataset "UHSnoDirectivity": shape (23,), type "<f4"> +attr: PeriodList [0.01 0.02 0.03 0.04 0.05 ... 7.5 10. -1.]

11.9 Deaggregation Data (*UHSoutput.txt output)

Table 11.9. Deaggregation Data

First Filename	DeaggrData_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	DeaggrData_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Number of Files	78

<table>
<tr><td>Sample File Content</td><td>-- sample key: Site15022
->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (23 members)>
+attr: DeaggregationInputFile Site15022/HazRuns/Vs1100/Run_UHS.txt
+attr: InputFilename Site15022/HazRuns/Vs1100/Run_UHS.txt
+attr: NHazardLevels 8
+attr: UHSdataFilename /Site15022/Vs1100\Vs1100\Site15022-Vs1100-noDir-UHSoutput.txt
+attr: Version ***Version45.1***
->**-1.0**:<HDF5 group "/Site15022/Vs1100/-1.0" (8 members)>
->**10000.0**:<HDF5 group "/Site15022/Vs1100/-1.0/10000.0" (3 members)>
+attr: AEP 0.0001
->**DeaggregationTable**:<HDF5 dataset "DeaggregationTable": shape (13, 8), type "<f8">
+attr: DeaggregationTableColumns MagnitudeBins
+attr: DeaggregationTableRows DistanceBins
->**DistanceBins**:<HDF5 dataset "DistanceBins": shape (13,), type "|O">
->**MagnitudeBins**:<HDF5 dataset "MagnitudeBins": shape (8,), type "|O">
->**2474.911**:<HDF5 group "/Site15022/Vs1100/-1.0/2474.911" (3 members)>
+attr: AEP 0.00040406
->DeaggregationTable:<HDF5 dataset "DeaggregationTable": shape (13, 8), type "<f8">
+attr: DeaggregationTableColumns MagnitudeBins
+attr: DeaggregationTableRows DistanceBins
->DistanceBins:<HDF5 dataset "DistanceBins": shape (13,), type "|O">
->MagnitudeBins:<HDF5 dataset "MagnitudeBins": shape (8,), type "|O"></td></tr>
</table>

11.10 Ground-Motion-Model Hazard Curves (*.out6 data)

Table 11.10. Ground-Motion Model Hazard Curves

<table>
<tr><td>First Filename</td><td>GMMHaz_GMMHazard_250sitesInFile_Site00001toSite00250.HDF5</td></tr>
<tr><td>Last Filename</td><td>GMMHaz_GMMHazard_250sitesInFile_Site19251toSite19316.HDF5</td></tr>
<tr><td>File Format</td><td>HDF5</td></tr>
<tr><td>Sample File Content</td><td>-- sample key: **Site15022**
->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (23 members)>
->**PGV**:<HDF5 group "/Site15022/Vs1100/PGV" (3 members)>
->**AmpList**:<HDF5 dataset "AmpList": shape (20,), type "<f4">
->**GMModelHazard**:<HDF5 dataset "GMModelHazard": shape (28, 20), type "<f4">
->**GMModelLabel**:<HDF5 dataset "GMModelLabel": shape (28,), type "<i4">
->**T00010**:<HDF5 group "/Site15022/Vs1100/T00010" (3 members)>
->**AmpList**:<HDF5 dataset "AmpList": shape (20,), type "<f4">
->**GMModelHazard**:<HDF5 dataset "GMModelHazard": shape (45, 20), type "<f4">
->**GMModelLabel**:<HDF5 dataset "GMModelLabel": shape (45,), type "<i4"></td></tr>
</table>

11.11 Directivity-Model Hazard Curves (*.out6 data)

Table 11.11. Directivity-Model Hazard Curves

<table>
<tr><td>First Filename</td><td>DirectivityModelHaz_DirModelHazard_250sitesInFile_Site00001toSite00250.HDF5</td></tr>
</table>

Last Filename	DirectivityModelHaz_DirModelHazard_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Sample File Content	-- sample key: **Site15022** ->**Vs1100**_Dir:<HDF5 group "/Site15022/Vs1100_Dir" (10 members)> ->**T00500**:<HDF5 group "/Site15022/Vs1100_Dir/T00500" (3 members)> ->**AmpList**:<HDF5 dataset "AmpList": shape (20,), type "<f4"> ->**DirectivityModelHazard**:<HDF5 dataset "DirectivityModelHazard": shape (5, 20), type "<f4"> ->**DirectivityModelLabel**:<HDF5 dataset "DirectivityModelLabel": shape (5,), type "|O"> ->**T00750**:<HDF5 group "/Site15022/Vs1100_Dir/T00750" (3 members)> ->**AmpList**:<HDF5 dataset "AmpList": shape (20,), type "<f4"> ->**DirectivityModelHazard**:<HDF5 dataset "DirectivityModelHazard": shape (5, 20), type "<f4"> ->**DirectivityModelLabel**:<HDF5 dataset "DirectivityModelLabel": shape (5,), type "|O">

11.12 Directivity-Model PSA and Directivity-Amplification Factor Hazard Curves and Uniform-Hazard Spectra (*.out6 data)

Table 11.12. Directivity-Model PSA and Directivity-Amplification Hazard Curves and UHS

First Filename	DirectivityModelHaz_DirModelHazardRatio_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	DirectivityModelHaz_DirModelHazardRatio_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5

Sample File Content	-- sample key: Site00001 ->**Vs760**:<HDF5 group "/Site00001/Vs760" (2 members)> ->**HazardCurves**:<HDF5 group "/Site00001/Vs760/HazardCurves" (10 members)> ->**T00500**:<HDF5 group "/Site00001/Vs760/HazardCurves/T00500" (5 members)> ->**BS13**:<HDF5 group "/Site00001/Vs760/HazardCurves/T00500/BS13" (3 members)> ->**Amp**:<HDF5 dataset "Amp": shape (20,), type "<f4"> ->**AmpRatio**:<HDF5 dataset "AmpRatio": shape (20,), type "<f4"> ->**Rate**:<HDF5 dataset "Rate": shape (20,), type "<f4"> ->**BS13_FaultNormal**:<HDF5 group "/Site00001/Vs760/HazardCurves/T00500/BS13_FaultNormal" (3 members)> ->**Amp**:<HDF5 dataset "Amp": shape (20,), type "<f4"> ->**AmpRatio**:<HDF5 dataset "AmpRatio": shape (20,), type "<f4"> ->**Rate**:<HDF5 dataset "Rate": shape (20,), type "<f4"> …. ->**UniformHazardSpectra**:<HDF5 group "/Site00001/Vs760/UniformHazardSpectra" (2 members)> ->**DirectivityAmpRatio**:<HDF5 group "/Site00001/Vs760/UniformHazardSpectra/ DirectivityAmpRatio" (8 members)> ->**10000.000**:<HDF5 group "/Site00001/Vs760/UniformHazardSpectra/DirectivityAmpRatio/10000.000" (5 members)> ->**BS13**:<HDF5 dataset "BS13": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0'] ->**BS13_FaultNormal**:<HDF5 dataset "BS13_FaultNormal": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0'] ->**BS13_FaultParallel**:<HDF5 dataset "BS13_FaultParallel": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0'] ->**BSS20**:<HDF5 dataset "BSS20": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0'] ->**CS13**:<HDF5 dataset "CS13": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0'] …. ->**PSA_Dir**:<HDF5 group "/Site00001/Vs760/UniformHazardSpectra/PSA_Dir" (8 members)> ->**10000.000**:<HDF5 group "/Site00001/Vs760/UniformHazardSpectra/PSA_Dir/10000.000" (5 members)> ->**BS13**:<HDF5 dataset "BS13": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0'] ->**BS13_FaultNormal**:<HDF5 dataset "BS13_FaultNormal": shape (10,), type "<f4"> +attr: SpectralPeriods ['0.5' '0.75' '1.0' '1.5' '2.0' '3.0' '4.0' '5.0' '7.5' '10.0']

11.13 Parent-Fault Hazard Data (*.out7 data)

Table 11.13. Parent-Fault Hazard Data

First Filename	ParentSourceHazardData_ParentSourceHazard_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	ParentSourceHazardData_ParentSourceHazard_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5

Sample File Content	-- sample key: **Site15022** ->**Vs1100**:<HDF5 group "/Site15022/Vs1100" (23 members)> ->**PGV**:<HDF5 group "/Site15022/Vs1100/PGV" (8 members)> +attr: AttenuationTag 1 +attr: Period -1.0 +attr: PeriodLabel PGV +attr: SiteLatitude 39.9 +attr: SiteLongitude -123.95 +attr: SiteTag 1 +attr: nAmp 20 +attr: nAtten 1 ->**AmpList**:<HDF5 dataset "AmpList": shape (20,), type "<f4"> ->**HazardData**:<HDF5 dataset "HazardData": shape (139, 20), type "<f4"> ->**MinDisList**:<HDF5 dataset "MinDisList": shape (139,), type "<f4"> ->**Poisson_Prob_Parent:<**HDF5 dataset "Poisson_Prob_Parent": shape (20,), type "<f4"> ->**SourceList**:<HDF5 dataset "SourceList": shape (139,), type "<f4"> ->**Wt_Total_Events_per_yr_Parent**:<HDF5 dataset "Wt_Total_Events_per_yr_Parent": shape (20,), type "<f4"> ->**al_WtList**:<HDF5 dataset "al_WtList": shape (139,), type "<f4"> ->**pSegList**:<HDF5 dataset "pSegList": shape (139,), type "<f4">

11.14 Parent-Fault Hazard Ratio Data (*.out7 data)

Table 11.14. Parent-Fault Hazard Ratio Data

First Filename	ParentSourceHazardData_ParentSourceHazardRatio_250sitesInFile_Site00001toSite00250.HDF5
Last Filename	ParentSourceHazardData_ParentSourceHazardRatio_250sitesInFile_Site19251toSite19316.HDF5
File Format	HDF5
Sample File Content	-- sample key: **Site00001** ->**Vs1100**:<HDF5 group "/Site00001/Vs1100" (23 members)> ->**PGV**:<HDF5 group "/Site00001/Vs1100/PGV" (5 members)> +attr: AttenuationTag 1 +attr: Period -1.0 +attr: PeriodLabel PGV +attr: SiteLatitude 32.35 +attr: SiteLongitude -117.2 +attr: SiteTag 1 +attr: nAmp 20 +attr: nAtten 1 ->**AmpList**:<HDF5 dataset "AmpList": shape (20,), type "<f4"> ->**HazardData_Ratio**:<HDF5 dataset "HazardData_Ratio": shape (214, 20), type "<f4"> ->**Poisson_Prob_Parent**:<HDF5 dataset "Poisson_Prob_Parent": shape (20,), type "<f4"> ->**SourceList**:<HDF5 dataset "SourceList": shape (214,), type "<f4"> ->**Wt_Total_Events_per_yr_Parent**:<HDF5 dataset "Wt_Total_Events_per_yr_Parent": shape (20,), type "<f4">