AELO Web Service User Guide

V1.0 2023-12-07

The AELO Web Service provides a means for users to obtain building-code ground motion parameter values for a single site. The ground-motion parameters are for use with the ASCE 7-16 and ASCE 41-17 Standards. The web service can be used programmatically via a REST API, or via a minimal web user interface.

Contents

Obtaining an Account

Accounts are assigned by the GEM IT team on an invitation only basis. If you do not have an account and feel that you should have one, please contact Paul.Henshaw@globalquakemodel.org

When an account is created for you, you will receive an email with a link to set up a password.

Using the Web User Interface

In this section we briefly describe how to use the AELO web user interface. The AELO web interface has been tested with Firefox and Chrome although it is possible that other modern browsers will work correctly.

Logging in

Open a browser and navigate to https://aelo.openquake.org, you should be presented with a page as shown below:

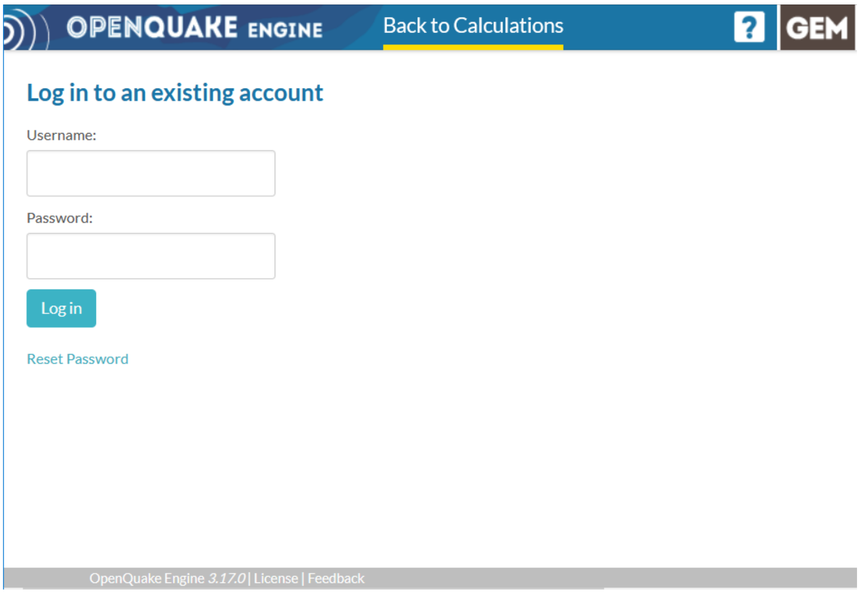


Figure 1: AELO Login page

Enter your username and password, you should now see a page with a short form for AELO calculation inputs and an initially empty list of calculations:

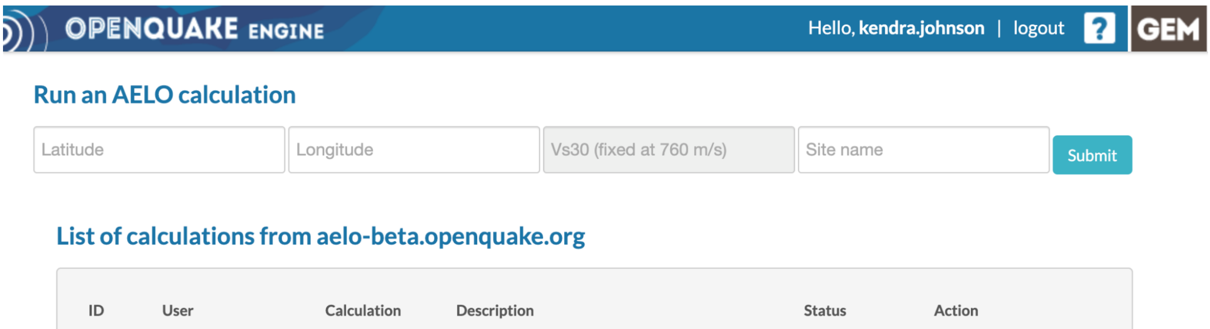


Figure 2: AELO calculation input form and empty list of calculations.

Running a calculation

In order to start an AELO calculation, we must provide the following input values:

Calculation Inputs

- Latitude: the latitude of the site (a floating point number in the interval [-90.0, +90.0])
- Longitude: the longitude of the site (a floating point number in the interval [-180, +180])

- vs30: the time-averaged shear-wave velocity from the surface to a depth of 30 meters (a positive floating point number). In the current version, this is fixed to the default value of 760 m/s. For more information about Vs30 please see https://earthquake.usgs.gov/data/vs30/
- Site name: an ID to assign to the site (the only accepted characters are a-zA-Z0-9_-:)

All four input parameters are required in order to perform an AELO calculation. Once the input values have been inserted, press the "Submit" button.

Monitoring Calculation Progress

Once a calculation has been submitted, it will appear in the list of calculations. In the example below, we can see a calculation in the process of being executed:

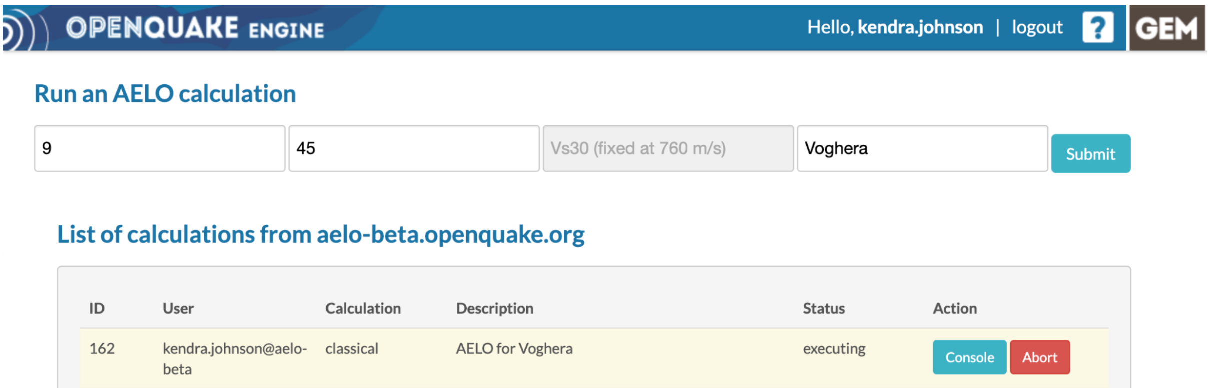


Figure 3: AELO calculation in execution

Depending on the location of the site, the calculation may take several minutes to execute. The AELO system will send you an email message when the calculation terminates, and the calculation will continue execution even if the browser tab is closed.

Once the calculation has completed successfully you can access the outputs by clicking on the "Outputs" button that appears in the web interface or by following the link in the notification email:

Figure 4: Email announcing completed job with link to outputs

Downloading Calculation Outputs

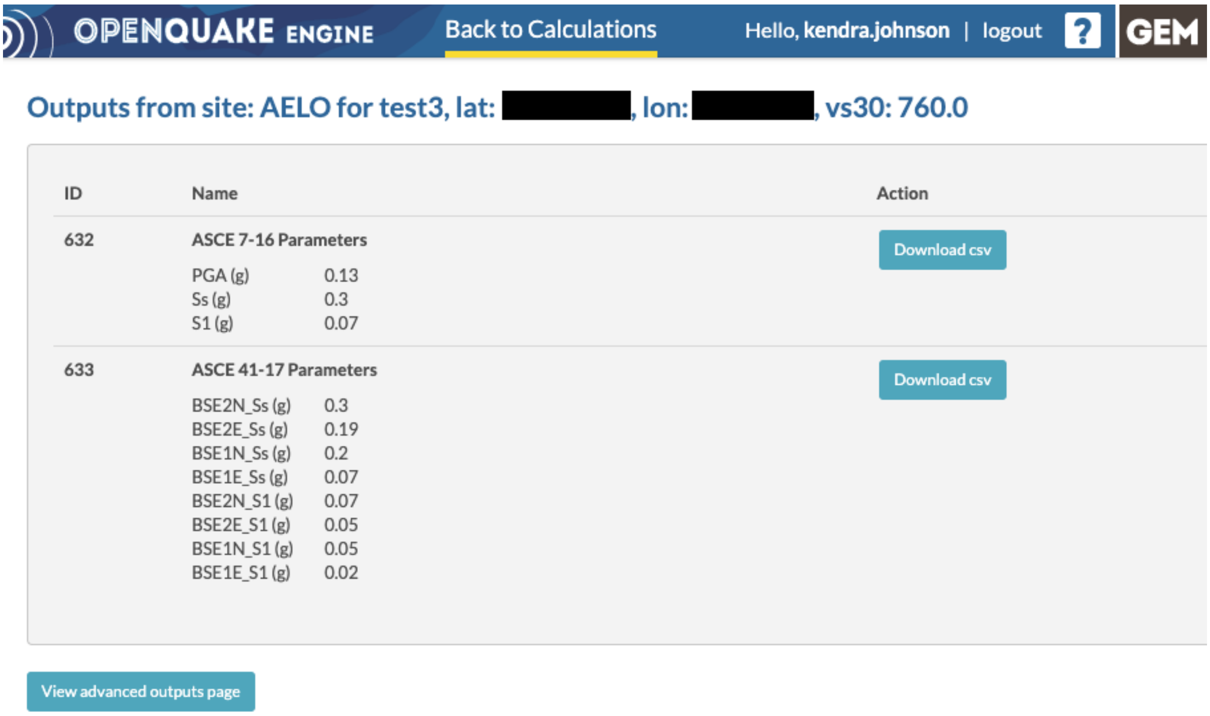


Figure 5: Calculation Outputs landing page

AELO calculations produce a number of different outputs divided into two categories: the most important outputs featured on the landing page of the "Outputs" button/link, and outputs accessible by clicking the button "View advanced outputs page" that may be interesting or useful to advanced users. The primary results - the ASCE 41-17 and ASCE 7-16 parameters - are printed within the outputs table, and are also downloadable in .csv format by clicking the "Download csv" button at right (see Figure 5). These, and all outputs, are documented in more detail in the Description of Calculation and Outputs section.

On the "Advanced outputs" page (see Figure 6), several figures can be viewed using the buttons labeled with "Show …". A figure can be saved by right-clicking the button and choosing "Save link as…". The full set of figures is included only when the deterministic part of the calculation is completed (see the Description of Calculation and Outputs section).

It is also possible to download the HDF5 datastore containing all of the calculation outputs, although we do not recommend this approach for most users since this file can be rather large and requires programming skills to interrogate effectively.

Please note also that outputs in the RST format, such as the Full Report, can sometimes contain very wide tables leading to very long lines. In order to view these files effectively, we recommend using a graphical viewer such as Microsoft WordPad which allows the user to disable automatic word wrapping.

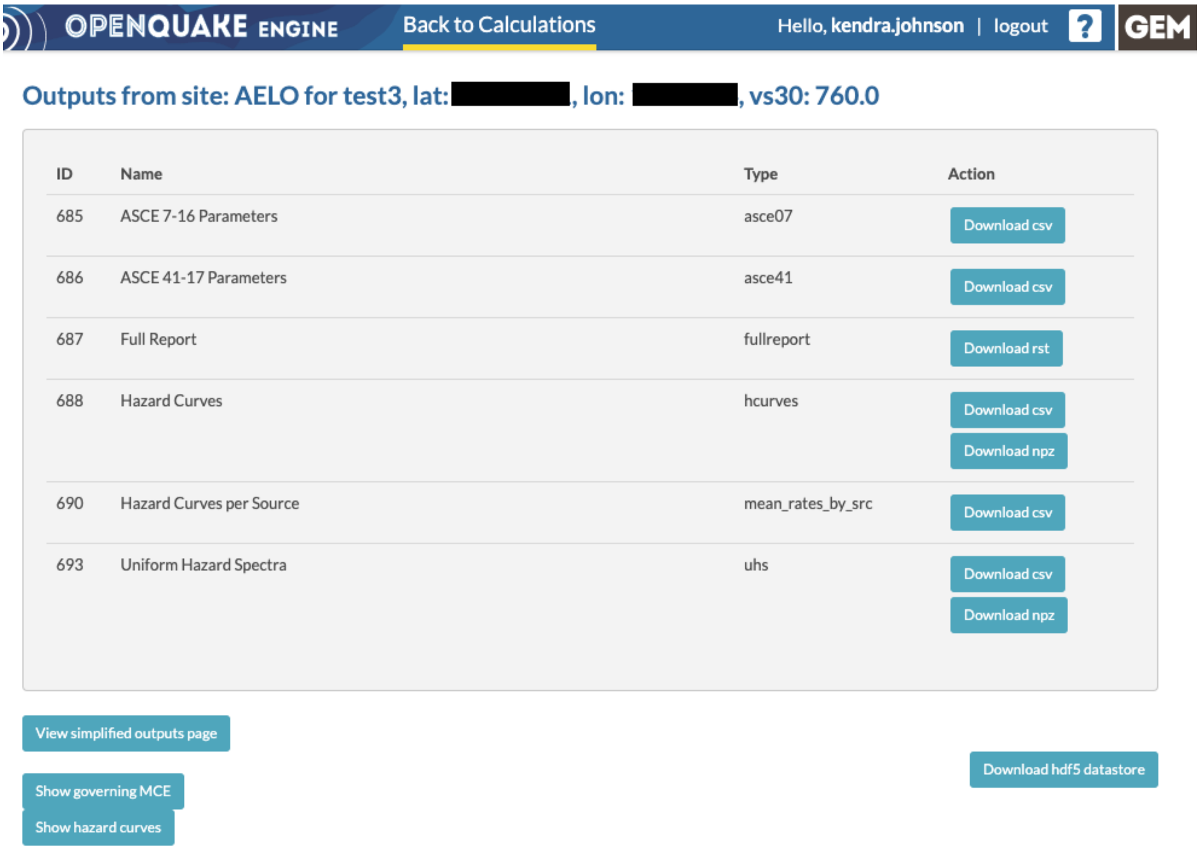
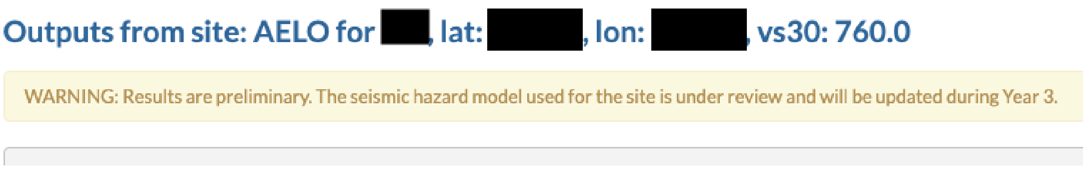


Figure 5: Advanced outputs

Output Exceptions

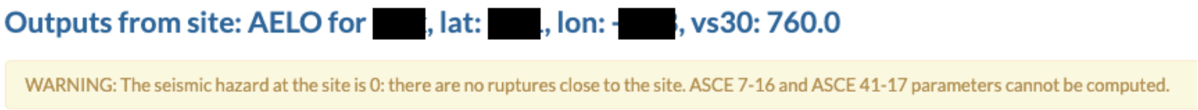
For some sites, the service cannot currently provide results, or we do not recommend using them. The reasons and the corresponding responses from the web interface are described here.

1. *The site is not covered by a hazard model in the Mosaic*: a pop-up window will indicate that the site is uncovered, and no calculation will begin
2. *The site is covered, but we do not recommend using results from the encompassing model during this phase:* the calculation completes, but the email alert and a warning bar on the main outputs page warns that the results are preliminary



3. *The calculated hazard is extremely low such that the hazard curves show 0g for probability of 1% in 50 years*: the calculation completes, but warns that the hazard was too low to compute the ASCE parameters

4. *The site is covered by a hazard model, but the model does not include sources within the maximum considered distance of the site*: the calculation completes, but warns that hazard is zero because no ruptures occurred nearby, and therefore ASCE parameters cannot be computed



QGIS Plugin

It is also possible to view and download AELO outputs using GEM's open-source IRMT plugin for the Desktop GIS tool, QGIS.
Please see the following web page for installation instructions:
https://docs.openquake.org/oq-irmt-qgis/latest/00_installation.html

Connect to AELO Web Service

Once the plugin has been installed, open the settings as shown in the figure below:

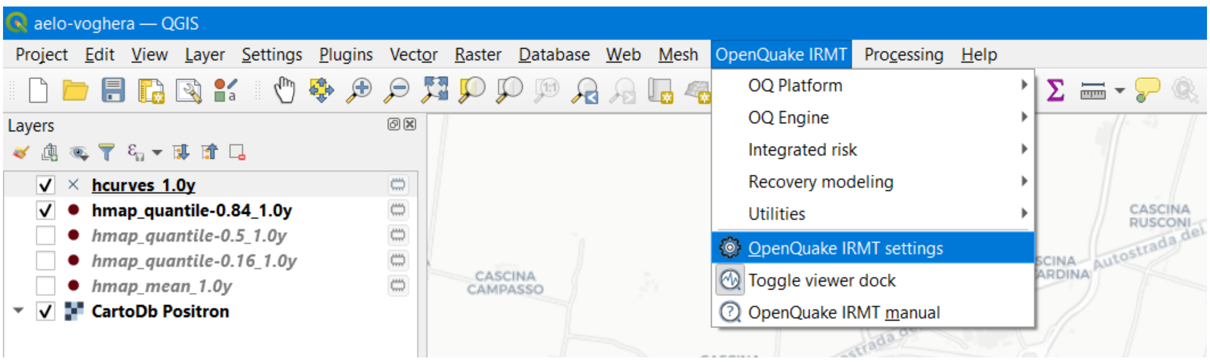


Figure 7: IRMT settings in QGIS

Click on the "New" button in the "OpenQuake Engine connection profile" (not the OpenQuale platform profile)

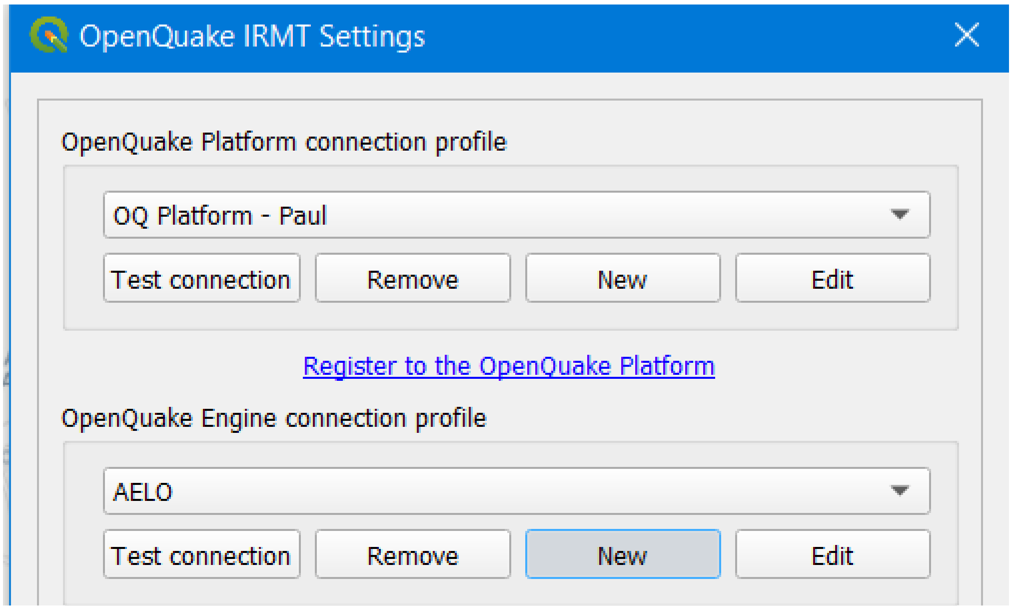


Figure 6: QGIS Plugin: New engine connection profile

Then fill in the form as shown in the figure below, obviously inserting your own username and password.

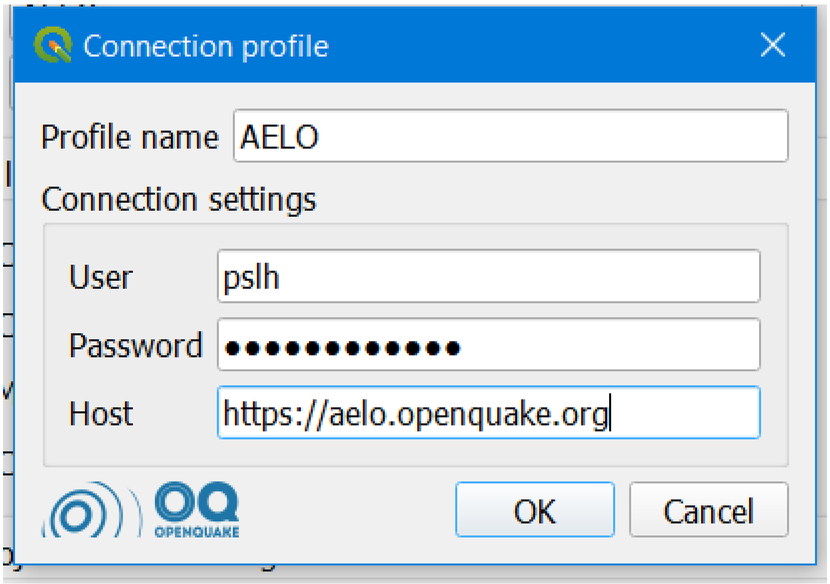


Figure 7: QGIS Plugin: AELO Connection settings

Test the connection with the “Test Connection” button. Assuming all is well, you can now connect to the AELO web service using the “Drive the OpenQuake Engine” menu item/icon, as shown in the figure below:

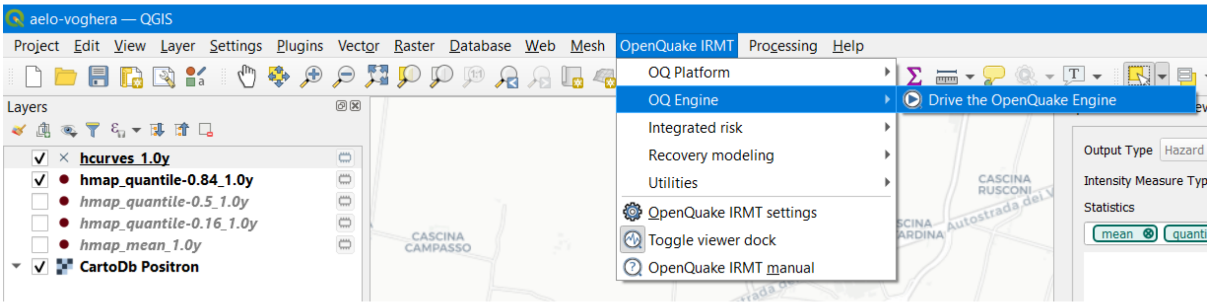


Figure 8: QGIS Plugin: Drive the OpenQuake Engine

The list of available calculations will be shown in a window similar to the one shown in the figure below:

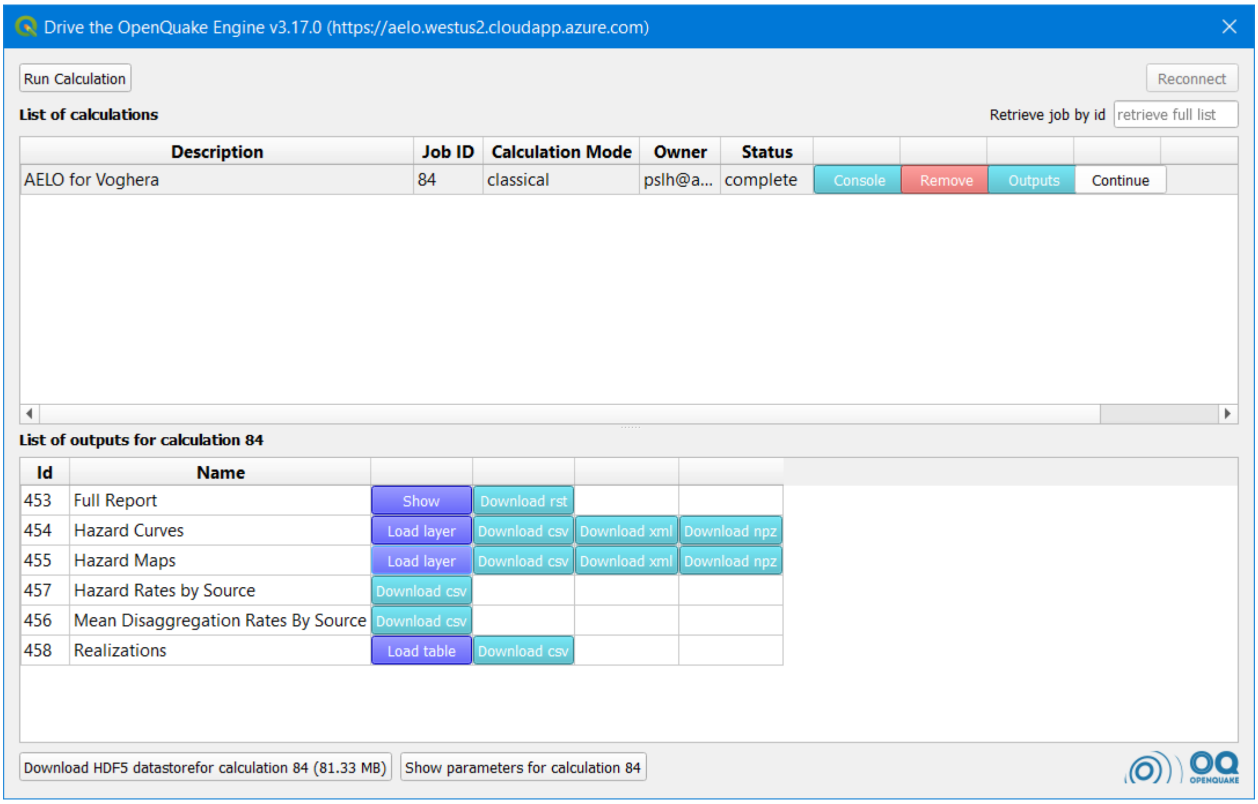


Figure 9: QGIS Plugin: Drive the OpenQuake Engine

In addition to the download options available via the Web UI, for some output types we also have a “Load Layer” option. If we click on the Load layer button for the Hazard Curve outputs we can view the curves in the graph viewer.

For AELO calculations, the default options for loading hazard curves are generally fine:

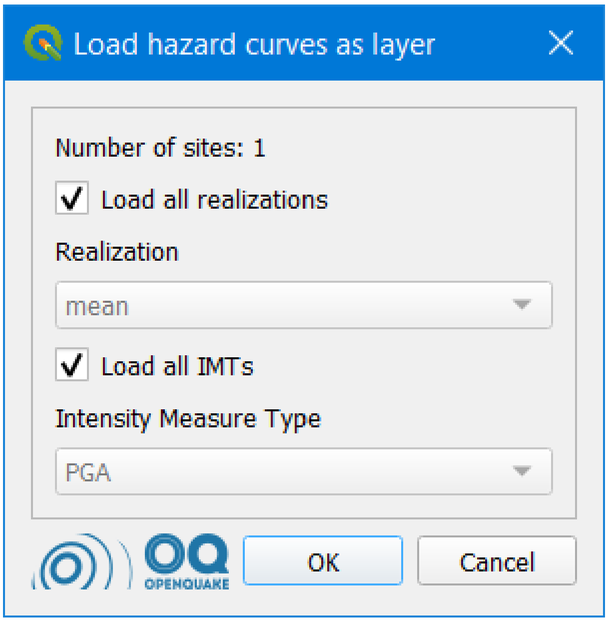


Figure 10: QGIS Plugin: default hazard curve options

After pressing OK, a layer will be loaded with a single cross icon identifying the site. Use "Select Features by Area" to select the site:

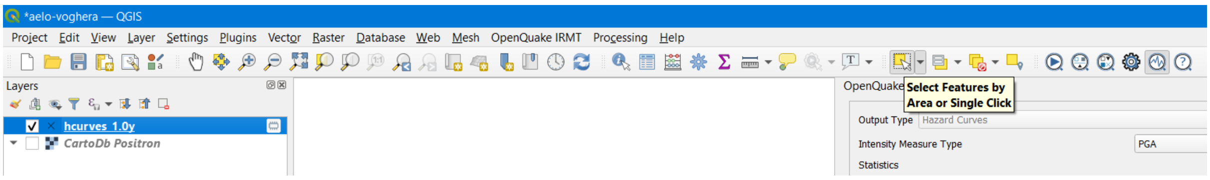


Figure 11: QGIS Select Feature by Area

The graph area will be updated to show hazard curves for the selected site:

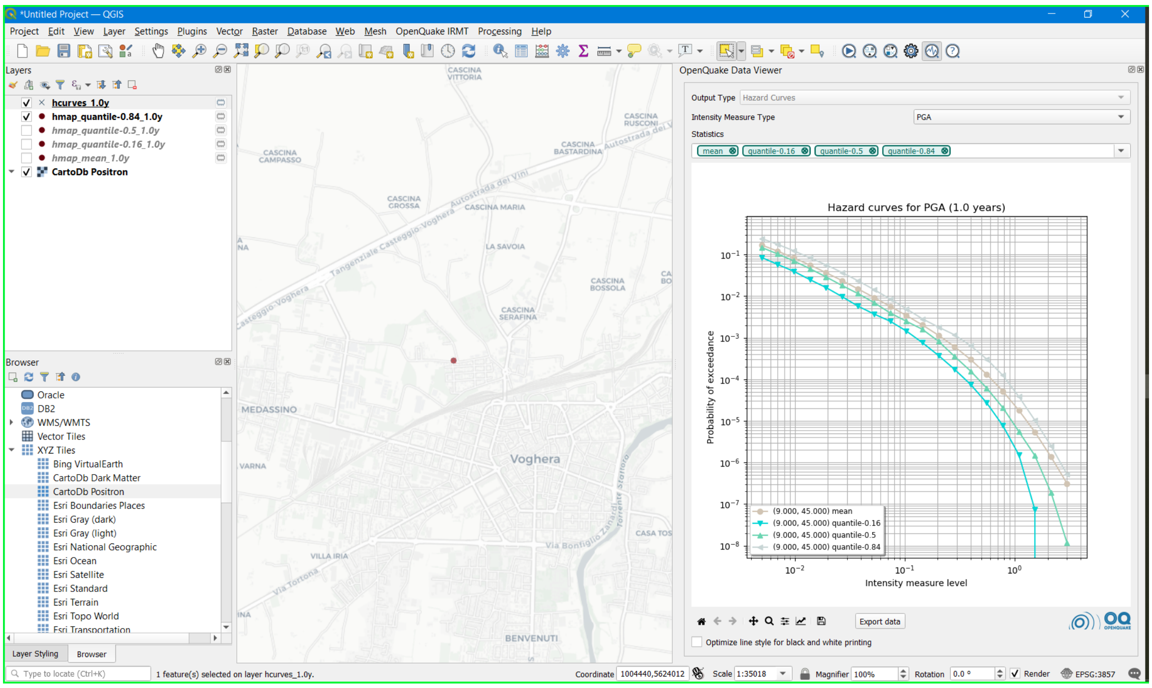


Figure 12: QGIS Plugin presenting hazard curves

Using the drop-down menus in the QGIS Plugin Data Viewer area, it is possible to change Intensity Measure Type and (de)select mean and quantile curves:

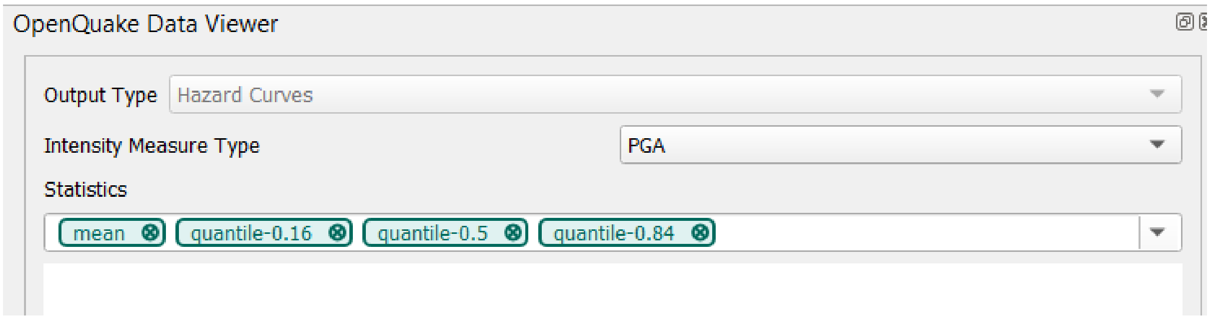


Figure 13: QGIS Plugin Data Viewer controls

For further information regarding the IRMT plugin please refer to the user manual https://docs.openquake.org/oq-irmt-qgis/latest/

Using the REST API

The AELO web service can also be accessed programmatically via a REST API, this is useful for integrating AELO with existing systems and/or for automated, non-interactive workflows.

This section briefly describes the REST API endpoints used for the most common operations. Please see https://github.com/gem/oq-engine/blob/master/doc/web-api.md for additional information regarding the OpenQuake engine REST API.

Authentication, login/logout

POST /accounts/ajax_login/

Attempt to login, given the parameters `username` and `password`

POST /accounts/ajax_logout/

Logout

Running a calculation

POST /v1/calc/aelo_run

Run a new aelo calculation for a site with the specified parameters.

Parameters:

```
* lon: the longitude of the site (a float in the interval [-180, +180])
* lat: the latitude of the site (a float in the interval [-90.0, +90.0])
* vs30: the time-averaged shear-wave velocity from the surface to a depth of 30 meters (a positive float)
* siteid: an ID to assign to the site (the only accepted chars are a-zA-Z0-9_-:)
```

Response:

```
The input values are validated and a `400 Bad Request` response is returned
in case any invalid input is found, specifying the reason of the failure.
If inputs are valid, the engine will first attempt to identify a Mosaic
```

```
model that covers the given site, returning a `400 Bad Request`
response in
case the site does not belong to any of the Mosaic models.
Otherwise, a new
job is created and a `200 OK` response is returned, like:

{"status": "created",
 "job_id": 1,
 "outputs_uri": "http://localhost:8800/v1/calc/1/results",
 "log_uri": "http://localhost:8800/v1/calc/1/log/0:",
 "traceback_uri": "http://localhost:8800/v1/calc/1/traceback"}

`outputs_uri` can be used later to retrieve calculation results,
after the job is complete.
`log_uri` can be called to get the log of the calculation, either
while it is still running or after its completion.
`traceback_uri` can be called in case of job failure (and only after
it occurs), to retrieve a full traceback of the error.
```

As soon as the job is complete, a notification is automatically sent via email to the user who launched it. In case of success, the message will contain a link to the web page showing the outputs of the calculation; otherwise, it will describe the error that occurred.

Description of Calculation and Outputs

The methodology used for this analysis is described in the report summarizing the activities completed within the first year of the AELO project. A shorter description of the method implemented can be found in Villani et al. (2023). The main steps composing the workflow consist of the following:

- Calculation of hazard curves from a probabilistic seismic hazard analysis
- Calculation of probabilistic Risk-targeted Maximum Considered Earthquake (MCE_R) and Geometric Mean Maximum Considered Earthquake (MCE_G) ground motions
- For cases where the Probabilistic MCE (MCE_R or MCE_G) does not exceed the deterministic lower limit, the governing MCE is the one obtained from the probabilistic analysis. Otherwise, we perform the following:
    - Identification of the earthquake sources controlling the hazard at the site
    - Calculation of disaggregation results for each individual source and selection of the controlling scenarios (i.e. the combinations of magnitude and distance with the largest contribution to the hazard) for each respective source
    - Calculation of deterministic MCE_R and MCE_G using the scenarios obtained at the previous points, subject to the deterministic lower limits
    - Calculation of the governing Maximum Considered Earthquake as the minimum between the deterministic and probabilistic MCE.

All outputs provided by the web interface are described below. The final results are in the files *ASCE 7-16 parameters* and *ASCE 41-17 parameters*, and are featured on the outputs landing page (“Simplified outputs”). Most users are likely to use only these; however, several additional outputs are included with results from intermediate steps that can be accessed by clicking “View advanced outputs page” at bottom left.

Main outputs

Note: * indicates that the field is printed on the simplified outputs page.

ASCE 7-16 parameters:

•***PGA**** min(*PGA_2_50* , *PGA_det*)
•***PGA_2_50*** Uniform-hazard PGA with a 2% probability of being exceeded in 50 years
•***PGA_84th*** Deterministic, 84th-percentile PGA; not needed if *PGA_2_50* ≤ 0.5g
•***PGA_det*** max(*PGA_84th* , 0.5g)
•***Ss**** min(*Ss_RT* , *Ss_det*]
•***Ss_RT*** Risk-targeted SA at 0.2s
•***CRs*** Risk coefficient, *Ss_RT* ÷ $S_{s,2/50}$
•***Ss_84th*** Deterministic, 84th-percentile SA at 0.2s
•***Ss_det*** max(*Ss_84th* , 1.5g)
•***Ss*_seismicity** FEMA P-154 (2015) seismicity region from *Ss* alone
•***S1**** Min(*S1_RT* , *S1_det*)
•***S1_RT*** Risk-targeted SA at 1.0s
•***CR1*** Risk coefficient, *S1_RT* ÷ $S_{1,2/50}$
•***S1_84th*** Deterministic, 84th-percentile SA at 1.0s
•***S1_det*** max(*S1_84th* , 0.6g)
•***S1_s*eismicity** FEMA P=154 (2015) seismic region from *S1* alone

ASCE 41-17 parameters:

•***BSE2N_Ss**** Same as *Ss* above
•***BSE2E_Ss**** Min(*Ss_5_50* , *BSE2N_Ss*)
•***Ss_5_50*** Uniform-hazard SA at 0.2s with a 5% probability of being exceeded in 50 years
•***BSE1N_Ss**** 2/3 * *BSE2N_Ss*
•***BSE1E_Ss**** Min(*Ss_20_50 , BSE1N_Ss*)
•***Ss_20_50*** Uniform-hazard SA at 0.2s with a 20% probability of being exceeded in 50 years
•***BSE2N_S1**** Same as *S1* above
•***BSE2E_S1**** Min(*S1_5_50* , *BSE2N_S1*)
•***S1_5_50*** Uniform-hazard SA at 1.0s with a 5% probability of being exceeded in 50 years
•***BSE1N_S1**** *2/3 * BSE2N_S1*
•***BSE1E_S1**** Min(*S1_20_50 , BSE1N_S1*)
•***S1_20_50*** Uniform-hazard SA at 1.0s with a 20% probability of being exceeded in 50 years

Advanced outputs

All outputs included in the “Simplified outputs” are also available on the “Advanced outputs” page.

Full Report

This file lists information about the calculation itself, including details about computation times and memory use.

Hazard curves

A hazard curve represents the most fundamental result computed for a site with a probabilistic seismic hazard analysis. It provides for various values of a selected intensity measure type (i.e. a scalar parameter describing a property of the expected shaking denoted in the header as *poe-<value>*) the corresponding probability of exceedance in the investigation time (in most of the cases corresponding to one year). The AELO web service provides hazard curves for each investigated site for three intensity measure types (IMTs) including PGA and Spectral Acceleration (5% damping) for periods of 0.2 and 1.0 seconds.

Deterministic Earthquake Scenarios

Representative scenario parameters per source and IMT derived from the single-source disaggregation results and used to compute the deterministic MCE.

Hazard curves per Source

This file provides values of the rate of exceedance in the investigation time (i.e. the hazard curves) obtained using the individual seismic sources controlling the probabilistic seismic hazard. The file contains several rows where each row provides the ID of the source, a label specifying the intensity measure type (IMT), a value of ground motion and the corresponding value of the rate of exceedance. A hazard curve for a single source and IMT can be extracted from this file by selecting the rows with fixed values of the source ID and IMT.

Mag-Dist-Eps Disaggregation per Source

This file provides the results of disaggregation by magnitude, distance, and epsilon (the coefficient of sigma in the ground motion aleatory uncertainty) for each of the sources that most contribute to the hazard at the spectral acceleration corresponding to the probabilistic MCE for each IMT (the MCEs are specified in the header). For each row the columns represent: the ID of the source, the center value of the disaggregation bin for magnitude, distance and epsilon, the IMT, and the rate of exceedance for the given bin at the MCE. Only bins with non-zero rate contributions are included.

Uniform Hazard Spectra

A spectrum where each ordinate has the same probability of being exceeded in the investigation time. This file contains values for the same intensity measure types listed in the description of hazard curves with certain values of the probability of exceedance in the investigation period. Here, the values of probability correspond to 10% and 2% probability of exceedance in 50 years.

Figures

Hazard curves

Plot of the hazard curves as intensity measure level "acceleration" (g) versus annual frequency of exceedance. PGA accelerations are represented as the geometric mean, and spectral accelerations for periods 0.2 and 1.0s are represented as the maximum horizontal component. The probabilistic MCE values for each intensity measure type are also plotted.

Disaggregation by sources

These plots are created only when the probabilistic MCE exceeds the deterministic lower limit. Each plot includes - for the given intensity measure type (IMT) - the total mean hazard curve from the probabilistic calculation, the probabilistic MCE that is disaggregated in the deterministic part of the workflow, and the hazard curve for each seismic source considered. The hazard curves for sources with the greatest contributions to the probabilistic MCE (e.g., the annual frequency of exceedance for the probabilistic MCE is at least 10% of that for the source contributing most) are colored and identified by their source ID (an OpenQuake source property) in the legend, while the other hazard curves are colored in gray. The plot contains all three IMTs, using the geometric mean to represent PGA, but the maximum horizontal component for the other two IMTs.

Governing MCE

This plot shows all of the hazard values and thresholds that were used to choose the final governing MCE, as described in the workflow above. PGA_{84th}, $S_{S,84th}$, $S_{1,84th,}$ $S_{S,RT}$, $S_{1,RT}$, and $PGA_{2/50}$ are as defined in the ASCE 7-16 outputs (*PGA_84th, Ss_84th, S1_84th, Ss_RT,* and *PGA_2_50*). DLL is the deterministic lower limit for the corresponding period, and the governing MCEs are PGA, S_S, and S_1 (*PGA*, *Ss*, and *S1*) in the ASCE 7-16 outputs.