PSHA Project
Deadline: May 2

General description

The aim is to understand how to perform a Probabilistic Seismic Hazard Analysis (PSHA) calculation and critically interpret the results and their sensitivity to model parameters. Each group of students (4 people) will implement a simple hazard model taken from scientific literature. Groups can choose their models from a pre-selected set of publications which will be made available to the students. Alternatively, groups can also propose a publication if they would like to implement a model not included in the pre-selected set and for a region of their interest. The pre-selected set of publications are, in general, older publications chosen for their simplicity, explicit description of seismic source parameters, and need for an updated ground motion prediction equation (GMPE).

You will be using the **OpenQuake (OQ)** PSHA code, currently developed within the Global Earthquake Model (GEM) Foundation. Examples of running the OQ are during the tutorial sessions (April 8th, 15th, 18th) and the theory behind PSHA will be covered during the lecture on April 12th. Moreover, several papers summarising PSHA and provided during this course can help you with this project (e.g. Baker, 2008; Slejko, 2017; Field 2003).

The main goals of the project are:

1. Understand how your input seismic hazard model was developed
2. Implement your model (or a simplified version of your model) in OQ
3. Run your model in OQ and compute a set of hazard results (hazard curves, maps, UHS)
4. Be able to interpret and explain the results you compute
5. Perform a critical comparison between the results you compute using OQ and any hazard results presented in the original publication, and explain logical reasons for any differences
6. Investigate the sensitivity of the model parameters to understand their relative impact on the hazard calculation

NOTE: The main goal of this project is NOT to *exactly* reproduce the results of the original publication. This may be impractical or impossible due to computational factors (e.g. the original authors used a different software), complexity of the original models, and use of old GMPEs. Rather, the goal is to successfully implement a seismic hazard model in OQ and to perform a critical analysis of the results.

Some of your models may need to be modified or simplified in order to feasibly implement them given the short duration of the course. This may include removing certain sources, simplifying the logic trees, etc. This will be discussed further during the tutorials. Do not hesitate to ask the

TAs for guidance in modifying or simplifying your models. A model that differs from the original version described in the publication can be used as basis for elaborating on point 5 (above).

Students will be graded on:

- A written report (described below) with a strict 2500 word limit (not including references). The limit is enforced to reduce the workload and encourage concise writing ("quality over quantity")
- An oral presentation (15 minutes + 5 minutes of questions)

All group members are expected to contribute to the written report and oral presentation.

The written report should contain the following:

SSC = seismic source characterisation
GMC = ground motion characterisation

Abstract

- Short summary of the project and main findings

Introduction

- Tectonic background of the region
- Major past events
- Main findings of other hazard studies in the area, if they exist

Overview of the original model

- Describe the SSC (how was it developed? What source geometries and magnitude frequency distributions were used?)
- Describe the GMC (which GMPEs were used?)
- Were epistemic uncertainties considered in the SSC and GMC through the use of logic trees? If so, describe

OQ implementation

- Describe *your* OQ implementation of the SSC (which sources did you implement? Which source parameters did you use in the .xml file ?)
- GMC: The GMPEs in your original publication have likely been supersceeded by more recent GMPEs. Define a selection criteria and select three GMPEs (implemented in OQ) to be used in your model via a ground motion logic tree. Assign branch weights based on your confidence in the GMPEs. Justify your selection and weighting. Compare the attenuation of the selected GMPEs to the one(s) originally used in your model. Use the selected GMPEs for your computations (next section).
- Describe and justify the calculation parameters used in the job.ini file

Results computed in OQ

- Compute, plot and comment on **hazard curves** for two main sites (e.g. coordinates of two major cities) for an investigation time of 50 yrs, Vs30=760 m/s, for PGA and one other spectral ordinate of your choice
- Compute, plot, and comment on **hazard maps** for a 10% PoE in 50 years (475 yr return period) using Vs30=760 m/s, for PGA and one other spectral ordinate of your choice
- Compute, plot, and comment on **uniform hazard spectra** for two main sites, computed for a 10% PoE in 50 years (475 return period) using Vs30=760 m/s

  Note: when possible, compute the hazard curves and uniform hazard spectra for the same sites that appear in the original publication

Sensitivity

- Perform a simple sensitivity study to understand the influence of the parameters used in the magnitude frequency distribution. Using one source, change the Gutenberg-Richter *a, b,* M_{min} and M_{max} values and observe how the hazard changes. Propose a hierarchy ordering the parameters from most to least influential

Discussion

- Compare your computed results using OQ (hazard curves and maps) to the results described in the original publication (those provided). When comparing hazard curves, compare the values. When comparing hazard maps, compare the values and the hazard patterns. Explain logical reasons for any differences (e.g. differences in the SMC, GMC, and parameters in the job file)
- Compare your hazard map to the ISC-GEM catalogue. Comment on the pattern of hazard relative to the pattern of seismicity
- Critique the original model. Suggest at least two ways the original model could be improved

References

Baker, Jack W. (2008). *An Introduction to Probabilistic Seismic Hazard Analysis (PSHA). Working paper, Stanford University.* Available at https://web.stanford.edu/~bakerjw/Publications/Baker_(2008)_Intro_to_PSHA_v1_3.pdf

Field, E. H. (2003). *Probabilistic Seismic Hazard Analysis (PSHA)*, *A Primer.* Available at http://www.opensha.org/sites/opensha.org/files/PSHA_Primer_v2_0.pdf

Slejko, D. (2017) Seismic Hazard Assessment. Course notes from the ROSE school.