Unit 5: How do earthquakes affect society? Student Assignment

5.1 Introduction

Unit 5 is a final exercise that will involve using all the data types and techniques you were introduced to in Units 1–4. The exercise will ultimately require you to produce a project report relating both the long-term (landscape timescale) and short-term (earthquake cycle timescale) tectonic history of an area that experienced a major earthquake, causing infrastructure damage and societal disruption. Unit 5 is intended to be a synthesis of the different techniques and concepts covered in the module but applied to a real-world scenario, emphasizing potential societal impacts.

You are provided with LiDAR and InSAR imagery for a recent major earthquake. In addition, the InSAR data have been uploaded to the Visible Earthquakes tool for analysis there. You may supplement the data with information from published articles.

Time in two laboratory periods will be allotted for this project, but completing it successfully also will require time spent outside of the laboratory times.

5.2 Data analysis and synthesis

Outlined below are a series of tasks that involve looking at the available LiDAR, InSAR, geologic and infrastructure data for a fault zone that has sustained a major earthquake. You will notice that you are being asked to apply a number of procedures and analysis methods that you have already conducted in Units 1–4.

Task 1. Investigating the geomorphology of the fault rupture zone

A. Using Google Earth, examine the rupture zone of the earthquake. Do the geomorphology and geologic setting provide evidence for the type of faulting that took place [see Unit 2]? Use of the Google Earth image time sequence feature may help for comparison of pre- and post-rupture topography along with the post-earthquake LiDAR image.
B. A number of articles and/or earthquake catalogs are available that provide seismological focal mechanism information, from which the earthquake type can be determined (which is independent from the geomorphologic evidence). Using this information, write a list of the geomorphic features you would expect to find associated with this type of faulting [see Unit 2]. Discuss which of the expected features are observed and the degree of their development.
C. Using your experience of other faults with a similar style of motion, consider how the fault compares in terms of the maturity/scale of its geomorphic features, and what that might tell us about its earthquake history and rate of motion. Comparatively how many earthquakes might it have taken to build the topography associated with the fault, compared with others?
D. Based on the geomorphic evidence found, and your experience of other faults with a similar style of motion, discuss whether, in your opinion, this earthquake could have been expected. How might this have affected the degree of preparedness for an earthquake on the fault?

Task 2. Characterizing the slip in the earthquake

A. Analyze the InSAR data for the earthquake selected and determine the total area that has been affected by the fault rupture and the type and amount of surface displacement. You might consider reporting this information using a map format and also showing the latitude-longitude coordinates of the boundaries of the area affected.
B. Create a model of the fault responsible for the earthquake using the Visible Earthquakes tool. List the characteristic fault parameters you determined from your model and create a block diagram that shows the model relative to its position on the map you created. Do you think the earthquake is typical of events that could happen on the fault, or could it sustain events of different sizes (and how/why)?
C. Assume that the fault parameters you determined are what would be typical for this locality and geologic setting. Calculate how many events would need to occur to create the type(s) of geomorphic features identified in Task 1. Make realistic assumptions about the possible average long-term rate of motion on the fault, and estimate the repeat interval for earthquakes on it.
D. Discuss what additional types of data/observations/information would be helpful to further understand the nature of the earthquake that took place (e.g. what could you learn from geological or seismological investigations, and what would you look at specifically?).
E. Rank the relative value and reliability of the data you have used in your analysis and comment on how any additional data would have improved and augmented the data you did use.

Task 3. Evaluating the impact of the earthquake on infrastructure, lifelines, and society

A. Use the resources provided and/or find additional resources (e.g. eyewitness, news or engineering reports) that describe and document the damage created as a result of the earthquake. You may choose to create a table and/or a map that would detail the particular infrastructure (e.g. buildings, roads, water lines, electrical lines), the level of damage, and the area or distance from the surface expression of the fault.
B. For each type of infrastructure, state what could be done to reduce future damage.
C. Considering the different types and severity of damage, estimate how long it might take for different infrastructure elements in the affected area to be repaired/restored, which elements might be prioritized, and what the follow-on effects for local inhabitants might be. Construct a graphical timeline that depicts events for the decade(s) following the earthquake. Be sure to distinguish both the damage, interval of disruption, and repair times (and costs) in your timeline.
D. Based on your deliberations and on what occurred during the earthquake, what recommendations might you make to prepare for/mitigate the effects of future earthquakes in this area?

5.3 Project Report

You should present your visualizations of the data, your findings and analysis in a short report (aim for no more than five pages of text, plus figures and figure captions). A grading rubric is included so you can get a sense of what is required of you. It is recommended that you complete the various sections of Tasks 1–3 prior to writing the report. Specific guidance about certain elements is given below.

- Organize your findings from the tasks into a series of representative sections, with section headings. There are several ways to achieve this; for example, by looking at effects on different timescales (geomorphology vs individual earthquake cycles vs human time scales), sorting by technique (LiDAR analysis vs InSAR analysis vs infrastructure susceptibility analysis), or by using the divisions set out in the rubric (e.g. selection of resources, data analysis, societal recommendations). These sections will form the bulk of your report.
- Make use of the grading rubric to gain an understanding of the items to include in the report and the expected level of your work. In particular:
  - Start with an introduction giving some background to the earthquake—when, where and why (tectonically) it happened, along with what you are doing to analyze it, and why.
  - Note that the rubric explicitly grades you on your discussion of the resources and data that you use, i.e. on the strengths and weaknesses of different techniques and of different information sources. Do not assume the reader knows this already!
  - Provide uncertainties in the numbers you estimate—which things can be estimated well and which cannot? How does this affect your interpretation or conclusions?
  - Note that organization and presentation is very important—take care to make your figures easy to read and interpret. Provide clear and explanatory figure captions!
  - Include an addendum in the report with comments about how your understanding of the impact of earthquakes on societal support infrastructure has changed as a result of working on this module.