GEOL 308L Natural Hazards Lab
Lab 06: Regional Seismicity

Learning Objectives

1. Evaluate the spatial extent of potential damage to a region from a large magnitude earthquake.
2. Evaluate the temporal variability of seismic hazard in a given region over one or more time scales.

You have been hired by a re-insurance company to evaluate the seismic hazards associated with a region. You will accomplish this with two tasks. Both tasks will use the resources found at the USGS earthquakes website http://earthquake.usgs.gov/earthquakes/map/.

1. Prepare an Earthquake Report for your given region.
2. Prepare a series of maps that display how seismicity changes over time.

Part I. Earthquake Report.

You will prepare an earthquake report that shows the intensity from one of the largest earthquakes in your region for the past century. The type of data that you will need to use is only available for more recent earthquakes, so it is possible that you can only use earthquakes from the past 50 years or less.

Your report will include a regional basemap. This could be a vector version of your region, or a satellite image based basemap. You will be responsible to choose this and to obtain the necessary data for your basemap.

Most large earthquakes have GIS data available to be used to display shaking intensity. These are available as raster and vector data. The types of data include peak ground acceleration (PGA), peak ground velocity (PGV), and Modified Mercalli Intensity (MMI). Once you find an earthquake, it is a simple matter to download the GIS data and then find a good way to display these data using the legend editor. Create a single map that displays these intensity data. Make sure to include the basic components that belong on every map.

Step 1. Obtain GIS Data

Visit the USGS website listed above. Note the options in the upper right corner. Each option provides a different way to view data in this web interface. From left to right are:

a. List – this displays or hides the list of earthquakes displayed on the map. The list shows up to the left of the map.
b. Map – this displays or hides the map display.
c. Settings – this changes various display settings (e.g. the temporal length and magnitude rage of earthquakes, basemap, and other features).
d. About – this allows one to learn new things about this interface.

Click on "settings" and then click on "Search Earthquake Catalog." A display of "Basic Options" is shown. One may select a magnitude range (Minimum and/or Maximum), a date range, and a geographic region.

Choose a date range of 1917-2017. Choose a large magnitude for the minimum and do not enter a maximum (e.g. 7.0 or 6.0). Start with M 7.0, but if there are no earthquakes as a result of your query, decrease the magnitude in steps of 0.5 until there are some earthquakes.

Click on the button "Draw Rectangle on Map" and a map interface opens up. Zoom and pan until your region is in the window. Single left click in one corner, than drag a rectangle, then single left click the corner opposite the first corner, forming a rectangle surrounding the region you are interested in querying. One may resize the rectangle by sliding the sides of the rectangle marked by white dots. Once you are satisfied with the region, click the "Use this Region" button.

Scroll down and click the "Search" button.

The map interface opens with earthquakes plotted as circles and a list of the earthquakes on the left. Scroll to find the largest earthquake with a dataset that will work for Part I. For example, click on a large magnitude earthquake. The earthquake list turns cyan, the epicentral dot turns cyan, and an html link displays in the lower left corner. Right click on the hyperlink and open this earthquake in a new tab. Navigate to that tab and inspect the data to see if the data type we need is available. If not, scroll up in time and choose the next largest earthquake.

To determine if the earthquake has a GIS dataset, first find out if there is a shakemap for the earthquake. If this is present, click on the shakemap. A new window opens with the shakemap in a box. Scroll down to the word "Downloads" and click on it. A menu opens, so scroll down until you find "GIS Files" and "ESRI Raster Files." An additional data set that might be of interest is the "HAZUS Data" dataset and, usable in Google Earth, the "Event KMZ file." Right click and save the GIS (vector) and Raster data sets. Save these into your directory on the D drive (e.g. "lab_05/original"). Right click and "Extract Here" to unzip the data.
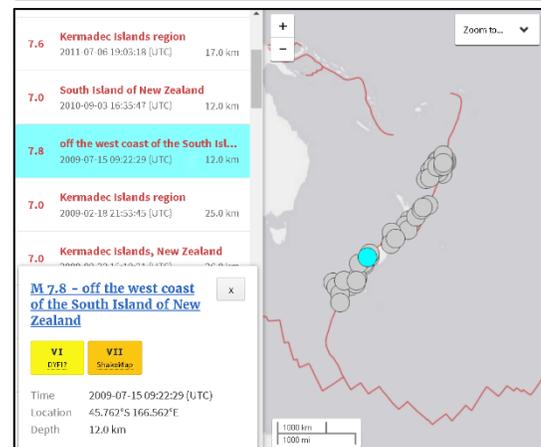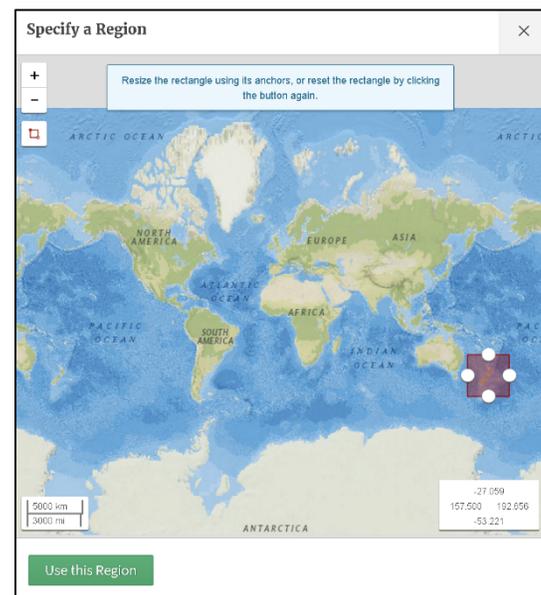
Lastly, navigate back to the page that has the map and earthquake list. Scroll up to the text that states the number of earthquakes plotted in the map area. Click on this text so that a button displays entitled, "Download Earthquakes."

Click on this button. There are a number of options available. Some options include kml files (these are viewable in Google Earth). You will need the "CSV" file (comma separated text). Right-click on this link, navigate, and save the file to the lab_06 directory with a cool name like "GEOL_308L_lab_06_19172017_EQGTE70.csv."
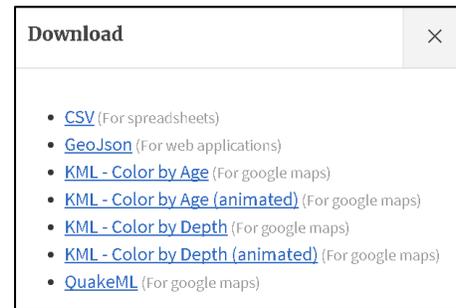
Open this file in a spreadsheet program. Save the file in xls format. This spreadsheet will include coordinate and magnitude data for the earthquakes displayed on the map.

Download
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- CSV (For spreadsheets)
- GeoJson (For web applications)
- KML - Color by Age (For google maps)
- KML - Color by Age (animated) (For google maps)
- KML - Color by Depth (For google maps)
- KML - Color by Depth (animated) (For google maps)
- QuakeML (For google maps)

Locate and obtain some cool basemap data. One useful source for vector data is the "Natural Earth" website http://www.naturalearthdata.com/.

Step 2. Display GIS Data

1. Launch ArcMap. Set the data frame properties projection/coordinate system to "WGS 1984."
2. Add the basemap data sets that you have obtained.
3. Display the epicentral data using the "display x y data" strategy we used in our second lab (when we plotted cities). Export the data as a shapefile. Plot these data (the shapefile) as circles (dots). Use the magnitude data to control the size of the circles. Edit the legend text so that it will display in a senseful manner in the legend when you eventually compose a map.
4. Add the data that you downloaded for the earthquake. Choose one of the types of data (MMI, PGA, PGV, etc.).
5. Display the intensity data in a way that:
   a. the basemap data help one locate themselves
   b. so the epicenters are visible
   c. the intensity data are interpretable

Step 3. Compose the Map

Compose the map with standard map composition components that we have been using in most every lab. Export the map. Navigate and name the file with a cool name.

Part II. Spatiotemporal Variation in Seismicity

We will use the same search interface to download CSV data for earthquakes of a range of magnitudes during different time periods. You may wish to experiment with different queries to see how the data vary with time and space. Your goal is to prepare several maps (3 to 5) that demonstrate how seismicity varies across some time scale. If we had more time, we would do this exercise for different time scales (i.e. compare decadal, annual, monthly periods).

One way to compare queries is to conduct one query, then copy and paste that url into several new browser tabs. Then one may edit the query in each browser tab for some different time range. Try experimenting with a single magnitude range, but with different time ranges. Try looking at several different decades to see if there is any apparent variation. Or, try looking at several different years within a decade. Alternately, one could try the first year of subsequent decades.

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Once you have chosen your temporal range, save the csv files from each of these queries. Plot the seismicity as before, using a basemap that you determine is the best for your map series. A great raster basemap can be found when using an internet search, "esri imagery." The first result might be "World Imagery – ArcGIS." This is a great global satellite imagery data set.

Prepare a map series that shows how seismicity varies spatiotemporally. One may use multiple "data frames" on a single map to do this. Make sure the labels on your maps make the map easy to interpret.

Conduct some research about the tectonics of your region. Look into the different types of faults and sources of seismicity. Look at maps, papers, and blogs about your region.

Write a 2 page report. Use font size 12 and double spacing. Describe the regional tectonics in a paragraph or two. Describe the data that you plotted, including the variation. Finally, write several paragraphs attempting to explain the spatiotemporal variation in the seismicity displayed on your maps. The report could include a small figure that shows the regional tectonics. If you include a figure, use a figure caption and refer to the source of the map.

Submit the map and report via email. Something that you will need to do is to name the files in a way that makes it easy for your employer to know who created them and what their content is. For example, the map in Part I could be named "GEOL_308L_lab_06_part_I_map_patton.pdf."