Downloading Earthquake Data from the USGS Earthquake Hazards Site for Anywhere in the World and Studying it Using ArcGIS

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Brief Description: In this assignment, students go to the USGS Earthquake Hazards website, do an earthquake catalog search, download earthquake data for a particular area, and compare what they can learn about the earthquakes by looking at the data in Excel with what they can learn by portraying the data in ArcMap and in interactive 3D in ArcScene.

Context: This exercise is part of an introductory geology course.

Prerequisite skills: Students must have basic ArcGIS skills and be able to create an ArcMap, manipulate layers in ArcMap, work with attribute tables, and do simple tasks in ArcScene.

Where situated in the course: This exercise takes place about a month into the course.

Concept goals: Students will consolidate concepts related to earthquake epicenters, foci, and magnitudes and explore subduction-related earthquakes and the geometry of a Benioff zone.

Higher order thinking skills goals: Students will analyze the distribution of earthquakes.

Other skills goals: Students will practice GIS skills learned in previous assignments.

Description: The USGS Earthquake Hazards Program web site allows you to download earthquake data as an Excel spreadsheet from any area in the world over a specific time period and magnitude range. This is a fantastic resource that makes it possible to study any area you want and not be limited to canned data sets. It's also very easy to save the Excel files in a way that can be imported directly into ArcMap and then into ArcScene.

In this in-class activity, students download earthquake data from the Sumatra area and examine it first in Excel. They quickly observe that, even when they sort the spreadsheet in various ways, they can develop only a limited picture of the data. In the second part of the activity, students bring the data into ArcMap to portray it spatially, and they change the symbols to portray various attributes of the earthquakes. In the final part of the activity, students display the data in three dimensions in ArcScene. This latter is particularly powerful, because students can interactively rotate the ArcScene, which helps immensely in their abilities to visualize the depth distribution of quakes.

Although the activity focuses on Sumatra, the activity could easily be done for any area of the world. Later in the semester in this course, students download earthquake data from other areas in the world when they evaluate earthquake hazards in other regions.

Evaluation: Students will be evaluated on the quality and insight of their written responses to two open-ended questions the accompany the activity.

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Name _____

Earthquakes
class Wednesday, September 12

Downloading regional earthquake data

From the Earthquake Center page (http://earthquake.usgs.gov/), select **Scientific Data**, and **Scientific Data** again on the Research and Monitoring page. Choose **Earthquake Catalog Search.** Then choose **Rectangular area.**

We're going to search for earthquakes in the Sumatra area since 1990. We'll set the search parameters for:

- Spreadsheet format
- USGS/NEIC 1973-Present
- Top Lat: 7
- Bottom Lat: -10
- Right Long: 112
- Left Long: 93
- Start year 1990
- Ending year 2007
- Minimum magnitude 5
- Maximum magnitude 9.9

Click Search. Click and drag to select all of the records, and Copy. Open Word, and Paste. Save the file as a **Text only** file. Launch Excel, and open your text file. Select **Delimited** in the first dialog box, and **Comma** in the second dialog box. Click finish.

Do a variety of sorts of your Excel spreadsheet data. To sort, click on **Data**, **Sort**. (If you get a warning message, choose **Expand the selection**). Choose the column by which you want to sort the data, and whether you want it ascending (smallest value first) or descending (biggest value first). Be sure that **Header Row** is checked.

What have you observed about depths? Magnitudes? Numbers of quakes?

Creating files for use in ArcMap

- In Excel, select the latitude, longitude, magnitude, and depth columns, choose **Format** from the main menu, **Cells**, and **Number**. Set the decimal places to **4**, and OK.
- ***Critical step!!!** Before you save the file, **click once in cell A1**. Then, select **Save As**, and scroll down to the format **DBF4**. Give your .dbf file a **SHORT** name, no spaces, and click OK, and Yes.
- ****Another critical step!!! YOU MUST CLOSE EXCEL BEFORE YOU CAN ADD THE DATA TO ARCMAP!!!*****

The Data in ArcMap

****Make sure that Excel is closed – don't just minimize the window.*****

Copy the **continents.shp** file to your C:\ drive. Start a new ArcMap, and add the continents shape file and your .dbf file.

You need to do one thing before your data will show up. If you look at the tabs at the bottom of the TOC in ArcMap, you'll see that the TOC has switched from Display to Source mode. Right lick on the .dbf file, and select **Display XY data.**

- Be sure that the **X Field** pulldown says **Longitude**, and the **Y Field** pulldown says **Latitude**. If it doesn't, select the correct ones from the pulldowns.
- You'll now have a dialog box that says **Coordinate System of Input Coordinates**, and, in that box, it will say **Unknown Coordinate System**. You need to define a coordinate system for your data so that it will plot properly on the map of the continents.
- Click **Edit**, **Select**, and select **Geographic Coordinate Systems**, **World**, **WGS 1984.prj** (the last option). Click OK. Now, the coordinate system should read **Geographic Coordinate System Name: GCS_WGS_1984**
- Click OK.

Now your earthquakes should show up on the map. But you won't be able to do anything with them in ArcScene quite yet. You need to first convert this **Events** layer to a shape (.shp) file.

- Right click on the events layer, and select **Data**, **Export Data**. All of the defaults are OK. Click on the folder icon, and navigate to where you want to save your new shape file, and give it a name. Remember: **SHORT, no spaces.** Click OK
- You can now delete your original events layer and return to the Display view (click the **Display** tab at the bottom of the TOC).

Open the attribute table for your new shape file (right click on the name in the TOC, and select **Open attribute table)**. All your data will be there. Close the attribute table.

In map view, select the **Information** tool (the "i"), and you can click on any earthquake on the map and find out information about it. It's all the information in the attribute table that allows you to display the data by various attributes.

Your earthquakes

All of the quakes are shown with the same symbol. We can easily change the symbols to show quakes by the values of various attributes.

- Go to Properties in the Sumatra_eqs layer, and select **Quantities.** Choose either graduated colors or graduated symbols In the value field, choose **DEPTH**. Choose the number of classes you want, and select a color ramp. Click OK.
- Add the earthquakes layer again several times, and color-code different properties on each layer.

What have you learned that you didn't learn from looking at the data in an Excel spreadsheet?

Your earthquakes in ArcScene

Go to ArcScene. Add the continents layer and the earthquakes layer. Zoom in to the Sumatra region. If you navigate around a bit, you'll see that all the quakes plot at the surface. Let's make the earthquakes plot at their correct depths!!

Go to the Properties for the earthquake layer, and select the Base Heights tab. Click the icon to the right of the box under Height. This is the "Expression Builder". Double click on DEPTH then single click on * and single click on – then .005, so that your expression looks like:

[DEPTH]*-.005

This will tell ArcScene to take the values in the earthquake depth column and multiply them by a factor to place them at the correct depth in the scene (because the map coordinates are not in kilometers, we need this conversion factor).

Click OK, and navigate around so that you can see the earthquake depths. You can also go to the Symbology page and code the quakes by color or symbol.

What have you learned about earthquakes in Sumatra area from portraying them in ArcScene that you couldn't tell as easily from the ArcMap view?