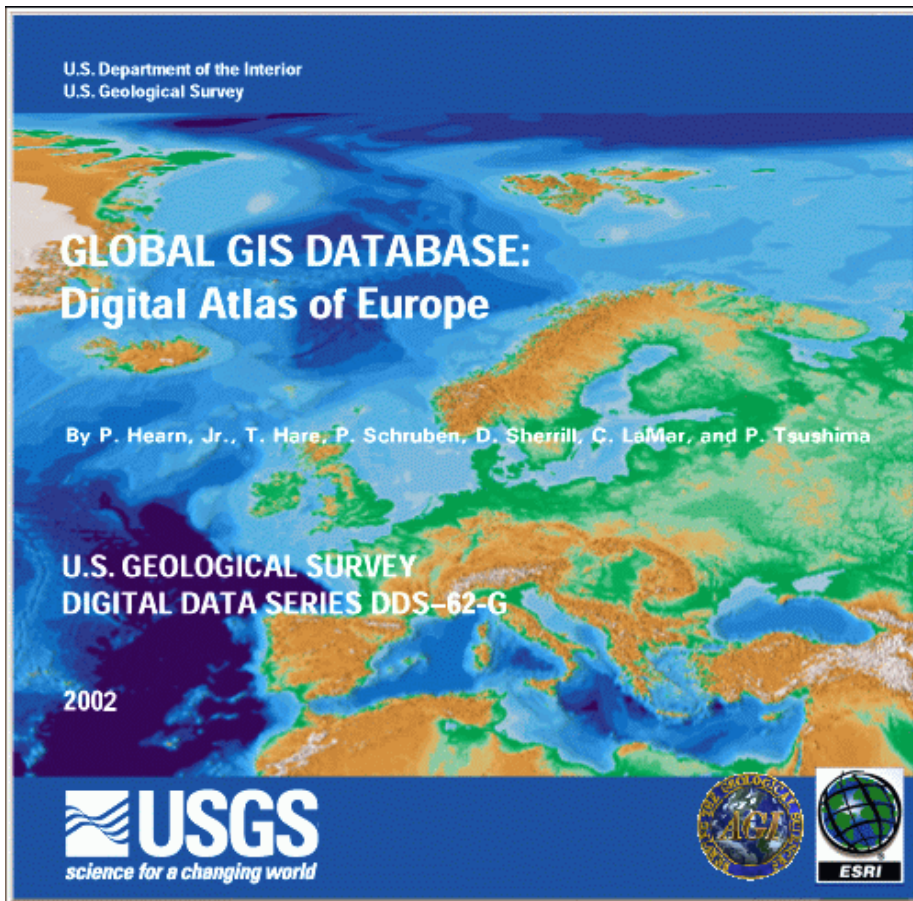


# Global GIS Education:

## *Exploring Earthquakes in Europe*

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## Global GIS Education: *Exploring Earthquakes in Europe*

### Description

In these lessons, students use Geographic Information Systems (GIS) together with the tools and data from the Europe Global GIS CD to investigate earthquakes, volcanoes, and population from a local to global scale. The lessons can be used with other data in the Global GIS project to investigate earthquakes in other continents. Furthermore, the methods used here can be applied to other map themes contained within the Europe GIS dataset.

The lessons are organized into 9 parts:

Part 1—What's Shakin'?

Part 2—Digging Deeper

Part 3—Earthquakes in Iceland

Part 4—Historical Earthquake: Lisbon 1755

Part 5—Modern-Day Earthquake: Turkey 1999

Part 6—Investigating Your Community

Part 7—Earthquakes Everyday

Part 8—Analyzing Recent Earthquakes

Part 9—Earthquakes Respect No Boundaries

## Problem Setting

Earthquakes in Europe are costly in both lives and property. As the population grows and development expands to cover more and more of the land area of Europe, more people are affected by earthquakes each year.

In this earthquakes lesson, students are given a scenario where they must report on the distribution and frequency of earthquakes in Europe related to cities, political boundaries, volcanoes, and fault lines. They analyze current earthquakes from the Internet, and assess the hazards from a continental to a local scale, to their community.

## Investigation

The U.S. Geological Survey was created in 1879 to help understand the geologic, biologic, hydrologic, and geographic characteristics and phenomena of the planet. Included in this mission is a thorough understanding of earthquakes. To help assess where and why earthquakes occur in Europe, the U.S. Geological Survey has hired you as an earth systems scientist to provide them a report that will include the distribution, frequency, and causes of earthquakes in Europe, specific regions of the continent, and the state where you attend school. Included in the report must be an analysis of the depth and magnitude of the earthquakes, and the locations and characteristics of cities, volcanoes, and faults in relationship to earthquakes.

As noted above, earthquakes cause millions of dollars of property and critical infrastructure damage each year. "Critical infrastructure" refers to large-scale systems that local, regional, and national governments build across the landscape. These include roads, airport runways, power lines, gas pipelines, water pipelines, sewer lines, railroads, fiber optic cable, broadband Internet lines, telephone lines, shipping docks, power stations, radio and television transmission towers, and canals.

1) List three kinds of critical infrastructure that could be destroyed or damaged during an earthquake. For each, describe why the destruction of these infrastructure resources is so disruptive to local, regional, and

national government and commerce.



### ••• Part 1: What's Shakin'?

In this part, you will examine earthquakes across Europe, noting their distribution, magnitude, and depth, and also examining certain regions on the continent.

After accessing the Global GIS interface, you will be viewing the "G" part of GIS with the map on the right side and a set of tools across the left and the top.

Turn off (uncheck) all themes except for the following:

- shaded relief base (at bottom of table of contents)
- political boundaries
- political boundaries labels

2) Parts of other continents besides Europe are shown on the map. What are they?

3) Describe at least three characteristics of the land surface in Europe, including areas where mountain ranges exist.

Movies, 3D, ...

Access the Movies, 3D menu at the top and Open Menu. Select and run europe\_eq\_anima.avi. Use the slider bar to position the movie at specific years you wish to investigate further.

4) What years of earthquakes does this movie depict?

5) The USGS seismologists want you to make three observations about the *spatial pattern* of earthquakes that you notice as they occur across the European continent. Include in your statements the extent of the earthquakes, and specific areas of Europe where earthquakes occur more often.

6) Make three observations about the *magnitude of earthquakes* and where earthquakes of certain magnitudes occur across Europe. Do large earthquakes only occur in specific regions? If so, where are they?

7) Do any specific years seem to have more earthquakes than others, or would you say that about the same number of earthquakes occur each year?

Close the movie and return to your GIS. Now you can further analyze the earthquake theme and draw some conclusions.

Turn on the earthquakes theme.

8) What time period is covered by the earthquake data?

- 9) Are there more earthquakes shown in the movie or more shown on your map? Why?
- 10) Do more earthquakes occur near the western and northern oceans or in the interior of the European continent? Why?
- 11) Do more earthquakes occur near the western and northern oceans or near the Mediterranean Sea? Why?
- 12) Describe the *pattern* of earthquakes in Europe in your own words.
- 13) Which part of Europe would you say contains the most earthquakes: Northern, Eastern, Southern, or Western?
- 14) What three countries would you say are most prone to earthquakes?
- 15) What three countries would you say are the least prone to earthquakes?
- 16) Compare the number of earthquakes that occur in the oceans and seas versus land.
- 17) Would you say from analyzing your data that most earthquakes in water occur in the deep parts of the oceans and seas, or in the shallow parts?
- 18) Compare the number of earthquakes in the Atlantic versus the Arctic Ocean.
- 19) Examine the feature that runs down the middle of the Atlantic Ocean by using the pan symbol  and moving along its full length. Would you characterize it as a valley (trough), a ridge, or both?
- 20) What is the name of this feature? You might need to look at other references sources outside of GIS to determine it, such as atlases or a textbook on plate tectonics.
- 21) Why is this feature so prone to earthquakes?
- 22) What country in particular needs to be concerned about earthquakes along this feature? Why?
- 23) What is the name of the island to the northeast of Iceland that exists along this feature?

Make volcanoes visible by checking the box to the left of the theme name. If you would like to make the volcanoes symbols larger, double-click on the volcanoes theme name.



- 24) How do you think this island formed?
- 25) What particular hazard exists to people on land when an earthquake occurs under the ocean?

26) In what part(s) of Europe would you say that people need to be concerned about earthquakes occurring in the ocean? Why?

Make major cities visible by checking on the box to the left of the major cities label.

27) What major cities would you say would be most vulnerable to an earthquake under the ocean?

28) Make fault lines visible. Describe three characteristics of the relationship of fault lines to earthquake locations in different locations across Europe.

29) Name an area where a fault exists but **few** earthquakes occur.

30) Name an area where a fault exists but **many** earthquakes occur.

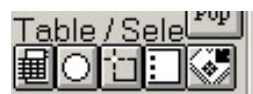
31) Why do earthquakes occur near some faults but not others?

32) Are there more earthquakes, or more volcanoes, in Europe? Why?

33) Make three observations about the pattern of volcanoes in Europe.

34) The USGS wants you to determine the relationship of earthquakes and volcanoes. Examine at least three different places around Europe and investigate the spatial relationship between earthquakes and volcanoes. Do volcanoes and earthquakes occur in the same places? Include the three places you examined, your conclusions about the relationship, and why you believe the relationship either exists or does not exist.


Single click on the earthquakes theme so that it becomes raised up, or "active."





Each row in the table represents one earthquake in the dataset.


35) Look in the upper left part of your screen under ArcView GIS to get a count of the number of rows in the earthquakes table. How many earthquakes are recorded in this dataset?

36) Approximately how many earthquakes are recorded during an average year? Show how you determined this answer.

Click on the "magnitude" field and sort it in descending order  .

Navigate to the top of the table and click on the row containing the earthquake with the highest magnitude to select it. You may have to select the black selection arrow to select a row.   The row will appear in yellow.

37) What is the magnitude of this earthquake?


Close the table. In the Global GIS Tools box, on the right side of Viewing Tools, go to "More Tools." Select the "Zoom to Selected"  in the Global GIS Tools box:







Use the "zoom into center" button a number of times to zoom into your selected earthquake  

Turn on the themes political boundaries, and political boundary labels.



38) In which country did the largest earthquake occur?

Access the earthquakes table again and clear your selection. 


Select the field "km" in the table. This represents the depth of the earthquakes in kilometers underneath the surface.

Click on the "km" field and sort it in descending order. . Navigate to the top of the table and click on the row containing the earthquake with the greatest depth to select it.    The row will appear in yellow.

39) What is the depth of this earthquake?

Close the table and select the "Zoom to Selected" tool in the Global GIS Tools box . Use the "zoom into center" button  a number of times to zoom to your selected earthquake.

40) In which country did the deepest earthquake occur?

41) Did other deep earthquakes occur in this country? Use the Identify button  and click on other earthquake epicenters to find out.

Zoom out to Europe.

42) You are asked to indicate in your USGS report the countries you consider to be most vulnerable to earthquakes. List the top three countries, and your reasons for including them.

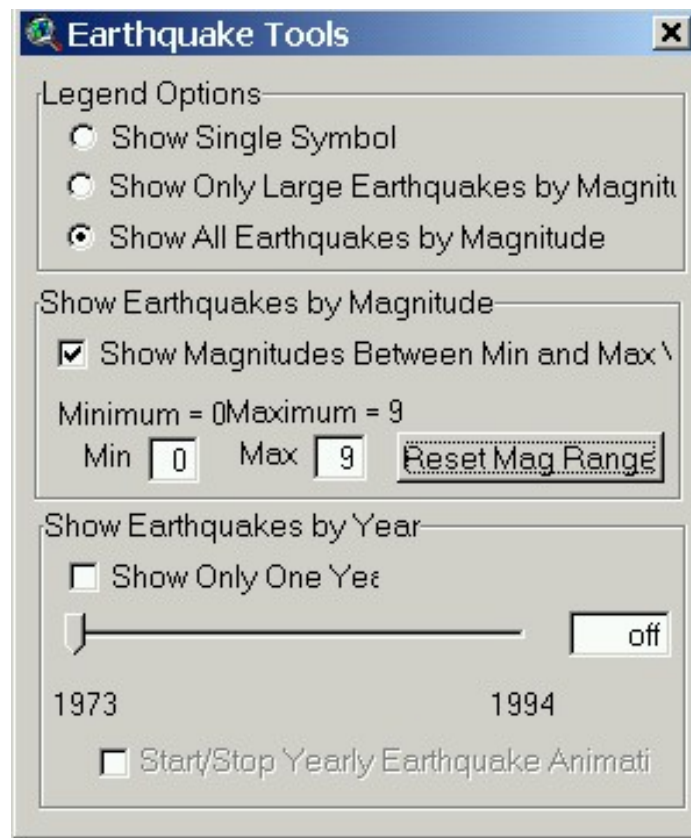
43) What is the magnitude of the earthquakes shown in your GIS?

44) If you displayed ALL earthquakes, would it be more or less than the number of earthquakes currently



shown in your GIS?

Click on "earthquake tools" in your Global GIS window. Show earthquakes of ALL magnitudes, as follows:



45) How does the pattern of ALL magnitudes compare to the earthquakes above magnitude 4?

Change the display back to showing earthquakes above magnitude 4.

Next, double-click on the Earthquakes theme to access the legend editor. Double-click on the earthquakes above 6 in magnitude and increase the size so that the large earthquakes stand out from the rest.

Examine your map.

46) Describe the pattern of large earthquakes in Europe in your own words.

47) Do the large earthquakes occur in areas where many other earthquakes exist, or do the large ones tend to occur off by themselves?

Pan  and zoom to Spain.

48) You receive an email from the USGS seismologists that ask you to determine three areas of Spain where most earthquakes occur. What three areas will you list in your report?

Turn on major cities and turn off earthquakes. You might have to zoom in to see the labels.

Create Profile

Use the "Create Profile" tool and draw a line from the Spain-France border near Andorra southwest across Spain to Gibraltar. Choose to profile the data set "elevation."

49) Describe how the land elevation changes across Spain from Andorra to Gibraltar.

Turn earthquakes back on.

50) Examine the earthquakes across your profile. What kind of terrain in Spain is more prone to earthquakes —valleys, central plateau, or mountains? Why? Turn off earthquakes, and note the location and names of the major cities. Turn earthquakes back on.

51) Of the major cities in Spain, indicate in your report to the USGS the 2 cities that you consider to be the most vulnerable to an earthquake. Indicate why you consider them to be the most vulnerable.

52) Congratulations! You have completed the first part of the assignment and have contributed much to the understanding of earthquakes in Europe. Indicate what you consider to be the most surprising thing you have learned in this part, the most interesting thing, and the most significant thing.

Most surprising:

Most interesting:

Most significant:


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### ... Part 2: Digging Deeper

In this part, you will examine the relationship between earthquakes and cities, and investigate earthquakes in a specific area in eastern Europe.

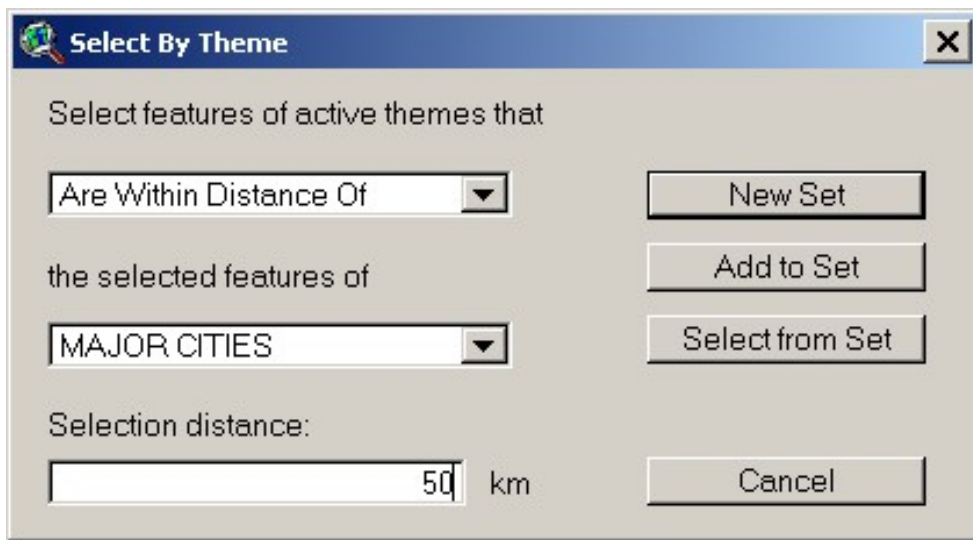
Click on the Advanced Interface button at the bottom of the Global GIS Tools window. You will notice the additional tools now at the top of your computer screen.


Make major cities the active theme by clicking once on it. Clear any previous city selections .

Make earthquakes the active theme by clicking once on it. Clear any previous earthquake selections .

Under the Theme pull-down menu, press "Select By Theme" to discover how many earthquakes are within 50 kilometers of major cities, as shown below. Click **New Set** when finished.





Examine the resulting cities table. . Look at the numbers "\_\_\_ of \_\_\_" in the upper left of your computer screen.

53) How many cities resulted from your query of the data? Explain in your own words what the results of your query means.

54) What *percentage* of European earthquakes are within 50 kilometers of major cities? Show how you determined this answer.

55) Make 3 observations about the pattern of earthquakes near European cities.

56) Compare the amount of earthquakes in Germany versus Spain. Which country would you say receives the most earthquakes?

57) Which country in Europe would you say receives the most publicity about earthquakes in newspapers, television, radio, and on the Internet?

58) Which country in Europe would you say receives the most earthquakes, based on your observations of the data on your map?

59) Compare your answer above to the two previous questions. Did you write a different answer for the two questions? If so, why do you suppose this is the case?

As you move around the map, notice the latitude and longitude values to the upper right of the view (map) window.

Zoom to the earthquakes near 26.53 east longitude and 45.70 north latitude. Set the scale to 1:1,000,000 by typing in the scale field in the upper right.

60) In which country is this?

61) Identify the two northeasternmost earthquakes (above 6.0 magnitude) in this area and use the identify

button to indicate  their magnitudes. List the magnitudes below.

Click on "Global GIS Help"  in Global GIS Tools. Go to "Datasets" and select the earthquakes theme.

62) What field name contains the **time** when the earthquakes occurred?

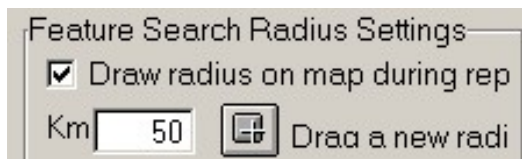
Based on this information, go back to your map and examine the time when the three earthquakes occurred. List the earthquakes below in the order of their occurrence.

63) Were these two large earthquakes associated with the same seismic event? Explain your answer.


64) What is an *aftershock*?

65) Do you think the earthquakes you are examining are evidence of an aftershock? If so, which earthquake was an *aftershock* of the first? Why?

66) Notice the "feature search radius settings" near the bottom of the Global GIS Tools window.



Drag a new search radius – a circle -- from these two earthquakes until the circle just touches the Pacific coastline. This should be a 20 kilometer search radius, and the number 13 should appear in the kilometers field.

Generate a map report  and click on the earthquake on the map again. Print the map report of this area.

67) Summarize in your own words what this report tells you.

You need to assess possible damage from future earthquakes in this region in your report, in terms of roads, airports, and population.

68) What is the 1998 population within 20 km of these earthquakes?

69) Who, in your opinion, are the most vulnerable segments of the population to earthquakes? Old people? Young people? Rural people? Urban people?

70) Turn on the roads layer. How far is the nearest road from the earthquakes?

71) Do you think roads could be damaged by earthquakes? Name three ways roads could be damaged.

- 72) How could the disruption of transportation affect evacuation from an earthquake and rescue operations?
- 73) What is the name of the nearest airfield to these earthquakes? How far is it from the earthquakes?
- 74) Do you think an airfield could be damaged by an earthquake? Describe three ways air services could be disrupted.
- 75) Congratulations! You have completed the second part of your mission and have contributed much to the understanding of earthquakes in Europe. Indicate what you consider to be the most surprising thing you have learned in this part, the most interesting thing, and the most significant thing.

Most surprising:


Most interesting:

Most significant:

.....

### ... Part 3: Investigating Earthquakes in Iceland

In this part of the unit, you will investigate earthquakes in Iceland, assess critical infrastructure, and assess the relationship of earthquakes to fault lines.

Make themes you have been working with the active theme by clicking once on it. Use shift-click to select multiple themes. Clear any previous selections .

- 76) Describe the pattern of earthquakes in Iceland.
- 77) Why does Iceland experience so many earthquakes?

A 6.1-magnitude earthquake occurred in Iceland on 21 June 2000. Visit this page:


[http://www.os.is/skjalfiti/index\\_e\\_21.html](http://www.os.is/skjalfiti/index_e_21.html)

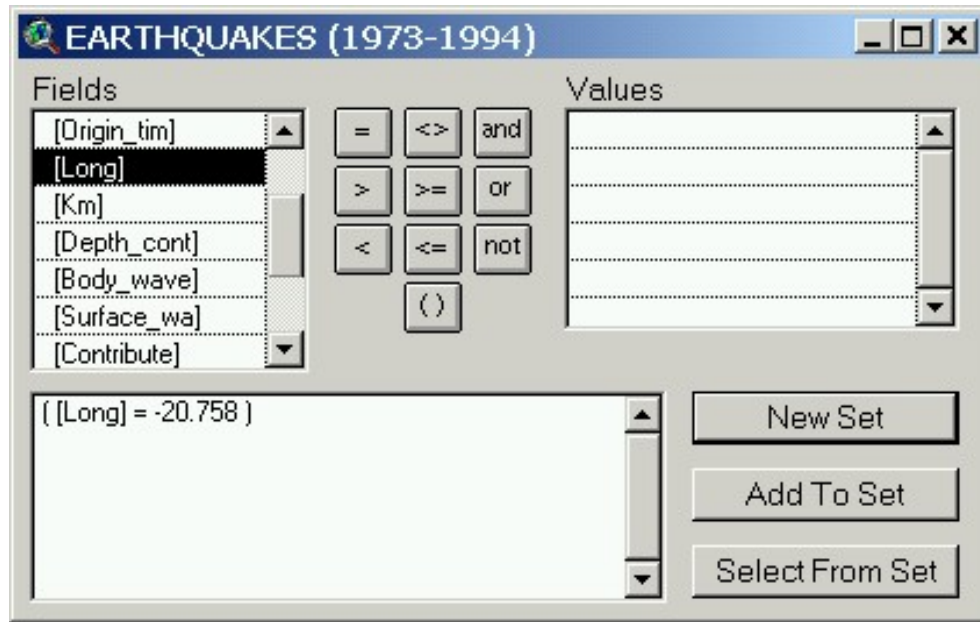
and click on **Pictures**.

- 78) After viewing the pictures, make three observations about the type of damage that this earthquake caused.
- 79) How severe would you say this earthquake was? Why?

Find this earthquake by its date and magnitude in your GIS, as follows.

Open the earthquake table .


Query  the table by asking for the earthquake at -20.758 (the minus sign indicates west longitude). Be sure to enter the information by clicking on the field names and equals sign.



Zoom to the earthquake at a scale of 1:3,000,000. The scale is in the upper right of the map. You can type in the exact scale as 3000000 if you wish in the scale box.


80) In what part of Iceland did this earthquake occur?

81) What direction from Reykjavik was this earthquake's epicenter?

82) Use the measure tool  answer the following. How far was the epicenter from Reykjavik?

83) Discuss how an earthquake occurring many miles from Reykjavik might have caused damage in that city.

Earlier, you considered the disruption that earthquakes pose to critical infrastructure. Turn on the airfields theme and name the nearest airfield to the earthquake.

84) Use the measure tool  to measure the distance to this airfield.

85) What city is the airport associated with?

86) Have you ever flown into this airport? Ask to find out if any of your classmates have flown into this airport.

87) Make roads, railroads, and utility lines visible. Make at least four observations about the proximity of these features to the earthquake.

88) Have other earthquakes occurred in this area of Iceland, or was the June 2000 earthquake an isolated case?

- 89) Turn on the Faults layer and discuss the relationship between earthquakes in this part of Iceland and fault lines.
- 90) Based on your investigations, indicate in your report to the USGS what you consider to be the two main reasons why this earthquake in June 2000 caused more damage than others in this area.
- 91) Do some research on this earthquakes in Iceland and indicate your findings below.
- 92) How does your research enhance what you learned about Iceland earthquakes through GIS?

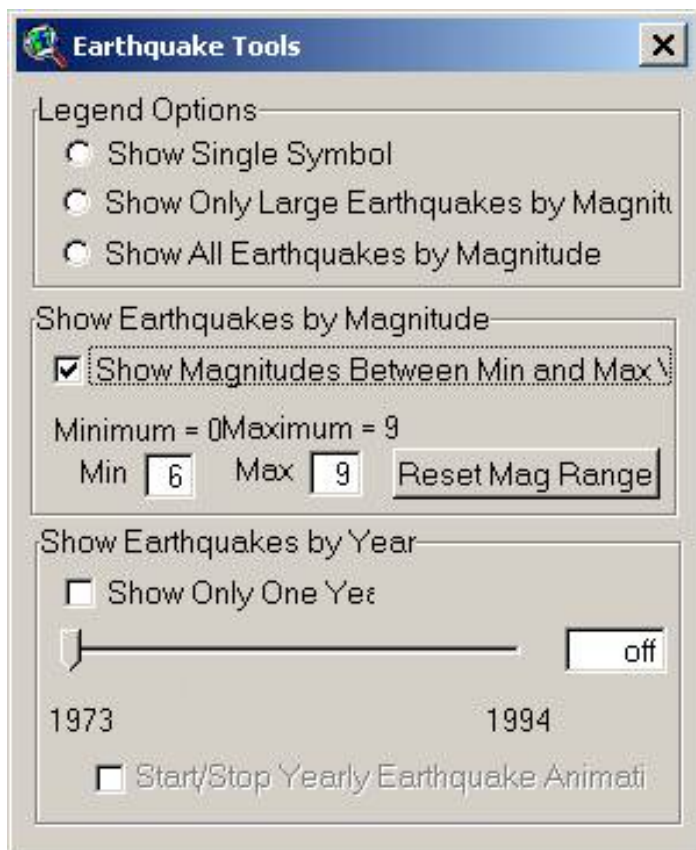
Next, you will examine faults in relationship to earthquakes throughout Europe.

Turn off all themes except faults, earthquakes, and the shaded relief base.

Zoom out to all of Europe using the globe symbol on the Global GIS Tools menu.



It is difficult to detect the relationship of earthquakes and faults, because of the large number of earthquakes. Reduce this number by clicking on "earthquake tools" in your Global GIS window. Show magnitudes between 6 and 9, as follows:



- 93) Describe the relationship between fault lines and earthquakes. Consider these questions in your narrative: Do earthquakes usually, or always occur near fault lines? Do earthquakes ever occur away from fault lines? If so, where? Do you think this map shows ALL of the faults in Europe, or just a few? How does this affect your answer?
- 94) Turn on earthquakes between 4 and 9, instead of 6 and 9. Does this affect your answer, above? Why or why not?
- 95) Turn on cities. Discuss the relationship between cities and fault lines for your report to the USGS.
- 96) Congratulations! You have completed the third part of the assignment and have contributed much to the understanding of earthquakes in Europe. Indicate what you consider to be the most surprising thing you have learned in this part, the most interesting thing, and the most significant thing.

Most surprising:

Most interesting:


Most significant:

.....


#### \*\*\* Part 4: A Historical Earthquake: Lisbon 1755

On 1 November 1755, Lisbon, Portugal was shaken by a large earthquake just offshore.

97) Zoom to Portugal and Lisbon. What body of water did the earthquake occur in?

Make the major cities theme active. Open the major cities table  and use the find button (looks like a binoculars) to search for Lisbon. Click in the row containing Lisbon to select it.

98) What is the population of Lisbon according to the data table?

Close the table. In the Global GIS Tools box, on the right side of Viewing Tools, go to "More Tools." Select the "Zoom to Select"  in the Global GIS Tools box:

99) In what part of Portugal is Lisbon?

100) Where did most earthquakes occur in Portugal and offshore from 1970 to 1994, according to your map?

101) How far was the closest earthquake to Lisbon from 1970 to 1994, what direction was it from Lisbon, and how large was it?

102) How many above magnitude 4 earthquakes occurred within 50 kilometers from Lisbon from 1970 to 1994?



103) Make two observations about the relationship of fault lines to earthquakes in Portugal.

In 1755, Lisbon was not only a city of 250,000 people, but the capital of the global Portuguese empire. It was one of the most important cities in Europe. Although Portugal had been hit by earthquakes in years past, it had been 200 years since the last major earthquake. The quake hit at 9:40 AM on All Souls Day. People died in three ways. First, many buildings collapsed, burying those inside and on the street outside.

Eighty-five percent of Lisbon's buildings were destroyed, including its famous palaces, the brand-new Opera House, and a 70,000-volume library. The earthquake destroyed also the major churches of Lisbon, and the Royal Hospital of All-Saints.

Second, the quake triggered a tsunami, which arrived soon afterwards. The survivors rushed to the open space of the docks for safety and watched as the water receded, revealing the sea floor, littered by lost cargo and old shipwrecks. The wave may have been 50 feet high.

104) From what direction did the tsunami come from?

Ships, docks and buildings in the city were battered by the high seas, and thousands were swept away. Third, lamps and cooking fires upset in the earthquake ignited a fire that proved impossible to control. It burned unchecked for three days, completing the destruction.

105) In all, perhaps 60,000 to 90,000 people died in the disaster in Lisbon alone. What percentage of the city's population were killed?

Thousands more died in other areas. The quake was felt throughout Western Europe.

106) Examine your map. What is the likely other country in Europe where people probably died as a result of this earthquake?

People also died in the northwest part of another continent.

107) Examine your map. What is the likely other continent where people were killed from this earthquake?

108) Consider the population of Lisbon in 1755 and today, and the population of Lisbon compared to other cities in Portugal. Would you say that Lisbon overcame this tragedy? Why or why not?

Read Rev. Charles Davy's account on:

<http://www.fordham.edu/halsall/mod/1755lisbonquake.html>

109) Does this account match what you have learned about the Lisbon earthquake? Where would you have tried to escape to if you were caught in this earthquake?

Zoom back to Europe. Now that you have examined a historically significant earthquake, it is time to examine a modern-day earthquake.



## ••• Part 5: A Modern-Day Earthquake: Turkey 1999

Zoom to Turkey and Greece. On Tuesday 17 August 1999, an earthquake struck the province of Kocaeli in Turkey.

110) What three major bodies of water are near Greece and Turkey?

111) Compare the seismic activity of this area to others you have examined so far, such as Iceland and Portugal.

The earthquake was 7.4 in magnitude. According to the USGS report, <http://pubs.usgs.gov/circ/2000/c1193/c1193.pdf>, the earthquake caused 17,127 deaths, 43,953 injuries, and damaged about 250,000 homes and businesses.

112) Compare the magnitude of this earthquake with others in the region. Was this earthquake larger than any earthquake in the region from 1970 to 1994?

113) Compare the magnitude of this earthquake with all others in the data set. Was this earthquake larger than any earthquake in the data set from 1970 to 1994?

114) Make two observations about the relationship of fault lines to earthquakes in Turkey.


The earthquake's epicenter was: 40.70 North Latitude, 29.91 East Longitude. Go to this spot on your map.

115) What is the closest major city to the epicenter?

116) What other major cities might have been affected by the earthquake?

117) How far was the closest earthquake to the 1999 earthquake, according to your map, from 1970 to 1994, what direction was it from the 1999 quake, and how large was it?

118) How many above magnitude 4 earthquakes occurred within 50 kilometers from the 1999 earthquake from 1970 to 1994?

Use the select feature button  to draw a box that is approximately 50 kilometers around the epicenter.

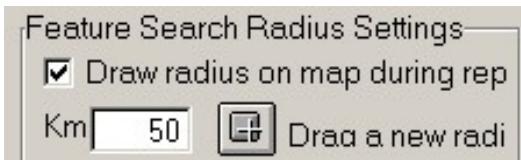
After selecting the earthquakes, access the table .


119) How many other earthquakes have occurred in this region?

120) How far is the nearest major fault to the earthquake epicenter?

121) Which is the closest airfield to the epicenter, in what direction is it, and how far away is it?

122) Generate a search radius, and drag a circle on the map with the Turkey epicenter as your starting point, as follows:



Next, generate a report  for this earthquake's location. Print the report and make at least five observations for your report for the USGS about the vulnerability this area—its population, roads, airfields, dams, and other critical infrastructure.


123) Think about what you have studied thus far. Would you say that a major earthquake is more likely to occur in Iceland, Portugal, or Turkey? Why?

Now that you have investigated major earthquakes, you will now turn your attention to your own community. If you don't live in Europe, turn select an area that you are interested in.


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\*\*\* Part 6: Investigating Your Community


In this part, the USGS needs you to report on your own community's vulnerability to earthquakes.

Make the themes you have been working with the active theme by clicking once on it. Use shift-click to select multiple themes. Clear any previous selections using the clear selection tool .



Zoom  to the country where you go to school. If you do not live in Europe, then select a country and then a city or community in which you are interested.


Make earthquakes the active theme by single clicking on it.


Label  the magnitudes of the earthquakes.

124) What country and community have you selected?

125) Describe what you consider to be the major natural hazards faced by your community, your country, and what rank you consider earthquakes to be in this list of hazards.

126) Describe the pattern and the number of earthquakes in your chosen country, region, and community.

127) Use the select feature button  to draw a box around the earthquakes that are in your chosen area.

After selecting the earthquakes, access the table . Look in the box in the upper left that indicates how many earthquakes are selected. How many earthquakes occurred in your selected region? Include a description of how much land you included in your selection box in your answer.

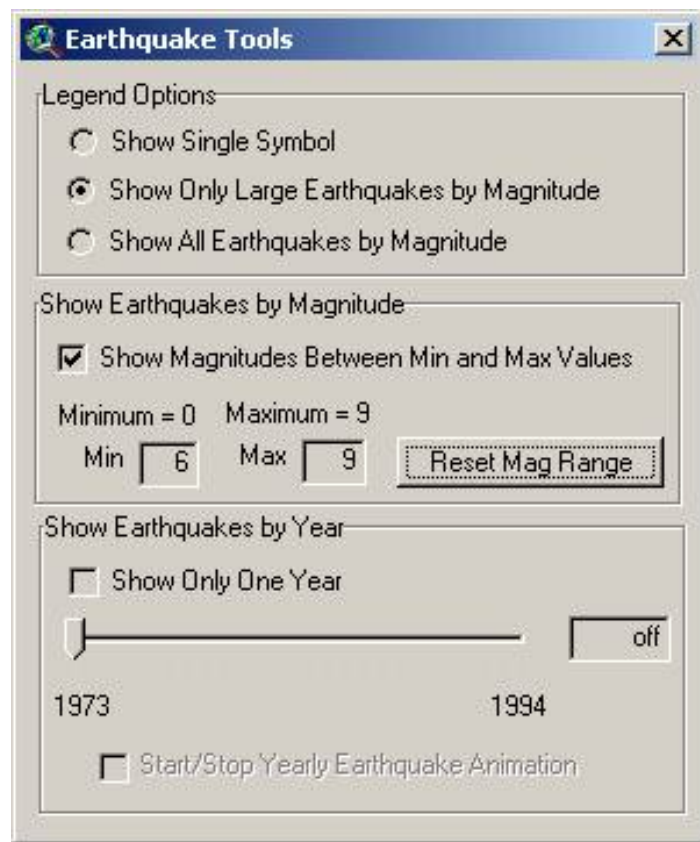
128) How do the pattern and number of earthquakes in your area compare to what you learned earlier about the pattern and number of earthquakes in Iceland?

Examine the earthquake map theme legend.

129) What is the range (minimum and maximum) of earthquakes that you are examining?

In the Global GIS Tools box, select the Earthquake Tool.

Click the "Show Magnitudes Between Min and Max" button and set the minimum magnitude to 6 and the maximum to 9. Press "Reset Mag Range" to reset the map, as follows:

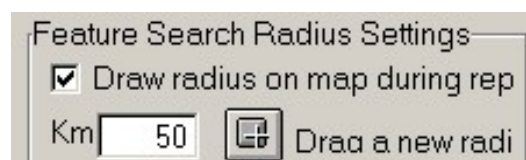


130) Where do most of the large (at least magnitude 6) earthquakes occur?


131) Do the large earthquakes have the same pattern of occurrence in Europe as those that you examined earlier that included magnitude 4 and 5 earthquakes? Why or why not?

Zoom closer to your own community at a scale of approximately 1:700,000.

132) Now that you know how to move to specific earthquakes, generate a search radius, as follows:





Next, generate a report , generate a report for the earthquake nearest your community. Print the report and make at least five observations for your report for the USGS about the vulnerability of your own area—its population, roads, airfields, dams, and other critical infrastructure.

133) Describe the earthquake nearest your chosen community: Indicate the location of your community, the direction from your school, the date it occurred, the magnitude, the depth, and the time of day it occurred.

134) Does anything surprise you about the earthquake event? Do you remember the earthquake? Did it cause any damage? Ask someone in your community to determine if they remember it; if you can find someone, indicate their response. If not, do some research on the earthquake and report the findings.

135) Congratulations! You have completed this part of the assignment and are contributing much to the understanding of earthquakes in Europe. Indicate what you consider to be the most surprising thing you have learned in this part, the most interesting thing, and the most significant thing.

Most surprising:


Most interesting:

Most significant:

.....

### ••• Part 7: Earthquakes Everyday

In this part, you will examine earthquakes by country in Europe, and compare recent earthquakes to your existing data.

Make the themes you have been working with the active theme by clicking once on it. Use shift-click to select multiple themes. Clear any previous selections using the clear selection tool .

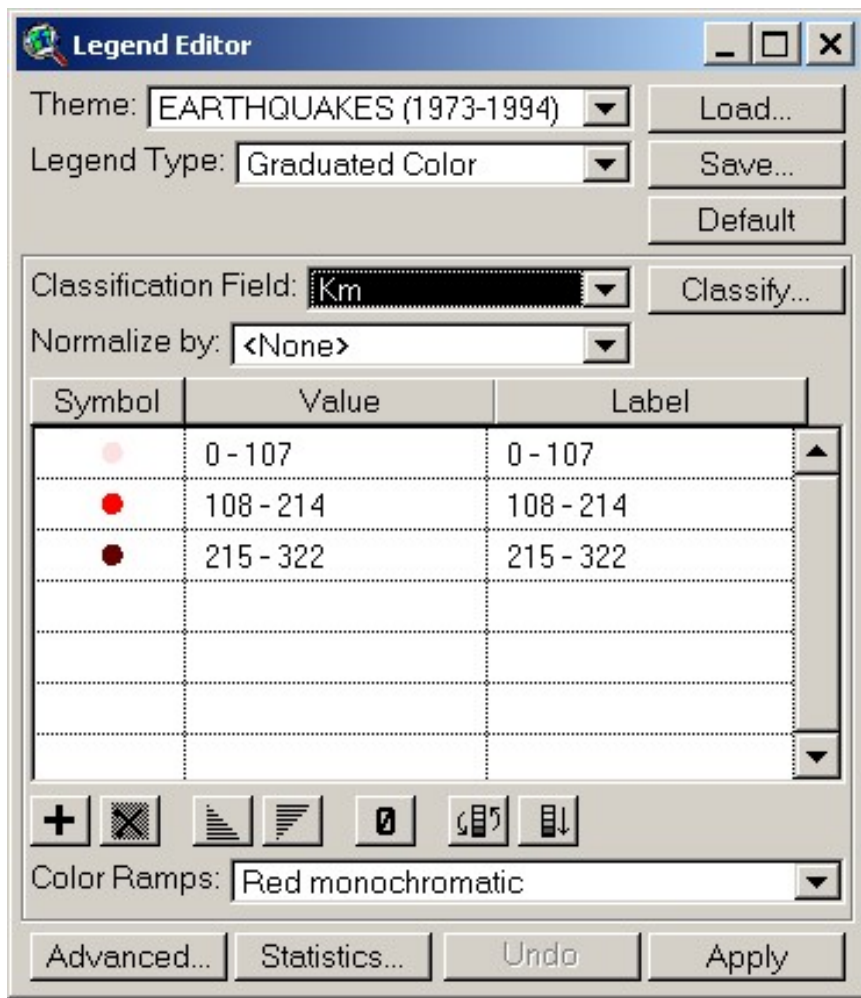
Make political boundaries and political boundary labels visible by checking the small boxes to the left of the theme names.

136) What country will you list in your report to the USGS that appears to suffer the most earthquakes?

137) Name two reasons, based on your observations of the map, why more earthquakes occur in this country than any other.

Make countries visible.

138) Change the legend from magnitude that you have been analyzing to examine the depth (“km” field) of earthquakes. Do this by double-clicking on the theme name to pull up the legend editor. Change the field name to depth, as follows:



Use this new legend by clicking on Apply.

Your new map represents the depth under Earth's surface at which the movement occurred, in kilometers underneath the surface.

139) Describe the pattern of the depth of the earthquakes and their distribution across Europe.

140) Is there a relationship between magnitude and depth? Why or why not?

141) What is the relationship between magnitude to the plate boundaries? Why? You may need a reference for plate boundaries on a map, in a textbook, or on the Internet.

142) What is the relationship between depth and the plate boundaries? Why?

143) Are certain types of plate boundaries associated with certain earthquake magnitudes and depth? Summarize what you know and can find out about this topic.

Minimize your GIS session.

Open a web browser. Access the USGS National Earthquake Information Center. This is the site in Golden, Colorado USA, that collects seismic information from all over the world.



<http://neic.cr.usgs.gov>

**USGS**  
Earthquake Hazards Program

**Latest Quakes** | EQ Facts & Lists | Hazards & Preparedness | For Kids Only | Regional Websites | Science & Technology

HOME | ABOUT US | EQ GLOSSARY | FOR TEACHERS | PRODUCTS & SERVICES | DID YOU FEEL IT? | FAQ | SEARCH

**National Earthquake Information Center**

The mission of the National Earthquake Information Center (NEIC) is to rapidly determine location and size of all destructive earthquakes worldwide and to immediately disseminate this information to concerned national and international agencies, scientists, and the general public. As [World Data Center for Seismology, Denver](#), the NEIC compiles and maintains an extensive, global seismic database on earthquake parameters and their effects that serves as a solid foundation for basic and applied earth science research.

**Earthquake Data Available from the NEIC**

- [Current Worldwide Earthquake List](#)
- [Latest Fast Moment Tensor Solutions](#)
- [Latest Energy & Broadband Solutions](#)
- [Earthquake Catalog Search](#)
- [Moment Tensor & Broadband Source Parameter Search](#)
- [AutoDRM](#)
- [Data Available Through FTP](#)
- [Routine U.S. Mining Seismicity](#)
- [International Seismograph Station Codes](#)
- [Large Earthquakes This Year](#)
- [Significant Earthquake Posters](#)

**Earthquake Activity in the Last Seven Days**

*Current World Seismicity*

Three globes showing earthquake activity with colored dots.

Select "Current Worldwide Earthquake List."

144) Examine this list. How many days does this information cover?

145) Does the number of earthquakes surprise you? Why or why not?

146) Are you familiar with any of these earthquakes? Did you hear about any of them on the radio, the newspaper, or on the Internet?

147) How many earthquakes appear in the list? **[a]**

148) How many earthquakes occur each day? Show how you determined the answer.

149) Examine the information about the list on the USGS earthquake web site. Does the list indicate ALL recorded earthquakes, or just the major ones? What is the cutoff criterion?

150) What percentage of earthquakes in the list occurred in Europe? Show how you determined your answer.

151) Does the pattern of new earthquakes in Europe fit the pattern you have been analyzing using your GIS tools and methods? Why or why not?

152) Indicate at least three things that you have learned about earthquakes in Europe from this lesson to this point.

153) Indicate at least three things that you have learned about GIS in this lesson to this point.

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### \*\*\* Part 8: Analyzing Recent Earthquakes

Only users who have a full version of ArcView can continue with this section.

In this part, you will incorporate the recent earthquakes as recorded on the USGS National Earthquake Information Center into your GIS so that you can further analyze them.

On the following site:

<http://neic.cr.usgs.gov>

You will notice choices at the end of the current earthquakes list. Select "comma-delimited earthquake list" to see it in the web browser window.

At the bottom of the current list, select "Comma-delimited Earthquake List" indicated on the image below:

<a href="#">2003/08/02 11:52:26</a>	51.31N	150.41E	539.9	4.4	<a href="#">SEA OF OKHOISK</a>
<a href="#">2003/08/02 10:18:37</a>	42.98N	17.77E	10.0	4.7	<a href="#">BOSNIA AND HERZEGOVINA</a>
<a href="#">2003/08/02 06:31:11</a>	37.64S	175.83E	217.0		<a href="#">NORTH ISLAND OF NEW ZEALAND</a>
<a href="#">2003/08/02 02:43:09</a>	18.24S	177.91W	401.6	4.5	<a href="#">FUJI REGION</a>
<a href="#">2003/08/02 00:53:10</a>	47.09N	74.96E	33.0	4.4	<a href="#">CENTRAL KAZAKHSTAN</a>

[Last 8-30 Days of Earthquake Activity](#) \* [Large/Noteworthy Earthquakes in 2003](#)

[Maps of Current Worldwide Earthquakes](#) \* [Maps and Lists of Current U.S. Earthquakes](#)

[Earthquake List Only](#) \* [Earthquake Map Only \(new window\)](#) \* [Comma-delimited Earthquake List](#)

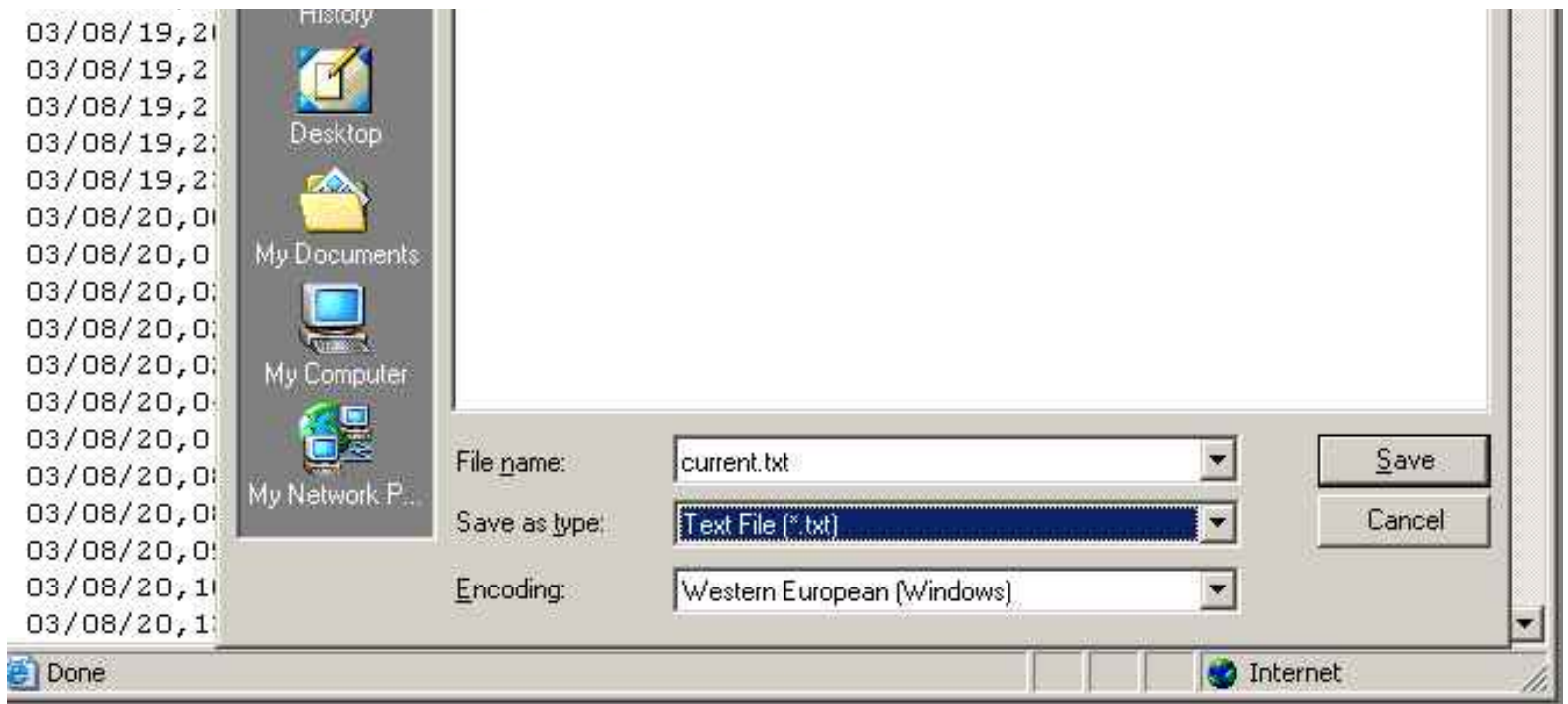
CLICK ON AN EARTHQUAKE BELOW FOR MORE INFORMATION

Using File, Save As, save the resulting file that appears in the list as a **plain text file** (not HTML, MS Word, or anything else) in an appropriate folder on your computer named "current.txt" as follows:

The screenshot shows a Microsoft Internet Explorer browser window displaying a list of earthquakes from the USGS NEIC website. The address bar shows the URL: <http://neic.cr.usgs.gov/neis/gis/bulletin.asc>. The main content area displays a table of earthquake data with columns for Date, Time UTC, Latitude, Longitude, Magnitude, and Depth. A 'Save Web Page' dialog box is open in the foreground, showing the 'Save in' field set to 'northamerica' and a list of folders including 'earthquakes\_files' and 'earthquakes\_short\_files'. The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The address bar also includes a search field, Favorites, Media, and a Go button.

Date, Time UTC	Latitude	Longitude	Magnitude	Depth
03/08/19,01:13:30	-33.02	-179.26	5.2	47.7
03/08/19,02:03:43	45.95	2.84	2.4	5.0
03/08/19,02:31:50	-39.64	174.70	3.9	37.0
03/08/19,02:56:58	-42.98	171.33	4.2	5.0
03/08/19,02:57:04	-32.2	-71.43	2.8	42.1
03/08/19,02:57:25	45.95	2.84	2.8	5.0
03/08/19,04:26:55	29.15	129.29	4.9	33.0
03/08/19,05:30:46	45.95	2.84	3.1	5.0
03/08/19,06:38:04	60.10	-153.4	4.4	157.0
03/08/19,08:32:38	48.43	6.67	1.9	5.0
03/08/19,10:18:48	38.81	20.50	3.8	0.0
03/08/19,13:52:10	-21.9	-179.61	5.0	605.2
03/08/19,14:01:19	39.87	33.10	2.7	6.8
03/08/19,17:12:52	45.93	2.78	3.3	10.0





Back in your GIS session, access the project window as follows:

Window--> Select the APR file:



Click once on Tables in the **project** window.

Click Add.

154) What kind of file did you save above (.dbf, INFO, or .txt?) \_\_\_\_\_ **[b]**.

155) In the lower left of the window, change the field to your answer in **[b]**.

Find your your text file in your folder and click OK.

Your table name should now appear in the list of tables along with a window with the data.

Go to the Window pull down menu. Click on the view window to make it active. This window should be named "Europe GIS."

Go to the View menu on the top and select *Add Event Theme*. Find your table current.txt.


Think of the Cartesian coordinate system from mathematics. Draw it below.

156) Which field is "x" - longitude or latitude?

157) Which field is "y" - longitude or latitude?

In the dialog box, indicate the correct fields for latitude and longitude based on your answers above.

Make the new theme appear by clicking on the small check box next to it.

158) Access the table.  How many earthquake epicenters are in your view?

159) How does this answer compare to your answer in **[a]** above? Why?


160) How does the spatial extent of the current earthquakes compare to the spatial extent of the Europe data? Why?

161) Compare the pattern of earthquakes over the past week to the earthquakes from Europe dataset. How many earthquakes last week were in Europe?

162) Do the new earthquakes follow the existing pattern? Why or why not?

163) Create a print of your map. All the information you wish to include in the final plot will be in a "layout." Zoom to your state or region. Determine which themes you would like shown in your plot.

Click on View --> Layout.

Use the "T" button  to add text to your layout.

Type in text. You should include the following items for your final map:

Your name(s).

Title of Map.

Date the map was created.

Print your layout to a printer by accessing: File--> Print.

164) Save your project using Fileà Save As. Place it in an appropriate folder. What is your project's name?

GIS allows for spatial data to be viewed in different map projections. Next, you will change the projection of your data so that you can examine Europe's earthquakes from the west coast.

Change the "projection" under View-->Properties to a **custom** orthographic projection, with a central meridian of 15 east longitude and a reference latitude of 50 degrees north.

Using this new projection, answer the following questions.

165) How does this compare to your old projection?


166) Scroll your mouse in the view. Are the coordinates in the upper right still in latitude and longitude? Why or why not?

167) Congratulations! You have completed this part of the assignment and have contributed much to the understanding of earthquakes in Europe. Indicate what you consider to be the most significant thing you have learned in this part of the lesson.


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### ••• Part 9: Earthquakes Respect No Boundaries

In this part, you will determine how many earthquakes occurred in each country through advanced GIS investigations.


Make themes you have been working with the active theme by clicking once on it. Use shift-click to select multiple themes. Clear any previous selections .

168) What country in Europe do you think has the most earthquakes?

Make countries (political boundaries) the active theme by single-clicking on it. Use the select feature button  and select the country (click inside the country) that you think contains the most earthquakes.

Make earthquakes the active theme by single clicking on it.

Under the Theme pull-down menu, press "Select By Theme" to discover how many earthquakes **intersect** the selected features of political boundaries. The "selected features of countries" is simply your selected county. Click **New Set** when finished.

Access the table for earthquakes.  This is the number of earthquakes that occurred within your chosen country.

169) How many earthquakes occurred within your country?

170) If you think there is a country with more earthquakes than the one you chose, repeat the above procedure for a different country.

Repeat the above procedure for France.




171) How many earthquakes occurred in France?


Repeat the above procedure for the United Kingdom.

172) How many earthquakes occurred in the United Kingdom?

173) Compare the number of earthquakes for at least 3 countries in Europe.

**The next section can only be completed by users with the full ArcView software package.**

Clear all selections from all datasets. 

The USGS says they need to focus research on the countries that contained the most earthquakes from 1973-1994. How will you find this information? To solve this problem, first examine the table associated with the earthquakes .

174) Does this table indicate which country the earthquakes occurred in?

Therefore, you need to join the country information from the administrative boundaries file to the earthquakes data so that you can determine which earthquakes were inside each country.

Go to the File-->Extensions menu.

Add the "GeoProcessing" extension. This adds a choice to the "view" menu.

Access the geoprocessing extension by pulling down: View--> GeoProcessing Wizard. This is the new menu choice that you added by accessing the geoprocessing extension.

Go to: Assign Data by Location, and click Next.

Next: Assign data **to** earthquakes **from** administrative boundaries.

175) Examine the earthquakes table.  What new fields have been added?

Click on the field "admin\_name".

Go to Field --> Summarize. Give the resulting file and appropriate name (such as quakesbyadminarea.dbf) and location and click "OK". Do not fill out anything else in the dialog box.

Examine your new table. Sort  the table on "count".

176) What does the count in the FIRST row of the summary table represent?

177) Compare the number of earthquakes under water versus the number on land. Show your work.

- 178) Which administrative area had the most earthquakes? Why?
- 179) Does this match what you expected? Why or why not?
- 180) How many were there in that administrative area?
- 181) Go to the map and access the administrative boundaries theme. Find out where this country is, name the country, and indicate the pattern of earthquakes there.


Go back to your quakesbyadminarea table.

- 182) What administrative area in **Spain** experienced the most earthquakes?
- 183) Which administrative area in **Romania** experienced the most earthquakes?
- 184) What administrative areas in **the Mediterranean Sea** experienced the most earthquakes? Why?
- 185) Were any administrative areas without earthquakes? Why? Include in your answer how you found out this information.

Examine the earthquakes table again .

Click on the field "cntry\_name".

Go to Field --> Summarize. Give the resulting file and appropriate name (such as quakesbycountry.dbf) and location and click "OK". Do not fill out anything else in the dialog box.

Examine your new table. Sort  the table on "count".

- 186) What does the count in the FIRST row of the summary table represent?
- 187) Compare the number of earthquakes under water versus the number on land. Show your work.
- 188) Which country had the most earthquakes? Why?
- 189) Does this match what you expected? Why or why not?
- 190) Describe the pattern of earthquakes in that country.
- 191) What country would you say has the greatest *density* of earthquakes? Is it the same as the country with the *most* earthquakes? Why or why not?
- 192) Which country had the second most earthquakes?
- 193) Describe the pattern of earthquakes in that country.

194) Indicate the top 10 countries for earthquakes in Europe:

195) Does this table indicate ALL of the earthquakes for Russia? Why or why not? Think about the continents that Russia is located in.

196) Were any countries without earthquakes? Why? Include in your answer how you found out this information.

Save your project, close your project, and exit ArcView.

197) Congratulations! You have completed the assignment and are ready to submit your results to the USGS. You have contributed much to the understanding of earthquakes in Europe. Indicate what you consider to be the most surprising thing you have learned in this part, the most interesting thing, and the most significant thing.

Most surprising:

Most interesting:

Most significant:

198) Indicate at least three things that you have learned about earthquakes in Europe from this lesson to this point.

199) Indicate at least three things that you have learned about GIS in this lesson to this point.

200) Give a presentation on earthquakes in Europe to your class, school, or community group. Include in your presentation:

(1)--Why earthquakes are a serious international natural hazard.

(2)--Where earthquakes occur in Europe

(3)--The relationship of cities, volcanoes, fault lines, and other features to earthquake epicenters

(4)--How GIS can aid in analyzing earthquakes and other spatial phenomena.

(5)--What you think the national and international community should do about earthquake preparedness.

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[U.S. Department of the Interior](http://rockyweb.cr.usgs.gov/outreach/globalgis/europe/earthquakes_europe.html)

[U.S. Geological Survey](http://rockyweb.cr.usgs.gov/outreach/globalgis/europe/earthquakes_europe.html)

URL:[http://rockyweb.cr.usgs.gov/public/outreach/globalgis/europe/earthquakes\\_europe.html](http://rockyweb.cr.usgs.gov/public/outreach/globalgis/europe/earthquakes_europe.html)

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