

Assessing Potential Seismic Risks of Indiana Urban Populations



By Walt Gray

Targeted Age: High School/Middle School

Lesson Structure: Individual Assignment or Group Project

Curriculum Objectives: 7.1, 7.2, ES1, ES2

Material Requirements: A computer with Internet access; printing or e-mail capability (optional).

Introduction

In this lesson, students will use IndianaMap to create geographic information systems (GIS) maps to demonstrate the amount of general seismic risk that exists for urban areas within the state of Indiana. Step-by-step directions and tutorial videos will provide students with the necessary resources to create the final product. A list of questions is provided in each section to judge student comprehension of the data presented to them. It is expected that students have studied the basics of seismology, especially the term *liquefaction*, before attempting this lesson.

As an instructor, keep in mind that GIS programs allow students to approach problems using a variety of different layers. Students might choose to address the issue using some creative combinations of GIS layers not addressed in this lesson.

What products does the instructor want the students to create and in what format?

IndianaMap provides students the ability to create a map, bookmarks, hyperlinks, and to print the maps they have created. As the instructor, you will need to determine functions you would like students to use during the lesson based on the technological issues in your classroom and the outcomes you desire.

General Class Discussion

Ask students to identify factors that should be considered when assessing seismic risks of an area. Responses will vary. Responses may include location of faults, seismic history, construction materials and techniques, soil types, soil moisture, and population density. Throughout this lesson, we will assume that construction materials and techniques are the same throughout the state.

Tell students that they will be provided with an online program that will allow them to display a variety of information on one map that will help them determine the seismic history of Indiana and the population densities of locations across the state. Have students log on to the tutorial site and then follow the instructions provided in the student handout.

Essential Questions to Be Addressed

Identify the region of Indiana at greater risk of experiencing seismic events compared to other regions.

Given the seismic history of Indiana, what magnitude of earthquake (Richter Scale) is the state most likely to experience in the future?

Which Indiana cities are at greater risk of experiencing greater structural damage and loss of human life?

Closure

Students should have recognized that the southwestern region of Indiana has historically been more seismically active owing to the presence of generally southwest-northeast trending faults in that region. The majority of these earthquakes range from 2.1 to 5.0 magnitude on the Richter Scale. While easily felt by humans, earthquakes of this magnitude generally cause only minor to moderate damage to structures. By comparing population densities, urban development, and seismic information it should be clear that the greatest seismic risk to human life and urban structures is in Evansville and Terre Haute.

Extension or Enrichment Ideas

Have students measure the distance between faults and nearby epicenters using IndianaMap.

Ask students to investigate liquefaction in more detail using the hydrology and geology layers found in IndianaMap.

Ask students to research historical seismic activity across the entire Midwest region of the United States.

The class could compare seismic data with the location of hospitals, dams, schools, major highways and roads, and energy-related sites to construct another aspect of the risks associated with earthquakes in Indiana.

Assessing Potential Seismic Risks of Indiana Urban Populations

(Student Handout)



Introduction

In this lesson you will learn how to use a geographic information systems (GIS) program (IndianaMap) to investigate the potential seismic risk of areas throughout the state of Indiana.

Essential Questions

What region of Indiana is at the greatest risk of experiencing a seismic event?

Given the seismic history of Indiana, what strength of earthquake (Richter Scale) is the state most likely to experience in the future?

Which Indiana cities are at greater risk of experiencing greater structural damage and loss of human life?

The IndianaMap Tutorial

1. Log onto http://inmap.indiana.edu/tutorial_video/Quick_Tour_GISAtlas.html.
2. Watch this tutorial video to learn how to use the variety of features to create your map. You may watch the video again if needed.
3. To end session, click on File in the upper left corner and select exit.

Creating a Map

1. Begin by logging on to the following Web site: <http://www.indianamap.org>
2. Now find the indianamap tab on the menu that runs across the top of the page.
3. Click on indianamap tab.



We are now going to unselect a few layers that appear by default on the map you are currently viewing.

4. Start by deselecting the **AutoRefresh Map** box. Note: This will require you to refresh the map each time you want to view a new set of map components.

5. Now click on the **Expand All** button to open all folders and subfolders.



6. Begin deselecting following layers: *Elevation*, *Place Names*, *Urban Areas*, *Interstates (TIGER)*, *Roads (TeleAtlas-labeled)*, *Roadways (INDOT)*, *Rivers (NDH)*, and *Lakes (NDH)*.

7. Scroll to the top and click on the **Collapse All** button.

8. Now click on the **RefreshMap** button. Your map should look like the image below:



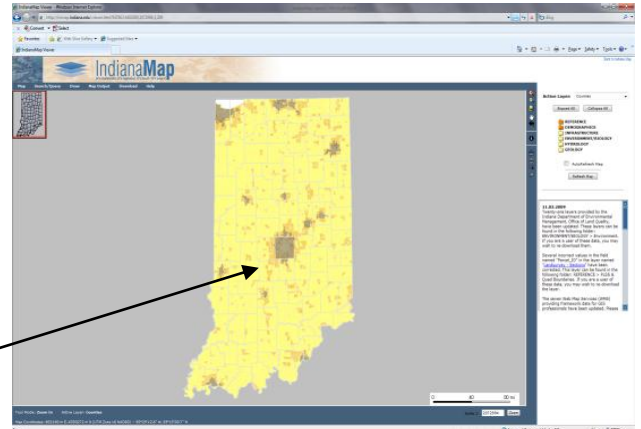
You'll notice that only the state and county boundaries are provided. Also note that the Reference file is orange and not yellow. This is because the layers titled *State* and *Counties* within this file have remained selected.

Adding Additional Layers

During the opening discussion, population density was mentioned as a factor related to the loss of human life during an earthquake. You will need to add layers that provide data related to populations density for the state of Indiana.

1. Click on the *Demographics* folder and then click the subfolder called *2000 Census & Population*.
2. Select the layers *Place Names* and *Urban Areas*.
3. Now click on the subfolder *Demographic Data*.
4. Select the layer *Population Density (Blockgroups)*.
5. Now click the **Refresh Map** button.
6. Scroll to the top and click the **Collapse All** button to close all the open folders.

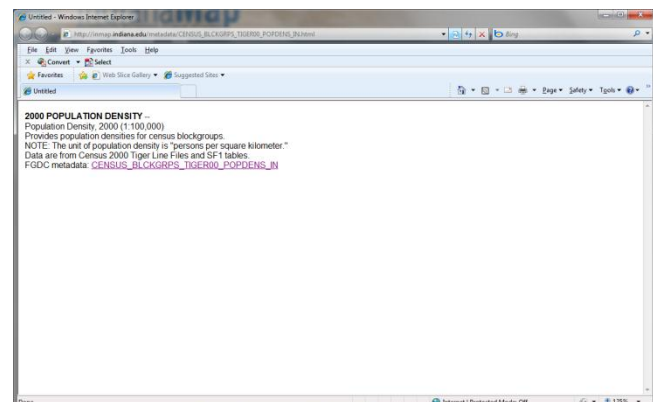
Your map should look like the example provided. Do not be alarmed if place names are not visible on your map.



Viewing Metadata

In order to learn more about the source of a data set, you will need to click on the “view metadata” icon located next to the layer name.

1. Click on the *Demographics* folder.
2. Next, click on the *Demographic Data* subfolder.



3. Find the layer *Population Density (Blockgroups)*.

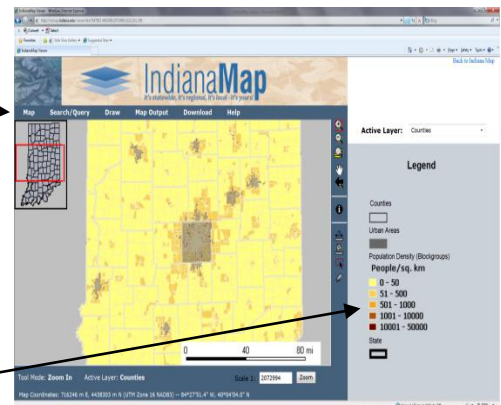
You should see three buttons next to the layer. Each is marked with a different letter or symbol: **m**, **d**, or a ↓

4. Click the button labeled with a lowercase **m**. This is the “view metadata” button. The popup window provides information related to the data shown on the map.
5. Exit metadata by clicking on the red X in the upper right corner.

Adding a Legend to a Map

A map without a legend does not allow us to extract data or draw any conclusions, so you should learn how to add a legend at this point.

1. To view the legend click on the **Map** tab found on the top menu.
2. A list appears which includes layers, legend, bookmarks, hyperlinks, and overview. Select **legend**.

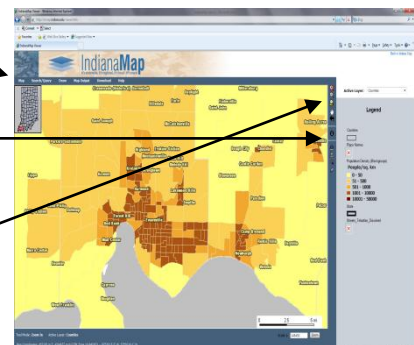


A legend should now appear to the right of the map.

Identifying Cities Using IndianaMap

You have already selected the *Place Names* layer found in the *2000 Census & Population* subfolder but you are unable to see the city names at the current scale. You will now learn how to zoom in and out in order to identify city names.

1. Return to the **Map** tab and select **Layers**.
2. Next, click on the **Select by Rectangle** icon on the vertical menu.
3. Click the **Zoom In** icon on the vertical menu.



4. In the lower southwestern region of Indiana you can see a relatively higher-populated area on the southern border. Use the cursor to draw a rectangle that surrounds this area. The program will automatically refresh the map for you. At this point should be able to view city names on your map.
5. Add a legend to your map by selecting **Legend** under the **Map** tab.
6. To return to the statewide view of your map simply select the **Zoom to Full Extent** icon located on the vertical menu.

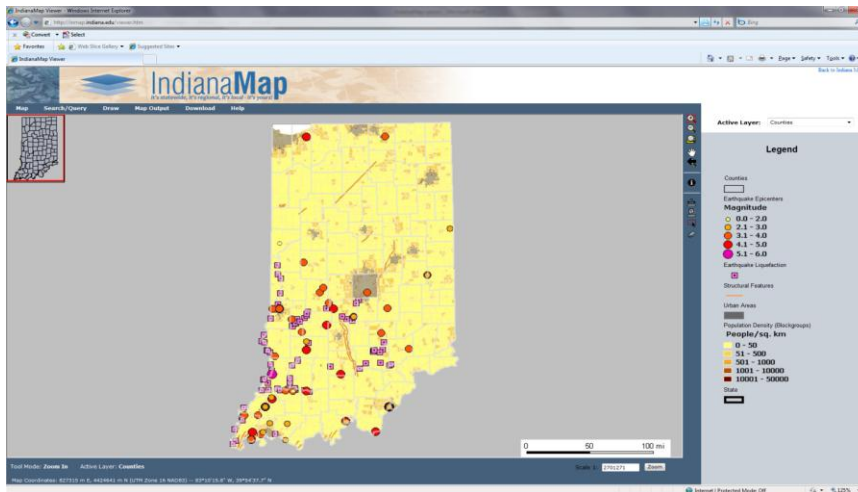
Using the skills you have acquired and the map you have created, answer the questions in Section One of the Student Response Sheet.

Adding More Layers

To learn more about the seismic history and potential for our state we will now add some layers that provide these data. Remember that the layers are found within the folders and subfolders of the Layers and Legend frame.

1. Zoom out to full extent if you have not done so.
2. Using the **Map** tab on the horizontal tool bar, click on **Layers** to view the folders and remove the legend.
3. Open the *Geology* folder by clicking on it now.
4. Next, click on the *Bedrock Geology* subfolder.
5. Select *Earthquake Epicenters*, *Earthquake Liquefaction*, and *Structural Features* within the *Bedrock Geology* subfolder.
6. Click **Refresh Map**.

7. To identify what all of these symbols and colors represent, you will need to click on the **Map** tab along the top horizontal menu and select **legend**. Your screen should look like the image below:



You are now ready to answer the questions in Section Two of the Student Response Sheet.

Creating Hyperlinks

To create a hyperlink of your map, watch the video tutorial at http://inmap.indiana.edu/tutorial_video/GIS_Atlas_Hyperlink_&_JPEG.html.

Printing Maps Created with IndianaMap

To print your map, watch the video tutorial at http://inmap.indiana.edu/tutorial_video/GIS_Atlas_Custom_Printing.html.

Student Response Sheet

Name: _____

Section 1. Population Density

1. Which two urban areas are the most densely populated areas of the state?
2. Name the two southwestern Indiana cities with the highest population density.
3. What is the typical population density of the city of Evansville? (include units)
4. Identify the source of the following data sets (Metadata):
 - a. Urban Areas: _____
 - b. Population Density: _____
5. Is population density a contributing risk factor in the death toll that can occur during an earthquake? Provide supporting details in your response.
6. Why would urban environments be at greater risk of experiencing structural damage to buildings and roads compared to rural locations? Explain your answer in detail.
7. Based only on urban development and population density data, would Indianapolis or Evansville be at greater risk of structural damage and deaths during seismic events? Provide supporting details for your response.

Section 2. Seismic Risk

8. Visually separate the state of Indiana into four regional sections (northeast, northwest, southwest, and southeast). Which region has the greatest number of:

Seismic Data	Region of Indiana with greater number of data points
Faults	
Epicenters	
Liquefaction Sites	

9. What is the normal magnitude of most earthquakes occurring in Indiana and what seismic event generated the greatest magnitude?
10. What is *liquefaction* and explain why this risk factor is so prominent in southwestern Indiana?
11. By analyzing the data created on your map, identify the urban area that may be at greater risk in terms of property damage and loss of human life. Provide detailed reasons for your selection.