Earthquake Probability Mapping for Idaho: An Internet Activity

***Putting Down Roots*, pp. 4-13**

Idaho State Standards:

Earth Science 1.2.1, 1.2.2, 1.2.3, 1.6.1, 1.6.2, 1.6.3, 1.6.6, 1.8.1, 5.1.1, 5.2.2
9th Mathematics 5.4, 5.5

Objectives:

Students will:

1. Display and interpret a probability map of an area in Idaho using the USGS 2009 Earthquake Probability Mapping application.
2. Explain how probability changes with a change in time and magnitude.
3. Correlate the probability map with the geologic provinces and seismic zones of Idaho.
4. Compare and interpret probability maps of three locations with the same magnitude and time span.
5. Communicate their findings in a summary report.

RATIONALE

In this activity students will use a computer application from the USGS web site https://geohazards.usgs.gov/eqprob/2009/index.php to display earthquake probability for different locations in Idaho. Students will input Idaho zip codes, a time span, and magnitude to generate a probability map. The web site was designed to display earthquake probabilities that are computed from the source model of the 2008 USGS National Seismic Hazard Mapping Project (NSHMP). The region of model validity is the coterminous (lower 48 states) USA and Alaska. The generated maps will show the probabilities of earthquakes within a radius of 50 km.

FOCUS QUESTION(S):

- Is there a difference between prediction and probability?
- What is the probability of an earthquake occurring within a given location in Idaho?
- How does the probability of an earthquake vary with time and magnitude?
- Which geological provinces in Idaho are most likely to be affected?

TEACHING CLUES AND CUES

Teachers may want to access https://geohazards.usgs.gov/eqprob/2009/documentation.php as background for understanding the finer details of the application.

Teachers may want to use this activity as a homework assignment or as a classroom discussion/presentation. Students should be familiar with Idaho Geologic Provinces as seen on the IGS poster or the black and white image found in the folder of this document. This activity also uses the *Putting Down Roots in Earthquake Country* from the Idaho Bureau of Homeland Security. Using pp. 10-13, students should determine in which seismic zone their towns or cities are located.

The parameters for magnitude and time span could be whatever you, the instructor, choose. However, it has been found that if you change only the magnitude (5.0, 6.0, 7.0) and leave the time span constant (100 years), there will be clearer difference between locations. Control all variables except one to facilitate student analysis. Adjust the time range and magnitude to see how the probability changes for a given location (keep the magnitude within 5.0 and 7.0 and a time span at or above 50 years).

See for yourself how the probability changes for a location with a magnitude of 7.0 and a time span of 100, 1,000, and 10,000 years, or change the magnitude from a 5.0 to 6.0 to 7.0 but keep the time span at 100 years.

MATERIALS:

for teacher

- Computer with internet access
- *Optional*: projection equipment
- List of Idaho Zip Codes (see document or access: http://www.555us.com/555ID/555id_zipcodes.htm
- Geologic Map of Idaho (poster size) – Classroom set http://www.idahogeology.org/Products/reverselook.asp?switch=title&value=Geologic_Map_of_Idaho,_color_poster or copies of the black and white image *Idaho Geologic Province* included in the accompanying CD-ROM.
- Highway or atlas maps of Idaho that show location of cities and towns (paper or computer image) http://itd.idaho.gov/maps/
- Copies of the publication *Putting Down Roots in Earthquake Country* from the Idaho Bureau of Homeland Security for each student (see address in Sources for acquiring copies)
- Answer Key, pp. 18-19

for the students: (work in pairs)

- Computer
- Geologic Map of Idaho
- Highway map of Idaho or Atlas
- *Putting Down Roots in Earthquake Country* , pp. 4-13
- Student worksheet/instructions p. 17

PROCEDURE:

Teacher Preparation

Purchase a classroom set of the Idaho Geologic Map poster or print out the black and white "Idaho Geologic Provinces" map found on the accompanying CD-ROM. Print out copies of the student worksheet for the students as well as a list of the Idaho Zip Codes for yourself (also found on the CD-ROM). Decide which zip codes you will use or let students choose. Demonstrate how the students will access and use the application at the USGS web site. Familiarize yourself with the application. Adjust the time range and magnitude to see how the probability changes for a given location. *See Teacher Clues and Cues.*

A. Introduction

Display the Geologic Map of Idaho. Make sure students know how to interpret the map. Each student should receive at least three locations to analyze, preferably one each in the northern, southwestern, and southeastern sections of Idaho. Reinforce the connection between earthquakes and geology. Give students time to find their cities/towns on the highway map or atlas and correlate it to the geologic map. A few, but not all, locations are identified on the geologic map.

B. Lesson Development

1. Provide the students with 3 locations (adjust the number of locations as needed).

2. Using Idaho maps and booklet information, determine where the three towns/cities are located and in which geologic province and seismic zone they are found.

3. Access the application at the USGS web site and input the variables assigned by the instructor.

4. Change the time span and magnitude variables as instructed and analyze the change, if any.

5. Save the map images. Import the images of each location into the summary report.

6. Write a summary of the findings on the probability of an earthquake in the three locations within a specific time span and magnitude. The summary should include a description of how the probability changes as the magnitude **or** time span changes, and an image of each location with the same magnitude and time span. With each location, include the identity of the geologic province and seismic zone in which it is found.

C. Conclusion

Students should see that, as the magnitude increases, the probability of an earthquake occurring over a specific time span will decrease. Different regions of the state will display greater, more obvious changes from one magnitude to the next. Students should see that there is more of a chance for magnitude 5 earthquakes than magnitude 7 earthquakes. However, they will also see that, if they go beyond a 7.4, there will be no data.

Adaptations and Extensions

Students may want to research probability maps of different areas of the United States, including Alaska. Suggest cities located along major rivers, edges of mountain ranges, along coast lines, etc.

Challenge students to see if they can determine the magnitude of the largest probable earthquake in Idaho *(M7.4, due to the types of faults that exist and rock structure in the state).*

Student worksheet

Earthquake Probability Mapping

(An Internet Activity)

Student Instructions:

1. Go the U.S. Geological Survey web site https://geohazards.usgs.gov/eqprob/2009/index.php to access an application that will allow you to compare the probability of an earthquake of a specific magnitude over a specific time period using three Idaho sites.

2. At this web site, you will input the location using three zip codes (given to you by your teacher), rather than the latitude and longitude. Click on the link to "input Zip Code"

3. List the three (3) Towns/cities and their zip codes that you have been assigned:

A. _____

B. _____

C. _____

4. Find the towns on the Idaho Highway Map. Use the Geologic Map of Idaho to determine in which geologic province the towns are located. Use the booklet ***Putting Down Roots in Earthquake Country: Your Handbook for Earthquakes in Idaho*** to determine the Seismic zone in which these towns are located (pp. 8-13).

5. Enter your first location's zip code and a "Time Span" and a "Magnitude" as instructed by your teacher. Click on "Compute Probability."

6. Save the generated image either as a PDF file or an image PNG file on your computer. A PDF file will result in a larger map saved. You will use these images in your summary report.

7. Go back to the map generator page and, without changing the zip code, change either the time span or the magnitude, according to your teacher's instructions. Do not change both. Generate a new map and save. Repeat one more time again changing the Time Span or Magnitude.

8. Enter the zip code of another one of your locations. Repeat steps 4 – 7 for this location.

9. Repeat the process again for your third location.

10. Write a summary report analyzing the probability of an earthquake occurring in your locations. Compare the different sites using the same magnitude and time span. Be sure to include location, geologic province, and seismic zone. Include rock type, if known, and any other relevant information.

11. Cite the resources used at the end of your summary, using appropriate citation methods.

ANSWER KEY (Sample)

The three locations analyzed were Athol, Idaho in the northern Idaho panhandle; Alpha (Cascade) in the west central mountains of Idaho; and the Idaho National Laboratory (INL) near Idaho Falls in southeastern Idaho. The probability parameters for each site were a magnitude of 7.0 within a 100 year time span. Athol, Idaho is located in the Idaho batholiths Kiniksu Outlier province of northern Idaho. This province is composed mainly of granite, intermixed with Belt Super Group metamorphic rock. This province resides within the Lewis and Clark seismic zone. The seismic zone is roughly 30 miles wide and approximately 240 miles long. It extends through northern Idaho to northwestern Montana.

The probability of an earthquake with a magnitude of 7.0 occurring within a 50 kilometer radius during a 100 year time span is basically zero (Figure 1). However, the probability increases as the magnitude (M5.0) decreases (Figure 2). Many of these lower magnitude earthquakes may be associated with rockbursts from mining activity within the 50 km radius. It is interesting to note that the probability increases further east into Montana. As a result, it is likely that the earthquake would be centered in Montana and felt within a 50 km radius, westward into the Idaho panhandle.

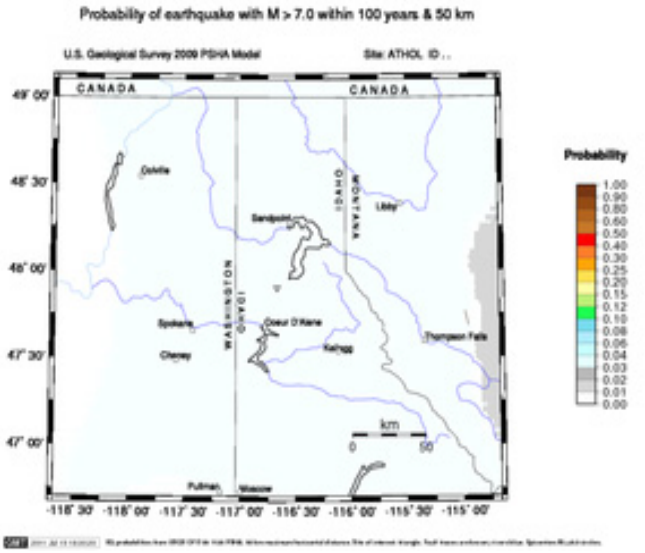

Figure 1

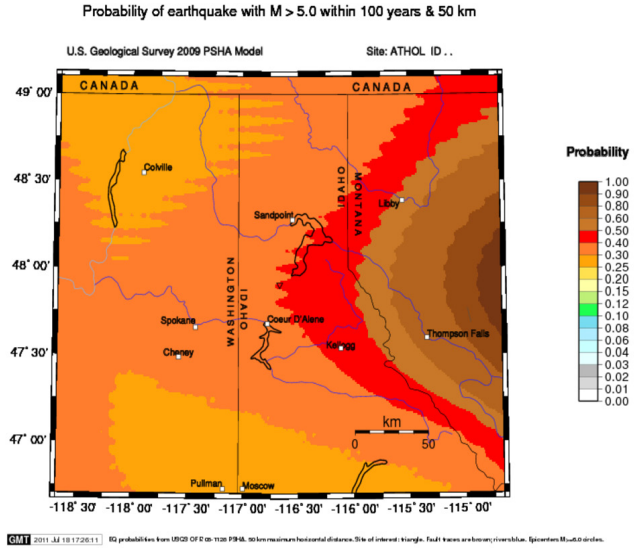

Figure 2

In southern Idaho, the probability of seismic activity varies between the western and eastern part of the state. The two locations compared were the INL (Idaho Nuclear Laboratory) facility outside Idaho Falls and Alpha a small community south of Cascade, ID. For example, between western and eastern Idaho the probability increases moving eastward. Using the same parameters for both locations--a 100 year time span, a 50 km. radius, and a 7.0 magnitude--the two sites were compared. The probability of a 7.0 magnitude earthquake affecting the INL location is higher than an earthquake of the same magnitude affecting Alpha, ID (Figures 3 and 4).

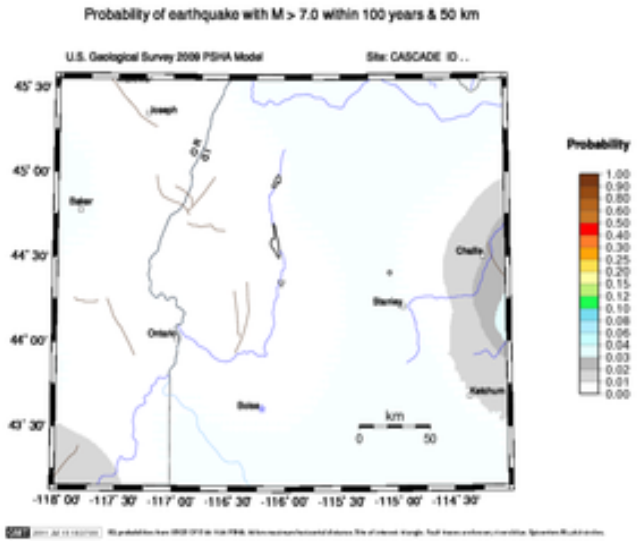

Figure 3

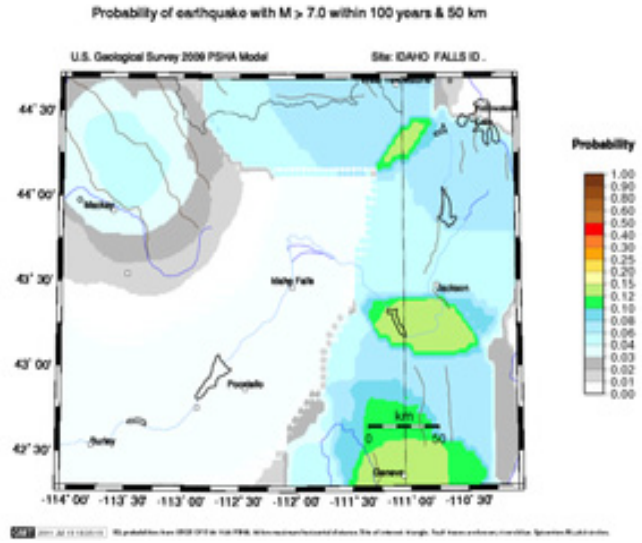

Figure 4

The location of Alpha lies in the Western Seismic Zone and is associated with the Long Valley fault zone. The geologic province in which it resides is the Atlanta Lobe of the Idaho batholith. The INL is located on the Snake River Plain mainly composed of basalt and located south of the Central Idaho Seismic Zone. It sits between two major faults--the Lost River Fault and the Lemhi Fault. According to the Probability maps of the two areas, the INL is 2 times more likely to be affected by a M7.0 earthquake than the area of Alpha, ID over the same 100 year time span. According to the probability maps in Figures 1, 3, & 4, it appears that the southeastern area of Idaho is more likely to have a M7.0 earthquake than the northern and southwestern area of the state.