Resilient Society - Activity
Earthquake Recurrence and Probability

Your Name _____

Conditional probabilities are estimates of the probability of an earthquake of given magnitude occurring in an area within a specified time period. These estimates are based on a synthesis of real-time data, historical records and geologic evidence of pre-historic earthquakes.

For this activity, you will use the history of earthquakes in the Pacific Northwest (PNW) in an attempt to determine the hazards this area is facing in the future.

You will gather data form a database and analyze that data with a basic calculator. The math is multiplication, division and finding averages; however, the numbers are not even and you should carry 3-4 numbers out from the decimal.   Follow the steps in order as this lays out the activity and outcome in a meaningful way.

You will be using the USGS to help you find the number of earthquakes in a given window of years with a limited magnitude range.

A.   Go to https://earthquake.usgs.gov/earthquakes/search/
B.   Select magnitude (e.g., 5-5.9)
C.   Select Custom time window (e.g., 1980-01-01 to 2010-01-01)
D.   Open Advanced and define PNW map area:
      50   North
      42   South
      -127   West

-119   East
    E. Leave the other fields blank
    F. Click <Search>

1. Complete the following:
    a) How many M3.0-M3.9 Earthquakes were there between 1980 and 2010?
    b) How many M4.0-M4.9 Earthquakes were there between 1980 and 2010?
    c) How many M5.0-M5.9 Earthquakes were there between 1980 and 2010?
    d) How many M6.0-M6.9 Earthquakes were there between 1980 and 2010?

2. How many M6.0-6.9 earthquakes have there been in the Pacific Northwest since 1872?

3. How many M7.0-7.9 earthquakes have there been in the Pacific Northwest since 1872?

Recurrence

4. What is the average number of earthquakes per year between magnitude 3.0 and 3.9? (Hint: Average = Total/10) Record your answer in the data table sheet below.

5. What is the number of earthquakes expected in ten (10) years? (Hint: # of quakes expected in 10 years = Average # of quakes per year x 10 years). Record your answer in the data table sheet below.

6. What is the average time (in days) between magnitude 3.0-3.9 earthquakes? (Hint: Average time between quakes = 365 days per year/ Average # of quakes per year). Record your answer in the data table sheet below.

7-15. Repeat 1-3 for 4-4.9, 5-5.9 and 6-6.9

DATA TABLE SUMMARIZING RESULTS

Magnitude Range	Average number in one year	Number Expected in ten years	Time between quakes (days)	Time between quakes (years)
3.0 – 3.9				
4.0 – 4.9				
5.0 – 5.9				
6.0 – 6.9				

16. Plot the magnitude against the average amount of time (in years) between each quake. A piece of log-normal graph paper is provided.

17. From your plot, project how often M 8 and M 9 earthquakes might happen by extending the best-fit line. What is their average rate of recurrence (years)?
    M8:   Recurrence:
    M9:   Recurrence:

18. Recent evidence has shown that there were great (M 8-9) earthquakes ~310, ~700, ~1200, ~1610, ~2080 and ~2610 years ago. Does this data fit with your calculations?

est. year	interval (years)
1700 AD	> 316
1310 AD	390
810 AD	500
400 AD	410
170 BC	570
600 BC	430

Great NWP EQs

19.   For every great earthquake (M 8-9) that occurs in this area, how many M7-7.9 earthquakes would you expect, how many M6-6.9 earthquakes, how many M5-5.9 earthquakes, how many M4-4.9 earthquakes? Can you generalize this systematic relationship between number of events and magnitude (this is called the Gutenberg-Richter Law).

Magnitude vs. Period