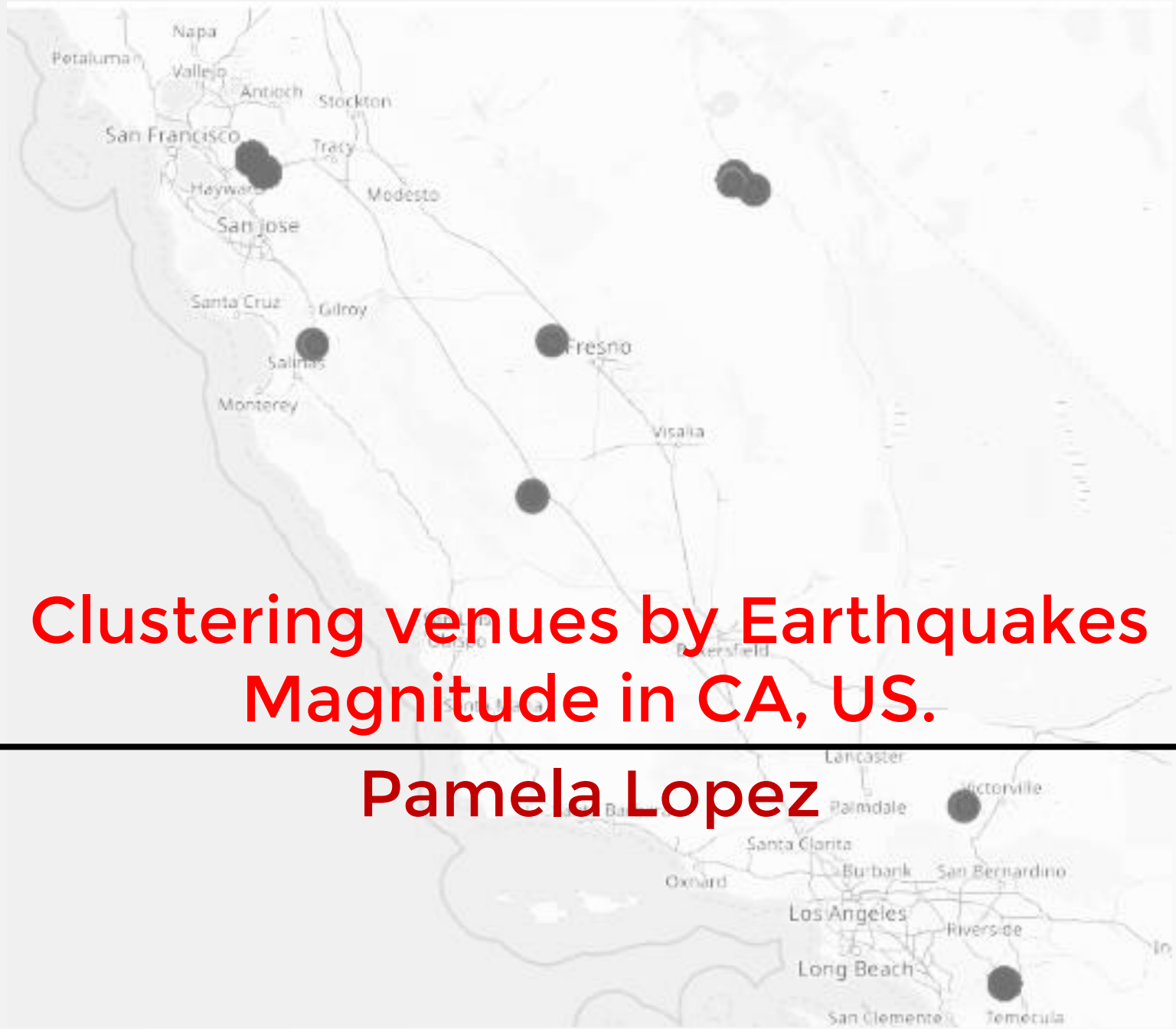


Clustering venues by Earthquakes Magnitude in CA, US.

Pamela Lopez

1. Introduction

EARTHQUAKE

used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth. (1)

HAZARD

is anything associated with an earthquake that may affect the normal activities of people. This includes surface faulting, ground shaking, landslide, liquefaction, tectonic deformation, tsunamis, and seiches. (2)

RISK

is the probable building damage, and number of people that are expected to be hurt or killed if a likely earthquake on a particular fault occurs. (3)

2. Data

- **SM2.5+ Earthquakes Past 30 Days Data**
  USGS Earthquake Hazards Program
  (https://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/2.5_month.geojson)

	id	mag	place	title	longitude	latitude
0	ci39120144	2.73	13km ENE of Ridgecrest, CA	M 2.7 - 13km ENE of Ridgecrest, CA	-117.551333	35.676333
1	nc73288720	2.94	16km NW of Pinnacles, CA	M 2.9 - 16km NW of Pinnacles, CA	-121.259499	36.638668
2	nc73288615	2.69	32km SSE of Somes Bar, CA	M 2.7 - 32km SSE of Somes Bar, CA	-123.294998	41.127998
3	ci39117528	2.59	22km ESE of Little Lake, CA	M 2.6 - 22km ESE of Little Lake, CA	-117.682667	35.850833
4	ci39116408	2.51	36km NW of Baker, CA	M 2.5 - 36km NW of Baker, CA	-116.316500	35.520833

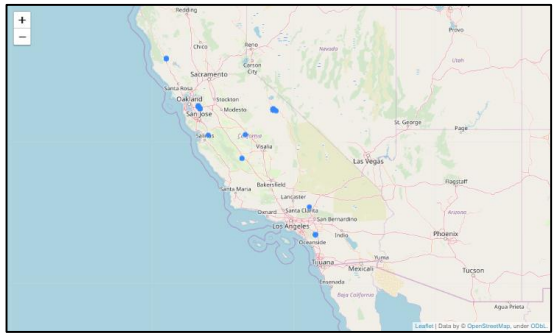
- **Fisrt 100th venues 1.5 Km arround each epicenter**
  Foursquare

	Earthquake	Earthquake Magnitude	Earthquake Place	Earthquake Title	Earthquake Latitude	Earthquake Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	nc73287360	2.54	3km E of Mammoth Lakes, CA	M 2.5 - 3km E of Mammoth Lakes, CA	37.640999	-118.950333	SKADI	37.637522	-118.965933	Modern European Restaurant
1	nc73287360	2.54	3km E of Mammoth Lakes, CA	M 2.5 - 3km E of Mammoth Lakes, CA	37.640999	-118.950333	Roberto's Cafe	37.641956	-118.966163	Mexican Restaurant
2	nc73287360	2.54	3km E of Mammoth Lakes, CA	M 2.5 - 3km E of Mammoth Lakes, CA	37.640999	-118.950333	Mammoth Rock-N-Bowl	37.636578	-118.964965	Bowling Alley
3	nc73287360	2.54	3km E of Mammoth Lakes, CA	M 2.5 - 3km E of Mammoth Lakes, CA	37.640999	-118.950333	Mammoth Tavern	37.637532	-118.965910	Pub
4	nc73287360	2.54	3km E of Mammoth Lakes, CA	M 2.5 - 3km E of Mammoth Lakes, CA	37.640999	-118.950333	Mimi's Cookie Bar	37.637504	-118.966654	Bakery

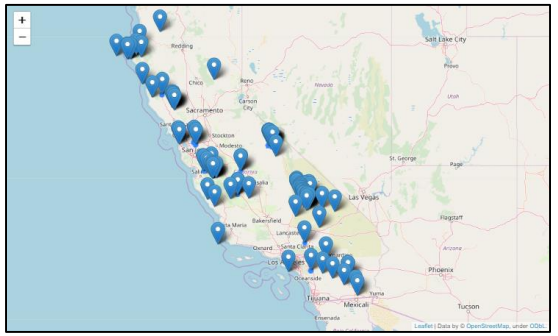
3. Methodology

- **Data visualization**

Venues data



Epicenters data



- **California's venue data preprocessing**

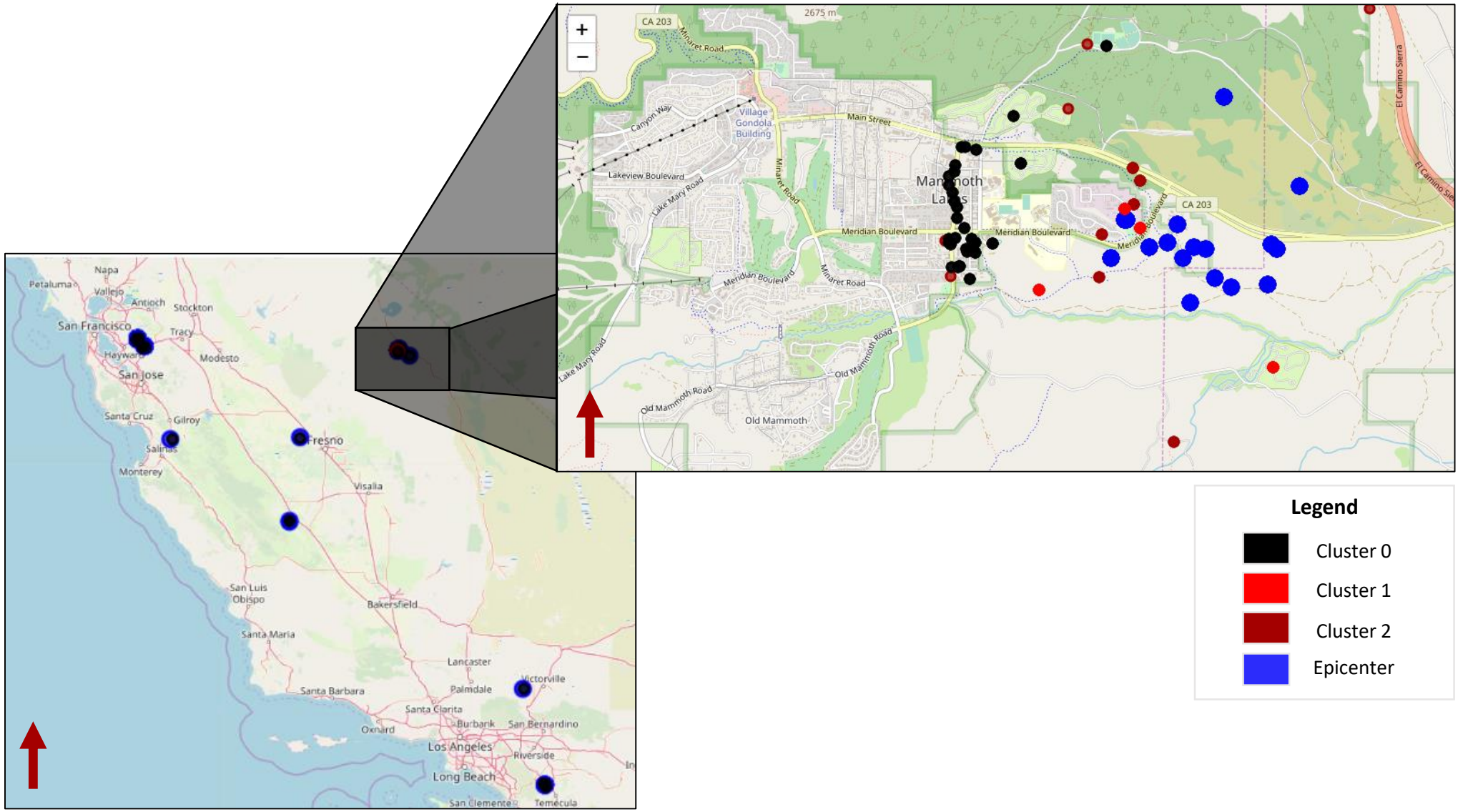
  5th most common Earthquake Magnitude by Venue

	Venue	1st Most Common Magnitude	2nd Most Common Magnitude	3rd Most Common Magnitude	4th Most Common Magnitude	5th Most Common Magnitude
0	7-Eleven	2.91	3.96	2.73	2.47	2.48
1	9110 Nail Salon	2.74	2.91	2.73	2.47	2.48
2	Amador Lakes Gym	2.91	3.96	2.73	2.47	2.48
3	Amador Rancho Park	2.74	2.91	2.73	2.47	2.48
4	Angelina's Cafe	2.47	3.96	3.14	2.48	2.5

- **K-means clustering**

  K=3

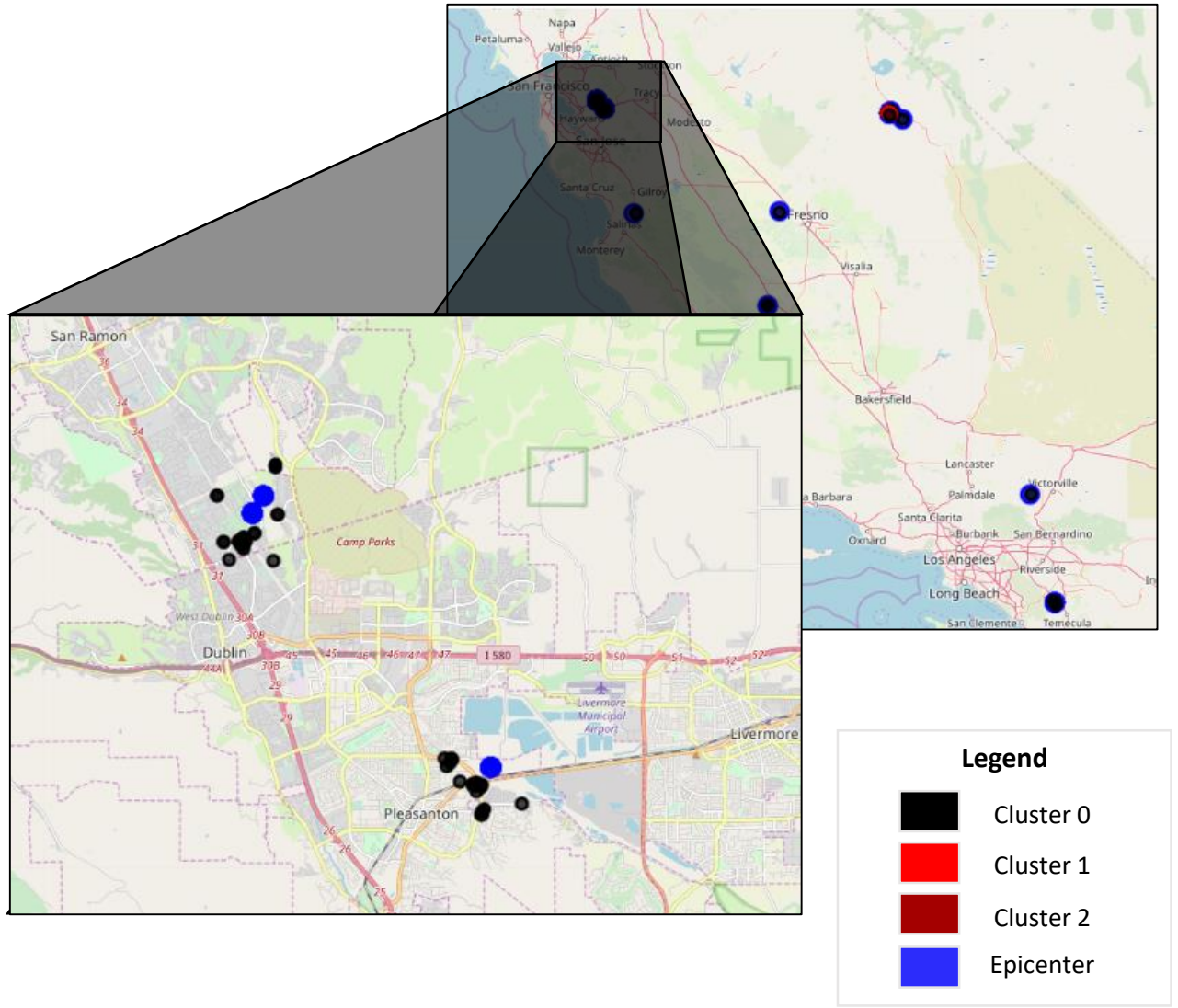
4. Results


Napa
Petaluma
Vallejo
Antioch
Stockton
San Francisco
Tracy
Modesto
San Jose
Santa Cruz
Gilroy
Salinas
Monterey
Fresno
Visalia
San Luis Obispo
Bakersfield
Santa Maria
Lancaster
Victorville
Santa Barbara
Palmdale
Santa Clarita
Burbank
San Bernardino
Oxnard
Los Angeles
Riverside
Long Beach
San Clemente
Temecula
CA 203
Minaret Road
2675 m
Village Gondola Building
Canyon Way
Main Street
Lakeview Boulevard
Lake Mary Road
Meridian Boulevard
Old Mammoth Road
Old Mammoth
El Camino Sierra
Legend
Cluster 0
Cluster 1
Cluster 2
Epicenter

5. Discussion

During the execution of this code there were many connection issues, so from the 50 Km considered in the beginning, the venues consulting was restricted to only 1.5 KM, that's why at first sight, the venues analized are almost over the epicenters points.

Zooming into then, it's clearly that the black points are closests to the epicenters (in most cases to just one). Only to the East it can be seen more diversity of clusters (black, dark red and light red).



6. Conclusion

- **The k-means clustering identified on the map that the venues nearest to the epicenters are in the Cluster 0, while the less common are Cluster 1 and Cluster 2.**

- **It is proposed that for better results, the venues consulting should include a greater radius value and it can also be included other earthquake magnitudes like 3+ or 5+, to have a better understanding of Earthquake Hazards.**

7. References

- https://earthquake.usgs.gov/learn/glossary/?term=earthquake
- https://earthquake.usgs.gov/learn/glossary/?term=earthquake%20hazard
- https://earthquake.usgs.gov/learn/glossary/?term=earthquake%20risk
- https://earthquake.usgs.gov/earthquakes/feed/v1.0/geojson.php