Seismically Hazardous Zones of Humboldt County

Abstract

This report is an analysis on the seismically hazardous zones of Humboldt County. The criteria to identify the most dangerous seismic areas in Humboldt County include fault zones, liquefaction zones, and high slope instability zones. Using ArcGIS and related tools, it is possible to identify and map the hazardous areas. The zones are separated by three levels based on a calculation of area: high seismic hazard zones, moderate seismic hazard zones, and low seismic hazard zones.

Introduction

Large earthquakes are among the scariest natural disasters someone can experience in their lifetime. In California, earthquakes are a common occurrence, with some being relatively small and others being very large. California is a part of a large geologic formation called the Ring of Fire. The Ring of Fire is essentially the outline of the Pacific tectonic plate and along its boundaries, occupants experience volcanic eruptions and earthquakes. Humboldt County is a part of the Ring of Fire, but it has its own fascinating geologic history. Humboldt County is where the Gorda plate, the North American plate, and the Pacific plate meet in the Pacific Ocean. Aptly named the Triple Junction, the formation is the cause of much stress to the tectonic plates, making Humboldt and Mendocino Counties some of the most seismically hazardous places in California.

Focusing on Humboldt County, much of the tectonic hazards are surrounding the Humboldt Bay area (Figure 1). This report aims to identify the most seismically hazardous areas in Humboldt County based on slope instability, fault lines, and liquefaction zones. Hillslopes are a constantly changing part of the geomorphology in Humboldt County. Hillslopes play an important role in sediment transport to coastal planes. Sudden failures, called landslides, occur when the hillslope experiences more stress than it can handle at one time and collapses as a result. In most cases, hillslope failure is caused by quick trigger mechanisms such as a heavy rainfall or earthquakes. The seismic waves from earthquakes violently vibrate hillslopes and produce more stress than the strength of the hillslope can handle and the hillslope face often collapses. Hillslope stability data is a good way to determine areas that are seismically hazardous to be in during or after an earthquake.

Liquefaction is another good identifier, because it is a phenomenon where a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid (3). Historic liquefaction zones are key to pinpointing dangerous seismic zones. Using historical hillslope, faults, and liquefaction data, we can get a fix on the biggest seismic safety hazards in Humboldt County.

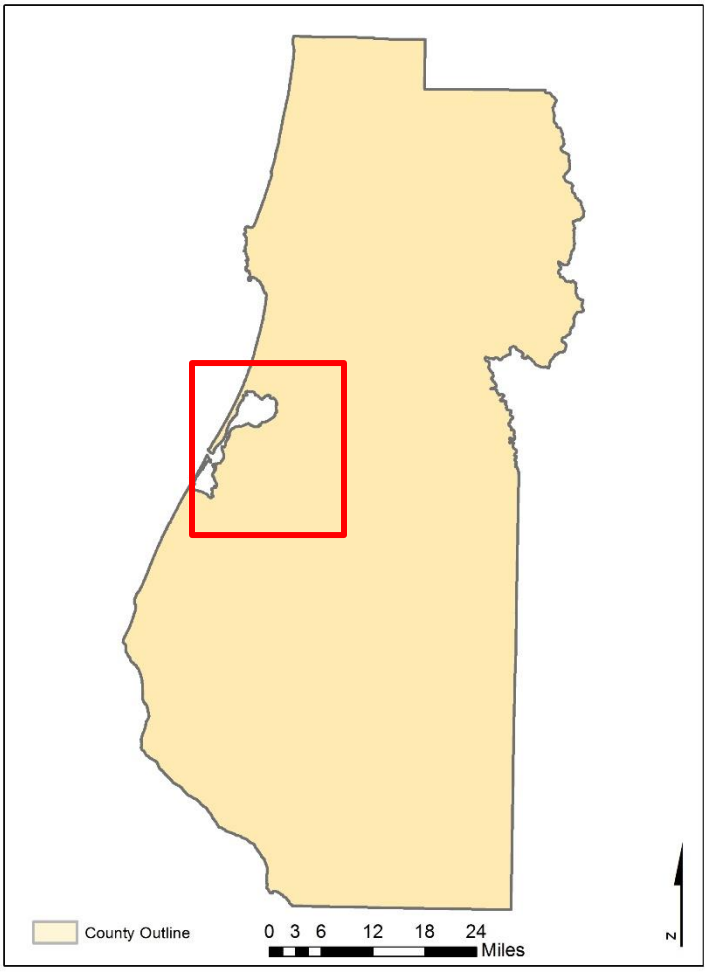

Figure 1: Locator Map of the seismically hazardous zones of Humboldt County

Methods

Data Download

The first step in identifying the seismically hazardous areas in Humboldt County is data collection. The data used to identify the seismically hazardous zones included fault zone data from Quaternary Fault and Fold Database of the United States, United States Geological Survey. The following data: slope instability zones, liquefaction zones, aerial imaging, county, and city boundaries of Humboldt County, was gathered from Humboldt County GIS Data Download. The data was downloaded into ArcGIS 10.2.2. Each layer was corrected to have the projection NAD 1927 State Plane California Zone 10 using the Project tool.

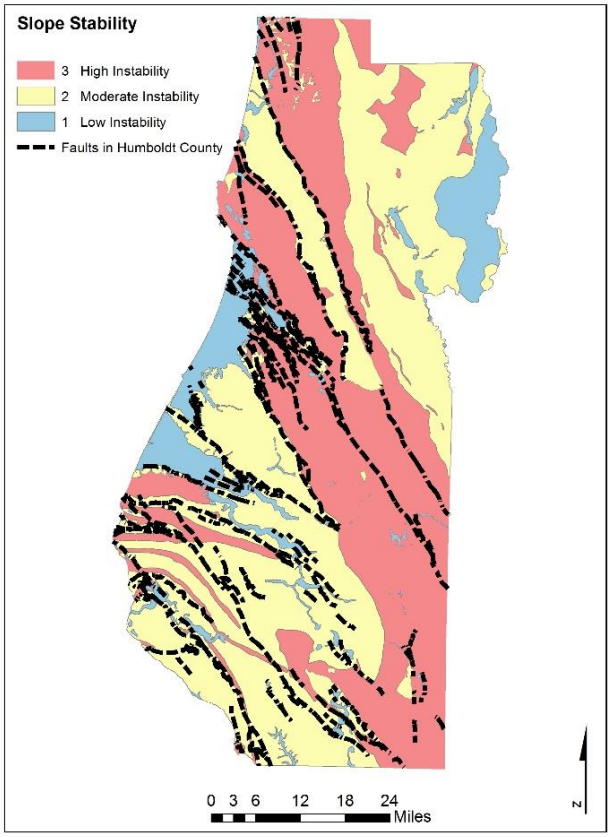

Figure 2: Map illustrating Slope Instability and the Fault Zone Data of Humboldt County

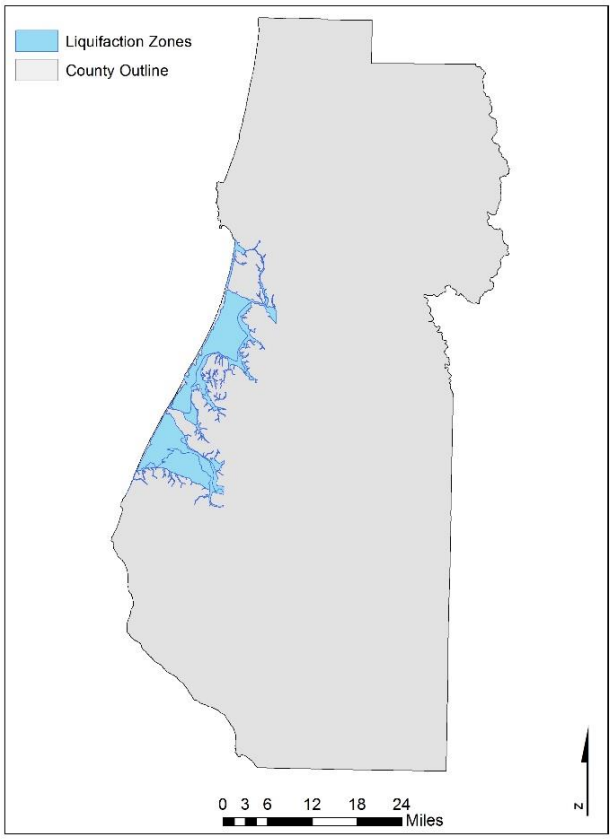

Figure 3: Map illustrating historic Liquefaction Zone Data of Humboldt County

Clip

The fault data was for the entire United States, so in order to complete the analysis the data had to be clipped to fit only in the boundaries of Humboldt County. This task was done using the Clip Analysis Tool and once finished, the fault zones were only visible within the Humboldt County boundaries and placed over the Slope Instability data layer to create Figure 2.

Selection and Intersection

The most seismically hazardous zones are located where the fault zones, liquefaction zones, and high slope instability zones intersect. First, the high slope instability zones had to be selected and made into a new layer from the original slope instability layer, which had three instability levels: high, moderate, low. The high slope instability zones had an identity of 3, from a selection of 1-3. The High Instability zones, in red (Figure 2), were selected and made into a new layer, with the other two levels removed. Once selected the next step was to intersect the three layers of liquefaction, faults, and high instability zones to locate the areas which present the most danger. The task was completed using the Intersect Analysis Tool in ArcGIS.

Buffer and Area

The intersect tool generated multiple seismically hazardous zones. It is not safe to be directly on or next to the zones, so adding a 0.2 mile buffer zone is important and provides a visual boundary around the areas to avoid. With the buffer zone, the final step was to calculate the area of each zone, using the Field Calculator Tool. The zones with the biggest areas were designated High Seismic Hazard Zones with areas larger than 0.8km. The medium size areas were designated Moderate Seismic Hazard Zones with areas larger than 0.4km but smaller than 0.8km. The smallest areas were designated Low Seismic Hazard Zones with areas smaller than 0.4km. Each different designation was selected and made into a separate layer, per seismic hazard level.

Results

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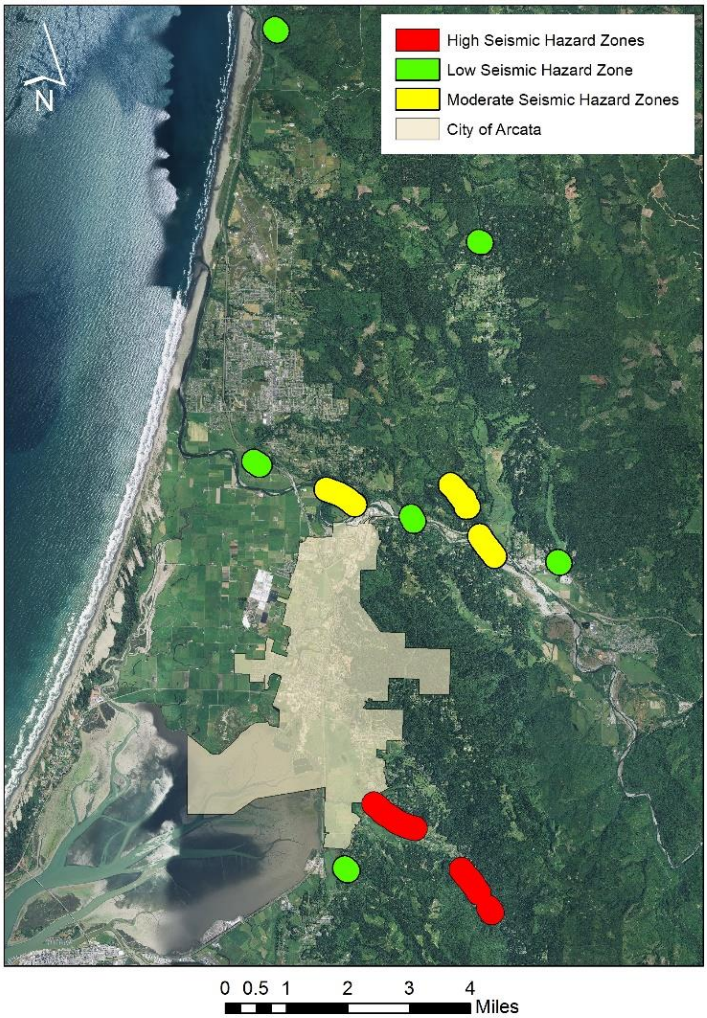

Figure 4: A map that displays the seismically hazardous zones near Arcata in Humboldt County.

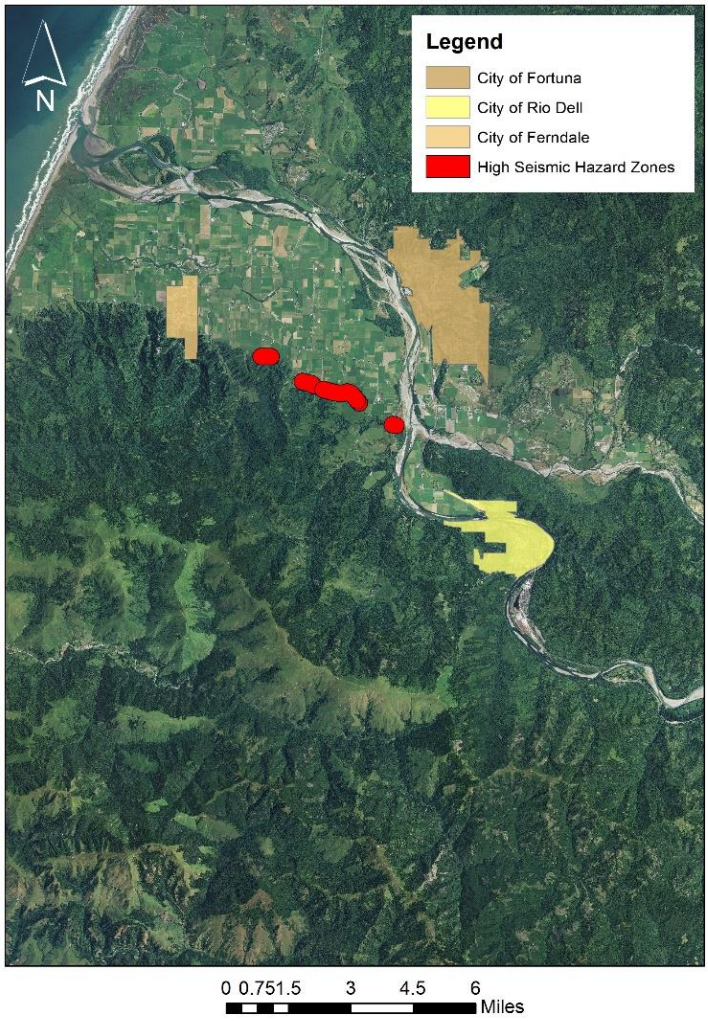

Figure 5: A map that displays the seismically hazardous zones near Fortuna, Ferndale, and Rio Dell in Humboldt County

The results revealed that the hazard zones were located outside of Arcata, Ferndale, Fortuna, and Rio Dell. The highest designated seismic hazard zones were clustered together, while the moderate and low hazards zones were sporadic. The seismically hazardous zones in Figure 4 and Figure 5 are pictured over an aerial photo taken by National Agriculture Imagery Program (NAIP), for location reference.

Conclusion

The analysis into the seismic hazards of Humboldt County has resulted in discovering multiple areas of concern that are all located in or alongside cities and the California coastline. The criteria for this report to identify the

most dangerous seismic areas in Humboldt County include fault zones, liquefaction zones, and high slope instability zones. Those datasets allowed us to pinpoint pieces of land the avoid; however, a more in depth study on what surrounds these areas, such as types of soil, residential areas, or geologic formations, would be required to form a more comprehensive report on the seismic dangers of the county. In conclusion, this analysis is a valuable guide for those looking to avoid seismically dangerous areas, especially after heavy rainfall or seismic activity from the surrounding area.

References

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