

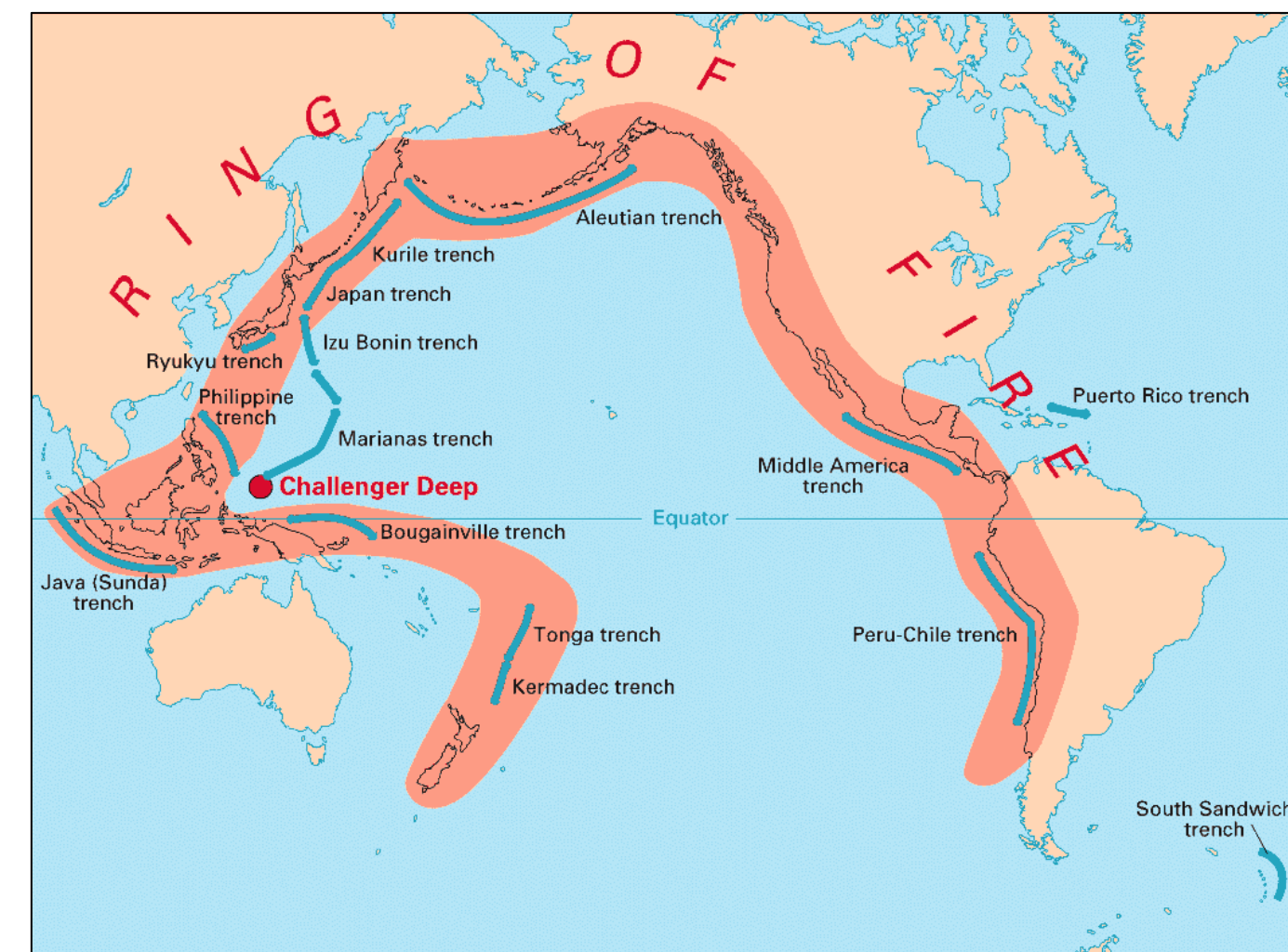
# Preparing for the Next Big Earthquake in Portland, OR: Proximity of Emergency Services and Accessibility to Resources

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## Background

Historically, the Ring of Fire region along the Pacific Ocean has been one of most seismically active regions on the planet. Of the 17 largest earthquakes recorded since 1900, 16 of these quakes occurred within this area. Some of the most notable earthquakes on this list include the Northern Sumatra quake of 2004 that claimed 227,898 lives and the Fukushima nuclear fallout that followed the Honshu quake in Japan during 2011. Due to the scares presented by earthquakes in this region we felt an assessment and projection of an earthquake impacting the Portland area would be of great benefit to its citizens. Many scientists who study the possibility of earthquakes in the region reference the Cascadian Subduction Zone, yet not much is mentioned about the five fault lines within the city of Portland (with some attention placed on the Portland Hills Fault).

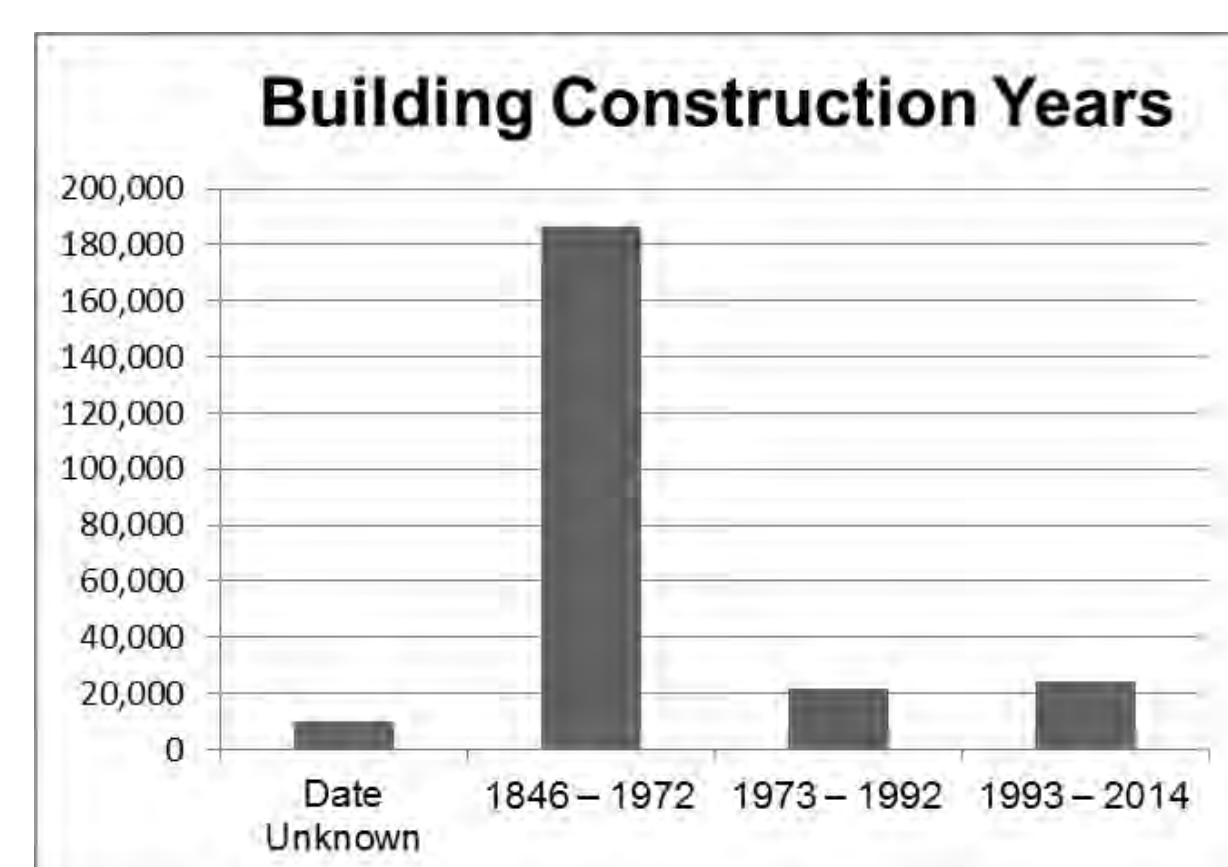
Location	Year	Magnitude
Chile	1960	9.5
1964 Great Alaska Earthquake	1964	9.2
Northern Sumatra, Indonesia	2004	9.1
Honshu, Japan	2011	9
Kamchatka	1952	9
Chile	2010	8.8
Ecuador	1906	8.8
Rat Islands, Alaska	1965	8.7
Northern Sumatra, Indonesia	2005	8.6
Northern Sumatra, Indonesia	2012	8.6
Andreanof Islands, Alaska	1957	8.6
Southern Sumatra, Indonesia	2007	8.6
Banda Sea, Indonesia	1938	8.5
Kamchatka	1923	8.5
Chile-Argentina Border	1922	8.5
Kuril Islands	1963	8.5



Map provided by USGS

## Logic

Hazard management continues to evolve with a worldwide intensification of natural disasters and increased focus has been placed on determining adequate evacuation routes. In the event that one of these catastrophic Pacific earthquakes hits Portland we wanted to ensure residents could be reached by emergency services and had access to the necessary resources. Many variables are taken into account when predicting natural catastrophes, but instead we decided to focus on the year of building construction, national bridge ratings, landslide points, and Total Release Inventory (TRI) of hazardous chemicals and materials. Year of building construction was not used in the GIS analysis, yet the other three variables were implemented to determine emergency response times, accessibility of resources, create obstructed areas, and show streets affected by an earthquake. The services we determined to be most sought after following an earthquake included emergency response (hospitals and fire stations), gathering space (community centers), and food/ water suppliers (grocery stores).



"Around 99 percent of Oregon's buildings are not designed to withstand the amount of gravitational acceleration or "ground G" found in a subduction zone earthquake." – Ivan Wong in *The Oregonian*

## Bridge Ratings

Bridge ratings were taken from the National Bridge Inventory (NBI) and our rating system was based off the Skagit River Bridge collapse in Washington. The Skagit River Bridge collapsed when an oversized semi-truck crashed into a steel beam of the bridge which previously received a rating of 57.4 out of 100. Because of this rating, we made an assumption that all bridges below the 57.4 rating would collapse in the event of an earthquake. Using the NBI rating system we found that 7 out of 13 bridges were at risk and were thus eliminated from the roads shapefile (see table to the right).

Bridge Name	Year Built	Rating
Glenn L. Jackson Memorial	1982	84
Marquam	1966	81
Fremont	1973	76
Morrison	1958	67
St. Johns	1931	65.5
Broadway	1927	59
Hawthorne	1910	57
I-5 (SB - Columbia)	1958	49
Steel	1910	48
Burnside	1926	47
Ross Island	1926	33
I-5 (NB - Columbia)	1916	18.5
Sellwood	1925	2

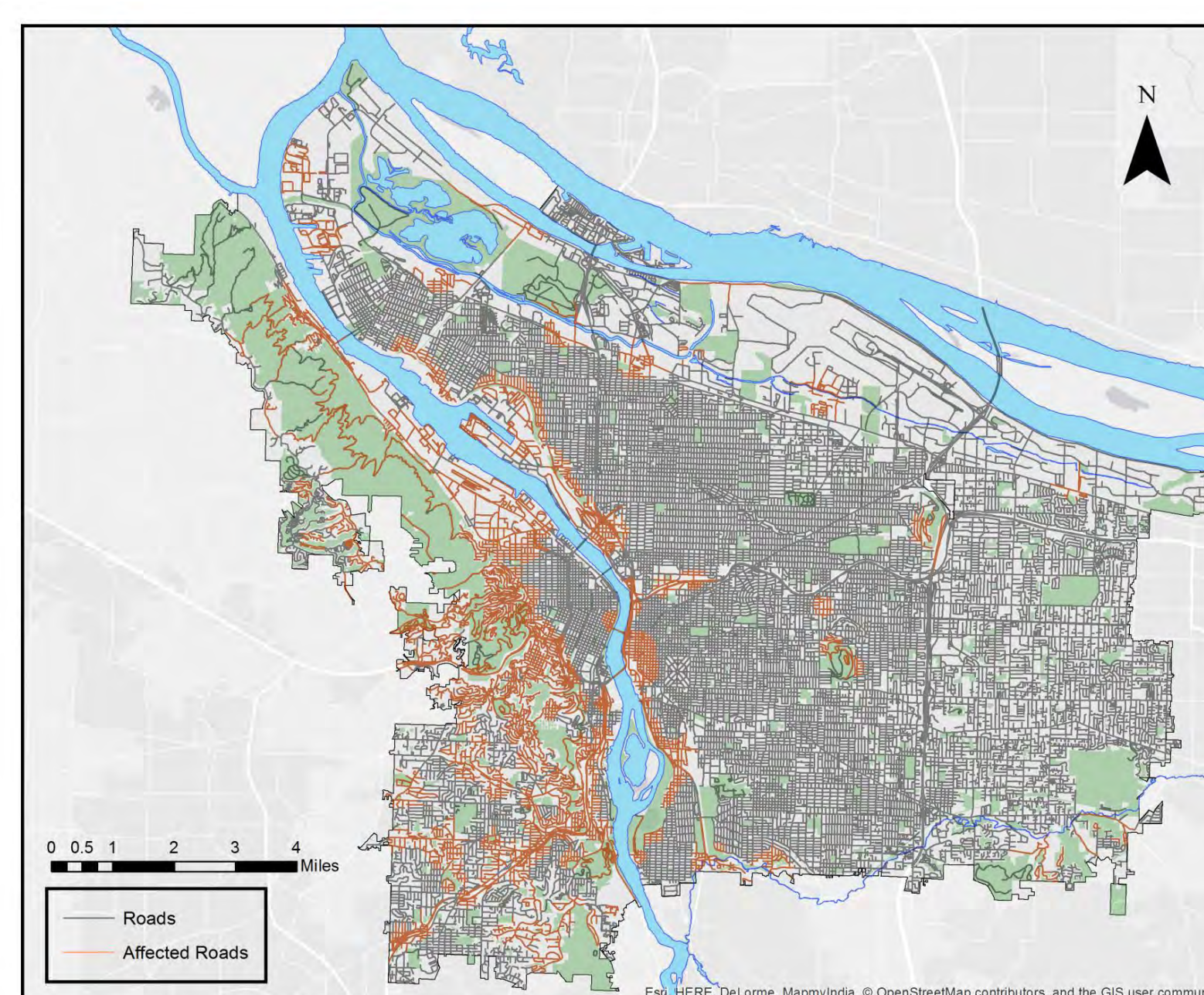
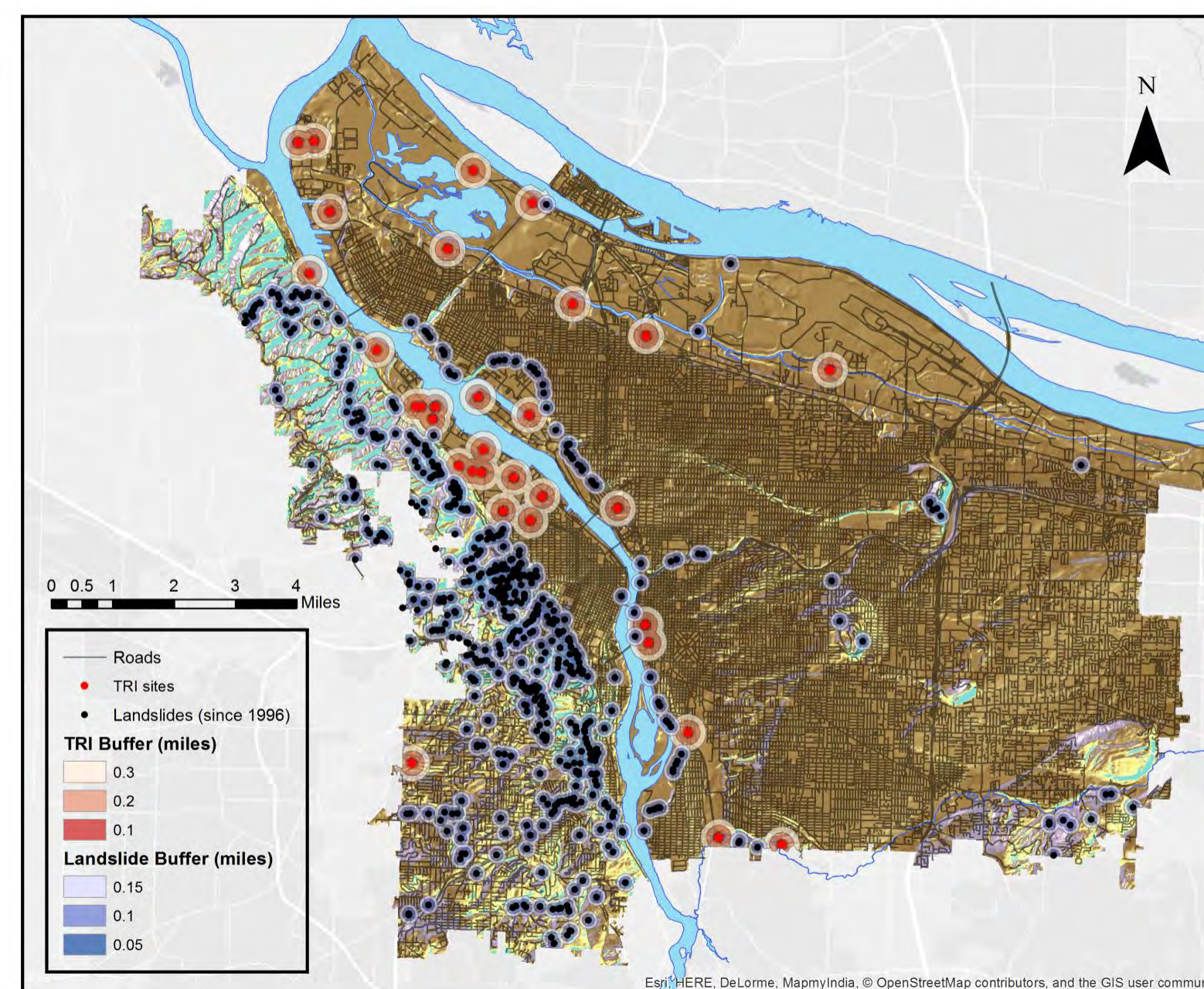
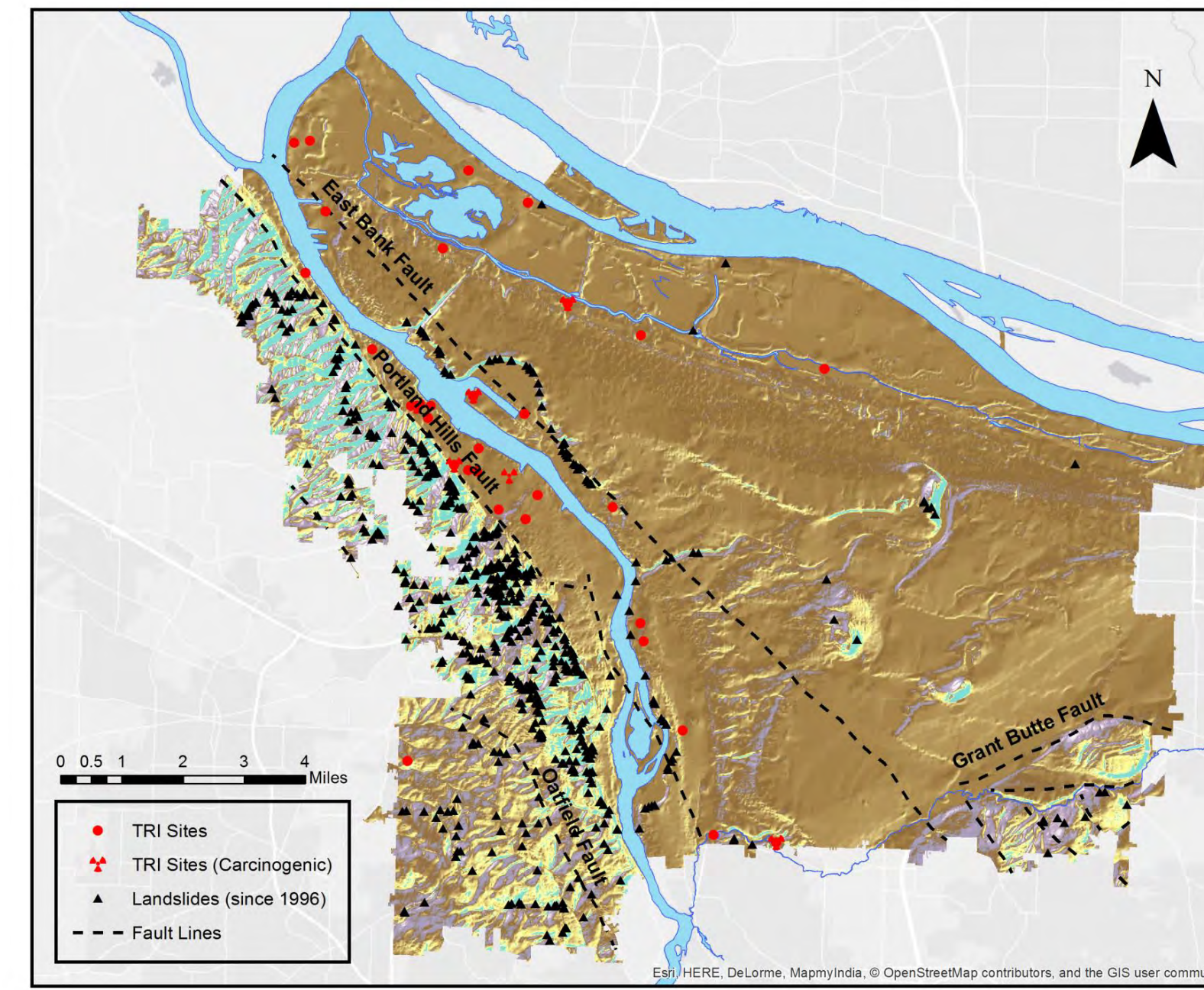
## Landslides

The landslide data used for this project dates from 1996 to present. These sparked an interest in the possibility of landslides following an earthquake and were utilized to assess areas that could be impacted. The vulnerability due to unstable slopes and soils represented a key variable for conducting our analysis.

## Toxic Release Inventory

TRI was introduced in 1986 by the United States Environmental Protection Agency to record data about toxic chemical and other waste releases within the United States.

With this study we decided to focus on sites that released 500 or more pounds of toxic waste on an annual basis. Our selection was based on the assumption that in the event of a disaster, these sites would contain and potentially release hazardous materials. Although 500 pounds might seem small, some of these sites range from 500 to 350,565 pounds of toxic release annually. Further selection was referenced using the carcinogenic sites among the selected producers (see map to the upper right for landslides and TRIs).



## Methods

Due to the many unpredictable variables in earthquake prediction, we employed conservative assumptions of distances for both buffer rings and network analyst around historic landslide occurrences, TRI release sites, and services.

## Buffer

Multiple ring buffers at distances of 0.05, 0.1, and 0.15 miles were used for landslides due to greater impedance of spreading from an earthquake. An additional multiple ring buffer was used for hazardous material dispersion of 0.1, 0.2, and 0.3 miles, as a result of environmental contamination and spreading of toxins via air, soil, and water. The map to the upper left shows the different multiple buffer rings utilized for landslides and toxic releases. Areas of the city within these buffer zones were considered obstructed, either environmentally or structurally, and there were possible failures of service provision. Due to the need for emergency response, landslide only obstruction areas were the only impedance to response times, while toxic contamination and landslide buffers provided hazards to citizens seeking groceries and shelter. The map to the lower left displays the impact these said multiple buffer rings would have on the current street system in Portland.

## Network Analyst

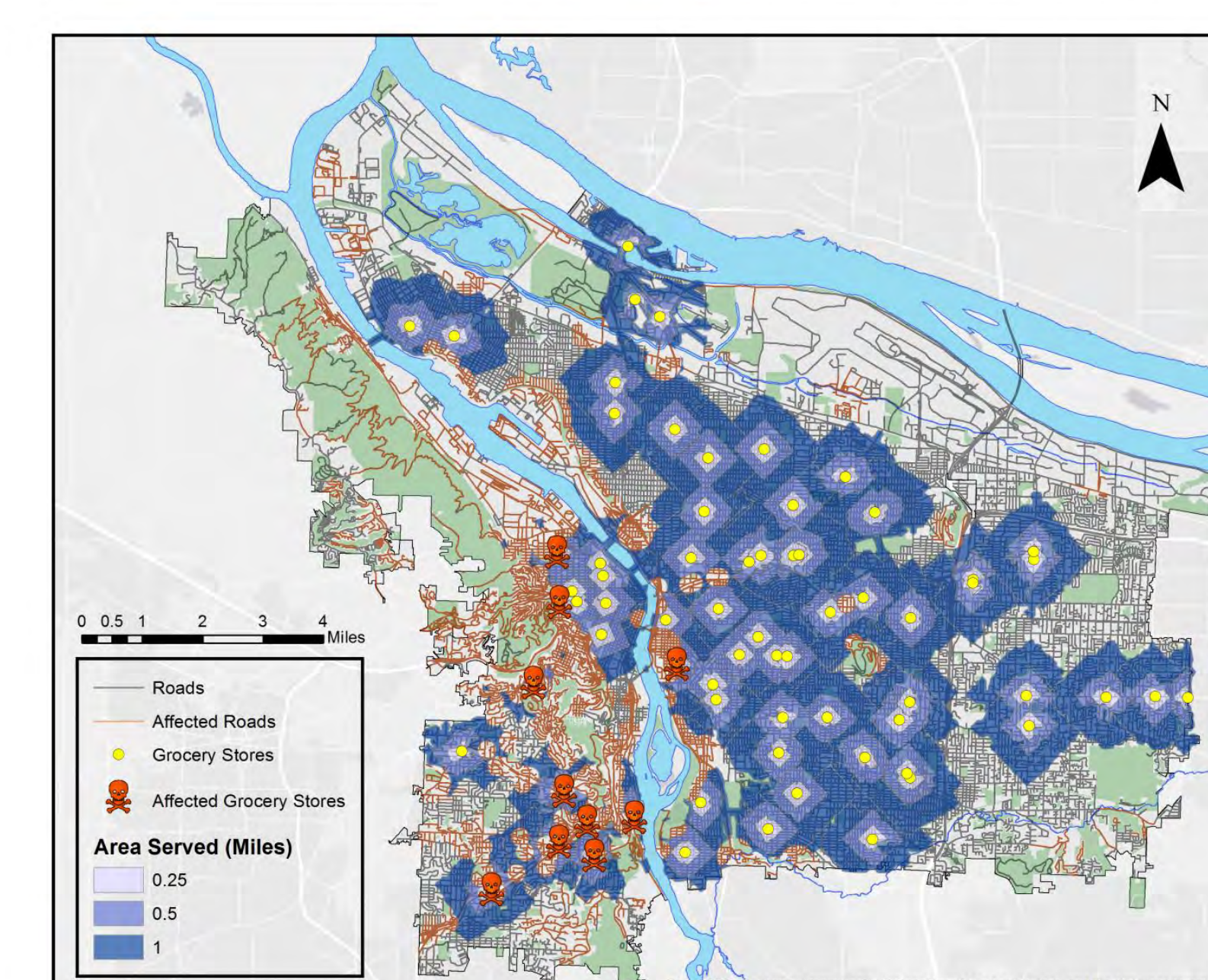
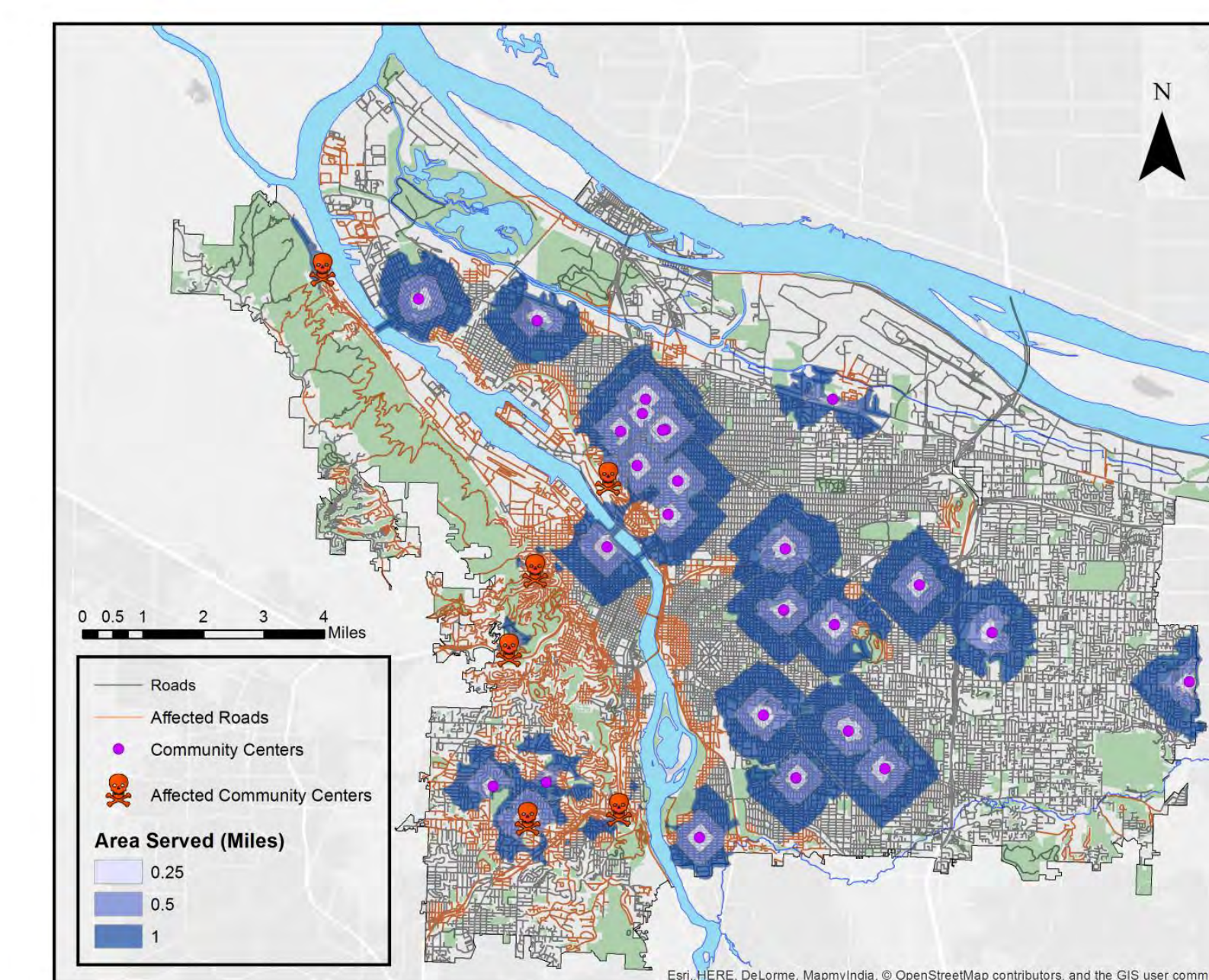
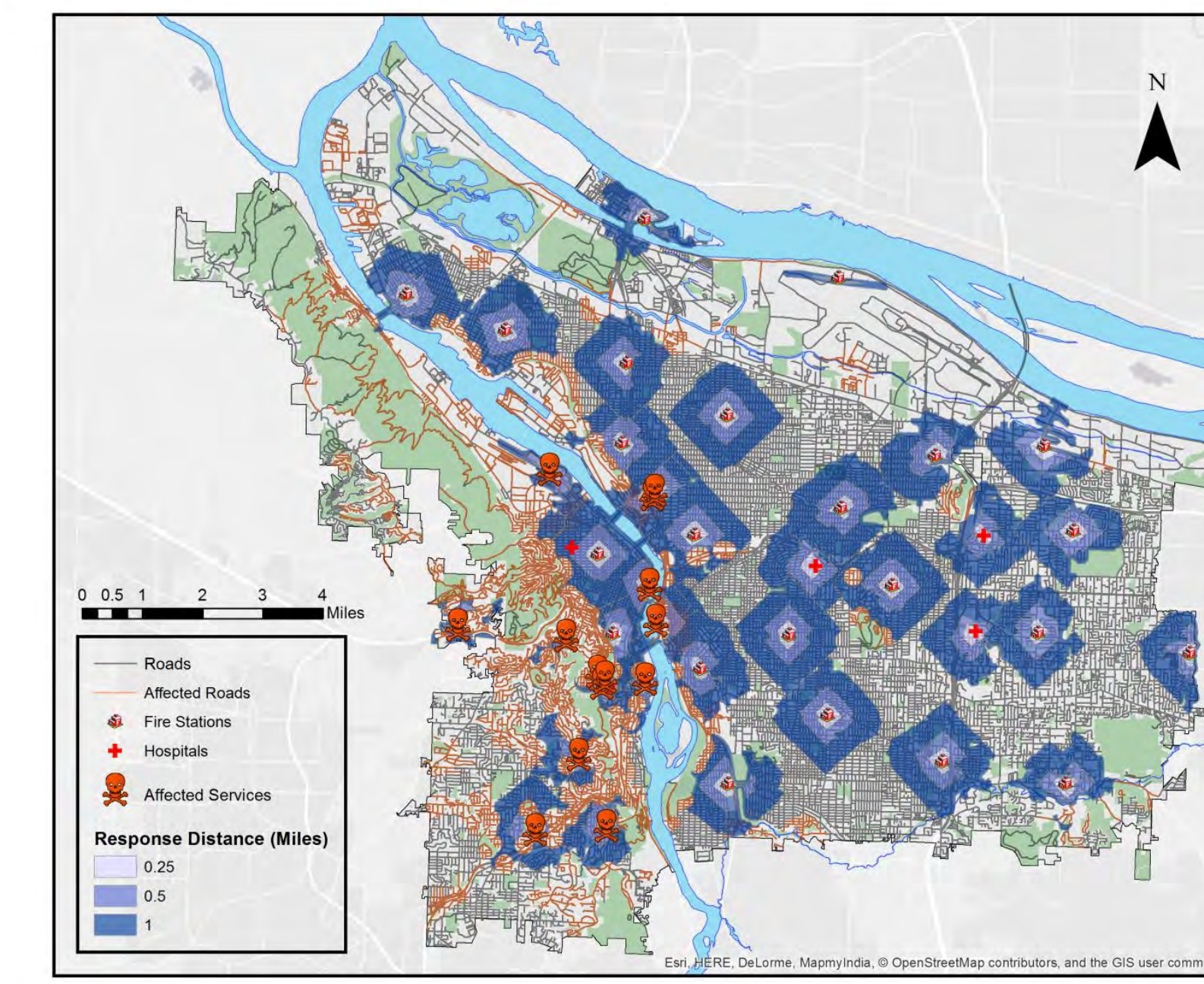
Access to services in the event of a disaster as the main goal allowed for the usage of Network Analyst to and from these services. Emergency response was the combination of both hospital and fire station locations, as both would provide similar triage services. Grocery stores and community centers were analyzed separately. All services mentioned above were assigned 0.5, 1.0, and 1.5 mile service distances.

## Sources

**Articles:**  
 - Gilles, N. 2012. The first four minutes: A timeline of Portland's upcoming cataclysmic quake. *Portland Mercury*. <http://www.portlandmercury.com/portland-the-first-four-minutes/Content?node=5786214> (last accessed 29 May 2014).  
 - Rose, J. 2013. I-5 bridge collapse: Oregon's bridges in better shape than most - but that's not saying much. *The Oregonian*. [http://www.oregonlive.com/commenting/index.ssf/2013/05/oregons\\_bridges\\_in\\_better\\_shape.html](http://www.oregonlive.com/commenting/index.ssf/2013/05/oregons_bridges_in_better_shape.html) (last accessed 5 June 2014).  
 - Zschomler, R. 2011. Cascadia Subduction Zone: Are Portland and Seattle prepared for an earthquake and tsunami? *The Oregonian*. <http://www.oregonlive.com/earthquakes/index.ssf/2010/07/earthquakes-west-coast-portland-seattle.html> (last accessed 3 June 2014).  
**Data Sources:** Department of Geology and Mineral Industries (DOGAMI), U.S. Environmental Protection Agency (EPA), Portland Community College (PCC), Portland State University (PSU), Portland METRO GIS Data (RLIS), and U.S. Geological Survey.  
**Software:** ArcGIS  
**Websites:** <http://nationalbridges.com>, [www.usgs.gov](http://www.usgs.gov)

## Analysis

Through the exclusion of services in obstructed areas, we projected the vulnerable service infrastructure in Portland. Selected red roads display areas with vulnerable accessibility, while the skull and crossbones represent services that are susceptible to a lack of adequate provision. The maps to the left display the three services referenced within this study (in order from top to bottom: emergency services, community centers, and grocery stores). By analyzing the map of emergency services it shows that responses would be drastically hindered by these variables and only two fire stations and one hospital could offer services on the westside of Portland following the landslides triggered by an earthquake. The South Waterfront neighborhood would be in trouble with the loss of the Ross Island Bridge, while emergency services are relatively spread out on the eastside. Due to current infrastructure and topography, the eastside of Portland provides far more accessible services than the west side of the city. This lower level of impedance on the services shows in all three of the maps. However, the access to community centers east of I-205 shows a lack of locations to seek refuge. No map shows the eastside's advantage more than the access to grocery stores. This can be seen in the map of network access to grocery stores with only one eastside store affected by landslides or hazardous material spillage. One can attribute this to the difference in topography and large areas of residential neighborhoods. From the data provided within the attribute tables, we concluded on the percentage of services potentially compromised by landslide vulnerability and toxic contamination (see table to the left). Of all the services in this study, the loss of 54.5% of the hospitals is the most alarming and raises more questions about Portland's ability to handle the consequences of a catastrophic Earthquake.



Service	Existing	Affected	% Affected
Fire Station	31	9	29.0%
Hospital	11	6	54.5%
Community Center	31	6	19.4%
Grocery Stores	70	10	14.3%

## Conclusions

As mentioned throughout our study, many variables exist that make predicting earthquakes all the more difficult. Based off these discoveries during the research phase we ultimately decided to focus on the accessibility to and from services. In the event of a disaster, these service areas will provide citizens support before exterior aid will arrive. With the previously mentioned bridge vulnerability, said aid may encounter additional slow response times to the city. Exclusion of these bridges creates a disconnect between both sides of the river, resulting in the west side of Portland having the most overall earthquake risk vulnerability. Other compounding variables may contribute to further representation of the susceptible infrastructure including landslide occurrence kernel density, slope factors, building material, and soil characteristics. Emergency management and preparedness allows for cautious estimates, unlike the disparate projections of earthquake prediction. With the results from this research one can determine how they will receive the necessary services following an earthquake or decide where the best community center is to reunite with loved ones.