Memon Final Assignment

Living With Natural Disaster Hazards in Sonoma County

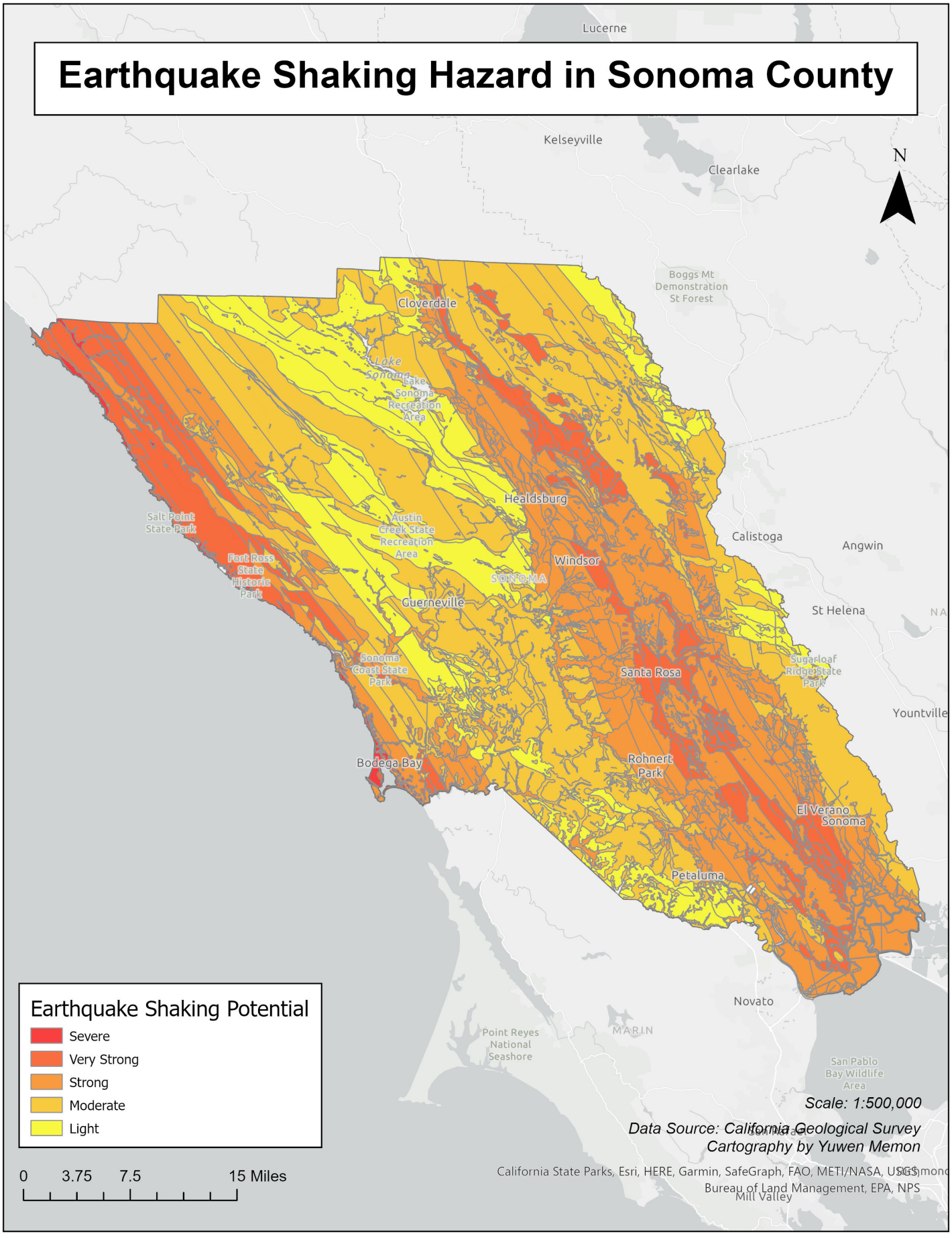
Sonoma County, California is an often sought after location for living. It has an idyllic mix of rural and suburban communities and is not too far from the city of San Francisco. However, just like most of California, Sonoma faces significant risks from many different natural disaster scenarios.

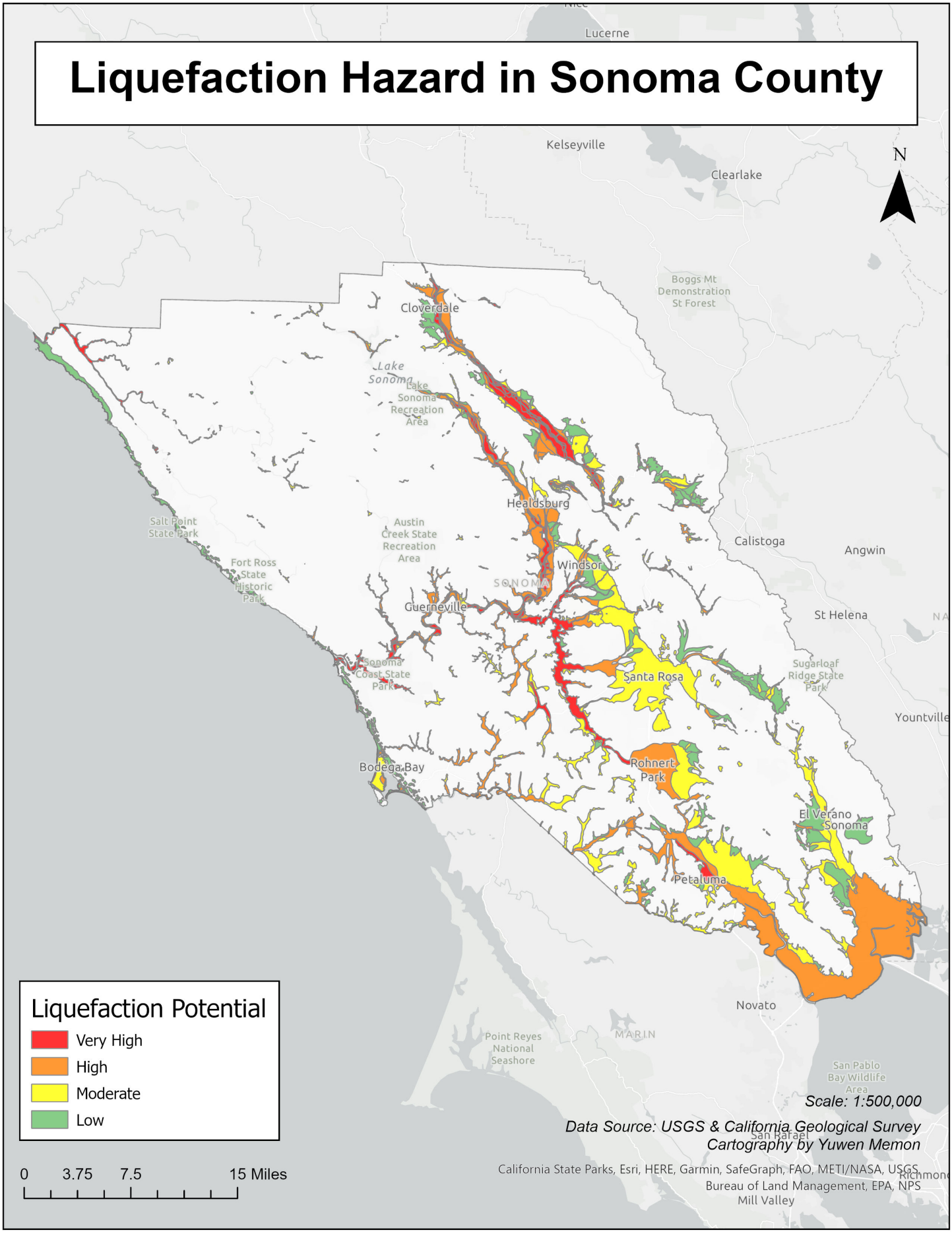
Three major faults run through Sonoma, including the San Andreas Fault. The county has lots of forestland, which has been prone to wildfires. Some recent wildfires have been quite catastrophic such as the Tubbs Fire in 2017, which caused over $1.2 billion in damages[1]. Additionally, there are many waterways that run though Sonoma, including the Russian River which has historically been prone to flooding – surging to over 40 feet only earlier this year (2023)[2].

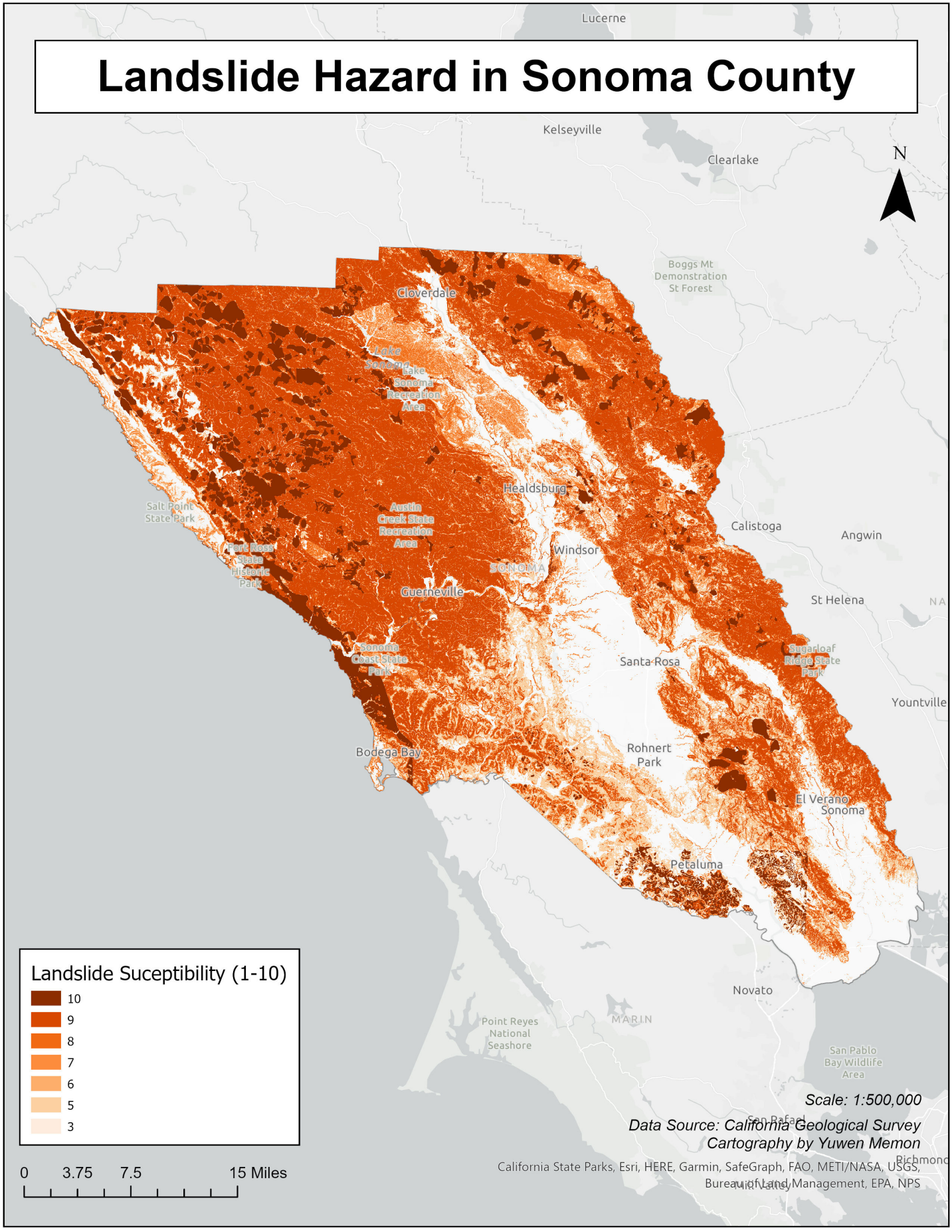
Anyone living or considering living in Sonoma County should be aware of the hazards their homes may face. Just recently, both State Farm and Allstate stopped issuing new home insurance policies in the entire state of California[3]. Risks from natural disasters can effect one's cost of living even before any catastrophic event even occurs.

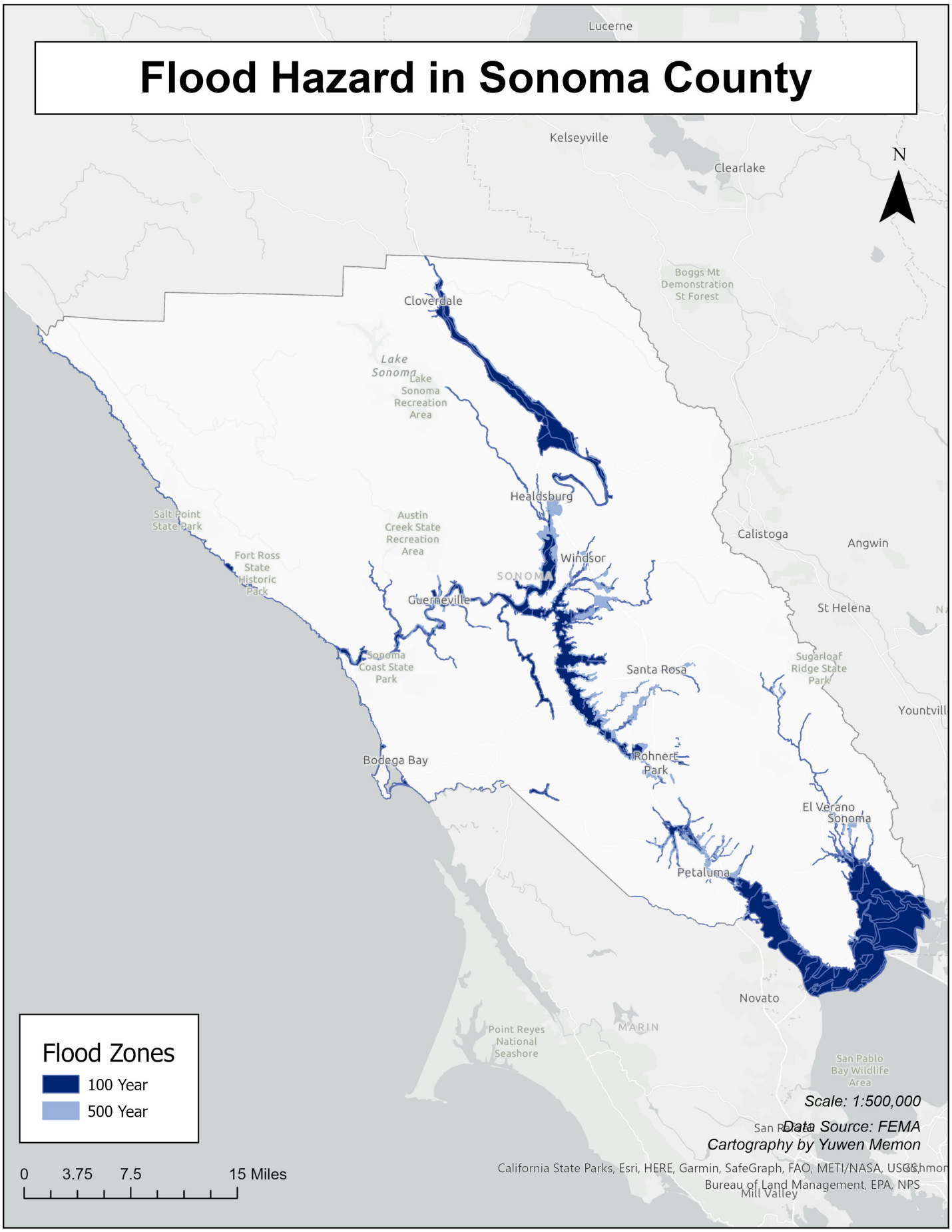
I performed a hazard analysis for Sonoma County using data made available by CAL FIRE, FEMA, the California Geological Survey, and the USGS. Data factored into this analysis featured hazards posed by earthquakes – notably ground shaking potential and liquefaction potential of soils, the latter of which can significantly amplify damage during a tremor event. Also considered were hazards posed by flooding, as well as landslides, which can be triggered by both earthquakes and significant rain events. Finally, the final variable to be factored in was wildfire risk. This is perhaps most signifigant as wildfires have been responsible for the most damage in recent years[4].

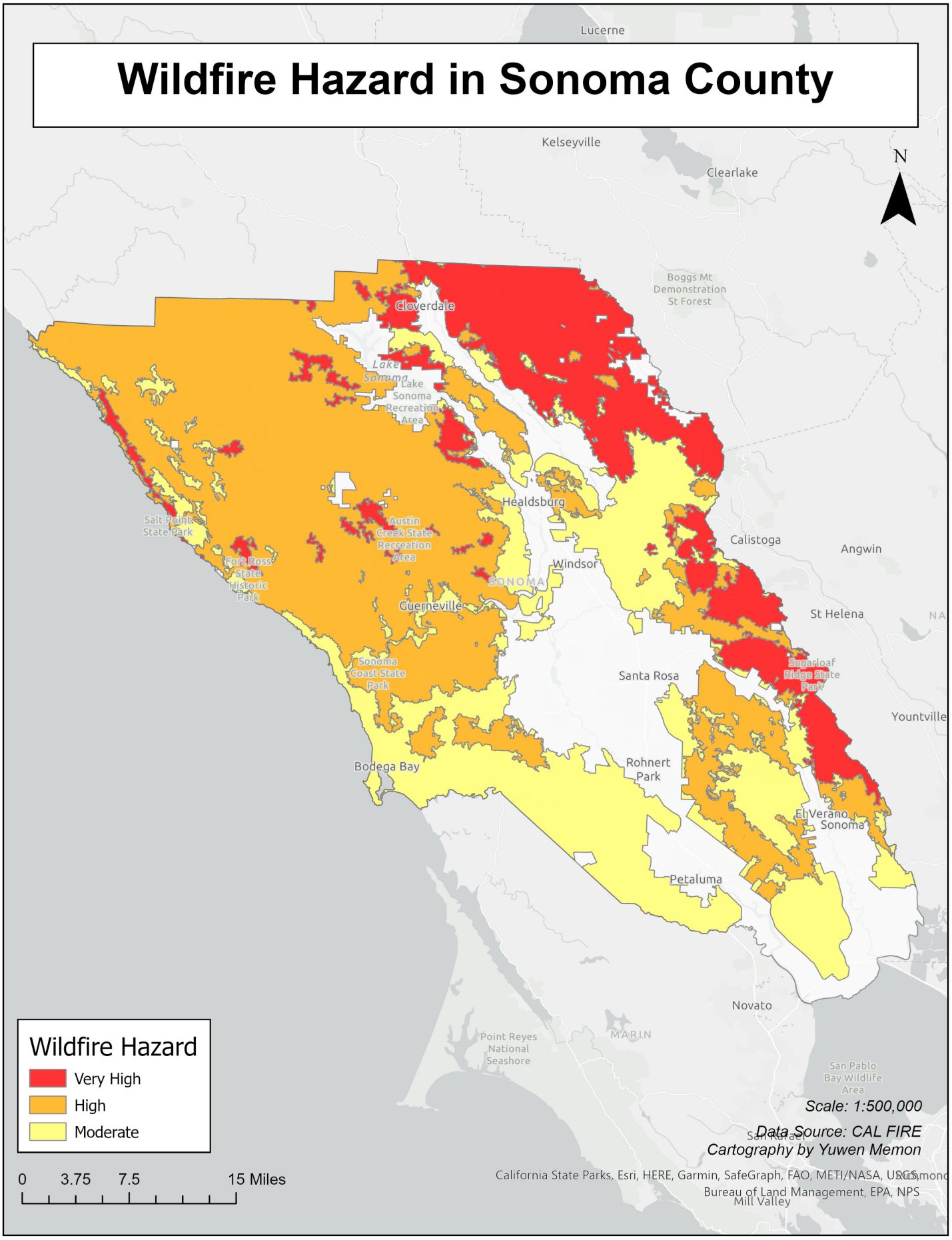
Earthquake Shaking Hazard in Sonoma County




Liquefaction Hazard in Sonoma County
N
Lucerne
Kelseyville
Clearlake
Boggs Mt Demonstration St Forest
Cloverdale
Lake Sonoma
Lake Sonoma Recreation Area
Healdsburg
Salt Point State Park
Austin Creek State Recreation Area
Fort Ross State Historic Park
Windsor
SONOMA
Guerneville
Calistoga
Angwin
St Helena
Sonoma Coast State Park
Santa Rosa
Sugarloaf Ridge State Park
Yountville
Bodega Bay
Rohnert Park
El Verano
Sonoma
Petaluma
Novato
Point Reyes National Seashore
MARIN
San Pablo Bay Wildlife Area
San Rafael
Richmond
Mill Valley
Liquefaction Potential
Very High
High
Moderate
Low
0
3.75
7.5
15 Miles
Scale: 1:500,000
Data Source: USGS & California Geological Survey
Cartography by Yuwen Memon
California State Parks, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS


Landslide Hazard in Sonoma County
Lucerne
Kelseyville
Clearlake
N
Boggs Mt Demonstration St Forest
Cloverdale
Lake Sonoma
Lake Sonoma Recreation Area
Healdsburg
Salt Point State Park
Austin Creek State Recreation Area
Fort Ross State Historic Park
Windsor
SONOMA
Guerneville
Calistoga
Angwin
St Helena
Sugarloaf Ridge State Park
Santa Rosa
Yountville
Sonoma Coast State Park
Bodega Bay
Rohnert Park
El Verano
Sonoma
Petaluma
Novato
MARIN
Point Reyes National Seashore
San Pablo Bay Wildlife Area
San Rafael
Richmond
Landslide Suceptibility (1-10)
10
9
8
7
6
5
3
0
3.75
7.5
15 Miles
Scale: 1:500,000
Data Source: California Geological Survey
Cartography by Yuwen Memon
California State Parks, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS


Flood Hazard in Sonoma County
Lucerne
Kelseyville
Clearlake
N
Boggs Mt Demonstration St Forest
Cloverdale
Lake Sonoma
Lake Sonoma Recreation Area
Healdsburg
Salt Point State Park
Austin Creek State Recreation Area
Fort Ross State Historic Park
Windsor
SONOMA
Guerneville
Calistoga
Angwin
St Helena
Sonoma Coast State Park
Santa Rosa
Sugarloaf Ridge State Park
Yountville
Bodega Bay
Rohnert Park
El Verano
Sonoma
Petaluma
Novato
Point Reyes National Seashore
MARIN
San Pablo Bay Wildlife Area
Mill Valley
Flood Zones
100 Year
500 Year
0
3.75
7.5
15 Miles
Scale: 1:500,000
Data Source: FEMA
Cartography by Yuwen Memon
California State Parks, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS


Wildfire Hazard in Sonoma County
Lucerne
Kelseyville
Clearlake
N
Boggs Mt Demonstration St Forest
Cloverdale
Lake Sonoma
Lake Sonoma Recreation Area
Healdsburg
Salt Point State Park
Austin Creek State Recreation Area
Fort Ross State Historic Park
Windsor
SONOMA
Guerneville
Calistoga
Angwin
St Helena
Sugarloaf Ridge State Park
Santa Rosa
Yountville
Sonoma Coast State Park
Bodega Bay
Rohnert Park
El Verano
Sonoma
Petaluma
Novato
MARIN
Point Reyes National Seashore
San Pablo Bay Wildlife Area
Wildfire Hazard
Very High
High
Moderate
0
3.75
7.5
15 Miles
Scale: 1:500,000
Data Source: CAL FIRE
Cartography by Yuwen Memon
California State Parks, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS
Mill Valley

Any of these hazards in isolation poses a significant risk to homes. To get a sense of “total risk” to any location in Sonoma, these maps were combined, scored on a basis of risk, and then totaled up using map algebra to get a “hazard score”. Each hazard class was given a score on a scale of 0-5 in the following manner:

Earthquake Shaking Potential

The Earthquake Shaking Potential data is supplied in the form of Spectral Acceleration. Spectral Acceleration is a measure of the maximum expected ground acceleration due to an earthquake. The numbers are represented in force as a multiple of gravity. Shaking below 1 would not be strong enough to cause most buildings to sustain damage in isolation (although it would still knock a few things around). Thus, the shaking potential hazard was scored as follows:

Low End SA	High End SA	Score
0.45	0.61	0
0.605555556	0.76	0
0.761111111	0.92	0
0.916666667	1	0
1	1.23	1
1.227777778	1.38	2
1.383333333	1.54	3
1.538888889	1.69	4
1.694444444	1.85	5

Liquefaction Hazard

The liquefaction data was already supplied as hazard classifications. They were simply scored as follows:

Liquefaction Potential Classification	Score
Very Low	0
Low	1
Moderate	3
High	4
Very High	5

Landslide Hazard

The landslide data was also provided as classes. This time, scored from 1-10 in terms of susceptibility based on the soil and slope steepness. They were scored as follows:

Landslide Susceptibility Classification	Score
0	0
3	1
5	2
6	3
7	3
8	4
9	4
10	5

Flood Hazard

The flood zones are classified into FEMA's standard two types of floodplain classification: 100 year and 500 year. A 100 year flood plain represents the area with a 1% annual chance of flooding. A 500 year flood plain represents a .2% annual chance of flooding. However, climate change is most likely shifting those probabilities. The flood zones were scored as follows:

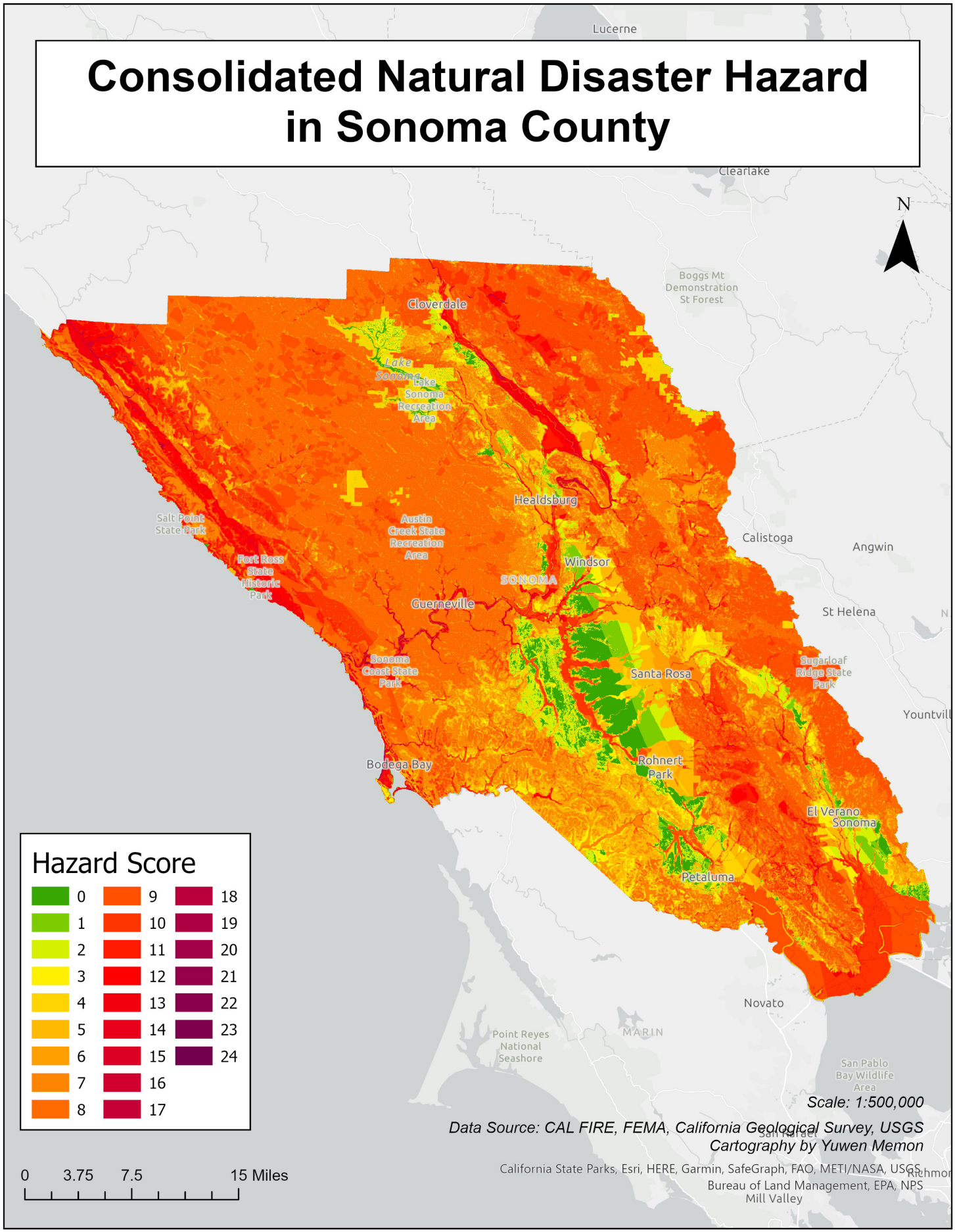
Flood Zone	**Score**
500-year	3
100-year	5

Wildfire Hazard

CAL FIRE's Fire Hazard Severity Zones are classified into three types "Moderate", "High", and "Very High". Since wildfires are becoming quite commonplace in recent years, and given the history of Sonoma with wildfires, even a "Moderate" classification represents a serious risk. The zones were scored as follows:

Fire Hazard Severity Zone	**Score**
Moderate	3
High	4
Very High	5

Consolidated Natural Disaster Hazard in Sonoma County

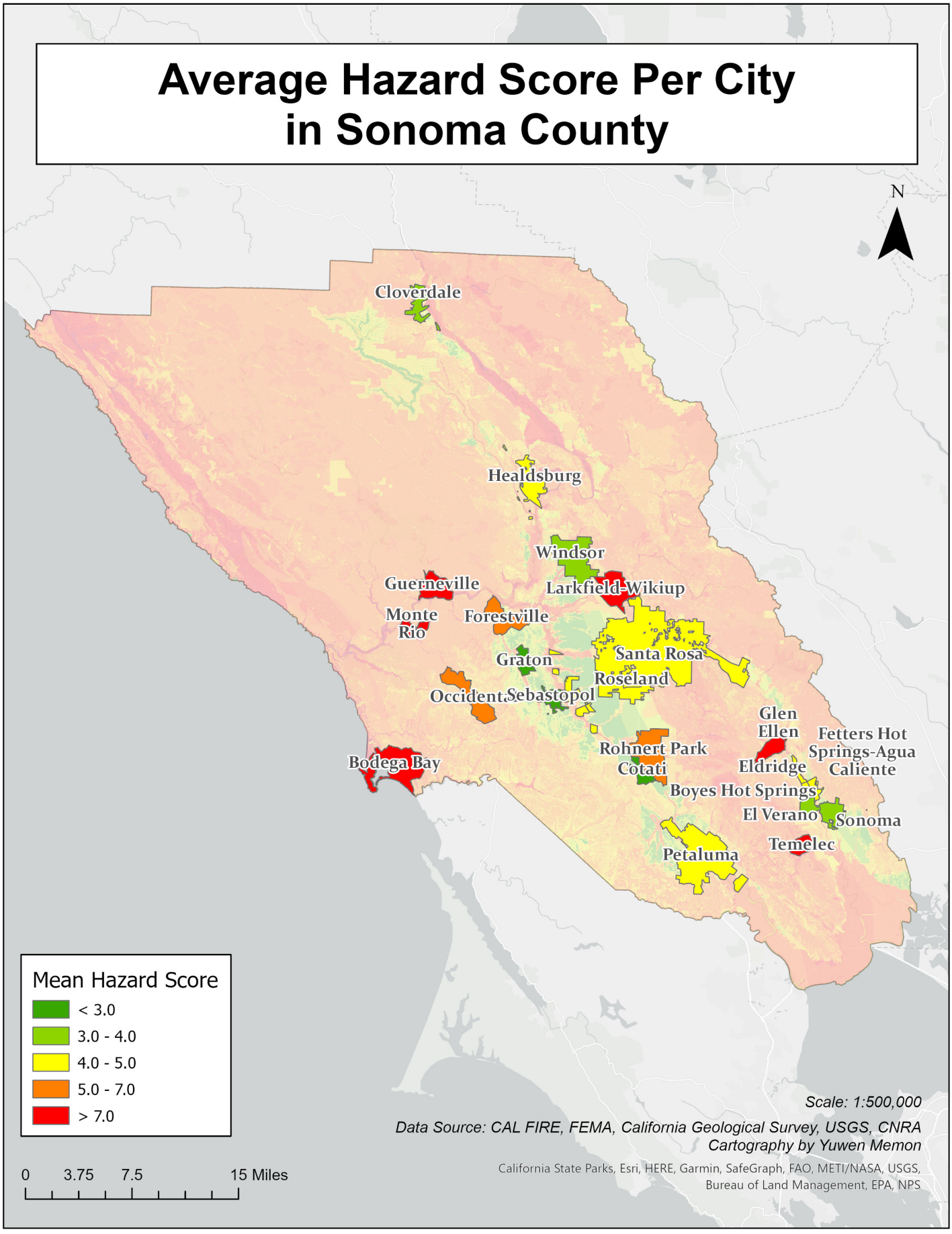


As one can see, much of Sonoma faces multiple hazard factors (as evidenced by any land with a score of more than “5”). However, there are good chunks of areas that face little to no hazards at all. Additionally, these overlap with populated areas such as the City of Sonoma, Sebastopol, and Petaluma, among others, which is good news for the residents of those areas.

Since Sonoma does have a lot of rural and undeveloped land, for the sake of an audience of prospective residents, it’s worth looking closer at the cities contained within the county. To get a sense of the average natural hazard risk for each city, geoprocessing and overlay analysis operations were used to calculate the average hazard score within each city’s boundaries:

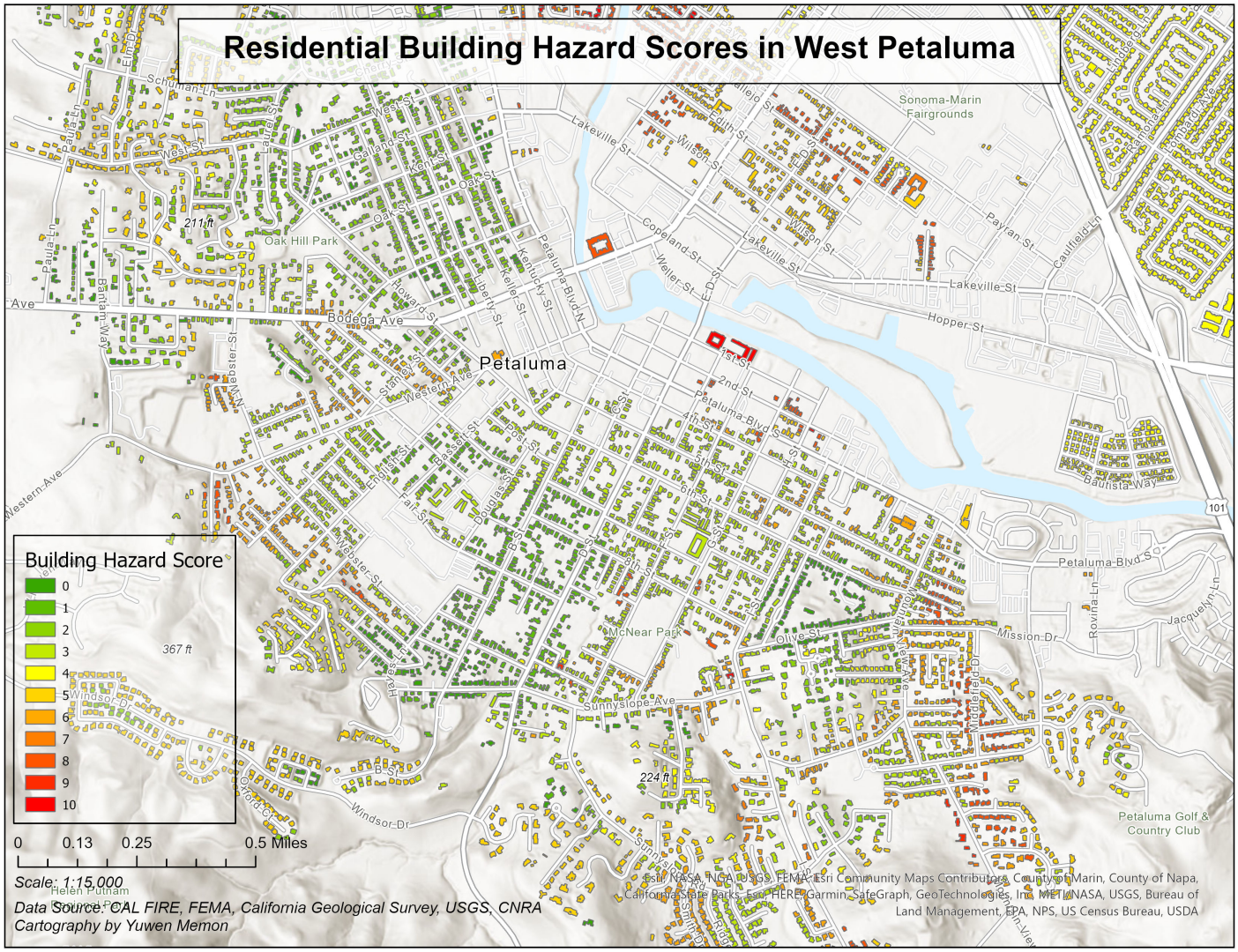
City	Average Hazard Score Within Boundaries
Guerneville	9.32
Monte Rio	9.2
Glen Ellen	8.54
Bodega Bay	8.03
Temelec	7.73
Larkfield-Wikiup	7.16
Occidental	6.37
Forestville	5.88
Rohnert Park	5.09
Petaluma	4.99
Eldridge	4.8
Fetters Hot Springs-Agua Caliente	4.59
Santa Rosa	4.52
Healdsburg	4.49
Roseland	4.4
Boyes Hot Springs	4.17
Cloverdale	3.99
Windsor	3.84
El Verano	3.7
Sonoma	3
Graton	2.66
Cotati	2.34
Sebastopol	2.08

Average Hazard Score Per City in Sonoma County



Guerneville and Monte Rio, which lie along the Russian River in heavily forested areas not too distant from the San Andreas fault, not surprisingly have the highest average hazard scores within their city borders. Meanwhile, Sebastopol, Graton, and Cotati – which all lie within a valley in mostly grassland, away from any bodies of water – have the lowest average hazard scores.

Taking an even closer look at residential properties, by using spatial joins of building data provided by Sonoma County with our hazard data, we can classify each residential building based on the hazard zone within where it lies. This kind of information would be useful to residents, prospective home buyers, or insurance agents. One can see how much hazards can very from home to home within a city by looking at this kind of data. For instance, in hilly West Petaluma, slopes and thus landslide hazard can cause stark differences in hazard scores, even between neighboring homes.



Further Exploration

It should be noted that I am no expert on natural disasters. I've simply given all hazard categories equal weight from 0-5, which might not be an accurate representation of their relative risk. A proper follow-up would be to reevaluate the scoring system by consulting with insurance experts, geologists, fire fighters, and other groups who have better background on the risks posed by natural disasters and how they compare to each other.

Sources

1. https://www.latimes.com/local/lanow/la-me-ln-fires-20171013-story.html
2. https://www.sfchronicle.com/bayarea/article/California-storm-flooding-17700721.php
3. https://www.latimes.com/business/story/2023-06-02/allstate-state-farm-stop-selling-new-home-insurance-in-california
4. https://www.nytimes.com/2022/08/01/climate/wildfire-risk-california-west.html

Map Data Sources

1. Cal Fire Hazard Maps: https://gis.data.ca.gov/datasets/CALFIRE-Forestry::fhsz-in-sra/explore?location=38.431267%2C-122.652021%2C9.00
2. Shaking Potential https://gis.data.ca.gov/datasets/cadoc::cgs-map-sheet-48-earthquake-shaking-potential-for-california-revised-2016/explore?location=38.406902%2C-122.588858%2C9.00
3. Liquefaction (KMZ File): https://earthquake.usgs.gov/education/geologicmaps/liquefaction.php
4. Flood Zones: https://mtc.maps.arcgis.com/home/item.html?id=929195bc63d74955bb54cf26c94b7659
5. Landslides (Working): https://gis.conservation.ca.gov/portal/home/item.html?id=87289025c11d4ba7ae65f0f472bf7c2d