Rebuild Florida

Threat Assessment for Less Severe Hazards

Attachment to 2022 Action Plan for Disaster Recovery - Hurricane Sally

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1.0 Wind

1.1 Hazard Overview

Wind is the horizontal motion of the air past a given point[1]. Winds occur when there are differences in air pressure, always moving from a location with high pressure to one with relatively lower pressure. Wind speed depends on two factors: (1) the pressure difference between two areas, and (2) the distance between those two areas. Stronger winds occur because of higher pressure difference and/or closer areas of high/low pressure. Wind speed is usually expressed in miles per hour or knots. The direction from which the wind is blowing is used to describe the wind. For example, "westerly winds" mean winds are blowing from the west. The wind events discussed in this portion of the assessment are non-hurricane, and non-tornadic wind events (i.e., mostly thunderstorm winds). Very few wind advisory events [sustained winds of thirty to thirty-nine (30-39) mph or wind gusts of forty-six to fifty-seven (46-57) mph] occur in the Hurricane Sally AOI on an annual basis.

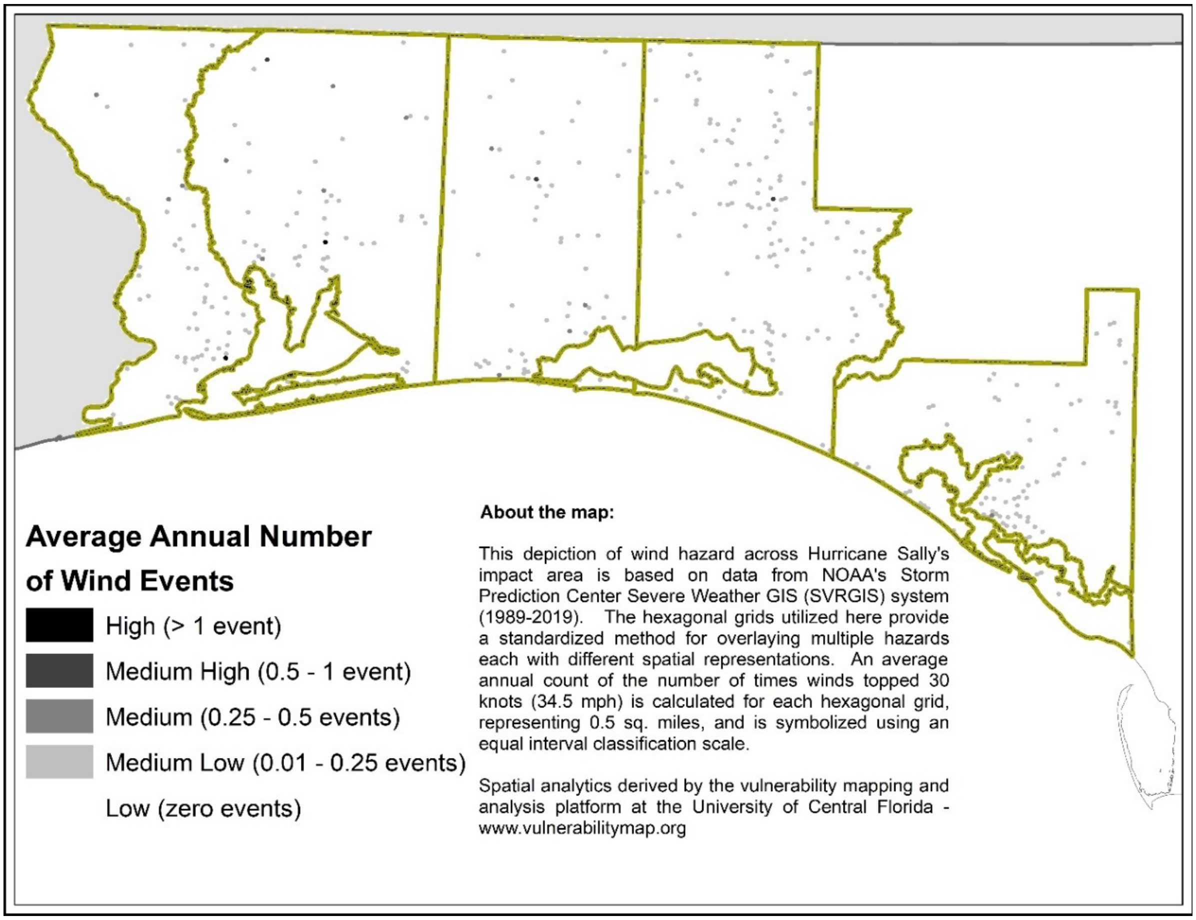
1.2 Data and Methods

Wind event climatology data (1989-2019) are obtained from the Severe Weather Database, NOAA Storm Prediction Center. Although the records of the entire dataset start from 1955, the earliest records in the Hurricane Sally AOI start in the mid-80s. Start and end locations for each wind event provide a general area of impact across the AOI. For each hexagon, the total frequency is calculated as the number of wind events intercepting each hexagon. Annual frequency is calculated by dividing the total frequency by the number of years on record.

1.3 Wind Hazard Frequency Analysis Results

Wind hazard is a lower threat to lives, livelihoods, and infrastructure across the Hurricane Sally AOI than other hazards. Most non-hurricane related wind events do not reach the threshold to cause damage, however the frequency of thirty (30)-knot winds across the AOI merits review. The map on the following page shows average annual frequency of thirty (30)-knot wind events over the thirty (30)-year period from 1989-2019 and indicates that wind hazard threat is not occurring frequently anywhere across the AOI, although Walton appears have more wind events than the other counties (Attachment Figure 1). All areas have a majority of their county area in low wind hazard threat areas (Attachment Table 1) making this particular hazard a low frequency event type.

[1] United States. NOAA. *National Weather Service Glossary*. Accessed at: http://w1.weather.gov/glossary/



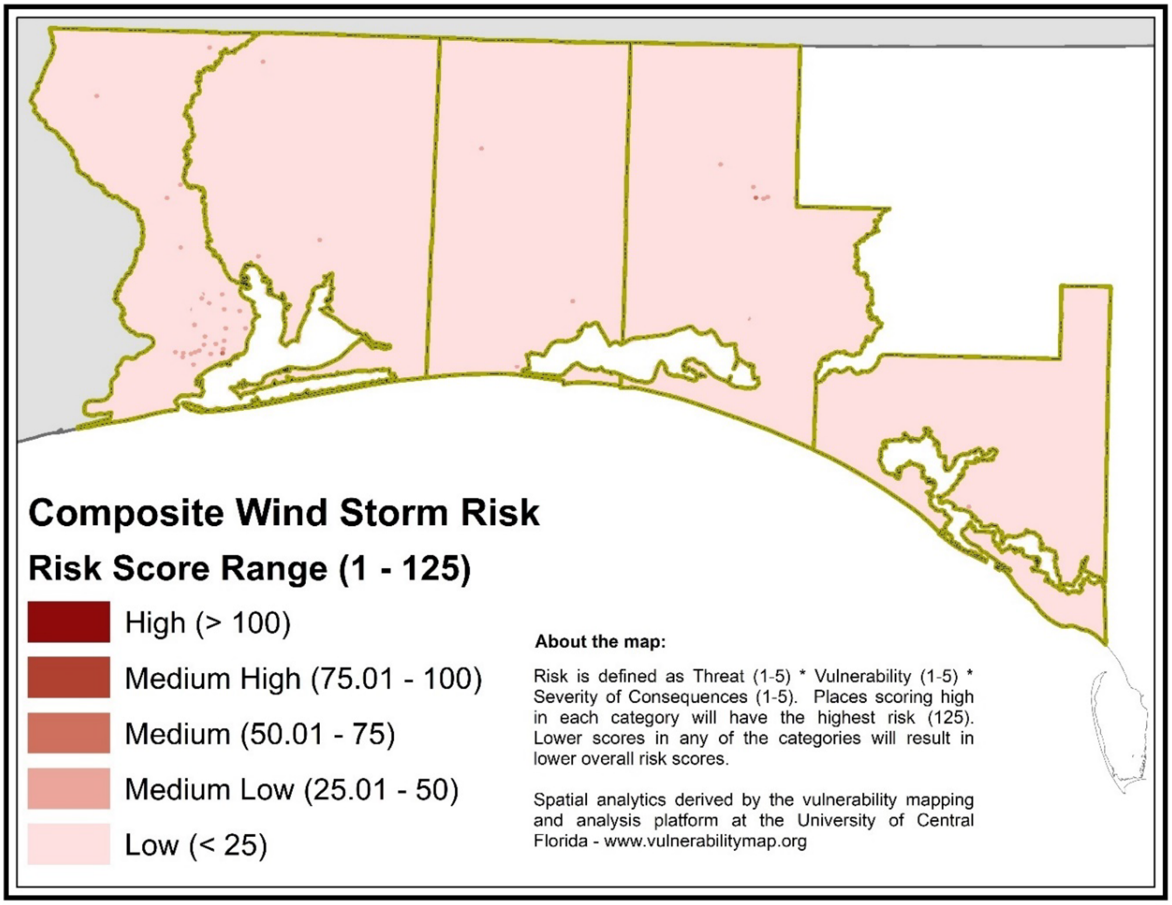
Attachment Figure 1: Wind Hazard Areas

Attachment Table 1: Wind Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	21,859	97.54%	522	2.33%	18	0.08%	5	0.02%	6	0.03%
Bay	4,091	3,962	96.85%	127	3.10%	2	0.05%	-	0.00%	-	0.00%
Escambia	3,977	3,870	97.31%	100	2.51%	3	0.08%	-	0.00%	4	0.10%
Okaloosa	4,842	4,758	98.27%	77	1.59%	6	0.12%	1	0.02%	-	0.00%
Santa Rosa	5,220	5,147	98.60%	63	1.21%	7	0.13%	1	0.02%	2	0.04%
Walton	5,030	4,866	96.74%	161	3.20%	-	0.00%	3	0.06%	-	0.00%

1.3.1 Wind Hazard Risk Analysis Results

Coupling wind hazard threats with underlying social, population, and lifeline vulnerability and a fairly low severity of consequences produces an unremarkable composite wind risk map (Attachment Figure 2). Escambia and Walton are the only counties with any land area in a medium or greater risk class, with Escambia county containing a very small medium-high wind risk area (Attachment Table 2).



Attachment Figure 2: Wind Hazard Composite Risk

Attachment Table 2: Wind Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,332	99.65%	71	0.32%	6	0.03%	1	0.00%	-	0.00%
Bay	4,091	4,089	99.95%	2	0.05%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,919	98.54%	54	1.36%	3	0.08%	1	0.03%	-	0.00%
Okaloosa	4,842	4,838	99.92%	4	0.08%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,215	99.90%	5	0.10%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,021	99.82%	6	0.12%	3	0.06%	-	0.00%	-	0.00%

2.0 Fog

2.1 Hazard Overview

Fog is a hazard to drivers, mariners, and aviators. There are several different conditions under which fog forms, however the most common across the Sally AOI is radiation fog. Radiation fog is the most common type of fog. Radiation fog mostly forms in the early morning and dissipates rapidly as air near to the ground cools. When the air reaches saturation, fog will form. Initially, fog will form near, or at, the surface and will thicken and extend upward as the air continues to cool (e.g., overnight). Radiation fog mostly occurs in sheltered valleys and near bodies of water. Its appearance is usually patchy and localized since wind disrupts the development of radiation fog.

2.2 Data and Methods

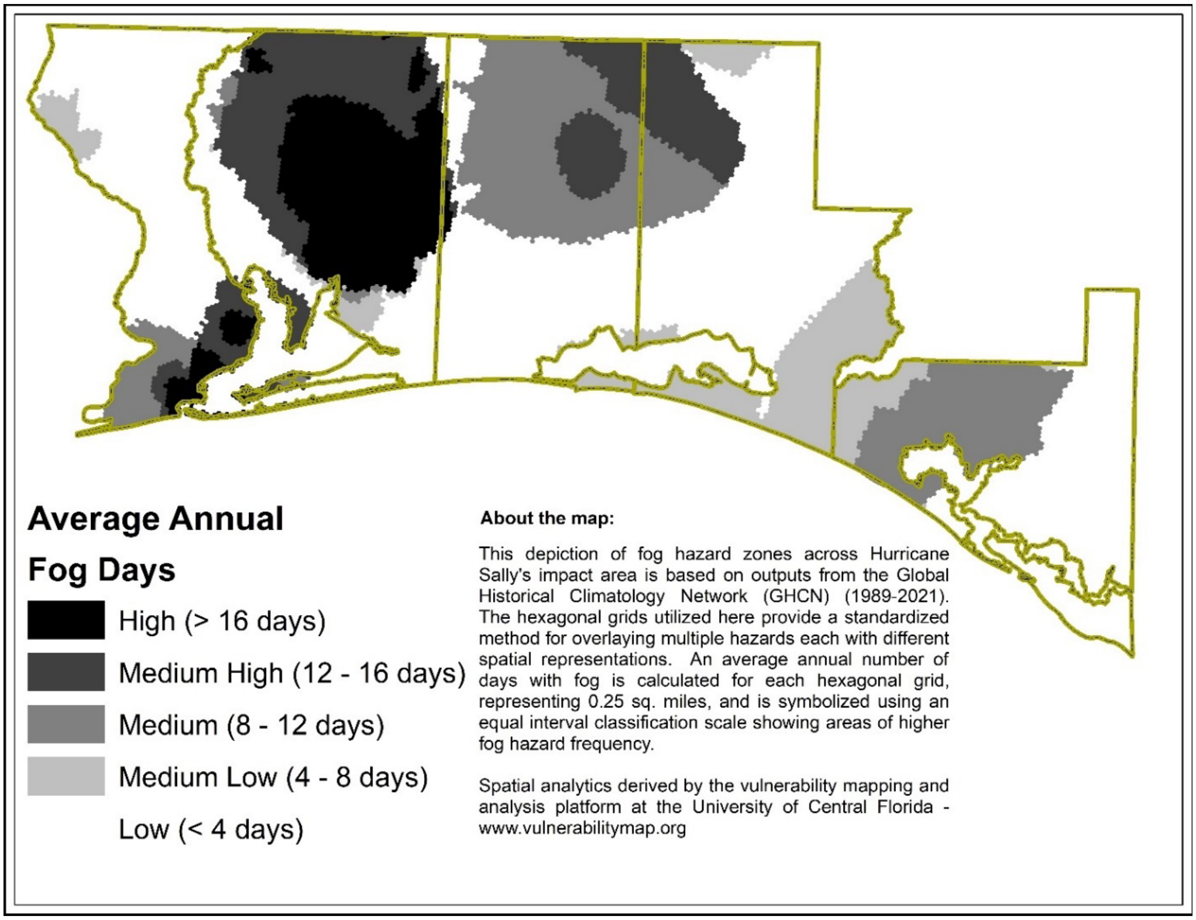
Although most weather stations collect temperature and wind data, relatively few have sensors capable of identifying fog. However, several weather stations in and around the AOI collected data on fog incidence. An AOI-wide depiction of daily fog frequency of occurrence was derived by interpolating fog events days from available weather station data and summarizing to the 0.25-square-mile hexagonal grid to provide a more nuanced understanding of fog hazard frequency across the Hurricane Sally AOI.

2.3 Fog Hazard Frequency Analysis Results

Fog hazard is most frequent in southern Escambia and central to northern Okaloosa Counties along several lower threat areas in Okaloosa/Walton and Bay Counties (Attachment Figure 3). Although fog does not occur very frequently across the AOI (<16 days annually), it does pose a threat to those operating motor vehicles, planes, and boats. By area, Santa Rosa has the highest amount of land (Attachment Table 3) - more than 35% - in a fog high threat class. Although fog is not a frequent hazard and does not cause significant damage to property and lives (generally), the spatial distribution of fog hazards affects some places more than others.

2.3.1 Fog Hazard Risk Analysis Results

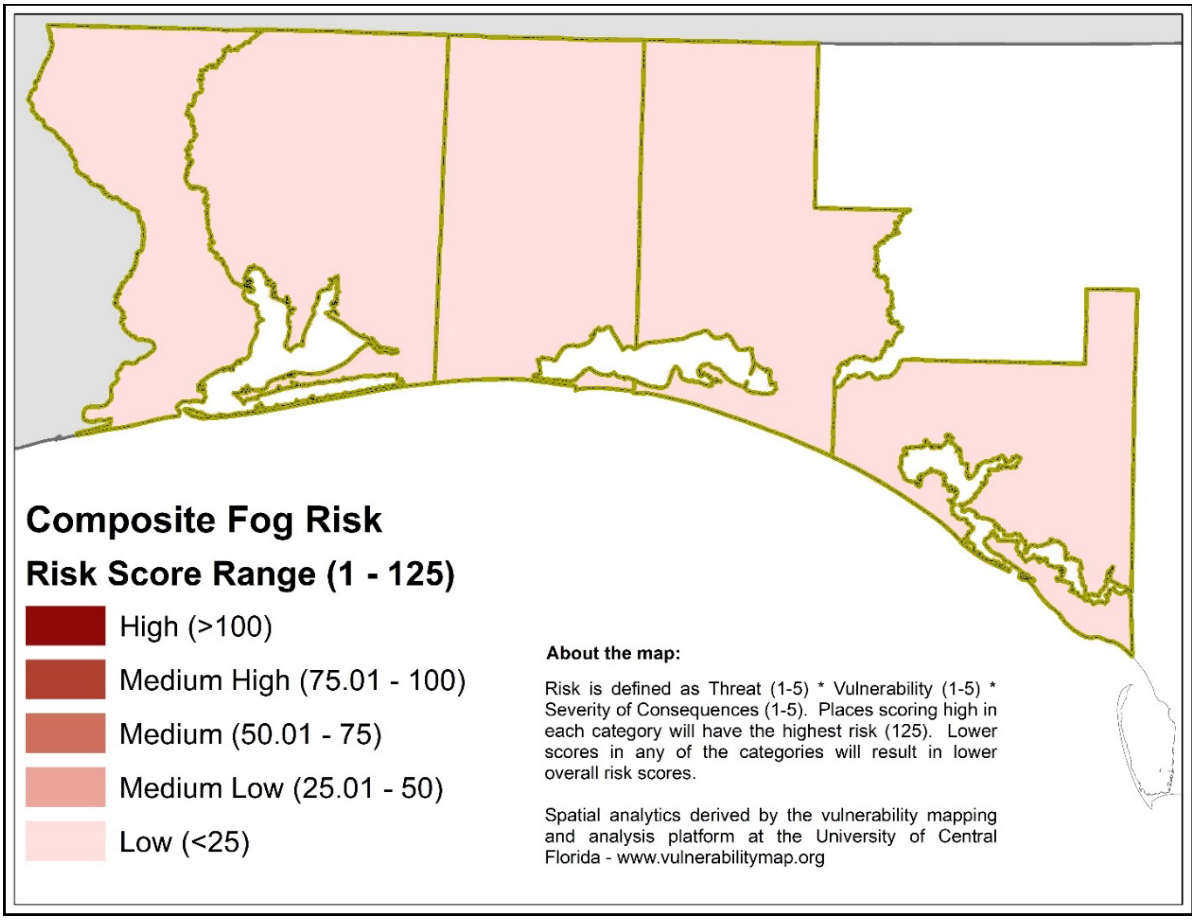
Fog has the lowest severity of consequences score (1 out of 5) across the AOI. Consequently, fog risk is low with every county categorized as low fog risk (Attachment Figure 4) and (Attachment Table 4). If fog caused more damage, fatalities, injuries, or was a higher priority its risk would increase significantly.



Attachment Figure 3: Fog Hazard Threat Areas

Attachment Table 3: Fog Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	11,146	49.74%	2,089	9.32%	3,769	16.82%	3,133	13.98%	2,273	10.14%
Bay	4,091	2,539	62.06%	351	8.58%	1,201	29.36%	-	0.00%	-	0.00%
Escambia	3,977	2,550	64.12%	149	3.75%	416	10.46%	467	11.74%	395	9.93%
Okaloosa	4,842	2,181	45.04%	206	4.25%	1,753	36.20%	635	13.11%	67	1.38%
Santa Rosa	5,220	1,562	29.92%	132	2.53%	101	1.93%	1,567	30.02%	1,858	35.59%
Walton	5,030	2,753	54.73%	1,325	26.34%	368	7.32%	584	11.61%	-	0.00%



Attachment Figure 4: Fog Hazard Risk

Attachment Table 4: Fog Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,410	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,977	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,842	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,030	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%

3.0 Hail

3.1 Hazard Overview

An infrequent hazard in the Hurricane Sally AOI, hail can occur year-round during severe thunderstorms. Hail is a precipitation type, consisting of ice pellets that form when water droplets bounce above and below the freezing level of the atmosphere. The size of hail is a function of the intensity of the updraft, and hence the severity of the storm. Strong vertical motion can keep lifting hailstones so that they continue to accumulate in size. The speed at which hail reaches the ground, or its terminal velocity, is a function of its size and weight. Hail can be small, generally pea-sized. But it may be larger, capable of damaging property and killing livestock and people.

3.2 Data and Methods

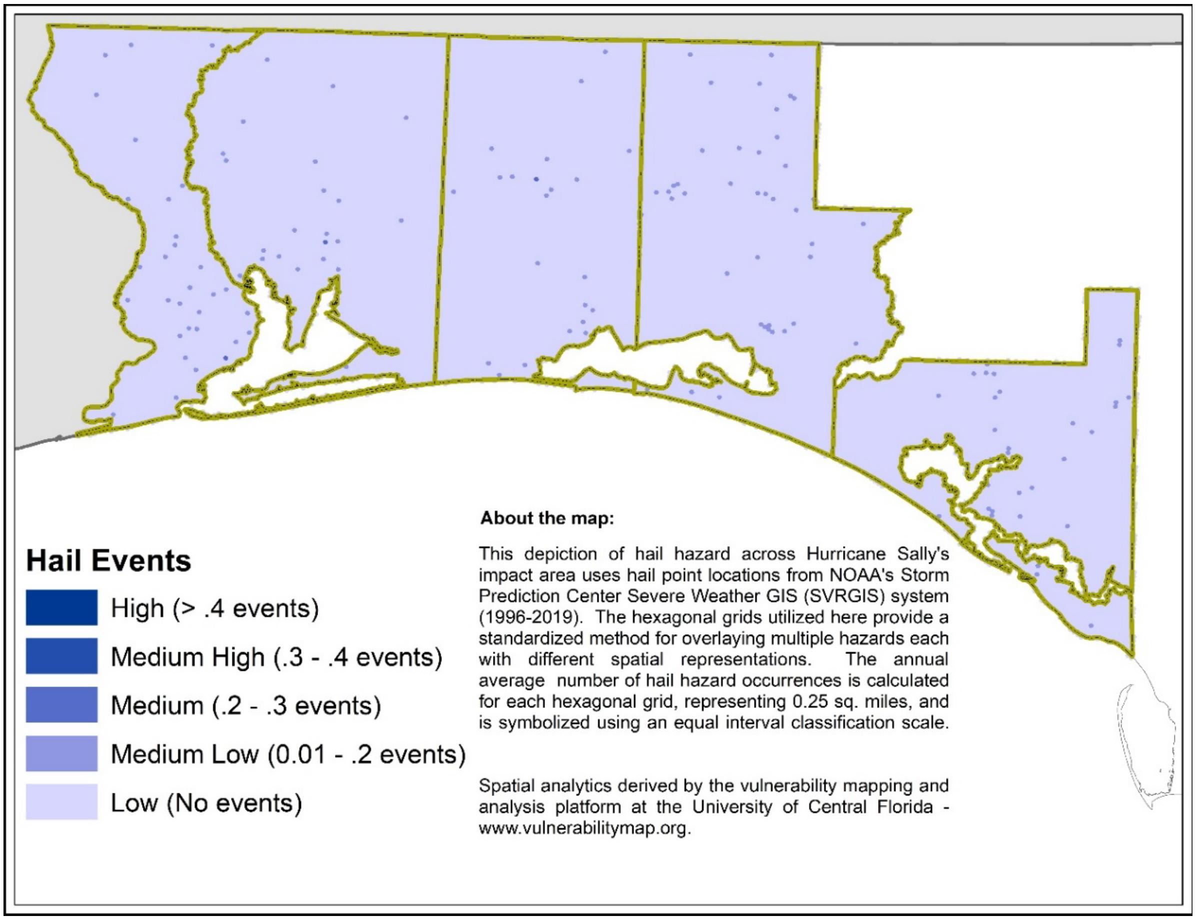
Hail climatology data (1996-2019) are obtained from the Severe Weather Database, NOAA Storm Prediction Center. Although the records of the entire dataset start from 1955, the earliest records in the Hurricane Sally AOI start in 1996. Start and end locations for each hail event provide a general area of impact across the AOI. For each hexagon, the total frequency is calculated as the number of hail events intercepting each hexagon. Annual frequency is calculated by dividing the total frequency by the number of years on record.

3.3 Hail Hazard Frequency Analysis Results

Hail hazards occur rarely across the Hurricane Sally AOI. Since 1996 only 239 instances of hail in the Hurricane Sally AOI have been recorded by NOAA. However, a visual inspection of the hail event pattern indicates that this hazard has impacted central portions of the AOI more than coastal areas (Attachment Figure 5). Generally, most places across the AOI have had few hail events, binning most counties in the AOI into the lowest hazard threat zone in terms of land area (Attachment Table 5).

3.3.1 Hail Hazard Risk Analysis Results

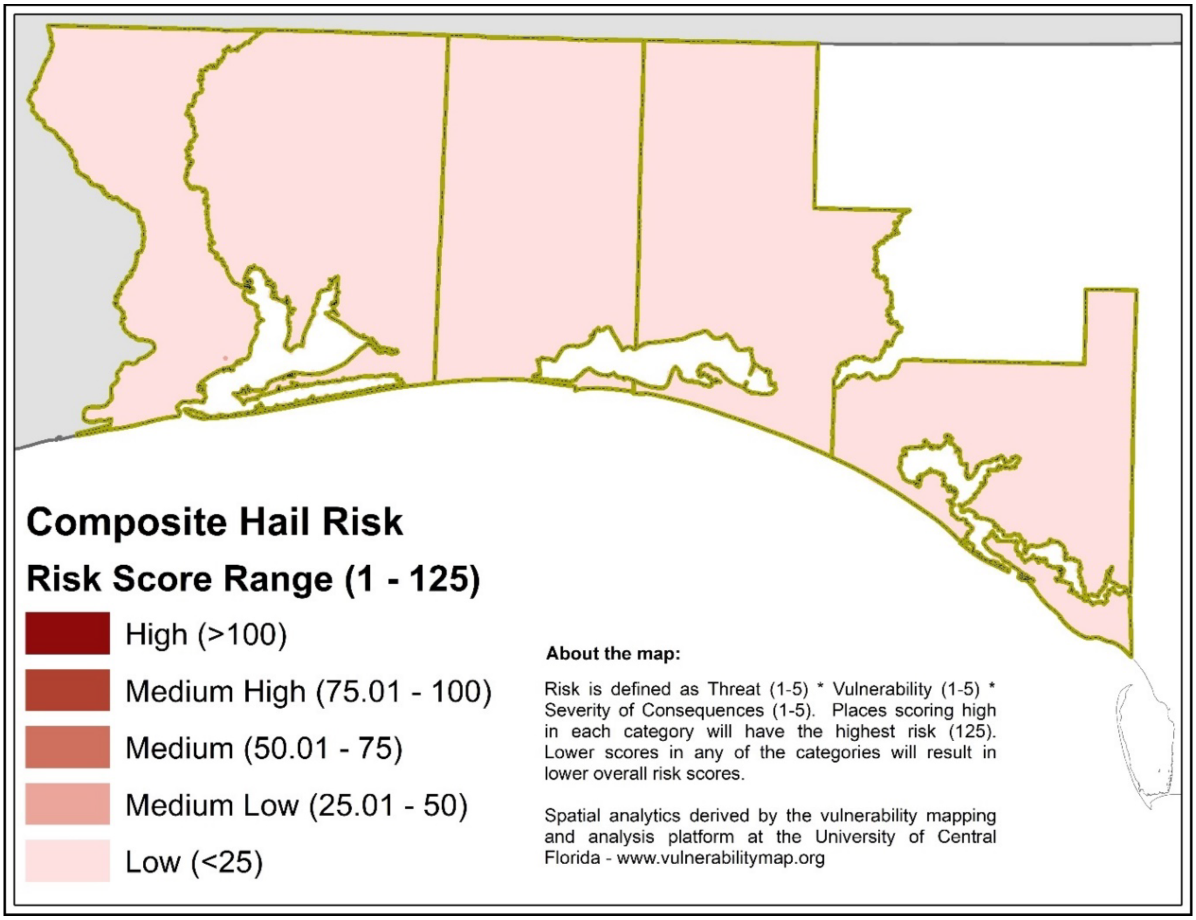
Like other low consequence and low frequency hazard threats, hail hazard risk across the AOI is minimal (Attachment Figure 6). Only two counties have any land area outside of the low hail risks classification (Attachment Table 6).



Attachment Figure 5: Hail Hazard Areas

Attachment Table 5: Hail Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,193	99.03%	210	0.94%	7	0.03%	-	0.00%	-	0.00%
Bay	4,091	4,045	98.88%	46	1.12%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,922	98.62%	51	1.28%	4	0.10%	-	0.00%	-	0.00%
Okaloosa	4,842	4,812	99.38%	29	0.60%	1	0.02%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,190	99.43%	28	0.54%	2	0.04%	-	0.00%	-	0.00%
Walton	5,030	4,972	98.85%	58	1.15%	-	0.00%	-	0.00%	-	0.00%



Attachment Figure 6: Hail Hazard Composite Risk

Attachment Table 6: Hail Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,406	99.98%	4	0.02%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,973	99.90%	4	0.10%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,842	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,030	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%

4.0 High Temperatures

4.1 Hazard Overview

A heatwave is an extended period of above-normal temperatures over a given period of time. The World Meteorological Organization (WMO) recommends the declaration of a heatwave when the daily maximum temperatures exceed the average maximum temperatures by nine degrees Fahrenheit (9°F) and last for a period of at least five (5) days. Temperature alone is insufficient to describe the stress placed on humans, as well as flora and fauna, in hot weather. It is crucial to consider the effect of relative humidity since it is essential to the body's ability to perspire and cool off. Once air temperature reaches thirty-five degrees Celsius (35°C)/ninety-five degrees Fahrenheit (95°F), perspiration becomes the most important manner of heat loss. Perspiration does not work if the water cannot evaporate (i.e. sweating in high relative humidity is less effective than in dry climate). Thus, high temperature days in Florida – where relative humidity is generally higher – can have deadly results for those people who are exposed (e.g. farm workers) and cannot find places to stay cool.

4.2 Data and Methods

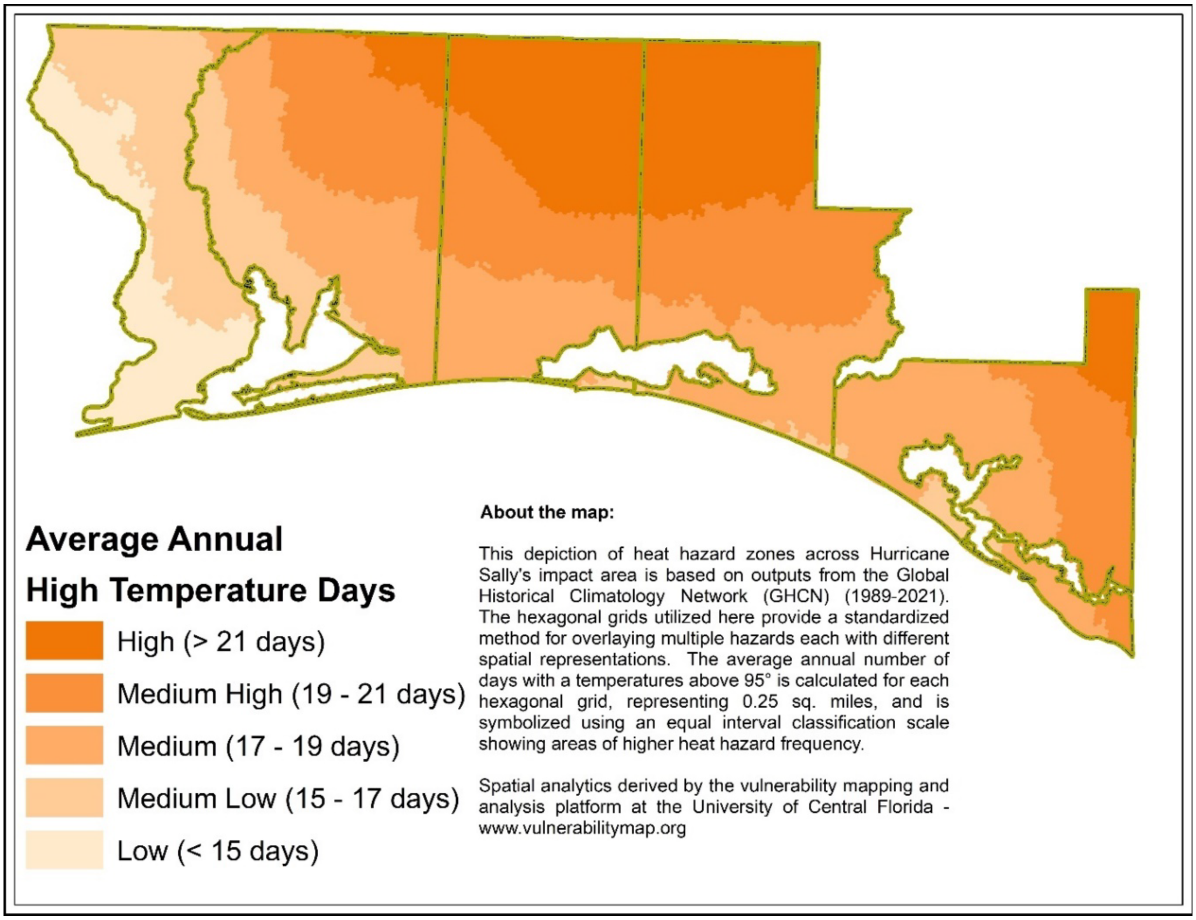
A similar method to that of fog was used for high-temperature data. Here, stations collecting historical temperature data across the AOI were identified and linked with GHCN data for the AOI providing a daily temperature record between 1991-2021. An area-wide depiction of the daily frequency of temperatures greater than ninety-five degrees Fahrenheit (95°) was interpolated from these weather stations and summarized to the 0.25-square-mile hexagonal grid to provide a more nuanced understanding of heat hazard frequency across the Hurricane Sally AOI.

4.3 Heat Hazard Frequency Analysis Results

Although temperatures do not regularly exceed ninety-five degrees Fahrenheit (95°F) across the Hurricane Sally AOI, there is a pattern of heat trending from north to south across these counties (Attachment Figure 7). Here, Escambia has the lowest heat hazard threat and Walton has the most land area (38%) in the high heat hazard zone (Attachment Table 7). Bay County, Okaloosa County, and Walton County have no land area classified as low heat hazard threat. Here, one can expect more than 15 days per year above ninety-five degrees Fahrenheit (95°F).

4.4 Heat Hazard Risk Analysis Results

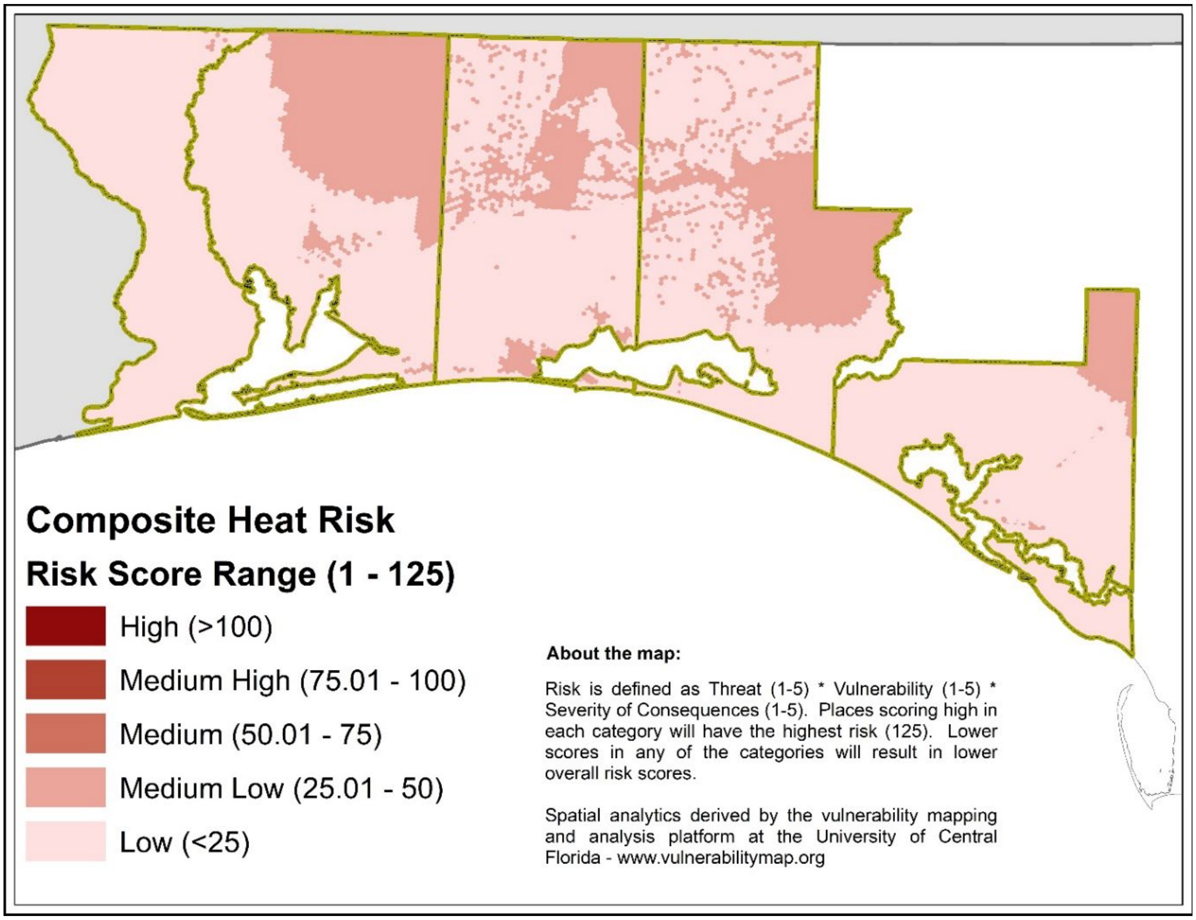
Because heat hazard does not cause property damage and is not a high priority hazard for the emergency management communities in the AOI, it has a lower severity of consequences. Overlaying this low SOC with high temp risk areas does produce differential risk across the AOI (Attachment Figure 8), however, this risk falls into the low to medium-low categories (Attachment Table 8). Santa Rosa, and Walton, followed by Okaloosa, have the most land area in at risk to high temperature hazards – although this risk tops out at a medium low classification.



Attachment Figure 7: Heat Hazard Areas

Attachment Table 7: Heat Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	1,903	8.49%	3,668	16.37%	6,763	30.18%	5,647	25.20%	4,429	19.76%
Bay	4,091	-	0.00%	313	7.65%	2,115	51.70%	1,289	31.51%	374	9.14%
Escambia	3,977	1,870	47.02%	2,003	50.36%	100	2.51%	4	0.10%	-	0.00%
Okaloosa	4,842	-	0.00%	89	1.84%	1,478	30.52%	1,287	26.58%	1,988	41.06%
Santa Rosa	5,220	33	0.63%	1,407	26.95%	1,951	37.38%	1,526	29.23%	303	5.80%
Walton	5,030	-	0.00%	95	1.89%	1,317	26.18%	1,690	33.60%	1,928	38.33%



Attachment Figure 8: Heat Hazard Risk

Attachment Table 8: Heat Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	17,219	76.84%	5,191	23.16%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	3,692	90.25%	399	9.75%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,965	99.70%	12	0.30%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	3,453	71.31%	1,389	28.69%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	3,342	64.02%	1,878	35.98%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	3,369	66.98%	1,661	33.02%	-	0.00%	-	0.00%	-	0.00%

5.0 Low Temperatures

5.1 Hazard Overview

Extreme cold temperatures occur relatively infrequently across the Sally AOI during the winter months. Frigid temperatures are largely a danger to humans and livestock, with impacts such as hypothermia or frostbite and impacts to crops including frost damage to citrus and other fruits and vegetables. Many fatalities may occur from carbon monoxide poisoning when utilizing faulty heating equipment or outdoor heating equipment indoors. Property damage is largely limited to unprotected (water) pipes. Disruption in water service and decreases in water pressure, however, cause a cascading problem for emergency responders (e.g., firefighting).

5.2 Data and Methods

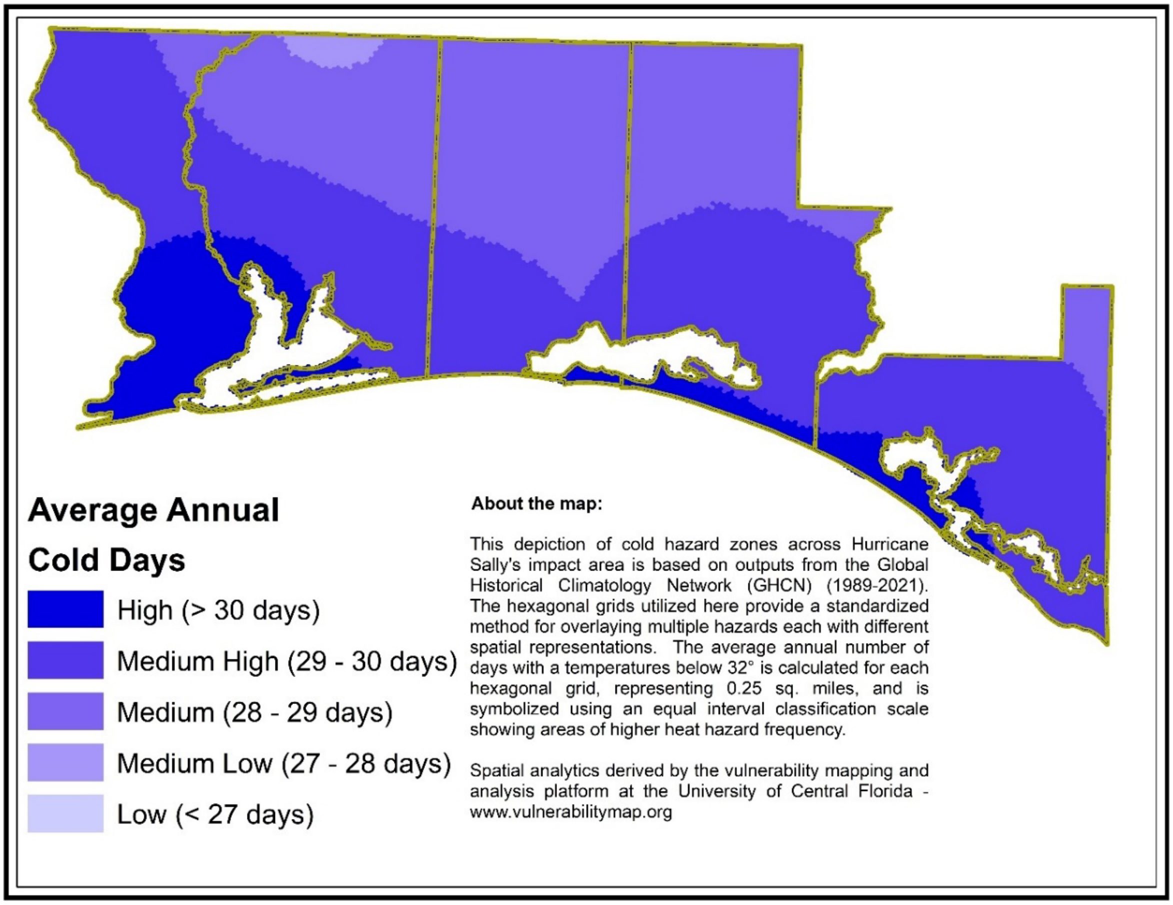
Like high temperature hazard threats, low temperature hazards were interpolated from available weather station data. Stations collecting historical temperature data across the AOI were identified and linked with GHCN data for the AOI providing a daily temperature record between 1991-2021. An area-wide depiction of the daily frequency of temperatures less than thirty-two (32°F) was interpolated from these weather stations and summarized to the 0.25-square-mile hexagonal grid to provide a visual depiction of cold hazard frequency across the Hurricane Sally AOI.

5.3 Low Temperature Hazard Frequency Analysis Results

Comparing high and low temperature hazards, one can see that temperatures more regularly go below freezing in this part of Florida than they exceed ninety-five degrees Fahrenheit (95°F) making cold hazard more impactful. Two (2) areas of the Hurricane Sally AOI, one (1) larger area in Escambia County and southwestern Santa Rosa County and one (1) along the coastal zone of Okaloosa, Walton, and Bay counties exhibit the largest cold hazard threat areas (Attachment Figure 10). These places see more than 30 freezing days per year with the Escambia high hazard threat area nearing 50% of its land area (Attachment Table 9). The remainder of the Hurricane Sally AOI is characterized by a lower number of low temperature hazard days. In this regard, a majority of Santa Rosa, Okaloosa, and Walton exhibit lower cold hazard threat.

5.4 Low Temperature Hazard Risk Analysis Results

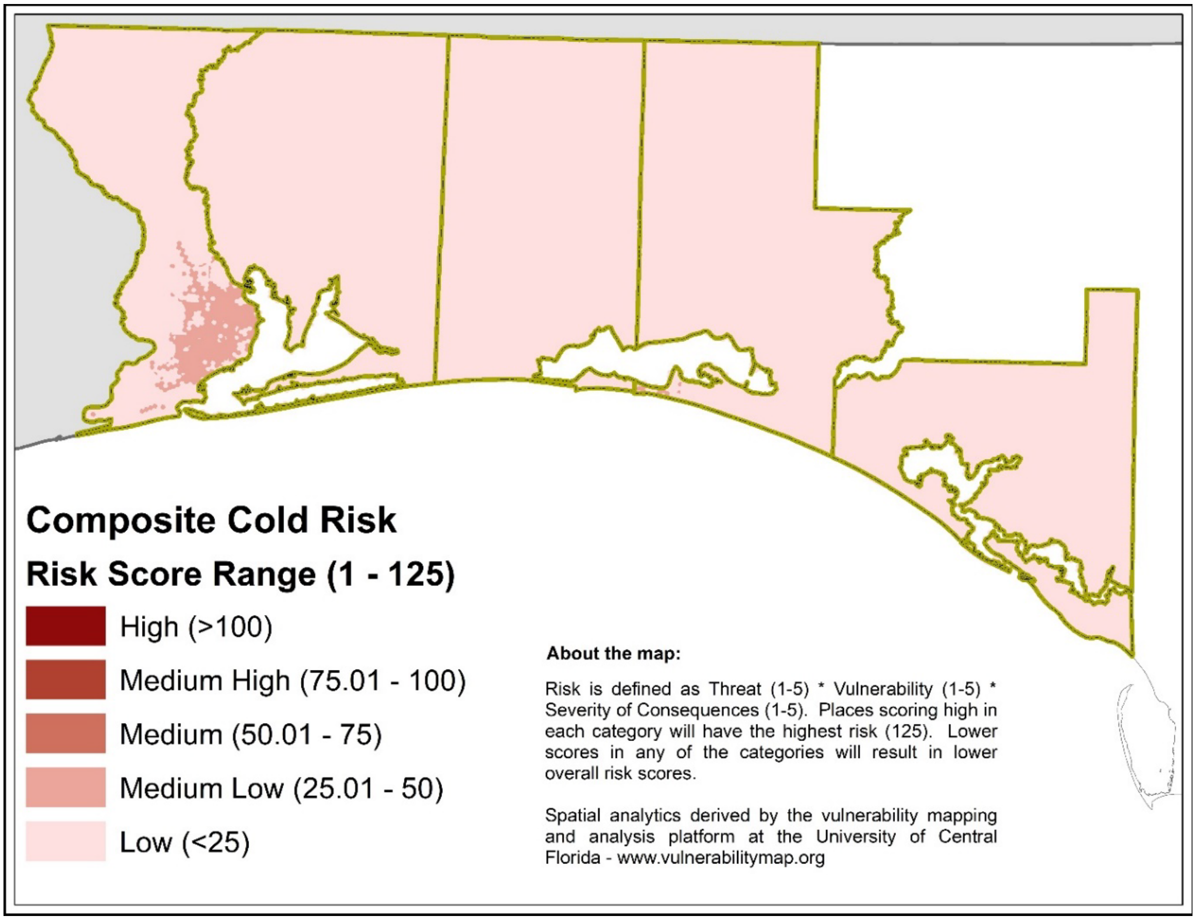
Like high temperature risk, the severity of consequences from cold hazards are not as extensive as other hazards in this assessment. As a result, most of the AOI is characterized by low risk in relation to low temperature hazard (Attachment Figure 10) with only two counties (Escambia and Walton) containing land in the medium-low risk category (Attachment Table 10).



Attachment Figure 9: Low Temperature Hazard Areas

Attachment Table 9: Low Temperature Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	-	0.00%	177	0.79%	7,655	34.16%	10,955	48.88%	3,623	16.17%
Bay	4,091	-	0.00%	-	0.00%	342	8.36%	3,080	75.29%	669	16.35%
Escambia	3,977	-	0.00%	-	0.00%	311	7.82%	1,679	42.22%	1,987	49.96%
Okaloosa	4,842	-	0.00%	-	0.00%	3,034	62.66%	1,669	34.47%	139	2.87%
Santa Rosa	5,220	-	0.00%	177	3.39%	2,090	40.04%	2,359	45.19%	594	11.38%
Walton	5,030	-	0.00%	-	0.00%	2,215	44.04%	2,491	49.52%	324	6.44%



Attachment Figure 10: Low Temperature Risk

Attachment Table 10: Low Temperature Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	21,687	96.77%	723	3.23%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,267	82.15%	710	17.85%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,842	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,017	99.74%	13	0.26%	-	0.00%	-	0.00%	-	0.00%

6.0 Winter Weather Hazards

6.1 Hazard Overview

Many hazards are associated with winter storms and weather including strong winds, coastal flooding, heavy snow and ice. There is no generally accepted classification of winter storms or destruction, but winter storm types include: blizzard, lake effect, ice storm, and nor'easter[2]. There are three components for winter storm formation: cold air, moisture, and lift. Cold temperatures below freezing at ground level allow for snow and ice formation; moisture from bodies of water allows for the precipitation that eventually freezes to snow and ice; lift allows moisture to rise for cloud and precipitation formation.

The severity of winter weather depends on a community's ability to manage and cope with the event, such as the rapid mobilization of snow removal equipment or road salt. Due to the rare occurrence of severe winter weather across the Sally AOI, coupled with the expensive costs to acquire and maintain the necessary resources to combat their effects, many communities are not prepared for such events. Winter storms are very infrequent in the panhandle of Florida. When they do occur, however infrequently, winter storms cause extensive property damage as well as indirect threats associated with vehicle accidents and the loss of power/heat. Telecommunications and power can be disrupted for days during these events. Depending on ice thickness, the size of the area covered, and the duration of the ice storm, the impact can be crippling: roadways become impassible, power is disrupted, communication is severed, and travel by vehicle or by foot may become treacherous, causing injuries and fatalities.

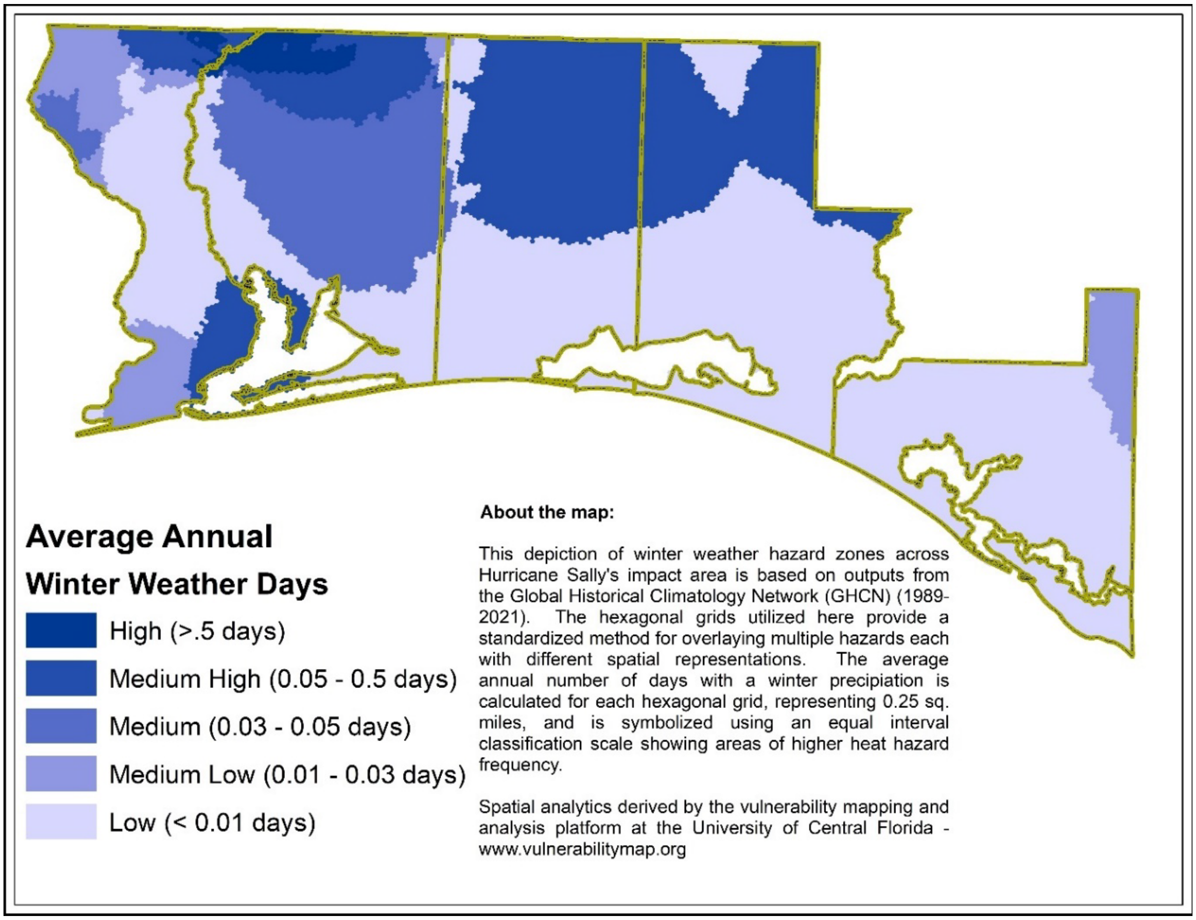
6.2 Data and Methods

A similar method to that of fog, high, and low temperature hazard threats was used for winter weather hazard analysis. Linking stations capable of collecting winter weather data with their data on the GHCN network provided information on winter precipitation across the AOI between 1989-2021. An area-wide depiction of the daily frequency of winter weather was interpolated from these weather stations and summarized to the 0.25-square-mile hexagonal grid to provide a spatial representation of winter weather hazard frequency across the Hurricane Sally AOI.

6.3 Winter Hazard Frequency Analysis Results

Although infrequent, the pattern of winter weather extends south from the Florida/Alabama boarder and west to east along then Northern portions of the AOI (Attachment Figure 11). Although the range of winter days is very small (0.01 - .5 days per year), distinct patterns of higher winter weather threat are visible in portions of both Escambia and Santa Rosa with land area in the highest threat category (Attachment Table 9).

[2] http://www.weather.com/encyclopedia/winter/types.html



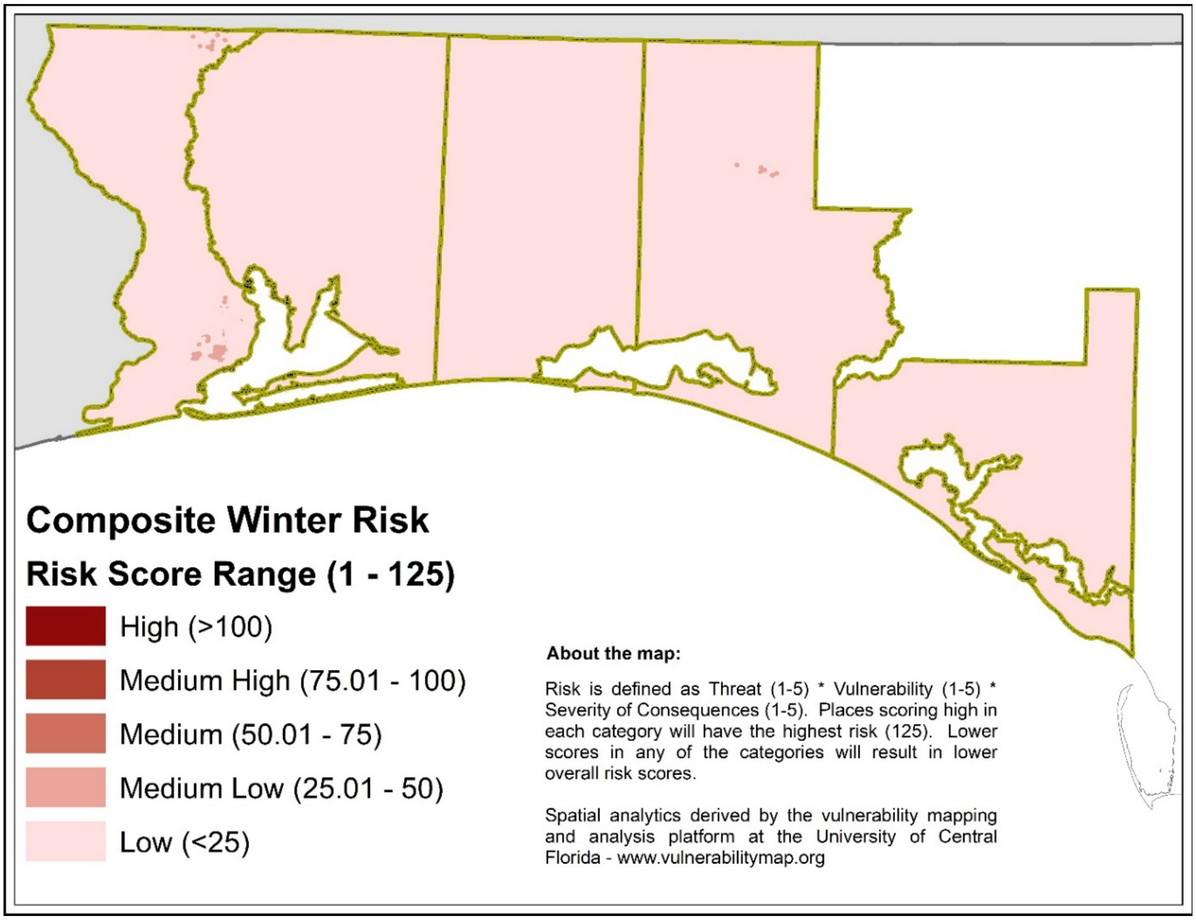
Attachment Figure 11: Winter Weather Hazard Areas

Attachment Table 11: Winter Weather Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	12,155	54.24%	1,626	7.26%	2,569	11.46%	5,704	25.45%	356	1.59%
Bay	4,091	3,689	90.17%	402	9.83%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	1,650	41.49%	1,177	29.60%	149	3.75%	907	22.81%	94	2.36%
Okaloosa	4,842	2,375	49.05%	12	0.25%	112	2.31%	2,343	48.39%	-	0.00%
Santa Rosa	5,220	1,600	30.65%	46	0.88%	2,383	45.65%	881	16.88%	310	5.94%
Walton	5,030	3,301	65.63%	-	0.00%	-	0.00%	1,729	34.37%	-	0.00%

6.4 Winter Hazard Risk Analysis Results

Like fog, high, and low temperatures, the consequences associated with winter weather have infrequently been realized across the AOI. As such, only a few very small pockets of medium-low exists across the AOI (Attachment Figure 12 and Attachment Table 12).



Attachment Figure 12: Winter Weather Risk

Attachment Table 12: Winter Weather Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,337	99.67%	73	0.33%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,912	98.37%	65	1.63%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,842	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,022	99.84%	8	0.16%	-	0.00%	-	0.00%	-	0.00%

7.0 Sinkholes

7.1 Hazard Overview

Sinkholes are a common feature of Florida's landscape and are only one of many kinds of Karst landforms, which include caves, disappearing streams, springs, and underground drainage systems, all of which occur in Florida. Karst is a generic term which refers to the characteristic terrain produced by erosion processes associated with the chemical weathering and dissolution of limestone or dolomite, the two most common carbonate rocks in Florida. Dissolution of carbonate rocks begins when they are exposed to acidic water. Most rainwater is slightly acidic and usually becomes more acidic as it moves through decaying plant debris.[3]

Limestones in Florida are porous, allowing the acidic water to percolate through their strata, dissolving some limestone and carrying it away in solution. Over eons of time, this persistent erosional process has created extensive underground voids and drainage systems in much of the carbonate rocks throughout the state. Collapse of overlying sediments into the underground cavities produces sinkholes which can cause damage to buildings and infrastructure located above them.

7.2 Data and Methods

Incidence of subsidence across Florida are collected and curated by the Florida Department of Environmental Protection[4] and made available as a GIS friendly point location file. Like hail and wind events, incidence of subsidence were plotted and, for each hexagon, the total frequency of sinkholes was calculated as the number of sinkholes intercepting each hexagon.

7.3 Sinkhole Hazard Frequency Analysis Results

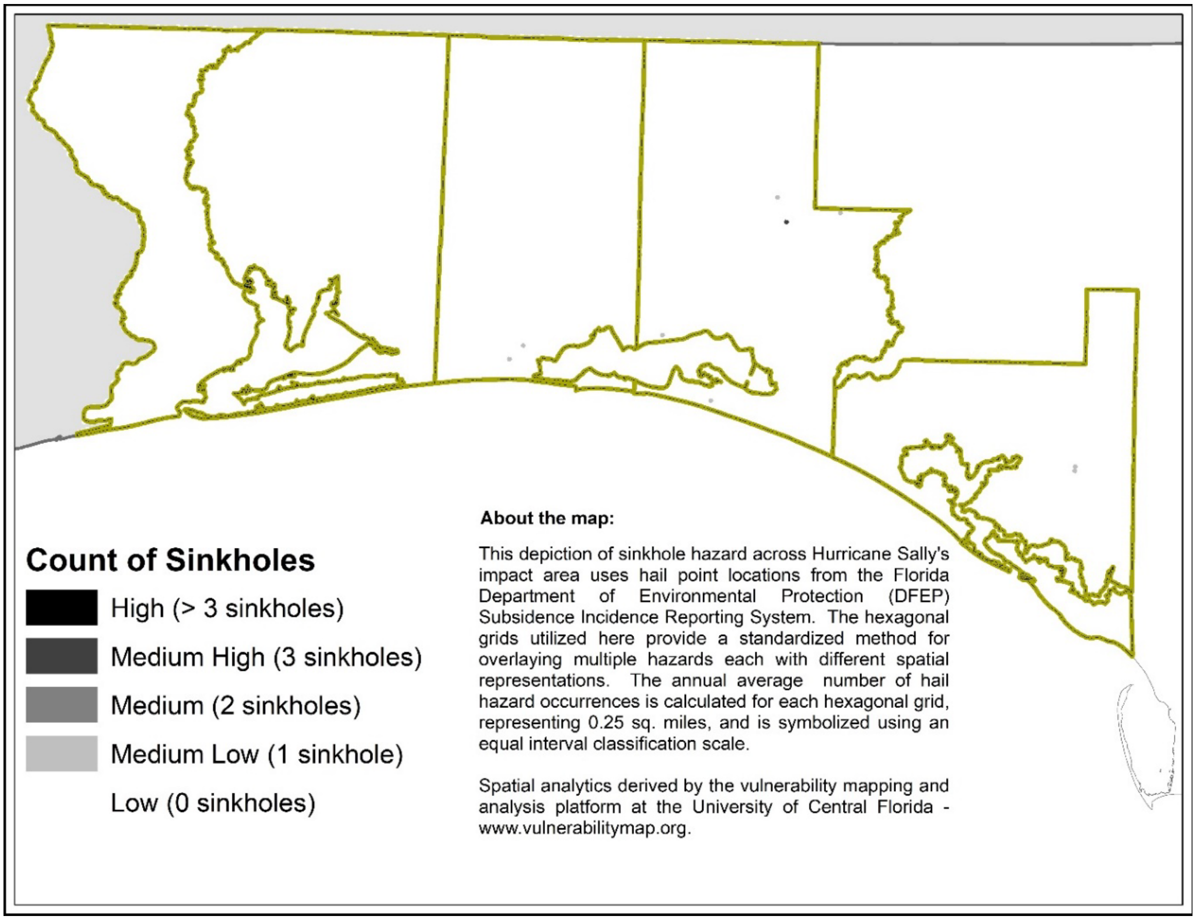
The least frequent hazard event across the AOI with only 11 reported sinkholes across the five Sally impacted counties, sinkhole are not a common threat, but when they do occur they have the potential to be more damaging that hail and winter storms in Florida. However, the spatial representation of sinkhole threats is unremarkable (Attachment Figure 13) as is the breakdown have hazard threat areas by county (Attachment Table 13).

7.4 Sinkhole Hazard Risk Analysis Results

Like other hazards with low threat and low severity on consequences, the risks associated with sinkholes do not rise to the same level as other threats such as hurricanes. Here, both the spatial risk representation (Attachment Figure 14) and tabular areal risk statistics (Attachment Table 14) show only low risk to sinkholes across the AOI.

[3] https://www.co.walton.fl.us/569/Local-Mitigation-Strategy-LMS

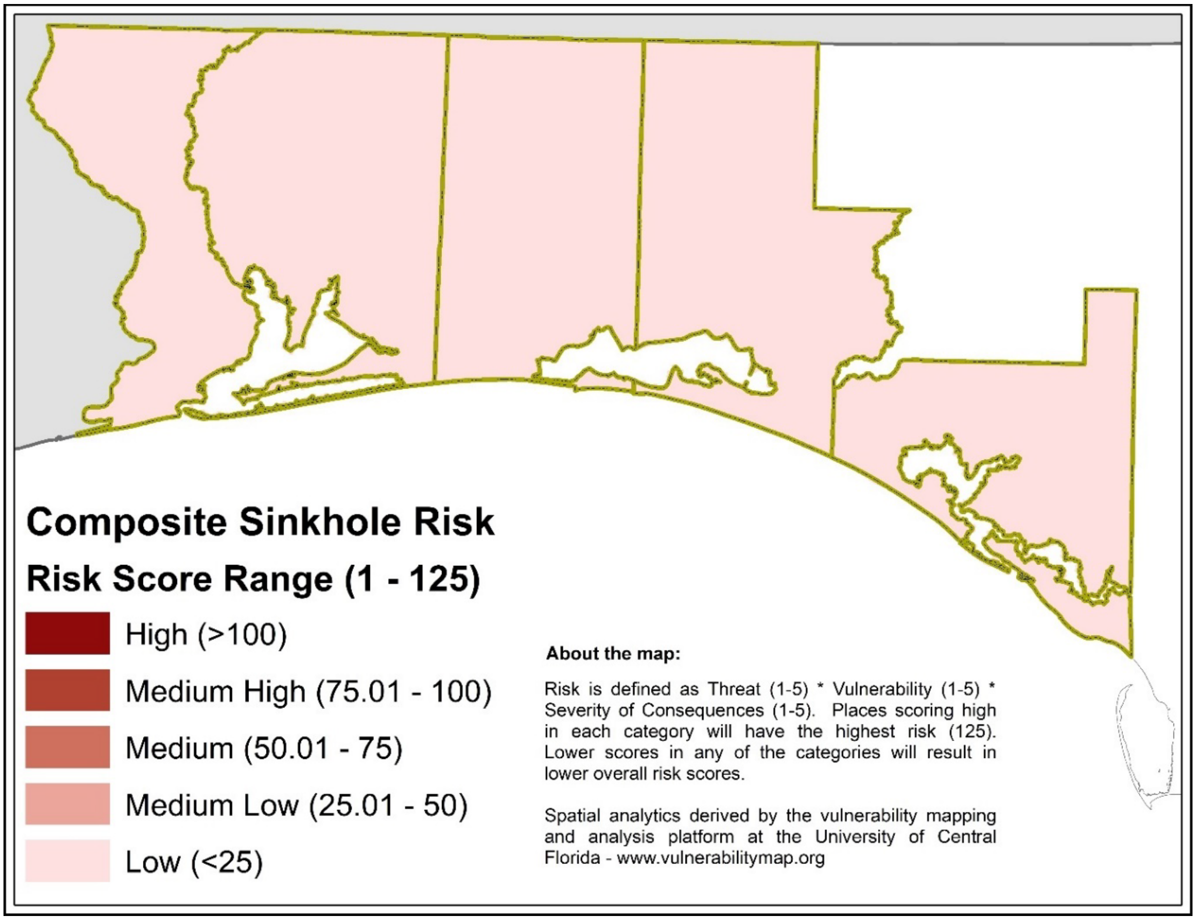
[4] https://floridadep.gov/fgs/sinkholes/content/subsidence-incident-reports



Attachment Figure 13: Sinkhole Hazard Areas

Attachment Table 13: Sinkhole Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,397	99.94%	11	0.05%	-	0.00%	2	0.01%	-	0.00%
Bay	4,091	4,088	99.93%	3	0.07%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,977	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,839	99.94%	3	0.06%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,023	99.86%	5	0.10%	-	0.00%	2	0.04%	-	0.00%



Attachment Figure 14: Sinkhole Hazard Composite Risk

Attachment Table 14: Sinkhole Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,410	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,977	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,842	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,030	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%

8.0 Earthquakes

8.1 Hazard Overview

An earthquake is caused by the release of stored energy within, or along the edge of, the tectonic plates of the Earth. They are characterized by a sudden shaking of the earth. The severity of an earthquake depends on its place of origin (epicenter) and the amount of energy released. Upon the occurrence of the earthquake, seismic waves radiate from the earthquake source, causing the shaking of the earth. The severity of the tremor increases as energy is released and decreases according to its distance from the epicenter. The tremors can be felt hundreds of miles from its epicenter. The intensity of shaking is the result of several factors, such as: the extent and type of earthquake, the distance from the epicenter, the area's soil conditions, and the relative orientation of the site with respect to the seismic event.

Among the damage earthquakes can cause are liquefaction, landslides, and significant damage to buildings and infrastructure. Liquefaction is a phenomenon that causes unconsolidated soils to lose their strength and act similarly to a viscous fluid (like quicksand) when these soils are subject to tremors due to an earthquake. The frequency and intensity of liquefaction that can occur during an earthquake is impacted by several factors including: the geological conditions of the area, groundwater depth, the tremor severity, and magnitude of the earthquake.

Earthquakes can cause landslides and other types of soil failures. Landslides are sudden movements of materials that emerge from the hills or mountains, free fall, sliding or rolling down. Landslides caused by earthquakes can occur on natural slopes, cut slopes on the ground, eroded rocks, or filled slopes. They are common in areas where they are abruptly cut off the slopes, on plain soils or fractured eroded rock. The frequency and intensity of landslides that may occur during an earthquake are due to several factors, including: geological materials contained in the area, the steepness of the slope, the water content of the material that slides, trembling land, and the magnitude of the earthquake.

8.2 Data and Methods

The United State Geological Survey (USGS), charged with overseeing all geophysical hazard activity in the US and its protectorates, has completed several studies of earthquake risk covering the Hurricane Sally AOI. One of the most recent is a 2018 United States (Lower 48) Seismic Hazard Long-term Model[5]. This study provides gridded seismic hazard curve data, gridded ground motion data, and mapped gridded ground motion values for the Hurricane Sally AOI region. In this case, as in many probabilistic seismic hazard analysis (PSHA), the greater than two percent (2%) probability of peak ground acceleration (PGA) has become the de facto measure for estimating seismic activity. Although considerable discussion in seismology, engineering, and emergency management is beginning to shift away from PSHA and PGA as a measure of risk[6,7] (e.g., hazard X vulnerability) it still proves to be useful for understanding the occurrence frequency of ground shaking. For the purposes of this hazard assessment, the greater than two percent (>2%) exceedance of peak ground acceleration provides a useful tool for understanding

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[5] https://www.usgs.gov/programs/earthquake-hazards/science/2018-united-states-lower-48-seismic-hazard-long-term-model

[6] Wang, Z. Understanding Seismic Hazard and Risk A Gap Between Engineers and Seismologists. Accessed at: https://www.iitk.ac.in/nicee/wcee/article/14_S27-001.PDF

[7] Mulargia, Francesco, Stark, Philip B., Geller, Robert J. Why is Probabilistic Seismic Hazard Analysis (PSHA) still used? Physics of the Earth and Planetary Interiors, Volume 264, March 2017, Pages 63-75. Accessed at: https://www.sciencedirect.com/science/article/pii/S0031920116303016

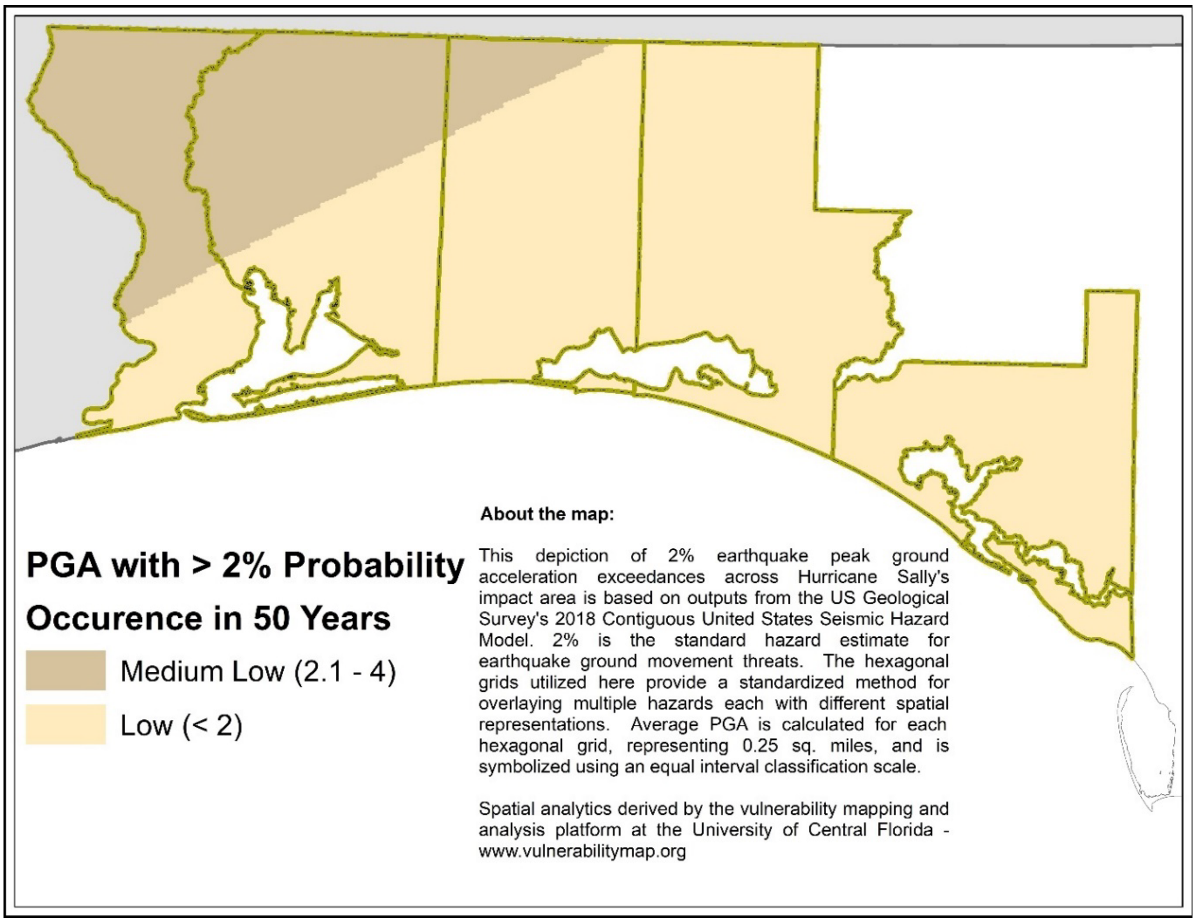
where the hazard is likely to occur, but not which buildings or communities are likely to be adversely impacted. In this assessment, average PGA values were calculated for each hexagonal grid and mapped using standard deviations showing us a clear pattern of increased hazard across the Hurricane Sally AOI.

8.3 Earthquake Hazard Frequency Analysis Results

Although earthquakes do not occur often in this part of the Unites States, there have been several instances within 50 miles of this AOI, including 17 earthquakes (within 50 miles) of Escambia since 2003[8]. Two distinct zones of PGA exceedance exist across the Sally AOI and although the probability of exceedance is low across the area, a threat still exists (Attachment Figure 15). As such, areas in Escambia, Santa Rosa, and Okaloosa have higher risk than other counties in the AOI (Attachment Table 15).

8.4 Earthquake Hazard Risk Analysis Results

The low frequency of this hazard coupled with lack of historical losses from earthquakes leads to a low overall risk for the AOI. The resulting risk map (Attachment Figure 16) and associated areal summary (Attachment Table 16) show an a low risk for these counties when compared to other hazards.

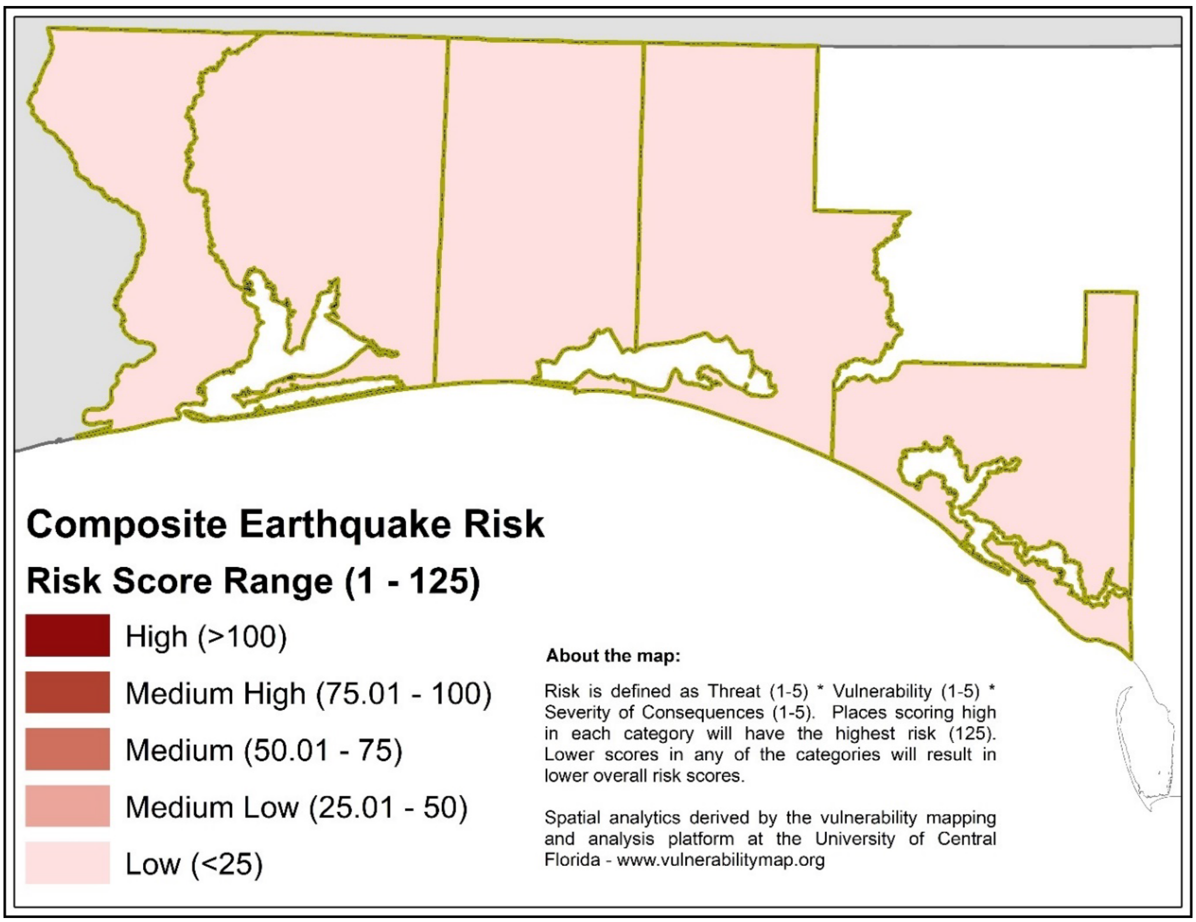


Attachment Figure 15: Earthquake Hazard Areas

[8] https://earthquake.usgs.gov/earthquakes/search/

Attachment Table 15: Earthquake Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	16,973	75.74%	5,437	24.26%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	1,637	41.16%	2,340	58.84%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,265	88.08%	577	11.92%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	2,414	46.25%	2,806	53.75%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,030	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%



Attachment Figure 16: Earthquake Hazard Composite Risk

Attachment Table 16: Earthquake Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	22,410	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,091	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,977	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,842	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	5,220	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	5,030	100.00%	-	0.00%	-	0.00%	-	0.00%	-	0.00%

9.0 Drought

9.1 Hazard Overview

Drought is described as "long periods of abnormal weather enough for water shortages to cause serious hydrological imbalances in the affected area"[9]. In simpler terms, a drought is a period of unusually dry weather that persists long enough to cause serious problems, such as damage to agriculture and rationing in the provision of potable water to the population. The severity of a drought depends on the degree of impairment in humidity levels, duration, and size of the affected area.

There are four (4) main approaches that can define a drought.

Meteorological Focus: a measure of deviation from normal precipitation levels. Due to climatic differences, which can be considered a drought in one (1) country may not necessarily be a drought elsewhere.

Agricultural Focus: refers to the situation where the amount of moisture in the soil does not meet the needs of a particular crop.

Hydrological Focus: occurs when surface water sources and groundwater are below normal.

Socioeconomic Focus: refers to the situation that occurs when physical shortages in water supplies begin to affect people.

The main cause of any drought is the lack of rain or precipitation. This phenomenon is called meteorological drought, and if it lasts it leads to a hydrological drought characterized by a disparity between the natural availability of water and natural water demands. In extreme cases this lack of water can also cause drought. Lack of precipitation for an extended period of time can have disastrous consequences for agriculture and metropolitan areas. In some areas of the countryside, it does not take long, as several weeks without rain can cause damage to crops. These areas must take measures on consumption savings, such as rationing.

9.2 Data and Methods

Produced jointly by the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, NOAA, and the US Department of Agriculture (USDA), the United States Drought Monitor (USDM) provides geospatial representations of drought hazard areas for the entire U.S. and outlying areas. The NDMC hosts the web site of the drought monitor and the associated data, and provides the map and data to NOAA, USDA, and other agencies[10]. Polygons produced by the USDM represent areas that have had drought conditions from 2000-2021 across the Hurricane Sally AOI. Each hexagonal grid was populated with the number of instances (weeks) of drought and categorized using an equal interval classification.

9.3 Drought Hazard Frequency Analysis Results

Drought hazard is most prevalent in northern Walton County and scatters smaller areas across Escambia, and Okaloosa, and Santa Rosa Counties (Attachment Figure 17) leaving Bay County as the only place

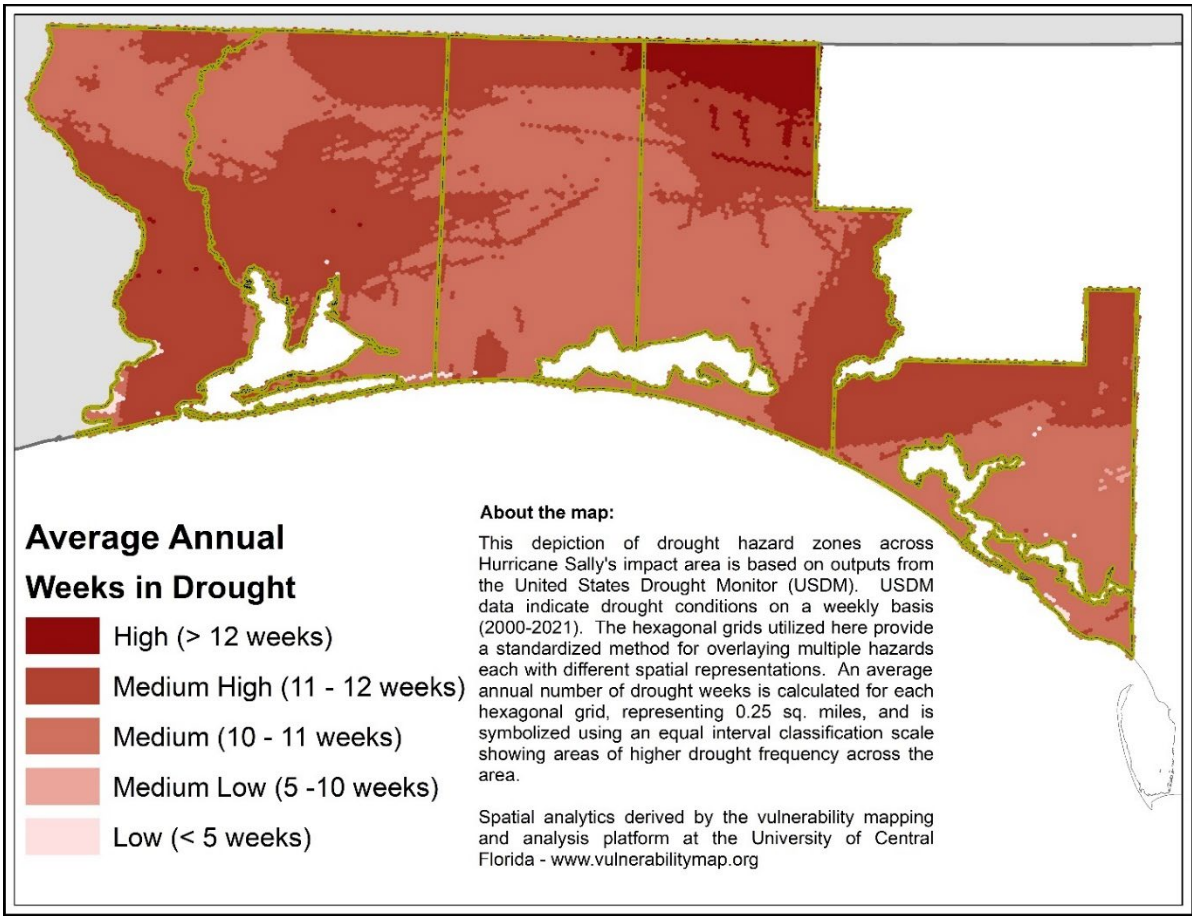
[9] Glossary of Meteorology, Boston, American Meteorological Society, 1959.

[10] The National Drought Mitigation Center, University of Nebraska-Lincoln. *United States Drought Monitor*. *Map Released: August 13, 2020*. Accessed at: https://droughtmonitor.unl.edu/

without land in high drought hazard threat zones (Attachment Table 17). Large swaths of land area across all counties (except Okaloosa) have more than 30% of their land area in medium-high drought risk zones.

9.4 Drought Hazard Risk Analysis Results

Drought's general low number of property losses, injuries, and fatalities coupled with its lower priority in local mitigation plans result in lower overall risk across the AOI (Attachment Figure 18) with scattered areas of medium-low risk in most counties. Here, although most counites are dominated by low risk, Bay County has nearly all of its land area in a low drought risk zone (Attachment Table 18).

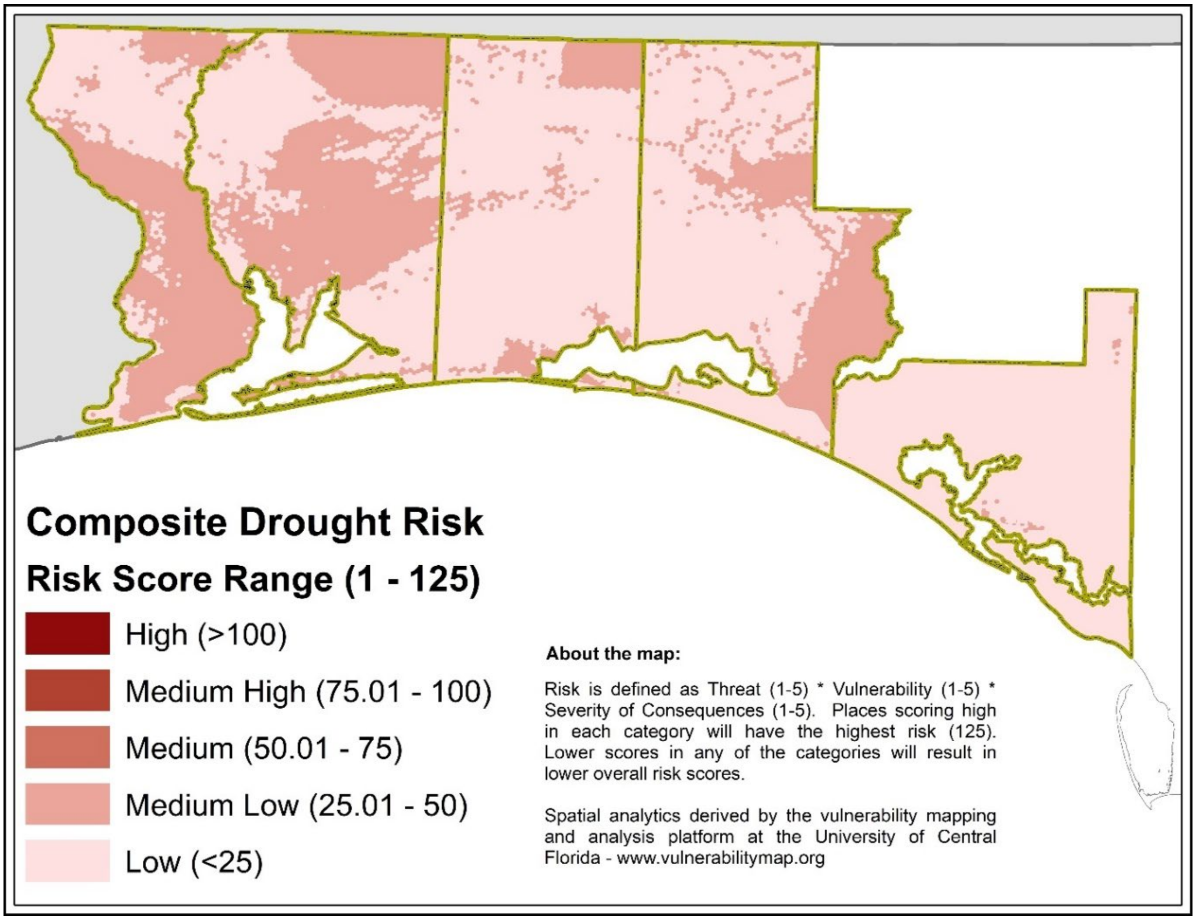


Attachment Figure 17: Drought Hazard Areas

Attachment Table 17: Drought Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	313	1.40%	23	0.10%	11,269	50.29%	10,096	45.05%	709	3.16%
Bay	4,091	136	3.32%	21	0.51%	2,439	59.62%	1,495	36.54%	-	0.00%
Escambia	3,977	83	2.09%	2	0.05%	1,269	31.91%	2,614	65.73%	9	0.23%
Okaloosa	4,842	24	0.50%	-	0.00%	3,638	75.13%	1,122	23.17%	58	1.20%

Santa Rosa	5,220	50	0.96%	-	0.00%	2,087	39.98%	3,081	59.02%	2	0.04%
Walton	5,030	27	0.54%	-	0.00%	2,280	45.33%	2,061	40.97%	662	13.16%



Attachment Figure 18: Drought Hazard Composite Risk

Attachment Table 18: Drought Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	15,377	68.62%	7,033	31.38%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,054	99.10%	37	0.90%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	1,623	40.81%	2,354	59.19%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,088	84.43%	754	15.57%	-	0.00%	-	0.00%	-	0.00%

Santa Rosa	5,220	2,562	49.08%	2,658	50.92%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	3,580	71.17%	1,450	28.83%	-	0.00%	-	0.00%	-	0.00%

10.0 Wildfire

10.1 Hazard Overview

A wildfire is any type of forest, grass, brush, or outdoor fire that is not controlled or supervised. While wildfire occurrence and extent are generally controlled by climate, wildfires are also controlled by local factors such as ignition source, topography, local weather patterns, variations in fuel characteristics (type and condition), land-use practices, and overall management practices. The amount of storm debris including downed trees left behind can vary depending on the hurricane. Following Sally's light impact on forestry[11], the small stands of trees that were destroyed can increase fire risk if not removed properly. Across much of Florida, wildfires tend to occur mainly in grasslands, croplands, or dry forest areas. Time of day, climate, and land cover have been the most significant drivers of wildfire across the Hurricane Sally AOI. Irrespective of how they start or how they spread, wildfires pose a significant threat to lives and livelihoods across the Hurricane Sally AOI.

10.2 Data and Methods

Like several other hazards in this assessment, wildfire extent data is either not readily available for the Hurricane Sally AOI from a national assessment such as the Monitoring Trends in Burn Severity (MTBS) database[12] or the USGS Geospatial Multi-Agency Coordination (GeoMAC), or the National Interagency Fire Center.[13], or available data is not comprehensive and complete for the AOI. For this assessment, Florida specific data on wildfire occurrences (1994-2000) was collected from the Florida Fish and Wildlife Conservation Commission's Florida Wildfire Occurrence Dataset[14]. The average annual number of wildfire events (1994 – 2000) for each hex grid was calculated for the Hurricane Sally AOI to create a representation of areal wildfire hazard threat.

10.3 Wildfire Hazard Frequency Analysis Results

Wildfire threat is greatest along the border areas between Santa Rosa and Okaloosa Counties and in central Walton County (Attachment Figure 19) with scattered areas of medium threat across each of the counties. While most of the wildfire threat across the AOI falls into the medium low threat category in terms of land area (Attachment Table 19), only Escambia has a high percentage of land in a low wildfire threat.

10.4 Wildfire Hazard Risk Analysis Results

Wildfire has a moderate SOC score across all counties in the AOI, ranging from a low of 2.5 in Escambia to over 3 in Walton (on a scale of 1-5) resulting in lower risks for Escambia only medium-low wildfire risk in Santa Rosa (Attachment Figure 20). Here, no county has any land area with a wildfire risk of medium or higher (Attachment Table 20).

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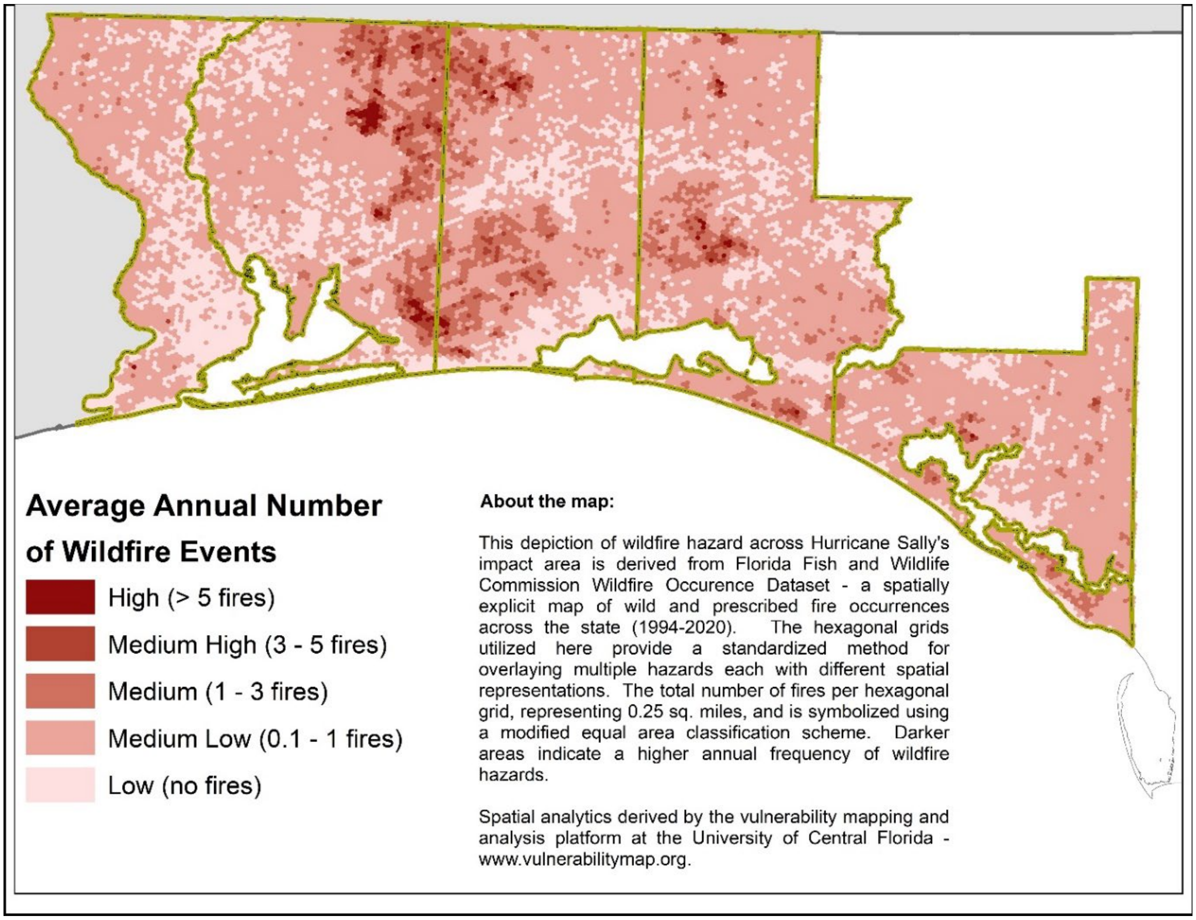
[11] http://www.northescambia.com/2020/12/florida-forest-service-offers-tips-to-care-for-timber-after-hurricanes-sally-and-zeta

[12] Monitoring Trends in Burn Severity. *Wildfire Data*. Accessed at: https://www.mtbs.gov/

[13] National Interagency Fire Center. Accessed at: https://www.nifc.gov/

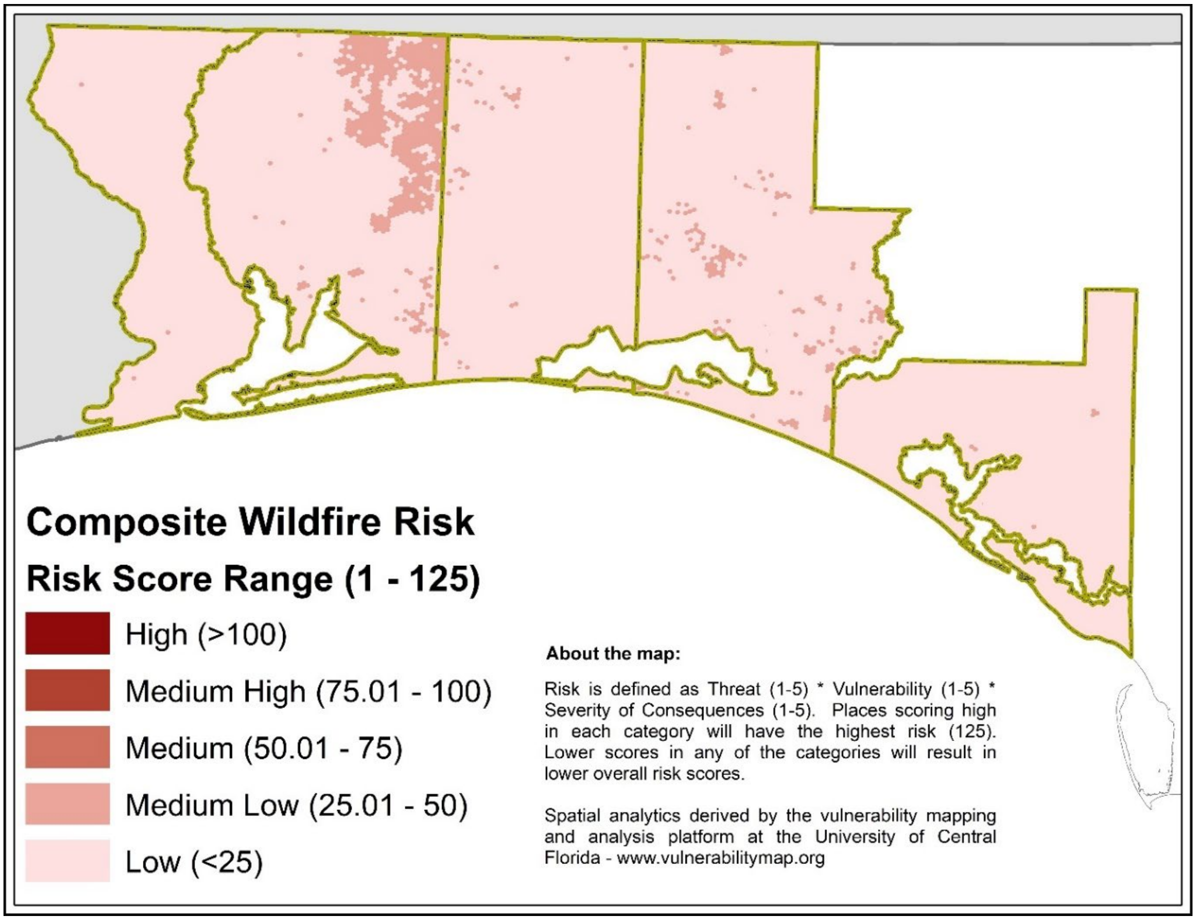
[14] https://myfwc.com/research/gis/regional-projects/florida-fire/



Attachment Figure 19: Wildfire Hazard Areas

Attachment Table 19: Wildfire Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	6,579	29.36%	13,560	60.51%	1,844	8.23%	326	1.45%	101	0.45%
Bay	4,091	1,022	24.98%	2,865	70.03%	191	4.67%	12	0.29%	1	0.02%
Escambia	3,977	1,961	49.31%	1,990	50.04%	24	0.60%	1	0.03%	1	0.03%
Okaloosa	4,842	1,329	27.45%	2,722	56.22%	659	13.61%	110	2.27%	22	0.45%
Santa Rosa	5,220	1,409	26.99%	2,886	55.29%	683	13.08%	175	3.35%	67	1.28%
Walton	5,030	1,138	22.62%	3,448	68.55%	380	7.55%	48	0.95%	16	0.32%



Attachment Figure 20: Wildfire Hazard Composite Risk

Attachment Table 20: Wildfire Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	21,417	95.57%	993	4.43%	-	0.00%	-	0.00%	-	0.00%
Bay	4,091	4,083	99.80%	8	0.20%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	3,974	99.92%	3	0.08%	-	0.00%	-	0.00%	-	0.00%
Okaloosa	4,842	4,737	97.83%	105	2.17%	-	0.00%	-	0.00%	-	0.00%
Santa Rosa	5,220	4,480	85.82%	740	14.18%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	4,834	96.10%	196	3.90%	-	0.00%	-	0.00%	-	0.00%

11.0 Lightning

11.1 Hazard Overview

All thunderstorms produce lightning, a spark of static electricity, that results from the buildup of electrical energy between positively and negatively charged areas. Whenever thunder is audible, there is the risk of a lightning strike. The only safe place during a thunderstorm is inside. Lightning has also occurred in volcanic eruptions, intense forest fires, surface nuclear detonations, heavy snowstorms, and in large hurricanes. There are four (4) types of lightning: cloud to ground, intra-cloud, cloud-to-cloud, and cloud to air. The term “heat lightning” is a misnomer and is not related to high temperatures. Heat lightning is lightning that is simply too far away for the thunder to be audible. Cloud-to-ground lightning is responsible for most fatalities, injuries, and property damage.

11.2 Data and Methods

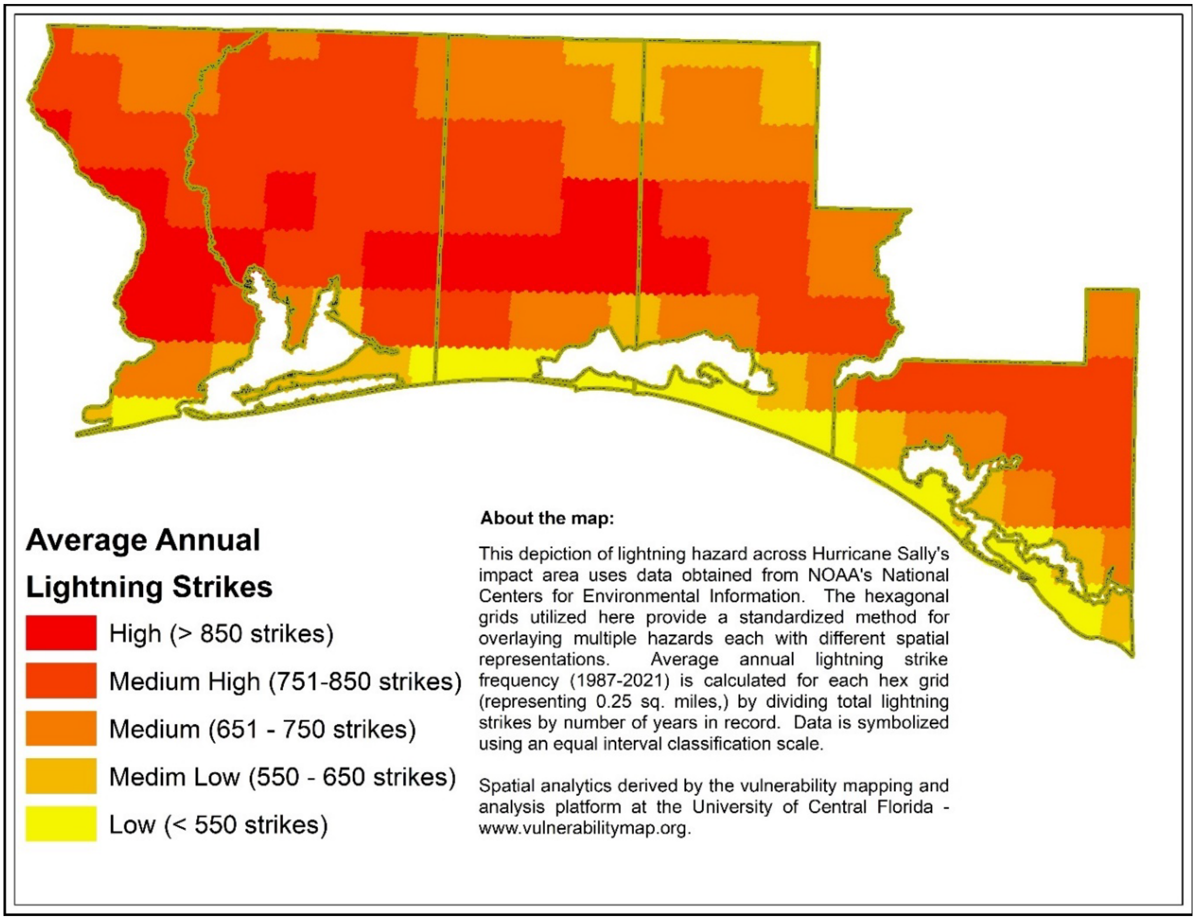
Lightning data for this assessment was obtained from NOAA's National Centers for Environmental Information (NCEI), National Lightning Detection Network (NLDN) which consists of over 100 remote, ground-based sensing stations located across the United States that instantaneously detect the electromagnetic signals given off when lightning strikes the earth's surface. Within seconds of a lightning strike, the location, time, and polarity, are communicated to NOAA where there are aggregated to a raster grid. This lightning raster was spatially overlapped with the 0.25 sq. mile hex grid and a summary of strikes and average annual strikes was calculated for each hex grid across the Hurricane Sally AOI.

11.3 Lighting Hazard Frequency Analysis Results

Although lightning can occur anywhere in the Hurricane Sally AOI, western portions of the AOI have a higher lightning strike frequency than other areas of the AOI (Attachment Figure 21) with every county expect Bay containing areas of high lightning hazard threat. Escambia has the most land area in high lightning hazard threat areas and Santa Rosa has the most land area in the medium high category (Attachment Table 21). Bay County has nearly 60% of its land area in medium – low lightning hazard threat zones.

11.4 Lighting Hazard Frequency Analysis Results

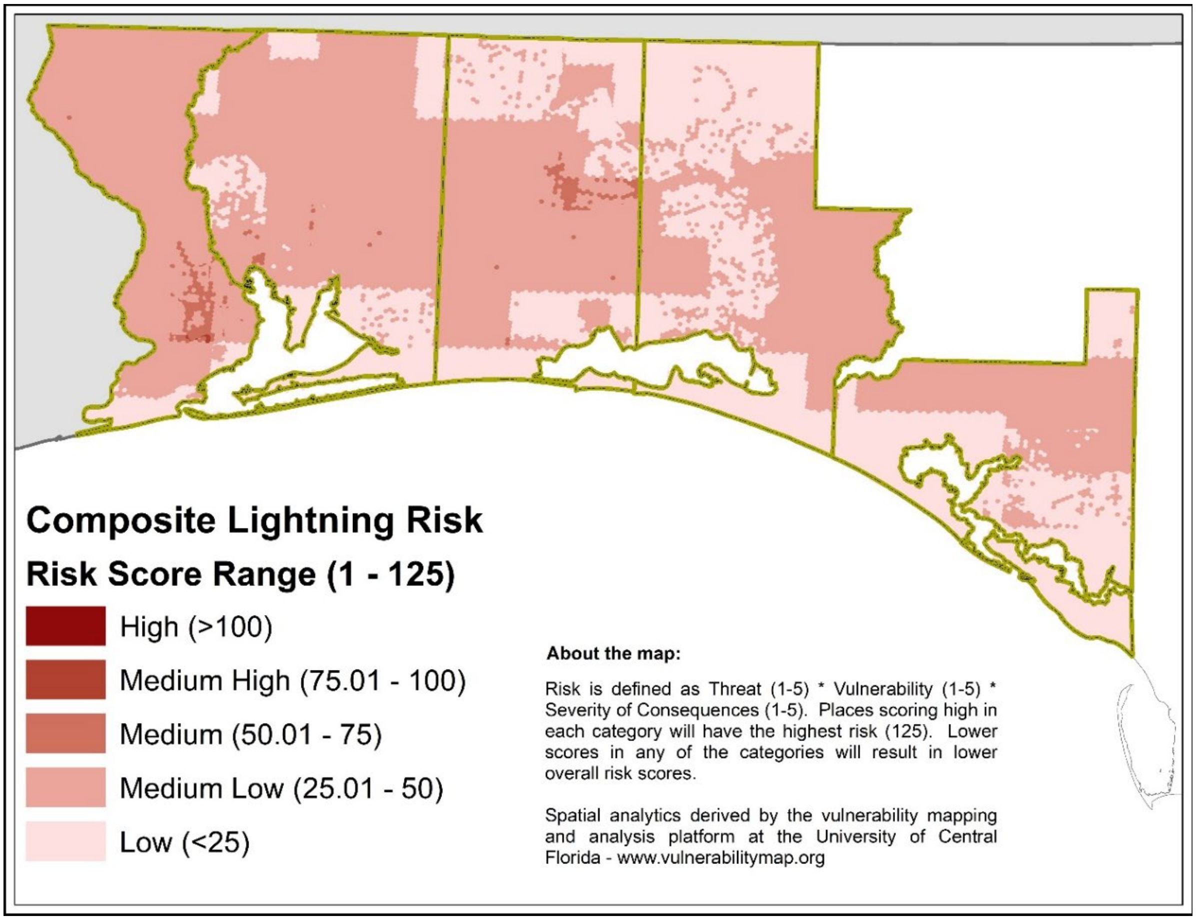
Accounting for vulnerabilities (social, population, and lifeline) and severity of consequences for lightning hazard provides a different representation of lightning risk where Escambia and central Okaloosa have the highest risk areas (Attachment Figure 22). Because of the generally lower SOC scores for lightning, most AOI land area is located in low to medium low lightning risk areas (Attachment Table 22).



Attachment Figure 21: Lightning Hazard Areas

Attachment Table 21: Lightning Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	2,075	9.26%	2,500	11.16%	5,880	26.24%	8,821	39.36%	3,134	13.98%
Bay	4,091	813	19.87%	658	16.08%	953	23.30%	1,667	40.75%	-	0.00%
Escambia	3,977	230	5.78%	231	5.81%	1,079	27.13%	1,320	33.19%	1,117	28.09%
Okaloosa	4,842	522	10.78%	437	9.03%	1,592	32.88%	1,243	25.67%	1,048	21.64%
Santa Rosa	5,220	88	1.69%	428	8.20%	497	9.52%	3,434	65.79%	773	14.81%
Walton	5,030	489	9.72%	838	16.66%	1,925	38.27%	1,416	28.15%	362	7.20%



Attachment Figure 22: Lightning Hazard Risk Areas

Attachment Table 22: Lightning Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	8,712	38.88%	13,340	59.53%	350	1.56%	8	0.04%	-	0.00%
Bay	4,091	2,568	62.77%	1,523	37.23%	-	0.00%	-	0.00%	-	0.00%
Escambia	3,977	505	12.70%	3,270	82.22%	194	4.88%	8	0.20%	-	0.00%
Okaloosa	4,842	1,929	39.84%	2,785	57.52%	128	2.64%	-	0.00%	-	0.00%
Santa Rosa	5,220	1,489	28.52%	3,702	70.92%	29	0.56%	-	0.00%	-	0.00%
Walton	5,030	2,626	52.21%	2,404	47.79%	-	0.00%	-	0.00%	-	0.00%

12.0 Sea-Level Rise

12.1 Hazard Overview

Sea level rise is an increase in the level of the world's oceans due to the effects of global warming and land subsidence. As ocean water becomes warmer, it expands. This results in ocean levels rising worldwide.[15] Global sea level has been rising over the past century, and the rate of rise has increased in recent decades. In 2014, the global sea level was 2.6 inches above the 1993 average—the highest annual average in the satellite record (1993-present). Sea level continues to rise at a rate of about one-eighth (1/8) of an inch per year.[16] Sea level rise poses a significant threat to people living and working in coastal areas.

12.2 Data and Methods

NOAA produces various future sea-level rise scenarios. A moderate scenario (four feet) of sea level rise above mean Higher High-water levels[17] was utilized in this assessment as a more conservative level of future coastal conditions. Like the flooding hazard, the percentage of land area spatially inside NOAA SLR zones was calculated for each 0.25-mile hex grid across the Hurricane Sally AOI. These were classified using an equal interval classifications scheme allowing users to clearly see where sea-level rise threatens the coastline.

12.3 Sea Level Rise Hazard Frequency Analysis Results

Like hurricane storm surges, sea level rise impacts are largely a coastal phenomenon with the AOI's bay and inland waterways seeing the heaviest potential impacts (Attachment Figure 23). Impacts on all coastal areas of Hurricane Sally's AOI are clearly evident and although a relatively small proportion of total land areas is in medium to high threat zones these areas will see stark impacts should this level of sea-level rise occur without mitigation. The percent of each county's total island-wide land area also changes for different sea level rise scenarios.

12.3.1 Sea Level Rise Hazard Risk Analysis Results

Incorporating vulnerabilities and SOC scores to create a measure of sea level rise risk depicts a similar spatial pattern the threat itself (Attachment Figure 24) indicating that the threat zones intersect vulnerable areas. Notably, Southeastern Escambia appears to have the most land area in elevated risk zones (Attachment Table 24). Although the percentage of land area is relatively small, the fact that this sea level rise is a coastal phenomenon means that most parts of the county will have a lower risk, but these areas are suitable for additional scrutiny, and mitigation planning. These areas adjacent to the shoreline (Attachment Table 23) have higher risk because they contain more people, higher vulnerability areas, and more lifeline infrastructure (see "Vulnerability Analysis" within section 2.6.2.3 Methodology of the 2022 State of Florida Action Plan for Disaster Recovery, for more information).

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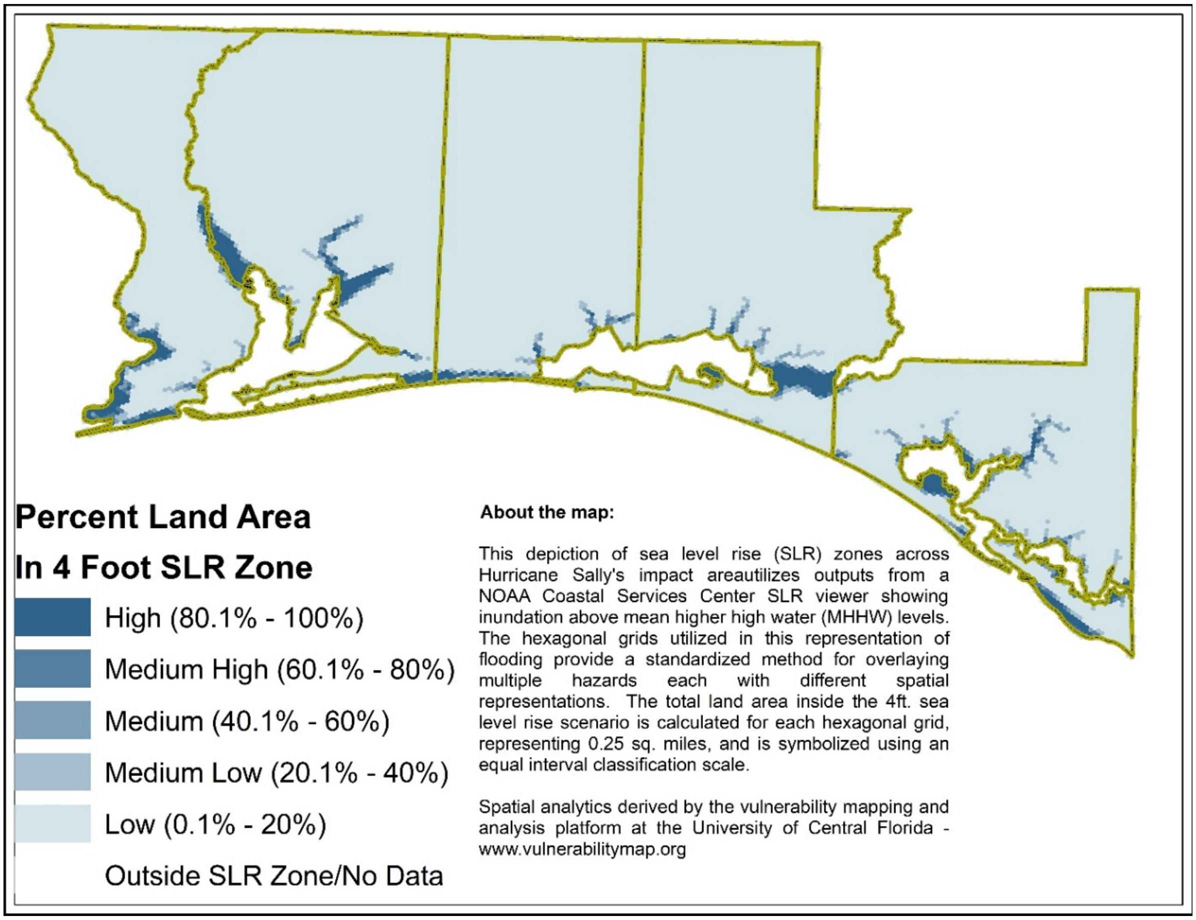
[15] National Geographic. *Seal* Level Rise. Accessed at: https://www.nationalgeographic.org/encyclopedia/sea-level-rise/

[16] US Department of Commerce. National Ocean Service. *Is seal level rising?* Accessed at: https://oceanservice.noaa.gov/facts/sealevel.html

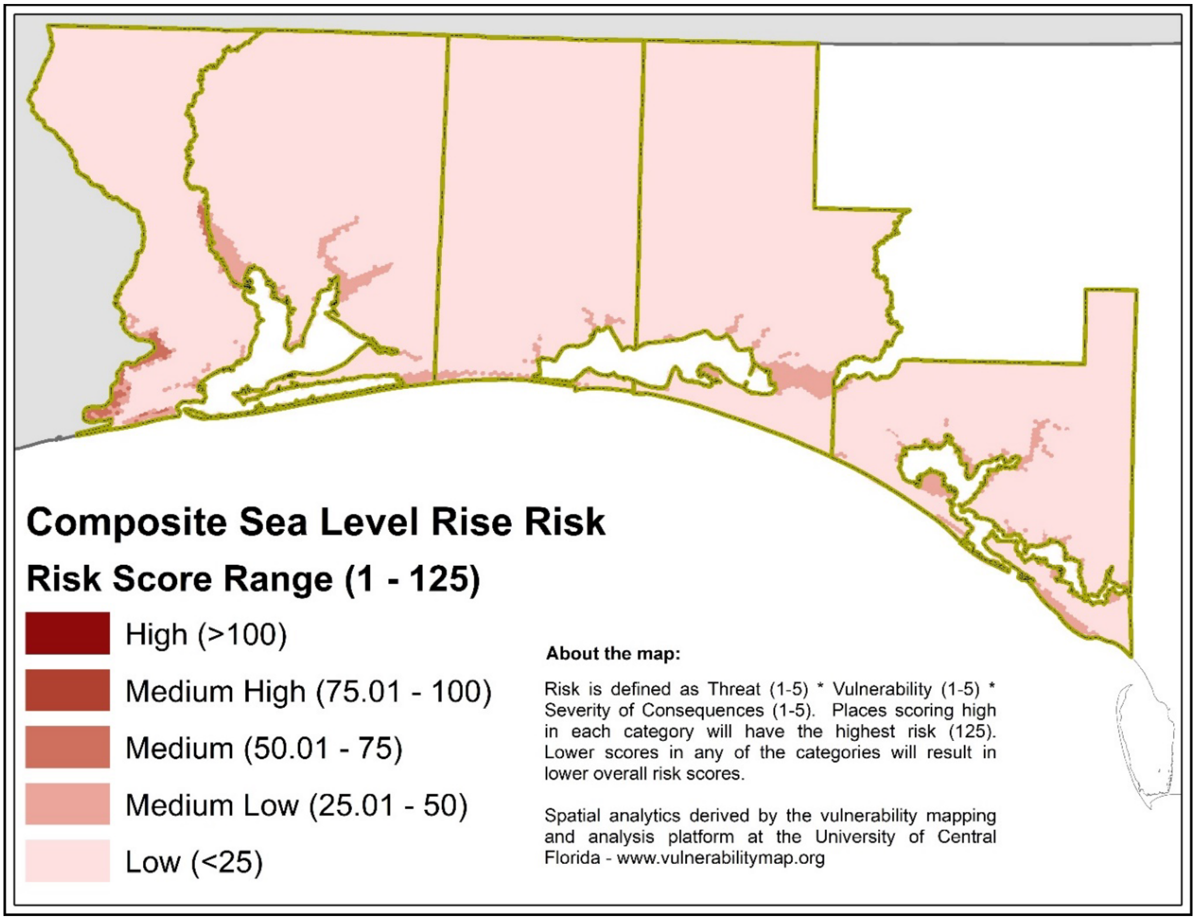
[17] US Department of Commerce. National Ocean Service. Tidal Datums. Accessed at: https://tidesandcurrents.noaa.gov/datum_options.html



Attachment Figure 23: Sea Level Rise (4 feet) Hazard Areas

Attachment Table 23: Sea-Level Rise Hazard Threat Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Threat Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	20,553	91.71%	580	2.59%	385	1.72%	270	1.20%	622	2.78%
Bay	4,091	3,541	86.56%	213	5.21%	140	3.42%	73	1.78%	124	3.03%
Escambia	3,977	3,519	88.48%	137	3.44%	84	2.11%	60	1.51%	177	4.45%
Okaloosa	4,842	4,618	95.37%	75	1.55%	52	1.07%	39	0.81%	58	1.20%
Santa Rosa	5,220	4,757	91.13%	94	1.80%	74	1.42%	72	1.38%	223	4.27%
Walton	5,030	4,775	94.93%	78	1.55%	43	0.85%	35	0.70%	99	1.97%



Attachment Figure 24: Sea-Level Rise (4 feet) Hazard Composite Risk

Attachment Table 24: Sea-Level Rise Hazard Risk Area Summary

Sally Area of Interest	Total (0.25 sq. mile) Hex Grids	Hazard Risk Category									
		Low		Medium Low		Medium		Medium High		High	
		Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids	Total Hex Grids	% of Hex Grids
All Counties	22,410	21,277	94.94%	1,016	4.53%	117	0.52%	-	0.00%	-	0.00%
Bay	4,091	3,798	92.84%	292	7.14%	1	0.02%	-	0.00%	-	0.00%
Escambia	3,977	3,666	92.18%	196	4.93%	115	2.89%	-	0.00%	-	0.00%
Okaloosa	4,842	4,716	97.40%	125	2.58%	1	0.02%	-	0.00%	-	0.00%
Santa Rosa	5,220	4,893	93.74%	327	6.26%	-	0.00%	-	0.00%	-	0.00%
Walton	5,030	4,880	97.02%	150	2.98%	-	0.00%	-	0.00%	-	0.00%