5. Vulnerability to Storm Surge

Methods

Storm surge refers to elevated water level that is pushed towards the shore by the force of strong winds that result in the piling up of water. The advancing surge combines with the normal tides, which in extreme cases can increase the normal water height over 20 ft. The storm surge arrives ahead of the storm's actual landfall, and the more intense the hurricane is, the sooner the surge arrives. Water rise can be very rapid and can move far inland, posing a serious threat to those who have not yet evacuated flood-prone areas. Debris carried by the waves can also contribute to damage. As a storm approaches the shore, the greatest storm surge will be to the north of the hurricane eye, in the right-front quadrant of the direction in which the hurricane is moving. Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast. Storm surge heights, and associated waves, are dependent upon the shape of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but with higher and more powerful storm waves. While disassociated with the Saffir-Simpson Scale which measures hurricane wind intensity, storm surge remains the leading killer of residents along immediate coastal areas.

Recent research (Knutson et al., 2010; Jagger and Elsner, 2006) has indicated that although the overall number of hurricanes is unlikely to increase in the future, there is a much higher likelihood that the number of strong hurricanes (i.e., Categories 4 and 5) will increase, leading to higher levels of storm surge. To analyze the potential impact of future storm surge on Florida's coastline, NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model was used to estimate storm surge heights from historical, hypothetical, and projected hurricanes. Florida SLOSH data were downloaded directly from the Florida Division of Emergency Management's GIS data clearinghouse (http://floridadisaster.org/gis/data/) and were imported into ArcMap for GIS analysis. SLOSH zones for hurricane Categories 1 through 5 were overlaid with Florida census tracts to estimate areas exposed to storm surge (Figure 12). For hurricane Categories 2 through 5, the total exposed area represents cumulative exposure (e.g., Category 5 includes the areas exposed to Categories 1 through 4 storm surge). Each tract was then categorized into one of five classes based on the probable land area impacted by each hurricane category using the following equal interval classification scheme so that future changes in risk at the tract- level can be easily seen in comparison to the current risk level:

- Out = No land area in the surge zone
- Low = Less than 25% of the tract area in the surge zone
- Medium = Between 25% - 50% of the tract area in the surge zone
- High = Between 50%-75% of the tract area in the surge zone
- Extreme = Greater than 75% of the tract area in the surge zone

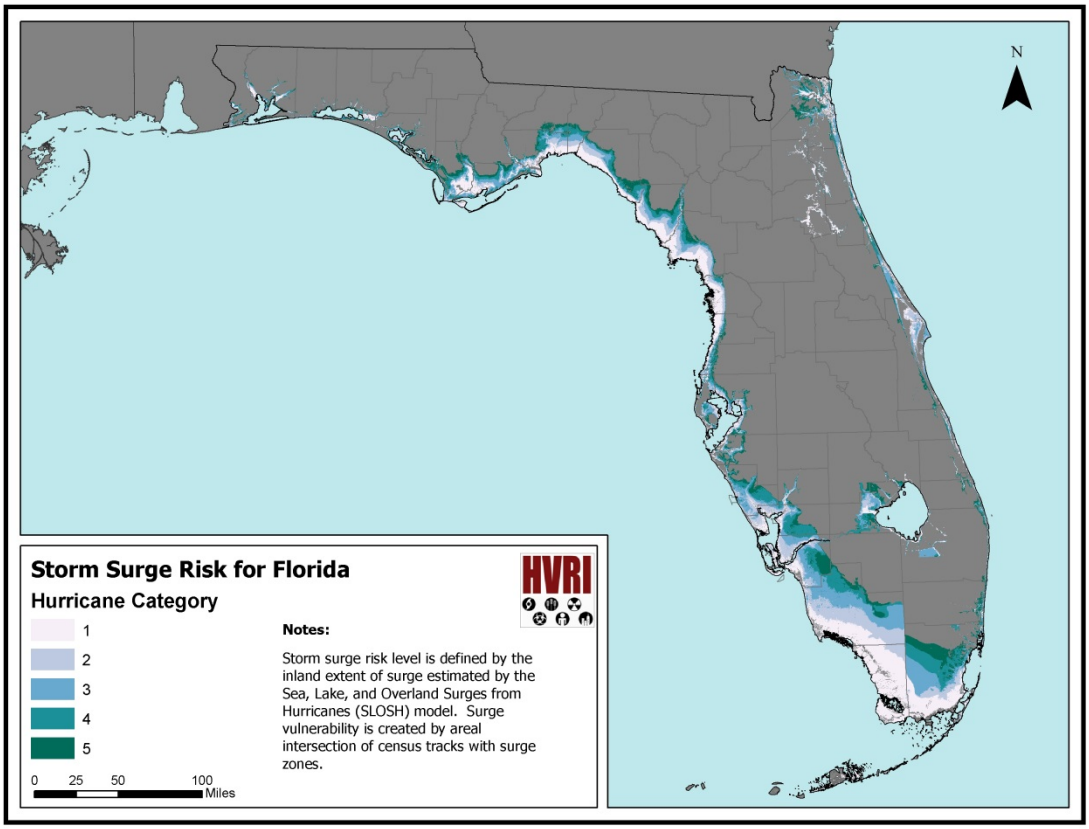

Figure 12: SLOSH zones in Florida.

State Summary

Every coastal county within the state is a potential target for hurricane storm surge but some have higher risk than others do (Figure 13). More than a quarter of total census tracts within Charlotte (25%), Collier (34%), Franklin (25%), Lee (28%), and Monroe (65%) Counties are at high or extreme risk to Category 1 storm surge (Table 21). Within these places where storm surge could have the greatest impact reside some large populations within Charlotte (> 30,000), Collier (> 65,000), Franklin (> 1,500), Lee (> 150,000), and Monroe (> 44,000) Counties (Table 22). However, these numbers do not tell the whole story. Places like Miami-Dade County, which has very few high or extreme risk Category 1 census tracts (1.93% of total land area according to Table 21), can have many people at risk (> 39,000) (Table 22).

Both the total number of tracts and the total number of people increase in a nearly linear fashion as the hurricane surge category increases. As the intensity of the hurricane threat increases, so does the possible impact of people and places along the coast. Four hundred eighty-one tracts have a large percentage of their land area located in high or extreme risk areas for Category 2 storm surge (Figure 14 and Table 23), in which 1.6 million people reside (Table 24). Category 3 surge zones represent nearly a doubling of the number of tracts (Table 25) at risk (n=805) and an increase of the population at high

or extreme risk to 2.9 million across the state (Table 26). For Category 4 storms, 35 counties have census tracts (n=1,109) in the high and extreme risk zones (Table 27). Populations in these areas of high surge risk exceed 4.2 million people across the state with one-quarter of a million or more in Hillsborough (274,000), Lee (564,000), Miami-Dade (883,000), and Pinellas (454,000) Counties (Table 28). High and extreme risk areas for Category 5 storms include 1,438 census tracts across 36 counties representing 5.6 million people (Table 29 and Table 30).

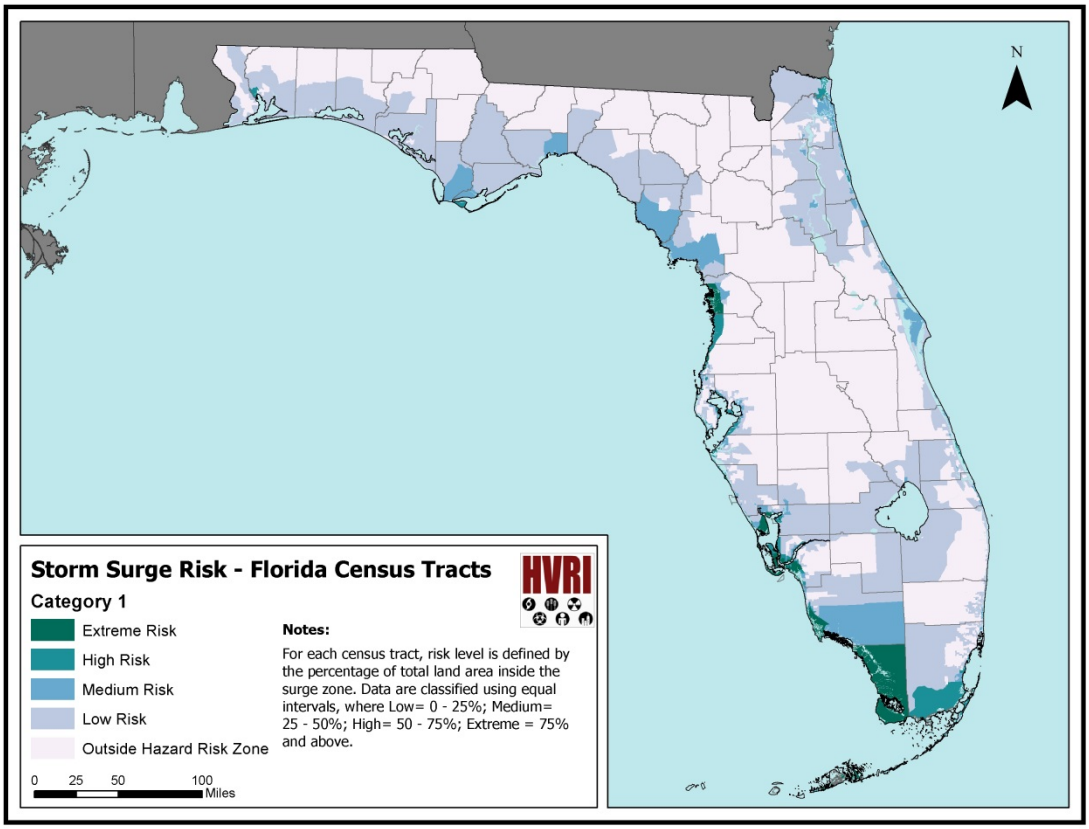

Figure 13: Category 1 storm surge risk in Florida.

Table 21: Census tract summary for Category 1 storm surge risk.

County Name	Category 1 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	100.00%
Baker	-	-	-	-	100.00%
Bay	-	-	-	84.09%	15.91%
Bradford	-	-	-	-	100.00%
Brevard	-	-	5.31%	46.90%	47.79%
Broward	-	0.28%	1.11%	27.70%	70.91%
Calhoun	-	-	-	-	100.00%
Charlotte	10.26%	15.38%	20.51%	43.59%	10.26%
Citrus	7.14%	-	10.71%	10.71%	71.43%
Clay	-	-	3.33%	63.33%	33.33%
Collier	20.27%	13.51%	8.11%	36.49%	21.62%
Columbia	-	-	-	-	100.00%
DeSoto	-	-	11.11%	33.33%	55.56%
Dixie	-	-	33.33%	33.33%	33.33%
Duval	-	0.58%	6.36%	47.98%	45.09%
Escambia	-	-	-	42.25%	57.75%
Flagler	-	5.00%	20.00%	30.00%	45.00%
Franklin	-	25.00%	25.00%	50.00%	-
Gadsden	-	-	-	-	100.00%
Gilchrist	-	-	-	40.00%	60.00%
Glades	-	-	-	75.00%	25.00%
Gulf	-	-	33.33%	66.67%	-
Hamilton	-	-	-	-	100.00%
Hardee	-	-	-	-	100.00%
Hendry	-	-	-	83.33%	16.67%
Hernando	-	8.89%	-	-	91.11%
Highlands	-	-	-	3.70%	96.30%
Hillsborough	1.25%	1.87%	4.36%	19.94%	72.59%
Holmes	-	-	-	-	100.00%
Indian River	-	-	6.67%	60.00%	33.33%
Jackson	-	-	-	-	100.00%
Jefferson	-	-	-	33.33%	66.67%
Lafayette	-	-	-	50.00%	50.00%
Lake	-	-	-	-	100.00%

County Name	Category 1 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Lee	14.97%	13.17%	8.38%	25.15%	38.32%
Leon	-	-	-	-	100.00%
Levy	-	-	10.00%	30.00%	60.00%
Liberty	-	-	-	100.00%	-
Madison	-	-	-	-	100.00%
Manatee	2.56%	6.41%	5.13%	38.46%	47.44%
Marion	-	-	-	4.76%	95.24%
Martin	-	-	5.88%	61.76%	32.35%
Miami-Dade	-	1.93%	0.77%	36.99%	60.31%
Monroe	22.58%	41.94%	19.35%	12.90%	3.23%
Nassau	-	8.33%	8.33%	75.00%	8.33%
Okaloosa	-	-	-	68.29%	31.71%
Okeechobee	-	-	9.09%	54.55%	36.36%
Orange	-	-	-	-	100.00%
Osceola	-	-	-	-	100.00%
Palm Beach	-	-	0.60%	21.43%	77.98%
Pasco	5.22%	2.24%	2.99%	9.70%	79.85%
Pinellas	4.08%	8.57%	6.53%	34.29%	46.53%
Polk	-	-	-	-	100.00%
Putnam	-	-	17.65%	64.71%	17.65%
Santa Rosa	-	4.00%	-	72.00%	24.00%
Sarasota	3.19%	5.32%	6.38%	55.32%	29.79%
Seminole	-	-	-	-	100.00%
St. Johns	-	5.13%	17.95%	66.67%	10.26%
St. Lucie	-	6.82%	4.55%	43.18%	45.45%
Sumter	-	-	-	-	100.00%
Suwannee	-	-	-	-	100.00%
Taylor	-	-	-	50.00%	50.00%
Union	-	-	-	-	100.00%
Volusia	-	0.88%	7.02%	33.33%	58.77%
Wakulla	-	-	25.00%	75.00%	-
Walton	-	-	-	54.55%	45.45%
Washington	-	-	-	14.29%	85.71%
State Total	**1.87%**	**2.78%**	**3.44%**	**27.59%**	**64.32%**

Table 22: Census tract population summary for Category 1 storm surge risk.

County Name	Category 1 Storm Surge Hazard Risk					County Name	Category 1 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	247,336	Lee	72,741	77,897	53,920	175,569	238,627
Baker	-	-	-	-	27,115	Leon	-	-	-	-	275,487
Bay	-	-	-	144,783	24,069	Levy	-	-	3,289	10,867	26,645
Bradford	-	-	-	-	28,520	Liberty	-	-	-	8,365	-
Brevard	-	-	23,342	197,825	322,202	Madison	-	-	-	-	19,224
Broward	-	1,533	13,272	410,914	1,322,347	Manatee	6,681	14,878	12,130	136,913	152,231
Calhoun	-	-	-	-	14,625	Marion	-	-	-	3,446	327,852
Charlotte	13,787	16,816	29,976	83,466	15,933	Martin	-	-	6,398	75,808	64,112
Citrus	9,092	-	15,609	12,806	103,729	Miami-Dade	-	39,683	19,116	897,358	1,536,970
Clay	-	-	13,596	147,755	29,514	Monroe	13,465	31,503	20,421	7,681	20
Collier	40,113	25,665	22,949	137,476	95,317	Nassau	-	12,311	1,759	55,185	4,059
Columbia	-	-	-	-	67,531	Okaloosa	-	-	-	108,985	71,837
DeSoto	-	-	1,218	9,431	24,213	Okeechobee	-	-	4,221	18,987	16,788
Dixie	-	-	4,101	7,331	4,990	Orange	-	-	-	-	1,145,956
Duval	-	6,261	55,662	406,195	396,145	Osceola	-	-	-	-	268,685
Escambia	-	-	-	131,964	165,655	Palm Beach	-	-	3,481	252,424	1,063,557
Flagler	-	3,217	11,313	27,674	53,492	Pasco	15,322	7,585	11,793	43,250	386,747
Franklin	-	1,690	2,804	7,055	-	Pinellas	22,665	69,607	57,706	331,813	434,751
Gadsden	-	-	-	-	46,389	Polk	-	-	-	-	602,095
Gilchrist	-	-	-	8,398	8,541	Putnam	-	-	9,421	49,578	15,365
Glades	-	-	-	12,884	-	Santa Rosa	-	4,266	-	117,951	29,155
Gulf	-	-	4,450	11,413	-	Sarasota	6,363	9,748	19,467	197,053	146,817
Hamilton	-	-	-	-	14,799	Seminole	-	-	-	-	422,718
Hardee	-	-	-	-	27,731	St. Johns	-	6,822	22,136	147,532	13,549
Hendry	-	-	-	31,336	7,804	St. Lucie	-	9,527	4,520	119,023	144,719
Hernando	-	12,229	-	-	160,549	Sumter	-	-	-	-	87,023
Highlands	-	-	-	5,124	93,662	Suwannee	-	-	-	-	41,551
Hillsborough	6,350	18,773	46,526	226,178	931,399	Taylor	-	-	-	13,097	9,473
Holmes	-	-	-	-	19,927	Union	-	-	-	-	15,535
Indian River	-	-	6,797	70,920	60,311	Volusia	-	2,315	23,659	148,548	320,071
Jackson	-	-	-	-	49,746	Wakulla	-	-	8,332	22,444	-
Jefferson	-	-	-	4,380	10,381	Walton	-	-	-	31,317	23,726
Lafayette	-	-	-	5,706	3,164	Washington	-	-	-	6,615	18,281
Lake	-	-	-	-	297,052	**State Total**	**206,579**	**372,326**	**533,384**	**5,080,823**	**12,597,814**

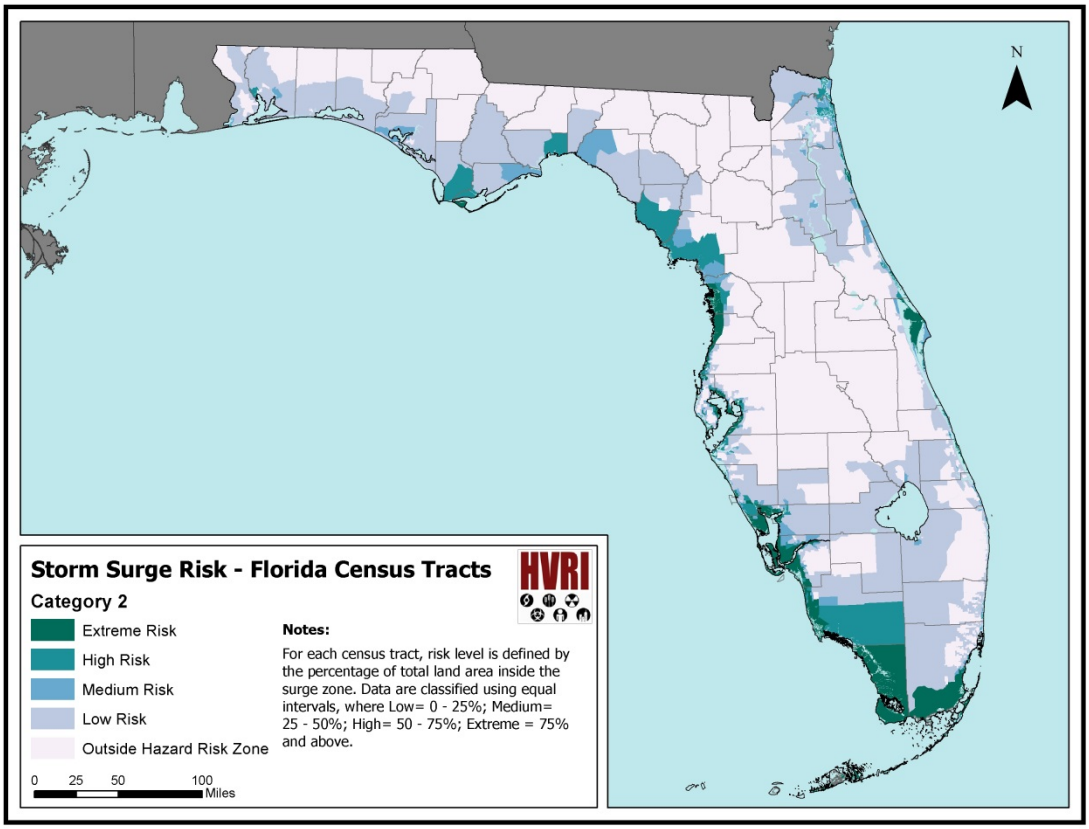

Figure 14: Category 2 storm surge risk in Florida.

Table 23: Census tract summary for Category 2 storm surge risk.

County Name	Category 2 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	100.00%
Baker	-	-	-	-	100.00%
Bay	-	-	15.91%	72.73%	11.36%
Bradford	-	-	-	-	100.00%
Brevard	6.19%	7.96%	7.08%	32.74%	46.02%
Broward	-	1.39%	2.22%	31.02%	65.37%
Calhoun	-	-	-	-	100.00%
Charlotte	64.10%	10.26%	7.69%	12.82%	5.13%
Citrus	7.14%	14.29%	7.14%	10.71%	60.71%
Clay	-	-	3.33%	63.33%	33.33%
Collier	72.97%	8.11%	5.41%	4.05%	9.46%
Columbia	-	-	-	-	100.00%
DeSoto	-	-	11.11%	66.67%	22.22%
Dixie	-	33.33%	-	33.33%	33.33%
Duval	-	2.31%	9.25%	45.66%	42.77%
Escambia	-	2.82%	1.41%	39.44%	56.34%
Flagler	5.00%	5.00%	20.00%	25.00%	45.00%
Franklin	25.00%	25.00%	25.00%	25.00%	-
Gadsden	-	-	-	-	100.00%
Gilchrist	-	-	-	40.00%	60.00%
Glades	-	-	-	75.00%	25.00%
Gulf	-	33.33%	-	66.67%	-
Hamilton	-	-	-	-	100.00%
Hardee	-	-	-	-	100.00%
Hendry	-	-	-	83.33%	16.67%
Hernando	6.67%	2.22%	-	2.22%	88.89%
Highlands	-	-	-	3.70%	96.30%
Hillsborough	10.59%	2.18%	4.36%	16.82%	66.04%
Holmes	-	-	-	-	100.00%
Indian River	-	6.67%	13.33%	50.00%	30.00%
Jackson	-	-	-	-	100.00%
Jefferson	-	-	-	33.33%	66.67%
Lafayette	-	-	-	50.00%	50.00%
Lake	-	-	-	-	100.00%
Lee	50.90%	5.99%	6.59%	13.77%	22.75%
Leon	-	-	-	-	100.00%
Levy	-	10.00%	20.00%	10.00%	60.00%
Liberty	-	-	-	100.00%	-
Madison	-	-	-	-	100.00%
Manatee	8.97%	7.69%	7.69%	32.05%	43.59%
Marion	-	-	-	4.76%	95.24%
Martin	-	-	5.88%	61.76%	32.35%
Miami-Dade	3.85%	2.12%	6.74%	33.72%	53.56%
Monroe	64.52%	22.58%	6.45%	3.23%	3.23%
Nassau	-	16.67%	33.33%	41.67%	8.33%
Okaloosa	-	-	4.88%	63.41%	31.71%
Okeechobee	-	-	18.18%	45.45%	36.36%
Orange	-	-	-	-	100.00%
Osceola	-	-	-	-	100.00%
Palm Beach	0.60%	1.49%	4.17%	17.26%	76.49%
Pasco	8.96%	10.45%	7.46%	13.43%	59.70%
Pinellas	18.78%	5.31%	12.65%	24.90%	38.37%
Polk	-	-	-	-	100.00%
Putnam	-	-	17.65%	64.71%	17.65%
Santa Rosa	-	4.00%	4.00%	80.00%	12.00%
Sarasota	18.09%	9.57%	11.70%	39.36%	21.28%
Seminole	-	-	-	-	100.00%
St. Johns	12.82%	7.69%	15.38%	56.41%	7.69%
St. Lucie	6.82%	2.27%	2.27%	43.18%	45.45%
Sumter	-	-	-	-	100.00%
Suwannee	-	-	-	-	100.00%
Taylor	-	-	25.00%	50.00%	25.00%
Union	-	-	-	-	100.00%
Volusia	0.88%	3.51%	7.89%	28.95%	58.77%
Wakulla	-	25.00%	-	75.00%	-
Walton	-	-	-	54.55%	45.45%
Washington	-	-	-	14.29%	85.71%
State Total	**8.19%**	**3.23%**	**5.39%**	**23.58%**	**59.62%**

Table 24: Census tract population summary for Category 2 storm surge risk.

County Name	Category 2 Storm Surge Hazard Risk					County Name	Category 2 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	247,336	Lee	326,862	38,451	39,784	91,074	122,583
Baker	-	-	-	-	27,115	Leon	-	-	-	-	275,487
Bay	-	-	26,398	124,208	18,246	Levy	-	3,289	4,656	6,211	26,645
Bradford	-	-	-	-	28,520	Liberty	-	-	-	8,365	-
Brevard	23,989	32,681	24,378	152,175	310,146	Madison	-	-	-	-	19,224
Broward	-	15,873	22,724	490,102	1,219,367	Manatee	16,517	25,983	22,072	122,551	135,710
Calhoun	-	-	-	-	14,625	Marion	-	-	-	3,446	327,852
Charlotte	93,807	14,823	19,947	29,491	1,910	Martin	-	-	6,398	75,808	64,112
Citrus	9,092	22,097	12,729	15,087	82,231	Miami-Dade	85,092	36,942	143,264	841,386	1,386,443
Clay	-	-	13,596	147,755	29,514	Monroe	50,873	15,354	5,744	1,099	20
Collier	187,749	24,311	29,482	35,089	44,889	Nassau	-	14,070	22,594	32,591	4,059
Columbia	-	-	-	-	67,531	Okaloosa	-	-	2,444	106,541	71,837
DeSoto	-	-	1,218	22,672	10,972	Okeechobee	-	-	6,316	16,892	16,788
Dixie	-	4,101	-	7,331	4,990	Orange	-	-	-	-	1,145,956
Duval	-	19,359	79,989	390,515	374,400	Osceola	-	-	-	-	268,685
Escambia	-	3,245	3,978	128,686	161,710	Palm Beach	2,673	10,779	35,697	223,207	1,047,106
Flagler	2,862	3,217	12,114	24,011	53,492	Pasco	29,636	39,078	31,695	66,663	297,625
Franklin	1,690	2,804	3,966	3,089	-	Pinellas	150,113	47,924	114,585	240,577	363,343
Gadsden	-	-	-	-	46,389	Polk	-	-	-	-	602,095
Gilchrist	-	-	-	8,398	8,541	Putnam	-	-	9,421	49,578	15,365
Glades	-	-	-	12,884	-	Santa Rosa	-	4,266	4,996	128,349	13,761
Gulf	-	4,450	-	11,413	-	Sarasota	41,160	32,194	44,256	177,791	84,047
Hamilton	-	-	-	-	14,799	Seminole	-	-	-	-	422,718
Hardee	-	-	-	-	27,731	St. Johns	16,699	11,457	23,055	128,266	10,562
Hendry	-	-	-	31,336	7,804	St. Lucie	9,527	2,777	1,743	119,023	144,719
Hernando	12,229	-	-	5,346	155,203	Sumter	-	-	-	-	87,023
Highlands	-	-	-	5,124	93,662	Suwannee	-	-	-	-	41,551
Hillsborough	117,296	17,186	49,424	199,578	845,742	Taylor	-	-	5,220	13,917	3,433
Holmes	-	-	-	-	19,927	Union	-	-	-	-	15,535
Indian River	-	6,797	12,047	64,227	54,957	Volusia	2,315	10,612	33,948	127,647	320,071
Jackson	-	-	-	-	49,746	Wakulla	-	8,332	-	22,444	-
Jefferson	-	-	-	4,380	10,381	Walton	-	-	-	31,317	23,726
Lafayette	-	-	-	5,706	3,164	Washington	-	-	-	6,615	18,281
Lake	-	-	-	-	297,052	**State Total**	**1,180,181**	**472,452**	**869,878**	**4,559,961**	**11,708,454**

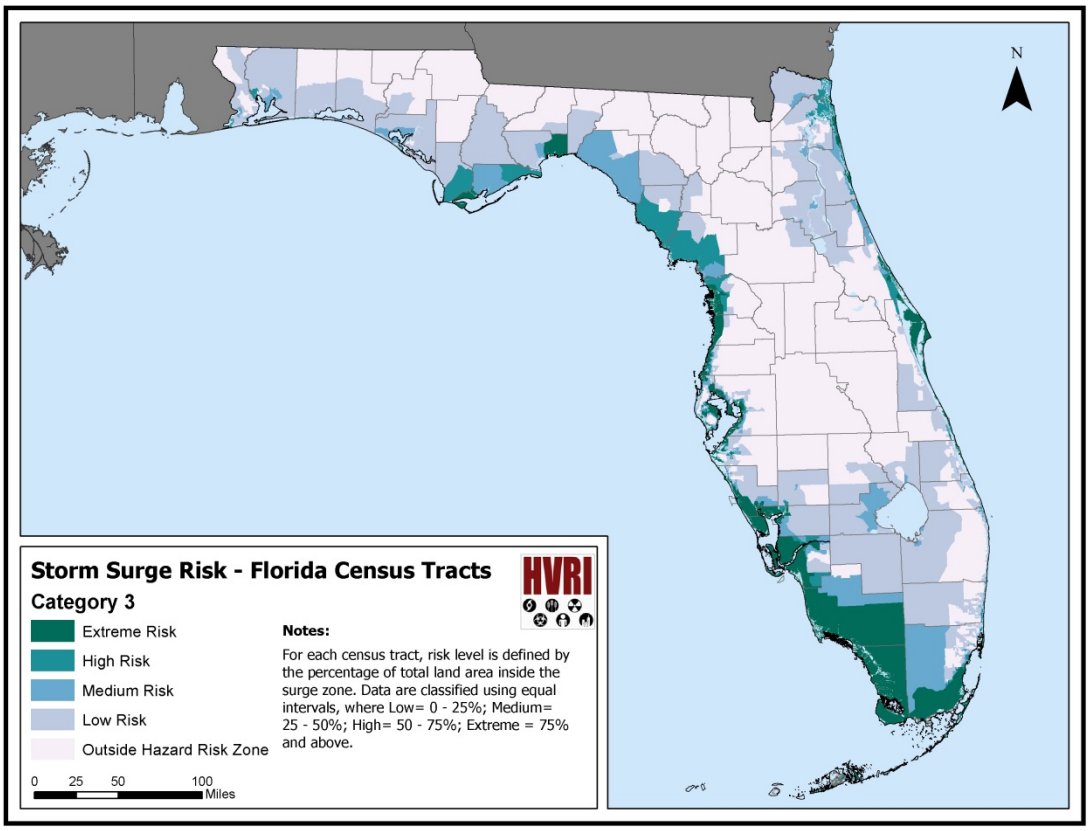

Figure 15: Category 3 storm surge risk in Florida.

Table 25: Census tract summary for Category 3 storm surge risk.

County Name	Category 3 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	100.00%
Baker	-	-	-	-	100.00%
Bay	-	9.09%	18.18%	61.36%	11.36%
Bradford	-	-	-	-	100.00%
Brevard	27.43%	4.42%	2.65%	27.43%	38.05%
Broward	1.39%	2.22%	6.37%	29.92%	60.11%
Calhoun	-	-	-	-	100.00%
Charlotte	79.49%	7.69%	5.13%	5.13%	2.56%
Citrus	10.71%	17.86%	-	10.71%	60.71%
Clay	-	-	10.00%	56.67%	33.33%
Collier	90.54%	1.35%	1.35%	-	6.76%
Columbia	-	-	-	-	100.00%
DeSoto	-	11.11%	11.11%	66.67%	11.11%
Dixie	-	33.33%	-	33.33%	33.33%
Duval	7.51%	6.36%	6.94%	38.73%	40.46%
Escambia	2.82%	1.41%	5.63%	42.25%	47.89%
Flagler	15.00%	10.00%	15.00%	15.00%	45.00%
Franklin	50.00%	25.00%	25.00%	-	-
Gadsden	-	-	-	-	100.00%
Gilchrist	-	-	-	40.00%	60.00%
Glades	-	-	25.00%	50.00%	25.00%
Gulf	-	33.33%	-	66.67%	-
Hamilton	-	-	-	-	100.00%
Hardee	-	-	-	-	100.00%
Hendry	-	-	-	100.00%	-
Hernando	6.67%	2.22%	-	13.33%	77.78%
Highlands	-	-	-	7.41%	92.59%
Hillsborough	14.64%	4.67%	4.36%	14.95%	61.37%
Holmes	-	-	-	-	100.00%
Indian River	10.00%	16.67%	6.67%	36.67%	30.00%
Jackson	-	-	-	-	100.00%
Jefferson	-	-	-	33.33%	66.67%
Lafayette	-	-	-	50.00%	50.00%
Lake	-	-	-	-	100.00%
Lee	74.85%	4.19%	4.19%	4.19%	12.57%
Leon	-	-	-	2.94%	97.06%
Levy	-	20.00%	10.00%	20.00%	50.00%
Liberty	-	-	-	100.00%	-
Madison	-	-	-	-	100.00%
Manatee	17.95%	7.69%	10.26%	28.21%	35.90%
Marion	-	-	-	4.76%	95.24%
Martin	2.94%	-	17.65%	52.94%	26.47%
Miami-Dade	9.25%	7.51%	8.86%	27.94%	46.44%
Monroe	87.10%	6.45%	-	3.23%	3.23%
Nassau	8.33%	16.67%	33.33%	33.33%	8.33%
Okaloosa	2.44%	2.44%	9.76%	58.54%	26.83%
Okeechobee	-	-	18.18%	45.45%	36.36%
Orange	-	-	-	-	100.00%
Osceola	-	-	-	-	100.00%
Palm Beach	0.89%	5.65%	4.17%	13.69%	75.60%
Pasco	25.37%	5.97%	6.72%	8.96%	52.99%
Pinellas	30.61%	8.57%	13.88%	17.55%	29.39%
Polk	-	-	-	-	100.00%
Putnam	-	-	17.65%	64.71%	17.65%
Santa Rosa	-	4.00%	20.00%	68.00%	8.00%
Sarasota	44.68%	7.45%	9.57%	20.21%	18.09%
Seminole	-	-	-	-	100.00%
St. Johns	28.21%	15.38%	10.26%	38.46%	7.69%
St. Lucie	9.09%	-	2.27%	45.45%	43.18%
Sumter	-	-	-	-	100.00%
Suwannee	-	-	-	-	100.00%
Taylor	-	-	50.00%	25.00%	25.00%
Union	-	-	-	-	100.00%
Volusia	14.04%	5.26%	10.53%	18.42%	51.75%
Wakulla	25.00%	-	25.00%	50.00%	-
Walton	-	-	9.09%	45.45%	45.45%
Washington	-	-	-	14.29%	85.71%
State Total	**14.54%**	**4.56%**	**5.95%**	**19.55%**	**55.40%**

Table 26: Census tract population summary for Category 3 storm surge risk.

County Name	Category 3 Storm Surge Hazard Risk					County Name	Category 3 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	247,336	Lee	488,476	17,733	25,181	15,734	71,630
Baker	-	-	-	-	27,115	Leon	-	-	-	8,099	267,388
Bay	-	6,474	32,383	111,749	18,246	Levy	-	4,691	3,254	10,234	22,622
Bradford	-	-	-	-	28,520	Liberty	-	-	-	8,365	-
Brevard	106,206	16,922	11,132	160,492	248,617	Madison	-	-	-	-	19,224
Broward	15,759	27,890	87,256	495,734	1,121,427	Manatee	46,072	28,188	35,295	103,240	110,038
Calhoun	-	-	-	-	14,625	Marion	-	-	-	3,446	327,852
Charlotte	128,013	14,386	11,832	5,747	-	Martin	2,691	-	19,083	73,560	50,984
Citrus	13,747	30,171	-	15,087	82,231	Miami-Dade	223,803	153,340	185,334	738,875	1,191,775
Clay	-	-	32,358	128,993	29,514	Monroe	68,846	3,125	-	1,099	20
Collier	276,280	2,018	18,805	-	24,417	Nassau	1,759	15,076	23,165	29,255	4,059
Columbia	-	-	-	-	67,531	Okaloosa	1,354	1,090	12,728	101,000	64,650
DeSoto	-	1,218	2,308	26,648	4,688	Okeechobee	-	-	6,316	16,892	16,788
Dixie	-	4,101	-	7,331	4,990	Orange	-	-	-	-	1,145,956
Duval	52,436	58,739	45,056	352,107	355,925	Osceola	-	-	-	-	268,685
Escambia	3,245	3,978	12,012	140,514	137,870	Palm Beach	3,771	49,612	45,467	188,434	1,032,178
Flagler	8,933	5,337	10,929	17,005	53,492	Pasco	94,129	28,918	32,074	44,675	264,901
Franklin	4,494	3,966	3,089	-	-	Pinellas	258,191	79,406	133,678	174,981	270,286
Gadsden	-	-	-	-	46,389	Polk	-	-	-	-	602,095
Gilchrist	-	-	-	8,398	8,541	Putnam	-	-	9,421	49,578	15,365
Glades	-	-	3,748	9,136	-	Santa Rosa	-	4,266	27,178	110,071	9,857
Gulf	-	4,450	-	11,413	-	Sarasota	143,026	18,624	68,466	76,240	73,092
Hamilton	-	-	-	-	14,799	Seminole	-	-	-	-	422,718
Hardee	-	-	-	-	27,731	St. Johns	40,280	18,732	24,574	95,891	10,562
Hendry	-	-	-	39,140	-	St. Lucie	12,304	-	1,743	123,373	140,369
Hernando	12,229	-	-	19,922	140,627	Sumter	-	-	-	-	87,023
Highlands	-	-	-	6,442	92,344	Suwannee	-	-	-	-	41,551
Hillsborough	170,545	45,391	41,816	188,619	782,855	Taylor	-	-	13,097	6,040	3,433
Holmes	-	-	-	-	19,927	Union	-	-	-	-	15,535
Indian River	8,503	14,065	7,309	53,194	54,957	Volusia	55,018	24,839	50,721	80,179	283,836
Jackson	-	-	-	-	49,746	Wakulla	8,332	-	8,301	14,143	-
Jefferson	-	-	-	4,380	10,381	Walton	-	-	7,367	23,950	23,726
Lafayette	-	-	-	5,706	3,164	Washington	-	-	-	6,615	18,281
Lake	-	-	-	-	297,052	**State Total**	**2,248,442**	**686,746**	**1,052,476**	**3,911,726**	**10,891,536**

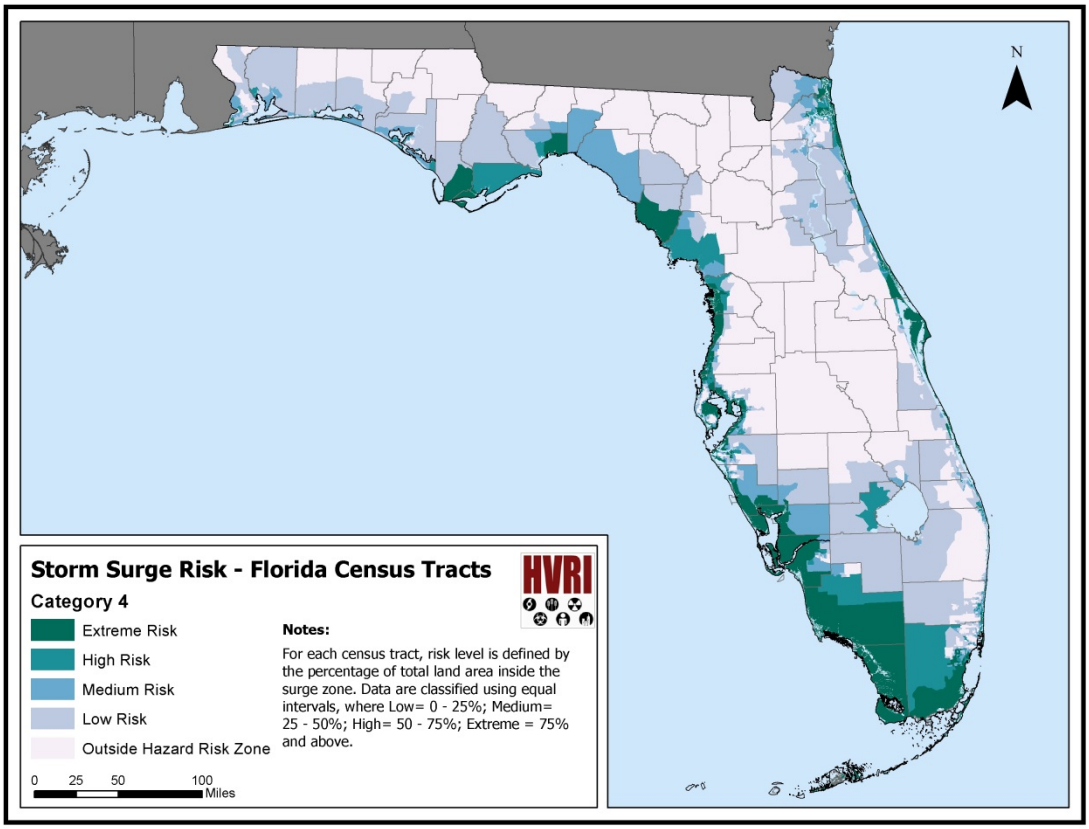

Figure 16: Category 4 storm surge risk in Florida.

Table 27: Census tract summary for Category 4 storm surge risk.

County Name	Category 4 Storm Surge Hazard Risk					County Name	Category 4 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	100.00%	Lee	86.23%	2.40%	2.99%	4.19%	4.19%
Baker	-	-	-	-	100.00%	Leon	-	-	1.47%	2.94%	95.59%
Bay	4.55%	22.73%	11.36%	50.00%	11.36%	Levy	-	20.00%	20.00%	10.00%	50.00%
Bradford	-	-	-	-	100.00%	Liberty	-	-	-	100.00%	-
Brevard	31.86%	3.54%	4.42%	29.20%	30.97%	Madison	-	-	-	-	100.00%
Broward	4.43%	6.93%	8.03%	26.87%	53.74%	Manatee	29.49%	7.69%	17.95%	25.64%	19.23%
Calhoun	-	-	-	-	100.00%	Marion	-	-	-	4.76%	95.24%
Charlotte	92.31%	2.56%	2.56%	-	2.56%	Martin	2.94%	14.71%	17.65%	44.12%	20.59%
Citrus	10.71%	17.86%	-	10.71%	60.71%	Miami-Dade	23.51%	13.49%	10.02%	21.58%	31.41%
Clay	-	-	13.33%	53.33%	33.33%	Monroe	87.10%	6.45%	-	3.23%	3.23%
Collier	90.54%	2.70%	1.35%	2.70%	2.70%	Nassau	41.67%	-	25.00%	25.00%	8.33%
Columbia	-	-	-	-	100.00%	Okaloosa	4.88%	4.88%	21.95%	41.46%	26.83%
DeSoto	11.11%	-	22.22%	66.67%	-	Okeechobee	-	-	27.27%	36.36%	36.36%
Dixie	33.33%	-	-	66.67%	-	Orange	-	-	-	-	100.00%
Duval	10.98%	6.94%	12.72%	30.64%	38.73%	Osceola	-	-	-	-	100.00%
Escambia	4.23%	4.23%	8.45%	39.44%	43.66%	Palm Beach	2.98%	5.95%	6.55%	9.52%	75.00%
Flagler	20.00%	5.00%	15.00%	15.00%	45.00%	Pasco	34.33%	6.72%	3.73%	4.48%	50.75%
Franklin	50.00%	50.00%	-	-	-	Pinellas	42.04%	8.57%	10.61%	13.47%	25.31%
Gadsden	-	-	-	-	100.00%	Polk	-	-	-	-	100.00%
Gilchrist	-	-	-	40.00%	60.00%	Putnam	-	-	17.65%	64.71%	17.65%
Glades	-	25.00%	-	50.00%	25.00%	Santa Rosa	-	8.00%	28.00%	60.00%	4.00%
Gulf	33.33%	-	-	66.67%	-	Sarasota	57.45%	5.32%	10.64%	11.70%	14.89%
Hamilton	-	-	-	-	100.00%	Seminole	-	-	-	-	100.00%
Hardee	-	-	-	-	100.00%	St. Johns	38.46%	7.69%	7.69%	38.46%	7.69%
Hendry	-	-	-	100.00%	-	St. Lucie	9.09%	-	6.82%	40.91%	43.18%
Hernando	6.67%	2.22%	2.22%	17.78%	71.11%	Sumter	-	-	-	-	100.00%
Highlands	-	-	-	11.11%	88.89%	Suwannee	-	-	-	-	100.00%
Hillsborough	21.18%	3.74%	4.98%	11.21%	58.88%	Taylor	-	-	75.00%	-	25.00%
Holmes	-	-	-	-	100.00%	Union	-	-	-	-	100.00%
Indian River	30.00%	3.33%	3.33%	40.00%	23.33%	Volusia	37.72%	4.39%	7.89%	8.77%	41.23%
Jackson	-	-	-	-	100.00%	Wakulla	25.00%	25.00%	25.00%	25.00%	-
Jefferson	-	-	33.33%	-	66.67%	Walton	-	9.09%	18.18%	27.27%	45.45%
Lafayette	-	-	-	50.00%	50.00%	Washington	-	-	-	14.29%	85.71%
Lake	-	-	-	-	100.00%	**State Total**	**20.66%**	**5.65%**	**6.79%**	**16.13%**	**50.77%**

Table 28: Census tract population summary for Category 4 storm surge risk.

County Name	Category 4 Storm Surge Hazard Risk					County Name	Category 4 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	247,336	Lee	551,533	12,534	23,240	18,560	12,887
Baker	-	-	-	-	27,115	Leon	-	-	3,108	9,969	262,410
Bay	3,101	31,502	26,708	89,295	18,246	Levy	-	4,691	9,465	4,023	22,622
Bradford	-	-	-	-	28,520	Liberty	-	-	-	8,365	-
Brevard	122,197	15,073	19,700	187,540	198,859	Madison	-	-	-	-	19,224
Broward	66,699	84,489	105,714	489,948	1,001,216	Manatee	84,514	29,491	58,348	89,551	60,929
Calhoun	-	-	-	-	14,625	Marion	-	-	-	3,446	327,852
Charlotte	154,008	2,133	3,837	-	-	Martin	2,691	17,607	21,780	64,226	40,014
Citrus	13,747	30,171	-	15,087	82,231	Miami-Dade	582,755	300,734	241,604	581,961	786,073
Clay	-	-	41,538	119,813	29,514	Monroe	68,846	3,125	-	1,099	20
Collier	276,280	20,823	5,920	11,176	7,321	Nassau	26,392	-	21,049	21,814	4,059
Columbia	-	-	-	-	67,531	Okaloosa	3,695	4,854	36,617	71,006	64,650
DeSoto	1,218	-	5,276	28,368	-	Okeechobee	-	-	8,119	15,089	16,788
Dixie	4,101	-	-	12,321	-	Orange	-	-	-	-	1,145,956
Duval	77,713	56,333	106,713	274,844	348,660	Osceola	-	-	-	-	268,685
Escambia	7,223	9,087	28,482	126,923	125,904	Palm Beach	28,894	47,890	85,410	134,305	1,022,963
Flagler	11,053	3,217	10,929	17,005	53,492	Pasco	137,222	33,682	19,852	24,822	249,119
Franklin	4,494	7,055	-	-	-	Pinellas	373,788	81,185	100,973	128,101	232,495
Gadsden	-	-	-	-	46,389	Polk	-	-	-	-	602,095
Gilchrist	-	-	-	8,398	8,541	Putnam	-	-	9,421	49,578	15,365
Glades	-	3,748	-	9,136	-	Santa Rosa	-	8,935	45,269	92,609	4,559
Gulf	4,450	-	-	11,413	-	Sarasota	215,998	19,959	38,171	44,947	60,373
Hamilton	-	-	-	-	14,799	Seminole	-	-	-	-	422,718
Hardee	-	-	-	-	27,731	St. Johns	54,327	7,585	21,674	95,891	10,562
Hendry	-	-	-	39,140	-	St. Lucie	12,304	-	9,114	116,002	140,369
Hernando	12,229	-	5,779	25,876	128,894	Sumter	-	-	-	-	87,023
Highlands	-	-	-	12,521	86,265	Suwannee	-	-	-	-	41,551
Hillsborough	245,534	28,919	64,289	131,293	759,191	Taylor	-	-	19,137	-	3,433
Holmes	-	-	-	-	19,927	Union	-	-	-	-	15,535
Indian River	26,701	3,176	3,750	64,900	39,501	Volusia	141,763	22,092	42,548	53,767	234,423
Jackson	-	-	-	-	49,746	Wakulla	8,332	8,301	8,867	5,276	-
Jefferson	-	-	4,380	-	10,381	Walton	-	7,367	12,304	11,646	23,726
Lafayette	-	-	-	5,706	3,164	Washington	-	-	-	6,615	18,281
Lake	-	-	-	-	297,052	**State Total**	**3,323,802**	**905,758**	**1,269,085**	**3,333,371**	**9,958,910**

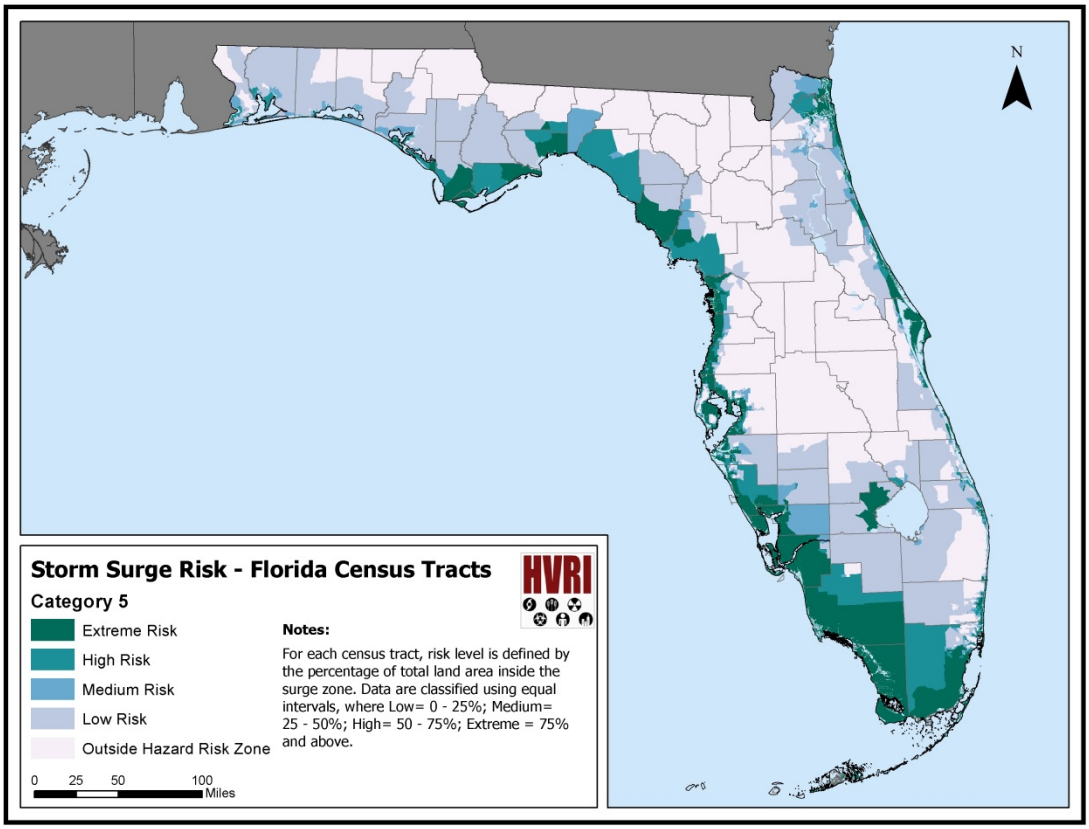

Figure 17: Category 5 storm surge risk in Florida.

Table 29: Census tract summary for Category 5 storm surge risk.

County Name	Category 5 Storm Surge Hazard Risk					County Name	Category 5 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	100.00%	Lee	94.01%	1.80%	0.60%	2.99%	0.60%
Baker	-	-	-	-	100.00%	Leon	1.47%	1.47%	-	2.94%	94.12%
Bay	22.73%	15.91%	9.09%	45.45%	6.82%	Levy	10.00%	20.00%	10.00%	10.00%	50.00%
Bradford	-	-	-	-	100.00%	Liberty	-	-	-	100.00%	-
Brevard	38.94%	6.19%	5.31%	26.55%	23.01%	Madison	-	-	-	-	100.00%
Broward	13.30%	9.42%	4.71%	23.55%	49.03%	Manatee	48.72%	21.79%	5.13%	17.95%	6.41%
Calhoun	-	-	-	66.67%	33.33%	Marion	-	-	-	6.35%	93.65%
Charlotte	92.31%	2.56%	2.56%	-	2.56%	Martin	14.71%	26.47%	17.65%	29.41%	11.76%
Citrus	14.29%	14.29%	-	14.29%	57.14%	Miami-Dade	42.77%	12.14%	8.86%	15.03%	21.19%
Clay	-	-	16.67%	53.33%	30.00%	Monroe	90.32%	3.23%	-	3.23%	3.23%
Collier	90.54%	5.41%	1.35%	-	2.70%	Nassau	41.67%	16.67%	16.67%	25.00%	-
Columbia	-	-	-	-	100.00%	Okaloosa	12.20%	9.76%	29.27%	26.83%	21.95%
DeSoto	11.11%	11.11%	11.11%	66.67%	-	Okeechobee	-	9.09%	18.18%	45.45%	27.27%
Dixie	33.33%	-	-	66.67%	-	Orange	-	-	-	-	100.00%
Duval	17.92%	8.09%	9.83%	32.37%	31.79%	Osceola	-	-	-	-	100.00%
Escambia	5.63%	7.04%	7.04%	39.44%	40.85%	Palm Beach	7.44%	6.55%	5.65%	7.74%	72.62%
Flagler	30.00%	15.00%	-	20.00%	35.00%	Pasco	40.30%	5.22%	2.99%	4.48%	47.01%
Franklin	75.00%	25.00%	-	-	-	Pinellas	48.98%	10.61%	5.71%	11.43%	23.27%
Gadsden	-	-	-	-	100.00%	Polk	-	-	-	-	100.00%
Gilchrist	-	-	20.00%	20.00%	60.00%	Putnam	-	-	17.65%	64.71%	17.65%
Glades	25.00%	-	-	50.00%	25.00%	Santa Rosa	4.00%	16.00%	28.00%	48.00%	4.00%
Gulf	33.33%	33.33%	-	33.33%	-	Sarasota	72.34%	7.45%	5.32%	8.51%	6.38%
Hamilton	-	-	-	-	100.00%	Seminole	-	-	-	-	100.00%
Hardee	-	-	-	33.33%	66.67%	St. Johns	43.59%	5.13%	7.69%	35.90%	7.69%
Hendry	-	-	-	100.00%	-	St. Lucie	9.09%	6.82%	2.27%	40.91%	40.91%
Hernando	8.89%	8.89%	15.56%	8.89%	57.78%	Sumter	-	-	-	-	100.00%
Highlands	-	-	-	11.11%	88.89%	Suwannee	-	-	-	-	100.00%
Hillsborough	25.23%	4.98%	6.54%	8.10%	55.14%	Taylor	-	50.00%	25.00%	-	25.00%
Holmes	-	-	-	-	100.00%	Union	-	-	-	-	100.00%
Indian River	33.33%	-	6.67%	40.00%	20.00%	Volusia	40.35%	6.14%	6.14%	7.89%	39.47%
Jackson	-	-	-	-	100.00%	Wakulla	50.00%	25.00%	-	25.00%	-
Jefferson	-	-	33.33%	-	66.67%	Walton	-	9.09%	18.18%	27.27%	45.45%
Lafayette	-	-	-	50.00%	50.00%	Washington	-	-	-	28.57%	71.43%
Lake	-	-	-	-	100.00%	**State Total**	**27.31%**	**6.81%**	**5.43%**	**13.88%**	**46.57%**

Table 30: Census tract population summary for Category 5 storm surge risk.

County Name	Category 5 Storm Surge Hazard Risk					County Name	Category 5 Storm Surge Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out		Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	-	-	-	-	247,336	Lee	591,863	12,534	2,800	11,557	-
Baker	-	-	-	-	27,115	Leon	4,991	3,108	-	9,883	257,505
Bay	24,753	33,155	15,353	86,526	9,065	Levy	1,402	6,543	6,211	4,023	22,622
Bradford	-	-	-	-	28,520	Liberty	-	-	-	8,365	-
Brevard	152,406	30,006	29,119	179,447	152,391	Madison	-	-	-	-	19,224
Broward	175,493	124,565	82,085	439,193	926,730	Manatee	147,238	75,856	15,357	61,569	22,813
Calhoun	-	-	-	12,192	2,433	Marion	-	-	-	9,822	321,476
Charlotte	154,008	2,133	3,837	-	-	Martin	16,120	35,030	23,043	57,272	14,853
Citrus	20,065	23,853	-	19,673	77,645	Miami-Dade	1,065,743	287,344	228,214	383,815	528,011
Clay	-	-	51,691	112,579	26,595	Monroe	71,971	-	-	1,099	20
Collier	276,280	33,112	4,807	-	7,321	Nassau	26,392	13,608	14,272	19,042	-
Columbia	-	-	-	-	67,531	Okaloosa	13,639	10,593	54,442	49,114	53,034
DeSoto	1,218	2,308	2,968	28,368	-	Okeechobee	-	1,803	6,316	19,890	11,987
Dixie	4,101	-	-	12,321	-	Orange	-	-	-	-	1,145,956
Duval	130,682	88,084	72,233	284,053	289,211	Osceola	-	-	-	-	268,685
Escambia	12,011	12,569	25,903	130,787	116,349	Palm Beach	79,166	62,776	75,570	113,458	988,492
Flagler	18,868	10,648	-	25,208	40,972	Pasco	168,610	26,412	17,687	20,805	231,183
Franklin	8,460	3,089	-	-	-	Pinellas	444,404	94,518	53,109	109,472	215,039
Gadsden	-	-	-	-	46,389	Polk	-	-	-	-	602,095
Gilchrist	-	-	3,040	5,358	8,541	Putnam	-	-	9,421	49,578	15,365
Glades	3,748	-	-	9,136	-	Santa Rosa	5,763	20,333	43,230	77,487	4,559
Gulf	4,450	3,076	-	8,337	-	Sarasota	264,135	29,899	14,958	40,377	30,079
Hamilton	-	-	-	-	14,799	Seminole	-	-	-	-	422,718
Hardee	-	-	-	10,347	17,384	St. Johns	59,012	8,234	17,177	95,054	10,562
Hendry	-	-	-	39,140	-	St. Lucie	12,304	9,114	4,468	115,019	136,884
Hernando	16,258	12,328	23,756	17,881	102,555	Sumter	-	-	-	-	87,023
Highlands	-	-	-	12,521	86,265	Suwannee	-	-	-	-	41,551
Hillsborough	278,825	73,528	69,702	99,775	707,396	Taylor	-	13,097	6,040	-	3,433
Holmes	-	-	-	-	19,927	Union	-	-	-	-	15,535
Indian River	29,877	-	7,638	67,126	33,387	Volusia	151,544	34,019	39,785	46,696	222,549
Jackson	-	-	-	-	49,746	Wakulla	16,633	8,867	-	5,276	-
Jefferson	-	-	4,380	-	10,381	Walton	-	7,367	12,304	11,646	23,726
Lafayette	-	-	-	5,706	3,164	Washington	-	-	-	10,239	14,657
Lake	-	-	-	-	297,052	**State Total**	**4,452,433**	**1,213,509**	**1,040,916**	**2,936,232**	**9,147,836**

Analyzing Hurricane Storm Surge in Combination with SoVI and MedVI

About Bivariate Classifications

Here we keep the exposure constant by using the same hazard threat surface but use different vulnerability perspectives (Social and Medical) in bivariate representations to create an easily understood depiction of not only increased threat but also a limited ability to adequately prepare for and respond to these threats. In doing so, we are able to quickly identify three specific geographic areas of interest:

1. Areas where the hazard itself should be the focus of planning and mitigation,
2. Areas where understanding the underlying socioeconomics and demographics would prove to be the most advantageous input point to create positive change, and
3. Areas where a combination of classic hazard mitigation techniques and social mitigation practices should be utilized in order to maximize optimal outcomes.

The following maps utilize a three by three bivariate representation in which one can easily identify areas of limited to elevated SoVI in relation to areas with low to extreme hazard classifications. Places identified in item number one in the preceding list are shaded in the blue colors and can be understood as locations where hazard

susceptibility is higher than SoVI or MedVI. Areas identified in item number two above, indicating where socioeconomics and demographics play an important role, are shaded in the pink/red colors and can be conceived as locations where SoVI or MedVI are greater than physical hazard threats. Places identified in item number three above are shaded either in gray-tones or in a dark burgundy color and can be understood as areas that have equal vulnerability and hazard classification scores.

Integrating Category 1 Storm Surge Risk with SoVI and MedVI

The threat of hurricane storm surge is greatest in low-lying areas. Figure 18 represents the combination of social vulnerability and threat from Category 1 storm surge across the state. Even a “small” Category 1 hurricane making landfall could have dire consequences for many places. Collier, Lee, Pasco, and Pinellas Counties all have census tracts characterized with high SoVI and at extreme risk during a Category 1 hurricane, representing almost 17,000 people (Table 31). Census tracts with high SoVI and at high risk are in Collier, Hillsborough, Lee, Miami-Dade, and Pinellas Counties, totaling 9 tracts and over 40,000 people (Table 31).

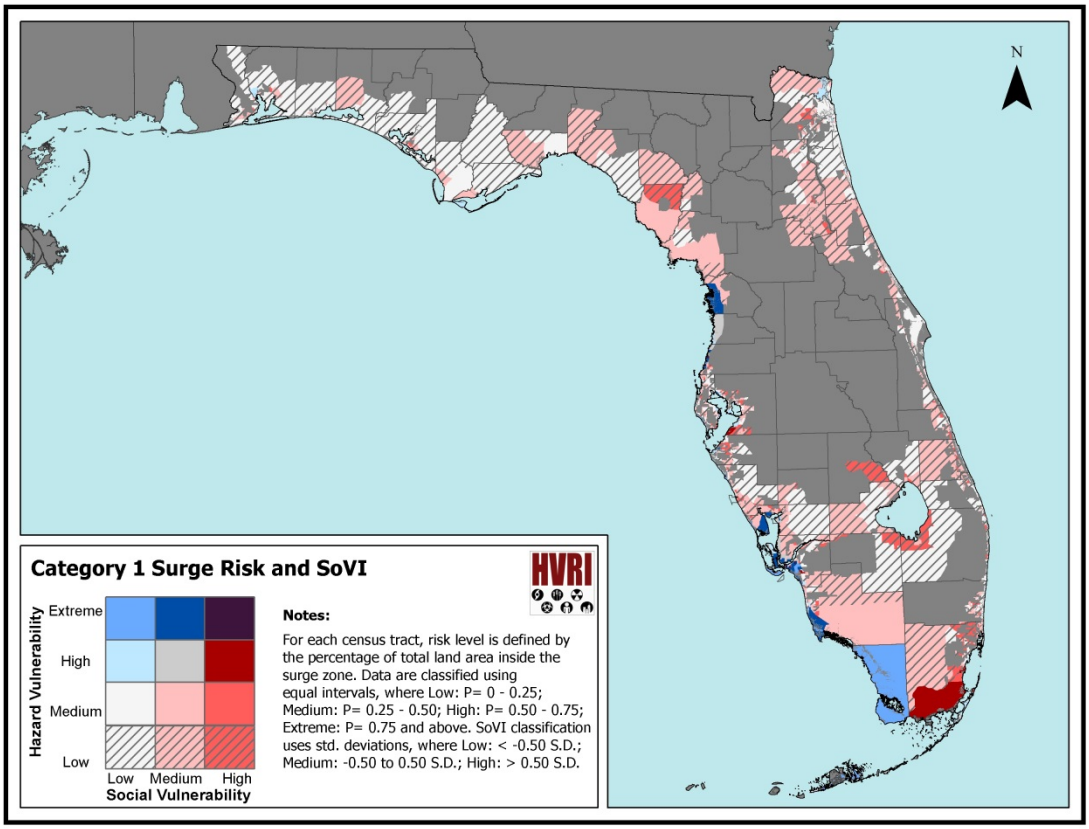

Figure 18: Bivariate representation of SoVI and Category 1 storm surge risk in Florida.

Table 31: Tract and population summary for counties with high SoVI and medium or greater Category 1 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 1 Storm Surge								
Collier	1	2,225	Lee	4	11,647	Pasco	1	1,487
Pinellas	1	1,463		-	-		-	-
State Total	**7**	**16,822**		-	-		-	-
High Risk from Category 1 Storm Surge								
Collier	1	1,184	Hillsborough	1	1,304	Lee	1	2,768
Miami-Dade	5	31,942	Pinellas	1	3,252		-	-
State Total	**9**	**40,450**		-	-		-	-
Medium Risk from Category 1 Storm Surge								
Hillsborough	2	8,439	Indian River	1	1,506	Lee	1	1,714
Manatee	1	4,914	Miami-Dade	1	9,319	Pasco	2	5,145
Pinellas	1	2,440	Putnam	1	3,107	Sarasota	1	2,562
St. Lucie	1	1,743		-	-		-	-
State Total	**12**	**40,889**		-	-		-	-

The combination of Category 1 storm surge and MedVI provides a similar picture where portions of the Big Bend area of Florida exhibit high MedVI but only low to medium Category 1 surge threat. However, low lying portions of Citrus and Hernando Counties on the Gulf Coast have both high to extreme MedVI and high to extreme hazard risk (Figure 19). In total, more than 200,000 people live across 19 counties characterized by both high medical vulnerability and medium or greater Category 1 storm surge risk (Table 32).

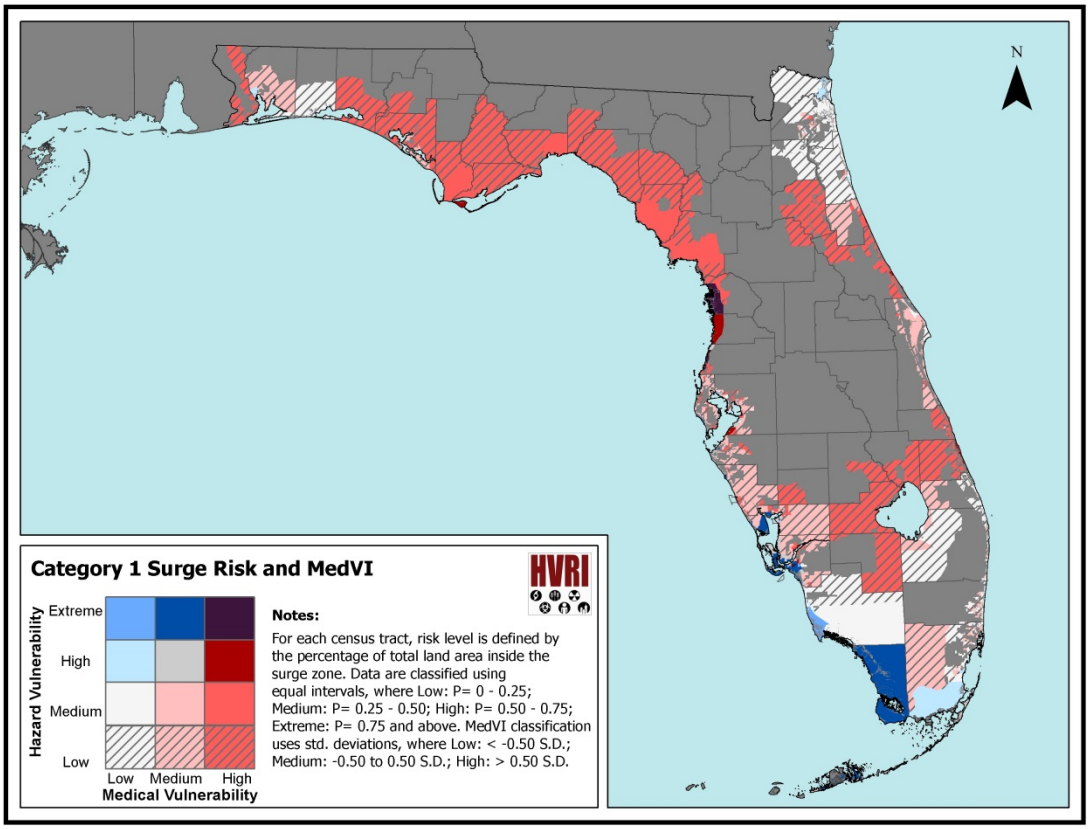

Figure 19: Bivariate representation of MedVI and Category1 storm surge risk in Florida.

Table 32: Tract and population summary for counties with high MedVI and medium or greater Category 1 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 1 Storm Surge								
Citrus	2	9,092	Lee	1	9,415	Pasco	7	15,322
State Total	**10**	**33,829**		-	-		-	-
High Risk from Category 1 Storm Surge								
Flagler	1	3,217	Franklin	1	1,690	Hernando	3	12,229
Hillsborough	2	5,057	Lee	3	12,341	Pasco	2	5,198
St. Lucie	3	9,527	Volusia	1	2,315		-	-
State Total	**16**	**51,574**		-	-		-	-
Medium Risk from Category 1 Storm Surge								
Charlotte	1	4,425	Citrus	3	15,609	DeSoto	1	1,218
Dixie	1	4,101	Flagler	2	4,465	Franklin	1	2,804
Gulf	1	4,450	Hillsborough	1	2,721	Indian River	2	6,797
Lee	3	8,816	Levy	1	3,289	Okeechobee	1	4,221
Pasco	4	11,793	Pinellas	1	4,797	Putnam	2	9,421
St. Lucie	2	4,520	Volusia	8	23,659	Wakulla	1	8,332
State Total	**36**	**125,438**		-	-		-	-

Integrating Category 2 Storm Surge Risk with SoVI and MedVI

Category 2 storm surge is likely to heavily impact counties in southwest, west central, and south Florida along with Duval and Brevard Counties (Figure 20) where social vulnerability is also often elevated. Sixteen counties across the state have tracts that are both high in social vulnerability and have at least a medium level of risk from hurricane storm surge. Nearly 350,000 people live within the 85 census tracts meeting these criteria (Table 33).

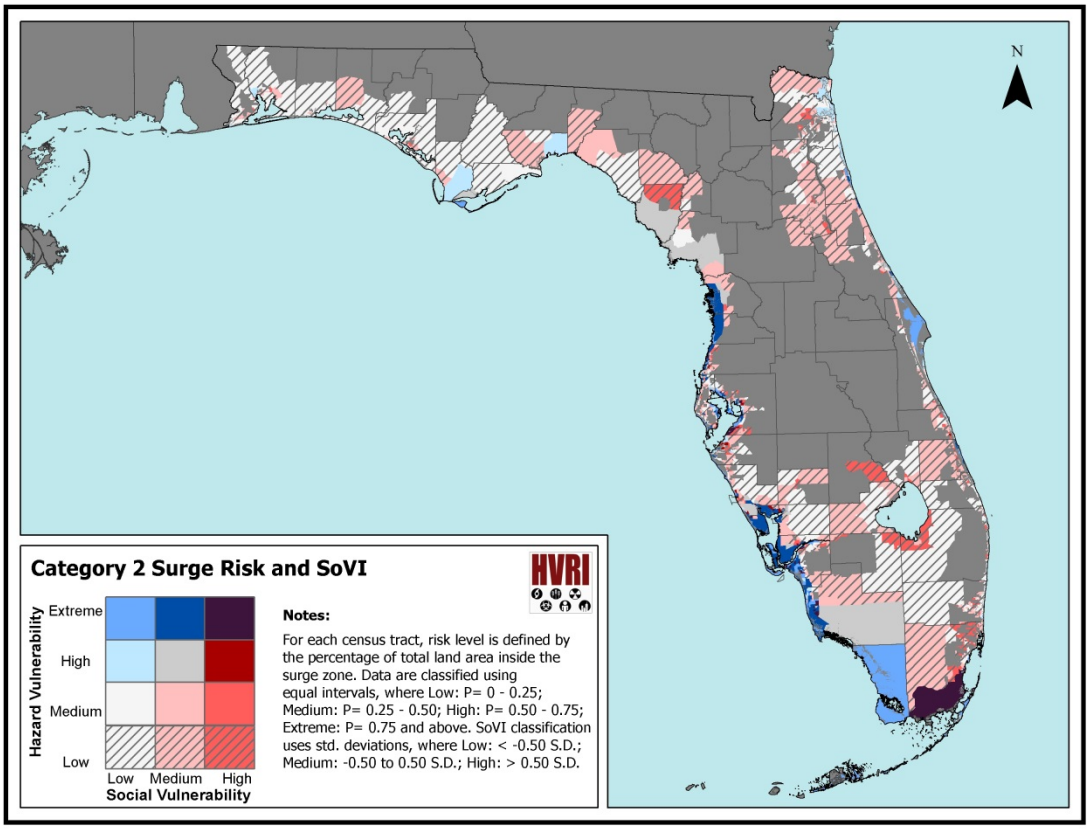

Figure 20: Bivariate representation of SoVI and Category 2 storm surge risk in Florida.

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Table 33: Tract and population summary for counties with high SoVI and medium or greater Category 2 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 2 Storm Surge								
Charlotte	2	7,730	Collier	10	52,265	Hillsborough	3	11,504
Lee	7	18,770	Miami-Dade	9	54,607	Pasco	1	1,487
Pinellas	3	7,523	Sarasota	2	5,317		-	-
State Total	**37**	**159,203**		-	-		-	-
High Risk from Category 2 Storm Surge								
Broward	1	3,098	Charlotte	2	8,265	Hillsborough	2	6,931
Indian River	1	1,506	Lee	2	6,381	Manatee	2	9,322
Miami-Dade	1	4,106	Pasco	5	12,636	Pinellas	2	6,817
Sarasota	3	7,077		-	-		-	-
State Total	**21**	**66,139**		-	-		-	-
Medium Risk from Category 2 Storm Surge								
Citrus	1	6,411	Duval	2	7,238	Hillsborough	2	6,479
Indian River	2	4,060	Lee	3	11,051	Manatee	2	10,045
Miami-Dade	8	55,051	Okeechobee	1	2,095	Pasco	1	2,517
Pinellas	3	12,090	Putnam	1	3,107	St. Lucie	1	1,743
State Total	**27**	**121,887**		-	-		-	-

Coupling medical vulnerability with Category 2 storm surge generates a different view of risks and vulnerabilities across the state (Figure 21). More than 25 counties have populated census tracts characterized by high medical vulnerability corresponding with medium to extreme Category 2 storm surge. Table 34 provides details on the locations of the most medically vulnerable places at risk to Category 2 storm surge and includes nearly 160 census tracts and more than 550,000 people.

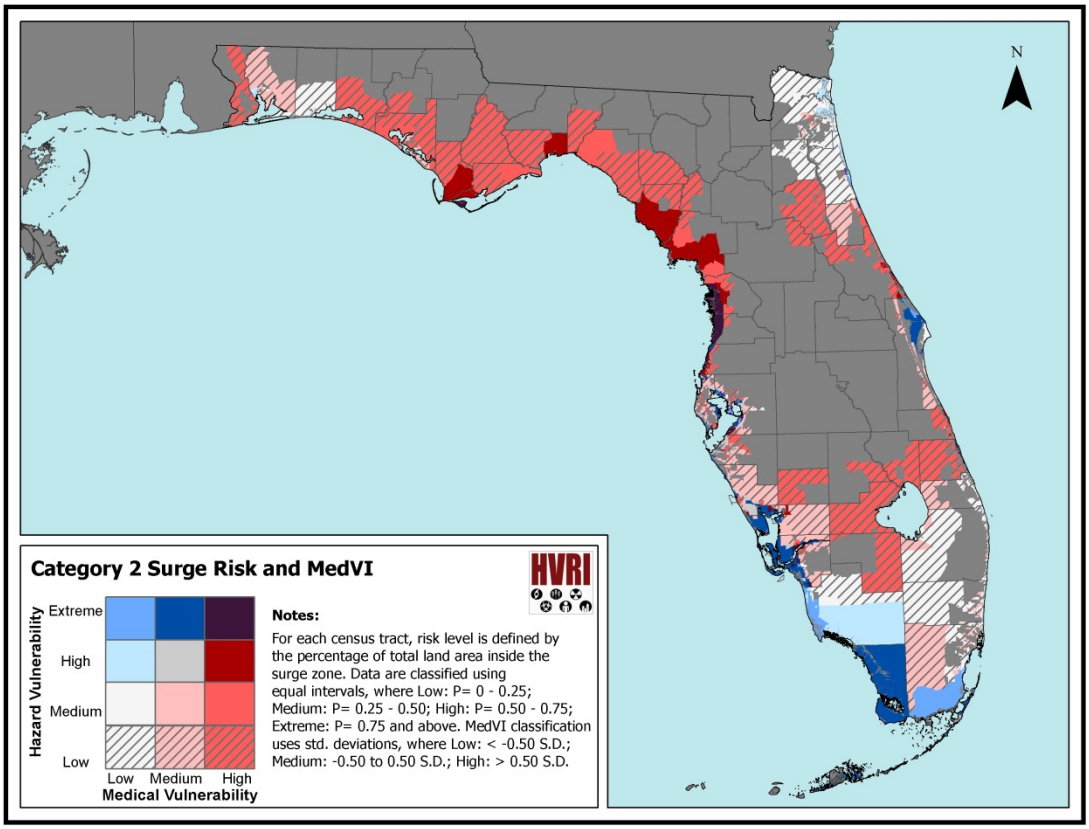

Figure 21: Bivariate representation of MedVI and Category 2 storm surge risk in Florida.

Table 34: Tract and population summary for counties with high MedVI and medium or greater Category 2 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 2 Storm Surge								
Charlotte	5	22,311	Citrus	2	9,092	Franklin	1	1,690
Hernando	1	12,229	Hillsborough	4	10,820	Lee	15	73,462
Pasco	11	27,249	Pinellas	2	8,401	Sarasota	2	4,834
St. Lucie	3	9,527	Volusia	1	2,315		-	-
State Total	**47**	**181,930**		-	-		-	-
High Risk from Category 2 Storm Surge								
Charlotte	2	9,923	Citrus	4	22,097	Dixie	1	4,101
Escambia	2	3,245	Flagler	1	3,217	Franklin	1	2,804
Gulf	1	4,450	Hillsborough	1	3,736	Indian River	2	6,797
Lee	4	13,531	Levy	1	3,289	Manatee	1	3,476
Pasco	14	39,078	Pinellas	3	9,405	Sarasota	1	2,679
St. Lucie	1	2,777	Volusia	4	10,612	Wakulla	1	8,332
State Total	**45**	**153,549**		-	-		-	-
Medium Risk from Category 2 Storm Surge								
Bay	3	13,447	Citrus	2	12,729	DeSoto	1	1,218
Escambia	1	3,978	Flagler	2	4,465	Franklin	1	3,966
Hillsborough	6	15,864	Indian River	4	12,047	Lee	3	11,301
Levy	2	4,656	Okeechobee	2	6,316	Pasco	10	31,695
Pinellas	10	40,765	Putnam	2	9,421	Sarasota	4	21,814
St. Johns	1	3,518	St. Lucie	1	1,743	Taylor	1	5,220
Volusia	9	33,948		-	-		-	-
State Total	**65**	**238,111**		-	-		-	-

Integrating Category 3 Storm Surge Risk with SoVI and MedVI

Looking at the combination of social vulnerability and Category 3 storm surge we see that the west coast of Florida is extremely vulnerable from both the social and hazard perspectives (Figure 22). Table 35 indicates that 21 counties containing 155 census tracts and more than 650,000 people are characterized by high levels of social vulnerability and at least a medium level of Category 3 storm surge risk. In particular, Miami-Dade County has 23 census tracts and more than 140,000 people in the intersection of extreme hazard risk and high social vulnerability.

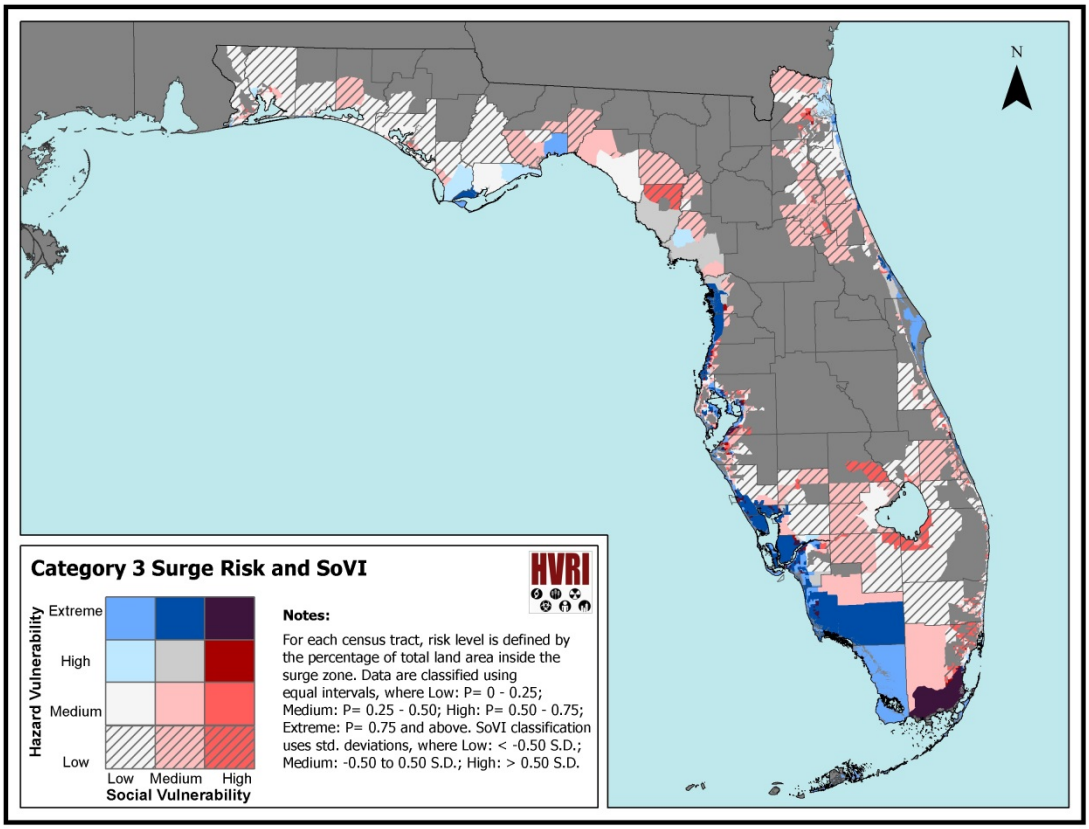

Figure 22: Bivariate representation of SoVI and Category 3 storm surge risk in Florida.

Table 35: Tract and population summary for counties with high SoVI and medium or greater Category 3 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 3 Storm Surge								
Broward	1	3,098	Charlotte	4	15,995	Collier	10	52,265
Hillsborough	5	18,435	Indian River	2	3,212	Lee	17	53,007
Manatee	1	4,408	Miami-Dade	23	140,460	Pasco	5	11,272
Pinellas	5	13,891	Sarasota	7	22,157		-	-
State Total	**80**	**338,200**		-	-		-	-
High Risk from Category 3 Storm Surge								
Citrus	1	6,411	Duval	3	10,830	Hillsborough	4	15,402
Indian River	1	2,354	Lee	2	6,395	Manatee	3	15,416
Miami-Dade	10	57,571	Pasco	4	13,321	Pinellas	5	20,525
Sarasota	1	3,370		-	-		-	-
State Total	**34**	**151,595**		-	-		-	-
Medium Risk from Category 3 Storm Surge								
Brevard	1	3,232	DeSoto	1	2,308	Duval	5	14,145
Hillsborough	2	10,175	Manatee	1	5,502	Miami-Dade	15	79,529
Okeechobee	1	2,095	Palm Beach	2	6,999	Pasco	4	17,288
Pinellas	3	10,785	Putnam	1	3,107	Santa Rosa	1	6,115
Sarasota	1	5,257	St. Lucie	1	1,743	Volusia	2	6,722
State Total	**41**	**175,002**		-	-		-	-

The pattern of medical vulnerability for Category 3 storm surge paints much the same picture with large portions of the entire coast exhibiting medium or greater storm surge risk (Figure 23). Included in the 29 counties exhibiting both high medical vulnerability and medium or greater surge risk are 250 census tracts and nearly 1 million people (Table 36). Counties with the highest population at extreme risk are Lee and Pasco Counties with more than 122,000 and 91,000 people, respectively, living at extreme risk and exhibiting high medical vulnerability.

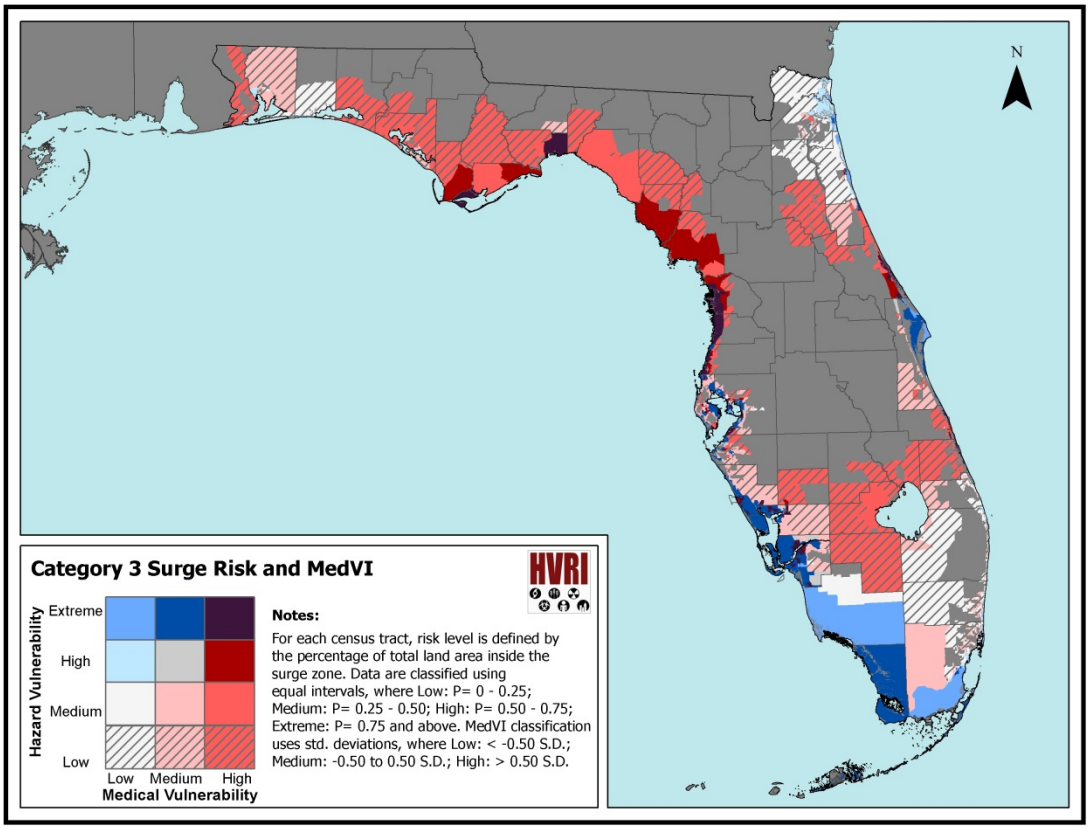

Figure 23: Bivariate representation of MedVI and Category 3 storm surge risk in Florida.

Table 36: Tract and population summary for counties with high MedVI and medium or greater Category 3 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 3 Storm Surge								
Charlotte	7	32,234	Citrus	3	13,747	Escambia	2	3,245
Franklin	2	4,494	Hernando	3	12,229	Hillsborough	7	24,398
Indian River	3	8,503	Lee	28	122,331	Manatee	1	3,476
Pasco	33	91,742	Pinellas	8	30,874	Sarasota	11	44,950
St. Lucie	4	12,304	Volusia	16	55,018	Wakulla	1	8,332
State Total	**129**	**467,877**		-	-		-	-
High Risk from Category 3 Storm Surge								
Bay	2	3,373	Citrus	5	30,171	DeSoto	1	1,218
Dixie	1	4,101	Escambia	1	3,978	Flagler	2	5,337
Franklin	1	3,966	Gulf	1	4,450	Hillsborough	6	16,908
Indian River	5	14,065	Lee	1	2,489	Levy	2	4,691
Manatee	1	5,959	Pasco	8	28,918	Pinellas	8	32,963
Sarasota	2	6,101	St. Johns	1	3,518	Volusia	6	24,839
State Total	**54**	**197,045**		-	-		-	-
Medium Risk from Category 3 Storm Surge								
Bay	5	19,794	Brevard	1	3,232	DeSoto	1	2,308
Duval	2	4,901	Escambia	4	12,012	Flagler	2	6,943
Franklin	1	3,089	Glades	1	3,748	Hillsborough	3	8,850
Indian River	2	7,309	Levy	1	3,254	Okeechobee	2	6,316
Pasco	9	32,074	Pinellas	13	48,795	Putnam	2	9,421
Sarasota	1	5,257	St. Lucie	1	1,743	Taylor	2	13,097
Volusia	12	50,721	Wakulla	1	8,301	Walton	1	7,367
State Total	**67**	**258,532**		-	-		-	-

Integrating Category 4 Storm Surge Risk with SoVI and MedVI

The pattern of risk and vulnerability for Category 4 storm surge indicates a high level of hazard vulnerability along nearly the entire western Gulf Coast in addition to most of Miami-Dade and Palm Beach Counties (Figure 24). Fourteen counties including 158 census tracts and 700,000 people exhibit high social vulnerability coupled with extreme storm surge risk from Category 4 storms (Table 37). An additional 122 tracts and more than 550,000 people are classified as living within areas of medium or high risk.

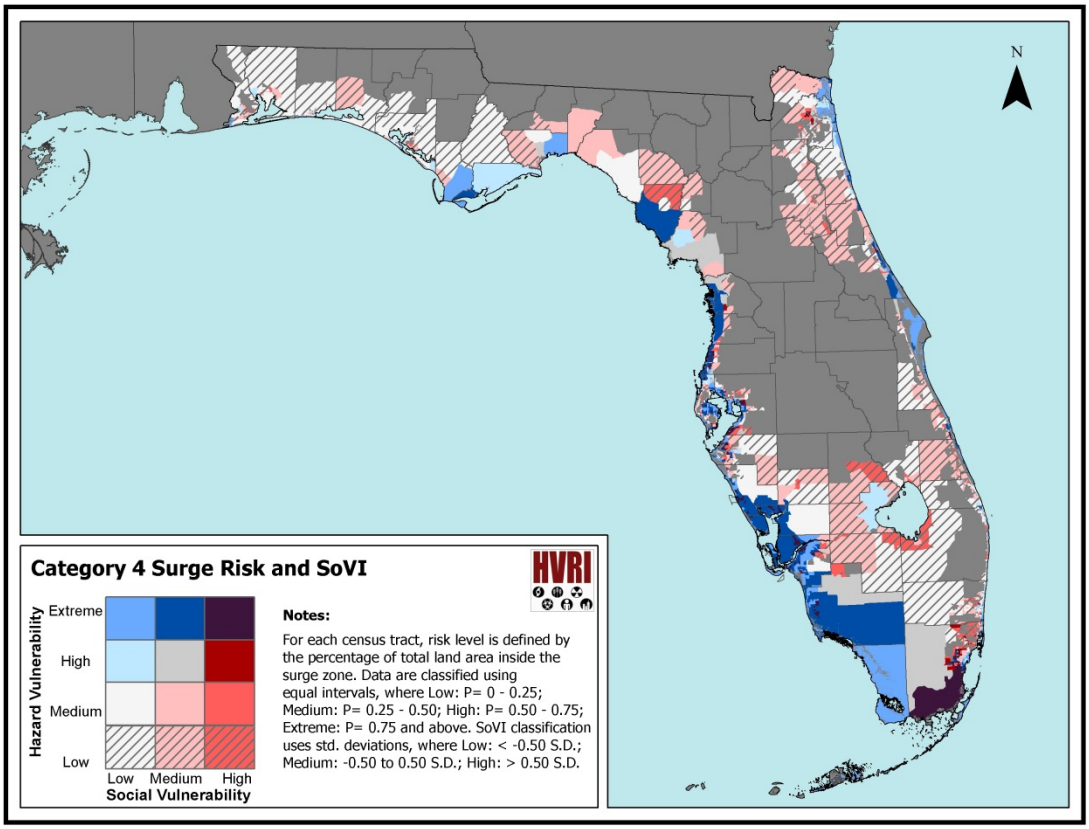

Figure 24: Bivariate representation of SoVI and Category 4 storm surge risk in Florida.

Table 37: Tract and population summary for counties with high SoVI and medium or greater Category 4 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 4 Storm Surge								
Brevard	1	3,232	Broward	1	3,098	Charlotte	5	17,905
Collier	10	52,265	Duval	3	10,464	Hillsborough	9	33,837
Indian River	3	5,566	Lee	24	76,593	Manatee	5	25,326
Miami-Dade	63	368,005	Pasco	10	30,269	Pinellas	11	39,618
Sarasota	8	25,527	Volusia	5	16,050		-	-
State Total	**158**	**707,755**		-	-		-	-
High Risk from Category 4 Storm Surge								
Broward	2	8,813	Citrus	1	6,411	Duval	6	17,392
Hillsborough	2	8,538	Manatee	1	5,071	Miami-Dade	28	150,051
Pasco	3	11,612	Pinellas	4	13,968	Sarasota	1	5,257
State Total	**48**	**227,113**		-	-		-	-
Medium Risk from Category 4 Storm Surge								
Broward	4	20,101	Collier	1	5,920	DeSoto	1	2,308
Duval	5	21,683	Hernando	1	5,779	Hillsborough	6	23,000
Indian River	1	3,750	Lee	2	9,924	Manatee	7	28,299
Martin	1	2,217	Miami-Dade	28	149,135	Okeechobee	1	2,095
Palm Beach	2	6,999	Pasco	2	6,442	Pinellas	4	13,843
Putnam	1	3,107	Santa Rosa	1	6,115	Sarasota	1	3,851
St. Lucie	2	2,668	Volusia	3	13,550		-	-
State Total	**74**	**330,786**		-	-		-	-

Nearly the entire big bend area of the state is faced with high or extreme levels of surge threat along with high MedVI (Figure 25). Here, 39% of counties exhibiting medium to extreme risk have more than 30,000 people each in tracts characterized by high medical vulnerability (Table 38). Of these, Volusia County has the most at risk and medically vulnerable population (more than 200,000 people), followed by Pasco County with more than 188,000 people in 59 tracts.

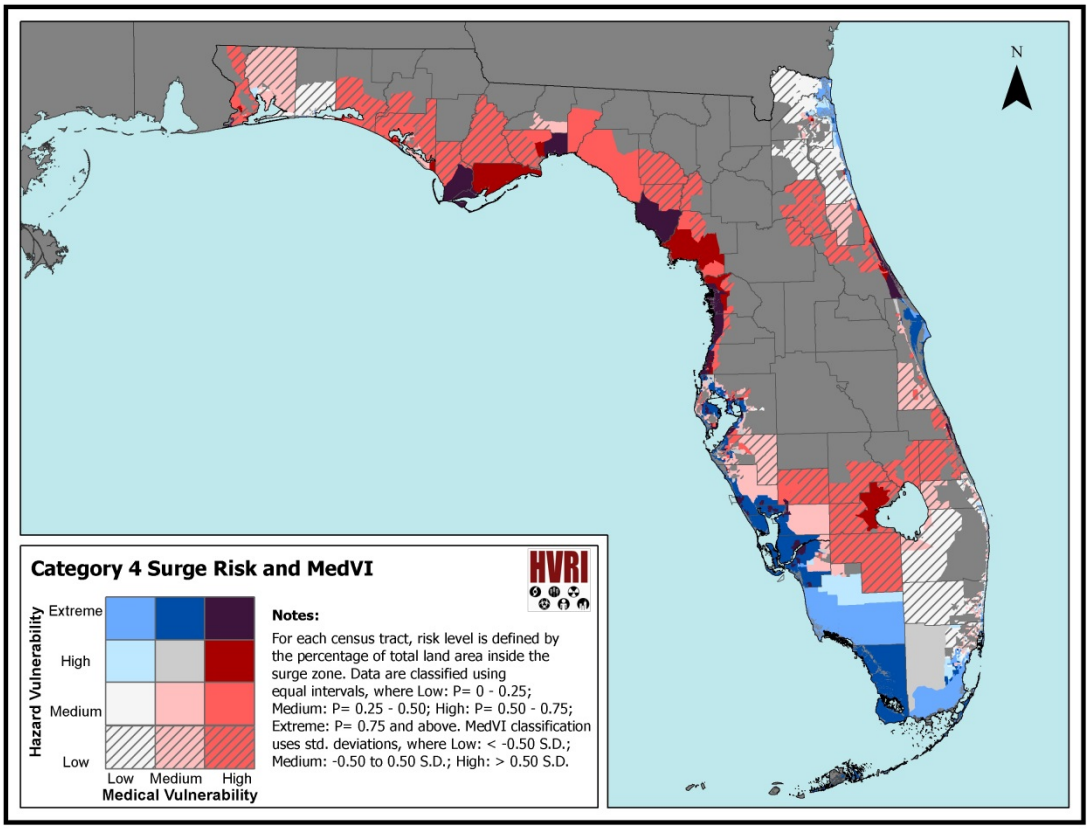

Figure 25: Bivariate representation of MedVI and Category 4 storm surge risk in Florida.

Table 38: Tract and population summary for counties with high MedVI and medium or greater Category 4 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 4 Storm Surge								
Brevard	1	3,232	Charlotte	7	32,234	Citrus	3	13,747
DeSoto	1	1,218	Dixie	1	4,101	Escambia	3	7,223
Flagler	1	2,120	Franklin	2	4,494	Gulf	1	4,450
Hernando	3	12,229	Hillsborough	14	46,778	Indian River	9	26,701
Lee	29	124,820	Manatee	2	9,435	Pasco	45	134,835
Pinellas	20	87,154	Sarasota	13	51,051	St. Lucie	4	12,304
Volusia	43	141,763	Wakulla	1	8,332		-	-
State Total	**203**	**728,221**		-	-		-	-
High Risk from Category 4 Storm Surge								
Bay	7	18,913	Citrus	5	30,171	Duval	2	4,901
Escambia	3	9,087	Flagler	1	3,217	Franklin	2	7,055
Glades	1	3,748	Hillsborough	5	10,131	Indian River	1	3,176
Levy	2	4,691	Manatee	2	7,765	Pasco	9	33,682
Pinellas	3	13,295	Sarasota	1	5,257	St. Johns	1	3,518
Volusia	5	22,092	Wakulla	1	8,301	Walton	1	7,367
State Total	**52**	**196,367**		-	-		-	-
Medium Risk from Category 4 Storm Surge								
Bay	2	12,437	Brevard	1	3,300	DeSoto	2	5,276
Duval	2	11,567	Escambia	6	28,482	Flagler	2	6,943
Hernando	1	5,779	Hillsborough	6	20,453	Indian River	1	3,750
Jefferson	1	4,380	Lee	1	3,924	Levy	2	9,465
Manatee	5	17,853	Miami-Dade	1	2,453	Okeechobee	3	8,119
Pasco	5	19,852	Pinellas	13	45,963	Putnam	2	9,421
Sarasota	1	3,408	St. Lucie	3	9,114	Taylor	3	19,137
Volusia	9	42,548	Wakulla	1	8,867	Walton	2	12,304
State Total	**75**	**314,795**		-	-		-	-

Integrating Category 5 Storm Surge Risk with SoVI and MedVI

Category 5 storm surge risk reaches far inland to many tracts with medium to high social vulnerability. Nearly all of Lee County is situated in a high or extreme Category 5 risk zone and many of these tracts exhibit high levels of social vulnerability (Figure 26). Fifteen counties containing 225 census tracts and 1.2 million people are both at extreme risk of Category 5 storm surge and characterized by high social vulnerability (Table 39). An additional 71 tracts across 18 counties containing more than 330,000 people have high surge risk coupled with high vulnerability.

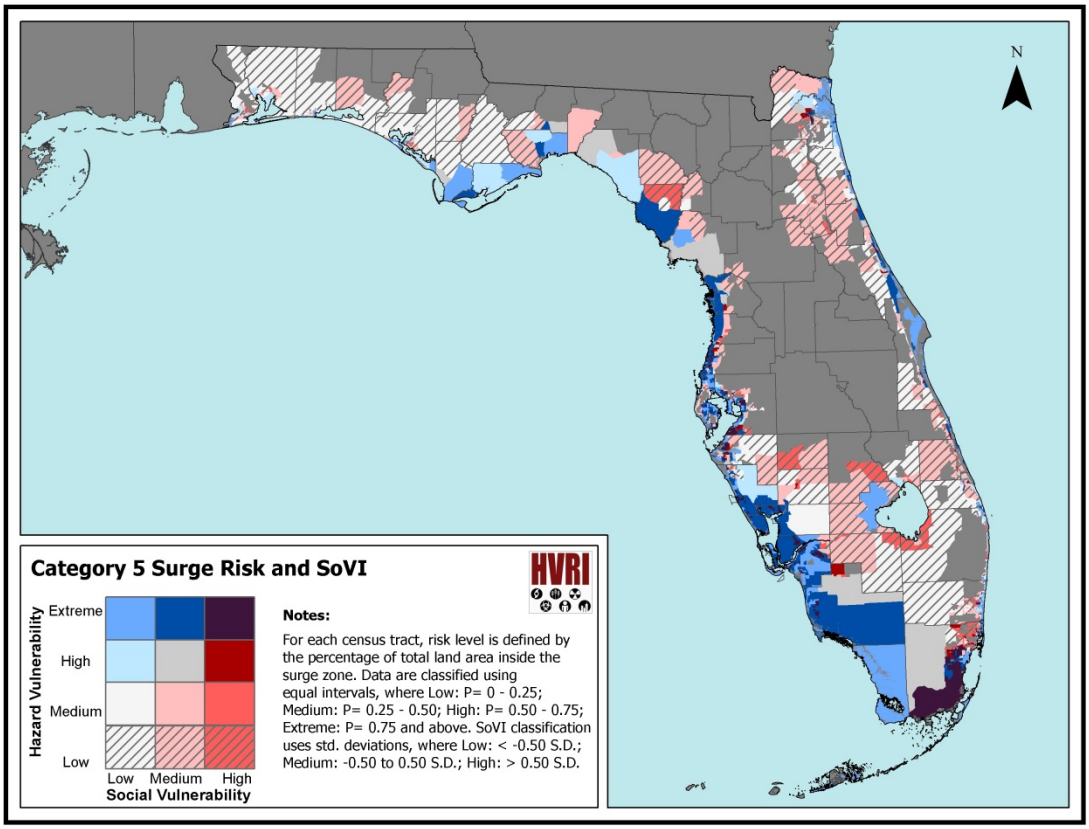

Figure 26: Bivariate representation of SoVI and Category 5 storm surge risk in Florida.

Table 39: Tract and population summary for counties with high SoVI and medium or greater Category 5 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 5 Storm Surge								
Brevard	1	3,232	Broward	5	19,173	Charlotte	5	17,905
Collier	10	52,265	Duval	10	32,654	Hernando	1	4,029
Hillsborough	13	51,770	Indian River	3	5,566	Lee	29	95,433
Manatee	11	46,876	Miami-Dade	127	710,725	Pasco	12	37,488
Pinellas	14	51,146	Sarasota	9	30,784	Volusia	5	16,050
State Total	**255**	**1,175,096**		-	-		-	-
High Risk from Category 5 Storm Surge								
Brevard	1	2,486	Broward	2	9,456	Citrus	1	6,411
Collier	2	12,289	DeSoto	1	2,308	Duval	6	30,599
Flagler	1	4,317	Hernando	1	5,779	Hillsborough	4	15,445
Manatee	4	20,659	Martin	1	2,217	Miami-Dade	36	192,194
Palm Beach	1	2,472	Pasco	3	10,835	Pinellas	3	7,682
Sarasota	1	3,851	St. Lucie	2	2,668	Volusia	1	3,963
State Total	**71**	**335,631**		-	-		-	-
Medium Risk from Category 5 Storm Surge								
Broward	6	34,035	Collier	1	4,807	Duval	2	9,247
Hernando	4	10,363	Hillsborough	6	25,918	Indian River	1	3,750
Miami-Dade	32	182,801	Okeechobee	1	2,095	Palm Beach	4	17,875
Pinellas	3	15,334	Putnam	1	3,107	Santa Rosa	1	6,115
Sarasota	1	3,043	Volusia	2	9,587		-	-
State Total	**65**	**328,077**		-	-		-	-

All of south central Florida is at risk to Category 5 storm surge – depending on the direction of the storm – and a good portion of the Lake Okeechobee area has medium to high MedVI (Figure 27) indicating that these populations will require additional medical attention before, during, and following a disaster event. In fact, more than 915,000 residents within 255 census tracts across 25 counties exhibit both high medical vulnerability and extreme Category 5 storm surge risk (Table 40). Additionally, more than 250,000 people reside in high risk surge zones and more than 260,000 live in medium risk hazard zones while exhibiting high levels of medical vulnerability.

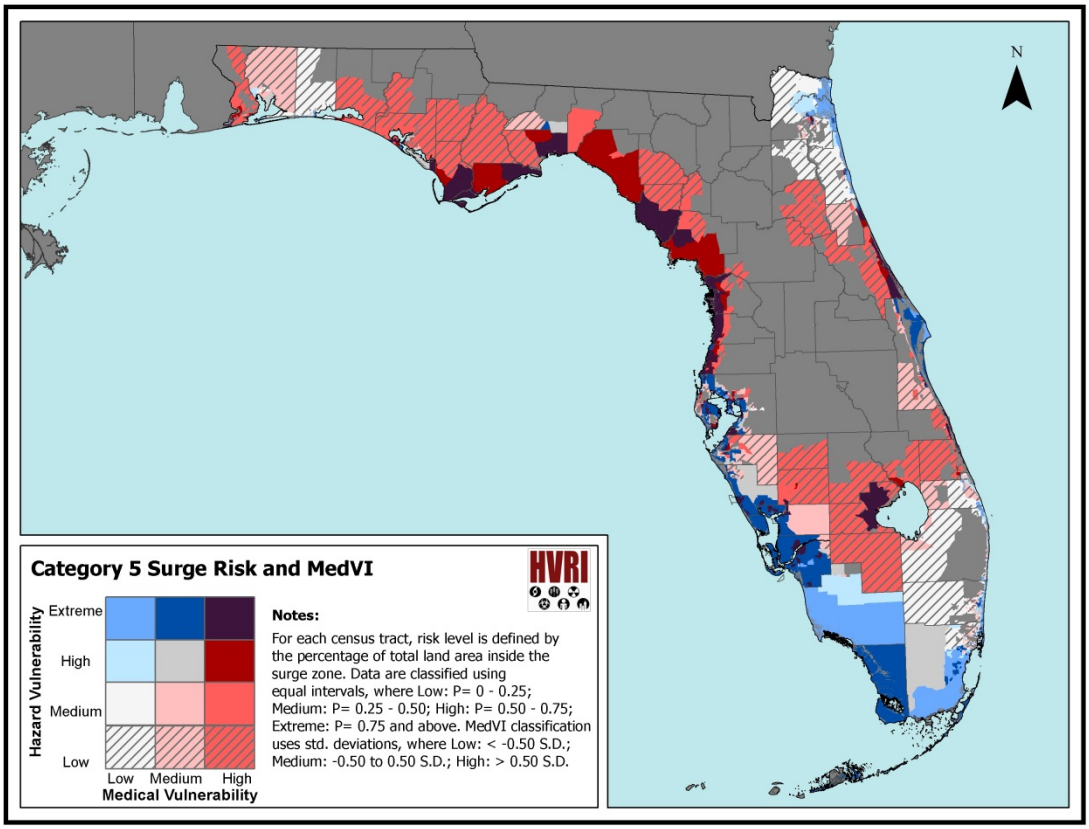

Figure 27: Bivariate representation of MedVI and Category 5 storm surge risk in Florida.

Table 40: Tract and population summary for counties with high MedVI and medium or greater Category 5 storm surge risk.

County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts	County Name	Number of Tracts	Total Population of Tracts
Extreme Risk from Category 5 Storm Surge								
Bay	7	18,913	Brevard	3	10,176	Charlotte	7	32,234
Citrus	4	20,065	DeSoto	1	1,218	Dixie	1	4,101
Duval	3	10,384	Escambia	4	12,011	Flagler	3	9,935
Franklin	3	8,460	Glades	1	3,748	Gulf	1	4,450
Hernando	4	16,258	Hillsborough	21	67,661	Indian River	10	29,877
Lee	32	136,588	Levy	1	1,402	Manatee	7	26,456
Pasco	53	166,223	Pinellas	22	96,127	Sarasota	14	56,308
St. Johns	1	3,518	St. Lucie	4	12,304	Volusia	46	151,544
Wakulla	2	16,633		-	-		-	-
State Total	**255**	**916,594**		-	-		-	-
High Risk from Category 5 Storm Surge								
Bay	2	9,034	Citrus	4	23,853	DeSoto	1	2,308
Duval	1	6,084	Escambia	5	12,569	Flagler	2	6,662
Franklin	1	3,089	Gulf	1	3,076	Hernando	3	12,328
Hillsborough	6	21,780	Levy	2	6,543	Manatee	2	10,271
Okeechobee	1	1,803	Pasco	7	26,412	Pinellas	10	35,419
Sarasota	1	3,408	St. Lucie	3	9,114	Taylor	2	13,097
Volusia	7	34,019	Wakulla	1	8,867	Walton	1	7,367
State Total	**63**	**257,103**		-	-		-	-
Medium Risk from Category 5 Storm Surge								
Bay	3	11,088	Brevard	4	19,162	DeSoto	1	2,968
Duval	3	9,123	Escambia	5	25,903	Gilchrist	1	3,040
Hernando	7	23,756	Hillsborough	7	24,517	Indian River	2	7,638
Jefferson	1	4,380	Levy	1	6,211	Manatee	1	2,848
Miami-Dade	1	2,453	Okeechobee	2	6,316	Pasco	4	17,687
Pinellas	6	24,932	Putnam	2	9,421	St. Lucie	1	4,468
Taylor	1	6,040	Volusia	7	39,785	Walton	2	12,304
State Total	**62**	**264,040**		-	-		-	-

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