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Populations Vulnerable to Climate Change in New Jersey: Update of a Statistical Analysis

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Introduction

The purpose of this paper is to characterize and locate populations vulnerable to climate change in the state of New Jersey. To do so, a quantitative study examined the demographic and location attributes of socially vulnerable groups and their relation to an environmental hazard associated with a changing climate, using flooding as an example of the potential risks posed to these groups. An earlier study with similar objectives was completed in December of 2013; the methodology that formed the basis of the original study has since been updated[1] (Bickers, 2013; NOAA, 2014; Hazards and Vulnerability Research Institute, 2013). While the updated data and method used for this revised analysis has not yielded substantially different findings, the December 2013 analyses is updated in this paper using the updated data and methodology.

Vulnerability has been described as the potential for loss (Cutter, 1996). It is often characterized by metrics of exposure, sensitivity, and the adaptive capacity of engineered and social systems to respond or recover from negative shocks or stressors (Adger, 2006). Social vulnerability specifically focuses on the vulnerability of a person or social group and the factors that contribute to this vulnerability. Such factors include age, ethnicity and race, gender, physical ability and health status, socioeconomic status, occupation, access to knowledge and information, and geographic location. These characteristics help to explain why different groups can experience the impact from a hazard event differently even when exposure levels are similar (Blaikie, et al. 2003; Cutter, 2000; Heinz Center, 2002; Morrow, 1999). These characteristics typically overlap to form heightened levels of vulnerability within a population (Cutter et al., 2009; Morrow, 2008; Shonkoff, et al. 2009 & 2011). For example, older disabled and poor people typically are more vulnerable than others. However, research also shows that this same set of demographic attributes produces some of the most prepared people who help their neighbors during a hazard event (Greenberg, 2014).

[1] The methodology developed for the Bickers 2013 study was largely based on the SoVI 2006-2010, as developed by Dr. Susan Cutter of the Hazards and Vulnerability Research Institute at the University of South Carolina, with some modifications to the SoVI method (Bickers, 2013). Since the execution of the 2013 Bickers study, changes in the demographic and socioeconomic input variables that form the basis of the Cutter SoVI Analysis were updated. For example, a variable was added that measures the percent of unoccupied housing units and a variable measuring population density was removed from the SoVI 2006-2010 methodology. In this study, none of the original variables used in 2013 study were dropped from the updated statistical analysis, but one variable measuring percent unoccupied housing units was included to reflect the updated SoVI. The SoVI method update was included in recent data released by NOAA, which provide social vulnerability indices for US coastal states, and on the Hazards and Vulnerability Research Institute SoVI 2006-2010 website.

Unlike some forms of vulnerability assessment, social vulnerability is not an exact science. This means that, although populations displaying the characteristics identified above are known to have a decreased ability to respond or recover from an adverse event, it is impossible to forecast the occurrence of intervening factors, such as the help from family members or local community members, which might influence an individual's overall response and recovery ability. In spite of these limitations, researchers have developed quantitative methods that rely on proxy measures of vulnerability characteristics to better understand the composition and location of the most likely vulnerable groups. Examples of proxy measures for low socioeconomic status could be the percentage of households that live at or below the poverty level. The proportion who identify as disabled is another proxy used to understand the spatial distribution of vulnerable groups.

One such method is the Social Vulnerability Index 2006-2010 (SoVI), which serves as the basis for this study. The SoVI relies on the use of an advanced statistical analysis technique – principal components analysis – that is able to take demographic and social input variables and form multiple variable characteristics of vulnerable groups by identifying variables that are highly correlated to each other. In order to compare these variables to each other, the data is normalized using percentages, median values, per capita values, or density functions. A total of 30 input variables were used to run the analysis for this study (see Table 1), with data culled at the census tract level from the 2010 Decennial Census and the 2006-2010 American Community Survey.

The variables included in the SoVI reflect developments in vulnerability science and therefore have gradually changed over the years. For example, a variable measuring the percentage of unoccupied housing units was included since the execution of the original Bickers' study (Hazards and Vulnerability Research Institute, 2013; NOAA, 2014). Given the quantitative nature of this approach, there are limitations in both the methodology and the data used in this study. Limitations of the method include the reliance on normalized variables, which are good at displaying concentrations but should not be confused with a measurement of absolute size. As census tracts represent populations ranging in size from 1,200-8,000 persons, the same percentage value across different census tracts can represent drastically different population sizes. It should also be noted that the variables represented in the index are weighted on indicators of socioeconomic status and race, and other factors of vulnerability, such as age, are not equally reflected in the overall measurement. Finally, the analysis represents only current vulnerability, not a forecast of future vulnerability.

Other limitations are inherent in the data. The method relies on publically available data, where data is aggregated and available only at certain geographic scales. The unit level of census tracts was used for this analysis, as finer geographic scales (i.e. block group or block level data) could not be attained across all variables. Problems can arise when aggregating data to larger data scales, particularly as it relates to social vulnerability, as pockets of high concentrations of a variable can disappear when data is aggregated to larger scales of measurement (Cooley et al., 2012). Additionally, many variables rely on estimates provided by the American Community Survey (ACS). The United States Census Bureau generates estimates for the ACS based on a survey of a sample of the population, which differs from the Decennial Census, which provides total counts. The accuracy of ACS estimates generally decreases with increasing granularity of the scale of the data used. Lastly, although health measures are included in the SoVI, two health indicators; hospitals per capita and percent of population without health insurance, were not publically available for New Jersey at the census tract level and not included in the analysis. Ideally, such a study should have actual health metrics that are exacerbated by hazard events, such as heart, kidney, and pulmonary diseases, and measures of physical mobility. However, these data are not available at small geographical scales. Finally, the distribution of data when presenting exposure comparisons is assumed to be even across a census tract. In reality, the distribution of the population could differ greatly and should not be mistaken for point values. The results of this study should be considered with an understanding of these limitations.

Characteristics of Vulnerable Populations in New Jersey

After completing the new statistical analysis, nearly 70% of the statistical variance in the demographic and socioeconomic data could be attributed to six factors, of which four were deemed to be significant. The four significant factors have been classified as follows:
1) Race (Black), Family Structure, and Low Socioeconomic Status;
2) Linguistic Isolation, Ethnicity (Hispanic), High Population Density, and Low Socioeconomic Status;
3) Age (seniors); and
6) Unoccupied Housing.

A chart displaying the results of this analysis, with percent of variance explained for each factor can be found in Table 2. Table 2 provides a list of the correlated variables within each factor, with the most dominant variables displaying high component loading scores. Individual factor scores were then generated by census tracts and mapped, with the data categorized by quintiles. These factor scores are an indication of how strong an individual census tract identifies or displays the dominant variables within a factor. The higher the score, the more the tract displays the characteristics of the factor.

The top 20% of factor scores within the first three factors and the top 10% of factor 6 were taken to display areas that most identified with the characteristics of each factor. Factors 4 and 5, as seen in Table 2, were not investigated further and were not included in the summary analysis of high social vulnerability areas. The reason for excluding Factor 4 was because the measure (very high income status) was reflected in both Factors 1 and 2. In order to not weigh the summary areas towards further issues of socioeconomic status, the factor was not included. Factor 5 was not included in the analysis because it was deemed to not significantly contribute to vulnerability and merely reflected the urban versus rural divide in the state.

The pattern of clustering within the individual factors is described in the bulleted list below and provided in Figures 1-4 (see Appendix A, page 15). Estimates of population density and total population size within these areas are given to provide an idea about the characteristics of the geographic location, but it should be noted that not all of the persons residing within these tracts or captured in these estimates are vulnerable.

- Factor 1, or tracts with populations characterized by race (black), family structure (single parent, female-headed), and low socioeconomic status were concentrated within the state's urban areas and most prevalent in Essex, Camden, and Hudson counties. These census tracts had an average population density of 12,428 persons per square mile with a total population of 1,496,760 persons. These patterns can be seen in greater detail in Figure 1.

- Factor 2, or tracts with populations characterized by linguistic isolation, ethnicity (Hispanic), high population density, and low socioeconomic status were also concentrated within the state's urban areas and most prevalent in Hudson, Essex, and Passaic counties. These census tracts had an average population density of 23,036 persons per square mile with a total population of 1,701,733 persons. These patterns can be seen in greater detail in Figure 2.

- Factor 3, or tracts with populations characterized by age (seniors), was most prevalent along the coast and portions of densely populated northern urban areas. Counties with the highest concentration of these tracts were Ocean, Bergen, and Monmouth counties. These census tracts had a total average population density of 6,123 persons per square mile and

a total population of 1,812,087 persons, which includes seniors. These patterns can be seen in greater detail in Figure 3.

- Factor 6, or tracts with high percentages of unoccupied housing, was clustered along the coast and some areas within urban centers in the north. The counties with the highest proportion of these census tracts were Hudson, Essex, Ocean, Atlantic, Cape May, and Monmouth. Average population density for these tracts was 11,750 persons per square mile with a total population of 511,808 persons. These patterns can be seen in greater detail in Figure 4.

Table 1. Final Variables

This table displays the final variables used in the principal component analysis and the resulting extraction values, which measure the communality between an individual variable to all other variables.

Variable	Communalities*
Total Population	.523
Percent Asian Population	.561
Percent Black Population	.780
Percent Hispanic or Latino Population	.832
Percent Native American Population	.526
Percent Dependent Population (under 5 and 65 and above)	.889
Percent Children Living in Married Couple Family Households	.905
Percent Children Living in Single Parent Family Households	.901
Median Age	.896
Percent of Households Receiving Social Security Benefits	.815
Percent of Households in Poverty	.760
Percent of Households with $200,000 (or above) Annual Income	.858
Per Capita Income	.863
Percent Population with Limited English Proficiency	.869
Percent Female Population	.648
Percent Female Headed Households	.874
Percent Population Living in Nursing or Skilled-Nursing Facilities	.229
Percent Population with Less than 12th Grade Education	.636
Percent Civilian Unemployment	.571
Percent Non-urban Population	.443
Population Per Square Mile	.629
People Per Unit	.750
Percent Renters	.878
Median House Value	.824
Percent Mobile Homes	.210
Percent Employment in Extractive Industries**	.610
Percent Employment in Service Industry	.615
Percent Female Participation in Labor Force	.600
Percent Housing Units with No Car	.818
Percent Unoccupied Housing Units	.562

*Communalities are measures of the variance of a single variable shared with the extracted factors. Numbers range from 0.0 to 1.0. The higher the number the more variance is part of the extracted principal components.
**Percent employment in extractive industries here represents the population employed in the agriculture, forestry, fishing and hunting, mining, and construction industries.

Note: Median Gross Rent was included in earlier iterations of the principal components analysis (PCA), but the variable was ultimately excluded from the analysis. There was no data available for this variable for a substantial number of census tracts in the state (over 100), resulting in these census tracts being dropped from the analysis entirely. In order to maintain the highest number of tracts as possible within the PCA, the variable was excluded.

Table 2. Results of the Principal Components Analysis with Factors and Percent Variance Explained

Component	Cardinality	Name	% Variance Explained	Dominant Variables	Component Loading**
1	+	Race (Black), Family Structure (Single Working Mothers), Low Socioeconomic Status	21.52	Pct. Black Population	.856
				Pct. Children Living in Single Parent Family Households	.799
				Pct. Children Living in Married Couple Family Households	-.795
				Pct. Female Headed Households	.793
				Pct. Civilian Unemployment	.729
				Pct. of Households in Poverty	.675
				Pct. Female Participation in Labor Force	.576
				Pct. Employment in Service Industry	.560
				Pct. Population with Less than 12th Grade Ed.	.556
				Pct. of Housing Units with No Car	.523
				Per Capita Income	-.520
				Pct. Renters	.460
				Median House Value	-.446
				Pct. Asian Population	-.442
2	+	Linguistically Isolated, Ethnicity (Hispanic), Renters, High Population Density, Low Socioeconomic Status	17.93	Pct. Population with Limited English Proficiency	.912
				Pct. Hispanic or Latino Population	.866
				Pct. Renters	.729
				Population Per Square Mile	.726
				Pct. Housing Units with No Car	.705
				Pct. Households in Poverty	.540
				Pct. Native American Population	.510
				Pct. Population with Less than 12th Grade Ed.	.465
				Per Capita Income	-.429
				Pct. Employment in Service Industry	.412
				Pct. Children Living in Married Couple Family Households	-.408
				Pct. Children Living in Single Parent Family Households	.400
3	+	Age (Seniors)	9.99	Pct. Dependent Population (under 5 and 65 and above)	.916
				Pct. of Households Receiving Social Security Benefits	.850
				Median Age	.735
				Pct. Female Population	.543
4	-	*Wealth (High)	7.60	Pct. of Households w/$200,000 (or above) Annual Income	.787
				Median House Value	.787
				Per Capita Income	.617
5	+	*Employment (Extractive Industries)	6.54	Pct. Employment in Extractive Industries	.712
				Pct. Non-Urban Population	.574
				Pct. Asian Population	-.538
				Pct. Female Population	-.417
6	+	*Unoccupied Housing	6.01	Pct. Unoccupied Housing Units	.687
				Total Population	-.674
				People Per Unit	-.631
Cumulative Variance Explained			**69.59**		

*Cardinality was adjusted

**These are correlations between the original variables and the created component. The higher the loading, the stronger they identify with the component. The sign of the loading (+ or -) conveys how the variable relates to the component. For example, percent black population had a loading of 0.856 with the race; family structure; and poverty component; one of the strongest. All scores of ≥ 0.4 are shown in the table.

These factors are in no way a definitive list of the possible populations vulnerable to climate change in New Jersey. However, the statistical analysis has provided an idea of the characteristics or overlapping vulnerabilities within these groups and their location throughout the state. Although factors impacting vulnerability, such as financial resources or physical ability, were discussed in the introduction and are reflected within the first three factors, it is important to highlight the potential vulnerabilities that Factor 6 raises.

Factor 6, or tracts with high concentrations of unoccupied housing denote a potential social and economic vulnerability for communities where these tracts are present. As the pattern of clustering of these tracts is most densely clustered around the coast, we assume that these are areas of high seasonal occupancy and likely second home ownership. Loss of these seasonal homes from a natural disaster can threaten the economic viability of communities that rely on seasonal tourism, as experienced by many coastal communities post Superstorm Sandy. Additionally, the incoming tourists to these areas likely have less familiarity with evacuation procedures, location of hospital or other critical facilities, or connections with the local community to rely on during or immediately following an adverse event.

To better understand the potential impact of climate change on the identified vulnerable populations in the state, a discussion of New Jersey's physical vulnerabilities related to a changing climate is included below.

New Jersey's Physical Vulnerabilities

Given the complexities of climate, it is difficult to attribute the causation of an extreme weather event to climate change (Solomon et al., 2007; O'Brien et al., 2008). For example, Floyd hit the Raritan Basin hard, Irene caused damage throughout much of the state, and Sandy also caused damage throughout the state, but especially along the coast. However, researchers studying climate change impacts and trends in New Jersey expect the State to experience rising sea levels and an increased magnitude of storm surge, increased temperatures, and a likely continuance of the trend towards increased occurrences of heavy precipitation events (Broccoli et al., 2013). Such disruptions threaten the livelihood of vulnerable populations and serve to exacerbate the daily stressors experienced by these populations (Blaikie et al., 2003).

A vulnerability analysis was conducted to identify areas with hazards expected from a changing climate, using flood risk as an illustrative example. Current flooding was examined using the Federal Emergency Management Agency's Preliminary Flood Insurance Rate Maps or P-FIRMS. FIRMS are the maps developed by the agency that provide guidance on areas subject to floodplain management regulations and the mandatory purchase of flood insurance (FEMA, 2014). The areas that fall under floodplain management regulations and mandatory flood insurance requirements are referred to as the Special Flood Hazard Area (SFHA). The SFHA is also known as the 1-percent annual chance flood, base flood elevation, or the 100-year flood zone. This area is the area that would be inundated by a flood event that has a 1 percent chance of being equaled or exceeded within any given year. Lying outside of the SFHA, but included within the National Flood Insurance Program data is the 500-year flood zone, or areas with a 0.2% annual chance of being inundated by flood (FEMA, 2014b).

This data was examined to better understand the intersection of flooding risk and areas of high social vulnerability. The following section illustrates the spatial distribution of social vulnerability in the State and the intersection of these areas with the environmental hazard of flooding.

Geography of Vulnerable Populations in New Jersey

To better understand areas of high social vulnerability, the top 20% of factor scores within the first three factors and the top 10% of Factor 6 were taken and summed by census tract for the entire State. A 10% cutoff was used for number 6 because of the distribution of the scores by census tract were extremely skewed, that is, only about 10% of the census tracts identified with this factor. Census tracts were given either a one or a zero value depending on if it fell within the appropriate range for each factor. The method used for determining areas of high social vulnerability was: 1) if the census tract fell within the above range of the vulnerability factors and 2) if the census tract displayed 2 or more of the vulnerability factors.

The results of these analyses are included below and captured in Tables 3 and 4 and in Figure 5. These results depict the concentration of the vulnerability factors across the State. Figure 5 displays the spatial distribution of the data represented in Table 3. From this analysis, 15% of all census tracts in the State were classified as areas of high social vulnerability. These areas are collectively located in urban areas, the rural south and in coastal areas that are frequently impacted by storm events.

Table 3 displays the range of social vulnerability (with a maximum score of four) that could be attributed to each census tract, from no data to two or more vulnerability factors. The table summarizes the number of census tracts in the State that fall within each category. For example, starting in the first column, zero vulnerability factors are expressed in 940 or 46.8 percent of census tracts. A total of 35.7 percent of all census tracts have at least one vulnerability factor. The last column in the chart provides the cumulative number of census tracts that fall within each category and all categories that precede it.

Table 3. Census Tracts with High Social Vulnerability in New Jersey

Census Tracts with High Social Vulnerability*			
Number of Vulnerability Factors	Number of Census Tracts	Percentage of Census Tracts	Cumulative Number of Census Tracts
No Data**	44	2.2	44
0	940	46.8	984
1	717	35.7	1701
2 or more	309	15.4	2010

*High vulnerability is expressed by census tracts that fall within the top 20% of the vulnerability factors: 1) Race (Black), Family Structure (Single Working Mothers), Low Socioeconomic Status; 2) Linguistically Isolated, Ethnicity (Hispanic), High Population Density, Low Socioeconomic Status; 3) Age (seniors); or the top 10% of vulnerability factor 6) Unoccupied Housing.

**If a tract had no data for any one of the four vulnerability factors measured, the entire tract was excluded from the analysis. This does not imply that these tracts are not vulnerable, only that they lack sufficient data for this assessment.

Table 4 displays the concentration of social vulnerability factors by county. The table summarizes the number of census tracts that display two or more vulnerability factors by county and provides the percentage that these census tracts represent within each county. For example, Hudson County has 55 census tracts that display two or more vulnerability factors, which represents 33 percent of all of the census tracts within Hudson County. Finally, the chart provides the total number of census tracts that display two factors (309) and the percentage that these tracts represent within all tracts in the State (15%).

Table 4. Summary of High Social Vulnerability within New Jersey Counties

County Summary of High Social Vulnerability*			
County	Census Tracts with 2 or more Vulnerability Factors	Total Census Tracts in County	Percent Highly Vulnerable Census Tracts in County
Atlantic	20	70	29%
Bergen	14	179	8%
Burlington	6	114	5%
Camden	15	127	12%
Cape May	18	33	55%
Cumberland	8	35	23%
Essex	54	210	26%
Gloucester	3	63	5%
Hudson	55	166	33%
Hunterdon	0	26	0%
Mercer	10	77	13%
Middlesex	12	175	7%
Monmouth	17	144	12%
Morris	4	100	4%
Ocean	22	126	17%
Passaic	26	100	26%
Salem	4	25	16%
Somerset	0	68	0%
Sussex	1	41	2%
Union	19	108	18%
Warren	1	23	4%
Total Census Tracts in New Jersey	**309**	**2010**	**15%**

*High vulnerability is expressed by census tracts that fall within the top 20% of the vulnerability factors: 1) Race (Black), Family Structure (Single Working Mothers), Low Socioeconomic Status; 2) Linguistically Isolated, Ethnicity (Hispanic), High Population Density, Low Socioeconomic Status; 3) Age (Seniors); or the top 10% of vulnerability factor 6) Unoccupied Housing.

The following section takes a look at the intersection of social vulnerability and flood hazard data and provides estimates on population size and density within the impacted census tracts. These numbers should not be taken at face value, given that not everyone within a census tract is

necessarily a vulnerable population or would be in the census tract at the time of a flooding event. A census tract was determined to be within the flood hazard layer if the tract boundaries touched the hazard boundary. Census tracts were not evaluated to determine the proportion of the area or population impacted by a flood hazard. This means that all population totals provided in this analysis include the entire tract, regardless of whether the entire tract was exposed to a hazard. Data used in these analyses reflects the best available data. FEMA P-FIRM data was not available for the following counties at the time of this analysis: Hunterdon, Morris, Sussex, Union, and Warren, and therefore not included in the analysis. Only the southern portion of Burlington County was available at the time of this analysis and is excluded from the estimates below.

FEMA P-FIRM DATA: 100 and 500 year floodplains

Out of the total number of high social vulnerability census tracts in the State for which floodplain data was available (278), 69 percent or 193 lie within FEMA's designated 100-year floodplain or the 1% annual chance flood event. This is a striking finding that shows that a disproportionate amount of the most socially vulnerable tracts are in the flood hazard areas. These census tracts represent a total population size of 677,771 persons and an average population density of 9,574 persons per square mile. When adding the 500-year floodplain or the 0.2% annual chance flood event, 74% of high social vulnerability census tracts are impacted or 206 total tracts. These census tracts represent a total population of 724,156 persons with an average population density of 9,596 persons per square mile. Table 5 and Figure 6 provide insight into how these census tracts are distributed across the State by county. Counties with the highest percentage of vulnerable tracts within the floodplain were located in densely populated urban areas, particularly Hudson, Essex and Passaic Counties; and along the coast, such as Ocean and Atlantic Counties.

Discussion

This study offers a snapshot of the type of compounding vulnerabilities prevalent in the populations at risk to flood hazards in the State. In this context, flood hazards have been the cause of nearly all the presidential declarations in New Jersey (Greenberg 2014). The message from this statistical analysis is quite straightforward. A disproportionate share of the most socially vulnerable residents of New Jersey live along the urban corridor, along the coast and in certain rural areas, and notably these are also areas vulnerable to flooding. The analysis offers insight into where resources might be best focused in order to protect the most vulnerable of citizens. For example, in the form of identifying areas in need of further assessment to better examine the specific vulnerability characteristics prevalent within a county or local municipality.

Statistical analyses can only take risk managers part of the way toward making important choices. Practitioners or interested stakeholders have critical insights that must be considered about a specific characteristic of a population or the vulnerabilities present within a local community. Additionally, the knowledge of local practitioners and decision makers working in emergency management and hazard mitigation should be included.

Although there is a vast amount of publicly available data and online mapping tools, resources are needed to help build local capacity to interpret maps and create plans to address local vulnerabilities. Local level vulnerability and risk assessments are most effective when conducted with more refined data (i.e. smaller geographic scales) and local knowledge to develop recommendations for mitigating adverse impacts to vulnerable populations. This can take place in the form of municipal or county-wide Hazard Mitigation Plans, evacuation plans, local capacity building initiatives for planning and response such as efforts to identify and address vulnerabilities using the Getting to Resilience self-assessment tool[2], development of coastal resilience plans as supported by the state Coastal Management Office[3], or long-range comprehensive plans.

[2] http://www.prepareyourcommunitynj.org/
[3] http://www.state.nj.us/dep/cmp/czm_hazards.html

Communities need support to assess their hazard profiles, including identification of vulnerable populations, so that strategies to address identified vulnerabilities can be incorporated into local planning documents. This statistical work and its earlier version[4] provide insights as to high priority areas and can serve as a launching point for follow-up research and collaborations.

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[4] The overall results of the statistical analyses conducted in the two studies are similar. However, the updated analysis provides insight on a social vulnerability not captured in the earlier study, specifically, areas with high percentages of unoccupied housing.

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Table 5. Summary of High Social Vulnerability Census Tracts within the 100 & 500-yr Floodplains

Summary of High Social Vulnerability Census Tracts within the 100 & 500-yr Floodplains				
County	Number of High Vulnerability Census Tracts in floodplains	Pct. of High Vulnerability Census Tracts in floodplains[5]	Total Population	Avg. Population Density
Atlantic	20	7%	49,454	6,839
Bergen	7	3%	30,878	13,333
Burlington (only southern portion)	Incomplete Data	Incomplete Data	Incomplete Data	Incomplete Data
Camden	14	5%	50,868	7,067
Cape May	18	6%	46,981	2,014
Cumberland	7	3%	33,482	6,002
Essex	26	9%	88,586	16,943
Gloucester	3	1%	12,038	2,884
Hudson	32	12%	112,383	34,190
Hunterdon	No Data	No Data	No Data	No Data
Mercer	8	3%	23,590	7,353
Middlesex	9	3%	43,693	9,513
Monmouth	16	6%	55,898	6,089
Morris	No Data	No Data	No Data	No Data
Ocean	22	8%	76,039	2,064
Passaic	20	7%	92,374	17,699
Salem	4	1%	7,892	2,351
Somerset	0	0%	-	-
Sussex	No Data	No Data	No Data	No Data
Union	No Data	No Data	No Data	No Data
Warren	No Data	No Data	No Data	No Data
Totals	**206**	**74%**	**724,156**	**9,596**

[5] These values are calculated using the total number of high social vulnerability census tracts for which floodplain data were available at the time of these analyses (n=278); as noted, floodplain data were not available for several counties and thus those census tracts were eliminated from the calculation of the percentage of high vulnerability census tracts in the floodplain.

APPENDIX A

Figure 1. Socially Vulnerable Groups in New Jersey: Factor 1

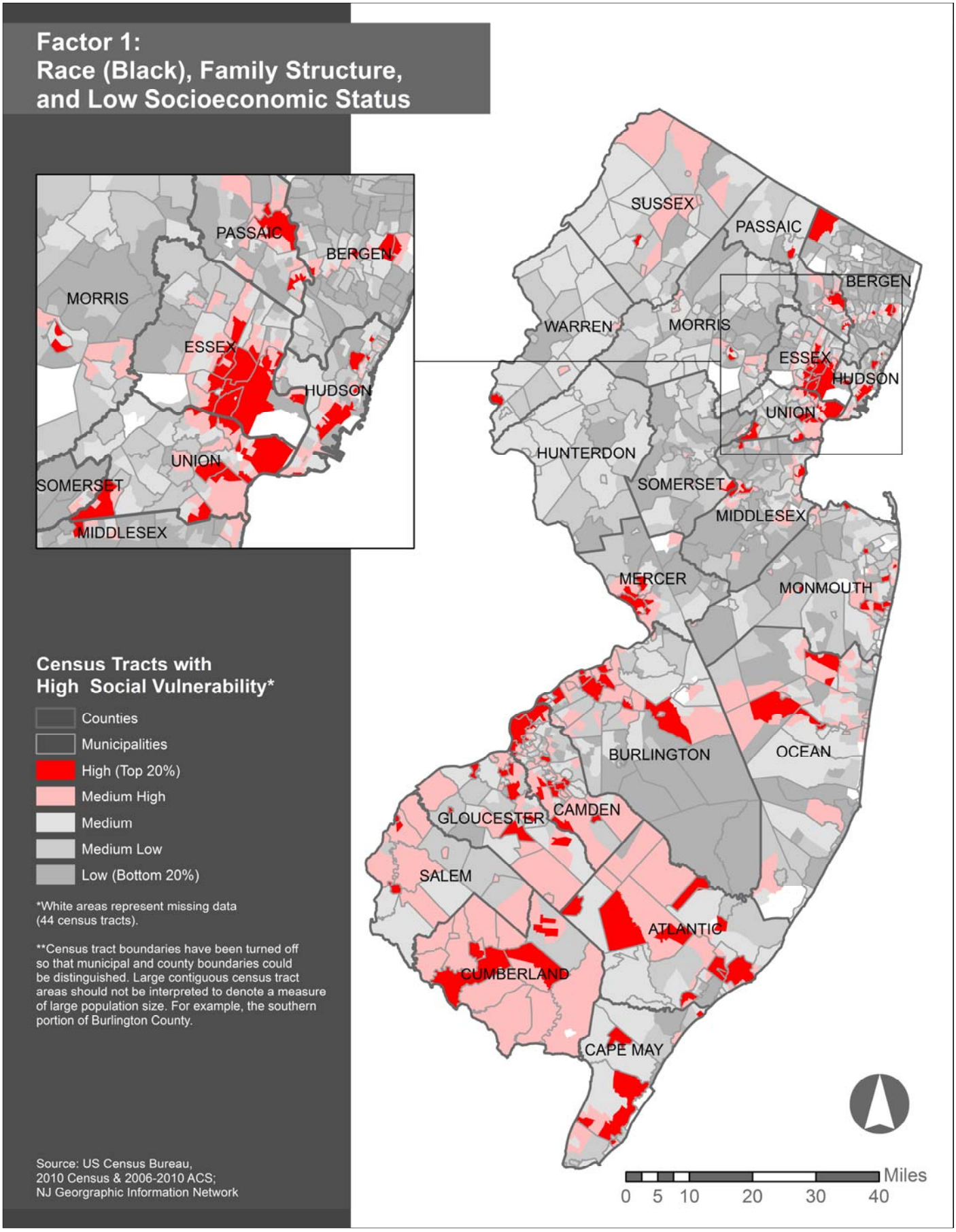


Figure 2. Socially Vulnerable Groups in New Jersey: Factor 2

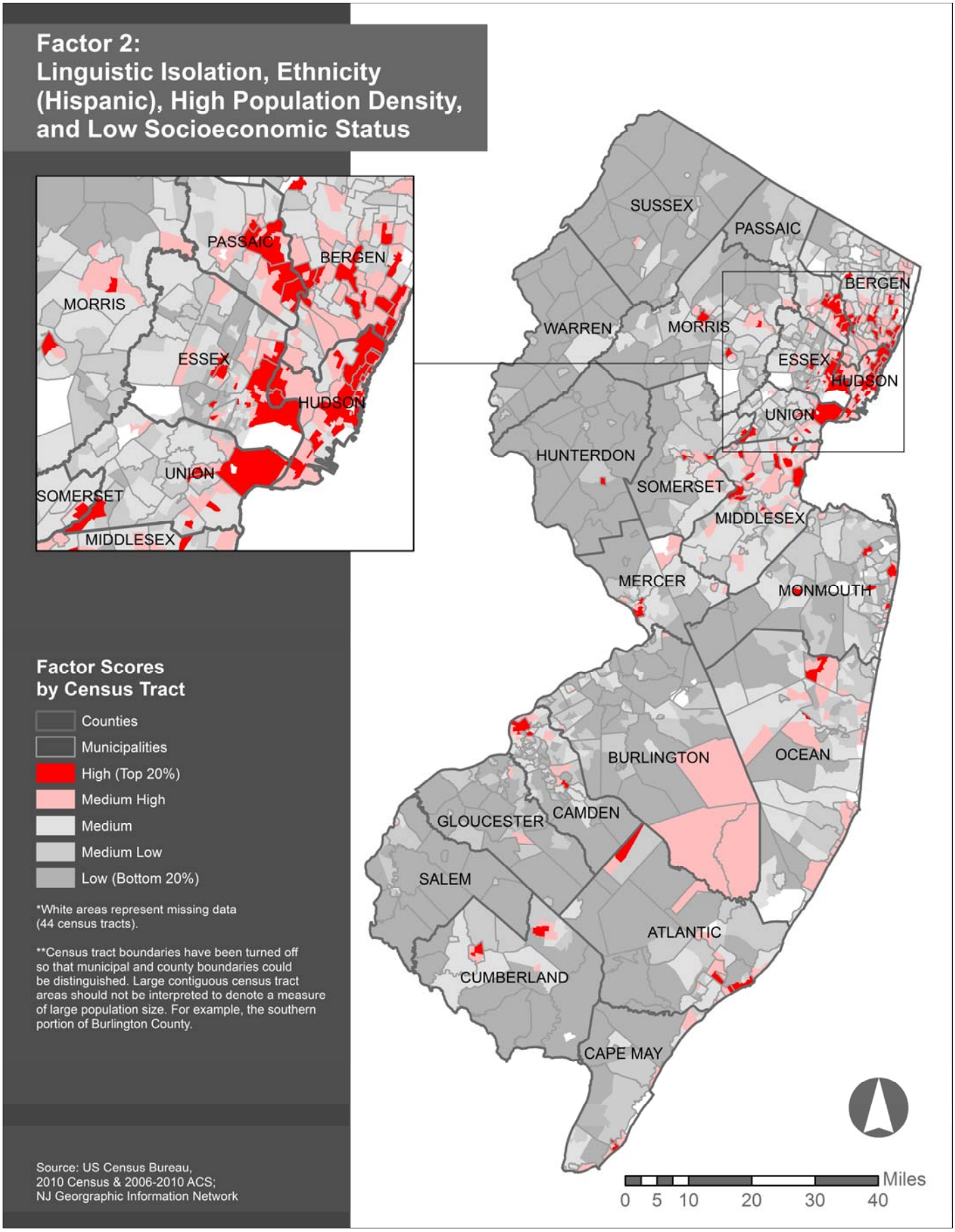


Figure 3. Socially Vulnerable Groups in New Jersey: Factor 3

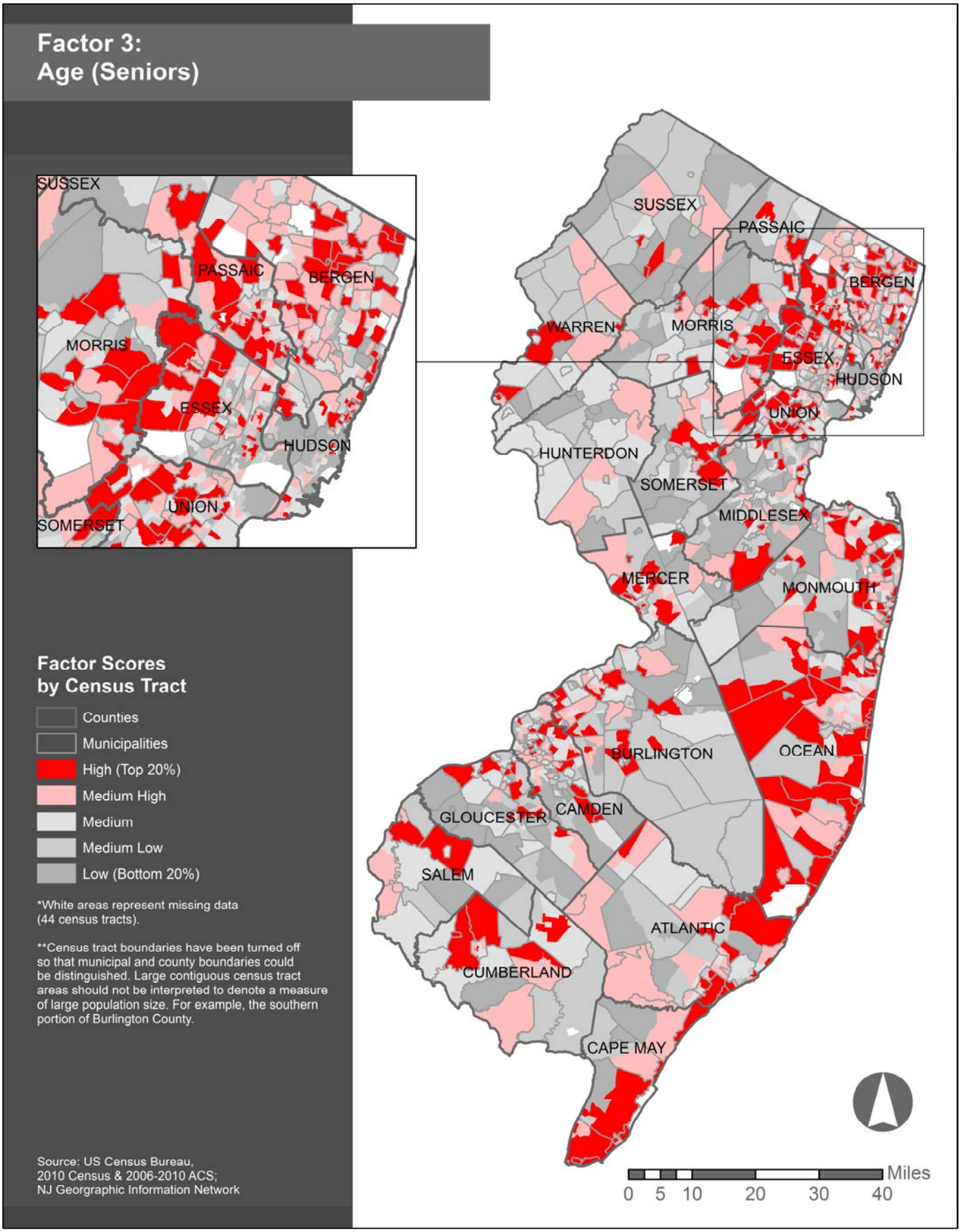


Figure 4. Socially Vulnerable Groups in New Jersey: Factor 6

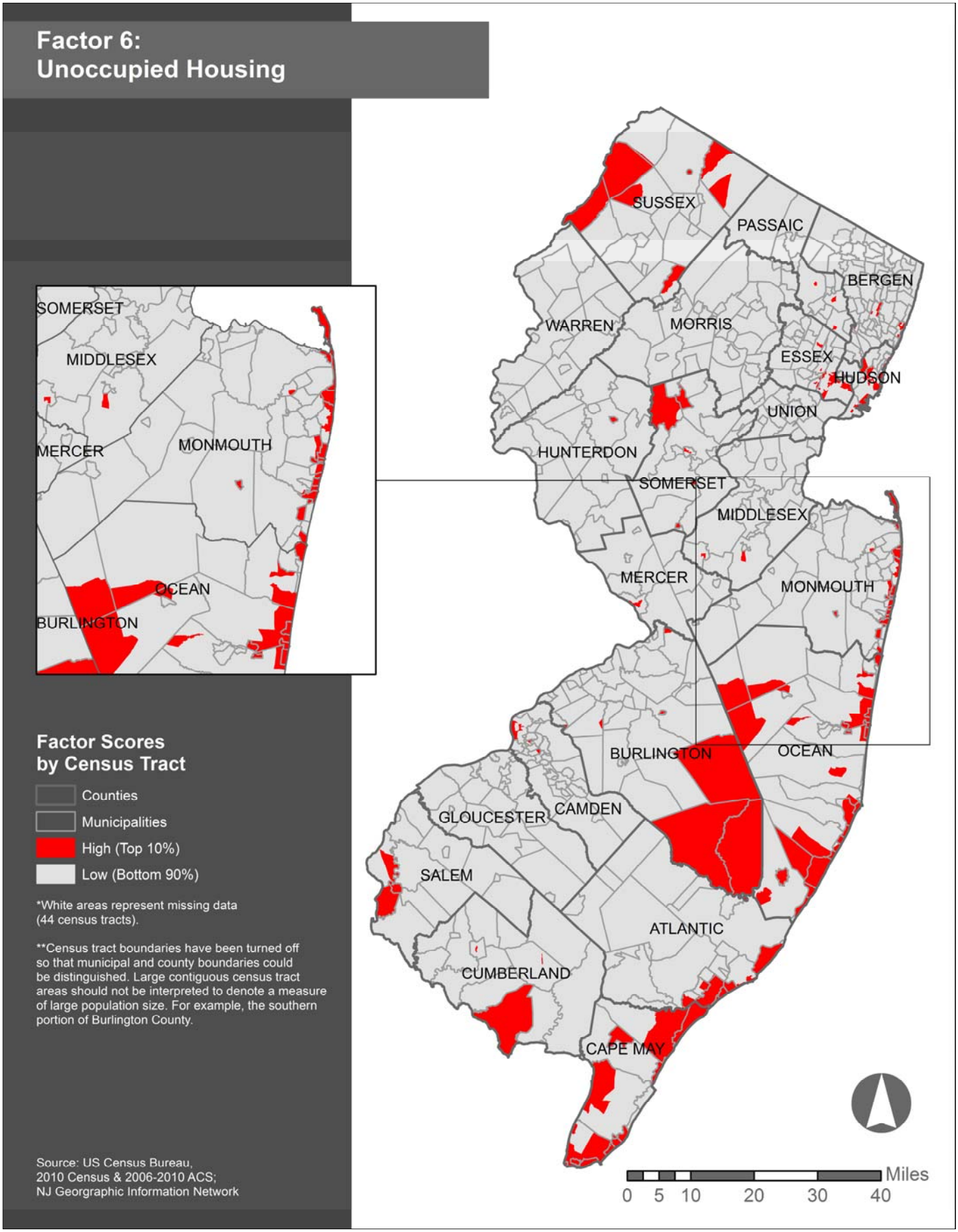


Figure 5. Summary of High Social Vulnerability Areas in New Jersey

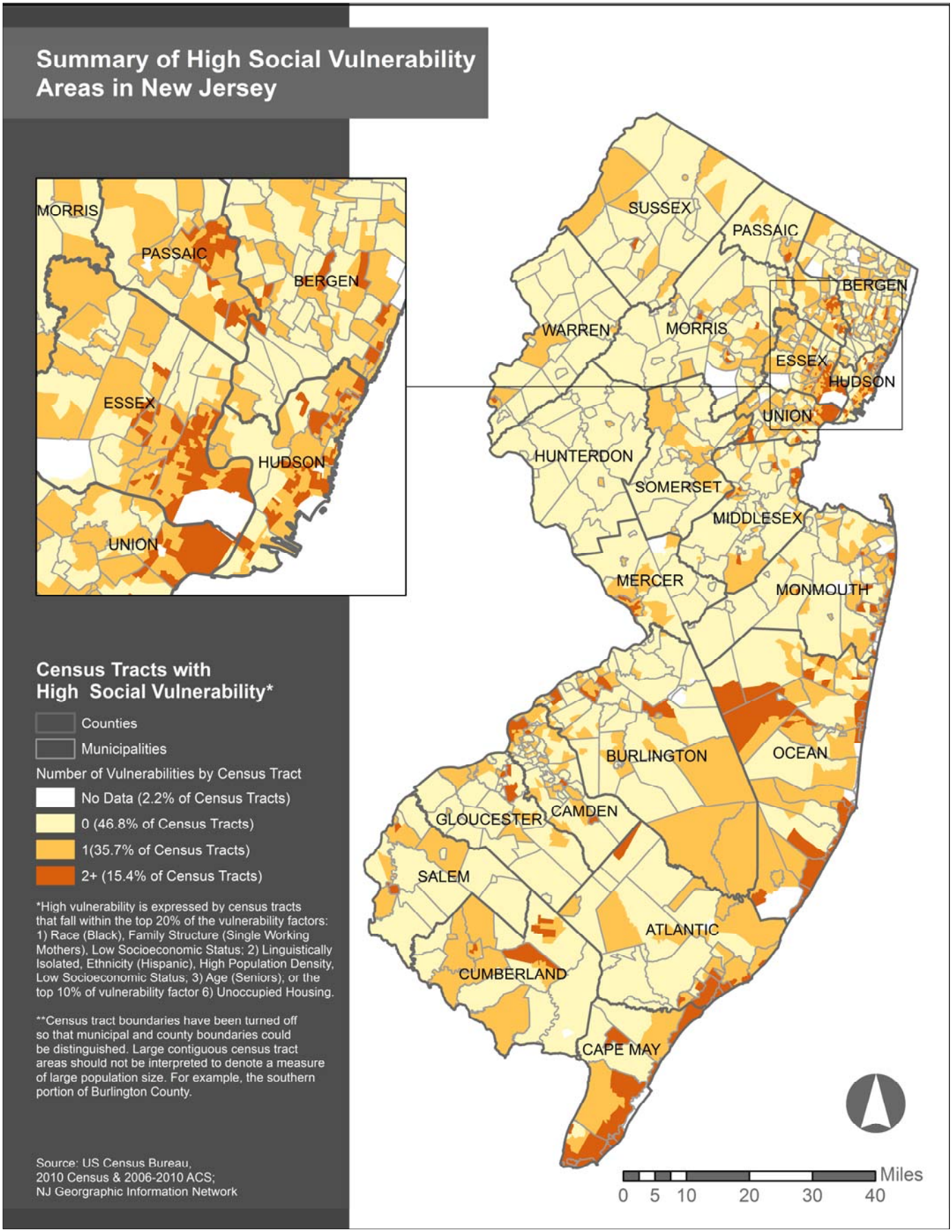


Figure 6. Areas of High Social Vulnerability and Flood-prone Lands

