Coastal Flood Risk and Climate Change Implications for New Jersey's Senior Citizens

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Introduction

Climate change has led to an overall increase in global temperatures, resulting in sea level rise, and an increase in the risk of natural disasters such as coastal flooding. Certain populations are more vulnerable to hazard exposures than others. Socially vulnerable populations are limited by issues of mobility, health, and socioeconomic resources in preparing, responding and recovering in the event of a major disaster. Therefore, even with the same natural hazard exposure, socially vulnerable populations are potentially at higher risk than others. As New Jersey continues to assess its risk from climate change in the wake of Hurricane Sandy, an analysis of the hazards faced by socially vulnerable populations can shed further light on needed state mitigation and evacuation policies. To this end, this report seeks to identify the risks faced by the elderly population in New Jersey with a focus on present day risks associated with coastal flooding and storm surges, impacts that are expected to increase as the climate continues to warm.

Socially vulnerable populations are defined by a number of characteristics. Most researchers agree that "age, gender, race, English proficiency and socioeconomic status" are among the major factors associated with social vulnerability (Blaike, et. al, 1994 and Peacock, et. al, 1997 as cited in Cutter, et.al, 2003). It is not within the scope of this paper to assess the risks of each of these socially vulnerable populations in the event of a disaster (for

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further research on other populations' risk see Eisenman, et. al, 2007; Fothergill, et. al, 1999; Ghafoori, 2012; Laditka, et. al, 2010; Maantay, et. al, 2009; Spence, et. al, 2011; Greenberg 2014). This report focuses specifically on seniors in New Jersey as a socially vulnerable population, and considers their social factors and their exposure to natural hazards that may place them at high risk for flooding and storm surges.

Vulnerabilities of Senior Citizens

The three major characteristics that identify seniors, defined in this report as people over 65 years old, as socially vulnerable are 1) Limited mobility 2) Compromised physical and mental health and 3) Sometimes reduced resources, including income and assistance (CDC, 2006; Cutter, et. al, 2003; Flanagan, et. al, 2011; HelpAge, 2000; Ngo, 2001; Wells, 2005). In terms of limited mobility, seniors who are physically impaired may require the use of elevators, which may be inaccessible during a power outage or difficult to navigate in a flood. They may be geographically isolated or living alone, making it challenging to identify their location, especially if communication lines are down and they cannot physically leave their home. They may require the assistance of caregivers or others in their social safety net that may be unable to reach them in a time of crisis. Even if they are able to leave their residence, they may not have cars or access to public transit. Additionally, they may be less likely to handle traveling long distances by foot to access food, alternative shelter, or medical services.

In terms of mental and physical health, the elderly may have medical conditions that require immediate and continued attention that could be temporarily unavailable at critical facilities, such as hospitals and emergency centers. Their exposure to extreme temperatures, stress, or prolonged lack of food and water may severely affect pre-existing health conditions and rapidly deteriorate their health. Seniors may have more difficulty hearing or seeing, and could have problems following evacuation instructions or seeking appropriate help. They can also face severe psychological trauma if their homes and livelihoods have been destroyed, and returning to a state of normalcy may be harder for this specific population.

In terms of reduced income, seniors may be dependent on limited financial assistance and lack the necessary resources to repair their homes or relocate. They may have been unable to or unaware of the need to purchase flood insurance or back-up emergency supplies for disaster mitigation. Seniors may not be able to afford to cook their own meals, and may be dependent on social services or charities for food, which may become unavailable during a disaster. Furthermore, they may not be able to afford new medical expenses incurred by damages from the catastrophe.

The above considerations are certainly not an exhaustive list of the potential social vulnerabilities of seniors. Certain issues may pose more problems depending upon individual circumstances and geographic location. In the case of New Jersey, a disproportionate number of seniors live in counties subject to storm surges and floods (Greenberg, 2014, 136). An overview of New Jersey's natural hazards exposure reveals a more acute risk that seniors face in a flood or storm surge.

New Jersey's Physical Vulnerabilities

In 2013, The Rutgers Climate Institute released its inaugural *State of the Climate Report* for New Jersey which highlights information related to temperature, precipitation and sea level rise for New Jersey.   The report (Broccoli et al., 2013) explains that increases in the amount of precipitation falling as heavy events have been noted throughout the Northeastern United States and there is reason to expect this trend will continue.   In addition, sea levels in New Jersey are rising faster than the global average, with a projected sea level rise of 7 to 16 inches by 2030, and nearly 13 to 28 inches by 2050; thus, the impact of future storms is likely to be more severe because of rising sea levels (Broccoli et. al, 2013). This means that seniors living in and near coastal communities may be subject to more intense floods and storm surges.

New Jersey's exposure to natural hazards can be accessed from a variety of publicly available data and tools. FEMA identifies current flood risk by issuing Flood Insurance Rate Maps or FIRMs. FIRMs designate Special Flood Hazard Areas or SFHAs, which are based on the 100-year floodplain or "an area that will be inundated by the flood

event having a 1-percent chance of being equaled or exceeded in any given year" (FEMA, Flood Zones). FIRMs also list an area's Base Flood Elevation Levels or BFEs, which is the height above sea-level that floodwater is expected to rise during a 100-year flooding event (NYC Special Initiative for Rebuilding and Resiliency). Other data that is used to evaluate flood risk include SLOSH MOMs[1] and projected sea level rise based on local NOAA tide stations[2]. Since flood risk is analyzed by overlaying a variety of data sources, (natural features, land elevation levels, storm surge and sea level inundation patterns, etc.) the same assessed areas may be designated with slightly differing levels of flood risk depending upon the scale and the data used in the study. Therefore, when interpreting flood risk levels, it is important to understand the combination of indicators that are used to assign a particular level of risk.

Geography of Senior Citizens in New Jersey

When interpreting population data, analysis should include both population density and absolute numbers, as only including one dataset may obscure an area's assessment of risk (Greenberg, 2014). For example, Table 1.1 shows that Cape May County has the highest proportion of seniors (23.7%); however, Table 1.2 (which lists senior population by absolute numbers), shows Cape May County as the 16th county (out of 21) for highest total number of seniors (with 22,735 seniors). In comparison, Bergen County has the highest total number of seniors (146,432), over 13 times more than the number of seniors in Salem County (county with the lowest number of seniors). Cape May, Ocean, Salem, and Bergen Counties have the highest proportion of seniors in New Jersey. In addition, Bergen, Ocean, Middlesex, and Essex Counties have the highest number of seniors in New Jersey.

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[1] "The SLOSH (Sea, Lake and Overland Surges from Hurricanes) model is a computerized numerical model developed by the National Weather Service to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes." "MOMs (Maximum of the Maximum) provides a worst cast snapshot for a particular storm category under "perfect" storm conditions." (Lathrop, Bognar, Buenaventura, Rovito, & Trimble, 2014,)
[2] NOAA, Sea Level Trends, Retrieved from http://tidesandcurrents.noaa.gov/sltrends/sltrends.html

Table 1.1 Senior Population By Percentage in New Jersey 2013, by County		Table 1.2 Senior Population By Absolute Number in New Jersey 2013, by County	
	% of Seniors		Number of Seniors
New Jersey, State	14.4	New Jersey, State	1,284,407
Atlantic	15.4	Atlantic	42,376
Bergen	**15.8**	**Bergen**	**146,132**
Burlington	15.2	Burlington	68,422
Camden	13.9	Camden	71,200
Cape May	**23.7**	Cape May	22,735
Cumberland	13.3	Cumberland	20,856
Essex	12.3	**Essex**	**96,739**
Gloucester	13.7	Gloucester	39,747
Hudson	10.7	Hudson	70,404
Hunterdon	15.2	Hunterdon	19,167
Mercer	13.5	Mercer	49,964
Middlesex	13.2	**Middlesex**	**109,072**
Monmouth	15.2	Monmouth	95,489
Morris	15.2	Morris	75,996
Ocean	**21.8**	**Ocean**	**126,946**
Passaic	12.9	Passaic	65,242
Salem	**16.1**	Salem	10,517
Somerset	13.7	Somerset	45,165
Sussex	14.1	Sussex	20,625
Union	12.9	Union	70,890
Warren	15.6	Warren	16,723

Source: U.S. Census Bureau, 2013 American Community Survey

Natural Hazards Exposure of Senior Citizens in New Jersey

The New Jersey Coastal Flood Exposure (CFE) Assessment report (2014) compiled by the Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA) at Rutgers University analyzes coastal flooding risk in New Jersey by identifying an area's hazards, exposures, and vulnerability. Risk assessment criteria included potential exposure to coastal hazards (i.e. areas with frequent flooding), Special Flood Hazard Areas (which includes data from the 100-year flood plain), BFEs (Base Flood Elevations), SLOSH MOMs projections, and shallow coastal flooding data. Present day or "current" as it will be called in the rest of this report, represented a baseline from the year 2000 to present day. Additional data were created using the same criteria as the current layer but included synthesized sea level rise information as a way to develop data projections into 2050 and 2100 (Lathrop et al., 2014). To address acute risk to seniors from coastal flooding, this report focuses on present day conditions and thus does not include projected sea level rise values from the CFE. Data was not available for some New Jersey counties because the county may be considered inland or was not in an area affected by the criteria used to create the coastal flood exposure data. Results for this comprehensive analysis found that with respect to coastal areas, much of New Jersey's Atlantic barrier islands/back bay, Cape May, Delaware Bayshore, Raritan/Newark Bay and Hackensack Meadowlands communities are exposed to moderate to high levels of flood exposure [risk]. In addition, there are approximately 38,000 acres exposed to coastal flooding (Extreme, High and Moderate categories combined) in the tidally-influenced portions of the Delaware River basin in Gloucester, Camden, and Burlington Counties. (Lathrop et al., 2014).

Overlaying the Rutgers Coastal Flood Exposure Assessment outcomes for current conditions with the population distribution of seniors in New Jersey portrays the risk seniors face as their population density is heavily concentrated along the northeastern coast close to the area of flood exposure, as seen in Figure 1.1. More specifically, Table 1.3 and the map in Figure 1.1 overlay New Jersey's senior population with current conditions under the Rutgers Coastal Flood Exposure Assessment. Likewise, Table 1.3 provides a county level summary of the proximity of senior citizen populations to areas that are currently expected to be

exposed to greater levels of flooding. Results from this analysis show that Atlantic, Burlington, Cape May, Monmouth and Salem Counties all had proportion of senior population values of fifty percent or greater within areas of high coastal flooding exposure.

Figure 1.1 2010 Population Density for Persons Over 65

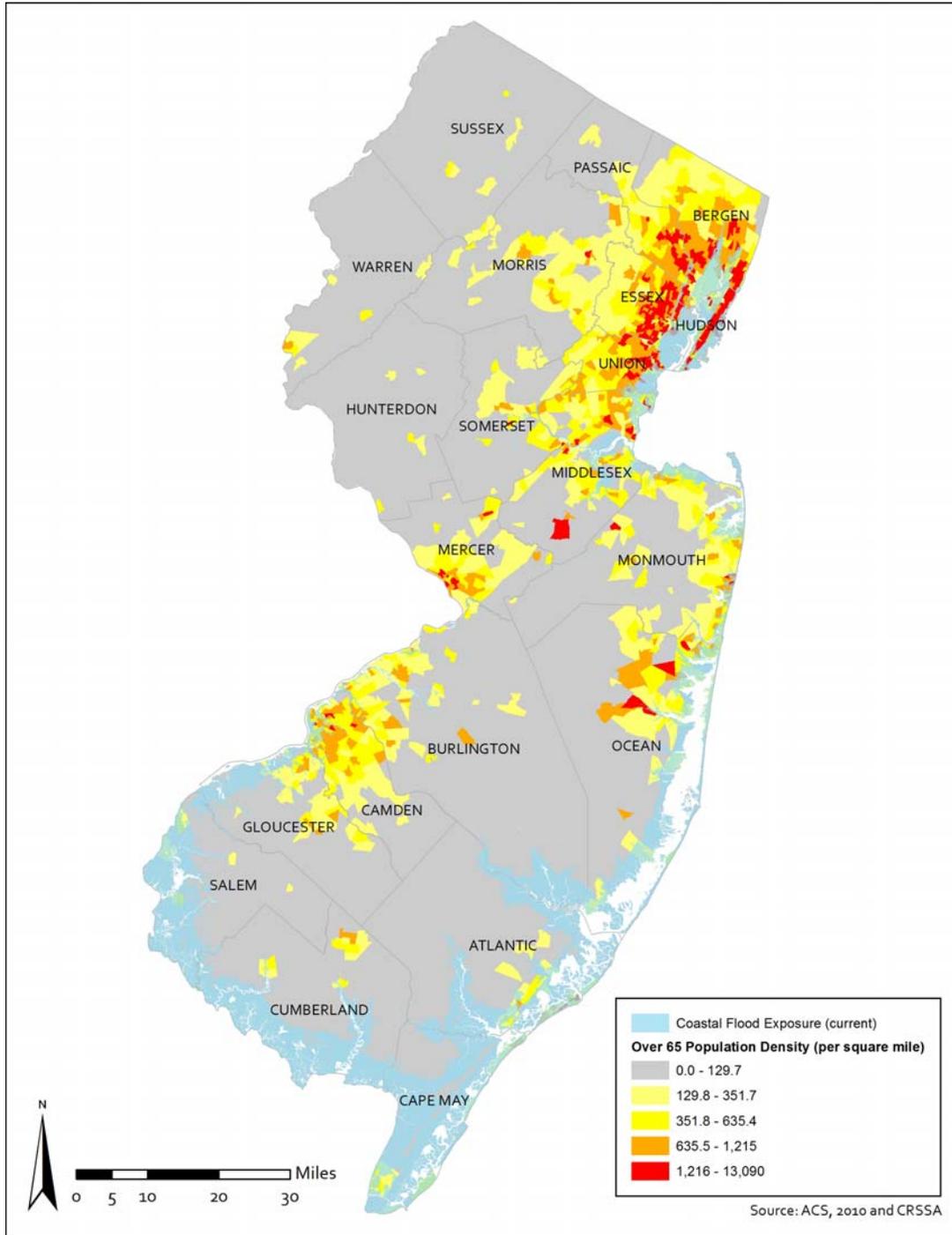**By U.S. Census Tract with Current Coastal Flood Exposure Hazard Data**

Table 1.3 Population over 65 within Coastal Flood Exposure (Current) Area		
County	**Total Population Over 65** (Based on 2010 Census, and 2006-2010 ACS 5 year summary)	**Percent of County Population** (Population over 65) within CFE (Current)
Atlantic County	38,902	74% (28,910)
Bergen County	137,103	26% (36,151)
Burlington County	62,377	50% (31,228)
Camden County	65,725	32% (20,832)
Cape May County	20,977	99% (20,920)
Cumberland County	19,875	45% (8,952)
Essex County	90,287	8% (7,199)
Gloucester County	35,699	40% (14,303)
Hudson County	66,066	46% (30,181)
Middlesex County	99,462	29% (29,131)
Monmouth County	86,721	51% (43,980)
Ocean County	121,104	49% (59,435)
Salem County	9,917	82% (8,143)
Somerset County	40,002	24% (9,404)
Union County	67,761	22% (14,724)

Source: Data provided by CRSSA, March 2015.

*Data unavailable for Hunterdon, Mercer, Morris, Passaic, Sussex, and Warren County[3]

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[3] Data unavailable for some NJ counties because the county may be considered inland or was not in an area affected by the criteria used to create the coastal flood exposure data.

Table 1.4 Critical Care Facilities[4] within Coastal Flood Exposure (Current) Area		
County	**Nursing Homes within CFE (Current)**	**Hospitals within CFE (Current)**
Atlantic County	2	**4**
Bergen County	2	0
Burlington County	0	0
Camden County	0	0
Cape May County	7	1
Cumberland County	0	0
Essex County	0	1
Gloucester County	0	0
Hudson County	2	5
Middlesex County	0	0
Monmouth County	4	2
Ocean County	2	0
Salem County	4	0
Somerset County	1	0
Union County	2	0

Source: Data retrieved from the New Jersey Geographic Information Network (NJGIN, 2014)

*Data unavailable for Hunterdon, Mercer, Morris, Passaic, Sussex, and Warren County[5]

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[4] Critical Care Facilities data taken from the New Jersey Geographic Information Network HSIP hospital and nursing home data available at https://njgin.state.nj.us/NJ_NJGINExplorer/DataDownloads.jsp.

[5] Data unavailable for some NJ counties because the county may be considered inland or was not in an area affected by the criteria used to create the coastal flood exposure data.

Natural Hazards Exposure of Critical Care Facilities in New Jersey

The distribution of critical care facilities used by seniors, specifically hospitals and nursing homes, are portrayed in Figure 1.2[6] and 1.3. Out of the 147 hospitals in New Jersey, 13 are located within the coastal flood exposure (current) area. Similarly, out of the 548 nursing homes in New Jersey, 26 are located within the coastal flood exposure (current) area. Notable counties that contain a large number of critical care facilities within the area of potential flood risk include: Atlantic (with 4 hospitals), Cape May (with 7 nursing facilities), Hudson (with 5 hospitals), Monmouth and Salem Counties (with 4 nursing facilities each). A more detailed breakdown of hospitals and nursing homes located within the coastal flood hazard (current) area is shown in Table 1.4. Bickers' study found that "nearly all New Jersey counties, with the exception of Burlington and Mercer counties, have high concentrations of nursing home populations and/or nursing home facilities that lie either directly in or in close proximity to flood prone lands" (Bickers, 14). Furthermore, although hospitals built in New Jersey since the late 1970s to mid-80s must adhere to locally-adopted floodplain management regulations and the state building codes that account for 1-percent-annual-chance flood events, older facilities built before individual communities began regulating flood hazard areas may not have had the same flood proofing and mitigation standards, (FEMA, 2013a), which may put them at greater risk.

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[6] Overlapping hospital locations may not be visible on the map due to the spatial resolution.

Figure 1.2 Location of Hospitals within the Coastal Flood Exposure (Current) Area
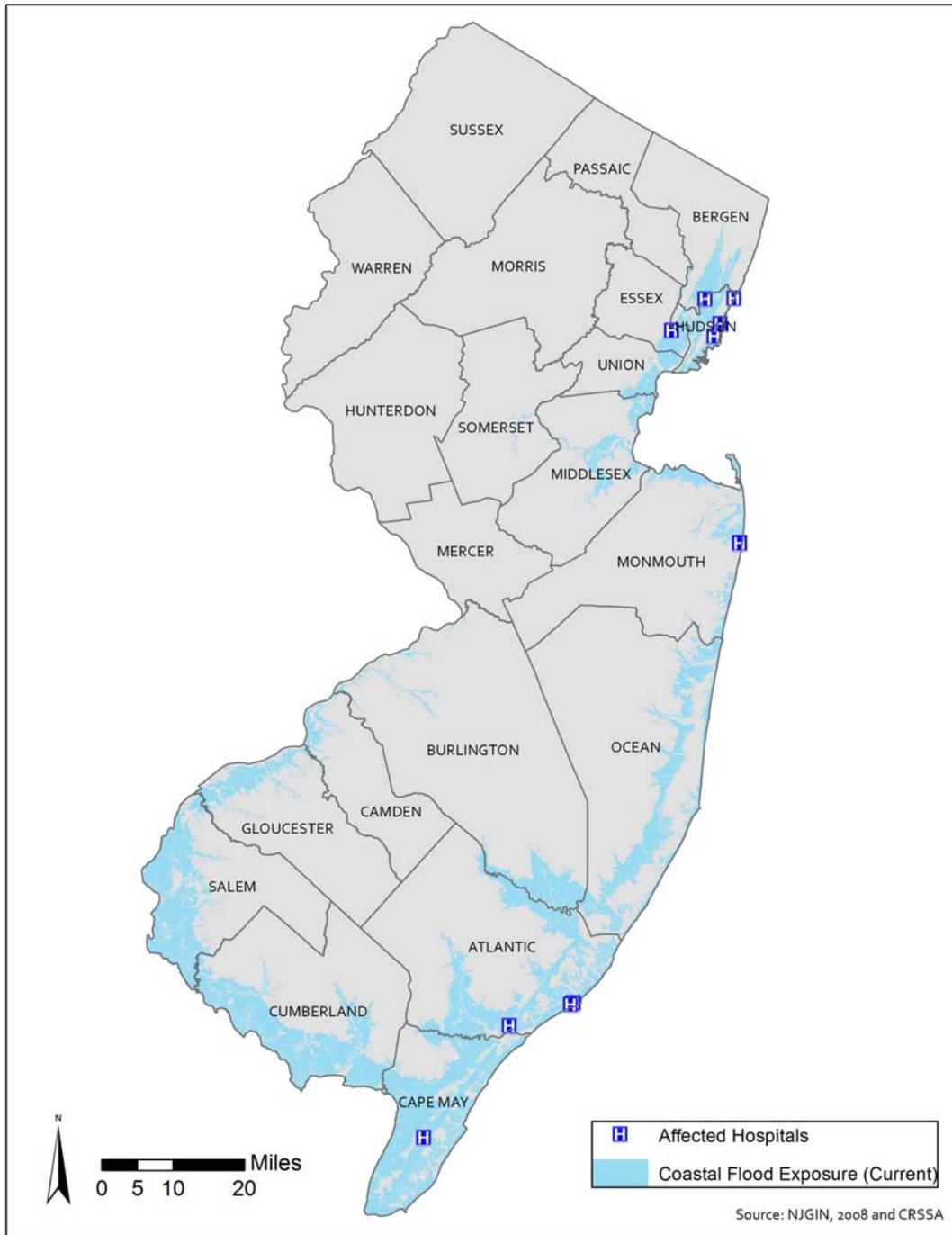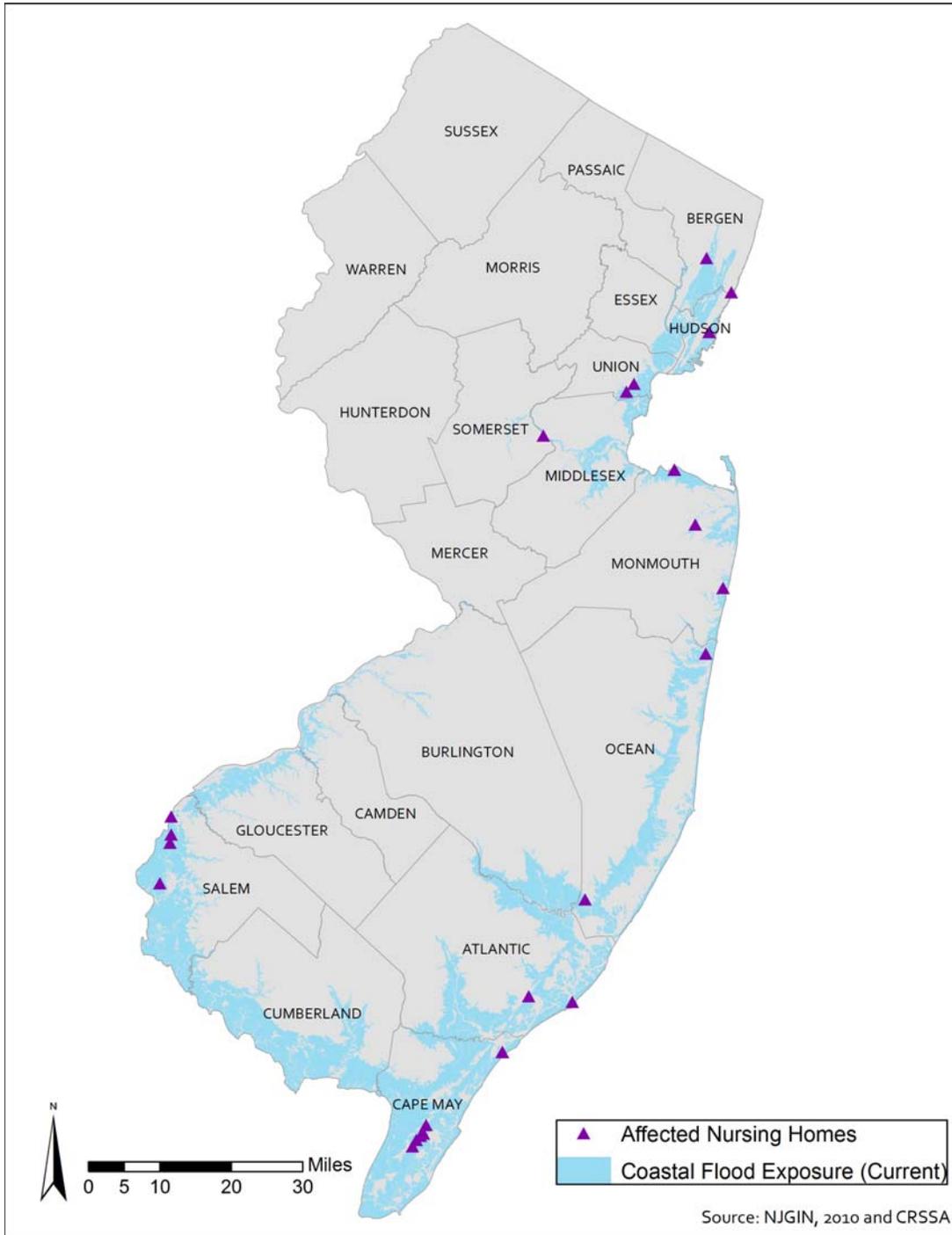
Figure 1.3 Location of Nursing Homes within the Coastal Flood Exposure (Current) Area

Summary

New Jersey is located in a hurricane hazard area and vulnerable to an increase in coastal and inland flooding as a result of climate change. Socially vulnerable populations are disproportionately more vulnerable at all stages of a catastrophic event (Flanagan, et.al, 2011) with the excess mortality rate of seniors in natural disasters at 10 times that of younger populations (Greenberg, 2014). Seniors who live in Atlantic, Burlington, Cape May, Salem, and Monmouth Counties have a higher potential impact from risks associated with coastal flooding and storm surges than other counties in New Jersey. Critical care facilities within these counties are also potentially vulnerable to the same risks from flooding.

Communities can take active steps towards developing resiliency and recovery plans for their socially vulnerable populations. FEMA (2014b) recommends that communities use flood-hazard maps (FIRMS) to determine their most recent flood insurance requirements and understand the risks of flooding in their community. In terms of resiliency plans for hospitals and nursing homes, FEMA (2014b) has issued recommendations for critical care facilities "to be located outside all high-risk flood areas, including Zones V and A." In terms of individual preparedness, the AARP (2014) recommends that seniors prepare for natural disasters by establishing their support network, gathering emergency contact information of people in their social safety net, and preparing an emergency kit with back-up medicines and medical supplies as necessary. There is currently a wealth of resources available to the public to plan and prepare for flooding and other natural disasters. By taking proactive steps, communities can help develop effective resiliency and recovery plans for their senior population.

Discussion

An issue facing New Jersey is to determine what are appropriate and effective risk management responses to the vulnerabilities described above? Drawing from Greenberg (2014), we suggest five:

1. Evacuation planning and sheltering has improved in New Jersey. One large gap that continues to need addressing is post-event recovery for displaced seniors, many of

whom remain displaced and are suffering from mental and physical health symptoms. Second, while evacuation planning has demonstratively improved, there are clusters of seniors who will choose to not evacuate or cannot readily be evacuated under certain conditions. Selected areas of the state need plans for sheltering in place.

2. The medical care system was heavily stressed by Sandy. It needs systematic assessment with regard to electrical power and backup systems and capacity to move people between facilities, as a start.

3. Seniors must not be cut off from caregivers. As much as some may resist communication devices, they must be persuaded to be more receptive to use of such devices so that their physicians, pharmacists, and caregivers are able to access them before, during and after hazard events.

4. Considerable attention has been given to the limitations of the ability of current infrastructure in the United States, including New Jersey, to effectively and consistently provide the operational support needed during hazard events. Critical infrastructure such as electrical power, water, sewer, and communications is even more critical for dependent seniors than for the population as a whole. Systematic and ongoing efforts are needed to prioritize critical infrastructure needs, especially those that on which vulnerable populations depend.

5. Clearly, senior citizens are at much higher risk than other populations during natural hazard events. A rational risk management approach to minimizing risk is to restrict permitting new facilities that cater to seniors in highly vulnerable locations, and to require upgrades of those that currently exist, especially if they have plans to expand.

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