Impacts of Sea Level Rise and Storm Surges on Emergency Management and Evacuation Route for Cape May County, NJ

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Introduction

Recently much attention has been paid to the issue of global warming and the effects this trend may have on everyday life. Global warming is expected to contribute to an increase in mean sea level rise significantly over the next 100 years. The International Panel on Climate Change estimates that over the next century mean sea level will rise between 0.6m (1.96850394ft) and 1.2m (3.93700787ft). Cape May County is the southern most county in the state of New Jersey. It is also a coastal area making it susceptible to flooding from storm events.

Permanent residential population of Cape May County is approximately 106,000. However, this dramatically increases during the warmer months where population exceeds 700,000. Regardless of time of year, it is imperative that the population be educated as to how to respond in the event of a dangerous storm. Further, predicting land and human infrastructure inundation due to a storm event combined with estimates for sea level rise over the next 100 years is a critical component for the decision makers responsible for writing the emergency management plan, evacuation route, and coordinating public outreach programs.

Background

The Cape May County web page did provide a starting point for understanding the emergency management plan and evacuation route. However, a trip to the county municipal building and a meeting with the folks at the Office of Geographic Information Systems revealed how the evacuation route was defined. The meeting revealed that the evacuation route was made up of all major roads, e.g. all county roads, state and U.S. highways. In Cape May County the state and U.S. highways consisted of U.S. Route 9 and the Garden State Parkway.

Further research into the low and high sea level rise estimates revealed a need to examine mean sea level on an annual basis. In their paper, *Maps of Lands Close to Sea Level along the Middle Atlantic Coast of the United States: An Elevation Data Set to Use While Waiting for LIDAR*, Titus et al point out that it may be advantageous to also consider that the highest sea level occurs in the spring season where sea level rises as high as 2.4 feet above the annual average sea level for the rest of the year (see Figure 1). Therefore, both low and high estimates for sea level rise would need to be mapped from NAVD88 (0) as well as from spring high water (2.4 feet above sea level).

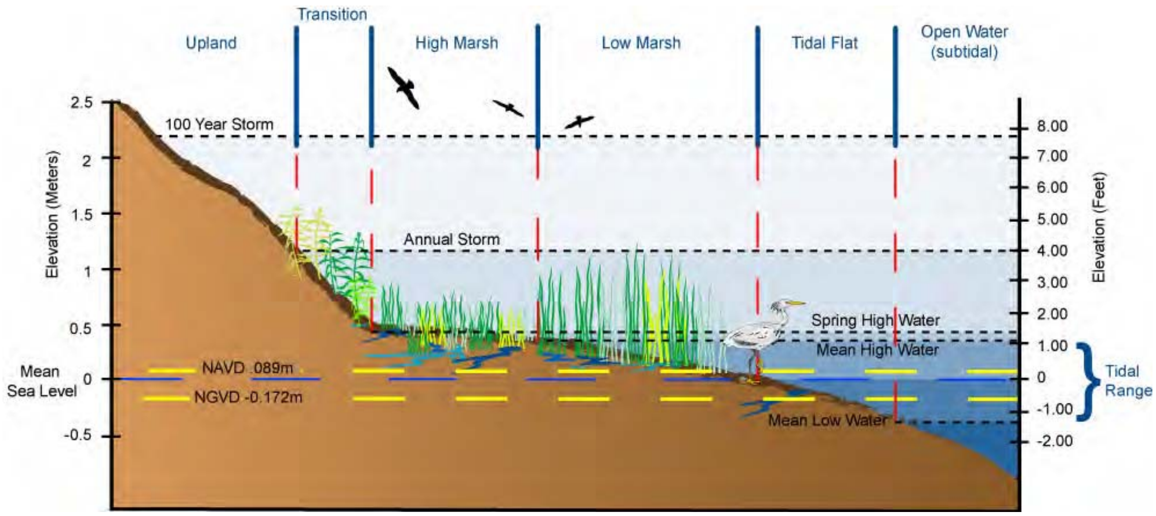


Figure 1

Objectives

Currently, the evacuation route for Cape May County is consisting of county roads and state highways (U.S. Route 9, and Garden State Parkway). Creation of both a spatial data subset of all county roads and state highways within Cape May County and the various sea level rise estimates and storm surge events will allow for identification and quantification of what roadways will be effected and under what scenarios inundation will occur as well as quantification of total length of inundation. This geospatial analysis will allow planners, and other decision makers of Cape May County to make more well informed decisions with respect to emergency management and preparedness in the event of a storm and with ongoing predicted sea level rise.

With population growing at an increasing rate it is becoming ever more important for government agencies to be able to make precision and informed decisions on how to deal with an ever changing environment. From this viewpoint our analysis aims to show how geographic information systems (GIS) can be a powerful tool to enhance place-based decision making for human infrastructure on the county, state, and federal governing level.

Methods

The NJ roadway network spatial dataset obtain from the NJ Department of Transportation (NJDOT) was clipped by Cape May County to produce a dataset of only those roads within Cape May County. From this dataset a selection of only county roads, state and U.S. highways including all associated ramps was then used to create the evacuation route feature class within the evacuation route geodatabse.

All of the sea level rise scenarios: from both NAVD88 (0) and spring high water (2.4 feet): low SLR, high SLR, low SLR + 30yr storm surge, low SLR + 100yr storm surge, and high SLR + 100yr storm surge were converted to vector. Once each scenario was converted to vector the spatial select tool was used to select all segments of road from the evacuation route feature class to create separate feature classes for evacuation route road segments inundated by each scenario. Each inundated road segment feature within each inundated road segment feature class was then quantified for length and then total length of inundation by each scenario was calculated.

Results

As predicted, the greatest number of road segments and the longest total lengths of inundation occurred under the high estimates for sea level rise combined with the 100 year storm surge. Further, those scenarios which were modeled from NAVD88 (0) inundated less roads and shorter total lengths than scenarios modeled from spring high water (2.4 feet above sea level). See Table 1, Figures 2 and 3 for complete results.

Table 1

Vertical Baseline Datum	Scenario	Number of Road Segments Inundated	Length of Inundation (feet)
NGVD88 (0)	Low SLR	26	28373.04486
NGVD88 (0)	High SLR	35	54543.18123
NGVD88 (0)	Low SLR 30yr SS	96	639759.0699
NGVD88 (0)	Low SLR 100yr SS	105	776770.8565
NGVD88 (0)	High SLR 100yr SS	115	942616.1068
Spring High Water (2.4 ft)	Low SLR	39	75412.98173
Spring High Water (2.4 ft)	High SLR	56	251618.9924
Spring High Water (2.4 ft)	Low SLR 30yr SS	109	843392.6253
Spring High Water (2.4 ft)	Low SLR 100yr SS	117	977145.784
Spring High Water (2.4 ft)	High SLR 100yr SS	128	1143070.491

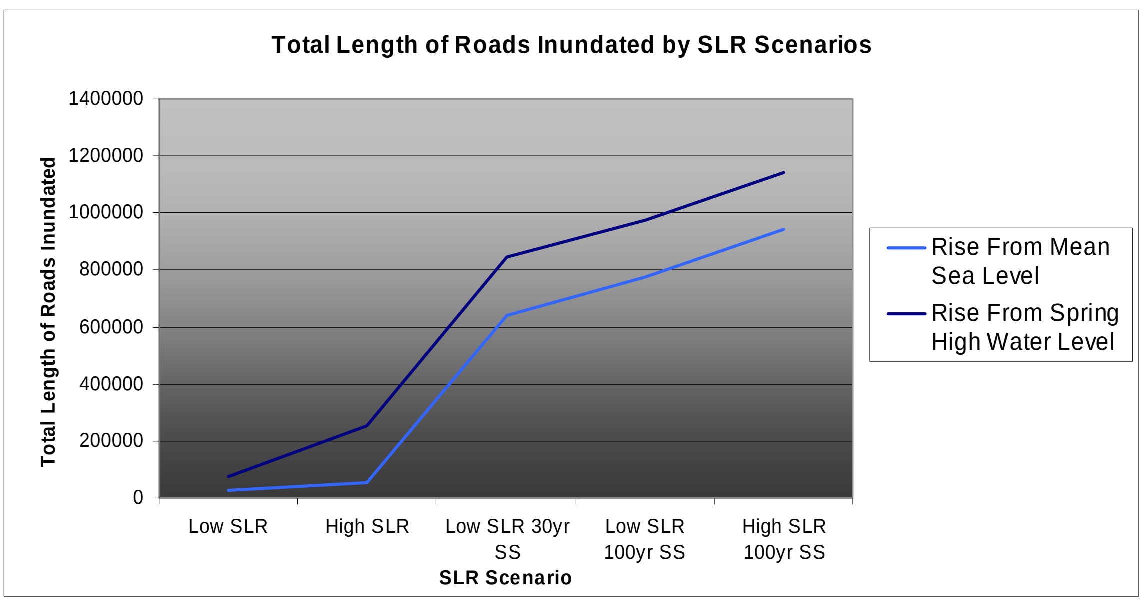


Figure 2

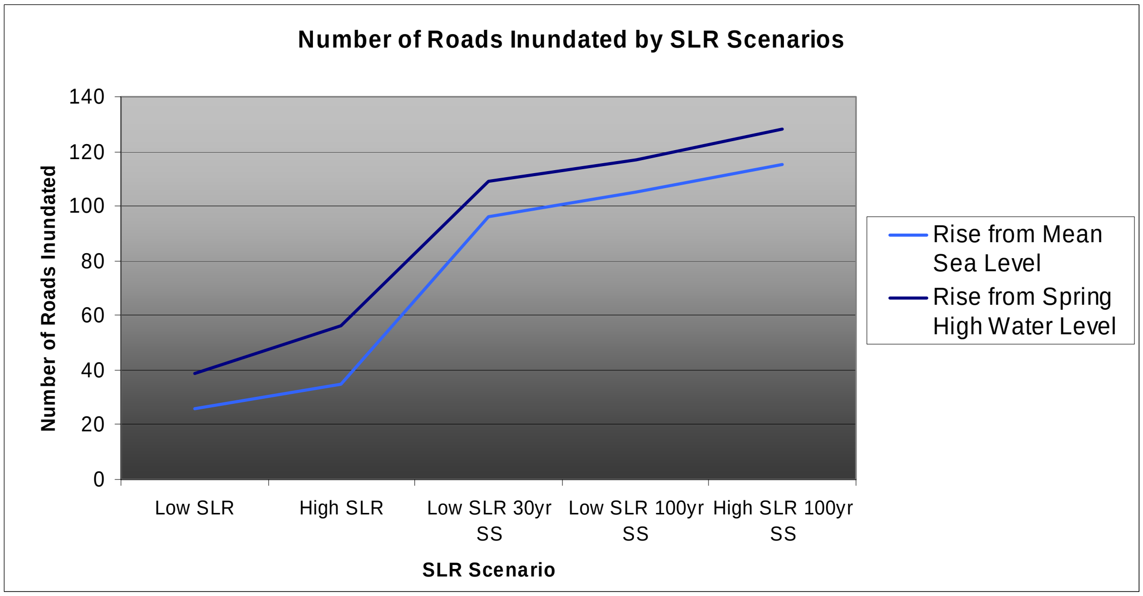
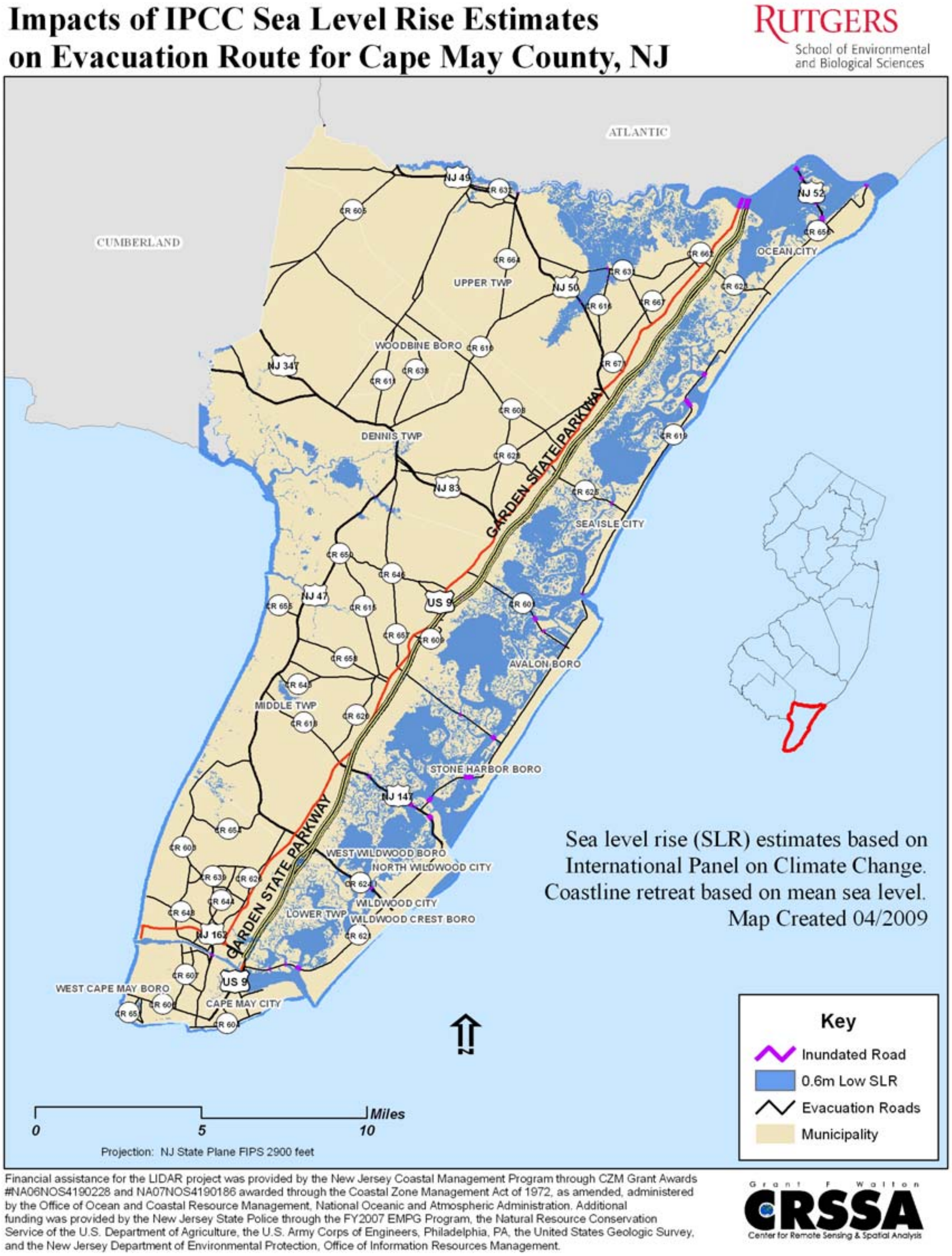


Figure 3

Summary and Conclusions

Overall, this analysis was successful in providing an assessment of what road segments were being inundated given each scenario. The graphs in figures 2 and 3 provide some insight on the rise in severity between the high estimate for sea level rise and the low estimate for sea level rise combined with a 30 year storm surge. Further analysis could be provided to show only the storm surges which would provide enhancement for deciding where to begin with mitigation efforts on evacuation route roads. Additionally a break down by municipality would be advantageous as this would represent the lowest level of government and may enhance raising public awareness leading to more immediate action. All resulting maps can be view below, Figures 4 – 13.


Impacts of IPCC Sea Level Rise Estimates
on Evacuation Route for Cape May County, NJ
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ATLANTIC
CUMBERLAND
UPPER TWP
OCEAN CITY
WOODBINE BORO
DENNIS TWP
GARDEN STATE PARKWAY
SEA ISLE CITY
AVALON BORO
MIDDLE TWP
STONE HARBOR BORO
WEST WILDWOOD BORO
NORTH WILDWOOD CITY
WILDWOOD CITY
WILDWOOD CREST BORO
LOWER TWP
WEST CAPE MAY BORO
CAPE MAY CITY
Sea level rise (SLR) estimates based on
International Panel on Climate Change.
Coastline retreat based on mean sea level.
Map Created 04/2009
Key
Inundated Road
0.6m Low SLR
Evacuation Roads
Municipality
0
5
10
Miles
N
Projection: NJ State Plane FIPS 2900 feet
Financial assistance for the LIDAR project was provided by the New Jersey Coastal Management Program through CZM Grant Awards #NA06NOS4190228 and NA07NOS4190186 awarded through the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. Additional funding was provided by the New Jersey State Police through the FY2007 EMPG Program, the Natural Resource Conservation Service of the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, Philadelphia, PA, the United States Geologic Survey, and the New Jersey Department of Environmental Protection, Office of Information Resources Management.
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Figure 4

Impacts of IPCC Sea Level Rise Estimates on Evacuation Route for Cape May County, NJ

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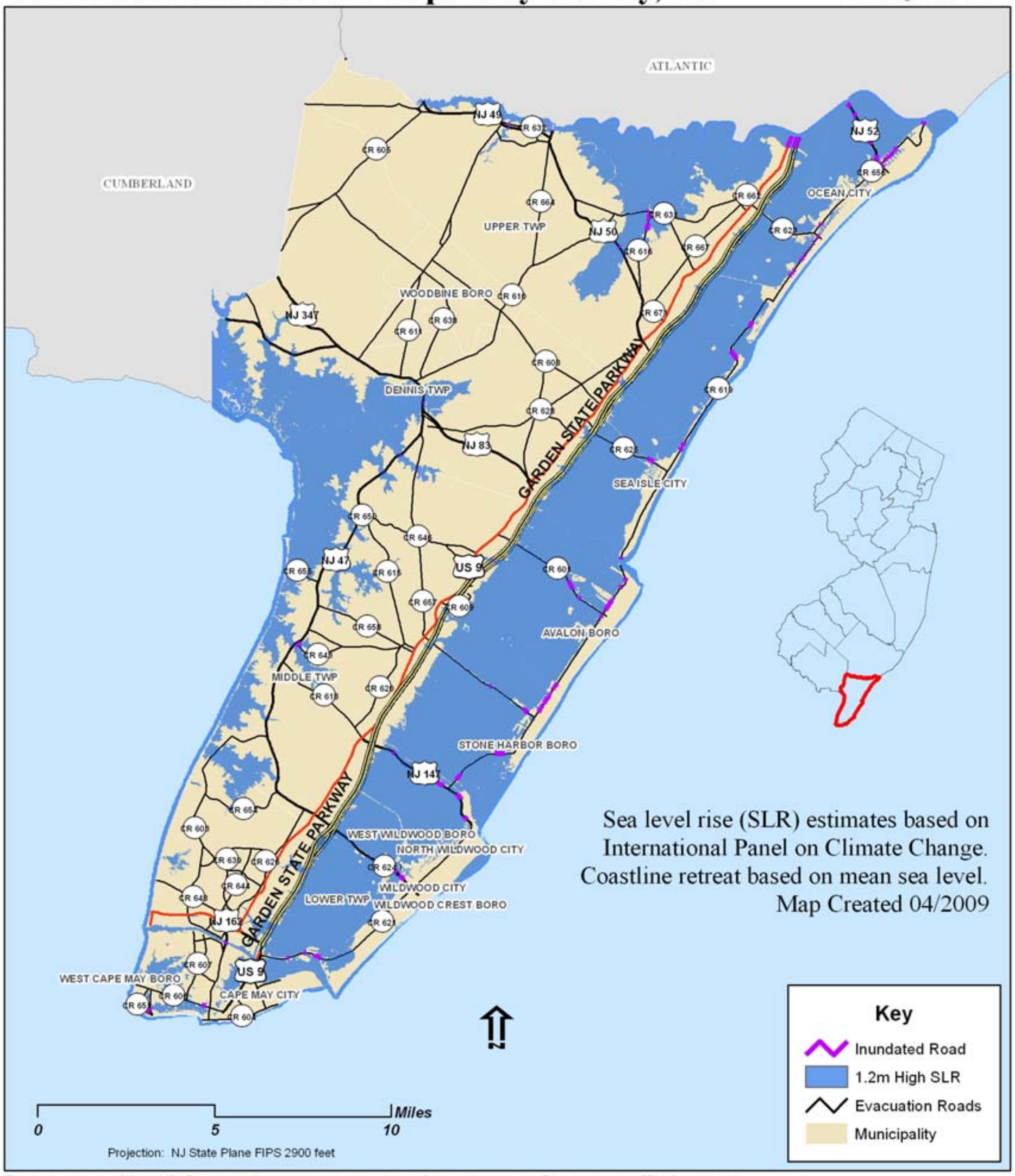

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Figure 5

Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ

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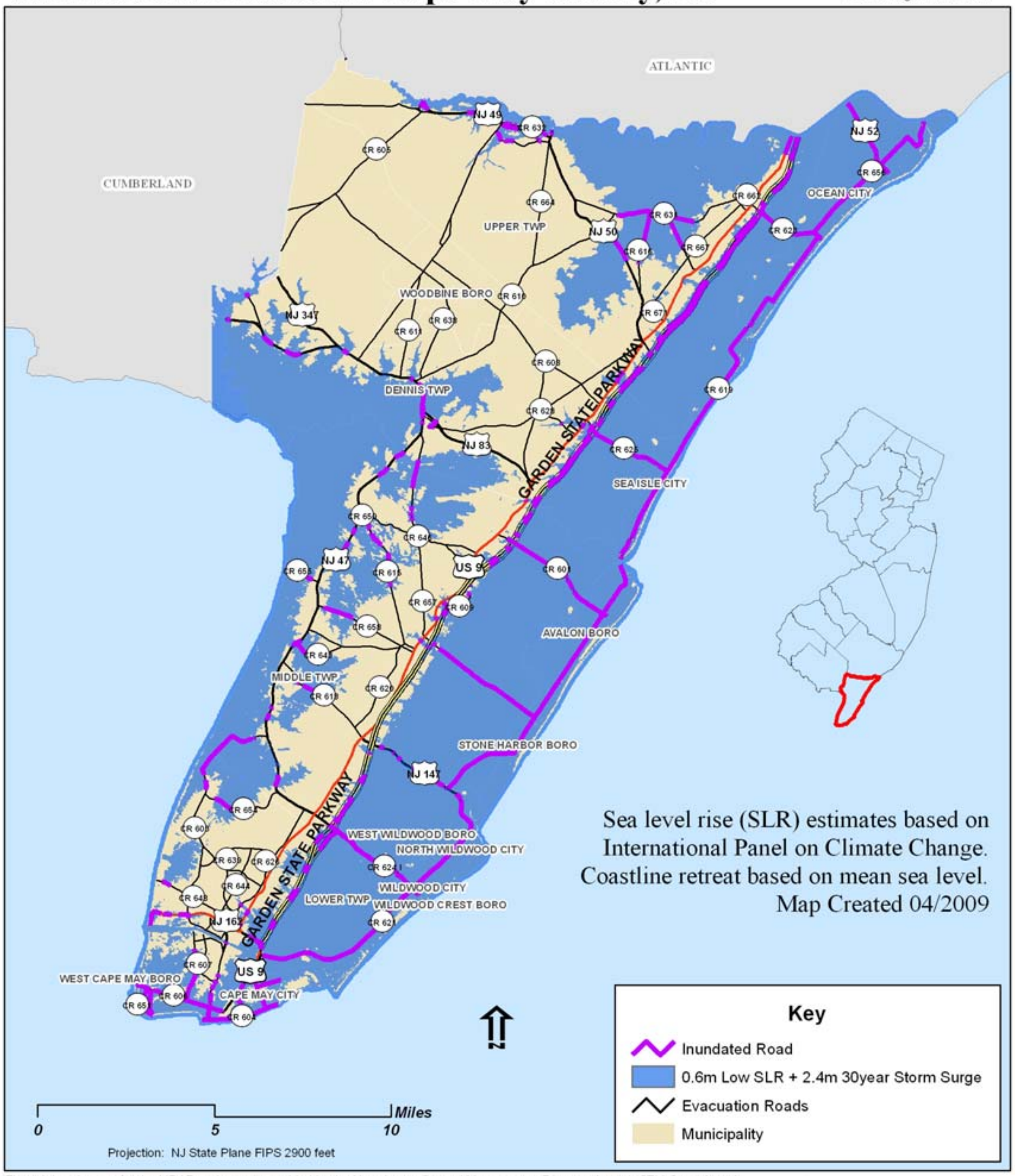

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Figure 6

Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ

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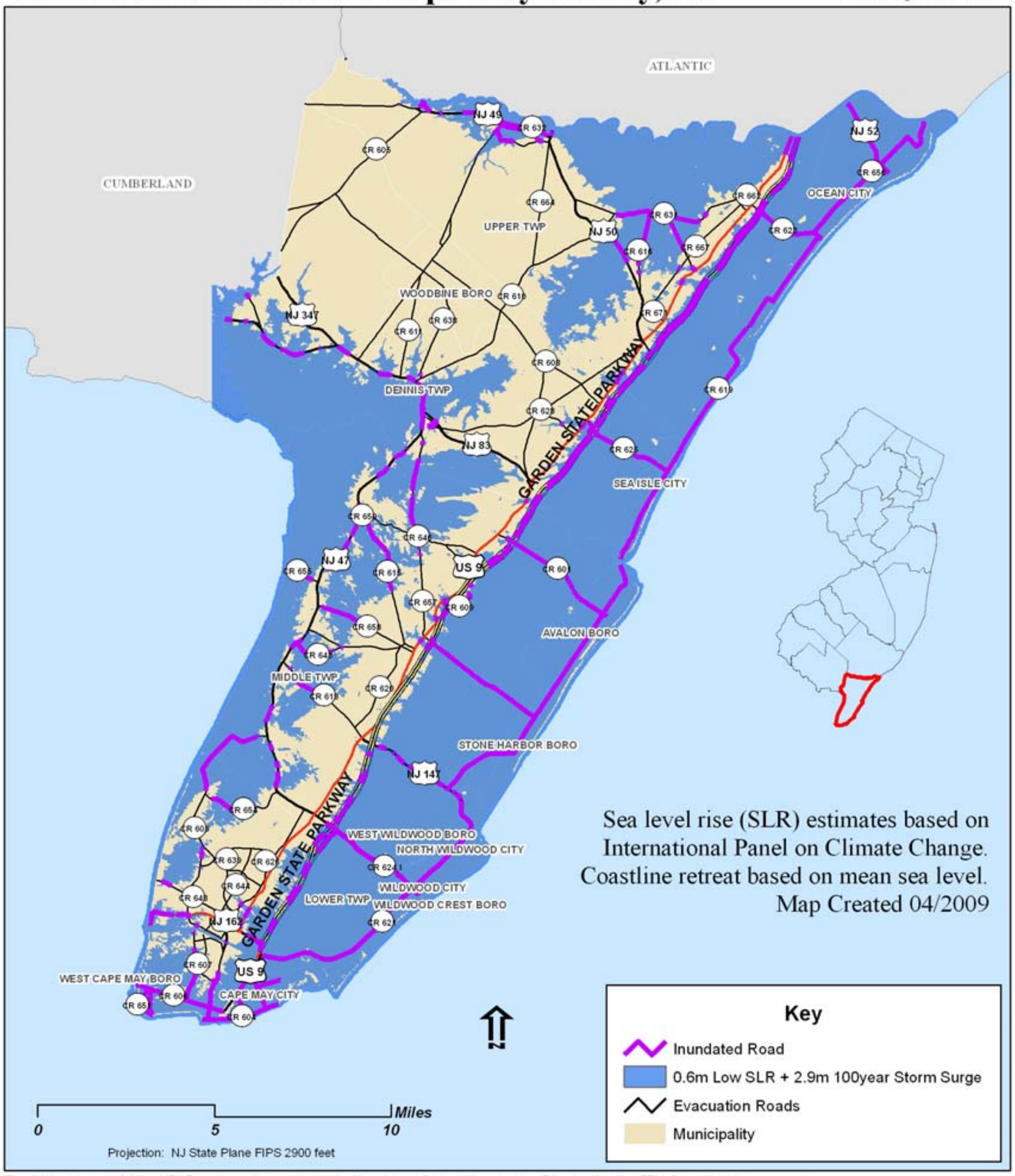

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Figure 7

Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ

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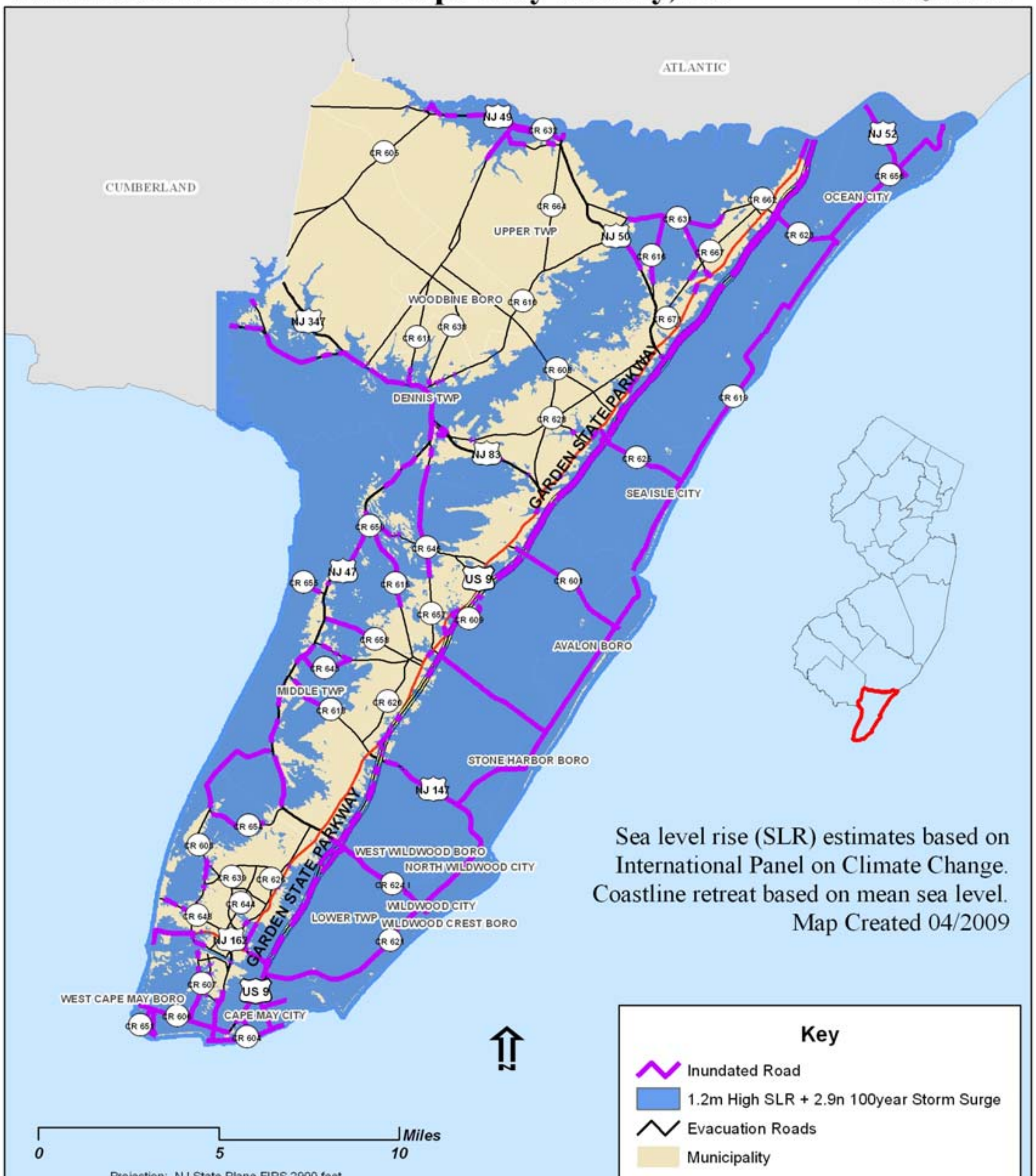

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Figure 8

Impacts of IPCC Sea Level Rise Estimates on Evacuation Route for Cape May County, NJ

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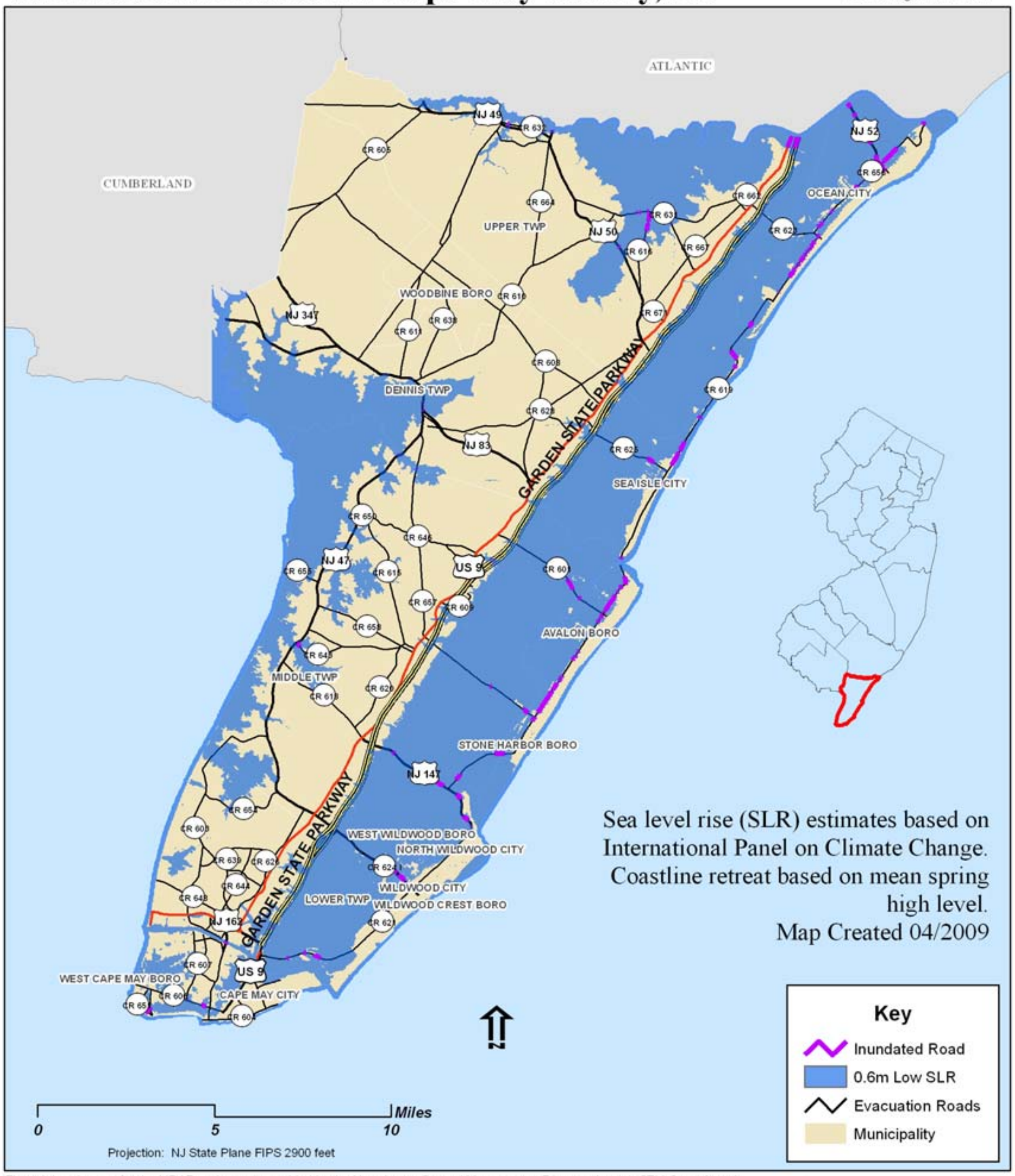

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Figure 9

Impacts of IPCC Sea Level Rise Estimates on Evacuation Route for Cape May County, NJ

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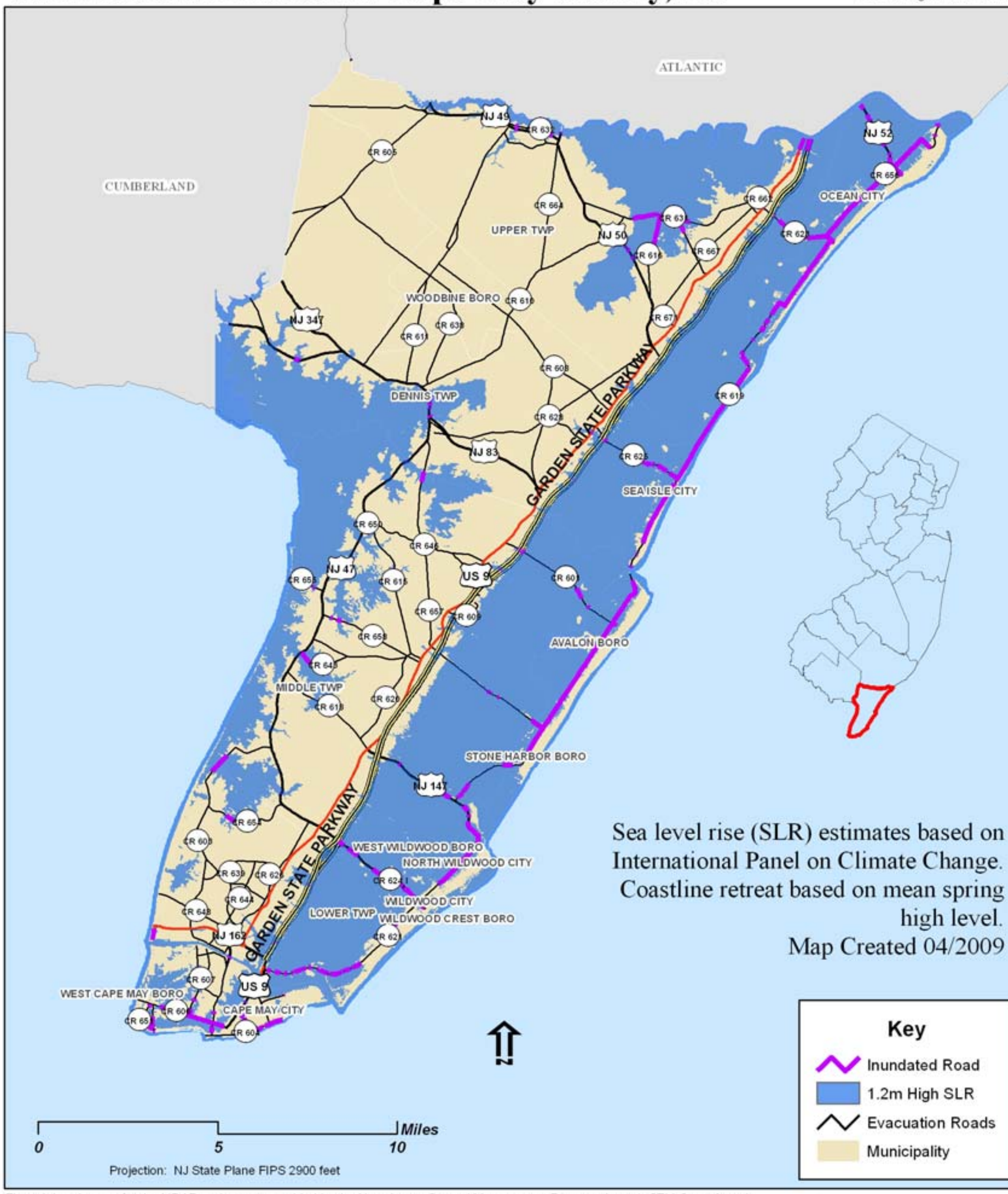

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Figure 10

Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ

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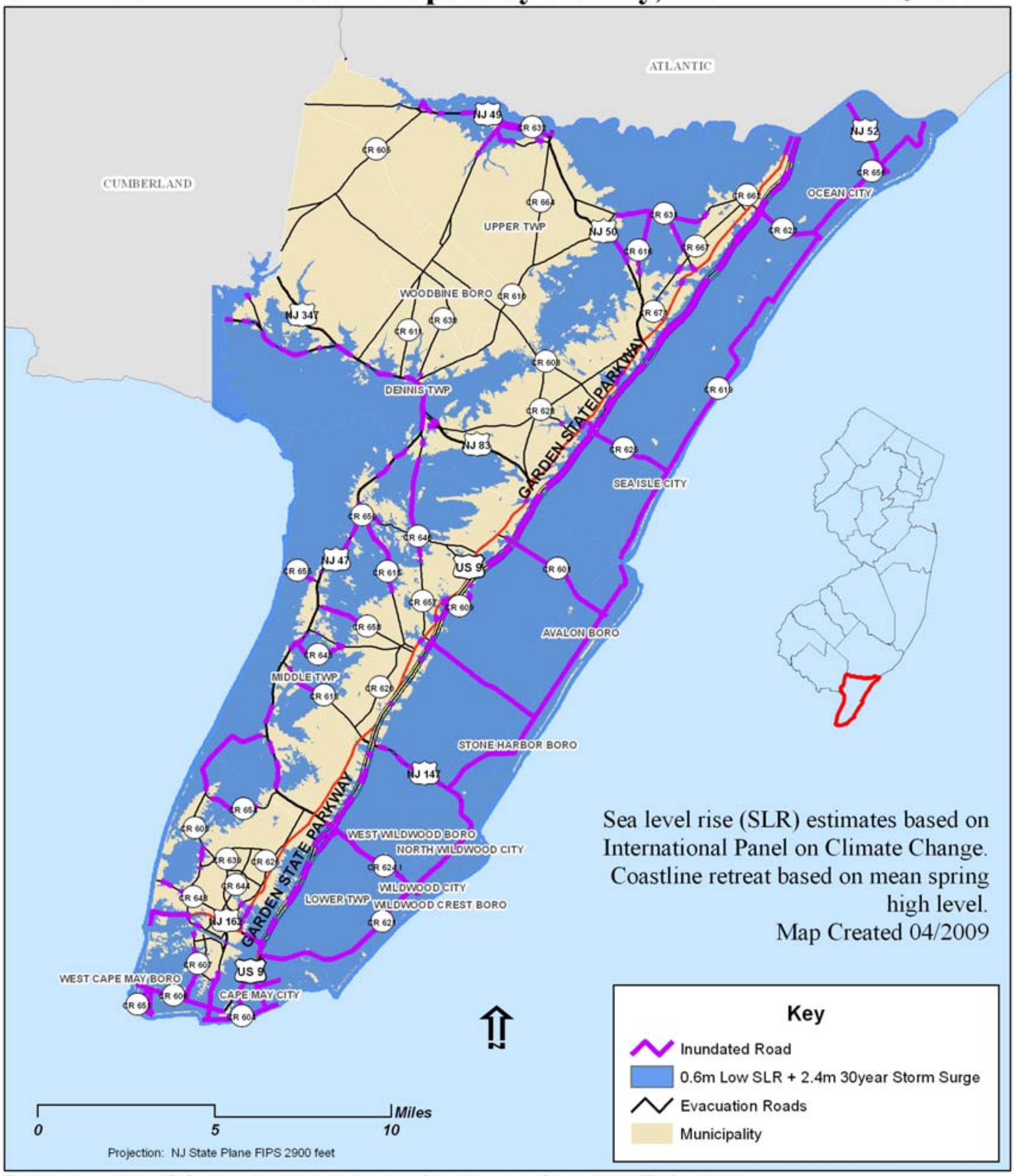

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Figure 11

Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ

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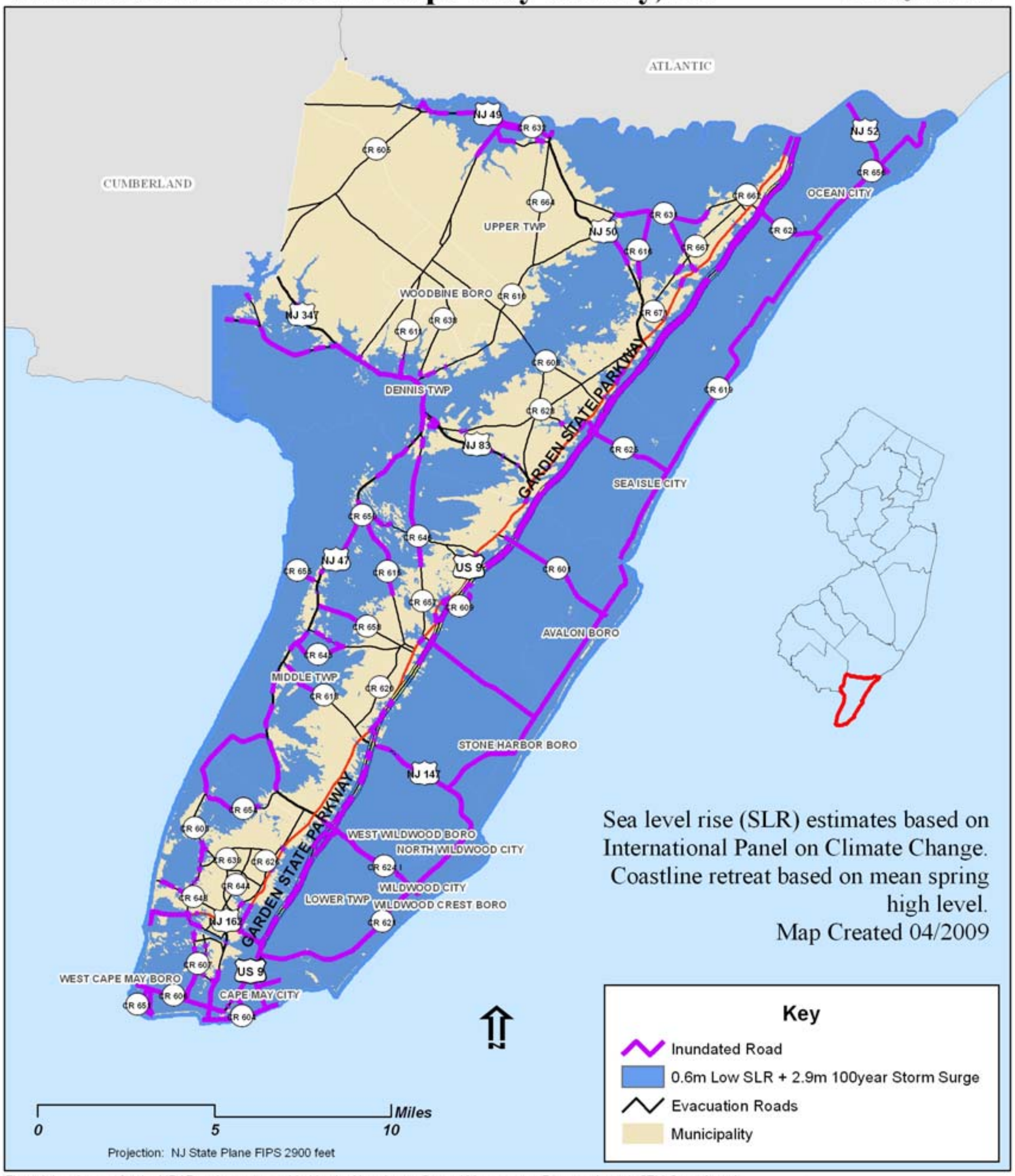

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Figure 12

Impacts of IPCC Sea Level Rise and Storm Surges on Evacuation Route for Cape May County, NJ

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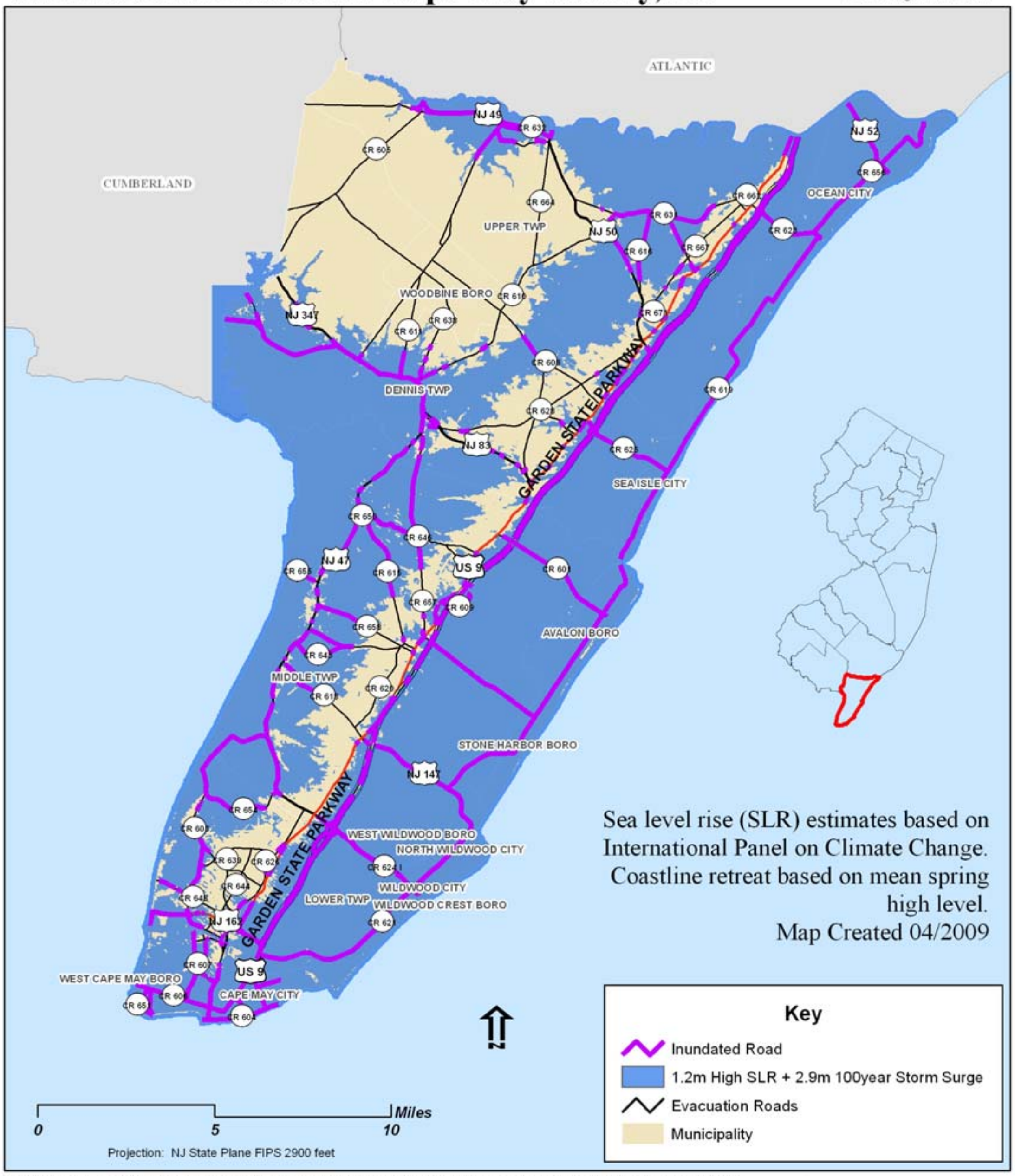

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Figure 13

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