Navigating Climate Impacts and Resilience – Rutgers' NJ Climate Navigator Tool
The Rutgers NJADAPT Program in New Jersey

Lucas Marxen, Associate Director
SEBS/NJAES Office of Research Analytics, Rutgers University
March 12, 2024

Who We Are, What We Do

Our mission and leadership

Our Mission

The New Jersey Climate Change Resource Center was established by statute in January 2020 to "create and support the use of impartial and actionable science to advance government, public, private, and nongovernmental sector efforts to adapt to, and mitigate, a changing climate." To that end, our mission is to:

- Conduct research with real-world applications to New Jersey's most pressing climate-related challenges;
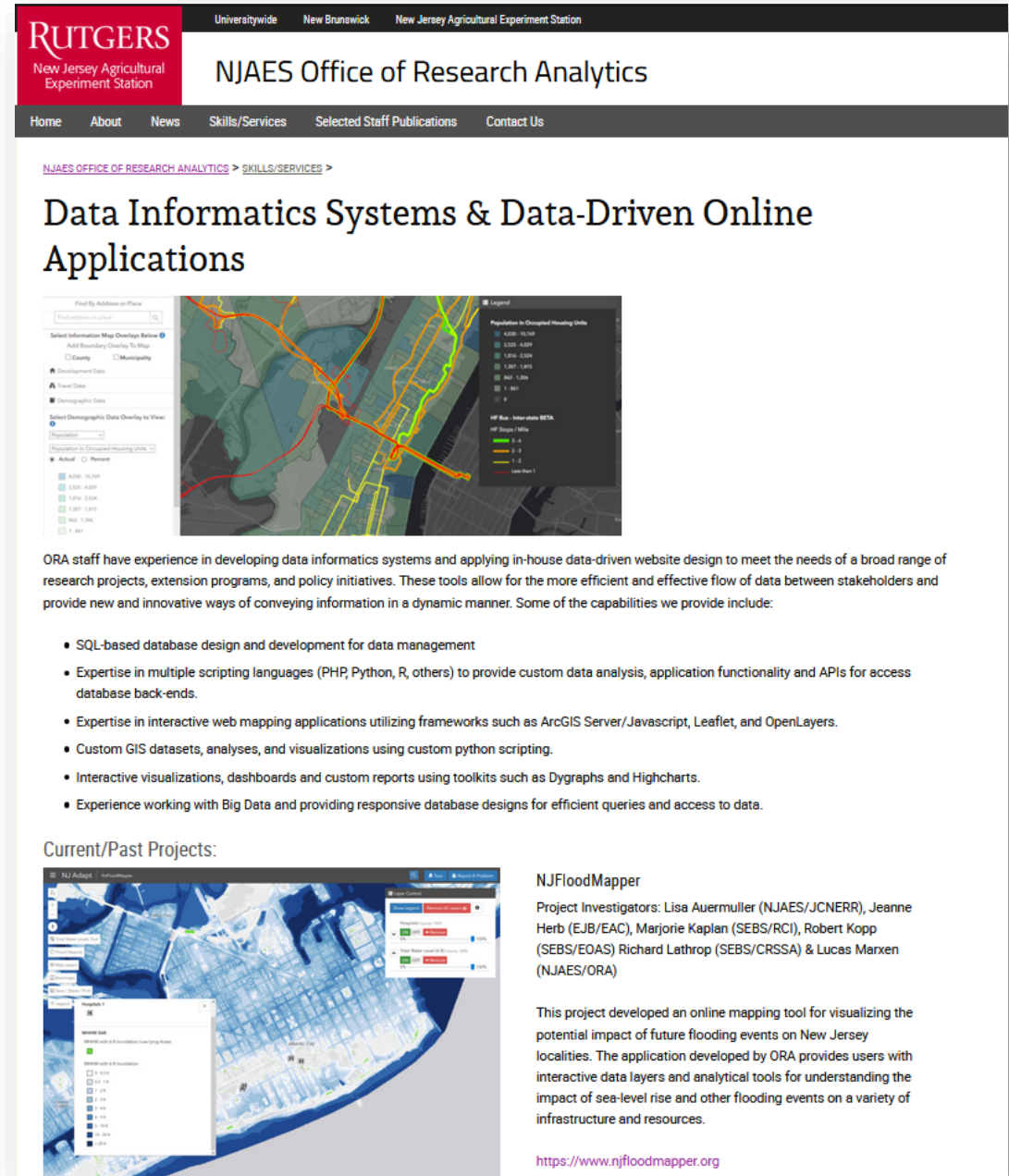
- Create planning tools, develop technical guidance, undertake pilot projects, and provide practical support for addressing climate change in New Jersey;

- Connect actionable research to policymakers, planners, practitioners, the media, communities, students, and other individuals through outreach, training, and education.

Background

- SEBS/NJAES Office of Research Analytics
  - Provides advanced statistical, spatial, economic, and technological tools to projects and programs throughout the NJAES and broader University.

  - Specialize in developing data informatics systems and data-driven online applications

  - Expertise in GIS, interactive web-mapping, and data visualization technology

  - Collaborate with experts and stakeholders to develop tools to meet research, extension and education mission of the Agricultural Experiment Station

The NJADAPT suite of tools were developed to address identified gaps in communicating climate science and data to policy makers, planners, and the broader public

Climate Dashboard

New Jersey climate trends in moderate and high emissions scenarios

The Climate Dashboard visualizes climate change trends and statistics for the whole of New Jersey. It compares today's conditions to future projections and can be displayed as maps or interactive charts. The projected changes are summarized in seasonal intervals (winter, spring, summer, fall) for six climate measurements in moderate (consistent with today's global policies) and high (continued growth of emissions by 2100) emissions scenarios.

Go to Climate Dashboard
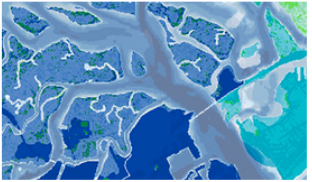
NJ FloodMapper

An interactive flood exposure mapping tool

NJ FloodMapper is an interactive mapping tool that allows users to conduct flood exposure analysis based on the best available science for sea-level rise and numerous other parameters, including total water levels, hurricane surge, FEMA flood zones, and Hurricane Sandy surge. Additional map layers depict infrastructure, environmental hazards, marsh and open space, social vulnerability, flood insurance payments for property loss, and land use.

Go to NJ FloodMapper

Climate Snapshots

Climate risks summarized by municipality, county and statewide

Adapting to climate change requires an understanding of potential hazards and exposure. These Climate Snapshots provide easy access to information about the people, places, and assets at risk from climate impacts in each of New Jersey's municipalities, counties, and the state as a whole. Snapshots include reports on built infrastructure, critical assets, natural and working lands, public health, vulnerable populations, and forestry.
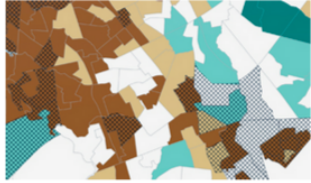
Go to Climate Snapshots

NJ HazAdapt

Data for hazard planners

Developed with the NJ Office of Emergency Management, this tool provides municipal and county hazard planners with easy access to data and resources that will assist with development of hazard mitigation plans. State and local users can assess flooding impacts on key FEMA lifeline sectors, socially vulnerable populations, and individual land parcels. The tool includes heat hazard data to understand the impacts of heat waves and the urban heat island effect.

Go to NJ HazAdapt

Climate Planning Tool

A guide to using coastal flooding data

This tool assists state and local officials, communities, hazard planners, and others to understand the impacts of climate change on coastal flooding in New Jersey. Backed by data on sea level rise, hurricanes, and tidal floods, the tool explains how to use data to analyze different flooding scenarios. The tool is presented in two storymaps: the first is a primer on flooding; the second is a step-by-step outline of a coastal flood vulnerability analysis.

Flooding Primer   GIS Assessment Steps
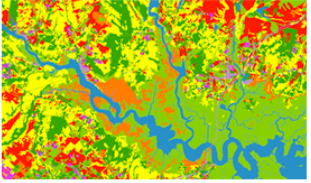
NJ Forest Adapt

Forest management tool

This mapping tool enables users to visualize data over multiple timelines and climate change scenarios. Users can explore changes in plant hardiness and heat zones, species distribution, daily minimum and maximum temperatures, heating and cooling degree days, and precipitation. Additional map layers include forest carbon density, canopy cover, impervious surfaces, forest types, pest and disease, wildfire fuel hazard, and more.

Go to NJ Forest Adapt

Climate Dashboards

How can we educate the public on the general science of climate change?

Climate Change Impacts on Mean Daily Maximum Temperature in New Jersey

The mean seasonal daily maximum temperature is the average of the daily hottest temperature experienced in the winter, spring, summer, and fall seasons throughout the state. The average daily maximum temperatures have been generally increasing in New Jersey in recent decades and are projected to continue through 2100 across all seasons, with higher emissions causing a greater increase in temperatures.

More about mean daily maximum temperature ⓘ

About the Data ⓘ

SELECT VISUALIZATION
- ○ Map
- ◉ Chart

SELECT TIME PERIOD
- ○ 2001-2020
- ○ 2021-2040
- ◉ 2041-2060
- ○ 2061-2080
- ○ 2081-2100

SELECT EMISSIONS SCENARIO
- ○ Moderate Emissions
- ◉ High Emissions
- Learn More ⓘ

SELECT SEASON
- ○ Winter
- ○ Spring
- ◉ Summer
- ○ Fall

Seasonal Maximum Temperature for 2041-2060 degrees

Minimum	Average	Maximum
84.4	88.4	92.7

Modeled Statewide Summer Maximum Temperature

— Projected Values — Historical Values

Highcharts.com
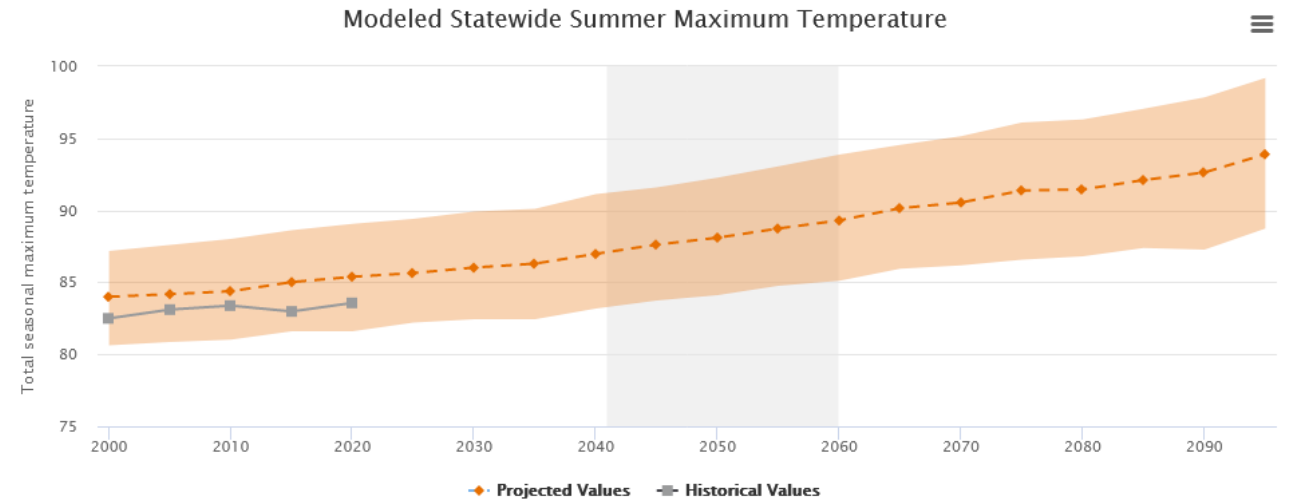
The above chart shows the projections of 32 climate models. The broad colored band shows the range of values that the models projected. The narrower the band, the more strongly models agree. The dashed line shows the average of those projections. The solid line shows the actual values that already occurred. They do not line up exactly with the average modeled values but do fall within the range, indicating the models are projecting realistic values.

This visualization is showing **high emissions**, corresponding to a future consistent with the strong, continued growth of fossil fuel consumption.

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5

NJFloodMapper

How can we help communities visualize the impacts of coastal and inland flood hazards on their infrastructure, people and resources?

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Total Water Level Approach

+ Flood event height

+ Sea-Level Rise (SLR)

Current High Tide
(0' Mean Higher
High Water (MHHW)

Total Water Levels Tool

Total Water Level Summary

Total Water Level Summary

Tide Gauge: Atlantic City, NJ

Emission Scenario: High emissions

Timeframe: 2090 Planning Horizon

SLR Estimate: Less than a 17% Chance of Exceeding - 5.3 ft.

Flood Event: 10-year-flood (10% AEP) - 3.3 ft. above MHHW

Total Water Level Estimate: 8.6 ft.

Total Water Level Estimate Mapper: 9 ft.

Results - The resultant Total Water Level is rounded to the nearest whole foot. The TWL inundation map represents 'still water', which reflects the astronomical tide, the storm surge, and limited wave setup caused by breaking waves.

The Total Water Level does not portray wave runup, the movement of water up a slope. Therefore, the inundation mapping more closely corresponds to FEMA's Still Water Flood Elevations (SWEL), not the Base Flood Elevation (BFE). **Therefore, this analysis could under-represent the amount of inundation, as the calculations do not consider wave velocity and other dynamic effects from storms.**

Summary

Previous | Next | Close Wizard | + Add To Map

Total Water Levels Tool

High emissions

7.2 ft.
Less than a 5% Chance of Exceeding

5.3 ft.
Less than a 17% Chance of Exceeding

3.4 ft.
Approximately a 50% Chance of Exceeding

2.1 ft.
At least an 83% Chance of Exceeding

1.4 ft.
At least a 95% Chance of Exceeding

Select a Sea Level Rise Estimate

Step 4 Analyzing at least two sea-level rise estimates is beneficial. Choosing one estimate in the 'likely' range, along with the 'high-end' estimate will allow you to see how a range of SLR scenarios change community level exposures to flooding.

You can choose between the following SLR estimates:

'High-End' Estimates:

There is less than a 5% chance of exceeding the SLR height value indicated. Using a high-end estimate is especially important for planning assets with long lifetimes (e.g., a bridge), or limited ability to move out of harm's way (e.g., a wastewater treatment plant).

Likely estimates:

- There is less than a 17% chance of exceeding the SLR height value indicated
- There is approximately a 50% chance of exceeding the SLR height value indicated
- There is at least an 83% chance of exceeding the SLR height value indicated

'Low-End' Estimate:

There is at least a 95% chance of exceeding the SLR height value indicated.

NJ Sea Level Rise Estimates Example

Step 4 of 5

Previous | Next

Total Water Levels Tool

Select a Flood Event or Choose Your Own Height:

3.3

4.8 ft. above MHHW
100-year-flood (1% AEP)

3.3 ft. above MHHW
10-year-flood (10% AEP)

2.4 ft. above MHHW
2-year-flood (50% AEP)

1.6 ft. above MHHW
Annual Flood (99% AEP)

0 ft. above MHHW
Permanent Inundation

Select a Flood Event

Historical Events

Select a Historical Flood Event

Step 5 - Choose between Flood Events Height using tide gauge specific data:

1. Historical Storm flood heights (e.g., Sandy)
2. Mean Higher High Water (MHHW)
3. NOAA's Annual Exceedance Probabilities (AEP), and

Flood event water levels are specific to each tide gauge and come from NOAA's Extreme Water Levels statistics program. Mean Higher High Water reflects permanent inundation, or where residents' feet will be wet on an almost daily basis. Selecting other water levels reflects recurring floods (i.e., the 99% AEP) or episodic flood events that could result from coastal storms (i.e., the 1% AEP). You can also choose historic flood events (like Sandy) to see how previous storms would look like in the future.

Step 5 of 5

Previous | Next

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Climate Snapshots

How can we make climate change impact analysis easily accessible?

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2 ft. Exposed

A 2-foot flood event along the New Jersey coast today can occur because of a coastal storm or especially high tide. By 2050, the same 2-foot flood event may happen during daily high tide alone because of sea-level rise. While daily high tides will result in flood inundation for parts of every day, coastal storm-induced flood events last only for the duration of a storm (although their impacts could be felt for far longer). Critical assets with exposures to a 2-foot flood event should consider short-term impacts from temporary inundation due to a storm, and longer-term impacts from permanent inundation when waters may not recede.
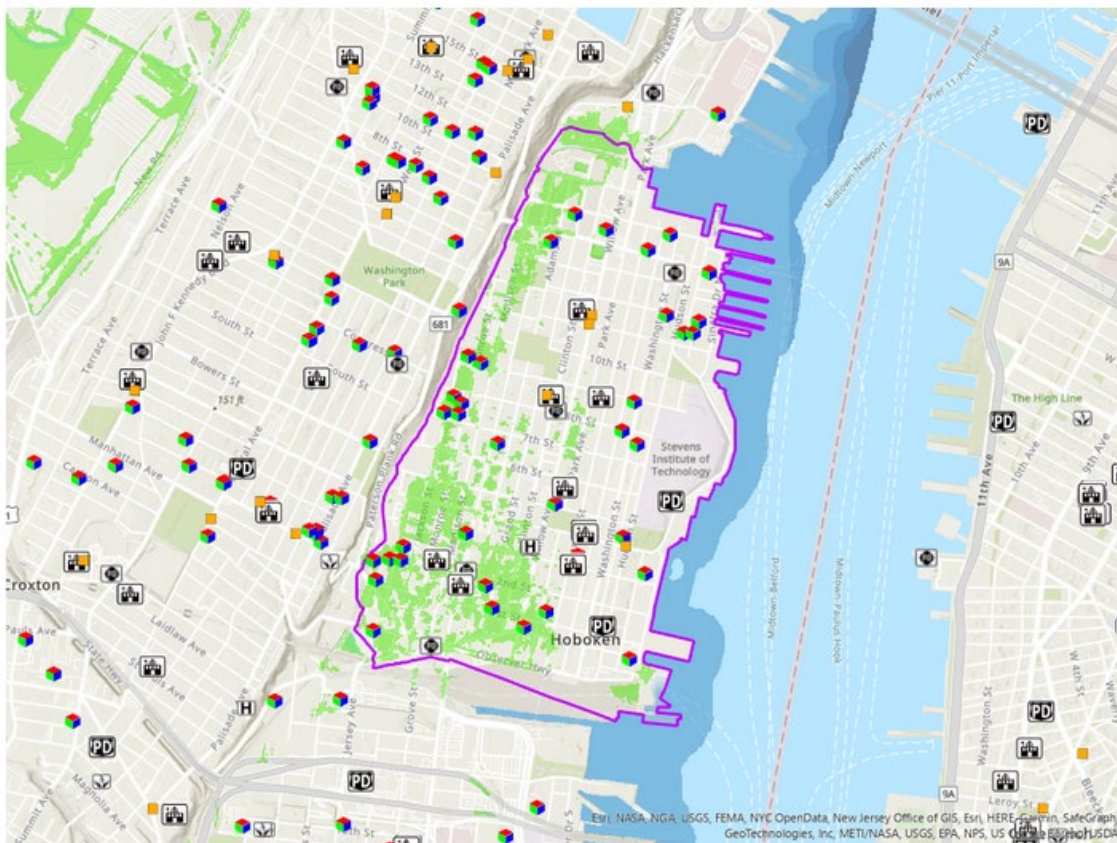
7 ft. Exposed

A 7-foot flood event along the New Jersey coast today can occur from a combination of coastal storm surge (hurricane or nor'easter) on top of a rising mean sea level. In the future, a 7-foot flood event along the New Jersey coast would become more likely to occur as the mean sea-level rises. For critical facilities it is important to be aware of and plan for currently "low probability, high consequence" flood events whose probability of occurring will become greater as sea-levels rise. Critical assets with exposures to a 7-foot flood event should consider short-term impacts from temporary inundation due to a storm, and longer-term impacts from the increasing probability that such an event could occur as sea-levels rise.
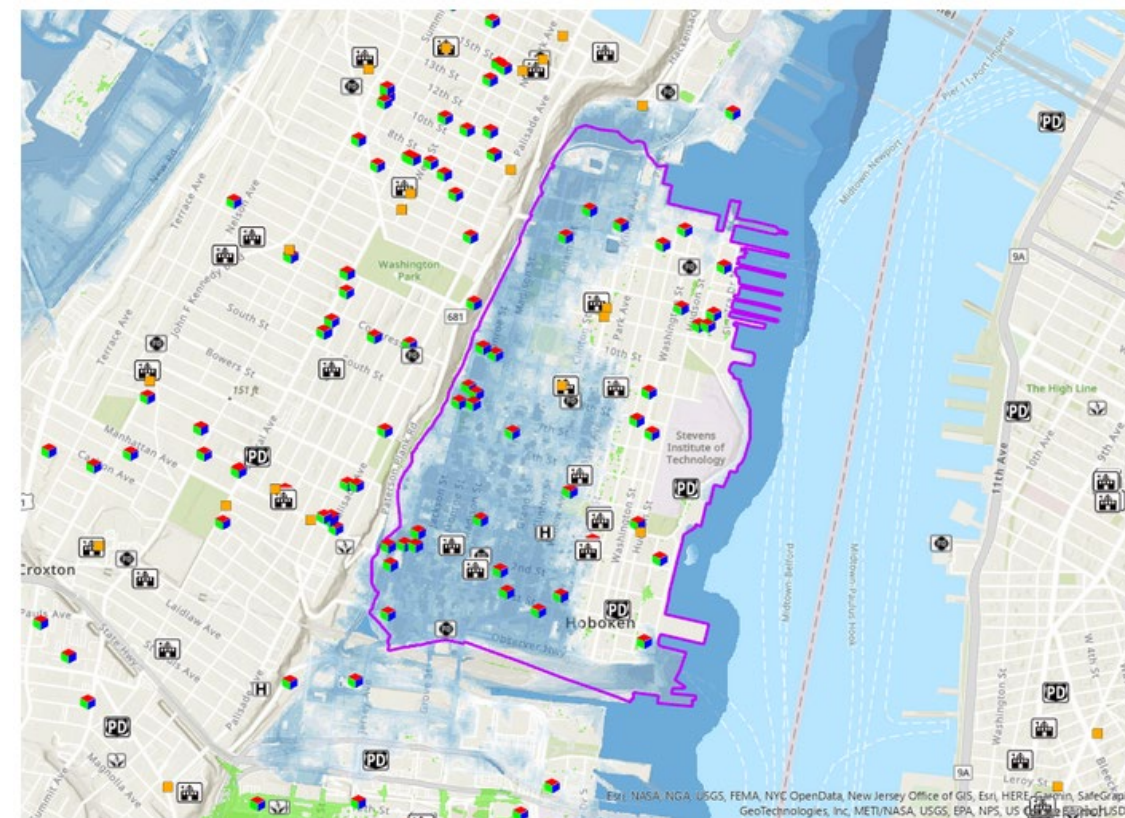
NJ Public Health Adapt

How can we help communicate the potential impacts of climate change on the public health and populations that may be at higher risk?

NJ Public Health Adapt – Heat Vulnerability Index

Exposure

Key factors:
- Dense urban areas with minimal canopy cover
- Traffic and pollution

Legend
Exposure
- 1
- 2
- 3
- 4
- 5
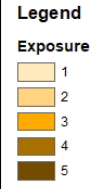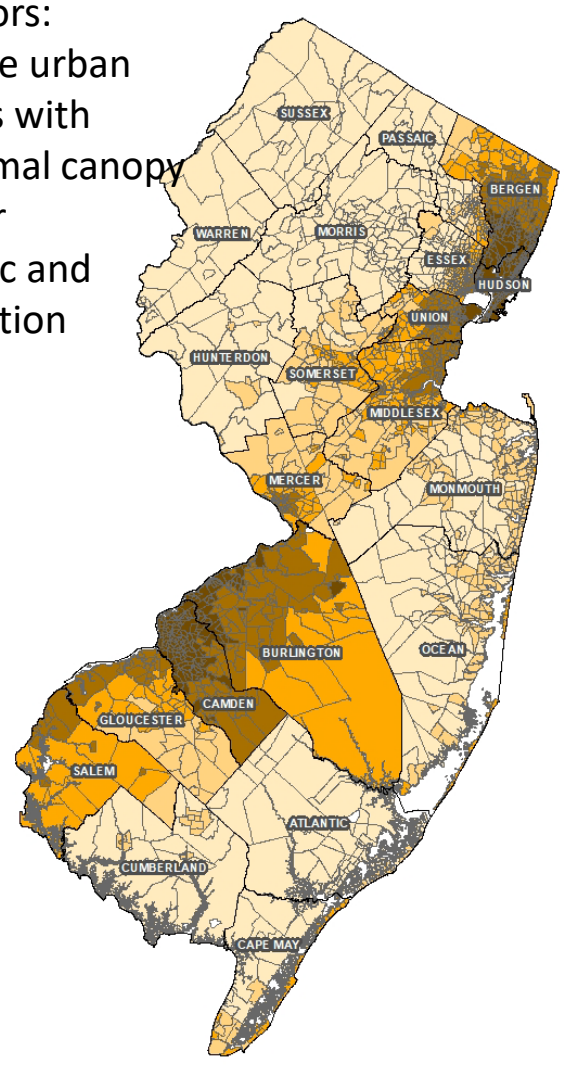
Sensitivity

Key factors:
- Age
- Health
- Living/working conditions

Legend
Sensitivity
- 1
- 2
- 3
- 4
- 5
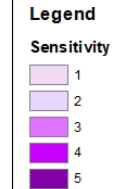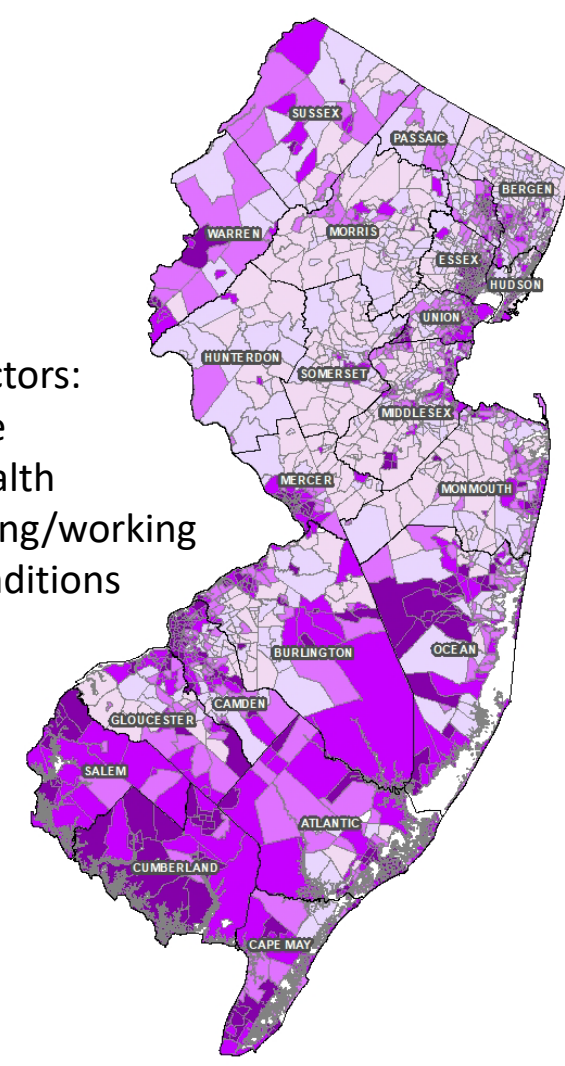
Adaptive Capacity

Key factors:
- Socioeconomic conditions
- Demographic factors

Legend
Adaptive Capacity
- 1
- 2
- 3
- 4
- 5
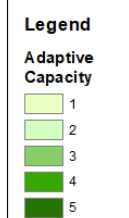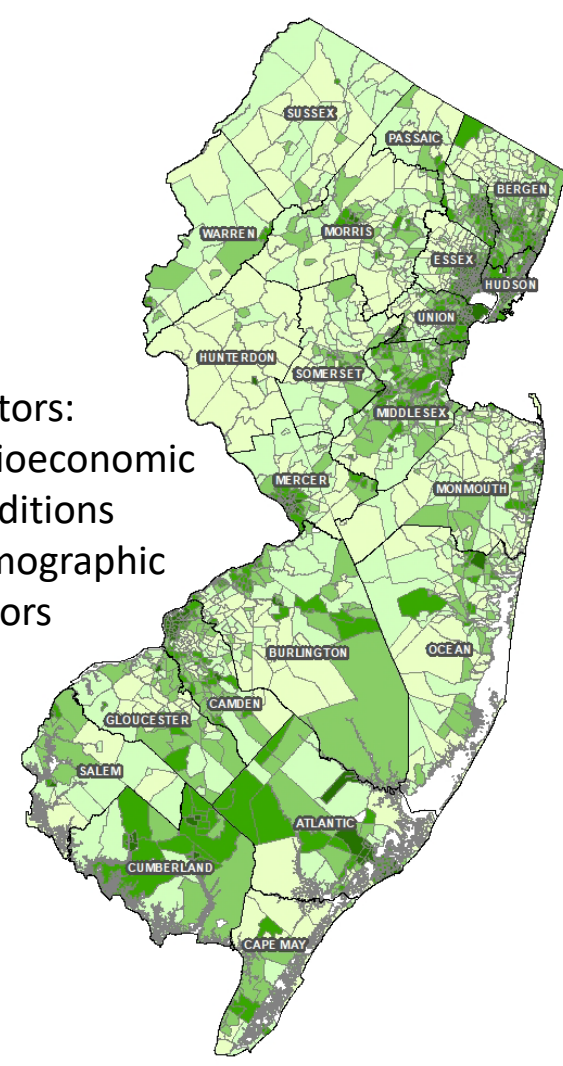
NJ Forest Adapt

How can we inform different stakeholder groups on the impacts of climate change to their sectors?
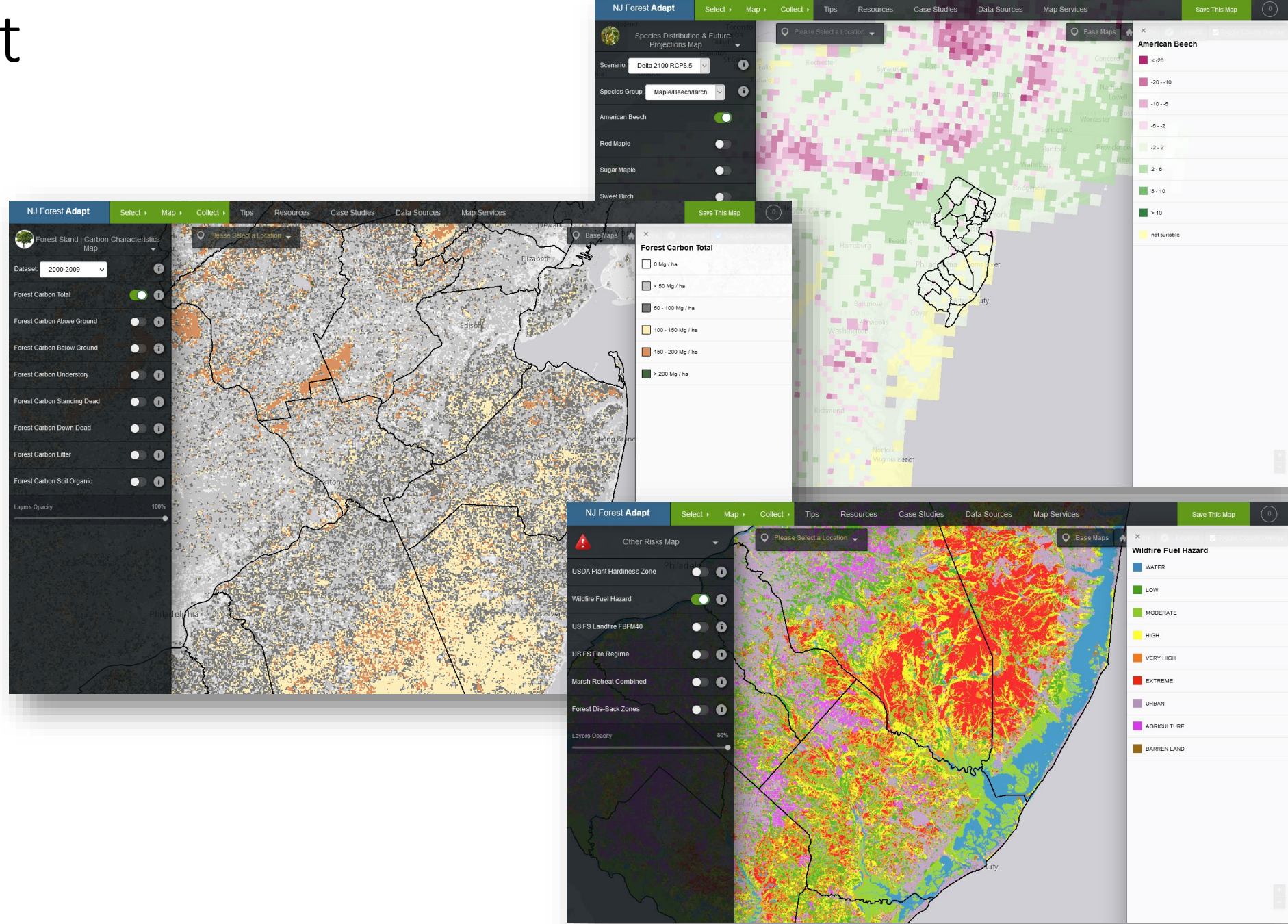
Agricultural Properties (Property Class 3A & 3B) Impacted by 2ft Sea-Level Rise
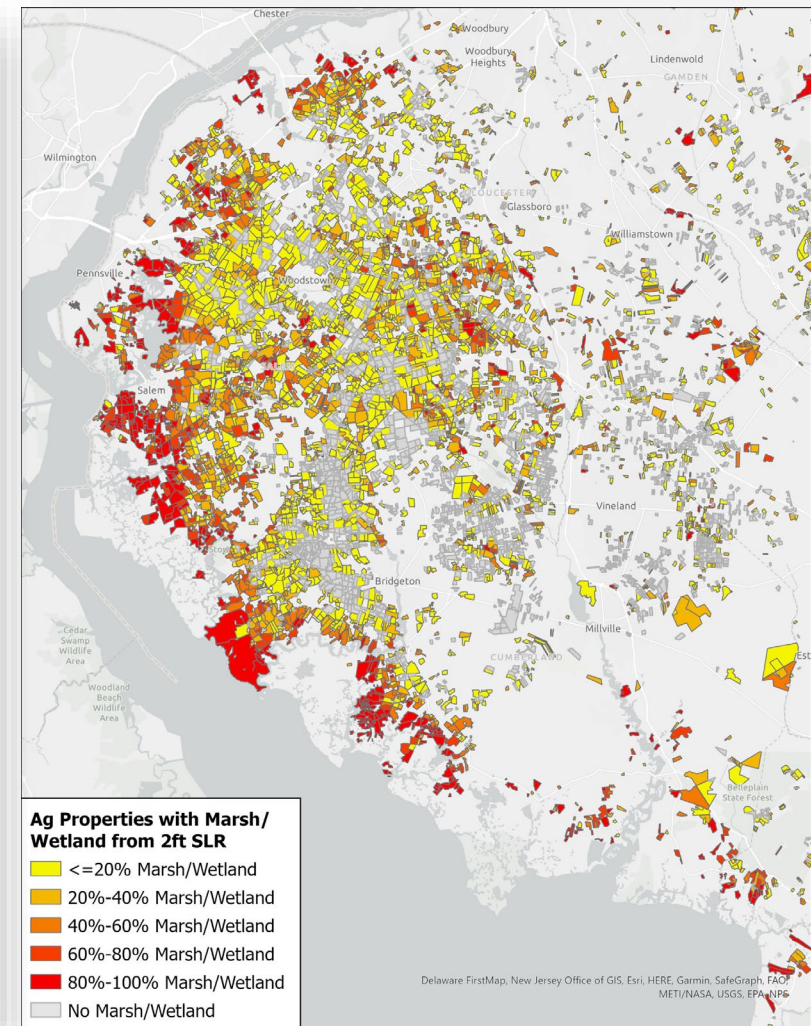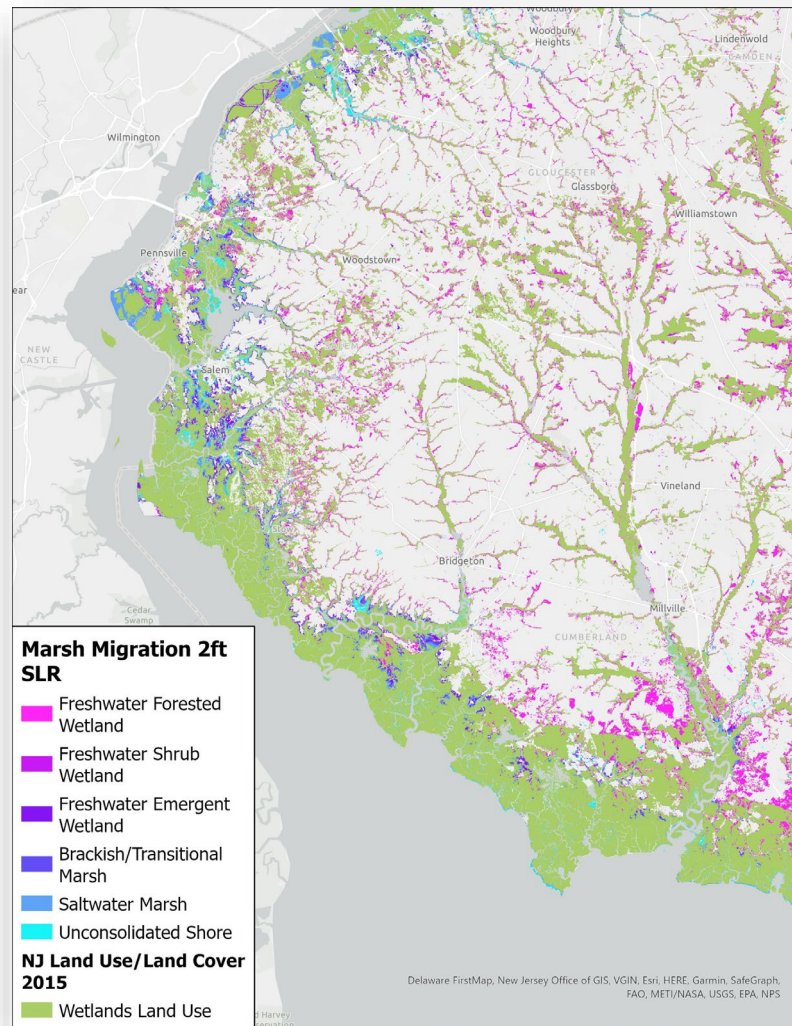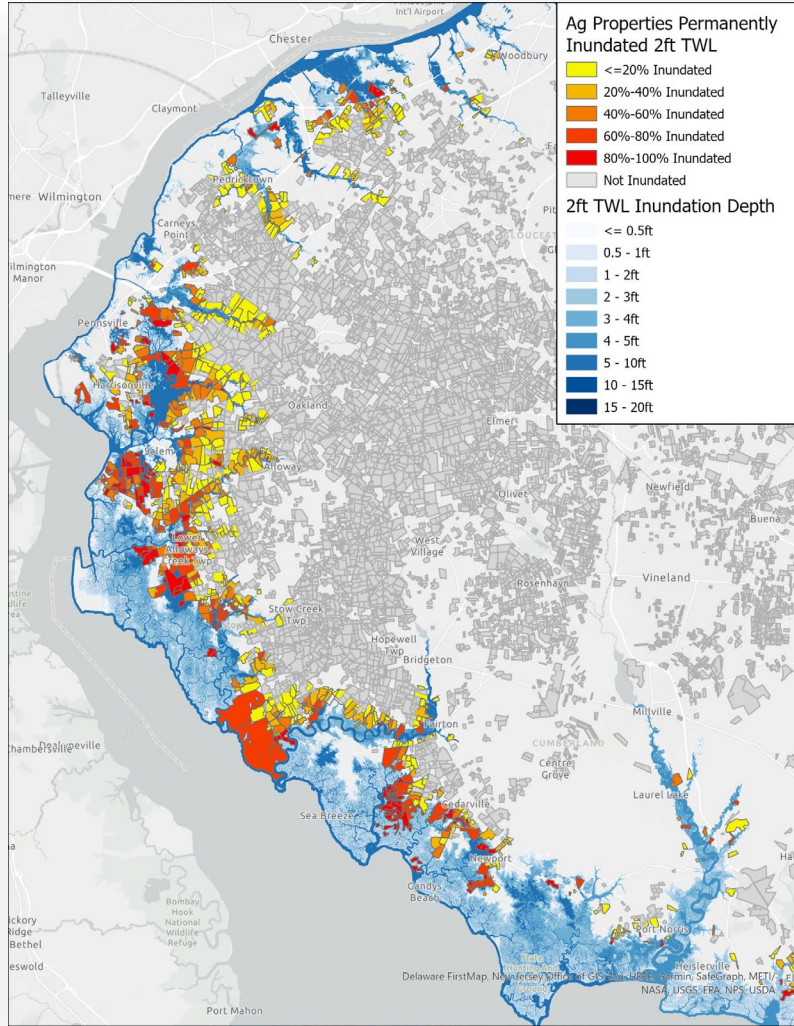
NJ HazAdapt

How do we provide detailed climate hazard analysis for planners to meet state and federal requirements?

NJ HazAdapt: A Hazard Mitigation Planning Tool

This tool was developed in collaboration with the New Jersey State Office of Emergency Management (OEM). It is intended to provide municipal and county hazard planners with easy access to data and other resources that can assist with development of Hazard Mitigation Plans consistent with guidance issued by the Federal Emergency Management Agency (FEMA). Additionally, this tool is designed to help state and local end users assess impacts of flooding on key lifeline sectors, socially vulnerable populations, and individual land parcels. It also includes data on heat hazards to assist end users with understanding impacts of heatwaves and urban heat island. Currently, this tool includes datasets on the following topics:

- Flooding and heat hazards;
- Social vulnerability to hazards to assist hazard planners in preparing communities for natural hazards; and
- Potential flood analysis for each tax parcel in New Jersey using the Parcels and MOD-IV Composite of New Jersey.

Spatial Datasets Available Here: https://arcg.is/1zLm4O

Please select a county or municipality

County
All Counties - Statewide

Municipality
Select Municipality

Available Datasets

Flood Hazard Analysis

Use this data to analyze the potential impacts of flooding events on Lifeline Sectors identified by the US Department of Homeland Security. Datasets include latitude and longitude coordinates to support mapping.

Downloads

Download All

Communications	Metadata	Hazardous Materials	Metadata
Energy	Metadata	Health	Metadata
Financial	Metadata	Safety and Security	Metadata
Food, Water & Shelter	Metadata	Transportation	Metadata

Maps

Communications	Hazardous Materials
Energy	Health
Financial	Safety and Security
Food, Water & Shelter	Transportation

Heat Hazard Analysis

Use the Heatwave Analysis to view annual statistics of historical (1981–2010) and projected future (2036–2065, 2070–2099) incidences of heatwaves by county.

Use the Heat Island/Overburdened Communities Analysis to assess intersections of potential heat islands and vulnerable populations by Census Block Group. The dataset provides impervious cover and canopy cover prevalence that could indicate potential heat island effects joined with the NJDEP's Environmental Justice - Overburdened Community data. Includes Census Block Group identifiers for joining with associated spatial datasets.

Downloads

Download All

| Heatwave Analysis (County-Level Data) | Metadata |
| Heat Island/Overburdened Communities Analysis | Metadata |

Maps

| Heat Island/Overburdened Communities Analysis |
| NJ Heat Vulnerability Index | Metadata |

Social Vulnerability

The Social vulnerability Index provides specific socially and spatially relevant information to help public health officials and local planners better prepare communities to respond to emergency events such as severe weather, floods, disease outbreaks, or chemical exposure.

Downloads

| Social Vulnerability Data | Metadata |

Maps

| Overall Social Vulnerability Analysis |
| Socio-Economic Vulnerability Analysis |
| Minority Status / Language Analysis |
| Household Composition / Disability Analysis |
| Housing Type / Transportation Analysis |

MOD-IV Parcel Flood Analysis

This dataset provides potential flood analysis for each tax parcel in New Jersey. The analysis was performed using the Parcels and MOD-IV Composite of NJ (Link) and intersecting it with 1-20ft of Total Water Levels (see the Total Water Levels Tool on NJFloodmapper for more information) and the FEMA Flood Zones for the 1% Flood Event, 0.5% Flood Event, Regulatory Floodway, and Areas of Undetermined Flood Hazard.

Downloads

| MOD-IV Parcel Flood Analysis Data | Metadata |

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New Jersey Climate Change Resource Center
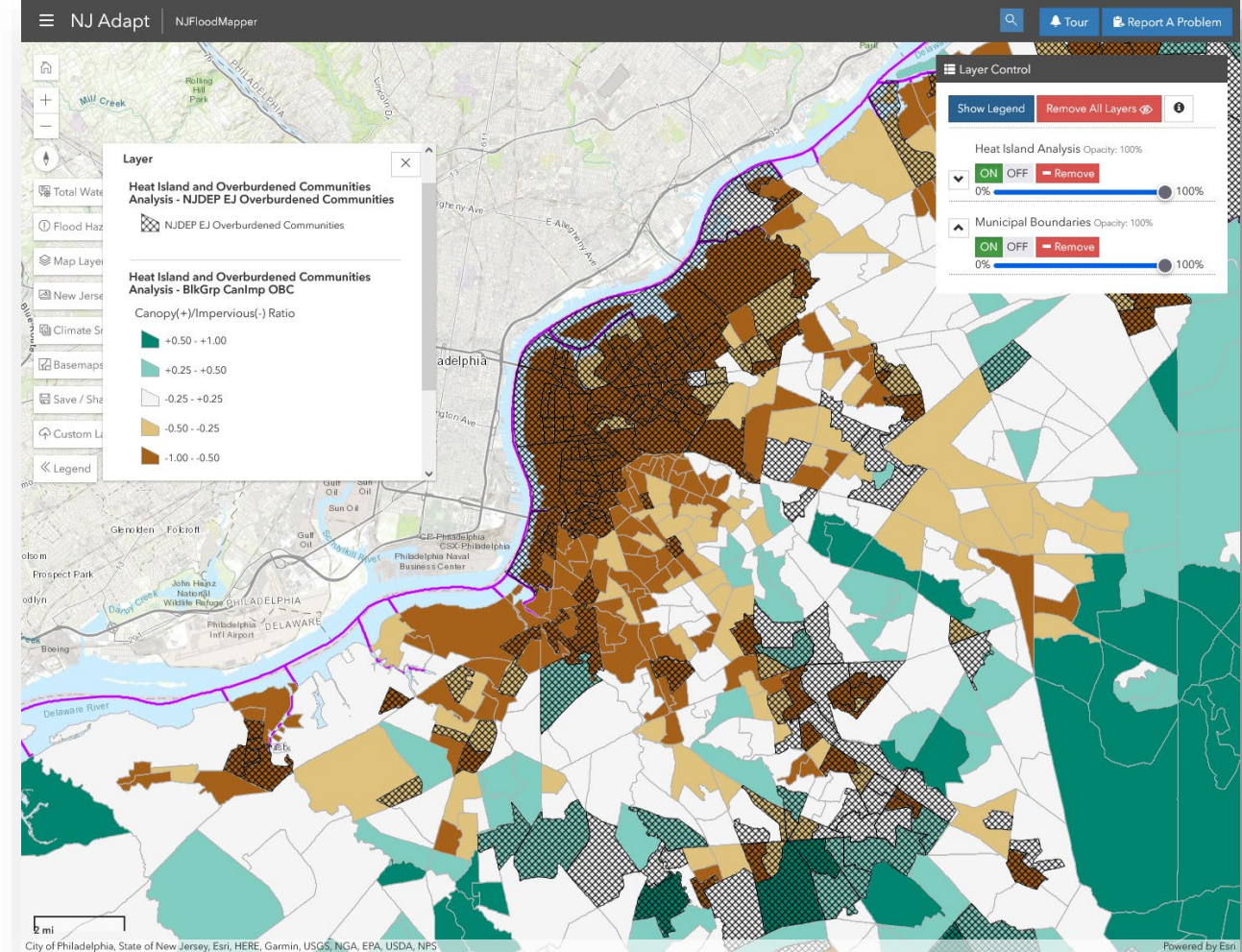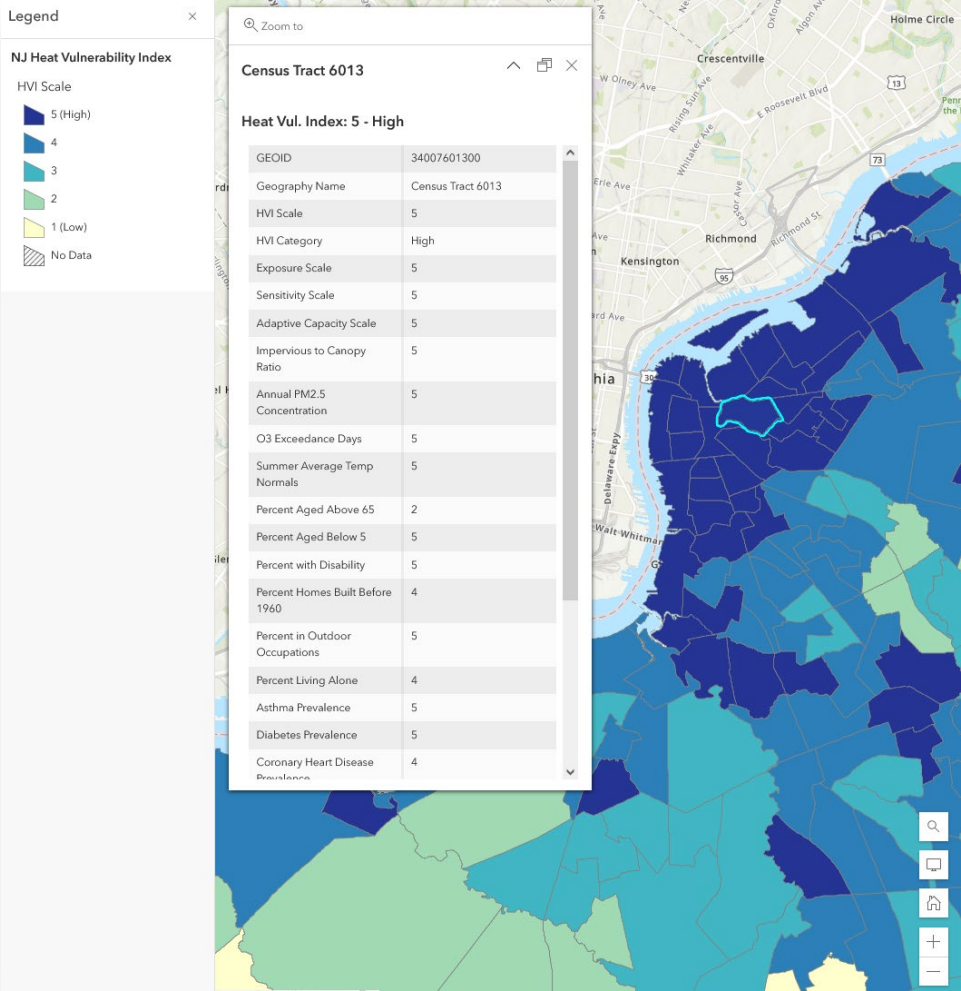
CountyID	County	Dataset	Threshold (F)	Annual Mean Heatwave Number	10% Annual Heatwave Number	90% Annual Heatwave Number	Annual Mean Heatwave Duration (Days)	10% Annual Heatwave Duration (Days)	90% Annual Heatwave Duration (Days)	Annual Max Heatwave Duration (Days)	10% Annual Max Heatwave Duration (Days)	90% Annual Max Heatwave Duration (Days)
1	Atlantic	Historical (1981-2010)	81.3	1.1	N/A	N/A	3.4	N/A	N/A	6.4	N/A	N/A
1	Atlantic	RCP4.5 (2036-2065)	81.3	3.8	2.8	7.3	8	6.3	12.7	13.2	9.4	21.2
1	Atlantic	RCP8.5 (2036-2065)	81.3	5.1	3.3	9.5	10.2	7.6	18	15.6	10.5	27.2
1	Atlantic	RCP4.5 (2070-2099)	81.3	5	3	10.1	10.2	7.1	15.8	14.8	10.3	25.1
1	Atlantic	RCP8.5 (2070-2099)	81.3	7.6	4.8	14.3	22.7	14.8	42.1	32.9	19.1	52.9

New Jersey Climate Change Resource Center

Warren County Parcel Analysis

Property Class	Properties in Regulatory Floodway	Properties in 1% Annual Chance Flood Zone	Properties in 0.2% Annual Chance Flood Zone	Acres in Flood Zones
1: Vacant Land	252	363	411	9,989
2: Residential (4 families or less)	928	1,795	2,181	81,992
3A: Farm (Regular)	2	6	6	167
3B: Farm Qualified	282	702	723	100,312
4A: Commercial	169	279	356	4,483
4B: Industrial	14	29	45	2,036
4C: Apartment	8	19	25	472
5A: Class I Railroad Property	30	45	51	395
5B: Class II Railroad Property	13	17	30	90
15A: Public School Property	10	15	16	901
15B: Other School Property	4	6	6	277
15C: Public Property	336	523	560	48,166
15D: Church and Charitable Property	6	12	15	621
15E: Cemeteries and Graveyards	3	7	7	264
15F: Other Exempt Properties	23	69	77	5,748
Total Properties	**2,080**	**3,887**	**4,509**	**255,913**

NJADAPT Local Climate-Related Hazard Planning Navigator

- **How can we provide a guided approach to accessing the various tools and datasets available in NJADAPT for specific planning purposes/needs?**

Coastal Flooding

Coastal flood inundation is affected by contributions from three factors:

- Tidal flooding - Flooding caused by twice-daily high-tides (also known as "sunny day" flooding or "nuisance" flooding). The term Mean Higher High Water (MHHW) is used to describe the average height of the highest tide over a recorded period;
- Sea-level rise - Sea-level rise increases the overall height of tidally-influenced waterbodies and, in doing so, increases the frequency and expanse of tidal flooding and worsens the impact of event-related flooding;
- Events - Flooding caused by events such as storms.
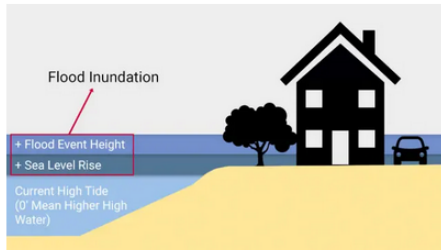
When planning for future coastal flooding, it is essential for end users to apply a future scenario(s) for sea-level rise to their hazard projections. The New Jersey Department of Environmental Protection (NJDEP) issued guidance for sea-level rise planning in 2021; further explanation of NJDEP guidance is in the box below.

⌃ Review NJDEP Guidance on Planning for Sea-Level Rise

In its **June 2021 sea-level rise guidance** for New Jersey, NJDEP outlines the following recommendations:

Planning Horizon - NJDEP encourages end users to consider both the design and reasonable life of activities for which hazards are being assessed when determining what planning horizon to apply. For example, NJDEP's guidance points out that planning for a 30-year typical mortgage may be useful when assessing impacts to residential structures. NJDEP recommends, in general, use of a 2100 planning horizon when planning for significant investments in infrastructure, such as coastal energy facilities.

Emissions scenarios - Projections for sea-level rise after 2050 are affected by the amount of greenhouse gas emissions in the global atmosphere. As outlined in the **2020 New Jersey Scientific Report on Climate Change**, a high GHG emissions scenario corresponds to a future in which there is continued growth of fossil fuel consumption; a moderate GHG emissions scenario corresponds to a future consistent with current global policies, and a low GHG emissions scenario corresponds to a future consistent with global accords such as the **2015 Paris Agreement**. NJDEP recommends, in general, use of a moderate emissions scenario.

Risk Tolerance - NJDEP recommends that end users consider the extent to which certain activities have the capacity to adapt to and/or tolerate hazards and risks. For those activities that have less risk tolerance, NJDEP recommends planning for high end projections of sea-level rise; for those activities that have high risk tolerance, NJDEP recommends that end users consider the extent to which those activities may have limited impacts and plan accordingly.

Geographic area of flooding - NJDEP recommends that end users add 5.1 feet to the geographic extent of the one-percent (100 year) storm base flood elevation to accommodate sea-level rise in coastal areas.

Building height - To allow for a margin of safety, NJDEP recommends that end users add a minimum of one foot of freeboard to the projected SLR for buildings and structures.

Get Started
Using NJADAPT Tools to Assess Coastal Flooding Hazards

Please select your desired geography in the menu at the top of this page to get customized analysis and outputs from this and the other tools in this navigator.

Please note some areas in New Jersey are not threatened by coastal flooding.

Maps

- **Explore an interactive map of current high-tide flooding** (2 feet of coastal flooding). This is the amount of nuisance flooding some parts of New Jersey are currently experiencing at highest high-tide. This data is sourced from the National Oceanic and Atmospheric Administration (NOAA).
- **Explore an interactive map of sea-level rise by the year 2100** (5 feet of coastal flooding). This map shows where the NJDEP advises the shoreline will potentially be in 2100. This data is sourced from NOAA.
- **Explore an interactive map of high-tide flooding by the year 2100** (7 feet of coastal flooding). This map shows the amount of nuisance flooding some parts of New Jersey are expected to experience at highest high-tide in the year 2100. This data is sourced from NOAA.

Reports - Climate Snapshots

- NJADAPT provides a numerous reports that detail flood impacts from 2ft (current) and 7ft (future) high-tide events, and 5ft of sea-level rise expected for 2100 (NJDEP recommendation), including effects to power plants, evacuation shelters, farmland, evacuation routes, as well as to people, including populations disproportionately affected by climate change. **Explore flood impact reports here** and **explore flood impacts on public health sites and vulnerable populations here**.

Statistical Data - NJHazAdapt

- **Download MOD IV property tax parcel data** showing percentage of flooding by following the link to NJHazAdapt, selecting your location at the top of the page, and then scrolling down to the MOD-IV Parcel Flood Analysis section at the bottom of the page. This data can be joined in GIS software to the NJ Geographic Information Network's **Parcels Composite of NJ** for mapping purposes.
- Review step-by-step guidance on creating a MOD IV property tax parcel data analysis for flooding using these **GIS Assessment Steps**.

Important information about NJADAPT data

The NJADAPT data tools incorporate provisions that ensure that the NJADAPT data are consistent with NJDEP's sea-level rise 2021 guidance. MOD IV data are property tax parcel data for the State of New Jersey that NJADAPT has included to allow exploration of how individual parcels of property are affected by flooding.

NJ Climate Navigator

- **How can we can provide a unified platform to provide guided and flexible access to all the data and tools available in NJADAPT and support more advanced features, functionality, and built-in analysis?**

NJ Climate Navigator

- **Modular Platform** – Ability to access all datasets and tools across current platforms through single unified interface

- **Decision Tree Framework** – Guide users towards most helpful data and tools

- **Integrated Guidance** – Provide users with guided applications to assist in completing plan requirements (CCRHVA, HMPs, BCBG, etc.)

- **New Dashboard Snapshot Framework** – Interactive UI for climate snapshot data

- **User Account Framework** – Allow users to save preferences, map views, analyses

- **Advanced Analysis Framework** – Custom analyses of datasets (e.g. – custom flood analysis of user provided data)

- **ArcGIS Hub** – Provide open access and standardization to all datasets

NJ Climate Navigator

- Timeframe
  - Port existing platforms over to new modular/unified framework (Spring 2024)
    - NJFloodmapper
    - NJ Forest Adapt
  - Data upgrades and development into data modules (Spring/Summer 2024)
  - Re-develop existing platforms over to new frameworks and UIs (Summer/Fall 2024)
    - Climate Dashboards
    - Climate Snapshots
    - NJ Haz Adapt
    - NJ Public Health Adapt
    - Individual Tools
  - Develop guided interface for exploring and selecting data/tools for custom workspace (Winter 2024)
  - Develop user account system (Winter 2024/2025)
  - Stakeholder engagement and feedback (Throughout Project)

Navigating Climate Related Vulnerability Assessment Across Programs and Case Example

Pritpal Bamhrah, AICP| Senior Research Specialist, NJ Climate Change Resource Center, Rutgers

March 12, 2024

Overlap across plans/funding programs

Climate Related Vulnerability/Risk Assessment

Municipal Master Plans

require *Climate Change Related Hazard Vulnerability Assessments*

Community Development Block Grant for Mitigation (CBDG-MIT)

HUD disaster funding

Plan Endorsement

state voluntary review of local government plans

Hazard Mitigation Plans

required for certain FEMA funds

Resilient Communities Program

Required for DCA funds

Overlap across plans/funding programs

- The climate related vulnerability or risk assessments don't line up 100% but there is a clear overlap across plans/programs.

- Various departments should align the requirements to make is simple for communities.

- The tools/guidance should enable the communities to perform these assessment and analysis in a way that can inform and serve various requirements.

Case Example - Planning for a Resilient Haddonfield

Source: https://picryl.com/media/indian-king-tavern-233-king-highway-east-haddonfield-camden-county-nj
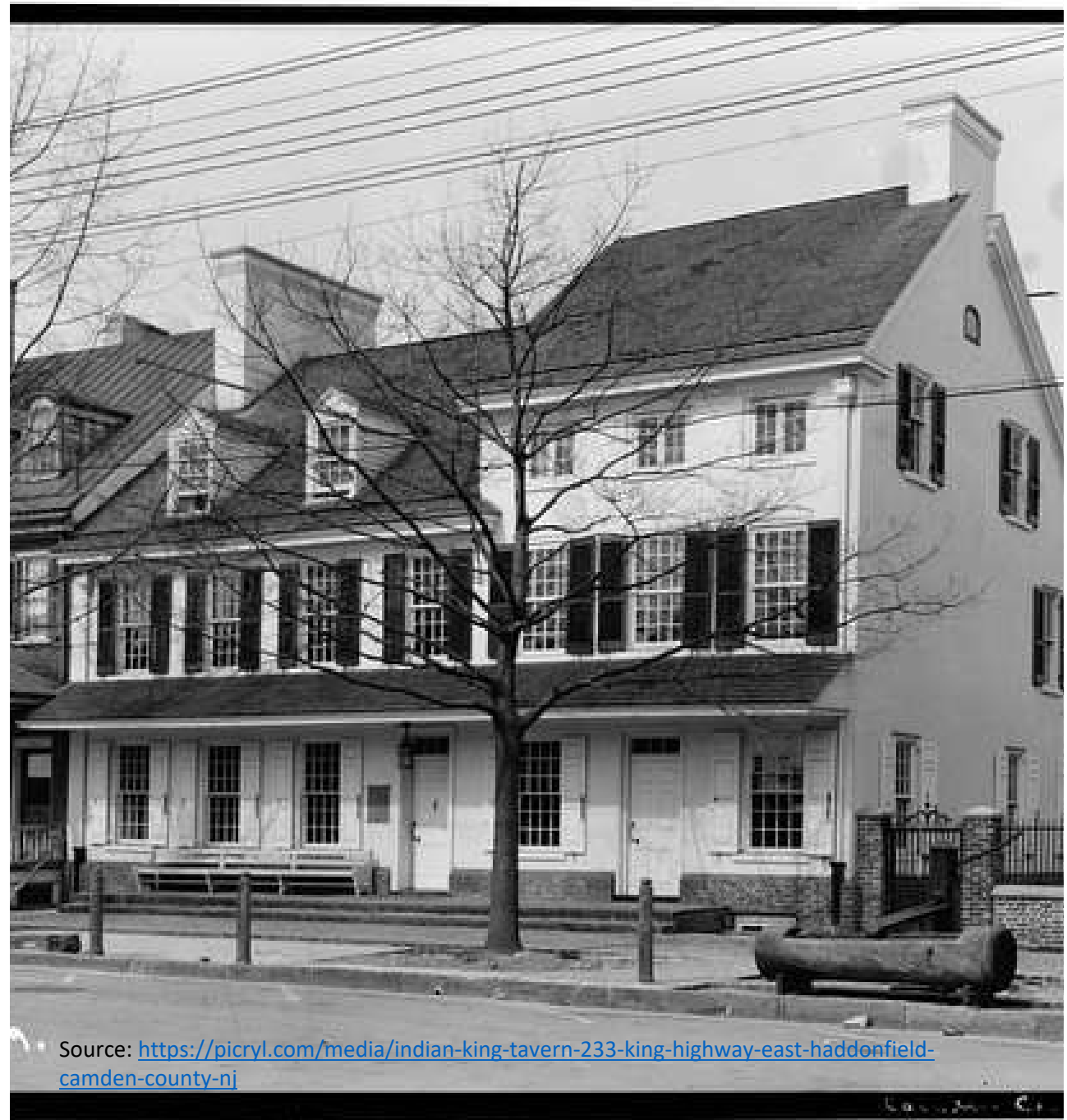
Background: Hazard Vulnerability Assessment in the Haddonfield Master Plan

In 2021, Governor Murphy mandated a **Climate Change-Related Hazard Vulnerability Assessment (CCRVHA)** in Municipal Land-Use Law.

The CCRVHA process involves several steps, including the **'Current and Future Threats Analysis.'**

Steps involved in the CCRVHA

☁	**Current and Future Threats Analysis**	Analyze threats and vulnerabilities associated with climate change-related natural hazards.
⛙	**Build-Out Analysis**	Conduct a build-out analysis for future residential, commercial, industrial development and assess associated threats and vulnerabilities.
⌂	**Critical Infrastructure Identification**	Identify critical facilities, utilities, roadways, and infrastructure crucial for evacuation and maintaining quality of life during natural disasters.
✓	**Master Plan Impact Analysis**	Analyze potential impacts of natural hazards on relevant components and elements of the master plan.
⚠	**Risk Reduction Strategies**	Provide strategies and design standards to reduce or avoid risks associated with natural hazards.
⇄	**Policy Statement**	Include a policy statement on the consistency, coordination, and integration of the climate change-related hazard vulnerability assessment with other relevant plans.
👥	**Scientific Basis**	Rely on the most recent natural hazard projections and best available science provided by the New Jersey DEP.

Source: Office of Planning Advocacy Department of State, Business Action Center: Municipal Climate Resilience Planning Guide

About this project

- Pennoni Associates is collaborating with Haddonfield Borough to prepare their 2024 Master Plan, which includes the CCRVHA.

- The New Jersey Climate Change Resource Center at Rutgers University, via the Climate Corps program, supports Pennoni Associates in analyzing public data for Step I of the CCRVHA.

- Data analysis is conducted using the NJ Adapt Suite of Tools provided by the NJRCC.

- A StoryMap is developed to communicate key environmental hazards to the Haddonfield community effectively.

About Haddonfield

- Located in Camden County, approximately 5 miles from Philadelphia.

- Spans across three square miles, with its 17 drainage areas discharging into the Cooper River and its tributaries.

- Relatively low poverty rate of 2%.

- Median income is $159,323.

- Over 79% of residents hold at least a Bachelor's degree.

- Median Rental Cost per month is $1,084.

- Median House Value is $558,300.
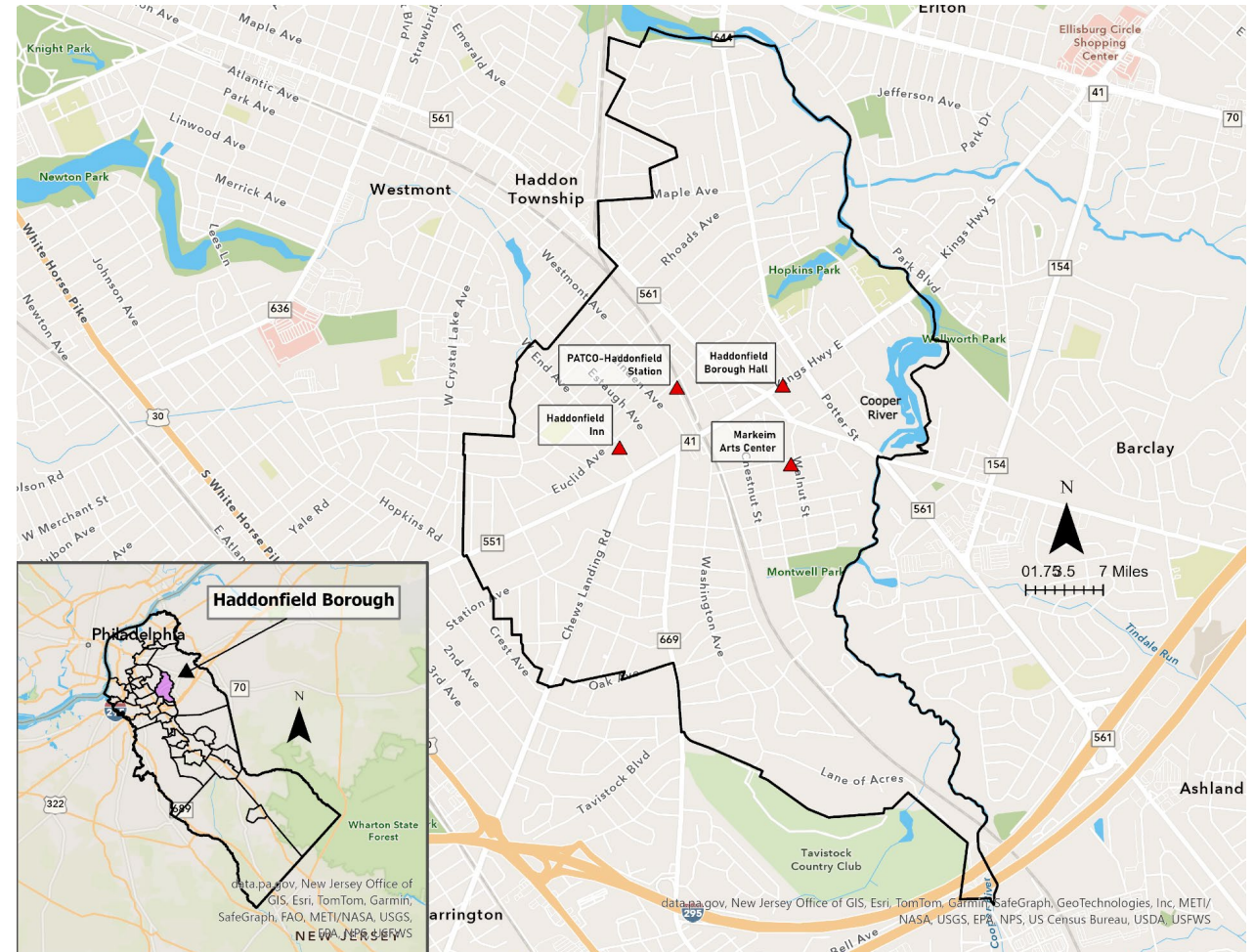
Source: NJGIN Portal

Land-Use
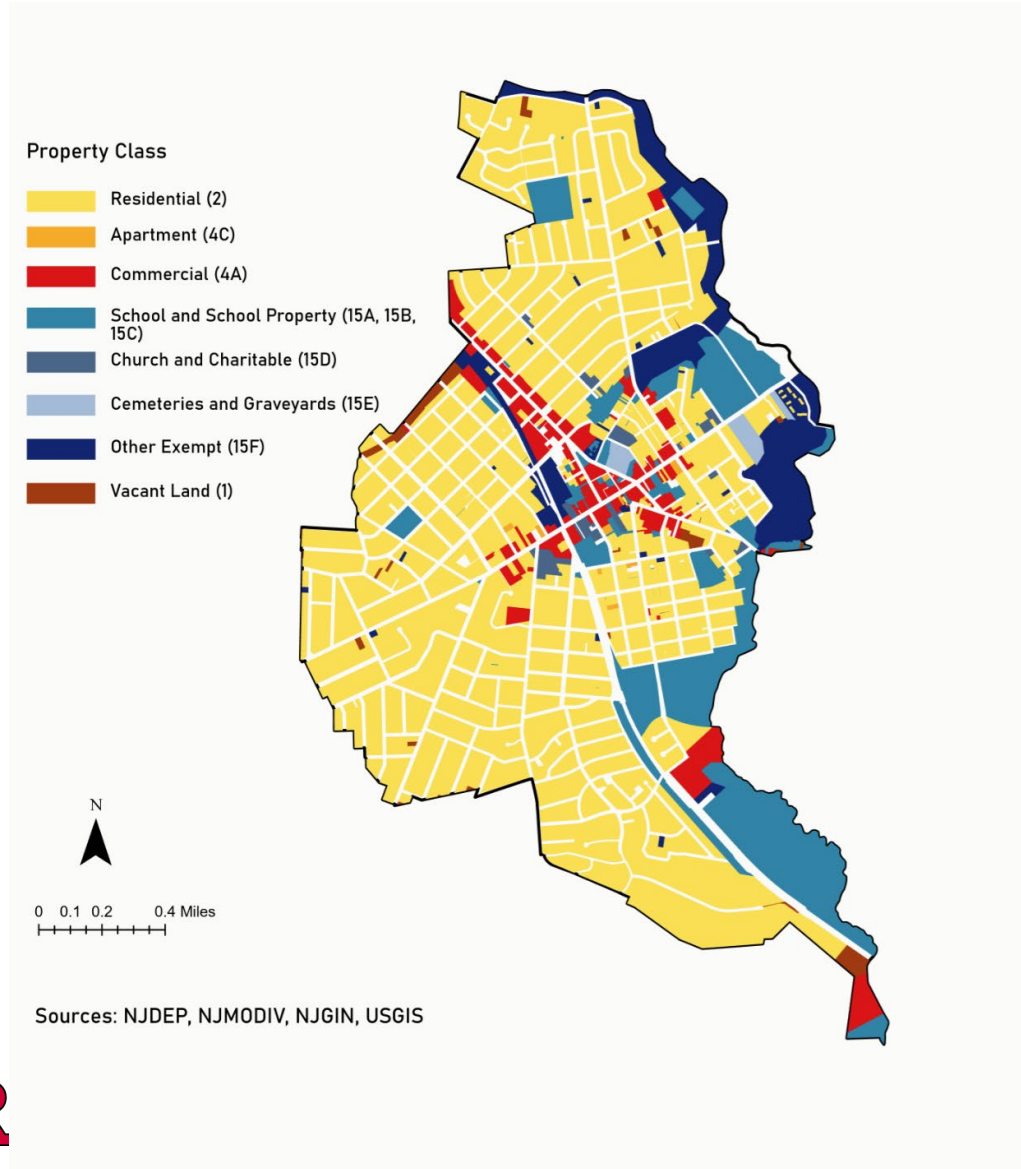
Around 90% of Haddonfield consists of developed land, primarily used for single-family residential housing.

Property Class
- Residential (2)
- Apartment (4C)
- Commercial (4A)
- School and School Property (15A, 15B, 15C)
- Church and Charitable (15D)
- Cemeteries and Graveyards (15E)
- Other Exempt (15F)
- Vacant Land (1)

N

0 0.1 0.2   0.4 Miles

Sources: NJDEP, NJMODIV, NJGIN, USGIS

Land-Use	# of parcels
Residential (2)	4,112
Apartment (4C)	12
Commercial (4A)	279
School and School Property (15A, 15B, 15C)	103
Church and Charitable (15D)	28
Cemeteries and Graveyard (15E)	3
Other Exempt (15F)	40
Vacant (1)	34

Source:NJ MOD-IV property tax data

Climate Change and Natural Hazards in New Jersey

The New Jersey Department of Environmental Protection has released the following data concerning climate change within the state:

TEMPERATURE in NJ has increased 3.9°F since 1895.

Heat-related hospitalizations in NJ increased 156% from 2004 to 2013.

ANNUAL PRECIPITATION in NJ is expected to increase from 6% to 9% by 2100.

SEA-LEVEL RISE could meet or exceed 1.4 feet by 2050. There is a 50% chance.

TROPICAL STORMS have the potential to increase in intensity due to the warmer atmosphere and oceans that will occur with climate change.

EXTREME RAIN in the Northeast increased in amounts by 55% between 1958 and 2016.

BIRD SPECIES are vulnerable to climate change. 29% of all NJ birds will be affected.

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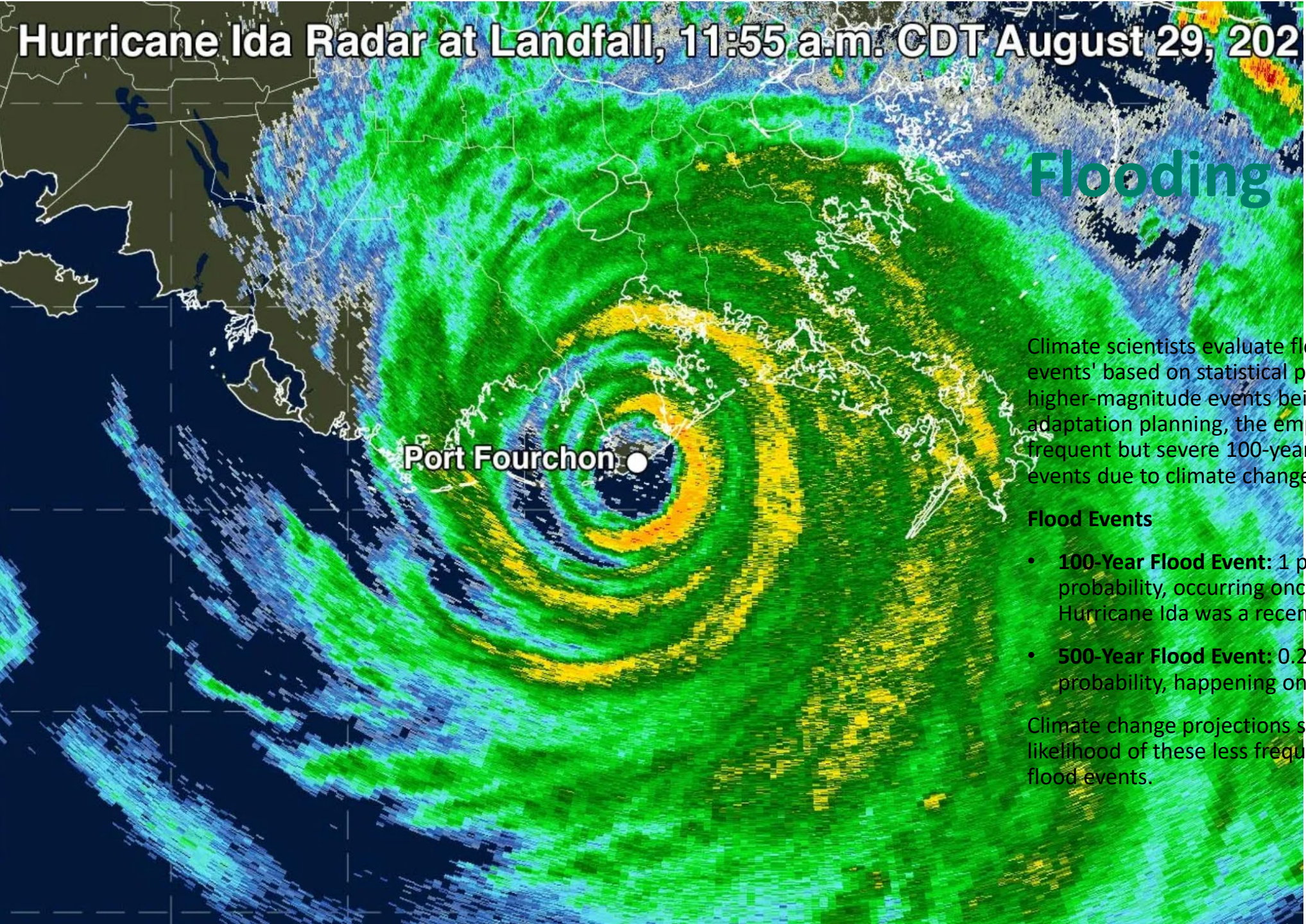
Hurricane Ida Radar at Landfall, 11:55 a.m. CDT August 29, 202

Port Fourchon

Flooding

Climate scientists evaluate floods through 'flood events' based on statistical probability, with higher-magnitude events being less likely. In adaptation planning, the emphasis is on less frequent but severe 100-year and 500-year flood events due to climate change.

Flood Events

- **100-Year Flood Event:** 1 percent annual probability, occurring once every 100 years. Hurricane Ida was a recent example.

- **500-Year Flood Event:** 0.2 percent annual probability, happening once every 500 years.

Climate change projections show increased likelihood of these less frequent, high-magnitude flood events.

Tax Parcel-Wise Flood Risk: 100-Year Flood Event

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Resource Center

Flood Exposure by Property Class (100-Year Event)

Under a moderate emissions scenario, when a flood event with a 1 percent annual probability of occurring transpires, the highlighted tax lots are at risk of flooding.

Property Class
- Residential (2)
- Commercial (4A)
- Public Property (15C)
- Vacant Land (1)
- Other Exempt (15F)
- <Null>

N

0   0.13 0.25   0.5 Miles
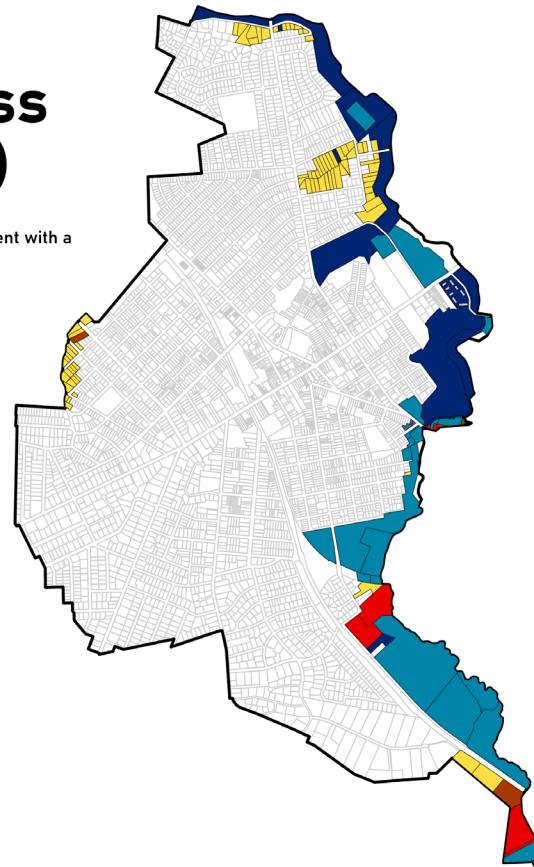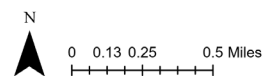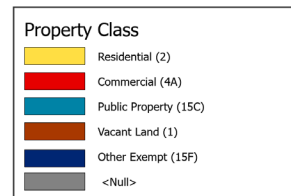
Sources: NJDEP, NJMODIV, NJGIN, USGIS

For each property class, the table below presents the total area of flooded parcels for each land-use, along with the total value of improvements and land. Improvement values represent the worth of physical structures on the property, while land values signify the value of the land itself.

Estimating the total damage value in dollars is helpful in projecting the potential **fiscal impact** on the municipality.

Property Class	# Parcels Flooded (% within property class)	Area Flooded per Property Class (in acres)	Value of Flooded Land Parcels	Value of Flooded Improvement
Residential (2)	74 (1.7%)	43	$24,250,500	$23,439,000
Commercial (4A)	6 (2%)	19	$1,004,700	$997,700
School and School Property (15A, 15B, 15C)	21 (23%)	136	$34,935,200	$5,872,500
Church and Charitable (15D)	2 (7%)	0.5	$334,300	-
Other Exempt (15F)	14 (35%)	103	$9,681,500	$1,193,600
Vacant Land (1)	4 (12%)	5	$506,200	-
Total	**121 (2.6% out of the total # parcels in each land-use)**	306.5 acres at flood-risk	**$70,712,400**	**$31,502,800**

Source: NJ MOD-IV property tax data

Tax Parcel-Wise Flood Risk: 500-Year Flood Event

Flood Exposure by Property Class (500-Year Event)

Under a moderate emissions scenario, when a flood event with a 0.2 percent annual probability of occurring transpires, the highlighted tax lots are at risk of flooding.

Property Class
- Residential (2)
- Commercial (4A)
- Public Property (15C)
- Vacant Land (1)
- Other Exempt (15F)
- <Null>

N

0   0.13 0.25   0.5 Miles
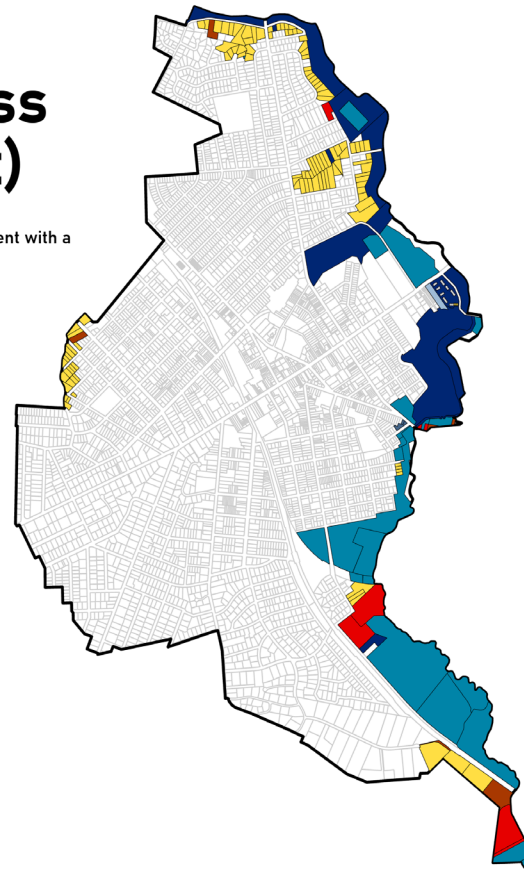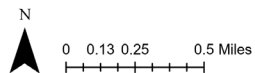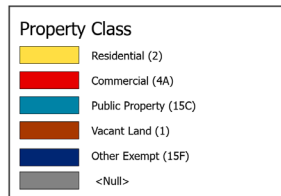
Sources: NJDEP, NJMODIV, NJGIN, USGIS

Property Class	# Parcels Flooded (% within property class)	Area Flooded per Property Class (in acres)	Value of Flooded Land Parcels	Value of Flooded Improvement
Residential (2)	106 (2.5%)	60	$33,652,900	$30,526,200
Commercial (4A)	8 (3%)	20	$1,445,000	$1,006,800
School and School Property (15A, 15B, 15C)	19 (21%)	136	$35,014,500	$5,872,500
Church and Charitable (15D)	1 (3.5%)	0.5	$334,300	-
Cemeteries and Graveyards (15E)	1 (33%)	1.5	$625,500	-
Other Exempt (15F)	11 (27.5%)	103	$9,681,500	$1,193,600
Vacant (1)	7 (20.5%)	6.5	$880,900	-
Total	**153 (3.3 % out of the total # parcels in each land-use)**	**327.5 acres at flood-risk**	**$81,634,600**	**$38,599,100**

Source : NJ MOD-IV property tax data

Extreme Precipitation

The table below illustrates projected rainfall amounts in Haddonfield for different storm events over a 12-hour period under a historical baseline and **two emissions scenarios**: moderate (RCP 4.5) and high (RCP 8.5).

Both scenarios anticipate increased rainfall compared to the baseline across storms of different likelihoods.

Storm Type	Baseline	Moderate Emissions, Mid-Century	Moderate Emissions, Late-Century	High Emissions, Mid-century	High Emissions, Late-Century
50% chance	3.30	3.50	3.60	3.63	3.83
20% chance	4.21	4.51	4.63	4.63	4.93
10% chance	4.99	5.39	5.54	5.49	5.89
4% chance	6.14	6.69	6.88	6.82	7.37
2% chance	7.13	7.85	8.06	7.92	8.63
1% chance	8.23	9.13	9.38	9.22	10.04

Rainfall is measured in inches.

What are emissions scenarios?

Emission scenarios, represented by Representative Concentration Pathways (RCPs), depict potential trajectories for greenhouse gas concentrations.

Developed by the IPCC, RCPs forecast greenhouse gas and air pollutant concentrations until 2100. These trajectories consider various socio-economic, technological advancements, and climate policies aimed at reducing emissions. The four RCP scenarios are summarized below:

Projected Atmospheric Greenhouse Gas Concentrations
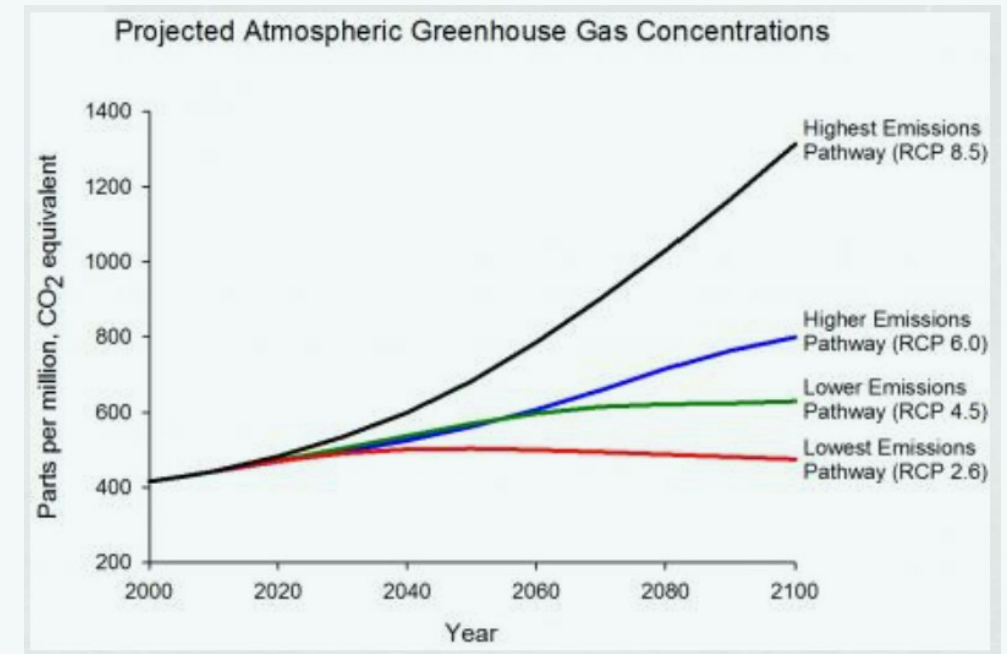
The image displays four distinct RCP trajectories. The highest, RCP 8.5, projects uncontrolled growth in greenhouse gas emissions throughout the century. In contrast, the lowest, RCP 2.6, anticipates emissions peaking between 2010 and 2020, followed by a decline. RCP 4.5 and RCP 6.0 represent moderate emissions pathways.

Flash Flooding

Flash flooding, often triggered by intense thunderstorms, occurs suddenly and catches people off guard due to its rapid onset. The probability of flash flooding rises with extreme precipitation events. Haddonfield faces vulnerability to flash floods in various developed and developable, and redevelopable areas.

This map, prepared by Pennoni Associates, displays developed and impervious surfaces. It also highlights areas excluded from development under current zoning regulations, shown in muted yellow.
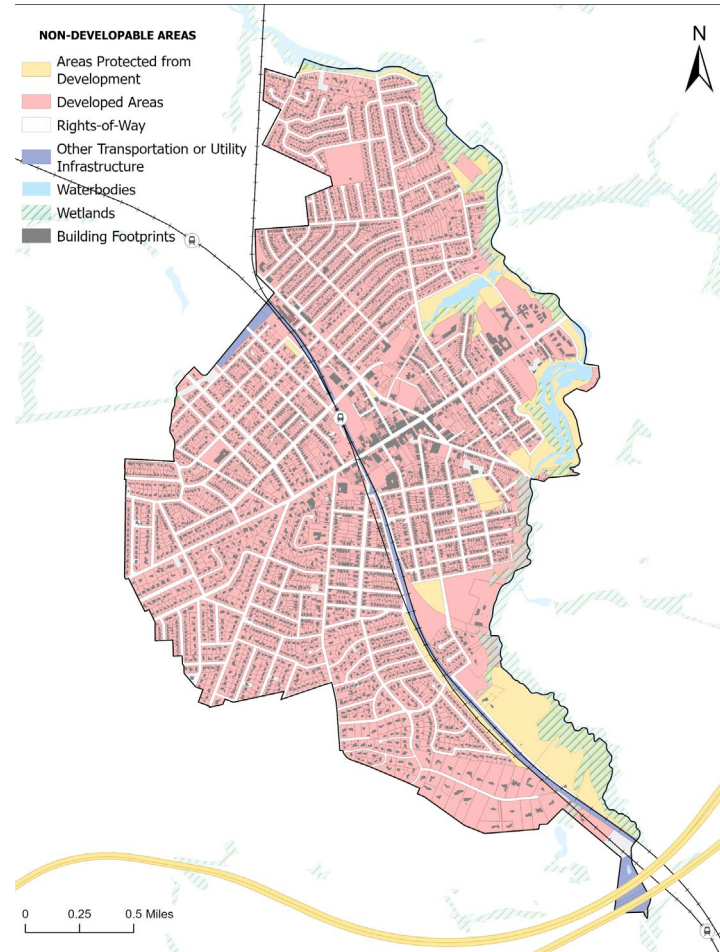
The map illustrates developed and redevelopable regions in Haddonfield susceptible to flooding. This encompasses areas (i) intersecting 100-year Floodplains (violet-highlighted polygons with dark violet boundaries and diagonal lines), (ii) within 500 feet of Flash Flooding Areas of Concern (red-highlighted polygons with dark red boundaries and diagonal lines), and (iii) Flash Flooding Areas of Concern (red-highlighted ovals).

Flash Flooding Areas of Concern

The areas shown in the map to the right are prone to flooding due to factors or a combination of factors like high volumes of runoff or tailwater surcharging from nearby water bodies or lack of adequate drainage infrastructure.

Pennoni Associates proposes the following infrastructure improvements and Green Infrastructure solutions for the Areas of Concern and estimates the costs for implementing them:

Problem Area	Estimated Cost	Type of Improvement (Green/ Drainage/Other)
Oak Avenue	$50,000	Paving/regrading
W Cottage Avenue	$100,000	Paving/regrading
East Park Avenue	$363,000	Dainage
Park Lane	$58,300	Green/regrading
Upland Way	$673,750	Drainage
Coles Mill at Grove Street	$100,100	Green
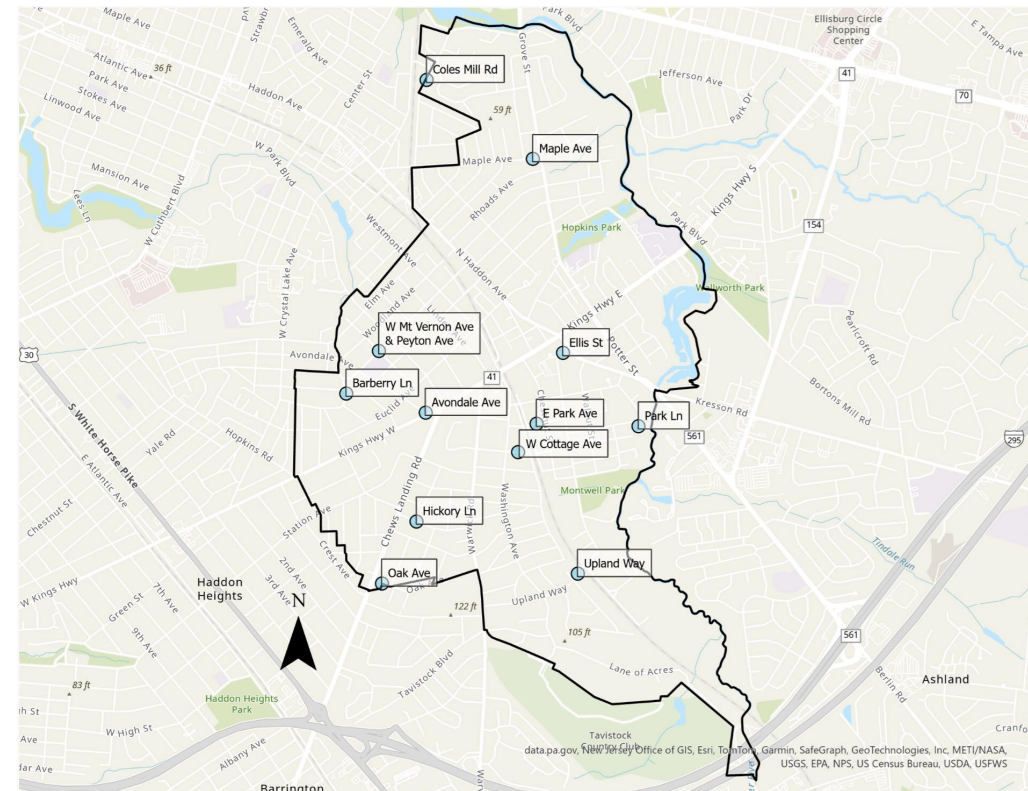
Source: Pennoni Associates (2022), Stormwater Drainage Study and Green Infrastructure Plan for Haddonfield Borough

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Extreme Heat

New Jersey is experiencing accelerated warming, surpassing the global average of 2.0°F (1.1°C) and the Northeast regional average of 2.7°F (1.5°C). Heatwaves are expected to increase in frequency and duration by 2050 (NJDEP, 'Climate Change and its Impacts'). The bar chart depicts the upward trend in New Jersey's average summer temperatures from 1900 to 2022, measured in °C, indicating a rise over the past century.

Trend in New Jersey Average Temperature
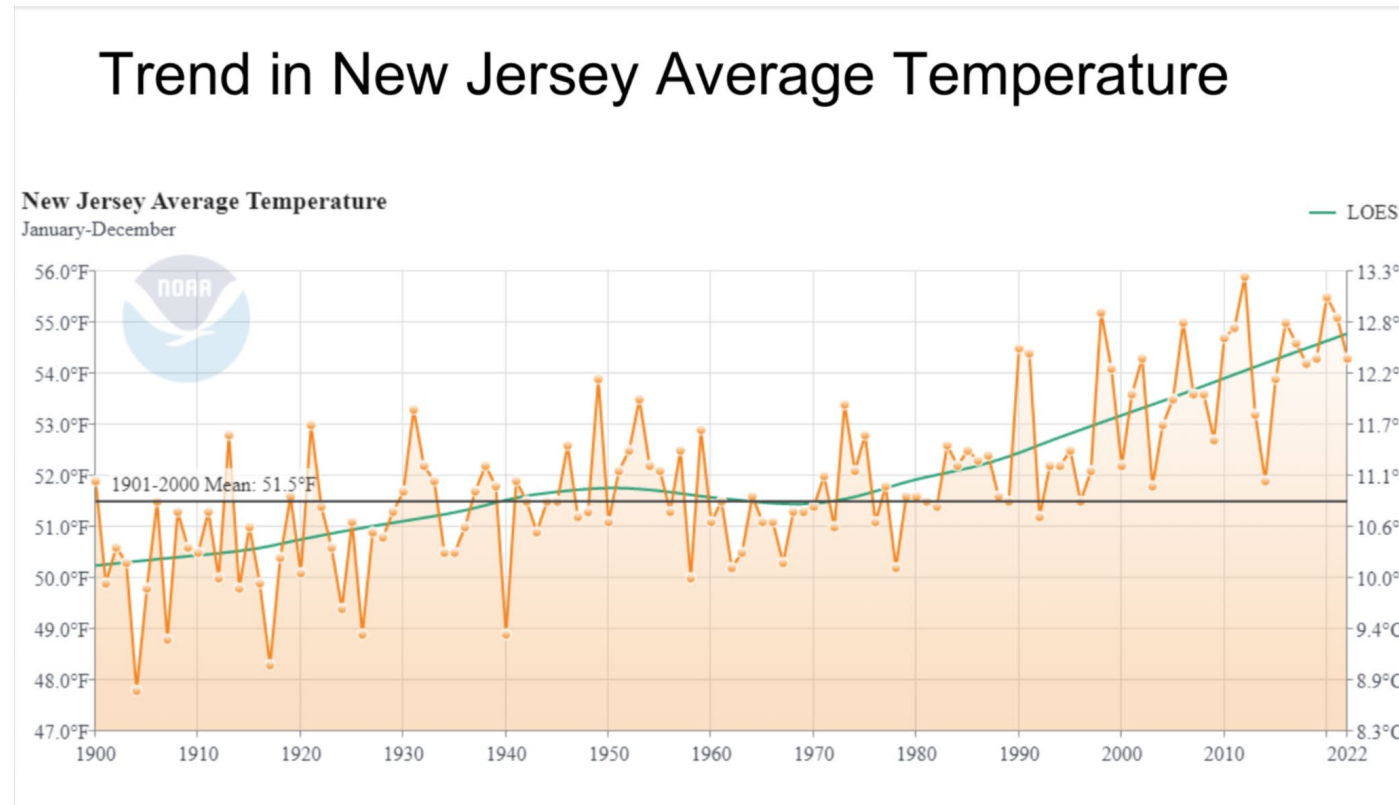
Source: NJCCRC using NOAA/National Centers for Environmental Information data

Impervious Coverage

Building Coverage
Impervious Coverage
Parcel Boundaries

Much of Haddonfield is developed, having a high proportion of impervious surface coverage, making it vulnerable to heat waves. The building coverage and impervious cove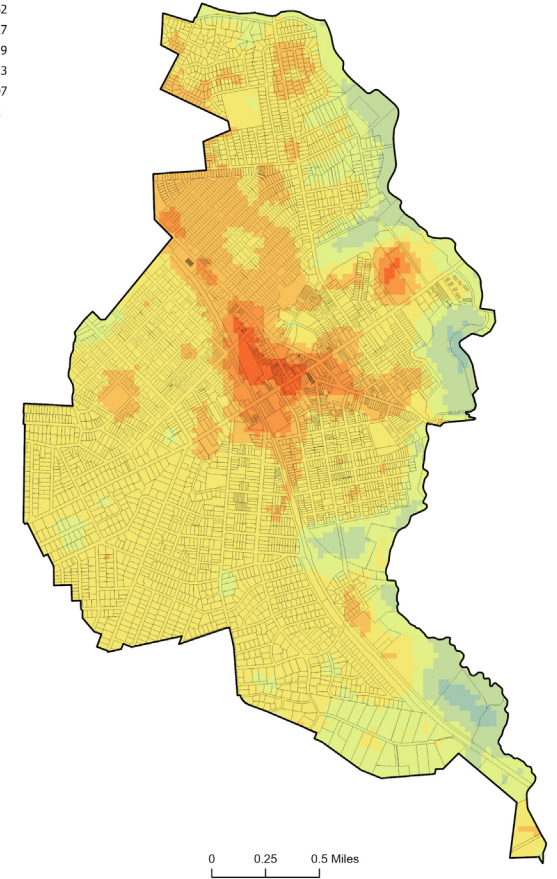rage within Haddonfield can be seen in the map on the left, prepared by Pennoni Associates as part of the Build-Out Analysis for the CCRHVA.

Land Surface Temperature (Fahrenheit)
- 127 - 162
- 119 - 127
- 113 - 119
- 107 - 113
- 102 - 107
- 97 - 102
- 92 - 97
- 87 - 92
- 81- 87
- 48 - 81

The central part of Haddonfield, consisting of the PATCO Haddonfield Station with its rapid transit lines and a concentration of commercial establishments, has a high proportion of impervious surface, along with a heightened transportation activity. Consequently, as the map below shows, the Land Surface Temperature in the borough for the year 2022, is higher in the central part compared to the rest of Haddonfield.

0   0.25   0.5 Miles

Source: Pennoni Associates (2022), Stormwater Drainage Study and Green Infrastructure Plan for Haddonfield Borough

Source: Pennoni Associates (2022), Stormwater Drainage Study and Green Infrastructure Plan for Haddonfield Borough

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Haddonfield's Heat Vulnerability Index

Haddonfield's four census tracts rank highest in Exposure due to prevalent environmental stressors. Following Exposure, Sensitivity and then Adaptive Capacity are prioritized. Despite high Exposure, positive socio-economic factors mitigate impact, resulting in a lower Heat Vulnerability Index (HVI) than Camden County.


Heat Vulnerability Index Indicators

- **Exposure:** Represents environmental stressors contributing to adverse health outcomes. Sub-indicators include Impervious Cover Ratio, PM2.5 Concentration, Ozone Exceedance Days, and Summer Average Temperature Normals.

- **Sensitivity:** Reflects individuals' and communities' susceptibility to extreme heat. Sub-indicators include Population Below 5 Years, Disability Rate, Homes Built Before 1960, Outdoor Occupation, Living Alone, Asthma, Diabetes, and Heart Disease Prevalence.

- **Adaptive capacity:** Signifies the ability to respond to extreme heat. Sub-indicators include Poverty Rate, Unemployment Rate, Linguistic Isolation, Education Level, Non-White Population, and Health Insurance Coverage.
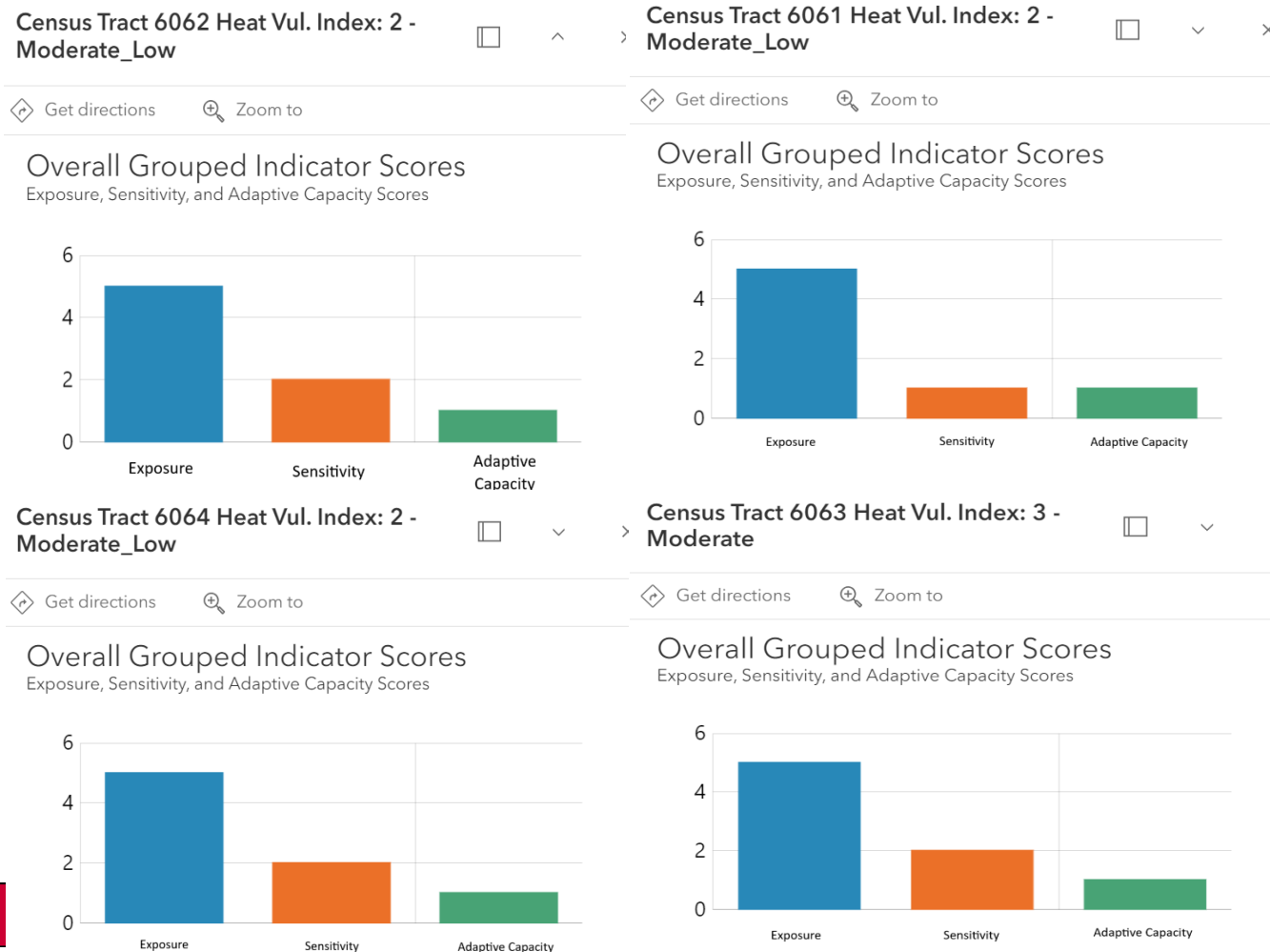
Haddonfield's HVI Compared to the Rest of Camden County

Overall, Haddonfield's HVI remains relatively lower compared to Camden County.

This can be partly attributed to Haddonfield having a higher canopy cover in each land use, compared to the rest of the county, contributing to reducing the community's vulnerability to extreme heat. **The canopy cover of Haddonfield compared to Camden County within each type of land-use category can be seen below.**
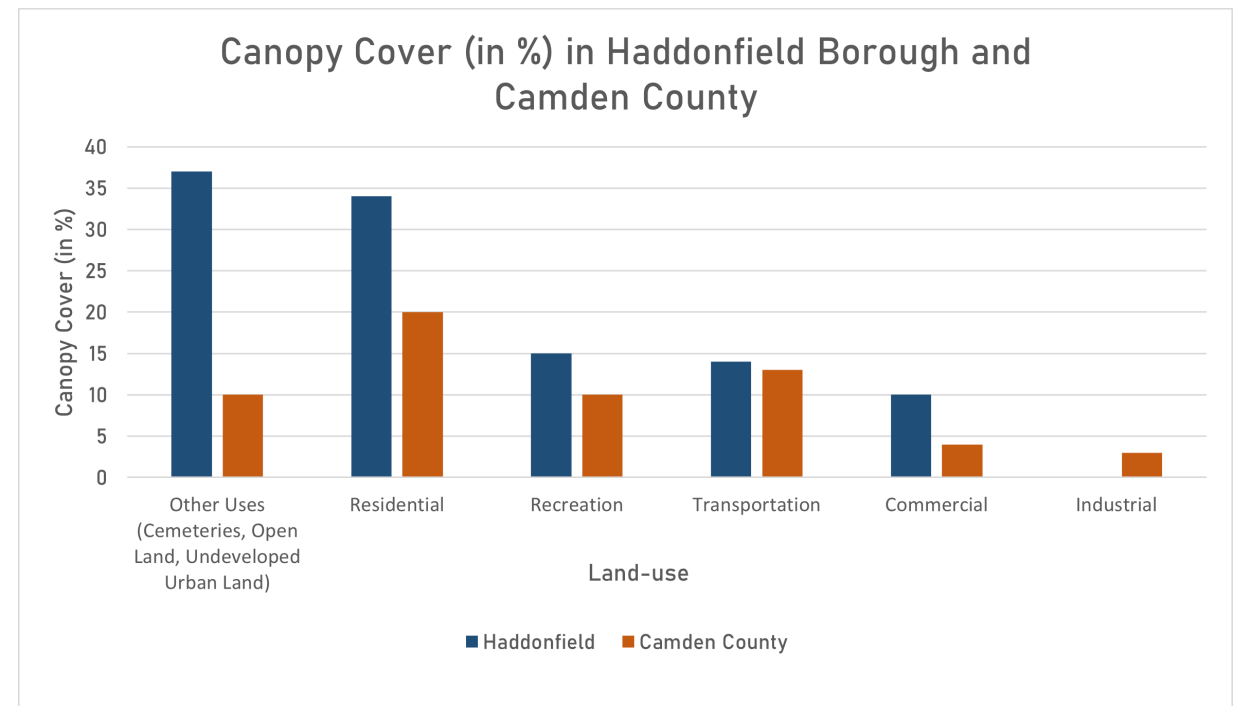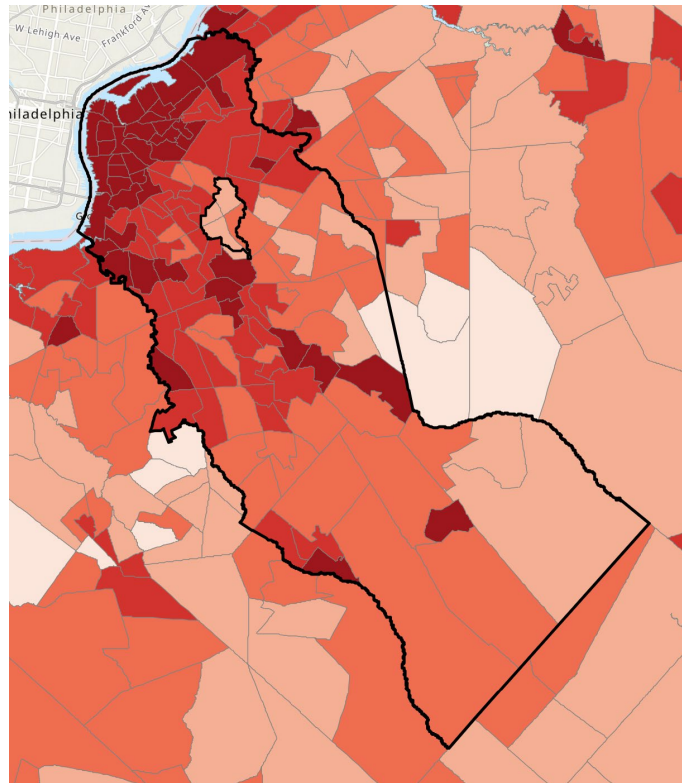
Climate Snapshots, New Jersey Climate Change Resource Center

Conclusion

- Haddonfield exhibits lower susceptibility to natural hazards compared to other parts of New Jersey and the Northeastern region, **yet the impacts of recent flash floods has been alarming**.

- It is imperative for the borough to **enhance its stormwater system** to address flooding during extreme storm and precipitation events.

- **Installing green infrastructure** is essential to bolster the community's flood mitigation capabilities.

- **Increasing pervious coverage**, particularly by expanding canopy cover, can mitigate both flood impacts and the effects of extreme heat.

THANK YOU!

Lucas Marxen

Associate Director

SEBS/NJAES Office of Research Analytics

ljmarxen@njaes.rutgers.edu

https://ora.rutgers.edu

Pritpal Bamhrah

Senior Research Specialist

New Jersey Climate Change Resource Center

pritpal.bamhrah@ejb.Rutgers.edu

https://njclimateresourcecenter.rutgers.edu

Websites

- NJ ADAPT
  - https://njclimateresourcecenter.rutgers.edu/nj-adapt/

- NJ Climate Dashboards
  - https://climatedashboards.rutgers.edu/

- NJFloodMapper
  - https://njfloodmapper.org

- Municipal Snapshots
  - https://climatesnapshots.rutgers.edu

- NJ HazAdapt
  - https://njhazadapt.rutgers.edu

- NJ Forest Adapt
  - https://njforestadapt.rutgers.edu

- NJ Public Health Adapt
  - https://njhealthadapt.rutgers.edu

- NJ Adapt Local Climate-Related Hazard Planning Navigator
  - https://njclimatenavigator.rutgers.edu/localplanning

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