Hazen

SeSwA Southeast Stormwater Association

Incorporating Climate Resiliency into Common Drainage Improvements

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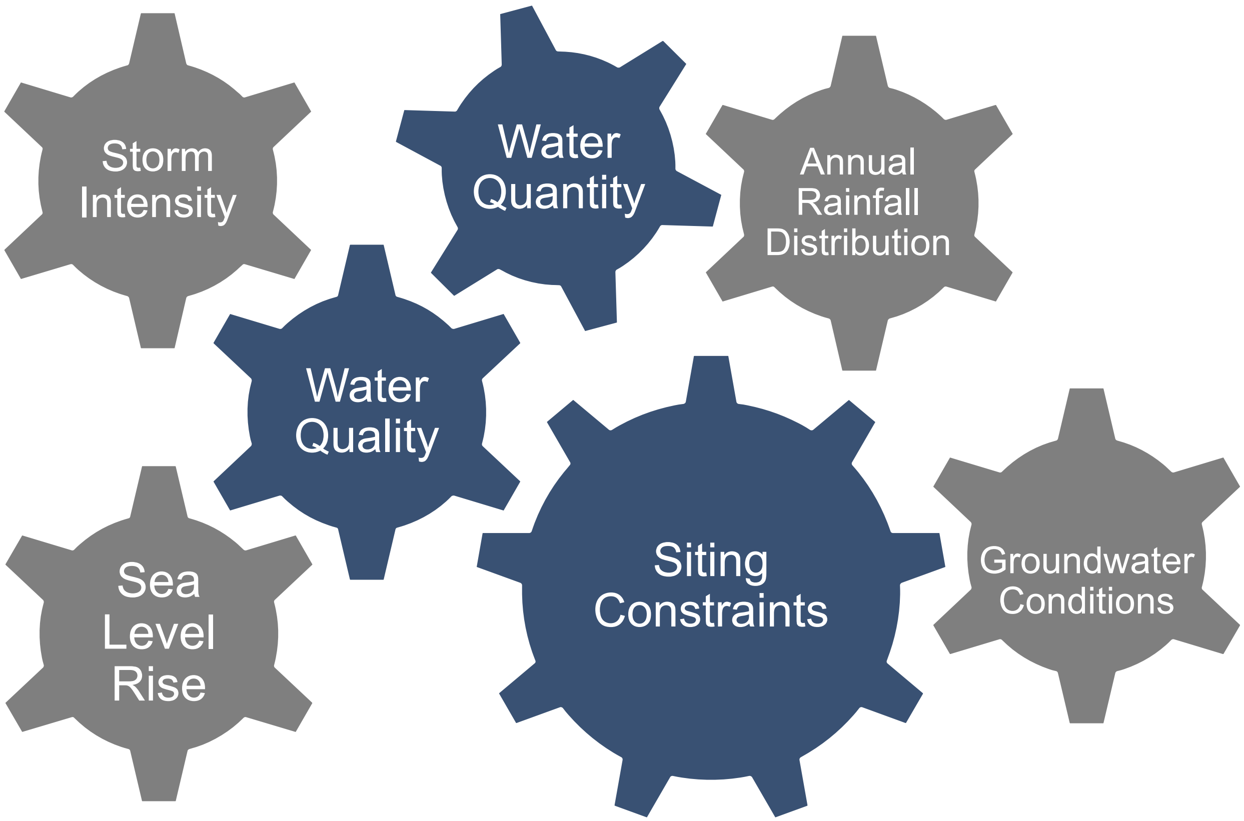
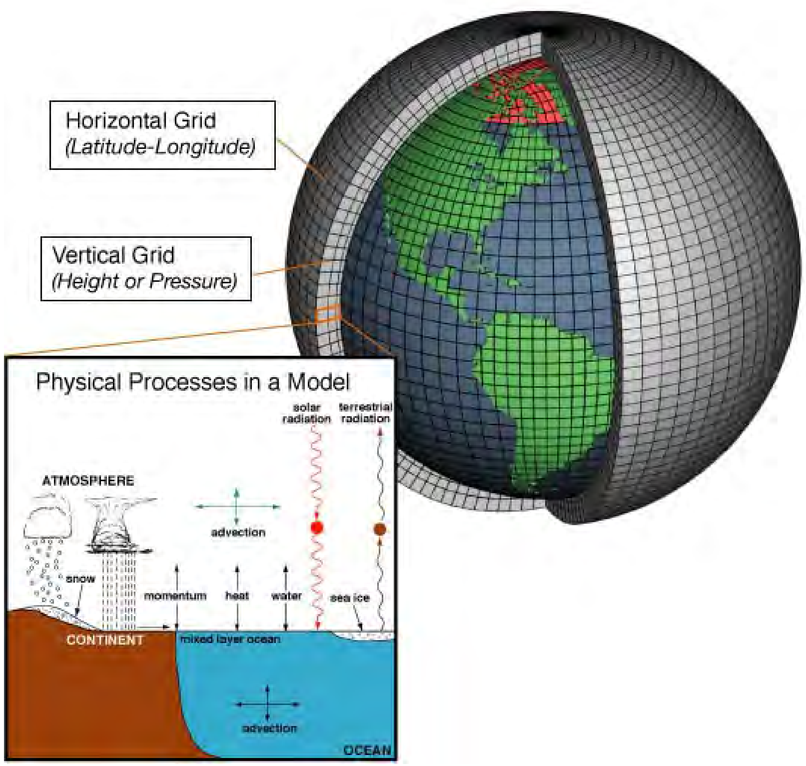
Climate Influences on Stormwater Management



Track and Project Impacts

Climate Impact Projections from Global Climate Models (GCMs)



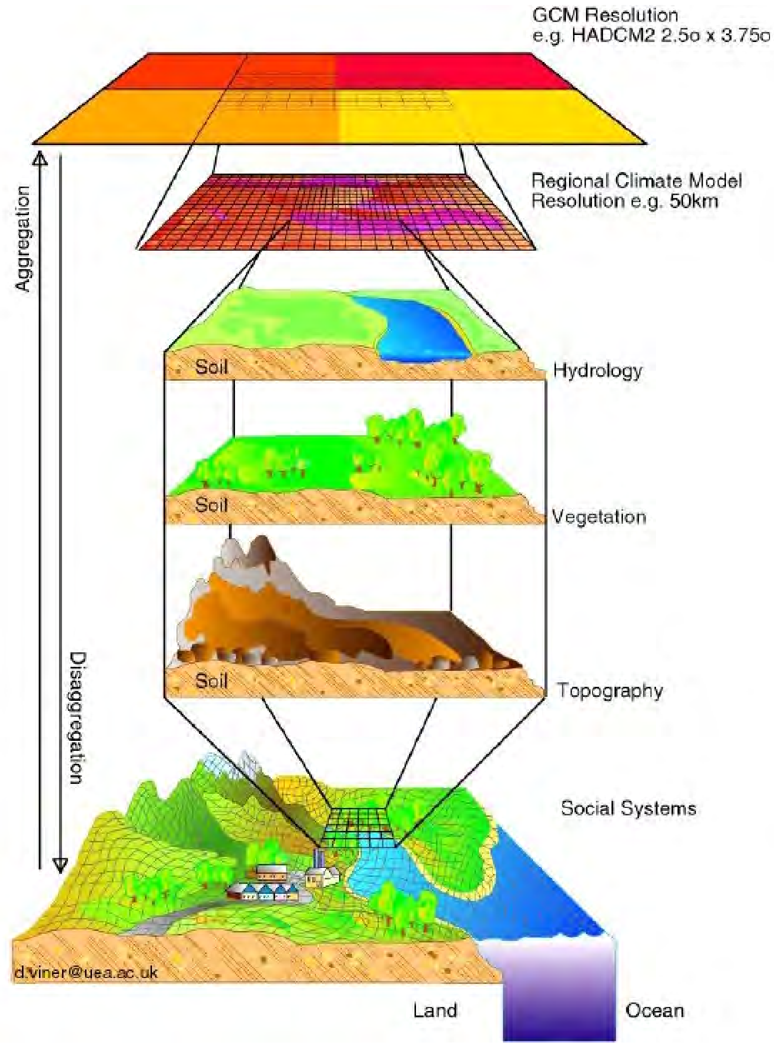
http://celebrating200years.noaa.gov/breakthroughs/climate_model/modeling_schematic.html

Downscaling

How do I obtain local climate impact projections?

Dynamic Downscaling:
Replicate physical processes

Statistical Downscaling:
Statistically correlate changes



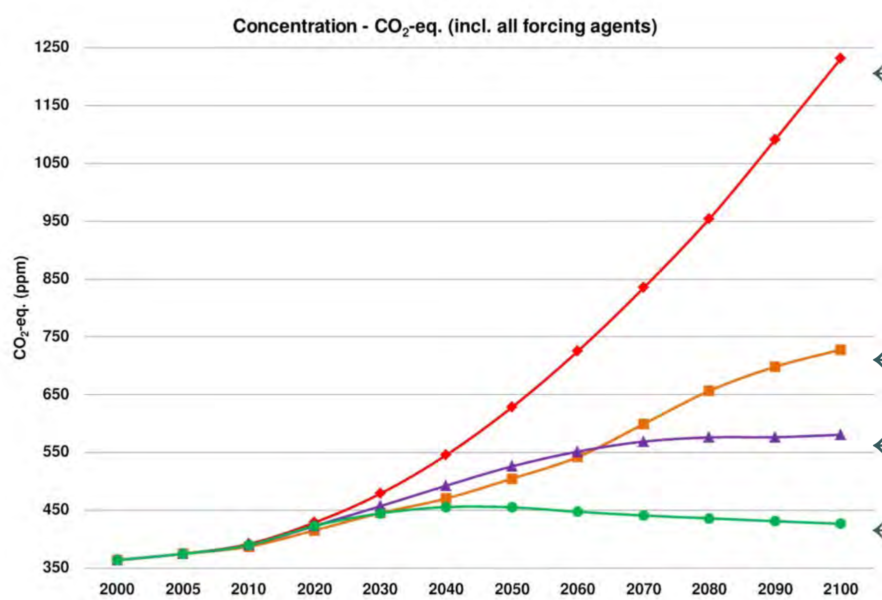
http://www.cccsn.ec.gc.ca/?page=downscaling

Track and Project Causes

GHG Representative Concentration Pathways (RCPs)

Greenhouse gas concentration trajectories

Radiative forcing in 2100 vs. pre-industrial



← RCP 8.5 (Worst Case)

←RCP 6.0

←RCP 4.5

←RCP 2.6 (Best Case)

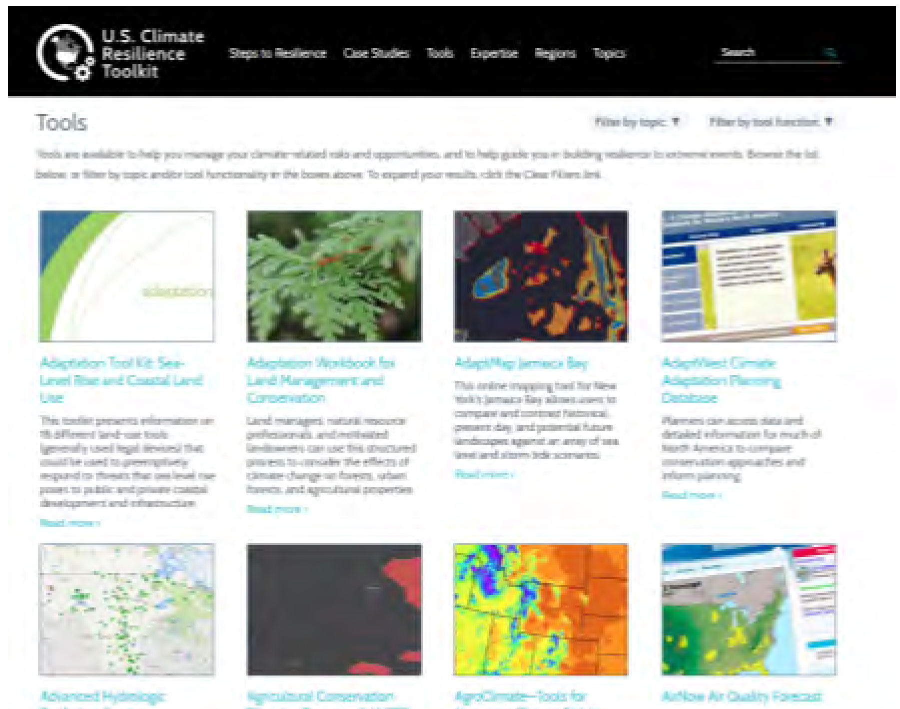
IPCC 5th Assessment Report

U.S. Climate Resiliency Toolkit

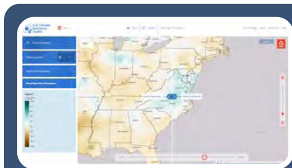
Wide array of tools

Varying degrees of accessibility

National and regional focus



U.S. Climate Resiliency Toolkit



NOAA Climate Explorer

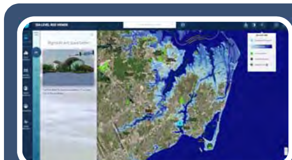
- Days with Storms >1 inch
- Mean Daily Precipitation

EPA CREAT

- Annual Precipitation Depths
- 100-yr Storm Intensities

SWMM Climate Adjustment Tool

- 24-hr Design Storms



NOAA Sea Level Rise Viewer

- Sea Level Rise Projections
- Inundated Areas

NOAA Climate Explorer

Overview maps and graphs

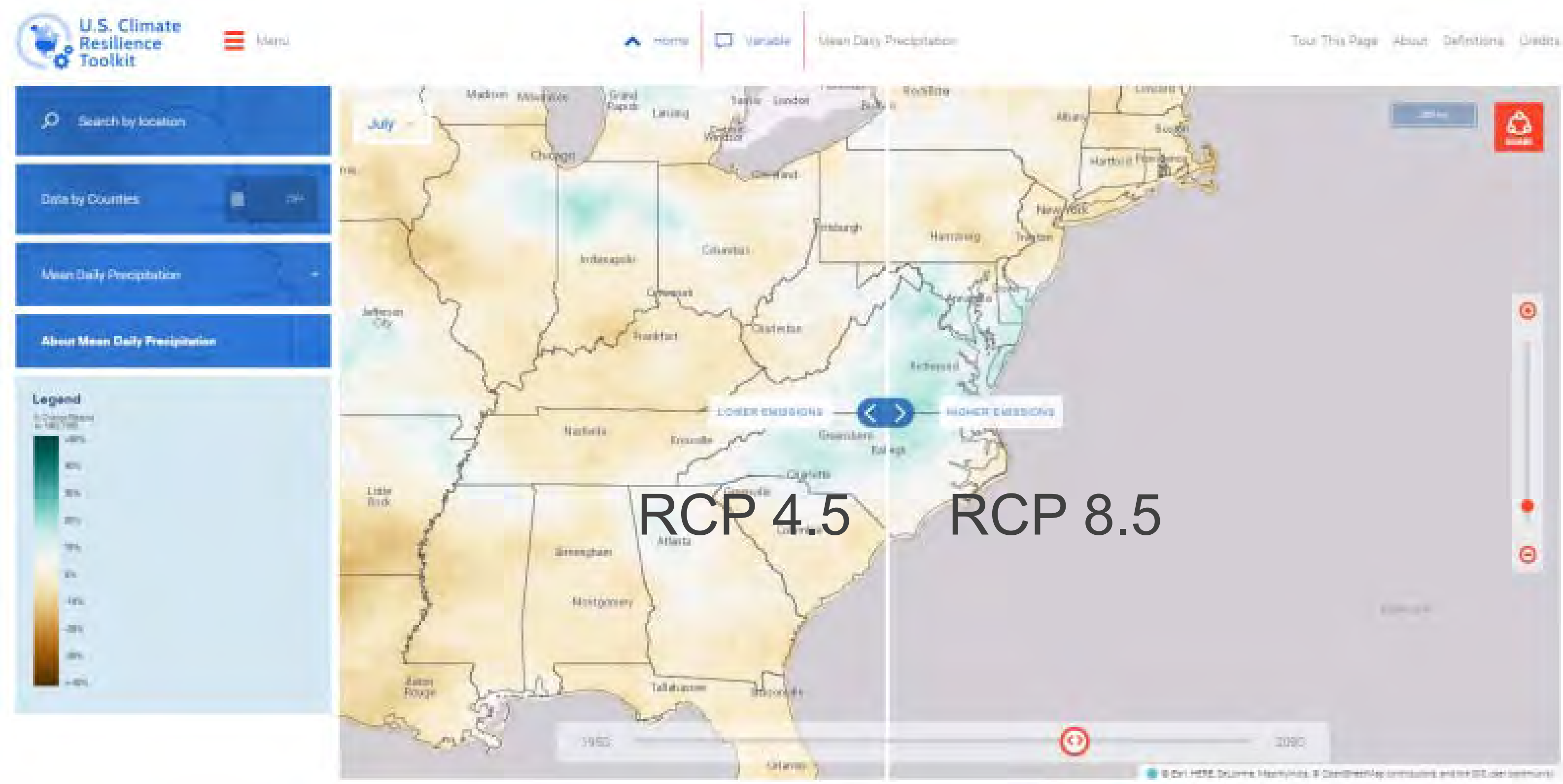
Data by county

Statistical downscaling

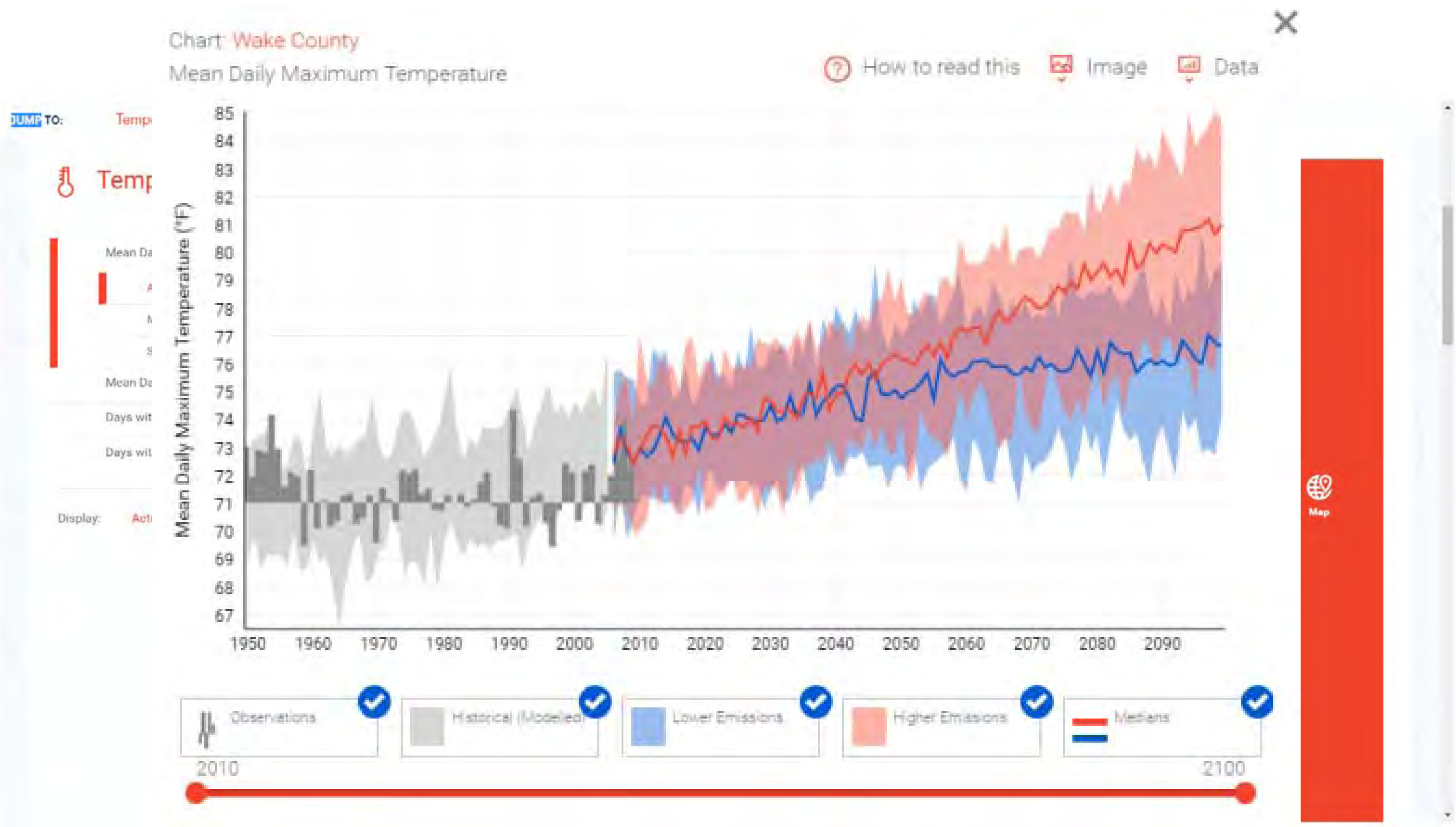
Main Parameters:

- Temperature
- Precipitation
- Heating/Cooling Degree Days

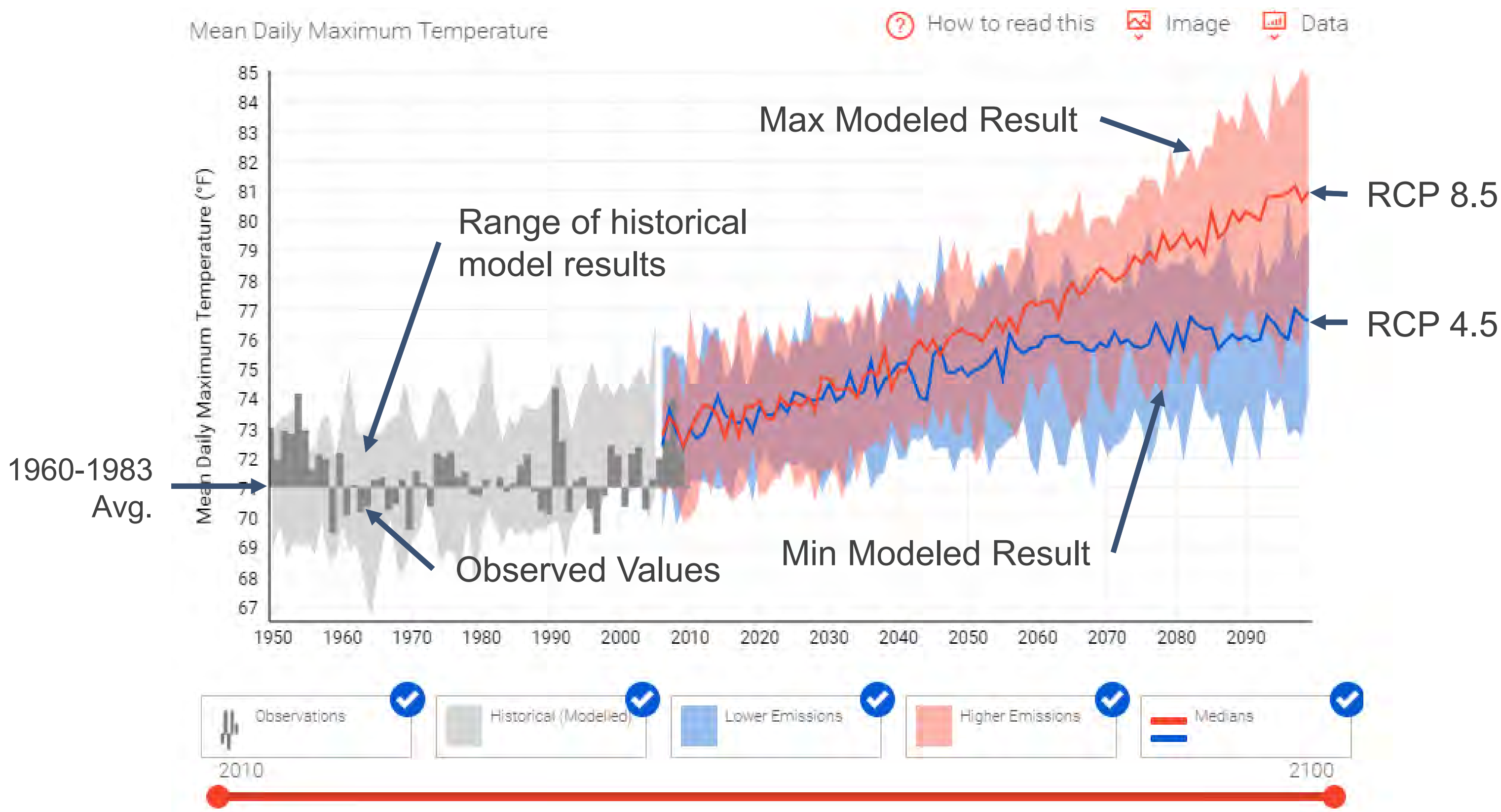
NOAA Climate Explorer



NOAA Climate Explorer

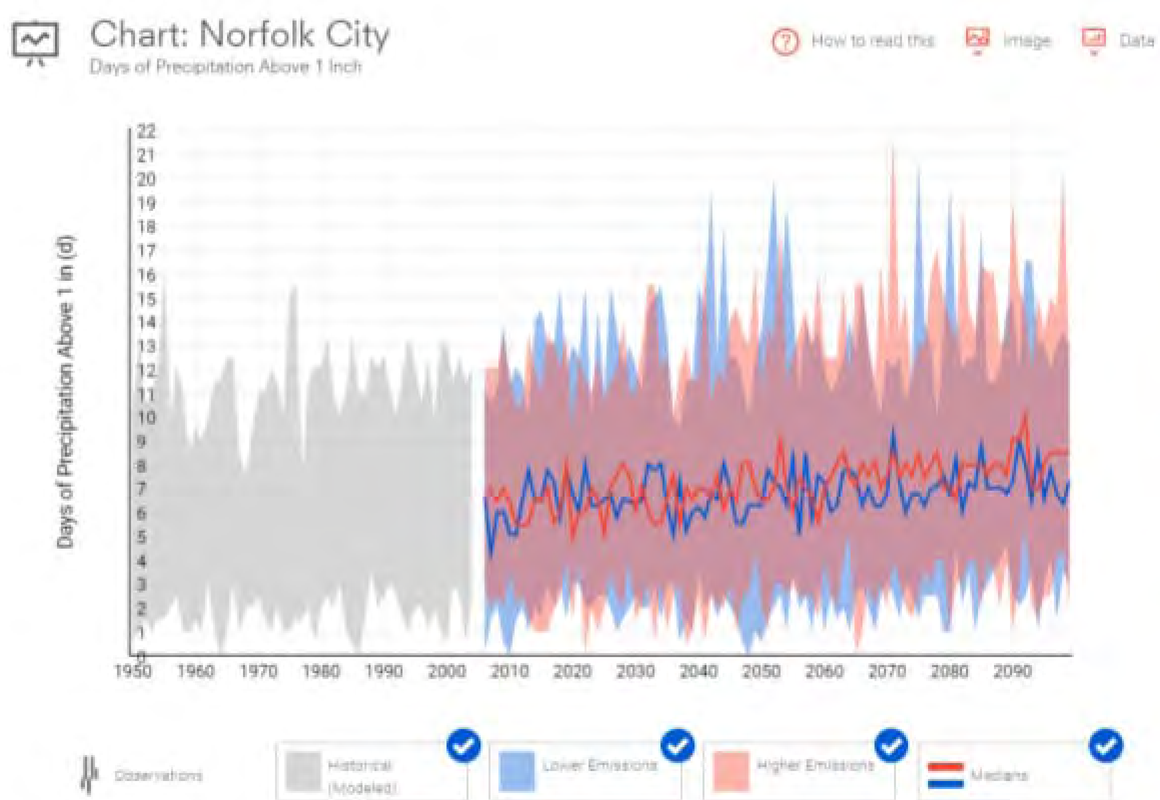


NOAA Climate Explorer



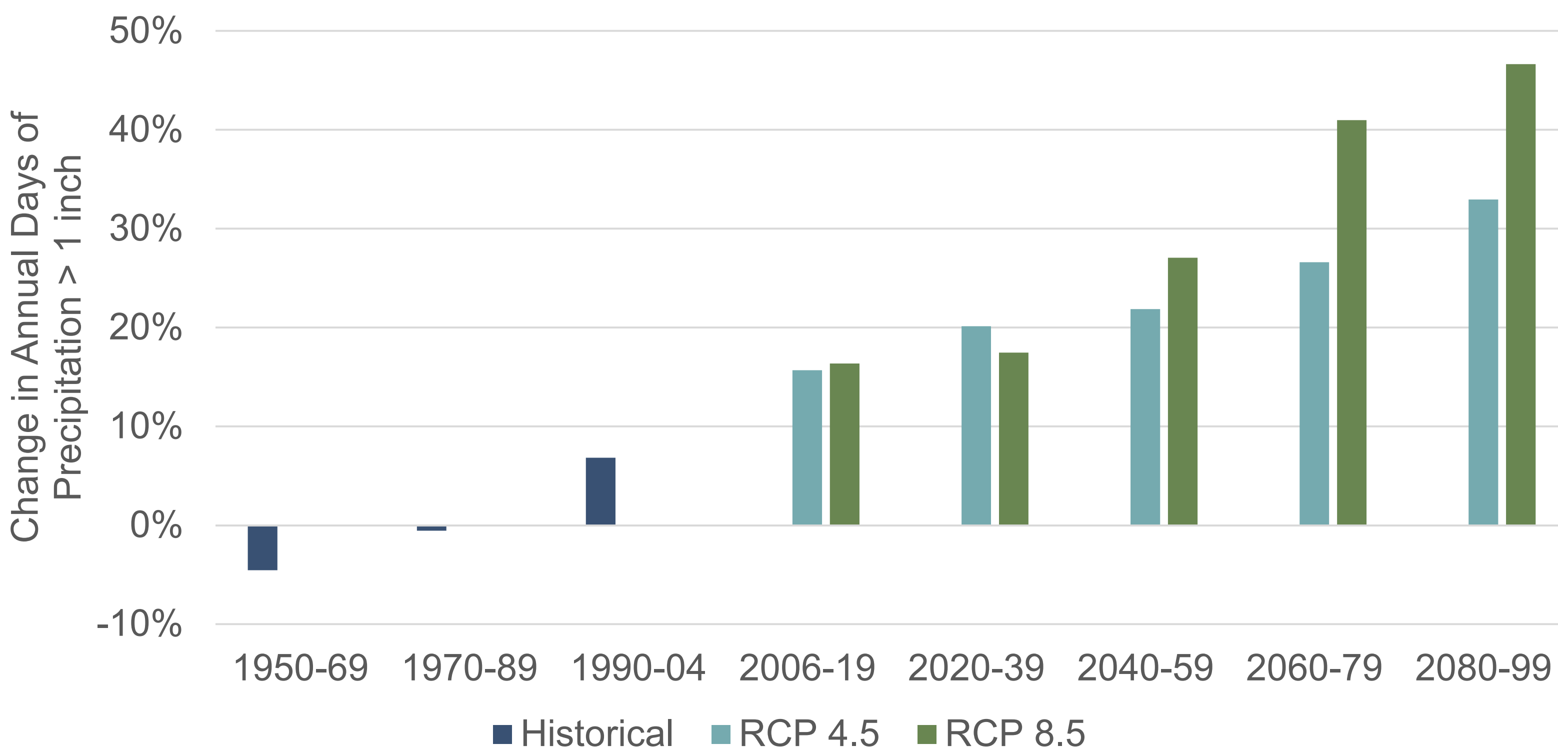
NOAA Climate Explorer

Days of Precipitation > 1 inch



NOAA Climate Explorer

Days of Precipitation > 1 inch



EPA CREAT

Climate Resiliency Evaluation and Awareness Tool

Framework for localized assessments

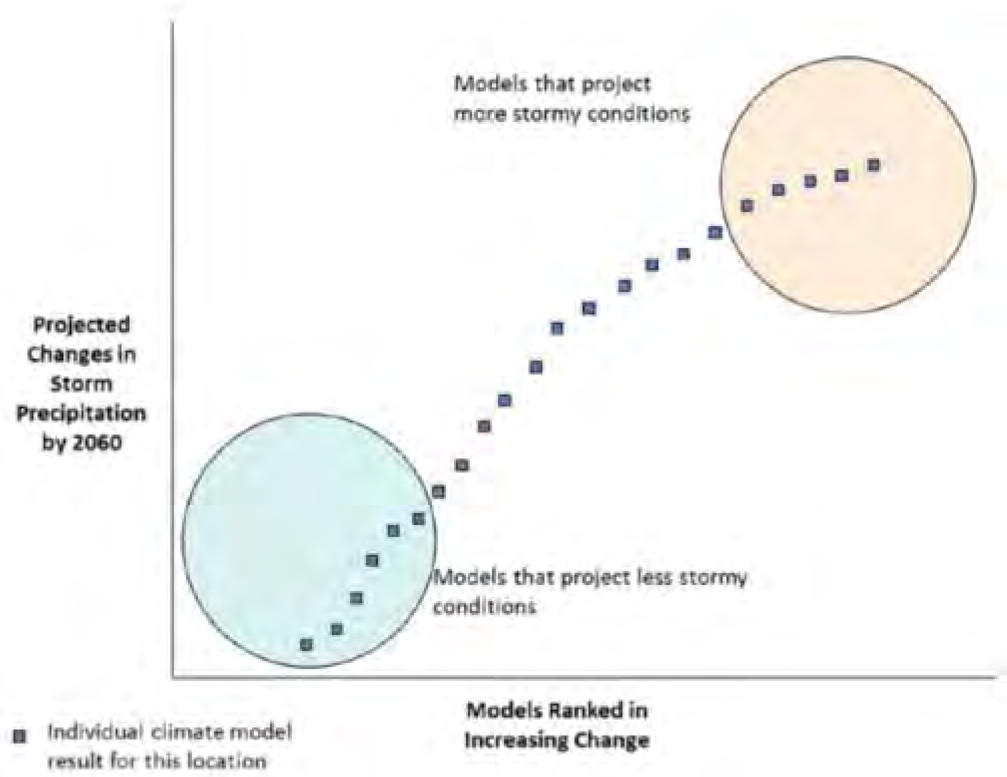
3 base scenarios
- Hot / Dry
- Central
- Warm / Wet

3 horizons
- 1981-2010 baseline
- 2026-2045 (2035 period)
- 2051-2070 (2060 period)

Main Parameters:
- Temperature
- Precipitation
- Sea Level

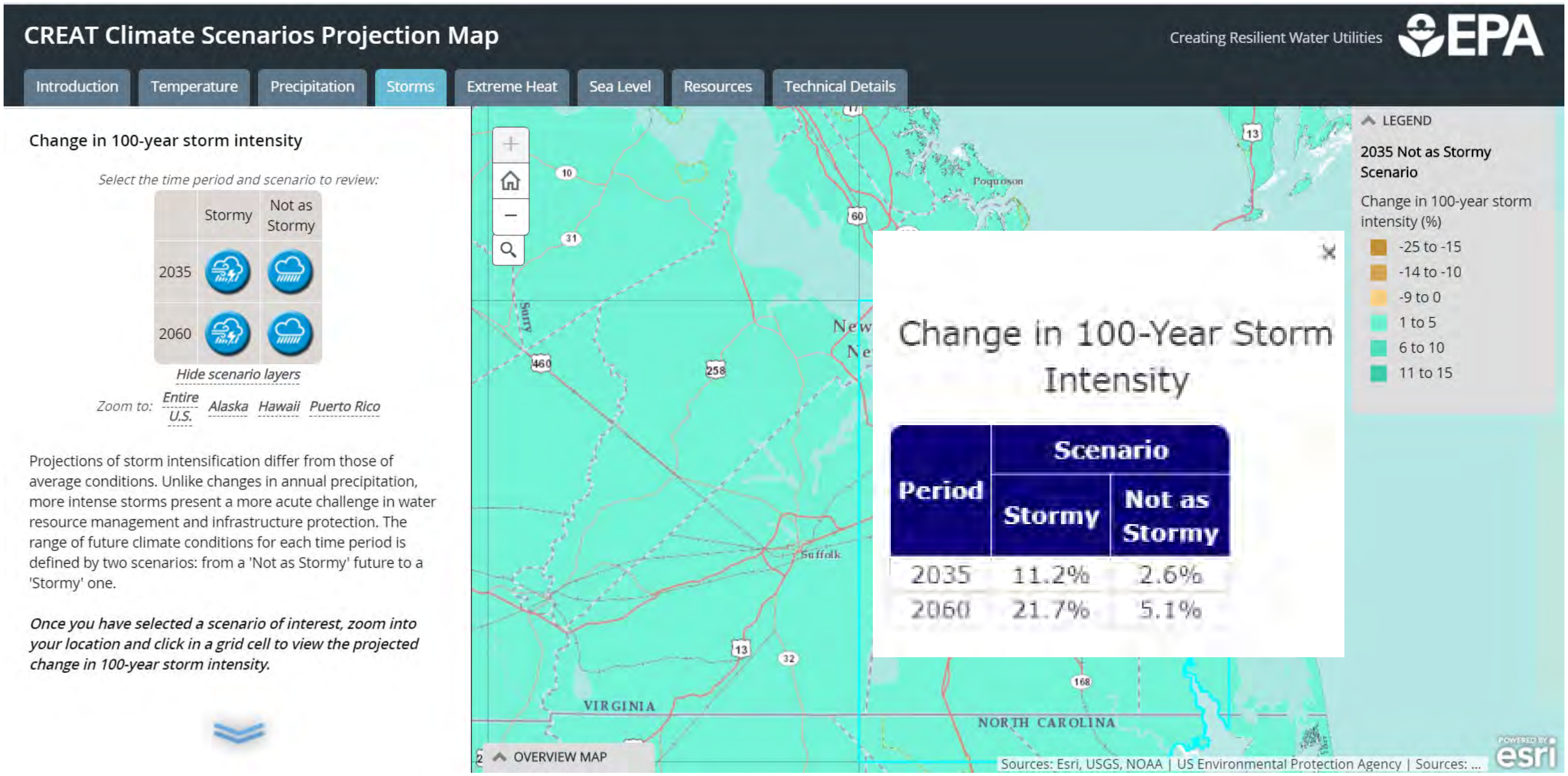
EPA CREAT

Stormy vs. Not as Stormy



EPA CREAT

Change in 100-year storm intensity



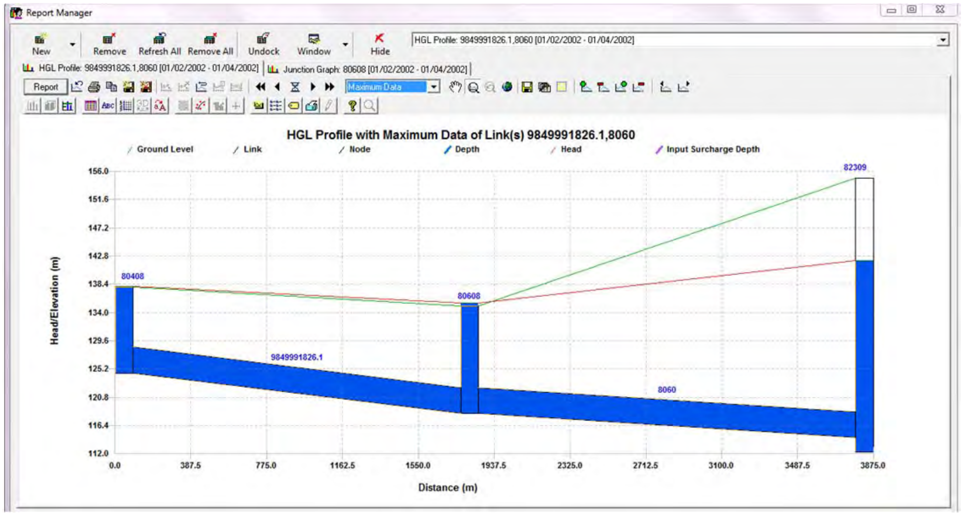
SWMM Climate Adjustment Tool

Add-on for EPA's StormWater Management Model

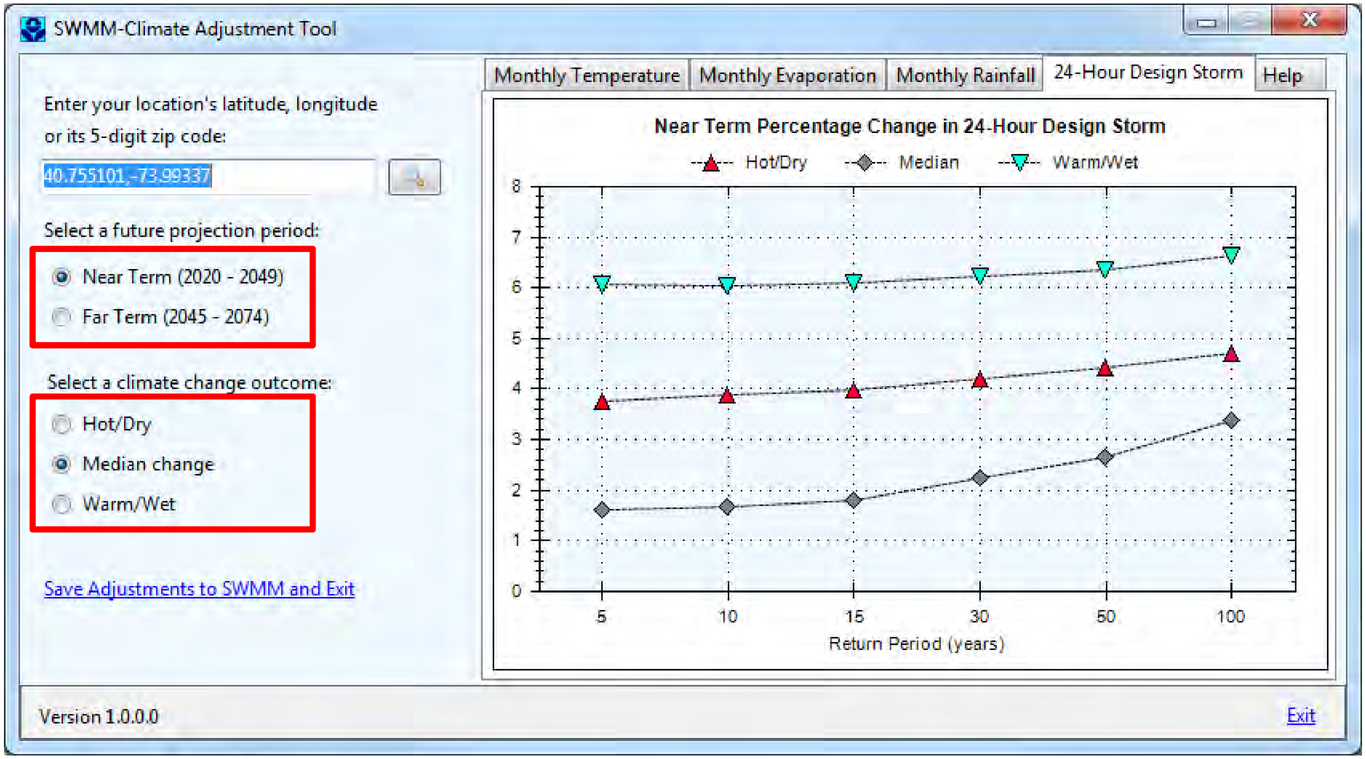
Based on EPA CREAT data

Parameters:

- Monthly temperature
- Monthly evaporation
- Monthly precipitation
- 24-hr design storm



SWMM Climate Adjustment Tool



10-Year Rainfall Adjustment Factors

Greenville, NC

Model Scenario	Increase
Hot / Dry	+2.1%
Median	+0.5%
Warm / Wet	+3.1%

Model Case Study – Brook Hollow

Greenville, NC

Model Case Study – Brook Hollow

Greenville, NC

Characteristics

- Residential
- Small drainage areas (0.2 – 2 acres)
- Primarily curb and yard inlets

Model Case Study – Brook Hollow

Results

Hydraulic Grade Line Changes

	Hot / Dry	Median	Warm / Wet
Existing	+0.06	+0.17	+0.22
Improved	+0.13	+0.48	+0.80

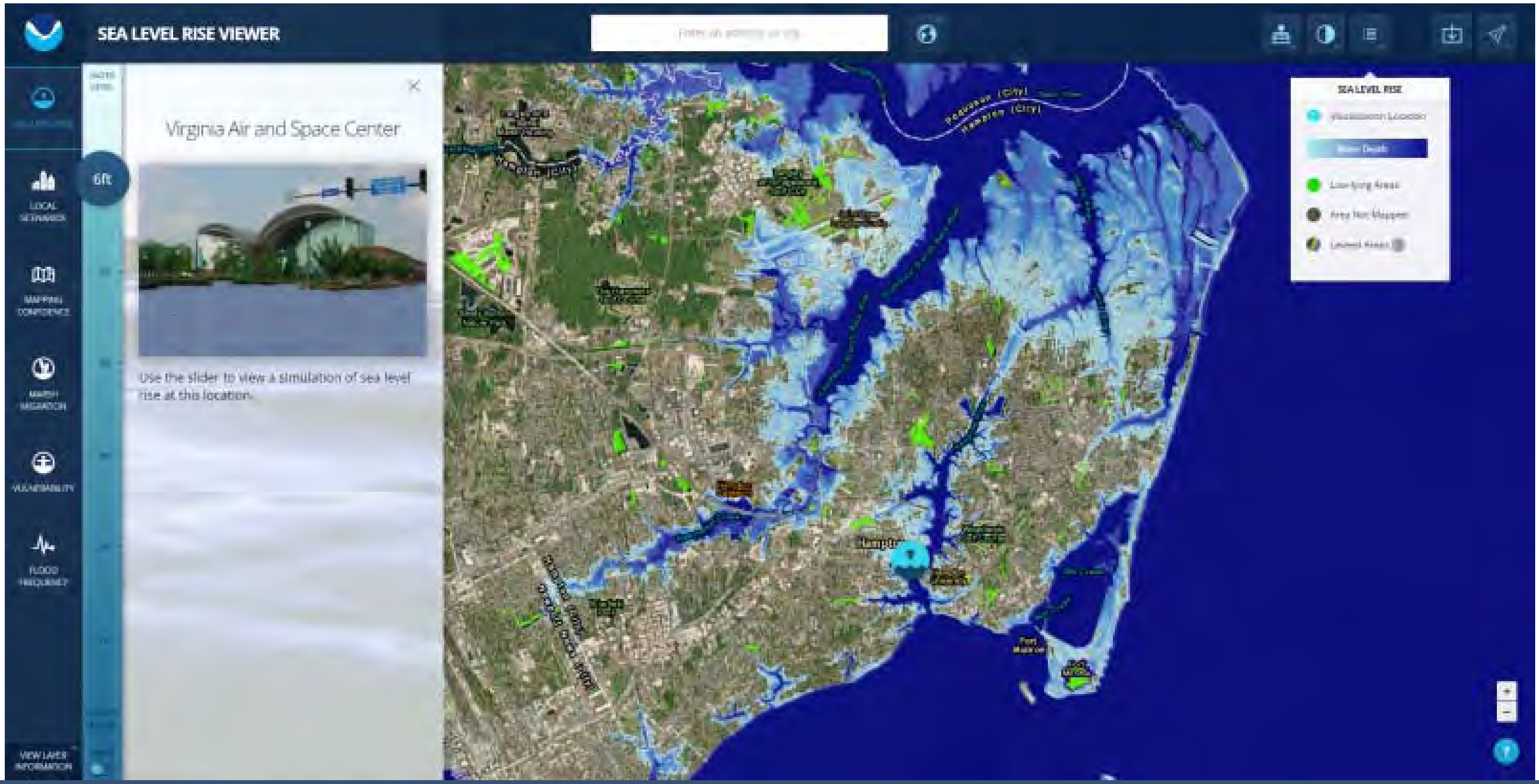
Model Case Study – Brook Hollow

Conclusions

Conclusions

- SWMM-CAT = simple assessment of CC impact
- Allows quantification of impact
- Which scenario should be used?
- Brook Hollow: small changes in HGL
- “Tight” designs can fail when adjusted

NOAA Sea Level Rise Viewer



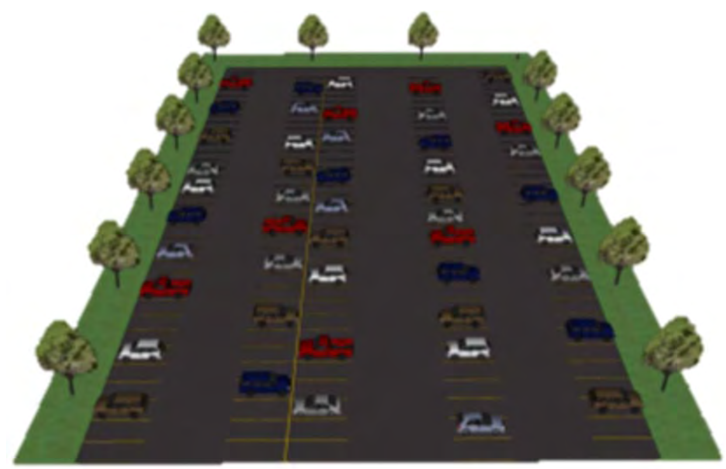
Stormwater Control Design Example

Site Overview and Design Objectives

New 2 acre 75% impervious development

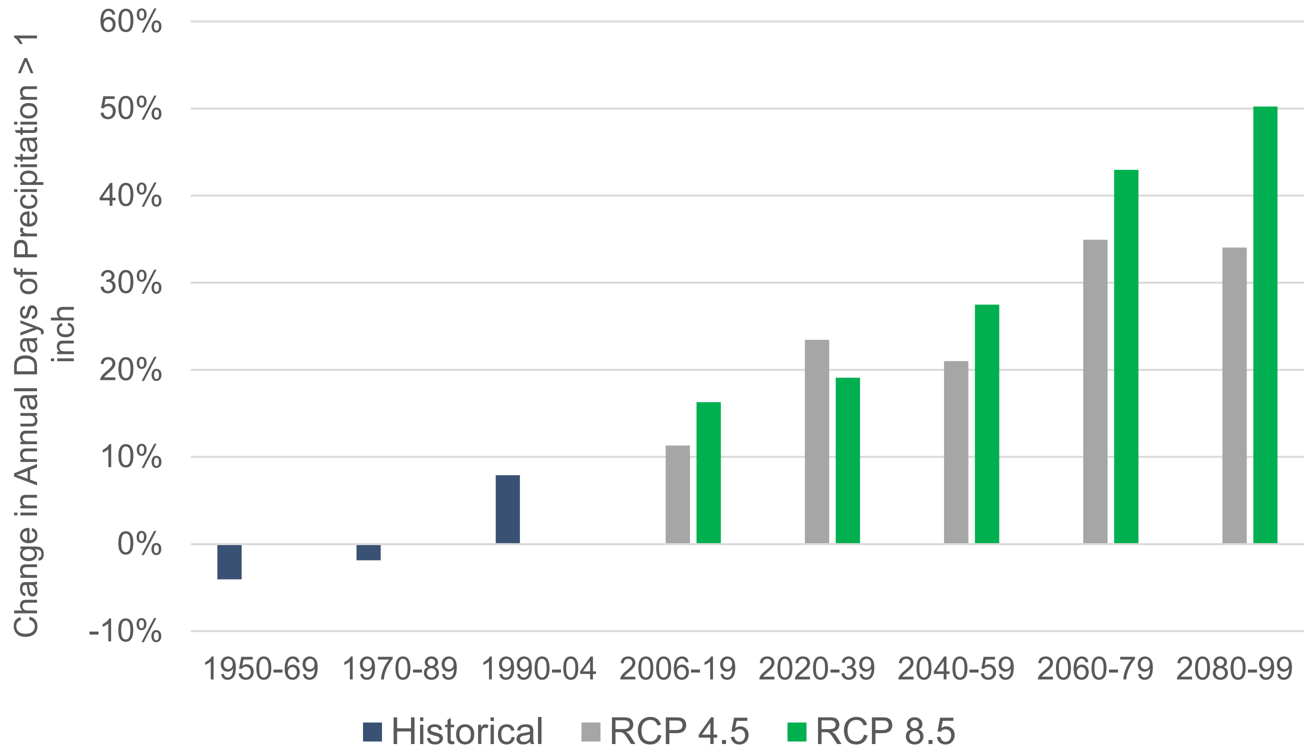
Design requirements:

- Water quality
    - WQv capture
- Water quantity
    - 10-yr peak attenuation



Water Quality Design Example

Climate Change Adjustments

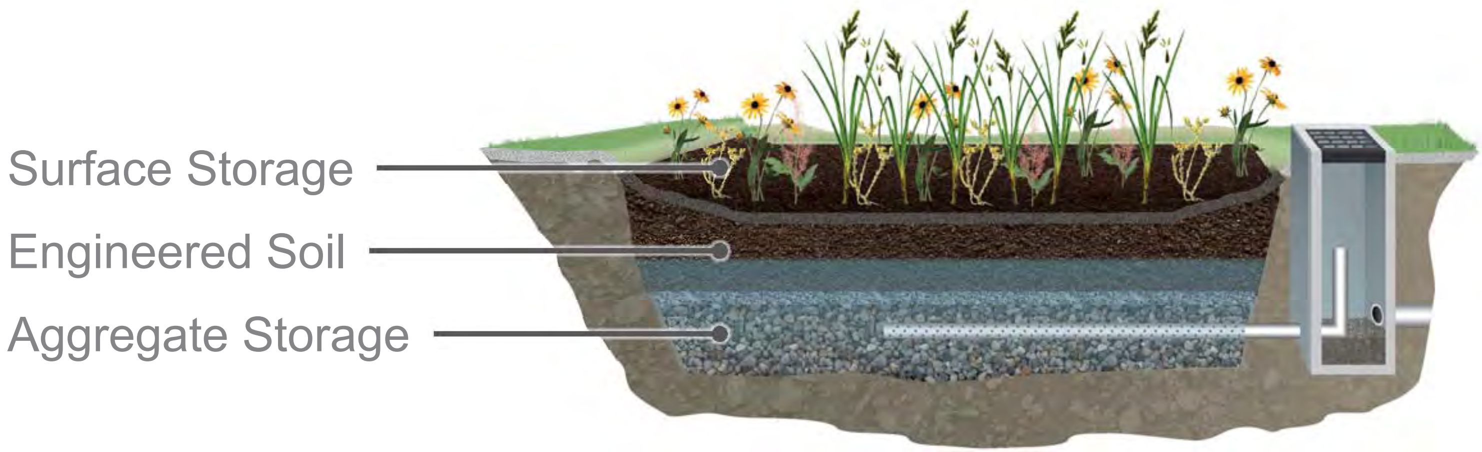


Water Quality Design Example

Climate Change Adjustments

Possible Design Adjustments

- Increased surface storage capacity
- Rapid infiltration riser / gabion
- Adjustable outlet / overflow configuration



Water Quantity Design Example

Climate Change Adjustments

Parameter	Current 10-yr, 24-hr	Warm / Wet 2060 10-yr, 24-hr
Storm Depth	5.7 in	6.0 in
Pre-Dev Runoff	9.3 cfs	10.1 cfs
Post-Dev Runoff	14.2 cfs	15.0 cfs
Storage Volume	10,600 ft^3	10,970 ft^3
Peak WSE	2.4 ft	2.5 ft

No design changes required in this instance

Marginal increase in peak WSE and storage volume

Variable Impacts on Stormwater Design

- Type of Stormwater Design
- Design Objectives
- Geographic Area
- Climate Modeling Scenario
- Duration of Analysis

Days with >1 Inch of Precipitation

		2020-2039		2080-2099	
City	Days with >1" of Precip	RCP 4.5 Lower GHG	RCP 8.5 Higher GHG	RCP 4.5 Lower GHG	RCP 8.5 Higher GHG
Boston	6.9	18%	16%	32%	45%
Richmond	5.4	23%	19%	34%	50%
Miami	2.9	11%	9%	23%	17%
Chicago	3.1	27%	24%	30%	58%
Dallas	6.5	-3%	2%	8%	3%
Phoenix	0.4	11%	22%	11%	34%
Los Angeles	3.3	7%	14%	6%	23%
Seattle	12.7	9%	5%	24%	32%

Far Term 24-hr Design Storm Changes

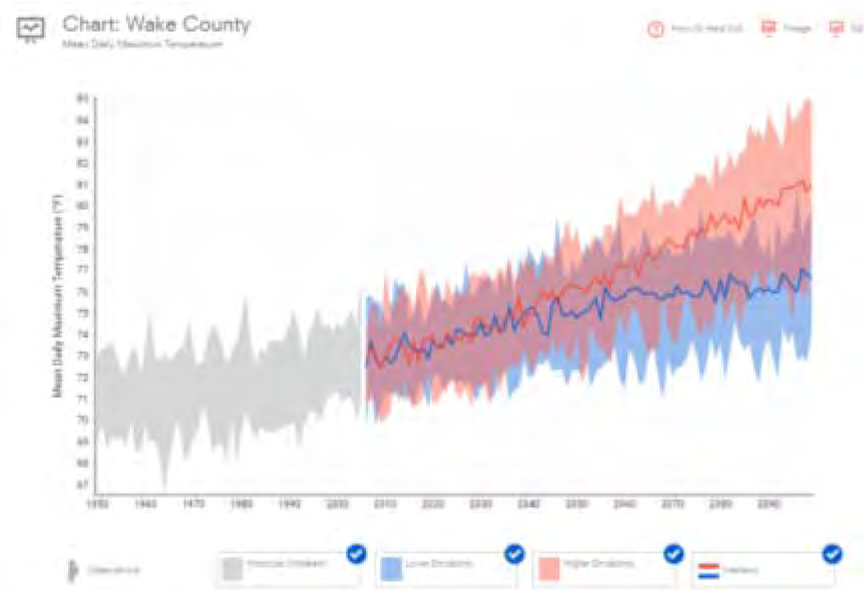
Period of 2045-2074

City	10-yr 24-hr Storm Depth		
	Hot/Dry	Median	Warm/Wet
Boston	+9%	+8%	+10%
Richmond	+6%	-2%	+6%
Miami	-8%	+29%	+16%
Chicago	+9%	+9%	+9%
Dallas	+9%	+23%	+11%
Phoenix	+14%	+17%	+16%
Los Angeles	+15%	+17%	+13%

Role of Uncertainty

Difficult to choose a single best value or model

Combination of tools can inform direction of design changes



How much should a design change?

Key Considerations

Expected longevity

Risks of failure / reduced performance

Cost of changes

Feasibility of future adaptation

Stakeholder input

Communicating Results

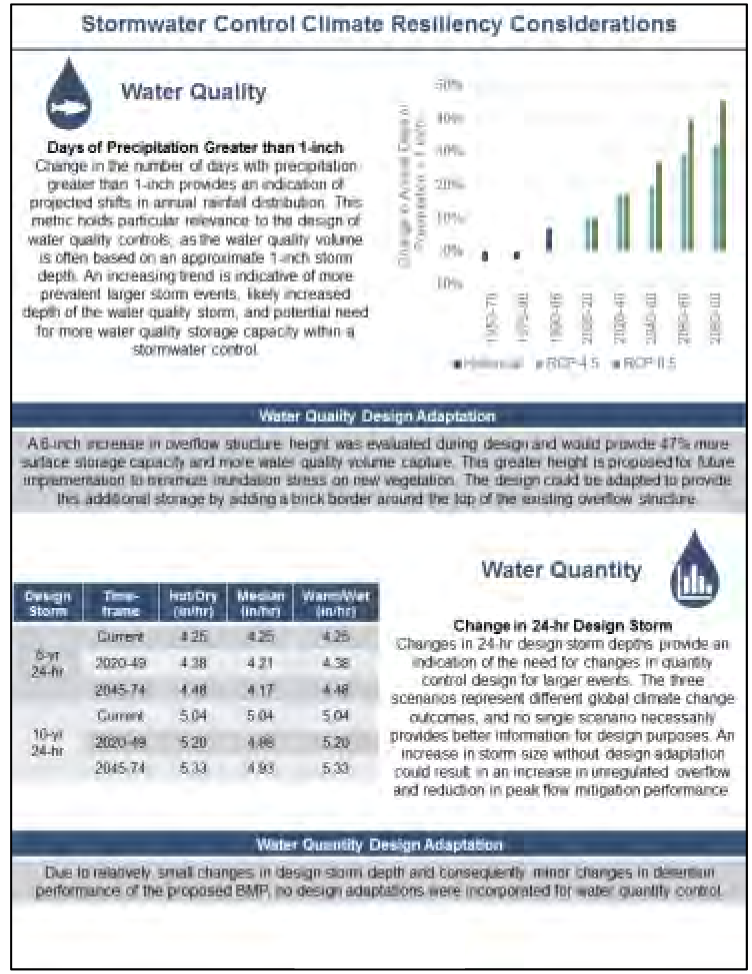
Key Considerations

Analysis background

General direction and magnitude of changes

Nature of uncertainty

Risks of no design change



Stormwater Control Climate Resiliency Considerations

Water Quality

Days of Precipitation Greater than 1-inch

Change in the number of days with precipitation greater than 1-inch provides an indication of projected shifts in annual rainfall distribution. This metric holds particular relevance to the design of water quality controls, as the water quality volume is often based on an approximate 1-inch storm depth. An increasing trend is indicative of more prevalent larger storm events, likely increased depth of the water quality storm, and potential need for more water quality storage capacity within a stormwater control.

Water Quality Design Adaptation

A 6-inch increase in overflow structure height was evaluated during design and would provide 47% more surface storage capacity and more water quality volume capture. This greater height is proposed for future implementation to minimize inundation stress on new vegetation. The design could be adapted to provide this additional storage by adding a brick border around the top of the existing overflow structure.

Water Quantity

Design Storm	Time-frame	Hot/Dry (in/hr)	Median (in/hr)	Warm/Wet (in/hr)
5-yr 24-hr	Current	4.25	4.25	4.25
	2020-49	4.38	4.21	4.38
	2045-74	4.48	4.17	4.48
10-yr 24-hr	Current	5.04	5.04	5.04
	2020-49	5.20	4.88	5.20
	2045-74	5.33	4.93	5.33

Change in 24-hr Design Storm

Changes in 24-hr design storm depths provide an indication of the need for changes in quantity control design for larger events. The three scenarios represent different global climate change outcomes, and no single scenario necessarily provides better information for design purposes. An increase in storm size without design adaptation could result in an increase in unregulated overflow and reduction in peak flow mitigation performance.

Water Quantity Design Adaptation

Due to relatively small changes in design storm depth and consequently minor changes in detention performance of the proposed BMP, no design adaptations were incorporated for water quantity control.

Conclusions

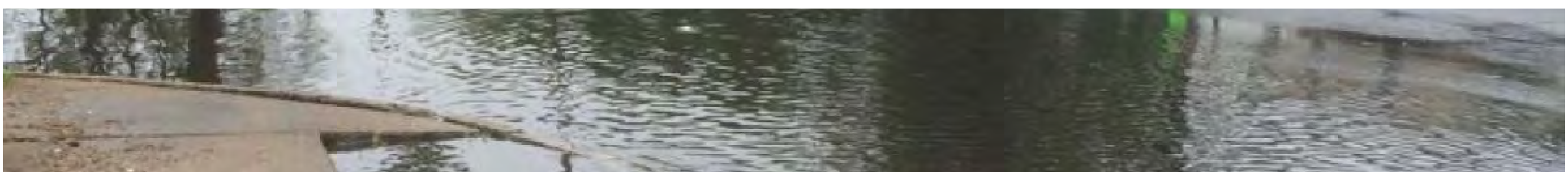
Climate changes can impact stormwater efforts

Impact of climate change is variable

Tools available to assist in planning and design

Need for thoughtful communication of results

Value in incorporating adaptability



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