





Incorporating Climate Resiliency into Common Drainage Improvements

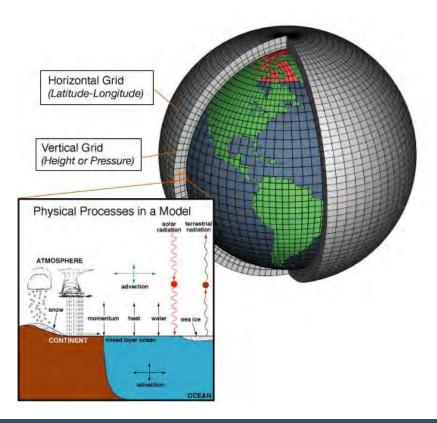
Matthew Jones, PhD, PE mjones@hazenandsawyer.com

Water Storm Annual Quantity Intensity Rainfall Distribution Water Quality Siting Groundwater Sea Conditions Constraints Level Rise

Climate Influences on Stormwater Management

Track and Project Impacts

Climate Impact Projections from Global Climate Models (GCMs)



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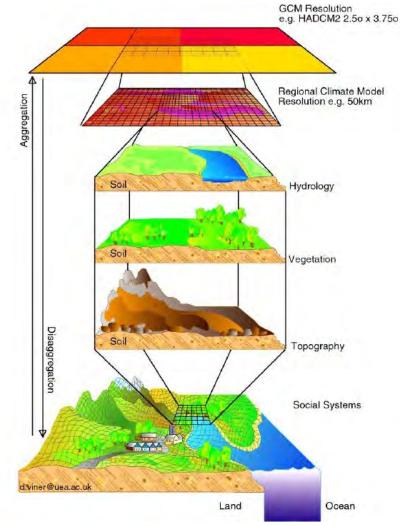
http://celebrating200years.noaa.gov/breakthroughs/climate_model/modeling_schematic.html

Downscaling

How do I obtain local climate impact projections?

Dynamic Downscaling: Replicate physical processes

Statistical Downscaling: Statistically correlate changes

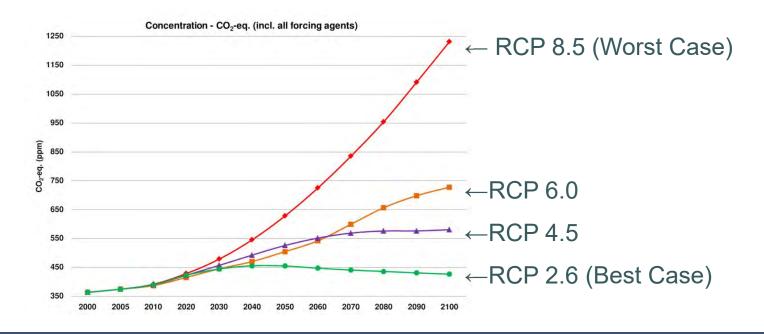


http://www.cccsn.ec.gc.ca/?page=downscaling

Track and Project Causes

GHG Representative Concentration Pathways (RCPs)

Greenhouse gas concentration trajectories Radiative forcing in 2100 vs. pre-industrial



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IPCC 5th Assessment Report

U.S. Climate Resiliency Toolkit

Wide array of tools

Varying degrees of accessibility

National and regional focus



Tools

1 hore

Filter by topic. # Filter by tool function. #

Tools are available to help your manage your climate valuated rails and opportunities, and to help guide you in building valuence to extreme events. Benere the lat. below to filter by tapic and/or icol functionality in the bosin above. To expand your results, click the Clear Vilien link.



Level Rise and Coastal Land

This toulist preserve evidentiation up.

Its prevent whet can could lighteen by used logit lies/used that could be used to preventitively respond to threats that on-level rare protect to public and private coastal

development and refractionstate

18 different land-cast trols



Adaptation Workbook for Land Management and Land managers matural reports preferances and restanting Undewent car use this shuctured pinness to consider the effects of climate change on forests, uban forests, and agricultural properties



Adapt/Map Jamieca Bay This traine inspiring fand for New Mark's Jamaco Ray allows users to compare and contrast federated present day and potential future landscapes against an array of sea laset and sizero tele scenarezi



Adapt/Net Cimin Adaptation Planning Detabase

Namesi can access data and detailed information for much of North America to-Longaury intransition approaches and prism parving





Artilow Air Quality Forecast



Nyncultural Conservation AgroCimate-Tools for

U.S. Climate Resiliency Toolkit



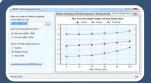
NOAA Climate Explorer

- 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



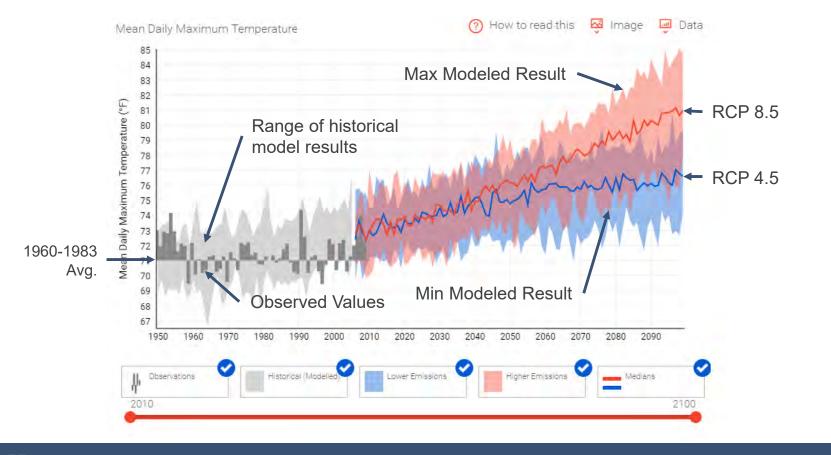
Overview maps and graphs Data by county Statistical downscaling Main Parameters:

- Temperature
- Precipitation
- Heating/Cooling Degree Days

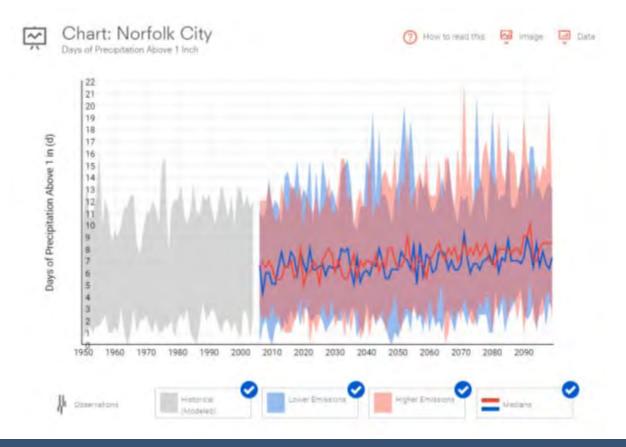




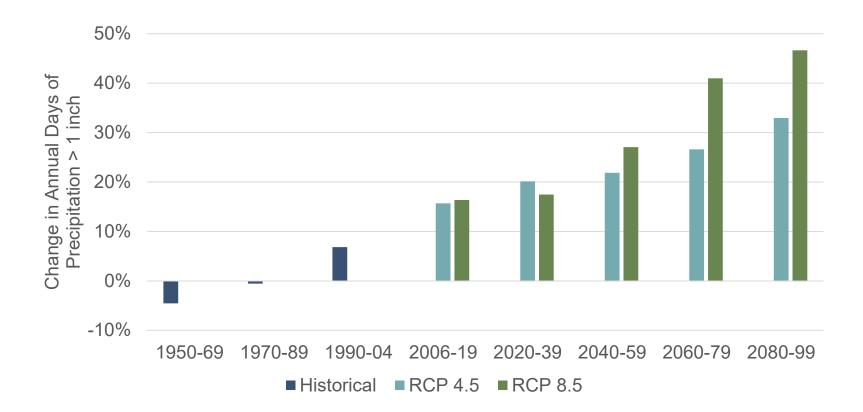




Days of Precipitation > 1 inch



Days of Precipitation > 1 inch



EPA CREAT

Climate Resiliency Evaluation and Awareness Tool

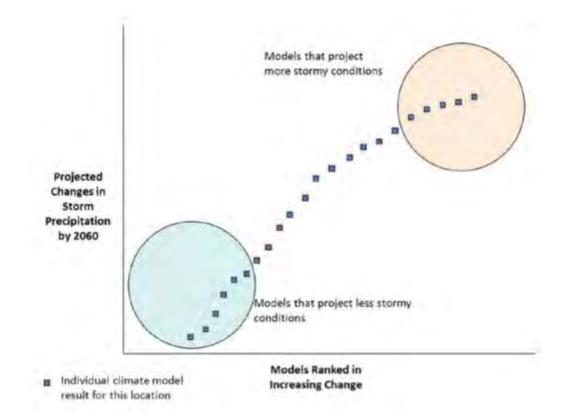
Sea Level

Framework for localized assessments3 base scenarios3 horizonsHot / Dry1981-2010 baselineCentral2026-2045 (2035 period)Warm / Wet2051-2070 (2060 period)Main Parameters:TemperaturePrecipitationImage: Contral for the state of the sta

CREAT 3.0

EPA CREAT

Stormy vs. Not as Stormy

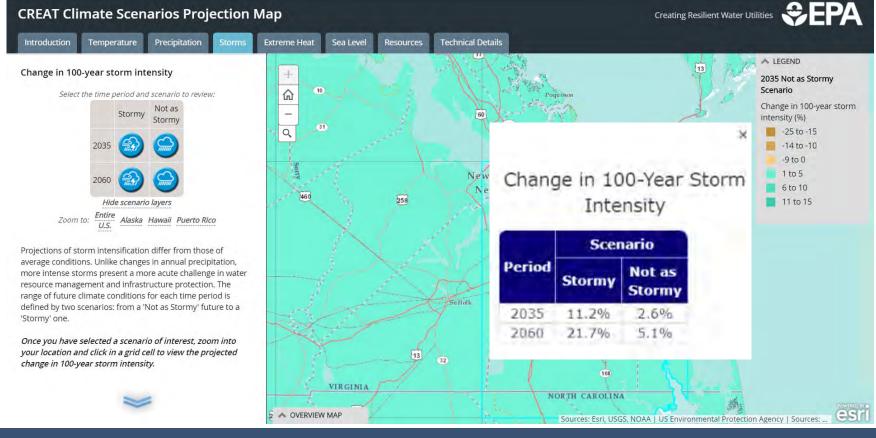


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EPA Climate Resilience Evaluation and Awareness Tool Version 3.0 Methodology Guide

EPA CREAT

Change in 100-year storm intensity

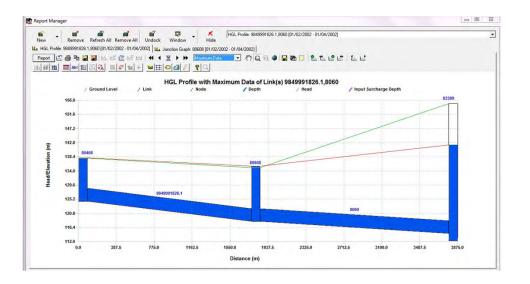


SWMM Climate Adjustment Tool

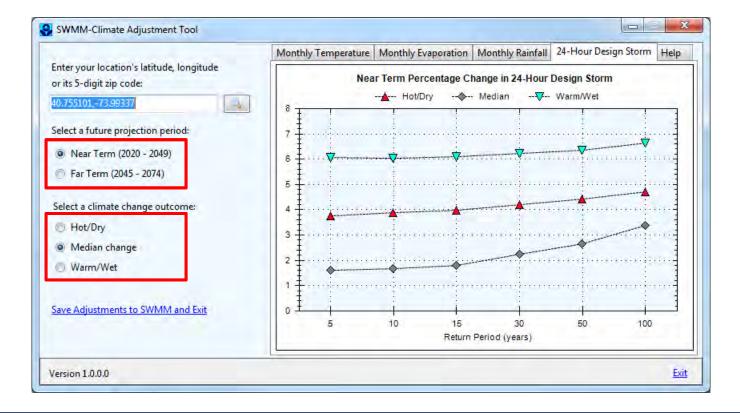
Add-on for EPA's StormWater Management Model Based on EPA CREAT data

Parameters:

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



SWMM Climate Adjustment Tool



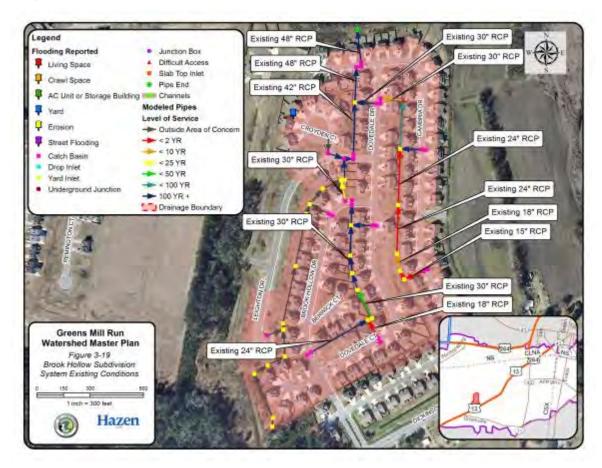
10-Year Rainfall Adjustment Factors

Greenville, NC

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



Greenville, NC



Greenville, NC

Characteristics

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



Results

Hydraulic Grade Line Changes

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



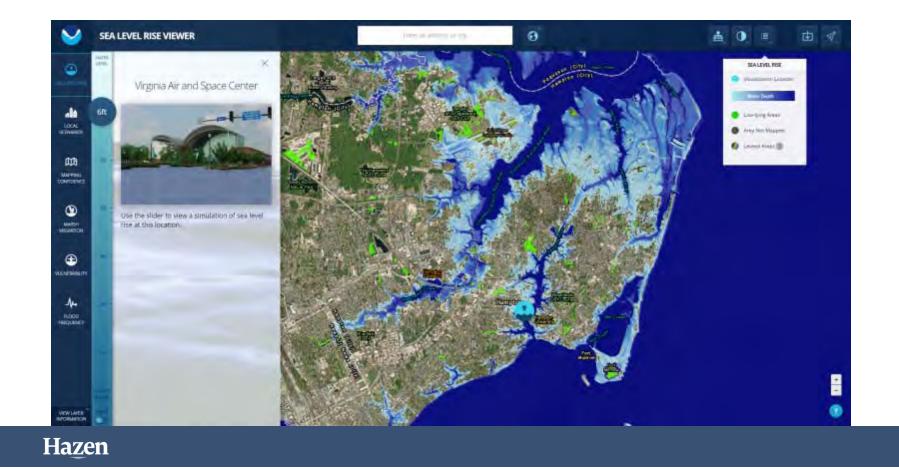
Conclusions

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

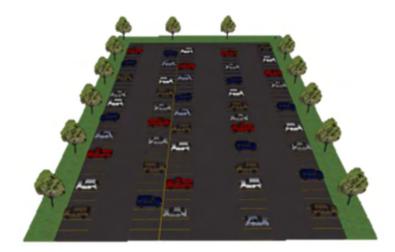


Stormwater Control Design Example

Site Overview and Design Objectives

New 2 acre 75% impervious development Design requirements:

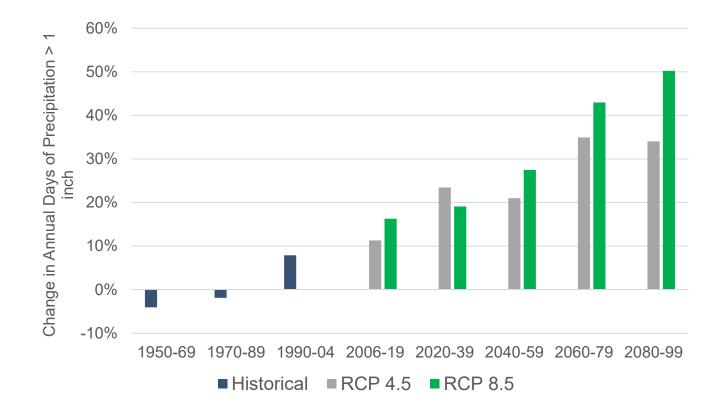
- Water quality
 - WQv capture
- Water quantity
 - 10-yr peak attenuation





Water Quality Design Example

Climate Change Adjustments

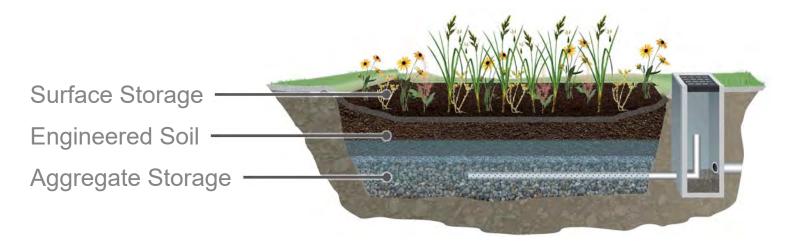


Water Quality Design Example

Climate Change Adjustments

Possible Design Adjustments

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



Water Quantity Design Example

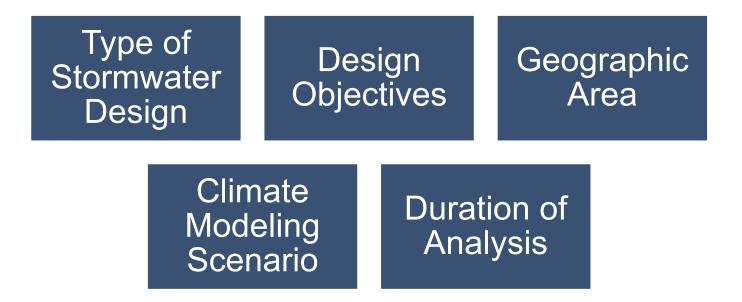
Climate Change Adjustments

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





Days with >1 Inch of Precipitation

		2020-20	039	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

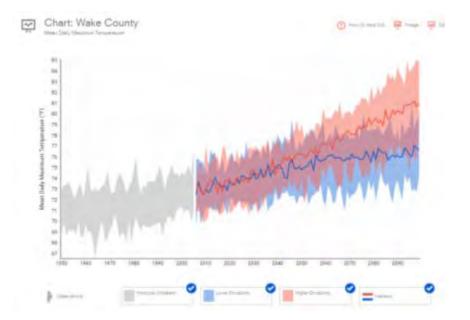
Period of 2045-2074

[10	-yr 24-hr Storm	n Depth
City	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

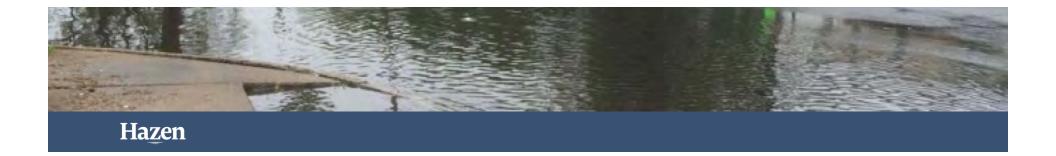
Nature of uncertainty

Risks of no design change

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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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