Climate Change – Infrastructure – Adaptation

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Agenda

1. What science tells us
2. How water utilities can use the science

Scientists agree:
The climate is changing.

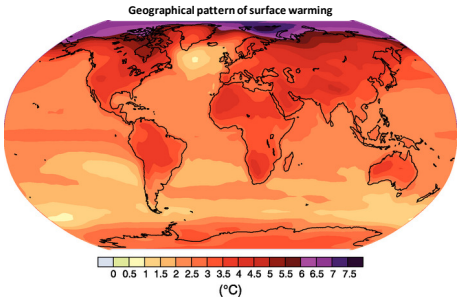
IPCC 4th Assessment Report

- Intergovernmental Panel on Climate Change: **"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."**

IPCC 4th Assessment Report

- Projections:
  - Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century
  - Increase in frequency of hot extremes, heat waves and heavy precipitation
  - Increase in tropical cyclone intensity
  - Poleward shift of extra-tropical storm tracks with consequent changes in wind, precipitation and temperature patterns

Projected Surface Warming



From www.ipcc.ch: Figure SPM.6. Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi-AOGCM average projection for the A1B SRES scenario. Temperatures are relative to the period 1980-1999.

Managing Climate Change

March 28, 2012: IPCC released full report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)"

"The challenge for the future is… improving the knowledge base and… empowering good decisions, even for those situations where there is lots of uncertainty."

– Chris Field, cochair of IPCC's Working Group II

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Summary of IPCC Findings

- Atmosphere is gaining new energy which is changing the dynamics, though we don't know how the dynamics are changing
- We do know that extremes will be extreme
- We have to anticipate extremes and plan for it

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Projections of NYC Panel on Climate Change

FIGURE 1: PROJECTIONS OF THE NEW YORK CITY PANEL ON CLIMATE CHANGE

	Baseline (1971-2000)	2020s	2050s	2080s
Air temperature	12.8°C (annual mean)	Increase by 0.8°C-1.7°C	Increase by 1.7°C-2.8°C	Increase by 2.7°C-4.2°C
Precipitation	118.1 cm (annual mean)	Increase by as much as 5%	Increase by as much as 10%	Increase by 5%-10%
Sea level rise	NA	5.1-12.7 cm	17.8-30.5 cm	30.5-58.4 cm
Coastal storms:				
100-year return period	Roughly once every 100 years	Roughly once every 65 to 80 years	Roughly once every 35 to 55 years	Roughly once every 15 to 35 years
500-year return period	Roughly once every 500 years	Roughly once every 380 to 450 years	Roughly once every 250 to 330 years	Roughly once every 120 to 250 years
PROJECTIONS OF SEA LEVEL RISE FROM RAPID ICE MELTING				
Sea level rise	NA	12.7-25.4 cm	48.3-73.7 cm	104.1-139.7 cm

Source: C. Rosenszweig and W. Solecki, New York City Panel on Climate Change, "Climate Change Adaptation in New York City: Building a Risk Management Response," Annals of the New York Academy of Sciences 1196, (2010).

From: Civil Engineering, "Anticipating Climate Change" April 2011

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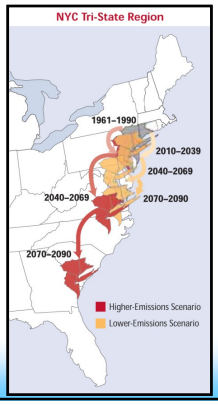
Impacts of Climate Change

- "Migrating Climates" concept from Union of Concerned Scientists
- Arrows track what summers could feel like in the Tri- State area over the course of the century under 2 emissions scenarios.



From "Confronting Climate Change in the U.S. Northeast 2007" northeastclimateimpacts.org

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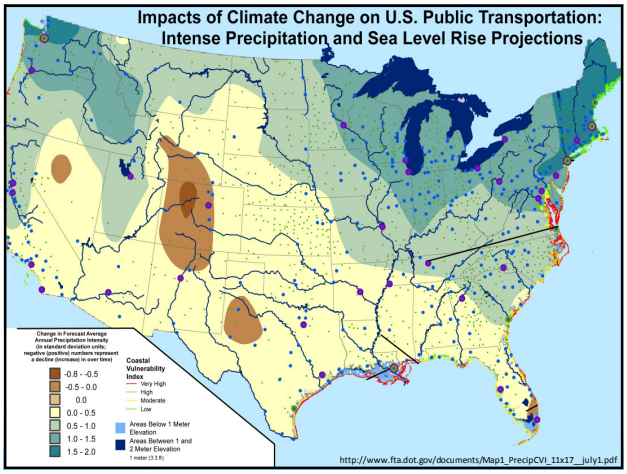
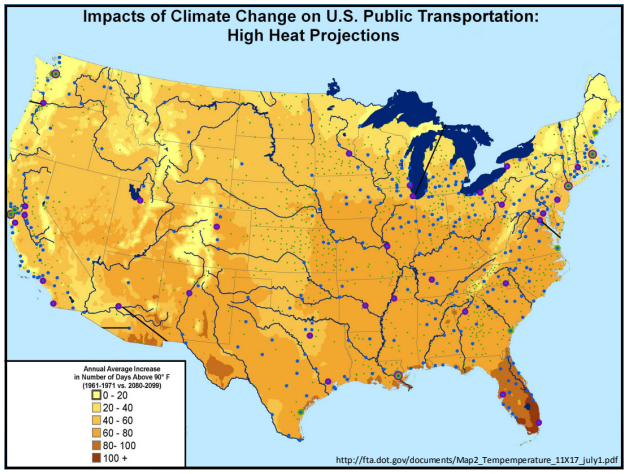




Impacts of Climate Change

- Large scale weather events will be more frequent, have greater intensity, last longer and have impacts that will be more extreme than we are accustomed to
- It is expected that on the global scale, 1-in-20 year hottest weather days will become 1-in-2 year by end of 21st Century
  - Except in higher latitudes of the northern hemisphere where it is likely to be 1-in-5 year

Impacts of Climate Change

- According to U.S. Federal Government's Global Climate Change Research Program:
  - Sea level rise and storm surge will increase the risk of major coastal impacts, including both temporary and permanent flooding of coastal infrastructure

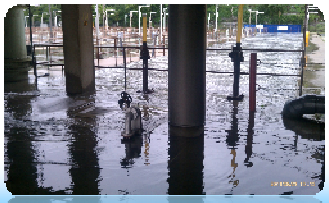
Impacts of Climate Change

- Intensity of storms will increase, resulting in infrastructure damage
  - Higher winds
  - More precipitation
  - Flooding
  - Hurricanes

Hurricane Irene: storm surge and flooding in Asbury Park, New Jersey, www.nationalgeographic.com

Potential Impacts to Water Utilities

- The increase in temperature will potentially improve the digestion of sludge
- Increased intensity of strong hurricanes will lead to more evacuations, infrastructure damage and failure



Hurricane Irene: Flooding at a WWTP

Potential Impacts to Water Utilities

Hurricane Irene: Flooding at a WWTP

- Sea level rise and storm surge will increase the risk of major coastal impacts, including both temporary and permanent flooding of facilities
- Intense storms will increase the risk of power outages and potentially catastrophic failure

Adapting to Climate Change

- What is adaptation?
  - A term still looking for a definition
    - IPCC plans a definition for its 5th Assessment Report due 2014
    - Sample definitions
      - IPCC TAR, 2001a: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effect, which moderates, harms or exploits beneficial opportunities
      - UNFCCC Secretariat: Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change, (ie; flood walls)

Adapting to Climate Change

- US EPA: Adaptation to environmental change is not a new concept. Throughout history, human societies have shown a strong capacity for adapting to different climates and environmental changes.

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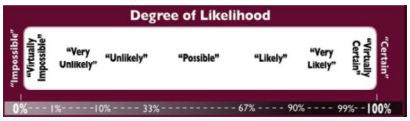
Goal of an Adaptation Plan

- To understand:
  - Nature and magnitude of the risk of climate change
  - Planning and operational options for reducing risk
  - Relative costs and benefits of the options



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Different Methodologies

Approaches for adaptation planning are evolving.

Much of the planning is being developed by the transportation sector, which has been hit hard by extreme weather.

- "Asset by asset" engineering approach
- "Criticality" assessment
- "Screening" by asset characteristics
  - NJ TRANSIT case study

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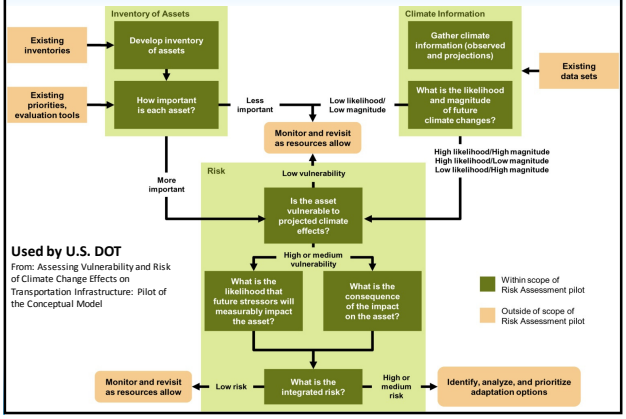
Traditional "Asset by Asset" Methodology



Used by U.S. DOT

From: Assessing Vulnerability and Risk of Climate Change Effects on Transportation Infrastructure: Pilot of the Conceptual Model

"Criticality" Assessment Methodology

Establish major vulnerabilities, then identify and evaluate options

- Identify critical assets and services
- Analyze historical climate and projected future climate
- Identify vulnerability to impacts
- Evaluate potential adaptation options

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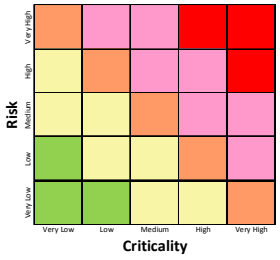
"Screening" Methodology

- Identifies the relevant risks
- Identifies assets that are at higher risk
- Evaluates the criticality of those assets
- Facilitates planning for assets that are both high risk and critical



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NJ TRANSIT Research Approach

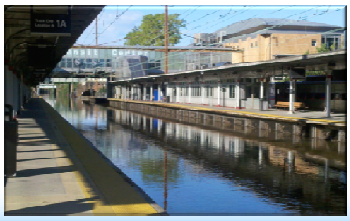
- Identify potential climate impacts through literature review
- Identify climate impacts on classes of assets
- Identify indicators to assess severity of impacts on assets for the planning horizon
- Map assets potentially at risk
- Determine resilience strategies
- Provide estimates of costs to implement resilience strategies

Screening Tool: Summary Table of Asset Categories

- Asset categories: e.g. buildings, structures
- Summary of info for each asset category:
  - climate impact
  - effect on the asset
  - specific assets at risk
  - planning horizons for 5, 10, 20 and 50 years
  - short term operational result
  - potential resilience strategies
  - implementation cost estimates by unit

Next Steps

- Use the Screening Tool to
  - determine criticality
  - prioritize projects and plan for the changing climate

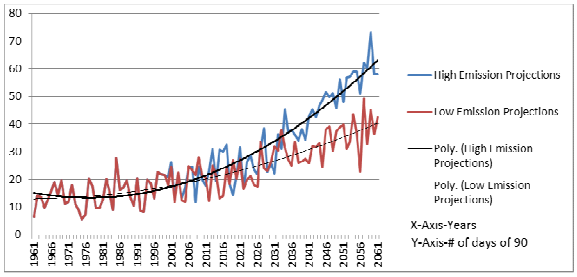


Trenton Transit Center-Hurricane Irene (NJ TRANSIT)

Indicators of Risk

- No short term (5-20 year climate) models currently available
- First Environment developed *Indicators of Risk* to quantify expected increase in extreme weather events using scientifically accepted models
- *Indicators* illustrate the scale of risk associated with the impacts
  - Days over 90 Degrees
  - Sea Level Rise
  - Storm/Flood Frequency

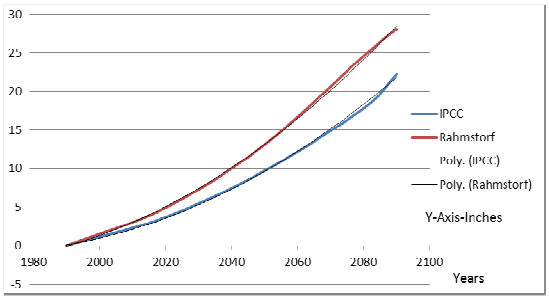
Days over 90 (°F)



Days over 90 (°F)

Years	Baseline Ave.	Increase in days over 90 – Trend High Emissions	Increase in days over 90 - Trend Low Emissions	% change Trend – High Emissions	% change Trend Low Emissions
1980-1999	16.3				
2012-2016		26	22	57%	37%
2017- 2021		28	24	74%	45%
2022- 2031		33	26	100%	58%
2032- 2061		47	32	187%	95%

Sea Level Rise in Inches



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Sea Level Rise in Inches

Sea Level Rise in inches over 1990 base year	Range in inches during period - IPCC	Range in inches during period- Rahmstorf
2012-2016	2.4-3	3.4-4.2
2017-2021	3.1-3.7	4.4-5-3
2022-2031	3.9-5.5	5.5-7.7
2032-2061	5.7-12.5	7.9-16.8

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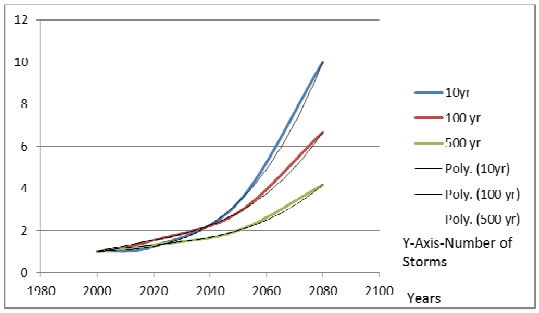
Storm/Flood Frequency



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Storm/Flood Frequency

	Average % Increase in Frequency over Year 2000		
	10 Year Flood	100 Year Flood	500 Year Flood
2012-2016	13%	39%	23%
2017-2021	23%	51%	30%
2022-2031	47%	72%	41%
2032-2061	209%	171%	93%

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Adaptation Strategy for Water Utilities

- The infrastructure of wastewater treatment plants, water districts, and solid waste facilities are at risk
- Screening methodology used for transportation is applicable to water utilities
  - Different infrastructure
  - Same approach

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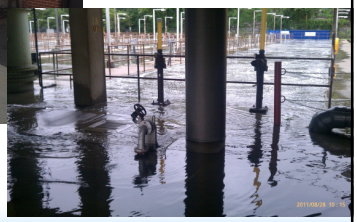
Hurricane Irene – WWTP

Before flooding



During flooding

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Questions?

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