CLIMATE CHANGE AND THE WASTEWATER SECTOR

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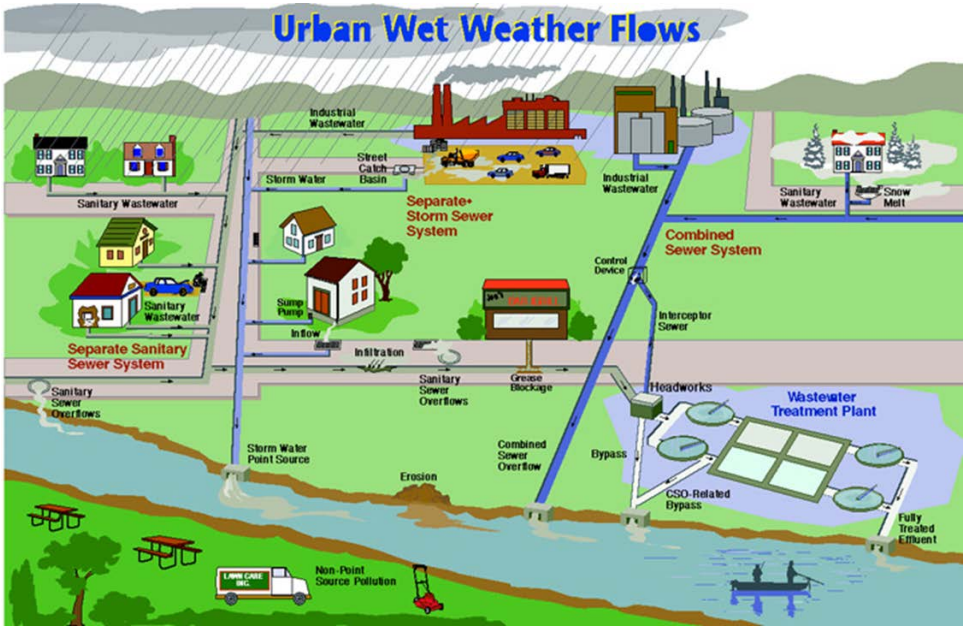
KEY FEATURES OF WASTEWATER SECTOR

- Coastal, riverine, or low-lying location of treatment plants
- Unable to stop or control incoming flow
- Aging Infrastructure
  - often >100 yrs old
- Gravity fed collection systems
  - Combined sewer overflow (CSO)
  - Separate sanitary and stormwater
- System failure or malfunction leads to:
  - Discharge of wastewater to waterways, or
  - Back-ups into homes or streets



Source: U.S. Environmental Protection Agency

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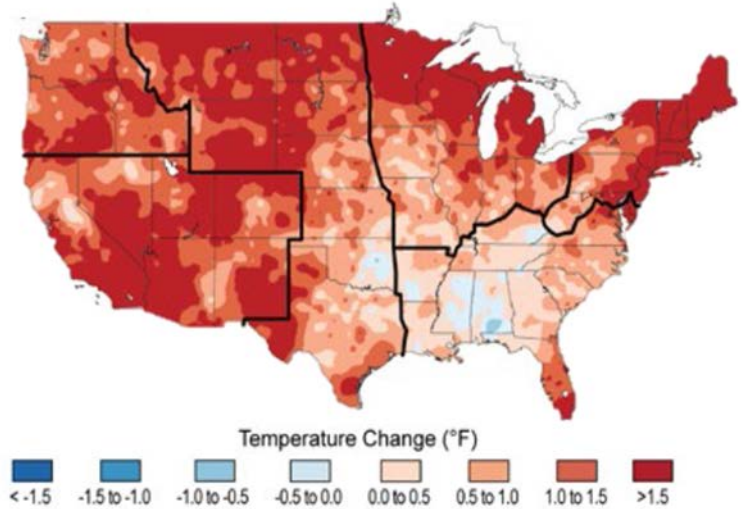
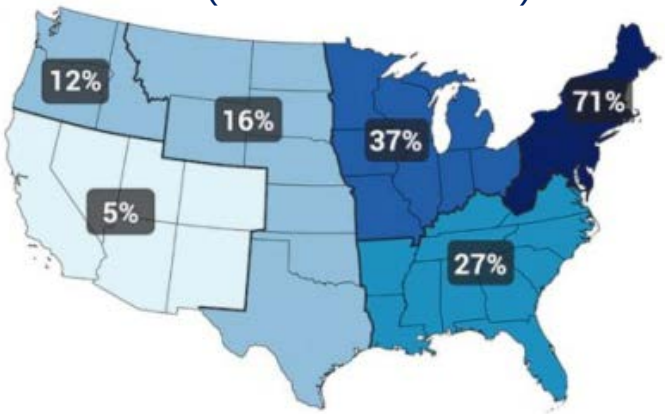
GLOBAL CLIMATE TRENDS

- Increased temperature
- Increased annual precipitation
- Seasonal precipitation changes
  - Extreme rainfall events
  - Drought
- Increased incidence and intensity of extreme events
  - Storms
  - Heatwaves
- Greater storm surge
- Increased sea level rise

Observed Temperature Change
(from 1991 to 2012)



Observed Change in Heavy Precipitation
(from 1958 to 2012)



Source: National Climate Assessment Report, 2014

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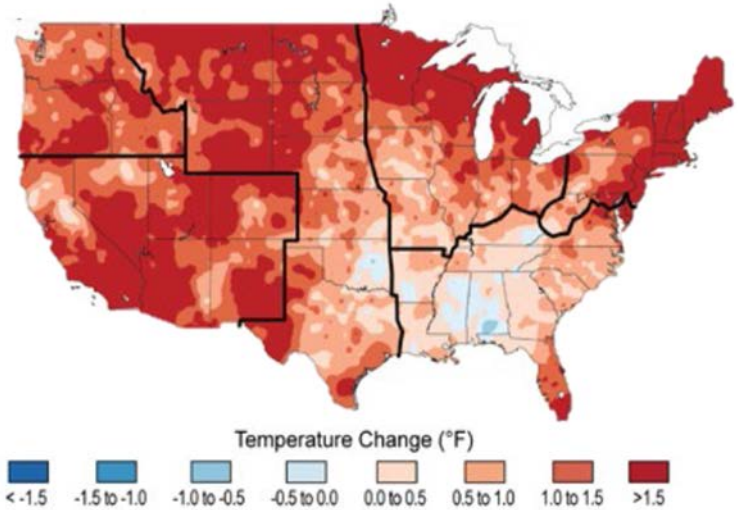

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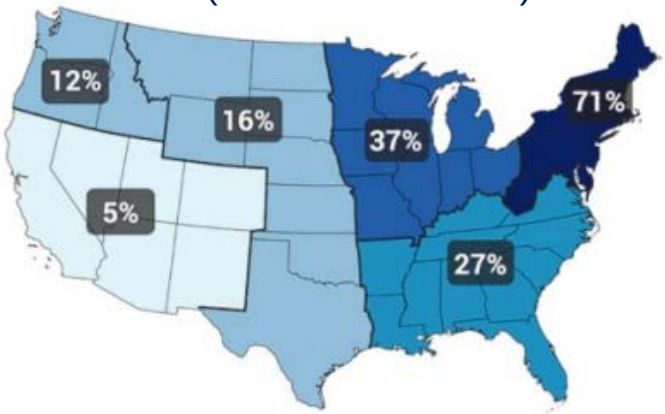
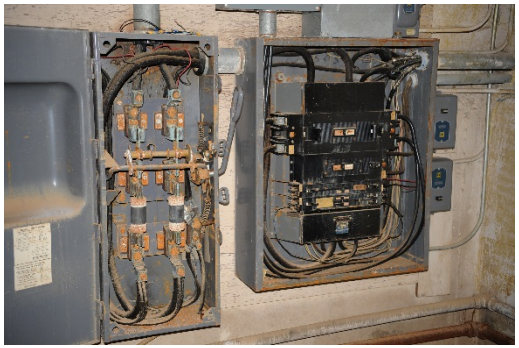


Source: National Climate Assessment Report, 2014

WASTEWATER SECTOR: KEY CLIMATE IMPACTS

- Inundation and flooding of treatment plants and conveyance infrastructure with saltwater
  - Failure of electric components
  - Loss of biological material
  - Corrosion of metal components



Source: FEMA Photo Library

- Reduction or complete loss of power or electric infrastructure
  - Failure of pumps
  - Reduction or loss of treatment capacity
  - Discharge of raw or partially treated wastewater
  - Contamination of treatment train

Source: EPA, 2015, *Power Resilience*

Source: FEMA Photo Library

WASTEWATER SECTOR: KEY CLIMATE IMPACTS

- Impairment of gravity-fed collection
  - Poor drainage
  - Backflow
  - Maintenance/inspection challenges
- Increase inflow beyond capacity
  - Discharge of raw or partially treated wastewater
- Damage and blockage from debris and trash

Source: EDOT, 2009, *A Guide for Local Street and Highway Maintenance Personnel*

Source: EPA, 2014, *Sanitary Sewer Overflows*

Source: FEMA Photo Library

CASE STUDY: NEW JERSEY & SUPERSTORM SANDY

- ~100 NJ wastewater treatment facilities reported operational impacts
  - Affecting 3.5 million people, or >40% percent of the state's population

- In all, ~11 billion gallons of raw or partially treated wastewater discharged into Northeastern waters

Source: NOAA; Photo Credit: Doug Kuntz, Newsday

CASE STUDY: NEW JERSEY & SUPERSTORM SANDY

- Largest sludge processing facility was inundated and rendered inoperable
  - Processes 25% of NJ and 15% of NYC sludge
  - ~100 facilities impacted

- Saltwater intrusion resulted in corrosion of pipes and destruction of electrical systems
  - In some cases, taking months to receive and install replacement and refurbished parts for damaged pump controls, pumps, and generators

- Estimated $2.6 billion damage to drinking water and wastewater infrastructure statewide

Source: CO DOT, 2009, *Development of New Corrosion/Abrasion Guidelines for Selection of Culvert Pipe Materials*

EXISTING EFFORTS TO ADDRESS CLIMATE CHANGE IMPACTS

- Identify facility vulnerabilities
  - Planning level assessments and preparedness strategies
- Develop more resilient systems
  - Backup power strategies to ensure continued operations
  - Reducing stormwater runoff (e.g., green infrastructure)
- Invest in adaptation measures
  - Storm walls and flood gates
  - Relocation or raising of critical infrastructure (e.g., electric components)
  - Retrofitting with waterproof or corrosion-resistant materials or components

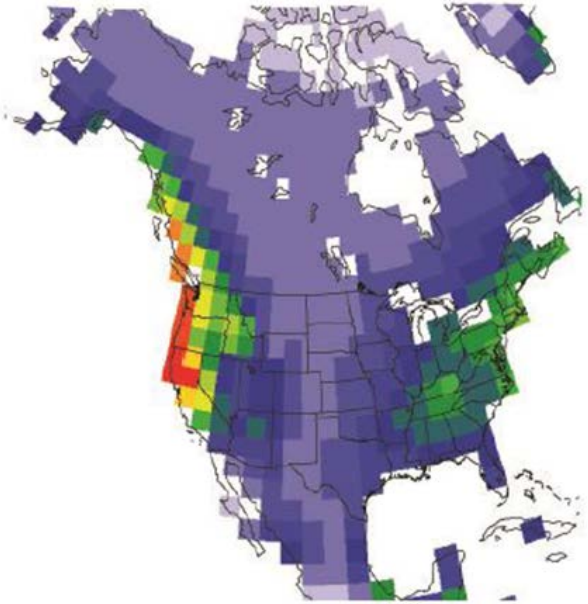
Source: EPA, 2015, *Power Resilience*

Source: FEMA Photo Library

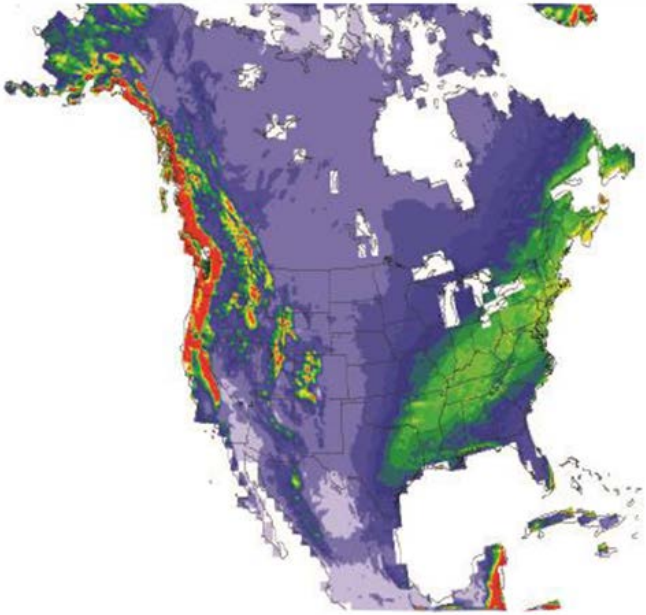
VULNERABILITY ASSESSMENT TOOLS

- **Regional Climate Modeling**
  - Downscaling is used to “translate” global climate model outputs at the regional scale
  - Increased spatial resolution of climate model output:
    - 1–2 degree grid (global scale)
    - 1/8 degree grids (regional/local scale)

Global Climate Model
(250-km special resolution)



Regional Climate Model
(12-km special resolution)

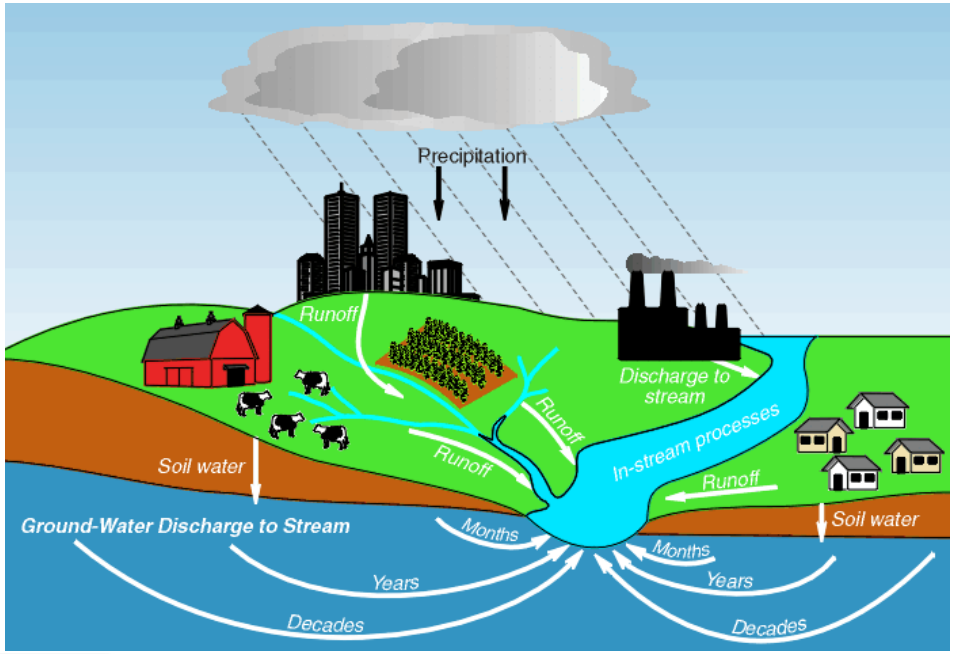


Source: Argonne National Laboratory

VULNERABILITY ASSESSMENT TOOLS

- **Hydrologic Modeling**
  - Translates climate change projected precipitation into stream flow
  - Precipitation varies spatially and temporally
  - Considers drainage characteristics of a watershed
  - Accounts for land use and potential human roles

Rainfall ≠ Runoff



Source: U.S. Geological Survey , 1998

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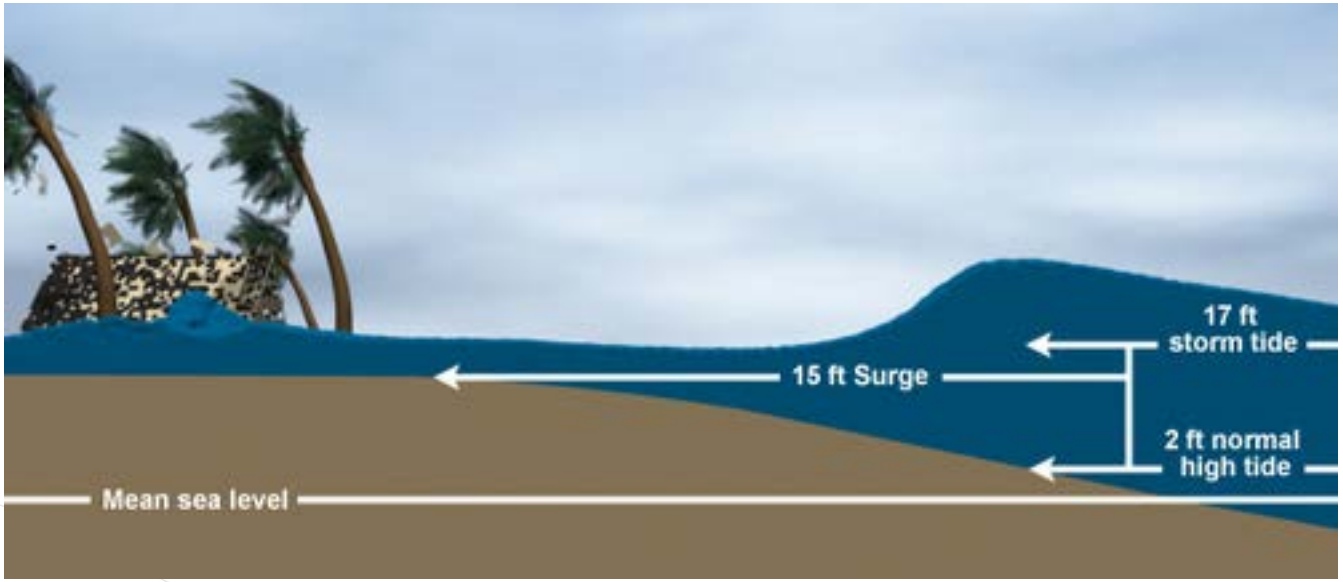
VULNERABILITY ASSESSMENT TOOLS

- **Storm Surge Modeling**
  - Simulates winds (speed and direction), tides, storm surges, waves (height and direction), and currents in the track a hurricane
  - Accounts for current and future climate conditions
    - Sea level rise
    - Increased precipitation – additional river flows and flooding

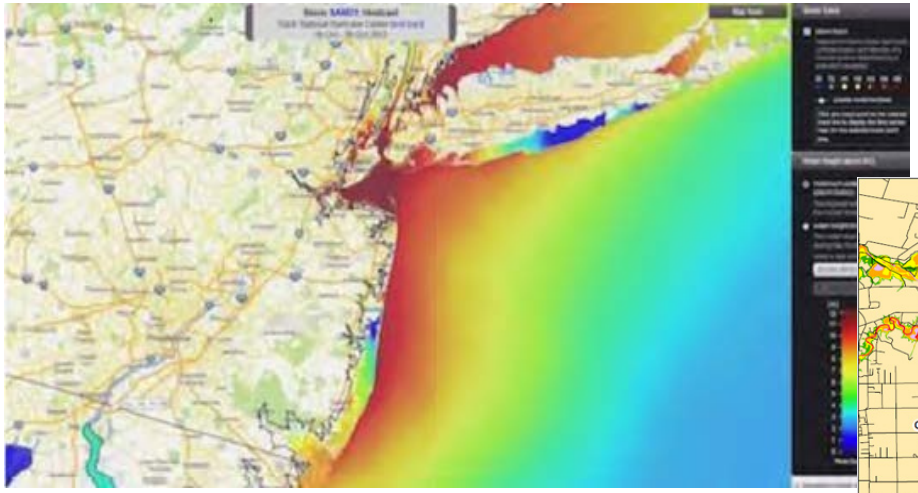


Source: NOAA

VULNERABILITY ASSESSMENT TOOLS

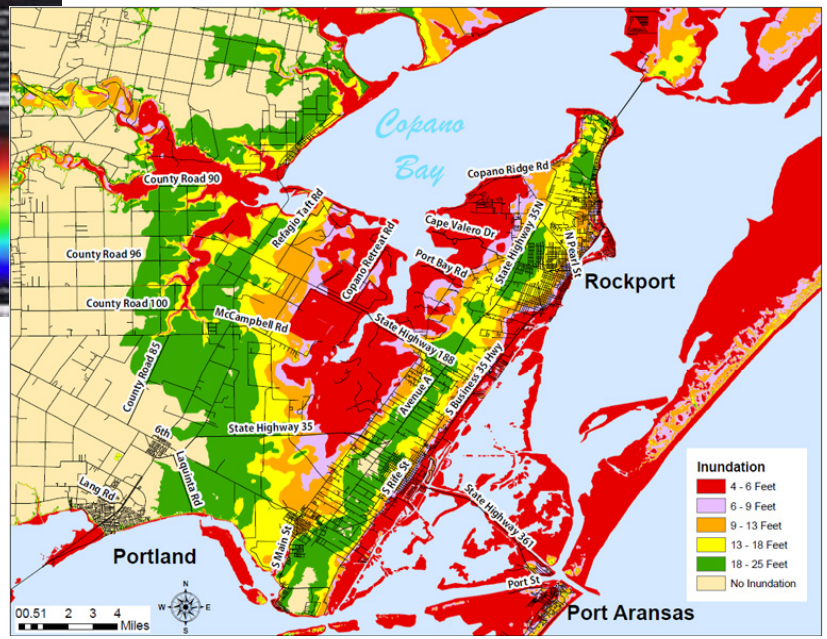
- **Storm Surge Modeling**

Maximum Water Inundation



Source: DHS, 2012, *Getting Ahead of the Storm Surge: ADCIRC Model*

Stillwater Inundation Maps



Source: NOAA

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VULNERABILITY ASSESSMENT TOOLS: SUMMARY

- Coupling Regional Climate – Hydrologic – Storm Surge modeling to produce climate informed inundations maps

Regional Climate Change

Downscaled Regional Data

- Precipitation – average/maximum

Hydrologic

Surface Flow Routing

- Translates CC precipitation data into runoff and CC streamflow values

Storm Surge

- Generates Storm Surge Maps – coastal flood hazard layers
- Uses sea level rise combined with inland contributions from CC streamflow values

Wastewater Infrastructure Planning

Wastewater Routing

- Consequences of failure
- Uses CC streamflow values coupled with storm surge levels

IMPLICATIONS FOR INFRASTRUCTURE PLANNING

- Data to support facility upgrades and investments
  - Identify facility vulnerabilities
  - Develop more resilient systems
- Decision support tools for wastewater infrastructure planning, analysis, and design
  - Combined sewer overflows (CSOs)
  - Sanitary sewers
  - Stormwater drainage systems and runoff routing
  - Green infrastructure
- Information to support use of FEMA recovery funds
  - Rebuild and invest in adaptation measures
- Data to support long-term planning and regulatory compliance

THANK YOU!

QUESTIONS?

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