Green Infrastructure & Urban Forests for Water Quality, Sustainability & Resilience:

Including Emerging Perspectives on Benefits for Energy, Water, Health and Community Development

Village of Mamaroneck
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Overview

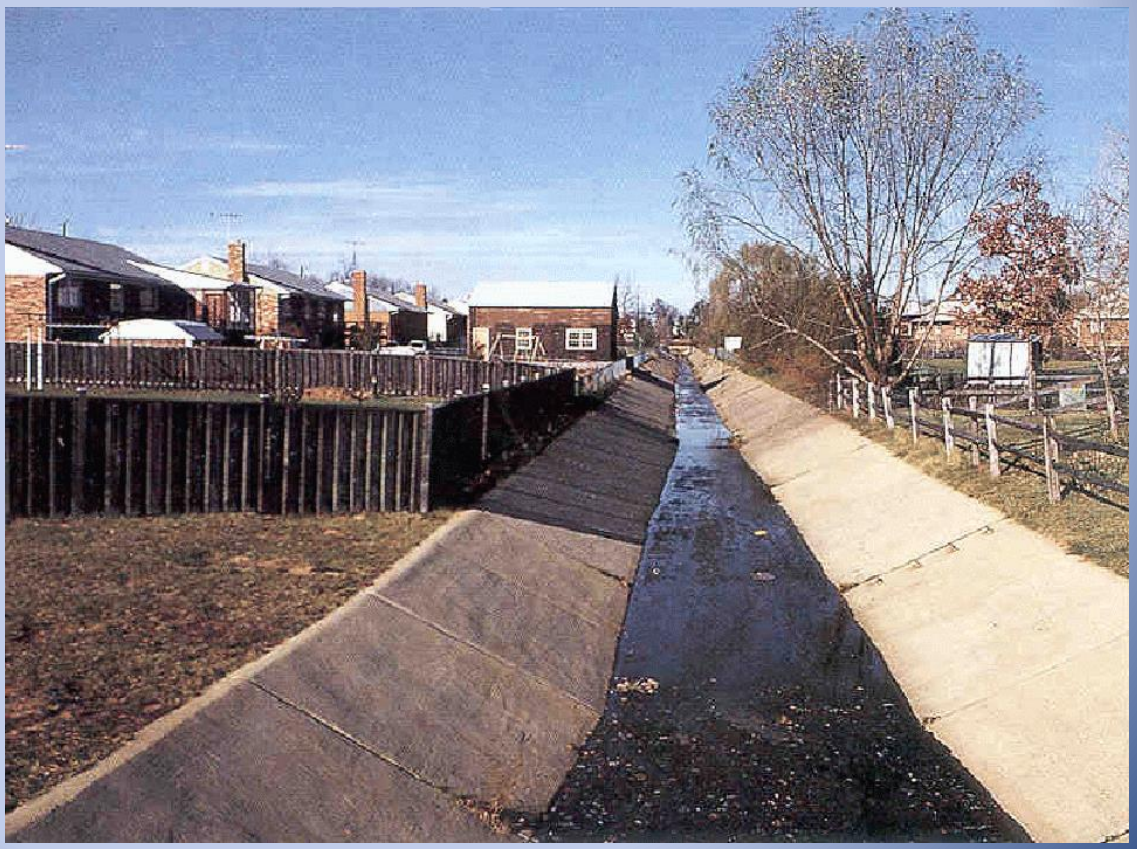
How are best practices for managing water related to sustainability, climate mitigation, greenhouse gas reduction, and resilience, and why should you care?

Photo courtesy of Marilyn Wyman, Cornell Cooperative Extension of Columbia and Greene Counties

How do we manage water on the land?

History and habits

- Drainage – move water Away
- Old habits are hard to break
- Opportunity to better integrate water management with habitat and other goals



Key trends and drivers

- Water quality goals -- regulations based on US Clean Water Act (1972)
- Point-source discharges of pollution were original focus of Clean Water Act
- Wastewater overflows include
  - Combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs)

Trends and drivers, continued

- *Non-point sources* of pollution carried in runoff is newer focus c. 1980s
  - Soil and sediment
  - Nutrients and pathogens – septic systems, fertilizer, pet waste, leaves, leaky sewers, agricultural runoff, etc.
  - Automotive chemicals – oil, antifreeze, etc.
  - Road salt
  - Lawn & turf chemicals – fertilizer, pesticides, herbicides
- Stormwater management regulations are largely aimed at managing non-point sources of pollution

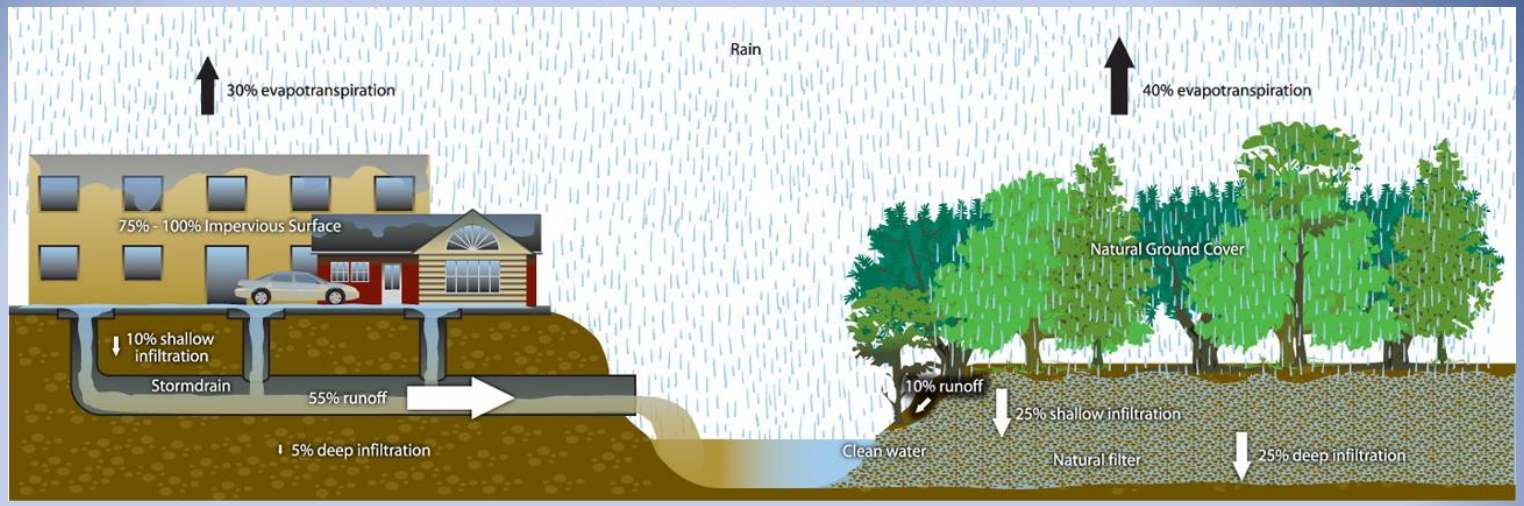
Trends and drivers, continued

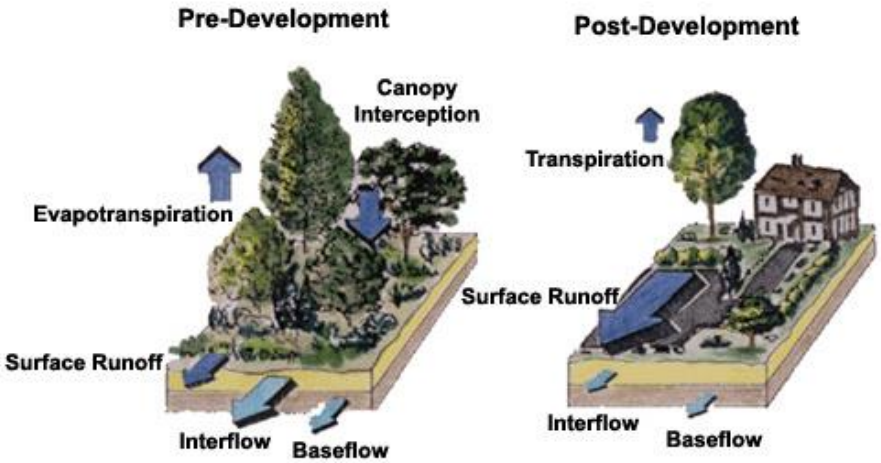
- Flooding

Moodna Creek in Cornwall, NY

Moodna Creek in New Windsor, NY after flooding from Irene in 2011

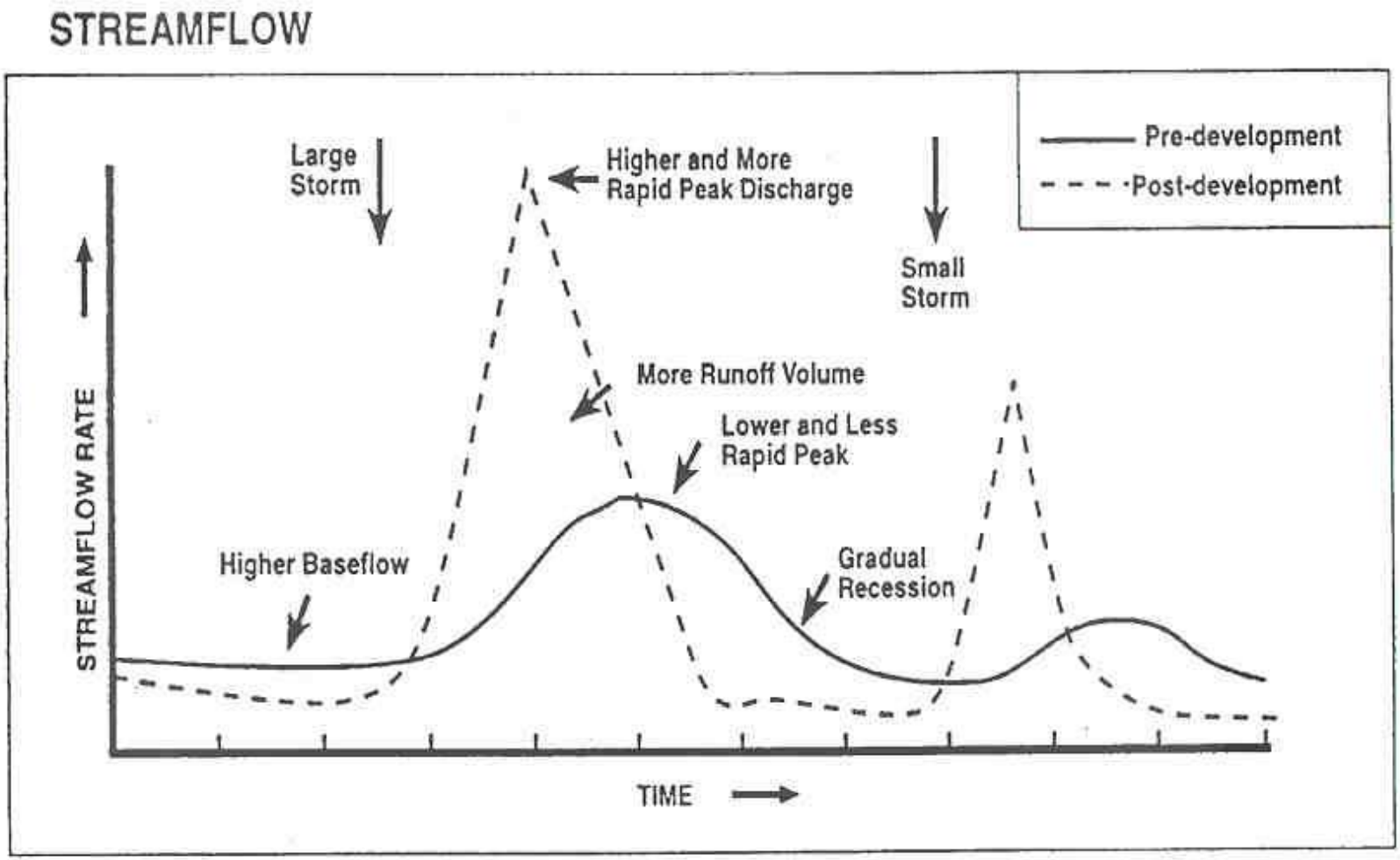
Changes in watershed hydrology due to urbanization





Graphic above by Chris Cox, College of Agriculture and Life Sciences at Virginia Tech, from Federal Stream Corridor Restoration Handbook
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/restoration/?cid=nrcs143_026903

Figure 1.5 Change in Hydrograph following Development
(Source: Schueler, 1987)

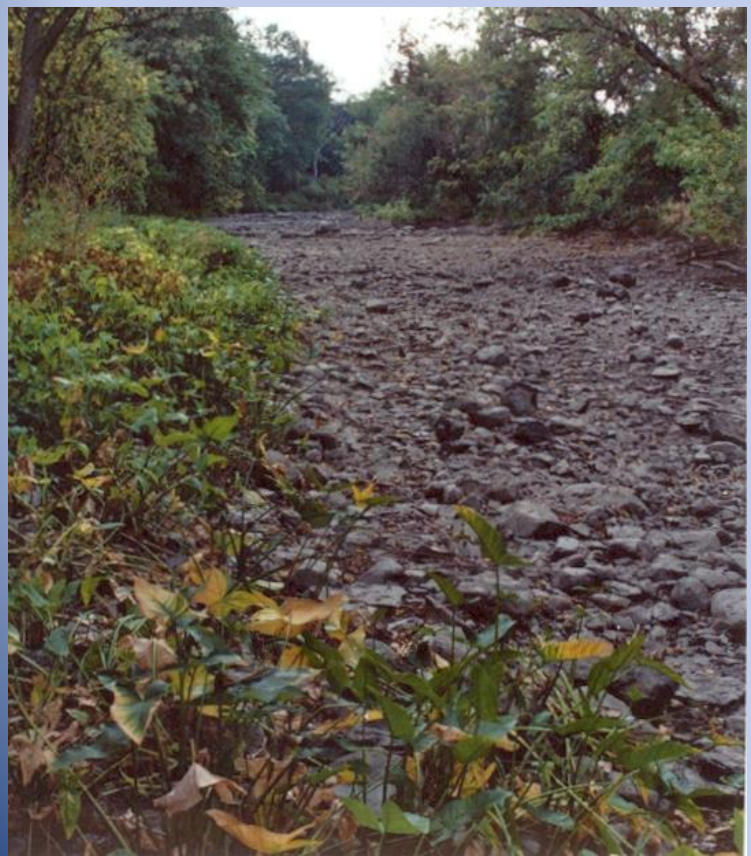


The impervious surfaces and conveyance systems of developed sites result in an earlier and higher peak discharge rate.

Impacts of impervious surfaces & conventional drainage practices

Pavement and buildings prevent infiltration of water into the soil so

- Groundwater recharge is reduced
- This depletes base flow to feed streams in dry weather
- Increased runoff volumes and velocity causes stream erosion



Green infrastructure

- Paradigm shift – *don't* move the water away!
  - Spread it out
  - Slow it down
  - Soak it in

Swale with curb cut at shopping center in upstate NY

Green roof at Beacon Institute Beacon NY

Green infrastructure = site-scale practices for water

rain gardens, bioretention, rainwater harvesting and reuse, pervious pavement, street trees, vegetated swales, riparian buffer protection and restoration, green roofs, green walls, downspout disconnection, stream daylighting

and <u>trees</u>

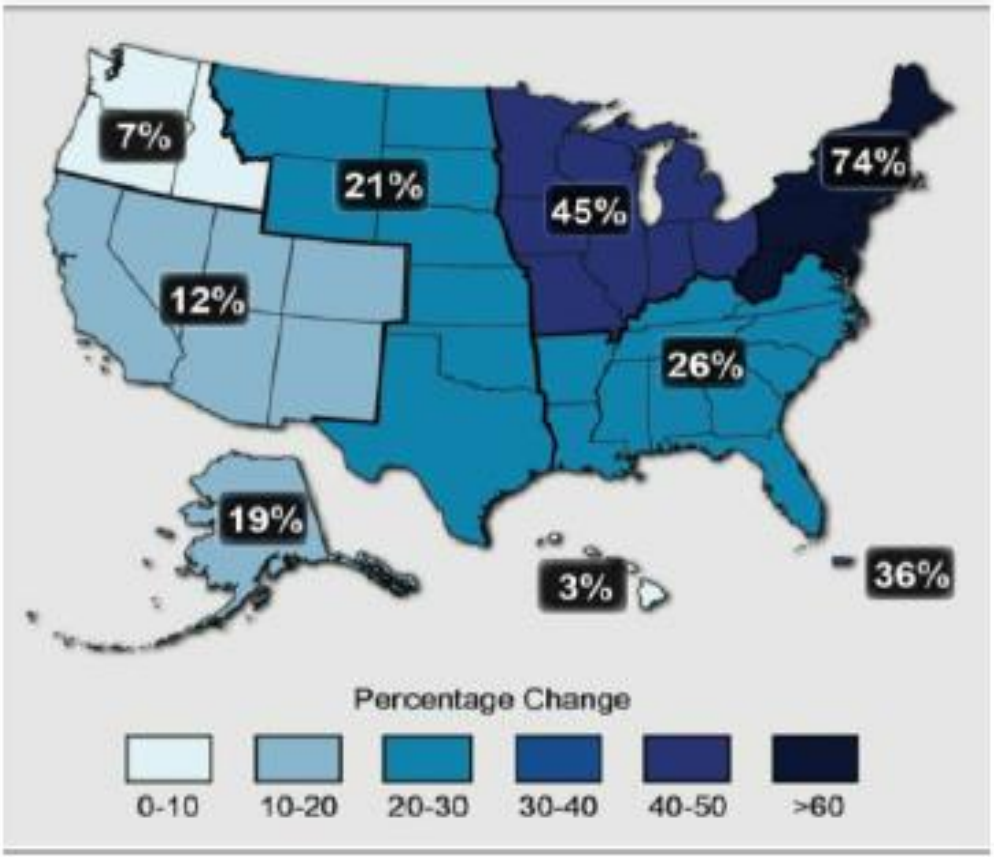
Porous parking lot at SUNY-New Paltz

Rain garden at Black Rock Forest

Tree photo courtesy of Marilyn Wyman, Cornell Cooperative Extension of Columbia and Greene Counties

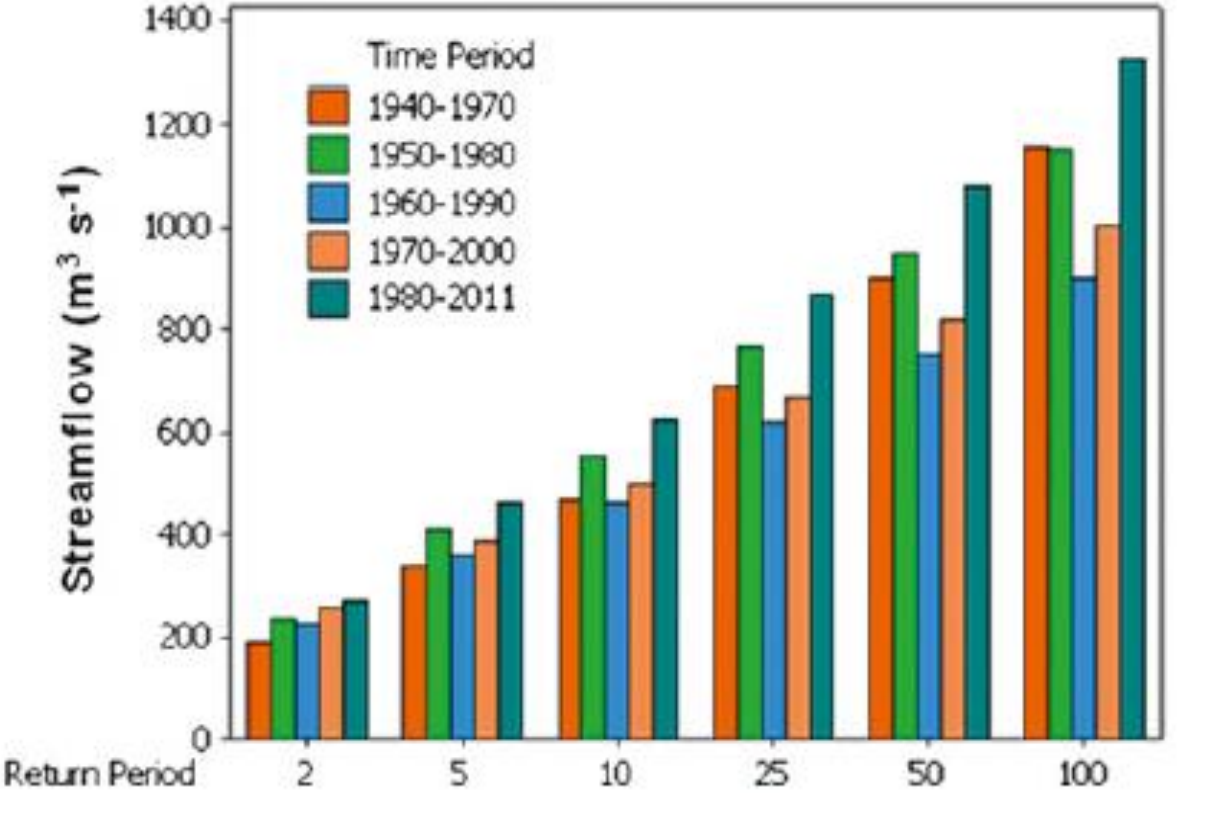
The frequency of larger storms has increased significantly in our lifetime, more in Northeast than other parts of the U.S.

Graphic from *Reducing the Impact of Severe Flooding,* Cornell University Cooperative Extension Hudson Estuary Watershed Resiliency Project



Percentage Change in Very Heavy Precipitation throughout the United States—The map shows percent increases in the amount of precipitation falling in *very heavy precipitation* events (defined as the heaviest 1% of all daily events) from 1958 to 2011 for each region. The Northeast has seen a 74% increase in these events during this time period.

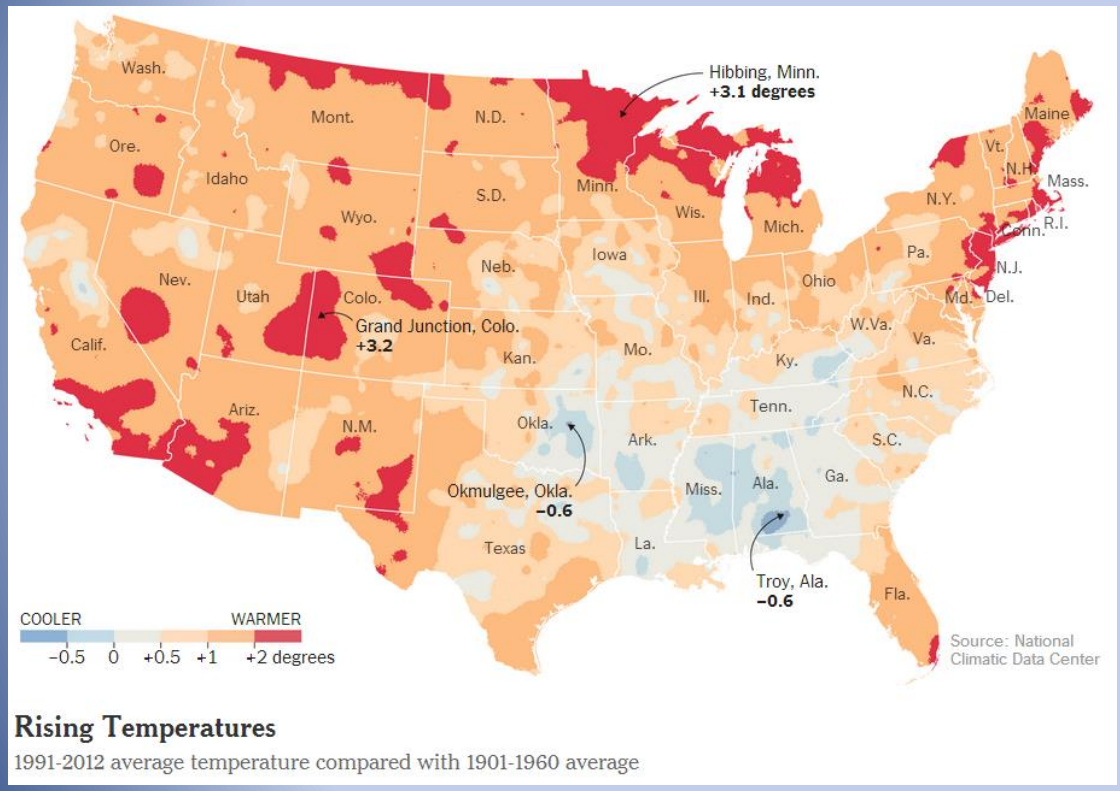
Source: Draft National Climate Assessment, Jan. 2013



In the Hudson Valley & Catskill Mountain region, the 10-year flood from the period 1960-1990 became the 5-year flood during 1980-2011, and the 25-year flood from 1960-1990 became the 10-year flood for 1980-2011

From Matonse, Adão H, Allan Frei, 2013: A Seasonal Shift in the Frequency of Extreme Hydrological Events in Southern New York State. J. Climate, 26, 9577–9593

U.S. National Climate Assessment issued May 6, 2014



John Holdren, Director, White House Office of Science and Technology Policy, speaking about the new report in NY City on May 7, 2014

U.S. Climate Has Already Changed, Study Finds, Citing Heat and Floods

By JUSTIN GILLIS MAY 6, 2014

http://www.nytimes.com/2014/05/07/science/earth/climate-change-report.html?_r=0

Lamont-Doherty Earth Observatory in Rockland County

Melting snow drains away, avoiding re-freezing and reducing icy conditions

Patrick O’Reilly P.E., at LDEO in spring of 2013

“But pervious paving won’t stand up to freezing conditions.” Actually…

Pervious asphalt is on left side of this photo and conventional paving on right. Note the cracking in conventional paving used for entrance ramp eight years after it was built.

Mid-Hudson Regional Sustainability Plan, completed in May 2013 as part of NY State's Cleaner Greener Communities program

How are best practices for managing water related to sustainability, climate mitigation, greenhouse gas reduction and resilience?

Decision: focus on trees

Trees are…

Widespread across the landscape

Important for energy efficiency, management of the electric grid, and carbon mitigation & sequestration

"Charismatic megaflora", i.e. big – the largest base of existing green infrastructure assets

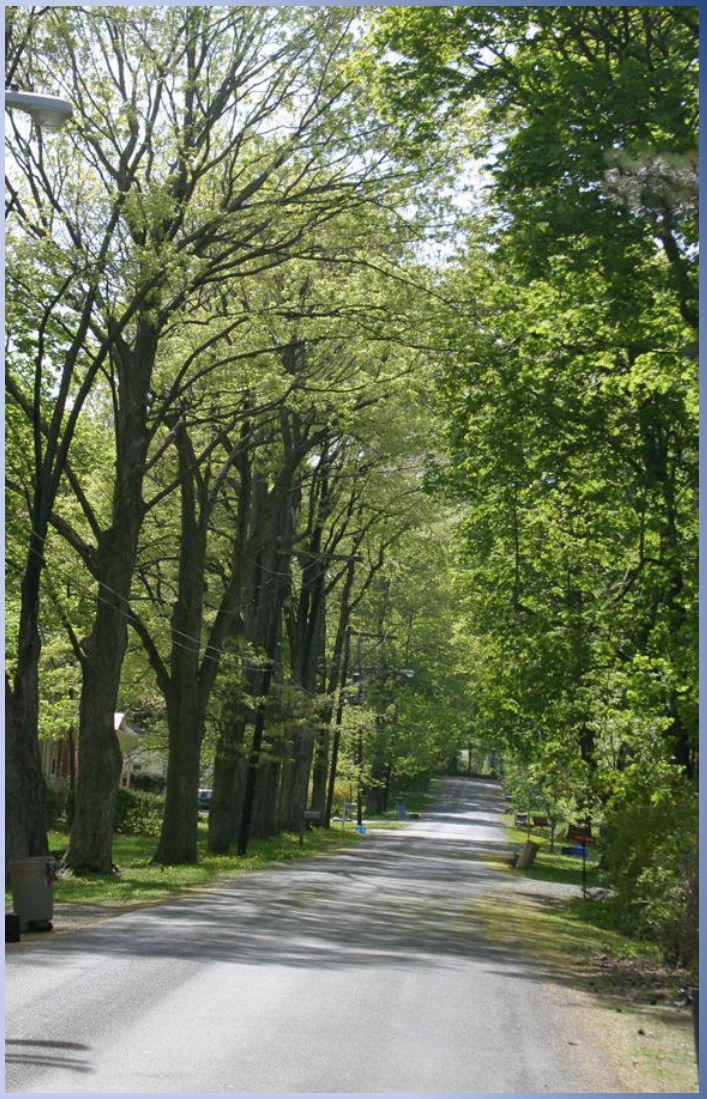
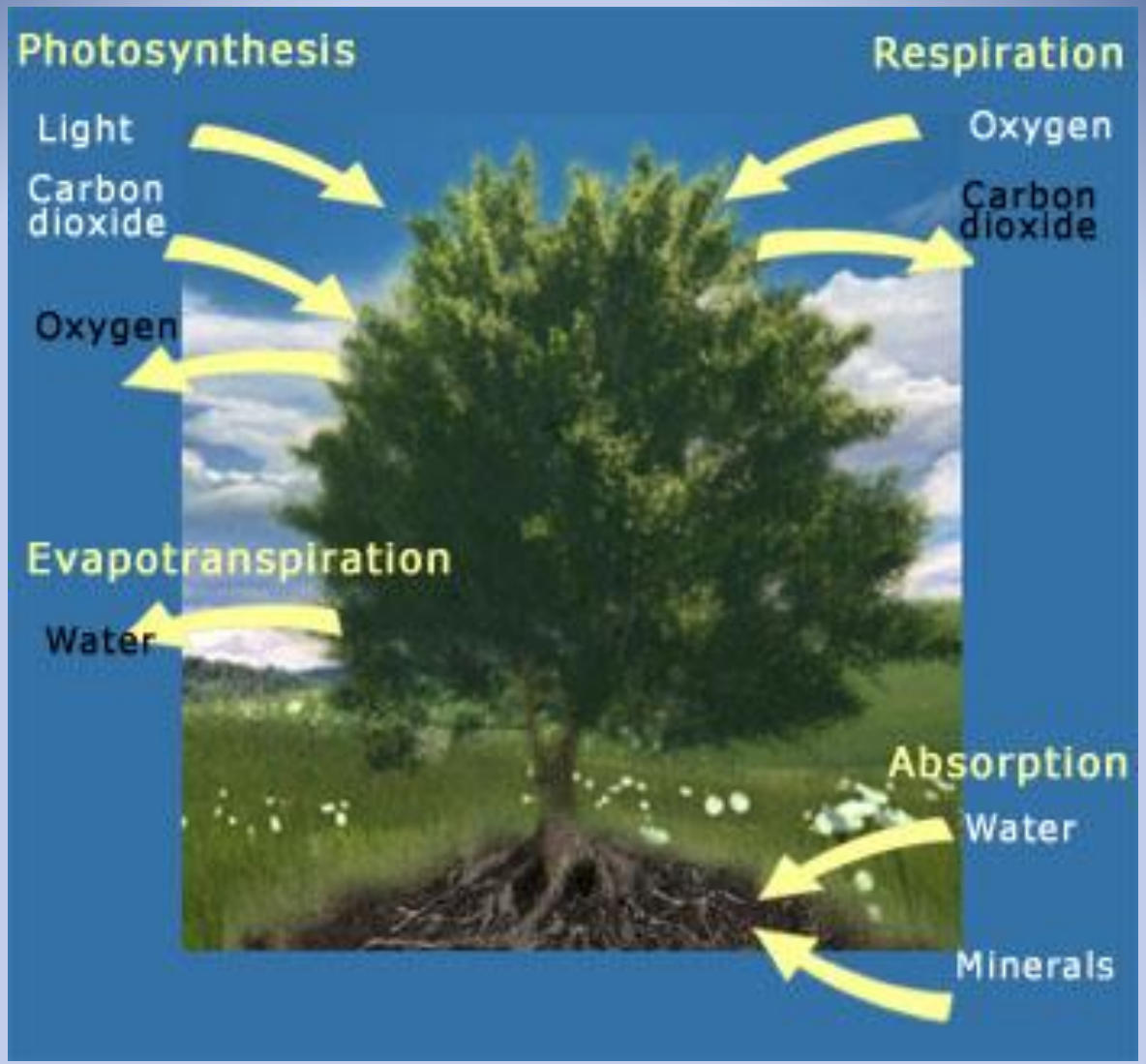


Photo from *Health and Incidence & Severity of Decay of Street Tree Maples in Four Upstate New York Cities*
http://www.dec.ny.gov/docs/lands_forests_pdf/streetmaples.pdf



Evapotranspiration (ET) = link between water and energy flows

ET, shading, buffering winter winds = energy efficiency benefits of trees

http://www.aucoeurdelarbre.ca/en/branching-out/teachers/module3-html.php

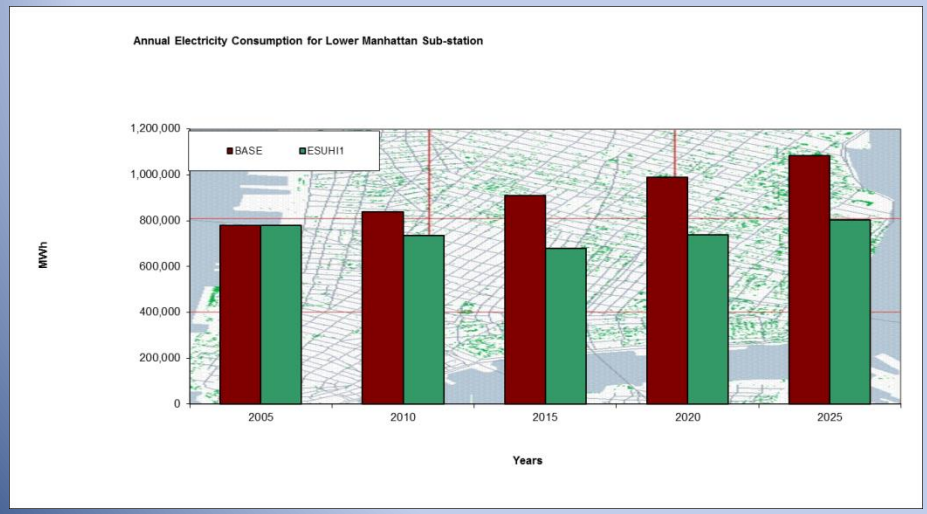
How much energy do trees save?

"Trees … can cut cooling costs by 20 to 40 percent." "Evergreens block wind. They can help you save 20 percent or more on heating costs." (Con Edison email to customers in May 2014.)

In CA cities, $500 million/year savings in wholesale electricity costs to utilities in 2001 (McPherson and Simpson 2003)

US Department of Energy: 15-50% reduction in air conditioning costs (http://energy.gov/articles/energy-saver-101-infographic-landscaping)

Impacts of UHI Measures and Energy Star Technologies: >20% reduction in annual electricity consumption in urban NYC neighborhood (USEPA, citation below)



From *Urban Heat Island and Global Warming -- An Analysis of the Current State of Knowledge and Market Transformation Efforts in US Cities*. Patrick Kelly, EPA April 2007

Multiple benefits of green infrastructure

- Cooling streets, parking areas and buildings in urban areas by reducing *urban heat island* impacts
- Reduced energy use and public health benefits
- Contributes to aesthetic quality
- Reduced rates of certain crimes
- Safety improvements – less icing in parking areas (porous paving)
- Phytoncides boost human immune system, other health benefits *
- Mental and emotional health, including faster healing times after surgery
- Increased property values
- Runoff reduction and water quality

* The Forest Rx, Gloria Van Duyne, NYS DEC, in Taking Root Summer 2013
See http://www.dec.ny.gov/lands/90720.html

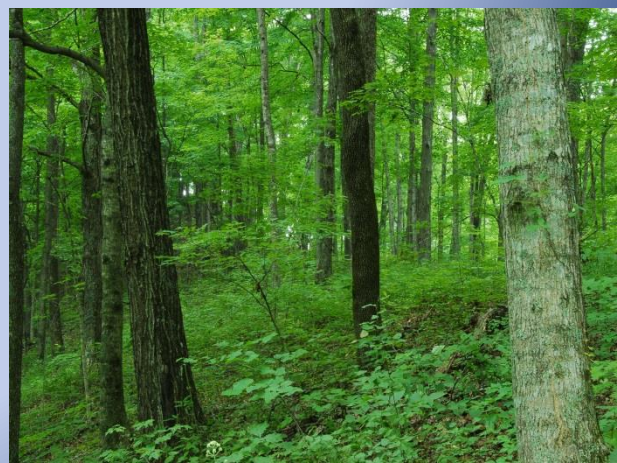


Photo courtesy of Marilyn Wyman, Cornell Cooperative Extension of Columbia and Greene Counties

Challenges for tree planning and management

Storm risks

Real and perceived risks to buildings, etc. and precautionary cutting

Interference with power lines, utilities face competing interests

Need for training and technical assistance including public works/highway departments

Challenging urban environments with limited space and compacted soils

Trees washed downstream in Irene/Lee 2011 – Moodna Creek marsh, New Windsor NY

Work of Professor Dr. Nina Bassuk, Program Leader, Urban Horticulture Institute at Cornell University, and colleagues

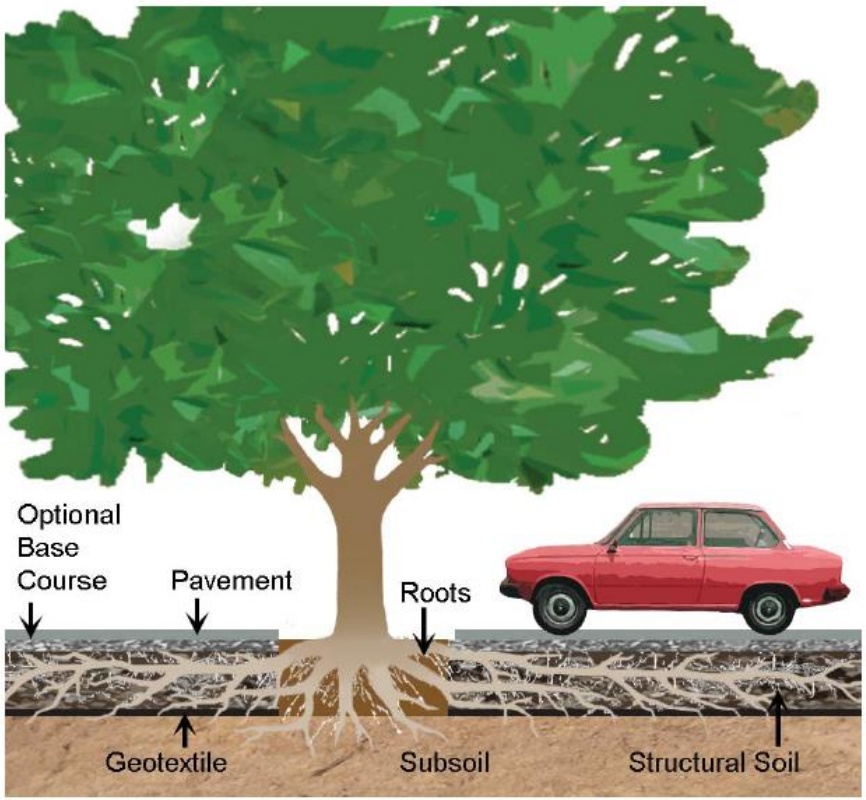


Figure 2. This system both serves as a parking lot and as a stormwater management facility. In addition to this double use of space, the structural soils also provide vastly greater soil volumes for tree root growth than traditional parking lot construction. Note: Gravel base course is optional, since the structural soil is designed to be as strong as a base.

Figure by Sarah Dickinson.

Managing Stormwater for Urban Sustainability Using Trees and Structural Soils
http://www.hort.cornell.edu/uhi/outreach/pdfs/TreesAndStructuralSoilsManual.pdf

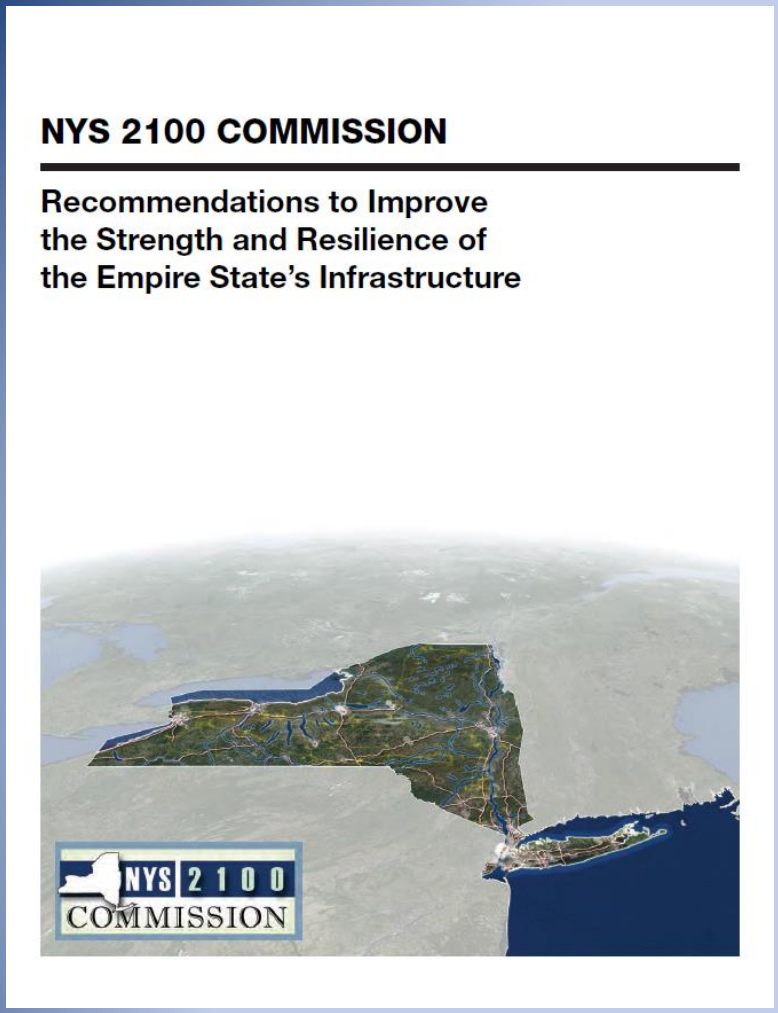
Giving trees room to grow in urban environments

Soil volume effects on tree growth potential. Honeylocusts in Syracuse, NY – trees on the right are in tree pits with limited volume, while those on left are in tree pits and adjacent to a larger green area with more room for root growth.

Photo courtesy of Nina Bassuk, Cornell University Urban Horticulture Institute.

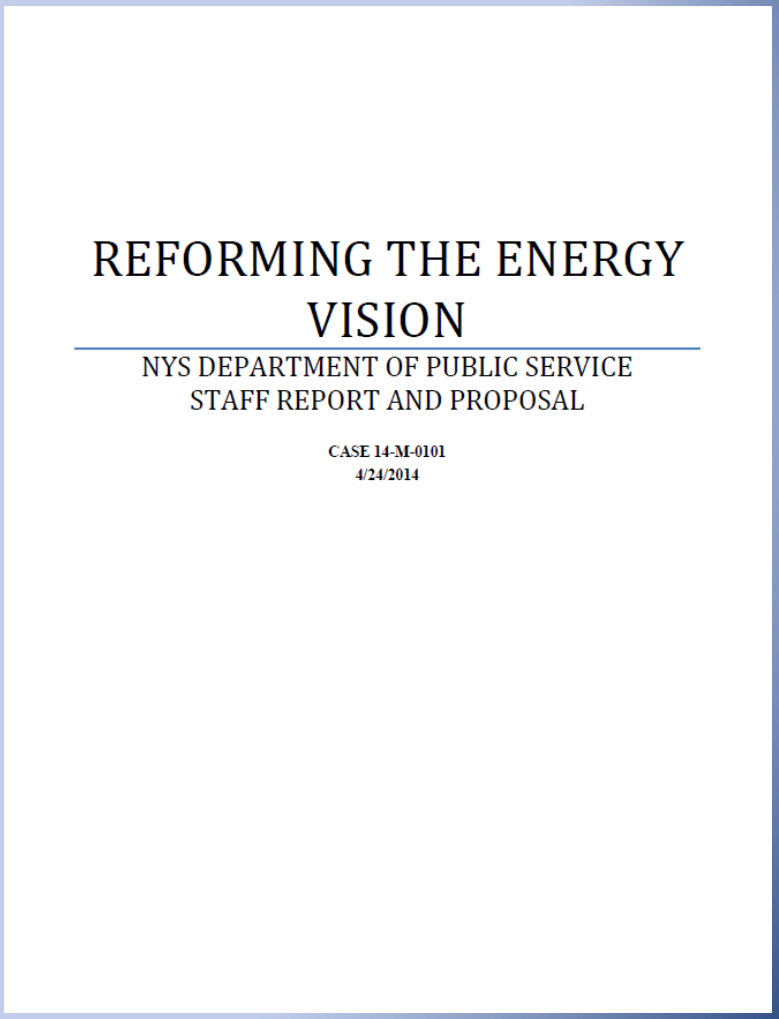
Monitoring root growth with ground-penetrating radar

Photo courtesy of Nina Bassuk, Cornell University Urban Horticulture Institute.



Report from NYS 2100 Moreland Commission established after Superstorm Sandy in 2012 – "**Promote and expand urban forests… to combat stormwater runoff and urban heat**" (p. 131)

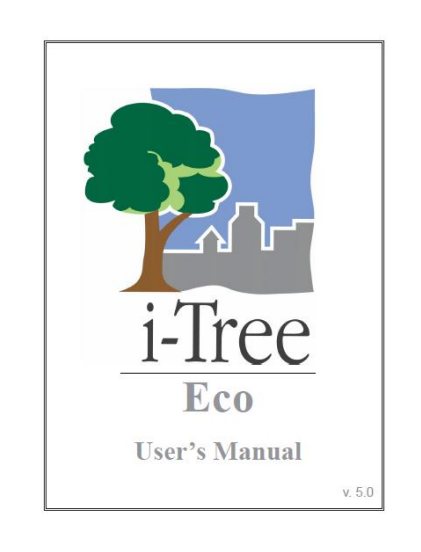
April 2014 – NY State Department of Public Service staff report kicks off major reform initiative for electric grid resilience, efficiency, and carbon reduction

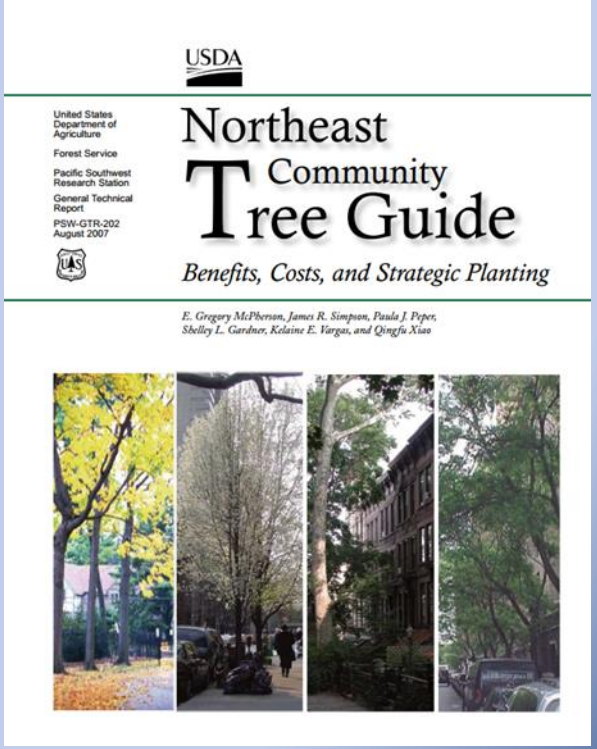


Challenge and opportunity: integrate trees with other energy & climate priorities including solar energy

Home in Warwick NY, designed by Rick Alfandre, Alfandre Architecture

Tree assessment, valuation & risk management resources





Philadelphia Green Infrastructure Plan Triple Bottom Line benefits

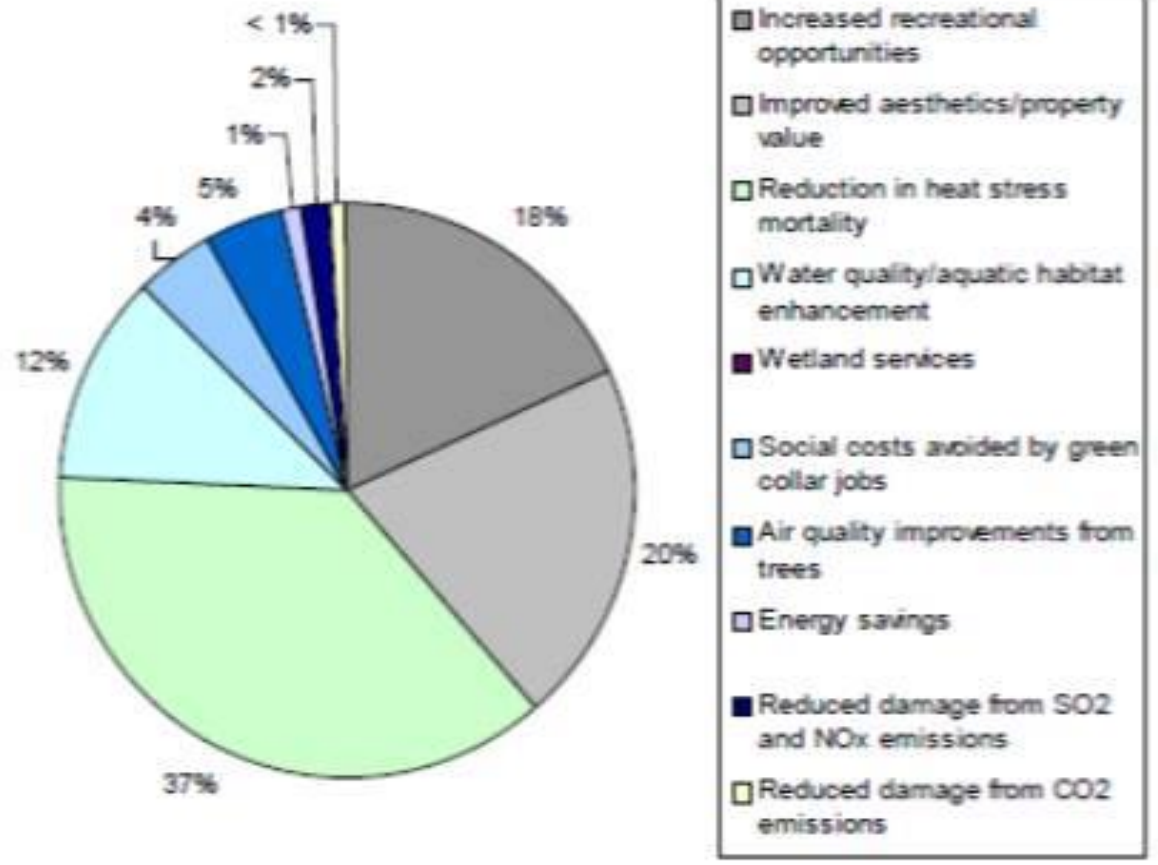


Figure 5.2. Shares of City-wide present value benefits of key CSO options: Cumulative through 2049.

How are best practices for managing water related to sustainability, climate mitigation, greenhouse gas reduction, and resilience?

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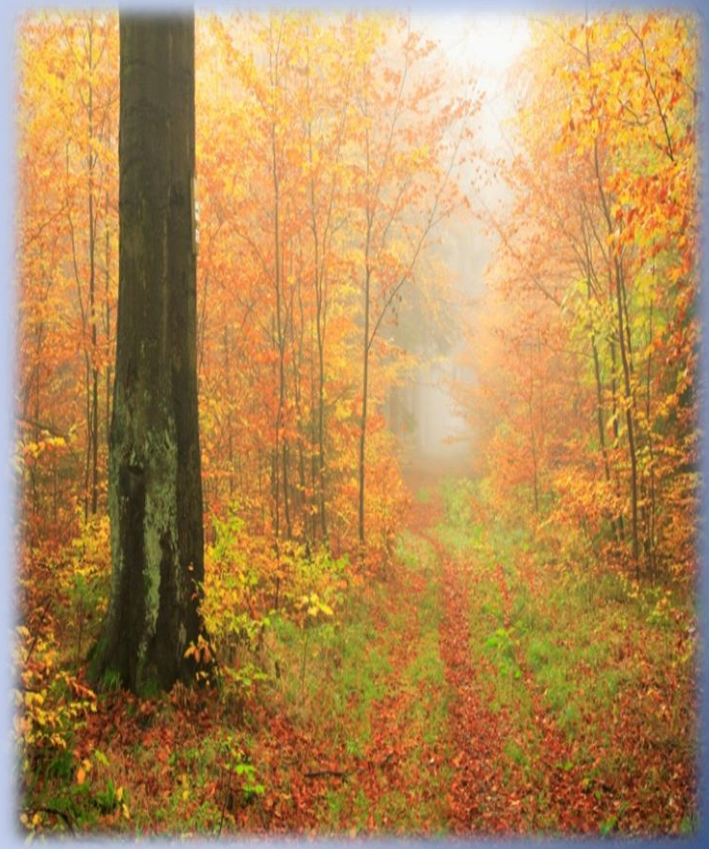

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