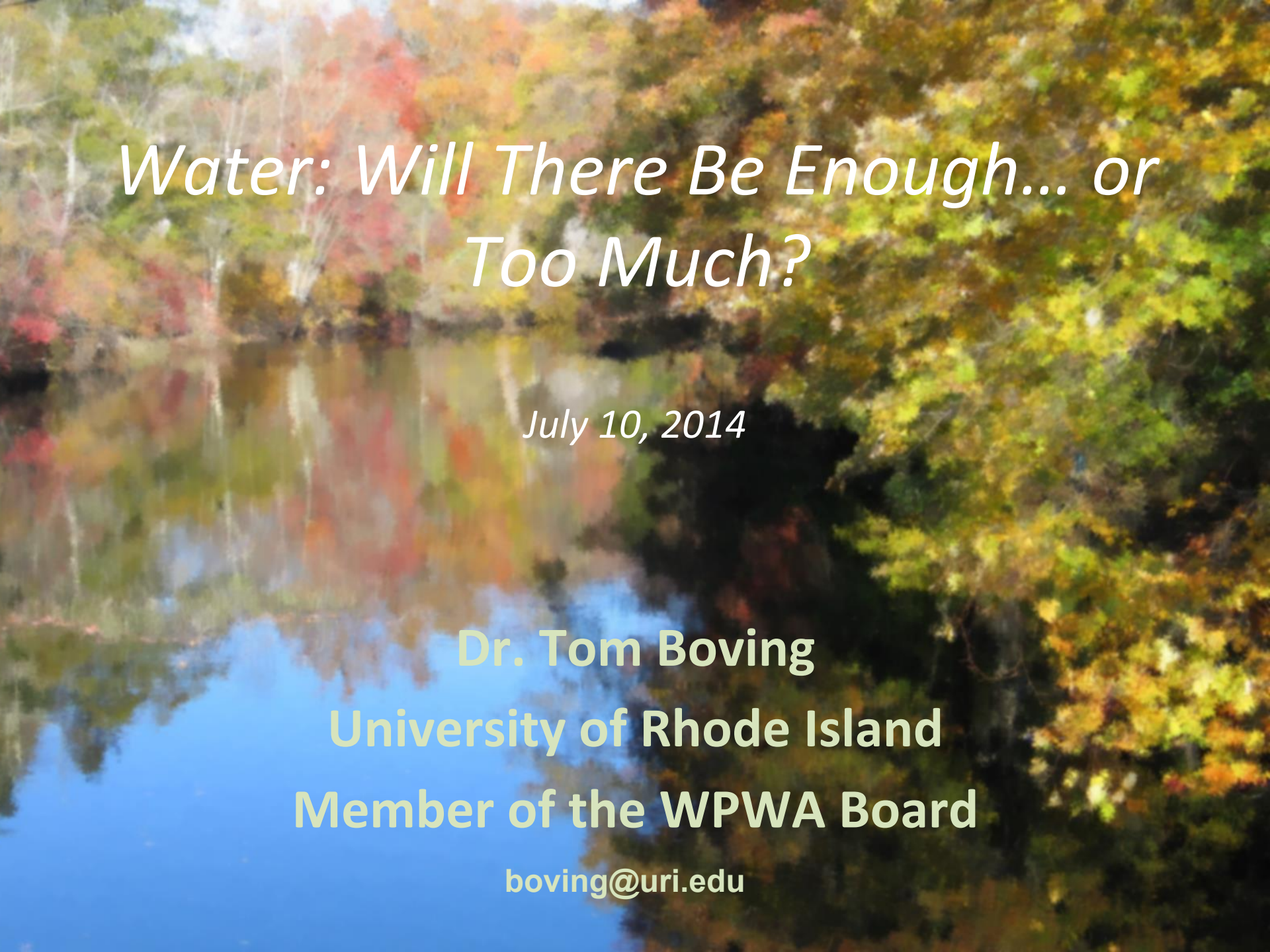


Water: Will There Be Enough… or Too Much?

July 10, 2014

Dr. Tom Boving
University of Rhode Island
Member of the WPWA Board
boving@uri.edu

Disclaimer

- It is very difficult, if not impossible, to discuss in detail the changes that will happen at the resolution of a state the size of Rhode Island, let alone the Wood-Pawcatuck Watershed.

- But…there is no doubt that changes are happening!

Overview

- The Big Picture
  - Past, present and future climates
- Consequences of climate change
- Adaptation strategies
- Closing remarks

Opening Statement

3rd National Climate Assessment 2014

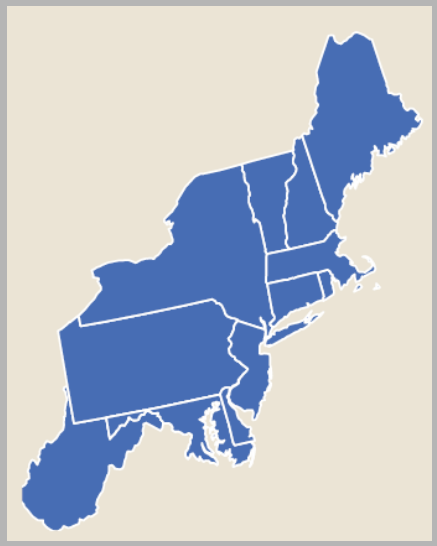
- Climate change is posing a growing challenge to the Northeast's environmental, social, and economic systems.

Focus of this presentation is on (ground) water resources.

http://nca2014.globalchange.gov/report/regions/northeast

Climate Change in the Northeast

- Heavy precipitation events have increased in magnitude and frequency.
  - Between 1958 and 2010, the Northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events.



Climate Change in the Northeast

- The combination of a projected increase in heavy precipitation and likely sea level rise may lead to more frequent, damaging floods.

Switch Rd.
March 2010

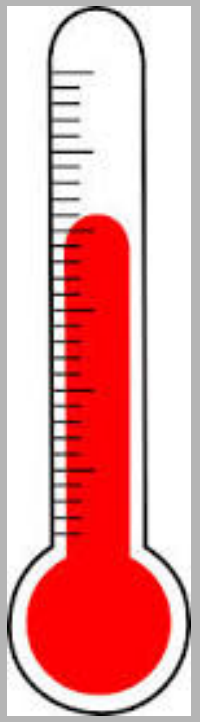
WPWA Office, Wood River
Photograph by: Chris Fox
Date of Photograph: March 30, 2010

Climate Change in the Northeast

- Our region has experienced a greater recent increase in extreme precipitation *than any other region* in the United States.
  - Winter and spring precipitation is projected to increase, especially but not exclusively in the northern part of the region.

Climate Change in the Northeast

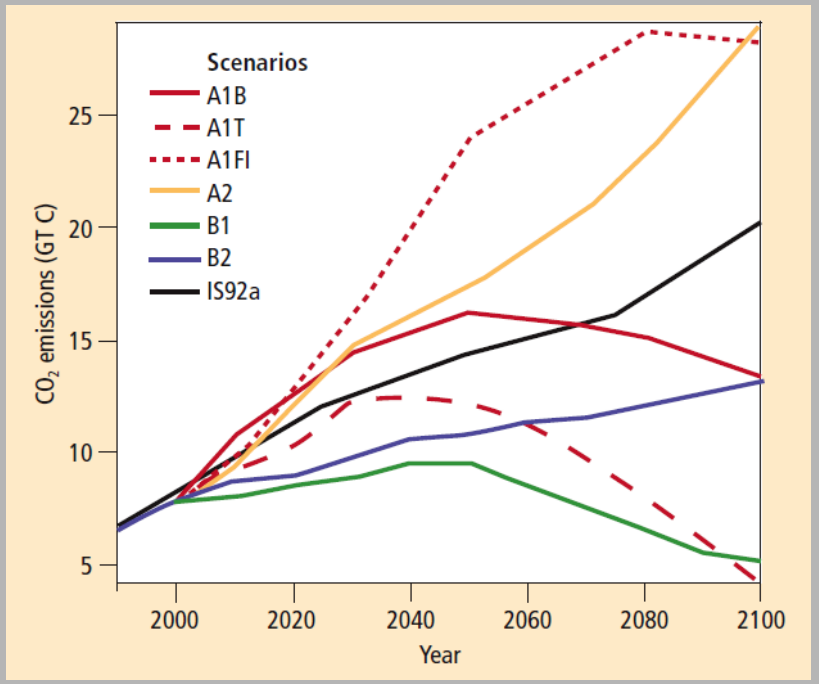
- Between 1895 and 2011, temperatures in the Northeast increased by almost 2˚F and the average winter temperature increased by 4°F.



What’s next?

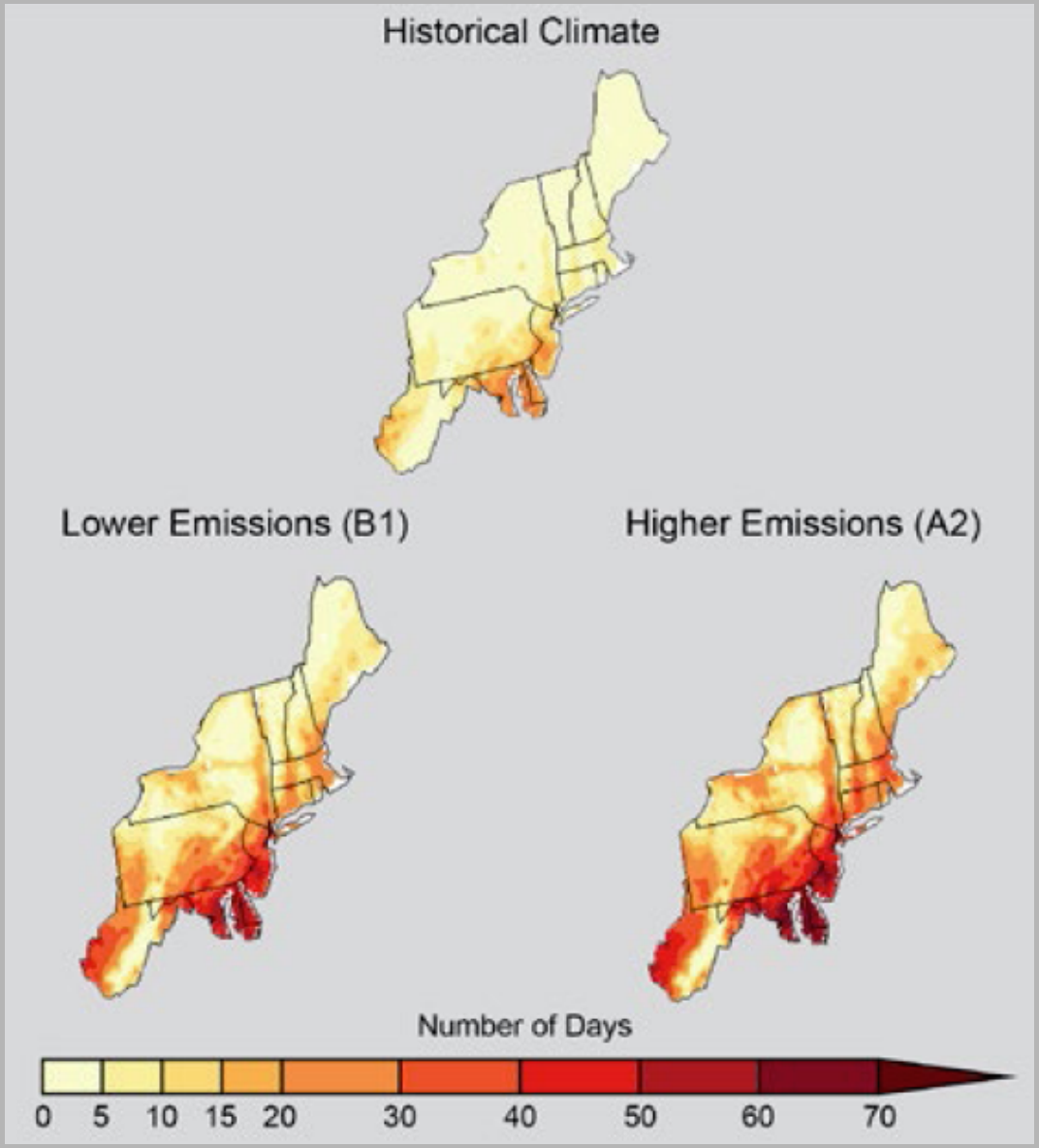
Emission Scenarios

- Higher emission (A2) scenario:
  - Global GHG emissions continue to increase
- Lower emission (B1) scenario:
  - Global GHG emissions are reduced substantially



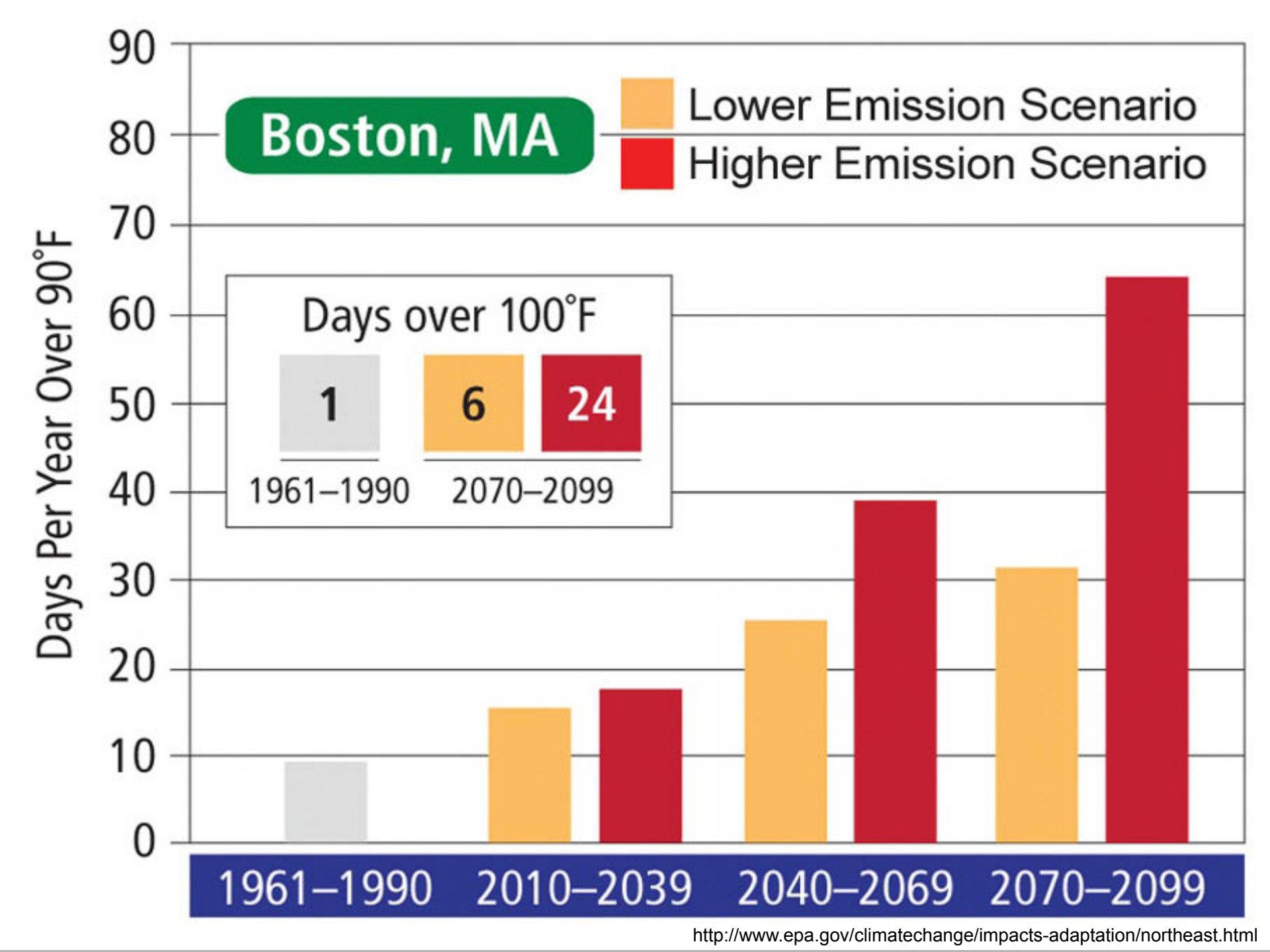
Temperatures continue to rise.

The frequency, intensity, and duration of heat waves is expected to increase.



Projected increase in the number of days per year with a maximum temperature greater than 90°F averaged between 2041 and 2070, compared to 1971-2000,

http://nca2014.globalchange.gov/report/regions/northeast



http://www.epa.gov/climatechange/impacts-adaptation/northeast.html

Hartford could see as many as 30 days per year with temperatures reaching 100°F.

Rainfall amounts continue to increase.

By the end of the century, New York City may experience a 100-year flood every 10 to 22 years, on average.

RI Revised Rainfall Amounts

RI County	24-hour (Type III) Rainfall Amount (inches)						
	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Providence	**2.7** *2.7*	**3.3** *3.3*	**4.1** *4.2*	**4.9** *4.8*	**6.1** *5.6*	**7.3** *6.2*	**8.7** *7.0*
Newport	**2.8** *2.7*	**3.3** *3.4*	**4.1** *4.3*	**4.9** *4.9*	**6.1** *5.7*	**7.3** *6.3*	**8.6** *7.1*
Bristol	**2.8** *2.7*	**3.3** *3.4*	**4.1** *4.3*	**4.9** *4.9*	**6.1** *5.7*	**7.3** *6.3*	**8.6** *7.1*
Kent	**2.7** *2.7*	**3.3** *3.4*	**4.1** *4.3*	**4.8** *4.9*	**6.2** *5.7*	**7.3** *6.3*	**8.7** *7.1*
Washington	**2.8** *2.7*	**3.3** *3.4*	**4.1** *4.3*	**4.9** *4.9*	**6.1** *5.7*	**7.2** *6.3*	**8.5** *7.1*

Updated values
Previous values

Source: NRCC - Northeast Regional Climate Center

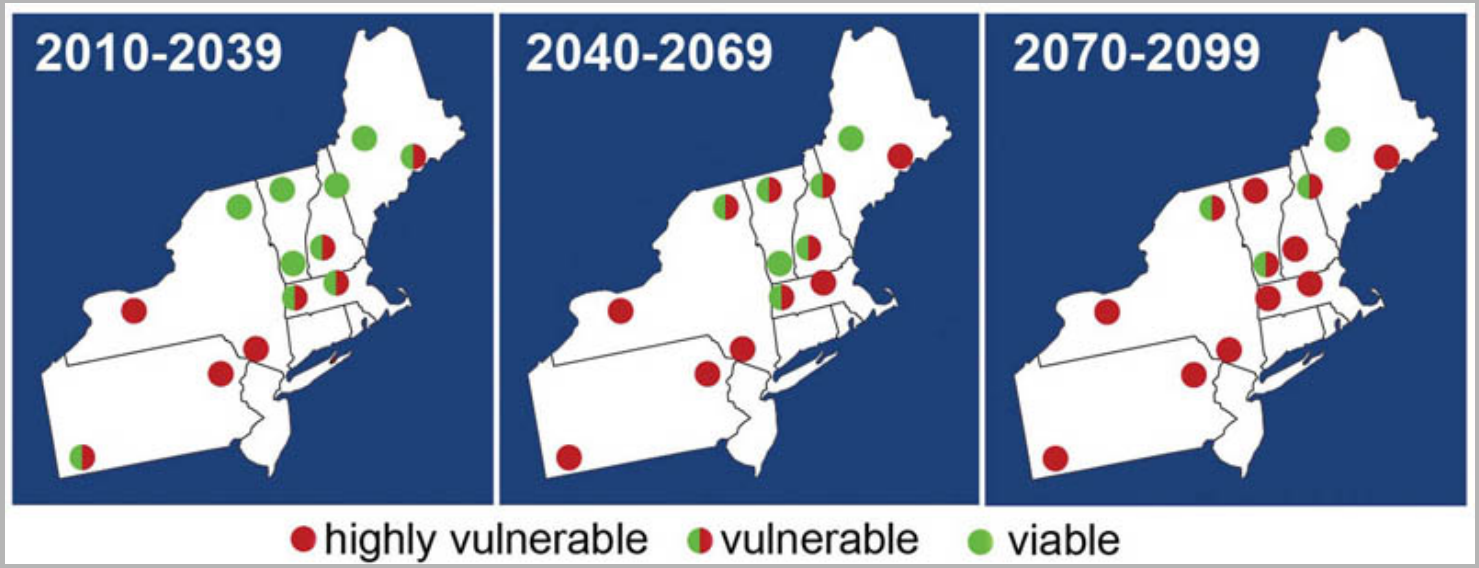
A few words about Statistics

"100-year event" is misleading!

- Better: "…an event having a 100-year recurrence interval."
- Plain English: "1% chance of happening in any year."

Climate Change in the Northeast

- Majority of winter precipitation now falls as rain, not snow.



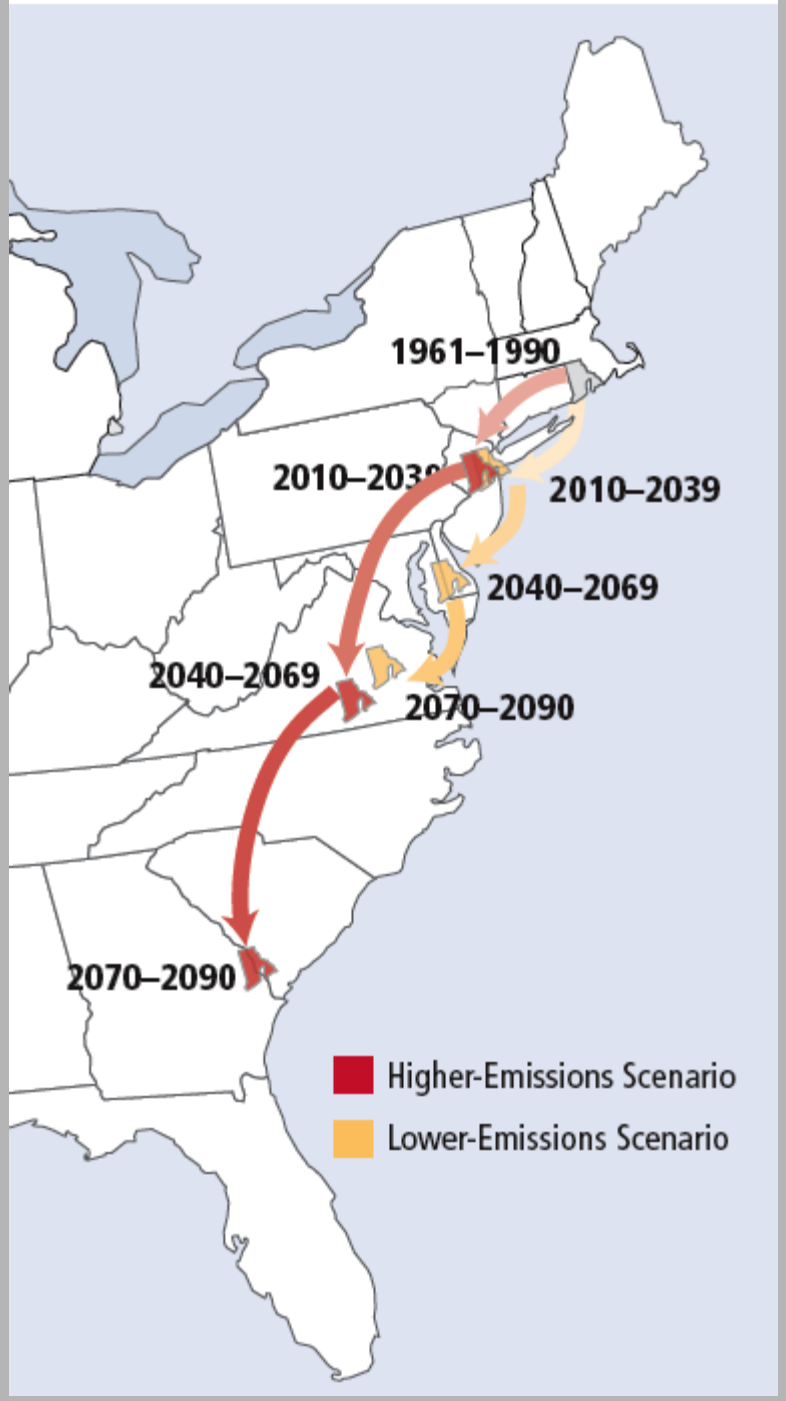
The average length of the ski season may decline to less than 100 days, and winter nights are expected to be warmer.

Ski resorts may require more artificial snowmaking to produce snowpack. Artificial snowmaking requires additional water and energy.

The picture that says it all

Migrating State Climates

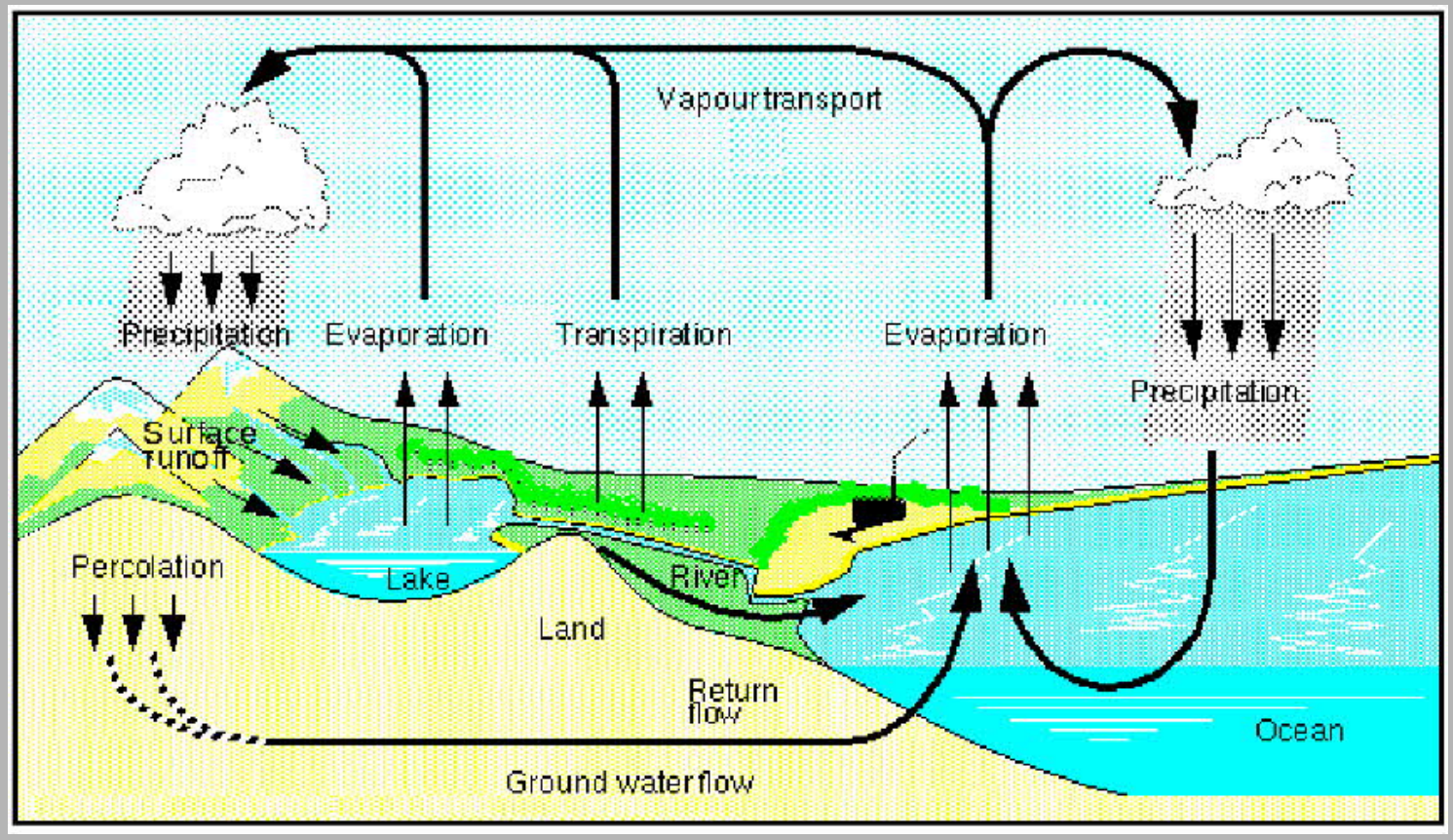
Our summers could be as warm as South Carolina's summers are today by the end of this century.



http://www.climatechoices.org/assets/documents/climatechoices/rhode-island_necia.pdf

Alton Pond – ca. 2070

Expect more extremes



Higher temperatures plus more water speed up atmospheric and hydrologic processes!

What it means…

A much more dynamic Water Cycle!

- Higher ET
- Higher humidity → stronger storms
- Higher P: Higher erosion rates → increased pollution
- Higher T: Increased loss of DO in surface water
- Increased plant growth / invasive species?
- Existing infrastructure reaches capacity
- …..

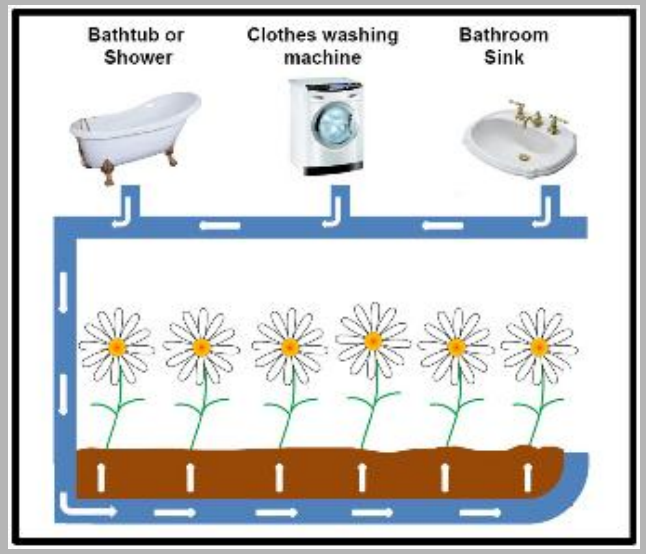
Higher Evaporation/Transpiration

- Plants transpire more water. This increases the demand for irrigation water. Drought risk!

It is estimated that 65-70% of the water people use is lost through evaporation, leaks and other losses.

What can I do?

- Rethink gardening!
  - Select less water intensive plants.
  - Invest in smart irrigation systems.
  - If possible, re-use (grey) water.



Planning to build a new home?

Talk to your architect about water reuse systems!

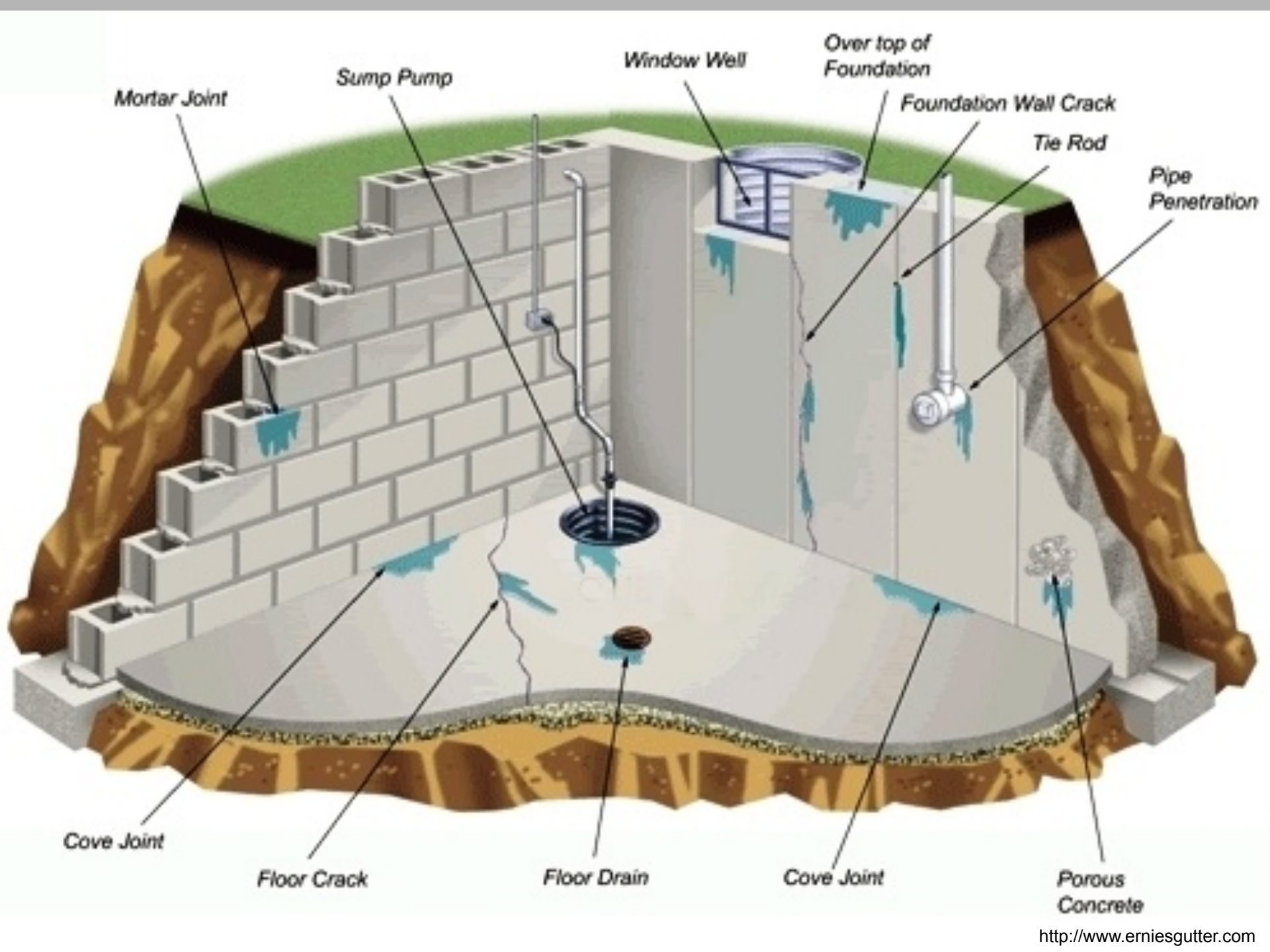
Higher humidity

- Increased amount of moisture in the air results in more powerful storms and increases the potential of flooding.

http://adaptmag.com

What can I do?

- Do not build in flood-prone areas!
- Protect against raising groundwater levels:
  - Divert water away from foundations
  - Install and maintain sump pump
  - Seal cracks in basement
  - French drain
  - Sewer check valve
  - Install A/C to protect against mold



http://www.erniesgutter.com

Higher Erosion Rates

- More intense precipitation and runoff can decrease river and lake water quality in many ways, including increases in sediment, nitrogen, and other pollutant loads.

What can I do?

- Break the force of water: slow it down
- Minimize the use of fertilizers and pesticides.
- Allow water to quickly infiltrate:
  - Permeable pavement or detention ponds
- Maintain wetlands

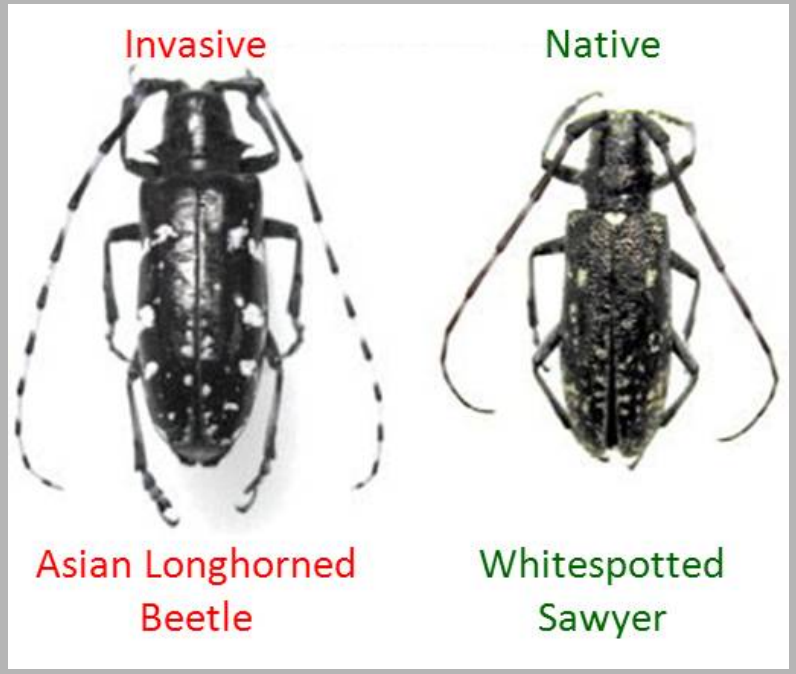
Higher Temperatures / More CO_2

- Our floral and faunal communities will adjust to changing environmental conditions.

Charlestown Beach anno 2100

What can I do?

- Watch for invasive species!
- Report sightings.



URI Invasive Plant Management Certification Program (IPMCP)

http://web.uri.edu/ceoc/invasive-plant-management-certification-program-ipmcp/

Thursday, July 24

…same place, same time.

- **Conserving Tomorrow's Plants and Animals….today!**
  - Professor Pete August
  - State Biologist Gary Casabona

Wood-Pawcatuck Watershed Association

Existing Infrastructure Reaches Capacity

- Stormwater drainage systems were engineered for past climatologic conditions.

- Need to be upgraded to cope with increased water flows.

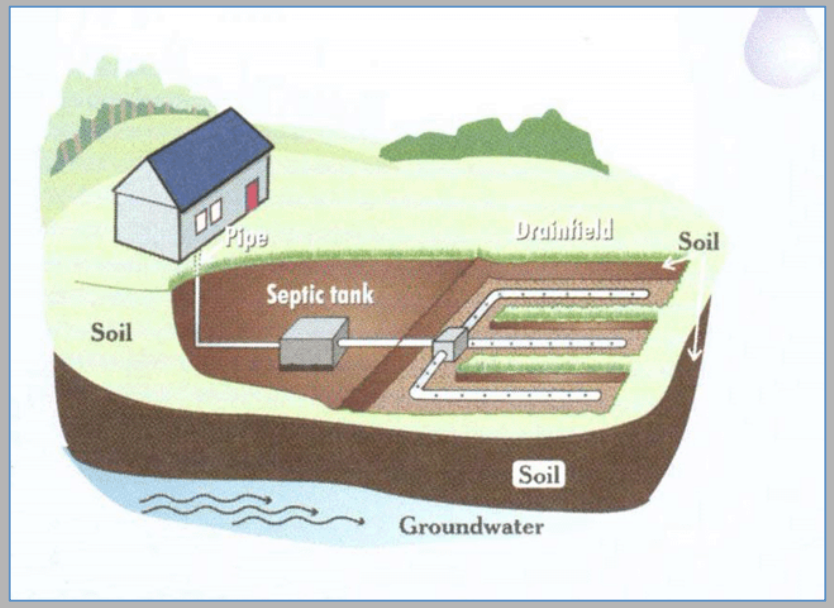
http://www.thebeatnews.org/

What can I do?

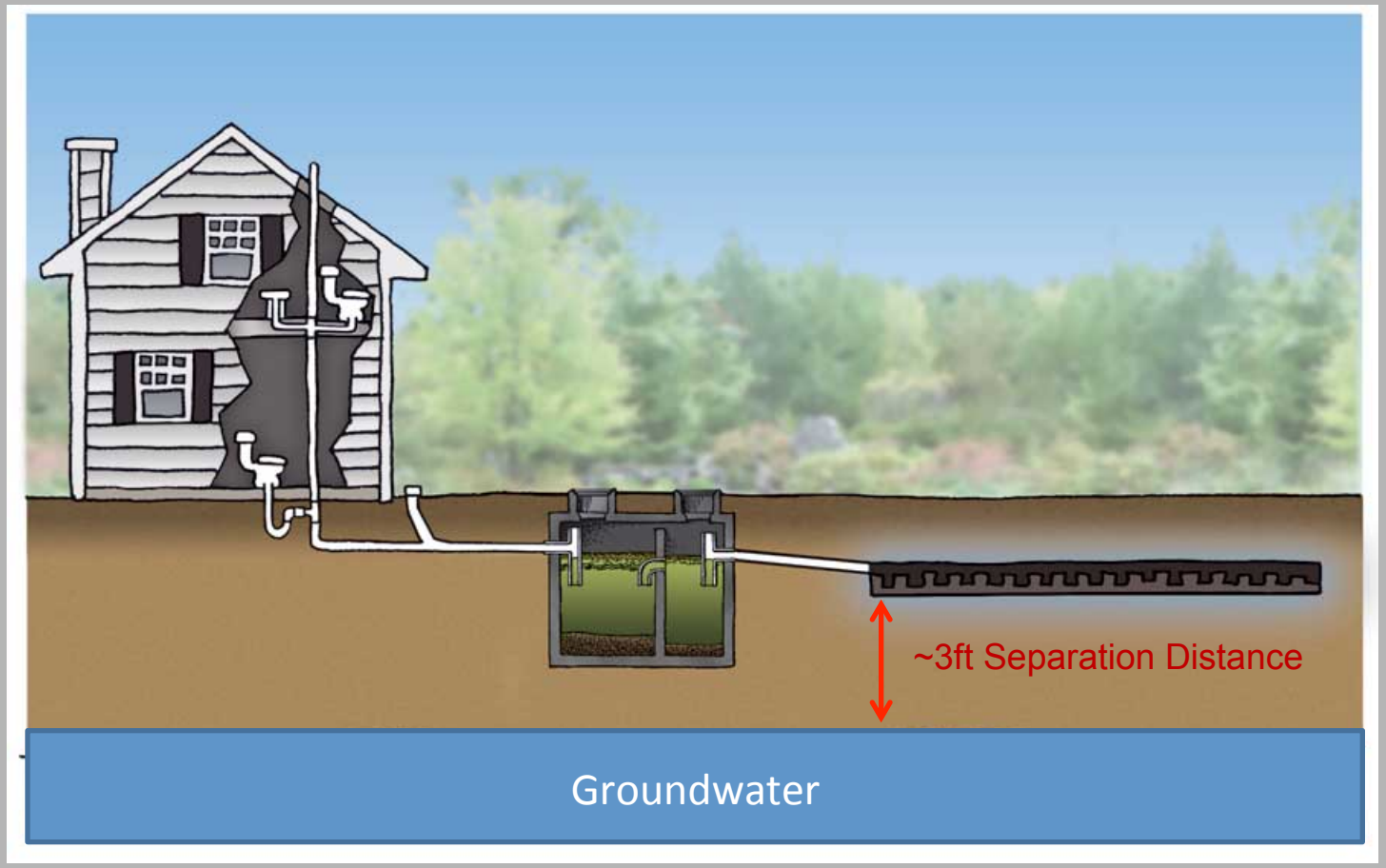
- Remove litter from manholes.
- Pick up trash along road sides.
- Inform your town hall about clogged drainage pipes.
- Call your representative and demand infrastructure investments.

Existing Infrastructure Reaches Capacity

- Increasing precipitation and temperature affects the functioning of onsite water treatment systems (aka septic systems).

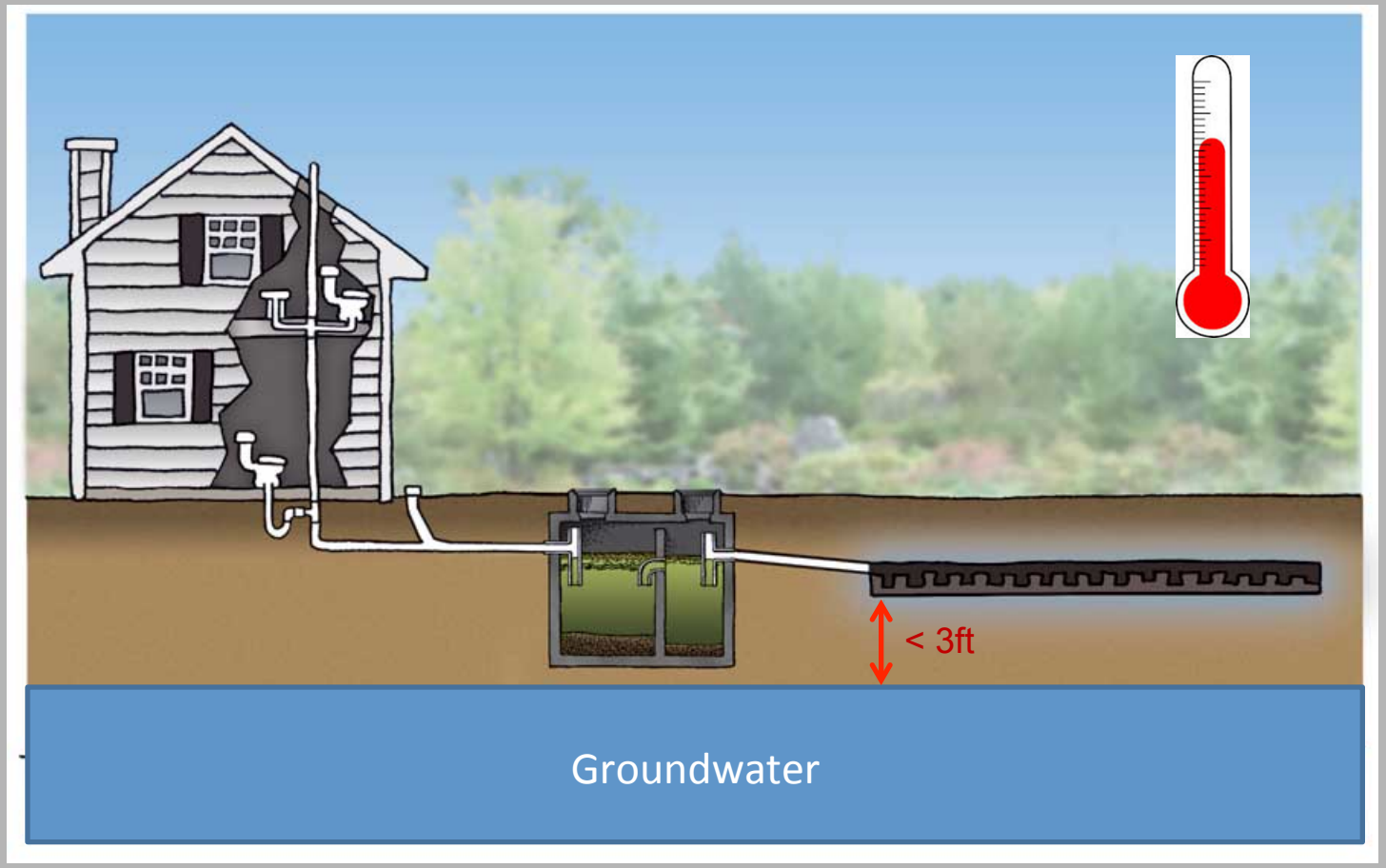


Current Conditions



Water Table

Future Conditions



…fresh from the URI labs:

Climate change

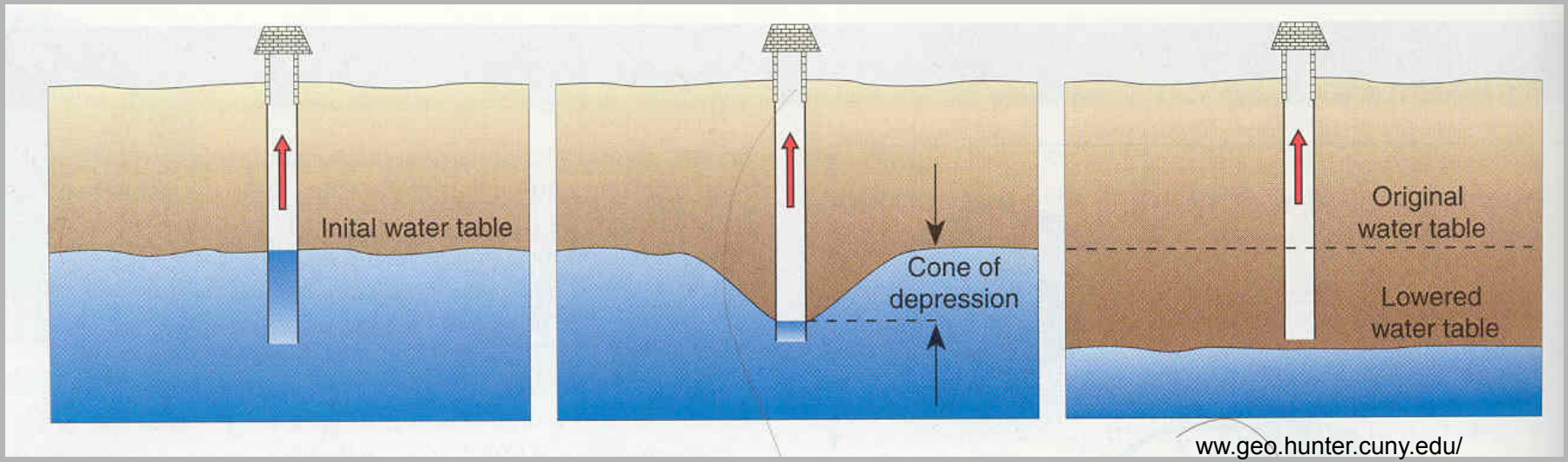
- Reduction in available oxygen
- Release of fecal coliform bacteria and viruses
- Release of P
- Impact on N removal may be improved

Existing Infrastructure Reaches Capacity

- Drinking water supply system is ageing.
  - Losses due to leakage
  - Inefficiencies
- Demand and supply are out of sync.
  - Highest demand in summer - increase in tourist population

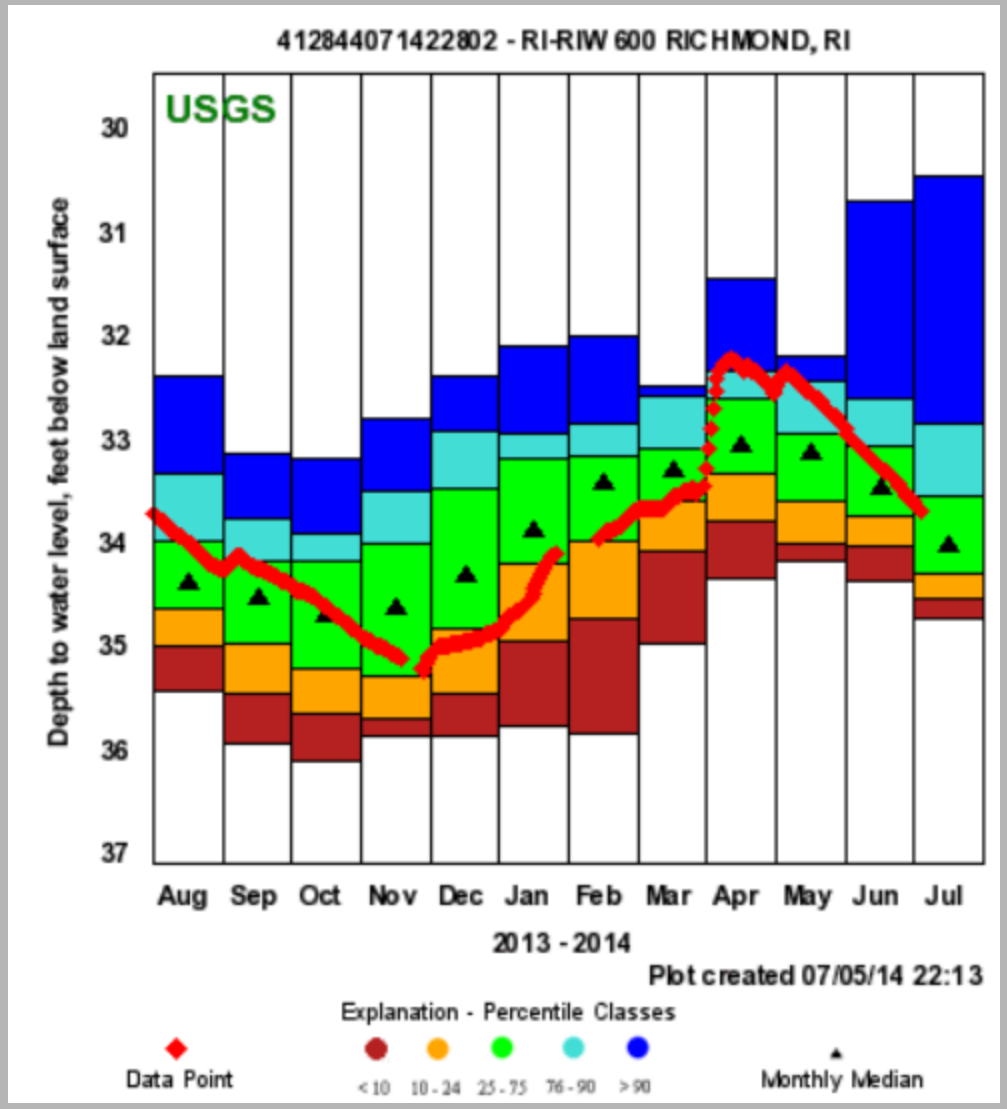
Water level fluctuations

Will groundwater levels be higher or lower in the future?

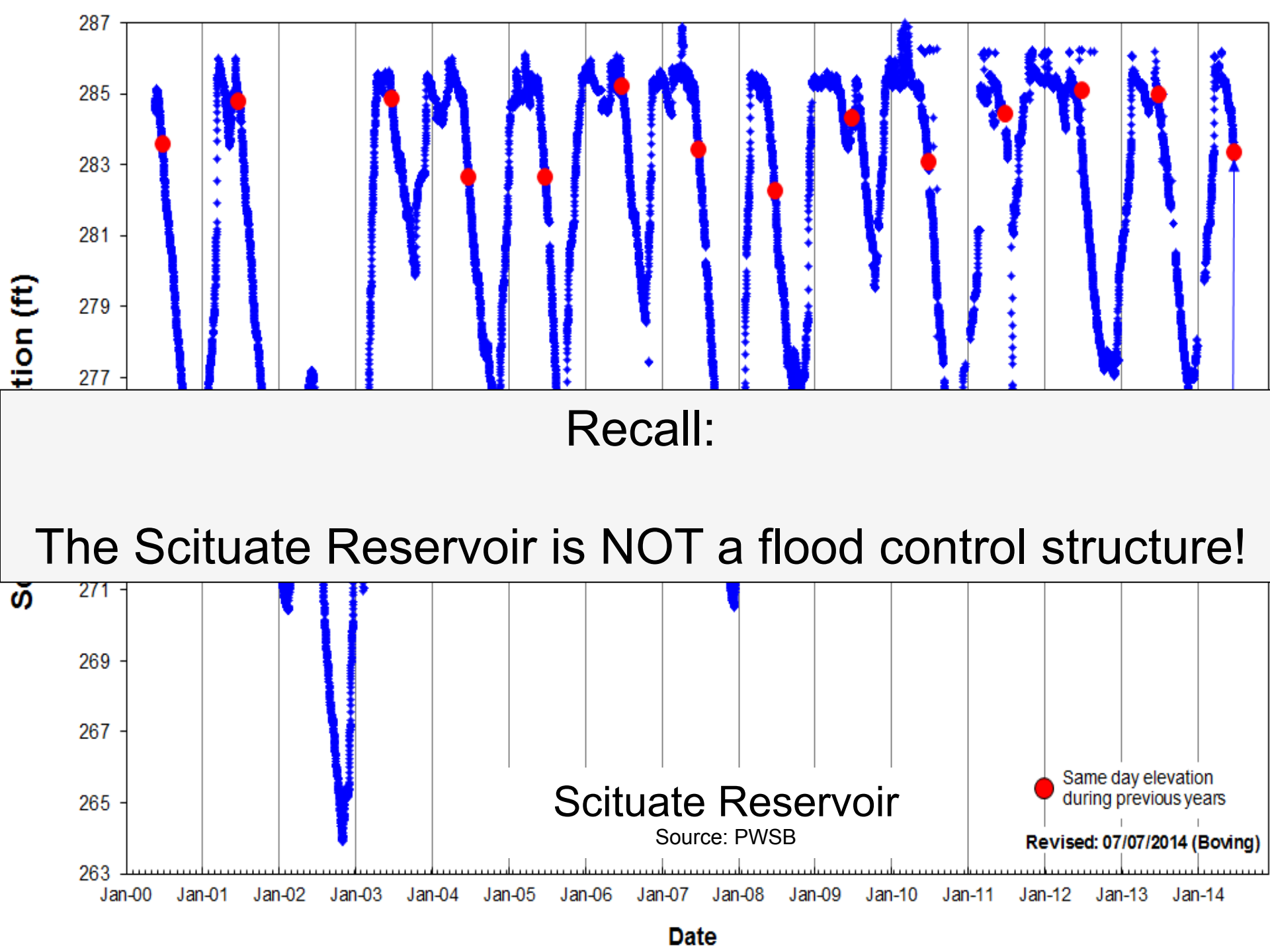


Over pumping groundwater is a new phenomena that has largely occurred since the 1950s because of the development of powerful electric and diesel pumps.

Current Groundwater Conditions



http://groundwaterwatch.usgs.gov/AWLSites.asp?S=412844071422802

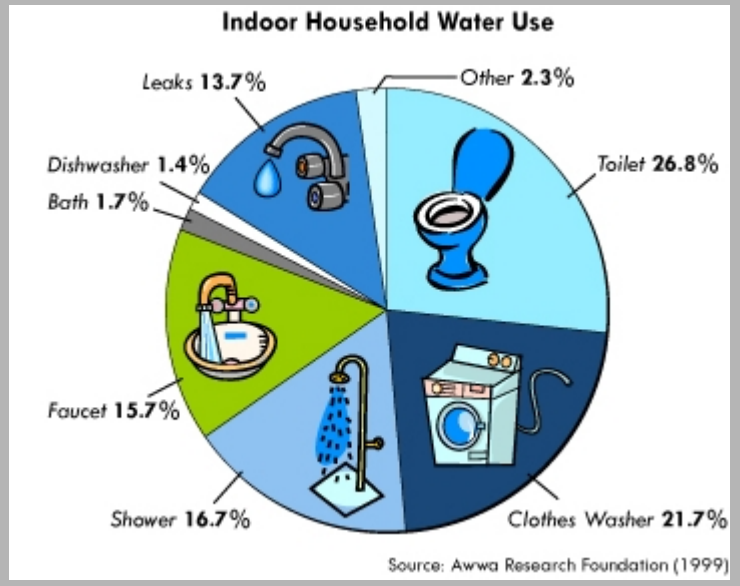


Recall:

The Scituate Reservoir is NOT a flood control structure!

What can I do?

- Know how much water you use – invest in a meter.
- Voluntarily limit the use of drinking water to most essential needs.
- Upgrade appliances in favor of more water-efficient ones.



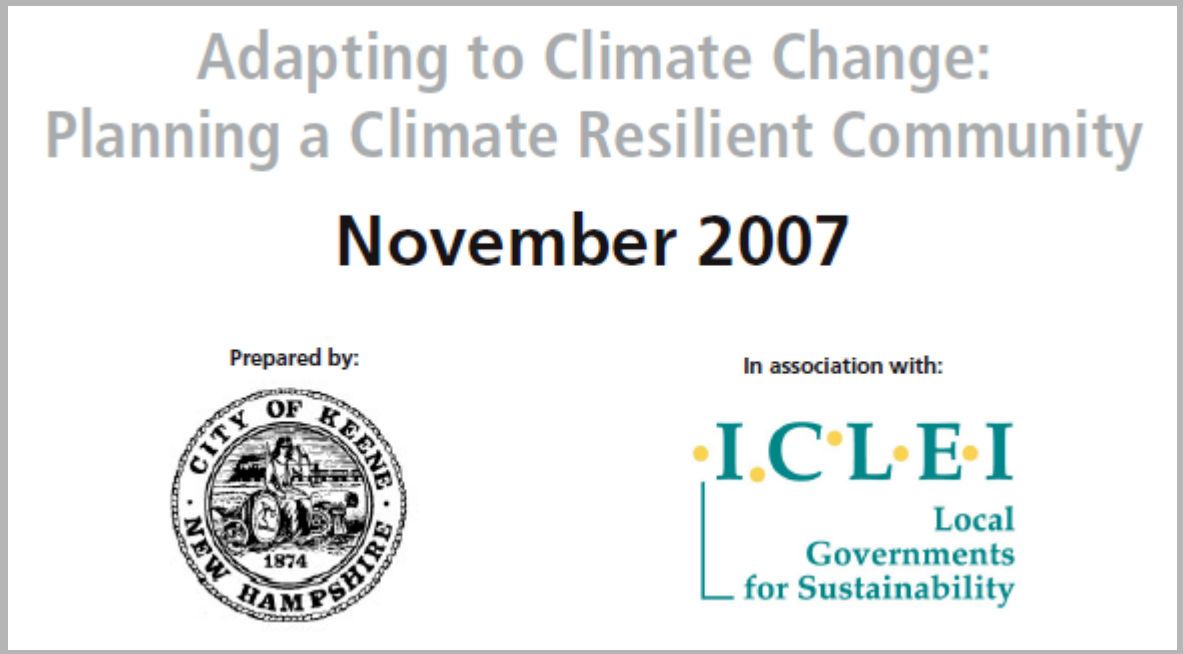
Adaptation and Institutional Responses

- Water resources managers and planners will encounter new risks, vulnerabilities, and opportunities that may not be properly managed within existing practices.

http://nca2014.globalchange.gov/

Keene, NH

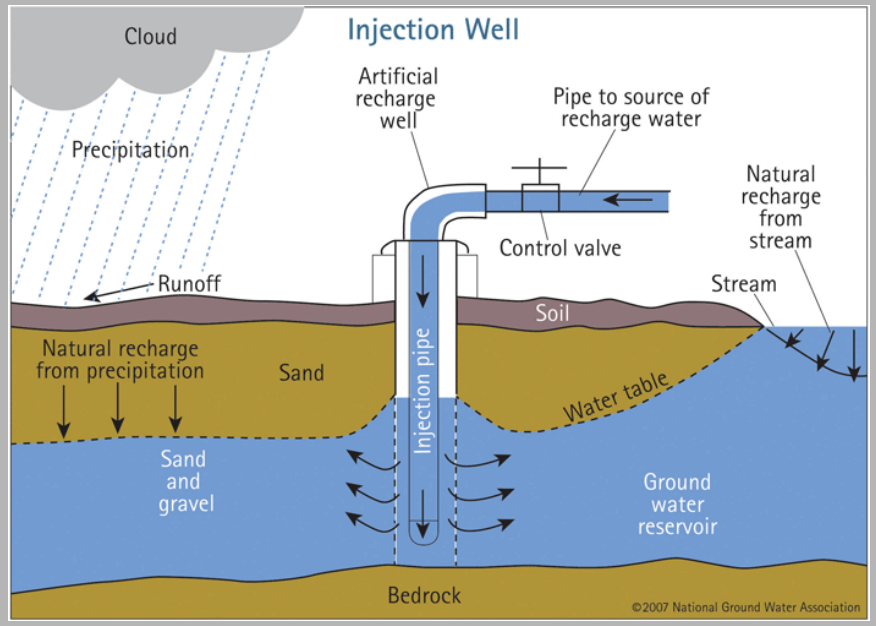
Convened a climate adaptation committee and included an adaptation approach in its Climate Resilient Action Plan



http://www.ci.keene.nh.us/sites/default/files/Keene%20Report_ICLEI_FINAL_v2_0.pdf

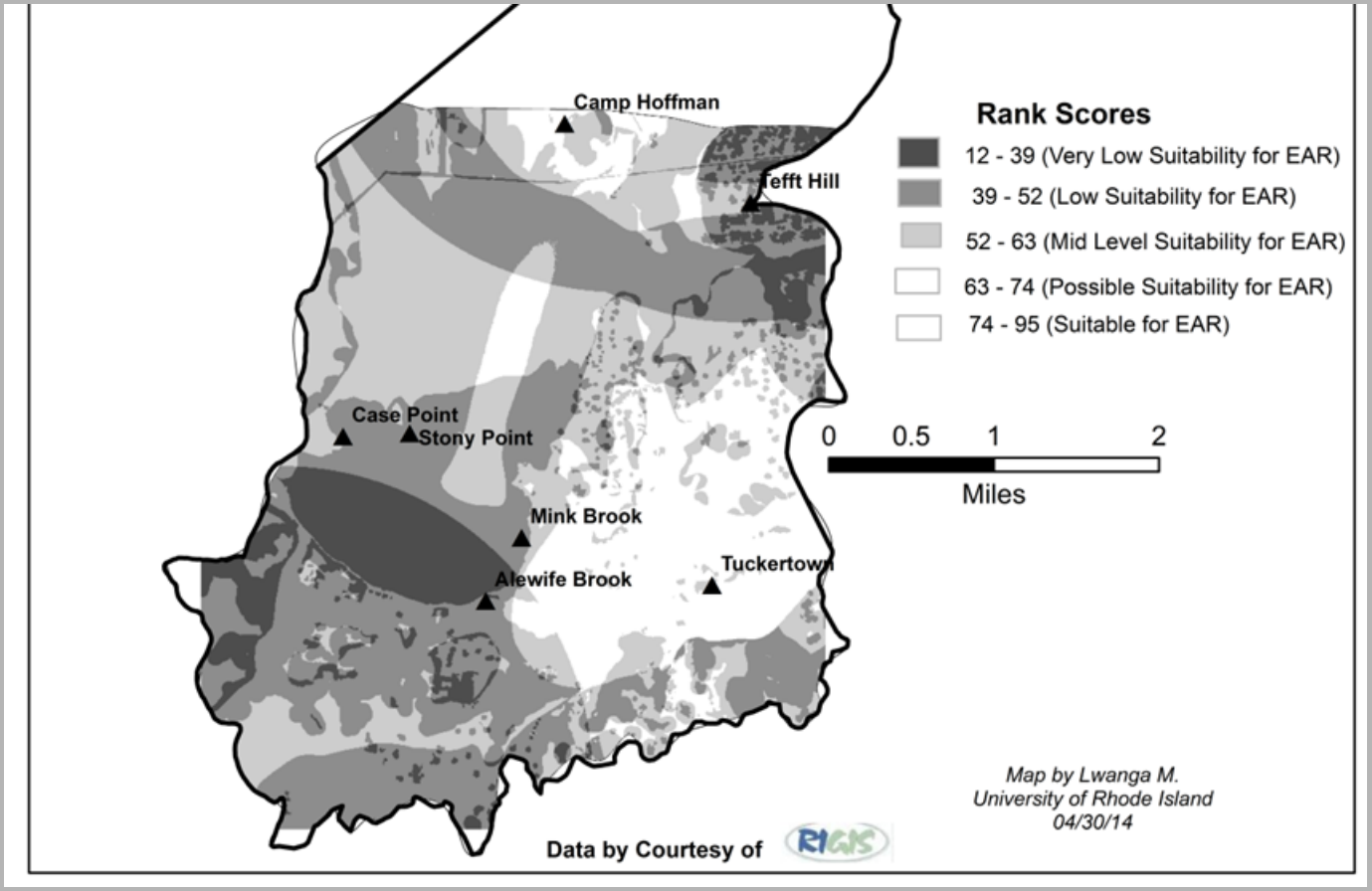
RI Adaptation Strategies

- *Enhanced Aquifer Recharge* (EAR)
  - A form of artificial recharge that involves the transfer of surface water to the subsurface.



During periods of high flow, river water is diverted and injected into the aquifer to enhance groundwater storage.

SUITABILITY RANKINGS FOR ENHANCED AQUIFER RECHARGE IN THE LOWER CHIPUXET BASIN IN SOUTH WEST RHODE ISLAND



Source: URI Graduate student Margaret Lwanga

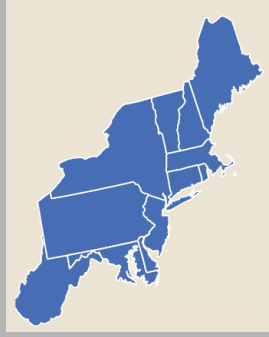
Adaptation and Institutional Responses

- Many institutional, scientific, economic, and political barriers present challenges to implementing adaptive strategies.

http://nca2014.globalchange.gov/

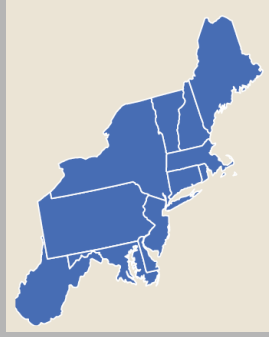
We Need an Active Community!

Summary



- The NE Region has experienced noticeable changes in its climate over the last several decades.
  - Average annual temperature is rising.
  - Heavy precipitation events increased in magnitude and frequency.
  - More flooding
  - Seasonal drought risk is projected to increase in summer and fall as higher temperatures lead to greater evaporation.
  - Majority of winter precipitation falls as rain, not snow.

Outlook



- Climate scientists project that these trends will continue.

- Temperature and the amount of precipitation are projected to keep rising.

- More rain and less winter precipitation falling as snow will likely increase the number and impact of flooding events.

http://www.epa.gov/climatechange/impacts-adaptation/northeast.html

A *pointed question…*

- Are we too focused on limiting our vulnerability to climate change impacts through various measures, while not necessarily dealing with the underlying cause of those impacts?

Mitigation versus ***Adaptation?***

Thank you!

Questions?

Adaptation Examples in the Northeast

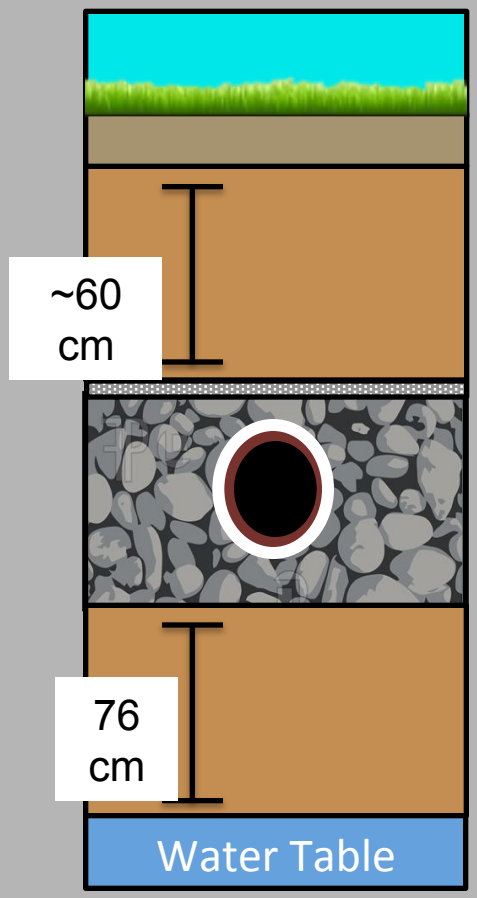
Massachusetts became the first state to officially incorporate climate change impacts into its environmental review procedures by adopting legislation that directs agencies to “consider reasonably foreseeable climate change impacts, including additional greenhouse gas emissions, and effects […].

Northeast cities have employed a variety of mechanisms to respond to climate change, including land-use planning, provisions to protect infrastructure, regulations related to the design and construction of buildings, and emergency preparation, response, and recovery. While significant progress has been made, local governments still face limitations of legal authority, geographic jurisdiction, and resource constraints that could be addressed through effective engagement and support from higher levels of government.

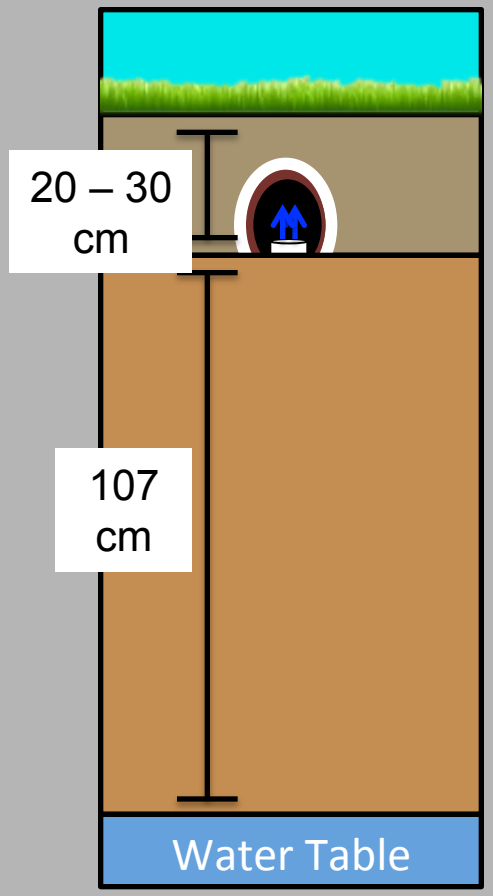
http://nca2014.globalchange.gov/report/regions/northeast

Conventional

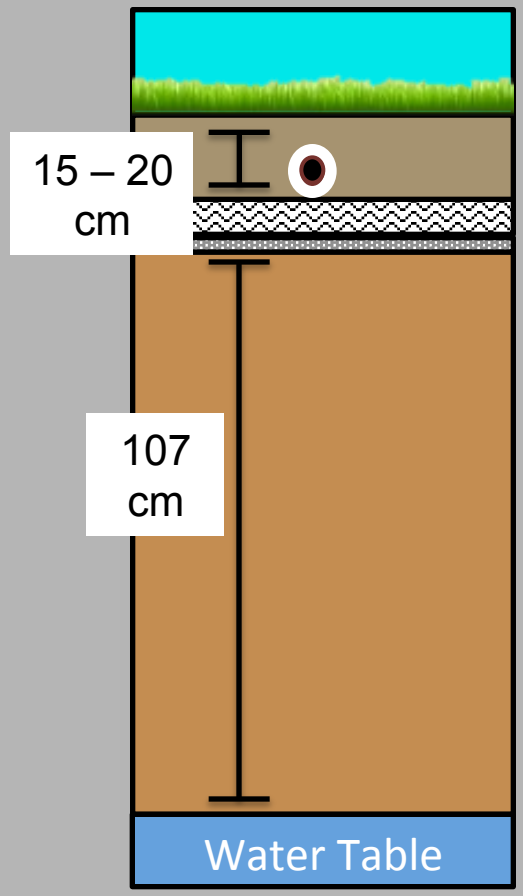
Advanced



Pipe and Stone (P&S)



Pressurized Shallow Narrow Drainfield (PSND)



Geomat (GEO)

Wetlands

- Increased frequency and intensity of severe storm events together with longer, more frequent drought periods in the late summer and early fall.
- Wetland areas would be vulnerable to both types of weather extremes.
  - In the event of severe storms, wetland areas are likely to be hit with flash floods. This could cause erosion and damage to fragile areas of wetlands, such as stream banks or water inlets to lakes and ponds.
  - Flash floods would also bring a great deal of silt and sediment into the wetlands, increasing their turbidity and decreasing their functionality. An increase in the amount of water entering wetlands may also cause them to reach their water-holding capacity, breaching their boundaries and exacerbating flood problems further downstream.
  - Conversely, wetlands are also in danger of decreasing in number and size. With an increase in droughts and a decrease in the amount of

http://www.ci.keene.nh.us/sites/default/files/Keene%20Report_ICLEI_FINAL_v2_0.pdf

Climate Change Impacts on the Water Cycle

- Climate change is expected to affect water demand, groundwater withdrawals, and aquifer recharge, reducing groundwater availability in some areas.

- Increasing air and water temperatures, more intense precipitation and runoff, and intensifying droughts can decrease river and lake water quality in many ways, including increases in sediment, nitrogen, and other pollutant loads.

http://nca2014.globalchange.gov/

Climate Change Impacts on Water Resources Use and Management

- Climate change affects water demand and the ways water is used within and across regions and economic sectors.
- Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas.
- Increasing flooding risk affects human safety and health, property, infrastructure, economies, and ecology in many basins across the United States.

http://nca2014.globalchange.gov/

Adaptation and Institutional Responses

- Water resources managers and planners will encounter new risks, vulnerabilities, and opportunities that may not be properly managed within existing practices.

- Increasing resilience and enhancing adaptive capacity provide opportunities to strengthen water resources management and plan for climate change impacts. Many institutional, scientific, economic, and political barriers present challenges to implementing adaptive strategies.

http://nca2014.globalchange.gov/

Climate Change: Effects in the Northeast

Precipitation

- Rainfall is expected to become more intense and periods of heavy rainfall are expected to become more frequent.
  - Number of heavy-precipitation events is projected to increase 8 % by mid-century, and 12 % to 13 % by the end of the century.
  - In Maine, New Hampshire, and Vermont the probability of high-flow events may increase as much as 80 %, accompanied by an increased risk of flooding.

Climate Change: Effects in the Northeast

Temperature

- Since 1970, the Northeast has been heating up at a rate of 0.5°F per decade. Winter temperatures have been rising even faster—1.3°F per decade between 1970 and 2000.

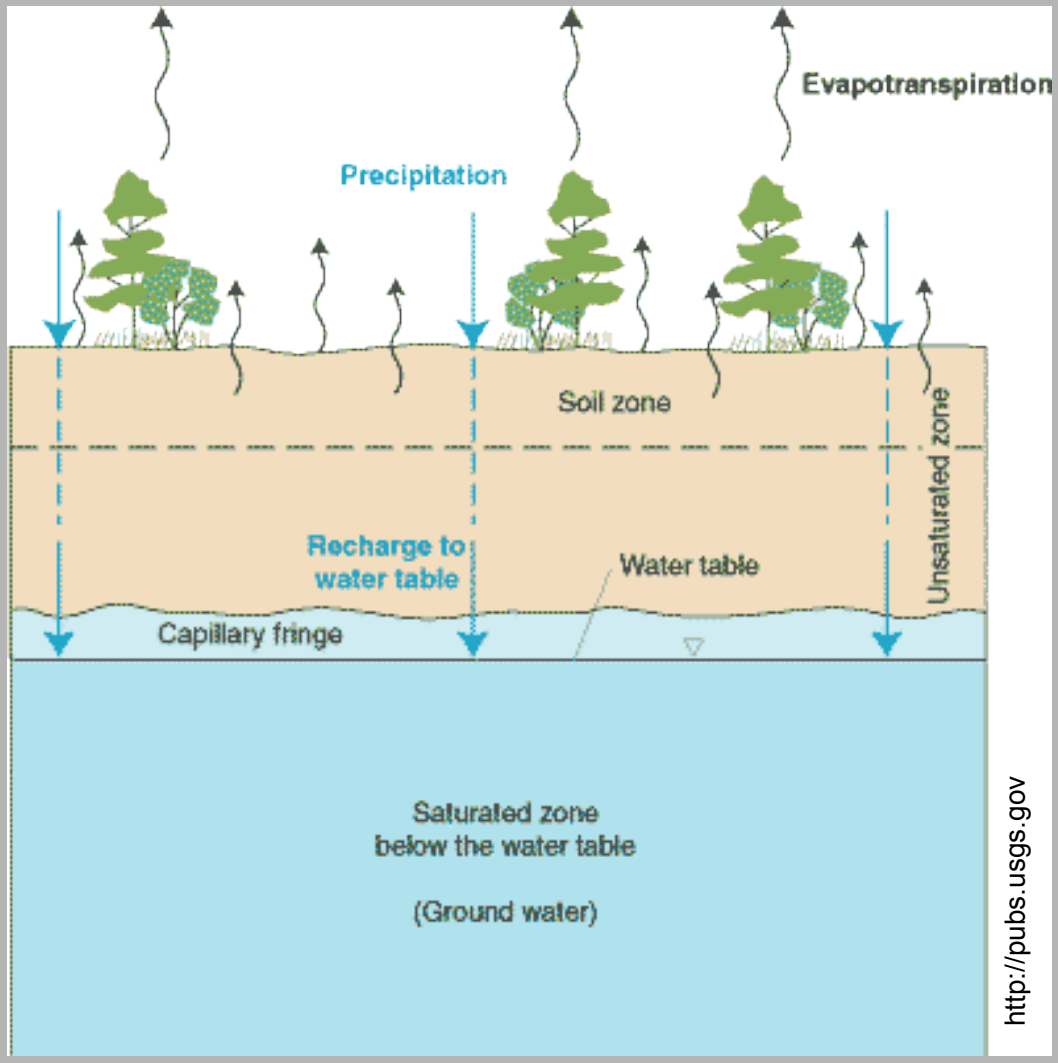
- Average temperatures are projected to rise another 2.5 to 4 °F in winter and 1.5°F to 3.5°F in summer above historic levels over the next several decades.

A *pointed question…*

- With regard to the challenge of confronting the impacts of climate change, is civilization abandoning ***mitigation*** measures to focus on ***adaptation*** strategies?
  - Mitigation: reducing the magnitude of climate change itself.
  - Adaptation: efforts to limit our vulnerability to climate change impacts through various measures, while not necessarily dealing with the underlying cause of those impacts.

Water:
Why do we care…

101 Groundwater

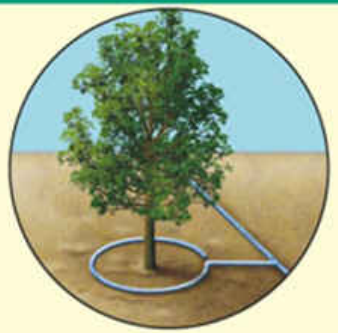


Some more "radical" adaptation strategies

Solutions

Groundwater Depletion

Prevention	Control
Waste less water	Raise price of water to discourage waste
Subsidize water conservation	
Ban new wells in aquifiers near surface waters	
Buy and retire ground-water withdrawal rights in critical areas	Tax water pumped from Wells near surface water
Do not grow water-intensive crops in dry areas	Set and enforce minimum stream flow levels
Reduce birth rates	



http://www.geo.hunter.cuny.edu