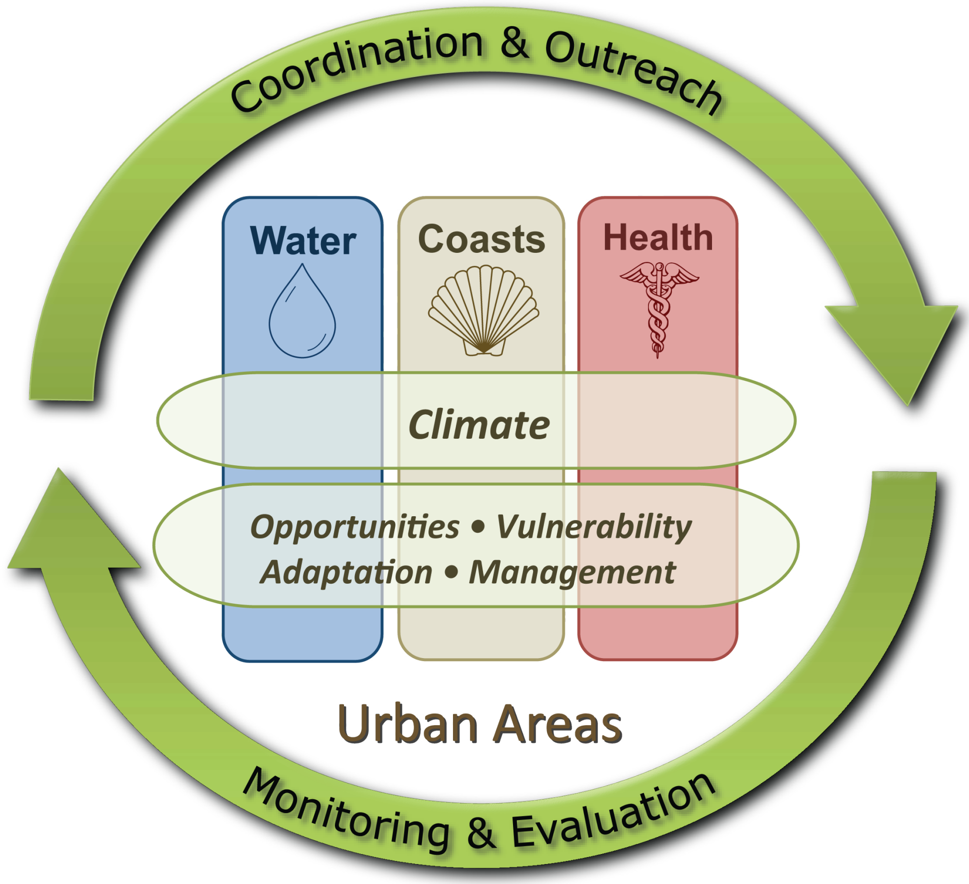
Consortium for Climate Risk in the Urban Northeast

Research Highlights, October 2011 - April 2012



CCRUN



CCRUN's Mission

To conduct stakeholder-driven research that reduces climate-related vulnerability and advances opportunities for adaptation in the urban Northeast

CCRUN: Moving Forward

The Consortium for Climate Risk in the Urban Northeast, or CCRUN, began its mission to serve stakeholder needs in assessing and managing risks from climate variability and change in October 2010, under NOAA's Regional Integrated Sciences and Assessments (RISA) program. CCRUN is designed to address the complex challenges that are associated with densely populated, highly interconnected urban areas.

Over the past six months, the CCRUN team has taken the opportunities afforded by involvement in the National Climate Assessment to develop a strong leadership role in stakeholder-driven climate impacts research in the Northeastern United States. CCRUN hosted both the urban and Northeast regional climate assessment workshops, thus reaching key stakeholders within the CCRUN project area as well as gaining new insights into the broader context in which the team's work can be placed as our project progresses. Moreover, nearly all CCRUN team members were able to make substantive contributions to the technical reports submitted on March 1, materials that have not only informed the National Climate Assessment, but which will be distributed in unabridged form through a series of peer-reviewed papers now under development.

Despite the challenging funding environment in which climate impacts research is currently operating, CCRUN team members have been able to leverage existing support from other sources, such as NASA, as well as obtain new funding to begin in earnest a number of the projects planned during our first year. One of our newly funded projects is made possible by the NOAA Coastal and Ocean Climate Applications (COCA) program, and will focus on the evaluation of approaches to adaptation planning in coastal areas vulnerable to storm surge flooding. This is one of several evaluation-related efforts that are under way or in the advanced planning stages, and which will be so critical in determining our success.

Another project recently funded is the Department of the Interior's Northeast Climate Science Center (NE CSC), which will be led by CCRUN PI Richard Palmer (UMass). Though the NE CSC is clearly a major project in its own right, the participation of both UMass and Columbia CCRUN team members in the NE CSC will encourage strong collaboration and leveraging of funding across both projects, while affording the opportunity to engage our other Northeast regional climate partners from a position of great strength and flexibility.

As we look ahead, we continue to explore a variety of opportunities with our existing city stakeholders, as well as the potential for new collaborations with community organizations such as New York City's Metropolitan Waterfront Alliance, which is interested in a partnership to develop better coastal evacuation plans and improve community awareness of storm hazards. We also plan to broaden our ability to reach stakeholders all across the CCRUN project area through education and outreach measures, from personal mentoring of students, to the provision of online tools and resources, to reaching out further via the web and social media.

The CCRUN Team

The team is comprised of investigators, research & support staff, and graduate students from five institutions across the CCRUN project area: Columbia University (CU), the University of Massachusetts-Amherst (UMass), City College of the City University of New York (CCNY), Stevens Institute of Technology (Stevens), and Drexel University (Drexel).

Lead Investigators, Principal Sectors: Alan Blumberg (Stevens), Patrick Kinney (CU), Richard Palmer (UMass)

Lead Investigators, Cross-Cutting Themes: Yochanan Kushnir (CU), Shiv Someshwar (CU)

Research Coordinator: Radley Horton (CU)

Project Manager: Linda Sohl (CU)

Investigators: Mark Arend (CCNY), Amy Auchincloss (Drexel), Mark Becker (CU), Ray Bradley (UMass), Casey Brown (UMass), Robert Chen (CU), Naresh Devineni (CU), Richardson Dilworth (Drexel), Lisa Goddard (CU), Vivien Gornitz (CU), Patrick Gurian (Drexel), Charles Haas (Drexel), Reza Khanbilvardi (CCNY), Upmanu Lall (CU), Malgosia Madajewicz (CU), Jamie Madrigano (CU), Joseph Martin (Drexel), Franco Montalto (Drexel), Philip Orton (Stevens), Julie Pullen (Stevens), Cynthia Rosenzweig (NASA-GISS/CU), Sabrina Spatari (Drexel), Brian Vant-Hull (CCNY)

Research & Support Staff: Dan Bader (CU), Kaitlin Butler (CU), Nickitas Georgas (Stevens), Annie Gerard (CU), Marie-Aude Pradal (Stevens)

Graduate Students: Bita Alizadehtazi (Drexel), Elizabeth DeVilbiss (Drexel), Kimberly DiGiovanni (Drexel), Elisaveta Petkova (CU), Jessica Pica (UMass), Nathan Rostad (Drexel), Mayu Sasaki (-CU), Maria Raquel Catalano De Sousa (Drexel), Stephen White (Drexel), Ziwen Yu (Drexel)

Research Affiliates: Paul Block (CU), Kathleen Callahan (CU), Suzana Carmaga (CU), Mark Cane (CU), Edward Cook (CU), Stuart Gaffin (CU), Christian Hunold (Drexel), Scott Knowles (Drexel), Peter Kolesar (Columbia University Business School), David Major (CU), Rouzbeh Nazari (CCNY), Mira Olsen (Drexel), Neil Pederson (CU), Anu Pradhan (Drexel), Andrew Robertson (CU), Richard Seager (CU), Mimi Sheller (Drexel), Jin Wen (Drexel), Steve Zebiak (CU), Jianting Zhang (CCNY)

Other Collaborators: Timothy Hall (NASA-GISS), Tiantian Li (China Centers for Disease Control), Leslie Patrick (CUNY Institute for Sustainable Cities), Alex Ruane (NASA-GISS), William Solecki (CUNY Institute for Sustainable Cities)

Columbia University in the City of New York

Stevens Institute of Technology — The Innovation University

University of Massachusetts Amherst

Drexel University

The City College of New York

Stakeholders and Partners

A & D Hydro, Inc.
Alternatives for Community and Environment (ACE)
American Red Cross of Greater New York
American Water Company
Appalachian Mountain Club
Ashburnham (MA) Department of Public Works
Bear Swamp Power Company, LLC
Boston Office of Environmental and Energy Services
Boston Public Health Commission
Brattleboro (VT) Water Department
Bristol (CT) Water Department
Brookfield Renewable Power, Inc.
Bucks County (PA) Water & Sewer Authority
Burlington (MA) Water Department
Canaan (NH) Water Department
Chester (PA) Water Authority
Chicopee (MA) Water Department
Clean Air Council
Clean Air-Cool Planet
Connecticut Department of Environmental Protection/Inland Water Resources Division
Connecticut River Watershed Council
Connecticut Water
Dalton Hydro, LLC
Delaware River Basin Commission
Delaware Valley Green Building Council
Delaware Valley Regional Planning Commission/Office of Energy and Climate Change Initiatives
Dorchester (MA) Environmental Health Coalition
East Hampton (CT) Water and Sewer Commission
Environmental Protection Agency
Fairmount Park Commission
Farmington River Power Co.
Fitchburg (MA) Public Works Department/Water Division
Green Mountain Power
Harvard University Graduate School of Design
Holyoke (MA) Gas and Electric Department
ICLEI
Keene (NH) Public Works Department/Water Division
L.S. Starrett Co.
Massachusetts Department of Conservation and Recreation
Massachusetts Department of Environmental Protection/Water, Wastewater, and Wetlands
Massachusetts Department of Fish and Game
Massachusetts Executive Office of Energy and Environmental Affairs
Massachusetts Water Resources Authority
Metropolitan District of Connecticut
Metropolitan Waterfront Alliance
Monson (MA) Water & Sewer Department
Montgomery County (PA) Advisory Committee on Climate Change
National Grid
National Park Service, Partnership Wild and Scenic Rivers/Farmington River, CT
National Park Service, Partnership Wild and Scenic Rivers/Westfield River, MA
Natural Resources Defense Council
The Nature Conservancy New Britain (CT) Water Department
New England Interstate Water Pollution Control Commission
New Hampshire Department of Environmental Services
New Hampshire Rivers Council
New York City Department of Health and Mental Hygiene
New York City Department of Environmental Protection/Bureau of Water Supply
New York City Department of Environmental Protection/Environmental Planning and Analysis
New York City Department of Parks and Recreation
New York City Office of Long-Term Planning and Sustainability
North American Energy Alliance, LLC
North Brookfield (MA) Water Department
Palmer (MA) Water Department
Pennsylvania Department of Conservation and Natural Resources
Pennsylvania Department of Environmental Protection/Climate Change Advisory Committee
Pennsylvania Environmental Council
Philadelphia City Planning Commission
Philadelphia Department of Public Health/Air Management Services Division
Philadelphia Department of Public Health/Environmental Health Services Division
Philadelphia Department of Streets
Philadelphia Energy Coordinating Agency
Philadelphia Industrial Development Corporation
Philadelphia Mayor's Office of Sustainability
Philadelphia Municipal Energy Office
Philadelphia Office of Emergency Management
Philadelphia Water Department
Philadelphia Parks & Recreation
Rivers Alliance of Connecticut
Springfield (MA) Water and Sewer Commission
Stratford (CT) Department of Public Works/Water Pollution Control
TransCanada
Turners Falls Hydro, LLC
US Army Corps of Engineers
University of Connecticut
Vermont Agency of Natural Resources
Vermont Department of Environmental Conservation/River Management Section
Vermont Department of Environmental Conservation/Water Quality Division
Vermont Department of Fish and Wildlife
Vermont Natural Resources Board
Vermont Natural Resources Council
West Harlem Environmental Action Group
Westfield (MA) Water Resources Department
Williamsburg (MA) Water and Sewer Commission
Women's Health and Environmental Network

Research Findings

1. **Climate Variability and Change as Simulated Over the Northeast** (Radley Horton, Dan Bader): Through our work with urban stakeholders, we have focused on intense precipitation events, extreme heat, and extreme cold as climate metrics that influence the water sector, infrastructure, and human health. We evaluated six Regional Climate Models (RCMs) that contributed to the North American Regional Climate Change Assessment Program (NARCCAP) with respect to how well the RCMs are able to reproduce historical mean climate and climate extremes in the Northeast, when receiving the best available historical data at the model boundaries. We then assessed RCM performance over the historical period when driven by global climate models, and finally, projected changes in mean climate and extremes for the middle of the 21st century under the IPCC A2 emissions scenario. Key initial findings include the following:

- While the regional climate models driven by the best observations are able to reproduce mean climate features, there are large biases in extreme events that require correction.
- Large changes in extreme heat and extreme cold are projected in Boston, New York City, and Philadelphia by the regional models driven by GCMs (Table 1).
- For some areas within the Northeast, extreme events in the RCMs change more than the mean (Figure 1); if correct, these results suggest that projections based on mean change approaches that have been used in the region in the past may underestimate extreme weather hazards.

Table 1.

	Percent Change, Ensemble	
	days over 90°F	**days below 32°F**
New York City	155.49%	-34.08%
Philadelphia	163.02%	-35.15%
Boston	191.46%	N/A

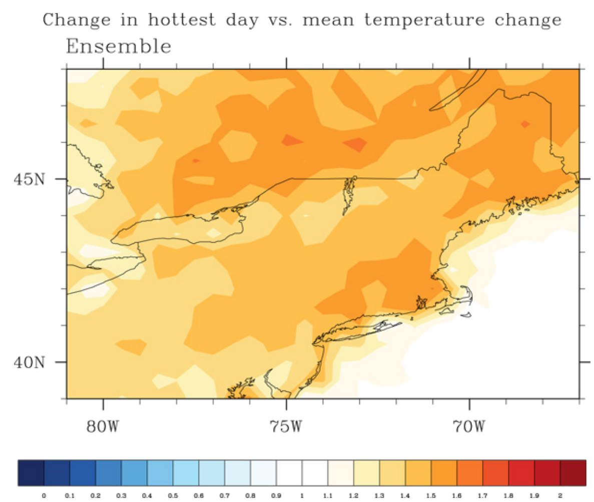


Figure 1.

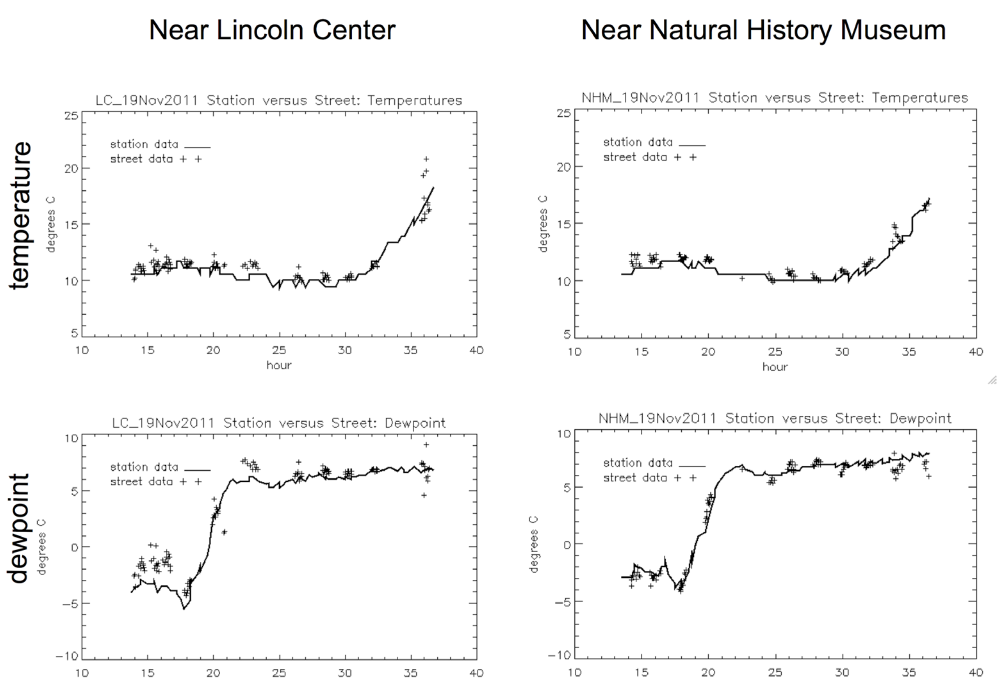
2. Increasing Net Annual Temperature-Related Mortality in a Warming Climate (Tiantian Li, Radley M. Horton, and Patrick L. Kinney): Climate change has led to increasing temperatures in recent decades, and further warming is expected over coming decades under a range of plausible greenhouse gas emissions scenarios. Higher temperatures may result in more heat-related mortality. However, warmer winters might also reduce cold-related mortality, and the net impact on annual mortality remains uncertain. Our objective was to analyze current, and project future, annual temperature-related mortality in New York City across a range of climate change models and scenarios.

Averaging over five climate models, we show that the projected net annual temperature-related deaths could increase by 5.4%, 12%, and 17% in the 2020s, 2050s, and 2080s under the B1 scenario, and by 7.1%, 17%, and 33% under the A2 scenario, relative to annual temperature-related deaths of 709 in the 1980s. Monthly analyses showed that significant mortality increases would extend beyond the June-July-August period due to warming over this century. These results suggest that, over a range of models and scenarios of future greenhouse gas emissions, increases in heat-related mortality could outweigh reductions in cold-related mortality.

3. **Diurnal Cycle of Station versus Street Level Temperature Differences** (Brian Vant-Hull, Maryam Karimi, Mark Arend): Health risks due to high temperatures are affected by the urban heat island, the strength of which varies depending on local physical characteristics and location within regionally induced meteorological patterns such as sea breeze and urban convergence zones. Local variations of a few degrees can have significant impacts on densely populated urban areas, so it is important to characterize these patterns.

As a pilot study, we have endeavored to characterize the temperature differences between two Manhattan volunteer stations on the Upper West Side (both rooftop emplacements) and street level measurements in the vicinity of each station (Figure 2a). These measurements were made over a 24-hour period to capture diurnal variations in these differences. We found that for both stations the street level temperatures are about 0.7 C warmer than the stations, likely due to the difference in altitude. As the temperatures warm, the street level temperatures seem to lag the stations, with smaller biases (Figure 2b).

Figure 2a. Map of measurement locations. **2b**. A 24 hour record of temperatures recorded by two stations (near the Natural History Museum and Lincoln Center) in solid lines, compared to a grid of street level measurements taken in the vicinity of each station, denoted by crosses. Dewpoints were also calculated from temperature and relative humidity. The time starts at the 14 EST (2 pm) on Nov 19, continuing to 12 EST (noon) on Nov 20, denoted as the 36th hour. The results show that the street level temperatures were generally half a degree C warmer than the station temperatures, likely due to altitude differences. The temperature bias decreased at night. The dewpoint plots show a warm front passing about 19 EST stabilizing the temperature at night.



Accomplishments

1. **Detailed Modeling of Recent Severe Storm Tides in the New York City Region** (*Investigators*: Philip Orton, Nickitas Georgas, Alan Blumberg, Julie Pullen; *Stakeholders:* New York City Department of Environmental Protection; New York City Mayor's Office of Long-Term Planning and Sustainability; FEMA NJ/NY Coastal Storm Surge Analysis; New York City Department of Parks and Recreation; Con Edison; New York City Department of City Planning; The City of Boston's Office of Environmental and Energy Services; North Jersey Transportation Planning Authority; *Leveraged funding:* None)

Coastal storms are among the world's most costly disasters, with strong winds, floodwater inundation, and coastal erosion capable of damaging and disabling infrastructure. New York City (NYC) is highly vulnerable to storm surge flooding, with some subways and highway tunnels at risk of being shut down after coastal flood elevations only ~2.25 m above local mean sea level (LMSL). NYC was struck by hurricanes three times from 1700-1900, with storm tide (total water elevation) estimated to be roughly 2.5-3.6 m LMSL, but more frequently receives moderate storm tides of 2.0-2.5 m that threaten vital infrastructure, such as an extra-tropical "nor'easter" storm that shut down subway service for over one week in 1992. With a daily gross metropolitan product of about $3.5 billion in 2010, even these moderate flooding events can prove extremely costly.

Storm surge modeling is an important tool for operational flood forecasting systems and for flood hazard assessments, particularly for understanding risks from these moderate to severe storms that have occurred only a few times, if any, in the historical record. In the past, highly simplified storm surge models were favored over more detailed models, and today, most storm surge modeling is still performed with two-dimensional hydrodynamic models (e.g. SLOSH and ADCIRC). This reliance on simplified models occurs in part because of incomplete understanding of the exact role and mechanisms of many factors that contribute to coastal water elevations. It also occurs because storm surge risk assessment can require thousands of storm simulations to provide probabilistic forecasts, and therefore having short model run times is useful.

Here, the importance of several oft-neglected aspects of storm surge flooding is analyzed using a highly detailed, well-validated, operational coastal ocean modeling system. Detailed simulations, comparisons with observations, and model

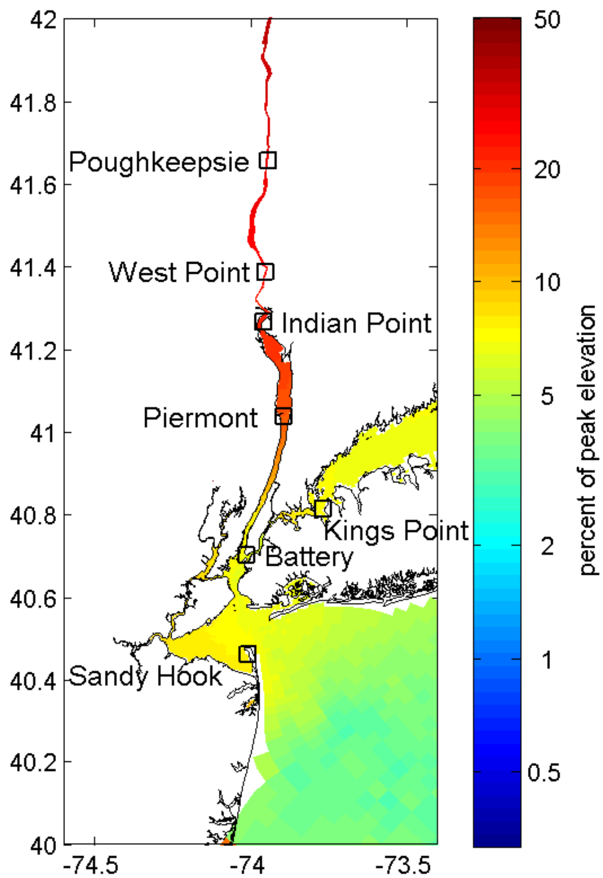


Figure 3. Percent of peak water elevation caused by freshwater river flow and water density variations in the New York City region during tropical storm Irene, based on sECOM hydrodynamic model runs. These details are typically neglected in storm surge modeling by FEMA and several research groups, and this leads to a underestimation bias in flood elevation predictions or hazard assessments.

sensitivity experiments are presented for the August 2011 tropical cyclone Irene and a March 2010 nor'easter that affected the New York City (NYC) metropolitan area. These storms brought strong winds, heavy rainfall, and the fourth and seventh highest gauged storm tides (total water elevations) at Battery Park.

The sECOM hydrodynamic model [e.g., Blumberg and Georgas, 2008] was used to simulate water levels across the study region. This model has been demonstrated to provide highly accurate storm surge predictions in an operational context, with the NYHOPS system. To "dissect" the storm tides and examine the role of various physical processes in controlling total water elevation, a series of model experiments was performed where one process was omitted for each experiment, and results were studied for eight different tide stations.

Neglecting remote meteorological forcing (beyond ~250 km) led to reductions of up to 34% in peak storm tide, neglecting water density variations led to reductions of up to 12%, neglecting a parameterization of enhanced wind drag due to wave steepness led to reductions of up to 11%, and neglecting atmospheric pressure loading led to reductions of up to 10%.

Very few storm surge modeling studies or operational forecasting systems incorporate freshwater flows or water density variations, yet combined omission of these two processes leads to a low-bias in storm tide for New York City sites like La Guardia Airport (8%) and The Battery (6%), as well as nearby vulnerable sites like the Indian Point nuclear plant (21%; see Figure 3). The negative bias of neglecting these contributions could be costly for a low-lying city like NYC with high financial and human vulnerability.

These results are of high value for future flood mapping, risk assessment, and warning system efforts, particularly for the New York City region and Hudson River. They are also of general interest nationwide, for their insight into the biases that can arise from oversimplified storm surge models.

2. **Climate Impacts on Municipal Water Supplies in New England: A Comparison of Two Systems** (*Investigators:* Richard Palmer, Casey Brown, Jessica Pica; *Stakeholders:* Please see full listing in the project descriptions at the end of this report; *Leveraged funding*: The Nature Conservancy, U.S. Army Corps of Engineers)

There is a growing concern associated with the impacts of climate change on municipal water supply systems. Much of this concern stems from possible changes in hydrology; however changes in municipal water demands can often dominate other factors. In this study, the two major water supply systems in New England are investigated to provide insight on potential impacts to these systems; specifically, we explore changes in system reliability and safe yield that particular GCMs and corresponding carbon emission scenarios have on the two municipal water supply systems. We first constructed a hydrology model for each system to replicate historic streamflows. The hydrology model is then forced by future climate data from GCMs to generate future climate altered streamflows. Finally, these streamflows can be used to drive the water resource system simulation models to estimate the effects that climate change might have on the water supply systems. Sensitivity to water demands for each system is also considered in this study. In addition, the study notes the uncertainties associated with each of these steps. Stakeholder interaction is essential to accurately represent how each system functions and to address each organization's concerns.

The two New England municipal water supply systems examined in this research are the Boston, Massachusetts and Providence, Rhode Island water supplies. The watersheds serving as these two cities' primary water supply sources are the Quabbin and Wachusett watersheds for Boston (Figure 4), and the Scituate watershed for Providence (Figure 5). The watersheds serving Boston and Providence are managed by the Massachusetts Water Resources Authority (MWRA) and Providence

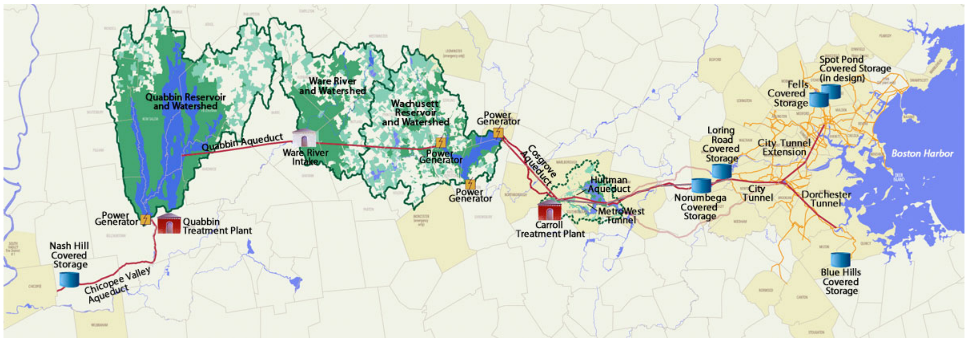


Figure 4 (left). The Quabbin and Wachusett watersheds supply water to Boston. Figure 5 (right). The Scituate watershed for the Providence water supply.

Water, respectively.

The mean annual precipitation over the MWRA system is approximately 46 inches and annual mean temperature over the entire system is 7 degrees Celsius. The Massachusetts Water Resources Authority system supplies wholesale water and sewer services to 2.5 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities. The combined storage of the reservoirs is equivalent to a 3-year supply of water. Boston's water system demands prior to 1992 were above the safe yield (approximately 300 mgd), but due to an aggressive water conservation program, demands have significantly declined and are currently significantly below the safe yield and are continuing to decrease. The Scituate Reservoir Complex has a total capacity of approximately 41 billion gallons and serves approximately 60% of the state of Rhode Island. Annual mean precipitation over the complex is approximately 48 inches and annual mean temperature is approximately 9 degrees Celsius. The Scituate Reservoir Complex, with a safe yield of 92 mgd, has been supplying on average 68 mgd to its customers over the last 20 years with a slight increase in demand predicted for the next 20 years. Water demand projections estimate 69 mgd and 71 mgd by 2015 and 2030, respectively.

The "abcde" hydrology model was selected as an appropriate tool to develop a watershed model. This model is a nonlinear water shed model that accepts precipitation and potential evapotranspiration as input and produces streamflow as output. The model also represents soil moisture storage, groundwater storage, direct runoff, actual evapotranspiration, and groundwater outflow to the stream channel. It uses five parameters to represent hydrologic characteristics and has been successfully used to produce monthly forecasts within New England. For this study, four independent hydrology models were calibrated at a weekly time step for each of the four basins associated with the MWRA water supply system: the Quabbin Basin, the Wachusett Basin, the Ware River Basin, and the Connecticut River Basin and one monthly time step model for the Providence Water system. All hydrology models were calibrated and validated using the USGS streamflow data. The systems models that are used to replicate water supply systems operations were constructed using the Water Evaluation And Planning system (WEAP) and STELLA for Boston and Providence systems, respectively. Operational decisions are made for each particular time step with no foresight of weather events.

Predictions of future mean temperature and precipitation of all 112 climate projections gradually increase along with their variability (Figure 6). For the Boston system the average annual temperature change is forecasted to be 1.5 ºC by 2030, 2.25 ºC by 2050, and nearly 3 ºC by 2070. The Boston system climate predictions were obtained for four locations and averaged for these figures. For the Providence system, the average annual temperature change is forecasted to be 1.25 ºC by 2030, 2 ºC by 2050, and 2.75 ºC by 2070. Boston's and Providence's systems average annual precipitation is forecasted to increase 5% by 2030, 7% by 2050, and almost 8.5% by 2070. Despite the variability of the forecasts, the overwhelming majority of models suggests warmer temperatures and increased precipitation in the future. The increase in temperature and precipitation will affect streamflow, but in different ways. Increased precipitation results in increased streamflows but higher temperatures results in decreasing streamflows due to increased evapotranspiration. When categorizing changes in climate by emission scenario, there is no clear distinction.

For both systems over all three forecasted time periods, streamflow increases when compared to the historic record in the winter, and decreases in the spring, summer and fall. With water supply demands being highest in the summer months, the impacts of lower spring streamflow threaten to limit water availability for Providence's system. Since Boston's system is multi-year storage system, there would have to be approxmately three consecutive years of low streamflow to encounter these negative impacts. A safe yield analysis of both systems was conducted to determine the yield that the systems could provide using the 2030s, 2050s, and 2070s data for all 112 climate projections. The MWRA system defines safe yield as the total system demand that will produce 98% reliability. Historic safe yield is about 347 mgd which has been calculated from historic climate data that the MWRA provided. Average yield for the future records are 352 mgd, 353 mgd, and 356 mgd calculated from the future climate data previously mentioned. Historic safe yield is about 90.2 mgd and the average yield for the future records are 103 mgd, 103.7 mgd, and 104.2 mgd. For both systems the average yield and interquartile range increase slightly while the range of extremes also increases.

In conclusion, the analysis of the Massachusetts Water Resources Authority and Providence Water supply systems provides insight to the impacts of climate change in the Northeast. The ensemble of the 112 climate projections for this study indicates deviation from the historic natural conditions will increase under climate change. Higher temperatures and increased precipitation cause an increase in winter flows. Less precipitation falling as snow reduces the water stored in the basin and lowers the spring flows. The climate projections indicate climate change will not significantly affect the summer months but will in the fall months. The climate data used in this study when organized by emission scenario contained a smaller change in temperature than that forecasted globally.

Both water systems can increase current demands continuously into the future. The Scituate Complex can maintain current operations as well as for the Boston system without threatening water availability. Drought events will occur when water demands are higher than safe yield but it is unlikely that either water supplier will encounter that.

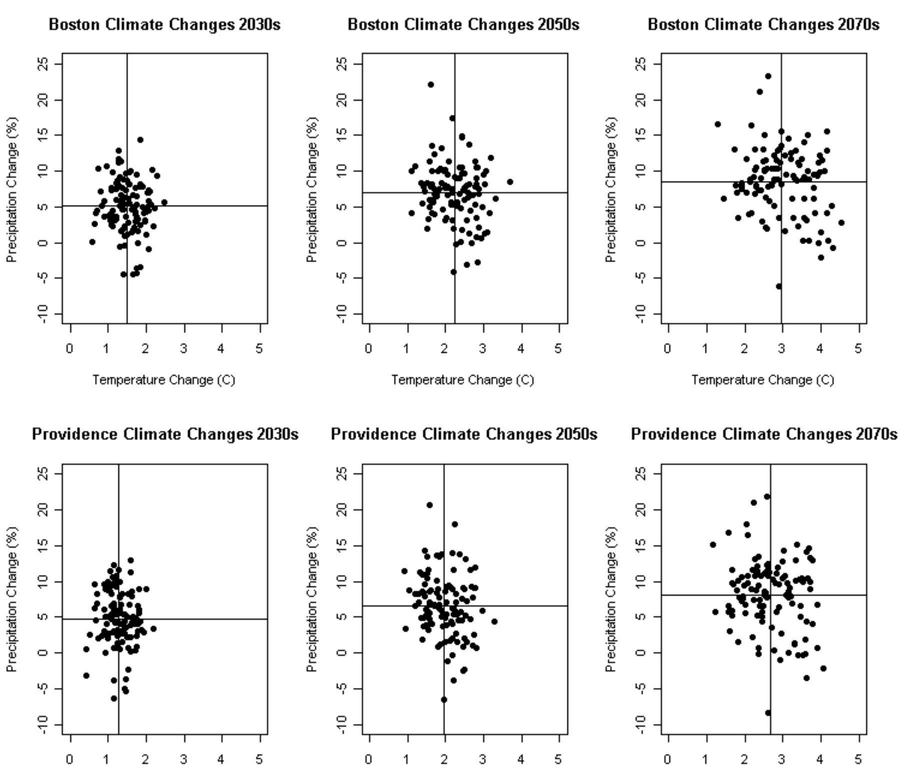


Figure 6. Projections of future mean temperature and precipitation of all 112 climate projections gradually increase along with variability.

National Climate Assessment Activities

During the past six months, CCRUN members supported the National Climate Assessment in several ways, with activity concentrated on the urban cross-cutting chapter and the northeast chapter. Technical inputs for both chapters were Co-led by CCRUN Lead PI Cynthia Rosenzweig.

Key activities in support of the Northeast region were centered around a large workshop in New York City held in November 2011, a listening session in Morgantown, West Virginia, and the creation of a 350-page, 40 author Draft Northeast Sourcebook describing climate impacts, vulnerability, and adaptation in the Northeast. The November workshop brought together academic, public and private sector representatives from the 12 states in the region to identify key assessment topics for the region, with an emphasis on emerging topics since the last Northeast assessment. With the conclusion of the workshop, writing teams were assembled for a seven chapter technical input report. Novel elements of the Northeast Sourcebook include a chapter of decision support and best practices in adaptation currently underway in the region, as well as a chapter summarizes the governance, partnership, and adaptation and mitigation history throughout the 12 states of the Northeast. One key finding was that certain parts of the region, especially West Virginia, have historically been underrepresented in climate assessment. To begin to address this gap, a listening session was conducted at the University of West Virginia in February 2012. This listening session identified key climate hazards and vulnerabilities in the state and sub-region.

During the rest of 2012, the Northeast Sourcebook will be finalized based on additional external review and drafts. The Northeast Draft Sourcebook is one of many technical input reports providing input for the Northeast Chapter of the National Climate Assessment, co-led by CCRUN research coordinator Radley Horton. Other activities will include additional listening sessions where the sourcebook findings will be vetted with audiences, with additional elements added as needed. Finally, sustained assessment activities will be entered around building long-term partnerships and improving data visualization and access.

For the urban chapter, a workshop of academic, public and private sector representatives was convened in October 2011 to support the development of the Urban, Infrastructure, Vulnerability Technical Input Report. Representatives from major cities in 15 states across the nation assembled to assess the emerging key impacts and vulnerabilities to climate change in U.S. cities and to document adaptation strategies and pathways which urban decision-makers and stakeholders are developing and implementing in response to changing climate risk. Chapter leads and writing teams addressed the four thematic report elements of urban context and climate risk, sectoral analysis, urban system cross-cutting elements, and tools and methods. The 200-page, six chapter input report was shaped and guided by both internal and external peer review processes and authored by sixty-one contributors. It will be finalized in 2012 and submitted for publication in book format through Island Press.

Workshops and Stakeholder Meetings

CCRUN investigators have sponsored or participated in the following workshops and stakeholder meetings (in chronological order):

10/24-25/11 C. Rosenzweig and W. Solecki, co-convenors, "NCA Urban Workshop: Climate Change in U.S. Cities," held at Columbia University, New York, NY

11/7/11 F. Montalto, Invited Speaker, "Green Infrastructure: Engineering multiple functions into urban landscapes." University of Pennsylvania, Graduate Program in Landscape Architecture

11/17-18/11 R. Horton, W. Solecki, and C. Rosenzweig, co-convenors, "NCA Northeast Workshop: Climate Change, Vulnerabilities and Adaptation," held at Columbia University and the NASA Goddard Institute for Space Studies, New York, NY

12/15/11 F. Montalto, Keynote Speaker and Breakout Session Facilitator, 6th Annual Meeting Hudson River Watershed Alliance, "Watershed Planning and Restoration: The 'Emergence' of Green Infrastructure Strategies"

1/11/12 C. Rosenzweig and L. Sohl, co-convenors, Climate Preparedness Workshop (co-sponsored with the Natural Resources Defense Council), held at Columbia University, New York, NY

1/12/12 F. Montalto, Webinar Presenter for the NOAA-funded Consortium for Climate Risk in the Urban Northeast (CCRUN) "Exploring green infrastructure program scenarios through stakeholder informed agent-based simulations"

1/12-13/12 F. Montalto and other CCRUN Drexel team members, EPA's 'Joint Initiative of Urban Sustainability Meeting', Philadelphia, PA

2/9/12 C. Rosenzweig, "Impact of Climate Change on the New York Region," presentation at the Westchester Municipal Officials Association monthly meeting, New Rochelle, NY

3/5/2012 F. Montalto and CCRUN Drexel team members, 2nd Semi-annual Green Infrastructure Research Summit; private meeting with stakeholders from NYC Department of Parks and Recreation and NYC Department of Environmental Protection

3/12/12 P.M. Orton, "Modeling Irene's storm surge and evaluating storm surge barriers for the NYC region." Informal lecture for stakeholder Con-Edison

3/15/12 F. Montalto, Exploring green infrastructure program scenarios through stakeholder-informed LIDRA 2.0 simulations," presentation at Hudson County, NJ Municipal Planning Offices to NY/NJ Baykeeper, Hackensack Riverkeeper, Sustainable Jersey City Program staff

Publications and Reports

Carr, J.L., Sheffield, P.E., and Kinney, P.L., 2012, Preparedness for climate change among local health department officials in New York State: a comparison with national survey results: *Journal of Public Health Management Practice*, v. 18, p. E24-32.

Catalano de Sousa, M., Montalto, F.A., and Spatari, S., 2011, LCA as a tool to evaluate watershed-scale CSO control strategies, including green infrastructure: *Journal of Industrial Ecology* (in press).

Devineni, N., Lall, U., Pederson, N., and Cook, E., 2012, Delaware River streamflow paleo-reconstruction using hierarchical Bayesian regression, accepted, *Journal of Climate*.

DiGiovanni, K., Gaffin, S., Montalto, F.A., and Rosenzweig, C., 2011, The applicability of classical predictive equations for the estimation of evapotranspiration from urban green spaces: green roof results: *World Environmental and Water Resources Congress 2011: Bearing Knowledge for Sustainability - Proceedings of the 2011 World Environmental and Water Resources Congress*, Palm Springs, Calif., 22-26 May, doi: 10.1061/41173(414)80.

Gaffin, S.R., Imhoff, M., Rosenzweig, C., Khanbilvardi, R., Pasqualini, A., Kong, A.Y.Y., Grillo, D., Freed, A., Hillel, D., and Hartung, E., 2012, Bright is the new black -- multi-year performance of high-albedo roofs in an urban climate: *Environmental Research Letters*, v. 7, 014029, doi:10.1088/1748-9326/7/1/014029.

Gornitz, V., *Rising Seas: Past, Present and Future*. Columbia University Press, New York (in press).

Horton, R.M., V. Gornitz, D.A. Bader, A.C. Ruane, R. Goldberg, and C. Rosenzweig, 2011: Climate hazard assessment for stakeholder adaptation planning in New York City. *Journal of Applied Meteorology and Climatology*, 50, 2247-2266, doi:10.1175/2011JAMC2521.1.

Major, D., Gornitz, V., Horton, R., Bader, D., Solecki, W., and Rosenzweig, C., 2012, Climate Adaptation in New York City. In : *Climate Adaptation and Flood Risk in Coastal Cities*, J. Aerts, W. Botzen, M.J. Bowman, P.J. Ward, and P. Diercke, eds. Londons and New York, Earthscan, p. 265-283.

Montalto, F.A., Bartrand, T.A., Waldman, A.M., Travaline, K., Loomis, C., McAfee, C., Geldi, J., and Riggal, G., 2011, Decentralized Green Infrastructure: The importance of stakeholder behavior in determining spatial and temporal outcomes: *Journal of Structure and Infrastructure Engineering* (in press).

Montalto, F., and Lucas, B., 2011, How are low impact stormwater control measures simulated by different computational models? *World Environmental and Water Resources Congress 2011: Bearing Knowledge for Sustainability - Proceedings of the 2011 World Environmental and Water Resources Congress*, Palm Springs, Calif., 22-26 May, doi: 10.1061/41173(414)57.

Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, and P. Grabhorn (Eds.), 2011: *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation*: Technical Report. NYSERDA Report 11-18. New York State Energy Research and Development Authority. Also available as the Annals of the New York Academy of Sciences, v. 1244, doi:10.1111/j.1749-6632.2011.06331.x. (Note: This volume includes several chapters by CCRUN members.)

Rosenzweig, C., W.D. Solecki, S.A. Hammer, and S. Mehrotra (Eds.), 2011: *Climate Change and Cities: First Assessment Report of the Urban Climate Change Research Network*. Cambridge University Press.

Steinschnider, S., Polebitski, A.S., Brown, C., and Letcher, B., 2012, Towards a statistical framework to quantify the uncertainties of hydrologic alteration under climate change: *Water Resources Research* (in press).

Steinschnider, S., and Brown, C., 2012, Dynamic reservoir management with real options risk hedging as a robust adaptation to nonstationary climate: *Water Resources Research*, 48, doi: 10.1029/2011WR011540.

Zhou, J., McCreanor, P.T., Montalto, F., and Erdal, Z.K., 2011, Sustainability: *Water Environment Research*, v. 83, p. 1414-1438.

Links to Other NOAA Programs

National Weather Service Northeast River Forecast Center: This NOAA entity is engaged in CCRUN PI Casey Brown's NOAA-SARP-funded project, "Collaborative Development of Climate Information for the Connecticut River Basin using Shared Vision Forecasting," which seeks to promote the adoption of forecasting techniques. The NWS NRFC has participated in a workshop with water managers in the Connecticut River Basin (March 2011), and interacts regularly with PI Brown, with the goal of establishing a climate knowledge network and an information baseline of the current use of climate information and forecasting in water management decision-making.

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Blumberg	Accurate Storm Surge Modeling: The Influence of Model Dimensionality, Freshwater, Tides, Stratification and Model Grid Area	Apr 2012	1) Manuscript submitted for review	Detailed simulations, comparisons with observations, and model sensitivity experiments are presented for the August 2011 tropical cyclone Irene and a March 2010 nor'easter that affected the New York City (NYC) metropolitan area. To "dissect" the storm tides and examine the role of various physical processes in controlling total water elevation, a series of model experiments was performed where one process was omitted for each experiment, and results were studied for eight different tide stations.	Nelson Vaz, of NOAA-NWS, Upton, New York	A
Blumberg	Coastal Flood Risk Assessment for the Urban Northeastern Corridor, Today and with Future Sea Levels	Sept 2015	1) Maps of the probability (per year) of inundation across each city; 2) Maps of flooding from specific extreme storm scenarios, also useful for planning; 3) Additional research papers summarizing these results, including one that focuses on risk analysis for a single severe coastal flooding event that affects the entire Northeastern urban corridor; 4) Documentation of our influence on the user community through our frequent communications with organizations (e.g. FEMA).	The Northeastern U.S. urban corridor of New York City, Philadelphia and Boston is threatened today by coastal storms, and climate change is likely to increase this threat due to predicted changes such as sea level rise. The primary objective of the project is to produce probabilistic risk assessments for the present, the 2050s and the 2080s, using stakeholder-defined metrics for urban watersheds. Major innovations beyond other prior studies include (a) the use of a highly detailed, extensively validated ocean model to provide probabilistic, yet accurate forecasts; and (b) inclusion of rainfall and storm surge based flooding in one combined modeling system.	New York City Department of Environmental Protection; New York City Mayor's Office of Long-Term Planning and Sustainability; FEMA NJ/NY Coastal Storm Surge Analysis; New York City Department of Parks and Recreation; Con Edison; New York City Department of City Planning; The City of Boston's Office of Environmental and Energy Services; North Jersey Transportation Planning Authority	A
Brown	Collaborative Development of Climate Information for the Connecticut River Basin using Shared Vision Forecasting	Dec 2012	Hopefully a paper will be published on the application of the diffusion of innovations framework used to assess the promotion and adoption of seasonal hydrologic forecasts by water managers in the Northeastern United States. Additionally, a June workshop and/or monthly newsletter is anticipated before the completion of this project.	The spread of technical information and practices is often lost in communication when transferred between a source and the end users. This research seeks to use Shared Vision Forecasting and the diffusion of innovations framework to promote the adoption of forecasting techniques. Through a series of workshops with water managers in the Connecticut River Basin, this research will establish a climate knowledge network and an information baseline of the current use of climate information and forecasting in water management decision-making. Better understanding of how managers adopt new forecast techniques and climate data will provide the feedback needed to improve forecasting and climate information.	National Weather Service Northeast River Forecast Center; see also list for PI Palmer's Connecticut River Basin project	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Horton	Climate variability and change as simulated over the Northeast	Apr 2013	1) Assessment of why regional climate models produce large biases with respect to extreme events; 2) Communication of potential for extreme heat and extreme cold to Northeast stakeholders	The CCRUN climate team, through its work with urban stakeholders, focused on intense precipitation events, extreme heat, and extreme cold, as climate metrics that influence for example the water sector, infrastructure, and human health. The team has evaluated 6 Regional Climate Models that contributed to the North American Regional Climate Change Assessment Program (NARCCAP). Initial work explored how well the regional climate models are able to reproduce historical mean climate and climate extremes in the Northeast, when receiving the best available historical data at the model boundaries. Next the team assessed regional climate model performance over the historical period when driven by global climate models. Finally, projected changes in mean climate and extremes for the middle of the 21st century under the A2 emissions scenario were explored.	Carl Spector, Executive Director, Office of Environment and Energy Services, Boston; Adam Freed, Deputy Director, Mayor's Office of Long Term Planning and Sustainability, NYC; Katherine Gajewski, Sustainability Director for City of Philadelphia	A
Khanbilvardi	Characterizing Thermal Neighborhoods for Climate Health Impacts	Apr 2016	1) Develop new methodology to create temperature projections at a neighborhood scale; 2) Create a web-based tool that shows downscaled temperature maps and related health risks. There will be both a nowcast and a 24-hour future cast.	A city's urban heat island can be subdivided into physically defined neighborhoods that respond differently to large scale environmental forcing. The observed bias from the modeled temperature would be similar throughout a thermal neighborhood, but vary between neighborhoods. Our objective is to use neighborhood-scale field campaign data to develop model output statistics to downscale model forecasts of temperature and humidity.	N/A	A
Kinney	Heat-related mortality risks in the urban northeast under a changing climate	Apr 2013	Quantification of current and future mortality impacts of temperature in the three cities, and exploration of who is most vulnerable.	The aim of this work is to quantify the exposure-response relationships linking daily temperature and death counts at the urban scale in each of the three project cities: NY, Boston, and Philadelphia. We will then apply this relationship to future projections of daily temperatures to assess potential future risks under different scenarios of climate change. We will also develop vulnerability indicators for the cities of interest and test whether mortality impacts vary in association with these indicators. This project builds on preliminary work we did for Manhattan in the ClimAid project.	New York City Department of Health and Mental Hygiene	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Kinney	Temperature, Ozone, and Mortality in the Tri-State Region	Oct 2012	1) Health analysis using the CMAQ/MM5 exposure model; 2) meta-analysis across regional county sub-groupings to understand how other factors may influence the relationship between air pollution, temperature, and mortality	Air pollution and heat stress are current public health concerns in urban areas, and these hazards are expected to be influenced by a changing climate. While environmental exposure data are rich in time, they are sparse in space. This limits health effects analysis, as well as our ability to understand fine-scale spatial variability in these exposure-disease relationships. In this project, we use fine-scale climate and air quality models, in conjunction with monitoring data, to enhance our ability to analyze health effects.	N/A	A
Kinney	Reducing Mortality from Heat Waves in the Urban Northeast	Apr 2013	Institutional maps and a report that describes decision making among stakeholders and identifies possible relationships between decision making and outcomes in Boston, Philadelphia and New York	Although heat heath warning systems are an important city-level adaptation measure, assessing and improving their effectiveness is difficult due the ambiguity associated with attributing heat-related deaths, the lack of clearly outlined structure, information flow, decision making processes, and interactions among the various stakeholders and communities before and during heat wave events (WHO). Thus, in the context of CCRUN, the heath team will perform interviews with key stakeholders in each city in order to characterize the type of triggers used to issue a warning, participating agencies, as well as and the interventions implemented as a part of the heat response strategy. In this process, we will also communicate the findings from our research to stakeholders and develop tools that may be used by stakeholders involved in the response to extreme heat.	New York City Department of Health and Mental Hygiene Climate Change and Public Health Workgroup	A
Kushnir	Hydro-meteorological conditions associated with extreme flooding in the Northeast United States rivers	Mar 2013	Statistical analysis of primary hydro-meteorological factors associated with extreme floods in US Northeast large river basins.	Extreme floods have historically wreaked havoc in both populated and unpopulated areas of the Northeast United States, especially between late winter and mid-spring. During this transition period, intense frontal rainfall can combine with seasonal snowmelt and dramatically increase flooding potential throughout the region. This project analyzes daily streamflow data from Northeast U.S. rivers to identify an ensemble of extreme of flooding events and the hydro-meteorological conditions that precede them. The climatology of the conditions leading to these extreme floods is determined by averaging key meteorological variables over all the identified events to determine what is common to all the events. We ask the question of whether such conditions can be predicted at longer lead times than those associated with weather forecasting.	N/A	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Kushnir	Space-time properties of extratropical storms along the US northeastern seaboard - present and future	Sept 2014	1) Database of extratropical storm density tracks that affect the eastern US and associated extreme weather conditions; 2) Classification storms by preferred tracks	Extratropical storms are associated with well-defined circulation patterns that affect the location of coastal impacts and their intensity. Using newly available reanalyses of weather data of the past century and more, we will generate robust estimates of probabilities by frequency, spatial extent, track, and intensity of storms that affect the Northeast coast and close by inland regions and determine trends and variability patterns. In particular we will explore the possibility of creating information that is conditional on large-scale circulation states such as those related to the El Niño/Southern Oscillation and the North Atlantic Oscillation phenomena.	N/A	A
Lall	Delaware River streamflow reconstruction using tree rings	Apr 2013	Development of statistical techniques for reconstructing flood and drought events on river systems	Using Hierarchical Bayesian Statistical techniques for understanding and modeling the hydrologic systems is one of the emerging areas of research. Given their ability to explicitly quantify the process model and parameter uncertainty through each estimation stage, Bayesian methods can be employed to better represent model and estimation uncertainties and indeed to find ways to reduce them by appropriate shrinking across spatial instances. In this project, we developed various Hierarchical Bayesian statistical techniques for reconstructing Delaware River flows using paleoclimatic information such as tree rings. This analysis will serve as the necessary building block for simulating water system operation and to provide a more objective evaluation of operating rules for reservoir systems consider changing conditions. The reconstructions also provided insights in to the probability of severe sustained droughts in this region.	Delaware River Basin Commission	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Lall	Water sustainability and the environment under a changing climate: Promoting Adaptive Management in the Delaware River Basin	Apr 2015	1) Plan for releasing water to relieve summertime thermal stress on local fish populations; 2) Assessment of the efficiency of the Supreme Court's "Excess Release Quantity" concept; 3) Assessment of whether water entitlement for New York City should be reduced	The Delaware water release policies are constrained by the dictates of two US Supreme Court Decrees (1931 and 1954) and the need for unanimity among four states: New York, New Jersey, Pennsylvania, and Delaware -- and New York City. Coordination of their activities and the operation under the existing decrees is provided by the Delaware River Basin Commission (DRBC). While much progress on improving the release rules has been made since 2006, we have identified a number of unresolved issues which deserve analytic attention, and for which we are confident that quantitatively based recommendations can be generated and offered for consideration to the stakeholders by the Delaware River Basin Commission.	Delaware River Basin Commission	A
Madajewicz	A comparative assessment of heat health warning systems in Boston, New York	March 2013	1) Maps of vulnerability to heat waves in NYC, Boston, and Philadelphia; 2) Reports and published papers that document lessons for designing HHWS to serve population with different vulnerability profiles; 3) A publicly-searchable reference database for Northeast- and heat wave-relevant adaptation and vulnerability literature	Many cities in the United States have introduced heat health warning systems (HHWS) in order to reduce mortality and morbidity associated with heat waves. Some evidence suggests that existing HHWS, early warning combined with actions to assist vulnerable populations, are saving lives, but the evidence is insufficient to guide the design of effective HHWS. We will conduct a comparative assessment of the major HHWS in the highly urbanized northeast. We will compare detailed evidence about the institutional structures of the three HHWS in order to understand which components are effective in saving lives and why, and what other cities can learn about how to reduce mortality and morbidity from heat waves under different climatic and socio-economic conditions. We will analyze how effectively each HHWS is serving the needs of the most vulnerable groups and what are the lessons for making HHWS responsive to the needs of the most vulnerable.	Kizzy Charles-Guzman, Director, Climate Change Public Health Program, NYC; NYC Department of Public Health and Mental Hygiene	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Madajewicz	Building resilience to storm surges and sea level rise - A comparative study of coastal zones in New York City and Boston	March 2014	1) Adaptation blueprints for types of neighborhoods represented among those that are most vulnerable to coastal flooding in NYC and Boston; 2) A guide to the information needed to identify each type of neighborhood and to match it to one or more blueprints; 3) An ex ante evaluation of likely future impacts that the adaptation blueprints will have on vulnerability to coastal flooding in the corresponding types of neighborhoods, and their costs, and assessment of the conditions under which different blueprints may be effective in other coastal, urban areas; 4) Dissemination of this information to other coastal municipalities	Along the northeast urban corridor (NEUC), damage from flooding related to storm surges is one of the most certain impacts of climate change, making adaptation in coastal zones that are vulnerable to storm surges one of the highest priorities in the NEUC. This project is a collaboration between the CCRUN coastal team, the evaluation team, CIESIN, and various stakeholders to develop adaptation blueprints that specify decision and implementation processes for well-defined types of neighborhoods. The assessment of vulnerability will also include socioeconomic factors, land use, and infrastructure. specified conditions.	Carl Spector, Executive Director, Office of Environment and Energy Services, Boston; Adam Freed, Deputy Director, Mayor's Office of Long Term Planning and Sustainability, NYC; Aaron Koch, Policy Advisor, Mayor's Office of Long Term Planning and Sustainability, NYC; Alan Cohn, NYC Department of Environmental Protection	A
Montalto	Climate information for water harvesting and re-use strategies in Philadelphia	Sept 2015	1) Study of actual performance of various green infrastructure facilities under variable climatic conditions; 2) Hydrologic and hydraulic modeling studies exploring the hydrologic response of different urban catchments to variable climatic conditions with and without GI facilities installed; 3) LCA studies performed at different scales mapping GI implementation to performance of larger water, stormwater and wastewater infrastructure systems; 4) Linkages of the above to stakeholder needs and interests	Climate change is expected to alter urban climatological conditions throughout the CCRUN study area. This research effort investigates the impact of changes to precipitation and temperature on the hydrology of urban spaces and the terrestrial and aquatic ecosystems connected to them directly or indirectly through infrastructure. Specifically, we are investigating relationships between climatological conditions and water/wastewater/stormwater infrastructure, with a focus on a) impacts of climate conditions on water and wastewater treatment plant performance, b) how varying levels of climatically impacted infrastructure performance relate to various indicators of public health and c) the use of various green infrastructure (GI) strategies as a climate change adaptation strategy (through its role in reducing the energy and GHG emissions associated with less stormwater and enhanced urban evapotranspiration).	New York City Department of Parks and Recreation; New York City Department of Environmental Protection; Philadelphia Water Department; Philadelp hia Department of Parks & Recreation; Philadelphia Mayor's Office of Sustainability; U.S. Forest Service; U.S. Army Corps of Engineers (Philadelphia District); U.S. Environmental Protection Agency, Regions 2 and 3; Pennsylvania Horticultural Society	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
Palmer	Impacts of Climate Change on the Massachusetts Water Resources Authority Water Supply System	Apr 2012	Projection of future generation of temperature, precipitation, and streamflow values for the MWRA watershed area	A study of the water supply system of the Massachusetts Water Resources Authority (MWRA) includes the watershed area for the City of Boston. Activities involved in this study include the creation of downscaled data from climate model projections, and hydrological model studies to explore the range of the potential impacts of climate change on the watershed. The streamflow projections produced by the hydrology model will then be input into a water supply system simulation model to help inform decision management for possible climate change scenarios. This project also involves the development of decision support tools to guide water supply operations and to facilitate stakeholder involvement.	Massachusetts Water Resource Authority	A
Palmer	Impacts of Climate Change on the Providence Water Supply System	Apr 2012	Projection of future generation of temperature, precipitation, and streamflow values for the Scituate watershed area	Variations in climate and their associated uncertainties make it difficult to determine the impacts of climate change on municipal water supply systems. This study investigates the impacts of climate change on the Providence, Rhode Island water supply. A loosely linked modeling approach is used, including: the selection of a large number of general circulation models (GCMs) to simulate regional climate, hydrology models at a basin scale, and water resource system simulation models. This approach is applied to the watershed serving as the city's primary water supply source, Scituate watershed.	Providence Water	A
Palmer	Evaluating reservoir operations and the impacts of climate change in the Connecticut River Basin	Apr 2013	Sub-daily (i.e. hourly to 6-hourly) optimization models will be constructed for four hydropower facilities in the Connecticut River Basin that will undergo FERC relicensing within the next 5 years	The Connecticut River Basin is the principal water source for communities in portions of Vermont, New Hampshire, central Massachusetts and central Connecticut, with over 70 major dams and reservoirs in operation to help control the water supply. This project will provide The Nature Conservancy, the US Army Corps of Engineers and other stakeholders with climate-informed guidance for current and future dam operations, and illustrate the potential trade-offs between policies that optimize one or more of services provided by the systems' operations. Downscaled data from climate model projections, fed into hydrology models, is used to construct informed streamflow forecasts; these in turn support a reservoir management model that enhances the biological community supported by the river, and existing infrastructural services including flood control, water supply, recreation and hydropower generation. This project also involves the development of decision support tools to guide river operations and to facilitate stakeholder involvement. Workshops are held to	Environmental Protection Agency, Metropolitan District of Connecticut, The Nature Conservancy, MA Dept of Fish and Game, US Army Corps of Engineers, MA Office of Energy and Environmental Affairs, Brookfield Power, TransCanada, The New Britain Water Dept, Springfield Water and Sewer Commission, University of Connecticut, VT Dept of Environmental Conservation, VT Water Quality Section, VT River Management Program, New England Interstate Water Pollution Control Commission, NH Dept of Environmental Services, MA Dept of Conservation and Recreation, CT Dept of Environmental Protection, NH Rivers Council, MA Dept of Environmental Protection, MA Dept of Environ-mental Protection, Water, Wastewater, and Wetlands, VT Agency of Natural Resources, Natural Resources Committee, VT Natural Resources	A

PI	Project Title	End Date	Deliverables/ Products	Abstract/Description	Partners	RISA-led project=A; RISA is contributor=B
				gather information about stakeholder requirements for the basin, such as ecological flow targets and dam operations	Council, CT River Watershed Council, Turner Falls Dam, Town of North Brookfield Water Department, Appalachian Mountain Club, The CT Water Company, City of Fitchburg Division of Water Supply, National Park Service Farmington and Westfield Wild and Scenic Rivers, Dalton Hydro, LLC., North American Energy Alliance, LLC., VT Dept of Fish and Wildlife, City of Fitchburg Public Works Department, River Alliance of CT, Bear Swamp Power Company, LLC., City of Holyoke Gas and Electric Department, Town of Ashburnham Dept of Public Works, CT Inland Water Resources Division, The Farmington River Power Co., L.S. Starrett Co., A & D Hydro Inc., Green Mountain Power, Brattleboro Water Dept, Easthampton Water Sewer Dept, Chicopee Water Dept, Williamsburg Water Sewer Dept, Westfield City Water Dep, Palmer Water Dept, Monson Town Water Dept, Stratford Water Pollution, Bristol Water Dept, Canaan Water Dept, Keene City Water Dept, Burlington Water Dept	
Someshwar	Planning for climate vulnerability in the Urban Northeast: A review of state and local-level planning and the use of climate risk and vulnerability methodologies and tools	April 2012	White paper on presenting gap analysis on risk and vulnerability in climate change planning withint the CCRUN project area	The state and city governments in the study area of the urban Northeast are at different stages of developing plans to address climate change. Critically, these plans draw upon a diverse set of understandings and meanings for what constitutes risk and vulnerability. The governments' reports and policy documents illustrate a range of approaches to assessing, quantifying and addressing climate- related risks and the most vulnerable populations. This paper provides a comparative analysis of the conceptual and practical approaches of the states and cities to climate risk and vulnerability. The analysis draws on publicly available documents from Connecticut, Massachusetts, New Jersey, New York, Pennsylvania and Rhode Island. In order to fill some of the gaps identified in integrating climate vulnerability into planning, the paper also briefly explores the landscape of tools for and approaches to assessing climate vulnerability and risk, and the resources available to help planners integrate these factors into policy and action.	N/A	A