



INSTITUTE FOR
Sustainable
Communities

CLIMATE LEADERSHIP ACADEMY

Promising Practices in Adaptation & Resilience

A Resource Guide for Local Leaders

Version 1.0

Produced in partnership with



Center for
Clean Air Policy
Dialogue. Insight. Solutions.





Table of Contents

Introduction & Overview	1
Case Studies.....	7
Themes.....	7
MODELS FOR ADAPTATION PLANNING	
Chicago Climate Action Plan.....	8
The Science/Policy Connection in the Chicago's Climate Adaptation Planning	16
Miami-Dade County's Adaptation Planning Process	21
New York City: Assessing Climate Risks	27
Toronto Climate Adaptation Planning	30
Overview of "Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments"	40
GETTING COMMITMENT ON CLIMATE ADAPTATION	
Boulder Residents get help from Artist Mary Miss to "Connect the Dots"	42
London's Climate Change Adaptation Strategy	45
BOLSTERING RESILIENCE BY INTEGRATING ADAPTATION INTO LOCAL PLANNING AND OPERATIONS	
Seattle and Tucson Manage Risks to their Water Supplies.....	50
Seattle Public Utilities' Flood Risk Management Strategies	56
New Orleans Community-Driven Adaptation and Planning	61
Dutch Dialogues Inform New Orleans' Approach to Life on the Delta	68
Insurance Industry Takes Steps to Address Future Climate Impacts	70
CROSS-JURISDICTIONAL COLLABORATION	
Southeast Florida Regional Climate Change Initiative	73
Resource Lists.....	77
General Resources	77
Scientific Assessments of Risks & Impacts.....	77
Online Portals and Peer Exchanges	78
Other Useful Background Information.....	79
Adaptation Planning	80
Examples and Case studies.....	80
Adaptation Planning Guidelines.....	80
Adaptation Planning Tools	82
Risk Assessments	83
Examples.....	83

Risk Assessment Guidelines	84
Assessment Tools	86
Climate Risks and Adaptation Strategies.....	88
Strategies for Various Climate Impacts	88
Development and Infrastructure	88
Heat	89
Public Health.....	90
Sea Level Rise.....	91
Storms/Flooding	91
Water Supply.....	92
Getting a Commitment to Adaptation	94
Examples of Effective Communication.....	94
Making the Case.....	95
Community Engagement	96
Acknowledgements.....	98



Introduction & Overview

The Challenge

The year 2010 is on track to be the hottest one on record.¹ Climate disasters have accompanied higher global average temperatures to make for a catastrophic summer. As this Resource Guide goes to press, some 20 million Pakistanis remain displaced by flooding that has affected one-fifth of their country. While it is impossible to link any one weather event to climate change, climatologists are increasingly convinced of the connection.² China and Niger, too, have experienced devastating floods in recent months, while drought has ravaged southern Africa and Russia.

The United States has also made climate news recently as New Yorkers suffered scorching heat waves; floods swamped Nashville, Arkansas and Oklahoma; and temperatures reached their highest level on the surface of Lake Superior. These weather extremes are claiming lives and exacting large social, environmental and economic damage and challenging cities as frontline operatives working to mitigate these impacts on their citizens.

Climate scientists have been warning us that such events are likely to intensify and become more frequent as the concentration of carbon dioxide increases in the atmosphere. The U.S. Global Change Research Program's 2009 impacts study found that climate change will stress water resources, challenge crop and livestock production, increase sea level rise and storm surge risks to coastal areas, and increase human health stressors including disease and poor air quality.³

Scientists have also urged action. Dr. Stephen Schneider, the distinguished climatologist who died in July, was among those who argued that collective action on mitigation and adaptation is necessary.⁴ Schneider saw the reduction of greenhouse gases and measures to deal with new climate impacts as two integral parts of a single strategy for survival. By reducing carbon dioxide emissions, we limit climate change to a level to which we can adapt.

As Schneider explained, the analyses and literature review in the last (2007) International Panel on Climate Change (IPCC) Assessment suggested that more familiar adaptive strategies, such as developing crop strains, flood control, irrigation systems, sea walls, and migration corridors, "are effective up to a few degrees of warming, after which these adaptations are exceeded. Above 3 degrees Celsius [or 5 degrees Fahrenheit] increase from 1990-2100, there is very little adaptive capacity."⁵

¹ "State of the Climate, Global Analysis, July 2010," National Climatic Data Center, National Oceanic and Atmospheric Administration. <http://www.ncdc.noaa.gov/sotc/?report=global>

² "More on Extreme Weather: Day Two stories go a step farther in drawing connection to climate change." Columbia Journalism Review. Aug. 17, 2010. http://www.cjr.org/the_observatory/more_on_extreme_weather.php

³ See key findings from *Global Climate Change Impacts in the United States* here: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>

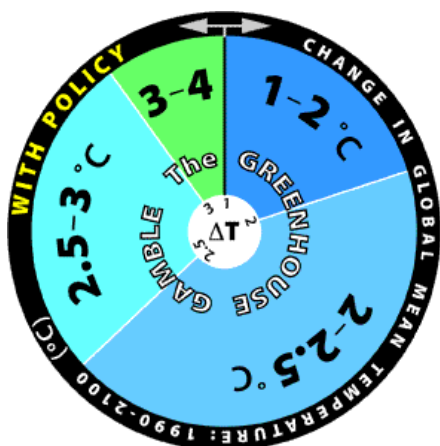
⁴ Not to be confused with 'win-win' strategies that have both adaptive and mitigative benefits; for example, green roofs which help manage stormwater, reduce cooling and heating loads, and reduce the heat island effect.

⁵ See <http://www.youtube.com/watch?v=hv6m409FauU>



THE GREENHOUSE GAMBLE™

The MIT Joint Program on the Science and Policy of Global Change's depiction of the likelihood of potential global average surface temperature change over the next hundred years.



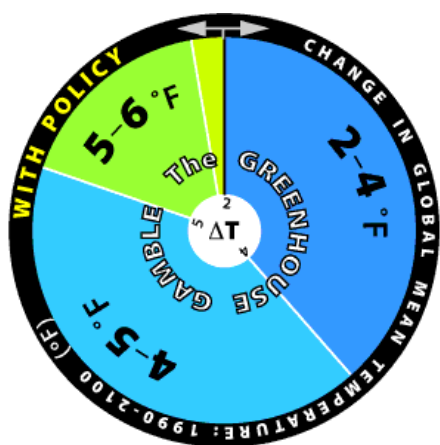
In this graphic, the size of each 'degree-change slice' represents a probability of occurrence over the next hundred years. The likelihood of each range of temperature change is:

1 to 2 °C, 20%; 2 to 2.5 °C, 43%;
2.5 to 3 °C, 27%; 3 to 4 °C, 10%

Note that these probability scenarios are based on the assumptions that the original signatories to Kyoto (including the United States, at 7% reductions below 2008 levels by 2010) implement their emissions caps.

Below is the Fahrenheit version, included because Americans typically do not think in terms of Celsius. The likelihood of each range of temperature change in Fahrenheit is:

2 to 4 °F, 38%; 4 to 5 °F, 42%;
5 to 6 °F, 17%; 6 to 8 °F, 3%.



Source: MIT Joint Program on the Science and Policy of Global Change, <http://globalchange.mit.edu/resources/gamble/policy.html>

State of Adaptation Planning

Climate change adaptation in the United States has largely been the work of cities and states, including many of those that are participating in the Institute for Sustainable Community's (ISC) Climate Leadership Academy on Adaptation & Resilience (Sept. 20-22, 2010). Cities such as Chicago and New York have recognized that climate projections of heat waves and storms pose threats to the health, safety and economic wellbeing of their residents. These cities are developing planning processes and taking actions to begin preparing for impacts that are expected to manifest over the next century. According to the Georgetown Climate Center's database of state and local adaptation plans, 14 U.S. cities and 13 states (12 coastal states and Colorado) either have or are developing adaptation plans.¹

Climate adaptation planning at the local and state level has, to date, advanced with little support from the federal government. But the White House has created a federal interagency task force to develop a national climate adaptation strategy. The task force is expected to make recommendations to the President in October 2010. The White House Council on Environmental Quality leads the effort, working with the White House Office of Science and Technology Policy and the National Oceanic and Atmospheric Administration. The task force includes representatives from more than 20 other federal agencies. Workgroups of the task force have hosted twenty listening sessions with stakeholders and experts, receiving input from more than 500 organizations.

To better understand the state of climate adaptation practice in cities, and the challenges that cities are facing, ISC's Climate Leadership Academy (CLA) team consulted with several nationally-recognized organizations and nearly 50 practitioners from the 16 U.S. cities participating in the CLA workshop. These

¹ <http://www.georgetownclimate.org/adaptation/adaptation-plans.php>



practitioners included sustainability directors, energy managers, urban and economic development planners, water resource and public works managers, and public health and safety officials. The interviews yielded important insights to bolstering climate resilience at the local scale, and represent some of the most up-to-date knowledge in the field:

1. *Cities routinely work to adapt to the current climate, although they may not consider the work in those terms.* Emergency preparedness plans, sound land-use and transportation planning decisions, wildfire prevention measures, water supply diversification, and robust infrastructure design all represent efforts that bolster climate resilience. Cities, in other words, possess much of the necessary expertise, mechanisms and tools to deal with climate change.
2. *A science-based risk assessment represents a critical early step* in developing an adaptation plan. Typically, risk assessments require access to localized climate projections and they involve a broad stakeholder process in order to evaluate the varied consequences (e.g. safety, health, economic) of predicted climate impacts.
3. *Scientists and policymakers are working together* to develop new climate risk assessment tools related to public health and infrastructure. The tools need to become more widely available, so that more cities can use them.
4. *Scenario planning* can help cities account for a range of possible futures, helping them manage the uncertainty of climate projections.
5. *Flexible adaptation pathways*, which account for uncertainty of climate projections, allow cities to begin the adaptation planning process, while giving themselves the ability to change their plans as new scientific data becomes available. This approach may also allow cities to spread the cost of adaptation over a longer period of time, as the implementation of strategies is phased in.
6. Although climate change will require costly, so-called hard solutions, such as the retrofitting of existing infrastructure, *proactive adaptation planning can reveal many low-cost or soft solutions*, such as improved emergency preparedness plans, public education, and new maintenance and operations procedures.

Practitioners' Key Challenges

The interviews that the CLA team conducted also revealed a set of common challenges in strengthening climate resilience:

1. *Risk assessment and prioritization.* To adapt to climate change, cities must understand and prioritize the risks they face. Many cities, however, have yet to conduct a thorough risk assessment, either because climate adaptation is not a policy priority, or because they lack the resources. As a result, cities may lack the detailed information (e.g. number of additional days above 90°F; inches of sea level rise) they need to gain support for adaptation planning.
2. *Integration of adaptation into planning and operations.* Even practitioners who work in cities that are relatively advanced in climate adaptation planning asserted that the integration of



climate concerns into planning and operations was difficult. “Everything must change,” as one practitioner put it, so that urban and transportation planning, environmental review processes, related laws and regulations, and engineering standards account for climate risk information.

3. ***Communications: Getting commitment on adaptation from government and the public.*** Nearly all practitioners said that they needed help in persuading colleagues, elected officials, and residents to take action on climate resilience. Some of the resistance may have to do with a lack of understanding about climate risks, and that the greatest of these risks are expected to materialize years into the future. Elsewhere, practitioners reported that they needed communications strategies for dealing with climate skeptics, or residents who distrust government. Some participants also said they needed new ways to talk about climate projections without angering or terrorizing residents who are subject to climate risks. The hesitation to communicate climate information was especially strong among practitioners who work in coastal cities, where residents would resist being relocated from flood-prone areas, or refuse to rebuild their properties in ways that could accommodate flooding.
4. ***Cross-jurisdictional, and cross-sectoral, collaboration*** (inter-agency, city-state, regional; public, academic, private). City practitioners may face added levels of complexity in working on climate change adaptation because managing climate risks involves numerous agencies, some of which may operate outside the city’s purview. Several agencies, for example, may share responsibility for the operation of a city’s transportation network. Often the resilience of one part of the system relies on the extent to which climate risks are managed across the entire system. A city’s resilience may also be affected by the climate preparedness of private utilities, telecommunications firms, and shipping companies. Some climate risks, such as drought, require regional cooperation so as to account for water resource management throughout the watershed.
5. ***Economic evaluation of adaptation measures.*** Evaluating the risks of climate impacts and the benefits of adaptation measures also presents a challenge to some practitioners. The difficulty stems from the complexity of the climate impacts, including their uncertainty and their tendency to intensify over time. More dynamic cost-benefit models than the ones that are typically used for project financing may be necessary to help practitioners make better informed adaptation decisions.
6. ***Funding adaptation.*** Adaptation is just emerging as an issue in most U.S. cities, so little or no money is budgeted for it. By integrating adaptation concerns into planning, some cities are hoping to bolster their resilience gradually, as new projects are built, existing infrastructure is refurbished or replaced, and current plans are revised. But often there is little or no money for entirely new adaptation projects (e.g. sea walls) or for retrofitting existing infrastructure that will be at risk to climate impacts before the end of its useful life.
7. ***Performance measurement for resilience.*** Cities that are implementing adaptation strategies have yet to develop ways to measure the extent to which they are becoming more resilient. These cities may be able to say that they took a number of actions (e.g. revised emergency response plan; built at higher elevations), but they cannot yet know the extent to which their residents are safer and their economies more resilient to climate disruption.



Practitioners also identified challenges for coping with particular climate impacts, such as sea level rise, stormwater management, flooding, heat waves, disease, drought, food security, and population growth caused by climate-displaced immigrants. These challenges often had to do with identifying solutions to these problems; in other cases, cities lacked the support and resources to implement the solutions.

About this Resource Guide

This Resource Guide represents a synthesis of the best available information we were able to find about the ways in which experts and practitioners across the country are working to meet the challenges outlined above. The Resource Guide is intended to help practitioners in cities and metropolitan regions resolve local issues, by showcasing promising practices in climate adaptation and resilience, and by providing efficient access to some of the very best information and resources that are available.

The Resource Guide is not an exhaustive compilation of available information—a near-impossible task given the growing volume of international studies, reports, websites, books and blogs on the topic of climate resilience. Still, this document reflects an intensive effort by the CLA team, including dozens of phone consultations with leading experts and practitioners and a great deal of web-based research, to identify, compile, vet and synthesize useful information on innovative policies, programs and practices being deployed throughout the country.

The Resource Guide includes:

- ***Case Studies*** that discuss how various local government practitioners have made progress on climate adaptation planning, including risk assessment, integration of climate concerns in planning, getting and keeping commitment to adaptation, and cross-jurisdictional collaboration.
- ***Resource lists by topic*** that direct practitioners toward the topic-specific sources of information—studies, reports, articles, and websites—that we believe are most likely to help them improve, expand and accelerate their adaptation and resilience efforts.

Finally, this Resource Guide is and will continue to be a work in progress. While the CLA team produced it initially for those practitioners who were attending the first Climate Leadership Academy on Adaptation and Resilience, the team intends to update and expand it on a regular basis, and make it available to local practitioners everywhere.







Case Studies

Themes

The case studies in this Resource Guide fall into one of four thematic groups:

MODELS FOR ADAPTATION PLANNING

- Chicago Climate Action Plan
- Interviews on the Science/Policy Connection in the Chicago Climate Action Plan
- Miami-Dade County's Adaptation Planning Process
- New York City Climate Change Risk Assessment
- Toronto Climate Adaptation Planning
- Resource Snapshot: Preparing for Climate Change

GETTING COMMITMENT TO CLIMATE ADAPTATION

- London's Climate Change Adaptation Strategy
- Snapshot: Boulder Residents Get Help from Artist Mary Miss to *Connect the Dots*

BOLSTERING RESILIENCE BY INTEGRATING ADAPTATION INTO LOCAL PLANNING AND OPERATIONS

- Seattle and Tucson Manage Risks to their Water Supplies
- Seattle Public Utilities' Flood Risk Management Strategies
- Briefing: Insurance Industry Takes Steps to Address Future Climate Impacts
- New Orleans' Community-Driven Adaptation and Planning
- Snapshot: "Dutch Dialogues" Inform New Orleans' Approach to Life on the Delta

CROSS-JURISDICTIONAL COLLABORATION

- Southeast Florida Regional Climate Change Initiative

These themes emerged from ISC's consultations with city adaptation practitioners and experts, and together constitute the scope of this Resource Guide. Note that each case study emphasizes one theme but also includes useful lessons regarding the others.



Chicago Climate Action Plan

The Chicago Climate Action Plan combines both mitigation and adaptation strategies in one document. The Task Force's reliance on rigorous scientific assessment, use of a multi-stakeholder process, and strategy of building off of existing initiatives make their story an instructive one for cities unsure of how to approach their adaptation planning efforts.

In November 2006, the City of Chicago formed a Climate Task Force to develop a climate action plan addressing both reductions in heat-trapping gas emissions (mitigation) and preparing for unavoidable climate changes (adaptation). Over the next two years, Chicago wedded a rigorous scientific assessment of regional climate change vulnerabilities under several scenarios and an economic analysis of potential impacts and risks with a comprehensive, multi-stakeholder climate action planning process funded from city budgets and philanthropic sources. The Task Force involved leadership from the Mayor's Office and city departments, the environmental community, key civic and business groups, foundations, universities, research centers, other local and nonprofit organizations, and the State of Illinois.

The Chicago Climate Action Plan (CCAP) was released in September 2008, and included a strategy on climate adaptation with nine major actions, a Quick Guide on Adapting to Climate Change in the Chicago Area, and a framework for implementing actions to cope with emerging and inevitable climate change impacts. The City also developed methods for monitoring and evaluating progress and assessed and published "lessons learned" from the planning process.

THE PROCESS

Creating the plan, preparing for change. The Chicago Climate Action Plan process can be divided into three phases leading to the launch of the Plan:

- *Research.* This phase included acquisition of funding, recruiting of outside partners, establishing leadership and management teams, engaging city departments, and conducting impact, risk and vulnerability assessments.
- *Planning.* This phase included developing, drafting, and vetting the Plan across the Task Force members, and engaging the public.
- *Implementation.* This phase focused mainly on preparing for the release of the Plan, publication of various research reports, and planning for implementation after launch.

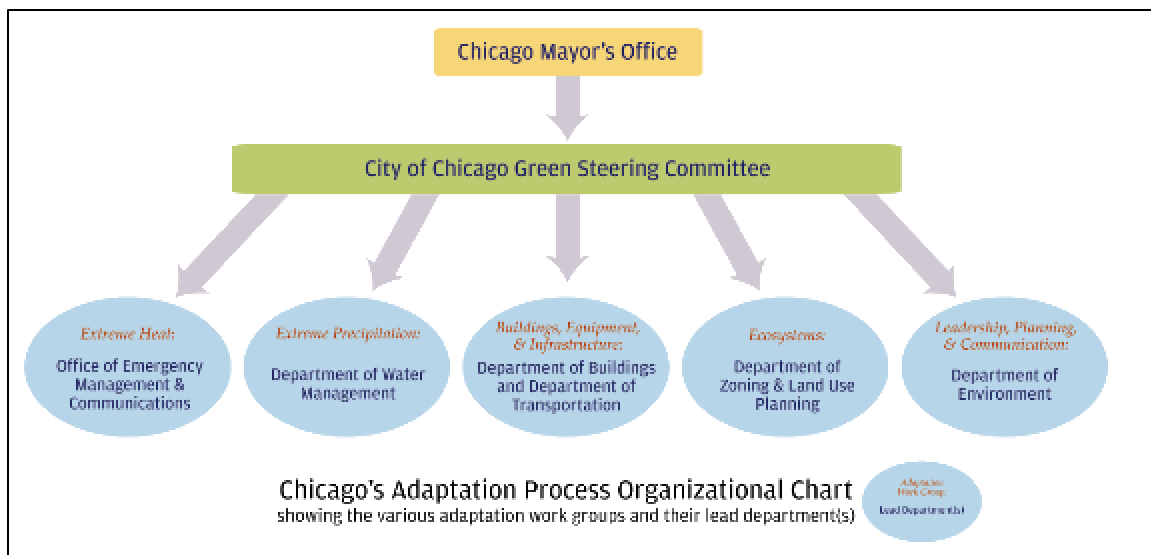
Vulnerability and risk assessments and adaptation planning to cope with impacts were components woven into the process coequal in status with getting reductions in greenhouse gas emissions.

Leadership of the Task Force was under the Mayor's Office and Department of Environment, but various City departments were given responsibility for developing key strategies and associated actions appropriate to their jurisdictions (see chart):

- Reduce vulnerability to extreme heat events. Lead: Office of Emergency Management and Communications



- Reduce vulnerability to extreme precipitation events. Lead: Department of Water Management
- Reduce vulnerability of buildings, infrastructure, and equipment to extreme climate conditions. Lead: Department of Buildings and Department of Transportation
- Reduce vulnerability to ecosystem degradation. Lead: Department of Zoning and Land Use Planning
- Leadership, Planning, Communications. Lead: Department of Environment



The two most innovative elements of the plan were analysis of economic impacts across various climate scenarios and sectors, and a prioritization scheme that scored actions on their suitability for early implementation and whether they addressed highest risk impacts.

Climate Impacts Report—Assessing climate impacts, vulnerabilities, and risks.¹ The report on projections and potential impacts was released in September 2008 along with the umbrella Chicago Climate Action Plan. The impacts research served as a means for the city to understand the problem, as well as to identify the benefits of acting in the near-term. The impacts report was authored by a team of researchers lead by the University of Illinois and Texas Tech with contributions from several other university, private sector, and Federal government researchers.

A number of key findings from the impacts report include: Chicago's climate is already changing as average temperatures have risen by 2.6° F since 1980. Fifteen of the last twenty years have seen above-average annual temperatures—and there are other alterations, including: winters warming by almost 4° F since 1980; decreases in winter ice coverage on Lake Michigan and smaller lakes in the area; a longer growing season, with flowering of trees and plants occurring a week earlier than during the previous century; several major heat waves, particularly those in 1995 (700 deaths attributed) and 1999; shifts in the water cycle, with less snow in winter, earlier spring melt; and a doubling in the frequency of heavy rainfall events over the last hundred years. The impacts report

¹Chicago Climate Change Action Plan—Climate Change and Chicago: Projections and Potential Impacts, Executive Summary, May 18, 2008. http://www.chicagoclimateaction.org/filebin/pdf/report/Chicago_climate_impacts_report_Executive_Summary.pdf



projects that it is extremely likely that global temperatures and temperatures over Chicago will warm further over coming decades based on expected greenhouse gas emissions.

Methodologically, the report drew on three climate simulation models, and a host of scientific and statistical downscaling techniques coupled with historic climate observations to evaluate past climate trends and project possible future changes specific to the Chicago area. The impacts assessment examined two alternative futures including a “higher” global emission scenario, assuming continued heavy fossil fuel use with atmospheric carbon dioxide levels rising from 385 parts per million (ppm) to almost 1000 ppm by the end of the century; and a “lower” emissions scenario assuming greater progress on mitigation globally, resulting in CO₂ levels rising to about 550 ppm by 2100. Consequent changes in temperature and precipitation were estimated and impacts were assessed on the public health system, water supply, ecosystems, infrastructure, and other key sectors.

*Economic risk report.*² The City of Chicago “Analysis of Economic Impacts from Climate Change analysis built off the preliminary findings of the Climate Impacts Report (i.e. on temperature and precipitation changes) assessing the economic risks to city infrastructure and services under the lower and higher emissions scenarios, by highlighting the benefits of action and costs of inaction. Sectors analyzed included buildings and infrastructure, transportation services, stormwater management, recreation, tourism, local food supply, and insurance.

Oliver Wyman, Inc., the risk management firm, estimated that the lower emissions scenario would entail approximately \$700 million in additional economic costs and \$2.5 billion for the higher scenario, accounting only for departmental functions. Costs were generally comprised of one-time or new ongoing impact to costs or revenue, or premature replacement costs. Costs were assessed across various city operations, activities, and investments (e.g. road, rail, and sewer repair and maintenance, police, trees and parks). Intra- and interdepartmental discussions were seen as essential for an effective analysis, feeding into processes for adaptation prioritization, planning, and capital budgeting.

PROJECTED CHICAGO CLIMATE IMPACTS

Heat

- Increase from 15 days of 90%+ per year to 35 (lower emissions scenario)/66 days (higher).
- Projected 30 days of 100%+ per year under higher emissions scenario
- Longer, more frequent, more intense heat waves
- Summer could feel like that of Atlanta, Georgia under the low scenario and that of Mobile, Alabama under the high scenario

Precipitation

- Increase in extreme rainfall events (i.e. > 2.5” in 24 hours)
- Increased risk of flooding

Public Health

- Increase in extreme heat-related impacts, including mortality
- Air quality deterioration
- More frequent vector- and water-borne disease outbreaks

Agriculture

- Shifts in growing conditions from current “hardiness zones” to conditions similar to those of Southern Illinois (lower emissions scenario) or Tennessee (higher).

Infrastructure

- Increased stress and risks to transportation systems and buildings, affecting budget and policy issues such as insurance rates, electricity demand, and building codes.

Source: City of Chicago

² To date, the full findings of the Economic Risk report have not been publically released; however, a summary of findings can be found in: Corporate Risk Case Study: City of Chicago Climate Change Task Force. Oliver Wyman, Inc. <http://www.chicagoclimateaction.org/filebin/pdf/report/CorporateRisk2008August5.pdf>



These two reports played significant roles in drawing attention to the issue and compelling action to launch the Chicago Climate Action Plan and implementation process, by defining the problem. They identified potential response paths, and provided a common basis for decision makers and managers to interact with each other and the public on why and how to move forward to adapt to emerging and future climate risks.

CHICAGO ADAPTATION STRATEGIES

Manage Heat: Update the heat response plan, focusing on vulnerable populations, complete further research into urban heat island effect and pursue ways to cool hot spots.

Pursue Innovative Cooling: Launch an effort to seek out innovative ideas for cooling the city and encourage property owners to make green landscape and energy efficiency improvements.

Protect Air Quality: Intensity efforts to reduce ozone-precursors through mitigation programs that reduce driving and emissions from power plants.

Manage Stormwater: Collaborate with the Metropolitan Water Reclamation District on a Chicago Watershed Plan that factors in climate changes and uses vacant land to manage stormwater.

Implement Green Urban Design: Implement key steps in Chicago's Green Urban Design plan to manage heat and flooding. These steps will enable Chicago to capture rain where it falls and reflect away some of the intensity of the sun on hot days.

Preserve Our Plants and Trees: Publish a new plant-growing list that focuses on plants that can thrive in altered climates. Also draft a new landscape ordinance to accommodate plants that can tolerate the altered climate.

Engage the Public: Share climate research findings with groups most affected—social service agencies, garden clubs, etc. Help individual households to take their own steps to reduce flooding and manage heat waves, such as installing rain barrels and back-up power for sump pumps and planting shade trees.

Engage Businesses: Work with businesses to analyze their vulnerability to climate change and take action.

Plan for the Future: Use the Green Steering Committee of City Commissioners to oversee City implementation efforts, and the Green Ribbon Committee of business and community leaders to assess how the plan is being implemented, recommend revisions, and report to the Mayor and all Chicagoans on our progress.

Source: <http://www.chicagoclimateaction.org/pages/adaptation/11.php>

*Risk prioritization.*³ MWH Engineering, Inc. took the information on physical and economic impacts, applied a scoring system based on impact likelihood and consequence, and produced a list of adaptation responses “strategies & tactics” (actions) to the greatest risks. The list was then prioritized based on costs and benefits related to adaptation, mitigation, and their overlap. Impacts with high likelihood and consequence were paid the most attention—i.e. with the riskiest outcomes,

³Further information can be found in: Chicago Area Climate Change Quick Guide: Adapting to the Physical Impacts of Climate Change (For Municipalities and Other Organizations), Edited by Julia Parzen, http://www.chicagoclimateaction.org/filebin/pdf/Chicago_Quick_Guide_to_Climate_Change_Preparation_June_2008.pdf



greatest potential economic impact, the most scientifically certain. MWH narrowed down 150 tactics associated with impacts to about 20 crucial actions. The firm selected those actions based on their multiple benefits, cost-effectiveness, risk, ease of implementation, and their potential to catalyze departmental action and compel public support. Key benefits included protecting health and safety, preventing damage to buildings and infrastructure, avoiding economic and city service disruptions, preserving ecosystems, and lowering city carbon footprint. Individual adaptation strategies and tactics were then scored on a scale of 1-5 ranking potential solutions as:⁴

- “Must Do/Early”: Tactics with high net benefit designed to prevent impacts with a short-term time horizon and with few impediments to implementation.
- “Must Do”: Actions with high net benefit, but potential impediments.
- “Investigate Further”: Those tactics that addressed longer-term impacts, but had strong benefit to cost ratios.
- “Watch”: Tactics that could have value in the long-term, but were high
- “No Regret”: Options that could deliver benefits greater than their costs, regardless of the extent of future climate change.

Examples of “Must Do” actions included tree planting with the goal of reducing the Urban Heat Island (UHI) effect; and revising air quality ordinances to better handle heat waves. An “Investigate Further” tactic had researchers create a thermal image map of the city to determine neighborhood or building “hotspots,” potentially indicating the locations of vulnerable populations during heat emergencies or where tree planting or green roofs could have greater benefit.

RISK ASSESSMENT SHOWCASE: URBAN HEAT ISLAND MAP



The urban heat island effect is caused by the tendency of hard, dark surfaces, such as roofs and pavement, to be measurably hotter than natural areas. It can raise a city's temperatures 4 to 10 degrees Fahrenheit on hot summer days. The City of Chicago conducted research on the impacts of the urban heat island effect. The City mapped Chicago's hottest spots and is targeting its cooling and energy efficiency efforts, such as the cool roofs and green roof grant programs, to those areas. In addition, the City overlaid a map of 311 and 911 calls regarding heat-related emergencies to assess the correlation between urban heat islands and heat stress-related issues.

Source: <http://www.chicagoclimateaction.org/pages/adaptation/49.php>

KEY PROMISING PRACTICES

Build on existing commitment. A key lesson was that many of the adaptation strategies and tactics developed could be implemented in parallel with Chicago's commitment to “green” infrastructure development. Green infrastructure goals were focused on improving stormwater management, reducing UHI, or encouraging green urban design (e.g. landscape & stormwater ordinances, green roofs)—also useful adaptive strategies.

⁴ Source: “Preparing for a Changing Climate: The Chicago Climate Action Plan's Adaptation Strategy”



Create an organizational process. Another key lesson was the importance of creating an organizational process for ongoing adaptation planning involving the Mayor's Office and City Departments. Success metrics and performance measures ensured accountability. Metrics were based on outputs (e.g. trees planted, gallons of water conserved, green and white roof square footage installed), impacts (e.g. number of sewer overflows reduced, or reductions in mortality during heat events), or quality of life measures (e.g. access to parks, continuity of City services).

Establish a hierarchy of responsibility. The City's "Green Steering Committee" now oversees several adaptation working groups, led by City departments, focusing on extreme heat and precipitation, impacts on buildings and infrastructure, and on ecosystems (see previous chart). Another working group focuses on leading the process and communications and outreach to the public. The adaptation working groups are in the process of implementing 39 adaptation tactics related to reducing UHI, drainage solutions, water conservation, energy management, urban forestry, and road and rail materials upgrades. Each activity is wrapped into a comprehensive inter-departmental action planning process covering personnel and outside collaborators, budget, timelines, and performance tracking. Additionally, Chicago has made provision for revising their adaptation planning process to incorporate new research and sources of information as they become available.

Pursue win-win strategies that combine mitigation and adaptation benefits. For example: *Chicago Trees Initiative.* The Chicago Trees Initiative (CTI) was launched in 2009 as a public-private partnership to analyze and expand Chicago's urban tree canopy with associated benefits in reduced UHI effect (including health benefits), improved stormwater runoff management, reduced electricity demand via shading, and carbon sequestration. A study determined that the structural value of these benefits from urban forestry in Chicago is \$2.3 billion and the total carbon sequestration rate is 25,200 tons/year equivalent or a value of \$14.8 million/year. During the past 15 years, Chicago planted more than 500,000 trees (adding 9,000 acres), achieving a City-wide tree count of 4.1 million trees. The City plans to plant approximately 1 million new trees by 2020, increasing its forestry cover 20%.

Green Urban Design Plan. The Green Urban Design (GUD) Plan was launched as a partnership among City agencies, nonprofits, and the private sector to help to better manage flooding (and heat impacts, discussed above). Rainfall filtration and capture is a key goal, using permeable pavements, rooftop and surface rain gardens, and green alleys. In 2007, 30 green alleys with permeable pavement and high-albedo concrete had been installed, along with over 200 catch-basins across the city.

Green alley design also encouraged homeowner involvement in disconnecting rain gutter downspouts from the sewer system, adding rain barrels to capture rooftop runoff, and adding backup power supplies to sump pumps to prevent basement flooding. The goal is to slow the rate of stormwater runoff onsite



In 2001, a 20,300 square-foot green roof was installed atop Chicago's City Hall as part of Mayor Daley's Urban Heat Island Initiative. When compared to an adjacent normal roof, City Hall's green roof was nearly 100 degrees lower, and contributed to \$5,000 in annual energy cost reduction, in addition to improving air quality and reducing stormwater runoff.

http://www.explorchicago.org/city/en/about_the_city/green_chicago/Green_Roofs_.html



to prevent localized flooding and to support the capacity of aging infrastructure to handle extreme precipitation events. Additionally, slower runoff and stormwater capture also reduces municipal pumping demand and electricity costs, meeting both mitigation and adaptation objectives.

A Green Alley Handbook⁵ was created to codify Best Management Practices and to encourage their spread. Over 2008-2009, 120 green alleys were installed converting 32,000 square feet of impermeable surface to permeable, and 55 acres of pervious surface and open space were created across the city—with 20% increase of pervious surface area per site over 265 building and construction projects. Additionally, over 775 miles of combined storm and sewer pipes were modeled to evaluate surface and basement flooding problem spots and identify cost effective solutions, including green infrastructure. In the area of water conservation, a five-year, \$620 million capital improvement project is saving an estimated 160 million gallons of water a day by reducing leaks. Because energy is used to pump, filter, distribute, and treat water for discharge, water conservation will help to decrease the 190,266 MWh of electricity the city consumes annually to pump and treat its water.

*Chicago Wilderness Action Plan for Nature.*⁶ In 2007, Chicago Wilderness (a regional alliance of 250 organizations connecting people and nature) established a Climate Change Task Force and strategic initiative, “to study and make recommendations on adaptation strategies and models for mitigation in order to address the local impact of climate change.” In 2008, the Task Force produced *Climate Change and Regional Biodiversity: A Preliminary Assessment and Recommendations* that fed into the Chicago Climate Action Plan. In June 2010, the CW Task Force released its Climate Action Plan for Nature, “the first to address issues of biodiversity conservation and climate change in the greater Chicago region.”

The final plan’s three main strategies were to:

- Advance climate research and recognition of the importance of land conservation in fighting climate change;
- Promote conservation practices that help local nature adapt to anticipated climate change impacts; and
- Marshal the collective expertise of Chicago Wilderness members to create local solutions that have global impact.

Specific adaptation strategies included:

- Assess the vulnerability of priority Chicago Wilderness terrestrial and aquatic conservation targets to climate change;
- Promote and maintain larger landscapes for biodiversity resiliency with connectivity of green space;
- Integrate stormwater management policy with information on how climate change is expected to impact the region; and

⁵ Chicago Green Alley Handbook. Chicago Department of Transportation.
<http://www.chicagoclimateaction.org/filebin/pdf/greenalleyhandbook.pdf>

⁶ <http://www.chicagowilderness.org/initiatives.php>



- Develop monitoring programs to evaluate adaptation strategies.

The Climate Action Plan for Nature informs the discussions of the city's adaptation working group on ecosystem degradation, and also those of the precipitation and heat extremes groups. For example, Goal 3 of the Plan for Nature recommends, "anticipate and plan for increased impacts to aquatic biodiversity from altered stormwater, groundwater, and drought regimes." The Plan argues that "direct linkages between stormwater management and biodiversity conservation need to be strengthened, especially related to climate change impacts...aquatic biodiversity needs to be a target of stormwater management in the Chicago Wilderness region." A lesson of these efforts is not only that Chicago recognizes that the management of urban infrastructure and ecosystems need to be integrated to successfully adapt to climate change, but also that it is essential to involve external and regional groups to provide both technical assistance and backing for adaptation planning processes, where the city is embedded in regional-scale issues like watershed and ecosystem management.

Written by Josh Foster, Center for Clean Air Policy

FOR MORE INFORMATION

Chicago Climate Action Plan (CCAP) website: <http://www.chicagoclimateaction.org>

CCAP Adaptation webpage: <http://www.chicagoclimateaction.org/pages/adaptation/49.php>

CCAP Research and Reports: http://www.chicagoclimateaction.org/pages/research___reports/8.php

Within the CCAP Research and Reports page, see in particular:

- Chicago Area Climate Change Quick Guide: Adapting to the Physical Impacts of Climate Change (For Municipalities and Other Organizations). Julia Parzen, March 2008
- Chicago Climate Change Action Plan-Climate Change and Chicago: Projections and Potential Impacts, Executive Summary. Katherine Hayhoe, Donald Wuebbles. May 18, 2008
- Corporate Risk Case Study: City of Chicago Climate Change Task Force. Oliver Wyman, Inc. July 2008
- Chicago Climate Action Plan—Strategy 5: Adaptation Report (excerpt from CCAP). September 2008
- Lessons Learned: Creating the Chicago Climate Action Plan. Julia Parzen. July 2009
- Preparing for a changing climate: The Chicago Climate Action Plan's adaptation strategy
- Journal of Great Lakes Research. Joyce E. Coffee, et al. August 2009

City of Chicago Analysis of Economic Impacts from Climate Change (Presentation). Craig Faris, Oliver Wyman, Inc. April 2008, [http://www.cleanairpartnership.org/pdf/\(3\)%20Chicago%20Economic%20Analysis%20-%20Oliver%20Wyman.pdf](http://www.cleanairpartnership.org/pdf/(3)%20Chicago%20Economic%20Analysis%20-%20Oliver%20Wyman.pdf)

Chicago Green Roofs website,
http://www.explorechicago.org/city/en/about_the_city/green_chicago/Green_Roofs_.html

Chicago Green Alley Handbook. Chicago Department of Transportation,
<http://www.chicagoclimateaction.org/filebin/pdf/greenalleyhandbook.pdf>



INTERVIEWS: MODELS FOR ADAPTATION PLANNING

The Science/Policy Connection in the Chicago's Climate Adaptation Planning

Climate science is at the core of sound adaptation planning. Climate projections allow cities to assess risks, help to make the case for adaptive actions to decision makers and the public, and provide a rational basis for prioritizing adaptation measures. The collaborations between government officials and scientists on local adaptation planning can be complicated because of differences in the organizational culture of the public and science sectors. There are also differences in how each sector understands uncertainty and the sorts of questions each is trying to address. The City of Chicago collaborated closely with scientists throughout its climate action planning process (which integrates mitigation and adaptation) and continues to do so in implementing the plan. The interviews here, with a city adaptation practitioner and the scientist who led Chicago's impact assessment, provide valuable lessons about the science-policy connection and what it takes to make it fruitful.

**JOYCE COFFEE, DIRECTOR OF PROJECT DEVELOPMENT, POLICY AND RESEARCH
CITY OF CHICAGO DEPARTMENT OF ENVIRONMENT (ADAPTATION LEAD)**

ISC: Why did Chicago take a science-based approach in its climate action plan?

JC: The Mayor's office called together a Climate Change Task Force, which guided the whole development of the Climate Action Plan. This group was comprised of big thinkers: heads of foundations, corporate leaders, scientists, government appointees. They argued that the first step should be an impact analysis. Other cities have gone directly to mitigation plans. Since our big thinkers acknowledged the need for adaptation very early, they emphasized the importance of a scientific impact analysis. To me, as an outsider at the time, it seemed quite unusual for a city to do that given that Chicago is not at risk for sea level rise and drought. So, I thought, how brave to spend resources on generic impacts, though they are meaningful impacts to us. Science really drove all of our analyses and planning, not just the adaptation aspects of the plan.

Although competition with other cities often motivates us to do this or that, it wasn't true in this case, as New York City and others had not done impact analyses at the time. And it wasn't a matter of having to convince anyone to use science. Instead, the Task Force found resources to follow through on its determination that a scientific impact analysis was important. The Joyce Foundation provided some seed funding, which convinced other foundations do the same. Soon we had enough money to hire scientists—Don Wuebbles and a team of researchers—to do the impact analysis.

ISC: What were the benefits of a science-based approach?

JC: We really benefited from the science early on, in terms of guidance and giving us some momentum to mitigate and adapt to climate change. We made the investment in time, money, and



thought of making sound research the foundation of the Chicago Climate Action Plan, in way we could be proud of. The science also helped us prioritize. A consulting firm, Oliver Wyman, did risk assessment work for us for free because it was the first time they had looked at city risk with relation to climate, though it's more common now. They took the climate change impact analysis that Don Wuebbles conducted and put a risk and economic lens on it; then MWH Global, an engineering firm, took all that information and looked at how to prioritize what to act on, and how. Without a scientific foundation, we wouldn't have been able to prioritize. Like any city would understand, a list of 100 action items *needs* to be prioritized.

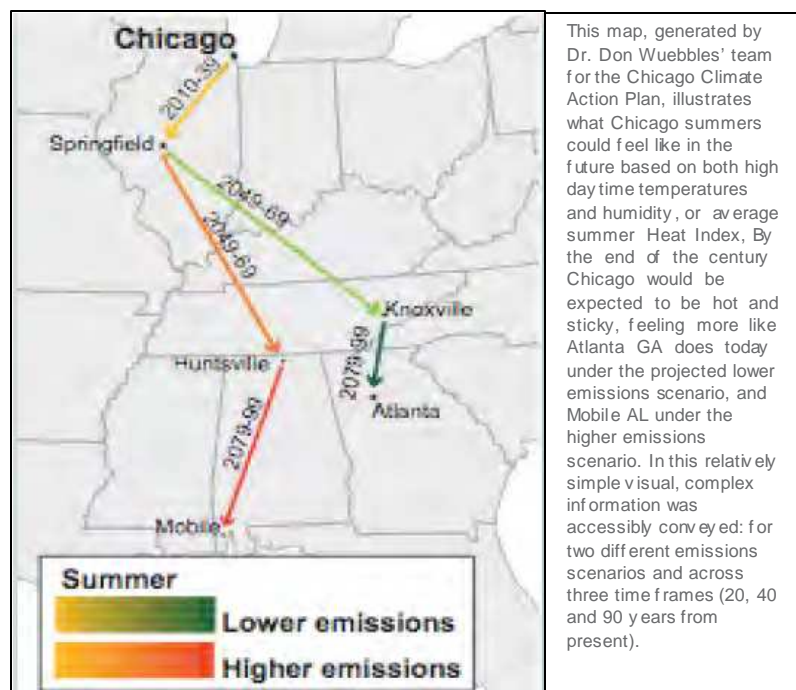
The science really helped us with the complexity of taking action. It gave us a methodology for grouping – a roadmap – for our adaptation activities: extreme heat, extreme precipitation, ecosystem changes, and building/infrastructure/equipment changes. Now if you look at the strategies in the actual plan, it's not in the four categories that I mentioned, because there were political motivations to the framing. For example, extreme heat translated to air quality. But when we, as staff, think about our work, the original categories are really helpful.

Of course, it wasn't just the science that convinced people to act. The issue of climate in 2007 was very new to most thought leaders in city government. It wasn't spoken about at the federal level, although our Mayor was pretty vocal about taking action on climate change. When Oliver Wyman went to the departments and told them about the various impacts on infrastructure, the ecosystem, and water, they just didn't think climate change would affect them. They didn't think they needed to put air conditioning in schools, or that rail lines would buckle. It was more of an iterative process. Getting the science was the initial step to do the risk assessment, and then we got popular press. Finally a couple of years later we had some extreme weather events, and when we met to discuss them, people said, these *are* getting more common, and we thought, "Wow, it really didn't take that long for people to come around."

ISC: How did Chicago use the scientific information from the impact assessment to engage stakeholders?

JC: The way we conveyed the science helped grab the attention of the public and thought leaders, by making climate change impacts real to people. For example, the projected increase in number of 100 degree days, and the mapping of climate change impacts [see graphic]—though controversial—really helped. Making climate impact real to people helped make the plan easier to implement.

ISC: How did the city manage the uncertainty of climate projections?



JC: One point of controversy was exactly how much Chicago's climate would change. Would it look



like that of Atlanta? Or like Mobile, Alabama? But to us, they're both very different from Chicago. Even the low emissions scenario had the climate moving. That was alarming; it got people's attention. I mean, we talked about this as a chance to improve quality of life, economic development, and air quality; but the point was, in spite of everything we could do, the climate is going to change. So that helped us make the case for adaptation and resilience.

ISC: What do you find challenging about engaging with climate scientists?

JC: There is major emphasis on climate science from the federal level. I'm in fairly good company with other implementers when I say: we know enough to act. I struggle to see how the questions the atmospheric scientists are asking are useful to what I need—I need answers from materials science, civil engineering... It's a paradox, because even as I say that, I'm sure the atmospheric scientists need to ask *those* questions in order to answer the questions *I'm* asking. For example, when I hear scientists say they need to know the exact degree change in temperature of the Great Lakes, I say, really? But, I do realize they need that information to calculate the new frost depths that will impact how deep our water lines need to be laid.

I talked to some land managers the other day, who said they think scientists aren't giving them the answers they need. While scientists think land managers aren't listening. But I do think we are at a crucial point in the conversation between scientists and implementers, and we are communicating much better with each other now than before.

I also think the questions are, in a word, hard. We would really like our National Weather Service data to reflect predictions of future events, rather than just past historical context, so we can better manage extreme heat events, for example. But predictive weather work is incredibly complicated and controversial.

ISC: What have you learned about working with scientists from this experience?

JC: Don Wuebbles and Katherine Hayhoe [atmospheric scientists at the University of Illinois and Texas Tech University, respectively] are interested in getting their science understood. They give presentations and interact with Congress and so forth. What they do allows me to do what I do. Even if a lot of pressure builds up between practitioners and scientists, it's been a huge benefit working with them.

I use their science for my own means, even if it's slightly uncomfortable for them. For example, I think our increase in potholes has to do with the changing freeze/thaw cycle, resulting from slightly



Chicago potholes made the local news in 2008. Such events can be opportunities for dialogue on climate impacts. Image credit: <http://abclocal.go.com/wls/story?section=news/team&id=5941279>

warmer winters. So if the Department of Transportation asks me, why do we have so many more potholes than we use to? I say, I don't know for sure, but read this impact assessment and think about what it might mean. I use the science to help us keep our hand on the wheel to remain an adaptable City.

It's also been nice being able to call on the scientists for a refresher. Just lately the Green Ribbon Committee, which now oversees the implementation of the Climate Action Plan, said, We need a new impacts analysis, what you have is three years old now. When



we contacted Katherine, it turned out that she has continued her Chicago-area research. Her findings have refined our understanding in a way that the Green Ribbon Committee is comfortable with.

ISC: What advice would you give to scientists who want to work with policymakers on local adaptation planning?

JC: It's a matter of listening on both sides. Generally the climate question has been in the atmospheric science realm. What I need now are sociologists, the material scientists who can tell me about permeable asphalt, scientists who can do cross-disciplinary questioning. Climate change demands all of us to step outside the comfort zone of our expertise.

ISC: What advice would you give to other cities seeking to engage scientists on adaptation planning?

JC: I don't have any directives, but maybe look for scientists that they think can *hear* them. Ask, Can they understand the questions a layperson is asking? Can they work in a cross-disciplinary way? Are they able to share information in a way that is comprehensible to, and actionable by, the client? For example, maps are great communication tools, but scientists aren't that comfortable with that method because they illustrate points conclusively, whereas science demands that a level of doubt remain in any thesis.

DONALD WUEBBLES, ATMOSPHERIC SCIENTIST AND PROFESSOR, UNIVERSITY OF ILLINOIS

ISC: Tell us a little about your experience as a scientist informing Chicago's plan.

DW: This is one of many times my research has informed policymakers⁷. I consider that an important part of what I do. I personally like to produce science that can have a direct relationship to the needs of policymakers.

ISC: How do you produce science so that it does relate directly to the needs of policymakers?

DW: I take the latest science from the global models and analyze it for a range of future scenarios under a range of assumptions. I then use different techniques to get things down to a local scale, to get local means and variabilities. Further analyses can then give answers to questions of stakeholders and policymakers. For example, what's the likelihood of getting events like the Chicago heat wave of 1995? What's the likelihood of heavy precipitation days? What happens to the efficiency of vehicles if the highway melts [i.e. the asphalt becomes more fluid in the heat]? My methodology involves lots of interactions with stakeholders to get at issues they are concerned about, and then translating, relating, the science to their needs.

ISC: Why did the city engage you?

DW: The Chief Environment Officer in the Mayor's Office at the time, Sadhu Johnston, approached

⁷ Among many of his contributions, Dr. Wuebbles developed the concept of Ozone Depletion Potentials, used in the Montreal Protocol and the U.S. Clean Air Act, and co-authored development of the concept of Global Warming Potentials used in the Kyoto Protocol and most carbon trading applications. He has also led several national and international climate and impact assessments.



us because they were well aware of previous things we had done. After we did the Great Lakes Climate Impacts Assessment, I did some outreach with the City of Chicago and city businesses on the output. Because Sadhu was at both of the meetings we did with the city, both the findings and his knowledge of me played a significant role in Chicago's policies into the future.

ISC: How did the complexity and uncertainty inherent in climate science create difficulties in your collaboration with policymakers?

DW: It was important that we be clear about how the uncertainties affect the analyses we were doing. We explained those uncertainties many times and how the uncertainty was being represented in the results we were providing. The complexity was in our work at all stages, but we have a lot of experience in how to take complexity and translate it in simpler ways for use by non-experts. We keep jargon out, and reduce the science to something people can relate to, like how a changing climate will affect Illinois.

The public can be confused about what global warming means, so based on a technique I developed about 10 years ago, I created a graphic that shows how Illinois will move over time to be in the summer more like the middle of Texas [see graphic on previous page]. So for example, compare Chicago to Atlanta, to Mobile, Alabama. People can grasp that. So how we represent complexity is to look for techniques so that people can relate what it means to their lives, to things they're used to dealing with.



Chicago in summer heat and smog during the July 1995 heat wave.

Image credit: Gary Braasch, *Earth Under Fire*

ISC: What advice would you give other climate scientists who work with city government officials?

DW: Establishing a strong dialogue with city officials and other related stakeholders is essential to success. We can learn from each other.

ISC: What advice would you give government officials about working with climate scientists on local adaptation planning?

DW: The science is important—establish a dialogue with high quality scientists who are cutting edge at understanding the issues. Recognize that using past weather and climate is not adequate in planning for the future.

Thanks to Joyce Coffee and Don Wuebbles. Edited by Elaine Wang, Institute for Sustainable Communities



Miami-Dade County's Adaptation Planning Process

Miami-Dade County (MDC) can be awarded early adopter status for their leadership role in adaptation in part because of their extreme vulnerability to climate change (e.g. from potential sea level rise; hurricanes), but also because the county tuned in early to worldwide efforts to mitigate global warming. MDC was a founding member of the Climate Protection Campaign of the International Council of Local Environmental Initiatives (ICLEI) in the early 1990s.⁸ Experience and research over the years had shown the real physical and economic threats from extreme weather events (e.g. Hurricane Andrew, 1992) to which the Miami-Dade region was subject.

Greater vulnerabilities were expected under various climate change scenarios. An adaptation planning process from 2003-05 led to the establishment in 2006 of the Climate Change Advisory Task Force (CCATF). The CCATF, comprised of a cross section of 150 county government, university, private sector, and citizen experts, released a set of adaptation recommendations in early 2008 (revised in 2010). Although many of the adaptation recommendations have yet to be implemented, MDC has innovated in other ways that have advanced the process. MDC's GreenPrint sustainability planning initiative, modeled after New York City's PlaNYC, has embraced climate adaptation as a key activity. MDC has also worked with the State of Florida on coastal adaptation planning, as well as with Federal government agencies on sea level rise impact assessment. Finally, MDC has entered into the pioneering Southeast Florida Regional Climate Change Compact with Broward, Monroe, and Palm Beach counties. The compact is a first in the U.S. regional agreement among counties to collaborate to mitigate and adapt to climate change including requesting federal support for climate adaptation projects (see related case study).

THE CONTEXT

Climate change impacts in Miami-Dade County. As a low-lying coastal community, Miami-Dade County is particularly vulnerable to the potential impacts of climate change: sea level rise, higher storm surge, and more frequent and intense hurricanes. According to a recent study, Miami currently is ranked first out of 20 cities in the world in total assets exposed to coastal flooding during a 1 in 100 year storm surge event. Miami's current exposed asset value is estimated at over \$416 billion, and this is projected to increase to over \$3.5 trillion by the 2070s. The County's sole source of drinking water, the Biscayne Aquifer, is extremely susceptible to saltwater intrusion as sea level rises, which is one of the first, most significant "creeping" impacts from climate change. Additionally, as sea level rises, the Everglades are expected to be inundated, making flooding a concern from the south, east, and west areas of the County.

"Miami-Dade County, Florida, is a coastal community where land elevations are measured in inches above sea level. Even the least perceptible change in the sea levels poses a serious threat to this community."

—NATACHA SEIJAS
Miami-Dade County Commissioner

*from Ask the Climate Question: Adaptation to
Climate Change Impacts in Urban Regions*

Adaptation planning. Miami-Dade County (MDC) has been working to address the broader implications of climate change over the last two decades. In the realm of mitigation, MDC established a Long-Term Urban CO₂ Reduction Plan in 1993, successfully enabling the reduction of

⁸ Harvey Ruvin, the MDC executive, was one of the founding members of ICLEI-US and still sits on their Board.



over 34 million tons of carbon from 1993 to 2005, through building energy efficiency, introduction of a county hybrid vehicle fleet, and using methane gas from sewage treatment plants. This effort was connected with MDC's early membership (1991) in ICLEI-Local Governments for Sustainability and their global Cities for Climate Protection (CCP) Campaign launched in 1993. The CO₂ Reduction Plan and involvement with ICLEI established a platform upon which to build the County's later climate change adaptation efforts. In 2007, MDC joined ICLEI's Climate Resilient Communities (CRC) project on local climate adaptation as one of five pilot cities in the United States.

A HISTORY OF HURRICANE IMPACT MITIGATION

Miami-Dade County is a national leader in hurricane preparation, evacuation and response. Notably, the county has used Federal Emergency Management Agency (FEMA) funds to strengthen numerous buildings against the ravages of hurricanes and severe storms. At Florida International University in North Miami, for example, the county used FEMA funds to harden the third floor of the campus library into a hurricane shelter, helping to ease the burden on evacuation routes. They have also used the money to help protect vulnerable communities. For example, in downtown Miami, the county spent \$99,000 in FEMA Hazard Mitigation Grant Program funds to install heavy-duty hurricane glass at one homeless shelter and \$158,000 to install perforated metal storm panels at another.



(from *Ask the Climate Question: Adaptation to Climate Change Impacts in Urban Regions*)

ICLEI members began discussing climate change adaptation in the wake of the Intergovernmental Panel on Climate Change Third Assessment Report (2001) that highlighted the 2° C rise in global average temperature that were inevitable regardless of actions to mitigate. ICLEI's global membership established adaptation as a strategic priority in 2006. Given MDC's vulnerabilities to climate change, Harvey Ruvin, the County's chief executive, wanted to lead a local adaptation planning effort that would become a model for the other ICLEI cities world-wide. He had already identified many key issues, opportunities, and important stakeholders in the County during the work on mitigation. This practical experience was helpful in establishing the first ad hoc committee on climate adaptation, which met from 2003-05, and the Climate Change Advisory Task Force (CCATF), which met through 2006.

In July of 2006, The Miami-Dade Board of County Commissioners passed Ordinance #06-113 that established the Miami-Dade Climate Change Advisory Task Force (CCATF). The CCATF made MDC one of the first communities in the United States to begin adaptation planning. Harvey Ruvin chaired the CCATF, a group of twenty-five appointed members comprising a diverse, multidisciplinary and highly knowledgeable group of individuals representing various sectors of the community. Members served in an advisory role for both climate change mitigation and adaptation planning. The CCATF was intended as a multi-year process that would evolve based on current science about anticipated climate change impacts, the viability of available adaptation measures, and the availability of funding over time for implementation.

The CCATF worked through an open process with over 150 stakeholders participating in six sub-working groups. These sub-committees included:



- *Science Committee*—compiled pertinent scientific information and analysis, and advised on potential impacts given certain sea level rise scenarios.
- *Built Environment Adaptation Committee*—provided recommendations for adaptive management of the built environment to predicted climate impacts.
- *Natural Systems Adaptation Committee*—provided recommendations for adaptive management of natural systems to predicted climate impacts.
- *Economic, Social and Health Adaptation Committee*—developed recommendations for adaptive management of economic, social and health impacts of climate change.
- *Intergovernmental Committee*—linked the Task Force and committees to various regional, state, local, and national organizations to help bring in resources and identify opportunities for funding.
- *Greenhouse Gas Reduction Committee*—recommended ways to reduce greenhouse gas emissions in the short- and long-term.

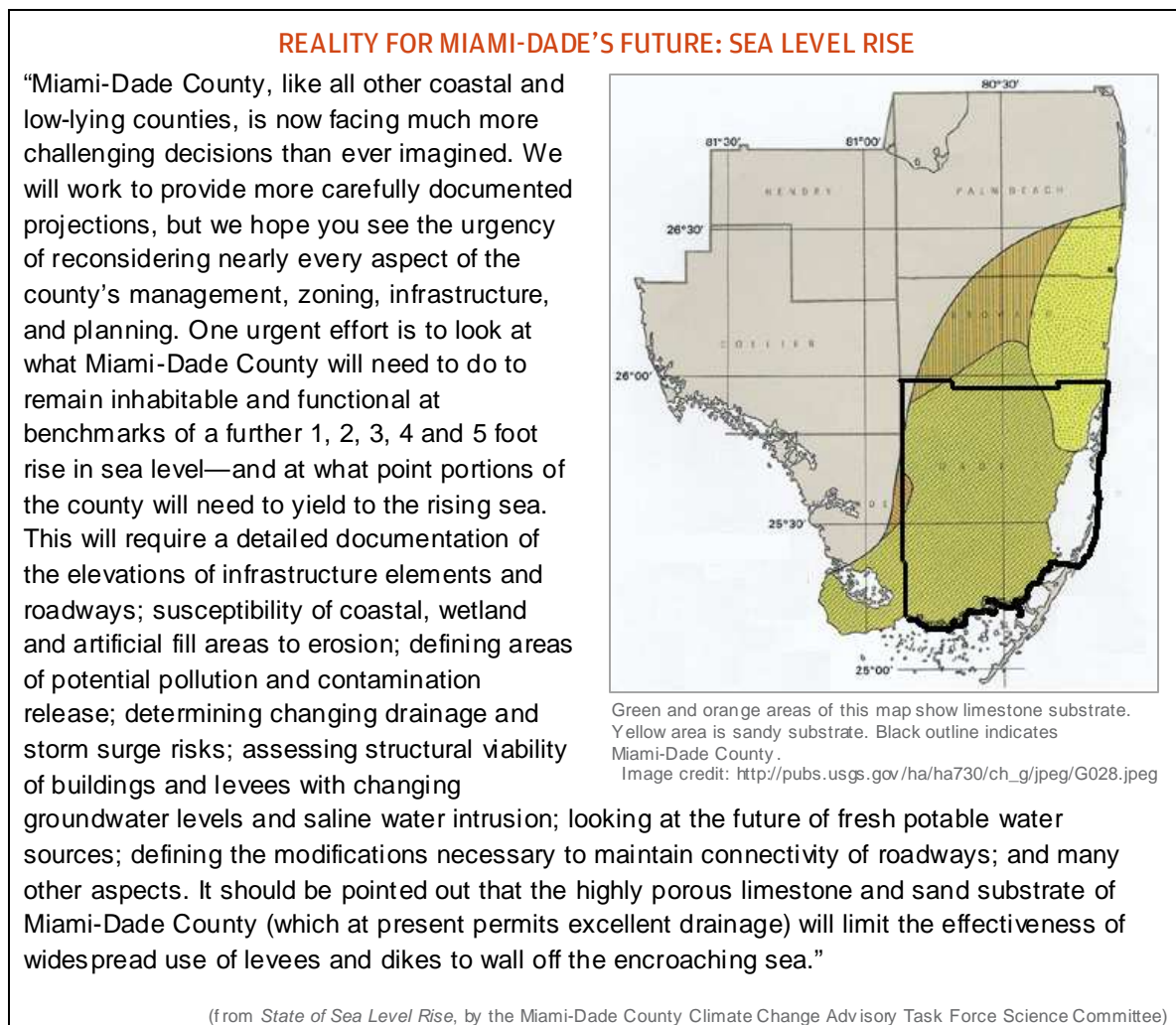
The working groups included scientists from several local universities and regional organizations, individuals from local businesses and environmental organizations, citizens, and staff from numerous County departments (see below).

CLIMATE CHANGE ADVISORY TASK FORCE SUB-WORKING GROUPS MEMBERSHIP	
Local Businesses <ul style="list-style-type: none"> • Building & Architecture • Engineering • Law • Agriculture 	Universities <ul style="list-style-type: none"> • University of Miami • Florida Atlantic University • Florida International University • Rollins College
County Departments <ul style="list-style-type: none"> • Public Works • Solid Waste Management • Transit • Parks and Recreation • Ports • Health • Budget • Housing • Emergency Management • Environmental • Planning & Zoning • General Services Administration Fleet & Facilities Management • Water & Sewer • Capital Improvements • Miami-Dade County Public Schools 	Environmental Organizations <ul style="list-style-type: none"> • Tropical Audubon Society • Urban Environment League of Greater Miami • Everglades Defense Council • Florida Wildlife Federation Regional Organizations <ul style="list-style-type: none"> • South Florida Regional Planning Council • South Florida Water Management District • Everglades National Park • Greater Miami Chamber of Commerce • Miami-Dade League of Cities • National Oceanic & Atmospheric Administration • Utilities (Florida Power and Light)



The Science Committee released a Statement on Sea Level Rise (SLR) in September 2007 (revised in January 2008) urging incorporation of sea level rise into adaptation planning, and directing the County to conduct higher resolution LIDAR coastal mapping, to better determine future risks from sea level rise under different climate change scenarios.

After a “First Report” in 2007, the CCATF delivered its “Second Report and Initial Recommendations” to the Miami-Dade Board of County Commissioners on Earth Day, April 22, 2008. In accordance to the Science Committee’s recommendations, one of the first projects undertaken was LIDAR mapping to create more detailed and accurate coastal maps for sea level rise scenarios. The intention was to identify priority areas and vulnerable infrastructure. Over the last two years, the Task Force has continued to meet to implement recommendations from the Second Report. The CCATF is also exploring ways to evaluate the cost of action and inaction on adaptation.



The updated 2010 report emphasizes the importance of green jobs, land conservation, greater public outreach and education, further engagement with local governments in the region, and active involvement in the South Florida Regional Climate Change Compact. A matrix of recommendations and system for tracking milestones was also instituted. However, many of the original adaptation recommendations from 2008 have yet to be implemented.



Institutionalized sustainability. The Miami-Dade established the Office of Sustainability (OSS) in 2007 to enhance environmental quality and livability in the County. Given the potential impact of climate change on sustainability goals, the OSS and ICLEI are working together to blend climate adaptation into the MDC community GreenPrint program. GreenPrint is an overarching effort to integrate sustainability into local planning. GreenPrint activities include application of a Sustainability Toolkit and tracking sustainability milestones with regard to climate change. In implementing GreenPrint, MDC is intentionally following the example of New York City's PlaNYC on sustainability. The GreenPrint website highlights local best practices in adaptation, including those of other cities inside and outside of the Urban Leaders network; makes linkages to MDC's plans for comprehensive development, open space, water-use efficiency, transportation, aesthetics, solid waste, and street trees. The website also contains an extensive catalogue of other local and state adaptation activities.

MDC is working on the mapping of sea level rise with federal and state agencies, including the National Ocean Atmospheric Administration (NOAA) Coastal Services Center and NOAA Coasts project, the NOAA National Hurricane Center, and the South Florida Regional Planning Council. MDC is also working with the U.S. Geological Survey on subsurface flow impacts from sea level rise (e.g. salt water contamination of aquifers). Taking a comprehensive inventory of county assets and infrastructure vulnerable to climate change impacts, particularly sea level rise, represents a significant proposed next step.

Partnerships across governance scales. Miami-Dade County is a member of a groundbreaking regional agreement to tackle climate change including climate adaptation. The Southeast Florida Climate Change Compact was signed by Miami-Dade, Broward, Palm Beach, and Monroe counties in October 2009 (for more information, see related case study).

Miami-Dade also is a member of the Florida Climate Change Adaptation Technical Working Group, which focused on developing state-level recommendations on adaptation as part of the Governor's Action Team on Energy and Climate Change. The Working Group's findings and recommendations were included in the October 2008 release of the Florida Acton Team Final Report to the Governor, including a chapter on adaptation strategies and a technical appendix detailing the Group's policy recommendations. The recommendations in this report are intended to guide climate action in Florida and shape the state's legislative policies and initiatives.

Next steps. MDC will continue to work with NOAA on a more refined county-wide case study on climate impacts, including developing regional climate planning scenarios. The County will complete local and regional climate action plans, complete GreenPrint, and begin implementation of adaptation actions. Finally, MDC will continue to stay apprised of national and international developments with other local governments working on climate adaptation planning and implementation.

FOOD FOR THOUGHT

Use successful mitigation efforts to set the stage for adaptation. Although Miami-Dade County recognized its vulnerability to climate change early, the county couched adaptation in efforts to mitigate climate change (i.e. a focus on preventing impacts first), until there was the willingness to face the unavoidable consequences. MDC leadership, committed to adaptation, recognized that mitigation efforts would prepare local stakeholders and create an institutional mechanism for



adaptation. MDC also recognized that simply maintaining momentum on climate change mitigation would eventually create a more robust adaptation process.

Create a stakeholder engagement process that represents all those who are at risk. MDC established adaptation components of the Climate Change Advisory Task Force well before most local governments were even thinking about adaptation. Among their key innovations were ensuring they had a strong scientific basis for adaptation planning by involving local universities and other experts. MDC also recognized early that climate change would impact all parts of government and the private sector, so it sought to engage a wide array of stakeholders. These were given equal say as that of county managers. MDC began the process with a set of initial dialogues, and maintained transparency throughout the process; the County created a publicly accessible database of information about climate change impacts and adaptive solutions, which included information about the status of adaptation milestones.

Make good use of available tools and models. MDC benefited from its involvement with ICLEI-USA, which provided valuable information and tools. MDC has also sought to emulate New York City's PlaNYC, which brings a comprehensive sustainability focus to the adaptation planning process. MDC additionally engaged the State of Florida as the Governor geared up his own adaptation planning process.

Account for the regional nature of adaptation planning. MDC was a founding member of the first regional, county-level agreement to mitigate and adapt to climate change – the Southeast Florida Regional Climate Change Compact. Given that climate change impacts must often be managed on a regional scale, this experiment in regional climate governance could be an important model for city and county governments across the country.

Written by Josh Foster, Center for Clean Air Policy

FOR MORE INFORMATION

Miami-Dade County Government Climate Change website under the Department of Environmental Resources Management, http://www.miamidade.gov/derm/climate_change.asp

MDC Climate Change Advisory Task Force (CCATF) website,
<http://www.miamidade.gov/derm/climatechange/taskforce.asp>

Within the CCATF website, see in particular:

- Committees
- Useful Web-links
- Recommendations & Status (updated June 2010)
- 2010 Annual Report and Supplemental Recommendations

MDC GreenPrint—Sustainability Planning website,
<http://www.miamidade.gov/greenprint/home.asp>



New York City: Assessing Climate Risks

The work of the New York City Task Force on Climate Change Adaptation represents a comprehensive model for assessing climate risks to critical infrastructure and developing a plan for action. While other U.S. cities have undertaken similar risk assessment and adaptation planning efforts, New York's process, with its sole focus on critical infrastructure, differs in its rigor and scope. A group of leading climate scientists provided localized climate projections to inform the risk assessment. And the task force comprised not only city agencies, but state government, authorities, and private companies that maintain or control critical infrastructure in the city.

THE PROCESS

Getting started. Mayor Michael R. Bloomberg launched the New York City Task Force on Climate Change in August 2008 with the goal of developing a roadmap for adaptation. The task force would take a science-based approach to assess the risks from climate change to critical infrastructure. Scientists would provide climate projections, which each organization on the task force would use to assess the magnitude of risk on particular infrastructure (e.g. roadways, bridges, tunnels, airports). The risk assessment would allow stakeholders to prioritize risks and plan adaptation measures accordingly. In announcing this initiative, the mayor cited scientific data that suggested more frequent and powerful storms would threaten coastal areas and that intense heat waves would strain the electricity grid. Addressing the city's resilience to climate change accounted for one of 127 initiatives in the city's PlaNYC, a climate and sustainability plan.

Localizing climate projections. A group of scientists from local academic institutions, along with engineering, legal and insurance experts formed the New York City Panel on Climate Change (NPCC) to advise and provide localized scientific data to the task force. NPCC used 16 state-of-the-art global climate models to generate a single set of future projections under three emissions scenarios (low, medium, high), based on varying assumptions about population and economic growth, the introduction and sharing of new technologies, and land-use changes, which could manifest over the rest of the century. The Rockefeller Foundation funded the initial work of the panel with a grant of \$350,000.

A challenge for the NPCC was to generate local climate projections that accounted for the technical complexity and the uncertainty inherent in climate science, while providing government officials and private company executives with information that they could readily use to conduct the risk assessment. NPCC sought to reduce the uncertainty by distilling projections from 16 climate models, by averaging those projections over thirty-year periods and reporting ranges of climate change rather than absolute values. The NPCC also reported the likelihood of each climate projection in a similar way to the one used by the International Panel on Climate Change (IPCC)⁹:

⁹ Climate Risk Information: New York City Panel on Climate Change, Feb. 17, 2009
http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf



Virtually certain	> 99% probability of occurrence
Extremely likely	> 95% probability of occurrence
Very likely	> 90% probability of occurrence
Likely	> 66% probability of occurrence
More likely than not	> 50% probability of occurrence
About as likely as not	33-66% probability of occurrence

Extreme Event	Probable Direction Throughout 21 st Century	Likelihood ¹
Heat Index ²	▲	Very likely
Ice storms/ Freezing rain	▲	About as likely as not
Snowfall frequency & amount	▼	Likely
Intense Hurricanes	▲	More likely than not
Nor'easters	Unknown	
Lightning	Unknown	
Downpours (precipitation rate/hour)	▲	Likely
Extreme winds	▲	More likely than not

This table from *Climate Risk Information*, by the New York City Panel on Climate Change, shows the probable direction of change over the 21st century, as well as the likelihood associated with the qualitative projection. For these variables, which can have large impacts on infrastructure, quantitative projections are not possible due to insufficient information.

Source: http://www.nyc.gov/html/planyc2030/downloads/pdf/ny_c_climate_change_report.pdf

Conducting the risk assessment. In February 2009, NPCC's Climate Risk Information report offered the task force simple climate projections for the mean annual changes in air temperature, precipitation, and sea level rise. The period 1971-2000 served as the baseline for the projections across three timeframes: the 2020s, 2050s, and 2080s. E.g., the task force learned that the central range of sea level rise was 2-5 inches in the 2020s and 12-23 inches in the 2080s. The NPCC also reported on quantitative changes in extreme events: heat waves and cold events; intense precipitation and drought; and coastal floods and storms. E.g., the NPCC projected that the probability of 1-in-100 year flood reoccurring would increase to once every 65-80 years in the 2020s, and once every 15 to 35 years by the 2080s.

Each organization represented in the task force used the climate projections to conduct a risk assessment in two phases. They first identified particular critical infrastructure that was at-risk and the likelihood this infrastructure would be affected by a projected climate impact. Task force members characterized the likelihood of occurrence as low, moderate, or high. In the second phase, the task force members evaluated the magnitude of consequence of each climate impact affecting the infrastructure, using criteria having to do with the effects on the agency's budget, the regional economy, safety, and the environment.

The task force used a specially designed spreadsheet, with a drop-down menu for each criterion, to characterize the magnitude of consequence as low, medium or high. The spreadsheet then averaged the selected values to categorize the risk for each specific infrastructure. Depending on both the likelihood of occurrence and the magnitude of consequence, the spreadsheet automatically yielded one of three possible categories of risk: "develop strategies" if the risk were high; "evaluate



further/develop strategies” if the risk were moderate; and “watch” if the risk were low. Task force members could manually change the final automatic selection if there were additional information that affected the risk categorization and for which the spreadsheet could not account.

The process for evaluating both the likelihood of occurrence and the magnitude of consequence of climate impacts engendered a discussion among varied teams of specialists—planners, engineers, facility managers—within the organizations that made up the task force. As a result, staff members, whose work did not ordinarily involve climate issues, were educated about climate change adaptation and the need to account for climate projections in the maintenance, planning and construction of infrastructure.

Yet the reliance on staff to evaluate risk at times also worked counter to the goals of the project by creating pressure to understate the danger. If staff characterized risks as high, they knew that they could be exposing their organizations to public pressure to reduce the risk. And in some cases, the ways to minimize that risk—for example retrofitting of infrastructure or new construction—were costly. So at least some of the participants in the process were hesitant to assert the full extent of the risk because doing so would bypass the organizational and political processes that ordinarily determine planning decisions.

Identifying adaptation strategies. Once the task force members completed the risk assessment process, they had to identify adaptation strategies. For this part of the process, the City of New York expanded the spreadsheet in ways that helped task force members consider the timeframe of the projected climate impact, any other stakeholders who would be affected by the implementation of a strategy, the estimated costs of adapting, and the extent to which funding was available. Strategies could range from low-cost ones, such as using temporary flood barriers (e.g. sand bags) before a storm, to expensive retrofits, such as constructing permanent flood walls, or raising facilities in low lying areas.

For each of the task force members, this risk assessment and the associated strategies are meant to create a foundation for the study, planning, and implementation of adaptation strategies. In addition, the City of New York plans to publish a report based on the entirety of the work that the task force performed, which will serve as blueprint on adaptation for the city as a whole. The report would be revised over time as new scientific data becomes available and stakeholders advance their adaptation plans.

FOOD FOR THOUGHT

Take a science-based approach. Working with world-class scientists lent the process credibility and helped task force members overcome any skepticism about the legitimacy of the climate projections. In addition, the NPCC presented information in ways that helped the task force make sense of the uncertainty associated with the projections, enabling risk assessment and prioritization.

Engage a wide array of stakeholders. The City’s goal to develop an adaptation plan for critical infrastructure made it necessary to put together a cross-jurisdictional task force, including private firms. The task force reflected the multitude of organizations that own, operate and maintain infrastructure in the city. Engaging all of these organizations ensured that they would all use the same data to plan for the future. Moreover, the involvement of numerous organizations in this effort seemingly made it safer to identify and communicate publicly about risks. The task force setting also facilitated coordination in cases where implementing an adaptation strategy affected another



organization.

Provide risk assessment tools that are easy to use. The spreadsheet that the task force used for the risk assessment, with clear criteria and drop-down menus, helped to systematize and simplify the process. This tool helped the task force isolate each factor in assigning risk, from likelihood of occurrence to magnitude of impact and timeframe, and to take a uniform approach in assessing the entire network of infrastructure in New York.

Written by George Sarrinikolaou, Institute for Sustainable Communities

FOR MORE INFORMATION

Climate Change Adaptation in New York City: Building a Risk Management Response,
<http://www.nyas.org/Publications/Annals/Detail.aspx?cid=ab9d0f9f-1cb1-4f21-b0c8-7607daa5dfcc>

Climate Risk Information for New York City,
http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf

Contact: Aaron Koch, Policy Advisor, New York City Mayor's Office of Long-Term Planning and Sustainability, 212-788-2644, akoch@cityhall.nyc.gov

CASE STUDY: MODELS FOR ADAPTATION PLANNING

Toronto Climate Adaptation Planning

Toronto's approach to climate adaptation planning has been an evolution with intent, driven, in part, by provincial and federal interest in climate adaptation and "triggering" effects of severe weather impacts in 2005. Additionally, Toronto consulted with cities already pursuing climate adaptation in Europe and the United States to stimulate its process.¹⁰ Toronto built momentum for climate adaptation policy and action on a tradition of "green" infrastructure development, heat event response plans, interest in sustainable energy use, and emerging global and regional concerns about climate change impacts. A rapid, city-wide, transparent climate adaptation planning process was initiated in mid-2007. The process culminated in April 2008 with the release of Ahead of the Storm: Preparing Toronto for Climate Change, Development of a Climate Change Adaptation Strategy. The strategy included a broad climate impacts risk assessment and recommendations for development of short and long-term climate adaptation strategies. Currently, Toronto is in an ongoing process of following-up recommendations from the Ahead of the Storm report.

TORONTO'S RATIONALE FOR ADAPTATION

"Projects that incorporate climate change considerations may be more costly than those that don't, but the costs of not protecting against climate change could ultimately be much higher [emphasis added]."

(from "Ahead of the Storm")

¹⁰Including London, Rotterdam, New York City, Chicago, and cities of the C40—Climate Leadership Group (<http://www.c40cities.org>)



THE CONTEXT

As a “greening” city, Toronto has a history of linking urban environmental and sustainability goals with managing weather impacts. Since 1999, Toronto Public Health has coordinated a Hot Weather Response Plan. A heat alert is called when there is a 65 percent likelihood of excess mortality (i.e., more deaths than would be expected on a normal day) and an extreme heat alert when the forecast likelihood of excess mortality is at least 90 percent. The alert system is designed to ensure those most at risk from heat impacts—poor, elderly, or ill residents, and children—receive warnings. In 2003, Toronto’s City Council approved a 25-year stormwater management plan for dealing with surface water quality and quantity, sewage overflows, and habitat protection. The plan encouraged the use of so-called green solutions. By 2005, Toronto was using alternative infrastructure practices, including green roofs, downspout disconnection and rainwater collection programs, basement flood prevention, green open space, wetlands and riparian protection, and urban forests to better manage stormwater and preserve regional water quality. However, the city had not yet considered potential climate change impacts in a strategic manner as part of these kinds of initiatives.

Getting started. During the summer of 2005, Toronto had 41 days where the average temperature was over 30°C (86° F), almost three times the average number of hot days between 1961 and 1990. The City issued 8 heat alerts and 18 extreme heat alerts during those 41 days, limiting the number of heat-related deaths. Toronto Public Health estimates that, in an average year, extreme heat results in 120 premature deaths, and it predicts that heat-related deaths will double by 2050 and triple by 2080 based on climate change scenarios.

During particularly intense rainfall in August 2005, a storm washed out part of Finch Avenue, and caused flash flooding to creeks, rivers and ravines, eroding stream-banks and damaging trees and parks. More than 4200 basements were flooded. The damages to public and private property were estimated at \$400-500 million—the most expensive storm in Toronto’s history. The Finch Avenue washout alone cost \$40 million to repair.



Finch Ave washout in Toronto during the flood of August 19, 2005. Image credit: <http://jane-finch.com/pictures/flood2005.htm>



Unlike other cities that have conducted local climate change vulnerability assessments (e.g. Chicago, New York City), Toronto inferred local impacts from available global and North American sources. Toronto then connected anticipated impacts across different climate emissions scenarios with actual occurrences of extreme weather including the 2005 events above. Putting this knowledge in the context of federal and provincial climate impacts assessments helped to bolster the case that climate adaptation planning was a necessity. From this body of evidence, the city began to link the kinds of actions that were prudent and viable for adapting to climate change. Toronto has not yet accomplished a finer-grain assessment of climate change impacts that would allow the city to draw a straight line between impacts on the city and what could be done about them. However, a risk assessment process is currently underway to create downscaled climate impacts models, develop a climate risk screening tool, and implement climate risk benchmarking pilot projects.

Emerging climate change planning process. In June 2006, the City Council directed the Toronto Environment Office (TEO) to develop sustainable energy plans for Toronto for short (to 2010), medium (to 2015) and long (to 2030) time frames. In 2007, Toronto began to formalize its response to climate change, linking actions on green infrastructure, services, and sustainable energy use.

In February 2007, the City Parks and Environment Committee directed the Toronto Environment Office to initiate a process entitled, “Change is in the Air: Toronto’s Commitment to an Environmentally Sustainable Future – A Framework for Public Review and Engagement.” After a series of administration and public meetings this process culminated in a June 2007 release of “Climate Change, Clean Air and Sustainable Energy Action Plan: Moving from Framework to Action, Phase 1.” The Climate Action Plan was approved by the City Council in July 2007 with three overall strategies: mitigation, adaptation, and strategies that have both mitigative and adaptive benefits.

The Climate Action Framework directed that “a plan be established to reduce the negative impacts of unavoidable changes to climate that are already underway, including: extreme heat; more intense storms; floods and droughts; damaging insects; and newly introduced diseases.” It also specified that the adaptation plan should identify strategies for city operations and the community; identify action steps including budgets; ensure response mechanisms (such as the heat alert response program); identify the requirements for data collection and management and modeling; and incorporate stakeholders’ input, including all relevant city agencies.

Subsequently, TEO created the Toronto Adaptation Steering Committee to develop the adaptation strategy. The Steering Committee was comprised of all city

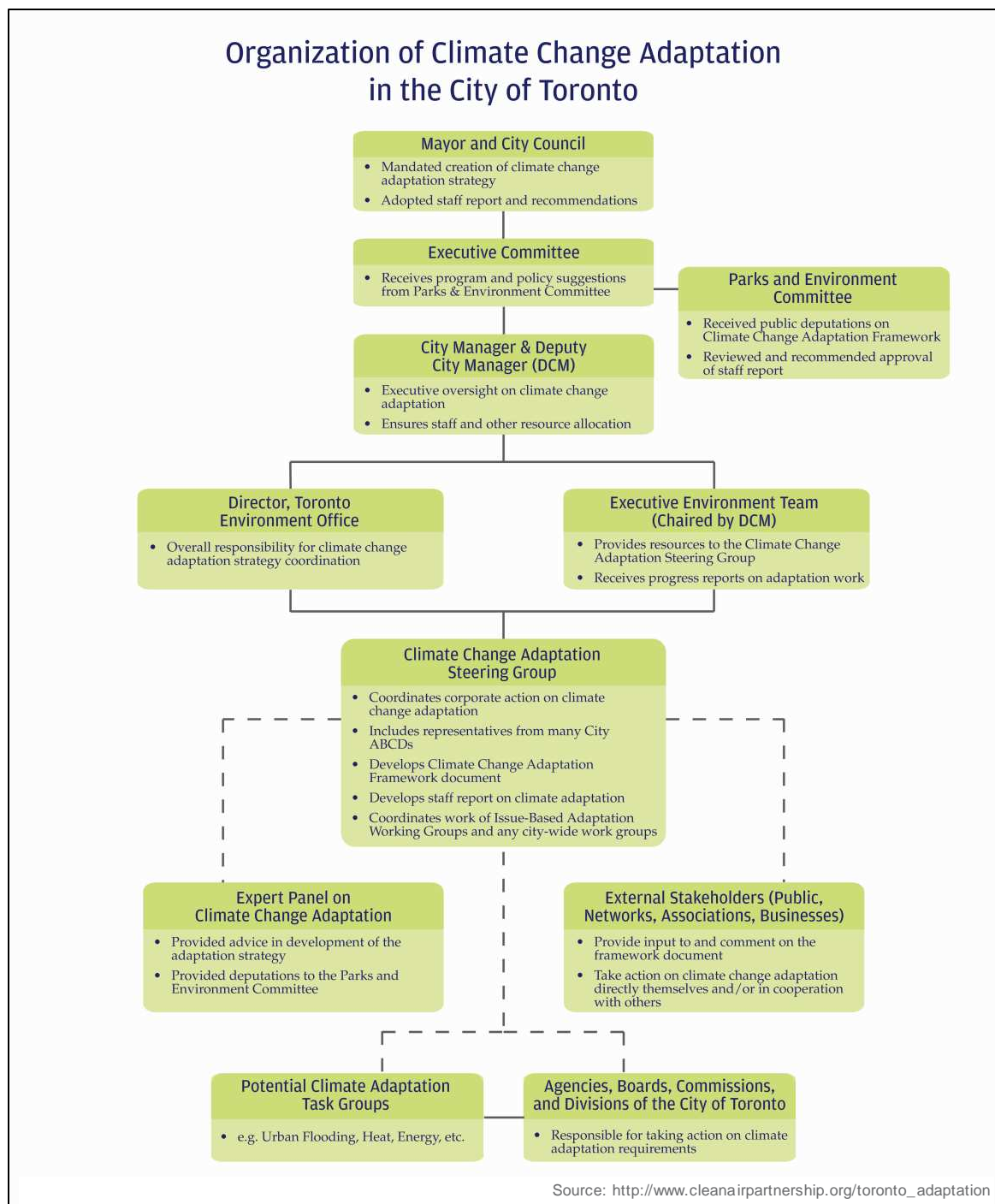
TORONTO’S PROCESS FOR DEVELOPING A COMPREHENSIVE ADAPTATION STRATEGY

1. Create the internal mechanisms and processes for the development of a comprehensive, multi-year adaptation process
2. Engage the public, business and other stakeholder groups
3. Incorporate climate change adaptation into city policies and high level plans
4. Use best available science to analyze how climate is changing locally and what the future is likely to bring
5. Use this analysis to identify Toronto’s vulnerabilities to climate change
6. Conduct a risk assessment to identify priority impacts requiring adaptation action
7. Identify and assess adaptation options to reduce the risk
8. Develop and implement climate change adaptation strategies
9. Monitor climate change, evaluate the effectiveness of adaptation initiatives in protecting the City from continuing changes, and adjust strategies when necessary.

(from Ahead of the Storm)



departments identified as vulnerable to climate change. Besides executive and departmental coordination, other tasks included communicating with stakeholders and the public about the adaptation planning process via a series of Forums through spring 2008, and engaging provincial and Federal governments. The Clean Air Partnership (CAP), a local non-profit, also served on the Committee providing technical assistance on adaptation planning. Their involvement was, in part, based on a series of reports they had authored on urban vulnerability to climate change, including “A Scan of Climate Change Impacts on Toronto” (2006), “Cities Preparing for Climate Change: A Study of Six Urban Regions” (May 2007), and “Time to Tackle Toronto’s Warming” (June 2007).



In January 2008, the City Parks and Environment Committee (CPEC) heard from six Canadian adaptation experts about expected climate change impacts for Toronto and recommendations for how to prepare. CPEC saw presentations related to climate impact vulnerabilities on infrastructure, watershed management, environmental, economic and social systems, and public health as well as insurance risks. The meeting was held in the context of the Ontario Expert Panel on Climate Adaptation, which had been recently created to make recommendations about province-wide adaptation strategies. Additionally, the Climate Change Impacts and Adaptation Division (CCIAD) of Natural Resources Canada was in the process of developing a report “From Impacts to Adaptation: Canada in a Changing Climate 2007”, reflecting advances made in understanding Canada’s vulnerabilities to climate change during the previous decade.

*Ahead of the Storm.*¹¹ In April 2008, Toronto released *Ahead of the Storm: Preparing Toronto for Climate Change, Development of a Climate Change Adaptation Strategy* in collaboration with the Toronto Adaptation Steering Committee, and the Clean Air Partnership. The report presented a detailed account of the environmental changes that would take place as a result of climate change and comprehensive explanations of how they would affect the city. It provided a rationale for incorporating adaptation into City of Toronto policies, programs and activities, described programs and actions already underway in the city that provide protection from climate change suggested short-term actions; and recommended a process for developing a long-term strategy.

With a number of resilience efforts underway, the report recommended two concurrent streams of activity: (1) a series of short-term actions to build on existing programs that would reduce vulnerability to climate change in specific areas, and (2) a nine-step process that would guide the development of a comprehensive long-term climate change adaptation strategy for the city. The city

“While stopping the release of greenhouse gases remains our first priority, it’s apparent that some degree of climate change has already begun. In developing an adaptation strategy, the City of Toronto is taking steps to prevent negative impacts associated with the realities of a changing climate while proceeding with actions designed to combat further change.”

—MAYOR DAVID MILLER
(from *Ahead of the Storm*)

identified a set of short-term actions for 2008-09 that had already been funded, including future climate prediction modeling to improve information on climate impacts, vulnerability and risk assessments for city operations, and an analysis of where green roofs could be most effective (which informed a subsequent new Green Roof by-law). The plan for developing the long-term comprehensive adaptation strategy included a three-year timeline and an emphasis on the importance of prioritizing risks. The plan detailed a nine-step process for creating the comprehensive strategy and included recommended actions for each step of the process.

The city also partnered with the Canadian Institute for Catastrophic Loss Reduction (ICLR) to develop an extensive online “municipal Reference Collection on Climate Change Adaptation,” complete with more than 300 issue-specific documents.¹²

¹¹ *Ahead of the Storm: Preparing Toronto for Climate Change, Development of a Climate Change Adaptation Strategy, Highlights & Report.* Both include a complete list of immediate and long-term adaptation activities and strategies. For a summary list of adaptation recommendations see REPORT pgs. 40-42. <http://www.toronto.ca/teo/adaptation.htm>.

^{*}See also Lowe, Josh Foster, Steve Winkelman. Ask the Climate Question: Adapting to Climate Change Impacts in Urban Regions, Center for Clean Air Policy, Washington, DC June 2009. http://www.ccap.org/docs/resources/674/Urban_Climate_Adaptation-FINAL_CCAP%206-9-09.pdf

¹² www.toronto.ca/teo/adaptation.htm



In April 2009, the city collaborated under the Toronto Urban Climate Change Network (TUCCN),¹³ to convene the event, “Not Business As Usual”, A Forum on Infrastructure and Climate Change Adaptation.” The purpose was to foster integrated approaches to bolstering the resilience of infrastructure. The forum goals included exploring the potential climate impacts on critical infrastructure, how to assess risks and impact (particularly from extreme events), best practices, innovative means to develop the adaptive capacity of infrastructure, and areas of greatest need for further research and decision support.

The TUCCN was originally formed to increase cooperation on adaptation research and advocacy in the metro region, by promoting professional cooperation, research, and policy development necessary for decision makers, and identifying research priorities based on the needs of decision makers.¹⁴

FOOD FOR THOUGHT

Toronto has learned a number of lessons during its adaptation planning process similar to other adaptation oriented cities in the United States. Among the crucial components are mayoral and engaged city leadership, a reliable source of scientific and technical information, buy-in from city departments, secured sources of funding, and transparent public engagement and capacity building leading to the elaboration of a comprehensive strategy. Toronto immediately saw that emissions mitigation and adaptation activities would be complementary (e.g. green roofs, urban forestry, water conservation; see Venn diagram on p. 43). Additionally, Toronto recognized the value of incorporating climate adaptation into already ongoing green infrastructure projects as a way to integrate climate adaptation from the start into city operations (see sidebar). Unlike some of their counterparts in the United States, however, Toronto was able to take advantage of preexisting provincial and federal activity on climate adaptation. Additionally, Toronto reinforced its adaptation activities via the Toronto Urban Climate Change Network.

RECOMMENDATIONS FOR INTEGRATING ADAPTATION INTO EXISTING PROGRAMS

Toronto's Ahead of the Storm Report cited examples of existing City programs, plans, strategies, and assessment procedures that reduce vulnerability to climate change, and recommended that these include considerations and explicit goals for adaptation from now on:

- Toronto's Official Plan
- Toronto's Heat Alert System And Hot Weather Response Plan
- Transit City Plan
- Construction Programs
- Wet Weather Flow Master Plan
- Basement Flooding Protection Subsidy Program
- Flood Warning Forecasting
- Emergency Plan
- Green Roof Pilot Incentive Program
- Urban Forest Management Plan
- Parks, Forestry and Recreation Strategic Plan
- Green Parking Lots design guidelines
- The Deep Lake Water Cooling (Enwave), Peaksaver, and Keep Cool Programs (Toronto Hydro)
- Green Development Standard
- Better Buildings Partnership
- Environmental Assessments of New Capital Projects
- Long Term Fiscal Plan
- Green Economic Sector Development Strategy

The following lessons learned are adapted from *Climate Change Adaptation in the City of Toronto: Lessons for Great Lake Communities* by Jennifer Penney of the Clean Air Partnership.¹⁵

¹³ Toronto Urban Climate Change Network (TUCCN): TUCCN is a network comprised of Toronto's leading government, academic, and environmental organizations involved in the research of climate change specific to the Greater Toronto Area.

¹⁴ From <http://www.tuccn.org>

¹⁵ http://www.cleanairpartnership.org/toronto_adaptation. Also see, “Climate Change Adaptation Planning in Toronto: Progress and Challenges,” Jennifer Penney and Thea Dickinson, Fifth Urban Research Forum, June 2009, <http://www.cleanairpartnership.org/files/Climate%20Change%20Adaptation%20Planning%20in%20Toronto.pdf>



The importance of diverse champions. Initial and continuing political and executive support is essential for the initiation, development and implementation of a comprehensive climate change adaptation strategy. Champions may emerge independently at the political or executive level, but more often, it takes a determined effort by staff or by external organizations that raise awareness of climate change impacts, make available credible information in plain language, and actively lobby for the development of an adaptation strategy.

Don't reinvent the wheel. Consult an available guide on climate change adaptation planning for local governments, to help in developing a clear process and avoid "reinventing the wheel." [See resource list for examples.]

Assign, empower, and develop staff. Establish an interdepartmental team to work on climate change adaptation. Ensure that the team has:

- A clear mandate for its work
- Participation by key policy and program staff
- Allocation of staff time
- A regular meeting schedule
- A reporting structure that ensures appropriate and timely responses from decision makers
- Training and capacity building opportunities
- Smaller working groups that can take on analysis and planning for key risk areas

"Toronto has taken advantage of shared knowledge and experiences from other Urban Leaders partner cities in the U.S., incorporating the best practices and most successful organizational approaches we have observed."

- DAVID MACLEOD
Climate Adaptation Lead,
Toronto Environment Office

It takes time and a concerted "inreach" effort to have the key departments understand what adaptation is, why it is necessary, and to get them to incorporate climate change into their thinking and planning. An explicit strategy of communications and engagement with staff is advisable.

Organize internal workshops and learning events to get staff familiar with the concept of climate change impacts and adaptation.

Finally, maintain a strong and focused climate change adaptation team to oversee the work of integrating adaptation strategies into different policies and departments.

Leverage existing resources. Take advantage of the growing number of external conferences, workshops, seminars and webinars to introduce staff to issues related to climate change impacts and adaptation.

Ensure availability of on-line resource/reference collections to become more informed about existing knowledge and best practices.

Initiate or join the efforts of others in the region to get a better handle on climate trends and regional climate projections.

Great Lakes communities should make use of the deep layer of existing expertise in the region on climate impacts and adaptation. Mobilize external resources and expertise by:



- Identifying local experts who would be willing to provide information and advice
- Establishing an Expert Panel or Advisory Committee with expert participation to provide input into vulnerability assessments and adaptation planning
- Inviting experts to comment on draft plans and strategies
- Utilizing local experts to conduct workshops or participate in working groups and contribute to building the capacity of staff
- Participating in available peer networks such as the Alliance for Resilient Cities

Build on what you have. Identify the actions that the municipality is already taking that reduce the risk of current extreme weather, and that are likely to provide some protection from future climate change. This can provide a foundation on which to build a stronger, more comprehensive adaptation strategy.

Starting a vulnerability assessment may be easier than you think. Use available resources to undertake a quick initial scan of vulnerabilities for your community to increase awareness of climate change impacts and the need to take action on adaptation. A review of recent extreme weather events, as reported in the local press, may provide useful indicators about impacts, costs and vulnerabilities. Later in the adaptation process, a more specific and detailed analysis of vulnerabilities may be necessary.

Engage stakeholders early. Prepare and release an issues paper or framework document that outlines the expected impacts of climate change and how to prepare for them, in order to engage staff, Council members and the public in thinking about the issues and the decisions that need to be made. If possible, engage a broad range of staff and other potentially affected stakeholders in reviewing and contributing to the document. *Ahead of the Storm* provides an outline that may be useful for other communities to use in developing their own framework documents.

The role of outreach. Education is necessary to inform the public about local climate change impacts and to help them understand adaptation actions that can be taken at the level of the individual household, and in the municipality. Public consultation on climate change adaptation strategies can work both to increase awareness of local climate change impacts, and also to build support for necessary actions.

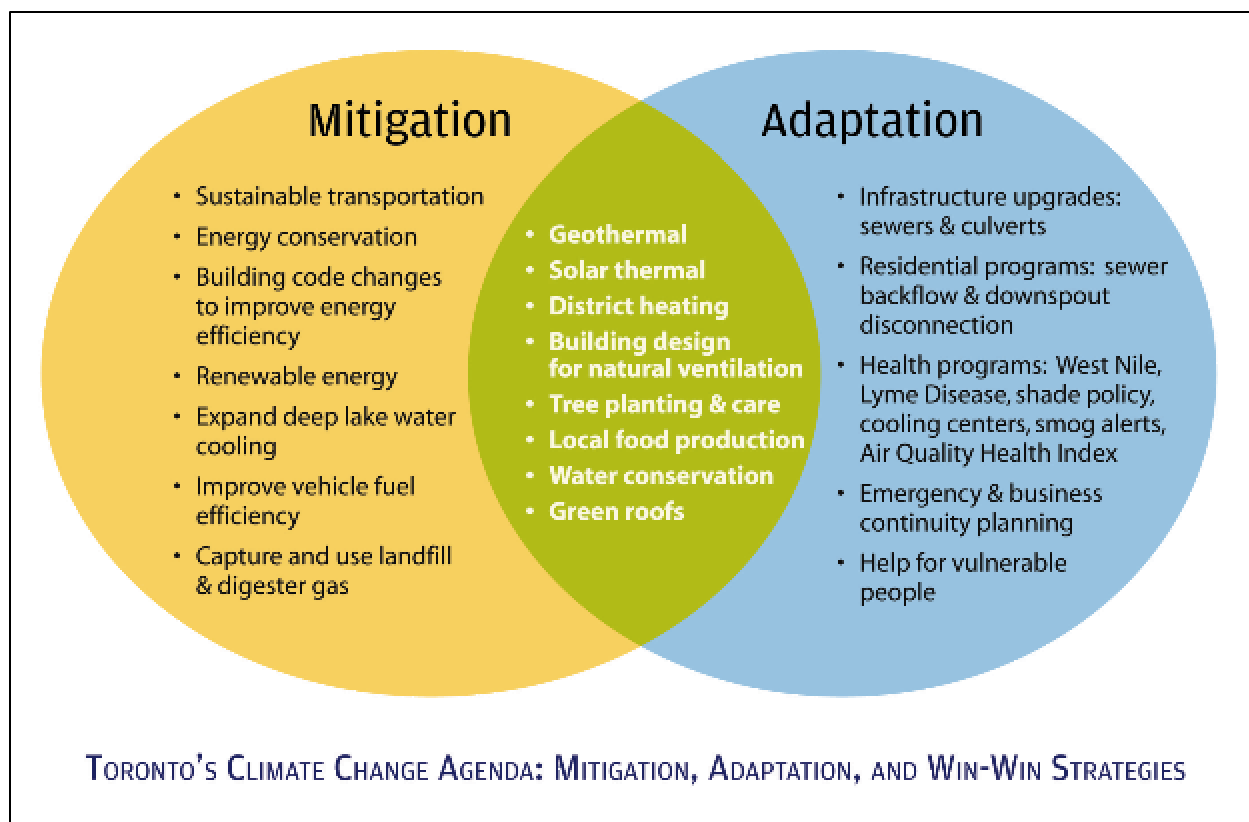
Consider multiple time frames. Adaptation planning needs to include short-term actions, longer-term planning processes, the implementation of upstream preventive measures and emergency preparation and response. Adaptation planners need to consider how to include and balance this range of activities.

It takes time to develop a municipal adaptation plan. Some short-term actions can be identified and acted on fairly quickly, but these should not substitute for longer-term assessment of vulnerability, priority risks and the effectiveness of different adaptation options.

Pursue no regret strategies. The goal of overall environmental sustainability should inform climate change adaptation strategies. Adaptation options and strategies that increase greenhouse gas emissions or contribute to other environmental and social problems should be avoided.

Written by Josh Foster, Center for Clean Air Policy





FOR MORE INFORMATION

Toronto's Climate Change, Clean Air and Sustainable Energy Action Plan website, <http://www.toronto.ca/changeisintheair>

Within the Action Plan website, see in particular:

- Toronto's Sustainable Energy Plan, June 2007
- Highlights/Moving from Framework to Action Phase 1, June 2007
- Staff Report, Moving from a Framework to Action, June 2007

Toronto Climate Change Adaptation website, <http://www.toronto.ca/teo/adaptation.htm>

Within the Adaptation website, see in particular:

- Climate Adaptation Experts Meeting website (includes presentations)
- *Ahead of the Storm* documents
- Climate Change Adaptation Staff Report, May 2008

Toronto's Steps towards Climate Change Adaptation, Presentation for Alliance for Resilient Cities (ARC), January 20, 2009, David T. MacLeod, Toronto Environment Office.
<http://www.cleanairpartnership.org/webinar9/Toronto.pdf>

Toronto Urban Climate Change Network (TUCCN) website, a network comprised of Toronto's leading government, academic, and environmental organizations involved in the research of climate change specific to the Greater Toronto Area.
<http://www.tuccn.org>



Related Toronto Programs:

- City of Toronto Environment Portal website,
<http://www.toronto.ca/environment/index.htm>
- Toronto Heat Alert System website,
<http://www.toronto.ca/health/heatalerts/alertsystem.htm>
- Toronto Hot Weather Response Plan website,
http://www.toronto.ca/health/heatalerts/beatheat_program.htm
- Hot Weather Response Plan Update 2006—Staff Report,
<http://www.toronto.ca/legdocs/2006/agendas/committees/hl/hl060227/it013.pdf>
- Toronto Water website, including water efficiency and stormwater programs
<http://www.toronto.ca/environment/water.htm>
- Toronto Wet Weather Flow Master Plan website,
http://www.toronto.ca/water/protecting_quality/wwfmmp
- Toronto Urban Forestry website,
<http://www.toronto.ca/environment/trees.htm>
- Toronto Green Buildings website,
<http://www.toronto.ca/environment/buildings.htm>

Third Party Reports

- A Scan of Climate Change Impacts on Toronto, Clean Air Partnership, 2006.
http://www.cleanairpartnership.org/pdf/climate_change_scan.pdf
- Time to Tackle Toronto's Warming: Climate change adaptation options to deal with heat in Toronto, Clean Air Partnership, June 2007.
http://www.cleanairpartnership.org/reports_time_to_tackle
- Climate Change Adaptation Planning in Toronto: Progress and Challenges, Jennifer Penney and Thea Dickinson, Fifth Urban Research Forum, June 2009.
<http://www.cleanairpartnership.org/files/Climate%20Change%20Adaptation%20Planning%20in%20Toronto.pdf>
- Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewer Overflows Project Design and Direction, Toronto Case. Natural Resources Defense Council, June 2006. <http://www.nrdc.org/water/pollution/rooftops/contents.asp>

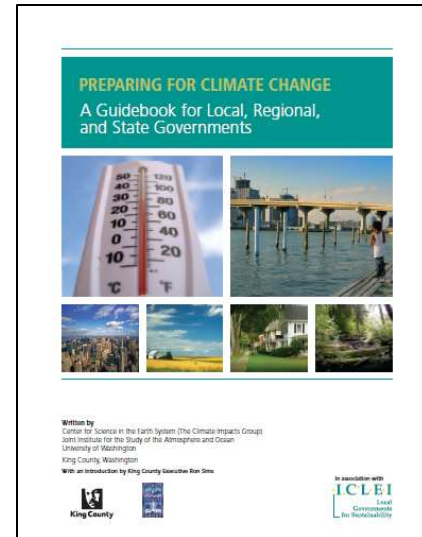


Overview of “Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments”

THE RESOURCE

As more and more cities grapple with how best to prepare for the local impacts of climate change, many can benefit from targeted assistance in developing a comprehensive, local adaptation plan. To help guide local leaders through the process, the Climate Impacts Group at the University of Washington has, in partnership with King County and the International Council for Local Environmental Initiatives (ICLEI), developed “Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments,” a step-by-step guide to the various stages of adaptation planning. ICLEI’s guidance was based on its experience with local and regional governments administering the Climate Resilient Communities Program.

The Guidebook is organized around ICLEI’s Five Milestones process for climate adaptation:



Milestone 1: Initiate a climate resiliency effort. While this is the first step in the process, it is perhaps the most difficult. Milestone 1 requires that a city identify future climate impacts and make adaptation to such impacts a government priority. To make progress, policymakers must build broad support and a coalition of stakeholders around an adaptation planning process. A team must be put in place to develop and implement an adaptation plan. Without this foundation, the next steps in the process would be extremely difficult, if not impossible.

Milestone 2: Conduct a climate resiliency study. To complete the second milestone requires analyzing specific, local climate change impacts. The Guidebook lays out the process for conducting a vulnerability study—identifying which systems are most sensitive and least adaptable to various impacts of climate change—and for conducting a risk assessment, which incorporates the likelihood of impact to vulnerable systems. The vulnerability study and risk assessment provide policymakers with information that will help them prioritize planning areas.

Milestone 3: Set preparedness goals and develop a preparedness plan. Step three guides the development of a concrete climate adaptation plan that is based on identified priority planning areas. The process begins by establishing a vision of a climate resilient community, which includes dimensions such as public awareness, effective community collaboration, and the adaptive capacity of built, natural, and human systems. The planning team should then set goals within each priority planning area, and identify individual actions to achieve those goals. The vision, goals, and actions are crafted into a comprehensive adaptation plan.



Milestone 4: Implement the preparedness plan. To implement an adaptation plan requires a number of specific tools and mechanisms; step four identifies a few of these, including zoning regulations and building codes, community partnerships, and infrastructure development.

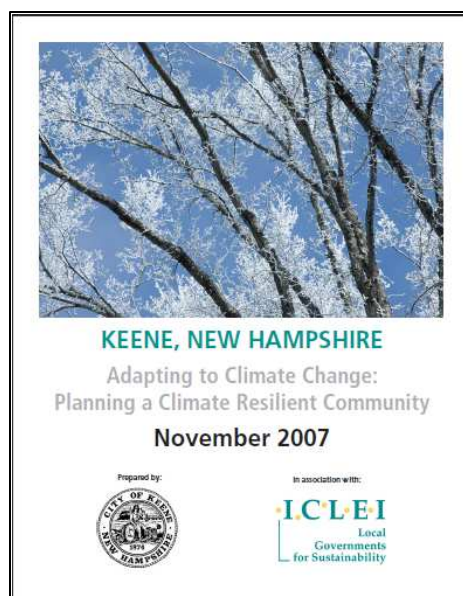
Implementing a preparedness plan also requires managing risk and uncertainty. Projected climate impacts, costs, and hazards are impossible to measure quantitatively. One way to manage the uncertainty is to implement “no-regrets,” “low-regrets,” and/or “win-win” actions, which provide some community benefit, whether or not current predictions of climate change impacts come to fruition. Water conservation programs and wetland restoration are two examples of such actions.

Milestone 5: Measure progress and update the plan. The final step in the process calls for monitoring and evaluating adaptation measures and communicating the findings to the community at large. Tracking performance allows policymakers to review their prior assumptions and update the plan accordingly. The evaluation process also provides transparency and accountability to the planning effort.

USING THE RESOURCE: KEENE, NH

Though few localities have formally used the guidebook to create an adaptation plan, the experience of Keene, NH provides some valuable insight on the guide: the City of Keene is one of ICLEI’s pilot Climate Resistant Communities, and the first to utilize ICLEI’s Five Milestone process in its adaptation planning; based on this experience, Keene City Planner Mikaela Engert served as one of the guidebook’s reviewers.

Building consensus (Milestone 1). Engert’s experience in Keene is instructive in particular to other small cities that lack resources for adaptation work. A number of government officials and other community stakeholders saw the adaptation issue only through the lens of hazard mitigation, and some initially thought it to be entirely inapplicable to their work. Engert describes a lot of “push and pull” as the adaptation planning team worked to bring in a broader group, and convince them that adaptation planning had to cut across traditional departmental boundaries.



“It’s all about how you frame it,” Engert says. “We did a lot of education up front to get people thinking productively about climate change: what mitigation and adaptation mean, and worked to find consensus points around adaptation. So even though people were coming at the issue from many different perspectives, they were using the same words, ideas and principles to talk about it. Pure science wasn’t enough; we needed to translate it into common language.” Eventually, Engert says, “it just clicked. Everyone wanted to incorporate their ideas, to the point that we actually had too much information. It was a great problem to have, because it got people excited.”

Planning and implementation (Milestones 3 and 4). Once the team built consensus around the need for adaptation planning, it embarked on a planning process, which culminated in a comprehensive plan in November 2007.



Keene has been implementing actions recommended in the plan since then—including a variety of low-impact development and infrastructure upgrades—working with different government departments and community groups. Because these are “win-win” implementation strategies, climate adaptation and mitigation are often not the stated goals of a given project. Keene’s ability to work through a comprehensive adaptation planning process allowed the city to weave these initiatives into larger community goals.

Integrating adaptation into everyday work. Keene is now on the brink of adopting a new master plan for the city. Its framework is a direct result of the city’s adaptation efforts, and the public awareness and consensus they built. “The platform is sustainability, but it’s not just a sustainability plan; it’s the overarching, master plan for Keene,” says Engert. “And that totally grew out of our mitigation and adaptation planning work. These issues are now integrated into everyday thinking and operations in the city, and inform all of our initiatives.” The master plan is scheduled to be approved in September 2010.

Thanks to Mikaela Engert, Keene City Planner; and Missy Stults, ICLEI Regional Program Manager. Written by Tom Wilson, Institute for Sustainable Communities.

FOR MORE INFORMATION

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments.
<http://www.cses.washington.edu/db/pdf/snoveretalgb574.pdf>

ICLEI Adaptation website, http://www.icleiusa.org/programs/climate/Climate_Adaptation

Keene adaptation plan, Adapting to Climate Change: Planning a Climate Resilient Community,
http://www.ci.keene.nh.us/sites/default/files/Keene%20Report_ICLEI_FINAL_v2_1.pdf

SNAPSHOT: GETTING COMMITMENT TO ADAPTATION

Boulder Residents get help from Artist Mary Miss to “Connect the Dots”

Conveying climate risk and hazard information to the public can be a difficult task. The Boulder Museum of Contemporary Art blended art and science to inform residents about future risks. One artist, Mary Miss, created an outdoor exhibit, aptly called “Connect the Dots,” to bring attention to the possible flooding of Boulder Creek.

The city of Boulder is located at the mouth of Boulder Canyon. Because of its location, with its steep slopes and long approach upstream, the city is highly susceptible to flooding. The city is considered to be a high hazard zone, where the question is not *if* there will be a flood but *when* will it happen.



Image credit: Mary Miss



In the spring of 1894, a 100-year flood inundated downtown Boulder. Flash floods in Boulder Creek caused widespread damage. Smaller floods also occurred in 1914, 1919, 1921, 1938 and 1969. The Federal Emergency Management Agency (FEMA) uses the 100-year flood benchmark to map the flood plain, which localities are required to account for in making land-use development decisions. A 100 year flood has a 1% chance of occurring in any given year. Some experts believe it is prudent for communities to be prepared for a 500-year flood event, which has a 0.2% chance of occurring in any given year. It is possible for two or more such events to occur in a single year. New weather patterns make the forecasting of such events less predictable.

"I knew flash flooding is expected to worsen with climate change," says Mary Miss, a New York-based artist and Boulder native. "I also knew that all these hydrologists and geologists were trying to explain the dangers of flash floods, but they were not taken seriously. How can you make it apparent to people?"

With the collaboration of U.S. Geological Survey, hydrologist Sheila Murphy and University of Colorado geologist Peter Birkeland, Miss presented the flash flood dangers by documenting its depth and extent throughout downtown Boulder.

Using a FEMA flood map as a guide, Miss marked the flood level by attaching six-inch diameter blue discs to trees in public parks, doors of the high school, and other municipal buildings. Some were affixed waist-high, some at eye-level, and others at 18 feet.

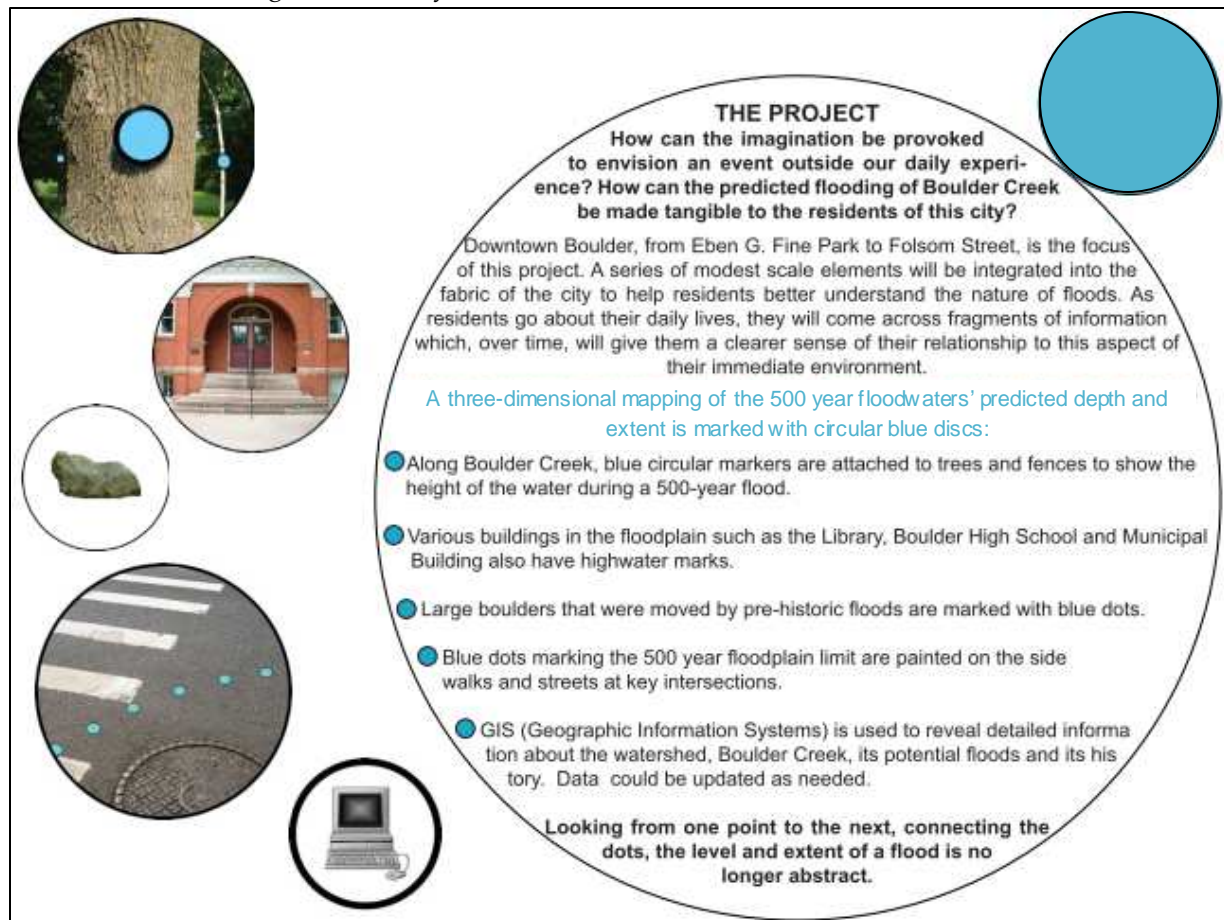


Image credit: Mary Miss



The success of Miss's "Connect the Dots" installation was its accessibility, said Murphy. It was smack in the middle of the city. Plus, the scientists conducted tours of the site for the general public and also for scientists attending the annual meeting of the Geological Society of America, held that year in Denver.

Murphy said she initially had been concerned about how much science would be conveyed in the art. In the end, she was impressed by Miss's commitment to accuracy. The dots were placed in the landscape at their exact survey points through use of a laser rangefinder. "It was a whole different way of presenting science," Murphy said. "As scientists, we are always trying to reach a different audience. This opened us up to a whole new group."

"Connect the Dots" was one of 51 artworks that comprised the exhibition *Weather Report: Art and Climate Change*, presented jointly by the Boulder Museum of Contemporary Art and Eco-Arts and curated by Lucy Lippard. Each piece of art was the result of collaboration among climate scientists or environmentalists and artists. Exhibiting partners included the University of Colorado at Boulder, the Boulder Public Library, the City of Boulder, Fiske Planetarium, and Norlin Library Galleries.

"What made the whole event so good was that the artists were so innovative. They were making the public so much more aware of the ideas than any scientist could," said Birkeland. "I could go out there and hold up a sign that said, 'The glaciers are melting' and people would say, 'So what?' But artists have an innovative way of saying it. One of them cut a one-meter chunk of glacier from the Rocky Mountains and displayed it outside on a refrigerated table that was powered by solar energy. That said a lot more."



Image credit: Mary Miss



Eco-Arts executive director Marda Kim puts it another way. “Artists can scream. Scientists can’t. Many scientists realize that pie charts and graphs don’t tell the whole climate change story. There need to be other ways to reach people.” Kim’s organization brings together scientists, environmentalists, and performing and visual artists—along with producers, presenters, scholars, spiritual leaders, policy makers, educators, businesses, and people from all walks of life—to use the arts to inspire new awareness of, discussion about, and action on environmental issues.

This case study was compiled by Elaine Wang, Institute for Sustainable Communities, from:

Visual Arts Advancing Dialog on Climate; “Artists Can Scream ... Scientists Can’t”, Lisa Palmer, Yale Forum on Climate Change & the Media, <http://www.yaleclimatemediaforum.org/2009/09/visual-arts-advancing-cc-dialog>

Connect the Dots: Mapping the Highwater Hazards and History of Boulder Creek, Mary Miss, http://www.marymiss.com/products_images/pdf/project107.pdf

Weather Report: Art and Climate Change, Boulder Museum of Contemporary Art, <http://www.bmoca.org/2007/09/weather-report-art-and-climate-change>

CASE STUDY: GETTING COMMITMENT TO ADAPTATION

London’s Climate Change Adaptation Strategy

In the wake of heavy flooding, heat waves and droughts, London is taking action to adapt to climate disruption while still drafting its comprehensive climate change adaptation strategy. The Mayor of London is leading the effort to create the strategy for the greater London region. Using a risk-based approach, the strategy is aimed at managing the uncertainties inherent in predicting future climate scenarios. London’s progress on adaptation is based on mayoral leadership, an effective public awareness campaign, and the city’s resourcefulness in finding relatively low-cost measures to manage its climate risks.



Visualization of what London could look like after climate change, by GMJ Design. www.gmjondonfutures.com

THE INITIATIVE

Several weather-related crises in the past decade have focused public attention on climate change in the United Kingdom. In 2003, summer heat waves reached 38.0 °C (100.4 °F), killing over 2,000 people in just 10 days. Extreme flooding across the country in 2007 led to 13 deaths and upwards of £6 billion in damages. These extreme weather events, currently rare, are expected to increase in frequency in the next century. (See “London’s Warming: the Impacts of Climate Change on London in 2002”.¹) In order to plan for and curb the effects these risks pose to London’s population and

¹ London’s Warming took about two years to produce and cost roughly £50,000.



economy, the city is preparing a climate change adaptation strategy using a risk-based approach. The Climate Change Adaptation Strategy is based on the main climate risks to London, and the areas of the city that are vulnerable to climate impacts. The strategy is also informed by an analysis of how climate change risks will change over the rest of the century: longer and more frequent heat waves, greater flooding, and more periods of drought. The strategy is therefore grounded in a risk-based prioritization of adaptation that is intended to manage risks and capitalize on benefits.

A two-stage consulting process which will inform the final strategy is expected to be completed in the summer of 2010. In August 2008, new Mayor Boris Johnson launched the draft version of the adaptation strategy, followed by consultation with bodies of the Greater London Authority, including the London Development Agency, Transport for London, London Fire Brigade, London Fire and Emergency Planning Authority, and the Metropolitan Police Authority. The draft then underwent examination by the London Assembly,² before being updated according to new climate data, and rereleased for public consultation.

The second version of the draft strategy was published in January 2010, and made available to the public for 3 months in early 2010. Through use of new media, including YouTube, Twitter, and a blog, the Mayor and his team captured a new cohort of citizens engaging in the climate discussion. The Mayor created a video to raise awareness of the strategy and posted it on YouTube, drawing attention to the public consultation website.³

But London hasn't waited for the final strategy to begin work on adaptation. The city's staged process shows that mayoral leadership and vision pay off, even in a context where the mayor has relatively limited power and little funding at his disposal.

Taking action now. Limited resources have forced London to act opportunistically on adaptation. For instance, the government has funded the Thames Barrier to reduce the risk of tidal flooding. But that work occurred in the absence of important surface water flood risk maps. The information required for these maps is held by several government agencies, none of which has overall responsibility for it.

The city's draft climate adaptation strategy recommends that surface water flood risk be studied further. So the Mayor and his adaptation team of five at the Greater London Authority (GLA)⁴ convened its member government agencies to conduct a scoping study. The study identified critical gaps in the city's knowledge of flooding risks, so the GLA put a bid before the national government to resolve this issue. The effort resulted in a national government grant of £3M to draw more accurate maps and to perform a cost-benefit analysis of reducing the risk of flooding through both urban greening solutions (e.g. green roofs) and large infrastructure projects (e.g. sea walls). By

² The London Assembly is a political body that oversees the Mayor.

³ <http://www.youtube.com/watch?v=WplvSvGXRA>

⁴ The Greater London Authority is the administrative body for the Greater London area. It is a strategic regional authority with powers over transport, policing, economic development, and fire and emergency planning. The Mayor of London and the 25-member London Assembly are a part of the GLA. The Greater London Authority is mostly funded by a direct government grant and by some local Council

tax money. The GLA is unique in the British local government system, in terms of structure, elections and selection of powers. The authority was established to replace a range of joint boards and provided an elected upper tier of local government in London for the first time since the abolition of the Greater London Council in 1986.



working on flooding even as the adaptation strategy remains in draft form, London is increasing its climate resilience.

The draft climate adaptation strategy predicts that London will experience 20% more winter rainfall in the coming decades. In order to offset this and other predicted increases in flood risk, the city has embarked on a greening effort. One example is green roofing projects underway in several high-profile development sites around London. The roofs absorb rainfall and reduce the speed at which rain water runs off buildings, which reduces the risk of flooding. The roofs are partly or completely covered in plants, grown in a mixture of soil and recycled construction waste such as crushed bricks, and laid on top of high-tech waterproof membranes. In addition to cooling and insulating buildings, green roofs create habitat for local flora and fauna. Advances in waterproofing technologies have led to their utilization in sustainable construction projects, and now serve as a model for how technological innovations can help climate adaptation efforts.

Raising awareness by presenting the science and engaging the public. Floods, droughts and heat waves have sensitized Londoners to climate risks. London has sought to build on this general public awareness by using climate models of future risks to persuade residents that the business-as-usual scenario is untenable. Alex Nickson, who leads the GLA adaptation team, summed up the public



message this way: “Adaptation buffers us from the extreme weather today and puts us on the path to greater resilience tomorrow. Many adaptation benefits also help us become more carbon efficient and have other societal benefits.” The GLA took its message to residents by holding over 100 workshops with various sectors and key agencies since work on the strategy began.

The GLA has also used the Internet to engage the public on the draft strategy. The city launched a website in February 2010, inviting residents to learn about climate risks and offer input on adaptation (<http://www.london.gov.uk/climatechange>). The Mayor and his team wanted Londoners to take ownership of the issue, to be more like, as Nickson said, San Franciscans. The goal was to “empower Londoners to recognize that

they have control over lots of the risks they face, and that the actions they take and preparations they make means that the government can more effectively deal with the vulnerable and the critical,” said Nickson. In total, over 7,000 people visited the site and contributed hundreds of ideas, the best of which will be incorporated into the final strategy.

Unfortunately the website was launched at same time as the Intergovernmental Panel on Climate Change came under heavy criticism from climate skeptics. As a result many of the public comments dealt with the validity of climate change rather than specific adaptation actions that Londoners could take. Still, the public awareness campaign did raise the strategy’s profile among the public. London’s new media approach also reached people who may never have participated in a standard public consultation process.

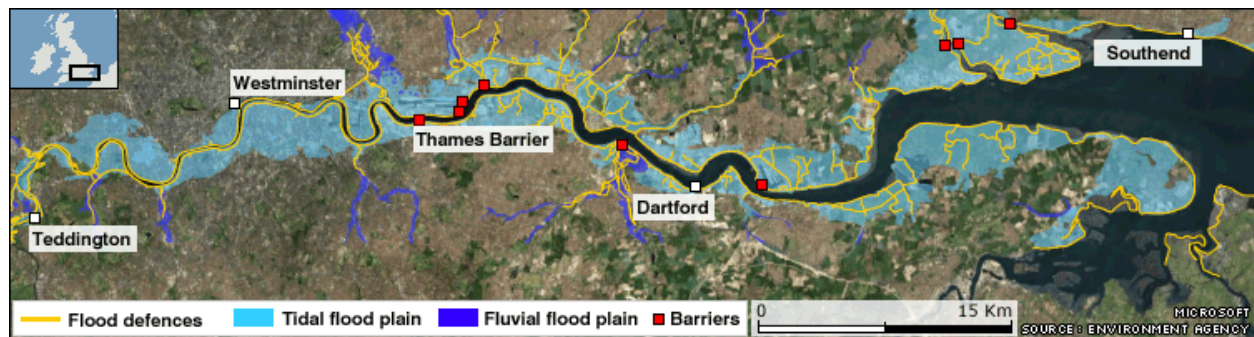
The role of dynamic leadership. Both Ken Livingston and Boris Johnson, London’s two mayors since 2000, have used charisma and influence to drive adaptation efforts. While those factors are important for any city leader, they are especially important in London, where the mayor lacks the authority that U.S. mayors typically command. It was Livingston’s commitment and dedication to



climate change that brought about direct responsibility for adaptation within the Mayor's office. In 2007, Ken Livingstone asked for the additional responsibility of developing the climate change adaptation strategy for greater London. The Greater London Authority was keen to give it to him, although it was "power without any funding and responsibility without additional power or funds," said Nickson.

"The mayor can't raise funds through taxation and building and business rates. A lot of the game we have to play is using our strategic analysis to demonstrate greater efficiencies and effectiveness. And then to say, 'Look at what we're doing anyway and see how we can make it more efficient'" said Nickson. For London, it is often about trying to get a bit of money from the public sector and a bit of money from the private sector in order to meet common goals.

Mayor Johnson, who succeeded Livingston, continues to use his office to influence action on adaptation. The Mayor recently asked business leaders to invest in adaptation as a way of safeguarding the future of their companies. The mayor told this audience that stronger firms, capable of adapting to climate change, would lead to greater job stability and better disaster planning and preparation, stemming from increased awareness in the workplace.



The extent of the floodplain in London, extending as far as the Thames Estuary. Image credit: http://news.bbc.co.uk/1/hi/shared/spl/hi/pop_ups/07/sci_nat_enl_1187112433/img/1.jpg

Making the case to the private sector. The GLA and the Mayor's team are working with business-to-business organizations, banks, and insurers in an engagement process aimed at getting the private sector to invest in adaptation projects and incorporate adaptation into their business plans. Through in-person meetings, the Mayor and the GLA develop relationships with the business community, key to the success of adaptation endeavors in London.

The GLA's message to firms both big and small is simple: It's a great time for businesses to be worrying about environmental issues because "you're running at your leanest, your value chain is at its thinnest, you're working on skeleton staff, you've got no cash in the bank, your procurement chain is all very thin. You are so financially stretched that with one flood you could go out of business. So now's the time to be thinking of climate risks, rather than putting them off to a time you think you're more affluent."

Turning to creative soft solutions when hard solutions are expensive or infeasible. Like the green roofing projects to reduce urban surface water flood risk, London looks for so-called soft solutions to climate change risks. The city is retrofitting 1.2 million homes to improve their energy and water efficiency. London is also trying to gauge the relative value of greening measures as compared to infrastructure projects, such as channels and reservoirs. The outcome of the analysis will help chart the city's course on adaptation. A better understanding of costs and benefits will also help London



seek funding from entities that benefit indirectly from the city's adaptation measures. An analysis, for example, of the benefits of green roofs to the local water utility, which may forego building new infrastructure to handle greater levels of precipitation, could help convince the utility to share the cost of adaptation.

FOOD FOR THOUGHT

London is making progress on adaptation while facing serious obstacles. “Despite no money, limited resources, a challenge in the engineering establishment, uncertainty in climate projections, the credit crunch, and the fact that London is built on a very old street plan (so there is no room to grow), we’re ready to roll.” Its success on this issue is based on an approach that may be instructive for other cities.

A risk-based approach grounded on the available science strengthens the message to the public that climate change poses risks to people’s everyday lives. Basing the information in the draft strategy on climate modeling, the GLA team brought information to the public through workshops, a website, and new media, resulting in a more engaged public. The aim was to empower Londoners to be better informed and prepared for climate change.

Mayoral leadership energized early implementation measures and the formation of a

ADVICE FROM ONE CITY TO ANOTHER

- Keep adaptation within the framework of sustainable development. Once you pull adaptation out and put it on a pillar you get unsustainable measures.
- Climate models are tools, not answers. They help you ask the right questions, but they don't give you answers.
- Identify criteria for success and sensitivity thresholds. You must know the threshold at which an extreme event or a gradual trend affects your city; otherwise, you can't apply the climate models. Understand your system, and how your system interrelates with other systems.
- Value action learning. “It's better to make mistakes but make progress, than make no progress at all.”

- Alex Nickson, Climate Change Strategy Manager,
Greater London Authority

comprehensive strategy. The draft strategy sets out key actions the Mayor believes London should take to prepare for climate change. Because the Mayor has limited funds and power to implement the strategy once developed, he must use his influence to gain support among the government, the public and the private sector.

When *working with the private sector* on adaptation, cities should let businesses talk to businesses as “a couple of exemplars are better than a thousand emails.” Work with leading businesses and then let them make the case for incorporating adaptation in business plans and supporting adaptation efforts and planning with industry colleagues. Cities should also seek to help firms to identify the business opportunities of adaptation.

Sound *cost-benefit analysis* is required in evaluating adaptation measures. The analysis may become especially complex in pricing the value of greening measures, such as green roofs used for flooding mitigation. The costs of avoided infrastructure projects should be factored in to the analysis.

Adaptation makes business sense. As Nickson said, it's about “reminding economists that whilst London is a world city today, if we want to reaffirm that position we need to be perceived as a safe place to do business and invest in. [We need] to compare our climate risks with other key



competitor cities, and if we can demonstrate that London is a more resilient place to do business, businesses will choose to select to work here and be located here. In parallel we'll be able to sell our adaptation, skills and knowledge to the rest of the world."

Written by Joyce Peters, Institute for Sustainable Communities

FOR MORE INFORMATION

London's Climate Change Adaptation Strategy website:
<http://www.london.gov.uk/climatechange/strategy>

Mayor Boris Johnson's outreach address on YouTube:
<http://www.youtube.com/watch?v=WplvSvvGXRA>

City of London Adaptation Strategy: www.cityoflondon.gov.uk/Corporation/LGNL

CASE STUDY: BOLSTERING RESILIENCE BY INTEGRATING ADAPTATION INTO LOCAL PLANNING AND OPERATIONS

Seattle and Tucson Manage Risks to their Water Supplies

Climate scientists warn that climate change may dramatically reduce fresh water supplies and deteriorate their quality in some U.S. cities. The water utilities in Seattle and Tucson have been working to understand how changes in climate may affect their plans to meet future water needs, and how they can increase the resilience of their water supplies given many uncertainties. While their water systems are different, there are strong similarities in the two cities' approaches, including their emphasis on partnerships with scientists, their attention to institutionalizing adaptation thinking in utility business, and their commitment to exploring a wide range of creative adaptation strategies.



Seattle's Cedar River Watershed.
Image credit: Seattle Public Utilities

THE SEATTLE STORY

Few people might suspect that Seattle's water supply is at risk. The city has long been known as a place of abundant water. For more than a century, it has met all its water supply needs with snow melt and rainfall from two mountain watersheds a short drive away.

Despite this long history of ample water, Seattle Public Utilities (SPU), the city's publicly-owned water utility, turned its attention to the potential water supply risks from climate change more than a decade ago.



SEATTLE: ASSESSING CLIMATE IMPACTS WITH A CHAIN OF MODELS

Model #1. The University of Washington's Climate Impacts Group (CIG) developed three scenarios for changing temperatures and precipitation in the Pacific Northwest (using two different greenhouse gas emissions scenarios coupled with three global climate models).

Model #2. CIG ran the three scenarios through a hydrology model to estimate how meteorological changes could impact hydrology in the watersheds that supply water to cities and towns.

Model #3. Seattle Public Utilities water managers took the output from the second model, on a climate-altered regional hydrology, and ran it through the utility's own models of water system operations to project local changes in Seattle's drinking water supply.

A climate assessment partnership with the University of Washington. Between 2002 and 2007, SPU collaborated with a group of climate researchers at the University of Washington—called the Climate Impacts Group (CIG)—on two studies to assess how meteorological shifts caused by climate change may affect hydrology in the Cedar and Tolt River watersheds.

The second study showed that climate change was likely to reduce regional water supplies. Under a moderate risk scenario, Seattle was projected to lose 13% of its water by 2050. SPU used the assessment as a basis for assembling a portfolio of adaptation strategies that could offset expected losses and make the city's water supply more resilient to climate change.

Looking for effective adaptation options. Since climate impacts were not forecasted to be severe before 2050, SPU looked most closely at “no

regrets” operational options that could be implemented by the utility itself in the near term and without significant cost to its rate payers, such as drawing down water levels in the Tolt Watershed reservoir below typical operating levels.

When SPU and its partner utilities released the results of this assessment and the initial adaptation planning it supported, they publicly acknowledged the “dynamic and somewhat speculative” nature of climate change research, and committed to conduct additional assessments in the future as scientific understanding of climate change increased. At the same time, SPU took steps to institutionalize its climate change work. Results were incorporated into the city's Water System Plan, a document that SPU updates every 6 years under Washington state regulations for drinking water supplies. SPU also established and staffed a new climate change program in the utility.

THE TUCSON STORY

Like SPU, Tucson Water, also a publicly owned water utility, is earning a national reputation for its work to better understand how climate may affect the city's water supply. The endeavor is a complex one, as the city relies on both local and imported (regional) water sources.

Under the 1922 Colorado River Compact among the seven states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, Tucson meets most of its potable water needs with Colorado River water pumped through the multi-billion dollar Central Arizona Project. Assessing its own risk of future water shortages is thus dependent on understanding how long-term climate change will affect the meteorology and hydrology in all the states that contribute runoff to the Colorado River. Tucson also utilizes water from local groundwater aquifers and reclaimed sources, making it necessary to understand how climate change may affect the availability and future use of local supplies too.



Partnerships with climate scientists. For help in building a credible and scientifically sound understanding of potential water supply risks associated with climate change, Tucson Water is developing a relationship with academic research teams, including Climate Assessment for the Southwest (CLIMAS), an internationally-known research center based at the University of Arizona and one of eight NOAA-funded Regional Integrated Science and Assessment programs.

Work to understand how climate change may affect access to Colorado River water has been underway for several years. Tucson Water is working with a consortium of other cities, the Bureau of Reclamation, CLIMAS, and other climate science research centers to assess the potential magnitude and duration of anticipated shortages on the Colorado River.



The Central Arizona Project is a 336-mile long system of aqueducts, tunnels, and pumping plants. Image credit: Central Arizona Project

The utility is also interested in understanding how potential shifts in local climate could alter seasonal patterns of water demand in the Tucson area. Could an average increase in temperature, for example, result in a longer peak demand season? Similarly, could a delay in the onset of the summer rainy season result in a longer period of high water demand? These kinds of changes would likely require adaptive actions to address potential operational challenges in future decades.

Integrating adaptation planning into regular utility business. In 2005, the state of Arizona passed legislation requiring all Arizona water providers to develop a plan for managing their water services during droughts. Tucson Water's 2007 Drought Preparedness and Response Plan included a sophisticated system of stages of drought urgency, defined both by regional and local supply conditions, and steps for managing water supplies at each stage.

As the utility's concern about long-range climate impacts has grown over time, it has elected to expand the scope of this existing plan to include climate assessment and adaptation, rather than initiate a separate planning process. The new version, renamed the "Integrated Drought-Management/Climate Variability Preparedness Plan," is currently under development and will be updated at least every five years as required by state law. The goal is to "institutionalize climate variability planning and thinking into the regular work of the utility, so that as staff come and go, it will continue to be a significant part of how the utility thinks," according to Ralph Marra, the utility's Water-Resources Management Administrator and Chief Hydrologist.

Tucson Water will rely heavily on scenario planning to maximize its future flexibility given many uncertainties about the feasibility of various adaptation options. "This is a tool that helps people to move ahead with adaptive planning without becoming panicked and paralyzed by uncertainty," explains Marra.





Tucson Water provides signs to sites that use reclaimed water. Image credit: Tucson Water

Scenario planning is helping the utility zero in on critical “planning uncertainties” that could impact its ability to keep its water-resources portfolio and extensive water system resilient. The extent to which its customers would be willing to pay for additional water resources, change their lifestyles to increase water use efficiencies, and/or accept reclaimed water for indirect potable reuse are examples. Better understanding of these and other planning uncertainties will help the utility develop more effective adaptation strategies.

Tucson Water is also deeply involved in other planning processes at the local and state levels. The utility plays an important role in a joint effort by the City of Tucson and Pima County to plan for a “sustainable water future.” This planning process is looking at actions, such as changes to zoning and building codes, which would increase the efficient use of water in the built environment.

FOOD FOR THOUGHT

Create accountability for increasing resilience. Both SPU and Tucson Water have found that vesting accountability for climate work in a single utility position helps ensure that the work will advance.

SPU created a new position—a Climate and Sustainability Manager—to coordinate its climate mitigation and adaptation efforts and to manage a small staff. “Our management saw the need for a primary point of contact after we watched climate change morph from a technical issue into an issue with managerial, policy and political implications,” explains Fleming, who currently occupies the position.

Tucson Water decided to vest accountability for its climate adaptation work in the same position that manages its strategic planning for long-range water resources management. Ralph Marra, who occupies the position, is overseeing the development of the city’s Integrated Drought-Management/Climate Variability Preparedness Plan. Like Fleming, he acts as the utility’s climate-change liaison with climate-science research teams, and represents the utility in work with other large water providers and jurisdictions. Marra has established a cross-division climate-change planning group within the utility, to provide input, distribute awareness of climate issues throughout the utility, and advance institutionalization of adaptation planning.

Creating a single point of accountability does not by itself guarantee the smooth integration of climate concerns in utility operations. The utility’s top executive must also support the position and communicate its role to the rest of the organization. Without this top-level commitment, the person responsible for adaptation will find it difficult to command the attention of people who are focused on immediate needs, rather than the longer-term risks of climate change.

Don’t be a passive consumer; co-produce assessments of climate impacts. SPU’s work with the University of Washington on the assessment of climate risks has evolved into a partnership based on the co-production of knowledge. “We have developed clear and defined roles for the university researchers and for utility staff that both parties agree to,” explains Fleming. “The researchers produce data on climate-altered hydrology and provide that data to the utility. The utility then runs



the data through its own system models to project real impacts on water supplies and develop appropriate adaptation options.”

SPU successfully used this approach in its 2007 impacts assessment study. In an earlier assessment commissioned from the University’s CIG, SPU did not have as active of a role in the co-production of knowledge. The process resulted in conflicts among the researchers, SPU, and other jurisdictions over the interpretation of the data and how it should be communicated to the public, and the study was never completed.

Tucson Water has also concluded that its own applied scientists and engineers should get involved in climate impact studies, by talking extensively with external scientists about their goal of developing a “plausible range of future possibility.” “A water utility is a 24-7 organization that must be ready to provide water at all times. It has a very practical orientation to problem solving,” explained Marra. “University research teams do not have the same type of 24-7 accountability, and they have very different cultures and needs. As a result, we can spend a lot of time talking about what acceptable answers to our questions might look like.”

When a water provider co-produces new knowledge about climate impacts, either by helping scope an investigation or by taking over a certain phase of the research, it builds its own institutional capacity. “It’s like the difference between being given a fish and being taught to fish,” explains Fleming. “If we don’t participate, we are missing a key opportunity to improve our knowledge and skills to accomplish work that is not going away anytime soon, and if anything will become a more critical need in the future.”

Define a broad solution set. Both SPU and Tucson Water are committed to a portfolio approach to adaptation planning. “We are working in a highly dynamic and uncertain planning environment,” said Marra. “Preparing a wide range of adaptive options will give us the best ability to respond flexibly and strategically as our understanding of potential future impacts and their uncertainties improves.”

SPU is exploring a range of “soft solutions”—such as refilling reservoirs to higher levels, drawing them down to lower levels, and getting its rate payers to conserve water—which would not be as expensive to implement as new infrastructure projects. Since 1984, Seattle’s water conservation program has contributed to a decrease in total water consumption of 28%, while population has grown by 26%.

SPU has evaluated the likely effectiveness of these strategies by running them through its model for systems operations, adjusted to include new scenarios for climate-altered hydrology. This enables the utility to estimate how much each strategy could offset supply losses expected from climate change. “We want to make sure that non-structural approaches such as conservation and operational adjustments are evaluated and pursued before large, expensive infrastructure investments,” said Fleming.



Seattle's Tolt River Reservoir. Image credit: Seattle Public Utilities



Tucson Water, in concert with other City departments, is also evaluating a broad set of adaptation strategies, such as:

- Regulations and guidelines to increase rainwater harvesting on private properties, and new standards for porous pavement;
- An ordinance requiring that all new development be piped for reclaimed water;
- Infrastructure investments to increase reclaimed water supplies;
- A collaboration with other cities to purchase additional rights for Colorado River Water;
- Water banking in local aquifers during surplus years; and
- More aggressive water conservation measures, expanded incentives, and public education.

Explore adaptation options during inclusive city planning processes. Creating a flexible portfolio of adaptation actions requires more than data and scenario planning. Many of the best options—those that have both mitigation and adaptation benefits—can only be evaluated and implemented with other partners. These options include denser patterns of urban development, green infrastructure and rainwater harvesting, and energy efficient buildings that place less demand on energy systems when water use is at peak levels.

A joint initiative of the City of Tucson and Pima County to plan for a “sustainable water future” involved city and county land-use agencies, water providers, wastewater agencies, community leaders, and environmental groups. The group identified strategies that included new development patterns to increase water efficiency, and expansion of green infrastructure. Leslie Ethen, the director of Tucson’s Office of Conservation and Sustainable Development, says that the participation of Tucson Water both helped to educate stakeholders about the water system and water-resource issues, and to broaden the utility’s perspective about possible solutions.

Broader engagement, however, entails greater complexity. “You need to do your own utility planning,” said Marra, “but also interweave that work with participation in other planning efforts, so that you can position the organization to be responsive to what its constituencies want and how they want you to adapt. It can be challenging at times.”

Written by Sarah McKearnan, Consultant to the Institute for Sustainable Communities

FOR MORE INFORMATION

Seattle Public Utilities’ press release with other jurisdictions announcing the results of their 2007 climate impact assessment, <http://www.seattle.gov/news/detail.asp?ID=8217&Dept=20>

Tucson’s Long Range Water Supply Plan: 2020—2050, a plan that uses scenarios to identify critical uncertainties and adaptive options, <http://www.tucsonaz.gov/water/waterplan.htm>

Seattle’s 2007 Water System Plan, http://www.seattle.gov/util/About_SPU/Water_System/Plans/2007WaterSystemPlan/index.asp



Research by the Climate Impacts Group at the University of Washington about climate impacts on Seattle's water supplies, <http://cses.washington.edu/cig/res/hwr/ccseattle.shtml>

CLIMAS website, <http://www.climas.arizona.edu>

Water Utility Climate Alliance, <http://www.wucaonline.org>

CASE STUDY: BOLSTERING RESILIENCE BY INTEGRATING ADAPTATION INTO LOCAL PLANNING AND OPERATIONS

Seattle Public Utilities' Flood Risk Management Strategies

Climate change is expected to increase the risk of flooding in cities across the country, either because of increased precipitation, or sea level rise and higher storm surge, or some combination of these impacts. In the aftermath of two extreme storms, the City of Seattle undertook a concerted effort to understand flooding trends and improve prevention and emergency response. Seattle's work highlights the difficulty of making projections about future flooding and the importance of low cost, "no regrets" actions, as well as strategic public outreach and education.

THE TRIGGER: TWO RECORD-BREAKING STORMS

The City of Seattle experienced two of the most damaging storms in its history in 2006 and 2007.

The first storm, in December 2006, produced intense rainfall over a single hour. The city's natural and artificial drainage systems could not accommodate all the runoff that resulted, and water rapidly flooded streets and buildings.



Flooding in North Seattle, Dec. 2007

Another record-breaking storm struck in December 2007, this time dumping nearly five inches of rain on Seattle in a 24-hour period. Again, severe flooding occurred throughout the city, some properties having as much as four feet of stormwater in basements and on ground floors.

Both incidents represented 100-year storm events (i.e. the rainfall released during each storm exceeded the amount the city would expect for a storm of its duration once every hundred years). The storms raised significant concerns at Seattle Public Utilities (SPU)—the city's publicly owned water, drainage and solid waste utility—about the effects of future flooding on public safety, critical infrastructure, and private property.

SEATTLE'S RESPONSE

SPU has launched six low cost actions to address the magnitude of flooding experienced by the city in recent years.



Assessing the increased risk of flooding. SPU hired Northwest Hydraulic Consultants (NHC) to examine historic rain data collected at 17 rain gauges across the City and analyze whether the frequency of extreme precipitation events had increased. The analysis showed a “weak increasing trend...in the number of days on which 25-year or greater precipitation events are recorded by at least one gauge.” The conclusion was that every 3.2 years, SPU could expect a storm to produce a volume of rainfall exceeding 100-year or greater precipitation events somewhere in the city.

SPU also worked with NHC to assess how potential changes in precipitation caused by climate change might affect flooding in the future. The project made use of work done by the University of Washington to downscale precipitation projections from global climate models for the region. NHC ran this precipitation data through a hydrological model of a key creek watershed in Seattle to see how changes in precipitation might affect stormwater runoff. However the results were too inconclusive to serve as a basis for future drainage planning.

Improving data collection. SPU’s assessment of historic rain gauge data left no doubt that the utility should expand and improve the information it had available for analyzing localized precipitation trends. The utility added 11 new rain gauges to its network, locating them in places where robust information about rainfall patterns was not yet available. It also improved procedures for gauge maintenance to increase the reliability of the record.

SPU also launched a new program to create better “eyes and ears” out on city streets when major storms strike. A new group of “storm observers”—utility planners and engineers who had no explicit emergency management responsibilities—were trained to go to specific sites during high intensity storms and prepare written notes and take photographs documenting what occurred. Having non-emergency crew in the field as observers allows the utility to gather information it needs for future planning, while keeping its emergency field crews focused on emergency response. It also creates a first line of defense, as storm observers can call in field crews when flooding is imminent.



SPU field crew member clears drainage infrastructure to prevent flooding

Tuning up pre-emergency planning and emergency response. After the 2006 and 2007 storms, drainage managers at SPU decided the utility needed a more regularly-updated list of the locations in the city that were most vulnerable to flooding. Staff from across the utility—planners, engineers and field crews—now convene after every storm season to revise this so-called dynamic hot spot list, and continue improving their understanding of the types of storms that are of the greatest concern at each site (e.g. some spots flood during short, intense rain events; others during steadier, longer storms).

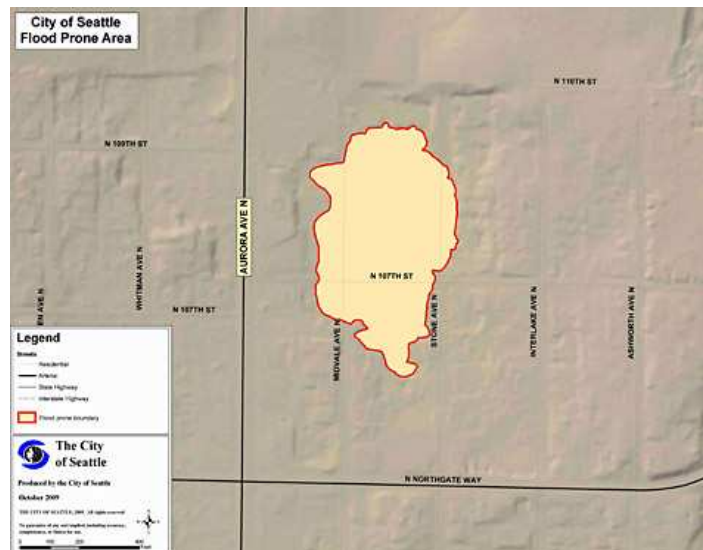
The updated hot spot list becomes a foundation for more strategic hazard mitigation and response planning. Sometimes, expensive retrofits of drainage infrastructure are needed, and little can be done in the short-term. In many cases, though, a simple increase in pre-storm maintenance, or a low cost structural fix, such as building a redundant inlet, can significantly ameliorate the problem. Utility staff have also created a set of customized emergency procedures for each location. Each year, drainage managers brief SPU’s director about the hot spot list and the work being done at each location, elevating the attention to flooding at the highest levels in the organization.



Finally, SPU has deployed new technologies to support more rapid and coordinated emergency responses to flooding. The utility is working with the University of Washington to develop a tool called Seattle RainWatch, which will provide neighborhood-scale precipitation forecasts for periods of thirty to sixty minutes. These forecasts will support better decisions about how to deploy crews to areas likely to receive high rainfall. At its Operations Control Center, a computer network now integrates real-time, city-wide information about weather trends, customer reports about flooding, and continuous information sent in by storm observers and field crews. The information is projected on a giant screen that emergency staff can all see, allowing them to shift from reactive emergency response driven by customer complaints to proactive deployment of field crews that can prevent major emergencies from ever occurring.

Regional communications. In the fall before each storm season, SPU jointly launches a multi-media educational campaign with many other nearby jurisdictions. A “Take Winter By Storm” website disseminates coordinated messages about the specific steps property owners can take to protect themselves and increase the resilience of their properties. Public service announcements featuring elected officials, and tips delivered by weather reporters during television weather forecasts also help educate residents about what they should do before and during storms.

Remapping flood prone areas. In addition to raising the awareness of all Seattle residents about how to prepare for flooding, SPU wanted to bring more intensive public education to those neighborhoods where the risk of flooding is highest. To target its public outreach efforts in this way, SPU first needed updated maps of flood prone areas that took account of more recent data on precipitation and stormwater flows. Its existing maps, prepared by the Federal Emergency Management Agency (FEMA), were not scheduled to be updated by FEMA anytime in the near future. So SPU secured FEMA’s agreement to let the utility revise the maps using its own data, staff, and resources.¹



One of Seattle’s updated maps of flood prone areas

SPU began with two areas that had experienced recent flooding, a creek watershed and a neighborhood with only artificial drainage structures. Using field measurements of the capacity of their drainage systems, models for predicting stormwater conveyance, and observations of water levels reached during the December 2007 storm, the utility produced revised maps with new boundaries for flood prone areas. The boundaries delineated the areas within which properties were likely to flood during a 100-year storm. SPU used the information to launch a targeted public outreach campaign, which included articles in local newspapers, public meetings, and letters to property owners at risk of flooding.

I

¹ Eventually FEMA will review Seattle’s revisions and approve them, at which time they will become the official FEMA maps.



Integrating climate impacts into capital project planning. “How climate change will affect flooding is not specifically known enough yet for us to make significant changes to our design standards for drainage projects,” says Gary Schimek, SPU’s Separate Systems Manager. In the meantime, though, SPU has made a push to increase consideration of flooding on a project-by-project basis. “We are trying to anticipate how new infrastructure will be affected when flooding does occur,” explains Schimek. “And we are looking at whether we can build individual projects for bigger storm events without substantially increasing our cost.”

FOOD FOR THOUGHT

Uncertainty in projecting future flooding impacts. When SPU asked scientists to predict what kind of flooding the city might experience as a result of climate-altered precipitation, the analysis did not produce results about which its planners and engineers felt confident. Using data from climate models to predict future flooding patterns is technically challenging in part because of the fine scale of information that drainage planners need to make decisions. They want to understand future impacts in increments of minutes rather than months (to reflect rapid changes in precipitation), and they want to project impacts at many different micro-locations within the city and its drainage system.

“This is very data intensive,” says Paul Fleming, SPU’s Climate and Sustainability Manager. “And there are real questions about whether we can even generate credible, useful, downscaled climate data for urban drainage planning.” Seattle is collaborating with New York, San Francisco, and a team of national climate and drainage experts to understand if it is possible to produce such detailed flooding projections.

If producing credible projections of flooding is currently impossible, then Seattle plans to ask the expert team to identify other ways to integrate potential climate impacts into drainage planning. Alternative methods could include designing drainage infrastructure using recent precipitation data, or data from historic storms that provide a good benchmark for potential future events, or building projects that can be adapted to sustain impacts from larger storms (e.g. through the purchase of nearby open space for additional flood storage).

Look for no-regrets solutions. While SPU works on reducing uncertainty about the frequency and extent of future flooding, its managers have opted to move ahead with adaptive actions that Fleming calls “no regrets solutions.” These are actions that can be implemented at a reasonable cost, and that produce real benefits under a range of potential future scenarios for climate-altered flooding, including low impact scenarios. Frequently, these are solutions that are non-structural, and require work across utility functions and with other government agencies.

One way SPU has identified no-regrets solutions is by actively learning about how other localities cope with flooding. In October 2007, the utility hosted an urban drainage and climate adaptation workshop with researchers and practitioners from all over the United States, as well as the United Kingdom and the Netherlands. Since then, the utility has joined two international research efforts with other water and drainage agencies (called MARE² and PREPARED). Participation in larger forums about climate and flooding has been a strong catalyst for SPU’s adaptation work.

² <http://www.mare-project.eu>



In just three years, SPU has made many no-regrets operational changes that bolster the agency's ability to diagnose problems at vulnerable locations, prevent future flooding where possible, and minimize public safety risks. "We have created an interdisciplinary dialogue about all of our vulnerable locations," says Schimek. "That process leads us to many innovative solutions." Using new tools such *Seattle RainWatch*, SPU is also enhancing its understanding of local storms, and positioning itself to improve emergency response and drainage management regardless of what happens with climate change.

Finally, SPU is adopting a few no-regrets strategies to make drainage capital projects more resilient to flooding. Evaluating whether projects can be built to a higher design standard (e.g. a standard based on the 50-year rather than the 25-year storm) for a small marginal cost is one example. Another is SPU's construction of swales, rain gardens and other types of green infrastructure in city rights-of way, as well as its work with other city agencies to increase the incentives for private property owners to build green infrastructure. Green infrastructure will improve infiltration of stormwater during mild and severe storms, and will produce many other benefits for water quality and neighborhood quality of life.

Encourage adaptive behaviors among residents. "Given the uncertainties we face in projecting climate-related changes in drainage at the scale at which we work, and given how expensive it is to build drainage infrastructure, trying to build our way out of this challenge is probably not the best approach," says Fleming. "We also need to enlist Seattle residents to take an active role in managing water in the urban environment."

SPU's work to revise FEMA flood maps, a task that lies outside the traditional domain of a drainage utility, will lay a foundation for sharing the responsibility for adaptation with city residents. By identifying more accurately where flooding is likely to occur during major storms, the new maps are informing decisions about drainage improvement projects. But just as importantly, the new maps are helping SPU work with the city's land use and legal

departments to ensure that property owners in the flood prone areas understand and are subject to city development regulations for areas at high risk of flooding. The revised maps also allow SPU to educate those property owners on what they can do voluntarily to manage risk. These are important strategies that do not rely on building more and expensive drainage infrastructure.

ENCOURAGING CITY RESIDENTS TO ADAPT TO FLOODING

- SPU's Adopt-A-Drain Program provides equipment and guidance to citizens who agree to clean leaves out of storm drains, as well as curb-side leaf pick-ups.
- Once every fall, SPU distributes sand bags at central locations
- City land use agencies are working together to educate property owners about approaches to development that reduce or minimize flooding risks.

Have a sensitive outreach strategy. An effort to publicize the revised maps of flood-prone areas in the media included referring reporters to home owners. These homeowners said that they wanted accurate and scientifically-based information about flooding risks. But when SPU sent letters to all affected property owners in the newly designated flood prone areas, this prompted a wave of angry phone calls as recipients struggled to understand their new status.

"In retrospect, we should have sent out several letters so we could deliver information in stages," says Holly McCracken, a Flood Control and Drainage Capacity Planner at SPU. "We tried to



accomplish too much all at once: informing people about their risks; letting them know we would do emergency response, but that they also had a responsibility to help themselves; encouraging them to get flood insurance; and announcing that their property would soon be subject to new development restrictions.”

SPU responded to the public outcry by organizing a round of community meetings at which staff spent hours listening to people’s concerns and answering their questions. McCracken was assigned to be the sole point of contact for property owners, a move designed to ensure that they heard consistent and sensitively-delivered information. “We know now that we have to focus first on helping people understand the real risks to their safety and their properties,” McCracken reports. “Otherwise those messages get lost.”

Written by Sarah McKearnan, Consultant to the Institute for Sustainable Communities

FOR MORE INFORMATION

Examples of regional and City of Seattle public communications about flooding,
http://www.cityofseattle.net/UTIL/Services/Drainage_&_Sewer/Emergency_Weather_Tips/StormsFlooding/index.htm

The region’s “Take Winter by Storm” website, <http://www.govlink.org/storm>

Green stormwater infrastructure in Seattle,
http://www.cityofseattle.net/UTIL/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/index.htm

CASE STUDY: BOLSTERING RESILIENCE BY INTEGRATING ADAPTATION INTO LOCAL PLANNING AND OPERATIONS

New Orleans Community-Driven Adaptation and Planning

The destruction and devastation that occurred after Hurricane Katrina has been well documented, but there is another story emerging from New Orleans. An extraordinary new level of civic and community engagement is helping to drive the recovery and rebuild a city that retains strong ties to its history and that is forward thinking in addressing future challenges. In the process, the city is becoming a laboratory for innovation in sustainable planning and design. As New Orleans continues to rebuild, it still faces many serious obstacles to long-term survival. Yet the city has embraced the concept that becoming a greener city is the right path to withstanding future storms and flooding. At the same time, the greening of New Orleans is making the city safer and more attractive to business and residents.

This case study highlights a few of the ways that the city, residents and community organizations are adapting to current and future climate impacts to create a dynamic and resilient new New Orleans.

RECOVERY AND RESILIENCE INITIATIVES

Post-disaster planning. Addressing the scale of damage in New Orleans after Katrina has been no



small challenge, but today the city has a state-of-the-art comprehensive master plan that will shape growth and development for the next 20 years. The plan promotes compact, mixed-use, energy efficient, neighborhood-oriented development, improved transportation, and many other strategies to support its three pillars of livability, opportunity and sustainability. Most importantly, the plan squarely addresses the main adaptation challenge for the city: its vulnerability to climate change and sea level rise, and the need for better protection from storms and flooding.

The plan recommends preparing for climate change by adopting standards and techniques to increase resilience, and by engaging the community in dialogue about risk and mitigation options. It also adopts a strategy referred to as “multiple lines of defense”—an integrated approach to flood



New Orleans Master Plan community forum. Image credit: www.nolamasterplan.org

control that calls for restoration of Louisiana’s coastal wetlands and other natural barriers, and structural strategies, such as levees. In a departure from the past, however, the plan also advocates learning to live with water, transforming it to an asset and integrating it in the urban landscape through canals and green infrastructure (see next snapshot). While the planning process was confusing and, at times, chaotic and exhausting, the end result is a broadly supported plan that was shaped by thousands of person-hours of community participation, as well as global best practices in sustainable urban planning and adaptation.

Making it happen. The story of post disaster planning in New Orleans is a complicated one. A governor’s conference two months after the storm set the stage with a vision of making New Orleans a model for innovative and sustainable approaches for protecting low-lying cities from flooding, developed through a community-based planning process. This framed a central challenge: In a city known fondly as The Big Easy, there was not a strong history of planning and a nearly nonexistent culture for civic engagement. A lack of strong central leadership and vision by the mayor after Katrina left a void filled by myriad planning processes launched by various public and private entities and neighborhood organizations that were committed to rebuilding their homes and neighborhoods. Ultimately, the City Planning Commission took charge, enlisting the help of a Boston firm, Goody Clancy, to develop the master plan. The plan merged elements of other earlier recovery-focused plans.

The City Planning Commission insisted on intensive public participation. Multiple methods—workshops, neighborhood meetings, media outreach, and a project website—were used to engage the more than 5,000 residents who participated in the shaping of the new plan. Despite the initial tensions about how and where to rebuild that characterized early post-storm planning efforts, the final version of the plan was greeted with wide enthusiasm. The next step will be the creation of a comprehensive zoning ordinance. The plan ensures continued civic engagement by incorporating elements for ongoing public participation to implement this sweeping new vision for the city.

Community based adaptation and mitigation in the Lower 9th Ward. In the wake of the storm, when the city’s planning process and resources remained at best unclear, many individual neighborhoods proceeded to develop their own recovery plans with the encouragement of the mayor. The Holy



Cross district in the devastated Lower 9th Ward was one of those neighborhoods. Less than a year after the storm, the Holy Cross Neighborhood Association (HCNA), in partnership with Tulane University and other neighborhood organizations produced a sustainable restoration plan for the entire Lower Ninth Ward. The resident-led effort represented the type of new civic engagement that is creating neighborhoods that are on the forefront of sustainability. The plan addressed four areas: urban design and the built environment, the economy, the environment and quality of life.

Some of the notable elements include:

- Encourage families whose homes were destroyed to relocate in the higher portions of the Ward, to consolidate buildings and residents, and to create a new, less-vulnerable “footprint”;
- Utilize the many vacant lots and open spaces for infill development and to maintain green space as buffers between residential and industrial areas;
- Preserve and enhance the existing, historic housing stock through green building technologies and designs; and
- Dramatically reduce the Lower 9th Ward’s carbon footprint and become an example to communities around the country.

Making it happen. Holy Cross was selected by specialists from Tulane/Xavier Center for Bioenvironmental Research and the Louisiana Department of Natural Resources as a pilot project to demonstrate ways of restoring or rebuilding damaged neighborhoods. While the availability of

outside expertise was helpful in developing the plan, the residents themselves shaped it through a process of planning exercises, design workshops and neighborhood needs assessments.



A building being reconstructed into the new home for the Holy Cross Neighborhood Association and the Lower 9th Ward Center for Sustainable Engagement and Development. This new structure will feature many materials from the historic building that stood there. Crews from Historic Green assisted with the deconstruction in March 2009; the completed center will be donated to the neighborhood, courtesy of the Preservation Resource Center. Image credit: Darryl Malek-Wiley

Soon after the Sustainability Restoration Plan was completed, the members of HCNA realized that a separate, formal organization was needed for implementation. In January 2007, HCNA launched the Lower Ninth Ward Center for Sustainable Engagement and Development, which was charged with sustainable rebuilding and advocacy for the entire Lower Ninth Ward. CSED’s mission is to encourage restorative rebuilding, sustain natural systems, support community leadership, and

stimulate civic engagement through an informed, protected, engaged, repopulated Lower Ninth Ward. CSED hopes to create a cohesive, prosperous, sustainable community that is carbon-neutral by 2030. Focus areas include the following:

- Link returning residents with sustainable building resources and training opportunities on restoring their homes;
- Assist the community through bulk purchasing of low or no cost sustainable technologies



and materials;

- Develop parks and community gardens; and
- Take positive action on behalf of Lower 9's unique natural systems, especially to protect its wetlands.

CSED is working to implement the strategy with a variety of partnerships with universities, and local and national partners such as the Sierra Club and Global Green.

From vacant lots to urban farms: making new use of empty land. One significant outcome of the comprehensive planning was a decision to maintain, rather than shrink, the city's overall footprint, even though the current population is somewhere around 80 percent of what it was before the storm, according to the New Orleans Community Data Center.³ As a result of storm damage and population decline, more than 60,000 vacant lots dot the city, most of these heavily concentrated in the hardest hit neighborhoods. While the lots present opportunities for future growth, they also leave once bustling neighborhoods looking empty and blighted. One solution is to transform these empty pockets into a network of urban farms and gardens.

Organizations such as the New Orleans Food and Farm Network (NOFFN) and a host of others are seizing the opportunity, training a new generation of urban farmers, who are transforming the plots into verdant gardens and orchards. In the process, they are improving the environment, creating opportunities for education about sustainable and organic growing practices, increasing the supply of local, fresh food, and creating a network of green infrastructure.

There has been a boom of urban agriculture initiatives across the city since the storm. Many of these initiatives integrate growing practices with education and training:

- Covenant House, which provides training and shelter for homeless youth, is turning ten empty lots in the Tremé neighborhood into fruit and vegetable farms in a partnership with NOFFN. The food that is grown will be sold to local restaurants, providing a source of revenue to support Covenant House programs, and will be a source of nutritious meals for shelter residents.
- The School at Blair Grocery is transforming the site of what was the first black-owned business in the Lower Ninth Ward, and which, like much of the neighborhood was boarded up after Hurricane Katrina. A former school teacher from New York City has worked with the neighborhood to re-open the former grocery store as something of an alternative school for neighborhood students, who are composting, planting, and harvesting as they learn about nutrition and local food. The Grocery is a source of fresh produce for neighborhood residents as well as area restaurants.
- The Backyard Gardeners Network in the Holy Cross Neighborhood is working to bring the neighborhood together through community gardens, where families can congregate and socialize, grow vegetables and pick from fruit trees. Thanks to a Cox Conserves Heroes Award, the organization will also be able to restore a dilapidated cottage to use for storage space and as an education center for community gardeners. "This is a neighborhood that doesn't have a grocery store," Network Founder, Jenga Mwendo said. "And yet a couple of generations ago, everybody had fruit trees in their yards. We're just trying to preserve and

³ <http://www.gnocdc.org>



encourage that tradition.”
Making it happen. The New Orleans Food and Farm Network is working to build a partnership with the city, which oversees many of the vacant properties, and other nonprofits to figure out how the lots could be purchased by or donated to nonprofit organizations. The Food & Farm Network is also talking with the handful of farmers currently growing in the city to see how they can support them in their efforts to turn their sites into models and the farmers themselves into mentors for the next generation.



Jenga Mwendo, the founder of Backyard Gardeners Network, shown here with her daughter. Image credit: Chris Granger, The Times-Picayune

The city master plan supports the growth of urban agriculture through a number of measures, such as removing zoning and regulatory barriers, encouraging food-growing on public and private property, inventorying possible sites, and providing renewable leases for gardening organizations, schools and neighborhood groups.

Architectural innovations to create safe affordable housing. Developers and nonprofit organizations are building sustainable and affordable architectural model homes throughout the city. The most well known, the Make it Right project supported by actor Brad Pitt, has built some 30 houses in an area of the Lower 9th Ward that was wiped out when the levees broke.

The houses incorporate high design elements (which have gotten a somewhat mixed response from area residents), as well as features that will make them safe, affordable and sustainable for low-income residents. The homes are modern, colorful and compact, using existing narrow lots. Taking a practical approach, the houses were elevated and built with accessible roofs for easy escape and rescue in the case of extreme flooding. One is a floating house—the first in the United States.



Image credit: Trevor Reichman

Because of this new concentration of green houses (which are surrounded by many vacant lots), the neighborhood actually has the highest concentration of LEED residences in country. The houses put a modern spin on traditional architectural elements, such as front porches that contribute to building the social fabric of these traditionally tight-knit neighborhoods. Global Green, which also built two green affordable homes in the Holy Cross District, has turned one of the houses into an educational center, providing daily tours that highlight features like net-zero energy use, green roofs, passive cooling,



and the use of green materials.

Making it happen. The overwhelming challenge of restoring or rebuilding the city's housing stock—70% of which was damaged by post-Katrina flooding, the lack of strong central leadership and resources, and the desire by many to help New Orleans rebuild, has led the city to become something of a mecca for experimental residential design. Urban designers, architects and architecture students saw an opportunity to put their skills to use by helping residents rebuild better, stronger, safer homes. Private philanthropy, public resources, real estate expertise, and residents interested in returning home were all part of the process. Residents and future homeowners were involved in selecting the designs that would eventually be built through a series of design competitions that involved some of the world's top designers.

FOOD FOR THOUGHT

The New Orleans situation is unique in many ways because of the scale of the disaster that created the impetus and the opportunities for change. Nonetheless, any city vulnerable to severe climate impacts can gain important insights and inspiration from the adaptation planning and recovery that is underway in New Orleans.

Drawing on local and global expertise. New Orleans looked both inward and outward for ideas and input. Residents and international expertise both had a strong influence on the planning and rebuilding process in New Orleans. Interaction with Dutch experts (see next case study) led to a fundamental rethinking of the city's approach to water while local residents are driving much of the rebuilding and innovation that is happening at the block and neighborhood level. It is important to see the value in both, and build internal and external partnerships around adaptation planning to stay ahead of coming impacts.

Forging public private partnerships. Government resources alone were insufficient for New Orleans to recover from the Katrina disaster, and they will likely be insufficient to implement all the strategies in the city's new comprehensive plan. The initiative, creativity and energy of citizens, public and private partners, and openness to outside expertise were all part of the effort for shaping the rebuilding process. New Orleans was able to tap into some exceptional outside partners, but local resources like Universities, small businesses/entrepreneurs, industry and residents were also tremendous asset for the city. All cities have access to these kinds of resources and can look for ways to build public-private partnerships well before a disaster strikes.

Engaging citizens in creating a safer future. Citizens and communities motivated to see New Orleans come back had a new purpose and reason to work together, giving rise to an unprecedented level of civic engagement that has helped drive the recovery. Residents and nonprofit organizations have had a huge impact. Their advocacy, for instance, helped lead to the closure of a major shipping channel (Mississippi River Gulf Outlet) that had come to be known as the "hurricane highway." Residents and businesses want to stay in New Orleans—but they also want to know they will be safe. Their interest in protecting family and



Image credit: http://kathyprice.tyepad.com/dispatch_from_new_orleans/2008/09/signs-of-the-ti.html



property can lead them to respond to new ideas and take part in community-wide dialogues and action, which can ultimately lead to better policies and planning. Engaging citizens in dialogue and planning for the future protection of their community can help build trust and collaboration, and increase the civic engagement that is part of what makes a community sustainable.

Planning matters. New Orleans lacked a history of planning and had to invent a process after the storm. The result was slow, inefficient, confusing, and probably more costly than necessary. Although the end result was quite positive, existing planning mechanisms would have likely made for a faster and smoother process and would have kept residents and business owners better informed. Cities that lack strong central planning should at least consider the kinds of planning issues that might come up after a disaster and how they would deal with them. Better yet, they can start planning and adapting now to mitigate and avoid the worst.

Written by Betty Weiss, Senior Program Advisor to the Institute for Sustainable Communities.

FOR MORE INFORMATION

New Orleans Master Plan website, <http://www.nolamasterplan.org>

“No More Surprises: Land Use Planning in New Orleans,” *The New Orleans Index at Five: Reviewing Key Reforms after Katrina*, <https://gnocdc.s3.amazonaws.com/NOIat5/LandUsePlanningEssay.pdf>

“To the Heart of the Matter: Coastal Restoration and the Future of New Orleans,” <https://gnocdc.s3.amazonaws.com/NOIat5/CoastalRestorationEssay.pdf>

Nonprofit network of New Orleans neighborhoods facilitating neighborhood collaboration and empowerment: Neighborhood Partnership Network, <http://www.npnnola.com>

Sustainable Restoration Plan of Holy Cross/Lower 9th Ward, <http://davidrmacaulay.typepad.com/SustainableRestorationPlan.pdf>

New Orleans Food and Fam Network, <http://www.noffn.org/article.php?story=nolacityfarms.urban>

Architectural innovation: “Houses of the Future” article in *The Atlantic*, <http://www.theatlantic.com/magazine/archive/2009/11/houses-of-the-future/7708>

Make it Right Foundation, <http://www.makeitrightnola.org>

Global Green’s work in New Orleans, <http://www.globalgreen.org/neworleans>

Community based adaptation and mitigation in the Lower Ninth Ward, <http://davidrmacaulay.typepad.com/SustainableRestorationPlan.pdf>

Climate Change and the Resilience of New Orleans: The Adaptation of Deltaic Urban Form, https://www.lincolnst.edu/pubs/dl/1677_892_AC%20Replacement%20Final.pdf

New Orleans and Climate Adaptation, Doug Meffert, in *Metropolitan Planning for Climate Change in U.S. and Australian Cities* (tentative title), Edward J. Blakely (editor), Lincoln Institute of Land Policy. Available in Spring/Summer 2011.

“Sustaining coastal urban ecosystems,” Torbjörn E. Tömqvist and Douglas J. Meffert, <http://www.tulane.edu/~tor/documents/NGcomm2008.pdf>



Dutch Dialogues Inform New Orleans' Approach to Life on the Delta

In addition to visiting the French Quarter, visitors to New Orleans may also one day see floating houses, meandering canals running down the middle of busy commercial avenues, and a lively lakeside boulevard with majestic views, thriving businesses, parks, marinas and hotels. These are just a few of the new ideas that are emerging from the Dutch Dialogues, a series of interactions between planners, architects and urban designers from the New Orleans area and their counterparts from the Netherlands.

The Dutch Dialogues are a collaboration between the Crescent City and a country that has developed some of the most sophisticated approaches to water management in the world: the Netherlands. They are inspiring New Orleanians to rethink their relationship to the water that surrounds the city. By integrating water into the urban fabric—instead of building ever higher walls to keep it out—New Orleans may find a way to be safer while also protecting, preserving and enhancing what residents value the most: the history, culture, and distinctive neighborhoods that give New Orleans its unique flavor.

The Dialogues grew out of a visit to the Netherlands—a country that lies largely below sea level, as New Orleans does - by a Louisiana delegation led by U.S. Senator Mary Landrieu in the months after Katrina. There participants saw first hand the Dutch approach to managing, living with and embracing water as part of everyday life rather than fighting against it.

Subsequently, with help from the Dutch Embassy, the American Planning Association and a New Orleans-based architectural firm, state and local officials organized the first official Dutch Dialogue, a fact finding visit to New Orleans by a Dutch team in March 2008 to learn more about New Orleans and whether the approach taken by the Netherlands could be adapted there. The following October a team of Dutch, U.S. and local experts reconvened in New Orleans to start brainstorming design ideas. Dialogue 3, in spring 2010, included a series of charrettes and planning sessions focusing on specific neighborhood and regional water-friendly strategies.



Dutch Dialogue 3 workshop, held at Tulane University's School of Architecture. Image credit: <http://dutchdialogues.com>

New Orleans sits along the Mississippi river and adjacent to Lake Pontchartrain, the largest lake in Louisiana, and is within a short distance from the Gulf of Mexico. Although water defines the city in many ways, attempts to manage it have treated this resource mainly as an adversary. Extensive measures to keep water out – complex pumping systems and unsightly levees, floodwalls and drainage canals – have ultimately only made the city more vulnerable. The failure of the levees after Katrina starkly illuminated the need for a different, and more effective, approach to flood protection. Like the Netherlands, New Orleans is situated on a muddy sediment-rich river delta, which is becoming increasingly vulnerable to flooding and storms as a result of climate change,



sea level rise, and natural subsidence. After a devastating flood struck the Netherlands in 1953 killing 2000 people, planners and policymakers there began developing new solutions to mitigate flood risk while creating attractive urban spaces and opportunities for residents to enjoy nature and recreation. The Netherlands today is a recognized leader in adaptive water management. The Dutch are convinced that New Orleans has the same opportunity to develop its own sound, innovative approach to water that goes beyond fixing levees to envisioning the kind of city that New Orleans could become.

For New Orleans planners, this means thinking about water management systems that increase flood protection and enhance safety and sustainability. The ideas that are being explored include a new super-levee along with neighborhood-scale systems like canals, urban wetlands and green spaces for stormwater storage and removal of concrete walls that now line drainage canals to provide waterfront access to neighborhood residents. A bold proposal to build new islands along Lake Pontchartrain could assist in reducing the risk of storm surge and protect levees.

Reversing a long-standing approach to how the city manages and public relates to water is no small matter. It requires thoughtful planning, policy changes, financial investments, and above all, a change in attitude by citizens and key institutions. New Orleans is off to a good start, having incorporated some of the Dutch Living with Water principles into the city's brand new comprehensive master plan. The state is working closely with the city and nearby parishes to integrate some of the Dialogue ideas into the ongoing recovery process. The idea seems to be catching on elsewhere too, as cities like New York⁴, Tampa Bay and San Francisco are taking steps to rethink their own relationship with water in adapting to sea level rise and other impacts from climate change.



Dutch Dialogue 3 workshop, held at Tulane University's School of Architecture. Image credit: <http://dutchdialogues.com>

Written by Betty Weiss, Senior Program Advisor to the Institute for Sustainable Communities

FOR MORE INFORMATION

Dutch Dialogues website, <http://dutchdialogues.com>

Book anthology of writings on the proceedings of the Dutch Dialogues Conferences, *Dutch Dialogues: New Orleans/Netherlands: Common Challenges in Urbanized Deltas*

⁴ For example, see http://www.believmag.com/issues/200910/?read=interview_nordenson for an interview with structural engineer Guy Nordensen regarding his Palisade Bay proposal for New York City, which includes renewing and expanding wetlands, introducing piers, parks, and tidal marshes, and a porous boundary between the city and the sea.

See also http://www.moma.org/explore/inside_out/2009/12/01/rising-currents-two-weeks-deep/#description for proposals, models, drawing, and analysis for New York City harbors and coastline.



Insurance Industry Takes Steps to Address Future Climate Impacts

The insurance industry, like cities across the United States, is grappling with how to deal with the projected impacts of climate change. While climate change represents potential new business opportunities for the industry, extreme weather events also pose a huge risk, not just to property insurers, but to health and life insurance providers too.

The success of the insurance industry depends on successfully anticipating and managing risk. The industry is, therefore, keeping a close eye on climate forecasts. Insurance companies have also taken steps to mitigate future climate impacts by reducing greenhouse gas emissions, though there is a growing recognition that because of the need to reduce risk in the short term, adaptation is actually far more relevant to the industry than mitigation. Some insurers are promoting greater resilience to climate-related events by providing incentives to homeowners to retrofit their houses in ways that protect against future storm damage.

But for the most part, the actions that insurance companies are taking today are based on models of historic climate patterns, not the new climate projections. Adaptation planning is challenging for insurers for a number of reasons:



<http://governancefocus.blogspot.com>

Adaptation varies by location. The way that insurers respond to climate risk depends on the type of hazard they have to account for, which varies considerably across insurance markets. The risks in coastal communities, for instance, are very different from, say, those in the Midwest. So it's impractical to think about a national or industry-wide response. Also, insurance is regulated at the state level, making for inherently varied approaches to dealing with the future risks of climate change.

Time horizons. Most insurance companies write policies on an annual basis. Premiums, deductibles and coverage limitations are determined based on sophisticated models and actuarial science that factor in historical data. These models are not currently designed to account for climate projections. But even if they were altered, the insurance policies couldn't be easily rewritten because of regulatory restrictions that protect consumers from dramatic rate increases.

Public insurance. There is a significant policy debate underway about the role of public insurance pools in insuring against economic losses in hurricane-prone and other vulnerable areas. Several federal bills, currently under consideration, could affect the balance of public and private responsibility.

The issue is also playing out at the state level. Florida in particular is having a vigorous debate about



the Florida Citizen's Property Insurance Corporation, a state insurance pool. In the interest of promoting fair and affordable insurance coverage, Florida set a cap on premiums, which resulted in many private insurers leaving the market. The state program is now deep in debt from the number of claims that it has had to pay out. There are also questions about the state's ability to pay future claims in the event of another major catastrophe. Florida wants a federal guarantee for the state program, but private insurers oppose the idea, arguing that the state program is artificially holding down premiums for coastal property owners. The state is under pressure from residents and businesses to keep rates affordable, but industry and environmental interests argue that the current rates encourage people to build and live in places that are unsafe, and that this behavior unfairly spreads the cost of insurance to people in non-coastal areas.

Despite these issues, some of the major insurers and reinsurers are taking steps to work with partners on climate adaptation and are discussing how to incorporate risk into their underwriting practices. Reinsurers, who take more of a global perspective, have been looking at adaptation in non-US markets, and are increasingly seeking ways to bring lessons from abroad to bear in the United States. So far the overall industry has a relatively shallow engagement on the adaptation side of climate change, but that is expected to change. Major players are taking the lead, and part of the role they see themselves taking is educating some of the smaller and medium sized companies. Industry leaders say that ultimately the answer is not to insure against risk, but to work with communities and government partners more effectively on risk management, so that hazards are manageable and, therefore, uninsurable. Some of the ways the industry is helping to advance local adaptation planning include:

Research. There is a fair amount of research underway to better understand the risks and possible impacts of climate change, and how the insurance industry can respond. The Economics of Climate Change Working Group, an international consortium which included foundations, private sector companies and international agencies, looked at cost-effective adaptation measures in several vulnerable regions of the world including South Florida. Members of the Working Group briefed Florida insurance commissioners and business leaders on the findings from their analysis, designed to help inform the local insurance debate and identify some potential solutions.

Assisting state/local government adaptation planning efforts. The state of Connecticut launched a comprehensive climate action planning initiative, led by the Governor's Steering Committee on Climate Change (GSC). The GSC formed an adaptation subcommittee that is assessing the impacts of climate change on Connecticut's infrastructure, natural resources, public health, and agriculture, and developing recommendations for changes to programs and laws that would enable state and local government to adapt to such impacts. The state's insurance regulatory agency is participating in the subcommittee.

The state also reached out to Swiss Reinsurance Company, a reinsurer with significant business interests in the state. Mark Way, Director of Sustainability Development for the Americas Risk Management Division of the Swiss Re, says his company was approached to provide advice and expertise to help frame the subject and help the subcommittee members think about the impacts of their decisions in the context of economic loss mitigation. His company also played an advisory role in the adaptation planning efforts of the New York City and the State of New York.

Tools and education. CERES, a national network of investors, environmental organizations and other public interest groups working with businesses on global sustainability issues, argues that the insurance industry can be a critical voice in finding solutions to the challenge of climate change.



CERES is working with stakeholders to find meaningful ways to think about and manage risk. CERES is also educating state insurance regulators and working with federal agency partners and the Community and Regional Resilience Initiative (CARRI, one of eight NOAA-funded Regional Impact and Science Assessment programs) to develop more robust risk assessment tools.

Advocacy and policy. The Smarter Safer Coalition brings together consumer advocates, insurance industry representatives, environmental advocates and emergency management agencies to promote safe, environmentally responsible, fiscally sound approaches to natural catastrophe policy. The coalition supports a federal government role in encouraging and helping homeowners to undertake mitigation efforts to safeguard their homes against hurricanes. They are fighting policies that, in their view, would provide unfair subsidies for insurance of coastal residential properties. The Coalition's position is that such policies encourage people to build houses in hurricane-prone, environmentally sensitive areas. Smarter Safer has also developed a statement of principles regarding approaches to building in such areas.⁵

Insurers are important partners for cities in mitigating economic losses to communities, businesses and individuals. While the insurance industry continues to identify ways it can respond to the challenge of global climate change, cities can take steps today to work with their insurance partners:

- In a process that is already underway in many places, one of the first steps is to identify key local hazards and potential risks.
- Start the conversation about how to better manage risk by identifying the key insurance and reinsurance entities serving the local community, and reaching out to them. Some of the larger companies could be helpful resources and partners in developing a local climate adaptation strategy.
- Look to how other cities have engaged the insurance industry in their efforts in order to learn from others' experiences.

Written by Betty Weiss, Senior Program Advisor to the Institute for Sustainable Communities

FOR MORE INFORMATION

Resilient Coasts: A Blueprint for Action, The Heinz Center and Ceres (endorsed by leading insurers, public officials, risk experts, builders and conservation groups), http://www.heinzctr.org/Press_Releases/resilient_coasts_blueprint.shtml

Chapter 6: Insurance Industry, New York City Panel on Climate Change: <http://onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.2009.05320.x/abstract>

CERES webpage on the insurance sector, <http://www.ceres.org//Page.aspx?pid=760>

Community and Regional Resilience Initiative (CARRI)'s Community Resilience System Initiative, http://www.resilientus.org/community_resilience_system_initiative.html

⁵ <http://www.smartersafer.org/about-us/statement-of-principles>

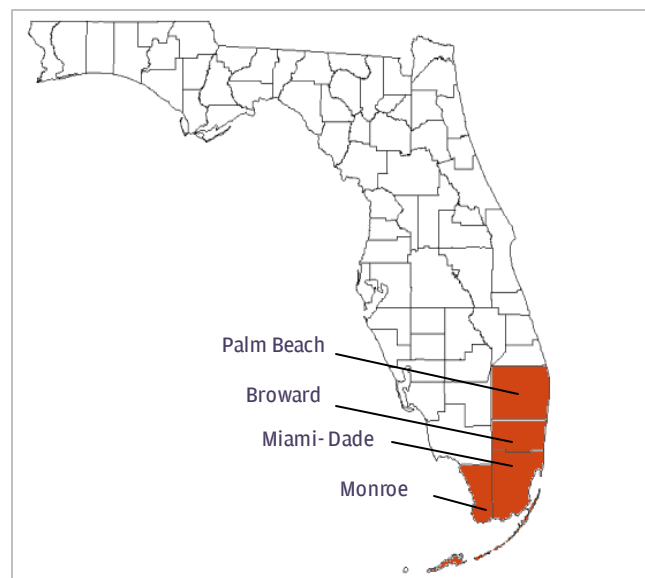


Southeast Florida Regional Climate Change Initiative

Broward County has been leading an initiative since 2009 to coordinate the mitigation and adaptation planning of a four-county area representing 127 municipalities. The initiative is based on an understanding of shared concerns, and is driven by strong leadership and a commitment to fostering relationships. The initiative has a diverse funding strategy, and is becoming a promising model of how governments can collaborate on climate planning across jurisdictional boundaries.

THE BASICS

Getting started. In May of 2009, elected officials and staff representing several Florida counties, including Broward, Miami-Dade, and Monroe traveled to Washington D.C. to attend the Local Climate Leadership Summit, seek Congressional support for a national climate policy, and bring attention to the unique vulnerabilities that climate change poses for Southeast Florida. On this trip, the group realized that they were all trying to tell the same story about climate change in Florida, but that they were using different information. Their projections for sea level rise and maps of vulnerabilities, for example, were slightly different. The discrepancies detracted from their shared message because it meant that the Southeast Florida delegation had to spend time explaining the differences while building a case for their adaptation needs.



Counties participating in the Southeast Florida Regional Climate Initiative.

These discrepancies, once noted by the delegation, spurred a discussion about the need to generate a common message and garner the regional attention and support of other elected officials. Commissioner Kristin Jacobs of Broward County, who had experience with regional water initiatives, directed her staff to organize a summit of Southeast Florida officials. The purpose of the summit was to kick off regional collaboration on climate strategies. Though these strategies would encompass both mitigation and adaptation, the summit would maintain a focus on adaptation because it provided an effective rallying point, given the anticipated Southeast Florida impacts of climate change on tropical storm intensity, drainage and flood control system operations, and local water supplies.

Southeast Florida Regional Climate Change Leadership Summit (Oct. 23, 2009). Broward County, working with the three other Southeast Florida counties, led the organization of the summit. The Climate Leadership Institute at the University of Oregon provided policy guidance, while Broward County staff in the Natural Resource Planning & Management Division set the overall framework for the event. Representatives from all 127 municipalities in the four counties were invited, which





Audience at the first Southeast Florida Regional Climate Leadership Summit. Image credit: http://www.pbcgov.com/newsroom/1109/11-04-09_climate_change.htm

resulted in 300 people attending. Some one half of the people who attended were elected officials from local, county, state, and federal levels. Other attendees included regional government staff in transportation, planning, and water management and climate. The context for the day-long summit was set by national experts and federal officials. The counties shared their existing efforts and regional considerations in transportation, water, and land use, and one Commissioner from each of the four counties participated in a panel discussion of focal points for

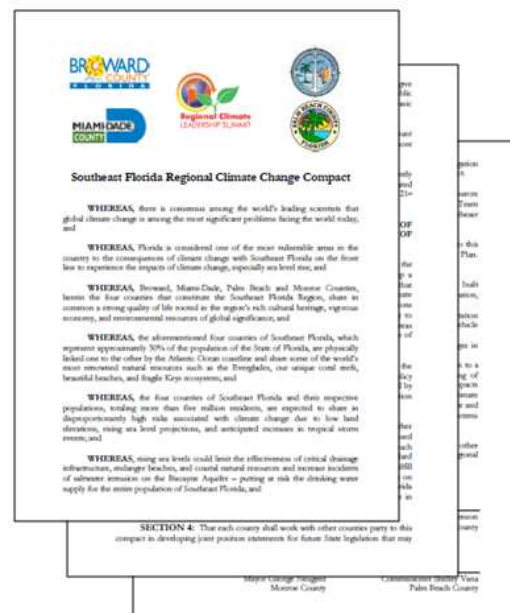
regional collaboration. The day ended with a press event during which these Commissioners signed the Southeast Florida Regional Climate Change Compact.

Southeast Florida Regional Climate Change Compact.

The Compact committed to four types of activities:

- Coordination in development and advocacy of climate legislation at the state and federal level;
- Dedicating staff for a Regional Climate Team that would develop a Southeast Florida Regional Climate Action Plan;
- Developing a regional strategy for climate mitigation and adaptation; and
- Hosting a summit annually to document progress and coordinate future activities.

At the conclusion of the Summit, each of the county representatives then had to gain support for implementation of the commitments from the county boards of commissioners. By January, each of the four boards had unanimously adopted the compact.



Current status A Regional Climate Steering Committee has been formed and is comprised of two representatives from each county, the Climate Leadership Institute, and the South Florida Water Management District, which serves sixteen counties. The Steering Committee meets on a monthly basis with sub-committees convening to take up specific assignments: Summit Logistics, Policy Coordination, and technical projects, the latter of which is part of the Regional Climate Team. This Committee has created a two year work plan geared to producing a regional climate action strategy. In service of this, current projects include a regional greenhouse gas inventory, a regionally-integrated vulnerability map, and unified sea level rise projections. The Compact Counties have also undertaken joint solicitation for resources to support their efforts and are in the process of



developing a joint federal and state legislative policy program. The second annual summit will be hosted by Miami-Dade County in October 2010.

FOOD FOR THOUGHT

Building buy-in in the face of political challenges. Not all of the four counties had Boards that immediately supported regional collaboration. They eventually agreed to support the effort for two reasons:

- *Recognition of changes in the physical environment.* Though philosophies differed on the validity of anthropogenic global warming, the four counties have all experienced salt water going through drainage culverts, and extreme high tide events causing seawater to overtop sea walls and flood people's backyards with greater frequency. Officials could all appreciate the need to make investments to respond to these trends, look beyond the inevitable historical contentions among the counties, and commit to working on sea level rise issues together.
- *Leverage.* By collaborating, the counties could enhance their ability to gain additional resources for the huge task at hand, too great for each of them alone. Together the 127 municipalities of the four counties represent one-third of the state economy and 5.5 million residents. As a group then, the four counties could better command money for adaptation.

In a regional collaboration, the two counties with fewer resources could gain access to the experts used by the other two. Broward County, for example, is considering extending the boundaries of its combined hydrological and climate change model to include suitable sections of Palm County, which could substantially reduce the cost of model development for Palm Beach County.



This map shows that the Biscayne Aquifer (in yellow) underlies the four counties in the compact (outlined in black), illustrating their shared resource, vulnerability, and opportunity for practical collaboration. Image credit: USGS

Successful coordination requires extensive communication. Dr. Jennifer Jurado, Director of Broward County's Division of Natural Resources and Management, who has led the initiative at the staff level, said that "extensive, extensive communications" has made the Compact work. She attributes the achievement of the four-way collaboration to the time taken initially to understand the points of view of the respective Boards of Commissioners and to build relationships across the counties.

Stepwise leadership. Commissioner Kristin Jacobs of Broward County led the initiative by initiating the conversation about collaborating with the other county representatives and by dedicating staff to the effort. Jacobs also solicited the support of a counterpart in each of the three other counties to sign the Compact. Each of these commissioners then sought and won support for the initiative from their full county boards.



One framework for collaboration facilitates other joint activities. Collaboration on adaptation under the Compact is allowing the counties to work together on other political issues. The counties, for example, organized a shared press event to voice their concerns about the BP oil spill. During the event, Commissioners from each county signed a joint letter to Congress, the Obama Administration, and the Florida State Legislature urging action, including passage of “comprehensive climate change legislation prior to the end of the Congressional session.”

Diverse funding and support strategies. As money explicitly available for climate adaptation work is not readily available, the Compact Counties have a diversified fundraising strategy, including pursuing federal appropriations, EPA Smart Growth Initiative, and NOAA Climate Program opportunities. They have also looked to stretch existing dollars via partnerships and the technical assistance programs of state, regional, and non-governmental entities.



Commissioners from the four Southeast Florida Compact counties send a joint letter to President Obama, Congress and Florida State Legislature. Left to right: Monroe Commissioner George Neugent, Miami-Dade Commissioner Katy Sorenson, Palm Beach Commissioner Shelley Vana, Broward Commissioner Kristin Jacobs.

Written by Elaine Wang, Institute for Sustainable Communities

FOR MORE INFORMATION

Text of Southeast Florida Regional Climate Change Compact.

http://www.broward.org/ClimateChange/Documents/fourcounty_compact.pdf

Program for the Southeast Florida Regional Climate Leadership Summit.

<http://www.broward.org/ClimateChange/Documents/sfrcls2009program.pdf>

Contact: Dr. Jennifer Jurado, Director of Broward County’s Natural Resource Planning and Management Division, jjurado@broward.org





Resource Lists

These lists include general resources on climate resilience, and resources specifically about adaptation planning, climate risks and adaptation, as well as getting a commitment on adaptation.

General Resources

This list includes overall resources on climate change adaptation, including national and regional assessments, online portals and peer exchanges, and other useful background information.

SCIENTIFIC ASSESSMENTS OF RISKS & IMPACTS

1. Reports on Confronting Climate Change: Science, impacts, and solutions

This webpage provides access to several reports in a series of in-depth reports on the potential consequences of climate change in several regions and states: the Midwest (IN, MN, MO, OH), Northeast (CT, MA, NH, NJ, NY, PA, RI, VT), Great Lakes region, and the Gulf Coast. To find the relevant publication, search the page for the name of the state or region.

Union of Concerned Scientists, 2007-2009

Webpage ► <http://www.ucsusa.org/publications>

2. Regional Integrated Sciences and Assessments (RISA)

This webpage provides access to all of the currently funded Regional Integrated Sciences and Assessments (RISA) program teams for three Western and four Southern regions. The regional teams support research that address complex climate sensitive issues of concern to decision makers and policy planners. Research areas include fisheries, water, wildfire, agriculture, public health, and coastal restoration.

NOAA

Website ► http://www.climate.noaa.gov/cpo_pa/risa

3. Transportation and Climate Change Clearinghouse—Climate Change Impacts

This annotated list of resources on the impacts of climate change on transportation infrastructure is continually updated.

Department of Transportation, 2010

Webpage ► <http://climate.dot.gov/impacts-adaptations/forecasts.html>

4. Climate Change Indicators in the United States

This report gives an overview of climate impacts and 24 climate change indicators for the United States. The report uses visual tools to help readers interpret these indicators.

USEPA, 2010, 80pp.

Download ► http://www.epa.gov/climatechange/indicators/pdfs/ClimateIndicators_full.pdf

5. Global Climate Change Impacts in the United States

This report summarizes, in plain language, the science and the impacts of climate change on the United States by region, now and in the future. It provides an overview of impacts on various aspects of society and the economy such as energy, water, agriculture, and health.

US Global Change Research Program, 2009, 196pp.

Download ► <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>



6. Why the Emergency Management Community Should be Concerned about Climate Change: A discussion of the impact of climate change on selected natural hazards

This draft report outlines key climate change issues for consideration from an emergency management perspective and introduces potential implications for the near-, medium-, and long-terms. It summarizes the current climate change literature, focusing on the estimated impacts on the location, frequency, and occurrence of natural hazards, such as tropical cyclones, wildfires, floods, and winter storms. It also identifies related policy issues in the areas of disaster mitigation, preparedness, response, and recovery. Finally, it provides potential courses of action to support future dialogue among emergency management practitioners from all levels of government to explore policy solutions in greater depth.

Joel Silverman et al., **CNA Analysis and Solutions**, Jun 2009, 48pp.

Download ► <http://www.cna.org/sites/default/files/research/WEB%2007%2029%2010.1%20Climate%20Change%20and%20the%20Emergency%20Management%20Community.pdf>

ONLINE PORTALS AND PEER EXCHANGES

7. Climate Adaptation Knowledge Exchange (CAKE) website

This searchable website features: profiles of adaptation project case studies (over 100), information resources (over 300), a directory of people and organizations engaged in adaptation work, tools for decisionmakers, managers, and educators (40), and a community section including an international events calendar and advice column.

EcoAdapt and Island Press, 2010

Website ► www.cakex.org

8. Adaptation Learning Platforms (ALPs) website

This website is designed as a place for researchers, practitioners, and others to interact, learn from each other, and advance the global common knowledge about climate change adaptation and preparedness. It includes a good resource library, wiki-based workspaces, moderated discussion forums, community networking, and an expertise locator. The site is open for all to read

WWF

Website ► www.AdaptationPortal.org

9. Coastal Climate Adaption

This site includes a wide range of resources on climate change impacts and adaptation, and a forum for coastal state and local government officials. The list of resources is organized by topic area and state, and includes adaptation plans, action plans, case studies, strategies, guidebooks, outreach material, risk and vulnerability assessments, stakeholder engagement guides, and training and workshop materials.

NOAA, 2010

Website ► <http://community.csc.noaa.gov/climateadaptation>

10. Climate Prep Blog website

This blog showcases climate change adaptation projects through compelling on-the-ground stories and tracking firsthand the progress of preparing for a changing climate at the national and international policy levels.

WWF

Website ► <http://www.climateprep.org>



OTHER USEFUL BACKGROUND INFORMATION

11. Coping with Global Climate Change: The Role of Adaptation in the United States

This report provides a strong overview of proactive adaptation approaches, including infrastructure planning and development, avoidance of "maladaptations", and the role of public policy. It provides more detail on approaches to agriculture, water resources, and sea level rise.

William E. Easterling III et al., **Pew Center on Global Climate Change**, 2004, 52pp.

Download ► http://www.pewclimate.org/global-warming-in-depth/all_reports/adaptation

12. Good Morning, America! The Explosive U.S. Awakening to the Need for Adaptation

The report provides an historical overview of the public, political, and scientific concern adaptation in the United States. It describes the shift from the early concerns with climate change and adaptation to the more recent awakening to the need for a comprehensive approach to managing the risks of climate change. It challenges assumptions that developed nations like the United States face relatively low vulnerability and possess high adaptive capacity to address climate change.

Susanne C. Moser, **California Energy Commission & National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center**, May 2009, 42pp.

Download ► <http://www.csc.noaa.gov/publications/need-for-adaptation.pdf>

13. Assessment of Climate Change Impacts on Local Economies

This report includes an overview of climate change impacts and actions in the Intermountain West: urban heat island and excessive heat events, urban water resources, flooding and floodplain development, ski resorts, national forests and parks, and ranching and farming.

Rosalind, H. Bark, **Lincoln Land Institute**, Oct 2009, 58pp.

Download ► http://www.lincolnst.edu/pubs/1706_Assessment-of-Climate-Change-Impacts-on-Local-Economies

14. Terrestrial Ecosystem Adaptation

This report explores how ecosystems might adapt to climate changes over the next half-century, predicts that large parts of the United States will confront a range of weather-related problems—from plagues of insect infestations to wildfires, from melting permafrost to dried wetlands, and from incursions of invasive species to large-scale species extinction. Although its primary focus is on ecosystems, it also provides map-based overview of heat, precipitation, and snow melt trends across the United States.

Steven W. Running and L. Scott Mills, **Resources for the Future**, 2009, 38pp.

Download ► <http://collaborate.csc.noaa.gov/climateadaptation/Lists/Resources/DispForm.aspx?ID=32>



Adaptation Planning

This list includes climate change adaptation planning examples, more case studies, guidelines and tools.

EXAMPLES AND CASE STUDIES

15. State and Local Adaptation Plans

This webpage tracks state and local efforts on adaptation planning, and provides links to and brief overviews of them. Localities include Homer AK, Phoenix AZ, several cities in CA, Miami-Dade County FL, Alexandria VA, King County WA, and Milwaukee WI.

Georgetown Climate Center, 2010

Download ► <http://www.georgetownclimate.org/adaptation/adaptation-plans.php>

16. Preparing the Pacific Northwest for Climate Change: A framework for integrative preparation planning for natural, human, built and economic systems

This report provides a framework for adaptation planning in Oregon which can help other areas think through components of their plans and how to integrate them.

Climate Leadership Initiative, University of Oregon, 2008

Download ► http://climlead.uoregon.edu/sites/climlead.uoregon.edu/files/reports/Preparing_PacNW_for_ClimateChange_4-2-08.pdf

17. Cities Preparing for Climate Change: A study of six urban regions

This report incorporates the lessons learned from six “early adopters” - London, New York, Boston region, Halifax, Greater Vancouver, and Seattle and King County - and addresses these experiences by phase of the adaptation planning process.

Clean Air Partnership, 2007

Download ► http://www.cleanairpartnership.org/pdf/cities_climate_change.pdf

ADAPTATION PLANNING GUIDELINES

18. Preparing for Climate Change: A Guidebook for Local, Regional and State Governments

This guidebook describes a step-by-step process for achieving a set of climate change preparedness milestones within the context of municipal planning, based on ICLEI’s five milestone process. For more information see the Resource Snapshot earlier in this Resource Guide.

University of Washington's Climate Impacts Group, King County Washington, and ICLEI, 2007, 186pp.

Download ► <http://cses.washington.edu/cig/fpt/guidebook.shtml>

19. Objective Setting for Climate Change Adaptation Policy

This guide presents an iterative process for setting objectives in climate change adaptation planning and implementation. It also describes how the model was applied by Defra (UK's Department for Environment, Food, and Rural Affairs) to generate strawmen objectives and targets. This methodology can help other regions systematically think through and prioritize their own objectives.

AEA Technology Environment, Stockholm Environment Institute, Metroeconomica, UK Climate Impacts Programme. 2005, 193pp.

Download ► http://www.ukcip.org.uk/images/stories/Tools_pdfs/Objective_setting.pdf



- 20. The Mitigation-Adaptation Connection: Milestones, Synergies and Contradictions**
This primer briefly describes an approach for integrating adaptation into mitigation planning, and provides several examples, by sector, of how mitigation and adaptation actions can be synergistic, and how they may be contradictory.
ICLEI, Aug 2010, 8pp.
Download ► <http://www.icleiusa.org/action-center/planning/The%20Mitigation-Adaptation%20Connection.pdf>
- 21. Identifying Adaptation options**
This guide includes a framework for identifying and selecting adaptation options.
UK Climate Impacts Programme, 2009, 35pp.
Download ► <http://collaborate.csc.noaa.gov/climateadaptation/Lists/Resources/DispForm.aspx?ID=4>
- 22. Climate Adaptation: Risk, uncertainty and decision-making**
This report provides an 8-stage decision-making framework for examining and choosing among available adaptation options. This framework is most appropriate for decision makers who have some knowledge of climate risks, but who want to better understand them and their adaptation options.
Robert Willows and Richenda Connell, eds., UK Climate Impacts Programme, 2003, 166pp.
Download ► http://www.ukcip.org.uk/images/stories/Pub_pdfs/Risk.pdf
- 23. Community and Regional Resilience: Perspectives from hazards, disasters, and emergency management**
This research paper outlines: what makes people and places vulnerable, including location, infrastructure and economic factors; what makes communities resilient, including recognizing and understanding hazards and planning for disaster recovery, planning and land use and development; and barriers to planning for resilience. It also reviews possible measurement and indicators for resilience and some frameworks for community resilience assessment.
Susan Cutter et al., Community & Regional Resilience Initiative (CARRI), 2008, 33pp.
Website ► http://www.resilientus.org/library/FINAL_CUTTER_9-25-08_1223482309.pdf
- 24. Adapting to Climate Variability and Change: A guidance manual for development planning**
This guidance manual provides through a 6-step process for incorporating vulnerability and adaptation into project design. Although developed for USAID's grantees, the guidelines are readily transferable to other project managers seeking to account for climate hazards.
USAID, 2007, 31pp.
Download ► www.usaid.gov/our_work/environment/climate/docs/reports/cc_vamanual.pdf
- 25. Adapting to Coastal Climate Change: A guidebook for development planners**
This guidebook provides a 5-step process for integrating climate change adaptation into development planning in coastal regions. The guide goes in-depth into assessment, action selection, integration, implementation, and evaluation. It also provides descriptions of several coastal adaptation measures.
USAID et al., May 2009, 148pp.
Download ► <http://www.crc.uri.edu/download/CoastalAdaptationGuide.pdf>



26. Urban Flood Risk Management: A tool for integrated flood management

This tool guides practitioners on flood management and includes information on various types of urban flood hazards, impacts of flooding in cities, risk assessment and management, and a framework for flood risk management. The tool also discusses integrating flood risks in urban planning, surface water management plans, and participatory planning.

Associated Programme on Flood Management, Mar 2008, 44pp.

Download ► http://www.apfm.info/pdf/ifm_tools/Tools_Urban_Flood_Risk_Management.pdf

27. The Resilience of New Orleans: Urban and coastal adaptation to disasters and climate change

This report includes an assessment of the carrying capacity of Coastal Louisiana in terms of geography, infrastructure costs, and land use challenges and opportunities. The methodology used can guide similar assessments for other coastal regions.

Douglas J. Meffert, **Lincoln Land Institute**, 2008, 16pp.

Download ► http://www.lincolnst.edu/pubs/1508_The-Resilience-of-New-Orleans

ADAPTATION PLANNING TOOLS

28. UKCIP Adaptation Wizard

This web-based tool guides users through a 5-step adaptation planning process and provides relevant resources for each step, including how to identify vulnerabilities to climate change and how to identify ways to reduce vulnerability. It is designed for use by a wide range of audiences new to climate change adaptation, and it provides a structure for planning and awareness-raising.

UK Climate Impacts Programme, 2010

Webpage ► http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=147&Itemid=273

29. Planning for Climate Change - Customizable Workshop Materials

The customizable workshop was developed for planners and coastal decision makers. Piloted in two locations in 2009 in Washington State, the materials, including all PowerPoints and streaming videos, are available on the website, and can be used as a roadmap for engaging planners and decision makers. The materials are grounded in science and focus on actions to prepare for and adapt to impacts of climate change.

Coastal Training Program, **National Estuarine Reserve System**, 2009

Webpage ► <http://www.nerrs.noaa.gov/CTPIndex.aspx?ID=455>

30. Local Government Climate Change Adaptation Toolkit

This toolkit includes a 68-page comprehensive manual providing a conceptual framework for adaptation and step-by-step instructions for 14 tools geared towards different stages of adaptation planning. The tools are also available for download from this page, including a planning workshop template, stakeholder identification worksheet, barriers document, and risk assessment scenario worksheet. The tools were piloted with 5 Australian communities prior to the toolkit's release in 2008.

ICLEI and Australia's Department of Climate Change

Webpage ► <http://www.iclei.org/index.php?id=adaptation-toolkit>



Risk Assessments

This list includes resources on risk assessment, including examples, guidelines, and tools. Note that these resources use different terminology for aspects of a risk assessment, and that they may cover different portions of the process.

EXAMPLES

31. Climate Change Adaptation in New York City: Building a risk management response

This webpage provides access to New York City's risk assessment by chapter. The information and recommendations are relevant to other cities, and could serve as a template for other city risk assessments. Content includes how and why New York City might adopt a risk-based approach; infrastructure impacts and adaptation challenges; a review of the range of current environmental laws and regulations for their applicability to climate change adaptation efforts; the role of the insurance industry; and recommendations for a monitoring program. The appendices include three workbooks to guide a climate change adaptation planning process: "Climate Risk Information" related to risks to critical infrastructure, "Adaptation Assessment Guidebook" which outlines a stakeholder process, and "Climate Protection Levels" which evaluates policies.

New York City Panel on Climate Change, **City of New York, NY; Annals of the New York Academy of Sciences**, May 2010

Webpage ► <http://www3.interscience.wiley.com/journal/123443047/issue>

32. Corporate Risk Case Study: City of Chicago Climate Change Task Force

This document reports the results of a Corporate Risk case study modeled for City of Chicago's municipally-controlled assets. Although it does not provide information on the proprietary methodology used, it does show output that can be obtained by such an analysis, which may be useful to others considering whether to undertake such an analysis.

Oliver Wyman, **CCAP**, Jul 2008, 9pp.

Download ► <http://www.chicagoclimateaction.org/filebin/pdf/report/CorporateRisk2008August5.pdf>

33. Risk-based Adaptation to Climate Change: A guide for Ontario municipalities

This guide argues for a risk-based approach to adaptation planning and outlines the process for risk management. It also highlights climate trends and projections in Ontario and Canada and has an appendix that discusses introducing climate change adaptation to local authorities. Another appendix discusses risk communications and perceptions and how to talk to the public about risks.

James P. Bruce, I.D. Mark Egener, David Noble, **Natural Resources Canada**, 2006, 42pp.

Download ► http://adaptation.nrcan.gc.ca/projdb/pdf/176a_e.pdf

34. Climate Change 2007: Impacts, Adaptation, and Vulnerability

The report available on this webpage is the Impacts, Adaptation and Vulnerability component of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. The 16-page "Summary for Policymakers" is available here: <http://www.ipcc-wg2.gov/AR4/website/spm.pdf>, and the 36-page chapter on North America here: <http://www.ipcc-wg2.gov/AR4/website/14.pdf>.

Martin L. Parry et al., **IPCC & Cambridge University Press**, Cambridge, United Kingdom, 2007, 1000pp.

Webpage ► <http://www.ipcc-wg2.gov/publications/AR4/index.html>



- 35. Regional Climate Change Effects: Useful information for transportation agencies**
This report provides the transportation community (including highway engineers, planners, NEPA practitioners) with digestible, transparent, regional information on projected climate change effects that are most relevant to the U.S. highway system. This information informs assessments of the risks and vulnerabilities facing the current transportation system, and can inform planning and project development activities.
Federal Highway Administration, 2010
 Webpage ► http://www.fhwa.dot.gov/hep/climate/climate_effects/effects00.cfm
- 36. CalAdapt/Google Earth Prototype**
This website provides user-friendly, interactive visualizations of the effects of climate change on California, including climate data, sea level rise, wildfire frequency, and snow pack projections. Visualizations are in Google Earth, viewable online or in Google Earth software that can be downloaded for free. The visualization tools are still in prototype phase and have been developed with funding from the California Energy Commission and Google.org.
Stockholm Environment Institute, State of California
 Webpage ► <http://www.climatechange.ca.gov/visualization/index.html>

RISK ASSESSMENT GUIDELINES

- 37. Assessment Approaches**
This presentation provides a clear, to-the-point explanation of different types of assessments and when they are most useful, namely impact, risk, vulnerability, policy, integrated, and adaptation assessments.
Jennifer Pouliotte, Ministry of Environment, Victoria, B.C., 2008, 12 slides
 Download ► <http://cibtadaptation.squarespace.com/storage/AssessmentApproachesOct2008-BCMoE-ClimateChangebranch1.ppt>
- 38. Shaping Climate-Resilient Development: A framework for decision-making**
This comprehensive report provides concepts and tools for thinking about adaptation in terms of risk and how to assess that risk—risk to life, to communities, and to economies and livelihoods. It provides guidance on quantifying the risks of climate disruption, how to make an economic case for investing in resiliency, and how to prioritize adaptation projects. It draws on a number of case studies around the world.
Economics of Climate Adaptation, 2009, 164pp.
 Download ► http://www.mckinsey.com/App_Media/Images/Page_Images/Offices/SocialSector/PDF/ECA_Shaping_Climate%20Resilient_Development.pdf
- 39. Best Practices Approaches for Characterizing, Communicating, and Incorporating Scientific Uncertainty in Climate Decision Making**
This report is a tutorial for climate analysis and decision-making communities on current best practice in describing and analyzing uncertainty in climate-related problems.
M. Granger Morgan, et al., U.S. Climate Change Science Program, Jan 2009, 96pp.
 Download ► <http://www.globalchange.gov/publications/reports/scientific-assessments/saps/sap5-2>



- 40. Climate Change Impacts & Risk Management: A guide for business and government**
Although the cases studies upon which it is based are Australian, this guide can be used by elected representatives, general management, and risk managers elsewhere particularly in their beginning stages of assessment and prioritization. This guide is designed to assist businesses and organizations adapt to climate change and integrate climate change impacts into risk management and strategic planning activities. Case studies about a large private company, a public utility, a government agency and a local government, illustrate a good risk management framework for managing increased risk to organizations due to climate change, and in particular the initial assesment and prioritization of risks.
Australian Government Department of Environment and Heritage, 2006, 75pp.
Download ► <http://www.climatechange.gov.au/en/what-you-can-do/community/~media/publications/local-govt/risk-management.ashx>

- 41. Vulnerability Assessment for Climate Adaptation**
This technical paper presents a structured approach to climate change vulnerability assessment. The paper recommends five tasks and suggests appropriate methods suitable for different levels of analysis. The five tasks link a conceptual framing of vulnerability to identification of vulnerable conditions, analytical tools and stakeholders.
Thomas E. Downing et al., 2002, 39pp.
Download ► www.aiaccproject.org/meetings/Trieste_02/trieste_cd/Vulnerability/TP3_Downing.doc

- 42. Assessing Vulnerability and Risk of Climate Change Effects on Transportation Infrastructure: Pilot of the conceptual model**
This webpage outlines a conceptual Risk Assessment Model that are being piloted by three to four State Departments of Transportation or Metropolitan Planning Organizations selected by the Federal Highway Administration (FHWA). FHWA will refine this draft conceptual model and develop a final version for all transportation agencies. The goal of the Risk Assessment Model is to help transportation decision makers (particularly transportation planners, asset managers, and system operators) identify which assets (a) are most exposed to the threats from climate change and/or (b) are associated with the most serious potential consequences of those climate change threats.
Federal Highway Administration, 2010
Webpage ► http://www.fhwa.dot.gov/hep/climate/conceptual_model62410.htm

- 43. Engineering Literature Review: Water resources - infrastructure impacts, vulnerabilities and design considerations for future climate change**
This review includes information on water infrastructure and climate change resource documents, impacts of climate change on water resources, and a summary, discussion and recommendations. Developed for a more adaptation-focused Canadian audience, this review can be a useful starting point for U.S. water managers seeking to assess their risks.
Slobodan P. Simonovic, PIEVC, 2008, 204pp.
Download ► http://www.pievc.ca/e/Appendix_C_Literature_Reviews.pdf

- 44. Community Resilience: A social justice perspective**
This report provides a good, brief overview of the key social factors that make a community vulnerable and ways to bolster resilience.
Betty Hearn Morrow, **Community and Regional Resilience Initiative (CARRI)**, 2008, 31pp.
Download ► http://www.resilientus.org/library/FINAL_MORROW_9-25-08_1223482348.pdf



ASSESSMENT TOOLS

45. Risk and Vulnerability Assessment Tool (RVAT)

This tool helps to identify people, property, and resources that are at risk of injury, damage, or loss from hazardous incidents or natural hazards. The webpage provides tools and methods to assist in completing vulnerability assessments. The website provides instruction on how to use the Community Vulnerability Assessment Tool, interactive mapping data, a community rating system, and a storm surge visualization tool.

NOAA

Webpage ► <http://csc.noaa.gov/rvat>

46. Community-Based Risk Screening Tool—Adaptation & Livelihoods (CRiSTAL)

CRiSTAL is a project planning and management tool. Used at the community level to incorporate local knowledge about climate change and resource use considerations into development projects, it helps project planners and managers integrate risk reduction and climate change adaptation into projects. CRiSTAL uses a series of worksheets to guide users systematically through the climate change context of their project, the resources at risk, existing coping strategies, and possible project modifications to reduce project vulnerability to climate change. It is designed as an Excel Workbook, but can be used in hard copy. The Workbook and Users' Manual are available in French, English, and Spanish.

International Union for Conservation of Nature, International Institute for Sustainable Development, Stockholm Environmental Institute's U.S. Center

Webpage ► <http://www.cristaltool.org/content/about.aspx>

47. Business Areas Climate Impacts Assessment Tool (BACLIAT)

This tool provides a good starting point for exploring the implications of climate change for a particular business or sector and for municipalities who would like to engage the business sector in climate adaptation efforts. It is comprised of a simple checklist for assessing the potential impacts of climate change under generic business areas. It encourages the consideration of both threats and opportunities and is most effective when used as part of a group brainstorming exercise.

UK Climate Impacts Programme, 2010

Website ► http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=82&Itemid=195

48. Climate Wizard

This web-based mapping program allows non-technical as well as technical users to view historic and projected future temperature and rainfall maps around the world (with finer-scale data for the United States).

The Nature Conservancy, the University of Washington, and the University of Southern Mississippi

Website ► <http://www.climatewizard.org>

49. Digital Coast/ The Coastal Risk Atlas

NOAA's Digital Coast provides data, tools, training, and examples for coastal communities that wish to address a specific issue and become more resilient. Launched in 2008, the Digital Coast is used to address timely coastal issues, including land use, coastal conservation, hazards, marine spatial planning, and climate change. One of the goals behind the creation of the Digital Coast was to unify groups that might not otherwise work together. It also provides information from the Coastal Risk Atlas.

NOAA, 2008

Website ► <http://www.ncddc.noaa.gov/digitalcoast>



50. NOAA Coastal Hazard Assessment Tool

The Hazard Assessment Tool is an easy-to-use Internet mapping application that helps users identify the potential hazards that affect a location. It uses geospatial hazards data and supporting base data to identify hazards, and helps with planning and permitting. Once a location has been selected, the tool queries the hazards data to determine the hazards zone(s) for the location and provides supporting information to put the hazards information in proper context.

NOAA

Website ► <http://www.csc.noaa.gov/hat>

51. HAZUS - FEMA's Methodology for Estimating Potential Losses from Disasters

HAZUS is risk assessment software for analyzing potential losses from floods, hurricane winds and other disasters. In HAZUS, current scientific and engineering knowledge is coupled with the latest geographic information systems (GIS) technology to produce estimates of hazard-related damage before, or after, a disaster occurs. Potential loss estimates analyzed in HAZUS-MH include: physical damage to residential and commercial buildings, schools, critical facilities, and infrastructure; economic loss, including lost jobs, business interruptions, repair and reconstruction costs; and social impacts, including estimates of shelter requirements, displaced households, and population exposed to scenario floods, earthquakes and hurricanes. HAZUS is available in DVDs for free.

Federal Emergency Management Agency

Webpage ► <http://www.fema.gov/plan/prevent/hazus>



Climate Risks and Adaptation Strategies

This list includes catalogs of climate change adaptation strategies: comprehensive resources, and strategies by type: public health, heat, freshwater supply, severe storm/flooding, sea level rise, and built environment.

STRATEGIES FOR VARIOUS CLIMATE IMPACTS

49. Climate Change Actions for Local Governments

This straightforward guide provides a large sampling of possible adaptation actions related to infrastructure, health services, natural resource management, water and sewerage services, and other areas. Descriptions, case studies, and examples are integrated together for easy reading. The guide was developed for Australia but it offers a useful starting point for U.S. cities.

Snowy Mountains Engineering Corporation Australia, **Australia Department of the Environment and Water Resources**, 2007, 76p.

Download ► http://www.climatechange.gov.au/en/what-you-can-do/community/~media/publications/local-govt/localadaption_localgovernment.ashx

50. Chula Vista Climate Action Planning - Climate Change Working Group

This webpage provides access to several 'planning matrices' – tables of detailed adaptation options by topic, compiled by the City of Chula Vista in Southern California for its adaptation planning efforts. Options identify references to other cities. Impact topics include water, energy, public health, biodiversity, business, and sea level.

City of Chula Vista, Department of Conservation and Environmental Services, 2010

Webpage ► <http://www.ci.chula-vista.ca.us/clean/conservation/Climate/ccwg1.asp>

51. Hazard Mitigation Best Practices Search

This database of best practice in disaster mitigation is searchable by location, sector type, hazard, type of activity, and keywords. Hazards include drought, severe storm, extreme temperatures, winter storm, and wildfire. Activities include building codes, outreach, floodplain management, land use/planning, community shelters, utility protective measures, vegetation management, and wetland restoration.

FEMA

Website ► <http://www.fema.gov/mitigationbp>

DEVELOPMENT AND INFRASTRUCTURE

52. International Conference: Strategies for Adapting Public and Private Infrastructure to Climate Change

This website presents a list of workshop materials for the international conference, "Strategies for Adapting Public and Private Infrastructure to Climate Change", held in El Salvador, June 30-July 1, 2010. Resources useful to a U.S. audience include the workshop agenda, concept note, conference presentations, and publications related to the topic of climate proofing of infrastructure in the context of climate change adaptation and urban and regional planning.

Adaptation Learning Mechanism, Jul 2010

Website ► <http://www.adaptationlearning.net/infrastructure-adaptation>



53. Adapting to climate change: A checklist for development

This checklist provides guidance on designing building developments to withstand a changing climate throughout their lifetime. The checklist covers issues such as water re-use and efficiency, reducing flood risk, avoiding overheating and minimizing damage from subsidence and heave.

Greater London Authority and London Climate Change Partnership, 2005, 72pp.

Download ► http://www.london.gov.uk/lccp/publications/docs/adapting_to_climate_change.pdf

54. Adapting to Climate Change: A case study companion to the checklist for development

The companion guide applies the Checklist for Development's guidance (above) and provides case studies of developments or buildings that incorporate adaptation in their design and construction. This guide provides replicable cases of buildings and developments that incorporated adaptation measures to increase resiliency to the changing climate. The case studies address climate change impacts, such as urban heat island effect and flooding, and they illustrate techniques relevant to key climate change adaptations issues, such as siting, site layout, ventilation, drainage, water, outdoor spaces and connectivity.

London Climate Change Partnership, 2007, 64pp.

Download ► <http://www.london.gov.uk/lccp/publications/docs/adapting-climate-change-case-study-ver2.pdf>

55. ClimateSMART—Climate Change: Developer's Risk Management Guide

This can serve as a model government guide for developers. It was created for developers of Halifax's coastal, low-lying, urban/forest fringe, and rural areas. The guide includes an overview of climate change, describes the predicted impacts on Halifax relevant to development projects, provides a step-by-step approach to assessing the risk, and provides a checklist that can be used in the planning and evaluating of development proposals.

Halifax Regional Municipality, 2007, 35pp.

Download ► <http://ccap.org/docs/resources/394/DevelopersGuidetoRiskManagment.pdf>

56. Summary of Cost Benefit Evaluation of Ecoroofs Report

This consultant's report presents cost and benefits of green roofs from the literature, including areas of stormwater management, energy, climate, habitat, amenity value, and building development. The total private and public costs were found to be \$27,143 over a 5-year period, and the benefit to be \$595,053 over a 40-year period.

David Evans and Associates, Inc. and ECONorthwest, City of Portland, 2008, 42pp.

Download ► <http://www.portlandonline.com/bes/index.cfm?a=261053&c=50818>

HEAT

57. Excessive Heat Events Guidebook

This guidebook provides information that local public health officials and others need to begin assessing their vulnerability to excessive heat events and developing and implementing notification and response programs. Cost-benefit guidelines are also included.

USEPA, Jun 2006, 60pp.

Download ► http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf



58. Heat Island Effect

This website provides access to EPA's Urban Heat Island Community Actions Database, by state & locality, initiative type, and strategy. Initiative types include ordinances, building codes, and outreach programs; strategies include trees and vegetation, green roofs, cool roofs, and cool pavements. It also has resources such as outreach materials, a compendium of strategies, and a Mitigation Impact Screening Tool.

EPA, last updated Aug 2010

Website ► <http://www.epa.gov/heatislands/index.htm>

59. Mitigating New York City's Heat Island with Urban Forestry, Living Roofs, and Light Surfaces

This report includes a step-by-step cost-benefit analysis of the titular approaches to mitigating the urban heat island effect.

New York State Energy Research and Development Authority (NYSERDA), 2006, 173pp.

Download ► http://www.nyserda.org/programs/environment/emep/project/6681_25/06-06%20Complete%20report-web.pdf

PUBLIC HEALTH

60. Ready for Change: Preparing Public Health Agencies for the Impacts of Climate Change

This manual provides practical guidance to public health departments prioritizing and implementing operational changes that allow public agencies to prepare their employees and communities for climate change. Actions discussed include those that can be implemented immediately and at low cost, to those requiring long-term planning and funding. Additionally, it provides guidance for demonstrating and communicating a commitment to reducing risks and building resilience. Topics discussed are extreme heat, disease patterns, water, food, air quality, and mental health. Developed for Oregon but transferable elsewhere.

Climate Leadership Initiative, **University of Oregon**, May 2010, 43pp.

Download ► http://climlead.uoregon.edu/sites/climlead.uoregon.edu/files/reports/PubHealthPrepManual5-10LR_0.pdf

61. CDC Policy on Climate Change and Public Health

This statement summarizes some of the main public health risks and populations at risk for specific climate impacts. It also identifies eleven priority health responses, most of which point toward actions to be taken in the future.

Center for Disease Control and Prevention, 2pp.

Download ► <http://www.cdc.gov/ClimateChange/policy.htm>

62. Environmental Health Primer

This primer provides a basic understanding of environmental public health concepts and principles to help local officials make better decisions. Geared to local boards of health but useful background information for other official audiences too. Chapters of relevance to climate adaptation include air quality (in Part 2), drinking water and wastewater (Part 3), and vector control (in Part 4).

National Association of Local Boards of Health, National Environmental Health Science and Protection Accreditation Council, **Center for Disease Control and Prevention**, 2003

Webpage ► http://www.cdc.gov/nceh/ehs/NALBOH/NALBOH_EH_Primer.htm



SEA LEVEL RISE

63. Synthesis of Adaptation Options for Coastal Regions

This guide provides a brief introduction to key physical impacts of climate change on estuaries and a review of on-the-ground adaptation options available to coastal managers to reduce their systems' vulnerability to climate change impacts. Estuaries are highly and uniquely vulnerable to climate change.

EPA, 2009, 32pp.

Download ► http://www.epa.gov/climate/readyestuaries/downloads/CRE_Synthesis_1.09.pdf

64. Resilient Coasts: A blueprint for action

This blueprint was designed for federal, state and local leaders and identifies critical steps to reduce risks and losses due to climate change. It discusses basic principles of coastal resiliency, and suggests strategies for climate change adaptation, including financing and insurance. The blueprint is designed to help individuals, communities and ecosystems withstand and recover from the impacts of coastal storms and rising sea levels.

Heinz Center and Ceres, Apr 2009, 9pp.

Download ► http://www.heinzctr.org/publications/PDF/Resilient_Coasts_Blueprint_Final.pdf

65. Coastal Communities and Climate Change: Maintaining future insurability

This report looks at the impact of climate change on flood risk at a number of coastal locations around the world, considering sea level rise, the effect of wind speed on storm surges, and changes in land use.

Although the four case studies mentioned in the report are from outside the United States, the lessons learned are applicable to any coastal community. That the publisher is a large insurance company may aid planners in making the case for adaptation action.

Lloyd's of London, 2008, 28pp.

Download ► http://www.lloyds.com/~media/Lloyds/Reports/360%20Climate%20reports/360_Coastalcommunitiesandclimatechange.pdf

STORMS/FLOODING

66. Guidance for Municipal Stormwater Funding

This paper discusses the evolution of local government's role in municipal stormwater management and serves as a resource to local practitioners as they address stormwater program financing challenges. The guide covers various sources of funding, legal considerations, implementation of stormwater funding programs and case studies from U.S. cities.

Doug Harrison Scott Tucker, eds., USEPA, NAFSMA, Jan 2006, 140pp.

Download ► <http://www.nafsma.org/Guidance%20Manual%20Version%202X.pdf>

67. How to Become StormReady®

This website provides guidelines and a toolkit to emergency managers to help them prepare their communities for severe storms, and explains how to apply to become a StormReady community. As of August 2010, there were 1,637 StormReady sites, including cities, counties, and commercial properties.

National Weather Service, last updated Feb 2010

Website ► <http://www.stormready.noaa.gov/howto.htm>



68. Stemming the Tide: How local governments can manage rising flood risks

This study analyzes how Virginian local governments can use existing land use powers to adapt to climate change impacts such as flooding and coastal erosion, increased pressures on emergency response and rising infrastructure and property damages. The study also looks at legal obstacles and specific land use tools for local governments implementing policy identified in Virginia's Climate Action Plan.

Andrew C. Sifton and Jessica Grannis, **Georgetown Climate Center**, May 2010, 24pp.

Download ► <http://www.georgetownclimate.org/adaptation/files/Va-Case-Study.pdf>

69. Urban Flooding

This document gives an overview of UK approaches to managing urban flooding, including dealing with an overwhelmed sewer system and examines ways to improve policy.

Parliamentary Office of Science and Technology, Jul 2007, 4pp.

Download ► <http://www.parliament.uk/documents/post/postpn289.pdf>

WATER SUPPLY

70. Become a Water Sense Promotional Partner

This website explains the benefits of entities, such as local government utilities, of becoming Water Sense promotional partners, including access to promotional material templates, and case studies of best practices.

EPA, last updated Jul 2010

Webpage ► <http://www.epa.gov/watersense/partners/promotional.html>

71. Clean Water Financing: Water Quality Cooperative Agreements

This page links to a number of water impact-relevant funding programs, including the Clean Water State Revolving Loan Fund (e.g. for estuary protection projects), Water Quality Cooperative Agreements, and Drinking Water State Revolving Loan Funds.

EPA, last updated Jul 2010

Webpage ► <http://www.epa.gov/OWM/cwfinance/index.htm>

72. Emerging Climate Change Impacts on Freshwater Resources: A perspective of transformed watersheds

This report discusses the effect of climate change on freshwater resources in the United States. Six case studies, illustrate regional, cost effective adaptation efforts for climate change affecting freshwater sources: Colorado River, Boston Metro, New York City, Flint River, Everglades, and San Joaquin River. Starting on page 24 the report also lists adaptive responses to climatic effects.

Alan P. Covich, **Resources for the Future**, 2009, 45pp.

Download ► <http://www.rff.org/rff/documents/RFF-Rpt-Adaptation-Covich.pdf>

73. California Water Success Stories, Executive Summary

This executive summary sketches 29 stories of effective water management in a variety of contexts. Though an older resource, it helps make the case that sustainable use of water does not require extraordinary actions, but rather a commitment to expanding existing, positive trends. It also reviews the repeating themes and success factors across the cases.

Peter H. Gleick et al., **Pacific Institute**, 1999, 25pp.

Download ► http://pacinst.org/reports/sustainable_california/ca_water_success_stories.pdf



74. Solutions: Saving water for the future

This report includes an outline of Denver's water utility's programs and projects to conserve and recycle water, including incentive, education, and outreach programs for the public.

Denver Water, 2010, 40pp.

Download ► <http://www.denverwater.org/docs/assets/DCC8BD7A-E2B9-A215-2D2FDDC3D6C736E7/Solutions2010.pdf>

75. U.S. Drought Portal (NIDIS)

The U.S. Drought Portal is part of the interactive system designed to: provide early warning about emerging and anticipated droughts; assimilate and control the quality of data about droughts and models; provide information about risk and impact of droughts to different agencies and stakeholders; provide information about past droughts for comparison and to understand current conditions; explain how to plan for and manage the impacts of droughts; and, provide a forum for different stakeholders to discuss drought-related issues. Drought information can be viewed by state or region.

National Integrated Drought Information System, 2006

Website ► http://www.drought.gov/portal/server.pt/community/what_is_nidis/206



Getting a Commitment to Adaptation

This list includes resources for communicating effectively about climate change adaptation. Included are examples of climate change adaptation communication, communication aides, persuasion strategies, and community engagement guides.

EXAMPLES OF EFFECTIVE COMMUNICATION

76. Engaging Chicago's Diverse Communities in the Chicago Climate Action Plan

This website provides links to the Field Museum's Division of Environment, Culture and Conservation's (ECCo) reports on community engagement in Chicago regarding implementation of the Chicago Climate Action Plan. The three reports currently available describe an inclusive approach for soliciting public perceptions of climate change issues.

The Field Museum Division of Environment, Culture, and Conservation, **City of Chicago Department of Environment**, Aug 2010

Website ► http://www.fieldmuseum.org/ccuc/ccuc_sites/Climate_Action/climate_action.htm

77. Preparing for Climate Change in the Great Lakes Region

This report summarizes the observations and findings from a one-day workshop of forty representatives from Great Lakes foundations, non-governmental organizations, agencies, and universities. The workshop's objectives were to identify policy changes that will enable Great Lakes communities to adapt to climate change and protect major ecosystems, and to identify strategies for implementing those policy changes.

Michigan Sea Grant, Feb 2009, 32pp.

Download ► http://www.miseagrant.umich.edu/downloads/climate/Climate_Workshop_Report.pdf

78. Adapting to Climate Change: A Guide for Business in Scotland

A brief, practical guide that officials can use as a model to engage their own business sectors. This guide for the private sector gives an overview of what risk and opportunities climate change may pose for Scottish businesses and explains how to build the adaptive capacity to deal with these risks.

Scottish Climate Change Impacts Partnership, 12pp.

Download ► <http://www.sccip.org.uk/3/82/0/Adapting-to-Climate-Change--A-Guide-for-Businesses-in-Scotland.aspx>

79. UKCIP's Climate Adaptation Resource for Advisors (CLARA)

This tool is useful for U.S. practitioners who want to engage their local business community. CLARA is a web-based UK resource aimed at helping business advisors support small and medium enterprises (SMEs) in understanding and preparing for the impacts of climate change. The factsheets are designed to be accessed directly by the business community. The site provides background information on climate change, advice on how to make the business case.

UK Climate Impacts Programme, 2010

Website ► http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=531&Itemid=547



80. Business as Usual

Developed for London, this paper could be used by officials elsewhere looking to engage and evolve their area's financial industries. It poses questions for discussions held between the Mayor of London and the city's financial leaders in insurance, pensions, fund management, banking, infrastructure, and utilities, regarding the need for them to take account of climate impacts.

London Climate Change Partnership, 2006, 28pp.

Download ► <http://www.london.gov.uk/lccp/publications/business-usual.jsp>

MAKING THE CASE

81. Developing a Communications Plan

This webpage, part of the Scottish Government's Climate Change Adaptation Toolkit, provides a step-by-step guide for writing an effective communications strategy.

The Scottish Government

Webpage ► http://www.sccipcommstoolkit.org.uk/index.php?option=com_content&view=article&id=19&Itemid=23

82. NOAA Weather Service

This website provides access to severe weather watches, information, and outreach tools which can be tailored for local public warning systems. Topics include air quality, excessive heat, fire weather, flooding, severe storms, and winter weather.

NOAA

Website ► <http://www.noaawatch.gov>

83. Learned Lessons on Key Considerations for Communicating Climate Risk

This webpage summarizes key considerations for communicating climate risk, based on lessons learned from developing climate risk communication strategies and implementing them on the ground in Africa and Asia, but applicable elsewhere. (Based on a synthesis report of the Advancing Capacity to Support Climate Change Adaptation project, which can be downloaded at <http://start.org/download/accca-synthesis.pdf>.) Strategies described are: two-way dialogue, knowing the local context, understanding the local know-how on climate risk, engagement in the process, combining strategies to target different stakeholders, strategic use of space, and innovative ways of communicating.

weADAPT, last modified Aug 2010

Webpage ► http://wikiadapt.org/index.php?title=Learned_lessons_on_key_considerations_for_communicating_climate_risk

84. Climate Communications and Behavior Change

This guide illustrates the challenges with existing climate change communications efforts and provides tips on how to frame and deliver outreach efforts in a way that motivates changes in thinking and behavior for a range of audience segments. The focus is not on climate adaptation though the guide does include some tips explicit to it.

Cara Pike, Bob Doppelt, Meredith Herr, Climate Leadership Initiative, University of Oregon, 2010. 54pp.

Download ► <http://climlead.uoregon.edu/sites/climlead.uoregon.edu/files/reports/ClimCommBehaviorChangeGuide.pdf>



85. Hold That Thought! Questioning five common assumptions about communicating with the public

This report discusses false assumptions about communicating with the public, and provides some guidance about designing more effective communications. The false assumptions are: We need to get the word out, We already know how to communicate, If they only had information Z then, Recipients of our information will consider it thoughtfully, and Successful communication is an art.

Joe Cone, **Oregon Sea Grant: Public Science Communication Research & Practice**, 16pp.

Download ► <http://seagrant.oregonstate.edu/sgpubs/onlinepubs/h08005.pdf>

86. Expand Your View: Insights for public communicators from behavioral research

This primer provides a research-based look at how to improve communication effectiveness. Topics include understanding and addressing psychological barriers, embracing voluntary learning, and fomenting social change. Not specific to climate change but useful to such public officials.

Joe Cone, **Oregon Sea Grant: Public Science Communication Research & Practice**, 24pp.

Download ► <http://seagrant.oregonstate.edu/sgpubs/onlinepubs/h08006.pdf>

87. Telling the Tale of Disaster Resistance: A guide to capturing and communicating the story

This guidebook provides some of the “best practices” of those who have promoted disaster-resistance efforts throughout the country, which can serve as one component in an overall adaptation outreach strategy. This publication explains what value documenting and disseminating disaster resistance provides to local governments, and provides a step-by-step guide on how to document disaster-resistance efforts, offers guidance for developing story leads, researching and documenting projects, and creating and promoting a finished product.

FEMA, 2001, 65pp.

Download ► <http://www.fema.gov/library/viewRecord.do?id=1762>

88. Communicating Climate Change: Podcasts with Social Scientists

This website features extended audio interviews with leading social scientists about the human dimensions of climate change. The podcast is aimed at professional science communicators, whose job it is to explain complex scientific concepts and the work of scientists to the public at large.

Produced by Joe Cone, **Sea Grant Oregon**, last updated Aug 2010

Website ► <http://blogs.oregonstate.edu/communicatingclimatechange>

89. Setting the Record Straight: Responses to common challenges to climate science

This brief document provides credible responses to some common 'skeptical' arguments against climate change. For more detailed, in-depth, treatment, see Grist's guide, "How to Talk to a Climate Skeptic" <http://www.grist.org/article/series/skeptics>.

CLI, Jan 2009, 9pp.

Download ► http://climlead.uoregon.edu/sites/climlead.uoregon.edu/files/reports/Setting_record_Straight.pdf

COMMUNITY ENGAGEMENT

90. Introduction to Stakeholder Participation

For those brand new to stakeholder participation, this document briefly examines several important aspects of stakeholder participation, provides guidance on identifying coastal management stakeholders, describes some of the most commonly used techniques, and discusses evaluation of stakeholder participation.



NOAA, 20pp.

Download ► http://www.csc.noaa.gov/cms/human_dimensions/Stakeholder_Participation_Guidance_Document.pdf

91. Stakeholder Engagement Strategies for Participatory Mapping

The participatory mapping tool is designed to help engage the public in land use decisions. The maps represent society's values, including social, cultural and economic values. The publication provides facilitators with strategies to lead a participatory mapping process. This process is particularly useful to create opportunities for stakeholder participation, capture new information, and help build community understanding and knowledge of climate risks. The mapping exercise also helps decision makers build community resilience and make better coastal management decisions.

NOAA, 28pp.

Download ► http://www.csc.noaa.gov/cms/human_dimensions/participatory_mapping.pdf

92. Participatory Learning and Action: Community-based adaptation to climate change

Through reflections, case studies and descriptions of available participatory tools, the authors give an overview of working in communities on adaptation efforts. The first section includes reflections on participatory processes and practice in community-based adaptation to climate change. These have a variety of entry points, including participatory vulnerability analysis and disaster risk reduction frameworks. The second section focuses on participatory tool-based case studies and describes a participatory process with an emphasis on the use of a particular tool. The third section, participatory tools, includes shorter, step-by-step descriptions of how to facilitate a particular tool in a community.

International Institute for Environment and Development, Dec 2009, 221pp.

Download ► <http://www.iied.org/pubs/display.php?o=14573IIED>



Acknowledgements

This Resource Guide was developed for the Climate Leadership Academy on Adaptation and Resilience that took place on September 20-22, 2010. The Guide was made possible by funding from the Kresge and Rockefeller foundations.

The ISC team that researched, wrote, and reviewed this Guide included Sarah McKearnan, Steve Nicholas, Joyce Peters, George Sarrinikolaou, Elaine Wang, Betty Weiss, and Tom Wilson. Josh Foster of the Center for Clean Air Policy contributed to the selection and writing of the case studies. George Sarrinikolaou was the project manager. Joyce Peters and Elaine Wang led the research. Sarah Woodard and Tom Wilson designed these materials.

This Resource Guide was shaped in consultation with practitioners in nineteen cities and regions across North America, as well as scientists and technical experts. In addition thanks go to the many people who provided information for the case studies.

About the Institute for Sustainable Communities

Since its founding in 1991 by former Vermont Governor Madeleine Kunin, ISC has led 75 transformative, community-driven projects in 21 countries. ISC specializes in developing and delivering highly successful training and technical assistance programs that improve the effectiveness of communities and the leaders and institutions that support them.

We welcome your feedback!

This Resource Guide is a work-in-progress. It will be converted into a web-based resource and continually updated to provide valuable resources to public, private and nonprofit sector leaders working to adapt to climate change and improve the resilience of their communities. If you have comments on the guide, or ideas for how to improve it, please send them to George Sarrinikolaou at the Institute for Sustainable Communities at gsarrinikolaou@iscvt.org.

Notes

Notes

Notes

Notes

Notes