Building a Climate Resilient National Capital Region

Federal and community agencies working together on climate preparedness and resilience.

Summary of Climate Change Vulnerability and Adaptation Workshop Results
Built Systems: September – December 2013
Workforce, Community and Natural Systems: February - April 2014

METROPOLITAN WASHINGTON Council of Governments

NASA

National Capital Planning Commission

United States Global Change Research Program

GSA

Organizations invited / participating in the workshops and webinars

Federal

Architect of the Capitol
Department of Agriculture
Department of Defense, Washington Headquarter Services
Department of Health and Human Services
Department of the Interior
Department of Justice
Department of Transportation
Department of the Treasury
Environmental Protection Agency
Federal Aviation Administration (Dept. of Transportation)
Federal Emergency Management Agency (Dept. of Homeland Security)
General Services Administration
Internal Revenue Service (Dept. of the Treasury)
National Aeronautics and Space Administration
National Archives and Records Administration
National Capital Planning Commission
National Park Service (Dept. of the Interior)
Naval Facilities Engineering Command (Department of Defense)
U.S. Global Change Research Program

Regional/State

Metropolitan Washington Council of Governments
University of Michigan (AAA Fellow)
Washington Metropolitan Area Transit Authority

Utility Companies

Alexandria Renew Enterprises
District of Columbia Water and Sewer Authority
PEPCO

Local/City

Arlington County
City of Alexandria
District of Columbia
- Department of the Environment
- Department of General Services
- Office of Planning
- Department of Consumer and Regulatory Affairs
- Homeland Security and Emergency Management Agency

Non-Governmental Organizations

Center for Clean Air Policy
DowntownDC Business Improvement District
Global Cool Cities Alliance
Greater Washington Board of Trade
National Geographic Society - D.C. Climate & Urban Systems Partnership
National Wildlife Federation
Smithsonian Institution

Front page photo credit: Kite Festival, Washington, DC (NCPC).

Building a Climate Resilient National Capital Region

Executive Summary

The National Capital Region is already experiencing the effects of climate change -- more frequent extreme weather events, rising temperatures, and recurring flooding. Climate scientists project that these changes will continue and anticipate more frequent and more intense impacts. People, property, and natural resources will be affected, changing and potentially disrupting the way we live and work in the National Capital Region. As the seat of the federal government and the nation's capital, the region has an unmatched concentration of federal buildings and operations, irreplaceable cultural and historic treasures, nationally significant monuments and landscapes, and diverse communities. The region's primary employment centers, infrastructure systems, and major rivers all converge within the monumental core[1].

> ***So the question now is not whether we need to act… [it] is whether we will have the courage to act before it's too late. And how we answer will have a profound impact on the world that we leave behind not just to you, but to your children and grandchildren.***
>
> President Barack Obama, June 25, 2013

Stewardship of the region's resources requires coordinating policy, tools, information, and expertise with others. Many federal, regional, and local agencies and organizations are individually exploring climate adaptation[2] strategies. Recognizing that no single entity can address all of its climate change risks working alone, these agencies are coming together to build capacity, networks, and partnerships that will build on work already underway.

Building a Climate Resilient National Capital Region was a series of webinars and workshops in 2013-4 that provided stakeholders a first look at the region's climate change risk, guided by the following:

VISION: A climate-resilient National Mall and National Capital Region for future generations, built upon science-informed planning and decision making and sound risk management.

OBJECTIVES: Build capacity, capability and confidence; create networks and partnerships; encourage proactive adaptation planning.

[1] Monumental core: the National Mall and nearby downtown District of Columbia neighborhoods, Alexandria, and eastern portions of Arlington, VA.

[2] Climate adaptation: actions to cope with or ameliorate current climate change impacts and plan for future changes. Immediate greenhouse gas emissions mitigation is a critical part of reducing future risks from climate change, but some climate change effects will continue to occur for a time regardless of emissions reductions due to greenhouse gases' atmospheric lifespan.

These webinars and workshops were conducted to share information and develop ideas to encourage proactive, collaborative adaptation planning for built systems, the workforce, community, and natural systems. This initiative:

- Brought together knowledgeable, interested people responsible for public facilities, operations and services in the National Capital Region.
- Provided them with useful, relevant information about climate risks, including localized climate data.
- Asked them to brainstorm and discuss climate adaptation strategies they might do individually or together.

The National Aeronautics and Space Administration (NASA), General Services Administration (GSA), US Global Change Research Program (USGCRP), National Capital Planning Commission (NCPC), Smithsonian Institution (Smithsonian), and the Metropolitan Washington Council of Governments (MWCOG) sponsored this initiative. Senior management support (particularly the federal government's senior sustainability officers) advanced this effort by enabling staff participation.

After 10 consecutive extreme heat days this track kink derailed a Metrorail train, July 2012 (no injuries reported) (WMATA).

Based upon regional climate change projections generated by NASA climate scientists, many agencies identified severe events including heavy precipitation, heat waves and sea level rise combined with storm surge as top climate-related threats. The consensus from the workshops/webinar participants is that:

Climate change poses a serious threat to the systems upon which the government and economy of the National Capital Region relies.

Understanding our shared vulnerabilities and coordinating our adaptation strategies help us leverage our limited resources for the most effective near term and long term actions.

The webinars and workshops drew upon NASA's experiences in using climate science expertise, coupled with an informed perspective on institutional stewardship, to develop relevant, actionable policies and adaptation strategies for NASA installations across the nation. NASA scientists provided localized climate

Flood damages the U.S. Department of Justice lobby in June 2006 (DOJ).

data, particularly helpful since our region does not fall neatly into the National Climate Assessment's climate regions.

More than 30 agencies participated in a series of workshops and webinars in fall 2013 focusing on built systems in light of a changing climate. Vulnerable built systems include transportation, wastewater, buildings, IT/Telecom, electrical grid, and others. Participants observed that some strategies could be implemented on an agency level and other strategies would benefit from inter-agency coordination.

Approximately 40 people from 20 agencies participated in a second group of webinars and workshops in early spring 2014 addressing the region's workforce, community, and natural systems. Vulnerable systems include workforce commuting, workforce and family health, working conditions, urban forests and managed landscapes, work load (and other factors affecting productivity), water quality, and drinking water supply.

Breakout groups developed topic-specific potential adaptation strategies and proposed specific implementation actions. These discussions considered key stakeholders, funding sources, partnerships and timeframes. They are intended as a framework for continuing discussion and coordination rather than as adopted strategy by any agency.

BUILT SYSTEMS	ADAPTATION STRATEGY
Transportation	Create and implement a Regional Climate Transportation Resiliency Action Plan, guided by a regional advisory body.
Energy/IT/Telecom	Ensure a Reliable Overarching Electrical Grid/Supply System Across the NCR in Response to a Changing Climate
Stormwater/ Wastewater	By 2030, implement a wastewater and stormwater management program to accommodate anticipated precipitation events in 2080 to protect people and infrastructure
Geographic/ Historic Areas	Flood Resilience in the Monumental Core
Governance	A. Develop joint funding for large-scale, cross boundary, multi-jurisdictional adaptation strategies B. Create an interagency body to address climate adaptation activities

WORKFORCE, COMMUNITY & NATURAL SYSTEMS	ADAPTATION STRATEGY
Terrestrial – managed landscapes, including forested areas	Protect and increase green systems in the NCR
Community Vitality	Enhance community vitality and heat resiliency with multi-purpose indoor/outdoor centers of activity and cooling
Aquatic Systems	Coordinate and integrate public engagement for stormwater management and Low Impact Development
Workforce Productivity	Achieve optimal worker productivity (maintaining/increasing worker productivity) in the face of more frequent extreme heat events

Outcomes

Through the Building a Climate Resilient Region webinars and workshops, participants:

- **Increased their awareness** of the growing threats of extreme weather events to the local economy and the region's long-term economic resiliency
- **Learned how to communicate and gain support** for their climate adaptation work with decision-makers within their agencies
- Participated in a **consistent vulnerability assessment process**, ensuring analyses were based on the same climate risk data and considering the sectors that had been collectively determined as most important
- Coordinated within their agencies to complete their homework, providing a **comprehensive look at their agency's vulnerability to climate risks**
- Learned about the vulnerabilities of peer organizations, **improving awareness of interdependencies and synergies** that can help or hamper adaptation efforts

Conclusions

Although the challenges are formidable, workshop participants noted that the threat is real, and the stakes are high. Hence, the National Capital Region must continue working together towards climate-preparedness.

Participants concluded that in order for the National Capital Region to become climate resilient, we must:

- Educate and inform our leaders and communities about the risks of climate change to the National Capital Region;
- Coordinate our individual adaptation efforts to maximize the benefits and minimize unintended negative impacts. The interdependencies among built systems with the socio-economic and natural systems imply that failure of one system will lead to a cascading failure of other systems;
- Agree on our collective risks and commit to a shared set of priority actions;
- Integrate adaptation strategies into existing policies, capital planning, and operations. Use a 'risk management' model to address climate risks;
- Fund system-wide adaptation actions through innovative partnerships; and
- Encourage grassroots initiatives alongside government actions.

What's next?

This effort helped agencies move forward on climate resilience, but there is much more to be done given the magnitude of the problem and the vital services, resources, and communities of the National Capital Region. First, representatives from the participating agencies will bring these ideas back to their respective agencies for further discussion and exploration. In addition, the sponsoring agencies will share the information and outcomes from the webinars and workshops with a broader audience, including climate adaptation practitioners, senior leadership within federal agencies and local government, and the general public. These steps will start to address the key barriers to climate resilience identified in the workshop to help the NCR move from exploration to action.

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INTRODUCTION

Building a Climate Resilient National Capital Region (Climate Resilient Workshops) was a series of webinars and workshops in 2013-14 that:

- Brought together knowledgeable, interested people responsible for public facilities, infrastructure, operations and services in the National Capital Region.
- Provided them with useful, relevant information about climate risks, including localized climate data.
- Asked them to brainstorm and discuss climate adaptation strategies they might do individually or together.

These webinars and workshops were conducted to share information and develop ideas to encourage proactive, collaborative adaptation planning for built systems, the workforce, community, and natural systems. The intent of the Climate Resilient Workshops was to share basic localized climate science, understand the climate challenges and opportunities for the National Capital Region, and bring together representatives from federal and local agencies and infrastructure providers to identify potential climate resiliency policies and strategies tailored to the region.

The National Aeronautics and Space Administration (NASA), General Services Administration (GSA), US Global Change Research Program (USGCRP), National Capital Planning Commission (NCPC), Smithsonian Institution (Smithsonian), and the Metropolitan Washington Council of Governments (MWCOG) sponsored this initiative.

The sponsors presented participants with the following vision statement and objectives to inform the process and define stakeholder expectations:

> Vision: A climate-resilient National Mall and National Capital Region for future generations, built upon science-informed planning and decision making and sound risk management.
>
> Objectives: Build capacity, capability and confidence; create networks and partnerships; encourage proactive adaptation planning.

The sponsors recognized that while a desirable long term outcome would be comprehensive adaptation strategies with committed partners and funding, coordination across the many regional stakeholders and jurisdictions is challenging and complex. Workshop participants affirmed this vision, and agreed that coordination across regional stakeholders and geographic jurisdictions involves coalition-building that necessarily extends beyond any single set of interactions. Thus, the workshop objectives focus on the need to continue to share information, learn from one another, and work together. The consensus from participants was that:

> *Climate change poses a serious threat to the systems upon which the government and economy of the DC region relies.*
> *Understanding our shared vulnerabilities and coordinating our adaptation strategies helps us leverage our limited resources for the most effective near term and long term actions.*

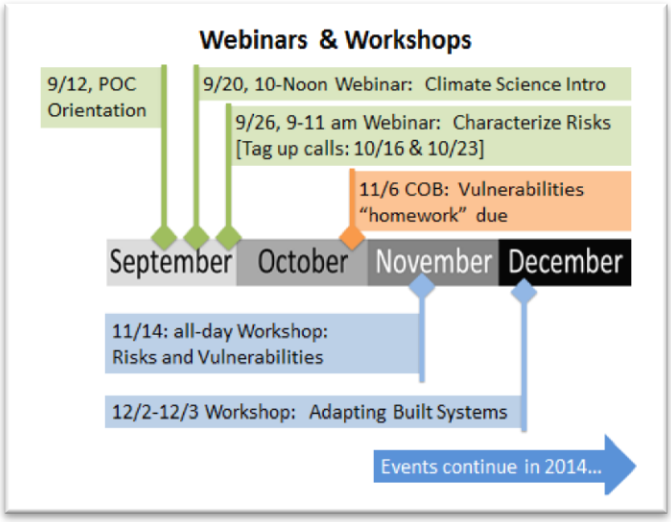
Climate and extreme weather risks affect many of the National Capital Region's assets including built systems, the natural environment, and people. The first webinars and workshops series, held in fall 2013, addressed built systems, which include transportation, wastewater, buildings, IT/telecom, electrical grid, and others. The second series, held in spring 2014, addressed workforce, community, and natural systems.

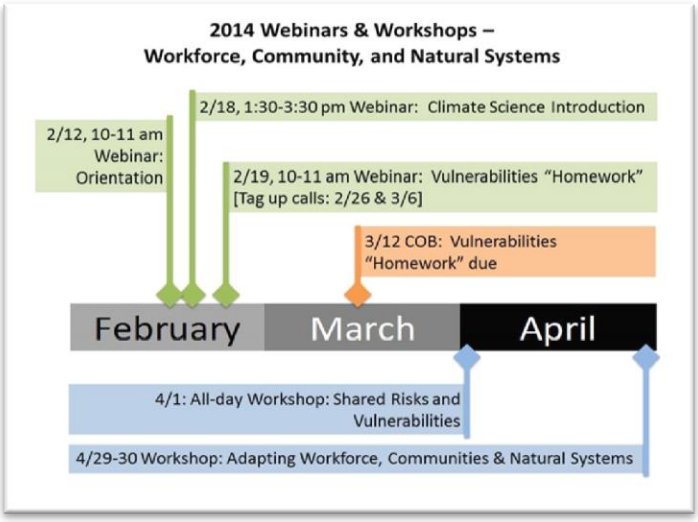
Representatives from federal and local organizations, research organizations, and regional/local utilities participated in the two webinars and workshops series. 63 representatives from 30 agencies participated in the fall built systems series. Approximately 40 people from 20 agencies participated in the second series in spring 2014 addressing the region's workforce, community, and natural systems. Agency participation is listed at the end of the report and on the MWCOG webpage, http://www.mwcog.org/environment/climate/resilience.asp. Most of the participating organizations are beginning to assess risks, and many have developed climate adaptation plans nationally and/or locally. This effort intended to build on those plans and explore strategies for collective action at the regional level.

FORMAT AND ORGANIZATION

NASA staff and contractors played a key role on the steering committee convened to plan and execute the Climate Resilient Workshops. The webinar/workshop structure was based on a process that has helped NASA senior leaders translate climate science expertise into relevant, actionable policies and adaptation strategies for NASA installations across the nation.

Each series followed the same general format. Initial webinars provided basic climate science information and projected climate change trends in the National Capital Region. Then, agencies were asked to complete 'homework' on vulnerabilities that informed subsequent workshop discussions.





The webinars and materials are available as online resources at www.mwcog.org/

Orientation Webinar

The Orientation Webinar provided an overview of the training series and time for Q&A.

Climate Science Introduction Webinar

In the second webinar, NASA science and infrastructure staff described the climate change projections and climate impacts expected in the region. NASA climate scientists also described these basic projections in a climate information handout developed for the Washington, DC metropolitan area. In addition to observed temperature and sea level trends, NASA provided projections for the 2020, 2050, and 2080 time periods.

Characterize Risks Webinar – Vulnerabilities Homework

In the third webinar, facilitators explained the instructions and templates for the 'Homework' exercise and how the results would be used during the *Risks and Vulnerabilities Workshop*. Participants were asked to answer the question, "Which four (built, workforce, community, or natural) systems are most at risk of impeding your goals and objectives now and in the future?" Through the Homework, participants:

- identified their top four priority vulnerabilities or risks and the associated *gradual changes* or *extreme event* climate variables (e.g., heat waves, heavy precipitation, sea level rise, etc);
- rated the impacts of each risk for three time periods: present, 2020s and 2050s;
- described the critical threshold of their system(s), if applicable;
- described the impacts of each climate variable to their system(s); and
- identified current responses (work-arounds) and planned responses to the described impacts.

The workshop facilitators compiled the results from the pre-workshop homework into a summary table that helped identify patterns of climate risk concerns across organizations.

Risks and Vulnerabilities Workshop

Workshop participants examined and discussed the homework results and described current impacts to systems that were of chief concern to their organizations. Many common areas of concern emerged from the discussion. Breakout groups worked together to summarize leading issues relating to specific system types; the breakout groups also crafted problem statements or challenge and opportunity statements to use in the following adaptation strategy workshop. These statements set up the issue(s) to be addressed and described the main areas for improvement.

Adapting Systems Workshop

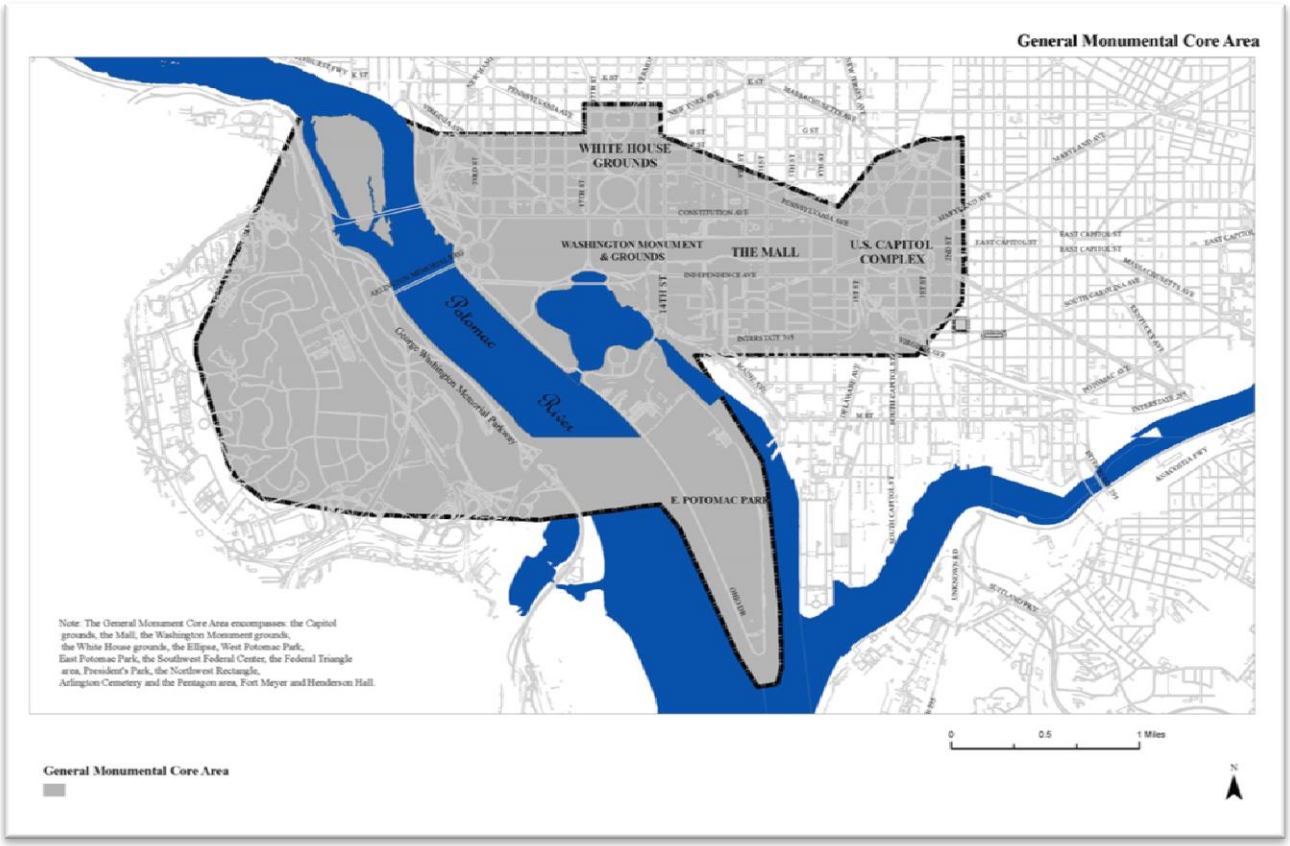
This workshop transitioned the focus from defining vulnerabilities to finding solutions, and to seeking partnerships to advance such solutions. Addressing the system issues outlined in the second workshop, participants identified near term and long term adaptation strategies for planning and implementation across the region's many jurisdictions and organizations. In addition, facilitators

asked participants to imagine two types of future local newspaper headlines: one for a climate resilient city and one for an ill-prepared city. The headline exercise characterized perceptions of the consequences of divergent futures and reinforced the need to begin adaptation planning now, rather than waiting until some options may be unavailable or ineffective.

CONTEXT and ASSUMPTIONS

Geographic Scope

This effort focused generally on the monumental core of Washington, DC, Arlington, and Alexandria, VA as shown in the map below. The area includes the National Mall, the White House, U.S. Capitol, the Pentagon, federal agency headquarters and offices, military installations, national memorials, museums, parks, and adjacent communities. The region's interdependent built systems, workforce, communities, and natural systems converge here, which is the economic heart of the region, the nexus of regional transportation and services, and the confluence of two major rivers.



The workshops and webinars recognized that the Monumental Core is interconnected through infrastructure, people, and natural systems with the entire National Capital Region (NCR).

Left: The Washington, DC Beltway and Vicinity. Infrastructure, rivers, people, and parks connect the Monumental Core (in the center of this map) to the wider National Capital Region.

Current Climate Adaptation Planning Context

National and regional, and local agencies and utilities have already begun planning for climate adaptation.

- Executive Order 13653, "Preparing the United States for the Impacts of Climate Change," is driving more climate adaptation work at the federal level which is expected to influence regulations and grant funding criteria for states and local communities.
- NCPC's work plan and MWCOG's Climate & Energy Action Plan recognize the need for climate impacts preparedness.
- In the District of Columbia, the Department of Transportation developed a plan to adapt its transportation system to climate change, the Department of the Environment is developing a climate adaptation plan as part of the Sustainable DC initiative, and the Department of Health's *Resilient DC* initiative is testing resilience-building strategies in selected District neighborhoods.
- Arlington County's Community Energy Plan aims to increase energy resiliency.
- The City of Alexandria's Climate Change Action Plan contains climate change impacts and preparedness goals.

- Washington Metropolitan Area Transit Authority is beginning to evaluate climate impacts to the region's transit system.
- Pepco, an electric service provider that serves the District of Columbia and the close-in suburbs of Maryland, recognizes the need for climate change planning.
- DC Water and Sewer Authority, which provides water and wastewater services and manages stormwater conveyance in combined sewer areas in the District of Columbia, is completing system-wide vulnerability assessments as part of the development of a climate action plan. DC Water is investing $13 million in a raised sea wall at the Blue Plains Advance Wastewater Treatment Plant.

Localized Climate Data for the National Capital Region

The workshops used regional climate change data provided by NASA climate scientists based on the global climate change data in the IPCC Fourth Assessment Reports. This data was particularly helpful since the region does not fall neatly into already established climate regions. The charts below show that by the 2050s, the National Capital Region will likely experience double the number of days over 90 degrees Fahrenheit per year and as much as 2 feet of permanent increase in average sea level[3]. The graph on the right includes two curves – the upper green line indicates potential sea level rise if rapid melting of land-based ice, such as glaciers and Greenland ice sheet, occurs. The lower blue line does not incorporate this potential climate phenomenon.

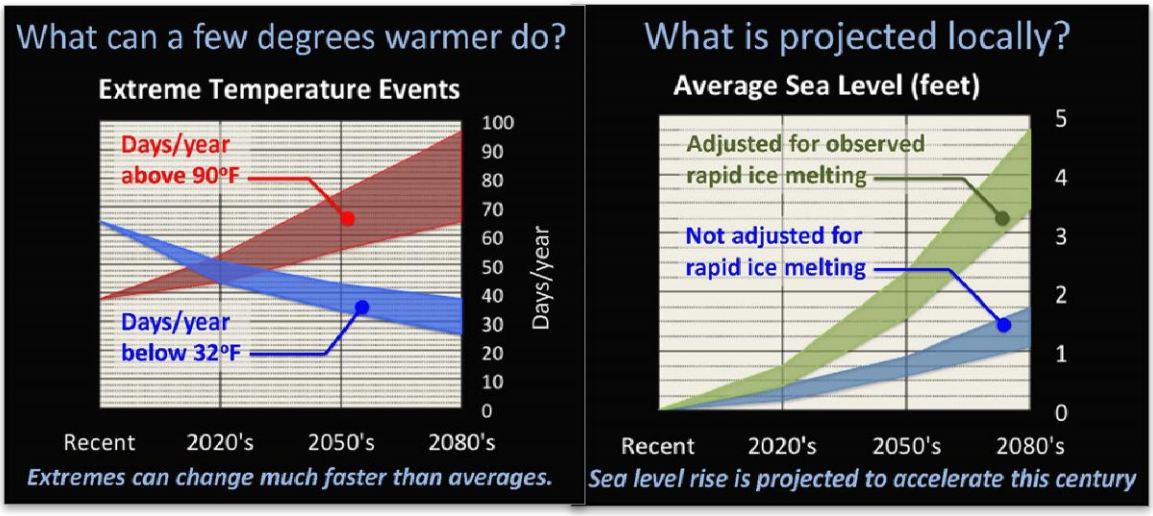
Climate Change Variables for Vulnerability Assessment Homework

Two types of climate change variables were used for the vulnerability assessments:

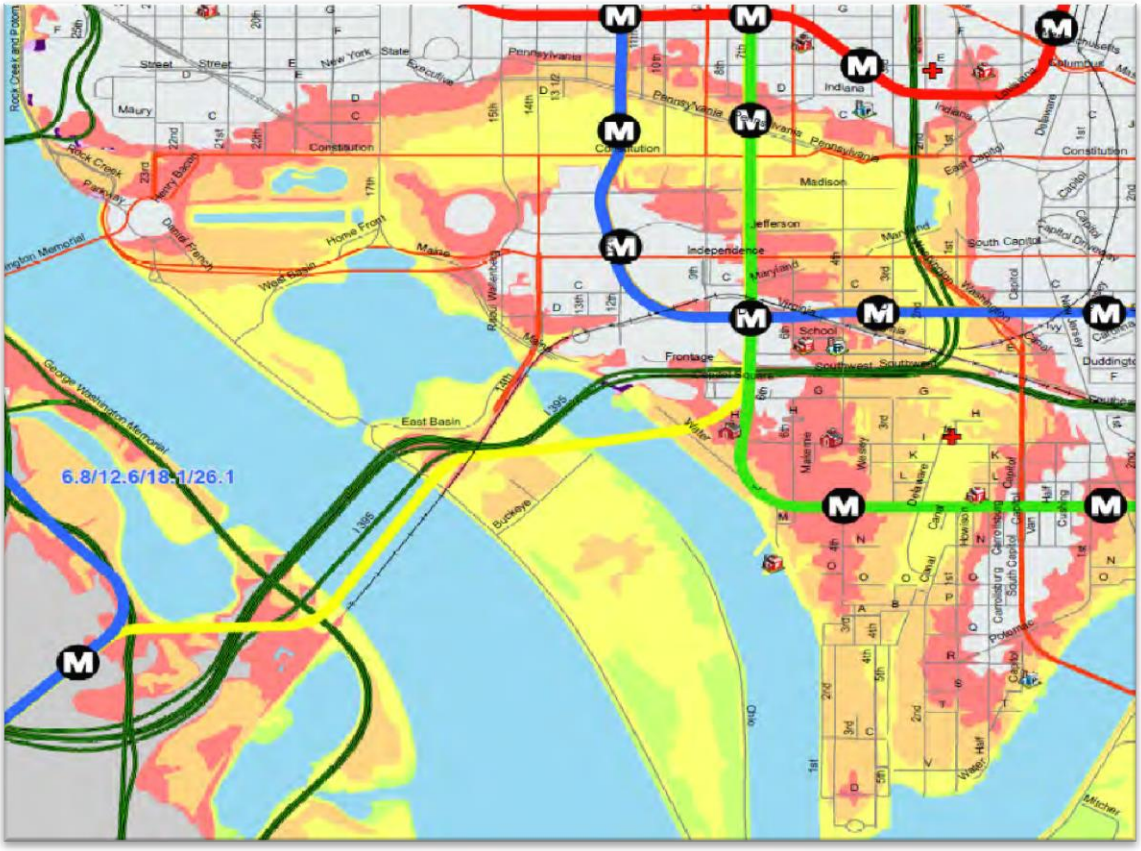
1. *Gradual changes* – higher average temperature, precipitation variability, sea level rise
2. *Extreme events* – heat waves, sea level rise with storm surge, more frequent heavy precipitation, drought

Extreme temperature thresholds used were 32° and 90° F. Workshop participants evaluated the impacts of heat waves defined as continuous stretches of days with high temperatures above 90° F.

[3] The trajectory of global greenhouse gas emissions influences climate projections' ranges towards the latter half of the century (for example, lower emissions lead to fewer days/year above 90° F and less rise in sea level).

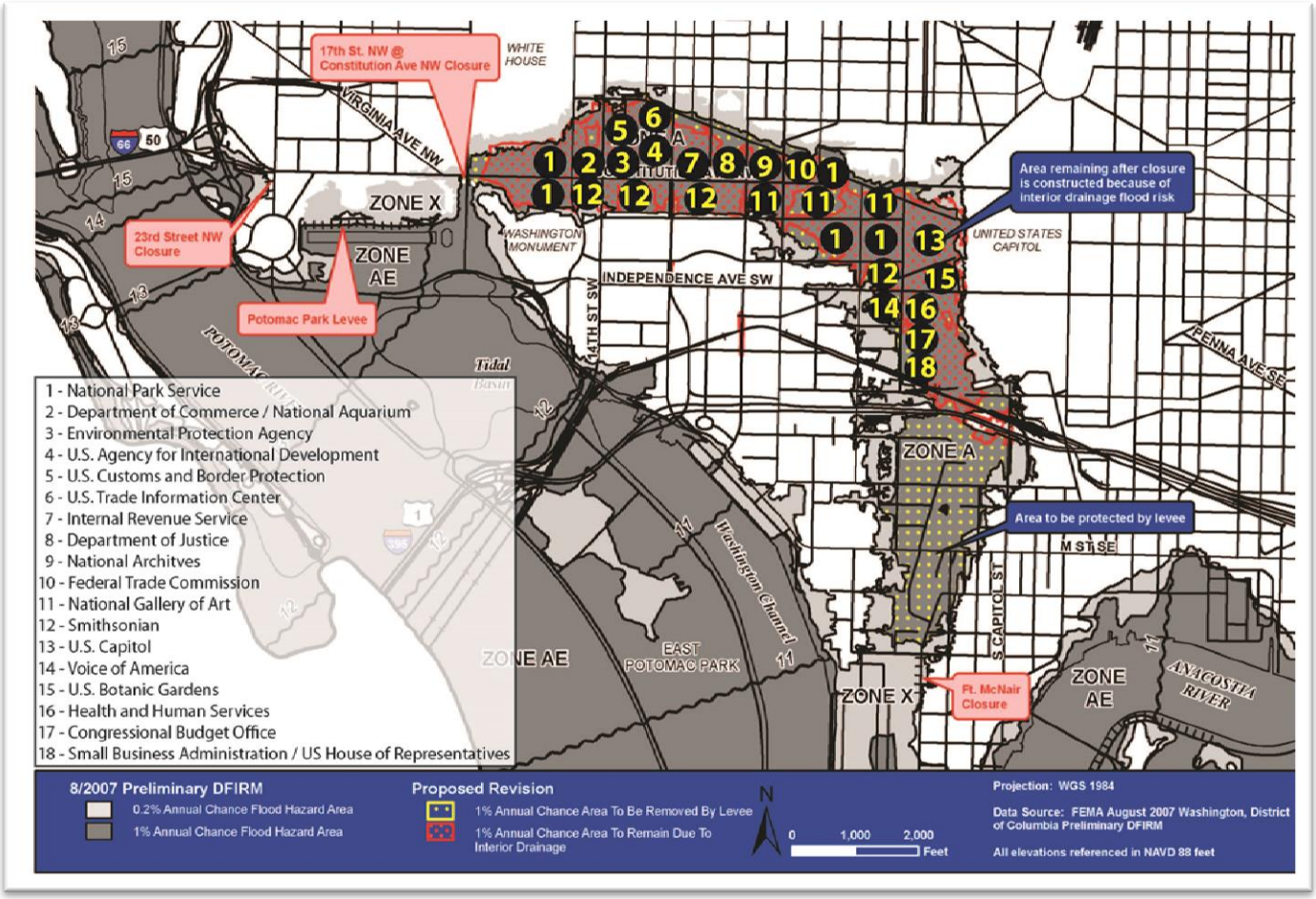


The vulnerability assessments used an 18-foot storm surge (comparable to a Category 3 Hurricane in Washington, DC) to illustrate the potential for significant storm damage as sea level continues to rise and the frequency of storms increases. The 2009 Hurricane Storm Surge Map (see below) for Washington, DC provided participants with areas most likely to experience flooding, shown in green, yellow and orange.



2009 Flood Map showing Areas of Inundation from an 18-foot Storm Surge (areas shown in yellow, green and orange).

In addition to storm surge and tidal flooding, the monumental core is vulnerable to flooding due to frequent heavy precipitation that overwhelms drainage systems. For purposes of the vulnerability assessment, the existing FEMA flood zone map for interior drainage flooding was used to determine areas that would be flooded due to heavy precipitation. The Potomac Park levee system, which is currently being upgraded, will protect the monumental core from storm surge and tidal flooding but not interior drainage flooding. NCPC developed the map below to show the areas and federal buildings that will remain in the FEMA flood zone after the Potomac Park Levee has been upgraded (area shown in red).



RESULTS

This section describes the results from the two workshop series: 1) Built Systems, and 2) Workforce, Community, and Natural Systems.

The results should be viewed as the framework for continuing discussion and coordination, not as adopted strategy by any agency.

1. BUILT SYSTEM RESULTS

Homework Findings

The following summarizes the vulnerability assessment homework that participating agencies submitted, including types of assets at risk, climate risks frequently identified, and examples of ways organizations currently address climate- or weather-related impacts ('work-arounds').

Types of Assets at Risk

- Buildings
- Electric Systems
- IT/Telecomm Infrastructure
- Regional Transportation System
- Navigational Aids
- Airplanes and Ground Fleet Vehicles
- Air Traffic Control Tower
- Wastewater Treatment Plants
- Sewer Pump Stations
- Drinking Water Pump Station
- Historic form of the city as a major cultural landscape

Climate Risks Identified

- Agencies identified more severe and pressing risks related to **Severe Events** rather than Gradual Changes
- The combination of **Sea Level Rise and Storm Surge** was often cited, as was **Heavy Precipitation**
- **Heat Waves** were often mentioned
- Less frequently, agencies identified risks relating to Sea Level Rise, Average Higher Temperatures, and Drought

Current Work-Arounds

Many agencies already have specific ways to mitigate risks heightened by climate change. For example:

- During high-heat days, reducing electrical load for lighting, elevators, and escalators to preserve power for cooling.
- Maintaining back-up generators for emergency power to life-safety systems and servers

- Implementing green (green roofs, rain gardens, landscaping) and gray (structural) infrastructure improvements to help address heavy precipitation events
- Teleworking on limited access days (e.g., flooding in DC)
- Health alerts for heat stress days

Built Systems Risks and Vulnerabilities Workshop (November 14, 2013)

Participants developed the following Challenge Statements and Opportunity Statements for each type of built system at the November 14, 2013 workshop.

BUILT SYSTEM: **Geographic Area: L'Enfant Plan and McMillan Plan, Alexandria Waterfront and Old Town Alexandria**
CHALLENGE STATEMENT: **Given the symbolic value of the nation's capital, the fact that the physical form and resources are nationally and historically significant, and that it cannot be moved:** • **We are not doing enough to protect the city, yet** • **It is difficult to make changes -- including adapting to climate change -- due to existing laws and conflicts with institutionalized values** OPPORTUNITY STATEMENTS: **Given the inevitability of flooding in the monumental core of Washington, DC, how can we best use water and hydrology infrastructure to redefine/improve the character of our capital city?** **Given increased temperatures, how can we make the area more resilient to heat islands via increased vegetation and green infrastructure?** **Given the complex relationship of various systems and the absence of a single authority on flood management, how can we work together?** **How can we involve and educate the public about our risks?**
BUILT SYSTEM: **Transportation Network- Transit (METRORAIL and buses)**
CHALLENGE STATEMENTS: **How can Metro become more resilient to storm surge, sea level rise, heat waves and more intense storms?** **How can businesses, agencies and individuals better prepare for Metro's vulnerabilities?** OPPORTUNITY STATEMENTS: **How can we better coordinate to create a more resilient regional transit system and communicate the information necessary to effectively transport passengers in a wide range of weather situations and modified work schedules?**
BUILT SYSTEM: **Transportation Network – Roads and Bridges**
CHALLENGE STATEMENTS: **How can our regional transportation network:** **1) become resilient to climate change impacts?** **2) prepare for impacts that cannot be prevented?** **How can we effectively communicate the risks to the public?**

OPPORTUNITY STATEMENTS: Educate and communicate about climate change preparedness plans to increase customer acceptance of the need for flexibility in their travel habits and schedules.
BUILT SYSTEM: Electric/Power Grid
CHALLENGE STATEMENTS: Given that all of the NCR's built assets rely upon the electrical grid for power supply, what can organizations do to reduce demands on the grid? What can PEPCO do to improve grid resilience? OPPORTUNITY STATEMENT: Given anticipated increased electricity usage during extreme heat, what can be done to better manage power use?
BUILT SYSTEM: Stormwater
CHALLENGE STATEMENT: How can we increase public acceptance of nontraditional fundraising vehicles to construct green infrastructure and other traditional stormwater solutions? OPPORTUNITY STATEMENT: Educate the public on the value of green infrastructure, rainwater harvesting, and more resilient treatment processes.
BUILT SYSTEM: Building Enclosure
CHALLENGE STATEMENT: How can we ensure a sustainable return on investment on our real estate assets given the monumental, historic and symbolic values of our buildings, while balancing life safety, historic preservation and security priorities? OPPORTUNITY STATEMENT: Building enclosures are the most expensive to repair or replace. Addressing the risks of climate change in the maintenance and monitoring of building enclosures extends the life of buildings and is part of making assets more robust and resilient.
BUILT SYSTEM: Building Components (e.g. HVAC, telecom, IT)
CHALLENGE STATEMENT: What measures can individual building owners take to make their HVAC and IT systems more resilient to spikes in cooling and heating demands due to expected increases in extreme temperatures?

Adapting Built Systems Workshop (December 2-3, 2013)

This section contains the results from the strategy breakout sessions at the December workshop.

Results from Strategy Breakout Session

Participants identified possible adaptation strategies for each of the challenge statement areas and completed worksheets for each proposed strategy. Breakout groups also discussed possible obstacles to planning, funding, and executing the proposed strategies. The chart below summarizes strategies reported out of each of the six topic groups. The workshop participants also recognized "Governance" as an area that needs to be addressed if coordinated implementation is to be successful.

Results from Strategy Breakout Session			
GROUP	CLIMATE VARIABLE	POTENTIAL STRATEGY	MAJOR STEPS FOR FURTHER STUDY
Transportation	Primary - Flooding, Heavy Precipitation, sea level rise (SLR) plus Storm Surge; Secondary – Heat stress, Power	Create and implement a Regional Climate Transportation Resiliency Action Plan, guided by a regional advisory body	1. Create a Transportation Resiliency Action Plan by November, 2016 2. Secure quick wins with a high ROI; for example, fixing vent shafts 3. Support more remote working; pilot a program allowing federal workers to work from any federal office 4. Promote livable communities within Activity Centers in the National Capital region 5. Educate system users about existing options
Energy	Primary - Higher Avg. temperature; Secondary – SLR and Storm Surge, Heavy Precipitation	Ensure a reliable overarching electrical grid and energy supply system across the NCR to respond to a changing climate	1. Conduct system assessment 2. Build a cross-organizational network 3. Develop strategic plan for regional reliability 4. Participate in demand side management plan 5. Implement upgrades
Stormwater/ Wastewater	Heavy Precipitation/ Flooding	By 2030, implement a wastewater and stormwater management program to accommodate anticipated precipitation events in 2080 to protect people and infrastructure	1. Implement best management practices to reduce stormwater load 2. Increase capacity of stormwater conveyance system where needed if possible 3. Assess and adjust wastewater treatment capacity and collection system (pipes, pumps, facilities); assess possibility for reclaimed water production and distribution

Results from Strategy Breakout Session			
GROUP	CLIMATE VARIABLE	POTENTIAL STRATEGY	MAJOR STEPS FOR FURTHER STUDY
Geographic/ Historic Areas	Flooding	Create a Flood Resilient Monumental Core	1. Develop roadmap/framework, with multi-jurisdictional coordination 2. Develop multi-jurisdictional working group (federal, DC, other) 3. Review agency action plans and coordinate elements across agencies and with local governments to identify overlaps and capitalize on synergies 4. Tap into private sector capital to build resiliency 5. Plan for eventual end of FEMA flood insurance
IT/Telecom (identical to energy)	Primary - Higher Avg. Temperature; Secondary – SLR and Storm Surge, Heavy Precipitation	Ensure a reliable overarching electrical grid and energy supply system across the NCR to respond to a changing climate	1. Conduct system assessment 2. Build a cross-organizational network 3. Develop strategic plan for regional reliability 4. Participate in demand management plan 5. Implement upgrades
Governance	N/A	A. Develop joint funding for large-scale, cross-boundary, multi-jurisdictional adaptation strategies	1. Tap into private sector capital to share risk and cost with private sector 2. Understand private stakeholder interests 3. Review existing local and federal agency budgets for opportunities for allocation to climate adaptation 4. Develop ability to pool funds across local, federal and private sources 5. Tap into other funding sources, such as foundations, philanthropic organizations and individuals, and other partners with “skin” in the game
		B. Create body to address climate adaptation activities	Create a congressionally-empowered body to address, coordinate, and provide funding related to climate adaptation activities (by 2016)

2. WORKFORCE, COMMUNITY, AND NATURAL SYSTEMS RESULTS

Homework Findings

In the vulnerability assessments submitted, participating agencies identified types of systems at risk, the climate risks involved, the resulting impacts, and examples of ways each agency currently addresses climate- or weather-related impacts ('work-arounds').

Types of Systems at Risk

- Workforce commuting
- Workforce and family health
- Working conditions
- Impacts on agricultural research
- Water quality
- Drinking water

Climate Risks Identified

- Agencies identified more severe and pressing risks related to **Severe Events** rather than Gradual Changes
- **Heat Waves** were mentioned frequently
- **Sea Level Rise and Storm Surge** combination was often cited, as was **Heavy Precipitation**
- Less frequently, agencies identified risks relating to Sea Level Rise, Average Higher Temperatures, and Drought

Sample Impacts

- **Heat stress for outdoor workers** – affecting the type of work that can be done *and* productivity
- **Flooding** prohibiting **access** to workplace/ parking
- **Flooding** affecting **commute options**
- **Sea level rise and flooding** requiring homes and offices to **re-locate**
- **Rising temperatures, drought, heat waves** affecting **health –** excess heat, elevated ozone, vector-borne diseases

Current Work-Arounds

Many agencies already have specific ways to mitigate risks heightened by climate change. For example:

- Sending workforce home when temperatures inside exceed 90 degrees
- Teleworking plans in place; improving IT/Cloud for teleworkers
- COOP (Continuity of Operations) Plans
- Having emergency sand-bagging contracts in place
- Flood response plan (DC Water)

- Green roofs, cisterns, green and gray infrastructure to manage precipitation
- Health alerts for heat stress days and Ozone Action days
- USDA Natural Resources Conservation Service evaluating drought tolerant plant varieties
- Flood gates at National Archives to protect electrical system

Workforce, Community, and Natural Systems Risks and Vulnerabilities Workshop (April 1, 2014)

Participants developed the following Problem Statements for each of the four breakout topics at the April workshop.

SYSTEM: **Terrestrial Natural System**
PROBLEM STATEMENT: The vitality and services provided by the NCR's terrestrial natural system is at risk due to increased occurrence of invasive species, tree mortality, pests, and other potential impacts resulting from higher average temperatures, precipitation variability, heavy precipitation/wind storms and drought events that climate change brings. What measures (such as policies, best management practices, regulations, or incentives) can city planners, researchers, and park employees take to prepare for and respond to these impacts?
SYSTEM: **Community Vitality**
PROBLEM STATEMENT: The neighborhoods of the Washington, DC region are at risk of losing their strength and vitality due to changes in climate that may cause serious disruptions to public transportation, flood homes and parks, and reduce the economic vigor of the area. In the face of a changing climate (with both gradual and extreme changes), how can communities foster resilience and vitality in these 5 areas: • Ability of neighbors to help each other / social connectedness • Access to critical services such as food and public amenities • Redundancy of infrastructure systems – transportation, energy, water, health • Temporary evacuation centers during major disasters • Education and acceptance of adaptation implementation The intent is to examine community vitality at the *neighborhood* scale.

SYSTEM: **Workforce Productivity**

PROBLEM STATEMENT:

The workforce of the Washington region is at risk from climate impacts on health, built infrastructure and transit systems due to heat waves and flooding.

What measures can organizations take to mitigate the disruptive effect of these events as they become more frequent and/or severe?

Consider several segments of the workforce:

- Professionals
- Emergency responders/cleanup/outdoor workforce
- Service Industry

SYSTEM: **Aquatic Systems**

PROBLEM STATEMENT:

The physical, chemical, and biological integrity of the National Capital Region's aquatic systems (streams, wetlands, and the Anacostia and Potomac Rivers) are at risk due to the impacts of climate change, including heat waves, drought, heavy precipitation, sea level rise and storm surge, higher average temperature, and precipitation variability. Most notably, the impacts that change water bodies' flow volume and seasonal flow have the potential to affect the overall health of the aquatic ecosystem and the quality of the drinking water supply.

What measures can we take to protect aquatic ecosystem health from the impacts of climate change?

Adapting Workforce, Community, and Natural Systems Workshop (April 29 - 30, 2014)

This section contains results from the strategy breakout sessions at the April 29-30, 2014 workshop.

Results from Strategy Breakout Session

Participants identified possible adaptation strategies for each of the problem statement areas and completed worksheets for each proposed strategy. Breakout groups also discussed possible obstacles to planning, funding, and executing the proposed strategies. The chart below summarizes strategies reported out of each of the four topic groups.

GROUP	CLIMATE VARIABLE	POTENTIAL STRATEGY	MAJOR STEPS FOR FURTHER ACTION
Terrestrial – Managed landscapes, including forested areas	Heavy Precipitation/ Wind, Droughts, Precipitation Variability, Higher Average Temperatures	Protect and increase green systems in the NCR	1. Assess and quantify full range of ecosystem services and benefits of existing green systems to form a baseline 2. Use an inter-jurisdictional, inter-sectoral group to obtain buy-in, input and perspective on an integrated plan 3. Map and connect habitat corridors 4. Develop a public outreach campaign that builds on, strengthens, expands, and links to existing efforts and focuses on benefits of adaptation, mitigation, and ecosystem services of natural landscapes 5. Remove regulatory barriers that prevent or discourage green/natural system strategies 6. Develop list of programs, plans, and activities needed to address gaps with specific metrics for 2020, 2030, 2040, 2050, and beyond
Community Vitality	Heat Waves/ Higher Average Temperature	Enhance community vitality and heat resiliency with multi-purpose indoor/outdoor centers of activity and cooling	1. Inventory current and potential cooling centers 2. Identify barriers to strategy implementation in zoning codes/use restrictions and needed policy changes 3. Form an outreach strategy for hosts/decision makers and users (including residents) 4. Incentivize/enhance host centers 5. Consider 'siesta' schedule

GROUP	CLIMATE VARIABLE	POTENTIAL STRATEGY	MAJOR STEPS FOR FURTHER ACTION
Workforce Productivity	Heat Waves and Variability	Achieve optimal worker productivity (maintaining/increasing worker productivity) in the face of more frequent extreme heat events	1. Conduct Training/Outreach to employees, managers, executives; work with Federal Occupational Health clinics to expand capacity 2. Expand worker populations who are able to telework 3. Implement more timely communications on heat events 4. Offer alternative hours/shifts, particularly for outdoor work 5. Allow adaptive dress codes 6. Establish cooling stations with sunscreen, water, alcohol rub, cooling awnings/screens
Aquatic	Heavy Precipitation	Coordinate and integrate public engagement for stormwater management and Low Impact Development	1. Inventory NCR stormwater/ green infrastructure programs and regulations 2. Engage senior leadership to develop charge/ goals for an overarching coordinating body 3. Form cross-sectional team to develop and implement outreach plan to coordinate and improve outcomes of various stormwater programs/ regulations

CONCLUSION

The *Building a Climate Resilient Region* webinars and workshops resulted in several outcomes for participants and their agencies and organizations.

- Participants increased their awareness of the growing threats of extreme weather events to the local economy and the region's long-term economic resiliency.
- Regional stakeholders used a consistent vulnerability assessment process, ensuring analyses were based on the same baseline climate risk data and considering the sectors that had been collectively determined as most important.
- Participants were motivated to coordinate *within* their agencies to complete their homework, providing a more comprehensive first look at their agency's vulnerability to climate risks in the National Capital Region.
- Participants coordinated *across* agencies and organizations, learning about their neighbors' vulnerabilities, and better appreciating the interdependencies and synergies that can help or hamper their adaptation efforts.
- Participants increased vulnerability assessment skills through the homework and workshop activities.
- Participants learned how to communicate and gain support for their climate adaptation work with decision-makers.

Key Observations

Through the interactive exercises in the workshops, participants gained a broader understanding of various aspects of climate change adaptation planning. The following reflects the key insights:

Understanding of Climate Impacts

- We need to understand the cascading effects of issues (e.g., how heat waves or flooding affect personal health which then affects worker productivity) and of solutions (e.g., teleworking may reduce some impacts, but lead to unintended consequences for the local economy).
- We need to gain consensus on our collective risks and what we consider to be acceptable risks.
- The problem is not just about technology; it is a people and systems problem.
- Climate impacts are not limited to Washington, DC; there are "spill-over" effects to the rest of the region, the US and the world.

Expanding Current Efforts

- We need a better understanding of the planning that has been done thus far, where the gaps lie, and where new initiatives are needed.
- Consider co-benefits of alternatives when selecting the best adaptation action. Many strategies will yield other positive benefits to communities (e.g., transportation alternatives, more trees, energy & emissions reductions).

- Ultimately, climate solutions should be 'mainstreamed' into regular operations. The 'risk management' model could be applied to climate impacts.
- We can integrate some elements of adaptation strategies into existing policies and programs now.

Interagency Coordination and Partnerships

- The National Capital Region has unique governance challenges due to multiple authorities with jurisdictions over land, infrastructure and natural resources.
- We need to identify/form the main authority to make decisions.
- Although the challenges are formidable, the threat is real, and the stakes are high—the National Capital Region must continue working together towards climate-preparedness.
- Many expressed that NCPC and MWCOG are uniquely positioned to help move the dialogue to action on the built systems issues.

Implementing Strategies

- The large scale of adaptation needs requires government funding, which has become more constrained. Consider innovative partnerships that can tap into private sector capital or both.
- Part of implementation will no doubt include public and policymaker education about the problem and solutions.
- Actions will require creative approaches by individual residents and business owners, property owners, federal agencies, local governments, regional service providers, and grassroots organizations -- from the site level to community-wide.

What is next?

This effort helped agencies move one step further down a path towards climate resilience, but there is much more to be done given the magnitude of the problem and the vital services, resources, and communities of the National Capital Region. First, representatives from the participating agencies will bring these ideas back to their respective agencies for further discussion and exploration. In addition, the sponsoring agencies will share the information and outcomes from the webinars and workshops with a broader audience, including climate adaptation practitioners, senior leadership within federal agencies and local government, and the general public.

The participating agencies want to continue exploring these ideas together, and NCPC and MWCOG will now take on the role of facilitating these conversations. Participating organizations and others in the National Capital Region can use this first set of strategies as a starting point to identify the short term actions that can be advanced quickly, and the longer term actions that should be prioritized for time and resource allocation. These steps will begin to turn ideas into action to build a truly climate resilient National Capital Region.

About the sponsor organizations

Metropolitan Washington Council of Governments (MWCOG) has been a leader in research and policy development in climate adaptation planning in the region since 2008. An independent, nonprofit association that brings leaders together to address regional issues, COG's membership is comprised of 300 elected officials from 22 local governments, the Maryland and Virginia state legislatures and the U.S. Congress. The region is seeing increasing climate risks to buildings and infrastructure, workforce, natural systems, and the wider community. COG will continue its coordinating role, but the support and dedication of regional partners is essential. Together we can create a more prosperous, accessible, livable, and sustainable region.

The National Aeronautics and Space Administration (NASA) didn't wait for external direction to recognize that climate risks could interfere with its success. Leveraging its considerable expertise in climate science, NASA scientists and stewards partnered with surrounding communities to develop a local adaptation process for its worksites across the nation. Headquartered in Washington DC, NASA was well-positioned to share this process with other stakeholders in the National Capital region. Consistent with its mission, NASA provided climate projections specific to the region.

The National Capital Planning Commission (NCPC) develops long range plans and collaborative initiatives to guide the development of the nation's capital, reflecting the region's concentration of national treasures, and federal assets and operations. NCPC is promoting wise stewardship of our nation's capital by partnering with regional stakeholders on federal, regional and local climate adaptation efforts to address the impacts of extreme weather and promote sustainable development.

US General Services Administration (GSA): As the landlord and caretaker for federal properties, GSA owns or leases 9,624 assets (sites and facilities), maintains an inventory of more than 370 million rentable square feet of workspace, and preserves more than 481 historic properties. GSA also has an annual business volume of over $60 billion, manages over 200,000 fleet vehicles, assists tens of thousands of federal travelers through GSA's electronic travel system, and serves as the focal point for data, information and services offered by the federal government to its citizens. Climate change poses threats to the facilities and supply chains GSA manages, but it also presents an opportunity to prepare today for a resilient future that reduces the federal government's exposure to climate risks and their associated costs.

US Global Change Research Program (USGCRP): As the Third National Climate Assessment and other authoritative sources confirm, climate change is happening now. The United States and the world are getting warmer, sea level is rising, and some extreme events like heat waves and floods are becoming more frequent and more severe. As part of its mission to empower the nation with global change science, the U.S. Global Change Research Program provides reliable scientific information about current and future changes, impacts, and effective response options at multiple scales that can be of use to the National Capital Region.