

Can We Get There from Here?

Transportation & Climate Adaptation

Steve Winkelman

Director, Transportation & Adaptation Programs

Transportation System Resilience, Extreme Weather, and Climate Change Webinar Series

Volpe National Transportation Systems Center

October 8, 2013

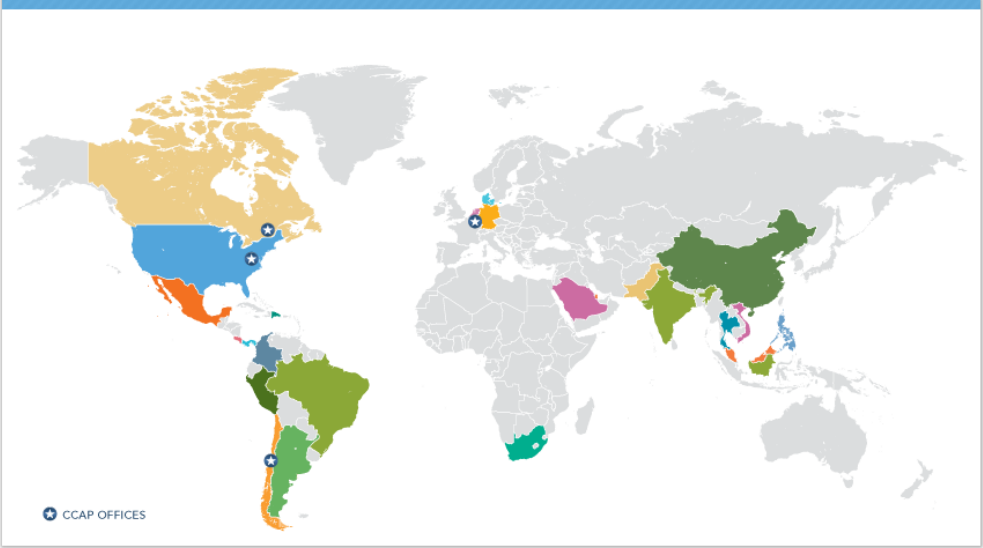
swinkelman@ccap.org



1. INTRODUCTION AND OVERVIEW

1. Introduction
2. What's the **problem**?
3. What **solutions** do we have?
4. What's needed for **implementation**?
5. Continuing **progress**

DIALOGUE. INSIGHT. SOLUTIONS.



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HOME : OUR WORK : CCAP WORLDWIDE

CCAP WORLDWIDE

CCAP works with policymakers around the world to develop, promote and implement innovative, market-based solutions to major climate, air quality and energy problems.



The screenshot shows the CCAP website header with the logo, navigation menu, and search bar. The main content area features a section titled 'Cross-Cutting-Themes' with a list of four bullet points. Below the list is a short paragraph about CCAP's work with policymakers.

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HOME : OUR WORK : CCAP WORLDWIDE

Cross-Cutting-Themes

- Greenhouse gas emission reduction
- Public - private collaboration
- National - Local policy coordination
- Maximizing economic and social benefits

CCAP works with policymakers around the world to develop, promote and implement innovative, market-based solutions to major climate, air quality and energy problems.

CCAP: CURRENT EFFORTS

- **MAIN: Mitigation Action Implementation Network**
 - Promote sustainable development in Latin America and Asia
- **US Climate Policy Initiative**
- **Sustainable Urban Transportation**
 - Colombia Transit-Oriented Development NAMA
 - Low-emissions development in Mexico and Saudi Arabia
- **Weathering Climate Risks**
Advancing community and corporate resilience

www.ccap.org

CCAP WEATHERING CLIMATE RISKS PROGRAM

- Resilience planning in Washington DC
- Catalyze implementation progress
 - Stakeholder engagement, Economic and policy analyses
- Inform and inspire replication
 - Pilots, policy recommendations, outreach, webinars, blogs...
- Measuring Climate Resilience
 - People, Infrastructure, Economy (PIE)
 - Implementation progress, effectiveness
- Advancing Mitigation/Adaptation Synergies

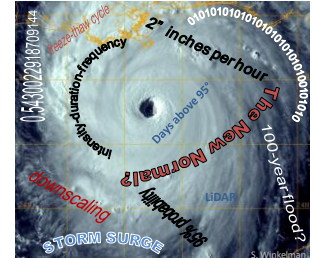


SURDNA FOUNDATION

CCAP's Weathering Climate Risks program is made possible through generous support from the Surdna Foundation.

SELECTED PUBLICATIONS: TRANSPORTATION AND ADAPTATION

- **Climate Adaptation & Transportation:
Identifying Information and Assistance Needs**
- **Severe Weather & Critical Infrastructure Resilience:
Preparing Washington D.C.**
- ***Growing Wealthier:
Smart Growth, Climate Change, & Prosperity***
- **The Value of Green Infrastructure for Urban Climate Adaptation**
- **Lessons Learned on Local Climate Adaptation**
- **Ask the Climate Question**



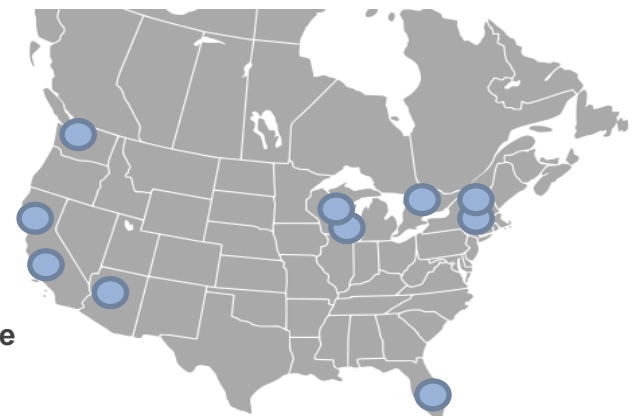
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ASK THE CLIMATE QUESTION!

What we build -- where and how -- makes a difference.

Ask the Climate Question

- **How will infrastructure, land use and policy decisions affect:**
 - **GHG emissions?**
 - **Resilience to climate change impacts?**
- CCAP's partners in the Urban Leaders Adaptation Initiative such as King County, Chicago, Toronto, NYC, asked the Climate Question across city departments and functions



CCAP Urban Leaders Adaptation Initiative

CLIMATE POLICY GOALS

- Maximize **GHG Mitigation**,
- **Adapt** to what can't be mitigated,
- Minimize **Suffering** and
- Enhance **Resilience**.

(based on) John Holdren

Director, White House OSTP



“It’s like breathing and eating” –
we must reduce GHGs and adapt!

~ Ron Sims

former King County Executive & HUD Deputy Secretary

“AN INCONVENIENT SEWER OVERFLOW....



... this isn't about polar bears; it's about backed-up sewers in your streets or basements.”

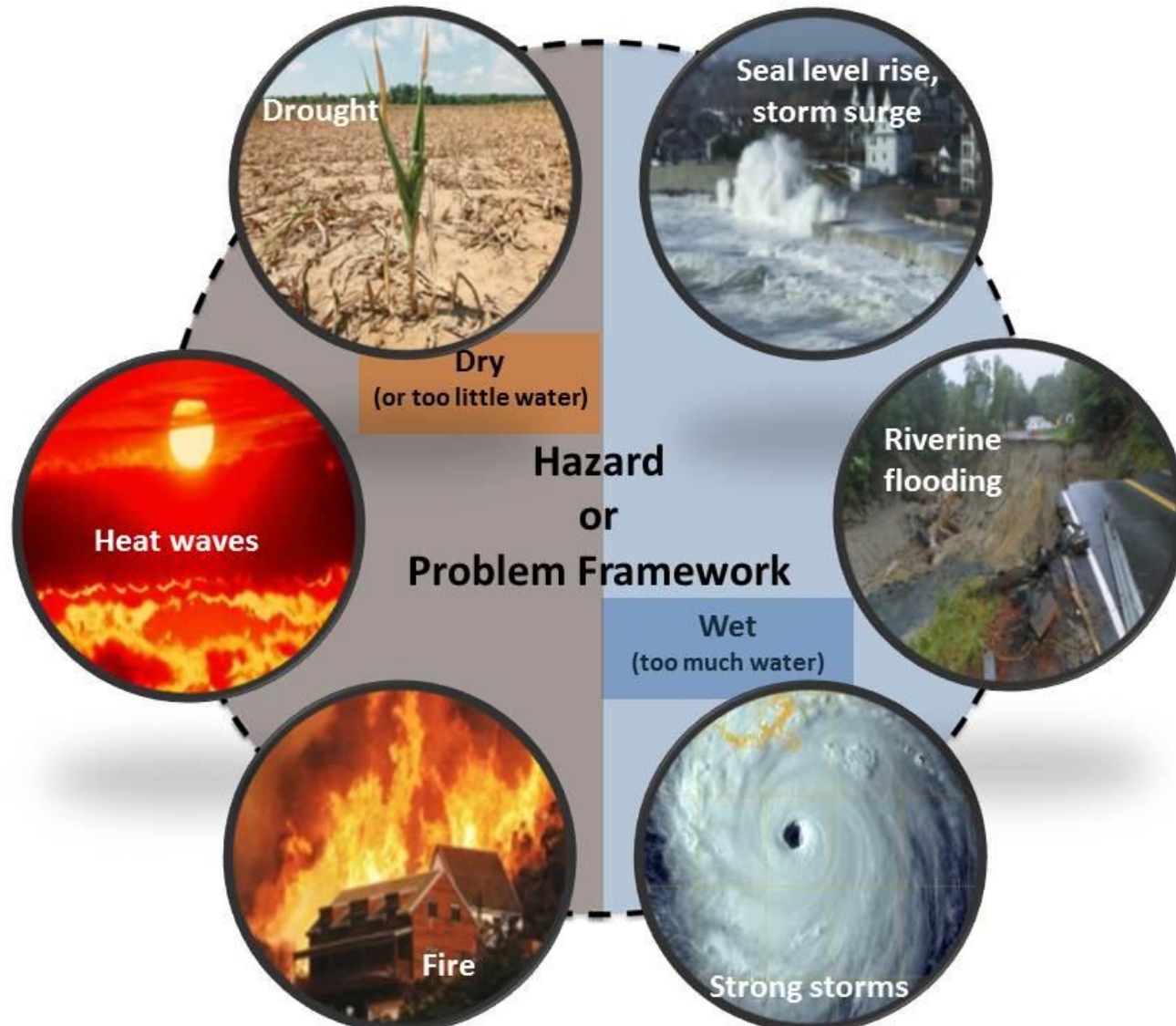
~ Steve Winkelman in *ClimateWire*, May 4, 2012

2. THE PROBLEM: A NEW NORMAL?

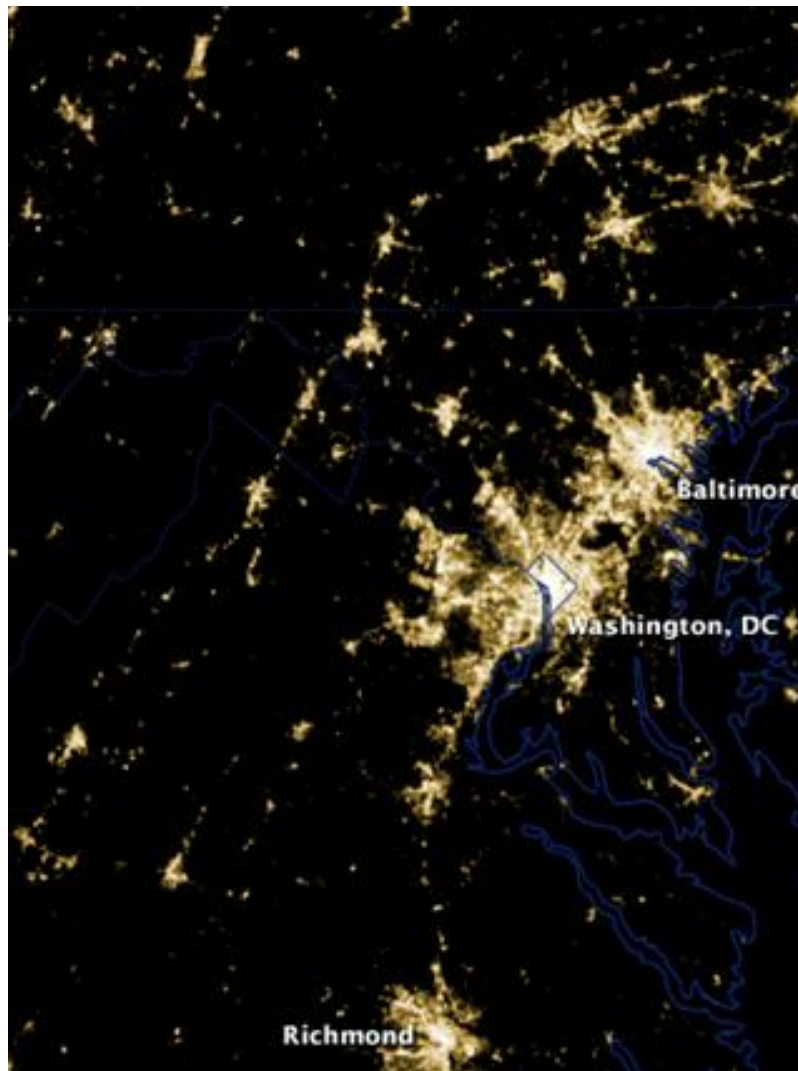
- **Extreme weather events on the rise**
 - Storms, floods, heat waves, wild fires...
 - 2011-12: double the average frequency of record extremes in temperature, precipitation, drought, and tropical cyclones (NOAA)
- **Major economic losses: Sandy: \$65 Billion** losses (2012)
- **Road repair costs from flooding**
 - **Colorado: \$500 million** (2013)
 - **North Dakota: \$195 million** (2011)
 - **Ohio: \$168 million** (2011)
 - **Vermont: \$200 million** (2011, Irene)
- **Climate change projected to increase impacts**



CLIMATE IMPACT FRAMEWORK: TOO LITTLE / TOO MUCH WATER

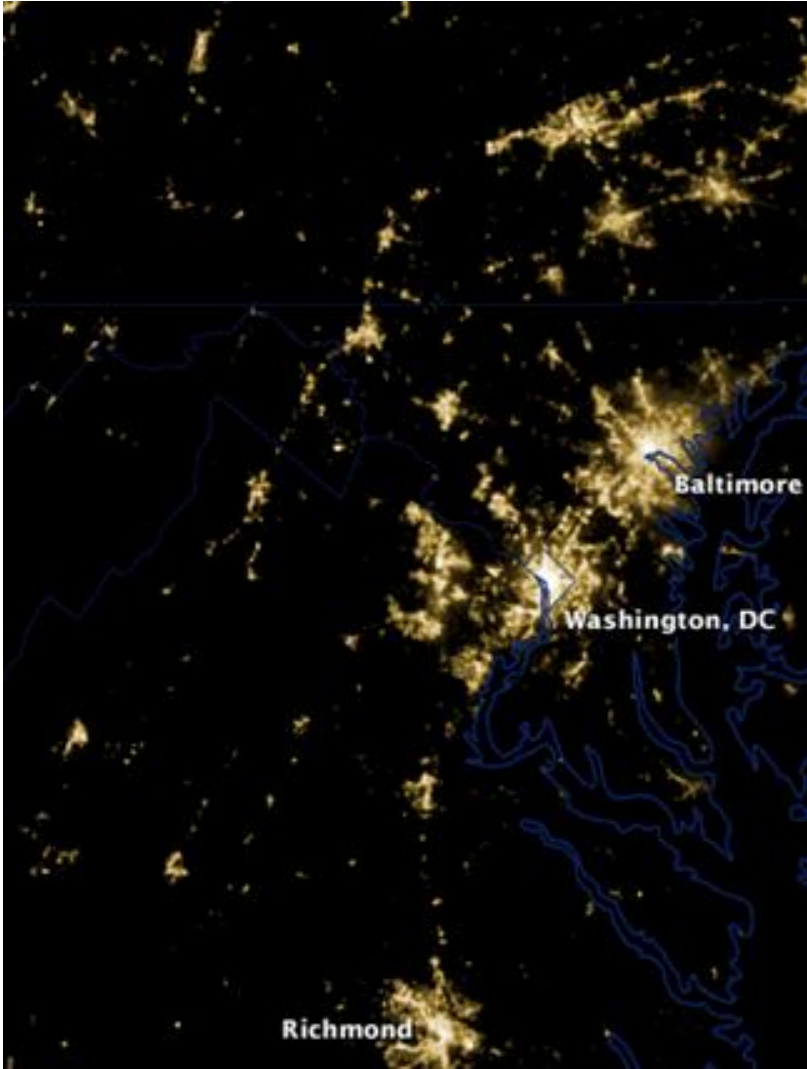


WHAT CAN WE DO WHEN...



June 2012 Derecho -- before
Source: NASA Earth Observatory

THE LIGHTS GO OUT?



June 2012 Derecho -- [after](#)
Source: NASA Earth Observatory

THE STREETS FLOOD?



Photo source: Keystone USA-ZUMA/Rex Features

ROADS ARE WASHED OUT?



Chris Schneider AP

TRAIN STATIONS FLOOD?



PA NY/NJ

WILDFIRES STRIKE?



Photo source: New York Daily News

EXTREME HEAT BUCKLES RAIL?



FTA

RUNWAYS SOFTEN?



Phillip Dugaw/Reddit

SECONDARY AND CASCADING EFFECTS ARISE?

- System interactions and interdependencies
 - Power, transport, water, telecom
- Hurricane shuts Galveston Port and Mississippi barge traffic
 - Droughts can do the same
- Storm → branches → river → culvert → road outage
- Multiple storms → soil saturation → sewer overflow, flooding
- Pine beetles + Heat wave → Fires, then storms → erosion
- Derecho → power out → Metro & signal lights out → traffic

3. WHAT SOLUTIONS DO WE HAVE?

A variety of measures:

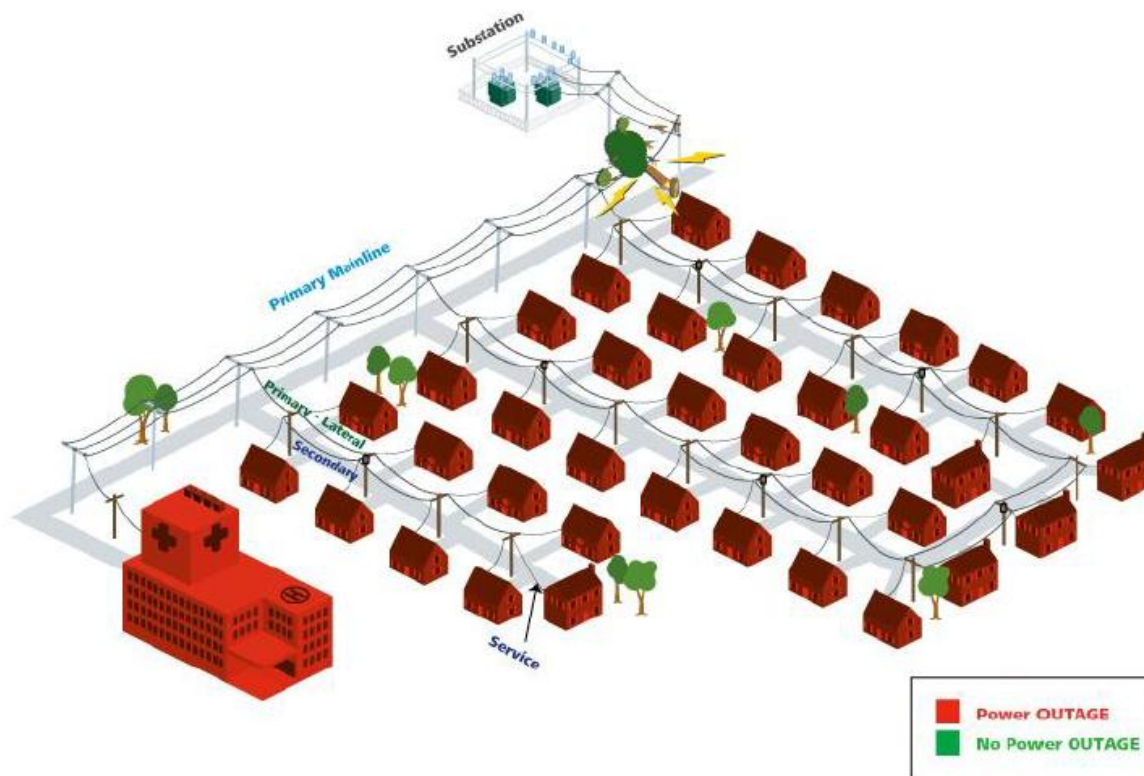
- Engineering, design, planning, policy
- Short-term and long-term
- Narrowly focused and broad scale
- Directionally-correct and comprehensive
- Cross-cutting and sector specific

LARGE-SCALE, COMMUNITY-WIDE PROTECTION



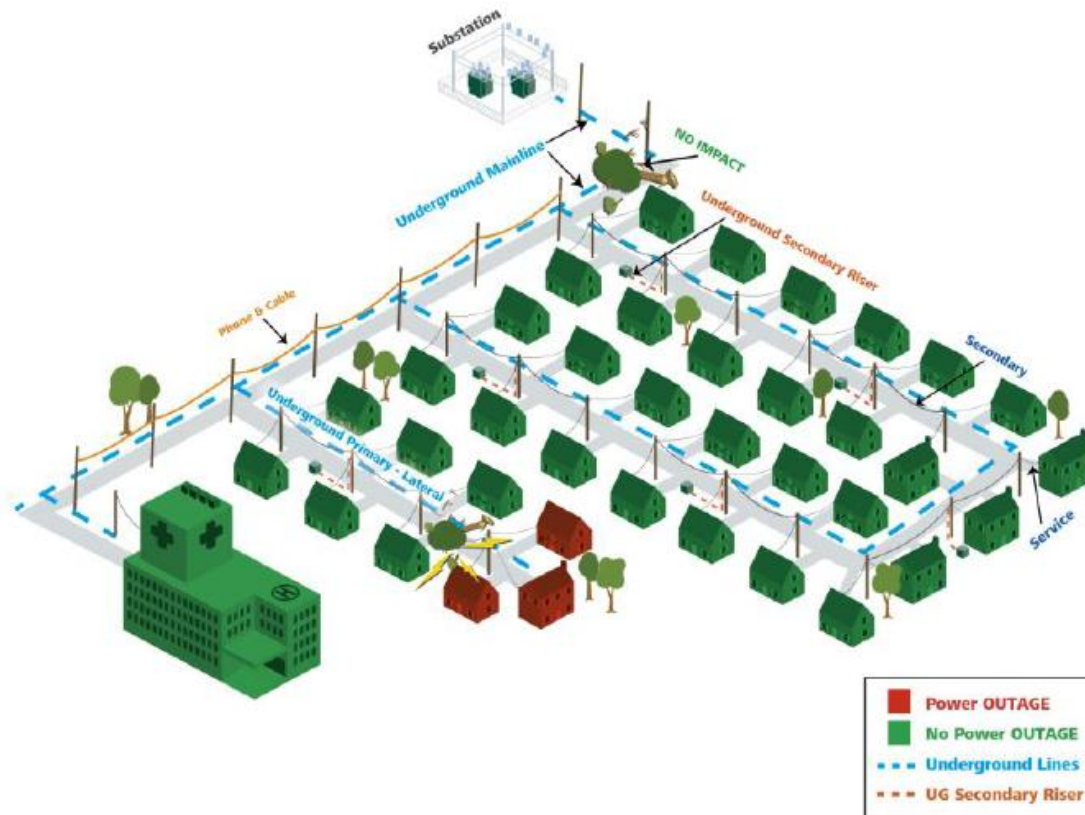
ELECTRICITY GRID RESILIENCE

EXISTING OVERHEAD SYSTEM



“UNDERGROUNDING” POWER LINES

PROPOSED UNDERGROUND PLAN



ALTERNATIVE MODES & NETWORK REDUNDANCIES



REDUCE METRO FLOODING ELEVATE GRATES, PRE-EMPTIVE SHUTDOWN



Problem

NYC subway flooding after a 2007 storm.

Source: MTA NYC Transit



Partial Solution

MTA NYC Transit has allocated nearly \$90 million toward raising ventilation grates and installing stair pads at subway entrances.

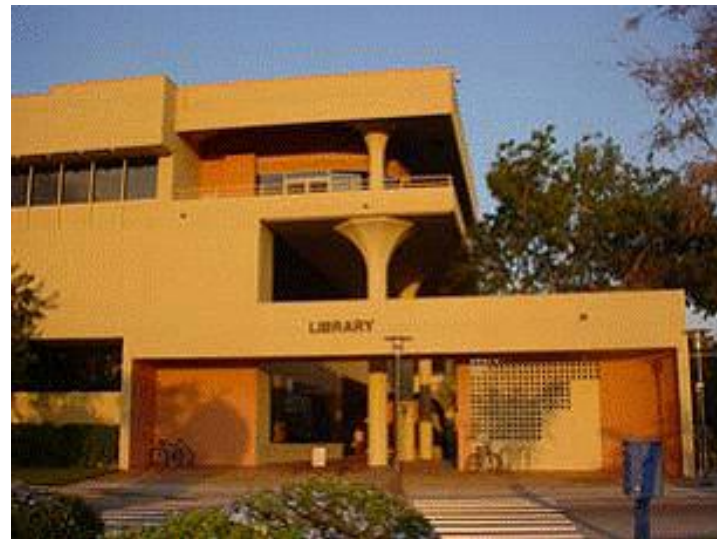
Source: MTA NYC Transit

EVACUATE IN PLACE



Houston: Hurricane Rita evacuation, 2005
Source: www.houstonfreeways.com

VS.



Florida International University – fortified library
Source: Miami-Dade County

GREEN INFRASTRUCTURE



Chicago Climate Action Plan



CULVERT REDESIGN: TORONTO



A 2005 storm in **Toronto** caused \$647 million in damages, including destruction of this culvert (left, \$4 million) in losses, which was replaced with a larger, more resilient culvert (right). Source: Toronto Environment Office.
Photo credit for damaged culvert: Jane-finch.com.



Photo credit for new culvert: City of Toronto Transportation Services.

VERMONT: CULVERT REDESIGN, RIVERS & ROAD TRAINING



FEMA initially denied reimbursement for larger culvert. Ongoing challenge with site-specific design flexibility vs. uniform application of a law. Georgetown Climate Center is preparing a case study (and provided these photos).

VTRANS: [Rivers & Roads Training](#)
Design, maintain, operate with the rivers foremost in mind.

4. WHAT'S NEEDED FOR IMPLEMENTATION?

RESILIENCE AND ADAPTATION PLANNING

- **Measure and document past events and impacts**
 - Physical, operations, economic
- **Project future impacts**
- **Assess vulnerabilities**
- **Evaluate resilience strategies**
- **Gauge available resources and capabilities**
- **Engage stakeholders throughout**
- **Identify and pursue implementation opportunities**

CHALLENGES

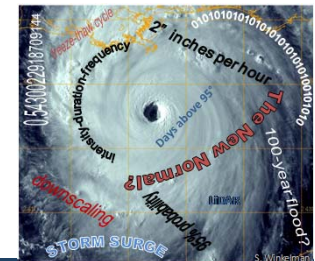
- **Analytical**
 - Physical impacts: System and model interactions
 - E.g., SLR + projected storms → surge → topography → flooding
 - Infrastructure interdependencies
 - Economic
 - Opportunity costs of impacts (business interruption, infrastructure...)
 - Costs and benefits of resilience measures
- **Institutional, Policy/Legal, Budgetary**
 - Conflicting goals or requirements (government, private sector, community)
 - Agreeing on risk tolerances, critical infrastructure
 - Stakeholder agreement on implementation and funding priorities
 - Staff capacity and availability
 - Restrictions on use of rebuilding funds
 - Limited funds to invest

INFORMATION & ASSISTANCE NEEDS CCAP/EESI WORKSHOP FINDINGS (1)

Climate Adaptation and Transportation Information & Assistance Needs CCAP/EESI for NOAA (2012)

1. Information on local, non-climate factors can be more important than climate science information.

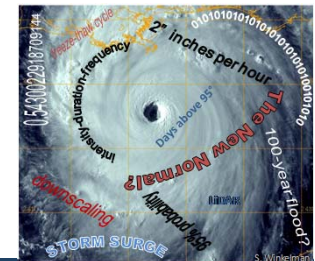
- Adaptation starts with determining how well critical infrastructure is adapted to *current* climate and weather
- Infrastructure elevation, state of repair, culvert capacity
- Land development trends
- Natural factors: soil saturation, tide levels, river flows
- Interactions, cascading impacts



INFORMATION & ASSISTANCE NEEDS CCAP/EESI WORKSHOP FINDINGS (2)

2. Improve climate & weather information products

- Precipitation Intensity Duration Frequency (IDF) curves (Atlas 14)
 - Keep updated for all regions
 - Add climate change projections
- Update flood maps taking climate scenarios into account
- Extreme events: enhanced spatial & temporal information
- Standardize sea-level rise GIS data
- Updated LiDAR elevation data



INFORMATION & ASSISTANCE NEEDS CCAP/EESI WORKSHOP FINDINGS (3)

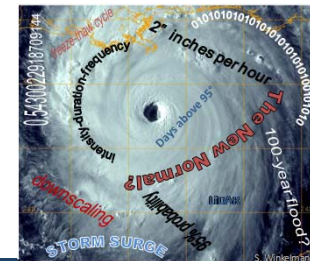
3. Communication

- Need central clearinghouse of data, information, guidance
- Clear summary of who's doing what, where to find what you need
- Best practices
- Help navigating tools, models data



4. Education

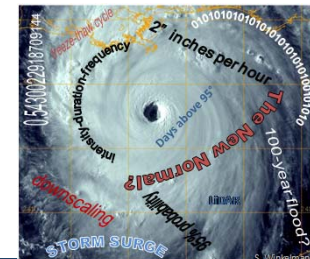
- Definition of critical assets
- Increase comfort in applying projections instead of historical data
- Peer exchange



INFORMATION & ASSISTANCE NEEDS CCAP/EESI WORKSHOP FINDINGS (4)

5. More and Better Tools

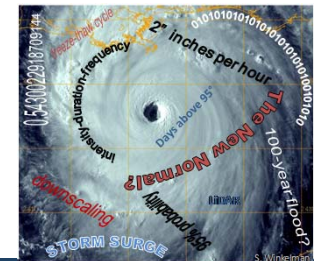
- *Integrate climate decision making into existing processes*
- Scenario analyses and planning
 - Determining **thresholds** and decision points
 - Determining **timing** of decisions, actions
 - Assessment of multi-sector interdependencies
- **Evaluating costs and benefits** of adaptation measures
- **Managing risk and uncertainty**
 - Guidance on operationalizing responses to probability ranges
 - **When are directionally-correct measures enough?**



INFORMATION & ASSISTANCE NEEDS CCAP/EESI WORKSHOP FINDINGS (5)

6. Research Needs

- Small scale events don't get enough attention
 - Can be significant in terms of storm water management
- Projected extreme events at higher time resolution
 - Hydraulic engineers interested in events of 6-hour or less
- Relating projected model results for precipitation to flow/runoff
 - Integrate with land use changes and other projected changes



INFORMATION & ASSISTANCE NEEDS CCAP/EESI WORKSHOP FINDINGS (6)

7. Engage Stakeholders

- Present images of problems and common-sense solutions
- Relate it to stakeholder priorities: Economic, Quality of Life
 - Economic costs & benefits for government, business, individuals

Growing Wealthier Matrix

Business	Household	Municipal & Regional	National
<i>Return on Investment</i>			
Access to new markets	Enhance or preserve housing values	Higher public revenues	More efficient use of transportation investments
Reduced investment risks	Better access to jobs	Reduced citizen opposition to development	Construction & transit jobs
Construction & transit jobs		Attracts private investment	
Higher property values		More efficient economy	
Productivity enhancements due to agglomeration			
<i>Savings on Expenditures</i>			
Employee health care savings	Save on travel costs	Infrastructure savings (construction & operation)	Energy security
Better information & decision making	Reduced energy & water use	Reduced costs from urban decline	Health care savings
Reduced parking requirements	Health care savings	Green infrastructure (such as natural filtration) replaces gray infrastructure	
Reduced energy & water use	Lower taxes for infrastructure services		
<i>Improved Quality of Life</i>			
Quality places attract high quality workers	Better access to services	Reduced exposure to congestion	Reduced GHGs
Improved environment for small businesses	Affordable housing	Thriving public spaces	
	Access to nature & recreation	Growth reflects community values	
	Increased physical activity	Protects natural resources	

8. Recommendations for Federal Agencies

– Research and Analysis

- Costs and benefits of resilience measures
- Data improvement
- Risk management methods
- Transportation structure, component, and material vulnerabilities

– Capacity Building

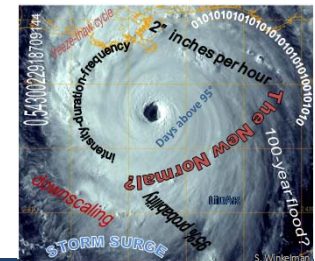
- Technical assistance (planning, design, construction, maintenance)
- Selecting and applying data and analytical tools
- Evaluation of measures (effectiveness, costs, benefits)

– Policy

- Integrating adaptation into planning processes, asset management
- Integrate adaptation with other environmental goals (GHG mitigation)
- Performance management guidelines on climate resilience

INFORMATION & ASSISTANCE NEEDS: CONCLUSIONS

- Transportation practitioners need help making decisions with imperfect data and perpetual uncertainty.
- **They already have much of the relevant experience**
 - Hazard mitigation, emergency response, flood management, land use planning
- **You can't always get what you want**
 - but if you try sometime,
you just might find
you get what you need.*
 - Mick Jagger



WHAT'S NEW?

- **Growing number of reports, tools and resources**
 - [USDOT](#), EPA, NOAA, TRB, NCHRP, [AASHTO](#), CALTRANS, [Georgetown](#)...
- **More and better plans, reports, pilots**
 - PlaNYC
 - Sandy Task Force
 - FHWA and FTA state, MPO and local pilots
- **New and evolving Federal policies**
 - President Obama's Climate Action Plan
 - STRONG Act (Sen. Gillibrand, Rep. Peters)
 - US Army Corps [North Atlantic Coast Comprehensive Study](#)

SOME RESOURCE HIGHLIGHTS

- **Federal Highway Administration**
 - [Climate Change & Extreme Weather Vulnerability Assessment Framework](#)
 - [Gulf Coast Study](#)
 - [Climate change resilience pilots](#) (SF, NJ, VA, WA, TN, MI, TX, ME, AZ, AK, CT, MA, S. FL, CA, MN, NY, OR, WA, IA, MD)
- **Federal Transit Administration**
 - [Flooded Bus Barns and Buckled Rails](#)
 - [Pilots](#) (Atlanta, LA, Chicago, Seattle, Houston, Tampa, San Fran, Philly)
- **Transportation Research Board**
 - Climate Change, Extreme Weather Events and the Highway System: A Practitioner's Guide ([NCHRP20-83\(05\)](#))
 - Forthcoming decision support software tool system
 - Pre-Event Recovery Planning Guide for Transportation ([NCHRP Report 753](#))
- **Engineers Canada**
 - [Public Infrastructure Engineering Vulnerability Committee](#) Engineering Protocol

POLICY AND PLAN RECOMMENDATIONS

- **PlaNYC** transportation strategies
 - Integrate climate resiliency into future capital projects
 - Elevate traffic signals, provide backup power, flood protection for tunnels
 - Expand services to increase system flexibility and redundancy
- **Hurricane Sandy Rebuilding Task Force**
 - Promote resilient rebuilding based on locally-driven solutions
 - Ensure coordinated approach to infrastructure investment (Fed, private, state, local)
 - Enhance local capacity for resiliency planning and implementation
- **President Obama's Climate Action Plan**
 - Integrate climate risk-management into infrastructure planning
 - Consistent approach to sea-level rise and flooding in federally-funded projects
 - Provide a toolkit for climate resilience
- **STRONG Act** (*proposed* by Sen. Gillibrand (S. 904), Rep. Peters (H.R. 2322))
Strengthening The Resiliency of Our Nation on the Ground
 - Gap & overlap analysis of federal resilience efforts
 - Interagency Extreme Weather Resiliency Action Plan
 - Equip state, local and private decision-makers to enhance resiliency

COLLEAGUES AT GEORGETOWN WANT YOUR INPUT



- **Examples** of transportation-adaptation activities: MPOs / State DOTs
(For FHWA case studies)
- **Federal support needs** (for the Kresge Foundation)
 - What do MPOs and state DOTs need from federal agencies?
 - What federal programs are being used to support adaptation?
 - What barriers are being encountered?
 - How to consider climate change in MAP-21 risk-based management plans?

Please send any suggestions, comments, or questions to:
lynch@law.georgetown.edu

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy

6. CONTINUING PROGRESS

- **Be Strategic and Opportunistic**

- Pursue comprehensive planning and analysis,
- But follow the money and stakeholder priorities
 - That's where short-term progress can be made
 - Common-sense goes a long way in answering the Climate Question

- **Collaboration is key**

- Within organizations, among organizations and sectors
- More and more federal, state, local, private collaboration
 - **FHWA** and **FTA** pilots
 - **Sandy Task Force**
 - **Washington DC:** DDOE, OP, NCPC, NASA, EPA, MWCOG, Pepco, BIDs, CCAP, Georgetown..
 - **MA:** MassDOT, Executive Office of Energy & Environmental Affairs, Boston, Cambridge, Boston Water and Sewer, Boston Harbor Assoc, UMass, CERES...
 - **SE. Florida:** Broward, Miami-Dade, Monroe, Palm Beach, NOAA, USACE, USGS, USEPA...

MAKE A COMPELLING CASE FOR ADAPTATION

CCAP's "PIE" framework -
People, Infrastructure and
Economy – *align integrated
climate planning with policy and
community priorities.*



A STITCH IN TIME...



A dollar spent on hazard mitigation saves society an average of \$4.

~ Multihazard Mitigation Council

PLANNING NOW SAVES MONEY LATER.

We tend to spend more cleaning up after disasters than planning ahead to prevent future losses.

Scenario	Losses	Preventative Measure
Sandy, NYC (2012)	\$19B	\$20B (PlaNYC)
Katrina, New Orleans	\$150B	\$30B (Amsterdam-style flood controls)
1.4m Sea Level Rise, San Francisco	\$62B	\$5B (Flood defense)

CLIMATE CHANGE WILL INCREASE LOSSES

Swiss Re analysis for PlaNYC based on hurricane models, climate change scenarios and city-level asset and economic activity.

- Sandy losses in NYC: \$19 billion
(\$13 B physical, \$6 B lost economic activity)
- Considered a “1-in-70” year event (1.4% chance)
- In 2050 \$19 billion loss will be a 1-in-50 yr event (constant \$)
- A 1-in-70 yr event in 2050 will cause a \$90 billion loss
 - More than 4-times as much

PURSUE ADAPTATION / MITIGATION SYNERGIES

Advancing Adaptation – Mitigation Synergies:

Climate Adaptation

- Investing in natural and built infrastructure
- Change in land use, relocation
- Residential programs promoting adaptation
- Emergency & business continuity planning
- Health programs

- **Green Infrastructure**
- **Power System Resilience**
- **Protect Sustainable Transportation**
- **Water & Energy Conservation**
- **Building Weatherization**

Greenhouse Gas Mitigation

- Energy conservation & efficiency
- Renewable energy
- Sustainable transportation, improved fuel efficiency
- Capture and use of landfill and digester gas
- Carbon sinks

ADAPTATION / MITIGATION SYNERGIES: SOME EXAMPLES...

Green Infrastructure:
Mitigate urban heat and
stormwater



Building Weatherization:
Improve energy efficiency & storm
resilience

Micro Grids & Distributed Renewables:
low-carbon, resilient power systems



Elevate Subway Grates:
Protect Low-Carbon Transit from
Flooding

Water Efficiency:
Reduce Pumping Energy Use & Prepare for
Declining Supplies



GLACIER BAY, ALASKA: THEN AND NOW



July 1984



2012 (US Dept of Interior Photo)

http://instagram.com/p/SdUoIzAu_n/

THANK
YOU

Steve Winkelman

Director, Transportation and Adaptation Programs

swinkelman@ccap.org

Shana Udvardy

Climate Adaptation Policy Analyst

sudvardy@ccap.org

For more information,
please visit us at

www.ccap.org