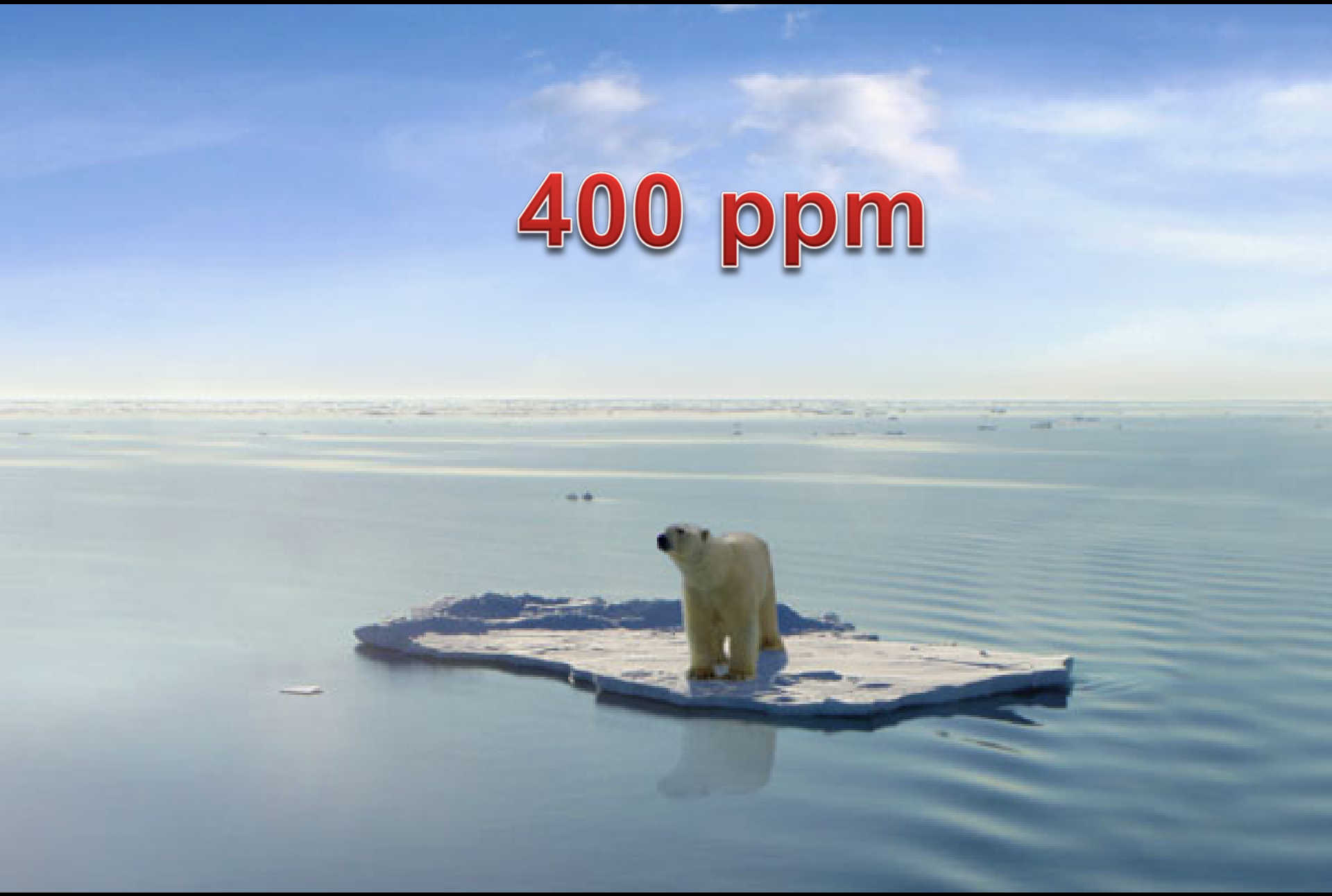
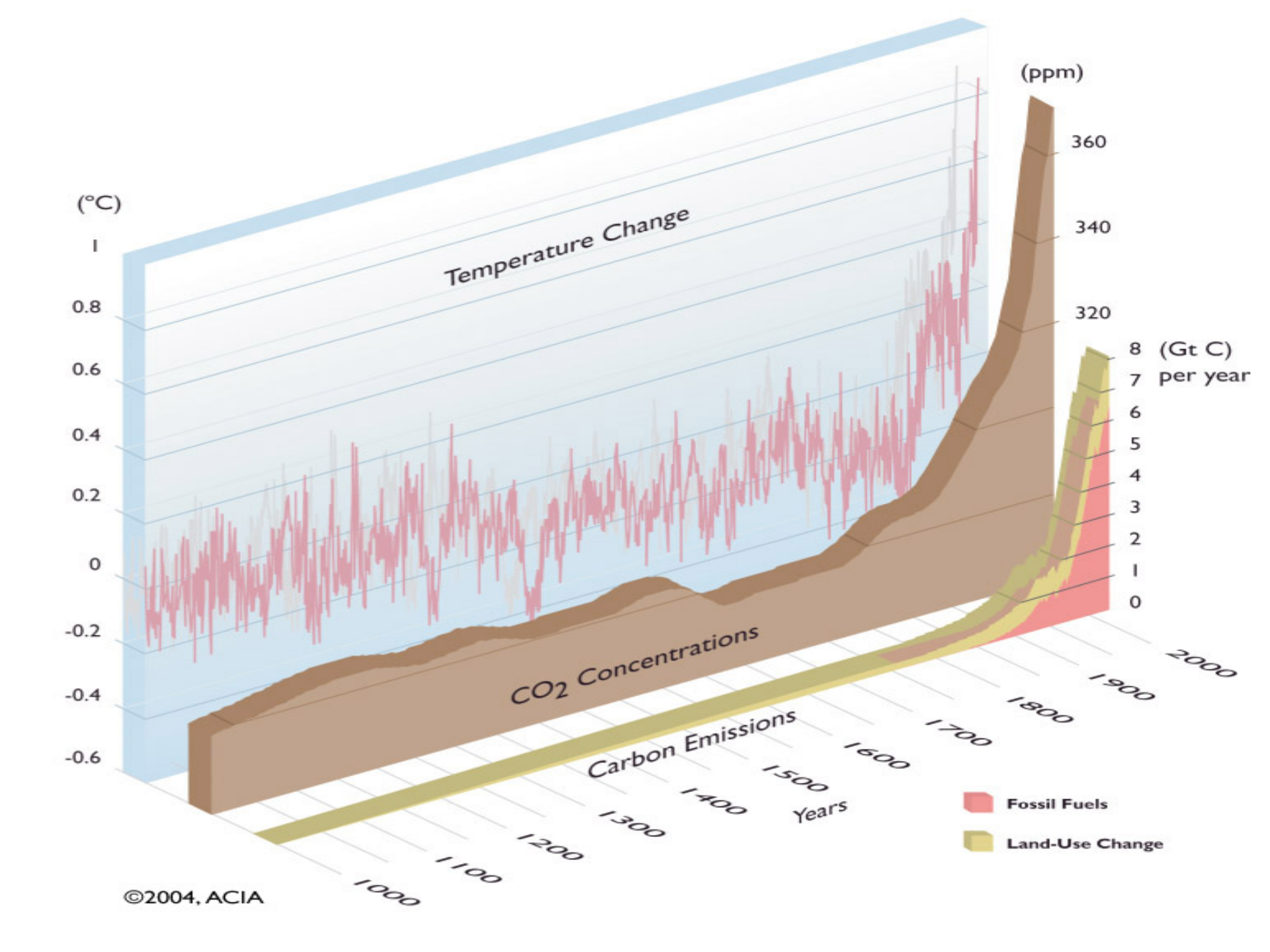
Assessing Vulnerabilities of Infrastructure to Climate Change

APWA Congress| August 25, 2013

PRESENTED BY

Kim Lundgren, Director of Business Development, GreenerU


400 ppm


(°C)
1
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0.6
0.4
0.2
0
-0.2
-0.4
-0.6
Temperature Change
(ppm)
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320
CO2 Concentrations
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6
5
4
3
2
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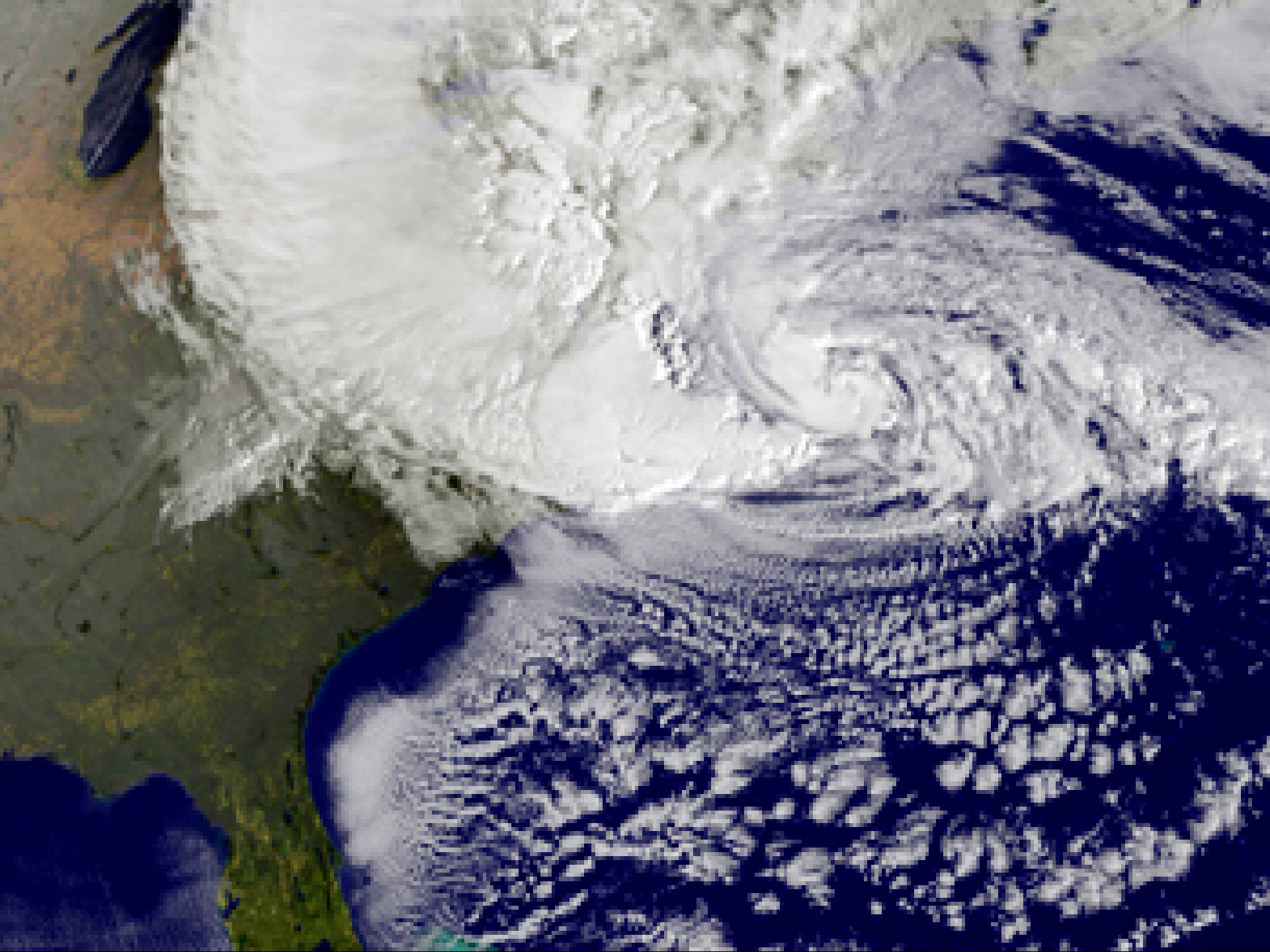
0
(Gt C)
per year
Carbon Emissions
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Years
Fossil Fuels
Land-Use Change
©2004, ACIA

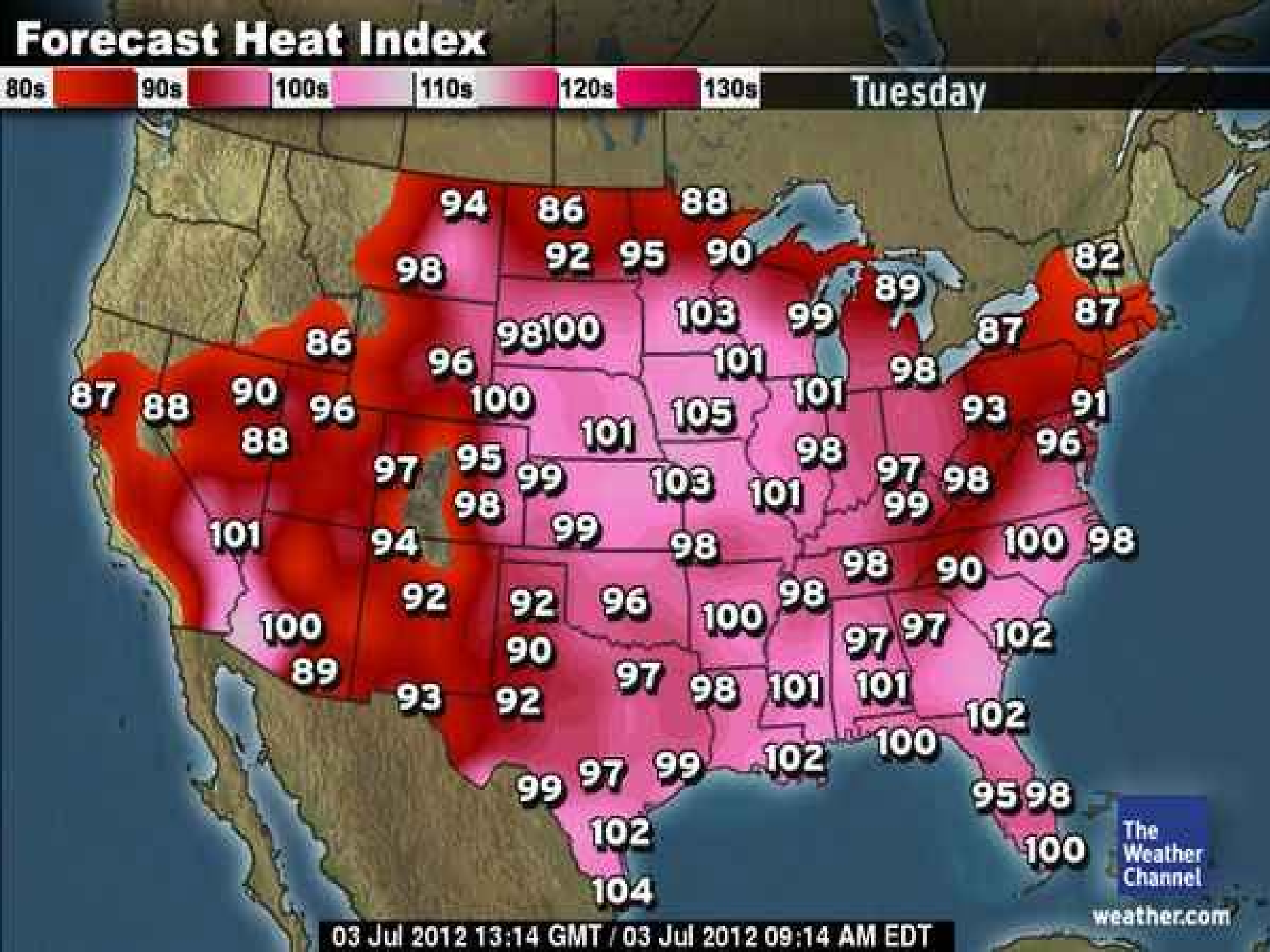
Vicki Arroyo, Georgetown Climate Center

TED TALK




NY 1
LIVE CAM 12:12 PM
58°


HUDSON RIVERFRONT
ONE WAY
ROAD FLOODED


Forecast Heat Index
80s
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100s
110s
120s
130s
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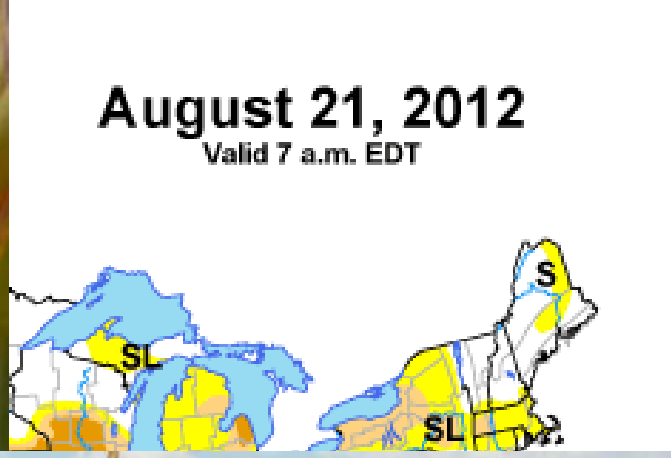
The Weather Channel
weather.com
03 Jul 2012 13:14 GMT / 03 Jul 2012 09:14 AM EDT



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drou

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S = S
(e.g.

L = L
(e.g.

The Drought Monitor focuses on bro
Local conditions may vary. See acco
for forecast statements.

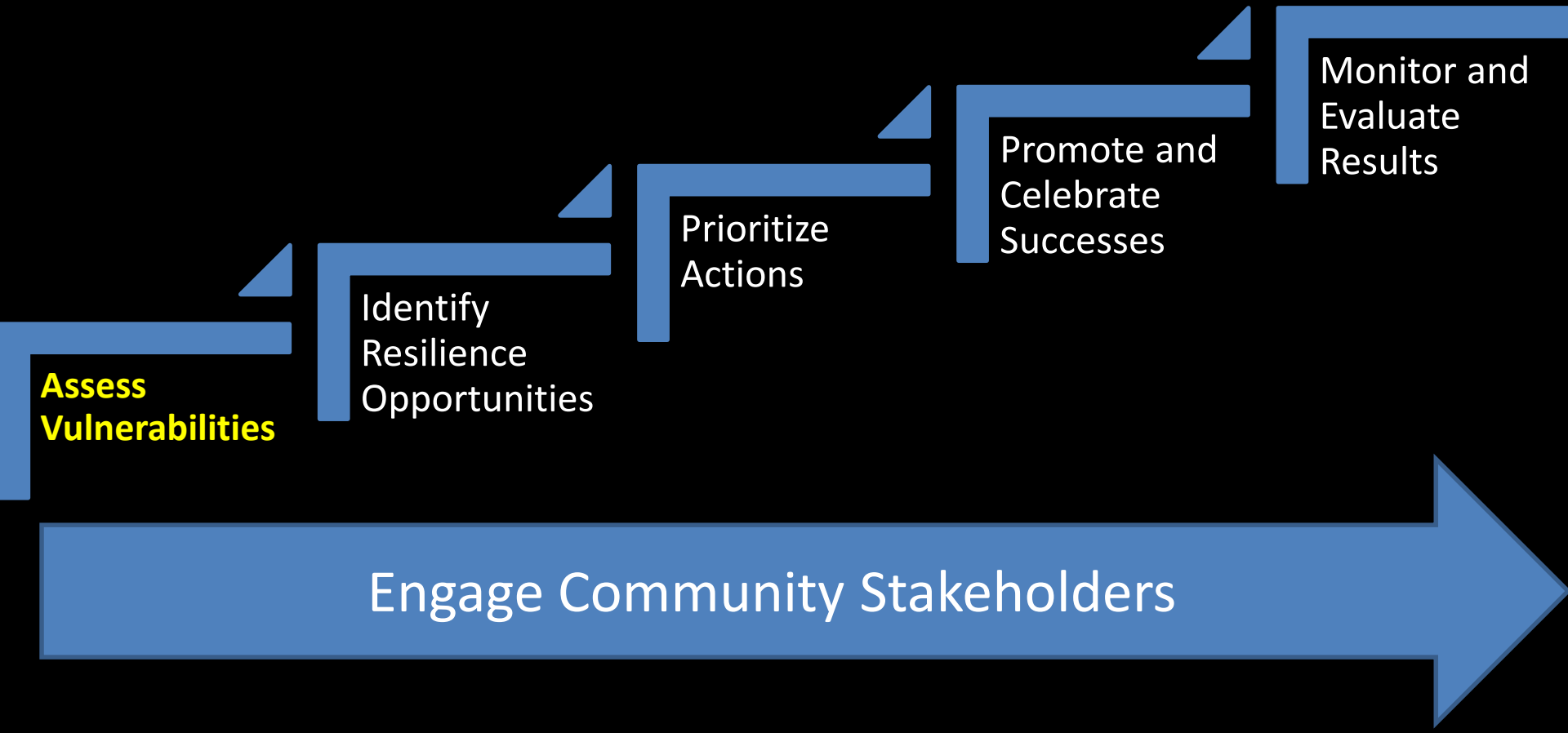
http://droughtmonitor.unl.

Key Definitions

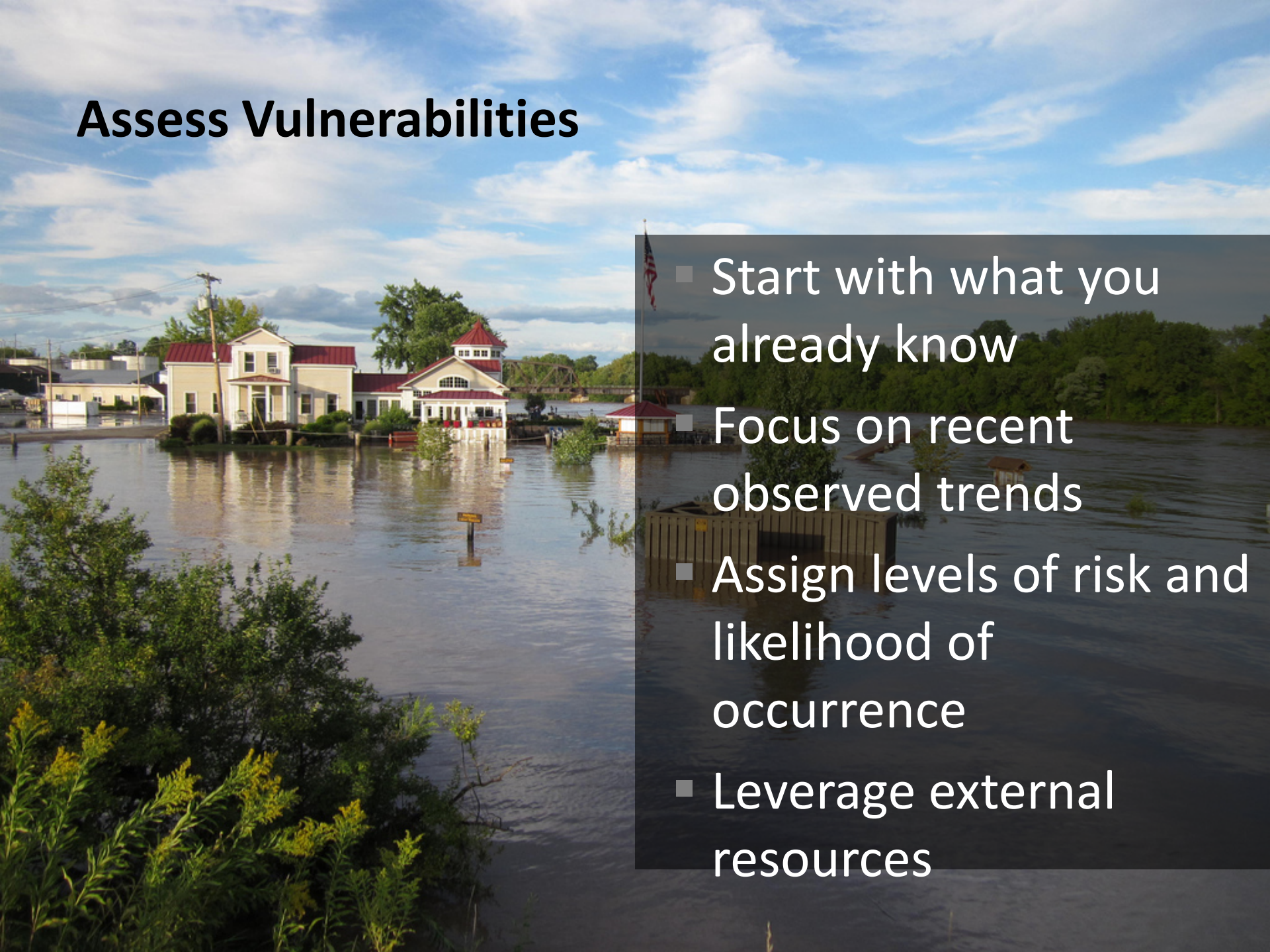
- **Changing Climate Condition:** These are the direct climate-related consequences of global climate change. They include things like changes to annual average temperature, precipitation, and sea level rise.
- **Climate Impact:** The effects that result from changing climate conditions. Climate impacts include things such as flooding, drought, heat waves, wildfires, and landslides.
- **Climate Effects:** These are the result of climate impacts on social, natural and infrastructure systems. Climate effects included changes to air quality, property damage, service disruptions, length of the growing season, water quality, and habitat changes.

Key Definitions

- **Resilience:** The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.
- **Risk:** The likelihood of an event happening and the consequence should that event take place.
- **Vulnerability:** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.


Assess Vulnerabilities
Identify Resilience Opportunities
Prioritize Actions
Promote and Celebrate Successes
Monitor and Evaluate Results
Engage Community Stakeholders

Assess Vulnerabilities



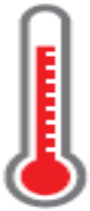
- Start with what you already know
- Focus on recent observed trends
- Assign levels of risk and likelihood of occurrence
- Leverage external resources

Risk Assessment

Changing Climate Condition	Sector A			
	Public Health	*Transportation*	*Water and Sewer*	*Critical Facilities*
Average Temperature increase of 3 - 5.5 degrees F (high confidence)	High Confidence; Medium Impact	High Confidence; Medium Impact	High Confidence; Medium Impact	High Confidence; Medium Impact
17-49 days over 90 degrees F (high confidence)	High Confidence; High Impact	ence; act	High Confidence; Medium Impact	High Confidence; High Impact
5% increase in overall precipitation (medium confidence)	Medium Confidence; Medium Impact	Medium Confidence; Medium Impact	Medium Confidence; Low Impact	M Co ; Low Im
9 to 12 events with rainfall exceeding 1 inch (medium confidence)	Medium Confidence; Medium Impact	Medium Confidence; High Impact	Medium Confidence; High Impact	Medium Confidence; High Impact

Best Practice: Vancouver, BC

Table 2: Snapshot of projected changes in climate for Vancouver

Climate Variable	Summary of Change	Snapshot of Anticipated Changes
	 Increase in average annual precipitation with a decrease in the summer.	**Averages**[A] Increase of 6% and 9% in winter and decrease of 15% and 14% in the summer by the 2050s and 2080s respectively. **Wet days**[B, C] By the 2050s, precipitation during extremely wet days is expected to increase 28% relative to the baseline period (1971-2000). **Extreme events**[C] By the 2050s, a daily rainfall event that occurred once every 25 years in the past is expected to occur almost 2.5 times as frequently.
	 Increase in average annual temperature with most notable change in night-time lows.	**Averages**[A] Annual increase of 1.7°C by the 2050s and 2.7°C by the 2080s. **Warm days** Summer days above approx. 24°C are projected to occur more than twice as frequently in the 2050s than during the baseline period 1971-2000. **Extreme events** In the 2050s, an extreme heat event that occurred once every 25 years in the past is expected to occur over 3 times as frequently.
	 Rising Seas	**Averages** The Province of B.C. recommends using 0.5m global mean sea level increase to 2050, 1.0m to 2100 and 2.0m to 2200. There is a wide range of projections for sea level rise by 2100 from 45cm to over 2m. **Extreme events** Sea level rise will cause problems when experienced together with storm surge. Detailed storm surge projections are not available.
		An increase in extreme events is projected including windstorms and heavy rainfall.

Best Practice: New York, NY

1 Understand the Vulnerabilities
Create Coastal Area Typologies that are representative of the range of uses, densities, conditions of the city's coastal zone.
Example: Low-density oceanfront beach

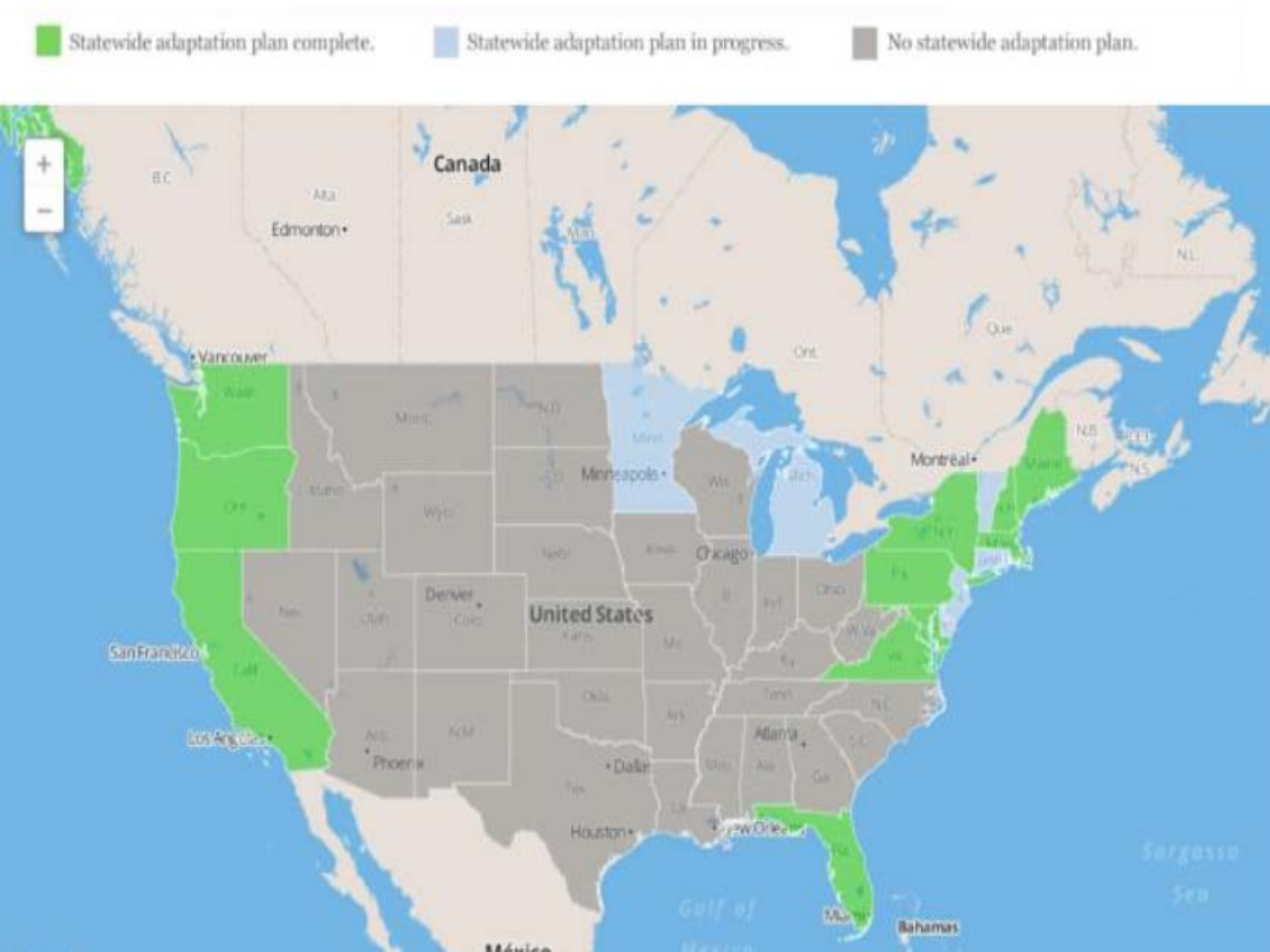
2 Identify Specific Adaptive Strategies
At the scale of the site, neighborhood and reach.
Example: Elevating a building

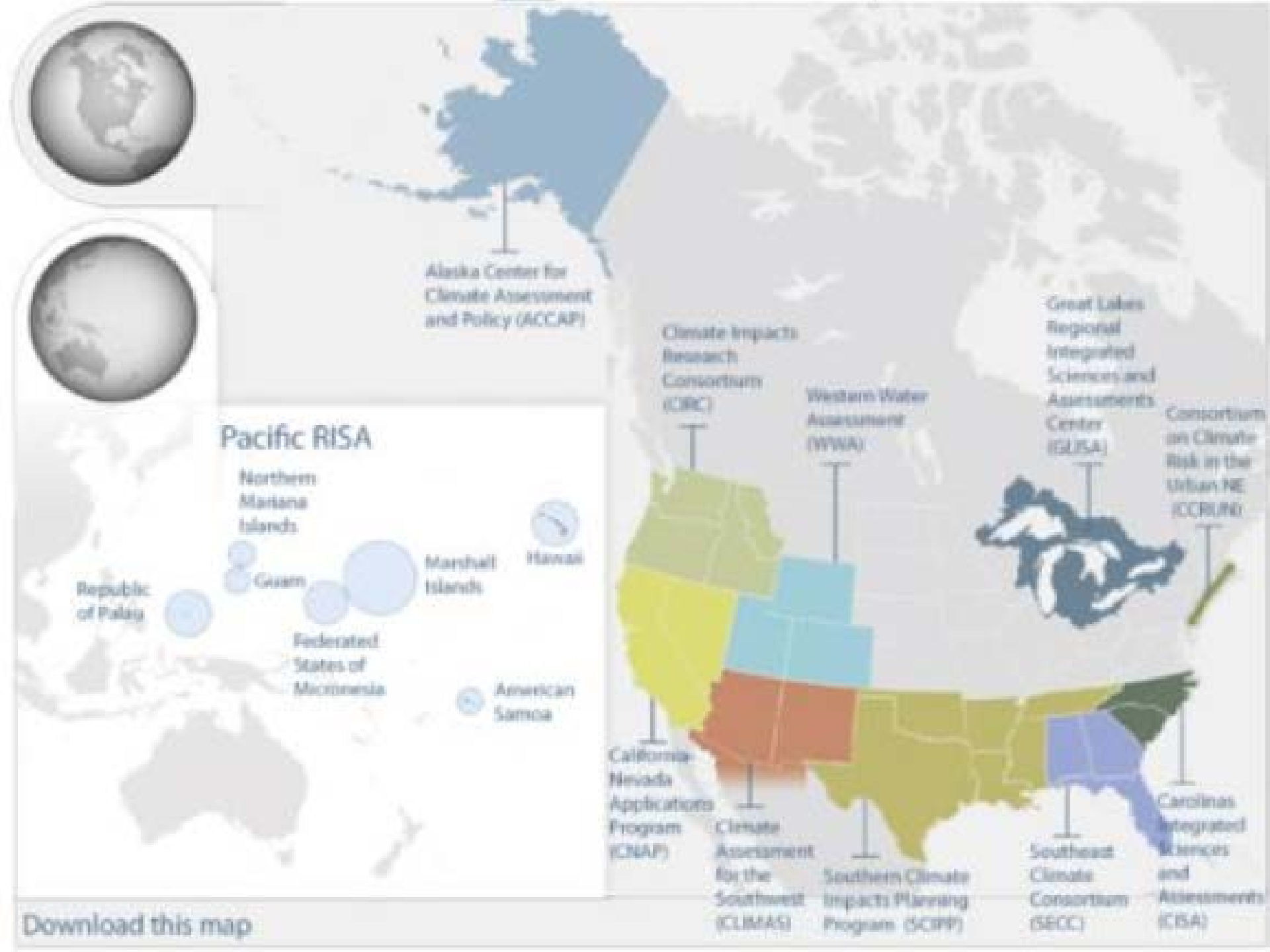
3 Develop Adaptive Approaches (A group of strategies)
A cohesive strategy which may be a combination of individual strategies.
Example: Flood proofing of private homes and building an off-shore barrier reef.

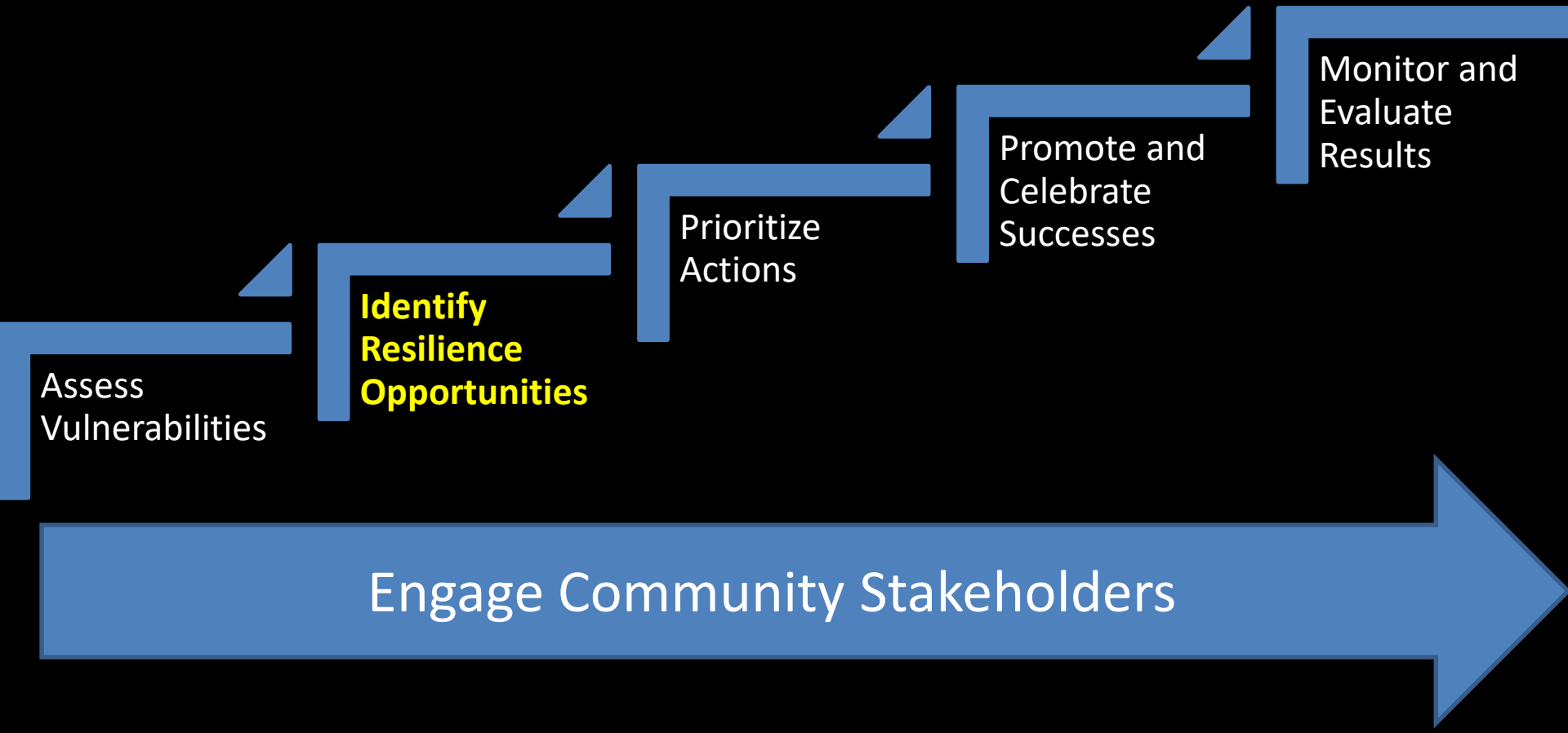
4 Evaluate
The overall costs and benefits of strategies for different kinds of neighborhoods.
Example: Implementation challenges, un-tested strategy, potential impacts on streetscape

Data Sources

- **State Climate Adaptation Plan or Vulnerability Assessment** http://www.georgetownclimate.org/adaptation/state-and-local-plans
- **NOAA Climate Program Office** http://cpo.noaa.gov/
- **US Global Climate Change Research Program** http://www.globalchange.gov/
- **Natural Resources Canada** http://www.nrcan.gc.ca/earth-sciences/climate-change/11610


Statewide adaptation plan complete.
Statewide adaptation plan in progress.
No statewide adaptation plan.
Canada
Edmonton
Vancouver
Minneapolis
Montréal
Chicago
Denver
United States
San Francisco
Los Angeles
Phoenix
Dallas
Houston
Atlanta
Bahamas
Sargasso Sea


Alaska Center for Climate Assessment and Policy (ACCAP)
Pacific RISA
Northern Mariana Islands
Guam
Marshall Islands
Hawaii
Republic of Palau
Federated States of Micronesia
American Samoa
Climate Impacts Research Consortium (CIRC)
Western Water Assessment (WWA)
Great Lakes Regional Integrated Sciences and Assessments Center (GLISA)
Consortium on Climate Risk in the Urban NE (CCRUN)
California Nevada Applications Program (CNAP)
Climate Assessment for the Southwest (CLIMAS)
Southern Climate Impacts Planning Program (SCIPP)
Southeast Climate Consortium (SECC)
Carolinas Integrated Sciences and Assessments (CISA)
Download this map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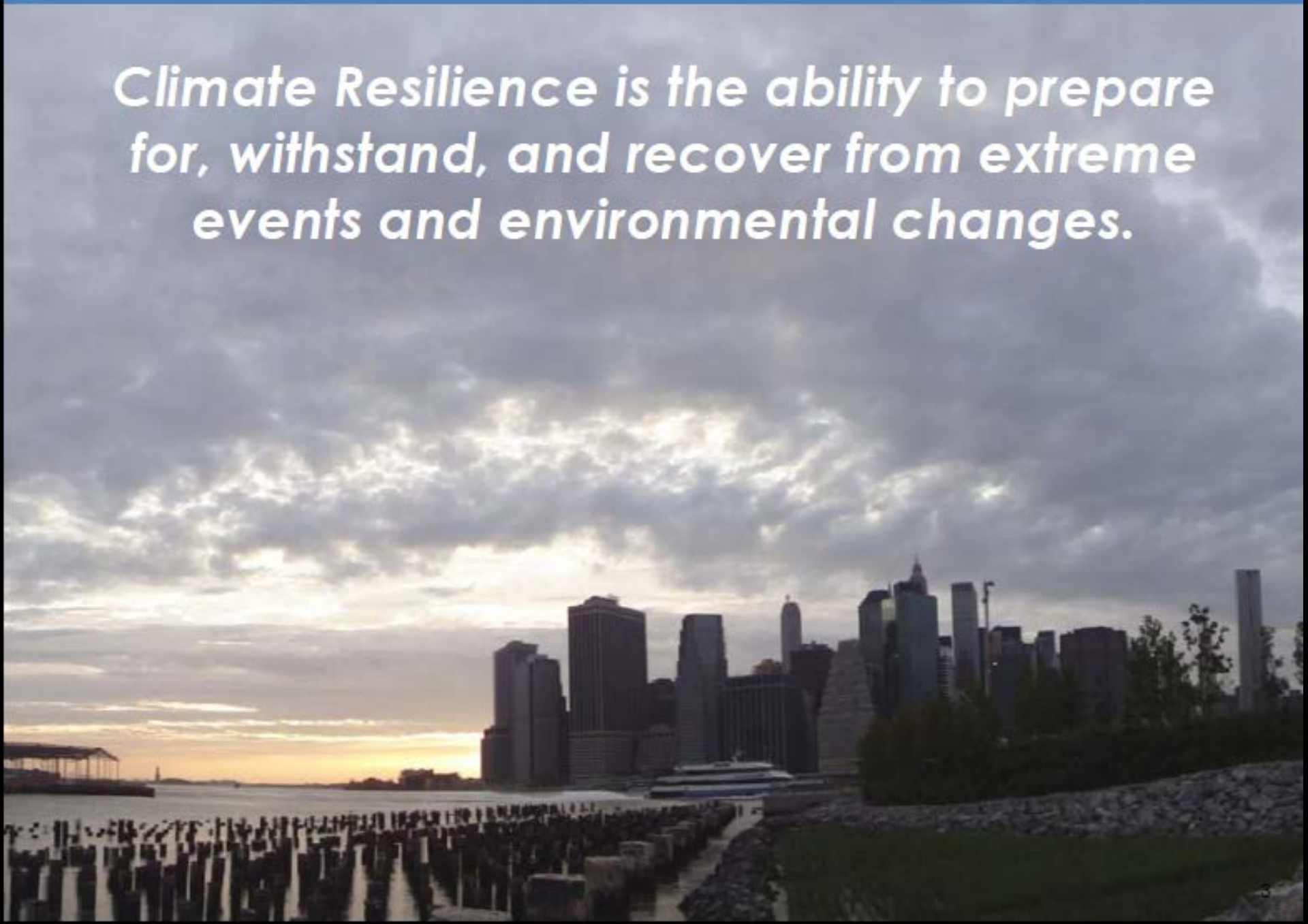
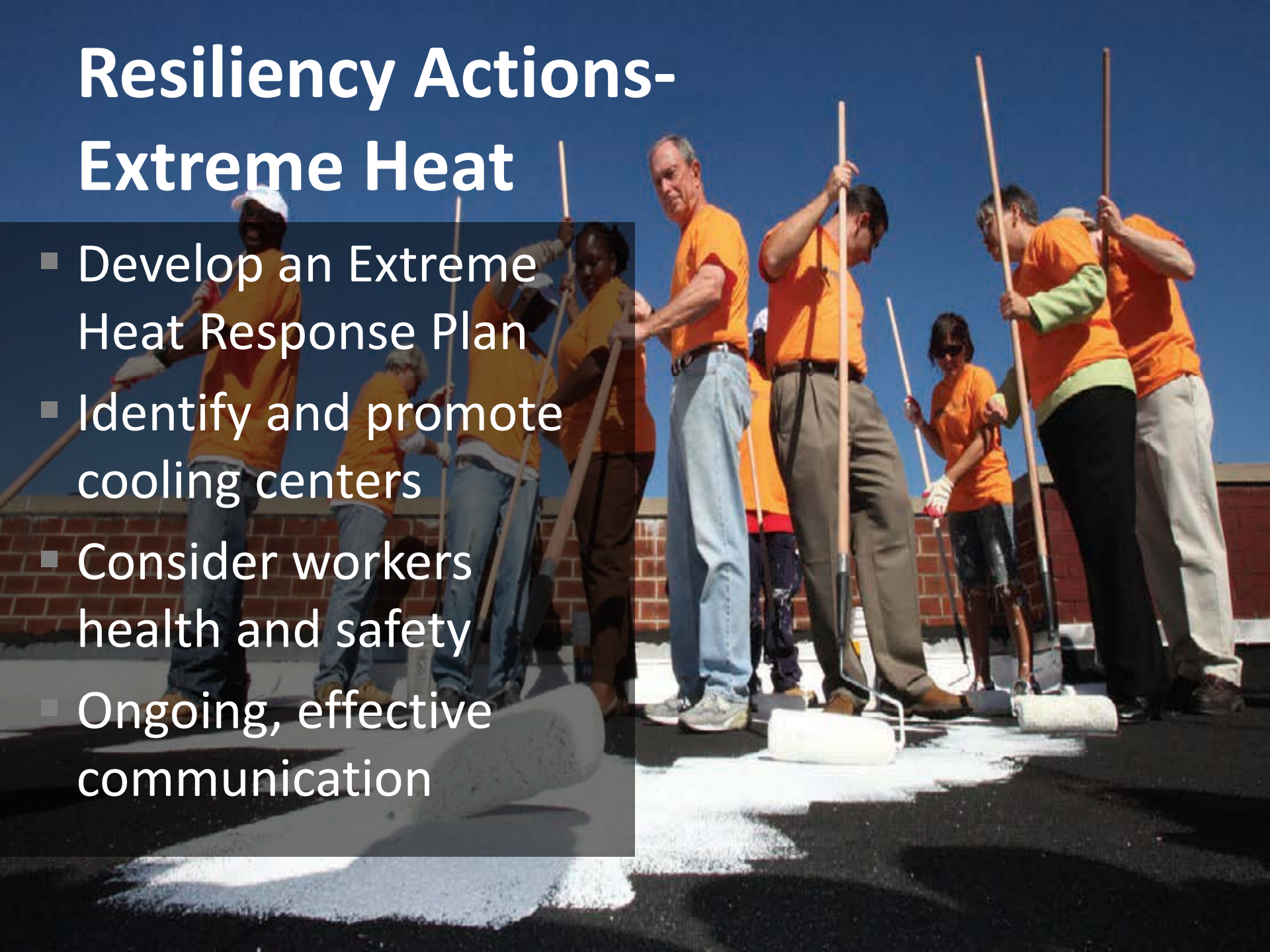
COASTAL CLIMATE RESILIENCE

Climate Resilience is the ability to prepare for, withstand, and recover from extreme events and environmental changes.



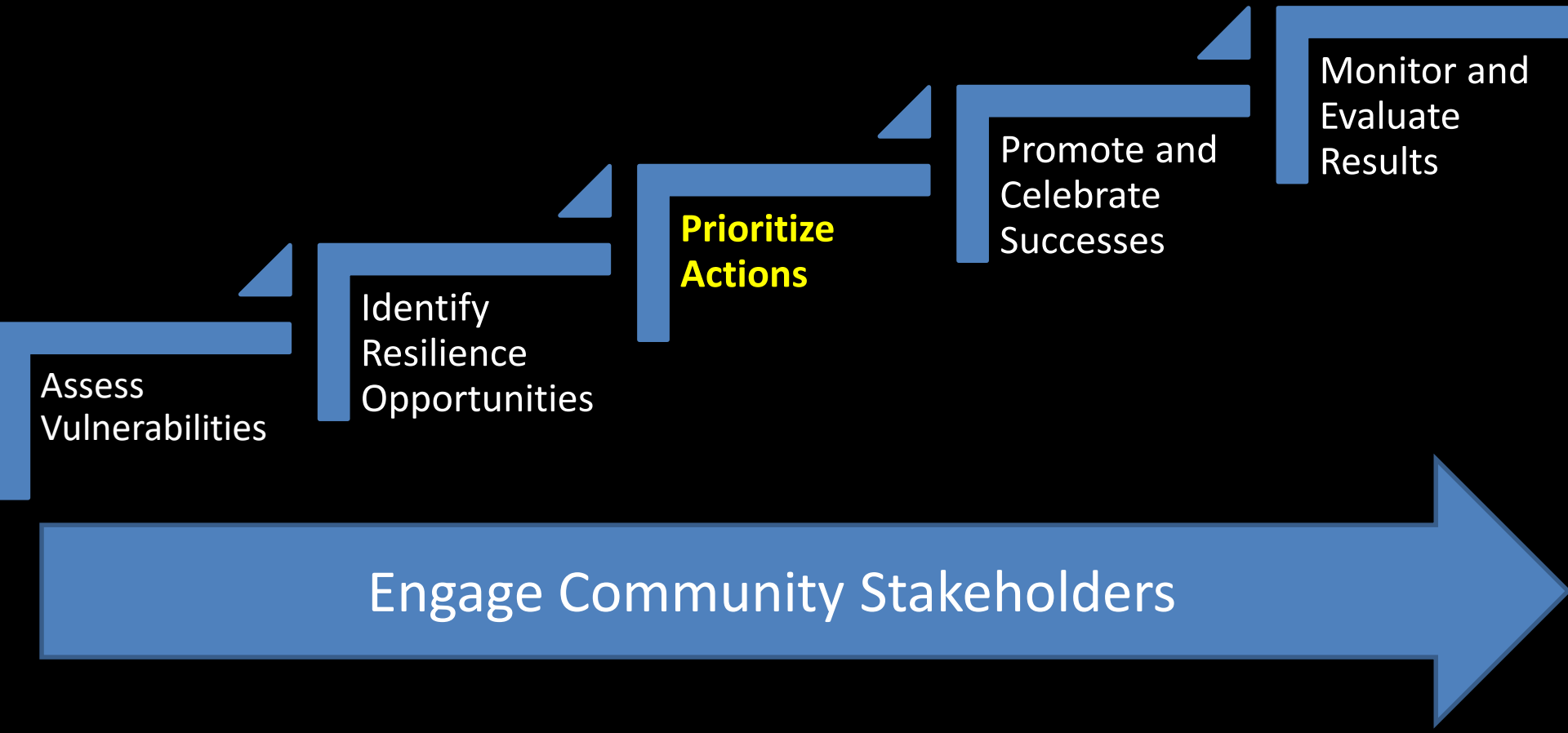
Resiliency Actions- Extreme Heat



- Develop an Extreme Heat Response Plan
- Identify and promote cooling centers
- Consider workers health and safety
- Ongoing, effective communication

Resiliency Actions: Flooding & Sea Level Rise

- Setbacks & Buffer zones
- Right sizing culverts and outfalls
- Updating floodplain maps
- Green Infrastructure
- Freeboarding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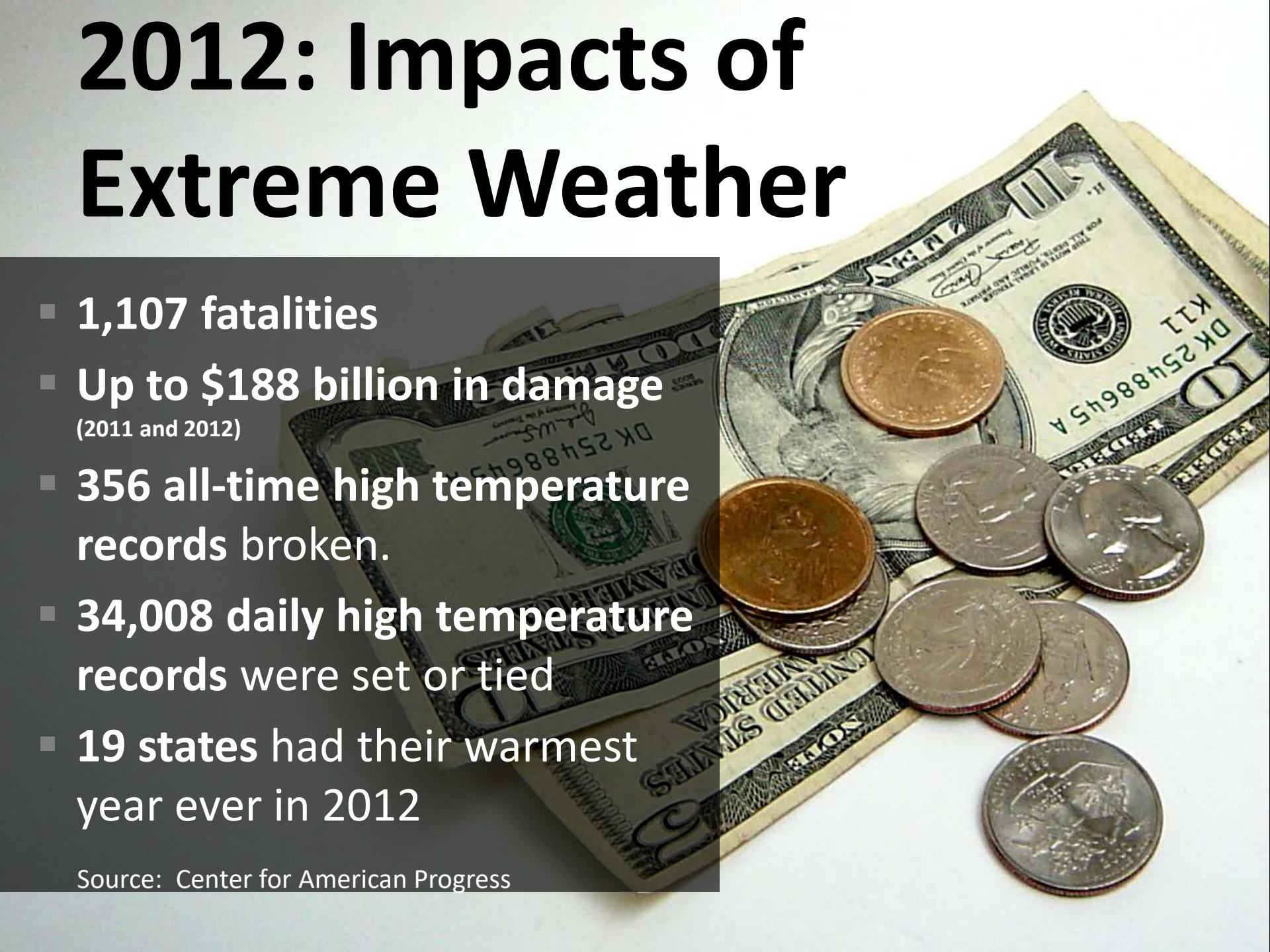
2012: Impacts of Extreme Weather

- **1,107 fatalities**
- **Up to $188 billion in damage** (2011 and 2012)
- **356 all-time high temperature records** broken.
- **34,008 daily high temperature records** were set or tied
- **19 states** had their warmest year ever in 2012

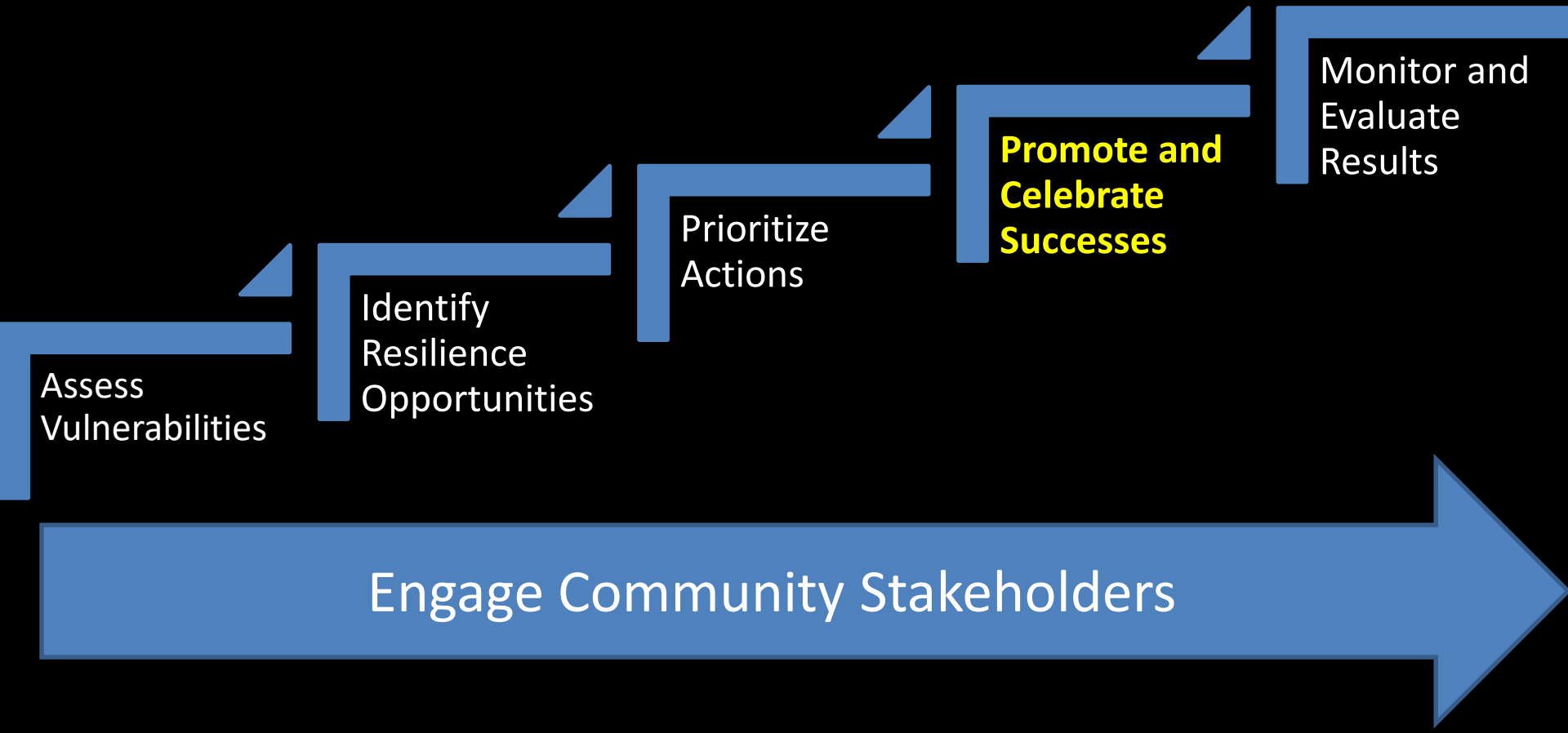
Source: Center for American Progress



Climatic Change	Impact Statement	Primary Service Area
Increase in sea level	Increased flooding along the Coast and Fraser River as sea level rises and the storm surge and waves breach height of land	Engineering General
	Increased damage to structures (seawalls) and shoreline resulting in greater discontinuity of use	Engineering General
	Reduced gravity drainage of the existing drainage system, resulting in more frequent flooding of the False Creek low areas and Southlands	Engineering - Sewers
	Saltwater intrusion in built up areas affecting the longevity of underground infrastructure	Engineering General
	Saltwater intrusion may foul fresh water wells or lead to water quality issues	Engineering - Water
	VPD facilities may not support emergency operations (low lying areas and lack of emergency power)	Police
	Liability issues in flood risk areas without restrictive covenants	Risk Management
	Increase in environmental refugees from surrounding areas increasing population stress on resources and development	CSG - Planning
	Increase in shoreline erosion affecting natural environment and public amenities such as parks, trails and access to the water	Parks and Recreation
	Saltwater intrusion at sanitary sewer pump stations will increase risk of corrosion and decrease in design life.	Engineering - Sewers
	Gradual inundation of low lying areas of land along the Coast or Fraser River	CSG - Planning
	Increased cost and difficulty acquiring insurance for private and public property owners in high risk areas	Risk Management
	Rising groundwater levels in coastal regions resulting in ponding and drainage problems	Engineering General

Tools

- **NOAA**
  - Coastal Communities Vulnerability Assessment Tool
  - Climate Data
- **ICLEI**
  - Adaptation Database and Planning Tool (ADAPT)
- **Rating Systems**
  - STAR
  - Envision™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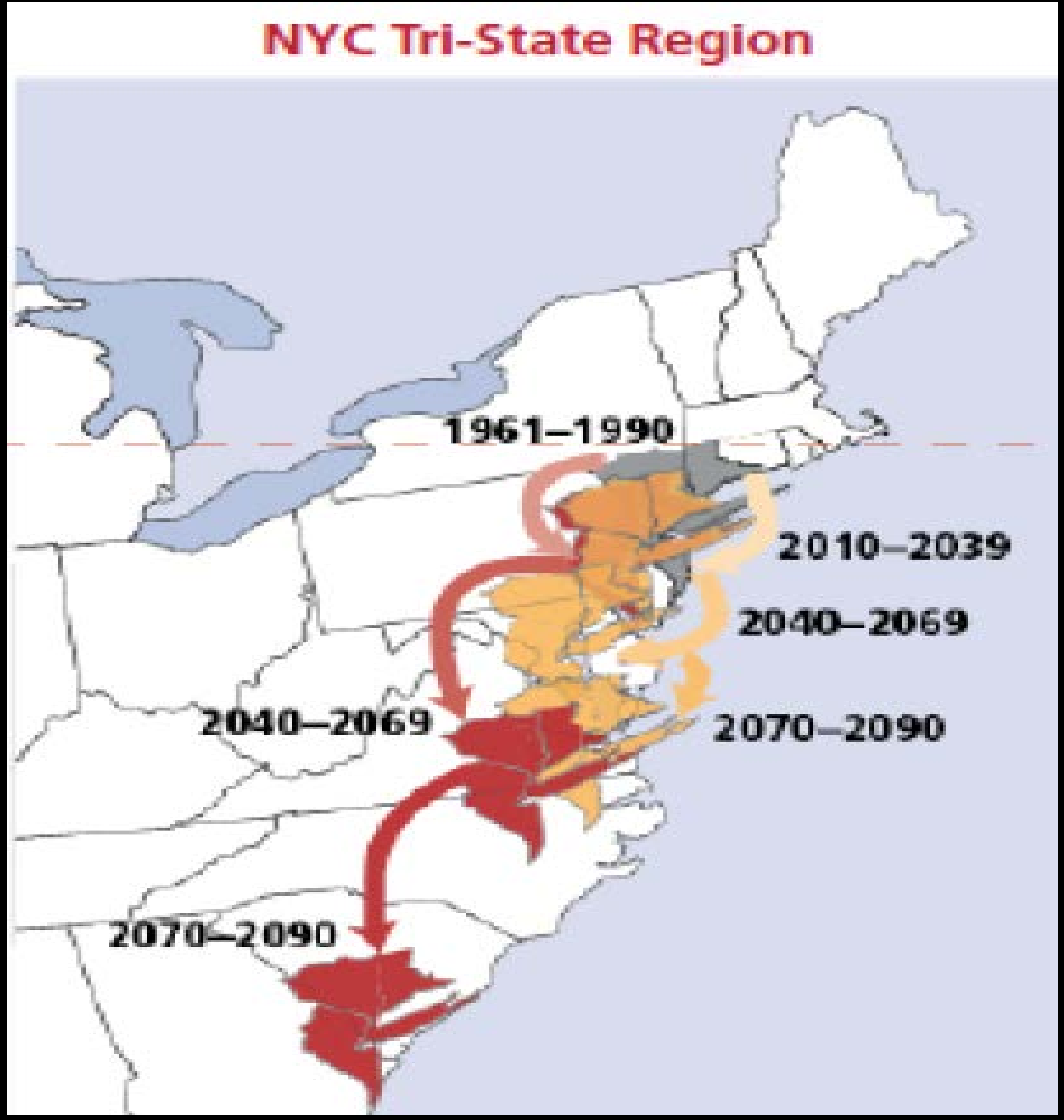
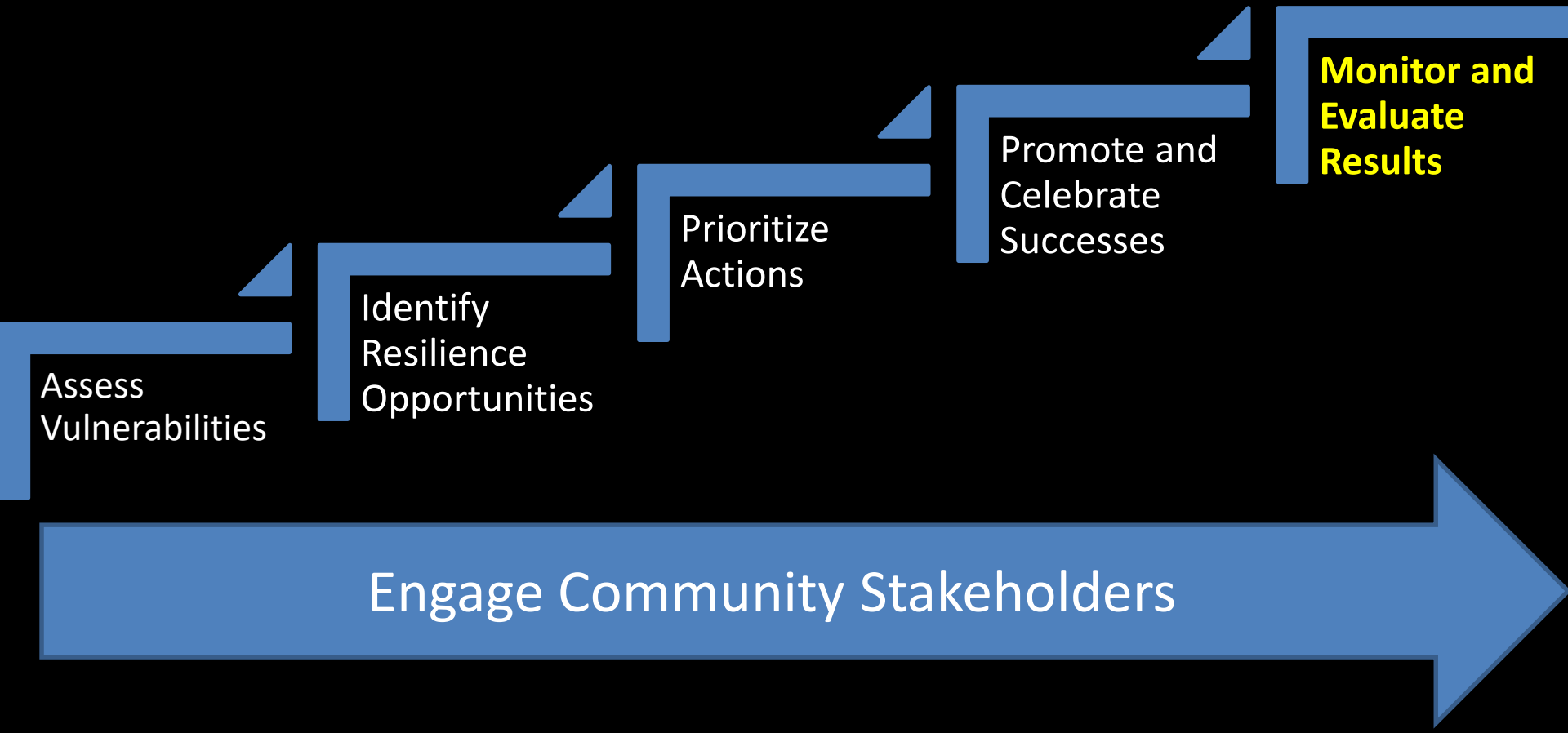

NYC Tri-State Region
1961–1990
2010–2039
2040–2069
2040–2069
2070–2090
2070–2090


APWA Resource
Center for Sustainability
You and Your Experience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Adaptation Indicators- Vancouver, BC

OBJECTIVE 1.1: MINIMIZE RAINFALL RELATED FLOODING AND ASSOCIATED CONSEQUENCES.

Potential Indicators:

- Number and or cost of insurance claims related to water incurred losses
- Number of combined sewer overflows
- Percentage of permeable ground to total ground coverage

OBJECTIVE 2.1: INCREASE THE RESILIENCE OF VANCOUVER'S INFRASTRUCTURE AND ASSETS TO COASTAL FLOODING AND EROSION.

Potential Indicators:

- Percentage of the population in unprotected coastal flood prone areas
- Value of City assets in unprotected coastal flood prone areas
- Changes to salinity of groundwater

OBJECTIVE 4.1: MINIMIZE MORBIDITY AND MORTALITY DURING HEAT WAVES.

- Heat related hospitalizations/mortalities
- Capacity of cooling centers
- Average distance to cooling centres from known hot spots/vulnerable population location
- Average temperature at assigned community hotspots
- Proportion of shade coverage (canopy cover)
- Number of new fountains in known hotspots

OBJECTIVE 4.2: MINIMIZE PER CAPITA WATER CONSUMPTION

- Water usage per capita
- Number of new grey water usage initiatives

Rating Systems

Envision™

- Rating system for sustainable horizontal infrastructure projects
- Includes a Climate & Risk Category

STAR

- Community wide sustainability rating system
- Climate & Energy Goal Area with Climate Adaptation objective

Next Steps for your Community

- Identify local data sources
- Assess vulnerabilities
- Develop an adaptation plan
- Take action
- Track your progress

Resources: Databases and Tools

Cake

- http://www.cakex.org/

Georgetown Climate Center

- http://www.georgetownclimate.org/

NOAA Climate Office

- http://cpo.noaa.gov/

ICLEI USA ADAPT Tool

- http://www.icleiusa.org/tools/adapt

Thank you!

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