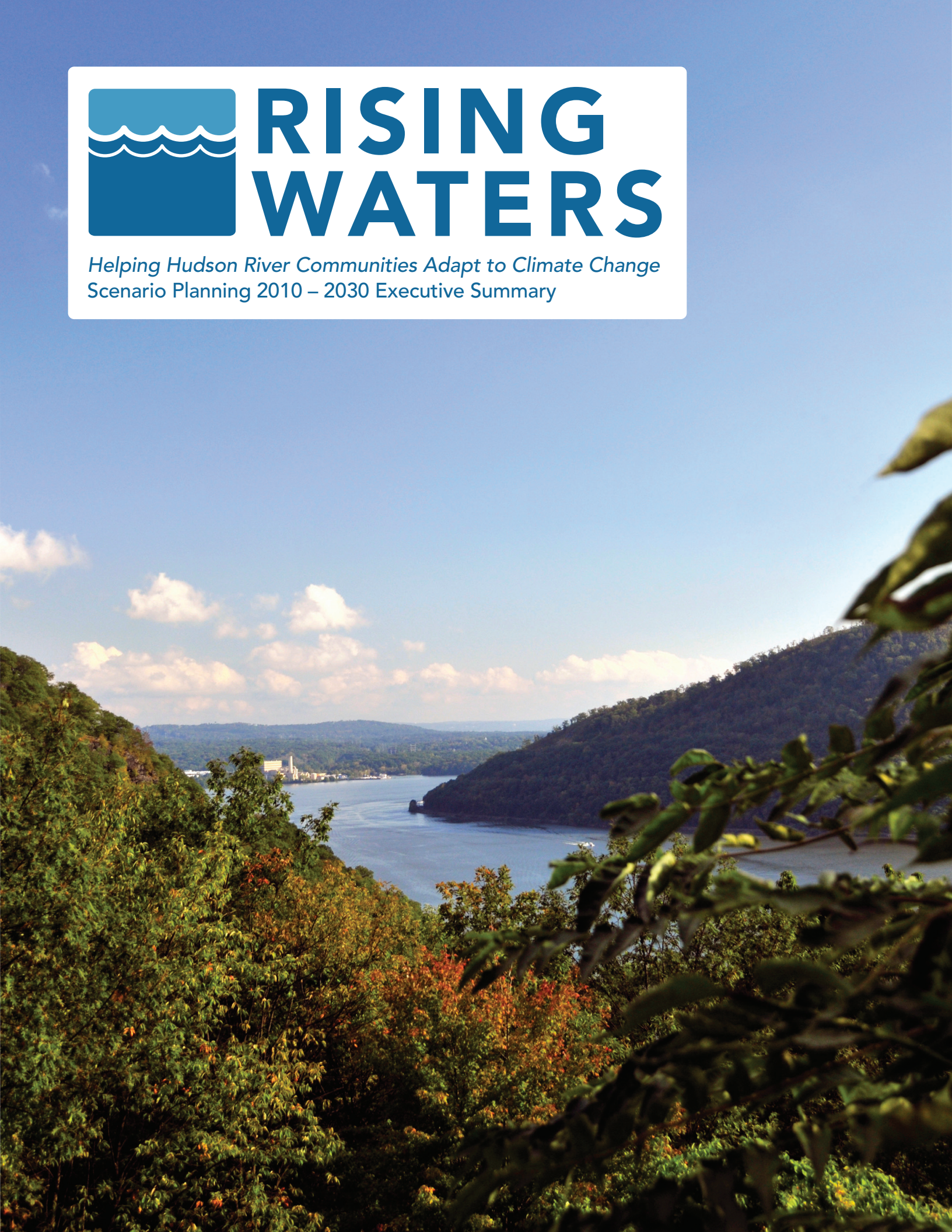
RISING WATERS

Helping Hudson River Communities Adapt to Climate Change

Scenario Planning 2010 – 2030 Executive Summary



RISING WATERS

Helping Hudson River Communities Adapt to Climate Change

Scenario Planning 2010 – 2030 Executive Summary

Cover photo by Sondra Paulson
The principal authors of the body of this report were
Steve Aldrich, Myka Dunkle, and James Newcomb of bio-era.

"RISING WATERS: NOAH KNEW THE TIME TO GET STARTED WAS BEFORE THE RAINS CAME. LET'S GET BUSY."
— *RISING WATERS PARTICIPANT*

EXECUTIVE SUMMARY

CLIMATE CHANGE IS ALREADY EVIDENT in the Hudson Valley — and is predicted to accelerate in the coming years. There is no point trying to sugar-coat it. Most climate scientists expect climate in the Hudson Valley to change dramatically over the course of the coming century. The Rising Waters project aims to strengthen the preparedness and adaptive capacity of the Hudson River Estuary Watershed (HREW) to meet the impacts of future climate change.

To help people think about the expected local impacts of climate change — and how the Hudson Valley might prepare for them, the Rising Waters project used scenario planning methodologies, first developed at Royal Dutch Shell. Creating scenarios educates participants on important aspects of complicated problems and helps to build a shared conceptual framework for dialogue leading to potential solutions. Scenarios build adaptive capacity because they build shared group understanding.

Lew Zimmerman

At a Glance: Hudson River Estuary Watershed

The Hudson River is the defining natural feature of southeastern New York, recognizable to millions who drive across its bridges and admire its grandeur from parks and historic sites. The most familiar part of the Hudson, running from Albany to New York City, is an estuary — a long arm of the sea subject to tides and the upriver press of salty ocean water. The estuary is home to a diverse array of plants and animals that depend on its productive waters for essential activities such as spawning and wintering.

The estuary, its tributaries and the lands that feed them are home to more than 200 types of fish, 19 kinds of rare birds and 140 rare plants. The Hudson mainstem is also flanked by wetlands that are influenced by the tide's daily floods.

Location: The Hudson estuary stretches from Troy to New York Harbor

Size: 5,300 square miles, 153 river miles

Population: 2.3 million residents in the Valley, excluding New York City

Major Land Uses in HREW: 62% Forest Cover; 17% Agriculture; 21% Other

The Hudson River Valley is also a uniquely important region of great historical and cultural significance — it is considered by many to be the birthplace of the modern day environmental movement in America. In 2009, the Quadricentennial will celebrate the historic voyages of Hudson and Champlain 400 years ago — the period when the region soon became "the center of the world" in a trade network linking the New World with the Old.

We hope to celebrate this historic moment by working with Hudson Valley communities to adapt as best we can to the inevitable effects of global climate change and ensure that the Hudson Valley remains a fabled, beautiful, healthy region when the 500th anniversary is celebrated in this special place we call home.

PROCESS

AS A MULTI-STAKEHOLDER EFFORT, the Rising Waters Project is governed by a Steering Committee of sponsors and project participants. *Rising Waters* is spearheaded by The Nature Conservancy and its partners, the Cary Institute of Ecosystem Studies, Hudson River National Estuarine Research Reserve (NERR), the New York State Department of Environmental Conservation Hudson River Estuary Program, New York State Water Resources Institute at Cornell University, and Sustainable Hudson Valley.

A diverse group of over 160 stakeholders, including railroad executives, utility companies, the insurance industry, emergency preparedness experts, health care groups, religious orders, state transportation, municipal and county planners, and conservation leaders have participated in the Rising Waters project.

Bio Economic Research Associates facilitated and managed the scenario planning process and participated in Steering Committee meetings. The development of the scenarios and consideration of their implications was the responsibility of a scenarios team of members drawn from among the participating stakeholders. The work of the scenarios team was supported by the independent efforts of working groups of volunteer participants. From early 2008 to April, 2009, the Rising Waters project has featured five public workshops with diverse groups of participating Hudson Valley stakeholders, and smaller meetings of teams iterating around the larger workshops.

Rising Waters Steering Committee

Katie Dolan, *Executive Director, Eastern New York Chapter, The Nature Conservancy*

Ellen Weiss, *Director of Communications, Eastern New York Chapter, The Nature Conservancy*

Betsy Blair, *Manager, Hudson River National Estuarine Research Reserve (NERR)*

Susan Riha, *Charles L. Pack Professor, Department of Earth and Atmospheric Sciences, Cornell University*

Stuart Findlay, *Aquatic Ecologist, Cary Institute of Ecosystem Studies*

David Van Luven, *Formerly Hudson River Estuary Program Manager, Eastern New York Chapter; The Nature Conservancy. The Steering Committee wishes to extend a sincere thank you to David for his vision and contributions to the planning phase of Rising Waters.*

Melissa Everett, *Executive Director, Sustainable Hudson Valley*

Kristin Marcell, *Special Projects Coordinator, NYS DEC Hudson River Estuary Program*

Stephen C. Aldrich, *President, bio-era LLC*

Rising Waters Participant Interests

Multi-Stakeholder Scenario Planning: 160 people to date

Business/Economic

- Academic
  - economics
- Agriculture
- Business groups from imper. areas
- Development
  - county
  - private
  - real estate
  - region
  - town
- Employers
  - large
  - small
- Financial community
- Fishing
- Insurance
- Marinas & boat clubs
- Planning
  - county
  - local
  - regional

Land

- Landowners
  - in flood-prone areas
  - major private
  - major public

Infrastructure/Service

- Education
- Emergency responders
- Engineers
- Health care
- Infrastructure
  - shoreline
  - transportation
  - utilities
  - water supply & treatment

Biological/Social

- Academic
  - biology
  - climatology
  - modeling
  - social science
- Art
- Conservation
- Environmental justice/low-income advocates
- Faith
- Historic preservation
- Philanthropic interests
- Toxics interests

Other

- Political leader
- Steering committee
- Publishing
- Not sure

THE SCENARIOS

EACH OF THE FOUR SCENARIOS developed in the Rising Waters project describe different outcomes and trajectories for preparedness and adaptive capacity within the Hudson River Estuary Watershed from 2010 – 2030.

- In **Procrastination Blues**, government officials and the public do little to prepare for climate change until a series of extreme weather events cause severe local damage and catalyze demands for action. The initial procrastination limits available response options and leads to less than ideal outcomes by 2030.

- In **Stagflation Rules**, the early years of the scenario witness low to negative economic growth, falling real estate values and little new development in the region. The poor economic conditions support less investment in climate change preparation, but public concern and awareness grow, land use regulations tighten, and somewhat surprisingly, the region's capacity to adapt increases — highlighting the possibility that money may not be the most important determinant of community preparedness.

- In **Nature Be Dammed**, actions to prepare begin early, with strong support and investment from the new Obama administration and a slow easing of the economic crisis. There is a lot of early enthusiasm and support for environmentally benign approaches to adaptation, but a series of damaging floods show off the limitations of these solutions and galvanize a backlash in favor of big, hard engineered, structural protections.

- In **Give Rivers Room**, a "muddling through" economic environment and a new administration with money to spend on infrastructure, combine with some nasty floods early in the scenario to fuel demands for big, hard engineered flood management infrastructure along the main stem. But the story doesn't end there, as later on, additional floods cause big problems downstream from the new infrastructure, and fuel another backlash — this time toward working more in concert with natural systems.

Scenarios at a Glance

	"Procrastination Blues"	"Stagflation Rules"	"Nature Be Dammed"	"Give Rivers Room"
How Much Gets Done?	-	-	+	+
Character of What Gets Done?	More control of Nature	More working with Nature	More control of Nature	More working with Nature
Extreme Weather	Flood, Spring 2015, UV & MWV; Flood, Fall 2016, MEV; Extreme heat wave, Summer 2016, LV	Flood, Fall 2011, MWV; Mod. heat wave, Summer 2012, U&LV; Flood, Spring 2013, MEV; Ex. heat wave, Summer 2014, LV; Flood, Spring 2015, UV; Flood, Summer 2015, LV	Flood, Fall 2009, MWV; Flood, Spring 2011, U&LV; Flood, Spring 2012, MEV	Flood, Fall 2009, MWV; Flood, Spring 2011, U&LV; Flood, Spring 2012, MEV

Scenarios at a Glance, Continued

	"Procrastination Blues"	"Stagflation Rules"	"Nature Be Dammed"	"Give Rivers Room"
Global Economy	BOOM-BUST — Goes from 4% to 6% til end 2011, then declines into short global recession in 2017; recovery to 2% by 2020; then slow growth to 2.5% by 2030	DECLINE –> SLOW GROWTH — Declines sharply in 2008/2009 to 2%, then rises slowly back to 4% by 2014 and rising steadily thereafter to 5.6%/yr by 2030	GLOBAL BOOM — Rises from 4%-8% till 2014, then declines to 6% before rising back to 8%+ by 2030	MUDDLING THROUGH — Hangs around 4% throughout
HV Gas Prices	LOW THEN HIGH — Decline from $3.80 to $2.05 from 2008-2011, then rise rapidly back to $5.00/gal by 2016, then slowly increasing til $8.00+ in 2030	RISING THROUGHOUT — Rise from $3.80 to $4.75 by 2011, then decline slightly in 2011/12 before steady ascent to $7.80/gal by 2030	DECLINE AND STAY LOW —Decline from $3.80 to $2.25 from 2008-2014, then rise slowly and steadily to $3.35/gal by 2030	SLOW BUT STEADY RISE —$3.80 in 2008 –> $4.85 in 2030
Public Attitudes	Waning interest and complacency early; but later strong demand to protect homes and businesses	Debt crisis dominates early, but extreme weather heightens interest in CC adaptation measures and supports coalition for low-cost action	Idealistic, grass-roots movement early; but extreme floods cause disillusionment with approach and fuel backlash of big control projects	Early extreme weather fuels initial support for adaptation measures; but support for big projects fuels disillusionment and backlash
HV Land-Use Trends	Development boom early; Conversion of ag land early; later ag boom, and hardening of infrastructure	Development in HV slows, agriculture expands, land-use regulations tighten	Development and sprawl grow; ag land is lost; big engineering solutions and hardening of infrastructure	Development and sprawl grow but only modestly, infrastructure projects grow then moderate
Political Climate	No action on climate change adaptation early; later rush to find "quick fixes"	Slow process of building political support for "carrot and sticks" in land-use planning and regulation as low-cost approach to managing climate change impacts	Strong "top-down" political support for CC adaptation; responds to backlash in flood aftermath	Strong "top-down" political support for CC adaptation; responds to backlash in flood aftermath

UV = Upper Valley; MV = Mid-Valley; LV = Lower Valley; U&LV = Upper and Lower Valley; MWV = Mid-West Valley; MEV = Mid-East Valley

Assumptions Across Scenarios

Climate Change: The Intergovernmental Panel on Climate Change (IPCC) A1B emissions scenario was chosen as the basis for assumptions about global climate change and sea level rise through 2030. These were held constant across the scenarios. A twenty-year "window" was chosen because it represents the horizon for most real-world investment and policy decisions. The group recognized that decisions and actions may be taken in expectation of a future stretching well beyond that horizon, so information on expected climate change impacts beyond 2030 is also considered in the full report.

Note: While projections are typically shown in ranges, the numbers shown in this chart reflect the assumptions used in the scenarios.

Economic: Each scenario characterizes economic conditions with reference to five key indicators: growth rates for the global, US, and HREW economies; and prices for retail gasoline and corn, and vary widely across the scenarios.

Drought and Biotic Invasions: The scenarios make no explicit assumptions regarding drought and biotic invasion. In short, while the climate and broad biotic environments change in parallel throughout all four scenarios, the scenarios allow for the easy creation of alternate scenarios. Local communities may want to factor in such factors as droughts or local biological invasions when creating variations of the scenarios.

Summary Of Scenario Assumptions Regarding Climate Change

	2030
Average Annual Temperature	+ 2.20° F
Average Winter Temperature	+ 3.3° F
Sea Level Rise	+ 2.8"*
Precipitation	+ 0.6%
Snow	Area of snow cover will contract. More precipitation will fall as rain instead of snow. Annual snow covered days will decrease by 14-16 days vs. 2001.
Extreme Rainfall Events	Increase in winter precipitation. Maximum precipitation in 5 days increases by approximately 10%. One more day per year of rain in excess of 2".
Heat Waves	Annual average of 22 days per year over 90° F and 3 days over 100° F
Drought	Little change.
Timing of the Seasons	Arrival of Spring (first leaf, first bloom) earlier by an average of 3 days. First frost 3 days later, last frost 2 days earlier. Growing season longer by 5 days. Ice in later, ice out a full week earlier. Peak stream flow 4 days earlier.
Local Ocean Surface Temp	+ 2° F

* These assumptions may be understated. A March 2009 report released in May 2009 in the journal *Nature Geoscience* states that northeastern U.S. coast is likely to see the world's biggest sea level rise from man-made global warming. This study along with the projected melt of the west Antarctic ice sheet indicate higher rates of sea level rise.

STRATEGIES FOR ADAPTATION

IN EARLY 2009, THE RISING WATERS PROJECT evaluated 80 specific ideas, generated by the project stakeholders, as well as a literature review of other climate change adaptation efforts around the world, for improving the region's adaptive capacity against eight agreed upon criteria. A simple scale was created for each of these criteria so that proposed response options might be rated relative to each other, and wherever possible, in accordance with objective measures.

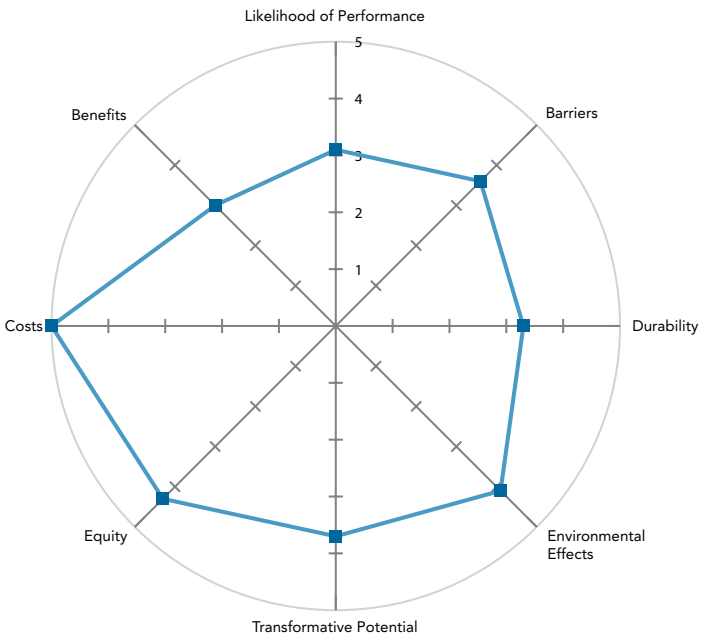
Response Scale

Evaluation Criteria	Level 1	Level 2	Level 3	Level 4	Level 5
Likelihood of Performing to Expectations when Implemented	Very Low	Low	Even Odds	High	Very High
Barriers to Implementation and Adoption	Very High	High	Medium	Low	Very Low
Durability	Very Low	Low	Medium	High	Very High
Environmental Effect	Very Negative	Negative	Neutral	Positive	Very Positive
Equity	Very Low	Low	Medium	High	Very High
Transformative Potential	Very Low	Low	Medium	High	Very High
Anticipated Economic Cost through 2030	>$100M	$10M–$100M	$1M–$10M	$100K–$1M	<$100K
Avoided Cost through 2030	<$100K	$100K–$1M	$1M–$10M	$10M–$100M	>$100M

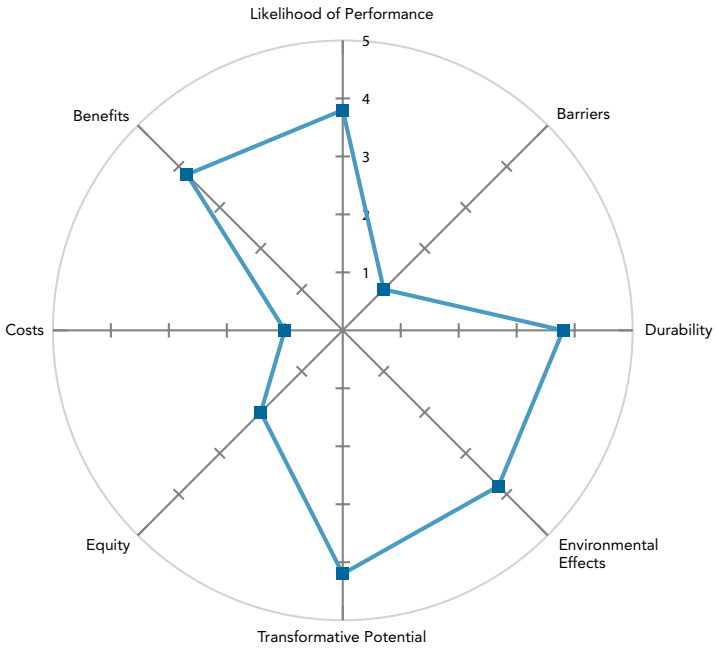
Surveys for each proposed response option were developed to measure the respondent's assessment of how a given response option would perform with respect to each selected criteria. Through this method, eighty response option ideas were collectively evaluated by invited experts, HREW stakeholders, and the general public. The spider diagrams below show ratings for two of the 80 climate change response options evaluated in the *Rising Waters* planning process. A rating of 5 is the highest, and the larger the area of the polygon, the better the response option.

Radar Graphic Examples

80. Hold regular, neighborhood meetings to "listen" to local adaptation needs, and mobilize local resources in response



34. Move or demolish all structures in the floodplain



Response options were also evaluated across the portfolio of four scenarios — both for the likelihood of adoption in each scenario and for how they would perform in each scenario. The response options were evaluated using a numerical scale that yielded a combined score for total likelihood of adoption and total performance. The chart below shows the adaptation strategies that were among the highest performers when measured across the scenarios.

Top Five Performing Response Options By Scenario

Response Option	Procrastination Blues	Stagflation Rules	Nature Be Dammed!	Give Rivers Room!	Total
Hold regular, neighborhood meetings to "listen" to local adaptation needs, and mobilize local resources in response	1	4	1	4	10
Develop and update emergency actions plans with community involvement. Coordinate with State Emergency Management Office.	1	3	3	3	10
Require local community governments to work with the NYS Emergency Management Office (NYSEMO) to complete and update regional hazard and pre-disaster mitigation plans	1	3	2	3	9
Require all state agencies to conduct flood audits of critical infrastructure	0	3	3	3	9
Change requirements for all new storm water permits	-1	4	2	3	8

FINDINGS AND RECOMMENDATIONS

FROM THIS COLLECTIVE multi-stakeholder process, several key findings emerged:

- Climate change is already underway in the HREW, and the best available scientific evidence is that our local climate will become increasingly warm, wet, and variable through at least the end of this century.
- Expected increases in the frequency and intensity of extreme weather pose the most immediate and serious direct threats to human and ecosystem health and well-being in the HREW between now and 2030.
- Sea-level rise due to global warming is a serious threat to human and ecosystem health over the course of this century. Sea-level is not likely to exceed more than one foot between now and 2030. However, recent reports indicate that these projections are conservative.
- Other significant potential threats due to climate change could arise within the 20 year time-horizon of the scenarios (such as increases in invasive pests and diseases, or the intensification and frequency of hurricanes making landfall in the region), but the extent and character of these risks are difficult to assess at this time.
- The capacity of the people and institutions of the HREW to withstand and adapt to changing climate will depend critically on preparing for expected impacts beforehand, and particularly on decisions and actions taken around land-use and regulation and building more resilient infrastructure.

RECOMMENDATIONS

Considering all of its work throughout the process — both regarding the likely future impacts of climate change, and what should be done to improve preparedness — the Rising Waters project achieved consensus on the following recommendations for climate change adaptation strategies in the Hudson Valley:

1) Improve community planning, communication, and preparedness for extreme weather and local climate-change threats. Potential actions to be taken by the coalitions (see Coalitions section) include:
   - Identify ways to incorporate climate change information into hazard mitigation plans
   - Provide public access to cool buildings during heat waves
   - Conduct community outreach campaigns on the local threats posed by climate change, and what can be done in response to maintain interest and momentum
2) Prepare communities for the future impacts of climate change by incorporating expected changes, such as more frequent flooding and heat waves, into all land-use decision-making processes. Potential actions to be taken by the coalitions include:
   - Encourage counties and large municipalities to integrate climate-change considerations over a 20-year time span into their land use planning efforts
   - Consider increasing the setback requirements for buildings near riverbanks in Hudson River communities to at least 75 feet
3) Guide future development out of flood-prone areas to reduce and minimize future losses. Potential actions to be taken by the coalitions include:
   - Create financial incentives to avoid development in flood-prone areas
   - Require "No Adverse Impact" standards to ensure that activities do not change the floodwater storage capacity of wetlands and floodplains and do not increase the flow velocity of streams, especially during floods
   - Establish a state funding mechanism to help communities enforce floodplain zoning and flood-related land-use and building codes

4) Improve the resilience of shorelines, natural systems, and critical infrastructure throughout the Hudson Valley to the impacts of extreme weather. Potential actions to be taken by the coalitions include:

- Require all state agencies to conduct flood audits of critical infrastructure such as hospitals, important road crossings, and wastewater treatment plants
- Identify and promote sustainable methods for shoreline erosion control that will secure key infrastructure while enabling vital natural communities to exist and migrate landward as sea level rises
- Identify and remove incentives for non-sustainable shoreline management methods, and create incentives for sustainable practices in shoreline management and erosion control
- Share best practices for fish friendly habitat options when shoreline construction/reconstruction is necessary

5) Apply cost-effective green technologies and use natural systems to reduce the vulnerability of people and properties to flooding and heat waves. Potential actions to be taken by the coalitions include:

- Work with policy makers to reduce the minimum size of wetlands regulated by the state
- Increase development setbacks from streamsides to 300' to protect people from flooding and to reduce property damage
- Provide training for each community's Local-Law-for-Flood-Damage-Prevention Administrator on best management practices for minimizing flooding
- Use LIDAR technology and conduct flood studies to improve on existing FEMA maps
- Identify the places most at risk of flooding by modernizing floodplain maps to reflect not only historical but likely future flood patterns

Doug Schneider

"HUMAN HEALTH IS TIED TO ECOSYSTEM HEALTH AND PEOPLE ARE ONLY AS HEALTHY AS THEIR ECOSYSTEMS."

— NANCY NICHOLS, AUTHOR OF LAKE EFFECT: TWO SISTERS AND A TOWN'S TOXIC LEGACY

"I THINK THE CONSERVANCY HAS EVERYONE IN THE VALLEY WORKING ON RISING WATERS. EVERYWHERE I GO, I RUN INTO PEOPLE WHO ARE PUTTING A LOT OF TIME AND EFFORT INTO THE PROJECT."

— FRANCES DUNWELL, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, HUDSON RIVER ESTUARY PROGRAM

- Undertake urban area greening programs, such as rain gardens and tree planting, to make communities more resilient against heat waves and to decrease stormwater runoff

6) Establish climate-change-adaptation funding to help communities reduce loss of life and property damage both in advance of extreme weather and in disaster response. Potential actions to be taken by the coalitions include:

- Gain support for passage of Green Jobs Bond Act slated for November, 2009 ballot by adding at least 10 new organizations to the existing coalition
- Create a state climate change adaptation fund
- Examine existing funding schemes to prioritize climate change adaptation activities

7) Conserve healthy forest, wetland, and river ecosystems as well as agricultural resources because they are vital to a successful adaptation to climate change. Potential actions to be taken by the coalitions include:

- Monitor, and where possible, manage these ecosystems to sustain ecosystem functions
- Begin an intensive program to restore streams to natural state and revegetating banks, ideally using the groups of plants most likely to occur at each location
- Develop long-term acquisition and easement plans to conserve floodplains

MOVING AHEAD: WORKING COALITIONS

AT THE FINAL PLANNING MEETING, the participants agreed to form working coalitions to move recommended strategies forward. Coalitions have been formed around the seven key recommendations. They will provide status reports at regular quarterly meetings as well as a broader stakeholder meeting planned at the Garrison Institute in April, 2010. The coalitions will begin work in May, 2009, with a special effort to include additional stakeholders who should be a part of the implementation process. The initial established coalitions are:

- Climate Change Adaptation and Disaster Planning
- Floodplain Management for Resilience
- Shorelines Protection and Management for Resilience
- Green Technologies and Land Use Planning
- Climate Change Adaptation Funding

If you would like to participate in one of the coalitions, please contact Katie Dolan at kdolan@tnc.org or Ellen Weiss at eweiss@tnc.org or (914)244-3271 ext 21. For more information, please visit our website at nature.org/risingwaters.

MEASURING OUR SUCCESS

FROM ITS INCEPTION, Rising Waters aimed to create connections and relationships with new stakeholder groups; include non-traditional partners in understanding how climate change will affect the Valley; have adaptation recognized as a key response to climate change; and lay the foundation for coalitions to implement strategies. Within The Nature Conservancy, we will measure the effectiveness of the Rising Waters process in accordance with the following indicators:

- Percent of stakeholder groups who a) learned about climate change issues from the scenario planning process; b) identify one or more of the resulting strategies as beneficial to their interests and support implementation: and c) intend to participate in one or more coalitions to advance a core strategy. Preliminary survey results indicate that participants found the Rising Waters process a valuable way to learn more about climate change in the Hudson Valley.

- Communications and outreach measures include the number of press reports on project; requests for speaking engagements about the project; and number of reports downloaded from web or requested from staff.

- Number of core conservation strategies being advanced by the coalitions. For example, the Hudson River shorelines and shallows are a conservation target. The Shorelines and Tidal Wetlands Protection Coalition will work to improve the resilience of shorelines, natural systems and critical infrastructure throughout the Hudson Valley to the impacts of extreme weather.

To obtain copies of the full Rising Waters report, visit www.nature.org/risingwaters or contact Ellen Weiss at eweiss@tnc.org or (914) 244-3271 ext.21.

SUMMARY

ACHIEVING THESE RECOMMENDATIONS will require strong individual and collective action. We look forward to working together with many HREW stakeholders to implement and refine these recommendations in the months ahead, and collectively understand whatever else needs to be done to strengthen the Hudson Valley's capacity to adapt to a changing climate.

Nancy Kennedy