Local Climate Change Adaptation and Resilience Plan Guidance and Template

New York State Department of Environmental Conservation
Office of Climate Change
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DRAFT

Contents

Acknowledgments

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Contributing staff:

Lauren Steinberg
Climate Policy Analyst
Office of Climate Change
New York State Department of Environmental Conservation

Ríobart É. (Rob) Breen, Ph.D.
Climate Policy Analyst, Adaptation Section Lead
Office of Climate Change
New York State Department of Environmental Conservation

Leo Matteo Bachinger, Ph.D.
Program Manager for Climate Impacts on Vulnerable Communities
Office of Climate Change
New York State Department of Environmental Conservation

Willow DeMulder-Eyres
Climate Policy Analyst
Office of Climate Change
New York State Department of Environmental Conservation

Thomas Hisgen
Deputy Director of Federal Affairs
New York State Department of Environmental Conservation

Mark Lowery
Assistant Director, Office of Climate Change
New York State Department of Environmental Conservation

Background

Overview of the Local Climate Change Adaptation and Resilience Planning Process

A climate change adaptation and resilience plan (CCARP) helps a community identify current and future climate change impacts and risks and then generate, adopt and implement effective measures to help the community adapt to change, both minor and transformative. Communities that adopt effective adaptation and resilience measures and build their adaptive capacity based on a high-quality CCARP can reduce economic, environmental, and social risk, mitigate losses and take advantage of any opportunities resulting from climate change.

No one-size-fits-all template or uniform planning approach can provide every local community with the perfect CCARP. To increase success of CCARP implementation, the planning should be a flexible, customized, participatory, collaborative process that engages diverse and representative members of the community, especially members representing disadvantaged communities, throughout the process in determining the scope, priorities, contents, plan components, and next steps for implementation. A successful, participatory planning process can even help communities increase their local adaptive capacity to mobilize and engage the public, develop leadership, improve open communication, make good decisions, resolve conflicts, build trust, and take collective action to help the entire community adapt to climate change impacts.

Climate change adaptation and resilience planning and implementation is challenging work, and there is no viable way to make this responsibility simple, easy and convenient without significantly reducing the effectiveness and robustness of the plan or passing on the responsibility to the next generation. Even the most motivated, well-intentioned communities may find limitations in their staff time and resources available to dedicate to developing a CCARP. In these cases, developing a robust but focused CCARP plan that can be amended in stages is better than developing no CCARP or an over-simplified plan that does not prepare a community for the rapidly unfolding impacts of climate change. Local governments and/or community organizations that do not have trained professionals on staff will probably want to work with experienced consultants or trained regional planners to assist with facilitating the steps of the CCARP planning process.

A CCARP is significantly different from other types of plans because it includes addressing current and future uncertainties, the unpredictability of complex social and ecological systems, and the unknowns of current and future climate change dynamics, including how and when policy makers will implement climate change policies and the public will shift behaviors. It includes addressing climate-enhanced hazards, non-hazard climate impacts, other significant climate-influenced changes already underway and even new opportunities under climate change. A CCARP also includes solutions that promote transformational change when needed.

The CCARP planning process, therefore, requires use of anticipatory processes and

tools, like exploratory scenario planning, robust decision making that works well under a variety of futures, and adaptation pathways that consider at what future point certain policies or actions will no longer be workable options.

Local governments that have completed local hazard mitigation plans (HMP) may recognize some similarities between a CCARP and an HMP, particularly if the HMP includes consideration of climate change hazards. For example, both HMPs and CCARPs aim to reduce risks and increase resilience, however, there are several fundamental differences between a CCARP and HMP that allow a CCARP to use information from and build on the HMP so the two plans can effectively complement each other to help communities build more comprehensive resilience and adaptative capacity in the face of short-term and long-term climate hazards, impacts and other changes. **Table 1** lists some defining characteristics of a CCARP. Both the HMP and CCARP are essential for addressing climate change in New York local communities. Any disaster response or hazard mitigation insights that may arise during the CCARP planning process that are a better fit for inclusion in an HMP can be shared with HMP leaders and later used to inform updates to future hazard mitigation plans.

Table 1: Characteristics of a Climate Change Adaptation and Resilience Plan
Manages for long-term change in the face of uncertainty.
Addresses climate hazards and non-hazard impacts (e.g., demographic change/migrants, ocean acidification, migrating species, and non-viability of certain crops over time).
Focuses on impacts to both humans and ecosystems, including biodiversity, natural resources and ecosystem services.
Uses anticipatory tools and projected future climate data (e.g., climate projections, scenario planning and adaptation pathways) to address future uncertainties, unpredictabilities and unanticipated events.
Uses systems tools to consider cascading, compound, cumulative and synergistic impacts.
Addresses intergenerational equity and includes youth and next generation engagement.
Uses best practices solutions when available and innovation processes to generate new, novel solutions when unprecedented climate challenges have no existing, viable solutions.
Includes behavior change solutions, ecosystem-based adaptation solutions and other technical solutions.
Includes solutions for major transformational institutional, social-ecological and cultural change.

Applies a maladaptation assessment to ensure proposed solutions do not increase resilience for one specific asset or group by decreasing resilience of other communities, disadvantaged people and/or ecosystems.
Takes advantage of new opportunities that climate change presents, like measures to transform local economies to address legacy socioeconomic inequities and environmental justice.

The community will need to take the initiative to lead the planning and implementation of comprehensive climate change adaptation and resilience strategies. This will require determining the readiness of the community to carry out this work at this time. State agencies can play a supporting role by providing thought leadership, technical assistance and guidance, best practices dissemination and training, convening and facilitation, initial coordination of structures for communication and collaboration, and initial or supplemental seed funding. State agencies can also make available a suite of climate change adaptation and resilience planning and decision- support tools that are usable by local communities and integrate geospatial data that can be used to develop maps for place-based analysis. Most of the effort, however, will be the local community leading the assessment, planning, implementation, and adaptation to change.

Steps of the CCARP Planning Process

1. Establish a leadership team, participatory engagement process and framework
    - Form a CCARP leadership team
    - Create a draft community (stakeholder) outreach, mobilization, engagement and stewardship strategy
    - Decide on the climate change adaptation and resilience planning process, approach, scope, plan components and structure
2. Develop a place narrative
    - Conduct a socioeconomic survey
    - Conduct an ecosystem survey
    - Describe the history of extreme storms or extreme weather events
    - Identify underlying threats, risks, barriers and challenges
    - Identify any data gaps and explicitly state any other unknowns and uncertainties
3. Conduct a climate change vulnerability assessment
    - Describe observed and projected climate change physical effects in New York State
    - Determine exposure, sensitivity and adaptive capacity
    - Identify and communicate uncertainties and unknowns
    - Create vulnerability assessment matrix
    - Apply resilience assessment*
    - Construct climate impact chains*
    - Conduct community plans consistency assessment*
4. Develop community future scenarios
    - Conduct participatory simulations

    - Develop a shared community vision
5. Develop recommendations for action
    - Select best practices and promising practices
    - Select nature-based solutions for ecosystem-based adaptation
    - Develop innovative solutions for adaptation*
    - Apply cost-benefit analysis to potential solutions*
    - Develop adaptation pathways*
    - Assess potential maladaptations
6. Develop monitoring and evaluation approach and plan
    - Develop indicators and metrics
    - Use data visualization dashboard*
    - Develop adaptative management process
    - Develop process for updating the CCARP
7. Develop a plan implementation strategy
    - Describe the governance and management structure
    - Describe implementation methods
    - Develop a budget and funding options
    - Develop a timeline for implementation
    - Describe monitoring and evaluation

*Highly recommended components of the CCARP, but these may be postponed to subsequent plan updates.

Flexible Framework

This Local Climate Change Adaptation and Resilience Plan Guidance and Template (template) is intended to be used as both a guide to the planning process and a template for the components of the community's CCARP document. The CCARP is developed for and with a local community in a specific place in New York State and can be an important part of a local government's effort to achieve certification through the Climate Smart Communities program. This template and process make use of second generation climate change adaptation and resilience planning, assessment, analysis, evaluation, and decision-support tools coming from the latest developments, insights and research drawn from regional, national, and international sources and networks of climate change adaptation professionals. The second generation CCARP goes beyond the first generation of climate change adaptation planning that relied heavily on hazard mitigation planning frameworks, processes, tools and assumptions. This CCARP template is to be used in conjunction with a formal climate change adaptation and resilience planning process facilitated by a professional planner and/or consultants working with a designated leadership team from the community and that represents the community.

The climate change adaptation and resilience planning process follows sequential steps that are fairly standard, however, some steps can be combined, condensed or even omitted as needed, based on the needs of the community. The CCARP can include all template components for a more comprehensive plan and planning process that address a full array of community needs, assets and climate change impacts, or the template can be modified and customized using a simpler, shorter and more narrowly

focused planning process that includes only those priority components the community wants to include or is ready to take on initially, like economic assets or community infrastructure facing impacts from sea level rise and flooding. Although the more comprehensive approach provides maximum benefits and potentially reduces the most climate risks and vulnerabilities, narrowing the scope of a community's first CCARP may be practical. Communities can later augment their CCARP by adding remaining components and additional relevant climate change impacts during subsequent updates.

At a minimum, communities can apply a **nexus approach** to CCARP planning. A nexus approach is a simplified systems approach that focuses on at least two specific climate change impacts (e.g., flooding with sea level rise, heat with drought). A nexus approach simplifies and focuses the process (initially) and still captures the dynamics of a few key interactive and synergistic climate impacts.

A Nexus Approach to Climate Change Adaptation and Resilience Planning

The physical effects of climate change (e.g., sea level rise, increased precipitation, extreme heat) do not occur in isolation of one another, nor are the impacts that these effects have on a community limited to just one sector of the community. Using a nexus approach when developing a CCARP allows adaptation planning practitioners to focus on only a few key climate change effects and assess how the interaction of those effects drive compound, cascading, cumulative, and synergistic impacts on interrelated and interdependent sectors of the community. Taking a nexus approach is an option for communities that may lack the staffing and financial resources to conduct a comprehensive CCARP process and can reduce the tendency to oversimplify assumptions that can lead to unanticipated impacts that the community has not prepared for.

The focused nexus approach can simplify and shorten the climate change adaptation process, but it will inevitably leave gaps by not addressing potentially significant climate hazards and risks and community vulnerabilities. By using a nexus approach, this template can be modular and incremental to accommodate an iterative, ongoing community climate change adaptation and resilience planning and implementation process. Like any planning process, the CCARP process will need to balance tradeoffs of how long it takes, how comprehensive and robust the plan is, and how many resources and how much funding are allocated to complete it. In the real world, no plan is high-quality, fast, and inexpensive.

Once completed, the community can submit its local CCARP to the New York State Climate Smart Communities program under the PE7 Enhance Community Resilience to Climate Change category (CSC PE7 Action: Climate Adaptation Plan) to earn points toward CSC certification. Where appropriate, any section of the template that corresponds to a CSC certification action under CSC PE7 will include a notation. Local governments can also apply to the Climate Smart Communities Grant Program for funding to implement adaptation actions.

How to Use the Template

This local CCARP template is designed to work both as a guidance document and framework template for following the CCARP planning process and developing a community-wide adaptation and resilience plan. Building resilience and adapting to climate change is complex and difficult work, and creating a comprehensive, detailed plan and strategy from the very beginning may be challenging for communities. This template makes the process easier by making the plan customizable to the needs of the community and by allowing the community to prioritize and decide which components and processes to include, which to exclude, and which to combine and integrate. In this way, the plan is modular. It is also assumed that the planning process and the community's CCARP are iterative and will be updated in the future, usually to integrate additional components that were not included in the initial or previous version of the plan.

Refer to the list of "Steps of the CCARP Planning Process" above for essential components of the CCARP and the highly recommended but optional components that may be postponed until future updates to the plan. To help communities decide which components of their plan to include or not include, each section of the template includes an explanation of why that plan component is important and includes a description of potential consequences for not including that component.

Each section also includes links of helpful and optional resources that provide additional guidance, tools or background information that are relevant to that component.

The following pages contain the CCARP template with process guidance represented by *blue italicized text.* Communities may copy and paste the remaining pages of this document into a new document to begin completing each component and developing a CCARP.

Appendix B of the CCARP template contains a self-assessment table that communities can reference to ensure that all components of their CCARP adequately meet the objectives of each component as detailed in the template. It is recommended that communities review the self-assessment table prior to the CCARP being finalized and adopted by the local municipality.

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Local Climate Change Adaptation and Resilience Plan

[Name of municipality]

[Prepared by]

[Date]

Table of Contents

Insert a table of contents that includes the components selected for the current CCARP and the associated page numbers. The sample table of contents below can be inserted directly into the CCARP or used as a guideline. Add the correct page numbers to the table of contents before finalizing the CCARP.

Acknowledgments

Acknowledge sources of funding that supported the development of this CCARP. Acknowledge contributions of key individuals involved in the plan development. This should include members of the CCARP planning team and might also include other people in state and local government agencies, the community, outside organizations, universities and nonprofit agencies who participated in the development of this plan.

This project received financial support from [insert].

We would like to acknowledge contributions of the following individuals [insert].

The CCARP Leadership Team included the following individuals [insert].

Additional contributors and reviewers included the following individuals [insert].

Local Government Commitment

Include a statement from local government officials describing support for this CCARP. This should be a copy or link to the adopted resolution.

Why is this plan component important? *This demonstrates the support of local government leadership, which will be needed for implementation, financial support, allocation of staff resources and commitment to adaptation and resilience.*

What are the potential consequences of not including this plan component? *This plan may not be fully supported by local government, which may slow or prevent full implementation without local government financial support and staff support and commitment to adopting adaptation and resilience actions that only local government can take.*

[Insert local government commitment statement.]

List of Figures

[Insert list of document figures.]

List of Tables

[Insert list of document tables.]

Executive Summary

The executive summary provides a brief overview of the CCARP and contains its main points, including

- *a statement of the problem or need that the CCARP is addressing,*
- *a summary of identified vulnerabilities and recommended actions,*
- *clearly defined conclusions, and*
- *a statement of the value and importance of the document for the intended audience.*

[Insert executive summary.]

Key Terms

Adaptation (climate change): In human systems, the process of adjustment to actual or expected climate and its effects to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC 2022).

Incremental adaptation: Adaptation that maintains the essence and integrity of a system or process at a given scale (IPCC 2022).

> **Transformational adaptation:** Adaptation that changes the fundamental attributes of a social-ecological system in anticipation of climate change and its impacts (IPCC 2022).
>
> **Adaptation limit:** The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions (IPCC 2022).
>
> **Hard adaptation limit:** No adaptive actions are possible to avoid intolerable risks (IPCC 2022).
>
> **Soft adaptation limit:** Options may exist but are currently not available to avoid intolerable risks through adaptive action (IPCC 2022).

Adaptive capacity: The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC 2022).

Adaptive management: A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables (IPCC 2022).

Adaptive governance Adjusting to changing conditions, such as climate change, through governance interactions that seek to maintain a desired state in a social-ecological system (IPCC 2022).

Capacity building: The practice of enhancing the strengths and attributes of, and resources available to, an individual, community, society, or organization to respond to change (IPCC, 2022).

Climate change: Changes in average weather conditions that persist over several decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changes in frequency and location of severe weather events, and changes to other features of the climate system (Grade et al. 2023).

Climate change effects: The physical effects of anthropogenic (human-caused) climate change, including changes in average temperatures, precipitation rates, sea level rise and ocean temperatures.

Climate change impacts: The impacts experienced by a human, natural system, or

human-made system as a result of climate variation including physical changes in average conditions or extreme weather. Examples of climate change impacts include flooding of homes or ecosystem changes (Vogel et al. 2016).

Disadvantaged communities: Those that bear the burdens of negative public health effects, environmental pollution, impacts of climate change, and possess certain socioeconomic criteria, or communities comprising high concentrations of low- and moderate-income households. To ensure New York State's investments and actions benefit all communities and address climate inequities, the State's Climate Justice Working Group adopted criteria to identify certain census tracts and households as disadvantaged communities.

Drought: An exceptional period of water shortage for existing ecosystems and the human population (due to low rainfall, high temperature and/or wind) (NOAA 2023).

Ecosystem-based adaptation (EbA): The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Ecosystem-based adaptation uses the range of opportunities for the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. It aims to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change. Ecosystem-based adaptation is most appropriately integrated into broader adaptation and development strategies (CBD 2009).

Ecosystem services: Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services, such as productivity or biodiversity maintenance, (2) provisioning services, such as food or fiber, (3) regulating services, such as climate regulation or carbon sequestration, and (4) cultural services, such as tourism or spiritual and aesthetic appreciation (IPCC 2022).

Exposure: The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected (IPCC 2022).

Extreme heat: Temperatures that are much hotter and/or humid than average. Because some places are hotter than others, extreme heat depends on what is considered average for a particular location at that time of year (CDC 2023).

Extreme cold: Individual days with a maximum temperature at or below 32°F or below 0°F; threshold used depends on the region within the state (Lamie et al. 2024).

Extreme precipitation: Event with more than 1, 2, or 4 inches of precipitation over a 24-hour period. Threshold used depends on the region within the state (Lamie et al. 2024).

Extreme weather: A period of abnormal weather conditions that can negatively affect humans, natural and human-made resources. Extreme weather is used in this report as an umbrella term referring to a combination of extreme heat, extreme cold, extreme precipitation, or extreme wind.

Extreme wind: Period with sustained or gusting wind speeds high enough to cause damage to trees, power lines, and other types of natural or human-made resources (NOAA n.d.).

Flood or flooding: The overflowing of the normal confines of a stream or other water body or the accumulation of water over areas that are not normally submerged (IPCC 2021).

> **Flash flood:** A flood caused by heavy or excessive rainfall in a short period of time, generally less than six hours. Flash floods can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance, after a levee or dam has failed or after a sudden release of water by a debris or ice jam (NWS 2023).
>
> **High tide flooding:** Occurs when sea level rise combines with local factors to push water levels above the normal high tide mark. Changes in prevailing winds, shifts in ocean currents, and strong tidal forces (which occur during full or new moons) can all cause high tide flooding, inundating streets and other infrastructure even on sunny days (NOS 2023).

Greenhouse gas (GHG): Any gas that absorbs infrared radiation in the atmosphere; examples include carbon dioxide, methane, nitrous oxide, ozone, and water vapor.

Hazard: The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (IPCC 2022).

Heat wave: A sustained period of abnormally high ambient temperatures lasting for several days. In the projections generated for the New York State Climate Impacts Assessment (2024), a heat wave is defined as three or more consecutive days with maximum temperatures at or above 90°F (Stevens, A., & Lamie, C., Eds. 2024).

Maladaptation: Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas (GHG) emissions, increased or shifted vulnerability to climate change, inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence (IPCC 2022).

Mitigation (climate change): Actions that reduce the levels of greenhouse gases in the atmosphere; includes reducing emissions of greenhouse gases and enhancing sinks (things that absorb more greenhouse gases than they emit). Examples include switching to renewable energy sources and implementing energy efficiency measures.

Mitigation (hazard mitigation): Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards (FEMA 2024).

Monitoring and evaluation (M&E): Mechanisms put in place to respectively monitor and evaluate efforts to reduce greenhouse gas emissions and/or adapt to the impacts of climate change with the aim of systematically identifying, characterizing and assessing progress over time (IPCC 2022).

Nature-based solutions (NbS): Actions to protect, sustainably manage and restore

natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (IUCN 2016).

Nexus approach: A simplified systems approach of analysis and assessment that considers only a few key climate change hazards and/or impacts and their interactions. Since climate change impacts do not occur in isolation of one another, a nexus approach allows for the consideration of multiple compound, cascading, cumulative, and synergistic impacts with their interactions and results. Applying a nexus approach can reduce the tendency to oversimplify assumptions that can lead to unanticipated impacts that the community has not prepared for.

Resilience: The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPCC 2022).

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions (IPCC, 2022).

Sensitivity: The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise) (IPCC, 2022).

Vulnerability: The degree to which physical, biological, and socioeconomic systems are susceptible to and unable to cope with adverse impacts of climate change. (SOCCR2, 2018). Generally, systems that are sensitive to climate conditions and less able to adapt to changes are considered to be vulnerable to climate change impacts.

Resources

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Introduction

Provide a summary of the CCARP's intended objectives and value to the community. Include a summary of the planning process, the participatory process, methods used, and who has been involved. Include a brief synopsis of the framework and any relevant findings, insights, or messages from the community.

[Insert introduction.]

CCARP Leadership Team, Participatory Engagement Process, and Framework

Form a CCARP Leadership Team

The CCARP Leadership Team can include members of an executive committee, community or stakeholder committee, Climate Smart Communities task force, science and technical advisory committee, and/or a youth committee. Secure outside consultant facilitation services, technical services, support services and training as needed. Define roles and decision-making processes, and use participatory, inclusive, collaborative and adaptive leadership processes.

[Insert section detailing the process used for establishing the CCARP leadership team, list the team members and roles, and create an organizational structure for coordinating and refining the planning process.]

Develop a participatory community (stakeholder) outreach, mobilization, engagement and stewardship strategy

Developing the CCARP should use participatory, inclusive, collaborative and adaptive community engagement processes, including a strategy for mobilizing and engaging youth leadership and disadvantaged communities. The Climate Smart Communities Community Engagement Primer includes guidance and best practices for engaging with disadvantaged communities. Communities should begin by developing the goals of public outreach efforts and the desired outcomes of public participation during the CCARP planning process. The IAP2 "Spectrum of Public Participation" can help communities to consider the pros and cons of various levels of public participation.

IAP2 Spectrum of Public Participation

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Incorporating participatory, inclusive, collaborative and adaptive engagement processes into the development of the CCARP allows members of the community the opportunity to provide input

on what should be addressed during the planning process and builds community capacity for strategic planning.

Develop a communication strategy for messaging. The Yale Program on Climate Change Communication provides helpful guidance for developing messaging strategies for various audiences. The strategy may include setting up an interactive online platform for dynamic communication, collaboration, education and dissemination of best practices and innovations, including story maps and progress dashboards.

Creating an education strategy can improve basic climate change adaptation and resilience literacy and participatory skills necessary for community engagement. Possible topics to consider include climate change, climate change adaptation, resilience, sustainability, watershed or coastal ecology, ecosystem services, governance, dynamics of social change, and social learning. A good social learning process that brings together staff and public with diverse values to dialogue, develop mutual perceptions, build trust, increase social capital, and resolve conflicts to accomplish common goals will also simultaneously improve social adaptive capacity in the face of climate change. Partnering with local education and environmental organizations can help to organize and host in-person and virtual education events.

[Insert strategy(-ies).]

Decide on the climate change adaptation and resilience planning process, approach, scope, plan components and structure

The community initially decides on the scope and analysis approach based on community needs (see list below), sectors, or community-generated priorities. Define the community and planning boundaries using municipal jurisdictions and watersheds or other ecoregional boundaries and delineate any special zones or priority areas of consideration. If appropriate, identify where watershed boundaries intersect town boundaries as possible Watershed Protection Improvement Districts (or other special purpose districts)—either as formal government special purpose districts or as informal voluntary citizen bodies—to foster adaptive governance. Using modular plan components, choose which initial, priority components to incorporate into the CCARP and which elements to postpone until the CCARP is updated in the future, and consider potential consequences and maladaptations for not including certain components. Any component that is not addressed in this round of the CCARP could be put into a "retention basin" section and explicitly listed as a component to be addressed during a future CCARP update.

Communities taking a nexus approach for adaptation planning should determine which synergistic climate change impacts to focus on (e.g., flooding and heat) in the current version of the CCARP. To streamline and provide directive to future CCARP updates, and to ensure continuous development of local adaptive capacity, the community should also include in a "retention basin" section all additional climate change impacts that will temporarily not be addressed and will be included in future updates to the CCARP.

To increase success and avoid conflicting strategies, the local CCARP should be integrated with climate action plans (climate mitigation plans that inventory and create strategies for reducing greenhouse gas emissions), local hazard mitigation plans, comprehensive plans, sustainability plans, and open space plans. A formal review process of these relevant plans can help avoid maladaptations and can result in strategic updates to these other plans.

List of Community Needs*

Community Governance Needs

- *Good governance*

- *Responsive and effective policy*
- *Equity*
- *Access*
- *Conflict resolution*
- *Self-determination*
- *Local media*

Community Social Development Needs

- *Sense of community*
- *Recreation*
- *Self-esteem*
- *Lifelong education*
- *Social supports and services*
- *Health care*
- *Creative self-expression*
- *Peace, safety and security*
- *Aesthetic enjoyment*
- *Relationships*
- *Spiritual development*
- *Arts and culture*

Community Economic Needs

- *Local goods and services*
- *Meaningful work*
- *Money*
- *Business startup capital, data and support*

Community Infrastructure Needs

- *Public buildings and spaces*
- *Waste processing*
- *Water infrastructure*
- *Communication*
- *Energy*
- *Transportation*
- *Housing*

Environmental Needs

- *Clean drinking water*
- *Outdoor recreation*
- *Open space*
- *Clean air*
- *Biodiversity*
- *Food and food production*
- *Natural resources for raw materials*
- *Clean and safe environment*
- *Other ecosystem services*

**(adapted from Hallsmith, The Key to Sustainable Cities, 2003)*

Why is this plan component important? *This component ensures that the CCARP has leaders with the responsibility and authority to carry out and advocate for the planning process.*

Strategic participatory engagement processes ensure the best knowledge and data are included in the plan, increase local awareness and literacy of climate adaptation, and that the community takes ownership and supports implementation of actions. A robust framework for the plan ensures that the CCARP is well thought out, will address the highest climate adaptation and resilience priorities for that geographic location, and fits the needs of the community,

What are the potential consequences of not including this plan component? *No one may be able to ensure the CCARP is initiated, completed, and implemented. The plan may be inappropriate for the community and not address the community's priorities. The plan may be completely inadequate for preparing the community for climate change impacts and may inadvertently increase maladaptations and vulnerabilities. In the end, the actions developed within the CCARP may not be implemented or taken seriously.*

Resources:

Adapting to Climate Change: A Planning Guide for State Coastal Managers (NOAA Office of Ocean and Coastal Resource Management)
https://coast.noaa.gov/data/digitalcoast/pdf/adaptationguide.pdf

Climate Adaptation and Resiliency Planning for New England Communities: First Steps and Next Steps by Colgan, Charles S.; Kartez, Jack D.; and Sheils, Martha P. (New England Environmental Finance Center) https://neefc.org/wp-content/uploads/2019/03/climatereport.pdf

Climate Smart Communities Community Engagement Primer:
https://climatesmart.ny.gov/fileadmin/csc/documents/InclusiveEngagement-Primer-CSC-Cert-2022-09-01.pdf

Climate Smart Communities PE7 Action: Climate Adaptation Plan
https://climatesmart.ny.gov/actions-certification/actions/?type=1336777436&tx_sjcert_action%5BactionObject%5D=88&tx_sjcert_action%5Baction%5D=getPDF&tx_sjcert_action%5Bcontroller%5D=Action&cHash=bdfb02340c60a2a3672f5cdffb229785

Community Resilience Planning Guide for Buildings and Infrastructure Systems – Volume I (NIST) https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190v1.pdf

International Association of Public Participation (IAP2) Spectrum of Public Participation
https://cdn.ymaws.com/www.iap2.org/resource/resmgr/pillars/Spectrum_8.5x11_Print.pdf

New York State Climate Impacts Assessment: Understanding and preparing for our changing climate. Stevens, A., & Lamie, C., Eds. (2024). https://nysclimateimpacts.org

Whole-Community Climate Resilience Planning (New Jersey Department of Environmental Protection) https://www.nj.gov/dep/climatechange/trainings/asat-about.html

[Insert the CCARP approach, scope, and plan components determined by the community, including the steps and outcomes of the decision-making process.]

Place Narrative

The place narrative is a narrative description of the community dynamics and the community's surrounding watershed ecosystem, including a history of extreme weather events and other climate change impacts already occurring. This section provides an overview of the general characteristics of the community. It may include a location description, maps, history of the community, demographics, governance structure, local economy, culture, heritage and values, natural resources, open space and ecosystem services, history of extreme storms or weather events that have impacted the community, and any previous climate action. In assembling a place narrative, ensure consistency with the chosen analysis approach (community needs-based, sector-based, or community-generated priorities-based). The place narrative is usually only a summary of assembled available sources of information. Using digital maps, charts and infographics can be helpful for effective data visualization. Some communities may prefer to conduct a community plans consistency assessment during this step rather than during the vulnerability assessment step. For more information, see the description of the community plans consistency assessment process under the next step, "Conduct a Climate Change Vulnerability Assessment."

***1. Conduct a socioeconomic survey** based on existing social, economic and governance data and develop a descriptive narrative. Assemble and review existing reports and management plans. The description should include key institutions and members of the public often overlooked, especially people from environmental justice communities and disadvantaged communities. Describe local economic engines and key local businesses; government operations and services, especially the capacity for decision making and management capacity for plan implementation and emergency response. Survey the underlying social values, norms, behaviors, group identities, literacy, and narratives of the community, and assess the readiness of the community to engage in a planning effort, including anticipated social acceptance levels and potential community conflict levels. Consider "narrative frames" of various social groups to help identify preliminary affinity groups. Identify any relevant community projects or initiatives underway, any climate action underway, and any data gaps.*

***2. Conduct an ecosystem survey** (or reference an existing natural resource inventory or other ecosystem assessment report) using GIS tools and other tools and methods. This survey includes identifying natural ecosystem processes and functions, ecosystem services and thresholds, biodiversity and habitats, and natural resources assets and uses. Identify ecosystem stressors and concerns, including any built infrastructure or modifications that impact natural ecological processes and ecosystem services. Identify any ecosystem or natural resources projects underway. Incorporate available local and traditional ecological knowledge.*

***3. Describe the history of any extreme storms or extreme weather events** that have impacted the community. If climate change attribute information is available linking these events to climate change, include this information.*

***4. Identify underlying threats, risks, barriers and challenges.** Based on the place narrative, identify any socioeconomic and ecosystem stressors, threats, risks, barriers and/or challenges that may increase community vulnerability to climate change impacts. Consider that these underlying challenges exacerbate the level of impact from climate change.*

***5. Identify any data gaps, and explicitly state any other unknowns and uncertainties**.*

***Why is this plan component important?** This component ensures that the CCARP considers the uniqueness of the local community and its ecosystem and develops actions that fit. It can*

also help the community increase awareness of and come to consensus about what makes the community and its ecosystem special and worth protecting and adapting in the face of climate change. It determines how ready the community is to mobilize to address climate change adaptation and resilience. It helps provide knowledge and data about how the social-ecological system functions and works, places where it is not working well, and which people receive the benefits and costs. It identifies how extreme weather events have already created impacts in the community and what preexisting stressors, threats, risks, barriers and/or challenges may increase vulnerability to climate change impacts. It helps to identify unknowns and uncertainties that affect how the community prepares for responding to climate change.

What are the potential consequences of not including this plan component? *The CCARP may be too generic to be effective and not be a good fit for the community or its ecosystem, inadvertently resulting in maladaptations. The community may not have enough information to determine what is threatened by climate change. Important omissions or blind spots may create unfortunate surprises or unanticipated damage or harm. Lack of knowledge creates additional vulnerabilities to climate change or may create a false sense of security that increases risk. Some people in the community may be excluded and may not be ready or motivated to take on climate change adaptation and resilience work, which can seriously undermine community adaptive capacity and resilience levels.*

Resources:

Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero (editors). 2014. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.

Hilke, C. and Galbraith, H. 2013. Assessing the Vulnerability of Key Habitats in New York: A Foundation for Climate Adaptation Planning. National Wildlife Federation, Northeast Regional Center. Montpelier, VT.

Habitat Maps and Reports, and Natural Resource Inventories, Hudsonia Ltd at https://wisteria-synthesizer-4fjp.squarespace.com/maps-reports#Natural-Resource-Inventories

2013 Finger Lakes Regional Sustainability Plan https://webgen1files.revize.com/geneseeny/Document%20Center/Archive/2013/Finger%20Lakes%20Regional%20Sustainability%20Plan/execsum.pdf

Community Resilience Planning Guide for Buildings and Infrastructure Systems – Volume II (NIST) https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190v2.pdf

[Insert place narrative.]

Climate Change Vulnerability Assessment

****CSC PE7 Certification Action: Climate Vulnerability Assessment***

Conducting a climate change vulnerability assessment is an integral step in developing the overall CCARP and results in generating the most appropriate implementation actions to address key climate change vulnerabilities and risks, and improve community adaptive capacity and resilience.

A climate change vulnerability assessment determines how vulnerable (or resilient) the community and ecosystem are to current and projected impacts of climate change. Use the appropriate set of assets or elements of the chosen analysis approach (i.e., community needs [see ***List of Community Needs****

], sectors, or community-generated priorities) along with downscaled data of observed and projected physical effects from the most current version of the New York State Climate Impacts Assessment to identify key ways that climate change is impacting the community and its ecosystem now, and is expected to impact them in the future. In the vulnerability assessment, consider climate change hazards, non-hazards (e.g., migration of people and fish populations) and potential opportunities (e.g., longer growing seasons and milder winters). Communities should review the sector reports of the New York State Climate Impacts Assessment and other resources listed below, for more information on how climate change is impacting agriculture, buildings, energy systems, health, the economy, transportation, and water resources in their region. Ecosystems, habitats, and plant and wildlife populations are also becoming increasingly vulnerable to the impacts of climate change and should be included in communities' vulnerability assessment as well.

A sample vulnerability assessment is provided in ***Appendix A*** *and contains downscaled data of observed and projected climate change effects and impacts presented in the New York State Climate Impacts Assessment. This language may be included in a community's vulnerability assessment as written or customized for use in a nexus planning approach, targeted to a specific region, or expanded with other relevant supplemental data. General descriptions of how the effects of climate change can create or intensify vulnerabilities in man-made and natural systems are included in the sample vulnerability assessment and can provide guidance to communities for determining the vulnerabilities of their specific assets, needs, functions, populations, and operations.*

Why is this plan component important? *Conducting a climate change vulnerability assessment enables communities to identify and assess how specific climate change impacts will interact with their specific needs, assets, or populations to create vulnerabilities specific to that community. A vulnerability assessment is essential for generating appropriate actions to improve resilience and adaptive capacity in response to those vulnerabilities. A vulnerability assessment provides information identifying the most vulnerable areas, sectors and social groups and the potential level of impact to help the community prioritize adaptation measures. A vulnerability assessment also puts into context the needs for intended adaptation measures and can provide justification of costs for implementation. Its findings can also be used as an educational tool for raising awareness of climate change risk to the community and generating public support for implementation.*

What are the potential consequences of not including this plan component? *The CCARP may be too generic to be effective and not be a good fit for the community or its ecosystems. The community may not have enough information to determine how specific climate change impacts will interact with the community's specific needs, assets or populations to determine climate change vulnerabilities for that particular community. There may be important omissions or blind spots that create unfortunate surprises or unanticipated damage or harm. Failure to conduct a vulnerability assessment may result in the community generating inappropriate or ineffective actions that may not improve resilience and adaptive capacity, resulting in maladaptations. Some community members may be overlooked or have increased vulnerability because adaptation actions based on general vulnerabilities do not account for their specific needs and risks.*

Vulnerability Assessment Process and Considerations

*Choose how to apply and focus the vulnerability assessment by identifying and prioritizing what elements of the analysis approach (**List of Community Needs***

sectors, or community-generated priorities) the community wants to address in the CCARP. The vulnerability assessment process can help a community to identify vulnerabilities of infrastructure and buildings; vulnerabilities of government, the local economy and business continuity, especially energy, transportation, communication, food and water, and supply chains; vulnerabilities of ecosystems and ecosystem services, including threshold-based limits to avoid exceeding tipping points; and vulnerabilities of homeowners, disadvantaged communities, special populations of concern, special needs groups or individuals, and families to current and future effects of climate change.

The most effective vulnerability assessments apply some level of systems analysis to identify dynamic interactions of the system, including primary, secondary, and tertiary impacts; synergistic (interactive) impacts; and cumulative, cascading, and compound impacts. Since climate change is a threat multiplier that exacerbates pre-existing stressors, risks, and threats, it is important to use the data and findings from the place narrative to identify underlying, pre-existing stressors, risks and threats exacerbated by climate change, including social inequities and environmental justice concerns. Some climate change threats may only develop or intensify in the future, but since it can take years or decades to prepare for action, the community will want to begin to address any priority concerns in the CCARP. A robust vulnerability assessment will consider exposure and sensitivity of the community and ecosystem to climate impacts and will assess the community's existing adaptative capacity and resilience levels. Explicitly identifying any uncertainties and unknowns is especially important.

A climate change vulnerability assessment is most effective and valuable if it is comprehensive, addresses the full array of climate hazards and risks, includes all community needs and assets, identifies all climate change threats and large-scale changes, assesses all interactions of climate impacts and their synergistic, compound, cascading and cumulative effects, and uses a risk categorization for prioritizing what is most important ("criticality") for the local community. Comprehensive vulnerability assessments are of higher quality and more robust, but are also more resource intensive, expensive, and time-consuming. It may be more realistic for communities new to adaptation planning to initially narrow the scope by adopting a nexus approach to the planning process and focus on at least two specific climate change impacts and how they may interact to produce compound, synergistic effects and expose the community to increased vulnerabilities and risks. Since many climate impacts can occur simultaneously, using a systems analysis approach with a vulnerability assessment, whether comprehensive or with a focused nexus, provides the community with a more robust vulnerability assessment compared to focusing on assessing single hazard vulnerabilities independently and in isolation. Despite reducing the scope or focus with a nexus approach, the CCARP should include a systems approach, since the

- *community is a system,*
- *economy is a system,*
- *ecosystem is a system,*
- *infrastructure is a system,*
- *democratic governance is a system, and*
- *climate change impacts work as a system.*

Included below is a detailed description of the vulnerability assessment process along with

*several tools that can be used to help conduct a more robust assessment. Tools include vulnerability matrix, resilience analysis, climate impact chains, and a community plan consistency review. A sample detailed vulnerability assessment with standard language for a local community is included in **Appendix A** that can be adapted for use in a community's CCARP.*

The focus of a climate change vulnerability assessment is a local, place-based community with discrete (usually watershed-based and municipal jurisdiction-based) geographic boundaries. It is important to always include ecoregional or watershed boundaries (often one or more HUC 10 or HUC 12 watershed boundaries) along with political jurisdiction boundaries because climate change effects occur within a community's surrounding ecosystem.

The vulnerability assessment should include ecological aspects (including ecosystem services) and social aspects, including the economy, infrastructure, and government operations. It should focus on assessing short-term and long-term disruptions (including reduction, erosion, collapse, or destruction) in functions, processes, and services of the community social and ecological systems. Consider critical thresholds and important tipping points in both ecosystems and social systems, especially since combinations of gradual climate change and disturbance events can trigger abrupt and irreversible system transitions into new and novel configurations and dynamics.

Climate change vulnerability can be assessed one community system component at a time using a vulnerability matrix (table), or as a nexus of at least two interactive community system components at a time using a graphic concept map (like IHMC's Cmap Tools or Cmap Cloud).

Compound Climate Extremes

Compound climate extremes describe two or more climate extremes occurring simultaneously or successively. Compound climate extremes pose a disproportionately greater risks to humans, infrastructure, and ecosystems than their univariate counterparts. Vulnerability assessments that only focus on climate change extremes independently can significantly underestimate impacts associated with the co-occurrence of extremes such as structural damage caused by strong winds and heavy precipitation associated with cyclones and storms, or crop failure and wildfires resulting from extreme heat and droughts. Communities should consider the vulnerabilities of their assets and ecosystems resulting from compound climate extremes.

Using a Nexus Approach

As mentioned previously in this template, communities may find their capacity to complete a fully comprehensive CCARP that includes all community vulnerabilities to all relevant climate change effects and impacts limited due to various factors, such as lack of staff and/or financial resources. However, these limitations should not mean that communities do not move forward on CCARP planning and implementation. Initially narrowing the CCARP scope by taking a nexus approach to the planning process and focusing on at least two specific climate change impacts (e.g., flooding with sea level rise, heat with drought) will still capturing the dynamics of compound and synergistic effects. Even an initially narrowed scope of a CCARP makes a community less vulnerable than if they had not pursued the CCARP process at all. Communities initially taking a narrowed nexus approach should revise the nexus approach in future plan updates to ensure that other important climate change impacts are not omitted from consideration.

Additional Considerations for a Robust Vulnerability Assessment

- *Climate change is a threat- and force-multiplier and will interact with the dynamics of the underlying system, especially weaknesses, fragilities, fractures, inadequacies, and any*

aspect that is overlooked, disregarded, or intentionally excluded.

- *Climate change unfolds with impacts that are direct (primary), indirect (secondary/tertiary), compound, cascading, cumulative, and escalate over time.*
- *Climate impacts may be episodic or continuous, acute or chronic.*
- *There can be various scales of analysis, from global, national, regional, state, ecoregional, local, to site-based.*
- *There can be various vantage points of analysis, from government, business, family, privileged, poor or marginalized.*
- *Can include public assets, private market (business) assets and/or (rarely) key household, family or individual assets that have particular vulnerabilities.*
- *Can include key, relevant institutional and cultural frameworks, including laws, norms, education or literacy, culture, and traditions.*
- *Can apply an economic resilience analysis focusing on local business continuity, supply chain disruption, and energy disruptions.*
- *Can be simplified initially by using a nexus approach that allows a focus on at least two specific climate impacts (e.g., flooding with sea level rise, heat with drought) to simplify and focus the process (initially) and yet still capture the dynamics of compound and synergistic effects.*
- *Communities may begin with qualitative methods such as categorizing vulnerability and risk as low, medium, or high. This approach is quick and effective in identifying vulnerable assets and characterizing risk. However, to set priorities for asset resilience for the most important parts of a complex system, communities are encouraged to do the extra work it takes to quantify vulnerability and risk using available quantitative data and tools (e.g., GIS map layers).*

How to Develop a Climate Change Vulnerability Assessment

Review Observed and Projected Climate Change Physical Effects in New York State

Scientific data on the physical effects of climate change already occurring and projections of how physical effects of climate change are expected to occur in the future are essential for evaluating what assets, infrastructure, and ecosystems in a community are and will be vulnerable to climate impacts. Conducting a climate change vulnerability assessment should begin with reviewing the most recent downscaled data describing observed and projected climate change physical effects in New York State. Observed and projected physical effects should be drawn from reputable sources like the New York State Climate Impacts Assessment and National Climate Assessment, which include physical effects such as changes in temperature and precipitation, sea level rise, and extreme weather across the state.

Sample language of downscaled observed and projected climate change physical effects in New York State for use in a community's vulnerability assessment is provided in the "Sample Vulnerability Assessment" in Appendix A. This sample language includes data and tables that may be customized or targeted to a specific region, expanded with other relevant supplemental data, or shortened for a better fit for the community. Communities should confirm that the most current version of the CCARP template is being used to ensure that the climate data referenced is from the most recent climate change impact assessments available for New York State.

Why is this plan component important? *This component acknowledges the science of*

climate change and ensures the CCARP is rooted in the latest climate science. It ensures the CCARP considers the most significant climate change effects relevant to anticipated key impacts on the local community and its ecosystems. It helps the community identify the specific climate change physical effects that are most likely to result in impacts that generate vulnerabilities in the community and its ecosystem based on preexisting stressors, threats, risks, barriers and/or challenges.

What are the potential consequences of not including this plan component? *The CCARP may not be based on the latest science, and it may lead to not prioritizing and addressing the right climate change impacts in the vulnerability assessment. The community may not have enough information to determine the most important threats by climate change. There may be important omissions or unknowns that create avoidable surprises or damages and harm. Lack of scientific knowledge can create additional vulnerabilities to climate change or create a false sense of security that increases risk. Failure to incorporate climate science can also result in recommended actions that may be a poor fit or be maladaptive.*

Resources:

Frankson, R., K.E. Kunkel, S.M. Champion, B.C. Stewart, W. Sweet, A.T. DeGaetano, and J. Spaccio, 2022: New York State Climate Summary 2022. NOAA Technical Report NESDIS 150-NY. NOAA/NESDIS, Silver Spring, MD, 5 pp. https://statesummaries.ncics.org/chapter/ny/

IPCC Sixth Assessment Report - Working Group II: Impacts, Adaptation and Vulnerability Fact Sheet - North America: Climate Change Impacts and Risks https://www.ipcc.ch/report/ar6/wg2/downloads/outreach/IPCC_AR6_WGII_FactSheet_NorthAmerica.pdf

New York State Department of Environmental Conservation. 2021. Observed and Projected Climate Change in New York State: An Overview. https://extapps.dec.ny.gov/docs/administration_pdf/ccnys2021.pdf

Stevens, A., & Lamie, C., Eds. 2024. New York State Climate Impacts Assessment: Understanding and preparing for our changing climate. https://nysclimateimpacts.org

U.S. Climate Resilience Toolkit. "Climate Explorer." https://toolkit.climate.gov/tool/climate-explorer-0

USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023

Determine Exposure, Sensitivity and Adaptive Capacity

*Determine the **exposure** of community system components to climate change impacts in context of climate impact chains (e.g., exposure to primary impacts, exposure to secondary impacts, etc.).*

Ask: Is this asset, need, and/or function vulnerable to [sea level rise, extreme heat, extreme precipitation, etc.]?

*Determine the **sensitivity** of the community system components (e.g., existing stressors, fragility).*
Ask: How vulnerable is this asset, need, and/or function vulnerable to [sea level rise, extreme heat, extreme precipitation, etc.]?

*Determine the **adaptive capacity** of the community system component (e.g., internal strengths,*

capacities or mechanisms for defense, protection, avoidance, or accommodation that are activated).
Ask: What built-in defensive, protective, avoidance, or accommodation capabilities and features can or will be activated and how effective could this be to reduce vulnerability of this asset, need, and/or function vulnerable to [sea level rise, extreme heat, extreme precipitation, etc.] and protect the system from failure?

Identify and Communicate Uncertainties and Unknowns

Clearly identify and communicate any uncertainties and unknowns concerning vulnerabilities of community system components to climate change impacts. Explicit identification of uncertainties and unknowns is an essential component of a robust climate change vulnerability assessment. If any community system components are not assessed, or any climate change impacts not included in the vulnerability assessment, these should be identified along with a brief overview statement acknowledging the exclusion and providing an explanation. This will help readers to consider potential ramifications, including potential maladaptations, of the intentional exclusion.

Create a Vulnerability Assessment Matrix

A vulnerability assessment matrix lists all community assets and all relevant climate change impacts. Wherever a climate change impact is relevant for a particular community asset, it is marked with an "X" in the matrix.

Community Assets		Climate Variable						
		Avg. Annual Temperature Change	Avg. Annual Precipitation Change	Sea Level Rise	Extreme Heat	Extreme Precipitation	Drought	Other
Physical Assets	Homes, Businesses and Public Buildings	X	X	X	X	X	X	
	Transportation Infrastructure	X	X	X	X	X		
	Parks, Forests, Wetlands and Other Natural Resources	X	X	X	X	X	X	
	Dams, Water and Wastewater Infrastructure	X	X	X	X	X	X	
	Energy and Communications Infrastructure	X	X	X	X	X		
	Farms	X	X	X	X	X	X	
	Other							
Community Needs, Functions and Operations	Local Economy and Supply Chains	X	X	X	X	X	X	
	Food Security and Drinking Water Security	X	X	X	X	X	X	
	Local Government Finances and Revenues	X	X	X	X	X	X	
	Disadvantaged Communities and Climate Migrants		X	X	X	X	X	
	Education		X	X	X	X	X	
	Ecosystem Services	X	X	X	X	X	X	
	Public Health and Health Care		X	X	X	X	X	
	Employment and Childcare	X	X	X	X	X	X	
	Other							

Apply Resilience Assessment

Incorporating resilience science can be particularly appropriate and helpful for conducting vulnerability assessments of social-ecological systems. A robust resilience analysis applies resilience thinking and considers the following:

Resilience of what, to what, for whom, in what place, at what scale, and how much, for how long, at what cost, with what tradeoffs? Who participates, who decides, who pays, who implements, and at what price?

Conducting a resilience assessment as a preliminary step in the vulnerability assessment process can help communities gain greater insights on the vulnerabilities of their social-ecological systems by first thinking about what elements of those systems already possess some degree of resilience to current and projected climate impacts. Resilience thinking can also expose vulnerabilities in a system that may not have been obvious unless thought of in the context of whether or not the elements are resilient to climate change impacts, and how.

Applying a robust resilience assessment to the vulnerability assessment process is a time and resource intensive step that not all communities will have the capacity to undertake, particularly communities that are new to the CCARP process. Communities that choose not to apply a resilience assessment to their first round of CCARP development should include it as a crucial step in subsequent CCARP updates.

*Communities can use resilience assessment tools like the Stockholm Resilience Center Wayfinder online resilience assessment tool. This systems-based tool provides a resilience science-based approach that may provide a particularly robust assessment because it relies on the latest insights from resilience thinking that presume change, complexity, and unpredictability of social-ecological systems. Resilience thinking has an extensive body of science and social science that is very applicable to climate change adaptation and resilience efforts. Principles of resilience thinking** include*

- *maintaining diversity and redundancy,*
- *managing connectivity,*
- *managing slow variables and feedbacks,*
- *fostering and understanding of social-ecological systems as complex adaptive systems,*
- *encouraging learning and experimentation,*
- *broadening participation, and*
- *promoting polycentric governance systems.*

*** See Stockholm Resilience Centre at https://www.stockholmresilience.org/research/research-news/2015-02-19-applying-resilience-thinking.html*

Construct Climate Impact Chains

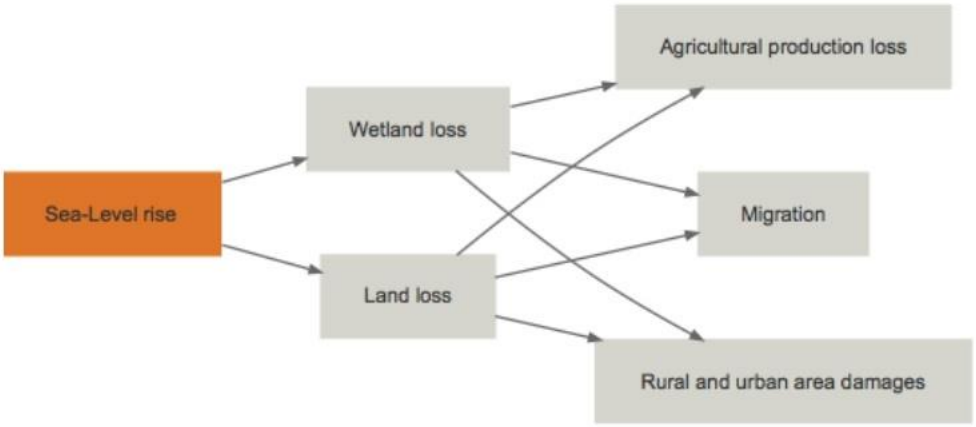
Climate impact chains are visual concept maps that diagram how climate change effects propagate through a system via direct and indirect impacts. A climate impact chain, "maps out" a visualized description or depiction of the community's social and ecological systems under climate change. Using climate impact chains can help to identify feedback loops and dynamic interactions within a system, including synergistic (interactive), cumulative, cascading, and compound effects. A concept mapping app (like IHMC's free Cmap Cloud or Cmap Tools) can

be very helpful in creating a climate impact chain. This step of a vulnerability assessment process can be developed collaboratively with groups of people and the public to facilitate participatory processes.

A physical climate change effect marks the beginning of an impact chain. Include relevant current and future climate change effects that will be included in the vulnerability assessment and add all relevant known and projected impacts as you move down the chain. Using lines and arrows to represent relations, connect climate impacts with community assets including primary, secondary and tertiary impacts, synergistic (interactive) impacts, cumulative impacts, cascading impacts, and compound impacts.

Elements for the climate impact chain are usually drawn from the place narrative and include community needs and key assets that will be included in the vulnerability assessment. These elements can include brief notations on their stressors, threats, and risks like current and legacy pollution, agricultural runoff, urban sprawl pressures, obsolete zoning restrictions, or sources of high greenhouse gas emissions. Connect elements with lines or arrows to show relationships within the systems and with climate impacts. Color coding can also be used to distinguish between different degrees of impact (e.g., primary, secondary), and between climate effects, impacts, and community assets, needs, and functions.

See below for a basic example of a climate impact chain for sea level rise.



Source: ci:grasp 2.0: Impact Chains (pik-potsdam.de)

Community Plans Consistency Assessment

**CSC PE7 Certification Action: Evaluate Policies for Climate Resilience*

Ensure consistency of the vulnerability assessment with any community climate action plans (plans that inventory and create strategies for reducing greenhouse gas emissions), local hazard mitigation plans and planning processes, sustainability plans, comprehensive plans, and open space plans to increase success and avoid conflicting strategies. This can include reviewing other existing community plans and projects to identify climate adaptation strategies and policies or projects that may increase or decrease vulnerability to climate change. Note that the local hazard mitigation plan addresses many of the natural disaster hazards that are exacerbated by climate change, so this information can be included in or coordinated with the local CCARP, as long as the data reflect anticipated future conditions and not just a trend analysis based on historic data. The CCARP can include recommended actions to be included

in updates to other community plans:

- *older or previous climate change adaptation and resilience plan (needing update)*
- *climate action plan (greenhouse gas mitigation plan)*
- *municipal comprehensive plan*
- *sustainability plan*
- *local hazard mitigation plan*
- *local waterfront revitalization plan*
- *harbor management plan*
- *watershed management plan*
- *lake management plan*
- *open space plan*
- *natural resources conservation plan*
- *natural resources inventory*
- *floodplain management plan*
- *stormwater management plan*
- *coastal erosion hazard area plan*
- *shoreline restoration plan*
- *local emergency response plan*
- *regional economic development plan*
- *regional transportation plan*

Local government staff members or departments could complete some aspects of the assessment independently; others likely require a facilitated group discussion including staff that have a thorough knowledge of the plans, so that team members can understand the content, overlaps, and gaps of the various planning documents.

Although it is the responsibility of local governments to develop and maintain community plans, engagement with the public during the step of a consistency assessment is crucial as residents and business owners often have firsthand experience with climate change impacts that are affecting the community. This input can help to identify where policies and projects included in community plans have fallen short of their intended outcomes, and where vulnerabilities still exist or have changed.

Local governments can refer to the questions provided in the Climate Smart Communities Climate Smart Resiliency Planning self-assessment tool as a guide for generating useful discussion between relevant staff and departments, as well as how to efficiently and meaningfully engage with the public to complete this component of the CCARP.

Questions that communities can start with to direct their community plan consistency analysis may include

- *Does the [plan] include consideration for climate change effects and impacts on the relevant community assets identified in the vulnerability assessment?*
- *Does the [plan] provide recommendations to address the vulnerabilities identified in the vulnerability assessment?*
- *Could any actions included in the [plan] increase the vulnerabilities identified in the vulnerability assessment and undermine efforts to adapt to climate change?*
- *Is the climate or community data used to develop the [plan] consistent with the data used in developing the vulnerability assessment (e.g., timeliness of data, what the data is saying)?*

Some communities may prefer to conduct a community plans consistency assessment during the earlier "Place Narrative" step rather than during this vulnerability assessment step. Conducting the community plans consistency assessment at an earlier stage may help communities to develop a better understanding of previous assessment work and use existing information to develop or inform the place narrative.

Resources:

Climate Smart Communities Climate Smart Resiliency Planning - A Planning Evaluation Tool For New York State Communities Version 2.0
https://climatesmart.ny.gov/fileadmin/csc/documents/Climate_Smart_Resiliency_Planning_V_2.0.pdf

Climate Smart Communities PE7 Action: Climate Vulnerability Assessment
https://climatesmart.ny.gov/actions-certification/actions/?type=1336777436&tx_sjcert_action%5BactionObject%5D=85&tx_sjcert_action%5Baction%5D=getPDF&tx_sjcert_action%5Bcontroller%5D=Action&cHash=777251658b1d512ef844617861f412aa

Climate Smart Communities PE7 Action: Evaluate Policies for Climate Resilience
https://climatesmart.ny.gov/actions-certification/actions/?type=1336777436&tx_sjcert_action%5BactionObject%5D=87&tx_sjcert_action%5Baction%5D=getPDF&tx_sjcert_action%5Bcontroller%5D=Action&cHash=698f3d6f974b826f02d5c36718da0d41

Cmap Cloud or Cmap Tools (Florida Institute for Human and Machine Cognition)
https://cmap.ihmc.us/

Earth System Dynamics- Understanding compound weather and climate events and related impacts https://esd.copernicus.org/articles/special_issue11_1091.html

Enfors-Kautsky, E., Järnberg, L., Quinlan, A, and Ryan, P. 2018. Wayfinder: a resilience guide for navigating towards sustainable futures. GRAID programme, Stockholm Resilience Center. www.wayfinder.earth

Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA) - Data Tools
https://www.midatlanticrisa.org/data-tools.html

Plan Integration for Resilience Scorecard https://planintegration.com/how-it-works/

Quinlan, A., Sellberg, M. & Perrotton, A. 2021. Resilience assessment. In: Biggs et al. (eds.) The Routledge Handbook of Research Methods for Social-Ecological Systems, Taylor & Francis Group, pp. 205–216. https://www.taylorfrancis.com/books/oa-edit/10.4324/9781003021339/routledge-handbook-research-methods-social-ecological-systems-reinette-biggs-alta-de-vos-rika-preiser-hayley-clements-kristine-maciejewski-maja-schl%C3%BCter

[Insert climate change vulnerability assessment.]

Community Future Scenarios

The community develops exploratory future scenarios using key future uncertainties and vivid narrative descriptions of possible community outcomes under climate change, based on the place narrative. Participatory table-top simulations are then used to explore these various future scenarios. To help the community members to imagine the future, visualization tools and interactive processes, including story maps, participatory GIS (pGIS), photorealistic visualizations, 3D augmented reality and role-play table-top simulation exercises to explore future scenarios may be used or developed. These exercises can be particularly useful in a nexus planning approach to demonstrate scenarios of compound and synergistic climate change effects and impacts. Based on the scenarios, a diverse representation of community develops a shared, preferred community vision to enable a transformational proactive adaptation strategy rather than a responsive, piecemeal approach.

Why is this plan component important? *Developing community future scenarios can help practitioners, policymakers, and the public identify and consider key uncertainties or unknowns and then anticipate and explore potential risks from climate change under various possible and plausible future scenarios. Exploring future scenarios puts communities in a position to better anticipate potential outcomes from uncertain climate hazards and enables them to develop more robust climate adaptation and resilience actions that will remain effective under the various future conditions. Using participatory processes to develop future scenarios, conduct simulations and develop a community vision can also help the community to generate consensus on community risks, adaptation approaches, vision and future direction, and adaptation strategies. The facilitated simulation activities help community members more fully experience scenarios to make them more real and accepted and helps them take ownership of and responsibility for their possible futures. Developing future scenarios can serve as the foundation for various pathways of adaptation implementation and inform planning and decision-making processes.*

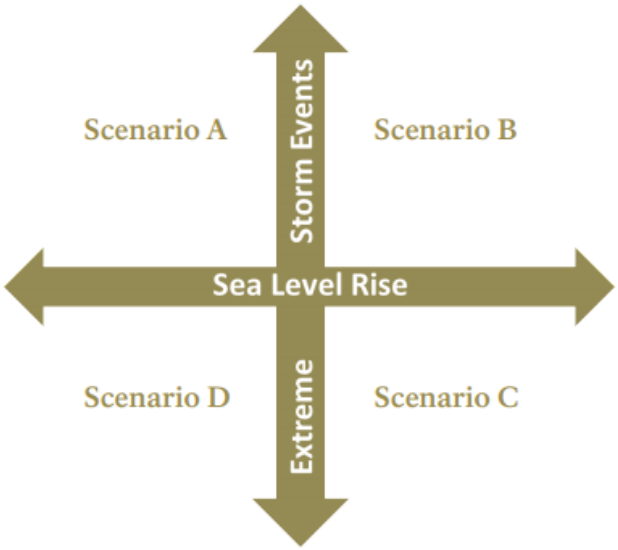
What are the potential consequences of not including this plan component? *Communities that do not develop future scenarios risk being underprepared for uncertain or unknown potential climate impacts or being blindsided or surprised by climate impacts that could have been anticipated. Not engaging in a participatory future scenario planning process, simulation exercises and community visioning reduces the likelihood of creating consensus on community risks, vision and future direction, and adaptation strategies. The potential impacts and risk from climate change unknowns and uncertainties can vary greatly, and communities that do not consider a range of scenarios for future impacts cannot prepare or protect their community members, particularly vulnerable groups, and critical resources and assets to the greatest extent possible. Without facilitated simulation experiences, it may be much more difficult for community members to fully experience scenarios based on reading a paragraph. They may find it difficult to accept scenarios as real, limiting their willingness and ability to take ownership of and responsibility for their possible futures. Excluding these plan components may also create a false sense of certainty and security among community members that only one future is likely and there are no other possibilities they need to prepare for. This can result in serious maladaptations that create high levels of vulnerability and risk.*

Exploratory Future Scenario Planning Process

1. Identify those forces, trends, and climate impacts that cause uncertainty in the future year _____ and for which the path they will take is uncertain. These are your "critical uncertainties." Critical uncertainties provide the foundation for the future scenario set, and two will be chosen as your axes on a "2 X 2 Scenario Matrix."

2. Of all your critical uncertainties, identify the ones that reflect a broad range of possibilities and impacts by the future year _____. For example, sea level rise can be one foot or three feet by 2070, depending on how climate change unfolds. Choose two uncertainties that, when combined in a scenarios matrix, have high impact and high uncertainty, and will generate four very divergent and contrasting future scenarios. The critical uncertainties should be independent of one another (e.g., not sea level rise and salty drinking water). These two uncertainties make up the two axes of the "2 X 2 Scenario Matrix," with a range of high and low conditions for each uncertainty. In the example below, Scenario A would have a box with "low sea level rise with many damaging extreme storm events." Scenario B would have "high sea level rise with many damaging extreme storm events." Scenario C would have "high sea level rise with no damaging extreme storm events." Scenario D would have "low sea level rise with no damaging extreme storm events."

3. Using the "2 X 2 Scenario Matrix" with the two critical uncertainties, draft a phrase based on the intersection of your two critical uncertainties for each of the four quadrants of the Scenario matrix. Brainstorm your four scenarios based on your four draft phrases and how they interact with all of the forces, trends and impacts in your community. It may be helpful to consider one scenario to be what happens if we adopt business as usual policies today, one scenario to be the most desirable future, one scenario to be the worst-case scenario, and one scenario to be if we adopt policies that only tweak around the edges. Make sure your scenarios are diverse and distinct from one another, cover a broad range of possibilities, and challenge our assumptions for the future. Each narrative should be very descriptive, use vivid imagery, and engage the emotions.



Resources:

Consortium for Scenario Planning (Lincoln Institute of Land Policy)
https://www.lincolninst.edu/research-data/data-toolkits/consortium-scenario-planning

Lawrence, D.J., Runyon, A.N., Gross, J.E. et al. Divergent, plausible, and relevant climate futures for near- and long-term resource planning. Climatic Change 167, 38 (2021).
https://link.springer.com/article/10.1007/s10584-021-03169-y

Moore, S., E. Zaveleta, and R. Shaw. 2012. Decision-Making Under Uncertainty: An Assessment of Adaptation Strategies and Scenario Development for Resource Managers.

California Energy Commission. https://escholarship.org/uc/item/1n1380vn

National Park Service Climate Change Scenario Planning Showcase https://www.nps.gov/subjects/climatechange/scenarioplanning.htm#Publications

Transformative Scenario Planning: Working Together to Change the Future by Adam Kahane (Berrett-Koehler, 2012) ISBN 9781609944902 https://www.bkconnection.com/books/title/transformative-scenario-planning?

The University at Arizona's Scenario Planning for Climate Adaptation at https://www.adaptationscenarios.org/workshops/scenario-planning-climate-change-adaptation-decision-making-state-art

[Insert description and outcomes of the community's future scenario planning process, including labeled figures of all developed scenario matrices.]

Participatory Simulations

Participatory simulations (also called tabletop exercises) are usually simple role-playing exercises that can allow participants to enter into and explore the details and implications of one or more of the four scenarios created as part of the future scenarios process. These facilitated participatory experiences require the creation of simple descriptions of scenes and hypothetical what-if situations and assignment of various roles and personas to participants. As participants take on the roles of their personas, they stay in character and have discussion-based interactions with one another using their imaginations to vividly explore the situations and especially ways that anticipated future climate change impacts are affecting their lives, homes, businesses, public facilities and neighborhoods. They vividly imagine, sometimes with the help of digital multimedia, the sights, sounds, and other senses and affective experiences. Post-activity sharing of reactions and discussion allows participants a fuller affective experience than just reading a description. Simulations are often used in emergency scenario planning and in educational settings as a highly effective experiential learning method.

Resources:

'As If You Were There' 360° Demonstrations (USDA Climate Hubs) https://www.climatehubs.usda.gov/hubs/northeast/project/360

Centre for Systems Solutions https://systemssolutions.org/

Long-Term Community Resilience Exercise Resource Guide (FEMA) https://preptoolkit.fema.gov/documents/1269813/0/LTCR+ERG+FINAL_20211102.pdf/

Social Simulations (Centre for Systems Solutions) https://socialsimulations.org/

New England Climate Adaptation Project – Role-Play Simulations (MIT Science Impact Collaborative) https://necap.mit.edu/role-play-simulations

Rumore, Danya; Schenk, Todd; and Susskind, Lawrence, "Role-play Simulations for Climate Change Adaptation Education and Engagement" (2016). Utah Law Faculty Scholarship. 30. http://dc.law.utah.edu/scholarship/30

U.S. Climate Resilience Toolkit: Planning for the Win! Using a Role Play Simulation to Plan for Climate Adaptation https://toolkit.climate.gov/case-studies/planning-win-using-role-play-simulation-plan-climate-adaptation

[Insert a detailed narrative of how the community conducted participatory simulation, outcomes, and labeled figures of all developed scenario matrices.]

A Shared Community Vision

Based on the place narrative and the experience of participatory simulations within the four future scenarios, the community develops a shared community vision that will unify the community, guide community climate adaptation actions, and remain viable under various possible future climate change conditions.

[Insert shared community vision statement.]

Recommendations for Action

Generate a list of climate adaptation and resilience strategies, practices and projects (actions and measures) that build resilience and adaptive capacity for both the community and the local watershed ecosystem. These strategies and actions should be in response to the vulnerabilities identified by the community in the vulnerability assessment. This component of the CCARP includes selecting best practices and promising practices, selecting nature-based solutions for ecosystem-based adaptation, developing innovations (when needed), applying cost-benefit analysis on potential solutions, applying adaptation pathways, and assessing potential maladaptations.

Recommended actions should include practices resulting in incremental changes, especially short-term coping strategies for immediate resilience benefits, and also consider practices that will bring about more long-term and transformative changes. Recommended actions should also include consideration of any limits in the capacity that human and ecological systems have to adapt to climate change impacts. Adaptation actions that are focused on systems near or at the threshold of their adaptation limits may not be ideal actions to invest in moving forward.

Some impacts from climate change will make it impossible to maintain some assets, functions or operations of the community, and small, incremental actions will be inadequate responses. Transformative adaptation actions may include restructuring, path-shifting, innovative, multiscale, systemwide, and persistent actions (Fedele, et al. 2019). Recommended actions should also consider institutional changes, policies, regulations, codes, laws and ordinances. Recommended actions should consider behavior changes based on the latest behavioral insights studies. Some increased adaptative capacity and resilience can result from simple lifestyle shifts or changes in habitual practices.

The Resistance-Resilience-Transformation (R-R-T) framework categorizes adaptation actions across a spectrum of categories that can assist communities with selecting appropriate actions and strategies based on their goals and objectives. In the R-R-T framework, resistance refers to actions that resist the changes brought by climate change; resilience describes actions that enhance the capacity of ecosystems to return to desired conditions (past or present) after a disturbance, and transformation refers to promoting change either through a "hands-off" (passive) approach, or through actions that direct and accelerate transformation aimed at driving a shift towards future projected conditions (active). Resilience shares the end goal with resistance of generally limiting changes, but it acknowledges that some changes are unavoidable and sometimes desirable. For instance, restoring forest ecosystems with a diversity of native species can increase resilience (i.e., because there is a greater likelihood that some tree species will continue to persist and function during a disturbance like drought or fire), but it may also lead to changes in forest composition (Peterson St-Laurent, et al. 2021). Deciding among actions for resistance, resilience, or transformation requires a clear understanding of

how climate change is impacting the community, and the adaptation goals the community is looking to achieve.

Similarly, the National Park Service has developed the Resist-Accept-Direct (RAD) framework, to guide communities in the types of actions they can consider. Communities may choose to develop ways to respond to climate change by resisting some changes (working to maintain or restore assets), accepting some changes (allowing some assets to change without intervening), and directing some changes (actively shaping or transforming how assets change toward preferred new conditions).

Source: Massachusetts Ecosystem Climate Adaptation Network (Mass ECAN) and Northeast Regional Invasive Species & Climate Change (RISCC) Management Network, https://www.massecan.org/resources-massecan/rrt.

Recommended actions should consider financial and budgeting solutions to pay for climate change adaptation and resilience responses. These include traditional funding mechanisms of increased state and federal grants, but these will not be adequate for addressing the full scale of community needs to address climate change impacts. Other recommended actions can include new local funding mechanisms, like green bonds, new taxes or impact fees assessed by watershed protection improvement districts, carbon markets, creation of a local currency, and payments for ecosystem services.

To increase success and avoid conflicting strategies, practices and projects, recommended actions should include critical updates to other relevant community plans, including the local climate action plans (which inventory and create strategies for reducing greenhouse gas emissions), local hazard mitigation plans, floodplain management plans, local waterfront revitalization plans, harbor management plans, metropolitan transportation plans, economic development plans, coastal erosion hazard area plans, natural resources conservation plans, stormwater management plans, sustainability plans, comprehensive plans, and open space plans, to ensure that these policy documents do not create conflicting policies or maladaptations. This is particularly critical for land-use decisions guided by the local comprehensive plan and open space plan.

It is also important to identify possible new opportunities and supplemental benefits arising from climate change impacts. For example, if climate change increases precipitation levels, constructing water retention basins, expanded drinking water reservoirs, and upland ponds could help to catch and store water for later use in times of drought. Longer growing seasons may create opportunities for growing new types of vegetables that would not otherwise grow in the region. In addition, the urgent need for adaptation and implementation products and services will require skilled labor and technological innovation, creating new job and economic opportunities through local small business creation and expansion.

During the CCARP planning process, insights, ideas, and solutions may arise that are related to emergency response or hazard mitigation and would be a better fit for inclusion in a local HMP. These insights can be set aside and later shared with the hazard mitigation planning team for consideration and use in future hazard mitigation plans or plan updates. Actions appropriate for a CCARP are more transformational and long-term, and account for how conditions will be different because of climate change based on available projections, as well as consideration for unknowns and uncertainties in the ways that climate change will impact a community in the future.

Examples of actions appropriate for an HMP:

- *Install monitoring systems that can detect hazards in real-time, (e.g., weather stations, river gauges). Use these systems to provide early warnings and alerts to transportation authorities and the public.*
- *Install backup power systems, such as generators and battery storage, at critical facilities and infrastructure sites to ensure continued operation during power outages.*
- *Use hazard-resistant materials and adopt hazard-resistant building codes to enhance the ability of infrastructure components to withstand hazard event impacts.*
- *Elevate buildings in flood zones above the height of historic flood levels.*
- *Train emergency response personnel for various contingencies and response activities, such as evacuation, traffic control, search, and rescue.*

Examples of actions appropriate for a CCARP:

- *Remove hard shoreline features and other barriers to migration of coastal and riverine ecosystems. Designate and protect "transition zones" near tidal marshes.*
- *Develop adaptive stormwater management practices (e.g., remove impervious surface, replace undersized culverts). Help private property owners better manage stormwater using green infrastructure through education and incentives.*
- *Offer property buyouts to residents in flood vulnerable areas. Restrict development in areas buffering water bodies or wetlands.*
- *Amend site plan requirements and building design guidelines to encourage light or permeable paving, shade, green roofs, vegetation, and tree canopy.*
- *Incentivize onsite renewable energy generation and storage. Build decentralized energy networks.*

It may also be helpful to apply a benefit flow analysis for adaptation solutions to ensure an equitable flow or distribution of adaptation and resilience benefits to all members of the community, including marginalized groups, special needs populations and disadvantaged communities.

Why is this plan component important? *This plan component assists the community to develop the solutions or actions that, once they are implemented, will address climate change risks and vulnerabilities and build resilience and adaptive capacity. Developing recommendations for actions is a participatory problem-solving process that can generate community support for carrying out these adaptation and resilience actions that will be needed to accomplish the intended objectives of the CCARP. The process ensures the community will identify the best and most appropriate practices that address a variety of high priority needs and risks. The community will be able to create innovations for problems without viable solutions and will prioritize using nature-based solutions for ecosystem-based adaptation when appropriate. Selected actions will have a high benefit-cost ratio. Using an adaptation pathways process allows flexible and incremental decisions to be made over time in consideration of changing and uncertain conditions and changing costs and benefits of various policy action options. Applying a maladaptation assessment allows the community to anticipate and avoid implementing harmful and risky maladaptations.*

What are the potential consequences of not including this plan component? *Excluding this plan component prevents the community from developing solutions or actions to address climate change risks and vulnerabilities, and the plan will not have implementable actions to build resilience and adaptive capacity. Without a participatory problem-solving process, it is unlikely the CCARP process will generate much community support for carrying out adaptation and resilience actions. Without this process, the community will not identify the best and most appropriate practices for addressing a variety of high priority needs and risks. The community will not create innovations and will have no viable solutions for some problems. They will not use nature-based solutions and will not advance ecosystem-based adaptation. They will not know if actions have a high benefit-cost ratio, and this increases the likelihood of low benefit-cost ratios and wasted resources. Under changing and uncertain conditions and changing costs and benefits of various policy action options, not using an adaptation pathways process reduces or even eliminates some flexibility in adopting solutions and may eliminate the possibility for incremental decision making over time, resulting in possible maladaptations, waste of resources, and adaptation traps that lock in trajectories that will not provide high resilience and adaptative capacity for long. Skipping a maladaptation assessment can prevent the community from being able to anticipate and avoid implementing harmful and risky maladaptive actions.*

Resources:

Adaptation Clearinghouse (Georgetown Climate Center)
http://www.georgetownclimate.org/adaptation/clearinghouse

Climate Adaptation Knowledge Exchange (CAKE) (EcoAdapt) http://www.cakex.org/

California Adaptation Planning Guide: Identifying Adaptation Strategies
https://resources.ca.gov/CNRALegacyFiles/docs/climate/APG_Identifying_Adaptation_Strategies.pdf

Center for Climate Strategies Adaptation Guidebook: Comprehensive Climate Action – Appendix 3 https://glslcities.org/library/center-for-climate-strategies-adaptation-guidebook-comprehensive-climate-action/

Deutsch, L. and Troell, M. 2021. Flow and impact analysis. In: Biggs et al. (eds.) The Routledge Handbook of Research Methods for Social-Ecological Systems, Taylor & Francis Group, pp. 412-425. https://www.taylorfrancis.com/chapters/oa-edit/10.4324/9781003021339-36/flow-impact-analysis-lisa-deutsch-max-troell?context=ubx&refId=8657bf99-00d7-4e7d-a7da-7a015a8a1a76

Fedele, Giacomo, Camila Donatti, Celia Harvey, Lee Hannah and David Hole. (2019).

Transformative adaptation to climate change for sustainable social-ecological systems. Environmental Science & Policy. 101. 116-125. 10.1016/j.envsci.2019.07.001.

Massachusetts Ecosystem Climate Adaptation Network (Mass ECAN) Resistance, Resilience, and Transformation Resource https://www.massecan.org/resources-massecan/rrt

Model Local Laws to Increase Resilience (New York State Department of State) https://dos.ny.gov/model-local-laws-increase-resilience

New York State Climate Impacts Assessment: Understanding and preparing for our changing climate. Stevens, A., & Lamie, C., Eds. (2024). https://nysclimateimpacts.org

Peterson St-Laurent, G., Oakes, L.E., Cross, M. et al. R–R–T (resistance–resilience–transformation) typology reveals differential conservation approaches across ecosystems and time. Commun Biol 4, 39 (2021). https://doi.org/10.1038/s42003-020-01556-2

Resist-Accept-Direct Framework - Climate Change (U.S. National Park Service) https://www.nps.gov/subjects/climatechange/resistacceptdirect.htm

U.S. Climate Resilience Toolkit: Tools https://toolkit.climate.gov/tools https://toolkit.climate.gov/tools

Best Practices and Promising Practices

Generate a list of best practices and promising practices for climate adaptation and resilience. Best practices include the well-thought-out practices that have already been successfully implemented by communities elsewhere and a body of evaluation and impact assessment research provides valid evidence that the practices actually work to increase resilience and adaptive capacity in the face of climate change impacts. Promising practices include the well-thought-out practices that have already been successfully implemented by communities elsewhere and do not yet have a body of valid evidence showing that the practices actually work. Promising practices may also include any new, well-thought-out practices developed using a logic model and innovation process to address a unique climate change adaptation or resilience problem that does not yet have viable solutions.

Best and promising practices considered by the community should aim to reduce the vulnerabilities of assets, needs, functions, etc. to relevant impacts of climate change identified and prioritized by the community during the vulnerability assessment step. Consideration of new and worsening vulnerabilities, as well as potential opportunities, identified during the future scenario planning exercises should also inform the types of best and promising practices selected by the community. Practices will be based on what an individual community has identified as vulnerable to current and future climate impacts, and how and when the community chooses to adapt and build resilience.

The resources listed below can help communities identify best practices and promising practices.

Resources:

Adaptation Workbook (Northern Institute of Applied Climate Science - US Forest Service) https://adaptationworkbook.org/

EPA Climate Change Adaptation Resource Center Searchable Case Studies for Climate Change Adaptation https://www.epa.gov/arc-x/searchable-case-studies-climate-change-adaptation

California Adaptation Planning Guide Appendix D https://www.caloes.ca.gov/wp-content/uploads/Hazard-Mitigation/Documents/CA-Adaptation-Planning-Guide-FINAL-June-2020-Accessible.pdf#search=adaptation%20planning%20guide

Hudson River Sustainable Shorelines https://hrnerr.org/sustainable-shorelines/

Open Standards for the Practice of Conservation https://conservationstandards.org/

Strategies for Climate Change Adaptation (USEPA Climate Change Adaptation Resource Center (ARC-X) https://www.epa.gov/arc-x/strategies-climate-change-adaptation

U.S. Climate Resilience Toolkit Options Database https://toolkit.climate.gov/content/options-database

US Forest Service Climate Change Resource Center Compendium of Adaptation Approaches https://www.fs.usda.gov/ccrc/climate-projects/adaptation-approaches

[Insert list of best practices and promising practices.]

Nature-based Solutions for Ecosystem-based Adaptation

Recommended actions should include nature-based solutions or ecosystem-based adaptation (EbA) projects when possible. Nature-based solutions can provide affordable, cost-effective, and effective measures for increasing resilience and adaptive capacity. To ensure high-quality nature-based solutions that foster ecosystem health, enhance biodiversity, and maximize ecosystem services to the community, it may be especially helpful to use the widely adopted Open Standards for the Practice of Conservation ("Conservation Standards"), a set of principles and practices using common concepts, approaches, and terminology for environmental conservation project design, management, and monitoring.

Resources:

Adaptation Gap Report 2020 (5th Edition) Chapter 6: Nature-based Solutions for Adaptation (UNEP) https://wedocs.unep.org/bitstream/handle/20.500.11822/34754/AGR20Ch6.pdf

Adaptation Workbook (Northern Institute of Applied Climate Science - US Forest Service) https://adaptationworkbook.org/

Center (ARC-X) https://www.epa.gov/arc-x/strategies-climate-change-adaptation

EbA Tools Navigator (Friends of Ecosystem-based Adaptation) https://toolsnavigator.friendsofeba.com/

Nature-based Solutions (IUCN) https://www.iucn.org/our-work/nature-based-solutions

Open Standards for the Practice of Conservation https://conservationstandards.org/

Strategies for Climate Change Adaptation (USEPA Climate Change Adaptation Resource Types of Nature-based Solutions (FEMA) https://www.fema.gov/emergency-managers/risk-management/nature-based-solutions

US Forest Service Climate Change Resource Center Compendium of Adaptation Approaches https://www.fs.usda.gov/ccrc/climate-projects/adaptation-approaches

Using Natural Measures to Reduce the Risk of Flooding and Erosion: Guidance From New York State's Department of Environmental Conservation and Department of State https://www.dec.ny.gov/docs/administration_pdf/crranaturalmeasuresgndc.pdf

[Insert recommended nature-based solutions for ecosystem-based adaptation.]

Develop Innovative Solutions for Adaptation

Climate change may pose unique and unprecedented challenges that communities and modern civilization may have never faced before. In situations where there are no best practices or promising practices that fit the needs and conditions, an innovation process can be used to generate creative new solutions to these emerging and complex problems.

Resources:

Nesta Innovation Spiral https://www.nesta.org.uk/helping-innovation-happen/

States of Change – Resources for Innovation Approaches https://states-of-change.org/resources/

The Open Book of Social Innovation by Robin Murray, Julie Caulier-Grice and Geoff Mulgan (Young Foundation, 2012) https://youngfoundation.org/wp-content/uploads/2012/10/The-Open-Book-of-Social-Innovationg.pdf

[Insert description of the community's innovation process and its outcomes.]

Cost-Benefit Analysis of Potential Solutions

Applying a cost-benefit analysis (also benefit-cost analysis) allows the community to compare the projected or estimated costs and benefits of several proposed actions or solutions to choose the solution with the best ratio. A variety of tools and processes can be used, with some being more comprehensive and quantitative, and some simpler and more qualitative. Applying a cost-benefit analysis helps to avoid wasting resources and can ensure maximum benefits and impacts of potential climate change adaptation and resilience actions. A cost-benefit analysis can also identify potential maladaptations. A basic and simpler cost-benefit analysis tool and participatory process is recommended for a CCARP but should be applied to all proposed actions to help prioritize choices.

Resources:

A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction (NOAA Office for Coastal Management) https://coast.noaa.gov/data/digitalcoast/pdf/gi-cost-benefit.pdf

Analyzing the Economic Costs and Benefits of CCA Options. (USAID Adapt Asia-Pacific) https://www.climatelinks.org/resources/analyzing-economic-costs-and-benefits-climate-change-adaptation-options

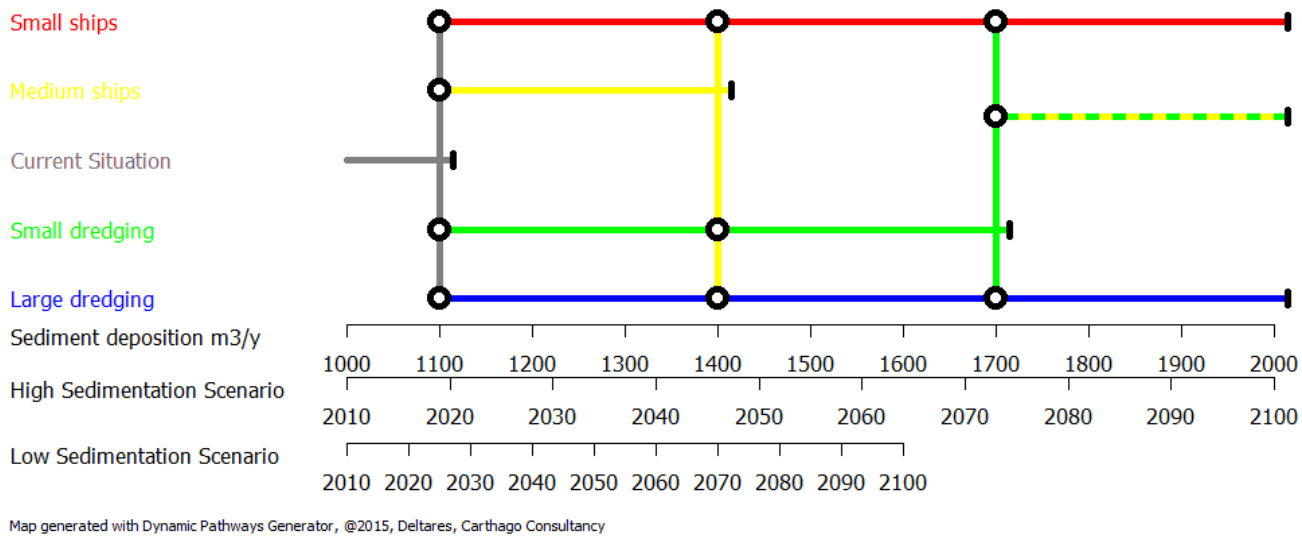
Cost-benefit analysis for climate change adaptation policies and investments in the agriculture sectors (United Nations Development Programme – Food and Agriculture Organization) https://www.fao.org/3/I8905EN/i8905en.pdf

[Insert cost-benefit analysis of potential solutions.]

Adaptation Pathways

Adaptation pathways maps represent a sequence of various options for policy actions over time. Using a climate change adaptation pathways process allows communities and decision makers to visually explore and map pathways for adaptation policy action options considering constraints and tradeoffs over time. Each policy action option is selected to achieve objectives under uncertain and changing future conditions and each reflects costs and benefits of policy implementation that are made explicit. Included in the pathways map are anticipated future

events that could disrupt or eliminate one or more policy options. This approach allows flexible and incremental decisions to be made over time in consideration of changing and uncertain conditions and changing costs and benefits of various policy action options. See an example of an adaptation pathways map below:



Resources:

Adaptation Pathways Network https://www.adaptationpathways.net/

Applied Adaptation Pathways User Guide (Adaptation Pathways Network) https://www.adaptationpathways.net/?page_id=5358

Adaptation Pathways (Resilient CA.org - California Governor's Office of Planning & Research) https://resilientca.org/apg/adaptation-pathways/

Pathways Generator (free Pathways Generator app by Deltares) https://publicwiki.deltares.nl/display/AP/Pathways+Generator

What is a pathways approach to adaptation? (CoastAdapt - Australia) https://coastadapt.com.au/pathways-approach

[Insert narrative description of adaptation pathway process and include screenshots of any pathways maps generated.]

Assessment of Potential Maladaptations

Maladaptation is an often well-intentioned adaptation practice, initiative or project that does not actually increase community or ecosystem resilience or adaptive capacity or, even worse, can make some people or assets even less resilient or more vulnerable to climate change. According to the IPCC's Sixth Assessment Report, maladaptations can create lock-ins of vulnerability, exposure, and risks to communities that exacerbate existing inequalities and/or make it difficult and expensive to change afterwards.

Maladaptive actions affect marginalized and vulnerable groups disproportionately or may decrease biodiversity, erode ecosystem resilience, and degrade ecosystem services. Action or postponing of action that forces increased impacts or other costs onto future generations is

another potential maladaptation that contributes to intergenerational inequity. Maladaptive responses to climate change can occur especially when assessing vulnerabilities to communities or assets in isolation without considering the entire system, or when responses focus on short-term coping actions without considering long-term impacts. Inherent uncertainties, unknowns, and unpredictabilities can result in surprise events or effects of locally unprecedented climate change impacts. Maladaptations can result in increases in greenhouse gas emissions and can result in a waste of time, money, and other resources.

The community should apply a maladaptation assessment to the list of recommended actions they have generated and for any climate change vulnerabilities that the community opts to not address at this time. Below is an example of a maladaptation matrix, although a concept map that modifies climate impact chains may also be used for a systems-based maladaptation assessment.

Sample Maladaptation Matrix

	Proposed Adaptation Action 1	*Proposed Adaptation Action 2*	*Proposed Adaptation Action 3*	*Postponed Adaptation Action 4*
How might action increase emissions of greenhouse gases?				
How might action transfer vulnerabilities to other communities?				
How might action increase vulnerabilities among vulnerable populations or disadvantaged communities?				
How might action be a short-term coping mechanism that undermines long-term resilience or lock in vulnerability trajectories?				
How might action decrease biodiversity and ecosystem resilience or degrade ecosystem services?				
How might action transfer vulnerabilities to future generations?				
How might action be undermined by future uncertainties?				

Resources:

Alexandre Magnan, "Avoiding maladaptation to climate change: towards guiding principles", S.A.P.I.EN.S [Online], 7.1 | 2014 http://journals.openedition.org/sapiens/1680

Jones, Lindsey and Carabine, Elizabeth and Schipper, Lisa, (Re)Conceptualising Maladaptation in Policy and Practice: Towards an Evaluative Framework (Junes 12, 2015). https://ssrn.com/abstract=2643009 or http://dx.doi.org/10.2139/ssrn.2643009

[Insert maladaptation matrix.]

Monitoring and Evaluation Approach and Plan

A monitoring and evaluation approach should be developed to incorporate both a process evaluation and an impact evaluation. Inclusion of the key aspects of resilience can be helpful for impact evaluations. A process evaluation should provide feedback on the efficiency, inclusiveness, timeliness and other good governance or good management criteria of the CCARP implementation efforts. For climate change adaptation and resilience, it is essential to also include impact evaluation to determine to what degree a community's risks and vulnerabilities have been reduced, adaptive capacity has increased, and climate change impacts cause less harm. This will require the selection of key indicators and corresponding metrics to allow ongoing monitoring, determining level of impact, providing feedback and learning that can be incorporated into adaptive management, and determination which climate adaptation and resilience practices are most effective. Monitoring implementation of adaptation actions and communicating progress using a data visualization platform (digital dashboard) can be effective.

Several elements of good governance can be included in an evaluation plan:

- *participatory*
- *consensus-oriented*
- *accountable*
- *transparent*
- *responsive*
- *effective*
- *efficient*
- *equitable*
- *inclusive*
- *follows the rule of law*

Why is this plan component important? *Monitoring and evaluation can ensure the long-term success of climate adaption actions through demonstrating effectiveness and accountability. Developing a monitoring and evaluation plan for CCARP can help communities answer questions like, "How can we know that our adaptation efforts are enough?" and "How can we know what's working and what's not?" A monitoring and evaluation plan for climate impacts is equally as important to determine to what degree a community's risks and vulnerabilities have been reduced and adaptive capacity has increased. Demonstrating accountability to municipal leaders and community residents is important for garnering continued support for action implementation, especially when it may not be known if adaptation actions will be effective until after a storm or extreme weather event occurs.*

What are the potential consequences of not including this plan component? *Communities will not have a means of measuring the effectiveness or sustainability of their adaptation actions over time, or of identifying elements of the CCARP that have proven to be unnecessary, problematic of inefficient in increasing resilience and adaptive capacity of the community. Without this information communities will not know if the actions implemented will achieve the objectives of the CCARP and community assets will remain or become more vulnerable. Excluding a monitoring and evaluation plan from CCARP may also result in failure to discover maladaptation, prior to reaching a tipping point. Municipal officials and members of the community may lose confidence in the necessity of adaptation actions if there is no way to track progress and effectiveness, especially if the cost to taxpayers need to be justified.*

[Insert monitoring and evaluation approach and plan.]

Indicators and Metrics

An indicator is a quality, trait, or state of a system that suggests ("indicates") or hints at something one is interested in. More specifically, an indicator is a sign that a particular set of adaptation actions are yielding the desired result and/or making progress in the right direction. Examples of indicators might include reduced damage to homes from flooding or uninterrupted food supply for all residents during storms.

A metric is a variable that can be measured (if quantitative) or otherwise tracked (if qualitative) that represents the indicator. The indicator, reduced flood damage, may be measured in several ways. If flood reduction activities were implemented after a devastating storm, and another comparable storm occurred later with less damage, then the metric might be the actual difference in damages, measured in dollars.

Using available resources, compile a comprehensive list of key indicators and metrics to monitor progress and impact of implemented CCARP actions. The community's process of developing indicators and metric should be inclusive and participatory.

Resources:

Evaluating the impact of nature-based solutions: A handbook for practitioners (Directorate-General for Research and Innovation - European Commission) https://op.europa.eu/en/publication-detail/-/publication/d7d496b5-ad4e-11eb-9767-01aa75ed71a1/language-en/format-PDF/source-206665393

Evaluating the impact of nature-based solutions: Appendix of methods (Directorate-General for Research and Innovation - European Commission) https://op.europa.eu/en/publication-detail/-/publication/6da29d54-ad4e-11eb-9767-01aa75ed71a1/language-en/format-PDF/source-search

Resilience Metrics (NOAA) https://resiliencemetrics.org/indicators-metrics

[Insert list of indicators and metrics.]

Data Visualization Dashboard

Using a publicly accessible online data visualization dashboard to effectively display monitoring data for implementation of adaptation actions can increase transparency and communicate progress to the public on the adaptation work that the community is doing. Data visualization can be presented in many ways including using simple spreadsheet charts with radar graphs or polar charts, GIS storymaps, etc. A data visualization dashboard may take the form of a webpage on an existing municipal website, or a specialized dashboard platform developed by a hired contractor.

[Insert description of the community's data utilization dashboard, including a link to the webpage where the dashboard can be viewed.]

Adaptative Management

During planning and implementation processes planners may need to course-correct and take

additional actions to maintain overall functioning and move toward organizational goals. To do this, they consider information about the state of a system, the progress to date, the effectiveness of an implemented action, the emerging risks, and other concurrent trends. This approach is called adaptive management. Adaptive management starts from the recognition that the management environment is complex and inherently uncertain and changing. Surprises are to be expected. Adjustments will likely be needed.

If progress or expected impacts are not occurring, adaptive management can be used to modify how the CCARP actions are being implemented. This is especially important when CCARP actions are innovations and promising practices, which have inherent uncertainties and may need additional trial and error periods. It is important to describe how adaptive management will be used as a participatory, collaborative learning process. Since adaptive management is especially helpful under conditions of constant change, uncertainty, and unpredictability characteristic of climate change impacts, describing the use of the adaptation pathways as a way to know when climate change impacts force new policy actions to be considered using adaptive management may be particularly helpful.

Include a basic, high-level description of the adaptive management processes used or to be used by the community, including data collection, the monitoring process using feedback loops with indicators and metrics for progress and impacts, and a situational assessment to aid decision making.

[Insert description of the community's adaptive management process.]

Process for Updating the CCARP

Develop a process and timeline for revisiting and updating the CCARP, including any items postponed or any items explicitly listed in the retention basin in the first release of the CCARP. The updated CCARP could include a section on new monitoring data generated since the previous edition as used to guide adaptive management decisions.

[Insert process for updating the CCARP.]

Plan Implementation Strategy

Developing and issuing a CCARP plan with recommendations for climate adaptation actions does not effectively increase resilience and adaptative capacity without implementing the actions. Creating an implementation strategy as part of the CCARP identifies the steps and resources needed to move to implementation and increases the likelihood of gathering the needed support from decisionmakers and the public. A robust CCARP implementation strategy includes brief and summarized high level descriptions of a governance and management structure for making and carrying out decisions; implementation methods and allocating resources needed to get the work done; developing a budget and funding strategy; developing a timeline or schedule for when each action is implemented and in what sequence; conducting monitoring and evaluation to guide data collection and determine effectiveness of the actions; and using adaptative management to facilitate decision making and modification under conditions of constant change and uncertainty. The ultimate outcome of an implementation strategy is building climate change resilience and adaptive capacity.

Why is this plan component important? *Implementing the CCARP initiates the actions that the community has identified as necessary to reduce risks to climate hazards, improve adaptive capacity and build climate resilience. A basic description of the implementation strategy provides enough detail to demonstrate the viability, quality, feasibility and robustness of the implementation of CCARP actions. This is essential for securing the support of the public, commitment from collaborative partners, and the support and authorization to proceed from local decision makers. This will also provide the initial directions and guidelines—a roadmap—for those responsible for implementation of the CCARP actions that will build community climate resilience and adaptive capacity to protect people, assets and resources in the face of current and future climate change impacts.*

What are the potential consequences of not including this plan component? *With no description of the CCARP implementation strategy, there will not be an adequate level of detail to demonstrate the viability, quality, feasibility and robustness of the implementation of CCARP actions. It is unlikely that the CCARP will have the support and authorization from local decision makers to proceed to implementation. Collaborative partners may be unwilling to commit to the collaboration, and the CCARP may not have adequate public support. Excluding this plan component may also result in increased frustration among community members that the local government leadership is not interested in protecting its people, assets and resources from the impacts of climate change. Even if the CCARP is somehow approved to move forward without an implementation strategy, without the initial implementation directions and guidelines (roadmap), those responsible for implementation will not have the information they need to carry out CCARP actions. An unimplemented CCARP will not be able to build community climate resilience and adaptive capacity, and the people, assets and resources of the community will continue to be vulnerable in the face of current and future climate change impacts.*

[Insert implementation strategy.]

Governance and Management Structure

The CCARP implementation strategy should include a description of the governance and management structure. This creates a clear structure, responsibilities and authorization for decision making, allocating resources, *and ensuring action, and will be essential for carrying out CCARP action implementation. Developing a local collaborative adaptive governance model may be beneficial to facilitate coordination, collaboration and adaptive management among local government, state and federal government, nonprofit organizations, academic institutions and private consultants and other businesses that will play a role in implementation of CCARP actions. Because of limited resources and staffing, using a "Stone Soup" network collaboration approach allows partner organizations and agencies to do portions of the work that cumulatively can get the job done. Using existing local bodies with expanded climate change adaptation and resilience roles takes advantage of available local expertise, acceptance and trust relationships already established within the community, and established lines of decision making and authority. For example, Conservation Advisory Councils and Climate Smart Community* taskforces *can add CCARP planning and implementation to their responsibilities. Note that both of these local voluntary groups can include youth leader members and take advantage of extra expertise from local college students and graduate students needing internship or volunteer experience to meet academic requirements and to build professional resumes.*

[Insert governance and management structure.]

Implementation Methods

The implementation strategy should also include a basic, high-level description of the implementation methods. This describes how the community will ensure the CCARP's adaptation strategies are carried out year after year. It can include a description of who does what, and how, with what resources. It should include basic goals, objectives and a list of the short-term (coping) measures and long-term measures. It can identify implementation gaps and challenges and possible strategies for overcoming these barriers. It should include a general description of the strategy for continued public and stakeholder involvement.

It may also be helpful to include a description of an online and offline network (community of practice) used for communication, learning and collaboration that will be essential for facilitating and supporting effective collaborative adaptive governance and implementation. This online and offline network facilitate top-down, bottom-up and peer-to-peer exchanges and can use existing online digital platforms and tools. Hybrid meeting venues can use a combination of periodic in-person leadership meetings, committee meetings, public town hall and also digital meetings to maximize participation.

[Insert implementation methods.]

Budget and Funding Options

The CCARP implementation strategy should include a high-level strategic budget with accurate costs for personnel, facilities, contracted services, and other resources. A strategic budget that includes a total amount and general categories showing how the funding will be used will be essential for getting approval and support for CCARP action implementation.

The implementation strategy should also include a description of the finance model used to generate adequate funding for CCARP action implementation. Consider traditional and non-traditional or innovative finance models as a way to pay for climate change adaptation and resilience actions. Traditional funding mechanisms include securing state and federal grants, but these will almost never be adequate for addressing the full scale of community needs to address adapting to climate change impacts. Non-traditional or innovative funding sources can include establishing new local finance mechanisms, like green bonds, new taxes or impact fees assessed by watershed protection improvement distracts, carbon markets, creation of a local currency, payments for ecosystem services and even new resilient economic development models that promote small business opportunities that are arising and will continue to emerge under climate change. Local small business opportunities can include installing green infrastructure, post-storm ecological restoration, relocating homes out of flood zones, expanding local food security with urban farming and aquaculture, wood-based product manufacturing using sustainably-harvested local wood supplies, native plant and tree nurseries, and resilient renewable energy microgrid installations. A good resource for climate change adaptation and resilience funding is the Ready-to-Fund Resilience Toolkit from the American Society of Adaptation Professionals (ASAP). This online toolkit can help local communities consider options for funding climate change adaptation and resilience.

Resources:

Ready-to-Fund Resilience Toolkit (American Society of Adaptation Professionals)
https://adaptationprofessionals.org/ready-to-fund-resilience-toolkit/

New York State Department of Environmental Conservation Funding Finder Tool
https://dec.ny.gov/get-involved/grant-applications/funding-finder-tool

[Insert budget and funding options.]

Timeline for Implementation

The implementation strategy should also include a basic anticipated timeline for implementation. This can be in the form of a Gantt chart, list or schedule of dates, or an actual calendar.

[Insert timeline for implementation.]

Monitoring and Evaluation

Include a basic description of the monitoring and evaluation process. Identify the chosen climate indicators and metrics that will be used to track progress, measure impacts and use adaptive management to modify implementation actions as needed. Any online network (community of practice) used for communication, learning and collaboration can also be used for data collection, reporting, and visualization of progress and impacts with an online digital dashboard.

[Insert monitoring and evaluation process.]

Appendices

Insert local legislature proclamations, resolutions, and/or declarations regarding climate change.

Insert maps.

Insert supplemental tables.

Insert supplemental figures, graphs, and photos.

END OF CCARP TEMPLATE

APPENDIX A

Sample Vulnerability Assessment

This climate change vulnerability assessment for [*name of municipality*] is meant to be an initial qualitative assessment of how climate change impacts community needs, sectors, assets, and values. In the earliest stages of less intense impacts, climate change acts as a "threat multiplier" by adding additional stresses to existing problems, challenges, and risks. Climate change is also influencing the intensity and frequency of extreme weather events. In the future, projected changes to temperature, precipitation, and sea level could result in even more significant impacts to the environment, infrastructure, economy, and human health.

The primary sources of climate change information used for the vulnerability assessment are 2024 New York State Climate Impacts Assessment,[1] the Fifth National Climate Assessment,[2] the U.S. Climate Resilience Toolkit Climate Explorer,[3] and other relevant climate change studies. The observed and projected physical effects of climate change in New York State referenced in this vulnerability assessment are summarized for the following variables:

- annual average temperature change
- annual average precipitation change
- sea level rise
- extreme weather (including extreme cold, extreme heat, extreme precipitation, drought, and wildfire)

Vulnerabilities were identified by reviewing community and watershed ecosystem information and screening community needs, including physical assets and operations against each applicable variable to determine potential obstacles to adaptative capacity and resilience. Data gathered from the process of conducting this vulnerability assessment for [*name of municipality*] will inform recommendations for actions to reduce these vulnerabilities.

Observed and Projected Physical Effects of Climate Change in New York State

Average Annual Temperature and Precipitation Change

As a whole, New York State has warmed at an average rate of approximately 0.21°F per decade from 1901 to 2022. This rate of warming is higher than the contiguous 48 states' average rate of 0.17°F per decade over the same time period. Winter warming is greatest, at a rate (0.33°F per decade) that is nearly double each of the other seasons. The rate of warming in New York State has increased over the last 40 years.[4] **Table 1** shows the warming temperature trends at statewide weather stations over a 1901-2020 time period.[4]

Table 1: Climate Trends for Observed Weather Stations in New York State (1901–2020)

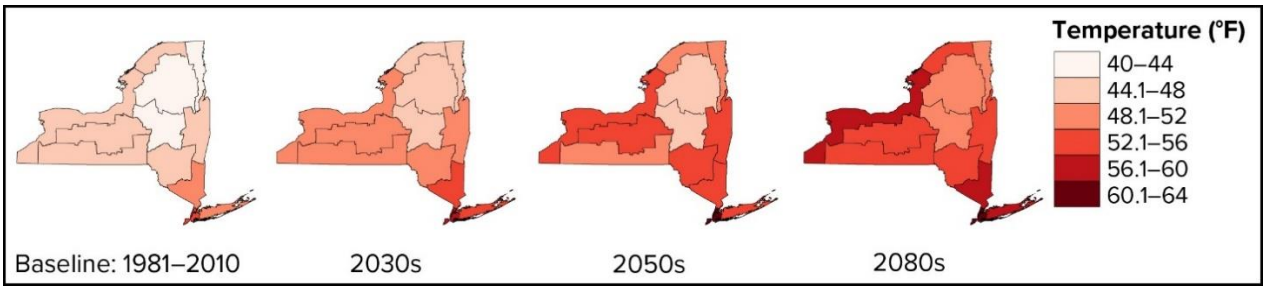
Region	Observed Weather Stations	Temperature Trend	Precipitation Trend
		°F/decade	inches/decade
Adirondacks	Indian Lake	0.18**	0.37
	Lake Placid	0.30**	0.45**
	Wanakena,	0.29**	0.20
Catskill Mountains	Mohonk	0.21**	0.63*
	Port Jervis	0.35**	0.30
Central/Finger Lakes	Dansville	0.15**	0.35**
	Ithaca	0.13**	0.55**
	Syracuse	0.22**	0.57**
Champlain Valley	Dannemora	0.34**	0.72**
Great Lakes	Buffalo	0.19**	0.88**
	Fredonia	0.11*	0.39*
	Oswego	0.34**	1.03**
	Rochester	0.22**	0.40**
	Watertown	0.19**	0.57**
Long Island	Bridgehampton	0.34**	0.53**
	Setauket	0.36**	-0.16
Mohawk River Valley	Cooperstown	0.15**	0.34
New York City	New York City/Central Park	0.34**	0.71**
North Hudson River Valley	Albany	0.28**	0.88**
	Saratoga Springs	0.09	0.59**
Southern Tier	Alfred	0.14**	0.31*
	Binghamton	0.22**	0.86**
	Elmira	0.12**	0.60**
	Norwich	0.08	0.37
South Hudson River Valley	Dobbs Ferry	0.34**	0.39
	Poughkeepsie	0.42**	0.32
St. Lawrence River Valley	Canton	0.24**	0.27*

Source: Bader and Horton 2023[5]
*Trend is significant at the 95% significance level. ** Trend is significant at the 99% significance level.

Annual average temperatures are projected to increase across New York State by 2.5°F–4.4°F by the 2030s, 3.8°F–6.7°F by the 2050s, and 5.1°F–10.9°F by the 2080s, relative to 1981–2010. Warming is projected to be greatest in the northern regions of the state, while New York City will continue to be the warmest part of the state with annual average temperature projected to be 6 to 10 degrees warmer compared to 1981-2010 (**Figure 1)**. By the 2080s, New York City's average temperature is projected to be comparable with the 20th century average for Birmingham, Alabama.

Average seasonal temperatures are projected to increase across all regions of New York compared with the 1981–2010 baseline. Winter temperatures are projected to increase the most, particularly for northern parts of the state, such as the Champlain Valley, North Hudson, St. Lawrence Valley, Adirondacks, and Great Lakes regions.[4]

Figure 1: Projected Annual Average Temperature in New York State Relative to 1981-2010 Baseline



Source: Lamie, et al. 2024.[4] This work is licensed under CC BY 4.0.

The maps show median (50th percentile) modeled results from a blend of the SSP2-4.5 and SSP5-8.5 greenhouse gas emissions scenarios. Data from projections developed for the New York State Climate Impacts Assessment: https://nysclimateimpacts.org/explore-the-assessment/new-york-states-changing-climate/#Data .

Annual precipitation across New York State increased at a rate of 0.47 inches per decade from 1901 to 2022.[4] **Table 1** shows increasing precipitation trends at most state weather stations.

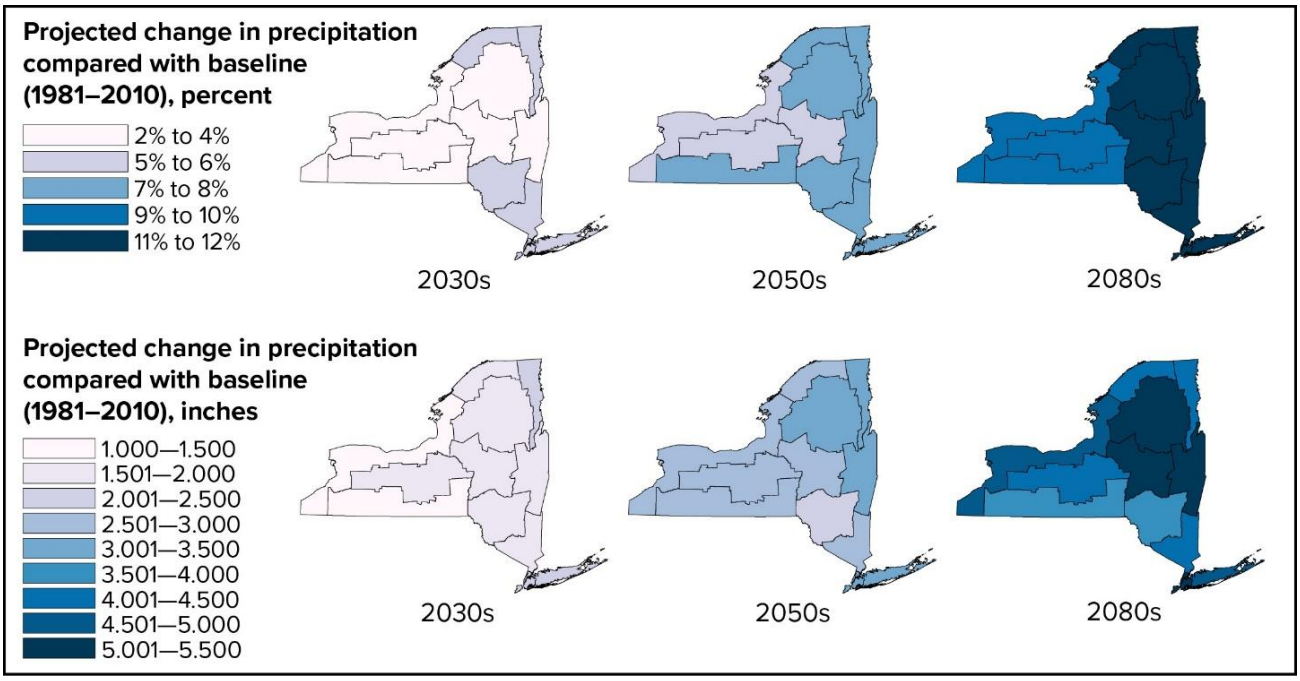
Annual precipitation is projected to increase in all New York State climate regions through the late 21st century. Across the state, precipitation is projected to increase by approximately 1% to 8% by the 2030s, 2% to 12% by the 2050s, and 6% to 17% by the 2080s, relative to a 1981–2010 baseline (**Figure 2**).[4] The largest percentage increases in annual precipitation are projected for the New York City, Catskills, and South Hudson regions. Precipitation is expected to increase in winter and spring across New York's throughout the 21st century, consistent with previous climate projections for the state.[6,9]

Snowfall, depth, extent, and water equivalent are projected to decrease across New York State. The snow season is projected to become compressed, with more precipitation falling as rain, including some lake-effect precipitation. Over the next few decades, warmer water and decreased ice cover on the Great Lakes are likely to increase lake-effect snow. As the state continues to warm, however, the additional precipitation caused by warmer lake conditions will increasingly fall as rain rather than snow.[4]

Vulnerabilities from Increasing Average Annual Temperature and Precipitation

Community assets, infrastructure, ecosystems and agriculture systems that are sensitive to small changes in temperature have increased vulnerability to average annual temperature changes. In wintertime, even slight average temperature changes

Figure 2: Projected Annual Precipitation in New York State Relative to the 1981–2010 Baseline



Source: Lamie, et al. 2024.[4] This work is licensed under CC BY 4.0.

The maps show median (50th percentile) modeled results from a blend of the SSP2-4.5 and SSP5-8.5 greenhouse gas emissions scenarios. Data from projections developed for the New York State Climate Impacts Assessment: https://nysclimateimpacts.org/explore-the-assessment/new-york-states-changing-climate/#Data

can mean snow and ice do not form and precipitation falls increasingly in the form of rain. Rapid freeze-thaw cycles can stress infrastructure, including underground water pipes, leading to additional breakages and need for out-of-season emergency repairs. Snow-dependent recreation and tourism economies are especially vulnerable. Increased ice jams on surface waters can increase flooding and create vulnerabilities for flood-prone areas. Changes in average temperatures throughout the growing season can throw off spring synchronization of pollinators and blooming flowers, stress some crops and create vulnerabilities for farms and farming communities. Increased summer warming may increase the number of days that facilities and homes need to use cooling systems, increasing energy costs and power grid stress. Increased precipitation can elevate risks of and vulnerability to flooding and can saturate agricultural soils during sowing and harvesting times, creating vulnerabilities for farmers. Increased temperatures can disrupt forests and wildlife habitats and cause species to shift to cooler regions, creating vulnerabilities for ecosystem services, biodiversity, and natural resources-based economies.

Ocean, Lake, and River Temperatures

Sea surface temperature is a key indicator of climate change. Sea surface temperature affects storm formation, other aspects of weather, and marine life. The northwest Atlantic has warmed by 0.67°F (0.37°C) per decade from 1982 to 2018, a rate is three times faster than the global average rate of 0.18°F per decade during a similar time frame. The rate of warming has accelerated in recent years, with warming within the northeastern U.S. continental shelf region having quadrupled during the period 2007–2016 compared with long-term trends.[4]

Marine heat waves occurred much more frequently in the New York Bight from 2010 to 2020 than in the last three decades. As global and regional air temperatures continue to increase, and as the oceans absorb extra heat trapped by greenhouse gases, global and regional sea surface temperatures are also expected to continue rising. Northeastern U.S. coastal waters have been projected to warm at a rate of up to 0.76°F (0.42°C) per decade through the period 2070–2099.[4]

Rising temperature and increasing precipitation affects the thermal and hydrologic dynamics of lakes, rivers, and streams, impacting biodiversity, and ecological processes. Warmer air temperatures can increase the temperature of freshwater systems and influence thermal stratification of lakes. Increased temperature leads to earlier snowmelt, which affects lake and stream water levels along with increased precipitation.[4]

Warming surface temperature in the Great Lakes increases rates of evaporation and delays lake ice formation, which can contribute to lower water levels (increased precipitation with climate change can offset this effect). Surface waters in Lakes Erie and Ontario warmed from 1995 to 2022 with observed warming being most notable during the spring and summer months. Surface temperatures are projected to increase across all five Great Lakes. The largest increases are projected for Lakes Superior and Ontario. The strongest warming is projected in spring and extends into summer, due to earlier and more intense stratification.[4]

Modeling studies of rivers and streams show that air temperature strongly predicts water temperature. This finding suggests that temperatures of New York's rivers and streams will continue to warm as air temperatures rise in the decades ahead. Increased streamflow from increased precipitation could offset some of this warming effect.[4]

Vulnerabilities from Increasing Water Temperatures

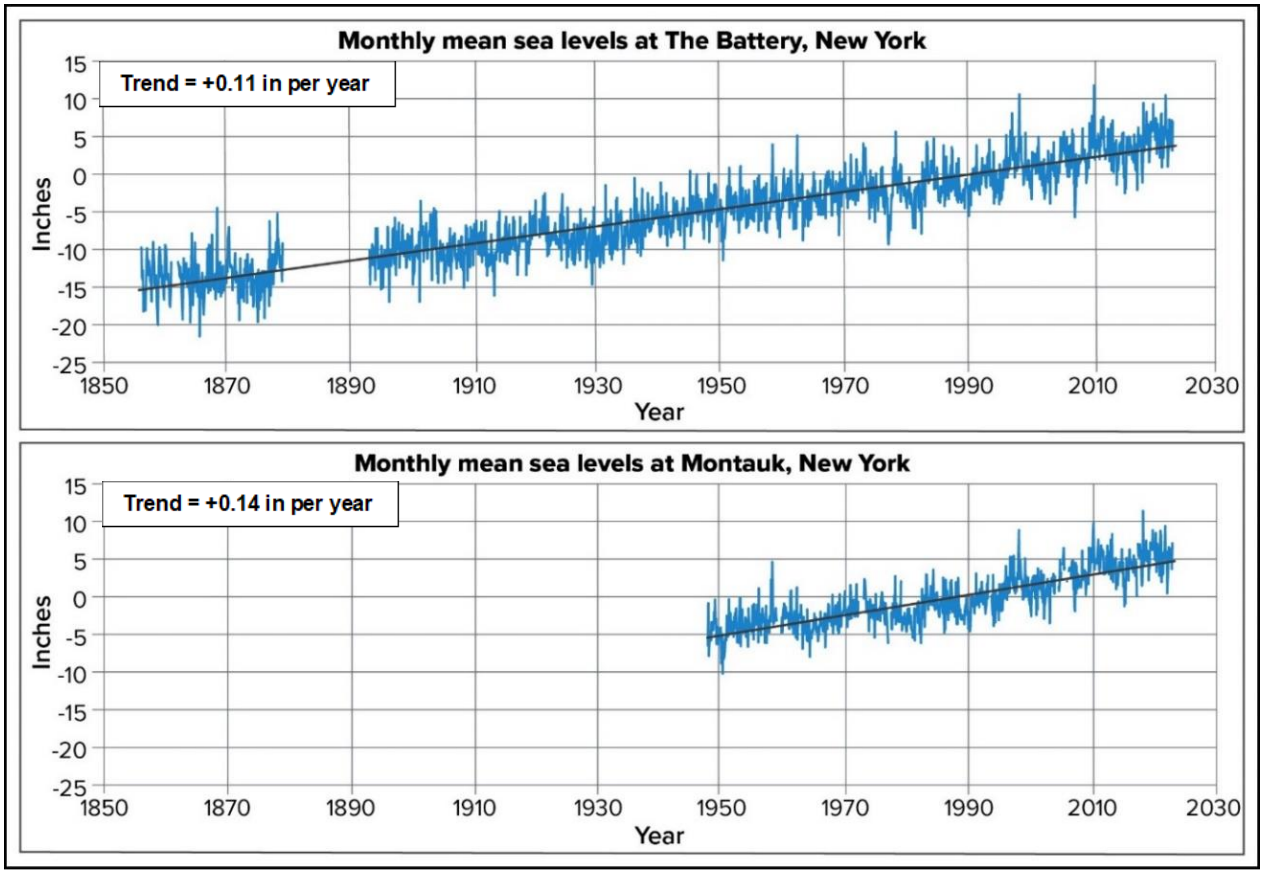
Coastal communities that depend on their ocean or Great Lakes resources and have marine and coastal assets, infrastructure, ecosystems, and fisheries and aquaculture industries that are sensitive to small changes in ocean or lake temperatures have increased vulnerability to average annual temperature changes. Warming oceans and Great Lakes can result in increased harmful algal blooms, decreased water quality, fish die-offs, and migration of marine and aquatic species important to biodiversity and the local economy. Recreational beaches are also vulnerable to increased warming of

waters.

Sea Level Rise

Coastal regions of New York such as Long Island, New York City, and tidal Hudson River are at risk from rising sea levels and enhanced coastal flooding. Sea levels in coastal New York are rising at rates faster than the global average.[4]

Figure 3: Monthly Mean Observed Sea Level Rise at the Battery and Montauk Point, New York



Source: Lamie, et al. 2024.[4] This work is licensed under CC BY 4.0.

Relative sea level at two long-term measurement sites in New York State, 1856–2022 (The Battery) and 1947–2022 (Montauk). Each graph shows sea level relative to the shore, which accounts for global sea level rise as well as local vertical land motion. Source of data: NOAA (2023)[7]

The rate of sea level rise in New York City (The Battery) averaged 0.11 inches per year from 1856 to 2022, amounting almost a foot of sea level rise in the last 100 years. The rate has accelerated to approximately 0.16 inches per year over the past 40 years. At Montauk, sea level has risen at a rate of 0.14 inches per year from the start of measurement (1947) to 2022. Both rates (**Figure 3**) are nearly double the 1920–2022 global average.[4]

Sea level is projected to rise along the New York State coastline and in the tidal Hudson River throughout the 21st century and beyond. **Table 4** shows projections of sea level rising by up to 1 foot by the 2030s, about 2–3 feet by the 2080s, and more than 4 feet by the year 2150. Under scenarios with a high rate of ice loss from Greenland, Antarctica, and glaciers, New York could experience sea level rise much higher than 4 feet by 2150. Local and regional factors are likely to continue to cause New York's sea level to rise more than the global average, based on projections through 2150 for the northeastern U.S. coast.[4]

Table 4: Projected Sea Level Rise at Three Locations in New York State

Station	2030s (inches)	2050s (inches)	2080s (inches)	2100 (inches)	2150 (inches)
Montauk	8-12	15-21	26-41	32-54	50-94
The Battery (NYC)	7-11	14-19	25-39	30-50	47-89
Albany (Troy Dam)	7-10	12-17	21-35	25-46	41-82

Sea level rise in inches relative to a 1995–2014 baseline. Ranges given represent the 25th to 75th percentiles of a blended set of three scenarios used by the IPCC: SSP2-4.5 with medium confidence, SSP5-8.5 with medium confidence, and SSP5-8.5 with low confidence. The latter scenario reflects the plausibility of higher-end sea level rise associated with accelerated loss of land-based ice. Data from projections developed for the New York State Climate Impacts Assessment: https://nysclimateimpacts.org/explore-the-assessment/new-york-states-changing-climate/#Data.

Sea level rise is expected to continue to increase the height and frequency of the state's coastal floods in future decades **(Table 5)**. High tide flooding (also called "nuisance" or "sunny day" flooding) is also becoming increasingly common along New York State's tidal coastlines. New York City currently experiences approximately 10 high tide floods per year as measured at The Battery, and that number could rise to 60–85 days by the 2040s. This projection means chronic flooding could affect low-lying coastal neighborhoods once a week or more. Regular tidal flood events will progressively affect additional low-lying coastal areas. Furthermore, the combination of sea level rise and storm surge will increase the frequency, extent, and severity of coastal flooding in New York State.[4]

Vulnerabilities from Sea Level Rise

Coastal flooding from sea level rise and storm surge creates additional vulnerabilities for coastal communities, including for homes, businesses and infrastructure located in the flood zone. Drinking water aquifers can experience saltwater intrusion. Infrastructure design and construction standards that did not anticipate frequent or extended immersion in saltwater can result in rapid degradation of and structural safety concerns for existing infrastructure. Coastal flooding can increase vulnerabilities to sewage treatment facilities, convey high volumes of household and commercial pollutants into nearshore waters, and make flooded roads and subway tracks unusable.

Table 5: Observed and projected high tide flooding at three locations in New York State.

Station	Flood threshold (height above mean higher high water)	Flood days per year, 1950–1969	Flood days per year, 1970–1989	Flood days per year, 1990–2009	Flood days per year, 2010–2022	Projected flood days per year, 2041–2050
Montauk	20.9 inches (0.53 meters)	1.2	0.9	2.3	4.3	50-90
The Battery	22.0 inches (0.56 meters)	1.9	1.8	4.3	10.0	60-85
Kings Point	23.6 inches (0.60 meters)	3.6	3.1	5.0	8.7	50-70

High tide flooding represents the number of days that the water level reaches a station-specific, probabilistically derived threshold as defined by NOAA.[8] Each number here represents an annual average over the time period shown. Projections represent the "likely decadal range" in NOAA's Annual High Tide Flooding Outlook, which extends from NOAA's "low" sea level rise scenario to NOAA's "intermediate" scenario.

Extreme Weather

Extreme weather events relevant to New York include extreme heat (several days with temperatures at or above 90°F), extreme cold (several days with temperatures at or below 32°F), drought, wind, and heavy precipitation events with related flooding.

Extreme Heat

Temperatures are more frequently exceeding thresholds historically considered to be "unusual" or "extreme" as warming shifts the entire distribution of temperatures and pushes more daily temperatures beyond thresholds once considered rare. Temperatures in urban heat islands are about 1 to 7°F warmer in the daytime and 2 to 5°F warmer at night than the surrounding areas, causing greater concern for heat impacts and health risks.[4]

From 1981 to 2010, the weather station at Central Park recorded an average of 17 days per year over 90°F, an average of four days per year over 95°F, and an average of two heat waves per year. In contrast, Lake Placid experienced an average of only 1 day a year above 90°F, no days above 95°F, and an average of one heat wave every 10 years between 1981-2010. The number of days above 90°F and 95°F are projected to increase across New York State during the 21st century, in addition to longer and more frequent heat waves **(Table 6)**.[4]

Vulnerabilities from Extreme Heat

Extreme heat events can create increased risks and vulnerabilities for human health, built infrastructure, agriculture, ecosystems, and local businesses. Outdoor workers, including agricultural workers, utility line workers, and construction workers, may have increased exposure to extreme heat. Infrastructure, including power transmission lines, not designed for frequent and extended exposure to extreme heat can result in structural degradation, reduced capacity and safety concerns. Extreme heat creates vulnerabilities to farm livestock and food crops and increases evaporation rates of drinking water reservoirs. Small businesses may not be able to afford to install new air conditioning or operate cooling for customers and stock, resulting in vulnerabilities to local supply chains, local goods and services and the local economy. Extreme heat can create vulnerabilities for ecosystems and natural resources-based economies by stressing trees and wildlife, resulting in increased mortalities and reducing biodiversity and ecosystem services.

Extreme Cold

Extremely cold days occur as a natural part of day-to-day variation in weather. The annual number of days below 0°F and days below 32°F are projected to decrease across the state. Projections of Lake Placid for example, show only 9 to 15 days per year below 0°F in the 2050s, and 2 to 11 in the 2080s, compared with 33 during the 1981–2010 baseline period. By the 2080s, the locations modeled for the New York State Climate Impacts Assessment are projected to lose between 31 (Central Park) and 96 (Oswego) days per year below 32°F compared to the 1981–2010 baseline.[4] Winter nights are also becoming warmer across New York State, with very cold nights (i.e., nights with a temperature below 0°F) occurring less frequently since 1990, compared with most of the 20th century.[4]

Vulnerabilities from Extreme Cold

The loss of days below freezing is concerning, as frozen conditions influence animal migration, control the activity and proliferation of pests (e.g., ticks), and affect hydrological cycles, the growing season, and more generally whether precipitation falls as rain or snow. The latter can create vulnerabilities to businesses and communities dependent on winter recreation. The decrease in extreme cold can also create vulnerabilities for farmers and human health. Insect pests that once experienced significant population die-offs during extended winter freezes may be able to survive during warmer winters, creating vulnerabilities for crops later in the season and transmission of diseases in people through insect bites.

Heavy Precipitation

Increases in the frequency and intensity of heavy precipitation have been observed worldwide and attributed to human-induced climate change. This is consistent with the expectation that warmer air, warmer bodies of water, and increased evaporation will contribute to the formation of more intense storms. Although extreme rainfall is more common in coastal parts of New York that are periodically affected by tropical storms and hurricanes, extreme rainfall is not exclusive to tropical cyclones and can cause

severe flooding to inland areas of the state. Recent flood events have severely affected the state, including a 2003 flood in Binghamton, Hurricane Irene and Tropical Storm Lee in 2011, a storm in August 2014 that broke precipitation records on Long Island, the remnants of Hurricane Ida in the New York City area in September 2021, and July 2023 flash flooding in the Hudson Valley and the Finger Lakes region. These events were associated with extreme rates of precipitation.[4]

The frequency of 2-inch precipitation events has increased since the 1950s across New York, with the frequency of 2-inch precipitation events peaking from 2010 to 2014. Across the Northeastern U.S., storms previously considered once in 100-year events (an event with a 1% chance of occurring in any given year) are also becoming more frequent, occurring nearly twice as often as expected in recent years.[4]

Table 6: Projected Changes in Extreme Events for Dobbs Ferry, New York

Extreme Event	Baseline (1981 – 2010)	2030s	2050s	2080s
# of days/year with maximum temperature at or above:				
90°F	18	29 to 48	41 to 64	48 to 87
95°F	4	10 to 18	13 to 29	18 to 57
# of heat waves/year	2	4 to 6	6 to 9	6 to 10
Average length of heat waves (in days)	4	5 to 5	5 to 6	5 to 8
# of days/year with minimum temperature at or below 32°F	105	74 to 90	54 to 82	25 to 67
# of days per year with precipitation exceeding:				
1 inch	15	15 to 15	15 to 17	16 to 18
2 inches	3	4 to 4	4 to 5	4 to 6
4 inches	0.2	0.2 to 0.2	0.2 to 0.2	0.2 to 0.5

Source: Adapted from Bader and Horton 2023.[5]

Shown are middle range (25th to 75th percentile) of 30-year mean values from model-based outcomes for the Dobbs Ferry weather station in the South Hudson River Valley assessment region. Data for projected changes in extreme events for other state regions can be viewed in the New York State Climate Change Projections Methodology Report Appendix: Climate Change Projections Tables (2023).

Days with more than one inch and days with more than two inches of precipitation are projected to become more frequent across the state. In addition, days with more than four inches of precipitation are also projected to become more frequent in many regions of the state by the 2080s **(Table 6)**.[4]

Vulnerabilities from Heavy Precipitation

Heavy precipitation events can lead to flooding and damage to infrastructure and ecosystems. Flash floods created by heavy precipitation events can cause property damage and lead to temporary displacement of residents and closure of businesses, creating vulnerabilities for residents in need of shelter and necessities. Frequent flood damage to homes can disproportionately create vulnerabilities for low-income residents that many not be able to repair flood damages right away and become exposed to unsafe and unhealthy living conditions caused by mold. Heavy precipitation can lead to significant soil erosion that can damage farm fields and crops, creating vulnerabilities to agricultural dependent communities and economies. Heavy precipitation events can also overwhelm wastewater treatment infrastructure and cause pollution runoff from land that impairs local water quality and ecosystems.

Drought

Projected increases in more frequent heavy rainfall events with fewer small events in between could imply longer dry spells that could encourage short-term (weeks to months) drought and increase the risk of rapid-onset drought, or “flash droughts” in some more vulnerable parts of the state, such as portions of the Finger Lakes region. Higher average temperatures in the warm season without increases in atmospheric humidity could lead to large increases in potential evapotranspiration and requiring more precipitation to maintain the soil moisture levels associated with the previously cooler climate. Reduced snow cover due to warming would increase flood risk in the cold season but would increase drought risk in the warm season as soils dry out earlier. Overall, the state has experienced—and will continue to experience—periods of drought.[4]

Vulnerabilities from Drought

Increases in short-term droughts and rapid-onset flash droughts can create additional vulnerabilities for drinking water supplies and agricultural operations, which both require a large quantity of clean water. Since food crops also depend on moist biodiverse soil, food security and farm businesses are more vulnerable because of climate-induced droughts. Hydroelectric facilities are more vulnerable to decreased power generation when water levels decrease significantly during times of drought.

Extreme Storms

Observed increases in air temperature, ocean temperature, and Great Lakes water temperature over the past century are indicative of conditions that favor the formation of stronger storms. Increased storm activity would be consistent with the observed increase in heavy precipitation events in New York. New York has suffered several destructive storms in recent years, including Hurricane Irene and Tropical Storm Lee in 2011, Superstorm Sandy in 2012, the remnants of Hurricane Ida in 2021, and the historic snowstorms that hit Western New York in November and December 2022.[4]

Coastal storms are also becoming more destructive because of sea level rise. As average sea level rises steadily at all of New York’s measurement locations, it creates a higher base elevation onto which storm surge is added. Historical trends and climate model projections support that tropical cyclone hazards—specifically winds and coastal and inland flooding—will increase over New York State over the 21st century.[4]

Vulnerabilities from Extreme Storms

An increase in extreme storms creates a wide range of vulnerabilities for communities across the state. Resulting storm damage, supply chain disruptions, and resident displacement can cause vulnerabilities for the local economy and resilience of the community. Stress on local emergency response because of more frequent and severe storms creates vulnerabilities to the health and safety of residents. Extreme storms create vulnerabilities for critical infrastructure like disruptions to the energy grid and water treatment services, and impeding access to evacuation routes. Strom damage to ecosystems increase vulnerabilities to communities by reducing the ability of ecosystems to provide services like flood protection.

Wildfire

Although the state has seen an increase in “fire weather” conditions (high temperature, low humidity, high wind), through increased fire prevention and suppression activities, both the number and extent of fires in New York have declined. However, New York State can be greatly affected by wildfires that occur elsewhere. For example, during June 2023, smoke from large wildfires in Canada blanketed New York, causing unhealthy air quality in much of the state. New York City reported the worst air quality of any city worldwide on June 7, far surpassing the city’s previous record-high concentration of fine particulate matter. Studies project that the risk of widespread air quality impacts will increase in future decades as a result of the increased risk of large fires elsewhere in North America.[4]

Vulnerabilities from Wildfires

An increase in wildfires that have the potential to impact New York air quality is of particular concern for sensitive populations that are more vulnerable to impaired air quality such as those with existing respiratory health conditions, low-income households, the elderly, pregnant individuals and children, and outdoor workers. Vulnerabilities from wildfires can extend to stressed capacities of local emergency rooms, and economic impact from lost worker wages. Wildfire impacts can amplify or expose additional vulnerabilities when compounded with other climate change impacts like heatwaves. For example, individuals that seek relief from heat at outdoor venues such as pools or beaches may be prohibited by poor air quality conditions.

Ecosystems and Natural Resources in a Changing Climate

Climate change is altering New York State’s ecosystems. Changes in average precipitation and temperature, in frequency and severity of extreme weather, and in sea levels all will severely alter ecosystems and impact natural resources, both immediately and over time. Human activities that degrade the environment are more impactful to New York State’s ecosystems than projected climate change impacts alone. The interaction of climate change and ongoing non-climate stressors associated with land use practices and changes accounts for substantial projected ecosystem impacts.[10]

Table 7 describes trends in several climate metrics and examples of potential impacts on ecosystems in New York State.

Table 7: Trends in Climate Metrics and Potential Impacts on Ecosystems

Climate Metric	Directions and Magnitude of Observed Change	Example of Potential Impacts
Water temperature: Rivers	+0.4°F to +0.8°F per decade	• Decreased population size of cold-water species • Loss of brook trout habitat
Water temperature: Lakes	+0.4°F to +2°F per decade	• Lengthening aquatic growing season • Increases in duration and intensification of stratification
Water temperature: Marine	+0.3°F to +0.6°F per decade	• Stress on cool water species • Longer algae growing season
Growing season length	+0.7 to +6 days per decade	• Increased gross productivity • Increased evapotranspiration • Increased warm season drought risk • Pollinator asynchrony
Winter conditions	-1.8 frost days per decade, -2.1 snow-covered days per decade	• Promotion of invasive and native insect pests • Increased risk of forest canopy damage
Evapotranspiration	No change to +0.11 inches per decade	• Cooling benefit in urban ecosystems • Drying of soils after floods • Intensification of drought
Climate velocity*	Generally north, 0.26 miles per year	• Range moves north • Species migration

Source: Adapted from Hess et al. 2024[10]
*The rate at which a species would need to migrate to remain in a stable environment as climate conditions change.

Forests and Open Lands

New York State's 19 million acres of forests cover account for 55% of the total land area in the state and provide valuable services including recreation, wildlife habitat, timber production, carbon storage, and clean water and air. Forests are vulnerable to increases in temperature, variability in precipitation, and frequency and intensity of extreme weather events. Increased precipitation and warming temperatures may change forest composition by shifting some tree species northward or to higher elevations. Mature trees are likely to experience increased stress from drought and extreme weather events, increases in invasive species, and land-use pressures. Forest tree species composition and the rate of change have varying impacts on ecosystem functions and services. Warmer temperatures and longer growing seasons can reduce

forest productivity due to invasive pest species, more intense drought impacts, and changes that slow regeneration, such as seedling loss to summer drying, competition from more abundant invasive plants, and damage from increased deer browse. Large floods can alter forest vegetation on steep slopes and in riparian areas due to erosion. Coastal forests and tidal swamps in the South Hudson and Long Island regions are likely to face increasing inundation and saltwater intrusion.[10]

These impacts are relevant to the forest products supply chain and the tens of thousands of workers employed in the timber and logging industries, threatening forests' role at the center of a sustainable bioeconomy. Some communities including Indigenous, rural, and urban communities may experience greater negative effects of climate change impacts on forests. Indigenous Peoples may experience loss of forest resources that support nutrition, recreation, cultural traditions, and spiritual practices. Rural communities rely on the scenic nature of forests and ecotourism. Urban forests help alleviate extreme heat, particularly for residents of low-income neighborhoods that do not have access to air-conditioned buildings.[10]

Open land ecosystems such as beaches, grasslands, and shrublands support many plant, insect, and animal species, and promote groundwater recharge. Rising air temperatures and longer seasons will shift competitive relations within plant and animal communities in favor of species more tolerant of warmer temperatures. Longer snow- and ice-free seasons will favor species that can extend their growing seasons. Heavier and more frequent precipitation and more severe storm events will increase flooding in low-lying fields and erosion in areas like sand dunes and gravel outcrops. The combination of added warmth and more soil moisture may provide advantages to faster-growing species, and higher rates of productivity may drive changes in the food web. These events will result in changes in plant species composition and corresponding shifts in animal communities.[10]

Wetlands

New York State has more than 50 types of wetlands. Wetlands provide a wide range of important ecosystem services to all regions of New York State, many of which contribute to climate resilience in watersheds. Wetland services include providing wildlife habitat and supporting biodiversity, soil retention, groundwater recharge, nutrient and toxin filtration, carbon sequestration, floodwater storage, shoreline protection, and aesthetics. Climate stressors may combine with non-climate stressors to result in major detrimental impacts to wetlands and species that depend on wetlands. Climate change will have a disproportionate impact on wetland ecosystems that are most vulnerable due to location, existing pressures, and size, such as coastal wetlands, riverine wetlands in developed watersheds, and small, isolated wetlands. Warmer temperatures will likely increase evaporation rate some wetlands and may stress wetland species during periods of drought. Climate change is projected to affect inland wetlands through increased evaporation that will alter total wetland area, distribution, and type as well as change the distribution of wetland-dependent species of an area.[10]

It is unlikely that even unobstructed coastal wetlands will migrate inland fast enough to outpace the current projected rate of sea level rise. However, in some areas tidal wetlands lost to inundation from sea level rise could be offset by tidal marsh migration into upland areas. The impact of sea level rise on wetlands is influenced by adjacent land use, density of development, and differences in the adaptive capacities of freshwater and saltwater systems. Freshwater wetlands adjacent to coastal zones will be negatively affected by saltwater intrusion into groundwater and more extensive storm surge.[10]

Erosion, pollution, and excess nutrient runoff are expected to increase with increasing extreme storm events which will negatively impact wetland vegetation and wildlife species. Waterfowl and shorebirds, for example, rely on the physical protection of wetlands for nesting, as well as the food they provide (e.g., plants, insects). Because birds provide important recreational opportunities for hunting and bird watching, changes in the overall availability and quality of wetlands will have cascading impacts on birds, recreation, and communities across New York State. Rising temperatures can cause seasonal shifts in the timing of insect emergence, bird migrations, and the life cycles of certain species that may result in the loss of synchronicity among interacting species, and lead to changes in food availability and species abundances in wetlands.[10]

Riverine Ecosystems

Riverine ecosystems consist of flowing water bodies embedded in watersheds that capture and transport water, organisms, and materials. New York State has 17 major watersheds. More frequent rainfall, heavier rainfall, and more extreme storm events could impact floodplains, disturb protective riparian vegetation, disrupt aquatic species, and raise seasonal water levels. Decreased snowfall will lead to less spring runoff and change the timing of spring peak-flow periods, especially in cooler regions. Fewer number of freezing days will raise spring water temperatures, affecting the seasonal reproductive cycles of aquatic plants and animals (more so in cooler regions). Warmer average air temperatures will yield warmer, oxygen-depleted waters and create more stress for cold water organisms and increase the occurrence of harmful algal blooms (HABs) statewide. Although total annual precipitation will increase, changing weather patterns with climate change could lead to more frequent or extreme droughts and reduced water levels in rivers and streams across the state.[10]

Aquatic habitat warming will alter biodiversity by reducing or eliminating cold water species, including species of recreational and economic importance to New York (e.g., brook trout). Increased contamination from fertilizers, pesticides, animal waste, and septic systems following heavy rainfall events can enhance the growth of HABs. As heavy precipitation events become more frequent, the threat of catastrophic flooding and dam failure will increase for riverine systems of all sizes, increasing the likelihood that aquatic communities and human populations will be displaced, and invasive species will spread. Changing climate conditions may also lead to lower streamflow from reduced spring snowmelt (or unusually early snowmelt), impacting the upstream migration of spawning fish species.[10]

In urban watersheds, the high percentage of impervious surfaces plus increasing frequency and intensity of precipitation events from climate change will continue to stress confined channels, leading to reduced filtration, increased surface runoff, and reduced riparian groundwater levels. Runoff and contamination from combined sewer overflows and industrial effluent threaten aquatic ecosystems and public health.[10]

Marine and Coastal Ecosystems

New York State has more than 2600 miles of marine and estuarine coastline. Coastal ecosystems consist of multiple habitat types (e.g., tidal wetlands, submerged aquatic vegetation, beaches and dunes, pelagic and benthic habitats) and numerous species (e.g., finfish, shellfish, zoo- and phytoplankton, seagrasses, algae) that provide essential services to communities in New York, such as minimizing coastal flood damage. As current climate trends continue, climate and non-climate stressors will likely increase, with varying impacts depending on ecosystem type and location.[10]

Fish species are particularly sensitive to changes in water temperature and as temperatures warm, fish in the northern hemisphere can either migrate northward or relocate into deeper water to reach colder temperatures. Marine mammals could feel indirect effects of climate change as their prey and habitat move northward and deeper. Shellfish are also likely to shift in response to warming, influencing the many organisms that consume them. In addition, temperature changes will affect species survival in New York's coastal waters in other ways. Changes in seasonal temperatures affect species life cycles, mating and development, interactions between predator and prey species, and other ecosystem interactions.[10]

The species shifts that occur as the climate warms, while creating challenges for existing fisheries and species compositions, could present opportunities for New York State in the future. Although historical fisheries may be lost, new fisheries could grow, along with new economic and cultural opportunities. For example, although winter flounder has been declining due to increased temperatures, summer flounder (fluke) and black sea bass have increased in abundance over the past decade, likely in response to warming water temperatures.[10]

Increased average precipitation and more frequent and intense extreme precipitation events will increase runoff of land-derived pollutants, nutrients, and sediments driving downstream impacts on water quality and habitats in marine and coastal waters. Large storms that affect the watersheds of river-connected estuaries can result in temporary decreases in salinity, which can have adverse impacts on species that require higher salinity levels.[10]

Coastal wetlands and marshes are at particular risk from rising sea levels. As sea levels rise, high tides encroach farther inland and low tides recede less. Under natural conditions, marshes would migrate inland as sea levels rise, maintaining an ideal location for tidal inundation. However, marshes may be unable to migrate at the pace of

future sea level rise and could also encounter coastal development that prevent migration. Erosion from increased storm frequency and strength, land-use change for development, and reduced sedimentation of coasts from dredging and watershed disturbance also increase the impacts of sea level rise on coastal ecosystems. Seagrasses and other aquatic vegetation in coastal wetlands and marshes play an important role in carbon sequestration. With the loss and degradation of these ecosystems due to sea level rise, marshes could transition from a carbon sink to a carbon source. [10]

Coastal groundwater sources will become more saline as sea level rise increases the underground infiltration of saline waters. Saltwater intrusion into groundwater will affect plant communities inshore that are not adapted to saline water. Saltwater intrusion into groundwaters in coastal areas will also affect drinking water, posing new health risks that will require infrastructure changes.[10]

Sea level rise will also increase the damaging effects of storm surges on ecosystems. Rising sea level will cause storm surges to reach farther inland and increase the volume of floodwater, exacerbating impacts on ecosystem dynamics on land and in coastal waters. Water in New York State's estuaries, for example, is already contaminated by bacteria (e.g., Enterococcus) from sewage overflow. Inundation of land during extreme storm surges will cause such contamination to increase. Increases in the frequency and magnitude of storm surges can lead to coastal erosion and loss of coastal wetland, beach dune, and barrier island habitats. These habitats serve as natural buffers for coastal communities, protecting them from wave action and flooding, removing pollutants and nutrients from runoff, and serving as carbon sinks.[10]

Urban Ecosystems

Approximately 88% of state residents live in urban areas. Climate change is expected to have multiple impacts on ecosystems in urban areas. New York City alone includes 520 miles of coastline and has high vulnerability to storm surge, which is expected to increase in severity as climate change raises sea level in the future. The cities of Buffalo and Rochester are located adjacent to Lake Erie and Lake Ontario, respectively, and are influenced by lake conditions and lake-effect weather patterns. New York City, as well as the cities of Buffalo and Syracuse experience warmer temperatures from heat island intensity (temperature differential between urban and adjacent rural areas) up to and exceeding 10°F during summer. Impermeable surfaces that accelerate runoff and other human activities that affect water quality heavily impact urban aquatic ecosystems and hydrology.[10]

Indigenous Lands

Climate change poses many challenges and risks to ecosystems within the territories that Indigenous Nations manage for agriculture, hunting, gathering, fishing, forestry, energy, recreation, and tourism. Indigenous Nations already face longstanding institutional barriers to their self-determined management of water, land, and other

natural resources. Because Indigenous health and well-being is rooted in interconnected social and ecological systems, disruptions from a changing climate can "threaten sites, practices, and relationships that have cultural, spiritual, or ceremonial importance and that are foundational to Indigenous Peoples' cultural heritages, identities, and physical and mental health."[10]

Cascading and Cross-Sector Impacts on Ecosystems in New York State

The combination of climate effects and their compounding and cumulative impacts on ecosystem processes pose a greater risk in terms of magnitude and uncertainty than individual climate hazards alone. For example, warming temperatures combined with seasonal changes in precipitation result in shifts among timing of interdependent species (e.g., flowering plants and pollinators), which could disrupt the resilience of species populations, ecosystems, and ecosystem services.[10]

The combination of climate and non-climate stressors can also lead to cascades of ecological changes that impact multiple sectors. For example, climate-induced northward spread of the invasive hemlock woolly adelgid can destroy hemlock stands along streams, resulting in a loss of dense canopy along the riparian corridor and destabilization of steep slopes, leading to increased penetration of sunlight, warming waters, and greater risk of erosion. Vulnerability to erosion is further compounded by an increase in the frequency and intensity of extreme storm events. This cascade of ecosystem impacts can also result in multi-sector impacts on society and economy (recreational fishing and ecotourism), human health, and water resources (water quality).[10]

Ecosystem Vulnerabilities to Climate Change

All communities are vulnerable to significant ecosystem changes from climate change impacts, since humans are dependent on the ecosystem services provided by heathy and diverse ecosystems. Communities that rely on nature-based recreation, natural resources, or agriculture for some or most of their local economy are especially vulnerable to climate change impacts on ecosystems.

In addition, the impacts of climate change on ecosystems and their beneficial services raise several environmental justice and equity issues because climate change impacts create disproportionate vulnerabilities for people from environmental justice areas and in disadvantaged communities. People in New York State experience climate change differently, depending on myriad factors that make some regions, communities, groups, and individuals more sensitive to harm from climate change and less able to cope and respond. For example, coastal communities will experience impacts from sea level rise, including flooding, storm surge, and saltwater intrusion, as well as land loss due to erosion, and rural communities will face impacts that affect their natural resource-dependent economies. Urban communities will experience intense impacts from extreme heat due to the urban heat island effect. However, some members of the community have reduced vulnerability to climate change impacts because they have increased adaptive capacity by benefiting from the regulating service of tree cover,

which can provide cooling in areas with parks and greenspace. However, parks and greenspace are unevenly distributed in cities, and disadvantaged community members are more vulnerable to extreme heat and drought. In some settings, adaptation may present opportunities for contributing to equitable transitions. For example, investing in new green infrastructure and nature-based solutions in urban ecosystems can increase adaptive capacity, reduce climate change vulnerability, and help to address historic inequities in the distribution of parks and street trees, which are disproportionately found in more affluent neighborhoods.

Although the effects of specific climate hazards on individual ecosystem properties can be substantial (e.g., extreme storm event impacts on headwater riparian wetlands), focusing on a single effect, species, ecosystem, or ecosystem service can result in overlooking some of the most important climate impacts and vulnerabilities. Interactions of climate and non-climate stressors and the cascading or cumulative changes that affect ecosystem processes pose the greatest risk in terms of magnitude of impact. These interactive and cumulative effects are also the most difficult to predict.

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APPENDIX B

Local CCARP Completion Self-Assessment

Prior to the municipality finalizing and adopting its local CCARP, the CCARP leadership team should review the plan and assess whether the contents demonstrate a level of comprehensiveness that would provide the greatest and most immediate value to the community, and that no major objectives of the plan components have been inadvertently omitted.

Upon completion of the CCARP process, the leadership team should evaluate each component in the local CCARP using the self-assessment table below and determine if objectives have been met adequately. If the answer to any of the questions below is "no", the CCARP leadership team may want to revisit those plan components.

CCARP Component	Does this component of our CCARP…
Form a CCARP leadership team.	• list members of the CCARP leadership team and define roles in the planning process? • describe the organizational structure for coordinating and refining the planning process? • demonstrate use of participatory, inclusive, collaborative, and adaptive leadership processes?
Create a community outreach, mobilization, engagement, and stewardship strategy.	• include a communication and education strategy? • incorporate engagement with youth leadership and disadvantaged community members?
Decide on the climate change adaptation and resilience planning process, approach, scope, nexus impacts, plan components and structure.	• define the CCARP scope and analysis approach? • describe chosen synergistic climate impacts (if taking a nexus planning approach)? • identify plan components to be included in the CCARP, and justify those to be held off for future consideration?
Develop a place narrative.	• detail the uniqueness of the local community and its ecosystems? • determine how ready the community is to mobilize to address climate change adaptation and resilience?

CCARP Component	Does this component of our CCARP…
Conduct a socio-economic survey.	• include key institutions, environmental justice communities, and disadvantaged communities? • describe the community's capacity for decision making and plan implementation? • identify relevant community projects, initiatives, and previous climate action?
Conduct an ecosystem survey.	• identify natural ecosystem processes, services, and uses? • identify ecosystem or natural resources projects underway? • incorporate local and traditional ecological knowledge?
Describe the history of any extreme storms or extreme weather.	• describe major extreme weather events that have caused significant damage, societal impacts, and economic losses to the community, and link these events to climate change?
Identify underlying threats, risks, barriers, and challenges.	• identify socio-economic and ecosystem stressors, threats, risks, barriers and/or challenges that may increase community vulnerability to climate change impacts?
Identify any data gaps, and explicitly state any other unknowns and uncertainties.	• identify data gaps, unknowns, and uncertainties that could affect CCARP planning and implementation?
Conduct a climate change vulnerability assessment.	• include a comprehensive list of community assets, needs, sectors, and functions? • view the community, economy, ecosystems, governance, etc. as systems made up of components that interact with, and may be dependent upon, one another? • utilize a nexus approach to consider the interconnectedness of community systems and the impacts of compound and synergistic climate effects? • reflect input from the public, disadvantaged communities, and other relevant groups?
Describe observed and projected climate change physical effects in New York State.	• include observed and projected climate impact data from a valid and current source?
Determine exposure, sensitivity, and adaptive capacity.	• determine exposure of system components to climate change impacts? • determine sensitivity of system components and existing stressors? • determine adaptive capacity by identifying characteristics and/or features that can reduce impacts and/or protect the system from failure?

CCARP Component	Does this component of our CCARP…
Identify and communicate uncertainties and unknowns.	• identify uncertainties and unknowns that could influence the vulnerability of community system components to climate change impacts? • justify reasons for not including certain community components or climate change impacts in the vulnerability assessment?
Create vulnerability assessment matrix.	• include a matrix of all assets, needs, sectors, and functions identified by the community as vulnerable to chosen climate change impacts?
Apply a resilience assessment.	• apply resilience thinking to the vulnerability assessment?
Construct climate impact chains.	• include a climate impact chain that illustrates interconnectivity of climate change impacts (primary, secondary, etc.) on the community?
Conduct community plans consistency assessment.	• describe how the community reviewed other major plans for consistency with the CCARP to ensure there are no conflicting strategies that may increase vulnerability? • reflect input from the public, disadvantaged communities, and other relevant groups?
Develop community participatory future scenarios and a shared community vision.	• describe the process and outcomes of the community's future scenario planning exercises? • include a shared community vision consistent with the CCARP place narrative, scenario exercises, and includes how the vision will guide adaptation actions under future climate conditions? • reflect input from the public, disadvantaged communities, and other relevant groups?
Develop recommendations for action.	• include a list of adaptation actions (including nature-based solutions) consisting of best and promising practices to reduce the vulnerabilities identified in the CCARP vulnerability assessment? • provide a cost benefit analysis for proposed actions? • include an adaptation pathways map? • apply a maladaptation assessment to the list of actions included in the CCARP?

CCARP Component	Does this component of our CCARP…
Develop monitoring and evaluation approach and plan.	• describe the community's CCARP monitoring and evaluation process, including how the community is tracking progress, measuring impacts, and using adaptive management to modify actions as needed? • list indicators and metrics selected by the community to monitor and track adaptation action effectiveness and determine if adjustments are necessary? • describe the community's adaptive management process, including how the CCARP will be modified as needed in a way that is realistic and achievable with available resources? • reflect input from the public, disadvantaged communities, and other relevant groups?
Develop a plan implementation strategy.	• describe how the community will ensure the CCARP's adaptation strategies are carried out, including how the local government will delegate responsibilities and authorize decision making roles? • identify implementation gaps and challenges and possible strategies for overcoming these barriers? • include a strategy for continued public engagement?
Develop a budget and timeline for implementation.	• include a strategic budget for implementing CCARP actions, and options for a variety of funding sources? • include an anticipated timeline for implementing actions?
Monitoring and Evaluation	• include a basic description of the monitoring and evaluation process for implementation? • identify the chosen climate indicators and metrics that will be used to track progress, measure impacts and use adaptive management to modify implementation actions as needed?