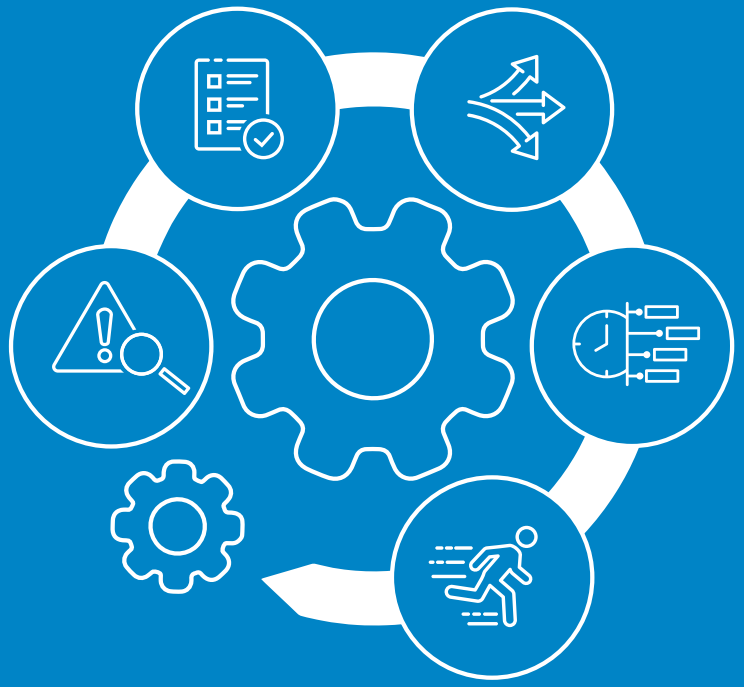
Implementing the Steps to Resilience

A PRACTITIONER'S GUIDE



VERSION 1

Special Thanks. Karin Rogers and Nina Hall of UNC's NEMAC authored early drafts of many of the resources highlighted throughout. LuAnn Dahlman, managing editor for NOAA of the U.S. Climate Resilience Toolkit, has consistently worked to translate the Steps to Resilience for the toolkit audience and personally innovated some of the resources referenced throughout this document. Jeff Hicks of Fernleaf, Interactive, has innovated much of the thinking about how to apply the Steps to Resilience within consultative decision support. A group of advisors provided substantive feedback about this document and its strategic focus: Joyce Coffee, Climate Resilient Consulting; Anna Marandi, National League of Cities; Melissa Ocaña, University of Massachusetts; Danny Peralta, The Point; Carolyn Yvellez, Farallon Strategies. The authors of four papers (published separately within the Climate-Smart Communities Series) engaged in active dialogue to provide perspective and input into this document: Abigail Abrash-Walton, Clara Fang, Beth Gibbons, Lara Hansen, Laura Hilberg, Jennie Hoffman, Rachel Jacobson, Arsum Pathak, Jessie Ritter, Bruce Stein.

UNC Asheville's NEMAC
National Environmental Modeling and Analysis Center

The Steps to Resilience Framework was developed in close partnership with UNC-Asheville's NEMAC, an ongoing partner of the U.S. Climate Resilience Toolkit.

Layout and design: Anna Eshelman

Recommended citation: Gardiner, Ned, ed., Matt Hutchins, Jim Fox, Aashka Patel, and Kim Rhodes. *Implementing the Steps to Resilience: a Practitioner's Guide.* Climate-Smart Communities Series, Vol. 6. NOAA Climate Program Office, 2022. 10.25923/9hhx-2m82

Feedback is essential for improving methods designed for deployment at a national level. Readers may send their thoughts or comments to noaa.toolkit@noaa.gov

October 2022

Climate Program Office

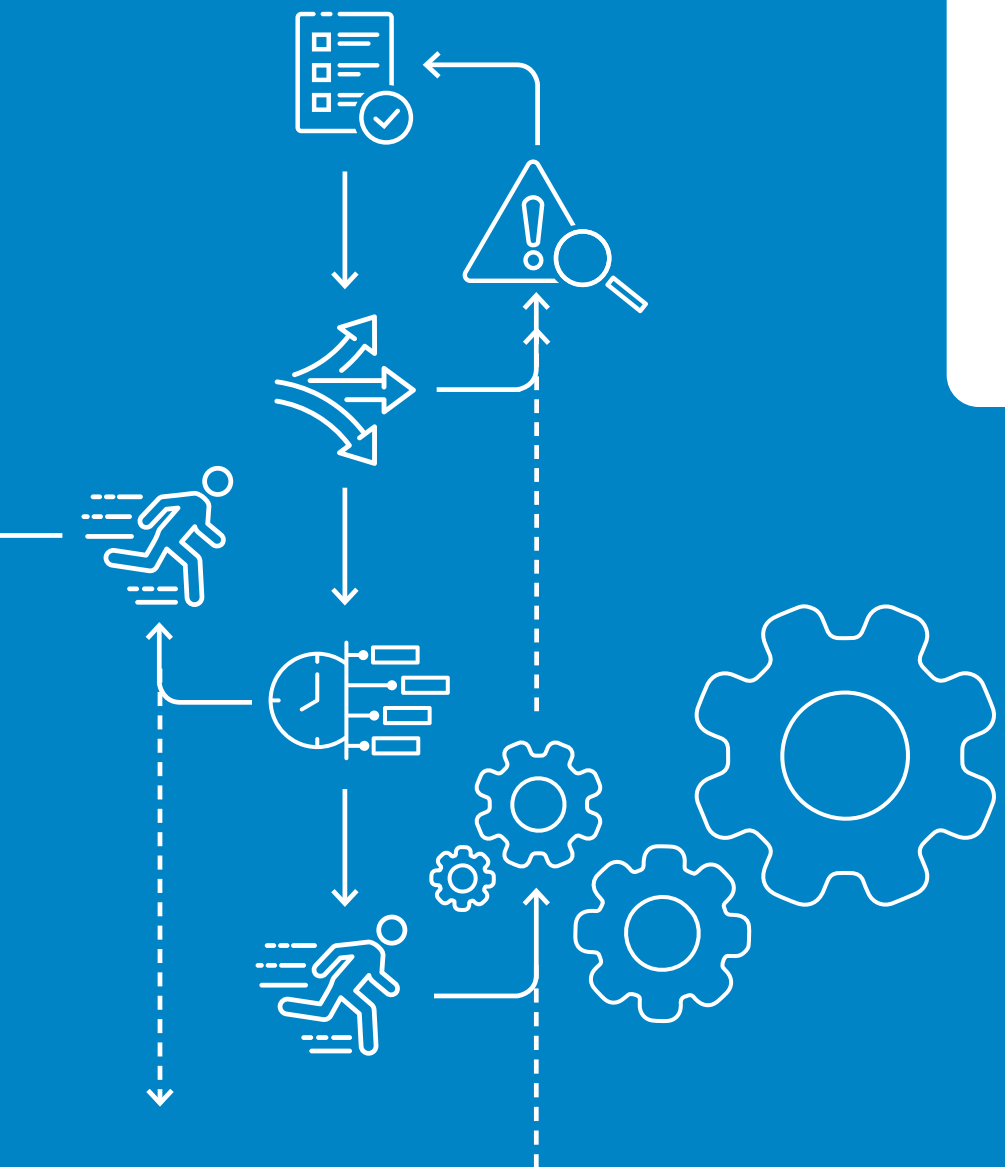
U.S. Climate Resilience Toolkit

fernleaf

Ned Gardiner (Editor)
Matt Hutchins
Jim Fox
Aashka Patel
Kim Rhodes


For Nina

Contents



Back to previous view

Contents

Contents

Step 1: Understand Exposure 14

Contents

Contents

Contents

Contents

Executive Summary

Through intentional outreach and engagement with professional climate adaptation and resilience service providers, the NOAA Climate Program Office publishes and freely distributes tools and resources to help communities throughout the United States understand and adapt to climate variability and climate change. The U.S. Climate Resilience Toolkit (CRT) is one such resource. Its Steps to Resilience[1] (StR) risk assessment and decision support framework underlies guidance and context-setting for how and when to use climate information to make better decisions. There are myriad methods for vulnerability and risk assessment, decision making, measuring and evaluating project components, and reporting on adaptation planning and implementation. *This guidebook offers a set of procedures to accompany each phase of the StR so that professionals may compare their efforts and so that progress toward climate resilience may be evaluated on a national scale even while communities work toward their individual goals.* The CRT team considers this guidebook a "building block" for climate resilience which can benefit the entire community of practice focused on climate resilience.

Climate service provision must greatly accelerate in order for communities around the nation to adapt and build resilience to climate challenges.[2] This guide is written for climate adaptation and resilience-building experts so that they may lend their own skill while building local capacity for climate resilience analysis, facilitation, and guidance. We call these professionals "climate service practitioners" or simply "practitioners." Over time, communities will build adaptation and resilience capacity among the ranks of civil service, engineering, and service delivery. This guide supports the expansion of climate service practitioners working within communities on a freelance basis, as part of a consulting team, serving the mission of a community-based organization, or functioning within local government.

This guide is intended for use by climate service practitioners in two ways: (1) during synchronous and asynchronous training on how to implement the StR; and (2) as guidance for practitioners working with a community to implement the StR. Climate adaptation is a multifaceted, diverse, and evolving practice, so a practitioner's knowledge and needs will also change over time. This guide itself will evolve and improve over time in order to best serve the needs of practitioners.

To the Reader

BUILDING CLIMATE RESILIENCE

While the costs of adapting to climate change may seem high, the costs of inaction are dramatically higher.[3] Billion dollar disasters have increased in number and cost (CPI-adjusted) by a factor of more than four in as many decades.[4] Aging infrastructure, more people and community assets in harm's way, and non-stationarity in the climate system all require that communities throughout the country upgrade infrastructure, services, and preparedness.

Yet local revenue is in demand for many pressing issues, and climate may not be the foremost priority for every community. To avoid the fallacy of a zero-sum game, climate adaptation efforts must align with community values if they are to be supported and successful.

To wit, a leading issue in American civil discourse is how best to redress inequity in the historical and current access to resources at all levels of society. Climate adaptation forces one to confront such disparities. Exploitation of natural resources, consumption of fossil fuels, and systematic marginalization of specific groups of people have emerged from a common set of economic and social systems. In many places, the communities of people who are most at risk to climate-related hazards are people of color. Increasing community resilience requires addressing discriminatory practices, so equitable social values must drive climate adaptation project prioritization.

Within the calculus of what efforts to fund and undertake, decision makers in communities need to evaluate the true costs of long-term impacts from climate change as well as the benefits from building resilience to enhance quality of life. What methods shall communities use to evaluate long-term impacts of climate change while balancing social and financial priorities? This volume is an attempt to address some of the myriad methodological challenges that question raises by drawing upon practical experience supporting climate adaptation around the nation.

Climate-informed decisions

Since 2014, the NOAA Climate Program Office has worked through the U.S. Global Change Research Program (USGCRP) to deploy the U.S. Climate Resilience Toolkit (CRT; toolkit.climate.gov), a compendium of resources from throughout the federal government for planning and deploying climate adaptation and resilience-building efforts at state and local levels. The Steps to Resilience (StR) framework was formulated based on tested practices drawn from diverse disciplines and regions, all concerned with how to use climate information to inform actions that prevent loss of life, property, and essential functions in the natural and built environment.[5] **Aligned with NOAA's mission, the CRT and StR focus on advancing the use of climate data to support state and local government decision-making.**

Building resilience means improving conditions so that the system can accommodate future disruptions. **Figure 1** illustrates two levels of resilience. On the top, a community asset or service operates at a steady state (business as usual) until an acute hazard occurs. If the level of service drops below a tipping point,

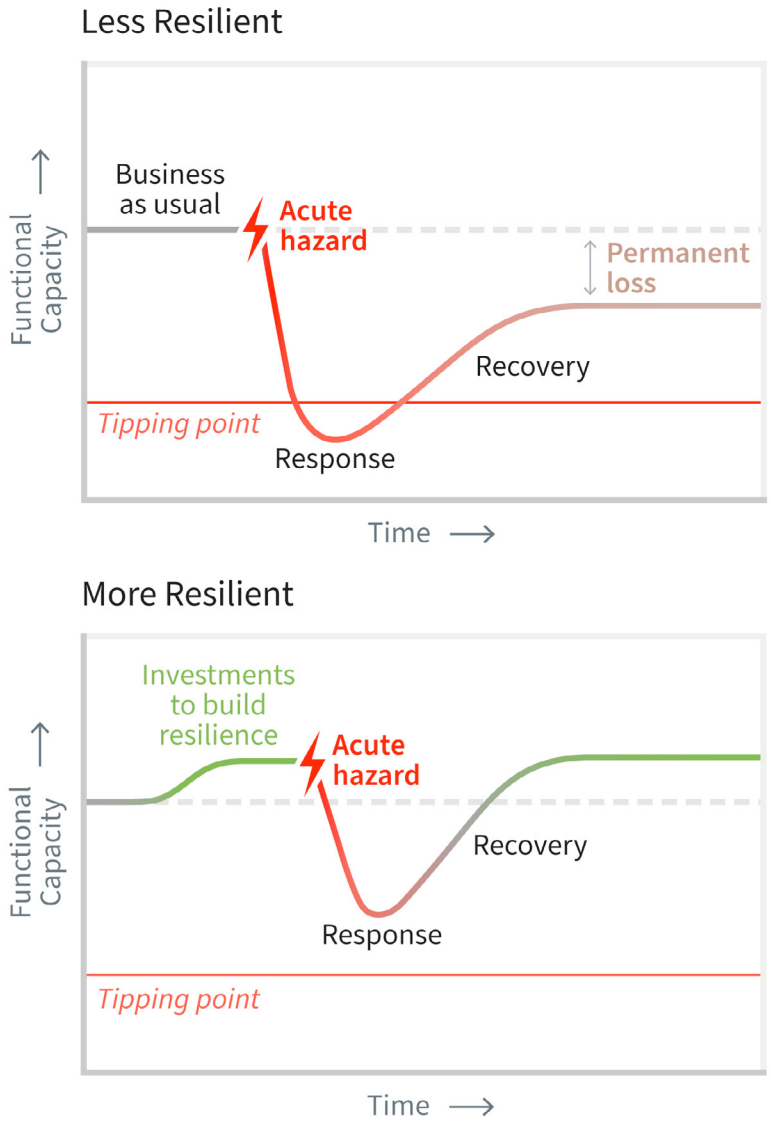


Figure 1. A pictorial definition of resilience. The system depicted on the left never recovers from an acute hazard whereas the one on the right has built resilience to events of the same magnitude by reducing exposure, vulnerability, and/or risk. Source: U.S. Climate Resilience Toolkit.

the system does not recover completely. The graph on the bottom depicts a different scenario in which actions are taken to improve overall conditions prior to an acute hazard. This proactive effort increases quality of life or system performance. From this higher baseline, the same acute hazard still requires a period of recovery, but no irreversible damage occurs.

The StR framework was drawn from existing adaptation and resilience-building efforts which address a large variety of potential climate-related impacts through diverse methods. That multiplicity of problems and problem-solving approaches is reflected within the CRT itself, which hosts hundreds of tools tailored to particular data sets, analytical methods, and end-user interests. That diversity of methods makes it difficult not only to use the CRT but also for practitioners to hone in on shared strategies for building resilience. In this guide, we have chosen to focus on procedures that can be replicated and scaled up readily.

This guide is a first effort to systematize a diverse set of procedures honed through adaptation and resilience consulting efforts conducted in dozens of communities. We intentionally limit the number of approaches described as well as the diversity of hazards, assets, and values to be considered and addressed. By narrowing our focus to a discrete set of data, analytical methods, and decision-making processes, and by focusing on social equity as a requisite for climate adaptation, we intend to greatly increase efficiency and capacity for replicating such efforts at a national level. *This guide is not intended to supplant other resources that practitioners may already use.*

We intend to deploy this resource as training guidance, implement its recommendations in dozens of communities, and gather feedback about what is most effective. The author team is committed to collecting data about hazards, assets, and methods for building resilience that do not appear in this version of the StR guidance. To be *credible, relevant, and salient,* we will continually invest in research and improvement of this guidance to address ever more potential climate impacts.

The developers of the CRT recognize the need to apply a systematic set of methods for following the StR so that practitioners may compare their results, measure their efficacy, successfully garner funding and finance, and grow capacity for scaling up and accelerating equitable resilience-building and adaptation efforts in every community around the United States and its territories.

The authors recognize important gaps in what this guide covers. For example, we do not provide tailored guidance for working in partnership with a tribal entity or community. As the Status of Tribes and Climate Change (STACC) 2021 report states, "Tribal nations are one of the most active entities in creating climate vulnerability assessments and adaptation plans"[6] and a number of resources have been developed by and for tribal communities and their partners. Guidance pertaining to tribal entities is best produced by Indigenous practitioners or an individual or a group with significant experience in working with tribes to ensure that any guidance on establishing intentional working relationships with tribal entities respects Indigenous leadership and sovereignty and defers to Indigenous methodologies and ways of knowing. **Throughout this guidance, we point to resources which cover other important gaps so we may focus more intently on the use of climate information in informing decisions using methods the authors themselves have tested.**

Climate service practitioners

Climate service provision must greatly accelerate in order for resilience to keep pace with climate challenges.[7] This guide to the StR targets a narrow audience, namely climate service practitioners who are working with local governments, non-profits, and communities that are ready and willing to use climate information to support decision making and that aim to create greater social equity in the process. Throughout this guide, this audience is referred to simply as practitioners. The practitioner will take on different roles and responsibilities in their work with communities, that could range from project manager and data analyst to supporting engagement with the community, depending on skill sets of the practitioner and the needs of the community.

Practitioners may come from the private and public sectors, academia, nonprofit organizations, and for-profit businesses (**Figure 2**). To be effective using this guide, practitioners must draw on a variety of skills and educational backgrounds, including planning, facilitation, spatial analysis, data science, Earth system science (including climate science, environmental studies, ecology, and other disciplines that involve systems analysis), engineering, management, project management, community engagement, hazard mitigation, and more.

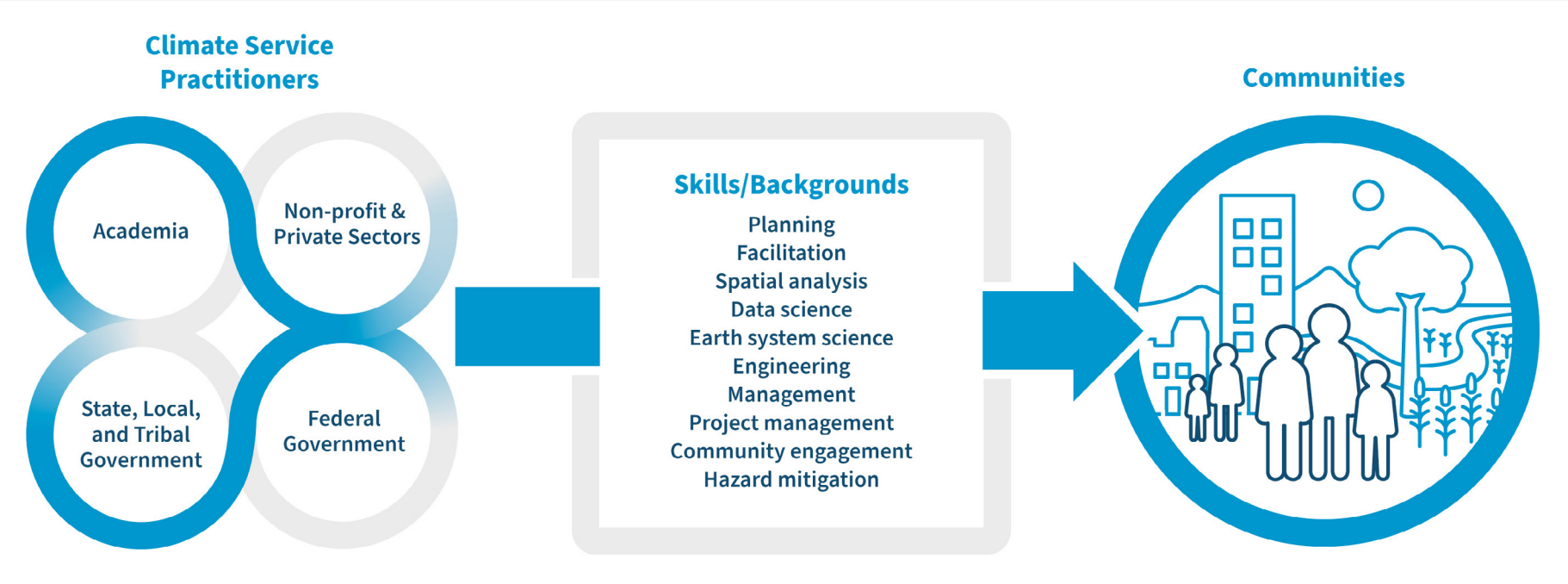


Figure 2. This guide focuses on Climate Service Practitioners who come from many sectors (interlocking circles on the left). Practitioners must draw upon a variety of skills, both individually and through support from others (central box), in order to serve communities where they work (circle on right).

Practitioners should be familiar with all of the following skills, getting assistance as needed in order to use the guidance herein:

- Read, understand, and interpret climate science literature.
- Work with a planning team and facilitate a process using principles of equity and inclusion.
- Use spatial data and information.
- Work with communities to understand concerns and determine requirements that define vulnerability, risk, and potential impacts from climate-related hazards.
- Access and understand relevant solutions to problems, working with subject matter experts in many domains.
- Develop equitable, finance-ready resilience plans by honing in on the data, methods, tools, and governance structures that can be replicated, compared, and improved quickly.

Systems thinking includes capacity to understand, articulate, and negotiate differing values. The practitioner should know the historical roots of inequity and climate-related risk wherever they work, seek to understand community concerns, and be familiar with how interventions can worsen or improve social and economic conditions. Technical knowledge of statistics, climate and weather data, risk perception, and the ways that non-climatic factors can exacerbate climate-related hazards are also essential skills for successful practitioners. The practitioner must be able to understand the way a whole system works, integrate many people's perspectives, and articulate the ways that physical changes manifest in complex human-natural systems.

Adaptation and resilience planning, design, and implementation must include a **broad range of perspectives**, for example by inviting residents most impacted by regional climate hazards or solutions to participate in those processes. Inequity may manifest in fields well outside of climate change adaptation or hazard mitigation, so the practitioner works with and learns from groups with diverging interests, including civic leaders inside and outside of government. Elected officials, staff, and citizens all have a role in setting and meeting goals for resilience planning, yet they traditionally have differing entry points for decision-making. Thus the practitioner must navigate governance, policy, and planning while considering constituent priorities.

Facilitation is a crucial skill among climate service practitioners. Incorporating community input requires a strong ethic of understanding diverse perspectives and involves the community (including community leaders and member representatives) as experts and holders of knowledge. The practitioner must recognize that problems may stem from differing mental models and sources of power. Challenges may be identified in the community due to sources of power, historical injustices, or climate hazards. However, people and communities should not be "problematized," but should rather be recognized as having strength, power, and solutions.

It would be difficult for a single person to hold mastery over this diverse set of expertise, but practitioners must continually learn about new practices because adaptation and resilience-building are evolving specialties. For example, becoming an equity-focused climate adaptation practitioner may require years of study and immersion in environmental justice to understand communities' lived experiences.

Community and government capacity

Communities comprise more than government and its functions. People, their activities, and their relationships are central to the definition and function of any community. Nonetheless, local governments (town, city, county, tribal, and state levels) have the mandate and responsibility to address infrastructure and population-level planning and project implementation. The procedures in this document support governments using the StR.

The instructions herein will increase practitioner capacity on a freelance basis and by individuals within local government and community organizations. Until capacity exists in every community, practitioners will be needed to supplement local capacity to develop and implement plans. Over time, communities will build adaptation and resilience capacity among the local ranks of civil service, engineering, and service delivery.

Staff time and commitment are common barriers to incorporating climate into decisions across government services. One way to overcome that barrier is to clarify what can be done and when. This guide focuses on specific milestones, roles, and responsibilities to help community government representatives understand and address exposure, vulnerability, and risk to climate-related hazards.

To be successful implementing a resilience plan, communities need capacity over the long term. Project implementation, monitoring and evaluation, community engagement about hazards and opportunities, ensuring that all relevant government operations incorporate up-to-date information about climate-related impacts, and sharing lessons learned with other practitioners **all require staff with expertise and time to follow through**.

Through training and the development of a practitioner workforce, this guidebook is part of a larger effort to increase community capacity to take action aimed at climate resilience. Communities may have different desired approaches for building internal capacity and preferences for working with practitioners. One community may want to hire an external consultant to guide, support, and implement all phases of the Steps to Resilience. Another may want to build capacity internally to take on all tasks and responsibilities throughout the process of building resilience. Most communities will likely fall between these two extremes. This guide is intended to make clear what tasks and roles exist so that no matter which approach a community adopts, the full suite of responsibilities will be addressed.

Equity in Climate Resilience

Equity in climate resilience implies race, class, ability or other social characteristics do not determine preparedness for the impacts of climate variability and change.[8] Four forms of equity within resilient social systems are (1) procedural, (2) distributional, (3) structural, and (4) cultural.[9] A practitioner may employ the following five principles in efforts toward meaningfully incorporating equity in all phases of planning and implementation of climate resilience. The reader is encouraged to read an accompanying essay[8] that addresses these principles within an equity-focused adaptation framework.

1: Focus on root causes and community strengths

The historical antecedents of climate change and the disproportionate impacts of its effects on people, communities, and cultures requires that the practitioner take a broad perspective on history and consequences of past decisions. The solutions to the climate crisis will be most effective when they address root causes of conflicts among the needs of people, the environment, and an interconnected economy. Climate adaptation policies, institutions, and cultural norms have sometimes perpetuated inequities, harming Black, indigenous, people of color (BIPOC), and other disadvantaged people. Countering systemic injustices requires centering belonging, equity, and justice in the solutions and the process of arriving at them.

Conversely, communities often have positive attributes and strengths that can serve as the basis for ongoing adaptation. A positive mindset about these strengths can advance climate adaptation efforts. Institutions, policies, and finance can focus on solutions that increase such community assets.

2: Balance power dynamics

Planning methods often involve a top-down approach wherein decision makers develop a plan which community members might be invited to comment upon, endorse, or, worse yet, accept. In the most egregious cases, communities–often communities consisting largely of people of color–have been demolished or reconstructed without consent or compensation.

In **community** co-creation, community members are treated as equal collaborators in all phases of a project: initiation, planning, action, and evaluation. Those who would be most impacted are authentically and deeply involved in determining outcomes. A community co-design process can focus on alliances that increase the capacity of historically marginalized communities to influence decision-makers and drive change.

3: Foster a sense of belonging

To be effective, climate resilience practitioners are urged to develop cultural competence about the community where they are working and devote substantial energy to understanding systemic oppression there. The practitioner will be most effective if they build trust, establish communication agreements, and take the time to get to know community members and leaders. Building this rapport may require **acknowledging past and present harms** perpetuated by those in power and working towards **healing and reconciliation**. To establish reciprocal trust, community partners need to be equal stakeholders and friends, i.e., not just welcomed to the table but supported to be there every step of the way, including with money, data, accomodations, and other resources.

4: Apply a place-based approach

More than 90 percent of U.S. municipalities are modestly sized and resourced, with populations fewer than 25,000 people.[10] Local governments play an essential role in allocating resources to address the complex challenge of climate change impacts.[11] Both "bottom up" community planning and "top down" national strategies may help regions deal with impacts such as increases in electrical brownouts, heat stress, floods, and wildfires. Such a mix of approaches will require cross-boundary coordination at multiple levels as operational agencies integrate adaptation planning into their programs.[12] Acting in isolation at the local scale can reduce the effectiveness of adaptive responses or lead to maladaptation. Cross-jurisdictional, cross-functional, cross-cultural collaboration is key. In a place-based systems approach, the local community is the primary source of knowledge. Community members are involved in every step of the process in an iterative process that honors learning and accommodates different competencies.

5: Evolve with the process

A common pitfall of community-driven planning is that the process is often viewed in linear steps to a predetermined objective, which is subjected to minor revisions upon community review or forced upon the community regardless of their opinions. A community plan is likely to fail without community buy-in. In addition, many planning efforts stall before implementation due to lack of resources and political will. The entire process of integrating equity into a climate resilience approach must be viewed as a circular iterative process that continues beyond implementation. Practitioners acknowledge that the StR is a long-term process that builds lasting relationships among the community and governmental or other traditional decision makers. This process should bridge the divide between the communities and governance structures. Correct and appropriate deliverables will be created from an equitable process.

How to use this guide

This guide is intended for use by practitioners in two ways. The first intended application is during synchronous and asynchronous training. Practitioners may use this as a workbook, marking it up with notes or filling out exercises. The second intended application is as guidance when working with a community to implement the StR (**Figure 3**).

Climate adaptation is a multifaceted, diverse, and evolving practice, so a practitioner's knowledge and needs will also change over time. This guide itself will evolve and improve over time in order to best serve the needs of practitioners.

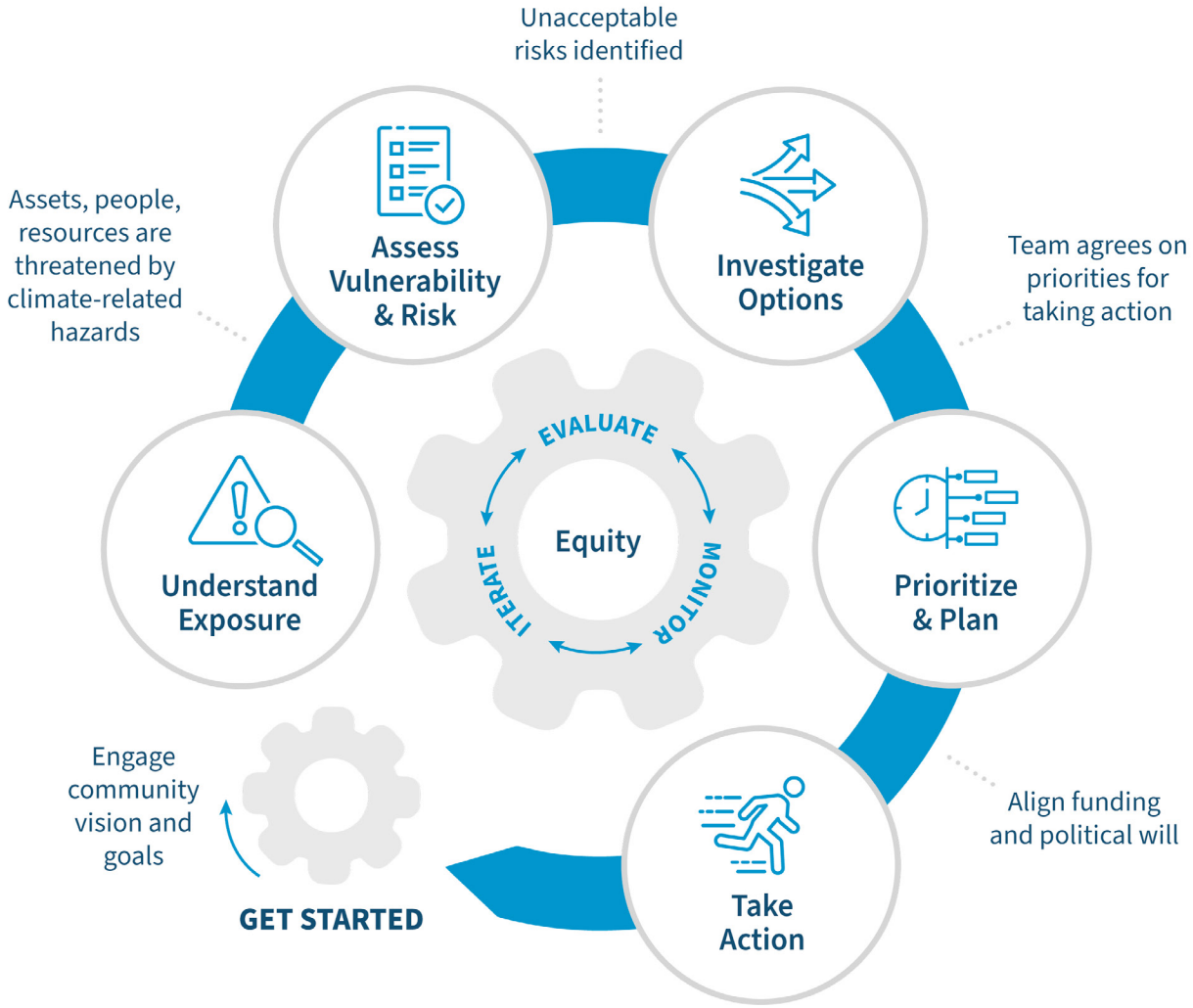


Figure 3. The Steps to Resilience.
Source: U.S. Climate Resilience Toolkit.

The Guide is formatted to follow the StR framework, with each chapter corresponding to a specific "step." Each step is introduced with objectives, a list of **resources** (such as worksheets and other guidance), opportunities for community participation, and questions for assessing success.

The bulk of this material is presented as "in practice" guidance. Context and guidance are provided for each objective of each step.

Each step includes an implementation example. Table 1 outlines all of the steps and objectives presented throughout this guide.

We have intentionally focused on the responsibilities, resources, and opportunities of governments (i.e., county or municipal) and quasi-governmental agencies. Given varying capacity, different pathways and levels of detail may be needed as practitioners and community members work through the StR. The steps are flexible to the needs of the community.

We also provide **Resources** that are referenced and linked throughout each step in two formats: (1) exercise worksheets that are meant to be completed by the practitioner, members of the planning team, or a combination; and (2) additional guidance, with in-depth facilitation tips, presentation templates, sources of information, and collections of external resources or job aids.

Table 1. Summary of the Steps to Resilience and its procedures.

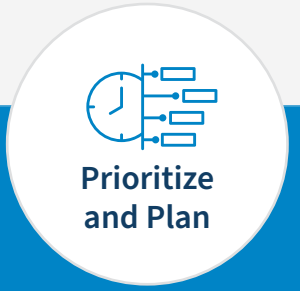
GETTING STARTED	STEP 1 Understand Exposure	STEP 2 Assess Vulnerability and Risk
Coordinate with the community champions to assemble a planning team and establish goals for the project. **0.1** Assemble a planning team **0.2** Community participation **0.3** Understand community history **0.4** Consult pre-existing plans and resilience efforts **0.5** Define equity-centered goals **0.6** Project kickoff	**Evaluate community assets and their exposure to climate-related hazards.** **1.1** Identify people and community assets, hazards and stressors **1.2** Document potential impacts with an exposure matrix **1.3** Inventory spatial, quantitative, and qualitative data **1.4** Meet with the planning team to review step 1 results	**Identify the people and community assets most vulnerable and at-risk to climate-related hazards.** **2.1** Determine type of assessment for each potential impact **2.2** Develop rulesets to assess vulnerability and risk **2.3** Review preliminary assessment with planning team **2.4** Use assessment results to create impact statements **2.5** Finalize assessment and synthesize findings **2.6** Review assessment findings with planning team

Table 1. Summary of the Steps to Resilience and its procedures. *(continued)*

STEP 3

List strategies to reduce the greatest climate-related risks to vulnerable populations and community assets.

3.1 Review vulnerability and risk findings
3.2 Refine resilience objectives
3.3 Research options
3.4 Identify acceptable options in your community



STEP 4

Design an implementation plan for the strategies that are most likely to reduce vulnerability and risk.

4.1 Prioritize resilience strategies
4.2 Evaluate projects and actions
4.3 Address uncertainty
4.4 Write an implementation plan

STEP 5

Implement and communicate the plan. Monitor. Iterate.

5.1 Implement the plan
5.2 Identify and seek opportunities for funding or finance
5.3 Create a plan to monitor and share lessons learned
5.4 Iterate and plan for persistent adaptation

Endnotes

1 https://toolkit.climate.gov/#steps

2 Cleveland, John and Peter Plastrik, "In Harm's Way, How Communities are Addressing Key Challenges of Building Climate Resilience", 2021.

3 B.M. Sanderson. and B.C. O'Neill. Assessing the costs of historical inaction on climate change. Sci Rep 10, 9173 (2020). https://doi.org/10.1038/s41598-020-66275-4

4 https://www.ncdc.noaa.gov/billions/summary-stats

5 Gardiner, E.P., Herring, D.D. & Fox, J.F. The U.S. Climate Resilience Toolkit: evidence of progress. Climatic Change 153, 477–490 (2019). https://doi.org/10.1007/s10584-018-2216-0

6 The Status of Tribes and Climate Change (STACC) website and access to the August 2021 report can be found here: http://nau.edu/stacc2021

7 Cleveland, John and Peter Plastrik, "In Harm's Way, How Communities are Addressing Key Challenges of Building Climate Resilience", 2021.

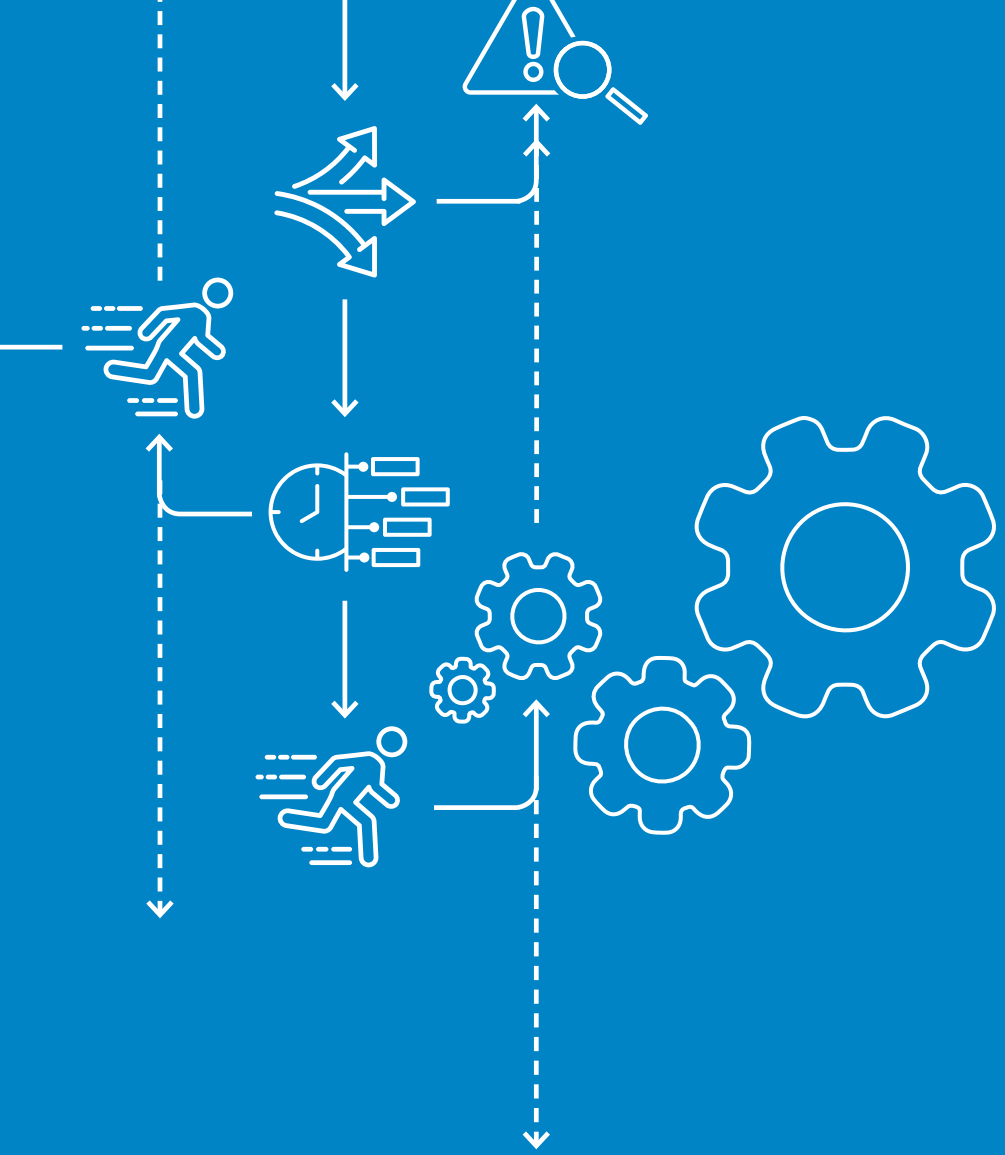
8 Fang et al., *Centering Equity in Climate Resilience Planning and Action: a Practitioner's Guide*, 2022.

9 Williams-Rajee, 2019. Climate Equity Conceptual Primer. https://www.denvergov.org/files/assets/public/climate-action/documents/climate-action-task-force/climateequityprimer.denver.pdf. Definitions are provided in the Glossary under the term "equity."

10 Abrash Walton et al., 2016

11 National Research Council, 2010

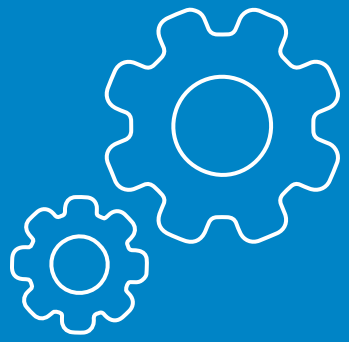
12 Melillo et al. 2014, p. 671-672



Getting Started

Back to previous view

GETTING STARTED



Overview

Coordinate with community champions to assemble a planning team and establish goals for the project. Before beginning climate resilience work, one must form a team and agree on the project's scope given the knowledge and interests of those who can affect or will be affected by adaptation actions. Engage stakeholders who are in a good position to identify community concerns or assets of interest. Consider how to deepen or broaden that engagement to ensure long-term success and buy-in with any decisions or outcomes. Be transparent at all stages, including how the scope and objectives of the resilience planning process was or will be agreed upon.

OBJECTIVES

- ☐ **0.1** Assemble a planning team
- ☐ **0.2** Community participation
- ☐ **0.3** Understand community history
- ☐ **0.4** Consult pre-existing plans and resilience efforts
- ☐ **0.5** Define equity-centered goals
- ☐ **0.6** Project kickoff

RESOURCES

- Step 0 | Implementation Examples
- Resource 0.1 | Planning Team Contact List
- Resource 0.4 | Plans, Initiatives, and Context Inventory
- Resource 0.5a | Vision, Values, and Goals
- Resource 0.5b | Project Timeline
- Resource 0.6a | Annotated Agenda: Kickoff Meeting
- Resource 0.6b | Kickoff Meeting Slides

QUESTIONS FOR ASSESSING THIS STEP:

- Is the full range of stakeholder perspectives represented in identifying community concerns or assets?

OPPORTUNITIES FOR COMMUNITY PARTICIPATION:

This step also presents an opportunity to use cross-sector partnerships to increase project capacity. These can include partners from the following sectors.[13]

Local government staff: representatives from government agencies (Public Works, Emergency Management, Sustainability, Housing, Health and Human Services, Finance, Transportation, Parks and Recreation, etc.), including those responsible for social and economic priorities.

Community partners: leverage existing community partnerships and foster new relationships with trusted frontline community leaders, faith-based groups, and community-based organizations and groups working to advance racial, economic and environmental equity, sustainability, community development.[14] Consider synergies in goals and anticipated outcomes. Community partners should be compensated for lending

their expertise[15] and should have an equal voice and influence to shape all aspects of the process as part of the Planning Team.

Regional Governance: regional, state and federal agency representatives with jurisdiction over regional transportation, energy, and water infrastructure systems, as well as social services such as public housing, welfare, risk insurance, and building codes.

Private sector and philanthropic organizations: leverage existing partners in the private sector and seek new relationships with community leaders such as the Chamber of Commerce or local anchor institutions that have a large stake in community resilience planning (hospitals, companies that employ large numbers of local residents). Consider synergies in organizational mission and sectors of action.

Academic institutions: universities, colleges, and community education centers all house experts with skills and experience that may prove useful throughout the StR.

Scientific and expert stakeholders: individuals or groups that can help elevate a sense of place and value for the ecosystems and their ecological functions will play a key role in including natural assets. Not all experts need to be engaged in each stage of the process, as such, consider them for participating on the broader planning team. For example, ecological scientists can help fill the information gaps early in the process, while resource managers can be most valuable during implementation decisions.[16]

Residents of the community who have expertise and are willing to participate on a planning team bring invaluable perspectives to planning efforts.

Planning team members will bring a variety of expertise that can both improve the process and contribute to positive outcomes. Source: Whitney Hansen, Fernleaf.

ITERATE! The StR are iterative. Team membership and roles may need to change over time depending on the goals within a given project phase.

In practice

0.1 Assemble a planning team

Before getting started, the practitioner should ensure the community they are planning to support is ready. That means that there are one or more *community champions*; champions are often civic leaders (such as representatives from non-profit or community-based organizations) who have the authority and capacity to convene government and community members in a process that involves weighing decisions and values.

Form a planning team that will remain closely engaged with the process. Establishing advisory committees of collaborators whose specific interests may be engaged at various stages. The core team should—at minimum—involve government agency representatives and community leaders rooted in frontline communities.

As the planning team is being assembled, make note of the departments or perspectives that are represented. Evaluate whether any important perspectives that may be missing and whether additional involvement is critical before moving forward.[17]

Note the Opportunities for Community Participation listed at the beginning of this chapter. Use the contact list resource **Resource 0.1 | Planning Team Contact List** to identify planning and core advisory team members.

Source: Cade Martin, Dawn Arlotta, USCDCP.

0.2 Community participation

Meaningful community participation is essential for equitable public planning. Particular emphasis should be placed on the experience, knowledge and expertise of frontline communities in understanding strengths, values, and vulnerabilities; shaping goals and strategies; and determining priorities for building resilience. As described in the Spectrum of Community Engagement to Ownership (**Table 2**), this requires a move away from conventional planning practices where community members are engaged minimally and towards more collaborative approaches that are built on a foundation of trust, transparency and reciprocal relationships between local government and communities they serve.[18] Strong community and local government capacity, adequate resources to support sustained collaboration, and leadership support are essential conditions for collaborative governance that shifts the power of decision making into the hands of communities most impacted by those decisions.[19]

Resilience planning teams must evaluate existing capacity, capabilities, and resources available for both local government staff and community members to participate in resilience planning. The Spectrum of Community Engagement to Ownership[19] guidebook provides guidance about techniques for evaluating readiness and for articulating goals for community involvement.

Table 2. Spectrum of Community Engagement to Ownership. Source: Rosa Gonzalez of Facilitating Power.[19]

THE SPECTRUM OF COMMUNITY ENGAGEMENT TO OWNERSHIP

Facilitating Power

▸▸▸▸▸▸ INCREASED EFFICIENCY IN DECISION-MAKING AND SOLUTIONS IMPLEMENTATION ▸▸▸▸▸▸ EQUITY

STANCE TOWARDS COMMUNITY	IGNORE 0	INFORM 1	CONSULT 2	INVOLVE 3	COLLABORATE 4	DEFER TO 5
IMPACT	**Marginalization**	**Preparation or Placation**	**Limited Voice or Tokenization**	**Voice**	**Delegated Power**	**Community Ownership**
COMMUNITY ENGAGEMENT GOALS	Deny access to decision-making processes	Provide the community with relevant information	Gather input from the community	Ensure community needs and assets are integrated into process & inform planning	Ensure community capacity to play a leadership role in decision-making and the implementation of decisions.	Foster democratic participation and equity through community-driven decision-making; Bridge divide between community & governance
MESSAGE TO COMMUNITY	***Your voice, needs & interests do not matter***	***We will keep you informed***	***We care what you think***	***You are making us think, (and therefore act) differently about the issue***	***Your leadership and expertise are critical to how we address the issue***	***It's time to unlock collective power and capacity for transformative solutions***
ACTIVITIES	Closed door meeting Misinformation Systematic Disenfranchisement Voter suppression	Fact sheets Open Houses Presentations Billboards Videos	Public Comment Focus Groups Community Forums Surveys	Community organizing & advocacy Interactive workshops Polling Community forums Open Planning Forums with Citizen Polling	MOU's with Community-based organizations Citizen advisory committees Collaborative Data Analysis Co-Design and Co-Implementation of Solutions Collaborative Decision-Making	Community-driven planning and governance Consensus building Participatory action research Participatory budgeting Cooperative models
RESOURCE ALLOCATION RATIOS	**100%** Systems Admin	**70-90%** Systems Admin **10-30%** Promotions and Publicity	**60-80%** Systems Admin **20-40%** Consultation Activities	**50-60%** Systems Admin **40-50%** Community Involvement	**20-50%** Systems Admin **50-70%** Community Partners	**80-100%** Community partners and community-driven processes ideally generate new value and resources that can be invested in solutions

Before proceeding with the StR, government staff may need training to be effective liaisons to and with communities. It may be necessary to host listening sessions for community and government leaders and representatives to learn about climate issues and community priorities. These activities cost money and time. It may be necessary to identify sources of funds to support community participation.[18]

Practitioners can use the USDN Equity and Buildings Framework[20] to create a community participation plan which includes the following elements:

- A clear purpose for seeking participation ("why").
- "Who" will be engaged.
- How will historically marginalized and frontline communities be prioritized?
- "How" and "when" participation from community members will be sought.

Frontline communities have a critical role in every step of the resilience planning process, especially in identifying and advancing solutions. Community engagement can be pursued in a variety of ways and at various levels.[21] It may be advantageous to the practitioner and the community to incorporate expert guidance when implementing community engagement strategies. For example, there may be an existing community-based organization (CBO) that is well suited to engage with frontline communities.

0.3 Understand community history

As stated in the principles of Equity in Climate Resilience above, the practitioner should understand the historical legacies of racism, colonization, and socioeconomic differentiation that shaped the community. Examples include segregation, urban renewal, hazardous waste and pollutants in proximity to low-income and minority

groups, as well as how present-day institutions, policies and practices continue to further entrench social and economic inequalities. To build this understanding, a practitioner should seek out the perspectives of impacted communities through analysis, reports, and other information produced by them. This understanding is critical for working with historically marginalized communities,[22] connecting climate vulnerabilities to their root causes, and identifying solutions that address these causes.

0.4 Pre-existing plans and resilience efforts

A planning team that has already conducted a vulnerability assessment may not require as much time in the first two steps in the StR. A community new to climate resilience planning may take more time getting started.

> The practitioner and planning team and can use **Getting Started | Plans, Initiatives, and Context Inventory** to compile a list of background information and pre-existing plans and initiatives.

Comprehensive plans and hazard mitigation plans are common in most communities and can be used in lieu of vulnerability assessments in some cases. Utilizing and improving such plans saves costs and minimizes duplication. In addition, gaining knowledge about local experiences, concerns from the community, the relationship between hazards and natural processes,[23] and what additional resources may be available will help provide context as the project progresses. The list of existing plans will also be used in later steps.

0.5 Define equity-centered goals

Use **Resource 0.5a | Vision, Values, and Goals** to elicit the community's vision or desires for a climate-resilient future, as well as record goals and values defined for the project.

Leave flexibility for refining goals and vision based on input from the community at each step during the course of the project. Visioning helps a community define the future it wants. Community participation in a shared vision can build an encouraging work environment and help create the conditions for fundamental change.

During goal-setting, be sure to address the equitability of desired outcomes. What social equity goals need to be adopted as part of the resilience planning effort to achieve the long-term community vision? The concept of Targeted Universalism — establishing universal goals and using targeted strategies to achieve those goals — can be helpful in the goal-setting phase.[24] Goals can seek to address the known pre-existing stressors in the community such as food insecurity, shortage of affordable housing, exposure to hazardous materials resulting from social, economic and environmental inequities.

Equity-centered goals can foster a sense of belonging, power-sharing, and community well being.[25] Goal-setting can be facilitated using the framework of multidimensional aspects of equity that were introduced in the Equity in climate resilience section and should consider procedural equity, distributive equity, structural (or contextual) equity.[26] Community partners on the planning team may be able to point to needs already articulated by marginalized communities. Broader community involvement at later

stages could help refine these goals. Procedures should be in place to reconcile competing interests among stakeholder groups.

The practitioner can coordinate with the community champion (or champions) to execute project goals of the planning team with buy-in from the broader community.

> Create a project timeline and identify important milestones using the **Resource 0.5b | Project Timeline** resource.

Finalize the planning team and roles as part of the project plan. Return to the contact list and make sure all information has been collected. Determine if there is additional expertise or connections to other stakeholders that are not represented.

> The practitioner can use the **Resource 0.5b | Project Timeline** to make notes about the community participation plan. Be sure that this document is available to everyone involved. Finalize the project plan by defining values, vision, and goals for the project, including equity-centered goals.

When finalizing this plan, coordinate how and where information, files, and spatial data will be stored and shared between the practitioner and planning team. Whenever these items are collected, the practitioner can store this on a file sharing system. The practitioner can also collect and organize any exercise resources completed by the planning team at the end of each step.

Stakeholders and decision-makers in the Minnehaha Creek Watershed District participated in an outreach event to explore recent and projected flooding impacts and to consider potential solutions. Source: Minnehaha Creek Watershed District.

0.6 Project kickoff

Although internal meetings have been held with the full planning team, the kickoff meeting is meant to be held with the larger community. This meeting will provide a broad overview of the project plan, timeline, and project goals. This is also an opportunity to introduce the team working on the project to community members.

This meeting should include the full planning team, the community champion, and community members should be invited to attend. This meeting is also an opportunity to check that the membership of the team reflects equity goals.

An annotated agenda is provided (**Resource 0.6a | Annotated Agenda: Kickoff Meeting**), along with a companion presentation template (**Resource 0.6b | Kickoff Meeting Slides**). Both should be updated as needed.

Endnotes

13 See more about local government staff, community partners, neighboring jurisdictions, and private sector or philanthropic organizations in Ready-to-Fund Resilience Guide Characteristic 1: Use cross-sector partnerships to increase project capacity.

14 Additional information about these partnerships can be found in the *Ready-to-Fund Resilience Guidebook Technical Document* and Table 2 that summarizes the potential outcomes of partnerships.

15 Documented examples for compensating community members: https://shelterforce.org/2021/02/26/paying-community-members-for-their-time/ and also this from Portland - https://www.portland.gov/civic/advisorygroups/stipends

16 From section 2.5, "Assemble Key Nature-based Solutions Stakeholders" *in Incorporating Nature-based Solutions into Community Climate Adaptation Planning.*

17 See Principle 2 on Page 17 and Fang et al. 2022

18 Yuen et al. Guide to Equitable Community-driven Climate Preparedness (2017)

19 The Spectrum and additional information on using it can be found in *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Race Equity Committees.* Also see full spectrum of community engagement from Rosa Gonzalez and the Movement Strategy Center.

20 Hays et al. Equity And Buildings: A Practical Framework For Local Government Decision Makers (2021)

21 *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Race Equity Committees* also provides a helpful summary of "Essential Conditions for Collaborative Governance" that may be helpful for communities looking to advance their level of engagement with the community.

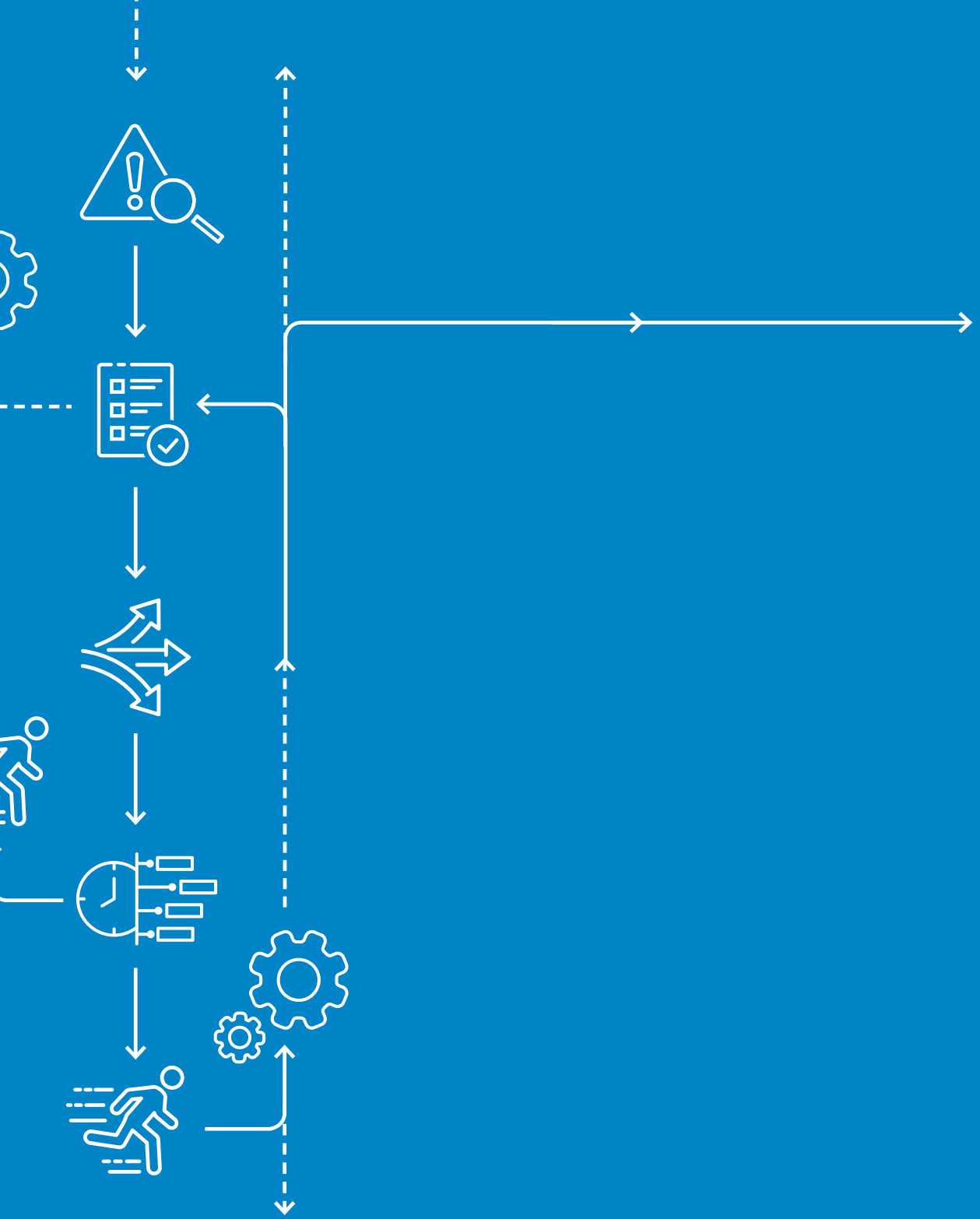
22 Fang et al. 2022.

23 Natural processes that are influenced by human-induced stressors can generate hazards. For a summary of natural processes, associated hazards and drivers, see Table 7 in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.*

24 Powell et al., https://belonging.berkeley.edu/targeted-universalism

25 Vital Conditions for Community Health and Well-being Framework identifies 'Belonging and Civic Muscle' as one of the seven conditions that promote community well-being. See the discussion by Well Being Trust: https://thriving.us/vital-conditions/belonging-civic-muscle/#what_you_need_to_know

26 A few references that discuss different dimensions of equity in the context of adaptation and resilience: Foster et al. 2019, Yuen et al. 2017); Meerow et al. 2019, GCC Equitable Adaptation Legal and Policy Toolkit.



STEP 1:
Understand Exposure

Back to previous view

STEP 1

Understand Exposure

Overview

Evaluate community assets and their exposure to climate-related hazards. Confirm that all relevant potential climate impacts are being considered to allow for a comprehensive assessment of vulnerability and risk in the next step. This may require exploring multiple sources of information such as climate projections, Traditional Ecological Knowledge, community knowledge, observational data.

OBJECTIVES

- [ ] **1.1** Identify people and community assets, hazards and stressors
- [ ] **1.2** Document potential impacts through an exposure matrix
- [ ] **1.3** Inventory spatial, quantitative, and qualitative data
- [ ] **1.4** Meet with the planning team to review step 1 results

RESOURCES

- Step 1 | Implementation Examples
- Resource 1.1a | Systems Thinking & Conceptual Models
- Resource 1.1b | Build a Conceptual Model
- Resource 1.1c | Community Asset Themes
- Resource 1.1d | Hazards & Stressors Research Guide
- Resource 1.1e | Evaluate Hazards and Stressors
- Resource 1.2a | Tools for Exploring Exposure
- Resource 1.2b | Potential Impacts Matrix
- Resource 1.3a | Sources for Spatial Data Collection
- Resource 1.3b | Using the Spatial Data Collection Sheet
- Resource 1.3c | Spatial Data Collection
- Resource 1.3d | Community Asset Types
- Resource 1.3e | Social Vulnerability Indicators
- Resource 1.4a | Annoted Agenda: Step 1 Meeting
- Resource 1.4b | Step 1 Meeting Slides

OPPORTUNITIES FOR COMMUNITY PARTICIPATION

- Identify community strengths, values, tangible, and intangible assets
- Document community experiences and insights from past events
- Identify community stressors, including disparities in access to resources
- Gather qualitative data from community members and partners
- Assess gaps in quantitative data by comparing with community knowledge and experiences

QUESTIONS FOR ASSESSING THIS STEP:

- Is the full range of stakeholder perspectives represented in identifying community concerns or people and community assets?
- What will future conditions look like for your location during the full lifecycle of the community asset?

Key Concepts

PEOPLE AND COMMUNITY ASSETS: People, resources, ecosystems, infrastructure, and the services they provide; the tangible and intangible things that people or communities value.

HAZARDS: An event or condition that may cause injury, illness, or death to people or damage to assets.

CLIMATE STRESSORS: A condition, event, or trend related to climate vulnerability and change that can exacerbate threats/hazards.

NON-CLIMATE STRESSORS: A change or trend unrelated to climate that can exacerbate threats/hazards.

In practice

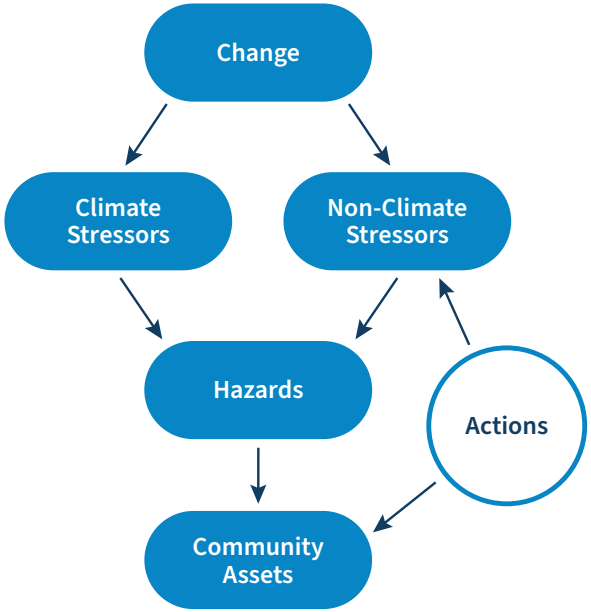


Figure 4. Conceptual model of potential climate-related impacts. Source: U.S. Climate Resilience Toolkit.

1.1 Identify people and community assets, hazards, and stressors

The diagram at left (**Figure 4**) illustrates the relationships among climate and non-climate stressors, hazards, and people and community assets that may be affected. Climate and non-climate stressors have the potential to change in the future and increase risk to communities. Hazards are exacerbated by climate and non-climate stressors.

Exposure of people and community assets to hazards is indicated by the relationship between hazards and people and community assets. Each unique combination of people and community assets and hazards is referred to as a potential impact.

Figure 4 articulates the relationships among people and community assets, hazards, and stressors and how future change could increase vulnerability and risk.

The following exercise can be used by the planning team to create their own conceptual model: **Resource 1.1a | Systems Thinking & Conceptual Models**

People and community assets

People and community assets are community groups, places, natural resources, infrastructure, and services the community agrees are important to protect. They include social, financial, cultural, political assets, and strengths of the community as well. These are the things that the community values, that promote well being, power the community's economy and make the neighborhood, community, or city special and unique. What is it about the people and sense of place that are unique? What are the strengths of the community?

The practitioner can work with the planning team to identify information about specific facilities, infrastructure types, or natural assets that are important to the community or that provide protective benefits. This may include locations of SNAP food retailers, emergency shelters, medical facilities, farmers market locations, for example. In addition, explore the full range of natural assets that go beyond recreational assets (such as trails, parks, etc.) to include wetlands and waterways, riparian buffers and floodplains, urban tree canopies, habitat corridors, and other natural assets. This focus can help practitioners in later steps to steer conversations on multiple co-benefits of natural assets such as protective benefits and community well-being and recreational benefits.[27]

The practitioner can use **Resource 1.1c | Community Asset Themes** with the planning team to begin placing community assets into themes that can be based on the combination of FEMA lifelines and critical infrastructure categories[28], local knowledge, and community values.

Themes reflect any given community's unique circumstances and will be used later during spatial data collection for vulnerability and risk assessments. Examples of community asset themes are shown in **Table 3**.

Table 3. Example Community Asset themes and types.

Community Asset	Type
Cultural & Community Services	Social services, faith-related services, recreation, community centers, senior services, childcare services, libraries
Food, Medical, and Shelter Facilities	Grocery stores, pharmacies, nursing homes, snap retailers, hospitals and healthcare-related facilities, emergency shelters
Government-owned Properties	Police and Fire Stations, city-owned properties, schools, emergency operations and logistics centers
Commercial and Industrial Property	Businesses, hotels, banks, mixed-use, industrial/manufacturing properties. This can also include jobs and sales volume that businesses provide.
Residential Property	Single-family residences, multi-family residences, condos, group homes, assisted housing
Parks, Greenways, Open Space (formally designated)	Parks, trails, undeveloped recreation areas
Natural Areas	Wetlands, waterways, riparian buffers and floodplains, urban tree canopies, habitat corridors, remnant natural ecosystem patches.
Roads and Mobility	Major and minor roads, critical access to essential and emergency services.

Specific data can also be collected for the project. The inset image, taken with a forward looking infrared (FLIR) camera, shows heat and is overlain on a regular photograph for context. In the FLIR image, lighter or brighter colors indicate warmer areas, while darker areas are cooler. Source: Science Museum of Virginia

Hazards and climate stressors

Document past and existing climate-related hazards (see **Table 4** for examples). Hazards may be identified from community experiences and using trusted sources of information. Example climate-related hazards include flooding, wildfire, and heat waves. The practitioner will need to provide a list of hazards and possible data sources to the planning team for review and feedback. Hazards can overwhelm, damage, or destroy the protective value of natural features, causing cascading impacts on the dependent communities (13).

Climate stressors are conditions, events, or trends related to climate variability and change that can exacerbate hazards. For example, rising sea levels can exacerbate the effects of coastal flooding. While coastal flooding may be a current issue, how this could change in the future as a result of sea level rise is also something to consider for long-range planning.

The practitioner can work with the planning team to use the following resources:

Resource 1.1d | Hazards & Stressors Research Guide provides guidance for using tools and information.

Resource 1.1e | Evaluate Hazards and Stressors provides a space to record your answers to the questions posed in **Resource 1.1d**.

Table 4. Potential climate-related hazards and associated climate and non-climate stressors. Source: U.S. Climate Resilience Toolkit.

Hazards	Climate Stressors	Non-climate Stressors
Tidal Flooding	Sea level rise	Aging infrastructure
	Heavy precipitation	Increased development/impervious surfaces
Storm Surge	Sea level rise	Aging infrastructure
	Tropical systems	Increased development/impervious surfaces
Floodplain Inundation	Sea level rise	Increased development/impervious surfaces
	Increase in rainfall frequency/intensity	Aging/undersized infrastructure
Extreme Heat	Temperature variability	Increased development/impervious surfaces
		Socioeconomic vulnerability
Wildfire	Drought (water shortage and vegetation dessication)	Wildland-Urban Interface/fuels & vegetation, historic fire suppression
	Temperature variability	Human-caused ignitions, historic fire suppression
Landslides	Increase in rainfall frequency/intensity, high temperatures, and snowstorms	Development/vegetation removal

Non-climate stressors

Non-climate stressors include land use, use of resources (energy and water), and infrastructure, economic, and social conditions that contribute to the impacts of a hazard. For example, impervious surfaces are a non-climate stressor and are known to contribute to increased runoff, erosion, and flooding in urban areas. Changes to non-climate stressors can have a more immediate and measurable influence on hazards than climate stressors.

NATURE-BASED SOLUTIONS CONSIDERATION:
The character, magnitude, and rate of direct and indirect climate-related impacts experienced by the natural system may be considered. For example, exposure to flooding is more widespread in the Gulf of Mexico compared to other regions, and the consequences of flooding affect the viability of fish and invertebrate populations. Likewise, changes in temperature and precipitation are the most widely used indicators of non-human species' exposure to climate change.[29]

1.2 Document potential impacts with an exposure matrix

Return to the information collected about hazards and stressors (**Resource 1.1e | Evaluate Hazards and Stressors**) and community assets (**Resource 1.1c | Community Asset Themes**), to work with the core team to inventory potential impacts resulting from exposure.

In addition to the resources already mentioned, the tools outlined in **Resource 1.2a | Tools for Exploring Exposure** can be useful for visualizing and understanding exposure and potential impacts.

Use **Resource 1.2b | Potential Impacts Matrix** to determine exposure at a screening level for community assets (example below).

Returning once again to the conceptual model, this exercise helps to determine if a hazard has the potential to impact a community asset. This establishes the potential impacts that will be evaluated and measured in a structured way in order for communities to make informed decisions. A spatial analysis of exposure will be conducted prior to assessing vulnerability and risk in Step 2.

Table 5. Example matrix of potential impacts, where "X" indicates exposure of an asset to a hazard, and therefore a potential impact.

Community Assets	Hazards			
	Flooding	Landslides	Wildfire	Extreme Heat
City-owned Facilities	×	×		×
Commercial Properties	×	×	×	
Residential Properties	×	×	×	
Endangered Fish Population	×			×

1.3 Inventory spatial, quantitative, and qualitative data

The practitioner can begin building an inventory of spatial datasets once community assets and hazards are identified. Sources will be a mix of local, state, and federal data, depending on the location and scale and general data availability.

Resource 1.3a | Sources for Spatial Data Collection includes a list of data products and sources. For some community assets, outside data sources will need to be consulted. For example, the USDA SNAP Retailers dataset is important to bring in for understanding where these services are in the community.

NATURE-BASED SOLUTIONS CONSIDERATION:
A community's climate risks are heavily influenced by non-climate stressors such as impervious surfaces and upstream conditions, such as land cover, land use, or disturbances such as deforestation. To create a conducive space for Nature-based Solutions in later steps, now is the time to understand the broader geographic context, scale, and consequences of landscape processes, such as watershed dynamics.[30]

Delineate study area

The planning team must agree on the study area. Depending on the type of community (city, county, multi-jurisdictional, etc.), the extents of municipal boundaries or census boundaries (census block groups or census tracts) can be used to delineate the study area. It also may be of interest to the community to summarize assessment results later by neighborhood areas using a collection of census boundaries or other community planning areas.

Inventory spatial data

Use the community asset themes that were developed along with the hazards and stressors research to inventory spatial data. There are three categories of spatial data that will need to be collected for the assessment in Step 2: boundaries and property records, community assets, and hazards.

Before beginning the collection, it will be helpful for the practitioner to review **Resource 1.3b | Using the Spatial Data Collection Sheet**, which details how and where these datasets can be found. When you're ready to carry out the spatial data collection, use **Resource 1.3c | Spatial Data Collection** to record what has been inventoried.

BOUNDARIES AND PROPERTY RECORDS

The tax assessor parcel data serves as the foundation of the community asset data for the assessment. They will be used in Step 2 to understand vulnerability and risk, and components of those, as well as represent facilities and services identified as valuable community assets to community members. Any additional community asset data collected, discussed below, will be spatially intersected with these parcel boundaries for the analysis.

The study area boundary, parcel data, building footprints, and all necessary attributes are included in the "Boundaries and Underlying Data" section of **Resource 1.3c | Spatial Data Collection**. The desired attributes for the data are outlined in this resource. If possible, it may be advantageous to give this list directly to GIS specialists on the project team in case they are able to identify and/or provide spatial data and information.

In addition to parcels, the community may have separate datasets for some buildings or property uses. The parcel data may be a combination of spatial and tabular data, and it will be important to keep track of that in the resource. In addition to the parcel data, another important dataset will be building footprints. These will be used to determine whether a structure is spatially within a hazard extent in the analysis. Building footprints may not be available from the community, but may be available from state or national sources.

NATURE-BASED SOLUTIONS CONSIDERATION:

Practitioners can employ a range of methods to identify a community's natural assets, such as beaches, forests, coral reefs, wetlands, etc., that provide different types of ecosystem services. Employing a combination of existing data sources, remote sensing, and community knowledge will help build a comprehensive understanding of natural assets and features in an area that is not limited to formally designated parks and recreational amenities (e.g., trails, fishing piers). Rather, practitioners should help communities explore the full range of natural assets such as wetlands and waterways, riparian buffers and floodplains, urban tree canopies, habitat corridors, and remnant natural ecosystem patches that may provide protective benefits or other services.[32]

COMMUNITY ASSET THEME SPATIAL DATA

Refer to **Resource 1.1c | Community Asset Themes**. Use the themes from this exercise to fill in this section of the Spatial Data Collection resource. Determine whether, either within the parcel data or another dataset (or both), there are sufficient data and information for the community assets listed within those themes to be used in the analysis. Add each one to the sheet with the corresponding dataset, adding more rows as needed.

If GIS-formatted data are unavailable, the next best option is tabular data that contains latitude and longitude coordinates or addresses that can be geocoded. As mentioned previously, these data will be spatially intersected with the parcel data to add granularity to the parcel use codes and should represent specific community asset types identified by the project team and community.

COMMUNITY ASSET TYPES

Community asset types are used to represent specific types of properties or services within each theme. For example, the "Critical Facilities" community asset theme can be further delineated into police, fire, emergency operations center, etc. These are often identified using the tax assessor parcel use codes and/or additional spatial data.

Refer back to **Resource 1.1c | Community Asset Themes**, where community asset themes were constructed, and use **Resource 1.3d | Community Asset Types** to develop corresponding community asset types. Examples are provided within the resource for guidance.

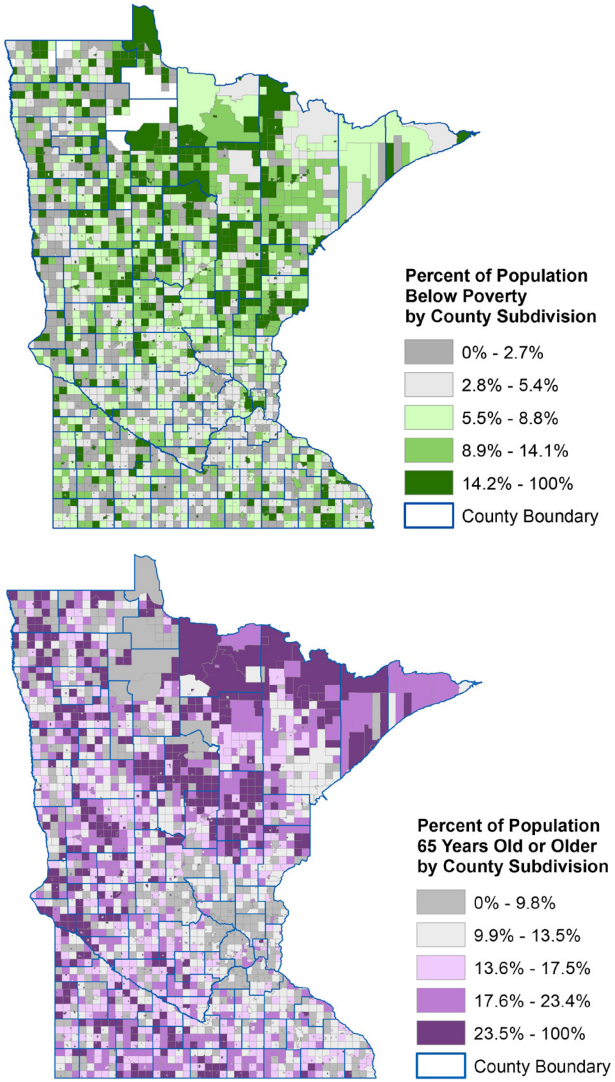


Figure 5. Decision makers can identify where to focus their resilience-building efforts by identifying where relatively high numbers of vulnerable people live. Source: Minnesota Department of Health.

This list will be used in Step 2 for the spatial analysis and can be a reference throughout the remainder of the project.

HAZARDS SPATIAL DATA

The "Hazards Spatial Data" section in **Resource 1.3c** can be used to identify the spatial data that will need to be collected for each hazard, including source, year, file location, and important attributes. These data will often come from federal or state sources, unless a community has completed a local study. Spatial data types can include polygon or raster. Spatial data collected should be the hazard data for the community, where the full extent of the study area is sufficiently covered.

In addition to spatial data, information related to non-spatial narrative assessments may be collected. This can also be recorded here, along with any supporting documentation for the data.

SOCIOECONOMICS

Socioeconomic indicators from the most recent U.S. Census Bureau American Community Survey or decennial census (whichever is most recent) can be collected at either the tract or block group scale.

Use **Resource 1.3e | Social Vulnerability Indicators** to learn about how to download and use census data, as well as record what indicators and datasets have been collected.

Evaluate completeness of quantitative data; use qualitative data to fill gaps

As spatial data are collected, be sure to identify if anything is missing. Gaps may exist if there exist spatial data that are not readily available. For example, a community asset may be pump stations, but such data may not be publicly available. One may need to request them from a governmental department. Another gap may be if a community has only a tabular list of certain facilities and no spatial data. True gaps may also exist if there are simply no data available for a community asset type or hazard. If no data exist for the community asset type, then make the community aware of the gap so that they might be able to address it in the future. If no or limited spatial data exist for the hazard, then the assessment may be done through qualitative methods such as narrative documentation. These differences will be covered in Step 2. It is important to note when such cases arise and integrate the understanding of data limitations when drawing insights from the vulnerability assessment in Step 2.

Community experiences and challenges documented through reports developed by community-based organizations or revealed through conversations with community partners and residents can be important sources of qualitative data that can fill gaps, provide nuances or reveal limitations of spatial data. The Planning Team can also consider participatory data collection and analysis (through data walks, for example) for community experiences and challenges that are not adequately represented in the existing qualitative or quantitative data.[31]

1.4 Meet with the planning team to review step 1 results

This meeting will provide an overview of the hazards and community assets identified (including asset themes), and data collection progress.

This meeting should include the full planning team, the community champion(s), and community members should be invited to attend.

An annotated agenda is provided (**Resource 1.4a | Annoted Agenda: Step 1 Meeting**), along with a companion presentation template (**Resource 1.4b | Step 1 Meeting Slides**). Both can be updated as needed.

Endnotes

27 Additional reading on community assets in the context of natural systems can be done in section 2.1 of *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*.

28 FEMA Lifelines and PPD21 Critical infrastructure categories include asset types that are often combined into one or multiple asset categories in this process.

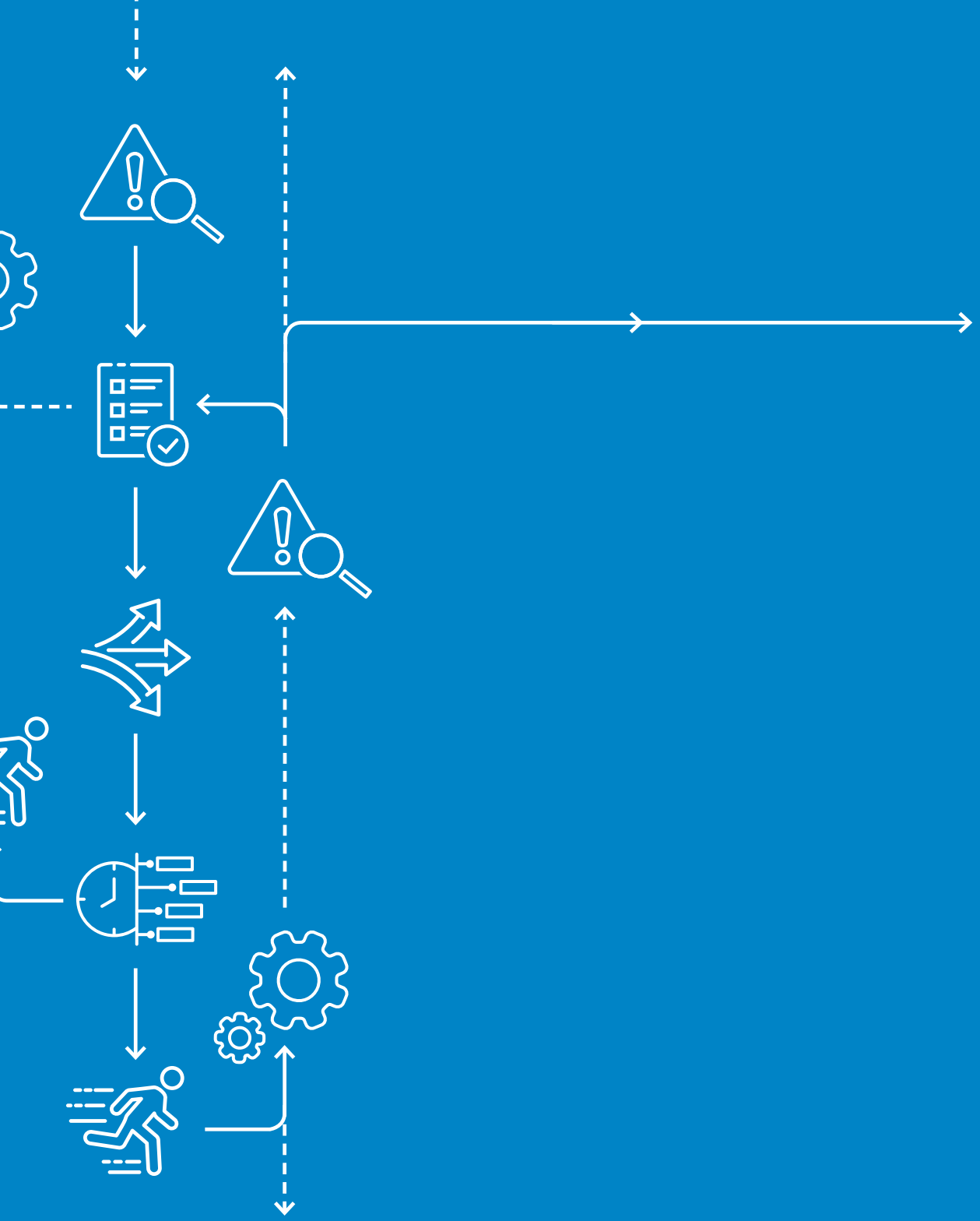
29 Section 3.1.1, "Approaches and Tools for Assessing Ecological Vulnerability" in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*

30 Section 2.3 of *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*.

31 Section 2.1 of *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.*

32 See brief discussion on 'Valuing Qualitative Data' in Fang et al. (2022) and references therein

33 Section 3.1.1 of *Incorporating Nature-based Solutions into Community Climate Adaptation Planning* contains examples of quantitative and qualitative tools and approaches to assessing natural systems.



STEP 2:

Assess Vulnerability and Risk

Back to previous view

STEP 2

Assess Vulnerability and Risk

Overview

Evaluate the vulnerability of community assets by enumerating qualities of sensitivity and adaptive capacity. Characterize risk based on the probability of the hazard and the magnitude of potential loss. Define these attributes by incorporating community input. This chapter addresses processes and expected outcomes as well as increasing capacity across the community to conduct and understand vulnerability and risk assessments. By the end, the community will identify the people and community assets most vulnerable and at risk to climate-related hazards.

OBJECTIVES

- [ ] **2.1** Determine type of assessment for each potential impact
- [ ] **2.2** Develop rulesets and assess vulnerability and risk
- [ ] **2.3** Review preliminary assessment with planning team
- [ ] **2.4** Use assessment results to create impact statements
- [ ] **2.5** Finalize assessment and synthesize findings
- [ ] **2.6** Review assessment findings with planning team

RESOURCES

- Step 2 | Implementation Examples
- Resource 2.1a | Determine Assessment Type
- Resource 2.1b | Narrative Assessment Development
- Resource 2.2a | Ruleset Library
- Resource 2.2b | Ruleset Development
- Resource 2.2c | Analysis QC
- Resource 2.3a | Preliminary Results Meeting Agenda
- Resource 2.3b | Preliminary Results Meeting Slides
- Resource 2.3c | Preliminary Results Feedback
- Resource 2.4a | Develop Impact Statements
- Resource 2.5a | Step 2 Synthesis Report
- Resource 2.6a | Step 2 Results Workshop Agenda
- Resource 2.6b | Step 2 Workshop Slides

OPPORTUNITIES FOR COMMUNITY PARTICIPATION

- Share analysis publicly. Involve frontline community representatives in data evaluation and in analyzing underlying drivers of inequities in climate vulnerability and risk
- Identify intersectional and compounding vulnerabilities

QUESTIONS AND METRICS FOR ASSESSING THIS STEP:

- Will future climatic conditions adversely affect community assets — function, integrity, access, cost–as defined and valued by the affected communities?
- Can the process be repeated by participants for subsequent iterations of this process either due to later learning or emerging challenges?
- Use climate hazard data (mapped or otherwise) to assess the impact these hazards will have on the community assets.

Key Concepts

VULNERABILITY: The propensity or predisposition of assets to be adversely affected by hazards.

SENSITIVITY: The degree to which a system, population, or resource is or might be negatively affected by hazards.

ADAPTIVE CAPACITY: The ability of a person or community asset, or system to adjust to a hazard, take advantage of new opportunities, or cope with change.

RISK: The potential for negative consequences where something of value is at stake, e.g., from f a climate-related hazard. Risk can be assessed by multiplying the probability of a hazard by the magnitude of the potential consequence or loss.

PROBABILITY: The likelihood of hazard events occurring, traditionally determined from the historic frequency of events.

MAGNITUDE OF IMPACT: A subsequent result (usually negative) that follows from damage or loss of an asset.

In practice

2.1 Determine type of assessment for each potential impact

Assessments of vulnerability and risk may be spatial or narrative. Use the questions outlined in **Resource 2.1a | Determine Assessment Type** to determine if a spatial or narrative assessment should be performed for every potential impact identified in the previous step, Understand Exposure.

Spatial assessments

Spatial assessments are most often performed at the level of individual facilities or properties using parcel and building spatial data collected in the previous step. Characteristics of the assets are then used to classify them into low, medium, and high levels of vulnerability and risk. Natural assets also may be mapped and analyzed, both for vulnerability and risk in their own right but also for their role in reducing risk of climate-related hazards to communities.[33] Most of the content of this chapter addresses details pertinent to spatial assessments.

Narrative assessments

For general planning purposes and/or when spatial data are not readily available, narrative assessments may be necessary or sufficient. Narratives can provide a detailed history of a hazard and potential future impacts, both in scale and magnitude. The assessment should include information related to the types of community assets that are

most commonly impacted by this hazard. Contextual maps and other data or graphical illustrations may be helpful to support a narrative assessment. As with a spatial data-supported assessment, the goal of such a narrative is to use available contextual information and data to understand what conditions could lead to vulnerability for the community in order to still frame/inform options to consider for building resilience.

> **Resource 2.1b | Narrative Assessment Development** provides guiding questions and an example of developing a narrative assessment.
>
> **Resource 1.1d | Hazards & Stressors Research** may be a useful resource for developing these narratives.

Sector-based assessments

Although either type of assessment can be done at the community or multi-jurisdictional scale, there may be a need to complete a sector-based assessment. This type of assessment may evaluate impacts to sectors that serve the community but exist outside its borders. Supply chains, transportation, water, energy are essential to any community but generally involve multiple jurisdictions. Because of the scale of these sector assets, disruptions to these can often be one of the largest vulnerabilities to a community. In the previous step, Understand Exposure, these extrinsic impacts were defined along with the study area. A sector-based assessment can be either spatial or narrative.

2.2 Develop rulesets to assess vulnerability and risk

Semantic rules based on attributes, hereafter termed "rulesets", are used to classify community assets as having "high, medium, or low" characteristics of vulnerability (**Table 6**) and risk (**Table 7**). For example, a neighborhood in the airshed of a facility that produces toxins may be considered at "high" risk to transport of those substances by winds. Or a school building in the 100-yr floodplain may be classified as having "high" vulnerability and risk.

The classifications of vulnerability and risk provide a way for the planning team to quantify levels of vulnerability and risk to people and community assets so the resilience planning team can agree upon where and why people are most vulnerable to hazards. Ordinal classifications can be incorporated as attributes of spatial data (points, lines, polygons, and rasters) to facilitate spatial analyses, further aiding decisions about what is at risk and where those risks are greatest.

Measures of vulnerability and risk can help prioritize options to build resilience to potential impacts of greatest concern. Developing and applying rulesets is a hallmark of vulnerability and risk spatial assessment in the StR.

The practitioner can use **Resource 2.2a | Ruleset Library** to work with the planning team to build out rulesets for the community. The example rulesets may be easily modified, as necessary.

Resource 2.2b | Ruleset Development also provides an exercise that can be used to develop original rulesets with the planning team.

Incorporate unique, site-specific information

There are several opportunities to incorporate community input and site-specific data.

- Locations of community assets and criticality of community assets can be identified based on input from the planning team and community.
- If local hazard models are available, they can be incorporated (e.g., flood depth from inundation modeling and mapping).
- Local ordinance information, such as floodplain, steep slope, and other development requirements that can be used to consider levels of adaptive capacity to hazards (see more on this in later section).
- Community planning areas can be summarized to identify area-specific vulnerabilities and risks.
- Community-specific planning horizons can be used to determine the assessment thresholds (e.g. sea level rise and 30 vs 50-year planning horizon) and can inform the focus of central challenges (see more on this in later section).

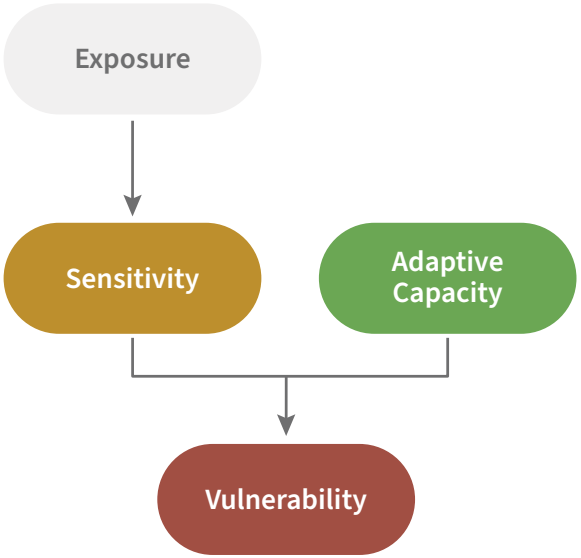


Figure 6. Components of vulnerability. Source: U.S. Climate Resilience Toolkit.

Vulnerability

Two factors comprise vulnerability: sensitivity and adaptive capacity (**Figure 6**). For different levels of sensitivity (**Table 6a**), factors such as the location of the structure and its criticality are considered. Is a structure in the inundation extent of a flood frequency layer, or is it the land itself which lies in a floodplain (parcel)? What is the use of the parcel? Is it a medical facility (a "critical" or "crucial" service to the community and therefore a parcel with high sensitivity) or a warehouse (lower sensitivity)?

NATURE-BASED SOLUTIONS CONSIDERATION:
Assessments can consider the vulnerability of natural systems. Doing so in parallel with other valued community assets allows communities to identify when and where existing and intact natural systems can continue providing benefits and services, and where it is necessary to proactively protect or restore ecosystems. Read more about assessing the vulnerability of natural systems in section 3.1 of *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.*

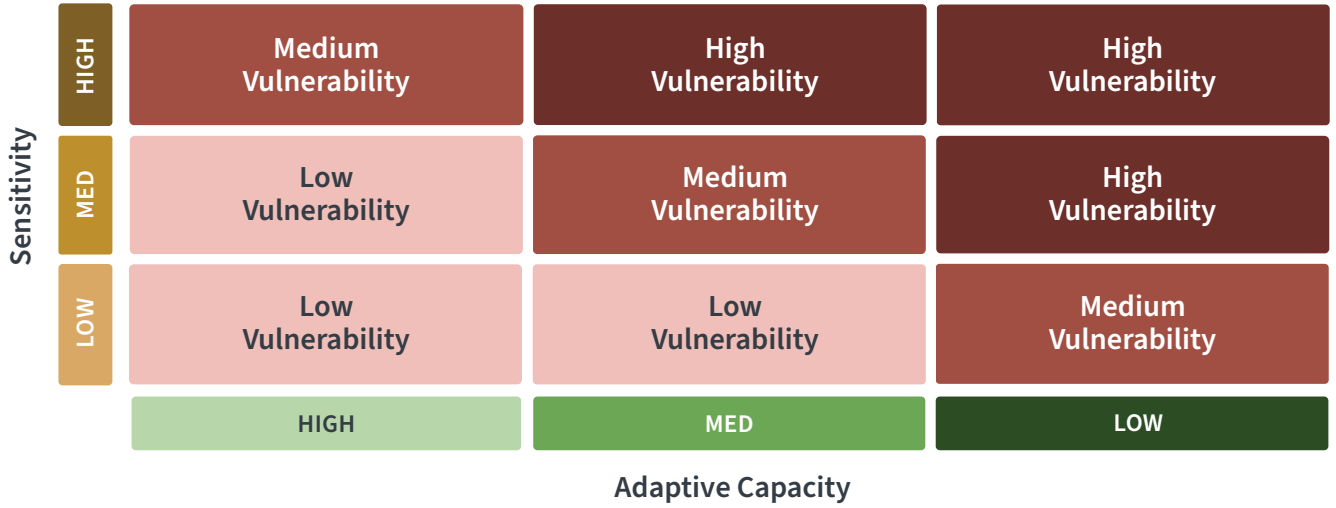
Adaptive capacity (**Table 6b**) addresses the likelihood that the function of the community asset or the livelihood of the population of interest will remain intact following the climate-related hazard of interest. For example, what year was a structure built relative to the year that floodplain development regulations were put in place (**Table 6a**). If built beforehand, it is reasonable to assert it has less adaptive capacity; if built afterward, the building would likely have freeboard or other building standards in place, making it more able to resist a hazard. Higher adaptive capacity implies greater ability to cope with potential impacts (**Table 6b**; **Figure 7**).

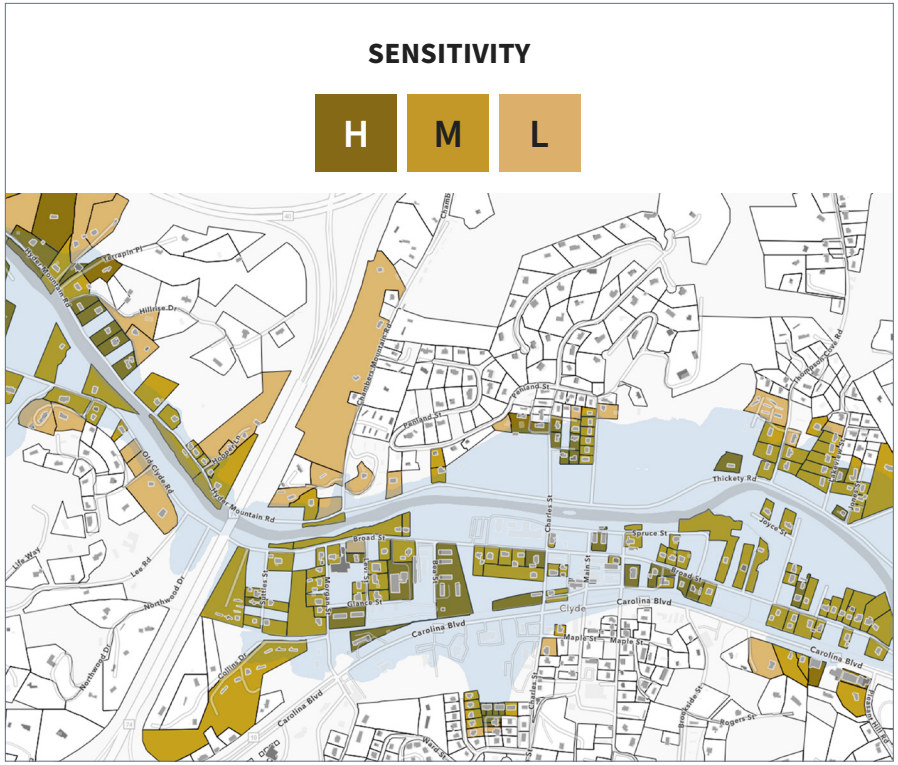
Tables 6a and 6b. Sensitivity and adaptive capacity are the component metrics for vulnerability. **(a)** Example rulesets for a property exposed to flooding. **(b)** Vulnerability is classified into low, medium, and high categories based on the rulesets in **(a)**. Such a vulnerability analysis can be applied to spatial data or narrative assessments.

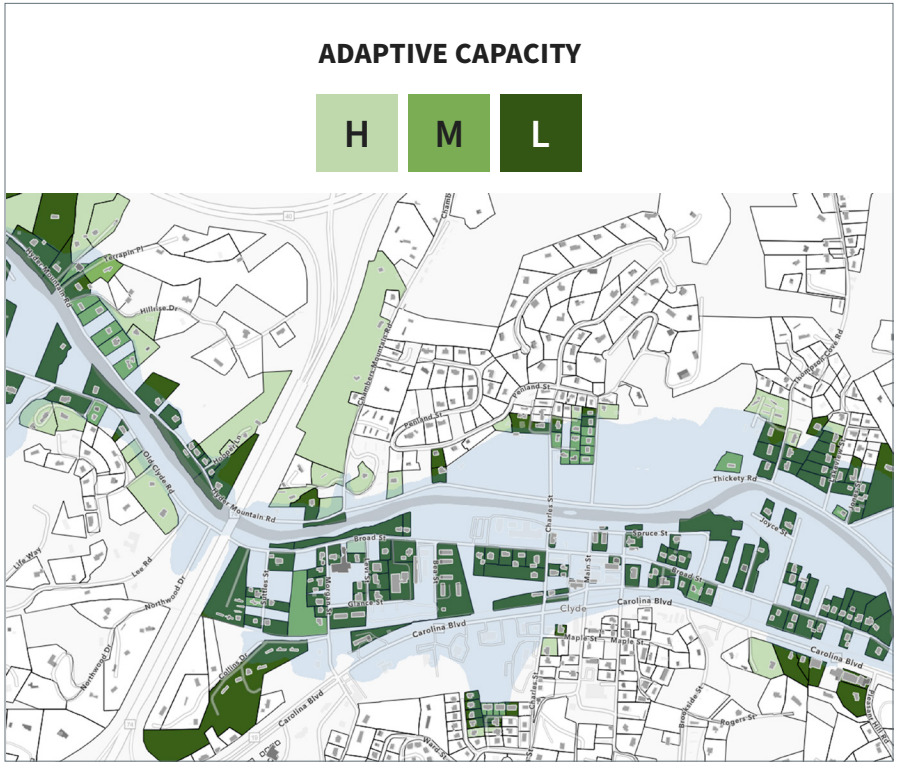
(a) Example flooding rulesets for the components of vulnerability.

Level	Sensitivity	Adaptive Capacity
High	Structure in inundation extent & criticality of impact is high	Building in floodplain, most recent floodplain development regulations apply or no structure in floodplain
Medium	Structure in inundation extent	Building in floodplain built after flood-plain development requirements were put in place, some regulations apply
Low	No structure in inundation extent (land only)	Building in floodplain built before any floodplain development requirements were in place

(b) Vulnerability classification into three groups.







Figures 7a and 7b. Examples of spatial analysis outputs generated for sensitivity and adaptive capacity. Source: Fernleaf.

On the map above, properties that are high sensitivity are where the structure is in the inundation extent and is some type of high criticality, such as a hospital.

Properties have high adaptive capacity (light green at left) if they have characteristics that improve the ability to cope with or recover from the hazard. Using the ruleset above, structures have high adaptive capacity if they were constructed with the most recent flood regulations.

NATURE-BASED SOLUTIONS CONSIDERATION:
Species and ecosystems vary in their sensitivity to climatic shifts, as well as their adaptive capacity to accommodate or cope with change. Depending on the type, pace, and scale of climatic impacts, many species and ecosystems will themselves require specific adaptation measures to maintain or enhance their capacity to deliver benefits and services.

In natural systems, sensitivity refers to the extent to which species or natural systems would be affected by or respond to changing direct or indirect climatic impacts. Factors such as physiological characteristics, plasticity, and evolutionary potential can increase or decrease a species' sensitivity. Information on ecosystem thresholds or tipping points can be a useful indicator to understand their ability to withstand climate impacts.

Adaptive capacity in ecological systems depends on the diversity and flexibility across traits (e.g., metabolic rates, reproductive strategies), organizational levels (e.g., genetic species, populations), and interactions with suitable habitats (e.g., habitat diversity, connectivity) while for species adaptive capacity is influenced by attributes such as genetic diversity, dispersal capacity, mode of reproduction, and physiological tolerance. A range of

Populations and community assets with both high sensitivity and low adaptive capacity have the highest vulnerability. The map at left (**Figure 8**) shows a three-class vulnerability assessment using the rulesets described above.

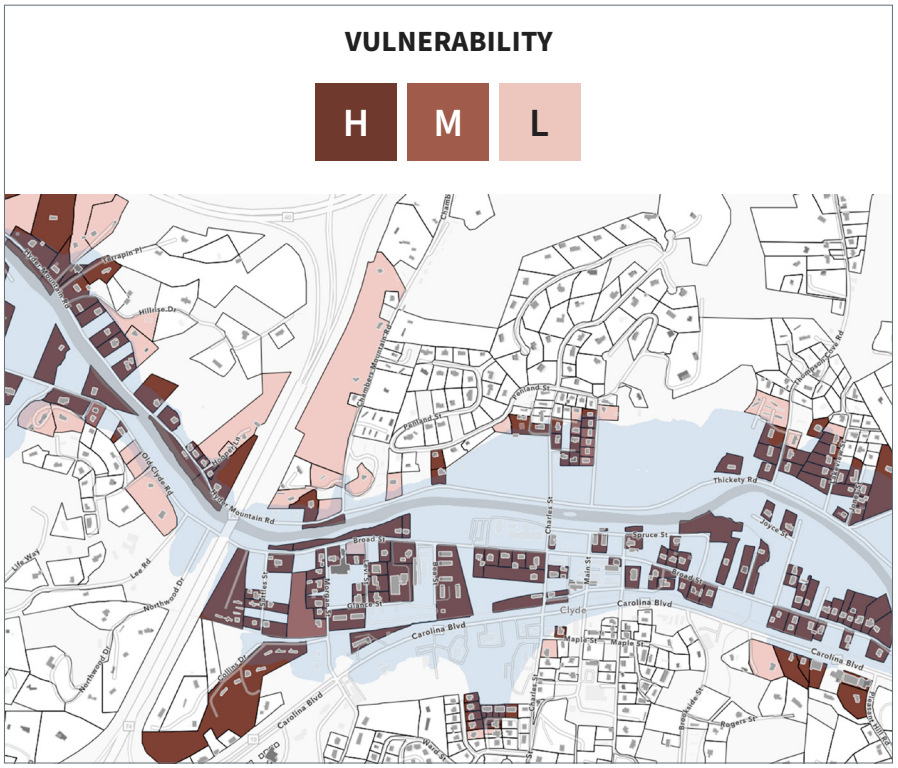


Figure 8. Example spatial analysis output generated for vulnerability. Source: Fernleaf.

Sensitivity and adaptive capacity are combined to look at vulnerability. Properties that are highly vulnerable have low adaptive capacity and high sensitivity.

factors influence the species and ecosystem's capacity to adapt. Information gathered for assessing sensitivity can inform the adaptive capacity assessment as well. The external factors that affect adaptive capacity, for instance, habitat connectivity, may require additional considerations. Practitioners can leverage ecological indicators and existing habitat assessments for understanding adaptive capacity.

Learn more about these vulnerability concepts in the context of natural systems in section 3.1, "Assessing vulnerability of natural assets," in *Incorporating Nature-based Solutions in Community Climate Adaptation Planning.*

Risk

Risk is the combination of probability of the hazard occurring and the magnitude of impact (**Table 7**; **Figure 9**). Risk can be expressed as:

Risk = Hazard Probability x Magnitude of Impact

Probability is often determined using the annualized likelihood of the hazard occurring, while consequence addresses various levels of significance if a threat were to occur. Examine historic occurrences of the hazard for the area and climate projections that increase the frequency or severity of the hazard over time.

For example, if a 100-year floodplain (area with a 1% chance of flooding each year) was mapped more than a decade in the past, one should evaluate whether increased precipitation intensity and frequency bring increased flood probability and therefore risks; for most areas of the United States, climate change has brought heavier downpours, more rapid snowmelt, sea level rise, and other hydrologic changes that have boosted probabilities of flooding. Therefore, climate change information improves understanding of the risk of climate-related impacts that could befall community assets. This information can improve the determination of appropriate rulesets to evaluate the risk of the impact.

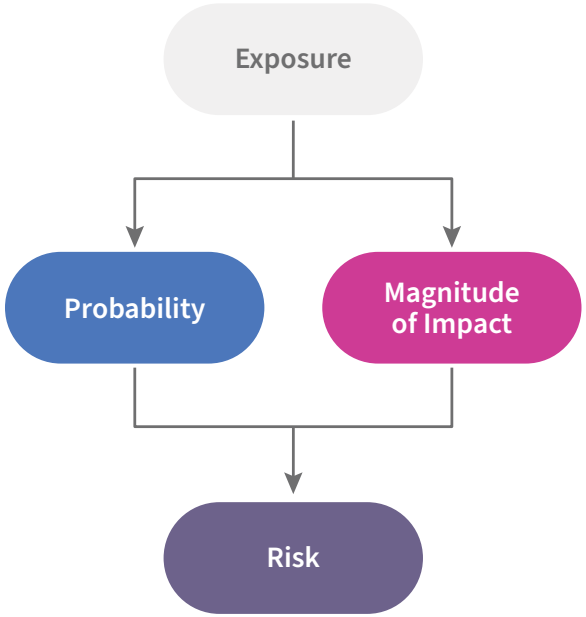


Figure 9. Components of risk. Source: U.S. Climate Resilience Toolkit.

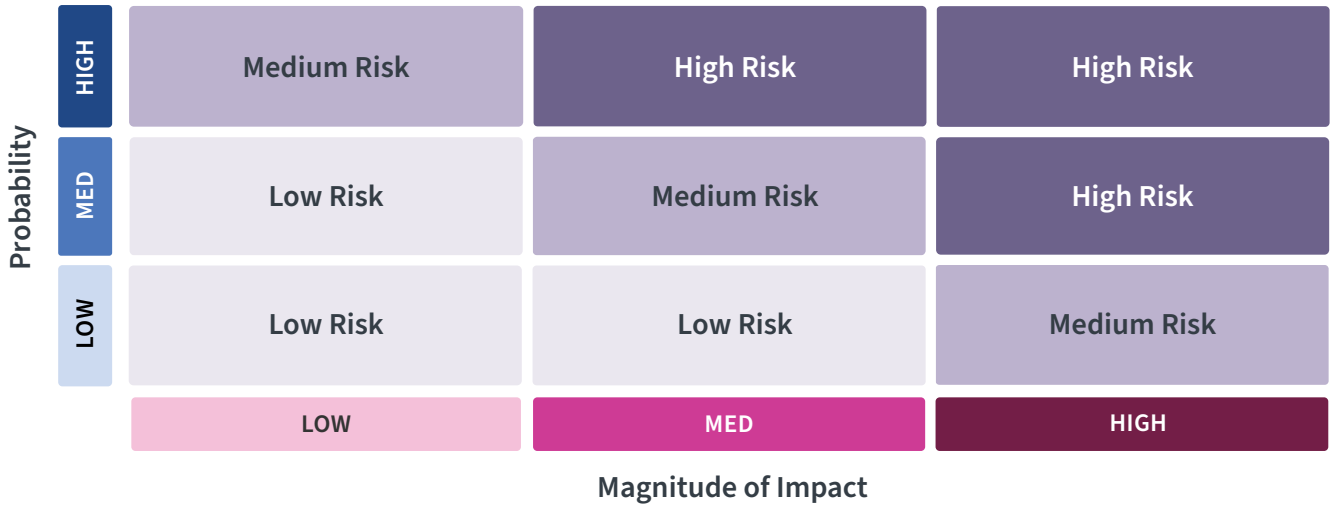
Tables 7a and 7b. Example rulesets and classifications for risk. Source: Fernleaf.

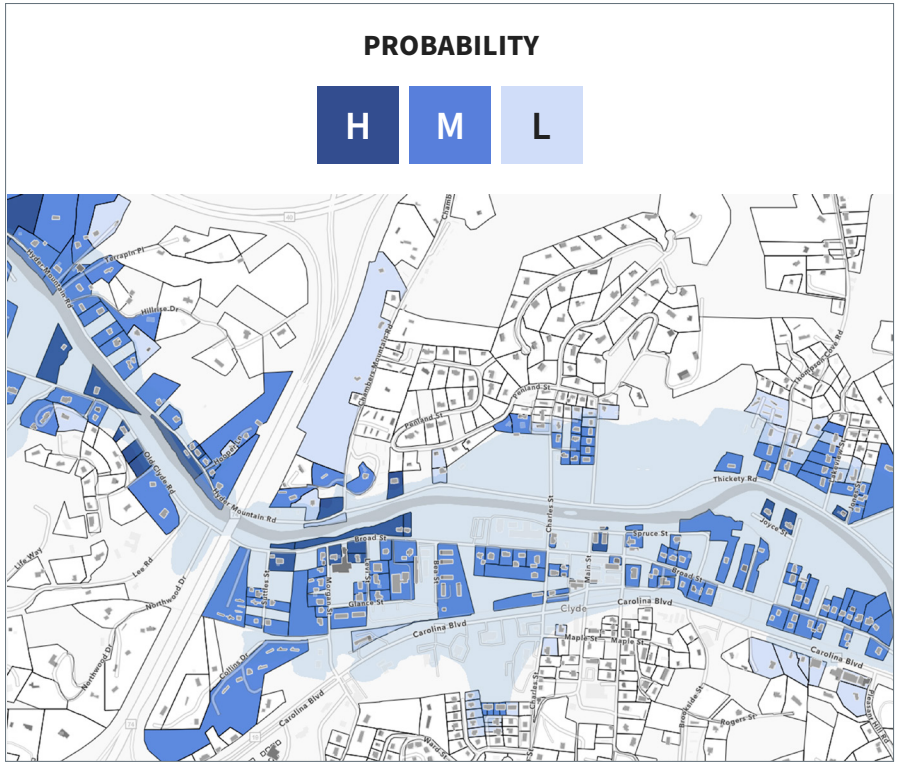
NATURE-BASED SOLUTIONS CONSIDERATION:
Of particular importance for natural systems is understanding how and where alteration, either climatic or human-caused, may influence the probability and magnitude of impact of the hazard, including riverine flooding, coastal flooding, extreme heat, drought, and wildfire.[34]

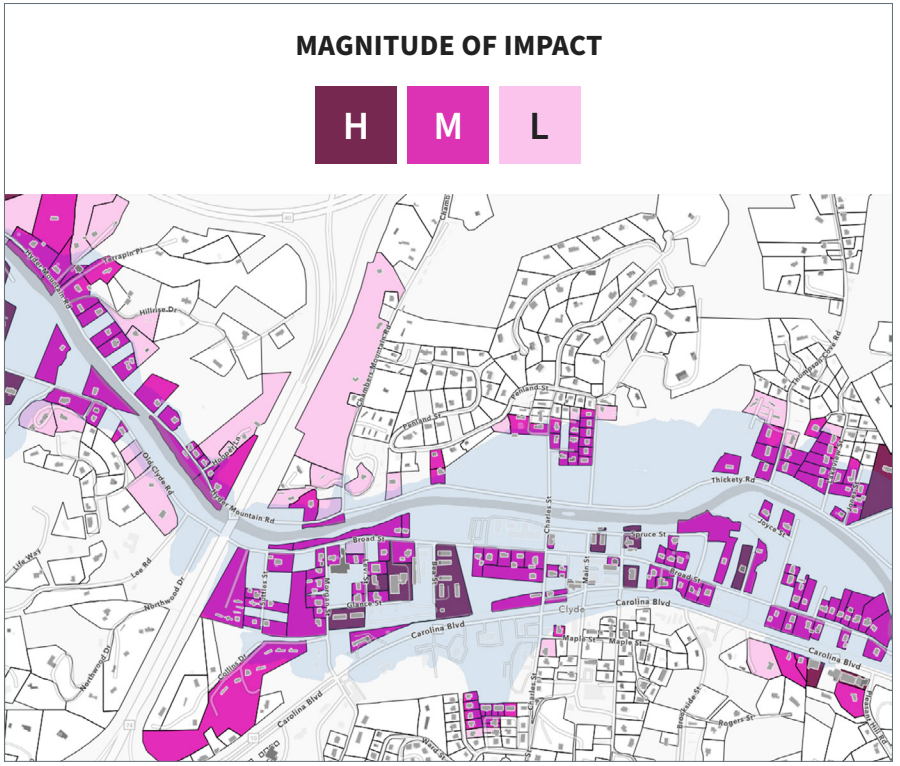
(a) Example high, medium, and low rulesets for a flooding assessment

Level	Probability	Magnitude of Impact
High	Structure in inundation extent & criticality of impact is high	Structure exposed to potential flood depth 1.5ft or greater in wave action zones OR 3ft or greater in stillwater zones
Medium	Structure in inundation extent	Potential flood depth between -2 ft to 1.5ft in wave action zones OR 1ft to 3ft in stillwater zones
Low	No structure in inundation extent (land only)	Potential flood depth less than -2ft in wave action zones OR less than 1ft in stillwater zones

(b) Classifications of risk. Source: Fernleaf.







Figures 10a and 10b. Examples of spatial analysis of probability (**a**) and magnitude of impact (**b**). Source: Fernleaf.

Properties with a high probability are those where the structure is in the 100-year extent (**Figure 10a**, dark blue). The 100-year flood has a higher probability of occurring than a 500-year flood.

The magnitude of impact is higher (**Figure 10b**, dark pink) for structures exposed to a flood depth of 1.5ft or greater or that are within a wave action zone.

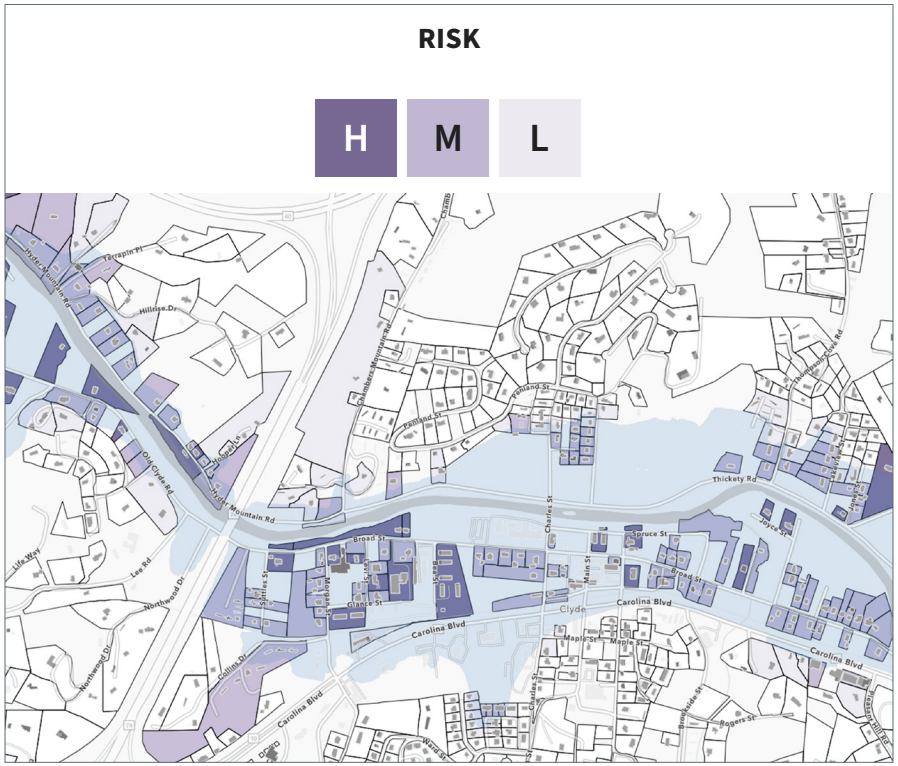


Figure 11. Example spatial analysis output generated for risk. Source: Fernleaf.

Probability and magnitude of impact are combined to generate one overall value for risk (**Figure 11**). Properties with the highest risk (**Figure 11**, dark purple) are where both probability and magnitude of impact are high.

Combined vulnerability and risk

Vulnerability and risk provide distinct views of how exposure can disrupt people's lives, community-valued services and assets, etc. By combining these metrics (**Table 8**; **Figure 12**), practitioners will be able to quickly screen the highest priority community assets and resources exposed to a given climate-related hazard, and also to consider options according to different levels of risk. It also provides the ability to consider high impact/low probability events, or community assets that are highly vulnerable but at low risk.

Once vulnerability and risk are determined, they may be combined into one overall metric with ordinal values of "high / medium / low." Having analyzed (**Table 8**) and mapped (**Figure 12**) these data through an agreed-upon assessment of rulesets, the resilience planning team may focus on populations and community assets with medium or high combined vulnerability and risk.

Whereas the ruleset examples provided above are for direct impacts to physical assets in the built-environment, a similar spatial analytical approach can be applied to understand health impacts at a neighborhood level. When scientific studies link population groups or pre-existing health conditions with

hazard-related health outcomes, aggregate data on “sensitive or at-risk populations” (terminology often used in public health contexts) can be used in combination with environmental data to identify areas with concentrated vulnerability in a community. For example, older adults and infants, pregnant women, individuals with pre-existing conditions such as diabetes, cardiovascular diseases, asthma are known to have higher biological sensitivity to extreme heat; outdoor workers (particularly those who are undocumented) and athletes are more likely to be exposed to extreme heat; income, poverty and race have been associated with increased hospital admissions during extreme heat events. Below is an screening-level vulnerability assessment for extreme heat where in dark red are the census block groups with “high” vulnerability based on the areas having high percentages of older individuals and infants, highly developed land cover, high percentages of low-income households, and low tree canopy coverage.

Table 8. Classifications of combined vulnerability and risk. Source: Fernleaf.

Risk	LOW	MED	HIGH
HIGH	Medium Combined Vulnerability and Risk	High Combined Vulnerability and Risk	High Combined Vulnerability and Risk
MED	Low Combined Vulnerability and Risk	Medium Combined Vulnerability and Risk	High Combined Vulnerability and Risk
LOW	Low Combined Vulnerability and Risk	Low Combined Vulnerability and Risk	Medium Combined Vulnerability and Risk

Vulnerability

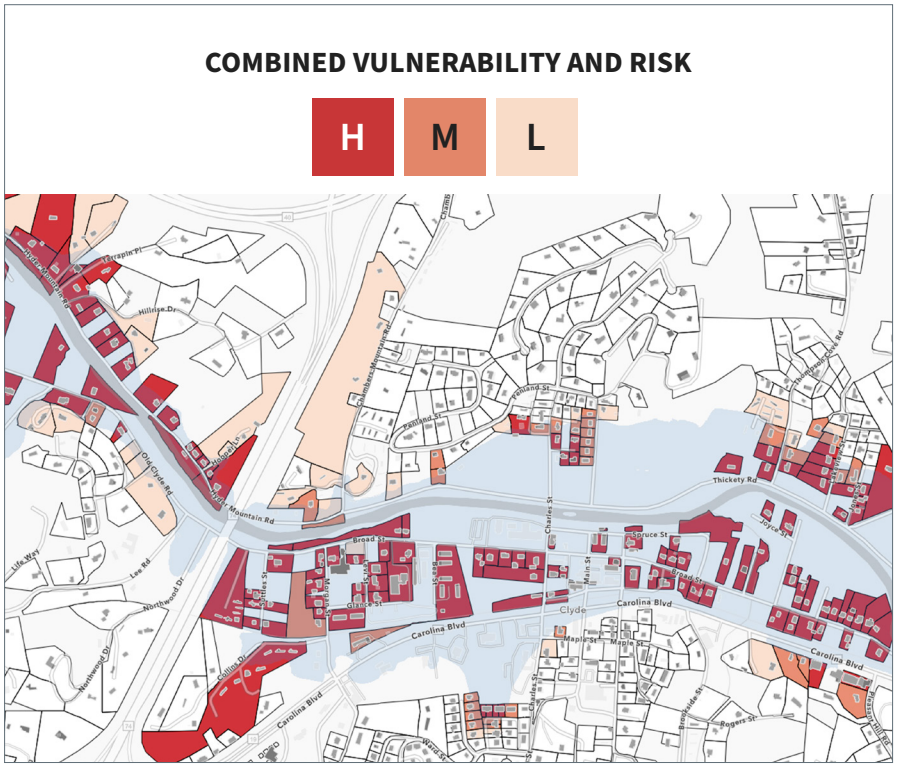


Figure 12. Example spatial analysis output generated for combined vulnerability and risk. Source: Fernleaf.

when combined, depict which properties of greatest concern (**Figure 13**, dark red). These properties should then become the focus of resilience efforts in later Steps.

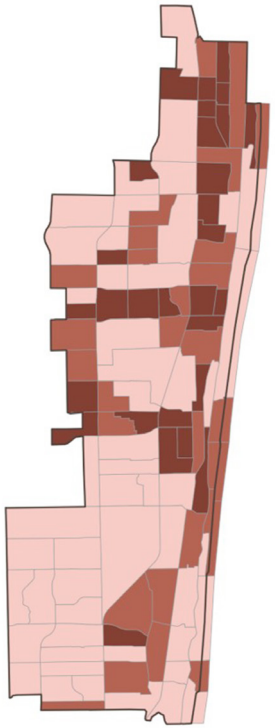


Figure 13. Example neighborhood-level map of vulnerability to extreme heat (darker indicating greater vulnerability). Source: Fernleaf, Southeast Palm Beach County Coastal Resilience Partnership.

Understand pre-existing stressors and disproportionate impacts to people

Hazards are known to disproportionately impact low-income individuals, people of color, other marginalized groups and historically underserved neighborhoods that already face chronic economic, social and environmental challenges (*pre-existing* or underlying *stressors*) in *frontline communities*.[35] Examples of pre-existing stressors at the community level can include challenges in access to basic needs (housing, food, water), resources (transportation, health care,) and opportunities (education, recreation, economic) as well as social capital. The root causes of these challenges are the result of or historical and contemporary structural inequities, i.e. "the interpersonal, intrapersonal, institutional and systemic mechanisms that organize the distribution of power and resources differentially across lines of race, gender, class, sexual orientation, gender expression and other dimensions of individual and group identity".[36] *Societal inequities are reflected in differential climate vulnerabilities of some people and communities as well as are exacerbated by climate change*.[37] The figure on the following page from USDN's Guide to Equitable, Community-driven Climate Preparedness Planning[38] shows the relationship between root causes, social, and biological factors.

Pre-existing stressors in a community result in greater sensitivity of some people, groups and neighborhoods to climate hazards (**Figure 14**) as well as reduced ability to adapt to, cope with and recover from climate hazards (adaptive capacity) resulting in disproportionate losses and impacts to well being and safety following hazards. In addition, disproportionate impacts can also result from uneven exposure to climate-related hazards.[39] Below are several ways the practitioner can support developing this understanding with the planning team:

Use of spatial indicators: The planning team and community members are likely going to be able to name the most acute or widely experienced pre-existing stressors in their community which could be a starting place for the practitioner to look for more

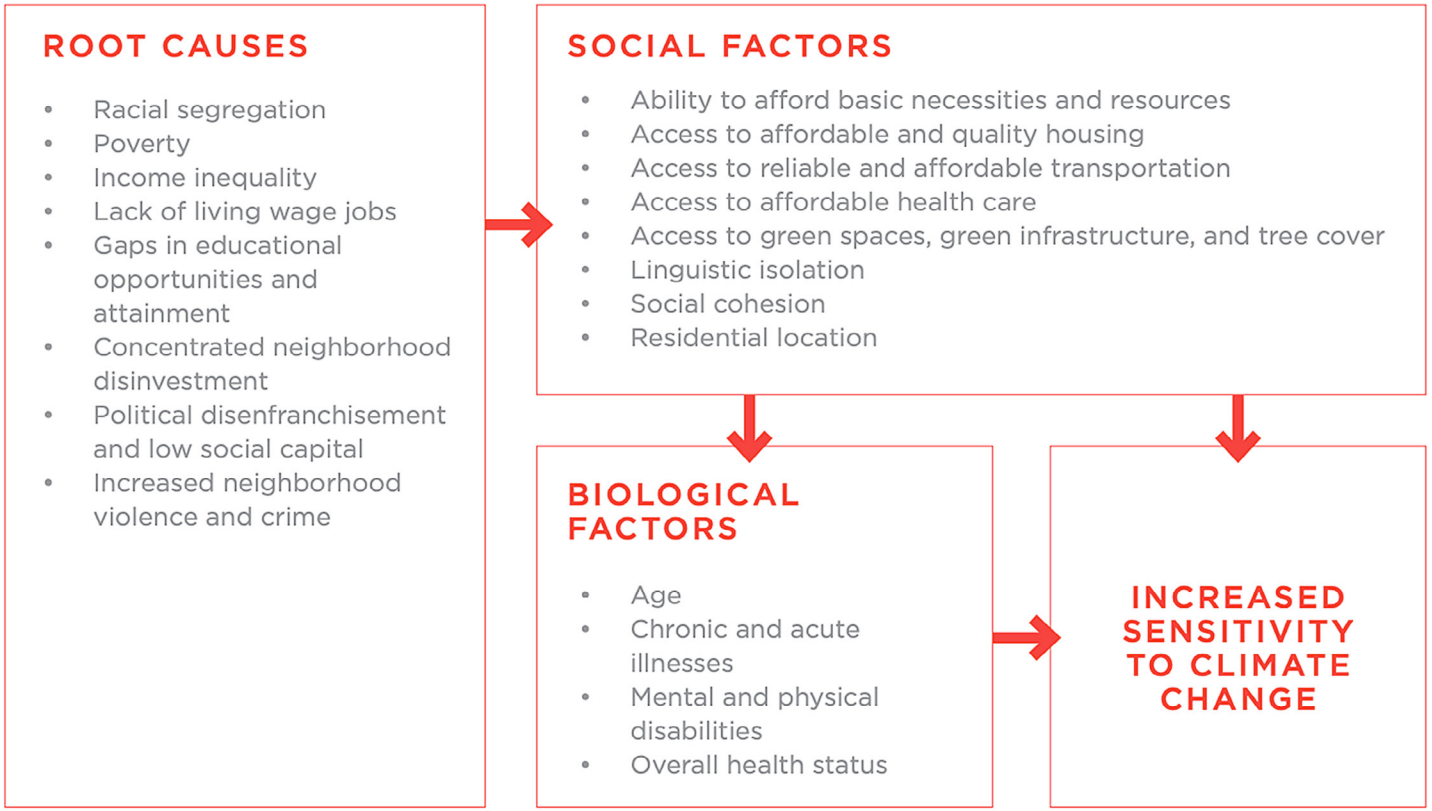


Figure 14. Relationships between root causes, social and biological factors. Source: USDN.

information. Spatial indicators can provide a more concrete understanding of unequal distribution of resources and opportunities across neighborhoods (distributive inequity) and also visualize where multiple stressors may overlap spatially. Some sources of information and approaches include:

1. USDA Food Access Research Atlas[40] which identifies where low-income and low food access overlap at the census tract level.
2. EPA EJScreen combines census-based demographic data with data on environmental hazards to help identify areas where low-income individuals and communities of color face higher pollution burdens.
3. CDC Social Vulnerability Index (SVI) calculated at the census tract level combines 15 census variables to help identify communities that may need support before, during or after disasters.

The following resource includes links with descriptions for several of these data resources: **Resource 1.3e | Social Vulnerability Indicators**.

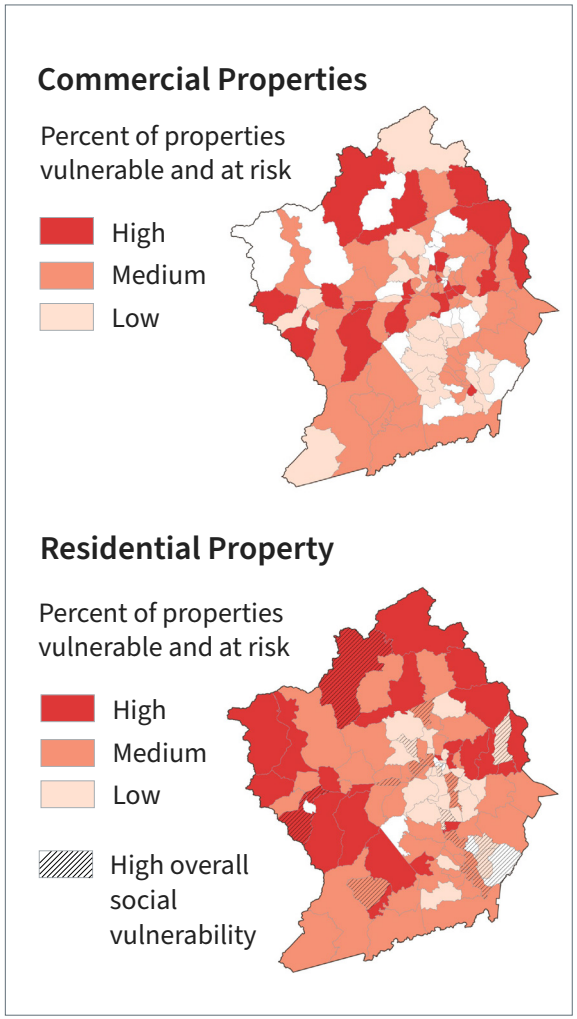


Figure 15. Example planning-level maps for combined vulnerability and risk showing commercial properties (top) and residential property (bottom). Source: Fernleaf, Land of Sky Regional Council.

Collaborative analyses with community leaders and community-based organizations: Community partners rooted in frontline communities have knowledge and expertise to help with "ground-truthing", fill in gaps where data representing community experiences are not available, and enable careful use of quantitative data on pre-existing stressors, social vulnerabilities, etc. This means avoiding deficit-based interpretations of individuals and groups as inherently vulnerable or lacking and developing a shared understanding of the historical context (see "Understand community history") as well as current policies, regulations, and practices that are at the root of challenges faced by frontline communities. The practitioner or community partner can facilitate an exercise to trace root causes of community stressors.[41] This careful interpretation and analysis is essential for identifying and prioritizing solutions that address causes of disproportionate impacts rather than just the symptoms. This can also include using qualitative data (see In practice objective 1.3) that may include understanding and concerns expressed by community representatives.

Use of other community asset vulnerability and risk assessments: Aggregate-level information can be used with assessment results to understand co-occurrences of physical and social vulnerability. Community asset assessments of vulnerability and risk may reveal disproportionate impacts to people, for example when high vulnerability and risk coincides with assisted and affordable housing, community services such as community centers, and food infrastructure.

Figure 15 shows the proportion of community assets in three classes of vulnerability x risk. The top image shows neighborhoods in dark red where 100% of commercial properties (including offices, industrial properties, commercial and retail properties) are vulnerable and at-risk to flooding. **Figure 15** (bottom) shows the neighborhood areas where a high percentage of residential properties that are vulnerable flooding (darker red) co-occur with areas that have relatively high overall social vulnerability (hatching), which is based on CDC's SVI.

Table 9. Classifications of combined vulnerability and risk. Source: Fernleaf.

Theme and Asset	Asset Total	Floodplain Inundation (FEMA)	Storm Surge		Tidal Flooding and SLR (vulnerability)		
			Cat 3–5	Cat 3–5	2 ft + MHHW	3 ft + MHHW	4 ft + MHHW
Critical Services & Community Facilities							
Critical Facilities & Govt-Owned	137	77 (56%)	16 (12%)	97 (71%)	1 (1%)	2 (1%)	17 (12%)
Parks, Cultural, & Entertainment	53	25 (47%)	9 (17%)	30 (57%)	NA	2 (4%)	7 (13%)
Residential & Commercial Properties							
Residential	9,645	4,736 (49%)	1,093 (11%)	5,498 (57%)	48 (<1%)	160 (2%)	845 (9%)
Commercial & Industrial	516	299 (58%)	33 (6%)	350 (68%)	4 (1%)	7 1%)	42 (8%)

Generate assessment outputs

SUMMARY TABLES

A table that summarizes the final assessment results can be provided as a standalone document for the planning team and community. Below, find an example (**Table 9**) focusing on four community assets. The table presents a lot of numerical information, but it can provide a quick overview for geographic areas assessed in the project.

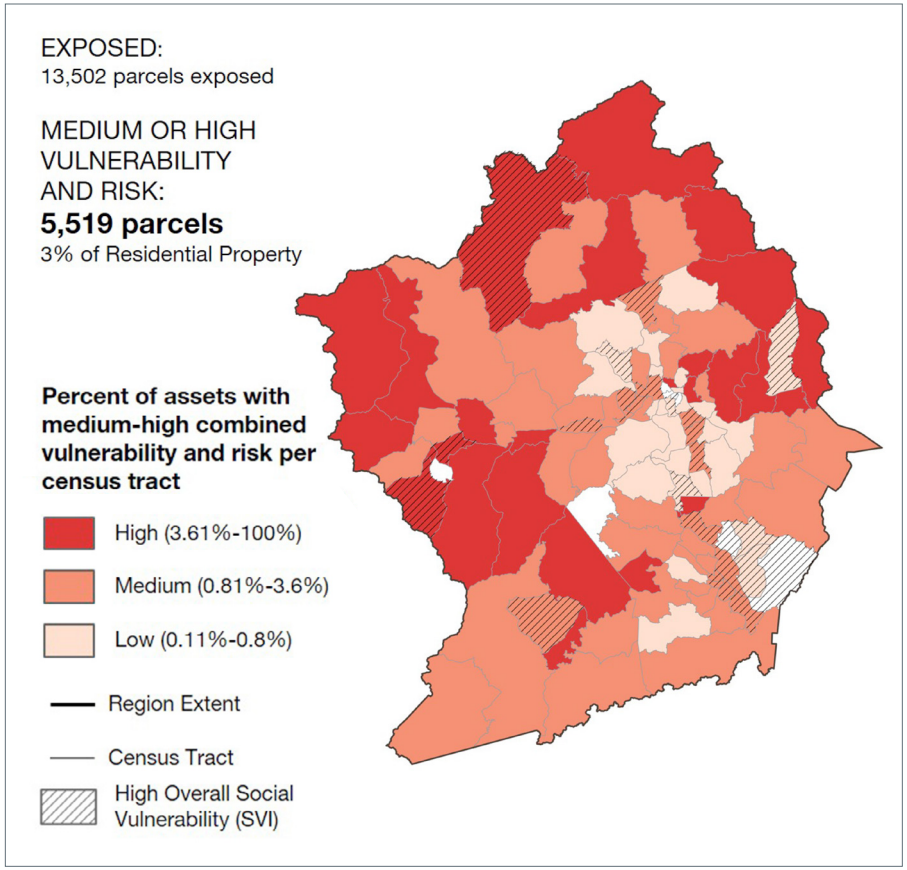


Figure 16. Map of census tracts with higher levels of combined vulnerability and risk in darker red. Source: Source: Fernleaf, Land of Sky Regional Council.

PLANNING-LEVEL MAPS

Planners often focus on census tracts, so results may be aggregated to this level to facilitate conversations with planners (**Figure 16**). Depicting vulnerability x risk and social vulnerability at this same unit of analysis can simplify conversations meant to balance both sets of considerations.

COMMUNITY ASSET-LEVEL MAPS

Asset-level maps can display the analysis results for each potential impact and can be used to identify specific properties in the study area.

In addition to displaying the combined vulnerability and risk results, the maps can also display the rulesets as "high," "medium," or "low" to help determine which assessment factors are driving the vulnerability and risk of each property (**Figure 17**).

Figure 17. Community asset-level map with higher levels of combined vulnerability and risk for parcels in darker red. Source: Fernleaf.

QUALITY CONTROL PRELIMINARY ASSESSMENT RESULTS

After completing the spatial assessment, the results may go through several rounds of quality control (QC). This process is essential for ensuring the data outputs are spatially accurate and rulesets are applied correctly.

Use **Resource 2.2c | Guidance: Analysis QC** to keep track of and communicate the status of analysis and any issues that are identified during the QC process. If there are issues found, the assessment will need to be revised and another round of QC done.

2.3 Review preliminary assessment with planning team

After the initial analysis is complete and results are QC'd, meet with the planning team to share the preliminary results and receive feedback. Examine rulesets, study area boundaries, and outputs to ensure that the assessment factors are being applied as expected. This is an opportunity to ensure transparency in the assessment approach and methods.

Use the following resource to get started on planning the workshop and make updates to the agenda and slides as needed:

Resource 2.3a | Preliminary Results Meeting Agenda
Resource 2.3b | Preliminary Results Meeting Slides

During the meeting the practitioner can facilitate an exercise to begin thinking about the results in terms of any noticeable impacts and patterns, but also to receive feedback. Even after detailed QC of the results, team members who are most familiar with their community may notice something is missing or not quite right.

Use **Resource 2.3c | Preliminary Results Feedback** to collect this feedback.

2.4 Use assessment results to create impact statements

Identify major vulnerabilities and highlight drivers of vulnerability and risk

In addition to understanding challenges that individuals and neighborhoods face as pre-existing stressors, the purpose of the step 2 assessment is to identify how hazards exacerbate these pre-existing stressors. One way to do that is by combining information of built-environment vulnerabilities with that on pre-existing stressors. For example, is the limited affordable housing stock of a community at risk to severe coastal flooding? Another way may be to identify areas within a community where a high proportion of vulnerable community assets co-occur in areas with concentrated poverty, people of color or “at-risk” individuals. This information can help identify priority neighborhoods for strategies where that may be a relevant consideration.

NATURE-BASED SOLUTIONS CONSIDERATION:

Certain factors, such as the ecological significance of the system, the magnitude and likelihood of climate impact, and the conservation and societal goals of the community influence a community's risk and consequences faced by hazards. The consequences of climate impacts are not felt equally by all groups, therefore identifying a range of stakeholders that is involved is crucial.[42]

Consider the geographic context of NbS projects with regard to highly vulnerable neighborhoods and populations: "factors such as the ecological significance of the system, the magnitude and likelihood of climate impact, and the conservation and societal goals of the community influence a community's risk and consequences faced by hazards. Since the consequences of climate impacts are not felt equally by all groups, involving a range of stakeholders is crucial to ensuring multiple and diverse viewpoints are included in the decisions."[43]

Understand consequences and develop impact statements

For each of the potential climate-related impacts, discuss how consequences will be experienced in the event of a hazard. Impact statements can be drafted to articulate major vulnerabilities, their drivers, and their consequences for identifying options that can address them effectively. These types of statements are comprised of three key ingredients:

- Summarize an assessment finding (may include geographic area, if applicable).
- Articulate the primary and secondary impacts and consequences of vulnerabilities identified on people, built environment, services, etc.
- Identify the cause(s) of vulnerabilities.

The **Resource 2.4a | Develop Impact Statements** provides an overview and guiding questions for the practitioner and planning team to develop impact statements.

2.5 Finalize assessment and synthesize findings

Integrate feedback from planning team

Use **Resource 2.3c | Preliminary Results Feedback** from the preliminary results meeting to further refine and finalize the assessment.

Feedback on rulesets may be the most common type of feedback provided. For example, determining if the rulesets were applied appropriately or if a particular type of asset that should have been considered high criticality was overlooked. Incorporate any changes that need to be made and run the assessment again.

QC final assessment results

Now that any changes to the assessment have been configured and new results are in-hand, another round of QC should be completed to ensure accuracy.

> As was done previously, use **Resource 2.2c | Analysis QC** to track the QC and note any issues. Ideally, these will be the final results.

However, the assessment may need to be re-run if there are errors and another round of QC will be needed.

Prepare synthesis and share

As mentioned earlier, results can be shared with the project team through a few different types of summary materials: summary table, planning-level maps, and asset-level maps. Use these options to highlight the impacts numerically and visually at the entire community-level, and also at the individual property-level. Each provides value for understanding and exploring the results and drivers of vulnerability and risk.

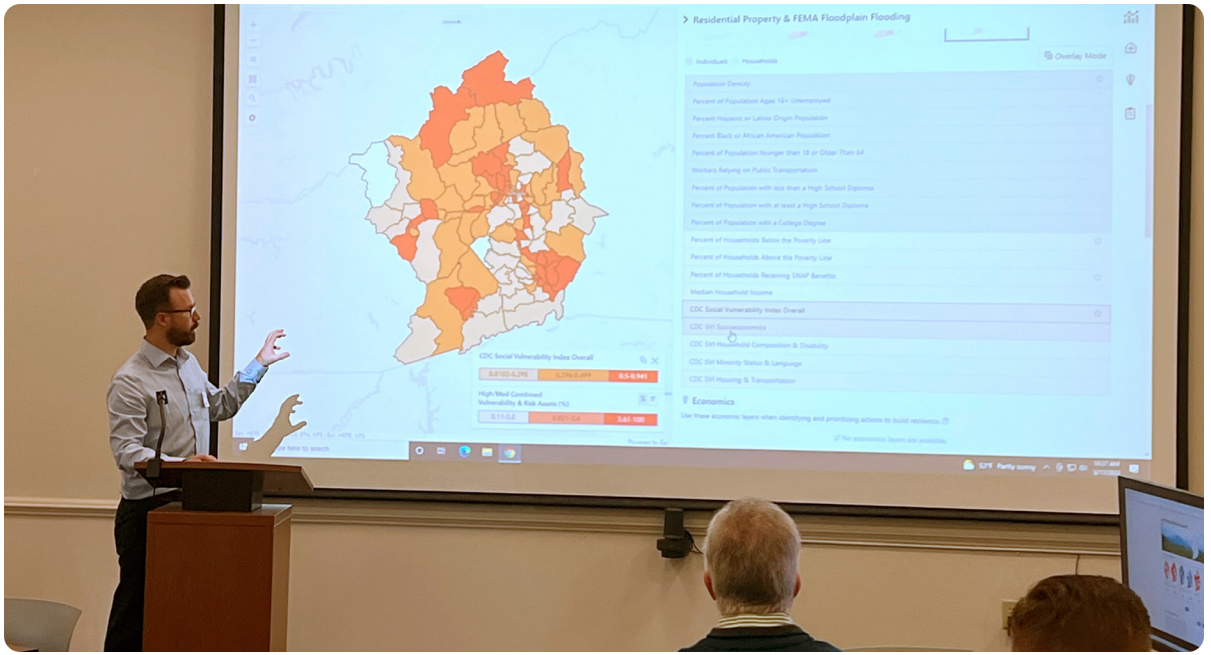
One of the final tasks in Step 2 is for the practitioner to compile the assessment results and impact statements into a short progress report that can be shared with the planning team and community. This report will serve as a valuable reference going forward. In addition to summarizing what has been assessed thus far, some key questions to consider and reflect on for this report include:

- Are there geographic areas with concentrated vulnerability and risk?
- What are the drivers of vulnerability and risk (adaptive capacity, vulnerability, etc.)?
- What are the primary types of vulnerabilities (certain people and community assets, hazards)?
- How are vulnerabilities expected to change in the future?
- Is there anything that was missed in Step 2 that may not have been made clear from the assessment results (such as issues known by the community)?

A template in **Resource 2.5a | Step 2 Synthesis Report** has been provided to capture all relevant information thus far.

In addition to the impact statement worksheets collected from the planning team, a variety of the previous resources will also be referenced to help fill in this template. The template is for a single hazard and the practitioner should use and change it however it fits the unique needs of the project, while reflecting the details of each hazard assessed. This synthesis will be used as a refresher for the group before beginning the brainstorming process in Step 3, but can also serve as a record for the community and be used in other ways.

Matt Hutchins reviews region-wide vulnerability and risk assessment results and socioeconomic metrics with the planning team. Source: Fernleaf.



2.6 Review assessment findings with planning team

A final meeting should be held with the full planning team to review the final assessment results and collaborate to develop insights through the use of impact statements.

Use the following resources get started on planning the workshop and make updates to the agenda and slides as needed:

Resource 2.6a | Step 2 Results Workshop Agenda
Resource 2.6b | Step 2 Workshop Slides

Endnotes

34 Section 3.2, "Approaches and Tools for Assessing Hazard Risks Due to Altered Natural Systems" in Incorporating Nature-based Solutions into Community Climate Adaptation Planning

35 Georgetown Climate Center's Equitable Adaptation Legal & Policy Toolkit.

36 National Academies of Sciences, Engineering, and Medicine 2017. Communities in Action: Pathways to Health Equity. Washington, DC: The National Academies Press. https://doi.org/10.17226/24624

37 Thomas et al. 2018, Explaining differential vulnerability to climate change: a social science review. doi.org/10.1002/wcc.565

38 Yuen et al., 2017. *Guide to Equitable, Community-driven Climate Preparedness Planning*

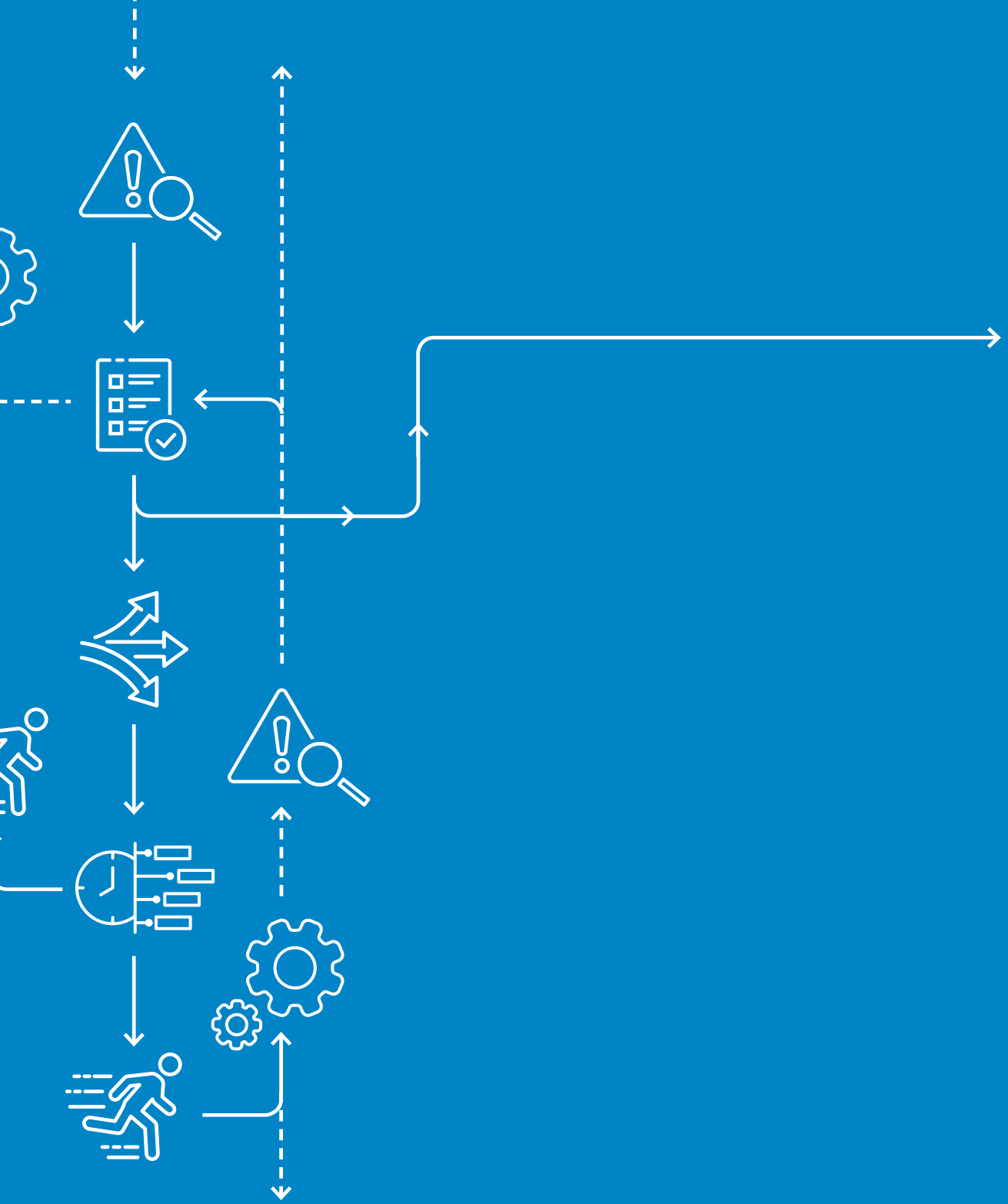
39 EPA. 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430-R-21-003.

40 https://www.ers.usda.gov/data-products/food-access-research-atlas/

41 "But Why" technique for analyzing root causes from the Center for Community Health and Development, https://ctb.ku.edu/en/table-of-contents/analyze/analyze-community-problems-and-solutions/root-causes/main

42 Section 3.4, "Consider Key Vulnerabilities and Hazard Risks" in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*

43 Section 3.3, "Integrate Equity and Environmental Justice Concerns" in *Incorporating Nature-based Solutions in Community Climate Adaptation Planning*



STEP 3:
Investigate Options

Back to previous view

STEP 3

Overview

List options to reduce the greatest climate-related vulnerabilities and risks to vulnerable populations and community assets. Having identified the greatest vulnerabilities and risks, the practitioner may consider how to focus subsequent planning on the most urgent needs. Options encompass objectives, strategies, and actions to build resilience to high priority vulnerabilities and risks. Resilience objectives should be consistent with the vision and goals of the community. Broad resilience objectives then provide a template for refining strategies and actions in subsequent stages.

The output from this step will be options to reduce the greatest climate-related risks to vulnerable populations and community assets.

OBJECTIVES

- ☐ **3.1** Review vulnerability and risk findings
- ☐ **3.2** Define resilience objectives
- ☐ **3.3** Research options
- ☐ **3.4** Ensure options are acceptable in your community

RESOURCES

- Step 3 | Implementation Examples
- Resource 3.2a | Step 3 Facilitation Recommendations
- Resource 3.2b | Develop Resilience Objectives
- Resource 3.3 | Database of Strategies and Actions
- Resource 3.4a | Options Inventory

OPPORTUNITIES FOR COMMUNITY PARTICIPATION

- Community input on resilience objectives and areas of focus.
- Align resilience actions with grassroots efforts.
- Agree on resources needed for continued, equitable engagement in the future.

QUESTIONS FOR ASSESSING THIS STEP:

- Do strategies address community-defined, highest priority climate-related impacts?
- Are actions linked to the vulnerabilities they are meant to address?
- Are expected outcomes clearly identified and linked to those actions?

Key Concepts

OPTIONS: Options encompass objectives, strategies, and actions to build resilience and can include policies, programs, projects, schemes, systems and technologies. Options require a subsequent decision about whether they will be enacted.

STRATEGY: Strategies elaborate the way in which resilience objectives are going to be achieved. While a strategy describes how a resilience objective may be achieved, it may not have a specific geographic scale or timeframe for implementation. Most options published in resilience plans are strategies.

ACTIONS AND PROJECTS: Actions and projects fit within a strategy and describe how a strategy will be carried out. Actions and projects have clear roles and responsibilities, timeframes, and geographic scale.

NATURE-BASED SOLUTIONS: Actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits.

GREEN INFRASTRUCTURE: a term that historically has been used to refer to the value and role of open space and ecosystem services broadly, but is now often used in a narrower sense focusing on nature-based approaches to stormwater management.

In practice

3.1 Review vulnerability and risk findings

Vulnerabilities and risks of greatest concern were identified through impact statements and summarized as central challenges in step 2. Review the output from assessing vulnerability and risk (**Resource 2.5a | Step 2 Synthesis Report**). Agree on the potential climate-related impacts to address in subsequent action steps. Be sure to address physical vulnerability (i.e., to buildings or infrastructure) as well as social vulnerability.

3.2 Define resilience objectives

ITERATE! Review the vision, values, and goals (**Resource 0.5a | Vision, Values, and Goals**) outlined at the outset of the project. Consider whether the list of climate-related impacts of greatest concern (**Resource 2.5a | Step 2 Synthesis Report**) reflect the scope, objectives, and interests of the project team (**Figure 18**). Is there anything within the vision and/or goals that should be added, modified, or emphasized at this point?

Given the range of issues to be addressed, are additional experts needed to properly identify and scope options for building resilience? Such expertise may also be useful in subsequent prioritization, planning, and actions.

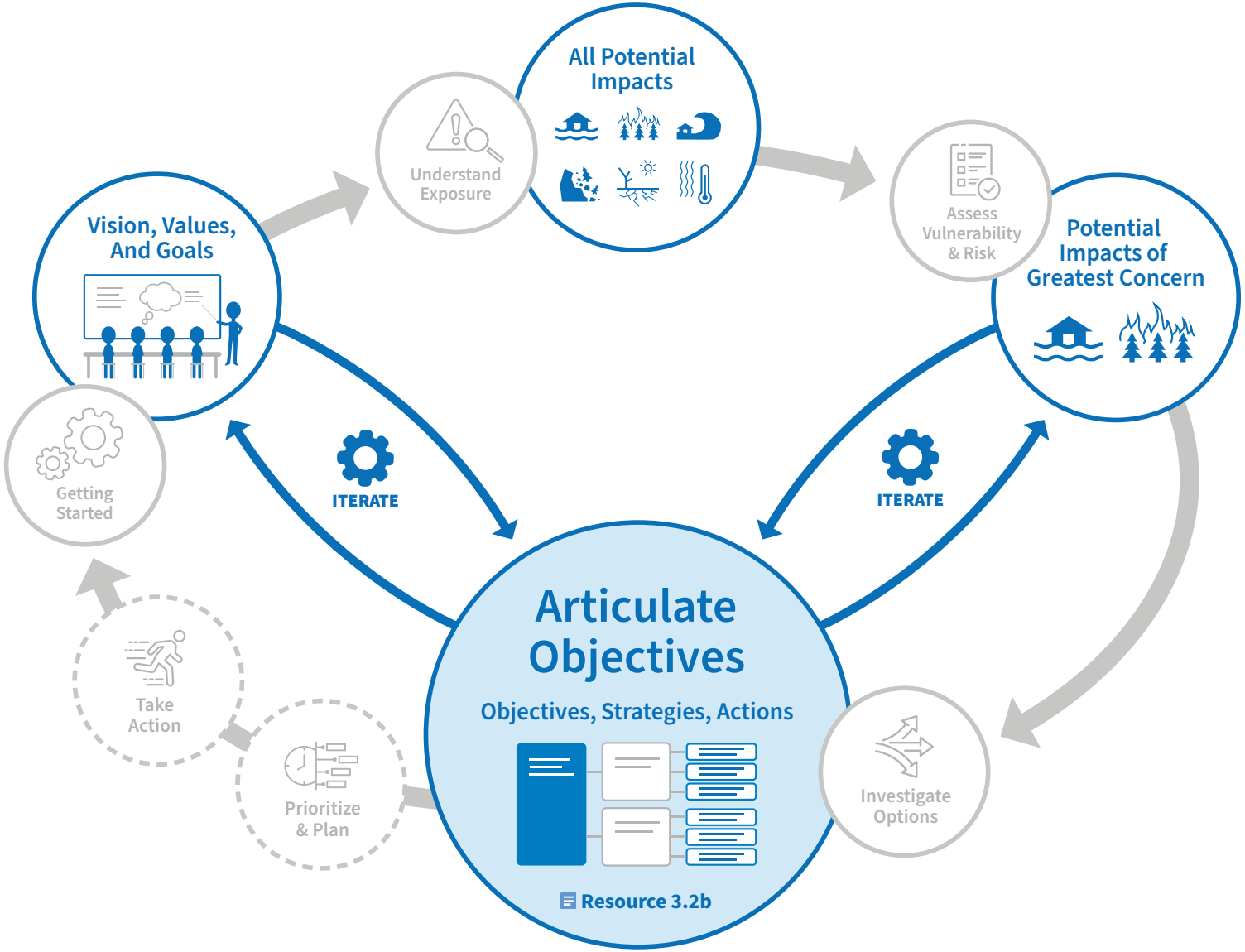


Figure 18. Define options based on the impacts of greatest concern, your team's overall vision, goals, and objectives.

FACILITATION

Team cohesion and buy-in are essential for the long-term success of resilience-building. The practitioner can facilitate the development of resilience objectives after reviewing goals and challenges (**Figure 19**). The resilience objectives should answer the question, "in light of the challenges identified and the community's long-term vision, what does the community want to achieve?" The **Resource 3.2a | Step 3 Facilitation Recommendations** provide some recommendations for carrying out this exercise with the team.

Given limited resources for implementation, it is helpful (even during the research phase of potential actions) to filter out strategies or actions that are clearly infeasible or not directly relevant.

Be sure that the resilience objectives within **Resource 3.2b | Develop Resilience Objectives** adequately address the highest vulnerabilities and risks.

Objectives that directly address inequity (i.e., disparities in access to food, shelter, health, recreation, and economic opportunities) can reduce sensitivity of frontline communities by building capacity to adapt and thrive. Information for setting such objectives can come from data or from the needs identified by the community.

Take stock of what has been learned from involving the community so far. What resources, capacities and capabilities can improve mutual engagement between community members and local government?

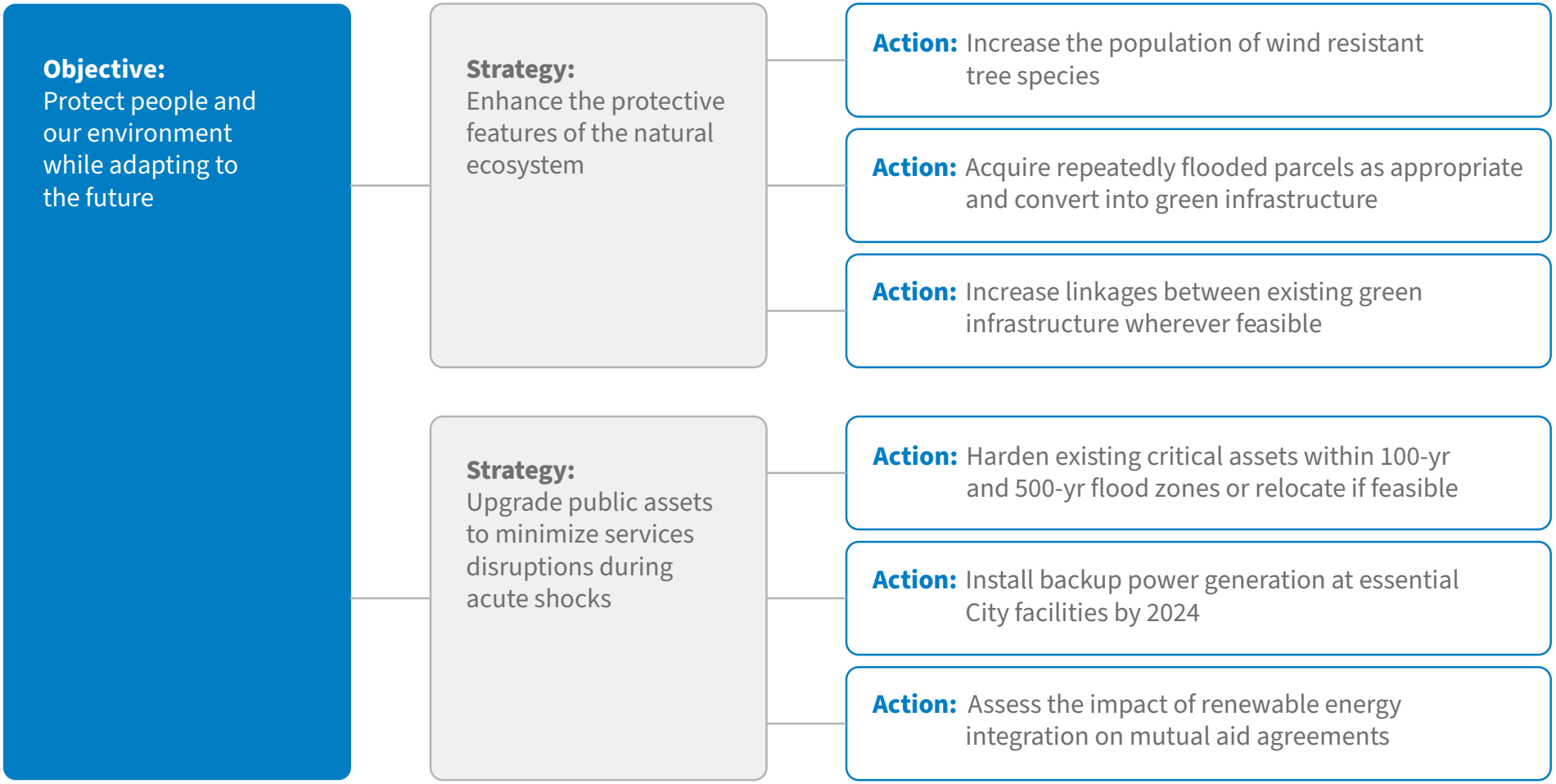


Figure 19. Options generally describe objectives, strategies, and actions which are hierarchically linked as shown. Source: Fernleaf.

3.3 Research options

Compile relevant strategies or actions from existing plans **Resource 3.2b | Develop Resilience Objectives**, for example county or municipal comprehensive, emergency management, hazard mitigation, stormwater, sustainability, capital improvement, and other plans. Such plans were listed in the preparatory phase of the project; update **Resource 0.4 | Plans, Initiatives, and Context Inventory**. The practitioner can start this and ask planning team members to provide input on their own departments' efforts. Look for opportunities where existing projects, programs, and plans can be augmented, modified, or leveraged to achieve one or more resilience objectives. Also make note of any current efforts that may conflict with resilience objectives or assessment findings (e.g., maladaptation).

Consult strategies or actions that other communities have considered or implemented to address similar challenges, including sector-based, regional, or state-level guidance.

Resource 3.3 | Database of Strategies and Actions is a database of actions collected from multiple sources and communities around the nation that target a wide array of vulnerabilities. These actions range from small planning efforts to large, multi-step strategies. The planning team may flag which of these strategies and actions from other communities they would like to consider.

NbS

Nature-based Solutions (NbS) may be prevalent in plans that address individual sectors for which land use is especially relevant, such as transportation or human health. **Table 10** contrasts conventional approaches and NbS for a variety of hazards.[44]

Table 10. Examples of Nature-based Solutions for Hazard Risk Reduction. Source: NWF.[44]

Natural Hazard	Conventional Approaches	Natural or Nature-based Approaches	Examples
Inland Flooding	Dams, dikes, levees, stream channelization, stormwater sewers, combined sewers, pumps	• Floodplain and watershed restoration • Green stormwater management • Protecting floodplains from development • Moving people and infrastructure away from high-risk areas ("managed retreat")	• Levee setbacks and dam removal; wetland restoration • Rain gardens; permeable surfaces • Local legislation limiting new development in floodplains/ high-risk areas • Open space acquisition and protection; voluntary buyouts
Coastal hazards	Seawalls, bulkheads, dikes, breakwaters, levees	• Coastal habitat protection and restoration • Living shorelines • Protecting coastal areas from development • Moving people and infrastructure away from high-risk-areas ("managed retreat")	• Protecting and restoring coastal wetlands; beaches, dunes, and barrier islands; coral and oyster reefs • Vegetation-only or combined vegetation and structural approaches (e.g., constructed marsh with sills or breakwater structures) • Voluntary buyouts; coastal open space protection
Extreme heat and drought	Dams and reservoirs, air conditioning	• Watershed restoration • Urban green infrastructure • Water conservation	• Headwater stream and forest restoration; beaver restoration • Urban forestry; green roofs; cool pavement • Rainwater harvesting; xeriscaping; water-saving agricultural practices
Wildfires	Wholesale suppression of wildfires	• Ecological forest management • Learning to live with fire • Reducing edge development in fire prone habitat	• Fuel reduction treatments; prescribed fire; post-fire restoration • Community planning and collaborative risk management; managed wildfire • Update land use/zoning

Equity

The Georgetown Climate Center Equitable Adaptation Legal and Policy Toolkit[45] provides case studies from communities in the U.S. that have worked to ensure that resilience efforts are equitable. The toolkit includes emerging practices in economic, housing, public health, energy, water, disaster and natural infrastructure sectors as well as policies that enable robust community involvement in resilience decision-making.

CO-DEVELOP CLIMATE RESILIENCE PROJECTS WITH COMMUNITY RESIDENTS[46]

A platform for community co-development helps shift funding and finance resources to communities most in need. This platform may:

- Enhance community trust and buy-in around a project, a key prerequisite for funder interest.
- Better identify and prioritize the funding 'ask.'
- Increase eligibility for funding opportunities that include a robust vulnerability assessment and community engagement as part of the funding criteria.
- Ensure accountability to outcomes that reflect community needs and assets rather than those reflecting a predetermined view of what resilience should look like.
- Grow investor support by establishing community buy-in.
- Maximize project design, readiness for funding, and outcomes by supplementing content expertise (city planners and engineers) with context expertise (community residents).

How:

1. Reassess how community needs and assets are understood via more human-centric vulnerability assessments.
2. Establish a platform for project co-development alongside community residents.
3. Ensure accessibility.

INCENTIVIZE CLIMATE RESILIENCE ACTION

Embedding resilience into local government policies and creating new policies to support the climate resilience agenda can:

- Increase certainty for investors.
- Reduce transaction costs.
- Incentivize resilience.
- Mitigate risk and avoid losses.
- Enhance transparency.
- Set a framework for data collection and ongoing monitoring and maintenance.
- Mandate best practice.
- Increase eligibility for funding.
- Unlock additional funding streams.
- Increase local government creditworthiness and, therefore, fundability.
- Ensure more equitable outcomes.
- Improve efficiency.

How:

1. Bake risks into institutional framework and policies.
2. Establish equitable resilience standards and incentives.
3. Support Structural Shifts.

For additional details see: Ready-to-Fund Resilience Guidebook Toolkit

ITERATE! This planning stage involves evaluating projects based on a variety of factors. Many communities iterate between Investigating Options and Prioritization and Planning before implementing any resilience actions.

3.4 Identify acceptable options in your community

Facilitate dialogue to ensure team members and all stakeholders agree that selected strategies, actions, and potential projects (**Resource 3.4a | Options Inventory**) are likely to address their primary concerns (See **Figure 18** and the following definitions from the Glossary for distinctions among these terms).

Strategy: strategies describe the way in which resilience objectives are going to be achieved but may not have a specific geographic scale or timeframe for implementation. Most options published in resilience plans are strategies.

Actions and projects: actions and projects fit within a strategy and describe how a strategy will be carried out. Actions and projects include roles and responsibilities, timeframes, and geographic boundaries.

ITERATE: If one or two types of options dominate, the practitioner should help the team investigate and ask why.

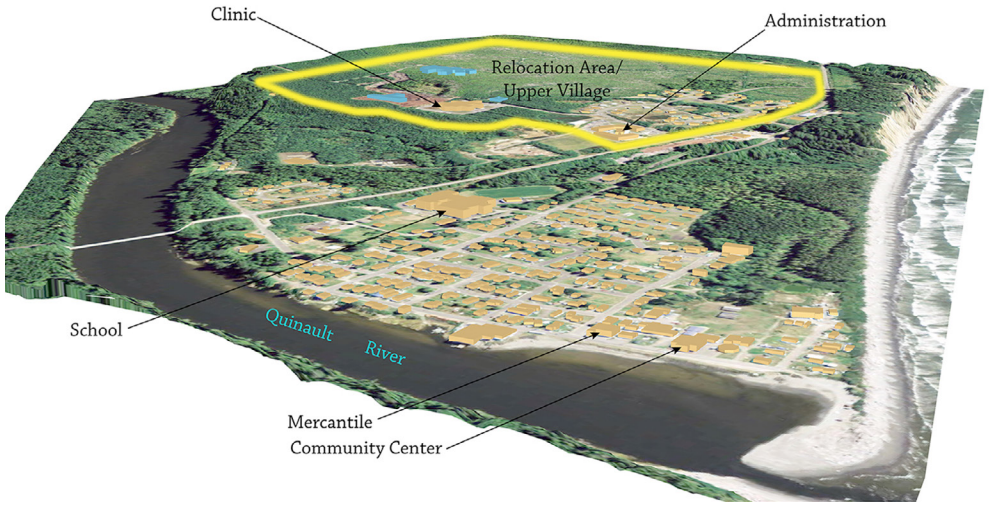
Types of options

Table 11 lists types of options to include within the options inventory. The list strategies and projects must be comprehensive enough to address the many ways climate-related hazards impact communities. A spectrum of the types of options a community might consider are represented in tabs within the Resource 3.4a | Options Inventory spreadsheet.

Understand how options reduce vulnerability and risk

To ensure that options are informed by the climate-related impacts of greatest concern (see Resource 2.5a), it is important to articulate how (and the extent to which) an option reduces vulnerability and risk to people, community resources and assets through one of three pathways: (1) reducing exposure, (2) reducing sensitivity, or (3) increasing adaptive capacity.

Note how options address vulnerability and risk in the Resource 3.4a | Options Inventory spreadsheet.



The visualization shows the existing village of Taholah, with the higher elevation area for relocation outlined in yellow. Source: Quinault Indian Nation Department of Planning, Community & Economic Development.

Table 11. Types of options for building resilience. Source: Fernleaf

Natural infrastructure	Natural infrastructure refers to the services that natural systems provide to people and is infrastructure that either uses, restores, or emulates natural ecological, geological, or physical processes. Green infrastructure is often placed under this umbrella and is a term that is now often used to refer to nature-based approaches to storm-water management.[49]
Built infrastructure	Actions that create or modify the design of infrastructure. Actions to to design new codes, standards, and engineering are also considered built infrastructure strategies.
Land use	Actions that incorporate climate information into land use practice, planning, and policy. Examples of NbS approaches to land use practices include wetland and watershed restoration projects that restore and protect existing natural systems.[50]
Planning, Policy, and Management	Planning, policy, and management strategies (excluding those related to land use) that integrate climate. Policy actions are focused on creating new or revising existing regulations and legislations. Operations and practice actions modify on-the-ground operations, management, and programs. Planning, policy, and management can encourage NbS solutions such as green roofs, urban forestry, and water conservation.
Governance Capacity Building	Actions that build and sustain capacity of government staff and decision makers (local or regional) to identify, assess and implement actions for adaptation and building resilience. These actions can take the form of building partnerships with other government, private, academic, or non-profit entities to share expertise and align resources; regional climate collaboration; analysis and research investments; capacity to monitor climate impacts as well as outcomes of taking action; and capacity for collaborative decision-making.
Community Engagement & Capacity Building	These are actions and investments that provide direct resources to community organizations, groups and individuals that are needed to cope, adapt and thrive in a changing climate. Communication, outreach and resources for community members to engage as partners in climate decision making and may be crucial to informing a large number of strategies.
Funding and Finance	External funding includes federal, state, non-profit, and private grants. Financing involves the mechanisms for borrowing money and paying it back in order to implement resilience actions.

Understand opportunities and considerations for social equity

Options will explicitly advance equity, require additional considerations to avoid exacerbating equity concerns, or both. The practitioner and the planning team may consider the following opportunities for explicitly advancing procedural, distributional and structural equity when brainstorming strategies:

1. Strategies that take into account unique disaster preparedness and recovery needs of diverse individuals, households, and groups (short-term; *distributive equity*).
2. Strategies that seek to reduce inequities in access to resources and opportunities within the community (i.e. *pre-existing stressors*) such as lack of affordable housing, food deserts, affordable medical care (short or long term; *distributive equity*).
3. Strategies that seek to improve local government and community capacity and capabilities to move towards more deliberative and participatory governance[47] (*procedural and structural equity*). Reflect on the readiness evaluation (see Frontline Community Participation) and experiences involving community members so far.
4. Strategies that seek to address root causes of differential vulnerability (i.e. structural inequities including structural racism and) such as through changes in policies, law, governance and culture that perpetuate systemic inequities, through reparative actions, and through actions that institutionalize accountability to frontline communities and support their leadership and voice in decision making.
5. Lastly, for all other options, **Table 12** provides a set of questions (co-developed with community partners for Portland and Multnomah County's Climate Action through Equity plan) that are useful to consider opportunities for equity-related co-benefits (engagement, capacity building, alignment and partnership, relationship building, economic opportunity, accountability) or, at a minimum, to avoid exacerbating equity concerns (disproportionate impacts, accessibility) and unintended consequences like gentrification.

Table 12. Equity Considerations from Williams-Rajee, D. Used with permission[51]

Shared Benefits	Can the benefits of action reduce historical or current disparities?
Engagement	Can the action engage and empower in a meaningful, authentic and culturally appropriate manner?
Capacity Building	Can the action help build community capacity through funding, and expanded knowledge base or other resources?
Alignment & Partnership	Can the action align with and support priorities of frontline communities, create an opportunity to leverage resources and build collaborative partnerships?
Relationship Building	Can the action help foster the building of effective, long-term relationships and trust between diverse communities and local government?
Economic Opportunity & Staff Diversity	Does the option support frontline communities through workforce development, contracting opportunities or increased diversity of city and county staff?
Accountability	Does the option have accountability mechanisms to ensure frontline communities will equitably benefit and not be disproportionately harmed?
Disproportionate Impacts (of actions)	Does the action generate burdens to frontline and marginalized communities?
Accessibility	Are the benefits of the action broadly accessible to households and businesses throughout the community – particularly, communities of color, low income individuals and emerging small businesses?

NATURE-BASED SOLUTIONS CONSIDERATION[48]

Consider that Nature-based Solutions (NbS) can both address equity concerns and exacerbate them. Nature-based Solutions, such as urban green space, offer broad health benefits, such as reducing chronic disease, promoting mental well-being, and providing safe places to exercise. While these solutions improve mental and physical health outcomes for communities, they also often support social and ecological community cohesion that can be undermined by traditional gray infrastructure solutions. In addition to various benefits, NbS can also create challenges for socially vulnerable populations in the form of unintended consequences. One example is the creation of green spaces that can cause an increase in housing costs and property values, ultimately resulting in gentrification and displacement of the very residents these strategies intended to benefit. Building on this knowledge of existing inequities early in the process, practitioners should consider concrete strategies centered on community members who are most affected by climate change as well as environmental and social injustices in their risk assessments. Certain NbS options may be rooted in existing vulnerabilities and may require a decision to be left out as potential adaptation solutions.

Record options with supporting information

The options inventory (**Resource 3.4a | Options Inventory**) represents the synthesis of all prior work: impact statements, resilience objectives, research. Supplement this inventory with the following attributes:

- Overall resilience objective and challenge(s) addressed.
- Strategy vs action or project (whether option is a strategy or more specific project-level action).
- Timescale for implementation: near-term, mid-term, or long-term.
- Lead agency and partners responsible.
- Notes on efficacy, feasibility, capacity, responsible entities, or potential partners and community strengths that can be leveraged.

Endnotes

44 From section 4 in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.* For more on NbS related to specific sectors, see section 4.2, "Nature-based Solutions for Other Key Sectors/Concerns".

45 Georgetown Climate Center's Equitable Adaptation Toolkit, https://www.georgetownclimate.org/articles/equitable-adaptation-toolkit-release.html

46 See Characteristic 4 in The Ready-to-Fund Resilience Guidebook

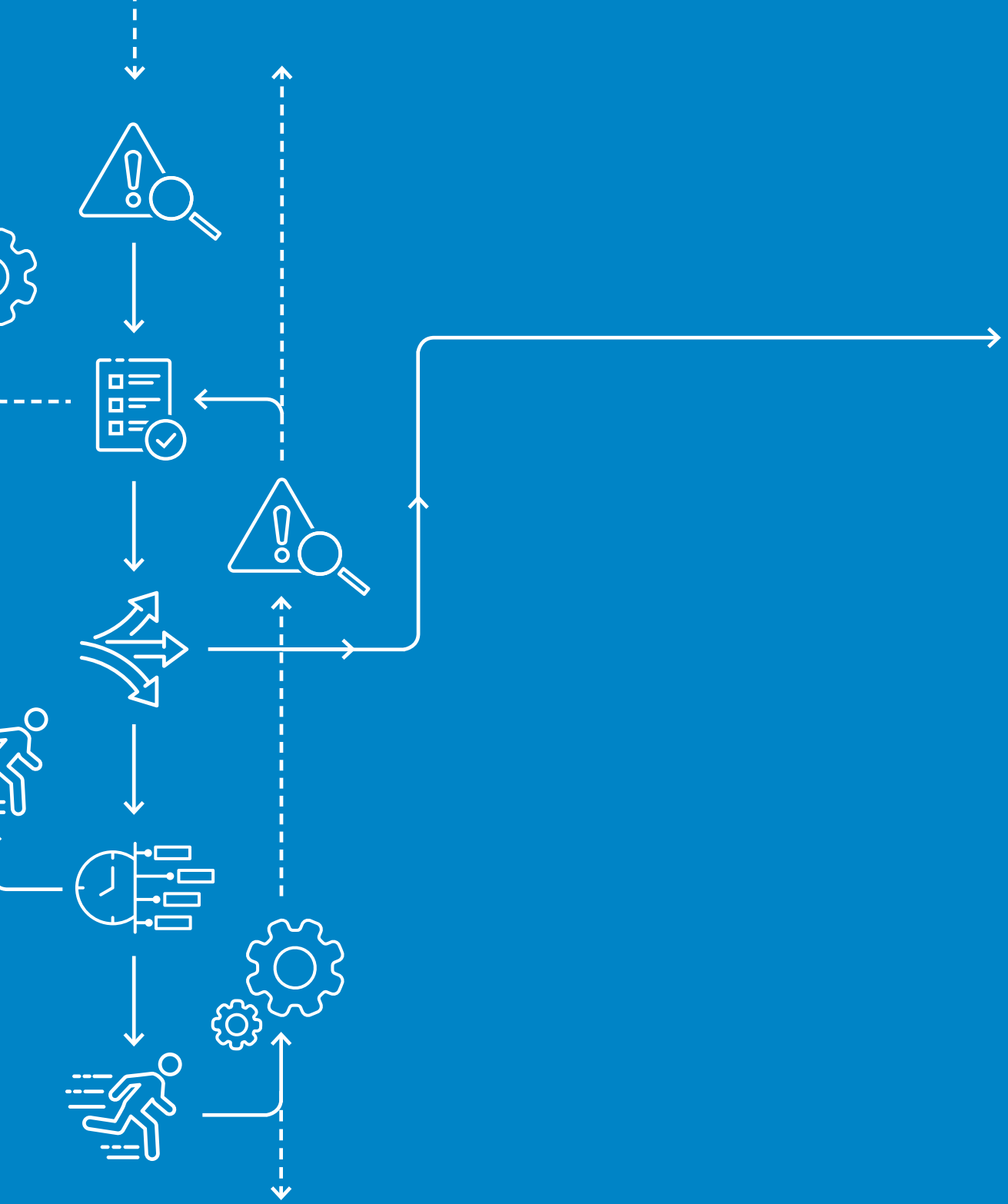
47 See section 1.2, "Related Terms and Concepts," in Pathak et al. for a complete description of Natural Infrastructure and other related terms.

48 For additional examples of all types of NbS by hazard, see section 4.1 in Pathak et al.

49 For identifying potential strategies, see the discussion of 'Essential Conditions for Collaborative Governance' in From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental and Racial Equity Committees. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

50 Williams-Rajee, D. and T. Evans. 2016

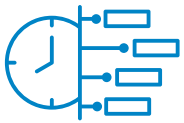
51 Refer to the section "Diversity, equity, and inclusion" on page 44 and section 3.3, "Integrate Equity and Environmental Justice Concerns" in Incorporating Nature-based Solutions into Community Climate Adaptation Planning.



STEP 4:
Prioritize and Plan

Back to previous view

STEP 4



Prioritize and Plan

Overview

Design an implementation plan for the strategies that are mostly likely to reduce vulnerability and risk. The goal of **prioritization** is to delineate achievable actions that address the highest priorities identified thus far and that have the support of community stakeholders. The goal of **planning** is to find synergy and cost savings within the resilience plan while eliminating unwanted, unintended consequences. This chapter provides tools for assessing project feasibility, especially removing barriers to implementation. Seek efficiency by protecting several valued assets rather than one set of assets at a time. Sequence actions to reduce risk across a range of priorities.

OBJECTIVES

- ☐ **4.1** Prioritize resilience strategies
- ☐ **4.2** Evaluate projects and actions
- ☐ **4.3** Address uncertainty
- ☐ **4.4** Write an implementation plan

RESOURCES

- Step 4 Implementation Examples
- Resource 4.1a | Criteria for Strategy Evaluation
- Resource 4.2a | STAPLEE Descriptions and Guiding Questions
- Resource 4.2b | STAPLEE Score Sheet for Prioritization
- Resource 4.2c | Considerations for a Benefit-Cost Analysis
- Resource 4.4a | Key Characteristics of Different Financing Tools
- Resource 4.4b | Barriers to Resilience Funding and Finance and Guidebook

OPPORTUNITIES FOR COMMUNITY PARTICIPATION

- Community input about priorities for strategies and actions

QUESTIONS FOR ASSESSING THIS STEP

- Does the plan address the highest priorities for exposure, vulnerability, and risk to climate-related hazards?
- Are there easily available, understandable and transparent prioritization criteria?
- Evaluate vulnerability and risk of outcomes from each action in the plan.
- Establish technical capacity so resilience work can continue in perpetuity.

Key Concepts

FEASIBILITY: the degree to which climate goals and response options are considered possible and/or desirable.

CLIMATE GENTRIFICATION: the process of wealthier, often whiter, populations moving to areas less exposed to the effects of climate change that were previously occupied by lower-income residents and communities of color, thus exacerbating displacement and disparities.

MALADAPTATION: action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors, or social groups.

RESILIENCE PLANNING: the process by which assets and hazards are defined within a community and a vulnerability and risk assessment is performed to help identify and prioritize resilience-building actions.

SCENARIO PLANNING: a method for exploring multiple possible (hypothetical) futures that allows decision makers to explore and understand complex systems while also acknowledging their inherent uncertainty. exacerbate threats/hazards.

The image at top shows the restoration of dunes in progress on the North Shore of O'ahu; at bottom are the newly restored dunes that will protect homes from high waves. Source: Hawai'i Sea Grant.

In practice

4.1 Prioritize resilience strategies

In addition to addressing one specific potential impact at a time, now is the time to find co-benefits across strategies so that the overall strategy within the resilience plan.[52] Enhance the Options Inventory (**Resource 3.4a | Options Inventory**) by focusing on what must be done and in what order. It is unlikely that the full list of potential strategies could or even should be implemented. The team will evaluate options against criteria which reflect stakeholder values. Making evaluation criteria explicit, understandable, and easily available allows stakeholders to see how their concerns are included in the prioritization process, as well as making tradeoffs transparent. It also makes clear how "success" is defined by decision-makers.[53]

Establish three to five criteria within **Resource 4.1a | Criteria for Strategy Evaluation**.

NATURE-BASED SOLUTIONS CONSIDERATION:[54]

Some evaluation criteria may need to be tailored to the structure and function of natural systems. The co-benefits that occur from nature-based solutions for human communities are sometimes obvious. Solutions for flood control not only results in the protection of habitat but also often in habitat restoration, species preservation, and increased connectivity across landscapes.

Historically, NbS such as parks, forests, green roofs, etc. have benefitted predominantly White and relatively affluent communities. Unless NbS efforts are deliberately designed and implemented with equity at the forefront, disadvantaged communities may continue to face climate-driven challenges, reinforcing existing inequity.

Reduction of vulnerability and risk

An essential criterion is whether a given strategy would reduce vulnerability and risk. Part of vulnerability and risk includes historical precursors to potential impacts, so now is also the time to address equity goals within the plan in addition to physical vulnerability and risk.

Feasibility

Feasibility encompasses many factors, the first of which is political will (including community values). Inadequate information and concerns over the effectiveness of a given solution may render a given solution unpopular.[55] Public support, including community receptivity to a planning team's recommendations, will be important for the ultimate efficacy of a strategy. Communities that value local ecosystems and public space may be more inclined to embrace Nature-based Solutions. Engage community members in dialogue about any action which affects people or depends on their participation.

Funding and finance are essential. Is they available? Can state and federal resources from the American Rescue Plan Act (ARPA) and the Infrastructure and Investment and Jobs Act (IIJA) be applied? What opportunities exist to find funding or finance, including innovative mechanisms? Even with funding, does the community have the requisite staffing, expertise, or other capacity to implement a given strategy? Consider each of these. Review the Ready-to-Fund Resilience paper for more information about obtaining requisite resources to initiate and complete resilience activities.

In order to understand if and how NbS is a good match for risk reduction in your system, you'll need to determine its efficacy in similar situations and consider how it could be assessed in your application. There are three primary ways to determine if any given NbS will be suitable: modeling, field-based experiments, or empirical evidence.

Evaluate strategies using selected criteria

Be sure to select additional criteria for evaluation of strategies. Use these criteria to evaluate potential strategies.

In **Resource 4.1a | Criteria for Strategy Evaluation**, record each strategy and its ID number. In the columns to the right, indicate benefits and feasibility for each strategy. During this exercise, consider dividing the planning team into working groups by hazard or type of strategy (e.g. natural infrastructure, built infrastructure, etc). This allows for the planning team to focus on topics and involve stakeholders or subject matter experts accordingly. Remember to include community members to enhance the **context** of these decisions.

In **Table 13**, a three-category (red color, strong impediment; yellow color, partial impediment; and green color, no impediment) system provides a quick snapshot using an intuitive "traffic light" visual that encapsulates team agreement on each option. The information captured through team deliberation will help in building a portfolio of strategies.

Table 13. Example traffic light evaluation of strategies. Source: Fernleaf.

Strong impediment to meeting criteria

Criteria partially met or addressable impediment

Meets criteria with no impediment or concern

		CRITERIA *(examples shown below)*				
		Benefits		Feasibility		
ID	STRATEGY	Co-benefits?	Does it meet social equity goals?	Is there staff capacity?	Is there political will?	Is funding available *(now or future)*?
ST-001	**Incentivize private property owners to implement green infrastructure through zoning**					
ST-002	**Implement the stormwater response plan to clear inlets and outlets, including teams on stand-by, before & during events**					
ST-003	**Evaluate streets for accessibility for various levels of service given SLR to promote best routes**					
ST-004	**Evaluate and implement tree planting recommendations in public areas**					

ITERATE!
Is there a potentially beneficial strategy that needs revision in order to be implemented (Quadrant 2)? For example, the strategy would be beneficial, but there is insufficient staff capacity or funding to carry it out. Determine what blockages exist (which fields are red), and return to the **Resource 3.4a | Options Inventory** to consider what actions should be added that can move this into the Quadrant 1 position (beneficial and feasible).

Classify options into quadrants based on benefits and feasibility

The strategy evaluation can highlight opportunities for improving a given strategy. The practitioner may classify strategies among four **quadrants**:

	less beneficial	beneficial
feasible	**3.** Less beneficial strategies that are feasible.	**1.** Beneficial strategies that are feasible.
barriers to feasibility	**4.** Less beneficial strategies that have barriers to feasibility	**2.** Beneficial strategies that have barriers to feasibility. Identify the types of barriers, such as funding, staff, capacity, or others.

Assign these quadrant numbers to each strategy within **Resource 3.4a | Options Inventory**.

IDENTIFY ADDITIONAL OPTIONS THAT TARGET BARRIERS TO FEASIBILITY

Look at all Quadrant 2 strategies. How can impediments be removed? A strategy that builds staff capacity may remove barriers for multiple beneficial strategies. These additional options may be prioritized, especially if it moves a Quadrant 2 strategy to Quadrant 1.

GAP ANALYSIS: POTENTIAL IMPACTS

For the strategies in Quadrants 1 through 3, consider how they address vulnerabilities across community asset themes and community values. It is important that strategies fit together to comprehensively address the team's resilience priorities. Look at each option type within **Resource 3.4a | Options Inventory** to determine if there are any major gaps within the full range of activities. Address those gaps.

NATURE-BASED SOLUTIONS CONSIDERATION:
Nature-based solutions require special considerations with respect to the time needed for both implementation and efficacy.[56] The phenology of plants, for example, can influence plant transpiration and therefore efficacy in regulating soil moisture. Establishing an NbS solution may require a period of time.

RECONSIDER TIMESCALE FOR IMPLEMENTATION
Consider if the timescale is near-term, mid-term, or long-term for the strategy and record that in Column I in the **Resource 3.4a | Options Inventory**. Sort Quadrant 1 to 3 strategies by "timescales," i.e., the time needed for implementation. *Will the vulnerabilities and risks identified in Step 2 impact your community before implementation is likely to be complete?*

Assemble a portfolio of prioritized strategies

Identify the strategies within each type that:

- Address central challenges identified from the assessment of vulnerability and risk;
- Are explicitly equitable by addressing one of the dimensions of equity and/or by targeting a root cause of inequity or disparity;
- Are top Quadrant strategies (1 or 2) or are strategies that remove a barrier to implementation for a Quadrant 2 strategy, thereby bumping it up to Quadrant 1);
- Be sure that the prioritization includes an acceptable diversity of vulnerabilities, community values, and timescales.

The prioritization work done to this point will reveal the highest ranking strategies within each option type. One may then compare feasibility and benefits across different types of options. For example, the vulnerability and risk reduction, co-benefits, and equity outcomes of a natural infrastructure strategy vs a gray infrastructure strategy can and should be compared to identify priorities across types.

4.2 Evaluate projects and actions

In this phase, focus on projects and actions for the strategies determined to be most beneficial for reducing vulnerability and risk. Then develop implementation criteria for the specific context of the project. Use **Resource 4.1a | Criteria for Strategy Evaluation** again to develop a new set of criteria for projects and specific actions.

The Federal Emergency Management Agency (FEMA) also provides a standardized and systematic method that could be employed to evaluate project-level actions using a set of criteria that fall into seven categories: Social, Technical, Administrative, Political, Legal, Economic, and Environment (STAPLEE).

Use **Resource 4.2a | STAPLEE Descriptions and Guiding Questions** to review guidance for each of the STAPLEE categories. Modify the STAPLEE criteria after reviewing the goals, vision, and values developed for the project to determine if anything needs to be altered or added.

Use **Resource 4.2b | STAPLEE Score Sheet for Prioritization** Prioritization to evaluate each category. Review and update any of the criteria as needed by the planning team.

Internalize project co-benefits to conduct a triple bottom line (social, environmental and financial) cost benefit analysis.

The triple bottom line (otherwise noted as TBL or 3BL) is an accounting framework with three parts: social, environmental (or ecological) and economic. Consider green infrastructure projects, such as wetlands restoration, brownfield remediation, or urban reforestation, that involve a network of "ingredients" for solving urban and climatic challenges by building with nature. In addition to maintaining water quality and mitigating flooding, such installations can clear and cool the atmosphere. This improves public health and lessens basement flooding. This improves property values and saves owners and renters money. It boosts tourism, which attracts business and produces tax revenue; and it reduces stormwater to treat that lowers public utility costs.

Consider the need for benefit–cost and expected value analysis

To qualify for FEMA funding, a benefit-cost analysis (BCA) is required.[57] A BCA is designed to determine whether an action is a worthwhile investment by comparing the cost to implement it to the expected value of the benefit it will provide. If the total value of reduced risk, increased resilience, and co-benefits are expected to have a comparable or higher value than the cost of implementing the project, expected value is positive. FEMA offers three elements to make the business case: the efficacy of hazard mitigation benefits, community co-benefits, and community cost savings.[58] These include the hazard mitigation benefits as well as community co-benefits and cost savings.[59]

CAVEATS ASSOCIATED WITH BCA

The three major limitations to BCA are (1) exacerbating inequities, (2) inability to capture the full range of value provided by natural systems, and (3) uncertainty in future conditions.

A BCA can undervalue the benefits of mitigation projects in lower-capacity and lower-income communities. A major pitfall of BCA in this context is that it singles out the economic value of property protected, resulting in an inequitable distribution of funds to those people whose property is of greatest value. Addressing the number of people impacted or services they require would require a non-monetary approach to assessing benefits and costs.[60]

Always consider the cost and benefits of NbS alternatives. Estimating the potential financial benefit of intangible things such as ecosystem services can lead to a broad range of expected values. Nature-based Solutions are dynamic systems that provide a multitude of benefits in addition to hazard risk reduction. Many qualities of NbS are currently not able to be captured by FEMA's BCA Toolkit calculations.[61] Similar issues exist with other agency accounting methods (such as USACE).

Too often, the dialogue around climate resilience investment only weighs avoided losses against the physical costs of a gray infrastructural investment. This conversation usually occurs after disaster strikes. While much work still must be done to account more effectively for these sorts of hard cost savings, it is critical that resources are also invested in the quantification of more holistic costs and benefits. It is essential to highlight proactively that these investments yield a triple dividend because it shifts the focus from the solely upfront project costs to include the cascading benefits over time.

The BCA requirement itself can be a barrier to implementation because of the capacity needed to carry out the accounting process. Some groups choose to engage risk management consultants to help produce a BCA. It is also important for the community to be aware of whether assessments by registered engineers are required by their particular state.

The simple equation of expected benefits accrued from the investment divided by the sum of all necessary costs incurred does not address uncertainties such as the rate of increase in risk over time due to climate change. Non-stationarity in the climate system is not considered within a standard BCA. Immediate needs tend to outweigh longer-term considerations when conducting a BCA.[62]

The guidance resource (**Resource 4.2c | Considerations for a Benefit-Cost Analysis**) expands on each of these issues, provides additional considerations, and suggests alternatives for improving traditional BCA methods. **Table 14** also lends insight into how to improve a BCA.

Table 14. Considerations for improving a cost-benefit analysis over more traditional methods. Source: Ready-to-Fund Resilience Guidebook.

THREE CONSIDERATIONS FOR IMPROVING YOUR BENEFIT-COST ANALYSIS[63]

	What is being valued?	What is the Accounting Timeframe?	Who receives benefits and who bears costs?
Considerations	Are we creating a business case that includes upfront capital costs and longer-term savings in maintenance and operations that are benefits related to increased health and safety? Do we consider how it stabilizes and/or increases the tax base, economic position, and community livability aspects, etc.	Have benefits and costs that accrue beyond a construction timeframe been considered? Has the project's real useful life been explained and accounted for in decision-making?	Who judges the project to be worthwhile from the standpoint of the use of local government resources? Are those who rate it highly in traditional positions of power, from the community, or who are historic beneficiaries of adequate public services? Who pays and who benefits from this work? Compared to other government-funded local projects, will this fund provide more or fewer resources to LMI and BIPOC communities?
How to	**1.** Internalize project co-benefits to conduct a triple bottom line (social, environmental and financial) cost-benefit analysis. **2.** Pursue innovative strategies to monetize the "intangible" benefits.	**1.** Correct the misaligned planning horizon of climate resilience investments by using alternative discount rates. **2.** Engage your CFO to discuss an alternative BCA.	**1.** Wherever possible, set investment priorities for LMI and BIPOC communities. **2.** Establish a platform for community and codevelopment (see Characteristic 4). **3.** Value qualitative community data in addition to quantitative indicators. Cite the considerations described above within project discussions.

4.3 Address uncertainty

Decisions to build resilience must consider not only the current vulnerability and risk, but also future risk due to a changing climate. A high price falls on those who are not ready for extreme events. Four principles can help mitigate the downside risk of decisions made in the face of deep uncertainty (DMDU).[64] First, consider multiple futures, not one single future, in your planning. Choose these futures to stress test your plans. It is better to have a range of scenarios and a plan that can adapt based on what is known and anticipated at the present. Second, seek robust plans that perform well over many futures, not optimal plans designed for a single, best-estimate future. Such a plan will be responsive to what is experienced and learned as the future unfolds. Third, make plans flexible and adaptive, which often makes them more robust. Such plans contain a strategic vision of the future, commit to short-term actions, and establish a framework to guide future actions. Fourth, use analytics to explore many futures and options. Strive for correctability of decisions, extensive monitoring, and flexibility.

Scenario planning

Scenario planning is a powerful yet under-utilized tool for ordering community perceptions about alternative future environments in which decisions might play out. Considering multiple future scenarios is a recommended best practice for addressing uncertainty in future climate conditions. Scenario-based planning allows the community to evaluate a suite of options that are robust under various plausible outcomes.[65] Scenario planning is a widely used method of envisioning possible future conditions.[66] The process typically involves identifying a decision challenge, enumerating the factors that are beyond one's control or that increase uncertainty, developing narratives describing distinct scenarios, and developing a plan robust to these scenarios. Communities can use scenarios to:

explore a variety of plausible future conditions; evaluate the implications of those conditions for their resources, infrastructure, and other management goals; balance cost and risk; and identify a portfolio of possible management strategies.[67]

Dynamic Adaptive Policy Pathways

Adaptation pathways is a decision-support framework for strategies that adjust over time and are therefore able to handle uncertainties in the present-day.[68] A framework of steps, triggers, and decision points is constructed. Each decision point has a series of options associated with it. Once the decision point is triggered, the options for that step are 'tested' against plausible futures and outcomes. A decision is made in light of the test, and the selection leads to the next section of the pathway. Adaptive Pathways typically include compelling visualizations of how and when strategies would be invoked based on tipping points and their timing.

A climate resilience planning team may put its prioritized options into Adaptation Pathways.[69] First, identify thresholds for potential climate-related impacts (see summary of central challenges in **Resource 2.5a | Step 2 Synthesis Report**) in your area of interest. For instance, some threshold amount of sea level rise would impact a set of assets in many geographical settings. Determine the **year that threshold might be reached** or exceeded. Such a choice is based on risk tolerance; many climate change projection datasets provide a range of trajectories based on unknowable assumptions, such as the rate of future greenhouse gas emissions, sensitivity of the climate system, and local manifestations of climate change. The time when a threshold is exceeded is an adaptation **tipping point**. Monitor climate conditions to anticipate tipping points. Use monitoring data to justify decisions to move from one adaptation pathway to another. Those decision points are referred to as "sign posts." The adaptation plan should articulate what actions are to be taken in association with tipping points and sign posts.

Members of the planning team gather to develop the implementation plan using information from the previous steps. Source: Whitney Hansen, Fernleaf.

4.4 Write an implementation plan

Create a plan for implementation of the highest priorities. Implementation plans are dependent on several factors related to both the project and community. Some guiding principles to consider for developing any implementation plan include the following ideas taken from the Ready-to-Fund Resilience Guidebook[70], unless otherwise noted.

Be explicit (e.g., in procurement documents) about the future risk scenarios the project must address. For NbS, it will be essential to understand how climate will affect organisms and ecosystem processes in the near to long-term.[71]

Define project requirements such as scope, design, budget, community engagement, and long-term monitoring and maintenance. If a project requires the cooperation of multiple departments (e.g., planning, sustainability, emergency management, and housing), begin the necessary collaboration. Communities already engage in several types of planning processes. NbS projects will likely require a paradigm shift from business-as-usual planning to improve internal cooperation and intersection among various departments and agencies.[72] However, mainstreaming and integrating NbS into existing policy and planning processes may ensure action.

For each component of the project, **consider the contingencies and legal viability of each project element. Demonstrate capacity to obtain any necessary consent or permits, meet regulations, or honor land rights prior to project implementation.**

Prepare a full funding & finance plan for prospective investors. This may include several aspects of the plan for implementing the project. In order to maintain momentum for the resilience team, some funding or financing may need to be identified.

Determine ability to fund or finance priorities

Public and private funds support government projects. Public funds come from revenue generation, including municipal, agency, state, and federal government taxes, fees, and charges. Private funds come from the capital markets, including bonds, bank loans, and even direct equity investments. Philanthropic funding is also part of private financing. Generally in the context of local government financial dealings, funding is understood to mean money that does not need to be repaid, like a grant, while finance is understood to mean money that must be repaid, like a loan or debt service on a municipal bond.[73] Funding and financing for resilience projects can be obtained through a variety of institutions, including non-profits and educational institutions, public sector institutions, and private sector institutions.

> Guidance for types of institutions that may be approached, as well as in what context they should be involved, for funding or financing, can be found in **Resource 4.4a | Key Characteristics of Different Financing Tools**.

For a particular project or strategy, a variety of funding and financing mechanisms may ultimately be needed. Identify any sources that have already been obtained and any that are possible or needed for the future.[74]

BARRIERS TO RESILIENCE FUNDING AND FINANCE

Federal and private sector climate resilience set the tone for climate resilience's financing landscape writ large.[75] Understanding the barriers to securing funding and finance at a more granular level informs planners about what is possible. For local governments, major barriers to resilience funding include lack of capacity to generate competitive grant proposals; competition for scarce resources; lack of political will among elected officials to allocate resources to projects that accrue benefits beyond an election cycle; leadership and/or community resistance to transformative change that increases social equity; the absence of a resilience leader or lead agency within a local government; competing priorities; differing timeframes and visions between municipal government and communities; the inability of a municipal government to hear and act on community needs; and a dearth of funds for the convening, planning and design often required to initiate funding or financing.

This Ready-to-Fund Resilience Guidebook addresses these barriers through 10 characteristics (**Figure 20**) across four areas:

- **Economic:** Relating to project accounting and bankability.
- **Capacity:** Relating to the ability to meet the demands required of systemic transitions.
- **Cultural:** Relating to internal processes, partnerships, and communications.
- **Regulatory:** Relating to the planning and policy environment at a local, regional, and national

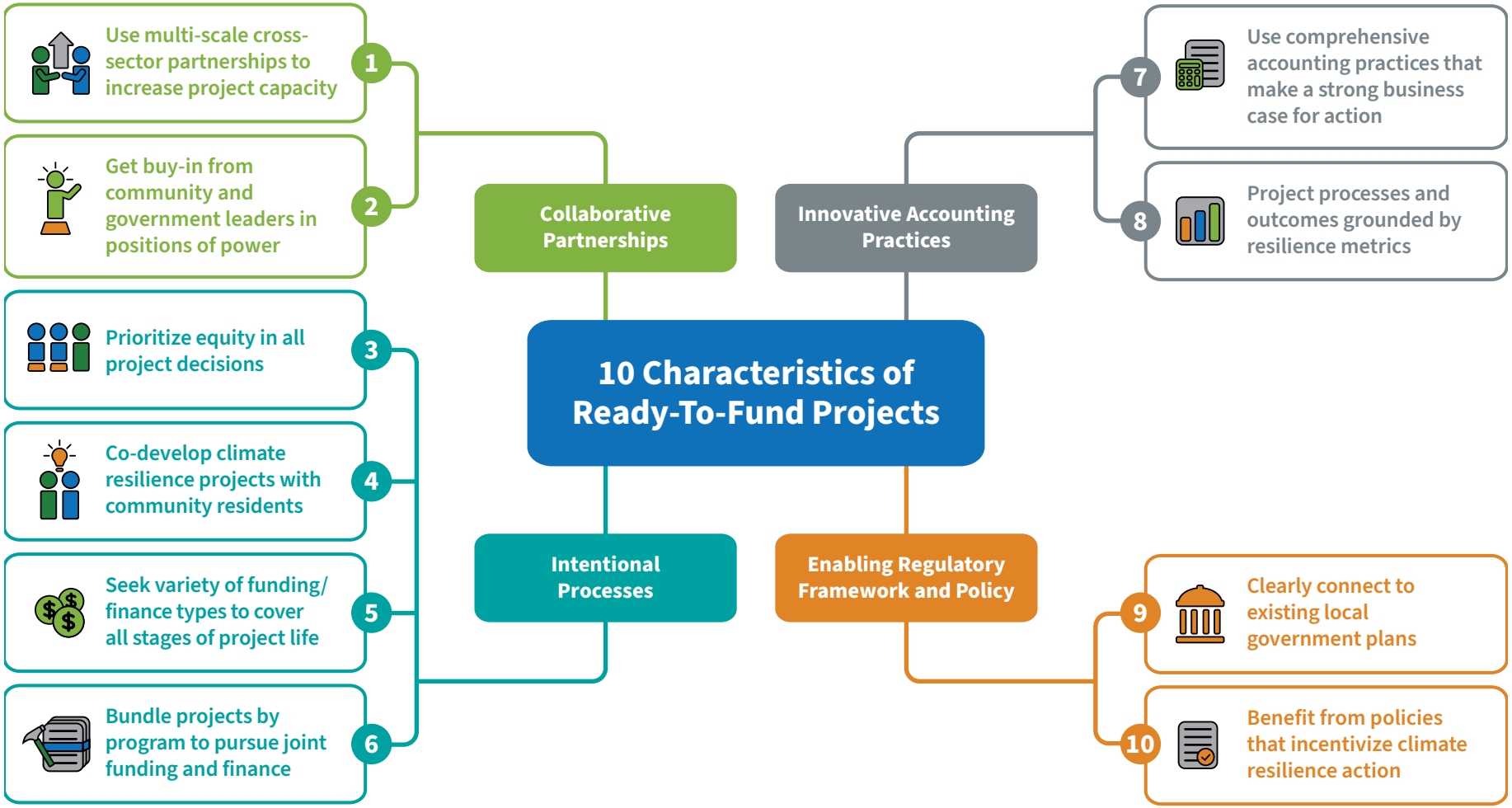


Figure 20: Ten characteristics of ready-to-fund resilience projects in four categories.

NATURE-BASED SOLUTIONS CONSIDERATION:
A well-known and significant barrier to NbS is the limited financial resources for their implementation. The federal government is responding to this challenge by taking specific actions, for example, incentivizing nature-based projects through grants such as BRIC. While these grant programs can help accelerate NbS, upscaling and maintaining these solutions will require a continuous funding stream with targeted investments in disadvantaged communities.[76]

See **Resource 4.4b | Guidance: Barriers to Resilience Funding and Finance and Guidebook Opportunity Mapping** for details on these barriers and the Characteristics that can be used to address them.

Consider trade-offs

Climate adaptation and resilience are not the only factors that enter into community planning. Trade-offs often involve balancing adaptation with sustainability, greenhouse gas mitigation, and increasing social inequalities.[77] The downside to focusing on a single hazard and its potential impacts is that one might lose perspective about unintended consequences and co-benefits. When developing a final implementation plan, the practitioner can help the community make sure that a proposed option will not create a bigger issue somewhere else or for other community assets.[78] Gentrification, community isolation, and ecosystem degradation from civil engineering projects are examples of maladaptation and unintended consequences associated with NbS implementation.[79] It is important to think broadly about unintended consequences and focus design efforts to reduce or eliminate them.[80, 81]

Conflicts across different community departments and stakeholder groups may become apparent when assigning limited resources to prioritized options. Some trade-offs would manifest at some future date or would be more viable at a later time or following the emergence of specific conditions. It is often difficult to get stakeholders to value future benefits compared to current necessities. Facilitated dialog can acknowledge and address these conflicts. Discuss trade-offs, and find ways to find agreement.[82] Communicate the trade-offs among economic benefits, equity issues, "green vs. gray" solutions, and other community value drivers.

Develop a timeline and milestones

Work with the planning team to document the plan. Include a narrative that summarizes: (a) the vulnerabilities that will be addressed; (b) the potentially exacerbating climate and non-climate-related stressors the team identified; (c) actions that were considered and which were selected, and why; (d) the anticipated costs, benefits, and outcomes of the plan; (e) an implementation timeline, with phases of work and completion times clearly identified.

Referring to the Quadrants identified above, justify the prioritization process, mention how barriers were identified as well as how those might be overcome, and discuss the timescale for emerging problems as well as concomitant actions to address those issues. Community members must take note if there is a phase difference between when a problem will emerge and when resilience action can be accomplished.

Endnotes

52 The Ready-to-Fund Resilience Guidebook recognizes co-benefits are part of resilience, not optional. See more from the toolit's step "Internalize project co-benefits to conduct a triple bottom line (social, environmental and financial) cost benefit analysis."

53 Additional discussion on these topics is available in Hoffman and Hansen, 2022.

54 This text box refers to Table 5. Refer to "Table 5. Summary of Guiding Questions to Prioritize Nature-based Solutions" in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning* for questions focused on value, trade-offs, planning, and decision points.

55 Section 5.3.2, "Enabling Conditions," and section 6.4.1, "Social and Cultural Context," in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning* go into more detail about these feasibility concepts in the context of natural systems.

56 Read more about this in the context of NbS in section 5.3.1, "When to Act" in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*.

57 https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis

58 This concept and others related are covered in section 5.2.1, "Limited Resources," in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*.

59 For more details related to NbS and FEMA funding, refer to section 6.4.3 "Financial and Regulatory Context" in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.*

60 Headwaters Economics, https://headwaterseconomics.org/equity/improving-benefit-cost-analyses/#point2

61 FEMA BCA Toolkit, https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis

62 Peterson et al., p. 51.

63 Read more about Characteristic 7 in *Ready to Fund Resilience Guidebook.* For additional information around alternative discounting practices, consider Appendix B.

64 See the Implementation Examples resource for a recorded presentation delivered in May 2019 as part of a two-day technical training course held by the Water Utility Climate Alliance (WUCA) in Tampa, Florida, https://toolkit.climate.gov/course-lessons/decision-making-under-deep-uncertainty-dmdu

65 From *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*, Section 3.1.1.

66 Scenario planning processes were pioneered by Schwartz and van der Heijden

67 From *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*, chapter 3.

68 Haasnoot et al. 2013

69 These are based on a synthesis of Haasnoot 2013 approach for pathways

70 Guiding principles are from the *Ready-to-Fund Resilience Guidebook*

71 From *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*, section 2.3 "Determine Geographic and Temporal Scale".

72 From *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*: Section 6.4.2, Barrier 3: Institutional Fragmentation.

73 From *Ready-to-Fund Resilience Guidebook*

74 Chapter 7, "Resources for Implementing Nature-based Solutions" in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.*

75 This section is from *Ready-to-Fund Resilience Toolkit*

76 Chelleri et al., 2015.

77 From *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*, section 6.4.3: Financial and Regulatory Context.

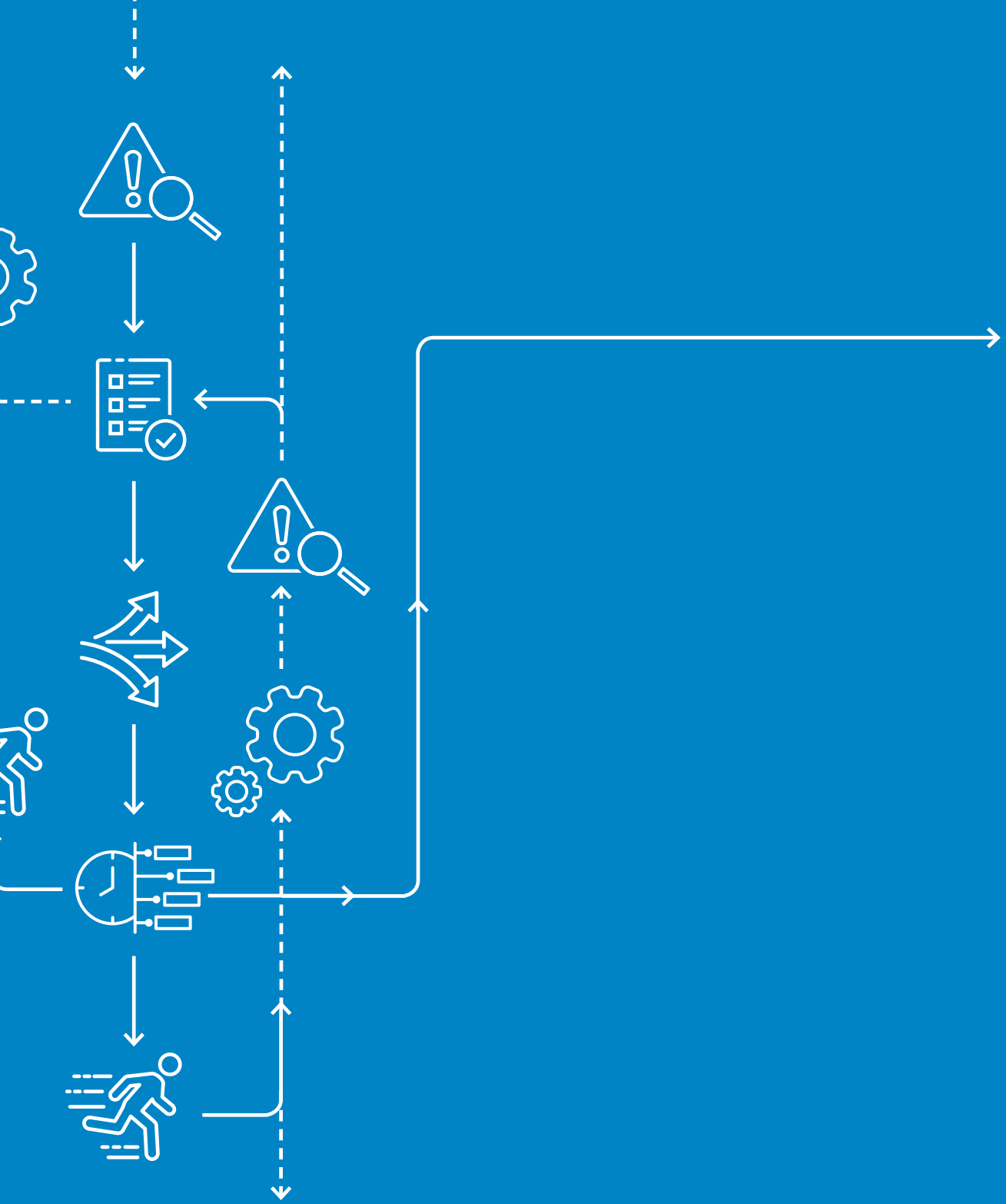
78 Charleston Medical District Lowcountry Oases

79 Seddon, N., A. Chausson, P. Berry, C.A.J. Girardin, A. Smith and B. Turner. 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B 375:20190120.*

80 From *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*, section 5.2: Trade-offs.

81 For more on climate gentrification, see Anguelovski et al. 2019.

82 Richters et al. 2015



STEP 5:
Take Action

Back to previous view

STEP 5

Take Action

Overview

Implement and communicate the plan. Identify funding sources. Monitor. Iterate. A resilience plan necessitates long-term capacity building. In addition to the technical capacity for any construction or project management activities, ongoing community engagement is crucial for buy-in, support, and measuring progress. Those measures of progress will assist with ongoing funding and finance efforts. Communicate project results with other communities who are engaged in similar efforts. Monitoring and evaluation are likewise essential or internal success and for building resilience capacity on a national level. Data collection will support iterative, persistent adaptation efforts. Focus data collection on ways to improve project goals and implementation strategies.

OBJECTIVES

- ☐ **5.1** Implement the plan
- ☐ **5.2** Identify and seek opportunities for funding
- ☐ **5.3** Create a plan to monitor and share lessons learned
- ☐ **5.4** Iterate: plan for persistent adaptation

RESOURCES

Step 5 Implementation Examples
Resource 5.1a | Guidance: Communications Plan
Resource 5.1b | Guidance: Measuring Success by Comprehensive Plan Element

OPPORTUNITIES FOR COMMUNITY PARTICIPATION

- The community can help with communication and outreach. Ideally, community members will be informed and involved throughout the process of implementation.
- Community partners help determine funding & finance as well as project timelines.
- Ensure actions address needs in the community.
- Taking action is part of an iterative cycle, so over time community participation shall be maintained.

QUESTIONS FOR ASSESSING THIS STEP:

- Has the action been implemented?
- Have the vulnerabilities been reduced by the actions? Is there evidence of having reduced impacts?
- Implement a monitoring plan to measure the function of social, built, or natural systems aligned with objectives of the action plan.

Key Concepts

MONITORING AND EVALUATION INDICATOR: a quality or trait of effectiveness, progress, or success.

INDICATOR: a quality or trait that suggests ("indicates") effectiveness, progress, or success.

BANKABLE: projects that possess an attractive economic profile that appears likely to deliver high enough risk-adjusted returns to attract private sector equity or debt.

FINANCING: obtaining money for a project that must be repaid eventually.

FUNDING: money available on a one-time or limited time basis (e.g., a grant) or over time (e.g., taxes or fees) that does not need to be repaid.

In practice

5.1 Implement the plan

Communicate the Plan

The StR processes, actions and outcomes should all be shared within and beyond the community to broaden understanding of what has taken place, if it is working, and to support neighboring jurisdictions that may be at an earlier phase of the adaptation process. Consider communication with peers in other communities through professional societies, regional government working groups, and online tools used for adaptation (e.g., Climate Adaptation Knowledge Exchange[83]). A Climate Adaptation Communications Plan can support monitoring and evaluation.[84]

- Are stakeholders aware of the current and projected effects of climate change?
- Are they aware of the associated risk for community assets and how the implemented actions reduce that risk?
- Were stakeholders included in the process of identifying risks and solutions?
- Can stakeholders track progress toward meeting adaptation goals and the effectiveness of those actions?
- Post surveys to evaluate awareness and participation in the plan via social media, the web, and other appropriate outreach mechanisms used in a given community.
- Interview local partners to gauge inclusion, awareness and sharing.
- Include methods for community tracking of adaptation or risk reduction progress.

To build national capacity, it is important for us to share lessons learned and best practices with our peers. Professional organizations such as the American Society of Adaptation Professionals (ASAP) and the U.S. Sustainability Directors Network (USDN) support these types of conversations. Many states offer regular resilience forums. The semi-annual National Adaptation Forum is an important convocation of adaptation professionals.

With climate resilience being a young services sector, vocabulary and metrics are not yet used in standard ways. Such standards, as well as measurements that establish efficacy of tested practices, will reveal opportunities for improvement in subsequent planning efforts.

Centering equity within climate resilience planning is contingent on active community participation throughout the StR. Reaching a variety of stakeholders and audiences requires multiple strategies and styles of communication. The Climate Adaption Communications Plan Template85 includes a sample plan template that can be used for communicating with a range of audiences. Identify opportunities to enable the conditions for higher levels of community engagement, involvement, and ownership based on the goals and needs of the community.

Resource 5.1a | Communications Plan can be used to help formulate your communication with various groups. Customize it as needed for target audiences.

GET BUY-IN FROM COMMUNITY AND ELECTED LEADERS[86]

Buy-in from community and government leaders in positions of power may increase the priority of resilience projects.

- Grow untapped support for resilience funding and finance.
- Counter pushback from individuals or departments with veto power that resist resilience investment.
- Ensure longevity of in-progress resilience projects beyond election cycles.
- Generate broader buy-in to increase investment opportunities.
- Align cross-sector departments and resources toward a common guiding vision to create project efficiencies and mutual benefits.
- Help to prioritize climate resilience projects within a competitive funding environment.
- Increase accountability for achieving resilience project impacts.

How:

1. Refine the value proposition of climate resilience.
2. Identify people in power and develop strategic messaging to attract them.

Strategic Message Examples:

- The cost of inaction exceeds the up-front investment in resilience.
- Highlight the interconnectivity between your different agendas and shared goals. Get them to see the agenda.
- Appeal to the bottomline.
- Tie-in effective economic arguments targeting major regional players or potential funders.

Grounding climate resilience projects within existing community plans can help secure funding and finance. Such coordination provides clarity to investors, resulting in more funds available for projects since a wider range of funds can be tapped and set aside for the climate resilience agenda. Coordination among local government leaders and partners builds synergy among projects, e.g., pooling resources and sharing costs. Actively mitigating risk is an enticement to investors in its own right.[86]

Internal government staff. Training and educating staff about resilience can lower resistance to subsequent planning and implementation. Communicate the project plan in multiple phases, by involving key staff at first and then pulling in every department to discuss the results and mainstreaming concepts. Workshops can be held to review and discuss the assessment results, actions identified, and the implementation plan(s) for taking action. The audience for this will be familiar with past and current initiatives, as well as the inner workings of the government process. Communicating the process and results may get detailed.

Elected and appointed officials may not have time to dedicate to a workshop or understanding the details of each assessment. Some may have limited interest in climate adaptation or a predilection for greenhouse gas emissions reduction over adaptation. However, plans will likely require approval by city councils, mayors, managers, or others, in accordance with local legal requirements. An efficient summary of the process behind a plan, the plan itself, and expected outcomes will be essential. FInd the best ways to gain support (e.g., budget savings or co-benefits) in order to garner support from stakeholders such as elected and appointed officials.

Coordinate efforts among partners across scales. Partners comprise different individuals and groups in each community. Community-based organizations, academics, and nonprofits can assist in local projects, outreach, and advocacy . Councils of

Governments (COGs) generally operate at a regional scale and support public services such as supply chains, regional transportation, housing, and economic development. Some may already have part-time or dedicated staff addressing regional greenhouse gas emissions and/or regional climate preparedness. State agencies, such as state departments of Transportation or Natural Resources may have a role, provide funding, or be impacted by local projects. Federal partners, even if they are providing pass-through funds, may need to be involved in the project.

Community members. Community-based organizations and other nonprofits may be able to help with communication and outreach. Ideally, community members will have been informed and involved throughout the process. However, details of the plan still need to be communicated so that the community knows what to expect. Failure to communicate the plan can also impact public support and long-term success of options, particularly those that may have less public buy-in.[87]

Mainstream and integrate with planning initiatives

One of the ways to ensure action on projects is to mainstream and integrate them into policy and planning processes of existing departments. Mainstreaming takes advantage of pre-existing decision-making structures and funding streams within a community. Coordination across multiple agencies and planning sectors, as well as collaboration with a diversity of stakeholders, will be essential to ensure that the project will be as effective as possible in reducing risks and enhancing co-benefits. Studies show an important connection between various types of land use planning and resilience outcomes, where failure to coordinate across different planning efforts could lead to maladaptive outcomes.[88] Mainstreaming may involve modifying current practices or creating new processes within municipal planning activities. A few examples of how to work with typical government departments are given below.

Jim Fox from UNC Asheville's NEMAC leads participants from the City of Asheville during a climate resilience planning workshop held in December 2016. Source: Karin Rogers, UNC Asheville's NEMAC.

Comprehensive & Land Use Planning. Use elements of the assessment to identify current and future challenges to provide recommendations related to land use decisions. These types of plans provide an avenue to embed NbS, particularly green infrastructure concepts, in the local policy instructions and implementation ordinances.[89]

The team can refer to **Resource 5.1b | Measuring Success by Comprehensive Plan Element**, which provides guiding questions for each step pertinent to comprehensive plan updates.[90]

Comprehensive plans are sometimes combined with or include elements of economic development or redevelopment plans. These also provide an opportunity to tie in resilience-building projects and initiatives.

Public Safety, Emergency Management, and Public Works Planning. Identify response capacity needs for people and community assets, as well as where to perform community outreach, particularly for vulnerable populations and neighborhoods that face disproportionate risk or may not be equipped to prepare for climate-related hazards without significant assistance. Portions of the resilience plan may be incorporated into Hazard Mitigation Plans. To receive funding from FEMA's hazard mitigation assistance grant programs, such as the BRIC program, proposed activities or projects must be consistent with a state's Hazard Mitigation Plan. Ensuring NbS and other resilience-building options are incorporated into state or community plans is important for pre-disaster mitigation funds.[91] Similarly, stormwater master planning may use information from this assessment to help inform high-level strategies and investments. This is an opportunity to incorporate multi-hazard and co-benefits between stormwater and other resilience strategies.

Sustainability & Climate Action Plans may be updated, especially adding elements of resilience; recognition of social vulnerability; alignment of co-benefits, especially around buildings and transportation.

Keep in mind that some of these plans are updated only periodically, with comprehensive plans being updated every five to ten years. It may be necessary to consider a phased approach to the project, and especially to implementing full strategies. For funding purposes, the importance of grounding resilience projects into existing community plans is below:

5.2 Identify and seek opportunities for funding or finance

OPPORTUNITY FOR ITERATION

As necessary, return to the funding and financing mechanisms introduced under Prioritize and Plan to seek additional resources and ensure the full project can be carried out. Revisit **Resource 4.4a | Key Characteristics of Different Financing Tools**

Bundling projects within an existing (non-climate) program can provide a fast path to implementation.[92] Consider what the program will be and who are the best partners for the program. The type of program may drive where to look for funding and finance opportunities.[93] Partners could include different government departments, academic institutions, or special interest organizations.

SEEK A VARIETY OF FUNDING AND FINANCE TYPES TO COVER ALL STAGES OF PROJECT LIFE[94]

Combine funding and finance from a variety of funding sources, referred to as 'blended finance' to cover all stages of resilience building from community co-development and project design to execution and longer-term monitoring and performance measurement. Blended finance may include commercial debt and equity, grants, concessional loans, subsidies, and other public support.

Why:
blended finance can:

- Support funding of climate resilience proactively in the wake of disruption.
- Expedite the funding process.
- Ensure that all components of the climate resilience-building process are covered, including grant writing, project planning and design and execution components.
- Cater to the development and application of climate adaptation plans with a longer-range timeline.
- Open up opportunities for new sources to cover grant match requirements.

How:

3. Stack a variety of funding and finance sources.
4. Incorporate innovative funding mechanisms such as social impact bonds, parametric insurance, and loans from community development finance institutions.
5. Work with partners on strategies about the types of funding or finance to pursue and at what time for types of projects.
6. Fight the urge to shy away from debt financing.

Jennifer Hanlon, Environmental Coordinator for the Central Council Tlingit and Haida Indian Tribes of Alaska, uses a microscope to identify phytoplankton and algal species. Source: Chis Whitehead, Sitka Tribe of Alaska.

5.3 Create a plan to monitor and share lessons learned

Metrics and monitoring

Measuring progress starts on day one of the project. Careful monitoring and evaluation throughout the project's lifespan and beyond can set up your team for measuring success and also can help build public trust and support, especially for NbS. For instance, residents who participated in the Indian River lagoon estuary restoration efforts in Florida regularly checked on progress (plant growth, etc.), tracked site success via social media, and returned with fellow restoration volunteers for recreational activities.[95] Establishing a baseline and measuring improvement may facilitate scaling up what works.[96]

Actively seek input and feedback to check if the actions you take are yielding the benefits you envisioned. Watch for any less-than-optimal results and address them as soon as possible. The team may find that additional resources are needed for the project; or they may find it could be easily implemented in other areas of the community. Review and use the findings to inform next steps in the process. Watch for early wins you can use to show the public and other stakeholders the efficacy of building resilience. Celebrate these successes and recognize stakeholders. You can leverage these successes to gain funding and support for larger initiatives. Measure the effectiveness of each step and make any adjustments necessary before moving to the next phase.

Evaluation of NbS can be carried out quantitatively or qualitatively by comparing case studies, laboratory studies, and systematic literature reviews. In communities with access to data, indicators may be quantitative. Other communities can incorporate a collaborative indicator approach of metrics such as integrated environmental performance, human health and well-being, citizen involvement, and transferability. When deciding NbS indicators for a specific community, the exact choice will rely on their particular location, climate risks, and availability of existing resources.[97]

5.4 Iterate and plan for persistent adaptation

Watch for opportunities to improve or recover from missteps. If your actions aren't producing the desired outcome, consider modifying your approach or making course corrections to your plan. As necessary, revisit your deliberations in each of the previous steps. With hindsight, you may be able to spot a previous oversight. If so, review options, re-evaluate risks and costs, and then decide what additional or different actions will help. Persist through setbacks to reach your goals.

Approaches to iteration

Decisions are constrained by imperfect knowledge and cognitive biases. Cycles of revision are necessary to improve the performance of strategies and actions. Once the team accepts uncertainty about what the future holds, it becomes essential to be flexible about when and how to respond. Building resilience depends on learning and responding effectively to lessons learned and outcomes, as well as determining how to incorporate new information, opportunities, and experiences. Iteration does not mean starting from scratch. Iteration means using new information, circumstances, resources, etc. to inform, refine, and improve a pre-existing plan or process.

In addition to monitoring and evaluating ongoing projects, revisit Pathways and Adaptive Management (section 4.3 above). The process of iteration recognizes that decision makers are making choices and decisions with the best information available at the time and can pivot as needs change or as new resources become available.

Adaptive management can be used to take small stepwise actions to implement strategies and actions rapidly and as needed. This approach is useful for addressing multiple impacts across a system and a variety of scales, while addressing intended or unintended side effects of an action. Because natural systems change over time, NbS are nearly

NATURE-BASED SOLUTIONS CONSIDERATION[98] Using the correct metrics of success will, ideally, yield answers to these questions:

Will the action need to be modified if conditions change? Either establish sign posts for modifying an action plan, or establish monitoring and evaluation procesdures to instigate a new action plan. Events that cause measurable impact in the near term (e.g., seasonal flooding, wildfires, near-term sea level rise), can be used as decision points for adaptive management decisions.

How can you adjust course if the action is not working? When a measure indicates that the action is not delivering the intended benefit or the ecosystem is being adversely impacted, it may be time to adjust course. A resilience plan should include a suite of actions that are appropriate at different points along a trajectory of change.

always managed adaptively. Monitoring and evaluation can help drive iteration. Adaptive design recognizes that needs of today may be different from what they will be in 50 years.

Indicators: When is it time to iterate?

The need for iteration may be triggered by an extreme event or the crossing of a threshold, or if new information on a particular hazard becomes available. In these cases, the assessment and plan may need to be updated. Or, new funding may have been identified that makes a particular action feasible. Another possibility is the opportunity to engage new and different stakeholder or community groups that bring in different perspectives. Below are some indicators to consider for determining when it is appropriate to iterate:

- When new information becomes available, such as new data or regulations that could inform the assessment of vulnerability and risk;
- As new planning or community engagement opportunities arise when previously resources may not have been available;
- As hazard events transpire, which could bring to light new priorities or information throughout the process;
- For long-term resilience planning, when considering that multiple actions and strategies will be needed to address long-term vulnerabilities;
- As new options become available due to changes in ability to implement;
- As priorities or needs change for the community; and
- As resources, stakeholders, or partnerships create new opportunities, such as the ability to include others who were not previously included.

Refer to your team's measures of success and goals/vision. If actions aren't producing the desired outcome, consider modifying your approach or making course corrections to your plan. Re-evaluate risks and costs, if needed, and then decide what additional or different actions will help correct your course.

Endnotes

83 https://www.cakex.org

84 This section and the following questions are from Hoffman and Hansen 2022

85 Hoffman and Hansen 2022, Appendix

86 For additional details and strategic messaging examples see Coffee et al. 2022

87 From Pathak et al. Section 6.4.1, Barrier 1: Public participation and acceptance.

88 From Pathak et al., section 6.1: Mainstream Nature-based Solutions Within Existing Planning Processes, and section 6.2: Coordinate Across Planning Efforts.

89 From Pathak et al., Section 6.1.2: Comprehensive Land Use Plans.

90 From Hoffman and Hansen, Table 2

91 From Pathak et al., Section 6.1.1: Hazard Mitigation Plans.

92 See *Ready-to-Fund Resilience* Characteristic 6.

93 Chapter 7 in *Incorporating Nature-based Solutions into Community Climate Adaptation Planning* provides a detailed discussion on funding and finance mechanisms specific to Nature-based Solutions.

94 For additional details see: Ready-to-Fund Resilience Toolkit

95 Kibler, K., G. Cook, L. Chambers, et al. 2018. Integrating sense of place into ecosystem restoration: anovel approach to achieve synergistic social-ecological impact. Ecology and Society, 23(4) cited in Pathak et al. 2022.

96 From Pathak et al., section 6.3: Implement and Monitor.

97 Pathak et al., Section 6.3..

98 Pathak et al., Section 5.4, “Decision Points,” which suggests questions for evaluation and adjusting course if the action is (or isn’t) working and if conditions change and modifications are needed.

Conclusion

This guidebook provides procedures, guidance, and customizable resources for enhancing climate resilience in communities across the United States. By consolidating this guidance, tailored to the StR[99], the NOAA Climate Program Office is shining light on its own strategic path to scaling up and accelerating climate adaptation and resilience planning throughout the nation's counties, communities, and neighboring tribal nations. The guidance presented here is offered to the Resilience Ecosystem as a resource for adaptation and resilience-building.

Because extreme weather-related events are always to be expected, building resilience does not end with publication of a plan, securing funding, or even implementing a project. It is our hope that the procedures outlined herein will support ongoing efforts to continually adapt to ever-changing climatic conditions.

Feedback is essential for improving methods designed for deployment at a national level. Readers may send their thoughts or comments to noaa.toolkit@noaa.gov

Bibliography

Abrash Walton, A., Simpson, M., Rhoades, J., & Daniels, C. *Local Solutions Report: Identifying and Meeting the Needs of Local Communities Adapting to Climate Change.* Keene, NH: Antioch University New England Center for Climate Preparedness and Community Resilience, 2016.

AECOM. *Paying for Climate Adaptation in California: a Primer for Practitioners* [Online], 2018. https://aecom.com/paying-climate-adaptation-california-primer-practitioners/

Anguelovski, Isabell, James J. T. Connolly, Hamil Pearsal, Galia Shokry, Melissa Checker, Juliana Maantay, Kenneth Gould, Tammy Lewis, Andrew Maroko, J. Timmons Roberts. *Why Green "Climate Gentrification" Threatens Poor and Vulnerable Communities.* PNAS 116(52): 26139-26143, 2019. https://doi.org/10.1073/pnas.1920490117

Arnold, Ross D., Jon P. Wade. *A Definition of Systems Thinking: a Systems Approach.* Procedia Computer Science 44: 669-678. 2015. doi:10.1016/j.procs.2015.03.050

Barnett, Jon, Saffron J. O'Neill. "Minimizing the Risk of Maladaptation" in Climate Adaptation Futures. Jean Palutikof, Sarah L. Boulter, Andrew J. Ash, Mark Stafford Smith, Martin Parry, Marie Waschka, Daniela Guitart (eds.). 2013. doi:10.1002/9781118529577.ch7

Center for Community Health and Development. "Section 4. Analyzing Root Causes of Problems: the 'But Why?' Technique." University of Kansas Community Tool Box [Online], 2022. https://ctb.ku.edu/en/table-of-contents/analyze/analyze-community-problems-and-solutions/root-causes/main

Charleston Medical District. "Lowcountry Oases" [Online], 2022. https://www.charlestonmedicaldistrict.com/lowcountryoases

Chelleri, Lorenzo, James J. Waters, Marta Olazabal, Guido Minucci. *Resilience Trade-offs: Addressing Multiple Scales and Temporal Aspects of Urban Resilience.* Environment and Urbanization 27(1): 181-198, 2015. https://doi.org/10.1177/0956247814550780

Cleveland, John and Peter Plastrik, *In Harm's Way, How Communities are Addressing Key Challenges of Building Climate Resilience,* 2021

Coffee, Joyce, Camilla Gardner, and Rachel Jacobson. *Ready-to-Fund Resilience.* Climate Smart Communities Series, Vol. 2. American Society of Adaptation Professionals, 2022. https://doi.org/10.25923/crr2-dh90

EcoAdapt. *Climate Adaptation Knowledge Exchange* [Online]. 2022. https://www.cakex.org

Enderami, Seyyed Amin, Elaina Sutely. *Community Capitals Framework for Linking Buildings and Organizations for Enhancing Community Resilience through the Built Environment.* Journal of Infrastructure Systems 28(1). 2021. DOI:10.1061/(ASCE)IS.1943-555X.0000668

Environmental Law Institute. "Climate Gentrification and Risk Planning: What is at Stake for Communities?" [Online], 2019. https://www.eli.org/vibrant-environment-blog/climate-gentrification-and-resilience-planning-what-stake-risk-communities

Facilitating Power, Movement Strategy Center, National Association of Climate Resilience Planners. *From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental & Racial Equity Committees*. Urban Sustainability Directors Network Innovation Fund. https://www.usdn.org/uploads/cms/documents/community_engagement_to_ownership_-_tools_and_case_studies_final.pdf

Fang, Clara, Jessica Hench, Christa Daniels, and Abigail Abrash-Walton. *Centering Equity in Climate Resilience Planning and Action: a Practitioner's Guide.* Climate Smart Communities Series, Vol. 3. Antioch University New England 2022. https://doi.org/10.25923/765q-zp33

Federal Emergency Management Agency. "*Benefit-Cost Analysis*" [Online]. 2022. https://www.fema.gov/grants/tools/benefit-cost-analysis

Federal Emergency Management Agency. "*Community Lifelines*" [Online]. 2022. https://www.fema.gov/emergency-managers/practitioners/lifelines

Federal Emergency Management Agency Press Release. "*FEMA Defines Equity in its Mission of Making Programs More Accessible*" [Online]. 2021. https://www.fema.gov/press-release/20210909/fema-defines-equity-its-mission-making-programs-more-accessible

Foster, Sheila, Robin Leichenko, Khai Hoan Nguyen, Reginald Blake, Howard Kunreuther, Malgosia Madajewicz, Elisaveta P. Petkova, Rae Zimmerman, Cecil Corbin-Mark, Elizabeth Yeampierre, Angela Tovar, Cynthia Herrera, Daron Ravenborg. *New York City Panel on Climate Change 2019 Report Chapter 6: Community-Based Assessments of Adaptation and Equity.* New York Academy of Sciences 1439(1): 126-173, 2019. doi://10.1111/nyas.14009

Gardiner, E.P., D.D. Herring, and J.F. Fox, J.F. *The U.S. Climate Resilience Toolkit: evidence of progress.* Climatic Change 153, 477–490, 2019. https://doi.org/10.1007/s10584-018-2216-0

Georgetown Climate Center. "Equitable Adaptation Legal & Policy Toolkit" [Online]. 2022. https://www.georgetownclimate.org/adaptation/toolkits/equitable-adaptation-toolkit/introduction.html

Gonzalez, Rosa. The Spectrum of Community Engagement to Ownership. Facilitating Power and Movement Strategy Center [Online]. https://movementstrategy.org/wp-content/uploads/2021/08/The-Spectrum-of-Community-Engagement-to-Ownership.pdf

Haasnoot, Marjolijn, Jan H. Kwakkel, Warren E. Walker, Judith ter Maat. *Dynamic Adaptive Policy Pathways: a New Method for Crafting Robust Decisions for a Deeply Uncertain World.* Global Environmental Change 23(2): 485-498, 2013. https://doi.org/10.1016/j.gloenvcha.2012.12.006

Hays, Jeremy, Minna Toloui, Manisha Rattu, Kathryn Wright. *Equity and Buildings: a Practical Framework for Local Government Decision Makers.* Urban Sustainability Directors Network, 2021. https://www.usdn.org/uploads/cms/documents/usdn_equity_and_buildings_framework_-_june_2021.pdf

Headwaters Economics. "Benefit-Cost Analysis Prioritizes Property Values Over People" [Online]. 2022. https://headwaterseconomics.org/equity/improving-benefit-cost-analyses/#point2

Hoffman, Jennie R., Lara J. Hansen. *Moving from Faith-based to Tested Adaptation Process and Approach: How Will We Know We're Adapting?* Climate Smart Communities Series, Vol. 4. Adaptation Insight, 2022. https://doi.org/10.25923/3t9f-8j83

Mitigation Framework Leadership Group. *National Mitigation Investment Strategy.* Homeland Security, 2019. https://www.fema.gov/sites/default/files/2020-10/fema_national-mitigation-investment-strategy.pdf

Institute for Tribal Environmental Professionals (ITEP). *The Status of Tribes and Climate Change Report.* STACC Working Group convened by ITEP, 2021. https://sites.google.com/view/stacc2021-itep/home

Intergovernmental Science-Policy "Platform on Biodiversity and Ecosystem Services (IPBES). Core Glossary" [Online], 2022. https://ipbes.net/glossary/biodiversity

Matthews, J.B. Robin (ed.). "Annex I: Glossary" in *Global Warming of 1.5 ° C.* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.) Cambridge University Press, Cambridge. Intergovernmental Panel on Climate Change. 2018. pp. 541-562, doi:10.1017/9781009157940.008. Also see [Online] https://www.ipcc.ch/sr15/chapter/glossary/

Lempert, Rob, Michelle Miro. "Decision-Making Under Deep Uncertainty" [Online}. U.S. Climate Resilience Toolkit, 2022. https://toolkit.climate.gov/course-lessons/decision-making-under-deep-uncertainty-dmdu

Melillo, J.M., T.T. Richmond, and G. Yohe. *Climate Change Impacts in the United States: Third National Climate Assessment.* U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31Wj2

Meerow, Sara, Pani Pajouhesh, Thaddeus R. Miller. *Social Equity in Urban ResilienceP lanning.* International Journal of Justice and Sustainability 24(9): 793-808. doi://10.1080/13549839.2019.1645103

National Research Council. *Adapting to the Impacts of Climate Change.* Washington, DC: National Academies Press, 2010. doi:10.17226/12783

Pathak, Arsum, Patty Glick, Lara J. Hansen, Laura E. Hilberg, Jessie Ritter, and Bruce A. Stein. *Incorporating Nature-based Solutions into Community Climate Adaptation Planning.* Climate Smart Communities Series, Vol. 5. National Wildlife Federation, 2022. https://doi.org/10.25923/2p5v-fz91

Peterson, Thomas D., Michelle Wyman, Gloria Flora, William Dougherty, Joel Smith, Stephen Saunders, Steve Chester, Tom Looby. *Center for Climate Strategies Adaptation Guidebook: Comprehensive Climate Action*. Center for Climate Strategies, 2011. http://trnerr.org/wp-content/uploads/2013/04/CCS_Adaptation_Guidebook.pdf

Powell, John A., Stephen Menedian, Wendy Ake. *Targeted Universalism Policy & Practice.* Haas Institute for a Fair and Inclusive Society, 2019. https://belonging.berkeley.edu/targeted-universalism

Reece, Jason, David Norris, Jillian Olinger, Kip Holley, Matt Marin. *The Sustainable Communities Initiative: Equity in Sustainable Communities Issue Brief*. Kirwan Institute for the Study of Race and Ethnicity, 2013. http://kirwaninstitute.osu.edu/wp-content/uploads/2013/09/FINAL_OM_9-5.pdf

Richters, Floor, Jan Maarten Schraagen, Hans Heerkens. *Balancing Goal Trade-Offs When Developing Resilient Solutions: a Case Study of Re-Planning in Airline Operations Control*. 6th Resilience Engineering International Symposium. Lisbon (Portugal), 22 – 25 June 2015. https://www.resilience-engineering-association.org/download/resources/symposium/symposium_2015/Richters_F.-et-al-Balancing-goal-trade-offs-when-developing-resilient-solutions-Paper.pdf

Sanderson, B.M. and B.C. O'Neill. *Assessing the Costs of Historical Inaction on Climate Change*. Sci Rep 10, 9173 (2020). https://doi.org/10.1038/s41598-020-66275-4

Seddon, Nathalie,Alexandre Chausson, Pam Berry, Cécile A.J. Girardin, Alison Smith, and Beth Turner. *Understanding the Value and Limits of Nature-based Solutions to Climate Change and Other Global Challenges.* Philosophical Transactions of the Royal Society B, 2020. 375(1794):20190120. doi: 10.1098/rstb.2019.0120

U.S. Department of Agriculture. "Food Access Research Atlas" [Online], 2022. https://www.ers.usda.gov/data-products/food-access-research-atlas/

U.S. Federal Government. "Billion Dollar Disasters" [Online], 2022. https://www.ncdc.noaa.gov/billions/summary-stats.

U.S. Federal Government. *U.S. Climate Resilience Toolkit* [Online], 2014. http://toolkit.climate.gov.

U.S. Global Change Research Program (USGCRP). "Glossary" [Onine]. 2022. https://www.globalchange.gov/climate-change/glossary

Well Being Trust. "Thriving Together" [Online], 2022. https://thriving.us/vital-conditions/belonging-civic-muscle/#what_you_need_to_know

White House Office of the Press Secretary. "Presidential Policy Directive – Critical Infrastructure Security Resilience", 2013. https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil

Williams-Rajee, Denise. *Climate Equity Primer.* Kapwa Consulting, 2019. https://www.denvergov.org/files/assets/public/climate-action/documents/climate-action-task-force/climateequityprimer.denver.pdf

Williams-Rajee, Desiree, Tarren Evans. *Climate Action through Equity.* Multnomah County, 2016. https://www.portland.gov/sites/default/files/2019-07/cap-equity-case-study-web29jul.pdf

Yuen, Tina, Eric Yurkovich, Lauren Grabowski, Beth Altshuler. *Guide to Equitable Community-Drive Climate Preparedness Planning.* Urban Sustainability Directors Network, 2017. https://www.usdn.org/uploads/cms/documents/usdn_guide_to_equitable_community-driven_climate_preparedness-_high_res.pdf

Glossary

The following definitions are those that are used throughout the Guide and Steps to Resilience framework. Some, but not all, of these terms can be found in the U.S. Climate Resilience Toolkit Glossary. Many of these definitions are adapted from the U.S. Global Change Research Program (USGCRP), Intergovernmental Panel on Climate Change (IPCC), and other sources, as indicated in the footnotes.

Actions and projects: Actions and projects fit within a strategy and describe how a strategy will be carried out. Actions and projects have clear roles and responsibilities, timeframes, and geographic scale.

Adaptation: The process of adjusting to new (climate) conditions in order to reduce risks to valued assets or to take advantage of beneficial opportunities. A community's "resilience journey" can be enabled by an adaptation plan.[100, 101]

Adaptive capacity: The ability of a person, asset, or system to withstand and adjust to a hazard, take advantage of new opportunities, or cope with change.[102]

Assets: see People and Community Assets

Bankable: Projects that possess an attractive economic profile that appears likely to deliver high enough risk-adjusted returns to attract private sector equity or debt.[103]

Biodiversity: The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems.[104, 105]

Climate Change: changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of severe weather events, and changes to other features of the climate system.[106]

Climate gentrification: the process of wealthier, often whiter populations moving to areas less exposed to the effects of climate change that were previously occupied by lower-income residents and communities of color, thus exacerbating displacement and disparities.[107]

Climate Service Practitioner (Practitioner): An individual working with a Community and Community Champion on implementing the Steps to Resilience. This individual is a climate adaptation and resilience-building professional that is skilled at building local capacity for climate resilience analysis, facilitation, and guidance. The Climate Service Practitioner could have a range of experiences and is trained to work with a community to evaluate climate risks and develop resilience strategies.

Climate stressor: A condition, event, or trend related to climate variability and change that can exacerbate hazards.

Co-creation: People from different departments, backgrounds, or disciplines joining efforts to learn something new.

Community: A state, regional, county, local municipal, or tribal government entity; as well as community members or non-governmental groups working with one of these entities that are willing to be active stakeholders in building Resilience.

Community Assets: resources, ecosystems, infrastructure, and the services they provide. Assets are the tangible and intangible things people or communities value.[108]

Community asset themes: assets that fit within a recognizable group may be organized by theme. For example, medical faciltiies, schools, fire and police stations, utility buildings, and transportation depots may all be listed as "critical facilities."

Community asset types: Assets that share attributes that distinguish them from other assets within a given theme may belong to the same "community asset type." In the example given in the definition for community asset themes, those types would include medical facilities, schools, fire and police stations, utility buildings, and transportation depots.

Community Based Organizations (CBOs): trusted public or private entities that are a resource to and/or provide specific services to a community or targeted population within a community based on a shared understanding of trust, awareness, and connection to its people.

Community champion: An individual accepting responsibility to bring members from the Community together as a team to implement the Steps to Resilience. This individual could be someone from the government entity, a community-based organization, or another community stakeholder group. The Community Champion also serves as the point person to work with Climate Service Practitioners and Decision Makers and is someone willing to be conversant in the concepts of community and climate resilience.

CRT: the U.S. Climate Resilience Toolkit (toolkit.climate.gov),

Cultural equity: A commitment to undoing racism through an intentional deconstruction of White supremacist assumptions and behaviors and the concurrent construction of equitable multicultural norms. The fourth aspect is overarching and integrates with the previous three (also see Equity below).

Distributional equity: Ensuring the resources or benefits and burdens of a policy or program are distributed fairly, prioritizing those with highest need first (also see Equity below).

Ecosystem-based adaptation: refers to the role of biodiversity and ecosystems in addressing climate-related vulnerabilities and risks to people and livelihoods.[109]

Ecosystem services: Benefits humans receive from ecosystems,[110] or simply "nature's contributions to people".[111]

Equity: The consistent and systematic fair, just, and impartial treatment of all individuals.[112, 113] Four components of equity are frequently cited and incorporated into community resilience.[114]

> ***Procedural equity:*** Ensuring that processes are fair and inclusive in the development and implementation of any program or policy.

Distributional equity: Ensuring the resources or benefits and burdens of a policy or program are distributed fairly, prioritizing those with highest need first.

Structural (intergenerational) equity: A commitment and action to correct past harms and prevent future negative consequences by institutionalizing accountability and decision-making structures that aim to sustain positive outcomes.

Cultural equity: A commitment to undoing racism through an intentional deconstruction of White supremacist assumptions and behaviors and the concurrent construction of equitable multicultural norms. The fourth aspect is overarching and integrates with the previous three.

Exposure: The presence of People and Community Assets in places where they could be adversely affected by Hazards.[115]

Feasibility: The degree to which climate goals and response options are considered possible and/or desirable. Feasibility depends on geophysical, ecological, technological, economic, social and institutional conditions for change. Conditions underpinning feasibility are dynamic, spatially variable, and may vary between different groups.[115]

Financing: obtaining money for a project that must be repaid eventually.[116]

Frontline Communities: Frontline communities are groups of people who are directly affected by climate change and inequity in society at higher rates than people who have more power in society.

Funding: money available on a one-time or limited time basis (e.g., a grant) or over time (e.g., taxes or fees) that does not need to be repaid.[116]

Green Infrastructure: a term that historically has been used to refer to the value and role of open space and ecosystem services broadly (e.g., Benedict and McMahon 2006), but is now often used in a narrower sense focusing on nature-based approaches to stormwater management (see Nature-based Solutions).[117]

Hazard: An event or condition that may cause injury, illness, or death to people or damage to assets.

Hazard Mitigation: The capabilities necessary to reduce loss of life and property by lessening the impact of disasters. Mitigation is used interchangeably with hazard mitigation in the emergency management field.[118]

Indicator: a quality or trait that suggests ("indicates") effectiveness, progress, or success.[119]

Justice: The process of acquiring equal access to rights, resources, opportunities, and power, as well as remedy of past harms. Achieving justice involves dismantling systems of oppression and privilege that create systemic disadvantages and barriers for certain individuals and groups.[120]

Maladaptation: action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors, or social groups.[121]

Magnitude of impact: A subsequent negative result that follows from damage to or loss of an asset. Quantifying potential consequences is an important part of determining risk.

Mitigation: Processes that can reduce the amount and speed of future climate change by reducing emissions of heat-trapping gasses or by removing them from the atmosphere.

Monitoring and evaluation indicator: A quality or trait of effectiveness, progress, or success.[122]

Natural Capital: the world's stocks of natural assets (see People and Community Assets), including geology, soil, air, water, and all living things.[123]

Nature-based Solutions (NbS): actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits (see Green Infrastructure).[124]

Nature-based Thinking: The concept calls for a paradigm shift in the existing anthropocentric and solutions-based approaches for managing nature to a broader nature-based, social-ecological (inclusive) approach. NBT is rooted in a) acknowledging the value of nature beyond solutions and services (recognizing nature's intrinsic value; 'nature for nature's sake'), while at the same time b) inclusivity of culturally diverse and community-centered ways of thinking about and relating to nature.[125]

Natural Infrastructure: a term that refers to the services that natural systems (see Ecosystem Services) provide to people, and is used especially to contrast with traditional conceptions of infrastructure as consisting only of engineered or hard structures. In particular, the term refers to infrastructure that either uses, restores, or emulates natural ecological, geological, or physical processes.[123]

Natural and Nature-based Features: a concept used by the U.S. Army Corps of Engineers and more broadly within the environmental engineering community; defined as landscape features that are used to provide engineering functions relevant to flood risk management and other hazard mitigation efforts. Importantly, this concept incorporates both the role of intact or restored natural features, as well as of engineered solutions that emulate natural functions or processes.[126]

Nature-based Solutions: Actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits.

Non-climate stressor: A change or trend unrelated to climate that can exacerbate hazards.

Options: Ways of achieving objectives. Options might be policies, programs, projects, schemes, systems, technologies, or anything else presenting a choice which itself requires a decision. Options may be mutually exclusive (A or B), or could be implemented individually or in combination (A and B). [127]

People and Community Assets: people, resources, ecosystems, infrastructure, and the services they provide. Assets are the tangible and intangible things people or communities value.[108]

Potential Impact: Effects on community assets, including both natural and human systems, that result from hazards. A potential impact is considered for every applicable community asset/hazard combination (e.g., residential property and flooding). Evaluating specific potential impacts is a critical step in assessing vulnerability and risk.

Practitioner: see Climate Service Practitioner.

Probability: The likelihood of hazard events occurring, traditionally determined from the historic frequency of events. With changing climate and the introduction of non-climate stressors, the probability of hazard events also changes.

Procedural Equity: Ensuring that processes are fair and inclusive in the development and implementation of any program or policy (also see Equity, above).

Projections: Potential future climate conditions calculated by computer-based models of the Earth system. Projections are based on sets of assumptions about the future (scenarios) that may or may not be realized.

Resilience: The capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption.[128, 129]

Resilience Planning: the process by which assets and hazards are defined within a community and a vulnerability and risk assessment is performed to help identify and prioritize resilience-building actions.

Risk: The potential for negative consequences where something of value is at stake. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard. Risk can be assessed by multiplying the probability of a hazard by the magnitude of the potential loss.[130]

Risk Assessment: a qualitative or quantitative study that estimates the combination of the likelihood of specific sets of events occurring and their potential positive or negative consequences.[131]

Risk Management: Plans, actions, strategies, or policies to reduce the likelihood and/or consequences of risks, or to respond to consequences.[132]

Ruleset(s): Semantic rule(s) based on attributes of populations or community assets used to define criteria for establishing low, medium, or high vulnerability or risk classifications.

Scenario Planning: A method for exploring multiple possible (hypothetical) futures that allows decision makers to explore and understand complex systems while also acknowledging their inherent uncertainty.

Sensitivity: The degree to which a system, population, or resource is or might be affected by a given hazard.

StR: The Steps to Resilience (StR) framework described throughout this document was formulated based on tested practices drawn from diverse disciplines and regions, all concerned with how to use climate information to inform actions that prevent loss of life, property, and essential functions in the natural and built environment.[133]

Strategy: Strategies elaborate the way in which resilience objectives are going to be achieved. While a strategy describes how a resilience objective may be achieved, it may not have a specific geographic scale or timeframe for implementation. Most options published in resilience plans are strategies.

Stressors: A condition, event, or trend that can exacerbate hazards. See Climate Stressors and Non-Climate Stressors.

Structural (intergenerational) equity: A commitment and action to correct past harms and prevent future negative consequences by institutionalizing accountability and decision-making structures that aim to sustain positive outcomes (also see Equity above).

Systems Thinking: A holistic approach to analysis that requires the capacity to solve problems at a complex, systems-level scale where many interrelated and interdependent parts interact within the whole system. Systems thinking requires the ability to understand system structure, recognize interconnections, identify feedback loops, understand non-linear relationships and adjust to dynamic conditions and behavior.[134]

Tipping Point: A level of change in system properties beyond which a system reorganizes, often abruptly, and does not return to the initial state even if the drivers of the change are abated. For the climate system, it refers to a critical threshold when global or regional climate changes from one stable state to another stable state.

Transformational Change: irreversible, persistent adjustment in societal values, outlooks and behaviors of sufficient width and depth to alter any preceding situation. A structural change that alters the interplay of institutional, cultural, technological, economic and ecological dimensions of a given system.[103]

Vulnerability: The propensity or predisposition of People and Community Assets to be adversely affected by hazards. Vulnerability encompasses exposure to potential impacts, sensitivity, and adaptive capacity.

Endnotes

99 https://toolkit.climate.gov/#steps

100 Adds to the definition in the US Climate Resilience Toolkit by incorporating "to take advantage of beneficial opportunities" as reflected in IPCC and UKCIP documents.

101 In natural systems, adaptation is the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate. From IPCC SREX, cited in Pathak et al.

102 Adapted from USGCRP and IPCC.

103 From Coffee et al.

104 IPBES Core Glossary, https://ipbes.net/glossary/biodiversity

105 Although often associated with the variety of species inhabiting a given place, biodiversity encompasses multiple levels of biological organization, from genes and species to ecosystems. In turn, each level of organization can be viewed as consisting of three major components: composition, structure, and function (Noss 1990 cited in Pathak et al.).

106 USGCRP

107 Environmental Law Institute, 2019.

108 NIST and FEMA commonly refer to distinct "Community Capitals." Enderami and Sutley (2021) provide seven such metrics; financial, political, social, human, cultural, natural, and built.

109 Colls et al. 2009 cited in Pathak et al. Although the phrase may suggest that ecosystems are the intended beneficiaries of the adaptation, instead they are the means for achieving human-oriented adaptation outcomes.

110 MEA 2005, cited in Pathak et al.

111 IPBES 2019, cited in Pathak et al.

112 FEMA Press Release 2021

113 Financial Equity is a developer's potential contributions toward project financing in terms of cash or land, or other assets. This can be calculated by subtracting any financial commitments from the value of any cash, land, or other assets (AECOM cited in Coffee et al. 2022).

114 Williams-Rajee, 2019.

115 Adapted from IPCC.

116 AECOM 2018 cited in Coffee et al. 2022.

117 U.S. EPA as cited in Pathak et al. 2022.

118 Mitigation Franework Leadership Group 2019.

119 Arnott et al. 2016, cited in Hoffman and Hansen 2022.

120 *Sensu* Avarna Group https:// theavarnagroup.com/wp- content/ uploads/2016/01/ Vocab-Sheet-v6.pdf

121 Barnett and O'Neill 2013

122 Arnott et al. 2016, cited in Hoffman and Hansen 2022.

123 Pathak et al. 2022.

124 Cohen-Shacham et al. 2016 cited in Pathak et al. 2022.

125 Randrup et al. 2020, cited in Pathak et al. 2022.

126 Bridges et al. 2015, cited in Pathak et al. 2022.

127 *Sensu* https://www.ukcip.org.uk/

128 The USGCRP uses the definition, "a capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment."

129 "The ability of communities to anticipate, accommodate, and adapt positively to or thrive amid changing climate conditions or hazard events, and also to enhance quality of life, reliable systems, economic vitality, and conservation of resources for present and future generations. Resilience differs by facility, community, and setting." (USDN, cited in Coffee et al. 2022)

130 Note the linkage of negative consequence to something of value, which is defined by **People and Community Assets**. "The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation response to such a hazard, on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and likelihood of its occurrence" (Matthews 2018).

131 Adapted from USGCRP and Matthews 2018.

132 Matthews 2018.

133 Gardiner et al. 2019

134 Arnold and Wade 2015.