Climate Smart Communities Initiative (CSCI) Risk and Risk Management Narrative

Overview

Risk drives many of life's decisions, and people are interested in ways to lower or mitigate risks and to make better decisions in the face of risk. A changing climate is increasing most communities' risk, which is creating a growing problem our society needs to address.

What is the definition of risk? The IPCC's and National Climate Assessment's definition of **risk** is the potential for adverse consequences. Put another way, risk is the probability and magnitude of a loss.

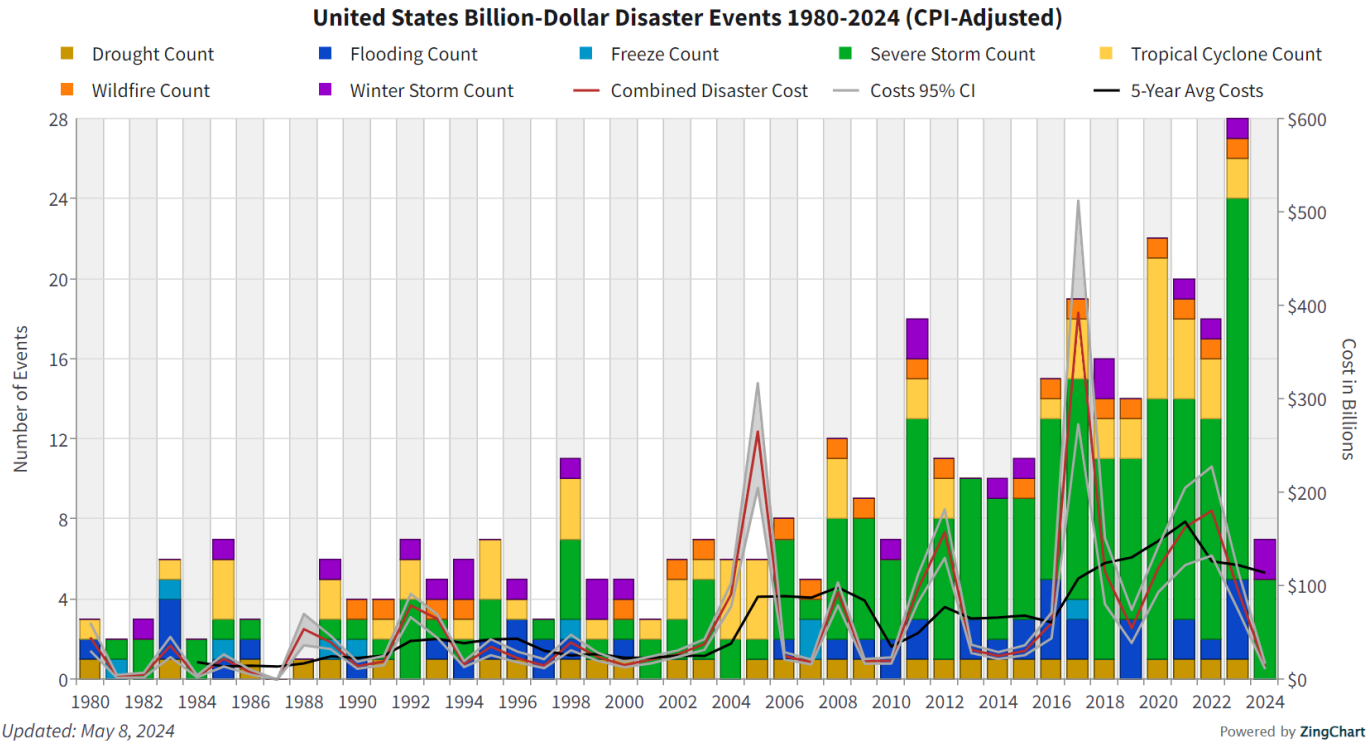
Building **resilience** is about finding ways to lower risk. **Community resilience** is the ability of communities to withstand and recover and learn from past cumulative or compounding disasters to strengthen future response and recovery efforts.

To build resilience, communities use a process that includes both risk assessment and **risk management**. One of these processes is the Steps to Resilience in the US Climate Resilience Toolkit. Whereas risk involves only losses (not gains), risk management provides an analysis of options to decision makers of the potential benefits if they decide to accept a risk and take action. Once a community determines it wants to build resilience to increasing climate-related risk, it needs to understand how to build a resilience plan and follow the plan to take action.

This document provides an overview of risk and risk management, and definitions of the key building blocks that are used during a risk management process.

How do we know a changing climate is increasing risk?

The chart below illustrates Billion Dollar Disasters: Severe Storms, Tropical Cyclones, Flooding, Wildfires, Droughts, Winter Storms, Freezes. There is a clear trend. Most of the increase over the past twenty years is from damage due to severe storms, tropical cyclones, and flooding. EPA's Disaster Resilient Design Concepts show the location of these primary hazards (Wildfire, Hurricane and Coastal Flooding, Inland and Riverine Flooding, Extreme Heat, Drought, Landslide and Mudslide, Tornado, and Earthquake).



The chart illustrates risk in a classic way. Risk is the probability of a negative consequence. The chart shows the cost in billions of these disaster events, a large negative consequence. It also shows the number of events per year is increasing, thus increasing the probability over time. Put together, there is an alarming increase in the risk due to these climate-related hazards and their impacts.

In addition to the trend of growing climate-related impacts, our society continues to develop in harm's way; exacerbating the problem by increasing the likelihood of more damage (and therefore cost) from these hazards.

Therefore, the (risk) problem with the growing cost of these disasters is getting worse, and governments and insurance companies cannot keep up. The result? Insurance companies are raising premiums and an increase in federal disaster payments will either add to the national debt or increase taxes.

But there are solutions!

Studies show that investing in resilience yields big returns, more than a 4:1 (four to one) Benefit Cost Ratio. With such a great solution to a growing problem, why are we not making more progress? Because every community's risk is unique. The people incurring risk vary by geography, hazard, and local culture. But all of these communities do have a common desire and linked questions - "Where should we invest (our limited resources) first to lower our risk? And how can we handle the uncertainty related to a changing climate, and the timing and severity of future hazards?"

To answer these questions, we need to have a trained workforce that knows **how to apply risk assessment and management processes** to assist decision makers at all scales of government.

Developing a common language for Risk and Resilience

To support this risk management approach, we must first normalize our understanding of how we are using specific terms. Within the climate adaptation community, there is fundamental agreement on how we use the terms regarding risk, but studies have shown (and this is supported by our experience) the terminology needs more consistency and improvement. For this discussion, the Fifth National Climate Assessment (NCA5) and Intergovernmental Panel on Climate Change's AR5 (IPCC) serve as the starting (not final) documents to ensure the definitions feel comfortable for all stakeholders. We have clarified some of these definitions, and use them throughout the Steps to Resilience. Definitions used in the U.S. Climate Resilience Toolkit and the Steps to Resilience Practitioner's Guide are highlighted.

These definitions are listed in the order of relevance to the risk discussion.

Risk (and Uncertainty)

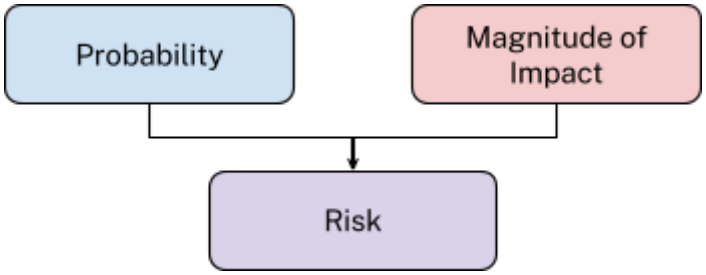
The IPCC and National Climate Assessment core definition of **risk** is "the potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain." The (IPCC) Conceptual Framework definition of risk also makes a linkage between vulnerability, hazard, and exposure: "In the context of climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards. Hazards, exposure, and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making."

This definition states

- Risk should be quantified for each hazard and its impact on a single asset (human, ecological system, infrastructure).
- The asset must be exposed to the hazard to be at risk.
- The asset's vulnerability to the hazard will help determine the adverse consequence of the impact.
- Once risk is assessed for each hazard and asset, a combined risk assessment of all hazards and assets can be determined.

NCA5 defines risk in a similar manner, "Threats to life, health, and safety, the environment, economic well-being, and other things of value. Risks are evaluated in terms of how likely they are to occur (probability) and the damages that would result if they did happen (consequences)."

We define **risk** as "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 consequence or loss. Risk must also consider uncertainty, so must address the changing probability (potential) of negative consequences in the future."



Probability is also referred to as likelihood, and is related to the frequency of the hazard occurring. This frequency is calculated in different ways by government agencies and insurance underwriters, but is typically based on the historical record of the past 30 to 50 years.

The **magnitude of impact** is also referred to as severity and can be measured by the consequences related to death, injury, damage, or loss of services.

Risk and uncertainty should not keep us from making key decisions on building resilience. The risk assessment created in the Steps to Resilience process (Assess Vulnerability and Risk) is today's reality. But we know things are rapidly changing, and we have to plan for future vulnerability and risk (as well as current). But forecasting the future includes a great deal of uncertainty.

Uncertainty is the inadequacy of knowledge related to the decision being made. Even if your information is imperfect, you should still measure and model it. Measurements that reduce uncertainty have a high value. There are internationally accepted ways to handle Decision Making under Deep Uncertainty, and those methods are applied in the Steps to Resilience (Prioritize and Plan).

Hazard

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

The definition in NCA5 is similar, "The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources."

Stressor

"A condition, event, or trend that can exacerbate hazards. For additional clarity, stressors are divided into two categories:

- Climate Stressor - A condition, event, or trend related to climate variability and change that can exacerbate hazards.
- Non-Climate Stressor - A change or trend unrelated to climate that can exacerbate hazards."

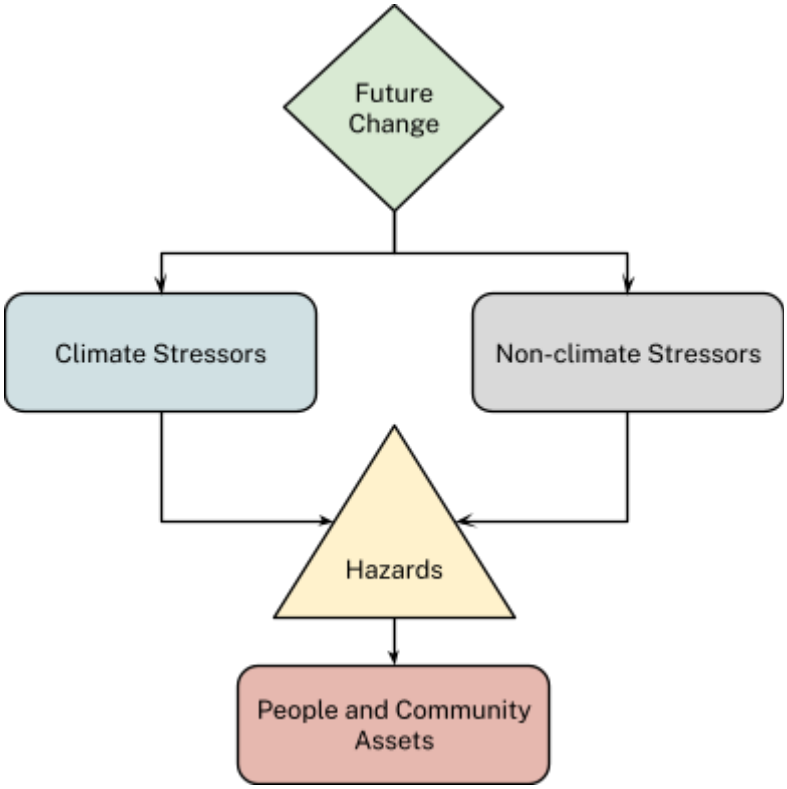
NCA5 defines a stressor similarly, "A factor that negatively affects people and natural, managed, and socioeconomic systems. Multiple stressors can have compounded effects, such as when economic or

market stress combines with drought to negatively impact farmers." Note how this example includes Non-Climate and Climate Stressors.

Assets (People and Community Assets)

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

NCA5 defines assets as people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets.



The relationship between stressors, hazards, and people and community assets can be conceptualized using the mental model shown in the figure above. The arrows indicate a "cause and effect" relationship. See the resource about conceptual models 2.1 Systems Thinking and Conceptual Models - Guidance for more details on how to construct conceptual models for specific communities and their hazards.

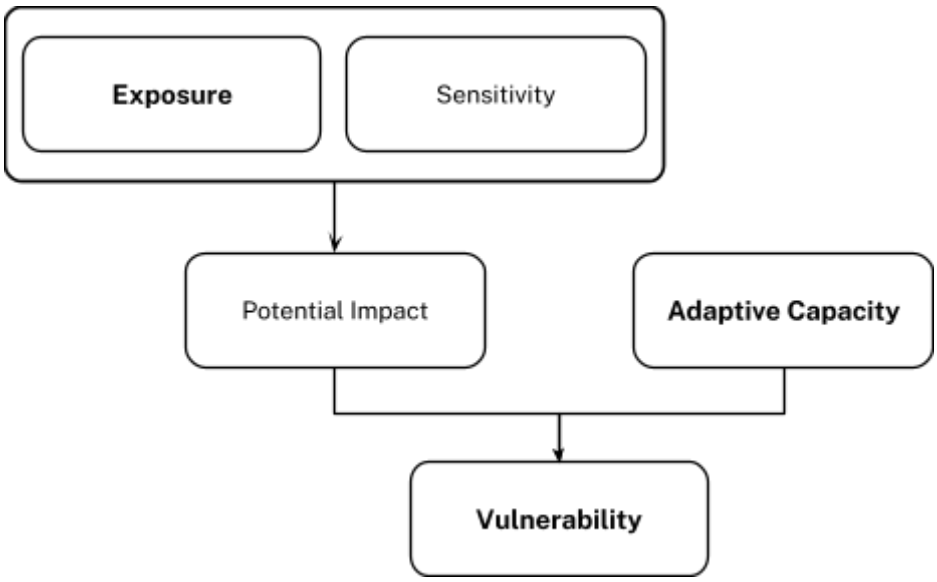
Exposure

"The presence of People and Community Assets in places where they could be adversely affected by Hazards."

NCA5 uses a similar definition, "The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected by climate change."

Vulnerability

Vulnerability is the propensity or predisposition of people and community assets to be adversely impacted and encompasses exposure to potential impacts, sensitivity, and adaptive capacity.



The relationship between risk and vulnerability is difficult to understand when looking at the impacts of different hazards on different assets. It is worthwhile to look at the definitions of the vulnerability building blocks (sensitivity, potential impact, and adaptive capacity) to gain a deeper understanding. A definition from the Los Angeles County Vulnerability Assessment uses a few different words to explain the same concept - "High climate **vulnerability** is generally defined as a combination of increased exposure to climate hazards; high sensitivity, or susceptibility, to negative impacts of exposure; and low adaptive capacity, or ability to manage and recover from exposure."

Potential Impact

Potential impact is the degree to which societal assets are adversely impacted by a potential threat. Effects on community assets, including natural and human systems, that result from hazards. Potential impact is determined by looking at exposed assets that are more sensitive. 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.

NCA5's definition of Potential Impact includes the relationships between risk, exposure, and vulnerability. "The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health, and well-being; ecosystems and species; economic, social, and cultural assets; services (including ecosystem services); and infrastructure."

Sensitivity

Sensitivity is the degree to which a system, population, or resource is or might be affected by a given hazard. In other words, the degree to which an asset (and its related services) is affected. Within asset classes (such as residential property), we determine levels of sensitivity by looking at the criticality or importance of the asset or its services. For example, when looking at residential property and flooding, the property is more sensitive if its primary structure is a multiple-residence, apartment, retirement or nursing home, or a mobile home community.

Another good definition comes from Climate Change Risk and Vulnerability: Promoting an Efficient Adaptation Response in Australia, "Sensitivity reflects the responsiveness of a system to climate influences, and the degree to which changes in climate might affect it *in its current form*."

Adaptive capacity

Adaptive capacity is the ability of a person, asset, or system to withstand and adjust to a hazard, take advantage of new opportunities, or cope with change.

NCA5 echoes this definition, "The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences."

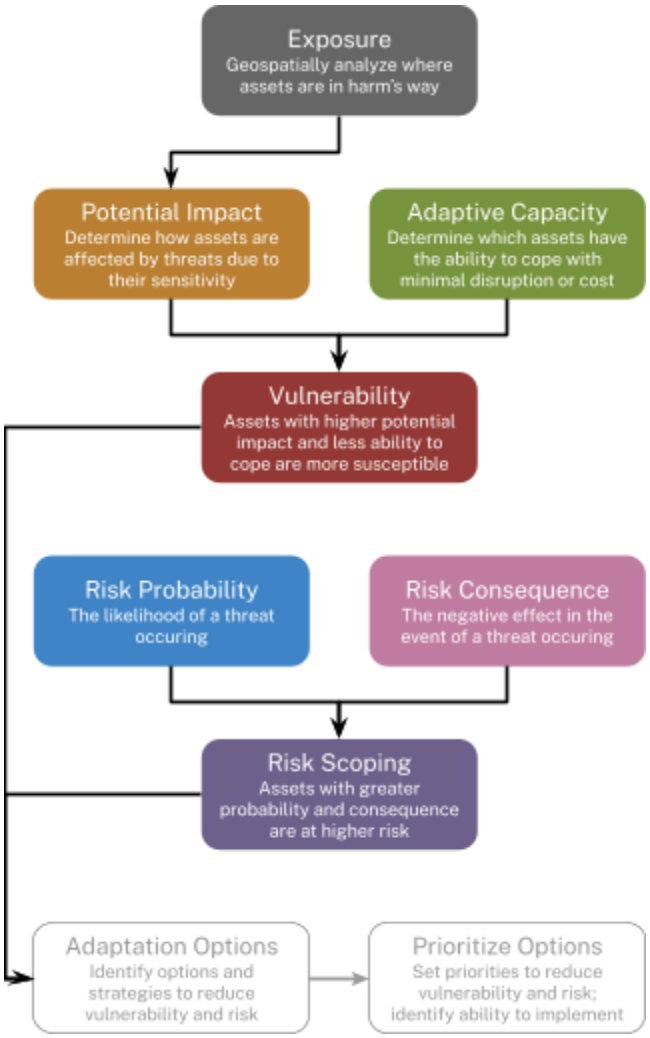
Risk Assessment

Throughout the Steps to Resilience, the Practitioner performs risk assessments. A Risk Assessment is a qualitative or quantitative study that estimates the combination of the likelihood of specific sets of events occurring and their potential negative consequences. As more information is gained, a clearer understanding of risk is obtained. The assessment includes both risk and vulnerability.

There are tiers of Risk Assessment (content and definitions from UK Climate Impacts Programme; UKCIP) that are done during different steps of the Steps to Resilience.

- Risk Identification (Steps: Get Started and Understand Exposure) - A preliminary risk assessment identifying all potentially significant climate-related hazards that may impact a decision. The intent is to limit the time and effort spent on data collection, and to provide an indication of the areas where risk may influence the decision.
- Risk Assessment (Scoping) (Steps: Assess Vulnerability and Risk) - Assets impacted by specific hazards with greater probability and consequence are at higher risk. During risk scoping, these assets and associated hazards are assessed in a qualitative, or generic quantitative risk assessment. In quantitative risk scoping using community property values (usually from county tax records), risk scope represents the approximate replacement value of a set of assets (based on improvement value). It does not represent probabilistic loss estimates, associated economic damages, or other external damages and should only be used to understand the limits of one asset/ hazard pair compared with another asset/ hazard pair. *This more detailed risk assessment*

may be done during risk management and associated analysis. Some assets such as critical facilities and natural properties may not be appraised the same as others.



- Detailed Quantitative Risk Assessment during Risk Management (Steps: Detailed for Prioritize and Plan) - Specific quantitative risk assessment of a detailed area considered for a resilience project or action. The assessment must incorporate the requirements of different funding sources (e.g., FEMA or U.S. Army Corps of Engineers) on how to incorporate future uncertainty into Benefit-Cost Analysis (BCA) and Return on Investment (ROI) calculations.

Risk Perception

Kenney (NCA3) states that **Risk Perception** refers to individual, group, or public views and attitudes toward risks. Risk perception encompasses perspectives on severity, scope, incidence, timing, controllability, and origins or causes. In the context of building resilience, risk perception of decision makers sometimes limits the ability to make balanced decisions and reflects different levels of risk aversion. Therefore, risk is not just the product of probability and loss. This assumes the decision maker is risk neutral. If the decision maker is risk averse, they will perceive the risk is greater.

Risk Management

The IPCC defines **Risk Management** as "plans, actions, strategies or policies to reduce the likelihood and or magnitude of adverse potential consequences, based on assessed or perceived risks." Similarly, NCA5 defines **Disaster Risk Management** as "processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of current and future disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, prevention and protection, and response and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development." Hubbard makes the distinction clear by stating that risk management is "the identification, assessment, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and or impact of unfortunate events."

The process mentioned in the definition above is called a risk framework. This framework helps decision makers understand risk and make decisions in a complex and changing world. The risk framework process, where information is created and integrated, should be easy to follow and not a "black box." The process itself is as important as the step-by-step products created by the framework. All data/ information should be completely transparent.

The best way to ensure transparency and shared understanding is co-production of knowledge among Government Champions and Practitioners. There is not a magic formula, simple risk index, or online tool that can handle all the nuances of risk; this is why the Practitioner's role of providing services to the Government Champion is so important. The Steps to Resilience Overview process is designed to facilitate learning and to reduce uncertainty and support decision makers. In this manner, the decision makers can move beyond assessing risks and developing options to 1) prioritize their options, 2) implement their strategies and actions, 3) monitor and evaluate how their resilience investments are performing, 4) reduce uncertainty as the future evolves, and 5) allow adaptation investments to evolve over time as knowledge is gained.

When using a structured process (like the Steps to Resilience), the focus should be first on risk assessment and then on risk management. Dealing with risk and uncertainty requires using a "tiered risk assessment" approach (UKCIP's Climate adaptation: Risk, uncertainty and decision-making) to characterize risk and provide qualitative and quantitative estimates of the risk that include uncertainty estimates.

The Steps to Resilience shows how to put data and tools into context for decision makers, namely by framing climate resilience within the context of risk and risk management (Gardiner 2019). The Steps to Resilience is not a unique risk framework; there are many comparable frameworks. For more details, refer to the other additional topic Comparable Risk Frameworks to the Steps to Resilience. These frameworks are not a specific recipe or process; rather, they help a Practitioner and Government Champion move from problem to solution. For example, the UK Climate Impacts Programme risk framework provides the following explanation.

> "This report recommends a structured framework and associated guidance to promote good decision-making. This should enable decision-makers to recognise and evaluate the risks posed by a changing climate, making the best use of available information about climate change, its impacts and appropriate adaptive responses. The report identifies methods and techniques for risk assessment and forecasting, options appraisal and decision analysis. Using these methods will be important in delivering policies and projects that are successful in the face of an uncertain future."

As a reminder, **Risk Management** is defined as "plans, actions, strategies, or policies to reduce the likelihood and or magnitude of adverse potential consequences, based on assessed or perceived risks." If the ultimate goal of any **risk framework** is to successfully identify actions and strategies that will build resilience in the most risk-prone areas of the community; and then compete for funding for projects, we should be introducing what the core requirements are at the beginning of the process and not wait until the end of the process to try and fit it together. That is why a community starts with setting goals linked to their community values. Having an understanding around what is needed to be successful will drive the work to those components of risk at the appropriate scale based on the resources and expertise of the team.

Resilience

Resilience is the capacity of interconnected social, economic, and ecological systems to prevent, withstand, respond to, and recover from a disruption.

NCA5 incorporates the concepts of risk and risk management into their discussions of resilience.

- The ability to prepare for threats and hazards, adapt to changing conditions, and withstand and recover rapidly from adverse conditions and disruptions.
- Climate resilience (NCA5): "The capacity of interconnected social, economic, and ecological systems to cope with a climate change event, trend, or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure. Climate resilience is a subset of resilience against climate-induced or climate-related impacts."
- Community resilience (NCA5): "The ability of communities to withstand and recover and learn from past cumulative or compounding disasters to strengthen future response and recovery efforts. This can include, but is not limited to, physical and psychological health of the population, social and economic equity and well-being of the community, effective risk communication, integration of organizations (governmental and nongovernmental) in planning, response, and recovery."
- Ecological resilience (NCA5): "The capacity of natural systems subject to instability to absorb disturbances without shifting to a fundamentally different ecosystem domain."

Roles and Responsibilities of Practitioner and Government Champion in Risk Assessment and Risk Management

Most communities and Government/ Community Champions do not need/ want to understand the nuances of risk; they just want to know the Practitioner knows and is applying the concepts the right way and in a manner that is comparable to other communities.

Moss (2019) lists key things a Practitioner should do and the challenges a Practitioner faces while doing risk management. He focuses on the importance of structured comparative risk analysis and the importance of developing information to support decision-making and implementation.

Alice Hill (2020) discusses the Practitioner as storyteller and translator, making meaning out of complex science. Translators are people who can turn complex climate data and information into language that speaks directly to the practical problems people are trying to solve in their daily lives in the face of climate disruption. She quotes Daniel Kahneman, “No one ever made a decision because of a number. They need a story.” Hill recommends the federal government, in partnership with the private sector, should create a cadre of climate-science translators (Practitioners) to help decision makers in state and local governments evaluate climate risks, develop resilience strategies, and access federal funding. She states that Great Communicators are people who can persuasively convey the opportunities and benefits that resilience brings, not only tomorrow but also today. Communicators are people who can speak with officials and the public about climate issues that often seem overwhelming and help them see a path forward (risk management).

Dealing with Risk in each Step of the Steps to Resilience

The previous discussions and definition of risk and risk management may seem a bit academic. The Steps to Resilience risk framework was designed to support Practitioners and Government Champions deal with risk, and manage their community’s risk to become more resilient. Here are some short summaries of how risk is covered in each step.

Get Started and Understand Exposure

These steps start with gathering local data to better understand what the community values (assets) that are exposed to different hazards (and are therefore at risk). It is important to include impacts from hazards by asking three questions.

1. What has historically happened?
2. What has happened recently?
3. What is projected to happen?

Recognizing hazards are increasing risk due a changing and variable climate recognizes how climate stressors might change current and future risk and introduces how to deal with uncertainty.

Performing these tasks can be supported by risk identification and screening, using risk indices to view what has happened in the past. These indices show what areas of the country have experienced the greatest risk from primary hazards. The introduction of Community Disaster Resilience Zones (FEMA.gov) illustrates the importance of risk screening. EPA's Disaster Resilient Design Concepts discusses the importance of this approach.

> "The public and private entities that invest in resilient infrastructure should carefully consider which communities most need these investments based on historical disadvantages and greatest current and projected exposure to hazards. The maps provided here illustrate the extent of the risks already observed from historical data; climate change is expected to amplify these hazard risks and to further impact poor and vulnerable communities at disproportionate rates."

These steps continue with summarizing these asset/ hazard pairs to understand where detailed assessment should take place and understanding if there is sufficient data to quantify. A key product is an Impact Matrix illustrating the asset/ hazard pairs. Often the Practitioner will create exposure maps for each asset/ hazard.

Assessing Vulnerability and Risk

In this step, the community wants to know what areas and assets in the community are most vulnerable and at risk to a specific hazard and how those "asset-hazard" pairs compare to one another in regard to risk. The UKCIP calls this approach a "generic quantitative risk assessment" and is sometimes referred to as risk scoping.

Risk assessment can be either quantitative or qualitative, but it must start to address risk at a very local level (neighborhood scale).

During this step, the Practitioner develops rulesets to assess vulnerability and risk for specific asset/ hazard pairs. This requires looking at potential impact (sensitivity), adaptive capacity, magnitude of the consequence, and probability of occurrence. These rulesets need to be consistently applied across the asset/ hazard pairs to complete a comparable vulnerability/ risk scoping that provides a means to compare where the risk is greatest in the community.

Investigate Options

This step starts with looking at the community's greatest risks and then comparing with the community's values and goals for the assessment and defining resilience objectives. This "value-focused" approach ensures limited resources remain focused on the key things the community values and faces the largest risk. **This is the first step in moving from risk assessment to risk management.**

The planning team researches and identifies options for building resilience to these risks. Options are considered that will reduce risk/ vulnerability and can be grouped into main ways to build resilience.

- Reduce exposure and or potential impact

- Increase adaptive capacity
- Increase response capacity

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

Prioritize and Plan

This step focuses on planning for the strategies and actions that are most likely to reduce risk. This requires taking the previous risk assessment results and performing a detailed quantitative risk assessment of a detailed area considered for a resilience project or action. This is moving from *just assessing the risk* to *managing the risk*. Whereas risk just considers a loss, risk management considers options that will provide future benefits and reduce the risk. The assessment must incorporate the requirements of different funding sources (e.g, FEMA or U.S. Army Corps of Engineers) on how to incorporate future uncertainty into BCA (Benefit Cost Assessment) and ROI (Return on Investment). For more detailed information, see the resource 5.5 Considerations for Benefit-Cost Analysis - Guidance.

The decision-maker must address uncertainty. The Practitioner is often called upon to provide guidance on risk and uncertainty. This is the topic of (DMDU) - Decision Making under Deep Uncertainty. The topics of risk perception and risk aversion must also be considered.

Alice Hill (2020) offers two key insights when finalizing resilience plans.

1. We are reluctant to pay short-term costs that are certain in exchange for future, uncertain benefits (DMDU).
2. We should experiment with methodologies to help ensure investments in resilience are made based on considerations of welfare impacts, not just economic losses.

Sources of the definitions

- NOAA
  - Climate Resilience Toolkit and Climate.gov
  - Steps to Resilience Practitioner's Guide (PG)
- FEMA
  - National Risk Index Technical Documentation
    - Map | National Risk Index
  - CDRZ - FEMA Community Disaster Resilience Zones
    - ASFPM Comments on CDRZ
    - Leveraging Federal Resilience Activities for CSCI
    - Fernleaf CDRZ notes
  - Summary of Steps to Resilience meeting (August, 2023)
- EPA
  - Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts
  - Equitable Resilience Builder | US EPA
  - Disaster Resilient Design Concepts
    - This points to First Street's Flood Factor
  - Being Prepared for Climate Change, a workbook for developing risk-based adaptation plans
- Others
  - OCM - Coastal Adaptation Planning Guide
  - NCA3 Chapter 26 - Decision Support: Connecting Science, Risk Perception, and Decisions - NCA3_Full_Report_26_Decision_Support_Melissa Kenney.pdf
  - IPCC's Risk management and decision making in relation to sustainable development
  - IPCC - The concept of risk in the IPCC Sixth Assessment Report: a summary of cross-Working Group Discussions; Guidance for IPCC authors
  - First Street Foundation Risk Factor Tool - https://riskfactor.com/
  - Climate Change Risk & Vulnerability, Australia (2015)
  - UKCIP - Climate adaptation: Risk, uncertainty and decision-making (2003)
  - Hubbard, Failure of Risk Management