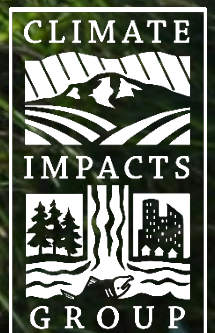


# MEASURING RESILIENCE IN SUPPORT OF EFFECTIVE INVESTMENT IN CLIMATE ADAPTATION

June 1, 2024

Prepared for the Washington State Legislature by the  
University of Washington Climate Impacts Group  
in accordance with the requirements of RCW 70A.05.010

**W**  
EARTHLAB  
UNIVERSITY of WASHINGTON



# Table of Contents

<b>Executive Summary</b>	<b>I-III</b>
<b>1. Introduction</b>	<b>1</b>
<b>2. Why Measure and Evaluate Climate Resilience?</b>	<b>2</b>
<b>3. Complexities of Measuring Climate Resilience</b>	<b>4</b>
3.1 Distinguishing between resilience and climate resilience	4
3.2 Climate adaptation doesn't always result in resilience; resilience doesn't always result in climate adaptation	5
3.3 Climate change is global; climate impacts, resilience, and adaptation are local	7
3.4 Climate resilience is a continuous process rather than a discrete outcome	7
3.5 Difficulty and limitations of establishing avoided loss	7
<b>4. Measuring and Evaluating Climate Resilience: Best Practices from the Literature</b>	<b>8</b>
4.1 Consider the triple dividends of resilience	8
4.2 Design climate resilience strategies and actions with intentional co-benefits	9
4.3 Structure outcomes of strategies and actions as building blocks of climate resilience	11
4.4 Measure climate resilience with relevant, flexible, and comprehensive indicators and metrics	11
<b>5. State of the States: How Others Are Measuring Climate Resilience</b>	<b>17</b>
5.1 Case studies: Approaches to Measuring Resilience by Other States	17
<b>6. Informing Washington State's Integrated Climate Resilience Strategy</b>	<b>18</b>
<b>References</b>	<b>26</b>

## Suggested Citation

Stowe, C.R. and C.L. Raymond, 2024. "Measuring Resilience in Support of Effective Investment in Climate Adaptation" Legislative report prepared by the Climate Impacts Group, University of Washington, Seattle.

## Contact Information

Carlie Stowe, Climate Resilience Specialist, [stowec@uw.edu](mailto:stowec@uw.edu)

Crystal Raymond, Climate Adaptation Specialist, [clrfire@uw.edu](mailto:clrfire@uw.edu)

## Executive Summary

The Washington legislature requested that the Climate Impacts Group at the University of Washington “examine existing best practices and new methods that could be used to measure and evaluate climate change resilience for the purpose of better understanding and tracking how investments made in climate change resilience translate into outcomes (RCW 70A.05.010 Development of an integrated climate change response strategy).” This report responds to the legislature’s request by detailing best practices for measuring climate resilience in support of effective climate adaptation. Information provided is the product of three sources: 1) a comprehensive review of peer-reviewed published scientific and gray literature, 2) a review of current climate resilience plans of all states, and 3) ongoing collaboration with the Department of Ecology and the interagency team tasked with the update of Washington’s Climate Resilience Strategy.

### Why Measure and Evaluate Climate Resilience?

**For governments to better understand how investments are moving the needle on climate resilience, strategies and actions must be monitored, measured, and evaluated to determine their effectiveness at contributing to desired outcomes.** In addition to quantifying the benefits of investments, measuring and evaluating efforts to build climate resilience can help governments to communicate a vision of and progress toward adaptation success, make strategic decisions and align plans, justify investments to taxpayers, demonstrate accountability, support learning, and improve effectiveness.

### Complexities of Measuring Climate Resilience

**There are no universal metrics of climate resilience and effectively measuring climate resilience is difficult to do for multiple reasons.** Unlike performance measurement for climate change mitigation where the almost universal standard metric is the reduction of greenhouse gas emissions, measuring climate resilience is a complex process with no universal metrics. It involves trying to track the causal relationship between changes made to social or natural systems and the increased ability of those systems to anticipate, prepare for, adapt to, and recover from the negative impacts of climate change. Challenges that have prevented the smooth implementation of climate resilience measurement include:

- distinguishing between resilience writ large and climate resilience;
- navigating the reality that climate adaptation doesn’t always result in resilience; resilience doesn’t always result in climate adaptation;

- determining the right scale of measurement, as climate change is global; climate impacts, resilience, and adaptation are local;
- understanding climate resilience as a continuous process rather than a discrete outcome;
- contending with the difficulty and limitations of establishing and measuring avoided loss.

## Measuring and Evaluating Climate Resilience: Best Practices from the Literature

- 1. The triple dividends of resilience are considered together when investing in resilience so that total benefits to society are not underestimated.** These dividends are saved lives and avoided losses, stimulated economic benefits as a result of reduced disaster risk, and broader social, environmental, and governance co-benefits.<sup>1 2</sup>
- 2. Climate resilience strategies and actions are designed with co-benefits in mind.** Investments in climate resilience will almost always have co-benefits which are important to account for when considering the value of the investment. When a process is intentional about co-benefits, more value will be gained from investments in climate resilience.
- 3. Outcomes of strategies and actions are measured as building blocks of increased climate resilience.** Determining the actual impact of climate resilience actions is difficult to do because these impacts are often obscure and emerge in complex systems over long timeframes. Rather than trying to directly connect a climate resilience action to a discrete outcome, the action should be put in the context of broader goals for adaptation and resilience goals, and all actions should be considered together for their collective effect on building climate resilience as a whole.
- 4. Climate resilience is measured through relevant, flexible, and comprehensive indicators and metrics.** Given the complexity of resilience and the difficulty in establishing causality between a resilience action and outcome, it is important to choose a variety of indicators and metrics that capture various contributions to climate resilience.

## State of the States: How Others Are Measuring Climate Resilience

**As an emerging practice, the process of measuring climate resilience is still being developed in the context of state planning.** Although many states have plans for climate resilience, most plans do not include indicators or metrics for measuring progress or other mechanisms to show how investments in climate resilience translate to outcomes. Approaches taken by states thus far vary from simple processes that indicate the status of proposed actions to more sophisticated approaches that identify indicators and metrics for the outcomes that the resilience strategy is designed to achieve. This varied state of practice reflects the complexities of measuring climate resilience, as well as the capacity needed to collect data and report on indicators and metrics.

## Informing Washington's Integrated Climate Resilience Strategy

Washington state is ensuring a more transparent resilience planning process that will enable investments to be more clearly connected to climate resilience outcomes by emphasizing implementation and measurability in the update to Washington's Climate Resilience Strategy. There is no one-size fits all approach to measure climate resilience outcomes and show how investments translate to these outcomes. The proposed approach in the update to Washington's Climate Resilience Strategy is being developed in close collaboration with the interagency climate resilience team, is guided by reporting frequency requirements outlined in RCW 70A.05.010 and incorporates best practice from literature and lessons from other states.



## 1. Introduction

In RCW 70A.05.010, Development of an integrated climate change response strategy, the Washington legislature requested that the Climate Impacts Group at the University of Washington “examine existing best practices and new methods that could be used to measure and evaluate climate change resilience for the purpose of better understanding and tracking how investments made in climate change resilience translate into outcomes.”

This report responds to the legislature’s request by detailing best practices for measuring climate resilience in support of effective climate adaptation. The information presented here is the product of three sources: 1) a comprehensive review of scientific and gray literature, 2) a review of current climate resilience plans of all states, and 3) ongoing collaboration with the Department of Ecology and the interagency team tasked with the update of the Climate Resilience Strategy for Washington State.

Climate resilience measurement is an emerging practice; there is no one-size fits all approach to tracking how investments made in climate change resilience translate into outcomes. In this report, we review the complexities of measuring and evaluating climate resilience and highlight best practices from the literature and climate plans of other states and cities to help address those complexities. We describe the current proposed structure to measure and track progress on climate resilience for Washington state and demonstrate how this approach incorporates best practices from the literature and other states.



**Climate resilience measurement is an emerging practice; there is no one-size fits all approach to tracking how investments made in climate change resilience translate into outcomes.**

## 2. Why Measure and Evaluate Climate Resilience?

For governments to understand if investments are moving the needle on climate resilience, goals, strategies, and actions must be monitored, measured, and evaluated to determine effectiveness at contributing to desired outcomes for resilience. Quantifying the benefits of investments by measuring and evaluating efforts to build climate resilience can also help governments to:

- communicate a vision of and progress toward success;
- make strategic decisions and align plans;
- justify investments to taxpayers;
- demonstrate accountability;
- support learning; and
- improve effectiveness.

Making progress towards a more climate resilient future entails a range of actions across regulation, policy, funding, communication and education, design, planning, project implementation, monitoring and evaluation. This requires a holistic approach that recognizes the interconnectedness of societal wellbeing, the economy and natural systems, and emphasizes the need for a “multi-dimensional approach to enhance communities’ social, human, natural, physical, and financial capacities to cope with and recover from the impacts of climate change.”<sup>3</sup>

**Effectively measuring climate resilience is an emerging practice and one that has proven especially difficult.** Unlike measuring and tracking progress on climate change mitigation, which generally involves tracking progress on greenhouse gas emissions reduction targets, there are no universal metrics of resilience success. Measuring climate resilience is a complex process that involves attempting to document the causal relationship between changes made to social and natural systems and the increased ability of those systems to anticipate, prepare for, adapt to, and recover from the negative impacts of climate change. Measuring climate resilience with indicators and metrics can show what successful adaptation to climate change looks like and if strategies and actions are moving the

### Key Terminology: Climate Resilience

**Climate resilience** is the ongoing process of anticipating, preparing for and adapting to changes in climate and minimizing negative impacts to natural systems, infrastructure, and communities. For natural systems, increasing climate resilience involves restoring and increasing the health, function, and integrity of ecosystems, while improving their ability to absorb and recover from climate-affected disturbances. For communities, increasing climate resilience means enhancing their ability to understand, prevent, adapt, and recover from climate impacts to people and infrastructure. (RCW 70A.65.010)

**There are no universal metrics of resilience success.**

state in the right direction. Many frameworks have been developed at different scales that pose various resilience indicators, (e.g. ARUP’s City Resilience Index<sup>4</sup>, UNDP Community-Based Resilience Analysis<sup>5</sup>, National Climate Resilience Framework<sup>6</sup>), but common challenges have arisen at the international, national, state, and local levels that have prevented the smooth implementation of climate resilience measurement.

**Examples and descriptions of existing resilience frameworks**

Framework	Description
ARUP’s City Resilience Index	Assesses resilience writ large for a city. Composed of 52 indicators intended to reflect the overall capacity of a city (individuals, communities, institutions, businesses, and systems) to ‘survive, adapt and thrive’ in the face of chronic stresses and acute shocks. Indicators are assessed through responses to 156 questions which combine quantitative and qualitative data and are then aggregated and presented in relation to 12 resilience goals.
UNDP Community-Based Resilience Analysis (CoBRA)	An analytical tool developed to identify indicators to measure resilience at the community scale. Largely qualitative and based on understanding resilience from a community perspective (via participatory qualitative approaches (e.g. focus group discussions and interviews). Indicators of resilience are defined by the community.
U.S. National Climate Resilience Framework	To guide the United States’ approach to climate resilience, in June 2023 President Biden directed the creation of a first-ever National Climate Resilience Framework to identify key values, priorities, and objectives to help expand and accelerate nationally comprehensive, locally tailored, and community-driven resilience strategies. Although no indicators of resilience are detailed, the plan recommends that federal agencies set targets and indicators to measure climate adaptation and resilience progress.



### 3. Complexities of Measuring Climate Resilience

In this section, we outline the complexities of measuring climate resilience that have challenged nations, states, and cities since attempts to measure climate resilience began.

#### Complexities of measuring climate resilience:

1. Distinguishing between resilience and climate resilience
2. Climate adaptation doesn't always result in resilience; resilience doesn't always result in climate adaptation
3. Climate change is global; climate impacts, resilience, and adaptation are local
4. Resilience is a continuous process rather than a discrete outcome
5. Difficulty and limitation of establishing and measuring avoided loss

#### 3.1 Distinguishing between resilience and climate resilience

**A primary challenge of measuring climate resilience is distinguishing it from resilience more generally. The lack of clarity in definition complicates efforts to determine and measure the overall benefit of climate resilience actions.** Climate resilience is a subset of social-ecological resilience that refers specifically to the capacity of interconnected social, environmental, and economic systems to *cope with*, *respond to*, and *recover from* hazardous climate change related events. Resilience is a broader term with different definitions depending on the field. Ecological science uses the term resilience to describe an ecosystem's ability to *maintain its functioning* in the face of change.<sup>7</sup> In social sciences, the term refers to the ability of an individual, group, or community to *cope with* and *recover from* disturbances or shocks as a result of social (e.g. economic recessions), or environmental (e.g. flooding) change. The ability an individual, group, or community has to recover from disturbances (their adaptive capacity) is determined by various social factors including historical, cultural, and political practices, power relations, social identities, and economic disparities.<sup>8 9</sup>

These ideas of resilience converge under the concept of 'social-ecological systems' which recognizes the linked nature of humans and the environment to inform more sustainable development and defines resilience as "the capacity to *adapt* or *transform* in the face of change in social-ecological systems, particularly unexpected change, in ways that continue to support human well-being".<sup>10</sup>

**This ambiguity in the definition of resilience complicates measuring climate resilience outcomes because climate resilience actions almost always increase resilience more generally. Not accounting for those broader resilience outcomes undersells the positive impacts of climate resilience actions.**

Separating climate resilience from resilience more broadly is difficult as resilience (and climate resilience) are both often determined by an individual, group, or community's social, political, and economic status.<sup>11</sup> Climate change impacts (e.g. increased frequency of high intensity precipitation events) will intersect with existing social, political, environmental, and economic development issues (e.g. economically disadvantaged households living in floodplains) to create more frequent disasters and severe impacts.

**Increasing climate resilience (and decreasing vulnerability) is related to reducing the structural inequalities rooted in social, political, and economic systems that put people and infrastructure in harm's way and exacerbate disruptions to critical ecosystem functions.**

### **3.2 Climate adaptation doesn't always result in resilience; resilience doesn't always result in climate adaptation**

**Climate adaptation, climate resilience, and resilience are often used interchangeably in the literature and policy. This can cause confusion when funding and evaluating efforts intended to increase climate resilience as initiatives that seek to increase resilience more broadly might not contribute to climate change adaptation.** Adaptation actions can benefit climate resilience and resilience more broadly,

but efforts to build resilience don't always lead to climate adaptation. For example, decisions about relocating infrastructure based on only historical flood frequency and extent might increase short-term resilience to flood risk, but without consideration of increases in flood extent and frequency with climate change, decision makers risk relocating infrastructure into future flood zones. Conversely, climate adaptation doesn't always build resilience, and adaptation actions can even undermine resilience efforts.<sup>12</sup>

One example of this is sunk-cost effects; investments in past adaptation efforts are prioritized

#### **Key Terminology: Adaptation**

**Climate adaptation:** The process of preparing for, and coping with, the impacts of climate change.

**Maladaptation (climate):** Occurs when actions are taken that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence. (NCA5)

over new opportunities or innovations.<sup>13</sup> For example, investments in shoreline hardening might result in a reluctance to embrace nature-based solutions later, which could be a more important and effective practice for building resilience of the floodplain in the long term. Clarifying terminology and intended outcomes of the action can help ensure that climate resilience is indeed an outcome of the action. This risk of actions not resulting in intended outcomes can be reduced by using monitoring and evaluation practices to learn from and adjust actions, and by maintaining a diversity of adaptation solutions.<sup>14</sup>

### ***What's the difference between climate change adaptation and resilience?***

The terms *climate change adaptation* and *resilience* are often used interchangeably in policy and academic discourse. The terms are complementary, but there are important distinctions between them. Climate adaptation refers to specific *processes* or *actions* that alters a social or natural system to accommodate changes in the climate. These processes or actions may or may not enhance resilience for that system. Climate resilience refers to the capacity of interconnected social, environmental, and economic systems to *cope with*, *respond to*, and *recover from* climate-related shocks and stresses. In practice, distinguishing between these two terms is more difficult.

Adaptation can happen over short or long timeframes, be transformative or incremental, and include individual actions or broad programs or strategies. Adaptation is often considered to be a part of climate resilience. However, climate resilience can include more holistic systematic changes to enhance capacity (social, natural, financial, physical) to cope with, adapt to, or transform in the face of changes to the climate. Building climate resilience therefore entails a range of actions across policy and planning realms, infrastructure, government services, education, communication etc., to enhance the capacity of systems to cope with and recover from the impacts of climate change. Resilience considerations can enhance adaptation actions or projects by encouraging a more holistic approach to addressing climate impacts. <sup>36</sup>

### 3.3 Climate change is global; climate impacts, resilience, and adaptation are local

**Standardized practices and indicators of climate resilience have not been developed because climate adaptation is an inherently local process requiring tailored approaches to the local context.** Climate resilience goals, strategies, and actions are most effective when they account for the specifics of the context in which they will be implemented. Because of this, governments that are identifying local goals for climate resilience must also develop tailored approaches to define indicators and metrics for measuring climate resilience that are specific to those local goals.<sup>15</sup> This makes it difficult to use standard practices and metrics based on other governments or regions.

### 3.4 Climate resilience is a continuous process rather than a discrete outcome

**Climate resilience is a moving target based on the dynamic needs of social-ecological systems in a changing climate – this makes attribution (connecting an investment to a climate resilience outcome) especially challenging.** Results of climate resilience and adaptation actions manifest over long time frames. It is likely that over the course of implementing an action, the social-ecological system will change, and new actions will be implemented at various scales (e.g. global, national, regional, local), so attributing an investment in the original action *as the cause* of a climate resilience outcome will become difficult or nearly impossible. It is more feasible to demonstrate how an action *contributes to* climate resilience goals overall.

### 3.5 Difficulty and limitations of establishing avoided loss

Avoided loss is often considered the most straight forward measurement of climate resilience outcomes (i.e. how much worse climate impacts would have been without intervention). However, not only is it difficult to establish due to the long timeframes and uncertainties associated with climate change impacts, but it also underestimates resilience outcomes by failing to account for the co-benefits associated with investments in climate resilience.<sup>16</sup>



## 4. Measuring and Evaluating Climate Resilience: Best Practices from the Literature

**Despite the challenges of measuring and evaluating climate resilience, it is necessary to measure how investments in climate resilience are contributing to resilience outcomes to understand if strategies and actions are moving the state in the right direction.** As the concept of climate resilience has advanced in practice, substantial effort has been invested to understand how to define resilience and adaptation success, and how to measure it most effectively. In this section we describe the best practices from the scientific and gray literature for measuring climate resilience outcomes.

### 4.1 Consider the triple dividends of resilience

**Using ‘avoided loss’ (direct and indirect damage to infrastructure and avoided deaths) as the primary metric to measure climate resilience and adaptation success results in an underinvestment in climate resilience.** Despite growing awareness of wide-spread losses associated with climate change impacts and evidence that investment in adaptation and risk reduction provides substantial savings in terms of avoided loss, there remains a deficit in investment for pre-event disaster risk reduction and climate change adaptation.<sup>17</sup> The National Oceanic and Atmospheric Administration estimates that for every \$1 spent on risk reduction (also called hazard mitigation), \$13 is saved in future costs.<sup>18</sup> This lack of investment in adaptation and climate resilience is partially due to uncertainty in future climate impacts, but also a hesitancy to allocate public funds towards preventative measures that are often considered ‘sunk costs’ in the absence of disaster or acute climate impacts.

Avoiding loss is an important outcome of investing in climate resilience, but it is not the only outcome to consider when making decisions about investments and quantifying the benefits of those investments. The three principal categories of benefit derived from investment in resilience are referred to as the ‘triple dividends of resilience’, which are 1) saved lives and avoided losses, 2) stimulated economic benefits as a result of reduced disaster risk, and 3) broader social, environmental, and governance co-benefits.<sup>19 20</sup> Considering all three dividends when measuring investments in climate resilience will generate a more complete estimate of the benefits to society, whereas considering only avoided losses will underestimate return on investment.

#### Best Practices for Measuring Climate Resilience:

1. Consider the triple dividends of resilience.
2. Design climate resilience strategies and actions with intentional co-benefits.
3. Structure outcomes of strategies and actions as building blocks of climate resilience.
4. Measure climate resilience through relevant, flexible, and comprehensive indicators and metrics.

**Dividend 1: Saving lives, avoiding losses, and recovering after a climate-related disaster.** Avoided losses are often the primary driver for investing in climate resilience and are the most obvious benefits from those investments. However, avoided losses are not easy to measure without a climate-related disaster event. Additionally, uncertainty surrounding when and where a disaster will strike makes it difficult to decide when and where to invest in resilience actions. This uncertainty also makes it difficult to show outcomes related to investments. Dividends 2 & 3 offer more immediate benefits related to resilience investments that can also be considered when determining outcomes.

**Dividend 2: Stimulated economic benefits as a result of increased climate resilience.** Evidence suggests that the mere possibility of a disaster has real impacts on present-day decisions and economic growth. In other words, the risk of climate impacts and future disasters loom as an ever-present background risk that impacts people's decisions.<sup>21</sup> This results in risk aversion, reduced entrepreneurship, and shortened planning horizons for individuals and businesses, ultimately stymying economic growth. Increasing climate resilience, especially for overburdened communities and vulnerable populations, can therefore allow these groups increased opportunity to build financial stability and capacity, and engage in long-term planning and investments. These benefits exist even in the absence of acute climate impacts.

**Dividend 3: Broader social, environmental, and governance co-benefits.** Investments in climate resilience almost always result in ancillary social, environmental, and governance co-benefits. This is because most climate resilience investments are not solely designed to reduce climate-related disaster impacts, but also aim to increase resilience of broader economic, natural, or social systems. For example, climate resilience actions intended to address wildfire risk can also have positive impacts on community health and local economies.

## 4.2 Design climate resilience strategies and actions with intentional co-benefits

**Investments in climate change resilience will almost always have co-benefits; considering these co-benefits provides a more complete accounting of the value of the investment.**

Designing multi-purpose climate resilience strategies and actions with co-benefits in mind intentionally helps to ensure greater outcomes from investments. Ancillary impacts of climate change adaptation can be either positive (co-benefits), or negative (maladaptation), and can also include cascading effects (such as those described above in dividend 2). Co-benefits can be considered the 'spillover' effects of the investment in resilience of social, environmental, and economic systems.<sup>22</sup> Co-benefits can include positive impacts on health and well-being,

biodiversity, reductions of greenhouse gas emissions, air-quality, water and resource management, etc.

When investments in climate resilience are intentional about co-benefits from the beginning, more value will be gained from the investments. Setting guidelines, as has been done through the principles outlined in RCW 70A.05.010, for the co-benefits that are desired to be achieved through climate resilience actions can ensure that those actions contribute to broader resilience

objectives (e.g. public health, environmental justice, habitat restoration). Investments ultimately save money by being multi-purpose.<sup>23</sup> Consideration of the values of these co-benefits creates a more complete accounting of the return on investment.

**When investments in climate resilience are intentional about co-benefits from the beginning, more value will be gained from the investments.**

**RCW 70A.05.010 requires that the updated Climate Resilience Strategy be guided by the following principles:**

- Prioritize actions that both reduce greenhouse gas emissions and build climate preparedness.
- Protect the state’s most overburdened communities and vulnerable populations and provide more equitable outcomes.
- Prioritize actions that deploy natural solutions, restore habitat, or reduce stressors that exacerbate climate impacts.
- Specifically, prioritized actions must include those related to drought resilience, flood risk mitigation, forest health, urban heat islands and the impacts of the built environment on the natural environment, Puget Sound health, and mitigating expected impacts on outdoor recreation opportunities.
- Prioritize actions that promote human health.
- Consider flexible and adaptive approaches for preparing for uncertain climate impacts, where relevant.
- Address the risk in each geographic region of the state with appropriate scope, scale, and urgency.

### 4.3 Structure outcomes of strategies and actions as building blocks of climate resilience

**Rather than trying to directly connect a climate resilience action to a discrete outcome (e.g. climate resilience), best practice from the literature is to put the action in the context of broader goals for adaptation and resilience.**<sup>24</sup> Determining the actual impact of climate resilience actions is difficult to do because these impacts are often obscure and emerge in complex systems over a long time. Also, because resilience is multi-dimensional and the aggregate of different types of capital (social, natural, financial, political, etc.), actions are rarely able to increase capacity across all these dimensions. Rather, it is likely that an action will fit in as a building block of climate resilience.

### 4.4 Measure climate resilience with relevant, flexible, and comprehensive indicators and metrics

**An effective way to understand if investments are achieving desired outcomes is to measure progress towards climate resilience with indicators and metrics.** Indicators and metrics can communicate a vision of and progress toward adaptation success, support strategic decisions, align plans, justify investments to taxpayers, demonstrate accountability, support learning, and improve effectiveness. No one set of indicators and metrics can fulfill these different purposes and selecting a reasonable number of indicators and metrics that are representative of various climate resilience goals can be difficult.

Indicators and metrics are most effective at measuring climate resilience when they:

- are grounded in the appropriate local context;
- incorporate flexibility;
- represent capacity, process, and outcomes associated with climate resilience; and
- are comprehensive but reasonable in scope.

#### Key Terminology: Indicators and Metrics

**Indicator:** A quality or trait that serves as a sign that a particular set of adaptation goals (strategies or actions) are yielding the desired results or making progress in the right direction.

**Metric:** A variable that can be measured (quantitative) or tracked (qualitative) that represents the indicator.





## Key Terminology: Types of Indicators and Metrics

**Outcome Indicator:** Indicative of the extent to which the desired future resilient state is being achieved.

- More direct indicator that resilience goals are being achieved
- Often take long time frames to achieve
- Often lack specific data to measure indicators
- Can be difficult to measure in the absence of extreme events
- Often attempt to measure the absence of something, such as a failure in the system

**Process Indicator:** Indicative of the progress being made towards the desired resilience goal, such as what is being done or spent. Process actions do not necessarily equal resilience or adaptation success in terms of achieving goals but do demonstrate accountability and are useful intermediary measures when outcomes are often not seen for many years.

- Process oriented
- Relatively easy to measure and track
- Show progress and contribute to learning

**Capacity Indicator:** Indicative of the capacity and resources necessary to make progress towards or achieve a resilience goal.

- Input oriented
- Show enabling conditions (social, technical, human, financial etc. capacities)

**Quantitative Metric:** A variable that can be counted or measured in numerical values.

- Relatively easy to measure (if data is available)
- Only provides a snapshot in time of the indicator and climate resilience

**Qualitative Metric:** A variable that can be tracked that helps to capture descriptive data.

- Contributes to a more complete story of the indicator and climate resilience
- Contains insights into the progress that is being made toward climate resilience goals
- Often requires more capacity and time to track

### ***Ground indicators and metrics in the appropriate local context***

Recognizing that climate change is global, but adaptation is local, actions to increase resilience will be most effective when tailored to the local context. Measuring climate resilience progress and outcomes will also be most effective when indicators and metrics are tailored to the goals, strategies, and actions designed to increase resilience for the given context, as opposed to standard indicators taken from other frameworks for other contexts. Defining resilience goals, strategies, actions, as well as an appropriate measurement framework will depend on the context, sectors, and people involved in the planning process. One way to ensure that indicators and metrics are grounded in the local context is to first define goals collectively for resilience, and then relate indicators and metrics to those goals.<sup>25</sup> Additionally, identifying indicators of those goals in conjunction with the development of specific strategies and actions can help ensure cohesion across the measurement framework.

### ***Incorporate flexibility***

Given that social-ecological systems are constantly changing, and climate resilience priorities are likely to change as well, incorporating flexibility into the measurement framework can ensure that indicators and metrics are responsive to evolving conditions. This can help prevent processes from becoming entrenched in measuring unhelpful indicators that don't contribute to learning about desired climate resilience outcomes.

### ***Represent capacity, process, and outcomes associated with climate resilience***

Capacity, process, and outcome indicators, when used together, can help paint a more comprehensive picture of climate resilience.<sup>26 27</sup> Outcome indicators are essential to understand if the desired future state of climate resilience is being achieved, but they often manifest over a long time and can be unsatisfying when trying to determine how investments are 'moving the needle.' A measurement framework that includes indicators of the processes and capacity necessary to build climate resilience can help show progress towards resilience outcomes despite the challenges of tracking climate resilience as a discrete outcome.<sup>28 29</sup> Tracking and evaluating progress towards climate resilience through the processes that are established (e.g. planning, engagement, decision-making) allows for near-term quantification of how investments are leading to outcomes.<sup>30</sup> Another way to demonstrate near-term

**Developing a complete understanding of the progress towards a climate-resilient future will require indicators that can describe the capacity and process needed to achieve resilience, as well as indicators that capture outcomes that describe what it looks like to achieve goals for climate resilience.**

return on investment is to measure and track capacity indicators.<sup>31</sup> Capacity indicators show that the conditions (funding, human capacity, knowledge) are being established to enable implementation of climate resilience actions.

For all indicators, best practice is to use both quantitative and qualitative metrics to track progress. These complementary metrics create a more complete picture of the indicator and contribute to learning that can inform the revision of indicators over time if necessary. Similarly, using a diversity of indicators meant to capture data at different points in the process of building climate resilience can also prevent entrenching measurement of an indicator that turns out not to be useful later.

***Develop comprehensive indicators that are reasonable in scope***

The need for a variety of indicators and metrics to paint the picture of climate resilience is clear, but this presents a practical challenge associated with measurement scope. Best practice for identifying indicators and metrics is to consider data availability and limitations. Will indicators and metrics rely on existing data, or will they require the collection of new data that might not yet be available and will take time and capacity to create? Implications for staff capacity and time needed to track and measure each indicator or metric should be considered. A small list of thoughtfully chosen indicators and a reasonable number of metrics is often more effective for demonstrating and evaluating progress than a long list.

## 5. State of the States: How Others Are Measuring Climate Resilience

State climate resilience plans developed in the last five years place a greater emphasis on defining actions that are specific and measurable.

Increasingly, state plans explicitly identify the need for a governance structure, mechanisms for implementation, and a process to track and report progress. However, details on these processes are rarely prescribed in plans, rather the plans often identify the need for an implementation plan that includes indicators and metrics and a process for tracking and reporting. This state of practice reflects the complexities of measuring climate resilience outlined in the previous sections, as well as the capacity required to collect data and report on indicators and metrics.

**Twenty-three states in the nation have a plan for climate resilience, yet most plans do not include indicators or metrics to measure progress or other mechanisms to show how investments in climate resilience translate to outcomes.**

**Of the few states and municipalities that have developed processes and structures for measuring climate resilience outcomes, approaches are varied, and all require resources and support from effective governance structures.** The approaches vary from simple processes that track the status of proposed actions to more sophisticated approaches that identify indicators and metrics for the goals and outcomes that the resilience strategy is designed to achieve. Most approaches currently being implemented are simplistic and in the early stages of measuring resilience outcomes. One theme identified in state plans is the need for resources to support the effort required to track, report and evaluate actions. A second theme is that the governance structure for implementing the climate plan is important for enabling effective tracking, measurement, and reporting.

### 5.1 Case studies: Approaches to Measuring Resilience by Other States

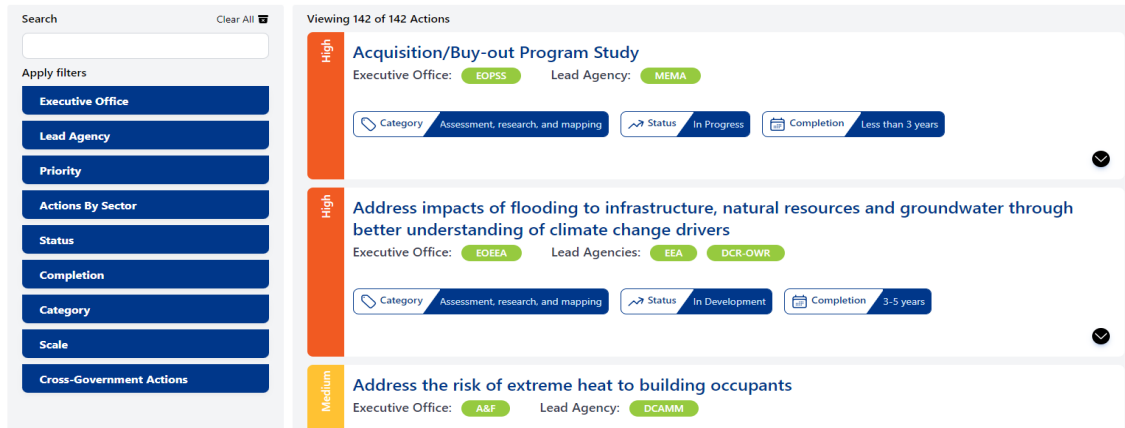
#### ResilientMass Plan Action Tracker

Massachusetts developed the ResilientMass Plan Action Tracker, an online dashboard that tracks over 100 priority resilience actions to address the climate risks described in the 2022 Massachusetts Climate Change Assessment.<sup>32</sup> The dashboard is periodically updated to reflect the status of each action and the expected timeline for completion. This approach increases

transparency and accountability because it requires continuous reporting of the action status. However, this approach is limited in its ability to demonstrate how individual actions contribute to broader resilience goals and outcomes.

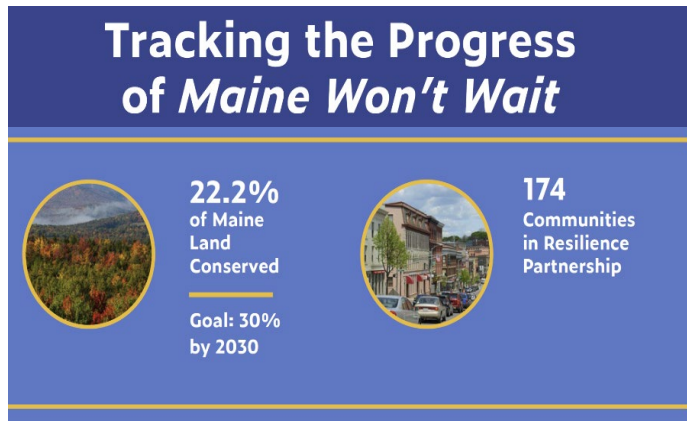
### ResilientMass Plan Action Tracker

State agencies identified over 100 initial priority actions to increase resilience and reduce the Commonwealth's risks and vulnerabilities related to natural hazards and projected climate changes. This tracker is maintained by the inter-agency ResilientMass Action Team (RMAT) and contains a list of actions identified through the 2023 ResilientMass planning process. All actions address at least one of the primary statewide climate change impacts identified in the 2022 Massachusetts Climate Change Assessment. This tracker will be updated periodically to reflect progress in implementing these actions.



### Maine Won't Wait - A Four-Year Plan for Climate Action

To track implementation of Maine Won't Wait, the state's four-year climate action plan, the state developed an online dashboard to track numerical targets and report success stories qualitatively.<sup>33</sup> The purpose of the dashboard is to inform the public and identify whether adjustments, enhancements or replacements to policies are needed to achieve resilience



objectives. The expectation is that the dashboard will be expanded over time as investments are realized, enabling more outcomes to be tracked. Although most of the goals in Maine's climate action plan focus on targets for reducing greenhouse gas emissions, some specifically measure resilience outcomes – the percentage of land conserved and the number of communities in resilient partnerships. By defining indicators

and metrics (quantitative or qualitative), this framework provides a more complete picture of how strategies and actions are contributing to broader resilience outcomes and show progress over time as more investments are made in resilience.

### Municipal Approaches to Measuring Resilience Outcomes

CRDC FOCAL AREA	OVERARCHING GOAL	OUTPUT INDICATOR	OUTCOME INDICATOR	PERFORMANCE STANDARD
TRANSPORTATION AND UTILITIES	Improve transportation and utility infrastructure to maintain viability during periods of extreme heat, severe weather, and flooding.	Number of transportation and utility projects that specifically incorporate climate projections into planned or implemented designs and operations.	Estimated costs saved through adaptive measures, including greening, hardening, retrofitting, or relocating utility and transportation assets.	Setting a minimum time by which transportation or utilities assets should be expected to return to normal functionality after a severe weather event reasonably expected based on climate projections.
BUILDINGS AND DEVELOPMENT	Retrofit existing buildings and design new buildings and development projects to withstand climate change impacts.	Number of buildings that specifically incorporate climate projections into planned or implemented designs and operations  Number of critical facilities designed to withstand increased risks due to climate change.	Estimated costs saved through integrating climate risks into building or development design decisions.  Percentage of residents living in buildings designed to withstand reasonably expected climate hazards.	Resilient building performance standards, such as requiring all new buildings to maintain thermal comfort levels without power on a 95 degree Fahrenheit day for 12 hours.
NEIGHBORHOODS AND COMMUNITIES	Make neighborhoods and communities safer and more prepared by strengthening community, social, and economic resilience.	Proportion of District residents living within a 10-minute walk from a resilience hub  The percent of tree canopy and/or impervious surface coverage in the most heat-sensitive areas.	Reduced number of ambulance dispatch calls or hospital admissions during severe weather events of similar magnitudes.  Reductions in UHI temperature differentials after installing cooling infrastructure (e.g., cool roofs and shade trees).	Setting specific standards, such as ensuring all evacuation routes stay operational if 14 inches of rain falls in a 24 hour period.

#### Climate Ready DC

Several municipalities have more developed processes for measuring and evaluating progress towards climate resilience outcomes. For example, the District of Columbia developed Climate Ready DC with a measurement framework that includes goals, indicators, and performance standards for four focal areas, or sectors.<sup>34</sup> Each sector has an overarching goal with one *output* and one *outcome* indicator. The *output* indicators are intended to monitor progress towards the overarching resilience goal. The *outcome* indicators will be tested and refined as data is collected. Progress updates are made through annual reporting.

#### Climate Budgeting in New York

New York City is the first city in the nation to pilot an innovative approach to integrate targets from the city's Climate Action Plan directly into the financial budgeting process of the city. Within the city's budget decision-making process, the city proposes, adopts, implements, monitors, and reports on measures to meet short-term targets for greenhouse gas emissions reductions.<sup>35</sup> Each action tracked through the budgeting process includes estimated emissions reductions along with the costs and financing required. This enables a more direct accounting of how near-term spending contributes to meeting long-term emissions reductions targets across all city agencies and creates a mechanism to track the broader impact of the city's budget on climate change.

## 6. Informing Washington State's Integrated Climate Resilience Strategy

**An emphasis on implementation and measurability in the update to Washington's Climate Resilience Strategy will increase transparency and enable investments to be more clearly connected to climate resilience outcomes.** Furthermore, by specifying principles to guide the development of the strategy, the legislation ensures that the actions and strategies included in the plan are multi-purpose and produce co-benefits, increasing the potential for realizing all three dividends of resilience: avoided losses, stimulated economic benefits, and broader social, environmental, and governance related co-benefits.

Performance measurement for climate resilience is an emerging practice, especially at the state level. There is no one-size fits all approach to measure and determine how investments translate to climate resilience outcomes. Best practices from the literature and lessons from other states are being applied to a measurement framework for the update of Washington's Climate Resilience Strategy. These practices are:

- a governance structure developed to support accountability, coordination implementation, tracking, and reporting on climate resilience strategies and actions;
- strategies and actions that are designed for implementation;
- consideration of co-benefits, detailed by the guiding principles, to ensure actions to build climate resilience also contribute to broader resilience goals (e.g. public health, environmental justice, habitat restoration); and
- an adaptive and flexible measurement framework to track and measure capacity that enables actions, processes for implementing resilience actions, and climate resilience outcomes.

The approach described below has been guided by requirements outlined in RCW 70A.05.010 regarding reporting frequency and developed in close collaboration with the Department of Ecology and the interagency climate resilience team tasked with updating the Climate Resilience Strategy.

**RCW 70A.05.010 Update & Reporting Frequency:**

"The department of ecology shall update the climate response strategy every four years and provide interim biennial work plans to the governor's office that report on implementation progress and summarize agency needs and priorities for biennial budget planning processes starting by September 30, 2025.

"Agencies responsible for implementing actions in the updated strategy shall provide information needed for reporting to the department of ecology by August 15th of odd-numbered years starting in 2025. Agencies may identify and include any resources needed to carry out duties under RCW 70A.05.040."

The Climate Resilience Strategy is still in development (*to be completed in September 2024*). Here we describe the draft structure of the strategy to provide context for the currently proposed measurement framework described below.<sup>1</sup> This proposed framework will continue to evolve and change as work continues to refine the climate resilience strategy over the next several months, including as a result of input received through outreach and engagement activities.

The Climate Resilience Strategy has climate resilience goals, strategies, and actions.

**Goals** outline an overall vision for climate resilience for three broad areas: 1) communities, 2) infrastructure, and 3) natural and working lands. A fourth goal, governance, outlines *how* the state will increase statewide climate resilience through the strategy.

**Strategies** are high-level cross-agency priorities designed to encompass the diversity of actions that contribute to climate resilience for a similar hazard or are accomplished through a similar approach.

**Actions**, guided by the principles outlined for the strategy, contribute to one or more of the climate resilience goals and address one or more of the climate hazards facing the state. Actions reflect agency and cross-agency priorities for climate resilience.

The current proposed measurement framework defines capacity, process, and outcome indicators at the goal level (*see Key Terminology: Types of Indicators and Metrics above*). These indicators will be measured by one quantitative metric and tracked by one qualitative metric. Outcome indicators will be measured every four years because they often require longer time frames to show results. Process and capacity indicators will be measured every two years because they show near-term progress and can help guide updates to the strategy and funding requests. The data for the

---

<sup>1</sup> This framework is subject to changes based on additional feedback from the public review period, and additional work done by the interagency climate resilience team between June 1, 2024 and finalization of the strategy in September 2024.



metrics associated with each indicator will include data from the results of actions that have been associated with the indicators. This structure has been proposed to provide a comprehensive view of how the actions are collectively contributing to the climate resilience goals. Strategies will not be measured but will be reviewed every four years in line with the update to the strategy. Further, action status (completed, in progress, not yet started) and funding status (received state or federal funding to implement, didn't require additional funding) will be reported on by lead agencies for the actions every two years. An example to illustrate this approach for a given goal, indicator, and set of actions is provided below.

This proposed measurement framework for Washington's Climate Resilience Strategy will take time and capacity to establish and implement. Once established, initial measurements will contribute to setting a baseline for the indicators against which future measurements can be compared. This approach to measuring progress towards climate resilience will need to be adaptively managed to ensure that the appropriate metrics are being measured and that no unintended consequences are occurring because of the framework.



**Proposed Measurement Framework for Washington's Climate Resilience Strategy**

Level of Strategy	Measurement Approach	Structure and Process	Recommendations and Justification
Goal	<p>Outcome, process, and capacity indicators</p> <p>Quantitative and qualitative metrics</p>	<p>Structure</p> <ul style="list-style-type: none"> <li>● Outcome and process indicators are defined for each goal.</li> <li>● Capacity indicators are defined only for the governance goal.</li> <li>● Quantitative and qualitative metrics measure and track progress for each indicator under the goals.</li> </ul> <p>Process</p> <ul style="list-style-type: none"> <li>● The ICR core staff will combine the information reported from each agency and action to report on the metric(s) and show progress made for each capacity and process indicator every two years and every outcome indicator every four years.</li> </ul>	<p>This approach to measuring climate resilience progress will provide a comprehensive view of how the actions are collectively contributing to the resilience goals.</p> <p>Measuring two metrics per indicator (when possible, one quantitative and one qualitative) will help create a more complete picture of progress for an indicator and maintain a manageable number of metrics.</p>
Strategy	No formal measurement	<p>Structure</p> <ul style="list-style-type: none"> <li>● Strategies are designed to encompass the diversity of actions that contribute to resilience for a similar hazard or with a similar approach.</li> </ul> <p>Process</p> <ul style="list-style-type: none"> <li>● The core staff and ICR coordinating committee assess the strategies every four years through the update process to determine if these are still the priority strategies.</li> </ul>	<p>Indicators and metrics for the strategies could also be developed and tracked to show progress on the strategies. We are not recommending this approach to avoid creating an unreasonable number of metrics and because the strategies are high-level.</p> <p>The four-year review of the strategies could include interviews with agency staff, case studies etc., and reporting on success stories and challenges associated with actions.</p>

<p>Action</p>	<p>Status reporting (<i>not yet started, in progress, completed</i>)</p> <p>Funding status (<i>received state or federal funding to implement, didn't require additional funding</i>)</p> <p>Action data contributes to the Goal level indicators and metrics</p>	<p>Structure</p> <ul style="list-style-type: none"> <li>• Actions have a lead agency, participating agencies, and timeframe.</li> <li>• Individual actions contribute to at least one indicator/metric at the goal level and often more than one.</li> </ul> <p>Process</p> <ul style="list-style-type: none"> <li>• Lead agency reports action and funding status to Ecology climate resilience core staff every two years.</li> <li>• All agencies contribute information for the capacity indicator metrics every two years.</li> <li>• Participating agencies contribute information to the process indicator metrics for the action every two years.</li> <li>• All relevant agencies contribute information for the outcome indicator metrics every four years.</li> </ul>	<p>The process shows how multiple actions collectively contribute to the climate resilience goals.</p> <p>Outcome indicators are more long-term, so we recommend a less frequent reporting period.</p> <p>Process and capacity indicators show near-term progress, so we recommend a more frequent reporting period.</p>
---------------	---	--	--

**Example of measurement framework for a given goal, indicator, and set of actions:**

**Goal 3: Natural and Working Lands (N&WL):** *Protect, restore, and adaptively manage natural systems and working lands so they can provide continued and enhanced ecological, cultural, social, and economic benefits under current and future climate impacts.*

<b>N&amp;WL Outcome Indicator #2 – Restored and resilient species and habitat exist and are connected across the landscape.</b>		
Quantitative Metric	Qualitative Metric	
# of acres of habitat restored	Story of restored habitat because of the actions	
<b>Connected Actions</b>		
9.INTER9 Increasing habitat connectivity for Washington’s wildlife		
9.INTER10 Interagency Shrubsteppe Resilience Implementation		
<b>Reporting: What</b>	<b>Who</b>	<b>Timeframe</b>
# of acres restored	All agencies conducting habitat restoration	Every four years
# of acres restored by action Stories of restored habitat	Interagency action leads	Every four years

## References

- <sup>1</sup> Tanner, T.M., Surminski, S., Wilkinson, E., Reid, R., Rentschler, J.E., and Rajput, S. (2015). The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. *Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI)*, London. [www.odi.org/tripledividend](http://www.odi.org/tripledividend)
- <sup>2</sup> Bapna, M., et al., (2019). Adapt now: a global call for leadership on climate resilience, Global Commission on Adaptation, Washington, DC (<http://hdl.handle.net/10986/32362>) accessed 19 March 2024.
- <sup>3</sup> Mehryar, S., (2022). What is the difference between climate change adaptation and resilience? Grantham Research Institute on Climate Change and the Environment. London School of Economics and Political Science. <https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-difference-between-climate-change-adaptation-and-resilience/>
- <sup>4</sup> *City Resilience Index*. (n.d.) ARUP. <https://www.arup.com/perspectives/publications/research/section/city-resilience-index>
- <sup>5</sup> UNDP Dryland Development Centre (n.d.). Community Based Resilience Analysis Conceptual Framework and Methodology. *Humanitarian Aid and Civil Protection Department of the European Commission's Drought Risk Reduction Action Plan*. [https://www.undp.org/sites/g/files/zskgke326/files/migration/nairobi\\_gc\\_red/CoBRRR\\_Conceptual\\_Framework.pdf](https://www.undp.org/sites/g/files/zskgke326/files/migration/nairobi_gc_red/CoBRRR_Conceptual_Framework.pdf)
- <sup>6</sup> The White House (2023). National Climate Resilience Framework. <https://www.whitehouse.gov/wp-content/uploads/2023/09/National-Climate-Resilience-Framework-FINAL.pdf>
- <sup>7</sup> Holling, C.S., (1973). Resilience and Stability of Ecological Systems. *Annual Review Of Ecology, Evolution And Systematics*. Volume 4.
- <sup>8</sup> Cohen, P. J., Lawless, S., Dyer, M., Morgan, M., Saeni, E., Teioli, H., & Kantor, P. (2016). Understanding adaptive capacity and capacity to innovate in social-ecological systems: Applying a gender lens. *Ambio*, 45(Suppl 3), 309–321. <https://doi.org/10.1007/s13280-016-0831-4>
- <sup>9</sup> Ossewaarde, R., Filatova, T., Georgiadou, Y., Hartmann, A., Özerol, G., Pfeffer, K., Stegmaier, P., Torenvlied, R., van der Voort, M., Warmink, J., and Borsje, B. (2021). Review article: Towards a context-driven research: a state-of-the-art review of resilience research on climate change. *Nat. Hazards Earth Syst. Sci.*, 21, 1119–1133, <https://doi.org/10.5194/nhess-21-1119-2021>.
- <sup>10</sup> Folke, C., Biggs, R., Norström, A. V., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society*, 21(3). <http://www.jstor.org/stable/26269981>
- <sup>11</sup> Wisner, B., Gaillard, J. C. & Kelman, I. (2012). Framing disaster: theories and stories seeking to understand Hazards, vulnerability and risk. *Handb. Hazards Disaster Risk Reduction*. 1st ed., 18–34. Routledge, London.
- <sup>12</sup> Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., & Schultz, L. (2006). A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. *Ecology and Society*, 11(1). <http://www.jstor.org/stable/26267801>
- <sup>13</sup> Janssen, M.A., T.A. Kohler, and M. Scheffer. (2003). Sunk-cost effects and vulnerability to collapse in ancient societies. *Current Anthropology* 44(5):722-728.
- <sup>14</sup> Mehryar, S., & Surminski, S. (2022). Investigating flood resilience perceptions and supporting collective decision-making through fuzzy cognitive mapping. *The Science of the total environment*, 837, 155854. <https://doi.org/10.1016/j.scitotenv.2022.155854>
- <sup>15</sup> Bours, D., McGinn, C., Pringle, P., (2014). Guidance Note 1: Twelve Reasons Why Climate Change Adaptation M&E is Challenging. SEA Change Community of Practice, and UK Climate Impacts Programme.
- <sup>16</sup> Bours, D., McGinn, C., Pringle, P., 2014. Guidance Note 1: Twelve Reasons Why Climate Change Adaptation M&E is Challenging. SEA Change Community of Practice, and UK Climate Impacts Programme.
- <sup>17</sup> Dicker, S., Unsworth, S., Byrnes, R., and Ward, B. (2021). Saving lives and livelihoods: the benefits of investments in climate change adaptation and resilience. *Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy*, London School of Economics and Political Science.
- <sup>18</sup> <https://coast.noaa.gov/states/fast-facts/hazard-mitigation-value.html>

- <sup>19</sup> Tanner, T.M., Surminski, S., Wilkinson, E., Reid, R., Rentschler, J.E., and Rajput, S. (2015). The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. *Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI)*, London. [www.odi.org/tripledividend](http://www.odi.org/tripledividend)
- <sup>20</sup> Bapna, M., et al., (2019). Adapt now: a global call for leadership on climate resilience, Global Commission on Adaptation, Washington, DC (<http://hdl.handle.net/10986/32362>) accessed 19 March 2024.
- <sup>21</sup> Tanner, T.M., Surminski, S., Wilkinson, E., Reid, R., Rentschler, J.E., and Rajput, S. (2015). The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. *Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI)*, London. [www.odi.org/tripledividend](http://www.odi.org/tripledividend)
- <sup>22</sup> Tanner, T.M., Surminski, S., Wilkinson, E., Reid, R., Rentschler, J.E., and Rajput, S. (2015). *The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management*. Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI), London. [www.odi.org/tripledividend](http://www.odi.org/tripledividend)
- <sup>23</sup> Tanner, T.M., Surminski, S., Wilkinson, E., Reid, R., Rentschler, J.E., and Rajput, S. (2015). The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. *Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI)*, London. [www.odi.org/tripledividend](http://www.odi.org/tripledividend)
- <sup>24</sup> Bours, D., McGinn, C., Pringle, P., 2014. Guidance Note 1: Twelve Reasons Why Climate Change Adaptation M&E is Challenging. SEA Change Community of Practice, and UK Climate Impacts Programme.
- <sup>25</sup> Visioning Success. (n.d.) ResilienceMetrics. <https://resiliencemetrics.org/visioning-success>
- <sup>26</sup> Brown, C., Shaker, R.R. & Das, R. (2018). A review of approaches for monitoring and evaluation of urban climate resilience initiatives. *Environ Dev Sustain* **20**, 23–40. <https://doi.org/10.1007/s10668-016-9891-7>
- <sup>27</sup> Hallegate, S., and Engle, N.L., (2019). The search for the perfect indicator: Reflections on monitoring and evaluation of resilience for improved climate risk management. *Climate Risk Management*. *23*, 1-6
- <sup>28</sup> Moser, S., & Boykoff, M., (2013). Climate change and adaptation success. The scope of the challenge. In S. Moser & M. Boykoff (Eds.), *Successful Adaptation to Climate Change Linking Science and Policy in a Rapidly Changing World* (1st ed., pp. 1–33). Routledge.
- <sup>29</sup> Brown, C., Shaker, R.R. & Das, R. (2018). A review of approaches for monitoring and evaluation of urban climate resilience initiatives. *Environ Dev Sustain* **20**, 23–40. <https://doi.org/10.1007/s10668-016-9891-7>
- <sup>30</sup> Moser, S., & Boykoff, M., (2013). Climate change and adaptation success. The scope of the challenge. In S. Moser & M. Boykoff (Eds.), *Successful Adaptation to Climate Change Linking Science and Policy in a Rapidly Changing World* (1st ed., pp. 1–33). Routledge.
- <sup>31</sup> United States Climate Alliance (2022). Fundamentals of Climate Resilience Outcome Metrics
- <sup>32</sup> ResilientMass Plan Action Tracker (n.d.) Resilient Mass Action Team. <https://resilient.mass.gov/actiontracker>. Accessed 12 April 2024.
- <sup>33</sup> Main Climate Council. (2020). Main Won't Wait A Four-Year Plan for Climate Action. <https://www.maine.gov/climateplan/the-plan>
- <sup>34</sup> Climate Ready DC. (2016). <https://doee.dc.gov/climateready>
- <sup>35</sup> PlaNYC: Getting Sustainability Done (n.d.). NYC Mayor's Office of Climate & Environmental Justice. <https://climate.cityofnewyork.us/initiatives/planyc-getting-sustainability-done/>
- <sup>36</sup> Mehryar, S. (2022, September 12). What is the difference between climate change adaptation and resilience? *Grantham Research Institute on Climate Change and the Environment Explainers*. <https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-difference-between-climate-change-adaptation-and-resilience/>