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Beyond the Bottom Line

Nonmarket Stated and Revealed Preference Methods for Community Resilience and Adaptation Planning

Jennifer F. Helgeson
Christina Gore

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Abstract

This report details the importance of nonmarket valuation techniques for community resilience planning. Community resilience planning decisions involve making trade-offs between the benefits and costs of different resilience projects. In order to make those decisions about trade-offs, the valuation of each benefit and cost must be accurately measured ad communicated in a meaningful way. Often community resilience projects involve valuing a good or service that is not sold in a traditional market, so nonmarket valuation is used in these cases. This report details commonly used nonmarket valuation methods (NVMs) that fall under the categories of revealed or stated preference techniques. The report also enumerates considerations for which methods are most appropriate in given circumstances. Additional considerations in the use of NMV, especially, in BCA, are noted.

Keywords

Benefit cost analysis, co-benefit, nonmarket valuation, revealed preferences, stated preferences, resilience dividend, resilience windfall.

Table of Contents

List of Figures

Acknowledgments

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1. Background and Motivation

The USA continues to see increased frequency and intensity of extreme weather events in recent years. This trend aligns with global observations linked to climate change. Average temperatures across the country are rising, with winter seeing the most dramatic increase of nearly 3°F since 1896 (EPA, 2021). This warming fuels heavier precipitation events, particularly in the Northeast, where the amount of rain during the heaviest downpours has increased by 60% since the 1950s – the highest increase nationwide (OSTP, 2023). These changes translate to more frequent and severe heat waves, floods, droughts, and wildfires, among other weather and climate acute and sustained impact, posing significant challenges for communities across the USA. From 1980–2024 (as of May 8, 2024), there have been 383 confirmed weather/climate disaster events with losses exceeding $1 billion each (CPI adjusted) in the United States (NOAA, 2024). This growing toll of climate-related damage has dramatically impacted homeowner insurance policies by increasing rates, reducing coverage, denying claims, making policies available only to the safest customers, and insurers leaving risky areas altogether. As established markets for reducing the risk to individuals and households of the impacts of global climate change fail (e.g., homeowners' insurance), nature based solutions (NbS) and engineering with nature options become ever more relevant. These newer designs to increase resilience require valuation of resources and services that do not typically have a market price. In this section we summarize the importance of non-market valuation (NMV) in community resilience planning and the purpose of this report.

A recent report finds that over the next decade, continuing current actions on climate-related resilience and adaptation to the infrastructure investment gap, "U.S. industries [may] avoid losing more than $1 trillion in gross output and helps avoid a loss of more than $600 billion in GDP." These values translate into household and employment benefits nationwide as "American families will have an additional $550 billion in disposable income over the next decade" and hundreds of thousands of American jobs could be saved (ASCE, 2024). Thus, planning for resilience and by extension the associated valuation of potential alternatives, is critical. Given the connections to nonmarket aspects in resilience planning, there is high importance in understanding and employing NMV.

An important part of building resilience is engaging in community efforts to plan for the resilience of the built and natural infrastructure that supports socio-economic functions in a community. One example of such guidance is the National Institute of Standards and Technology (NIST) Community Resilience Planning Guide (CRPG) (McAllister et al., 2015). In recent years, NIST continues to look at leading practices for building codes, standards, and practices with consideration for a changing climate (e.g., Averill et al., 2021) -- ref. workshops and one day talk with NOAA. Evaluation of the economics and associated business case for resilience planning is discussed in the NIST Special Publication 1197: Community Resilience Economic Decision Guide for Buildings and Infrastructure Systems (Gilbert et al., 2015). The focus on several nonmarket values and services in economic assessments of resilience and adaptation plans requires consideration to ensure that they are included in a community's evaluations of alternatives.

Community resilience planning and climate change adaptation taken through policy, actions, and planning, can provide benefits to society through a wide range of mechanisms—such as

enhancements to ecosystem services, health, and safety; avoided infrastructure and property damage; and improved resilience to a range of non-climate stressors—that may not always be considered and typically not monetized (Zamuda et al., 2019).

Circular A-94 stipulates that benefit cost analyses (BCAs) should include "comprehensive estimates of the expected benefits and costs to society based on established definitions and practices for program and policy evaluation" and should recognize "both intangible and tangible benefits" (OMB, 2023a). Benefit-cost analyses and other evaluations across community resilience alternatives should account for the full range of net benefits, including the benefits of increased resilience to climate, natural, and human-made shocks and stressors (e.g., land development pressure, population growth, and migration).

The National Institute of Standards and Technology (NIST) Special Publication 1197: Community Resilience Economic Decision Guide for Buildings and Infrastructure Systems (Gilbert et al., 2015) acknowledges the limitations of solely economic evaluations and explores the need to incorporate non-market values (NMVs). The accompanying NIST "Economic Decision Guide" Software (EDGe$) Tool Online (Helgeson et al., 2017; 2021) provides a framework for considering several non-market values, which may coincide with social goals, alongside economic net benefits when prioritizing resilience investments. Furthermore, Fung and Helgeson (2017) discuss co-benefits and Helgeson and O'Fallon (2021) note the importance of non-monetary valuation of co-benefits to achieve resilience dividends and windfalls, as well as the narrative context (that may not be truly monetizable). These types of valuations can all be ingested by the EDGe$ Tool Online with the goal of selecting an alternative that is most cost-effective and efficiently addresses the singular or compound risks for which a community plans to increase resilience

This NIST Special Publication (i.e., NIST SP 1322) is meant to augment community resilience planning economic evaluation with consideration for adaptation to and mitigation of future climate impacts. This move toward addressing future climate risks is aligned with opportunities to advance the frontiers of benefit-cost analysis in federal practice, as noted by the National Science and Technology Council's Subcommittee on Frontiers of Benefit-Cost Analysis report (National Science and Technology Council, 2023). This Special Publication focuses on techniques to calculate the economic valuation of goods and services that do not have a market price. The proceeding section of this report focuses on what is NMV. Then, we move to a discussion of stated preference methods. The next section then outlines revealed preference methods. The fifth section focuses on data and tools that are currently available to assist with NMV. Next, we discuss some additional considerations that should be made in an NMV study. The seventh section then presents an example. We finally end with concluding remarks.

2. Overview and Context

Benefit-cost analysis (BCA) is a tool used to evaluate the economic viability of a project or policy by comparing the expected benefits with the expected costs. One of the main challenges of BCA, especially when assessing community resilience planning alternatives, is assigning a monetary value to things that are not traditionally bought and sold in a market. This is where non-market valuation comes in. Often when you do not assign a value to something within a BCA framework, they are not included in the costs or benefits, so you are implicitly assuming that the value is zero.

Non-market valuation (NMV) refers to a set of techniques used to estimate the economic value of goods and services that do not have a market price. This can include things like clean air, wildlife preservation, or the beauty of a scenic landscape.

The following four steps illustrate how BCA and non-market valuation typically work together:

1. **Identify the Benefits and Costs:** A BCA first identifies all the relevant benefits and costs of a project or policy. This might include things like construction costs, increased revenue, improved public health, or environmental damage. Relevant classes of costs and benefits (i.e., direct, indirect, co-benefits/co-costs, etc.) are noted in Gilbert et al. (2015) and Helgeson and O'Fallon (2021).
2. **Valuing Market Goods:** For goods and services that are already bought and sold in a market, like construction materials or increased worker productivity, the market price can be used for their value.
3. **Non-Market Valuation Techniques:** For non-market goods and services, economists have developed various techniques to estimate their value. These techniques can include:
    - **Stated preference methods (SPMs):** Surveys that elicit how much people would be willing to pay for a particular good or service.
    - **Revealed preference methods (RPMs):** Analyzing people's behavior in existing markets to infer their value for non-market goods. For example, looking at how much people are willing to pay for houses near a park to estimate the value of the park itself.
4. **Monetary Value:** By applying these techniques, non-market valuation assigns a monetary value to the non-market benefits and costs. This allows them to be directly compared with the market-valued benefits and costs in a BCA or other economic evaluation.

There are several benefits to using NMV. The method can help inform decision-making; by including the value of non-market goods and services, BCA can provide a more complete picture of the costs and benefits of a project or policy. This can lead to better-informed decisions when the basis for decision making is development of a business case. Furthermore, many environmental benefits do not have a market price. Non-market valuation can help ensure these benefits and costs are considered when making decisions that could impact the environment.

There are also several challenges associated with NMV. Primary among these is accuracy, as the techniques used in non-market valuation can be complex and the results can be highly subjective

and context dependent. Furthermore, depending on the nature of the good or service being valued, there may be limited data available to use with non-market valuation techniques. Finally, cultural context may limit the value of NMV if a good or service truly is invaluable, or it is culturally inappropriate to assign monetary value (see Section 6).

Overall, BCA and accompanying NMV can be powerful in evaluation of projects and policies. Yet, it is important to be aware of the limitations of non-market valuation and to use the results in conjunction with other forms of analysis.

2.1. What is non-market valuation?

Non-market valuation (NMV) is a set of methods that attempts to put an economic valuation on things that are not commonly traded or valued in a traditional market setting. A traditional market good or service would include anything that someone can buy, so it has a price associated with it. Non-market goods and services are typically ones that someone cannot go to the store and buy like good air quality.

Clean air is not directly purchasable, but that does not mean that people do not value it.

NMV techniques bridge this gap, estimating what people would be willing to pay for cleaner air. This is crucial for economists and policymakers who guide community decisions. BCA and other economic evaluation techniques, which guide many decisions, can incorporate these non-market values to reflect a more holistic picture.

2.2. Why do we need non-market valuation in community resilience planning?

Community resilience planning decisions depend highly on benefit-cost analysis to determine which projects to allocate money to when communities are constrained financially. Benefit cost analysis (BCA) allows a community to select a project with the greatest net benefits (i.e., total benefits less total costs) to ensure the best community resilience project is selected, so it is vital to include all benefits and costs in the analysis.

Many community resilience projects have benefits that do not have typical market valuations. For example, if a community is considering a stream restoration project that would decrease flooding in their community, there are likely to be environmental benefits of the stream restoration, as well as the benefits to decreasing the number of homes and businesses that are at risk of flooding. These additional environmental benefits are often considered a net co-benefit (REF). The environmental benefits of the stream restoration may not have a market valuation, so non-market valuation approaches can be used to value the increased environmental quality of the river. Fully incorporating the benefits of each project that is proposed is important to be able to select the project that increases net benefits the most. If this community was considering the two options of stream restoration or building a levee system but did not include the non-market benefits and costs of each of the plans, then they might select a project with the lower net benefits due to undervaluing aspects with associated NMVs.

Increasingly, nature-based infrastructure (NBI) is used as an alternative or complement to engineered (i.e., grey) infrastructure, with examples including green roofs, land restoration

through reforestation, nature-based seawalls, and coastline rehabilitation. In short, NBI encompasses development that relies on natural processes to perform functions normally associated with engineered, human-made infrastructure. This 'green' infrastructure also provides a wide range of additional benefits—from preserving biodiversity and sequestering carbon, to economic and social effects such as job creation and improved public health. It also plays a key role in helping communities adapt to climate change, alleviating the effects of extreme weather events such as floods, droughts, and storms. However, these benefits are often hard to value, and without values are largely left out of traditional valuation when assessing project alternatives. These benefits can add-up: IISD (2021) reported that governments and investors could save USD 248 billion a year (2021 dollars), protect the environment, and benefit local communities by replacing or complementing newly built infrastructure with natural alternatives.

2.3. Use and Non-Use Values

There are two main types of values that we place on things: 1. use value and 2. non-use value. Use values take many different forms including extractive values and non-consumptive values.

- **Extractive value** is the value that something has to be used as a means of production or to be consumed directly. Extractive values include harvesting of plants and animals as well as extraction of minerals and precious metals. For example, if someone values a river for the ability to go and fish and then take that fish home to eat, then one has an extractive use value for the river.
- **Non-consumptive use value** is the value someone places on using or experiencing something, but their use of it does not change the thing being used. Non-consumptive use values can include things like viewing the wildlife that lives in and around a river. For example, if someone enjoys going to the river to be in nature and walk along the river, then one has a non-consumptive use value for the river.

Non-use values are a type of NMV that refers to the benefits people receive from a resource even if they never directly use it. Non-use benefits have been subdivided into existence value (i.e., the value people receive from simply knowing a resource exists), altruism (i.e., the value derived from having other contemporaries use a resource) and bequest value i.e., (preserving a resource for future generations).

- **Existence value** is the value people place on simply knowing that a resource exists, even if they never plan to use it themselves. For example, many people place a high existence value on endangered species, even if they never expect to see one in person.
- **Altruistic value** is the value people derive from knowing that others can use and/or enjoy a resource. This relates to discount rates across space. For example, people who support public parks may do so in part because they value the opportunity for others to enjoy nature.
- **Bequest value** is the value people place on preserving a resource for future generations. This relates to discount rates across time. For example, people who support sustainable

forestry practices may do so in part because they want to ensure that future generations will have access to forests.

Another type of value that someone might have is an option value. An option value includes the value of wanting to preserve an asset in case it has a future use or non-use value. Non-market valuation techniques are used to estimate the economic value of these non-use benefits, even though they are not traded in a market. This information can be used to inform decision-making about resource use and conservation.

2.4. Willingness-to-pay / Willingness-to-accept

There are two main ways to measure someone's economic value of a non-market good or service, which are willingness-to-pay (WTP) and willingness-to-accept (WTA).

- **Willingness-to-pay** is the maximum amount an individual would be willing to pay to acquire something. For example, if one offers someone a coffee mug for 10 dollars and they are willing to buy it, but if someone were to have told them the price of the mug was 11 dollars and they would have refused to buy it, then the maximum amount they are willing to pay to purchase the mug would be 10 USD.
- **Willingness-to-accept** is the minimum amount of money that someone would accept to give up something that they own. For example, if one offers to give someone 10 dollars for their coffee mug, but they refuse, then someone offers them 11 USD and they give someone the coffee mug their willingness-to-accept is 11 USD.

While willingness-to-pay and willingness-to-accept are similar ways to measure economic valuation, there are important differences between the measures. Typically, someone's willingness-to-pay is lower than their willingness-to-accept across domains (Barbeis, 2013); Brown and Gregory (1999) discuss the importance in the realm of environmental goods. Diamond and Hausman (1994) argue that contingent valuation surveys have methodological problems that often make their results unreliable. One issue is that respondents may not answer contingent valuation questions realistically, considering their budget constraints poorly. This can lead to inconsistent answers depending on how the question is framed (i.e., embedding effect). Though they are typically elicited through stated preferences, WTP and WTA are determinable through revealed preference techniques as well (e.g., hedonic pricing, discrete choice). More information on the different ways that preferences are measured can be found in **Section 3**.

2.5. Types of preference elicitation

The two main ways to elicit an individual's or group's valuation of non-market goods are revealed preference and stated preference. Revealed preference uses decisions that individuals have made to calculate what their implied valuation is on something. For example, someone who puts a high valuation on rivers might decide to live closer to a river than someone who does not have a high valuation of rivers, so this would be using someone's location decision to reveal something about their valuation of a non-market asset. Stated preference valuation depends on individuals' responses to questions about how they value something. Surveys are a very important tool in

eliciting stated preference non-market valuations, since the way that a researcher asks someone if they value a river can greatly influence their stated valuation of the river.

3. Overview of Stated Preference Methods

Stated preference methods (SPMs) are a group of survey-based techniques used to estimate people's preferences for goods and services that are not traded in a traditional market. SPMs typically ask people hypothetical questions about their choices, revealing their "willingness to pay" (WTP) or "willingness to accept" (WTA) for changes in these goods or services.

We overview the most common SPM techniques, below. The choice of method depends on the specific research question and the complexity of the good or service being valued. Johnston et al. (YEAR) describes different stated preference methods as well as best practices for designing surveys using stated preference non-market valuation techniques.

3.1. Choice Experiment (CE):

Choice experiments are a separate class of nonmarket valuation, but paired comparison, attribute-based methods (ABM), and contingent valuation (CV) can all be used within a choice experiment framework. Choice experiments typically use surveys where participants choose between hypothetical scenarios with varying levels of resilience benefits (e.g., reduced flood damage, improved social cohesion). Through analysis of the choices participants make, researchers or practitioners can infer the value they place on the net benefits (or costs) in question. Choice experiments can be seen as an extension of CV that overcomes some limitations. Contingent valuation can be susceptible to hypothetical bias, where respondents might overstate their WTP/WTA in hypothetical scenarios. By presenting multiple choices with trade-offs, CE can provide more realistic and reliable data (Mohammed, 2012).

3.2. Contingent Valuation (CV):

Contingent valuation is the most direct SPM. People are asked hypothetical questions about their WTP for a specific change in a good (e.g., cleaner air, improved park facilities). There are different formats for asking CV questions, such as open-ended (stating a specific amount) or closed-ended (choosing from a range of options). Contigent valuation is relatively straightforward, but can be susceptible to biases in how the questions are framed (e.g., Diamond and Hausman, 1994). While CV is not technically a CE, it can sometimes be implemented within a choice experiment framework. Traditionally, CV asks a single question about willingness to pay for a specific good or service. However, researchers can design a CV survey where respondents choose between different scenarios with varying costs associated with the same good or service. This can be in the form of surveys or via the use of payment cards (e.g., Becker et al., 2014; payment cards have also been compared to closed-ended surveys, and none was found to be superior to the other (Ryan and Watson 2009). This allows for a more nuanced understanding of WTP. Examples of using the contingent valuation method include Dahal et. al (2018), Haab et. al (2020), and Homes et. al (2004).

3.3. Attribute-Based Methods (ABM):

Attribute-Based Methods (ABMs) is an approach that breaks down a good or service into its key features (attributes) and their different levels (e.g., air quality: good, moderate, poor). Respondents are presented with multiple scenarios where these attributes and levels are combined (called "choice sets"). They then choose their preferred option from each set. By analyzing these choices, researchers can estimate the relative value people place on different attributes and their levels. Generally, ABM allows for more complex scenarios and is less prone to biases compared to CV. Examples of using attribute-based methods include Carrel et. al (2022), Doherty et. al (2021), and Johnson and Geisendorf (2022).

3.4. Paired Comparison:

The paired comparison method presents respondents with pairs of scenarios and asks them to choose the option they prefer. Scenarios can be full descriptions of goods or services or simply a comparison of two attributes at different levels. By analyzing these choices, researchers and other users of NMV can identify which attributes and levels are most valued by respondents. Paired comparison is a simpler method than ABM but offers less detailed information about the relative value of different attributes. Durocher et. al (2022) and Lockwood (1999) use a paired comparison method.

3.5. Stated Preference Examples:

We can assess the difference among SPM elicitation methods using the example of a coastal community planning for rising sea levels. To illustrate how these SPMs are employed, below is breakdown of how each method can be used to assess the value residents place on protecting their community from rising sea levels.

3.5.1. Choice Experiment (CE):

- **Attributes:** Flood protection level (high, medium, low), disruption to daily life during construction (high, medium, low), and long-term maintenance cost (high, medium, low).
- **Choice Sets:** Residents choose between different scenarios with varying levels of these attributes. For example, Scenario A: High flood protection, high disruption, and low maintenance cost vs. Scenario B: Medium flood protection, low disruption, and high maintenance cost.
- **Valuation:** By analyzing resident choices, researchers can understand trade-offs. How much disruption are they willing to accept for higher protection? Does minimizing maintenance costs outweigh immediate disruption? This reveals the relative value residents place on different aspects of coastal protection.

3.5.2. Contingent Valuation (CV):

- **Scenario:** The local government is considering building a seawall to protect the community from rising sea levels. Researchers conduct a survey asking residents: "Would you be willing to pay an additional $X per month in property taxes to fund the construction of a seawall?" They vary the amount (X) across different surveys to create a willingness-to-pay (WTP) curve.
- **Valuation:** The WTP curve reveals the maximum amount residents are willing to sacrifice financially for the seawall. This translates to the community's perceived value of the protection it offers.

3.5.3. Attribute-Based Methods (ABM):

The Attribute Based Methods (ABM) builds upon CE by including a monetary attribute alongside other relevant aspects.

- **Attributes:** Flood protection level (high, medium, low), environmental impact of the protection measure (positive, neutral, negative), and annual cost per household.
- **Choice Sets:** Residents choose between scenarios with varying levels of these attributes. For example, Scenario A: High flood protection, positive environmental impact, and high annual cost vs. Scenario B: Medium flood protection, negative environmental impact, and low annual cost.
- **Valuation:** By analyzing choices, researchers can understand how much residents value environmental benefits alongside protection level and cost. Are they willing to pay more for a solution that benefits the ecosystem, or is minimizing cost the top priority? This reveals the community's combined valuation of protection, environment, and affordability.

3.5.4. Paired Comparison:

- **Scenarios:** Scenario A: Current situation with increasing flood risk. Scenario B: Implement a community flood warning system and evacuation plan (lower cost, some disruption). Scenario C: Build a seawall with high upfront cost and minimal long-term disruption.
- **Instructions:** Residents choose which scenario they prefer out of the presented options.
- **Valuation:** By analyzing repeated comparisons, researchers can understand resident preferences for proactive measures (flood warning system) versus high-cost infrastructure (seawall). This reveals the community's valuation of early warning systems and their risk tolerance compared to large upfront investments.

4. Overview of Revealed Preference Methods

Revealed preference methods (RPMs) are a category of techniques used in economics to estimate the value people place on goods, especially non-market goods like clean air or scenic views. Unlike stated preference methods that ask people directly about their WTP, RPMs analyze actual consumer behavior in existing or proxy markets to infer their preferences.

Revealed preference methods focus on revealed choices through the assumption that people make choices that maximize their utility (satisfaction) given their budget constraints. By observing these choices, the value people place on different goods and services can be inferred.

Revealed preference methods typically rely on past behavior to estimate the value of something. They often are not directly applicable to community resilience planning, as they do not involve clear preferences for future scenarios or alternatives. Revealed preferences methods are also constrained by having an appropriate measure or proxy measure of the value in question. For more information on revealed preference method please see Peterson et. al (2003).

Stated Preference Methods are often more appropriate for directly capturing community preferences for different resilience options, since the options are hypothetical. Revealed preference approaches depend on the adoption of similar projects. Stated preference methods can be used alongside revealed preference methods to create a more comprehensive picture for policymakers. However, most revealed preference methods can be adapted to address community resilience planning, especially when collection of stated preference data is not feasible.

4.1. Avoided cost method

One way to evaluate the benefit of a good or service is to use an avoided cost method. This method relies on estimating the impact of costs that would have been imposed if not for the ecosystem services. For example, if one wanted to estimate the value of wetlands by using an avoided cost method, then they could estimate the avoided cost of flooding in that region. The valuation of that wetland would then be the benefits of avoiding the flooding. This method captures a piece of the valuation of wetlands but does not capture the entire value. This method also relies on being able to estimate the counterfactual situation of how much flooding would have occurred if the wetlands were not there, which can be difficult. Pascual et. al (2012) and Vazquez-Gonzalez et. al (2019) use the avoided cost method to value nonmarket goods.

4.2. Benefit transfer method

The benefit transfer method of evaluation depends on research done often in other geographic locations. This method can pull from other types of valuation and even combine multiple different non-market valuation methods. To use a benefit transfer method, one needs to find another estimate for the value of something that is similar to their context. For example, suppose there is a study that uses the avoided cost method to determine the value of avoided flooding due to wetlands on the North Carolina coast. If one wants to determine the avoided cost of flooding to South Carolina residents due to wetlands, then they might be able to use the previous study and scale the results appropriately. The benefit transfer method depends on the context in which the original study was conducted being similar enough to the context in which the benefit is being applied as well as the original study being a high-quality research study. A few examples of the benefit transfer method are Boutwell and Westra (2013), Richardson et. al (2015), and Zhou et. al (2020).

4.3. Expenditure analysis

Another way to assign a valuation for a non-market good is to use some sort of expenditure. For example, if there is a chemical spill that impacts the drinking water, then households might spend money on bottled drinking water to avoid exposure to the chemicals. This would be considered an averting expenditure and can be used to estimate the value of non-contaminated drinking water. In this example, the expenditure would only be estimating the cost associated with not being able to drink the water due to the chemical spill. If there were other costs of the contamination, then they would also have to be estimated separately. Typically, an expenditure analysis method is focused on very specific expenditures, so often underestimates the impact of some environmental change like a chemical spill. Examples of the expenditure approach include Abdalla et. al (1992), Courant and Porter (1981), and Srinivasan and Blomquist (2009).

4.4. Hedonic pricing methods

A hedonic pricing method decomposes the price that someone pays for a good into the attributes of that good. One common example is using a hedonic pricing method to evaluate the impact of housing characteristics. For example, someone can measure the value of a local park by using spatial variation in housing prices to estimate the impact of the proximity to the park on housing prices. In this case location is one of the attributes of the home and the proximity to the local park is one of the pieces of the home's location. Since houses are bought and sold frequently, hedonic models of housing are often used to determine the effect of living near different amenities including environmental amenities such as a park. For a hedonic model to be able to estimate the additional premium that individuals are willing to pay to live near an amenity, there

must be a large amount of turnover in the housing market and heterogeneity in the distance of houses to the amenity. Bishop et. al (2020), Nicholls (2019), and Poor et. al (2007) are examples of the hedonic pricing method.

4.5. Productivity Method

The productivity method estimates the impact of an environmental good as an input to the production of a good. For example, water is an input used in many manufacturing processes, so good water quality can impact the productivity of manufacturing. If having good water quality allows a manufacturer to produce more of a product with the same inputs, then this increase in productivity times the price of the product can be the valuation of good water quality. This way of estimating the value of a non-market good depends on knowledge of the process of production and how it is impacted by the environmental good. This is also just one piece of the full valuation of an environmental good like water quality. Examples of the productivity method include Barbier (2007) and Yokwe (2009).

4.6. Travel cost method

The travel cost method assumes that the amount that someone is willing to spend to travel to an amenity is more than their valuation of that amenity. For example, if one travels to the Great Smoky Mountains, then their travel costs can be added up to reveal their valuation. Travel costs include the cost of getting to the mountains as well as the cost of lodging and other expenditures that go into the trip. Typically, researchers may ask several questions in a survey around how much someone spent on their trip to estimate the cost of their trip. Travel costs can be highly heterogeneous depending on the distance that the person travelled. This method depends on being able to collect data on travel costs. Some examples of the travel cost method include Bateman et. al (1996), Tourkolias et. al (2015), and Willis and Garrod (1991).

4.7. Revealed Preference Methodological Limitations

While SPMs are ideal for capturing community preferences in resilience planning, there are situations where their use might not be feasible. Below we note how some of the mentioned methods can be creatively adapted, or alternative approaches considered, when stated preferences are unavailable.

- **Avoided Cost Method:** While it does not directly capture preferences, analyze past events where communities faced similar threats and the costs incurred due to lack of resilience measures. This can inform the potential economic benefits of future investments.
- **Benefit Transfer Method:** Even if a perfect match is not possible, identification of communities with similar characteristics that have implemented resilience strategies

makes the benefit transfer method viable for at least approximations. Analyze the economic benefits they experienced (e.g., reduced property damage) and adjust for any contextual differences. This can provide a rough estimate of potential benefits for your community.

- **Expenditure Analysis:** This can be used to understand existing levels of concern. Look for trends in spending on preparedness items (e.g., flood insurance, emergency kits) before and after major weather events. This can indicate a community's willingness to invest in some level of protection.
- **Hedonic Pricing Method:** Analyze trends in property values in areas with varying levels of existing resilience measures (e.g., levees, evacuation routes). This can provide some insight into the implicit value people place on different levels of protection.
- **Productivity Method:** Analyze historical data on economic losses from past disasters in the community (e.g., lost work hours, business closures). This can be used to estimate the potential economic benefits of resilience investments that could reduce such losses.

When using RPM for future planning it is important that potential limitations are acknowledged. Revealed preferences typically do not directly capture preferences for specific proposed future strategies, but rather, look at past and current preferences. Additionally, the value of a community resilience project includes many benefits, so using a combination of valuation techniques is often required to capture the range of these benefits.

4.8. Alternatives and supporting approaches:

There are several alternatives and supporting approaches to RPMs. Three of the most common are noted below.

- **Focus Group Discussions:** Facilitate discussions with diverse community members to understand their concerns, priorities, and risk perceptions regarding potential threats. This can provide valuable qualitative data on community preferences.
- **Expert Elicitation:** Gather insights from experts in community resilience planning, emergency management, and social sciences. They can offer informed opinions on potential strategies and their likely public reception based on their experience.
- **Scenario Planning:** Develop different hypothetical scenarios of future threats with varying levels of severity. Engage community stakeholders in brainstorming potential responses and resilience measures. This can stimulate discussion and reveal implicit preferences for different approaches.

By combining these approaches and acknowledging their limitations, one can gather valuable information to inform community resilience planning, even when revealed preferences are most readily available (e.g., even when SPM are not available).

5. Tools, Data, and Resources for NMV

This next section outlines several different tools, sources of data, and resources for non-market valuation with a particular emphasis on valuation in community resilience planning. These resources are valuable for researchers, practitioners, and communities in planning for increasing community resilience. All Uniform Resource Locators (URLs) noted in this section were updated in June 2024 and NIST is not responsible for the upkeep of the URL and associated information. Appendix A provides examples of generalized data sources for NMV in community resilience planning, depending on the specific aspect of resilience one is trying to quantify.

5.1. Select Federal Tools

Federal agencies have developed tools to support BCAs relevant to community resilience and adaptation. The methods and tools highlighted in this section are meant to provide examples, but this does not represent advocating for their use over other publicly available tools and processes that perform similar functions.

Two of these tools can be especially useful for BCAs of cross-sector climate change resilience and adaptation investments and are able to accept NMV for costs and benefits:

- National Institute of Standards and Technology Economic Decision Guide Software (EDGe$) Online Tool: An online application that supports evaluation of investment decisions to improve the ability of communities to adapt to, withstand, and quickly recover from natural, technological, and human-caused disruptive events. (REF)
- Federal Emergency Management Agency BCA Toolkit: A calculator developed using FEMA-approved methods and tools to determine the benefits of hazard mitigation projects. (REF)

Other tools are useful for BCAs of climate-related investments in specific sectors. Some examples include the following:

- Department of Energy Interruption Cost Estimator Calculator: A tool for electricity reliability planning that estimates service interruption costs and the benefits of reliability improvements.
- Bureau of Land Management/National Park Service/U.S. Geological Survey Benefit Transfer Toolkit: A set of online tools that estimate economic values and provide other information on ecosystem services and other non-market benefits of natural resources.
- Federal Highway Administration Tool for Operations Benefit Cost Analysis (TOPS-BC): A screening-level tool developed for transportation planners to support BCA of transportation strategies.

5.2. NMV databases and additional resources

There are several publicly available databases for NMVs related to ecosystem services and environmental services relevant to BCA and other economic valuation of community resilience. A select few are described below and were selected based on expert opinion for ease of use and a review of "NOAA's Weather and Climate Toolkit " tools and resources (NCEI, 2024).

- **The Ecosystem Services Valuation Database (ESVD):** This database includes case studies on the monetary value of various ecosystem services. While not directly tied to community resilience or adaptation projects, it provides valuable insights into non-market valuation methods that could be applicable to adaptation initiatives impacting ecosystems. https://www.esvd.net/

- **The Benefit Transfer Knowledgebase:** This database by the US EPA focuses on studies using the benefit transfer method for environmental valuation. This method can be applied to estimate the value of benefits achieved through adaptation projects. Find the database here: https://www.epa.gov/environmental-economics/benefits-transfer-procedures-problems-and-research-needs-1992-association

- For coastal communities, a range of complementary datasets that can support some of these planning decisions and associated NMV is available in **NOAA's Digital Coast Tool**: https://coast.noaa.gov/digitalcoast/data/home.html

- **Environmental Valuation Reference Inventory (EVRI):** This searchable online database contains information on over 4 600 studies related to the economic valuation of environmental assets, including ecosystem services. It allows you to filter studies by location, ecosystem type, valuation method, and keyword searches. While it doesn't provide the specific values itself, it's a great starting point to find relevant research: https://evri.ca/en

These databases may not cover every specific ecosystem service or environmental value a community is interested in valuing. In most cases it is ideal to combine them with other research methods like obtaining secondary data from academic journals or reports from relevant government agencies or non-governmental organizations (NGOs), if first-hand data collection is not possible.

Some additional resources include the following:

- **The Economics of Ecosystems and Biodiversity (TEEB):** While not a database itself, TEEB is a global initiative that provides a framework for valuing ecosystem services. Their

website offers various resources and reports that can be helpful for understanding non-market valuation: https://teebweb.org/

- **The National Oceanic and Atmospheric Administration (NOAA) Coastal Inundation Valuation Tool (CIVT):** This tool specifically focuses on valuing coastal protection benefits provided by ecosystems. It can be a valuable resource for communities facing coastal risks: https://coast.noaa.gov/slr/

- The National Oceanic and Atmospheric Administration (NOAA) offers resources on coastal community resilience: https://coast.noaa.gov/resilience-grant/

- The Federal Emergency Management Agency (FEMA) provides tools and data for building community resilience:https://www.fema.gov/emergency-managers/national-preparedness/plan/resilience-guidance

- **The World Bank's Climate Change Unit:** Offers resources on economic analysis of climate change impacts and adaptation: https://www.worldbank.org/en/topic/climatechange

- **The Organisation for Economic Co-operation and Development (OECD) Environment Directorate:** Provides guidance on valuing environmental impacts: https://www.oecd.org/environment/

There are several sources that discuss nature-based solutions (NBSs) and include case studies noting the design of community resilience-related infrastructure projects and climate adaptation methods. Several include information relevant to NMV for community resilience and climate adaptation practices even though these may not be the main goal or theme of the website or clearinghouse. In most cases these leverage case studies that may include leading practices in eliciting NMV or values that can be used in general assessment of benefits and costs of projects under consideration by other communities. The following are a few examples of leveraging publicly available data and using it free of charge.

A. The National Ocean Economics Program website: Includes a searchable database on “Environmental & Recreational (Non-Market) Values” that allows exploration of a library that provides a bibliography of non-market research papers regarding the ocean and coastal resources. Search preferences of this library can indicate publication or study types, authors, assets, methodologies, and other options. The search results list the publications' titles, authors, years, source information, and any available abstracts or asset valuations. https://www.oceaneconomics.org/NOEP/nonmarket/NMFAQs.asp

B. Blue Value: A searchable database of simplified and useful ecosystem valuation information focused on coastal and aquatic projects. The focus of Blue Value is on implementing practical solutions, rather than theoretical valuation methods. The online database showcases projects and their positive environmental or social impacts, even if not explicitly quantified in economic terms.

C. FEMA Guide to NbS offers guides to determining and using nature-based solutions that offer significant monetary and non-monetary benefits, such as economic growth, green jobs, increased property values and better public health. The bulk of guidance relates to design and use of NBS; however, there are some valuation resources from which one can draw. https://www.fema.gov/emergency-managers/risk-management/climate-resilience/nature-based-solutions

D. The U.S. Army Corps of Engineers (USACE) Engineering With Nature® (EWN) Initiative enables more sustainable delivery of economic, social, and environmental benefits associated with infrastructure. https://ewn.erdc.dren.mil/

E. EcoShape develops and shares knowledge about Building with Nature: a new approach to hydraulic engineering that harnesses the forces of nature to benefit environment, economy and society https://www.ecoshape.org/en/

F. USEPA's Green Infrastructure Program: Website with resources to promote the benefits of green infrastructure, help communities overcome barriers to using GI, and encourage the use of GI to create sustainable and resilient water infrastructure that improves water quality and supports and revitalizes communities. https://www.epa.gov/green-infrastructure

G. The Arizona State University's Knowledge Exchange for Resilience shares knowledge, catalyzing discovery, and building solutions to catalyze change in order to build community resilience. This work addresses major challenges while reaping additional benefits—what we call resilience dividends—in social cohesion, economic prosperity, and environmental security. Together with our stakeholders, we are making a difference in Maricopa County by expanding our capacity to adapt, grow, and turn system-wide shocks into opportunities to thrive. https://resilience.asu.edu/

H. The Georgetown Climate Center's Adaptation Clearinghouse seeks to assist policymakers, resource managers, academics, and others who are working to help communities adapt to climate change. Content in the Adaptation Clearinghouse is focused on the resources that help policymakers at all levels of governments reduce or avoid the impacts of climate change to communities in

the United States. The Adaptation Clearinghouse tends to focus on climate change impacts that adversely affect people and our built environment. https://www.adaptationclearinghouse.org/about.html

I. UNEP Adaptation Finance Tracking: This database by the United Nations Environment Programme (UNEP) tracks climate finance flows towards adaptation projects in developing countries. While the focus is on financial aspects, project descriptions might provide hints about potential non-market benefits.

J. Adaptation Fund Project Database: This database by the Adaptation Fund showcases projects funded by the organization. Project descriptions might mention the intended social or environmental benefits alongside the core adaptation goals.

Additionally, there are NGOs and research institutions working on climate change adaptation that publish reports on specific projects that include NMV aspects. There are also several case studies of adaptation projects that mention economic valuation or BCA might not explicitly detail non-market valuations, but they could provide a starting point to understand the types of benefits considered in the project's design.

By combining information from these resources and conducting targeted searches for specific project types or regions, one can build a stronger understanding of the link between adaptation projects, community resilience options, and the non-market valuations associated with their benefits.

6. Critical Considerations in Use of NMV

There are several critical considerations to keep in mind when obtaining and/or using NMV for non-market goods and services. Equity in terms of engagement and distributional impacts are important aspects to consider. This is especially relevant as weather- and climate-related disasters are on the rise, and their impacts are often greatest in underserved communities (Jay et al 2023). Nonmarket valuation continues to develop and methods like BCA are continually enhanced to address several of these critical considerations.

6.1. Potential Expenses associated with employing NMV methods

Non-market valuation offers valuable insights for communities planning for resilience and climate adaptation, but it is not without its costs. Below is a summary of expenses that may be associated with the use of NMV methods.

Direct Costs:

- **Survey Design and Administration:** Developing clear and well-designed surveys tailored to the specific community context and chosen NMV method is crucial. This can involve hiring survey professionals, translators, and potentially offering remuneration/incentives to participants.
- **Data Collection:** Depending on the chosen NMV method, data collection can involve in-person interviews, online surveys, or mail surveys. Each method has its own associated costs for printing, postage, interviewer training, or online survey platform fees.
- **Data Analysis:** Analyzing NMV data can require specialized software and statistical expertise. Hiring analysts or training existing staff can add to the expense.

Indirect Costs:

- **Time Commitment:** Non-market valuation surveys can be time-consuming for participants, potentially leading to lower response rates. Encouraging participation and ensuring the survey length is reasonable is important but can require additional outreach efforts.
- **Complexity:** Understanding and interpreting NMV results can be challenging, especially for non-technical audiences. Presenting the findings in a clear and accessible way for community members and policymakers can necessitate additional resources.
- **Limited Scope:** While NMV provides valuable insights into preferences, it does not capture all aspects of community resilience. Combining NMV with other planning tools like engineering assessments or social vulnerability studies is often necessary, potentially adding to the overall planning budget.

6.2. Strategies to Minimize Expenses:

There are several strategies that a community might employ to minimize the expense of using NMV strategies. These include, but are not limited to, the following options:

- **Grant Funding:** Explore grant opportunities from government agencies or environmental organizations that support community resilience planning.
- **Collaboration:** Partner with universities or research institutions that might have expertise in NMV and be willing to conduct the study at a reduced cost.
- **Volunteer Involvement:** Recruit volunteers to assist with data collection or survey administration, reducing reliance on paid personnel.
- **Simple Methods:** Consider using less complex NMV methods like paired comparison, especially in smaller communities or for initial assessments.
- **Focus Groups:** Conducting focus groups alongside a smaller NMV survey can provide qualitative data that enriches the interpretation of the quantitative results.

While NMV involves some expense(s), the benefits of obtaining information that can be used in evaluation of alternatives specific to a given community and project, often outweigh the costs. The information gained about community preferences for resilience strategies can lead to more effective and sustainable alternative selection in the long run. By exploring funding options, collaborating with partners, and utilizing efficient methodologies, communities can make NMV a cost-effective tool for building resilience.

6.3. Equity

The types of applications for NMV implied in this publication are at the community level. Considering NMV for a community can be complicated, as the methods, especially SPMs, tend to be applied to individuals, and analyzed based on characteristics of individuals, such as NMV for the average individual given specific demographic characteristics (e.g., WTP for the average person surveyed in a given age range). Thus, it is important to clarify the characteristics of participants for SPM and to understand the match between the characteristics of those individuals from whom RPM data is determined and applied. In particular, inclusive engagement and distributional impacts are important to consider aspects of equity in NMV.

- **Inclusive Engagement:** Traditionally, project evaluation might prioritize readily available data or the perspectives of vocal community members. To ensure a more equitable evaluation, it's crucial to use inclusive engagement strategies that reach out to marginalized groups. This could involve targeted outreach, culturally sensitive communication methods, and ensuring multiple avenues for participation (e.g., online surveys, in-person meetings, and town halls in different locations).
- **Distributional Impacts:** Consider how the project's benefits and burdens will be shared across the community. A project might appear beneficial overall but exacerbate existing inequalities. For instance, a flood protection levee might protect wealthier neighborhoods while leaving low-lying areas, often occupied by lower-income residents,

even more vulnerable. Evaluations should identify potential biases and strive for solutions that benefit the entire community.

6.4. Uncertainty

Community resilience projects deal with future risks and benefits that are inherently uncertain. Climate change, for example, makes it difficult to predict the intensity of future storms. Incorporation of uncertainty into an evaluation using NMV might use scenario planning or sensitivity analysis.

- **Scenario Planning:** This method involves developing multiple future scenarios with varying levels of risk (e.g., weak storm, strong storm). By evaluating project performance under each scenario, you gain a better understanding of its robustness to different conditions.
- **Sensitivity Analysis:** This technique involves changing key assumptions in the evaluation (e.g., construction costs and discount rates) and analyzing how these changes affect the project's value. Sensitivity analysis helps identify which factors have the greatest impact on the project's success.

6.5. Verification and Validation:

As pointed out several decades ago by Diamond and Hausman (1994), verification and validation (V&V) of NMVs remains difficult. That said, as an evidence base grows through NMV application in several locations and the available evidence base increases, V&V is increasingly viable. In several cases, it is possible that community-level valuation is helped through the use of the *wisdom of the crowd*. The *wisdom of the crowd* concept suggests that aggregating the knowledge and insights of a large group of people can lead to better decision-making than relying on any single individual. This idea can be applied to non-market valuation in a few ways; some candidate options are listed below.

1. Surveys and Auctions: Online surveys can be used to gather opinions on the value of a non-market good. People can be asked things like "What would you be willing to pay for access to this public park?" or "How much is this clean air quality worth to you?"

"Second-price sealed-bid auctions" can be conducted where participants submit their bids without knowing what others are offering. The highest bidder wins, but only pays the second-highest bid. This can help uncover true valuations without the pressure of a typical auction.

2. Reputation and Gamification: Platforms can be created where users can value non-market goods and services. A reputation system can be implemented to incentivize accurate estimations - users with a history of good valuations get more weight. Gamification elements like points or badges can be used to encourage participation and make valuation more engaging.

3. Big Data and Machine Learning: Large datasets containing information relevant to the non-market good (e.g., usage statistics for a public park) can be analyzed with machine learning algorithms to identify patterns and predict valuations. Social media sentiment analysis can be used to gauge public perception and potential value of non-market assets.

There remains several challenges and considerations when striving to employ efforts that take advantage of the wisdom of the crowd. The accuracy of crowd-sourced valuations depends on the quality and representativeness of the crowd. The design of the valuation process can introduce bias, favoring certain perspectives over others. Additionally, participants may attempt to answer the questions how they perceive the survey designers want them to answer.

Overall, the *wisdom of the crowd* offers a valuable tool for non-market valuation. However, it should be used in conjunction with other valuation methods and careful consideration should be given to potential biases and limitations.

6.6. Risk Preferences

Non-market valuation plays a crucial role in community resilience and adaptation planning. It helps quantify the benefits of resilience investments that go beyond traditional economic measures. Risk preferences are a critical factor to consider in this valuation process.

- **Future Uncertainty:** Resilience planning deals with future events like natural disasters or economic downturns. These events are inherently uncertain, and people have different tolerances for risk.
- **Non-Market Values:** Many benefits of resilience investments are difficult to express in dollars and cents. For example, a stronger seawall protects not just property values but also the community's sense of security. Risk preferences help us understand how much people value these non-market benefits.
- **Prioritization and Decision-Making:** There are often many competing options for resilience investments. By incorporating risk preferences, we can prioritize projects that provide the most value to the community, considering their risk tolerance.

The following allow risk preferences to be factored into NMV.

- **Risk Aversion:** People who are risk-averse will place a higher value on projects that reduce the risk of a major disaster, even if the expected economic benefit is small.
- **Discount Rates:** The discount rate used to calculate future benefits should reflect the community's risk preferences. A higher discount rate implies a greater preference for immediate benefits over uncertain future benefits.
- **Willingness-to-pay Surveys:** These surveys can be used to assess how much people are willing to pay for different levels of resilience. By varying the level of risk reduction offered, we can get a sense of the community's risk preferences in the context of community resilience planning.

Incorporating risk preferences strengthens non-market valuation by providing a more nuanced understanding of the value that communities place on resilience. This can lead to better-informed decisions about how to invest in a community's future.

6.7. Value of life and injuries avoided

The Value of a Statistical Life (VSL) is a widely used metric in BCA. It represents the amount of money society is willing to pay to save a statistical life and is estimated through various methods, including hedonic pricing and surveys that ask people their WTP for a small reduction in their risk of death. Additionally, typically by implementing resilience plans, communities can expect fewer injuries and illnesses. By assigning a monetary value to these benefits, different resilience plans can be compared on a more *objective* basis. This helps decision-makers prioritize projects that offer the greatest societal benefits relative to their costs.

Yet, there are ethical concerns; putting a price tag on a human life, specifically reduction of risk to human life and injury, can be sensitive. The VSL is an average value and does not reflect the specific worth of any individual. Furthermore, estimating VSL involves complex methodologies and assumptions, subject to deep uncertainty. The resulting value can vary depending on the methods used and the specific context. For additional discussion of the complexities of determining VSL and ranges of monetary values employed, see Gilbert (2010), Gilbert et al. (2015), and Colmer (2020). Banzhaf (2022) provides a thorough discussion of VSL meta analyses.

6.8. Cultural values

There are several issues with the use of NMV across cultural contexts, this is especially true in indigenous contexts. Nonmarket valuation attempts to assign economic value to things that are not traditionally traded in markets, like clean air or cultural significance of a landscape. While NMV can be a useful tool, applying it to indigenous contexts raises several concerns and can be construed as culturally disrespectful.

- **Commodification of cultural values:** Indigenous knowledge systems view the environment with deep respect and responsibility, not in economic terms. Assigning monetary value can undermine awareness of nature that forms the basis for these cultural values and disconnect them from their spiritual significance (Cloud and Redvers, 2023).
- **Loss of power and control:** The NMV process can be dominated by external experts who determine the methods and metrics used. This can marginalize indigenous voices and knowledge in decision-making processes.
- **Incommensurability of values:** Some aspects of the natural world and cultural heritage are simply not translatable into economic terms. Thus, NMV might overlook intangible values like spiritual connection or sense of place.
- **Focus on quantification over quality:** Indigenous knowledge emphasizes understanding complex relationships within an ecosystem. NMV might prioritize quantifiable measures over the qualitative aspects of a healthy environment.

There are some potential ways to handle these limitations when NMV is used to build a "business case" for resilience or adaptation. Non-market valuation can be a useful tool for decision-making, but it is crucial to recognize the limitations when applied to indigenous contexts. By fostering collaboration and respecting unique ways of knowing, NMV can sometimes be adapted to better reflect the holistic values of indigenous cultures and their relationship with the natural environment.

- **Participatory approaches:** Include indigenous communities throughout the valuation process. This ensures their values and knowledge are integrated into the methodology.
- **Respecting diverse knowledge systems:** Acknowledge the validity of indigenous knowledge alongside scientific methods.
- **Focus on qualitative and quantitative data:** Use a combination of methods to capture both tangible benefits (e.g., flood protection) and intangible values (e.g., cultural significance).
- **Building trust and capacity:** Collaborate with indigenous communities to develop culturally appropriate valuation methods that do not rely on monetization.

6.9. Discounting and time preferences:

Some types of benefits can be especially difficult to quantify and/or monetize—this is especially the case for those that are projected to occur several decades in the future or that are the result of cascading impacts. This is particularly true for non-market goods and services. OMB guidance encourages valuing non-market goods and services if they can be justified by well-established methods or published studies (OMB, 2023).

Since NMV often deals with future benefits (e.g., lives saved from a clean-up project in a decade), considering discounting is crucial. A higher discount rate will decrease the present value of these future benefits, potentially making the project seem less worthwhile. Choosing the appropriate discount rate to incorporate in NMV, explicitly or implicitly, can be tricky. It should reflect society's time preferences while considering the specific context. For example, in some cases and contexts, the discount rate for environmental benefits that accrue over generations might be lower than for a short-term infrastructure project.

It is worth noting that high discount rates can undervalue benefits enjoyed by future generations, limiting intergenerational equity. Some argue for lower discount rates when considering long-term projects with lasting impacts due to the intergenerational equity created by larger discount rates.

By definition, the future is uncertain. Generally, discounting accounts for this by diminishing the value of far-off benefits; however, unexpected events can make such estimates imprecise. Discounting and time preferences are crucial considerations in non-market valuation. By carefully accounting for discounting and time preference, a more accurate NMV can be obtained and used, leading to better decision-making for the present and the future.

7. Emerging Method Example

The Community-informed Decisions for Equitable, Cost-effective, and Inclusive Disaster Resilience (Co-DECIDR) modeling approach, tailored for community-based resilience planning within socio-ecological systems (SESs). The Co-DECIDR approach is designed to enhance decision-making by incorporating trade-off analysis and considering the complex interplay between physical infrastructure, social institutions, and natural ecosystems. In the domain of resilience planning, choosing a suitable modeling technique is crucial (Helgeson et al., 2024). Economic modeling techniques (such as input-output models) offer simplicity and ease of use for policy assessment, but often at the expense of nuance and comprehensiveness. These methods typically rely on single-point estimates and may not fully capture non-market values, community preferences, distributional impacts, or the uncertainties associated with input variables (Boardman et al., 2018). Moreover, they may fail to address the structural complexities of socio-environmental systems, leading to potential oversights in planning for uncertain outcomes (Helgeson & Li, 2022). In contrast, sophisticated models—including agent-based and system dynamics models—encompass these complexities and uncertainties in resilience planning and evaluation of candidate strategies. Such models, however, come with their own set of challenges, including intensive demands on time, financial resources, and data requirements (Mls et al., 2023; Bottero et al., 2020).

To overcome these challenges, a growing need exists for user-friendly, accessible models that can provide prompt and reliable results for community resilience planning. The Co-DECIDR modeling approach addresses these needs by integrating Fuzzy Cognitive Mapping (FCM) with Benefit-Cost Analysis (BCA), harnessing the strengths of both methods and allowing for the consideration of both monetary and non-monetary valuation within resilience planning and providing an avenue by which community-level values can be assessed. This integrated approach systematically combines the qualitative depth of FCM with the quantitative precision of BCA, enabling planners to navigate through complex SES with greater clarity and effectiveness. Through more inclusive and transparent models like the Co-DECIDR approach, which incorporates economic factors and the broader socio-environmental context, we can enhance resilience interventions that equitably and effectively address the complexities and uncertainties of dynamic systems.

The Co-DECIDR approach is detailed by Helgeson et al. (2024). The process advances use of EDGe$, developed by the National Institute of Standards and Technology (NIST), offers a standardized modeling tool for the economic evaluation of resilience investments (Helgeson et al., 2017, 2021), but complementing it with FCM processes, which facilitates collaborative system modeling with stakeholders, capturing collective knowledge for disaster response prioritization and broader community concerns (Gray et al., 2013). Together, these tools streamline the planning process, allowing for a nuanced analysis of strategies against the backdrop of economic limitations and the SES's inherent complexities. Integrating economic models with the participatory modeling process is a promising approach to ensure the meaningful engagement of various disciplines and stakeholders, a vital aspect of comprehensive modeling for resilience planning in SESs (Miles, 2018, Helgeson & Li, 2022). By integrating FCMs into economic modeling

tools (e.g., BCA) for resilience planning in SES, can utilize both local expertise and systems modeling with economic evaluation of alternatives and consideration for community values that may not appropriately be assigned a dollar value through NMV.

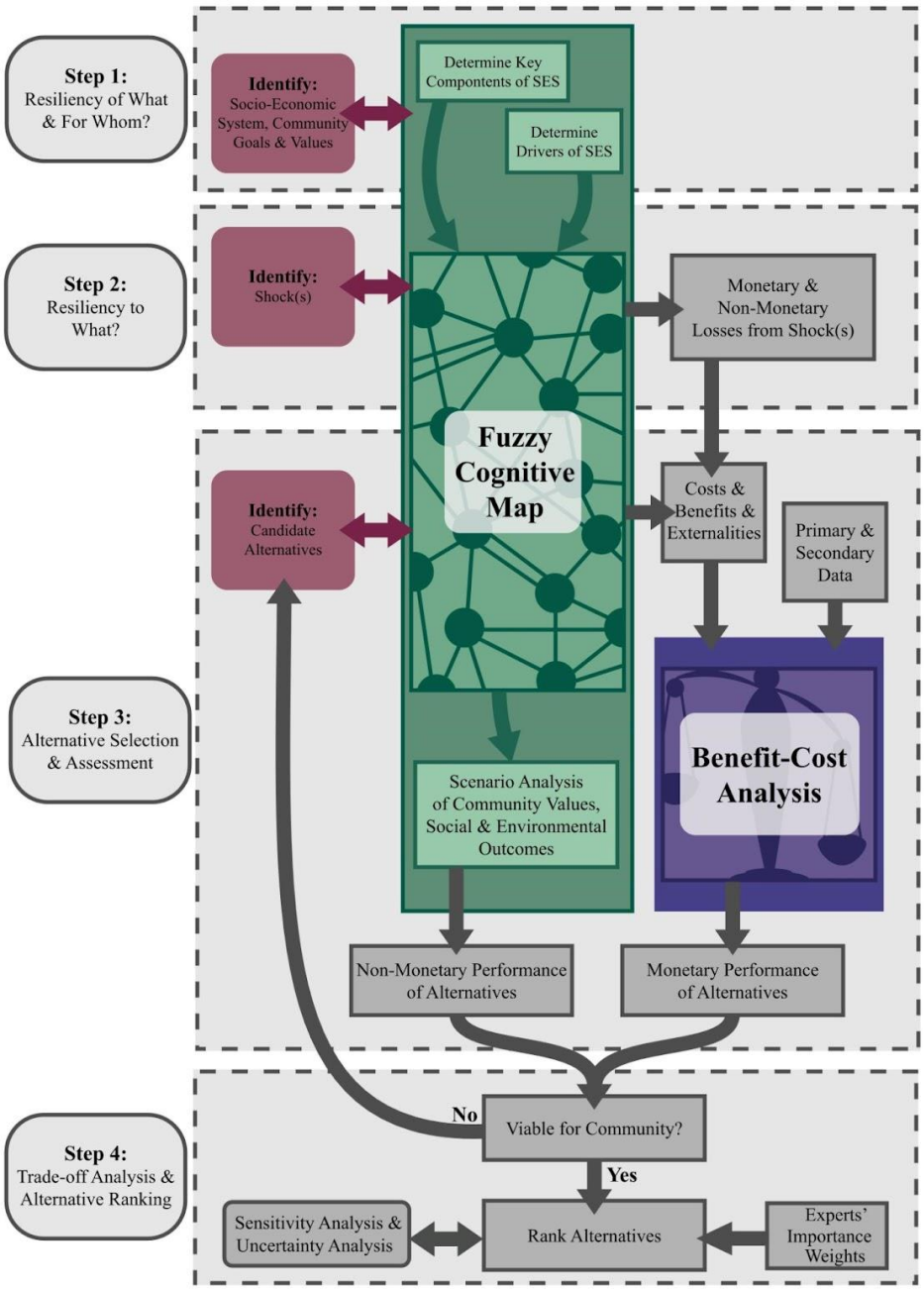

Figure 1. The four steps of the Co-DECIDR modeling approach

8. Concluding remarks and future efforts

The 2023 White House *National Climate Resilience Framework* noted that "[r]esilience projects are underinvested in due to numerous factors like payback periods that can be long and/or uncertain, benefits may go to a community rather than solely to investors, and traditional accounting mechanisms tend to focus on direct financial benefits (e.g., losses avoided), while limiting consideration of many indirect benefits (e.g., water quality improvement or cultural preservation)"(White House, 2023). The task of valuing costs, benefits, and trade-offs of alternative actions is further complicated by uncertainties about future climate impacts, the extent to which resilience or adaptation measures will effectively address climate change impacts over their lifetimes, and various methodological issues. Some BCAs have difficulty quantifying adaptation benefits because of an assumption of *stationarity* – that future climate risks and impacts will be the same as those in the past. Stationarity is not a valid assumption under a changing climate, and it will lead to underestimating the damages that may be avoided by investing in climate adaptation measures. Nonmarket valuation his allows for a more comprehensive assessment of the costs and benefits of policies or projects over time, considering potential changes in societal preferences, environmental conditions, and technological advancements.

Policymakers and planners also must weigh trade-offs between investments now and in the future, as some decisions can be delayed in order to leave other alternatives open for later when more information may be known about local climate changes. Such flexibility is difficult to build into decision-making processes. When considering actions that involve adapting to climate impacts (for instance, in infrastructure or natural resource management investments with long lifetimes) and addressing extreme hazards, BCAs are intended to provide objective and comprehensive estimates of the costs and benefits of those investments using best practices from the literature (e.g., Boardman et al., 2018). The usefulness of a BCA to weigh different alternatives depends on the ability to accurately value the benefits and costs of each alternative. Often in community resilience planning these benefits and costs include non-market goods and services that require NMV methods. Implicitly by not valuing a benefit or cost associated with an alternative in a BCA framework, the assumption that is being made is that the benefit or the cost is zero dollars.

Numerous BCA guidance documents exist to aid in framing BCA for federal investments and programs. The Office of Management and Budget (OMB) Circular A-4 (2023b), together with agency-specific guidance documents based on Circular A-4, provides guidance to federal agencies for BCAs in the context of regulatory analysis. OMB Circular A-94 provides additional guidance and recommended discount rates for BCAs of federal programs in other contexts.

In May 2024, FEMA announced long-sought changes to their BCA process for hazard mitigation and public assistance grants, which relate to developing community resilience and adaptation to a changing climate.

The following points highlight several significant changes and full details can be found at: https://www.fema.gov/grants/tools/benefit-cost-analysis .

- Reducing the discount rate from 7% to 3.1% when completing a Benefit Cost Analysis, which expands the range of projects states, Tribal Nations, territories and local governments may pursue. https://www.fema.gov/sites/default/files/documents/fema_policy-206-23-001-bca-discount-rate-and-streamlined-approaches_april-24-2024.pdf

- No longer requiring a full BCA for projects being funded through its Hazard Mitigation Assistance grant programs with a total cost of less than $1 million. https://www.fema.gov/sites/default/files/documents/fema_mit-hma-projects-under-1m-program-support-material_5.7.2024.pdf

- Making it easier for projects in historically underserved communities to be eligible for mitigation grant funding by Implementing distributional weights in determining the cost-effectiveness of a hazard mitigation project. The distributional weights will automatically adjust the Benefit-Cost Analysis results by increasing the building replacement value for properties located in census tracts with household incomes below the national median. https://www.fema.gov/sites/default/files/documents/fema_mit-interim-distributional-weights-methodology-report.pdf

There is continued FEMA BCA assistance offered to historically underserved communities as well as Tribal Nations to determine hazard mitigation project cost-effectiveness.

These changes facilitate access to make more communities resilient to natural hazards and the effects of climate changes; and address long-standing barriers certain communities—particularly those that are underserved—have had accessing mitigation grants through the Hazard Mitigation Assistance grant programs and Public Assistance mitigation funding.

There are still several needs that need to be addressed in the use of NMV, especially in the context of BCA for resilience planning. There is a need for a more comprehensive list of valuations relevant to community resilience planning decisions that includes benefits and costs that is accessible to communities that incorporates global knowledge that is useful in local decision making (Helgeson and O'Fallon). Potential line item in the budget for monitoring projects and seeing how NMV changes after a project was actually implemented. Additionally, more guidance for communities on how to use currently existing NMV studies and implement their own valuations is crucial for including the full benefits and costs associated with alternatives in the BCA framework.

In summary, leading practices in NMV for community resilience planning falls into four non-exclusive categories, as noted below.

1. Focus on what matters to the community:

- **Participatory approach:** Involve community members throughout the valuation process. Conduct focus groups, workshops, or surveys to understand their priorities and how they value different aspects of resilience (social, economic, ecological).

- **Context matters:** Consider the unique social, cultural, and economic characteristics of your community when choosing valuation methods. A one-size-fits-all approach does not work.

2. Combine revealed and stated preference methods:

- **Triangulation:** Combine revealed preference methods (RPMs) like travel cost or hedonic pricing with stated preference methods that ask people directly about their preferences. This strengthens the overall valuation.
- **Focus on practicality:** Choose methods that are feasible given budget and time constraints. Consider the expertise available within your community for data collection and analysis.

3. Address equity and fairness:

- **Unequal impacts:** Climate change and other threats often disproportionately impact vulnerable populations within a community. Ensure your valuation process considers the differential impacts on these groups.
- **Benefit sharing:** The valuation process should inform how benefits from resilience investments are distributed equitably within the community.

4. Transparency and communication:

- **Clear communication:** Clearly explain the chosen valuation methods, data sources, and limitations to stakeholders. This builds trust and understanding of the results.
- **Visualization:** Use maps, charts, or other visual aids to present valuation results in a way that is accessible and engaging for the community.

By following these leading practices, communities can ensure that NMV exercises effectively capture the true value of community resilience in each context and inform decision-making for a more resilient and equitable future.

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Appendix A. List of Abbreviations and Acronyms

ABM	attribute-based methods
BCA	benefit cost analysis
CE	choice experiment
CIVT	Coastal Inundation Valuation Tool
Co-DECIDR	Community-informed Decisions for Equitable, Cost-effective, and Inclusive Disaster Resilience
CPI	consumer price index
CRPG	Community Resilience Planning Guide
CV	contingent valuation
EDGe$	Economic Decision Guide Software
EPA	Environmental Protection Agency
ESVD	Ecosystem Services Valuation Database
EVRI	Environmental Valuation Reference Inventory
EWN	Engineering With Nature®
FCM	Fuzzy Cognitive Mapping
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
IISD	International Institute for Sustainable Development
NbS	nature based solutions
NBI	nature based infrastructure
NGO	non-governmental organization
NMV	nonmarket valuation
NOAA	National Oceanic and Atmospheric Association
OMB	Office of Management and Budget
RPM	revealed preference method
SES	socio-ecological systems
SPM	stated preference method
USD	United States Dollars

Appendix B. Resilience Types and NMV

Choosing the best data source for NMV in community resilience planning depends on the specific aspect of resilience one is trying to quantify. Here are some potential sources categorized by the type of resilience being valued:

Social Resilience:

- **Community surveys:** Conduct surveys to gauge social cohesion, trust amongst residents, and willingness to help neighbors.
- **Volunteer organization data:** Analyze participation rates in volunteer organizations and community events as indicators of social capital.
- **Social media data:** Analyze social media interactions during and after disruptive events to understand communication patterns and social support networks.

Economic Resilience:

- **Employment data:** Track unemployment rates, business closures, and recovery times after disruptions to assess economic vulnerability.
- **Insurance data:** Analyze premiums and payouts from flood insurance, crop insurance, or other disaster-related insurance programs.
- **Small business data:** Look at data on small business startups, closures, and loan applications to understand economic adaptability.

Ecological Resilience:

- **Environmental datasets:** Utilize data on factors like biodiversity, land cover, and water quality to assess the ecosystem's ability to absorb disturbances.
- **Remote sensing data:** Analyze satellite imagery or aerial photographs to track changes in vegetation cover or floodplains over time.
- **Climate change projections:** Incorporate data on future climate scenarios to understand potential future threats to ecological health.

Infrastructure Resilience:

- **Government records:** Use data on infrastructure maintenance budgets, age of infrastructure assets, and past service disruptions.
- **Engineering studies:** Consult engineering assessments of infrastructure vulnerability to specific hazards like earthquakes or floods.
- **Building permit data:** Analyze trends in building permits to understand the adoption of resilient building codes and practices.

It is important to remember some key considerations when NMV is involved, primary of which are:

- **Combining data sources:** For a more comprehensive picture, consider triangulating data from multiple sources.
- **Data quality matters:** Ensure the data you use is reliable, relevant, and geographically specific to your community.

Consider limitations: Be mindful of the limitations of each data source and potential biases in the data collection process.