How to Use Economics to Build Support for Climate Adaptation

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ABOUT HEADWATERS ECONOMICS
Headwaters Economics is an independent, nonprofit research group whose mission is to improve community development and land management decisions.

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I. Executive Summary

In the United States, a growing number of local governments have engaged with climate action, mostly through development of climate and adaptation plans.[1] However, the rate and pace of adaptation action has significantly lagged behind planning, especially in mid- and small-sized municipalities where resources are often constrained and local politics may further delay action.[1,2] The emphasis on response rather than proactive action is further exacerbated by the disproportionate level of federal disaster funding available for disaster response rather than planning and mitigation.[3] Local governments face an increasingly urgent need to adapt to a changing climate in ways that reflect their unique environmental, social, and economic conditions, all on a balanced budget and with limited federal support.

This report extends the application of economics beyond monetary costs and benefits or jobs and income, providing information to help local governments make the case for action. The report demonstrates how economic analyses can help sustainability directors, local government staff engaged with sustainability and climate work, and other partners make concise, data-driven cases for community adaptation and resilience.

Economic arguments can help to engage new audiences and frame project needs in compelling, novel ways that recognize local governments' competing priorities and limited budgets. The economic data and methods provided in this document can be used to:

- **Demonstrate how adaptation programs can meet other community goals such as improving equity and prioritizing underserved areas;**
- **Measure the social, economic, and environmental return on investment for adaptation programs and projects;**
- **Engage different audiences such as business leaders and those in health care and social services;**
- **Prioritize programs that create jobs and local economic benefit.**

Five main categories of economic analyses are described in this document and include:

- **Monetized benefit-cost analyses;**
- **Benefit analyses of cost-effectiveness or other criteria;**
- **Analyses that evaluate socioeconomic equity and distribution of benefits;**
- **Analyses of departmental budgets and strategies; and**
- **Analyses of economic trends, strengths, and impacts.**

Each method has pros and cons and appropriate applications for municipalities. The most effective method to use depends on the type of information decision-makers need to inform a decision, such as which technology to deploy to improve stormwater management, and which neighborhoods to prioritize for upgrades. The analysis method used also will depend on the information and expertise available to the city to conduct the analysis. The methods described in this report are not mutually exclusive and, in fact, often should be combined to evaluate programs in terms of social, ecological, and economic benefits.

This report shares insights related to effectively communicating economic information. Clear communication of economic data and results is critical to promote proactive action. Messages regarding climate adaptation programs and proposals should be tailored for specific audiences and as site-specific as possible. Recognizing political, strategic, budgetary, and economic concerns of an audience can help shape effective communications. The messenger for the economic information is as important as the message, and identifying a champion—someone for whom the economic case resonates, such as a business owner who will promote a program through its adoption and implementation—is a key to program success.

This report includes several real-world examples from cities that have used economic analyses to support their climate adaptation programs. Their experience provides useful illustrations for other local governments seeking to act on adaptation plans and increase their resilience to a changing climate. The details of how cities use economic analysis effectively, including the messages and messengers, provide insight for practitioners.

This report is directed to local government staff as well as organizations that support local governments such as universities, research groups like Regional Integrated Sciences and Assessments (RISA) teams, state and federal agencies, and nonprofits. The report is intended to bridge the gap between technical and academic literature and adaptation practitioners, highlighting the most relevant types of economic analyses and when they might be useful for local governments. Rather than outlining methodological details, this report focuses on how and when to use which methods most strategically.

II. Introduction

In the United States, a growing number of local governments have engaged with climate action, through mitigation efforts and the development of climate and adaptation plans.[4] Although there have been advancements in several carbon-reducing efforts , the rate and pace of adaptation action has significantly lagged behind. This is especially true in mid- and small-cized cities where resources are often constrained and a lack of political will and state and federal funding can further delay action.[1,5]

Economic analyses can help local governments and their partners make concise, data-driven arguments for community adaptation and resilience in the face of a changing climate, and more effectively transition from planning to implementation.

Used well, the tools of economics can frame messages to better reach decision-makers—including elected officials, department heads, and ratepayers—who must balance climate adaptation demands with limited budgets and other competing priorities.

This document explains how economic data and methods can be used to:

- **Demonstrate how adaptation programs can meet other community goals such as improving equity and prioritizing underserved areas;**
- **Measure the social, economic, and environmental return on investment for adaptation programs and projects;**
- **Engage different audiences such as business leaders and those in health care and social services; and**
- **Prioritize programs that create jobs and local economic benefit.**

This report comprises two main sections: first, we describe the successful use of economics to build support for climate adaptation action, with real examples from cities around the country. Second, we describe the most practical economic methods for cities to use and examples of how cities have used them. The report concludes with resources for additional information about the application of economic methods; this is where practitioners can find technical details and applications.

III. Methods for this Study

We used three methods to collect information for this study.

First, we surveyed peer-reviewed economic research and national and international guidance on economic methods for climate change adaptation to capture the range of relevant methods researchers have developed. This survey focused specifically on decision-support methods that address questions at a local government scale.

Second, to determine how (and whether) the available methods are being used, we evaluated how local governments are using economic methods and data by reviewing vulnerability assessments and adaptation plans on the Adaptation Clearinghouse hosted by the Georgetown Climate Center. This website provides a searchable database that helped us find numerous plans from a range of local governments.

Finally, we conducted interviews with sustainability directors, city department managers, elected officials, and advocates to learn what information and strategies have successfully supported their adaptation work. We interviewed representatives from 13 communities and organizations who are engaged with sustainability work, specifically in local governments.[6] The smallest of those interviewed is Warren, Minnesota (population 1,631), a small town that has done innovative mitigation projects, and the largest is San Antonio, Texas (population 1.5 million), which is using economic data to build support for adaptation programs. The communities we interviewed are facing increased exposure to flooding, landslides, extreme heat, drought, and sea-level rise. Additionally, although these places do not have particularly increased exposure, they are facing a range of social, environmental, and economic challenges. Lastly, they all tend to have politically conservative leadership or constituents.

Those interviews provided us with details about their successes, ongoing challenges, and provided insight on what local governments need to be more successful. Some are applying several economic methods (e.g., benefit-cost analysis and equity analysis) effectively, others have used economic methods for some applications and have found success, and others had not used economic information and described what they would find most helpful.

From these three sources we learned how some communities have succeeded in implementing climate adaptations based on their specific circumstances, including the types of economic analyses that have been used to support sustainability efforts and the strategies used to apply these methods effectively.

IV. Using Economics Effectively

Socioeconomic data and analysis are only effective when they are based on credible information and they are used strategically with a clear purpose and message that is compelling to a specific audience.

During interviews with local government staff, several themes emerged regarding successful use of economic reasons to build support for climate adaptation action. This section describes the steps local governments can use to effectively use economic information.

Know your audience

Effective use of economic information begins with a clear vision of the community's goals, and then identifying who can make that objective happen. This is the audience for your information, and is the individual, group, or organization that can approve or champion a program. They might be the person who needs to approve the budget, adopt the regulations, or provide the expertise. For example, if the objective is to increase resilience to extreme heat by increasing the number of shade trees in low-income neighborhoods, the audience might be the director of the streets or parks department who is working directly with residents of that neighborhood. Once the key audience has been identified, hone in on information that speaks directly to the concerns of that specific person, organization, or neighborhood. Much of the work relates to turning data and analysis into information that reflects community priorities, which key decision-makers can understand and act upon.

> *"Methods and tools that are transparent, accessible, and easy to use would provide far greater value than complex ones that are hardly used."*
>
> *-Jia Li, Improving the Practice of Economic Analysis of Climate Change Adaptation, 2014*

Different messages resonate with different audiences. Table 1 provides a crosswalk between the types of methods and the audiences and topics for which they are most relevant. Detailed descriptions of the individual methods follow later in the report.

Once the audience is identified and clear requests or recommendations are developed, the next step involves considering where and how the target audience receives information. Busy elected officials or department heads often do not have time to wade into the depths of an economic analysis, but may find a two-page summary with thoughtful charts and graphs compelling. Technical staff may want all the details and a full report. A bullet-pointed social media post might grab the attention of younger audiences. A blog or newspaper editorial could reach a broader audience.

The final component of tailoring information for a specific audience entails writing clearly and avoiding jargon. Economics as a topic can be challenging for many people; good examples that use local situations can illustrate economic concepts and analytical results in an accessible way.

Table 1. Messages can be tailored to specific audiences.

Audience	What matters to these folks?	What messages resonate?	Economic arguments/methods*
Local elected officials	Community health, safety, and welfare; campaign commitments; budgets; constituency winners and losers; re-election	· Project creates jobs and brings new funding to the area; · protecting "xyz" is worth the cost; · win-win programs; reduce impacts of climate change on underserved neighborhoods; · neighborhood-level data and data from familiar peer municipalities	❷ Benefit-cost analysis using economic impacts ❶ Benefit-cost analysis using avoided costs ❻ Equity and distribution analysis ❺ Multi-criteria analysis ❽ Economic context
Local government department heads	Community health, safety, and welfare; budgets; staffing; interdepartmental coordination; competing demands and priorities; meeting local elected officials' needs	· Supports department mission; · helps meet budgets over the long term; · coordination; · complements other municipal plans and departmental strategies	❶ Benefit-cost analysis using avoided costs ❹ Cost effectiveness analysis ❻ Equity and distribution analysis ❼ Department budget and strategy analysis
Budget officers	Affordability; fiscal responsibility; quantifiable costs and benefits	· Project helps meet budgets; · prevents cost-overruns or economic losses in the future	❶ Benefit-cost analysis using avoided costs ❹ Cost effectiveness analysis ❼ Department budget and strategy analysis
Technical staff	Costs and benefits; reliable data; logical procedures	· Protecting "xyz" is worth the cost; · doing Y will most likely result in Z	❸ Benefit-cost analysis using non-market valuation ❹ cost-effectiveness analysis
Fiscal conservatives	Economic efficiency; debt avoidance	· Investing today will save time and money in the future; · convenience; · safety	❶ Benefit-cost analysis using avoided costs; ❷ Benefit-cost analysis using economic impacts ❼ Department budget and strategy analysis
Moderates	Risk mitigation; economic fairness	· Avoidance of damage and expenses from natural hazards; · "doing our fair share" – responsible citizenship	❹ Cost-effectiveness analysis; ❺ Multi-criteria analysis ❽ Economic context
Progressives	Obligations to future generations; equitable outcomes; environmental stewardship	· Racial and environmental justice; · clean air and water, abundant wildlife; · green infrastructure; · alternative energy; · right thing to do for future generations; · neighborhood decision-making	❸ Benefit-cost analysis using non-market evaluation; ❻ Equity analysis; ❺ Multi-criteria analysis
Chamber of Commerce, local businesses	Regulatory predictability; economic impacts	· Project creates jobs; · good return on investment; · local economic drivers will be sustained; · brings new people to the area; · convenience	❷ Benefit-cost analysis using economic impacts; ❽ Economic context
Climate change activists, NGOs	Climate change impacts on people and the environment	· Climate change is threatening the world as we know it – we must act	❸ Benefit-cost analysis using non-market valuation; ❺ Multi-criteria analysis
Ratepayers / taxpayers	Fees; taxes; quality of life; community stability	· A small investment now will avoid tragedies with enormous costs in the future; · your neighbors are participating; · safe and reliable infrastructure; · safe neighborhoods	❶ Benefit-cost analysis using avoided costs; ❺ Multi-criteria analysis ❻ Equity and distribution analysis

* The numbers refer to descriptions in Table 2.

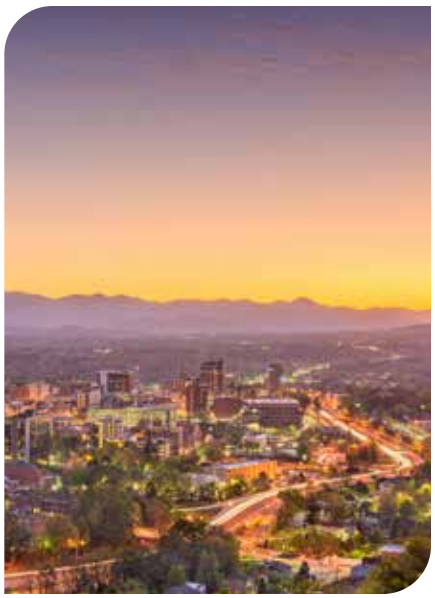
Recognize political, strategic, budgetary, and economic context

Successful sustainability projects—whether directed by a sustainability department or another local government department—identify how sustainability goals align with citywide planning processes, budget processes and timelines, and department-level strategic goals. Incorporating adaptation efforts into existing, ongoing processes (e.g., budget cycles, comprehensive plan revision, and tree planting schedules) – known as mainstreaming - can lower the hurdles to implementing projects.[7] "Mainstreaming" refers to integrating climate adaptation into city planning processes that are already being done for other sectors such as infrastructure retrofits, water management, and health.

- ***Asheville, North Carolina,*** *identifies how their sustainability office's work aligns with city and other departments' goals. The sustainability office works to demonstrate to the mayor, council, and department heads how sustainability work can help them meet those goals. After the sustainability office completed its climate resilience assessment, they recognized that the city's top priority was affordable housing and so they are highlighting sustainability-related projects that can contribute to that goal.*

- ***San Antonio, Texas,*** *was designated a federal ozone non-attainment area in 2018, meaning it does not meet the national ambient air quality standards and must take actions to improve air quality. The sustainability office is framing the cost-benefit analysis of a transition to an electric vehicle fleet as part of broader efforts to help the city improve its air quality. This can help the city avoid significant health impacts and more costly fixes.*

- *In* ***North Kingstown, Rhode Island,*** *many businesses are still focused on recovering from the last recession. This has made it difficult to engage the business community in long-term sustainability initiatives like upgrading building codes to address sea-level rise. Therefore, the sustainability staff has focused on tangible tasks that affect everyday activities, such as upgrading roads that are eroding due to coastal erosion.*



Expand beyond costs and benefits

Comparisons of costs to benefits is often the default analytic tool to evaluate decisions. Other methods may be more effective if the data are not available, the community has other priorities, or the project under consideration involves a payoff far in the future. In particular, equity and distributional analyses that identify neighborhoods most affected and their socioeconomic conditions may be better suited to addressing a local government's goal of increasing equity.

For example, non-market valuation methods can provide a city with estimates of the value of improved health due to improved air quality, and determine whether these benefits outweigh the costs. But alone, these methods do not address the neighborhoods most affected and underlying environmental injustices that the program may alleviate.

- ***San Antonio, Texas,*** *has taken a "triple bottom line" approach that emphasizes the social and environmental benefits of a program as well as the financial. For example, its sustainability plan evaluates all potential adaptation strategies to determine whether they also support the community priorities of air quality, economic vitality, equity, resilience, and water resources.*[8]

- *In* ***Urbana, Illinois,*** *sustainability staff have worked to understand residents' barriers to adopting a new program with the goal of reducing multiple barriers to adoption, besides just costs. For a solar program, they have found success emphasizing costs in terms of payback period, as well as:*
  - *Social norms (e.g., your neighbors are participating, shown via a city map);*
  - *Emotional appeals (e.g., it is the right thing to do for future generations);*
  - *Convenience (e.g., vetting contractors and soliciting bids to reduce legwork for homeowners).*

- *In* ***Buffalo, New York,*** *the Buffalo Sewer Authority emphasizes the "co-benefits" of green infrastructure, such as planting a tree to manage stormwater but also cool the surrounding environment and reduce energy*

use. The city also is using green infrastructure to address historical environmental justice problems such as racial and economic segregation as part of a citywide initiative to improve equity. After identifying underserved areas, Buffalo Sewer is emphasizing workforce development and contracting with diverse community-based organizations, incorporating neighborhood revitalization such as green spaces into green infrastructure projects, and prioritizing neighborhood engagement and outreach to include diverse participation in neighborhood decision-making.[9]

- *In **Dayton, Ohio,** expensive infrastructure projects such as reinforcing levees to protect drinking water sources from contamination may not provide tangible benefits until far in the future or in the event of extreme weather. When communicating with ratepayers to build support for source water protection, city staff describe both avoided treatment costs as well as avoided health impacts that could occur if contaminated flood water inundated a wellfield area.*

Local information tailored to your audience's interests is most persuasive

The more tailored the data or analysis is to a specific region, city, or even household, the more compelling it is to decision makers. Information must be tailored specifically to your audience. It should answer their question, "Why should I care?" People's concerns can be determined by understanding the broader budgetary, political, or regulatory constraints that they face. For example, the streets department director who is attempting to increase resilience to extreme heat may also be looking for ways to incorporate a mandate to address equity issues, or to reduce stormwater runoff. Measuring how planting trees could help the department meet those goals and at what cost (a cost-effectiveness analysis) could help to engage the department.

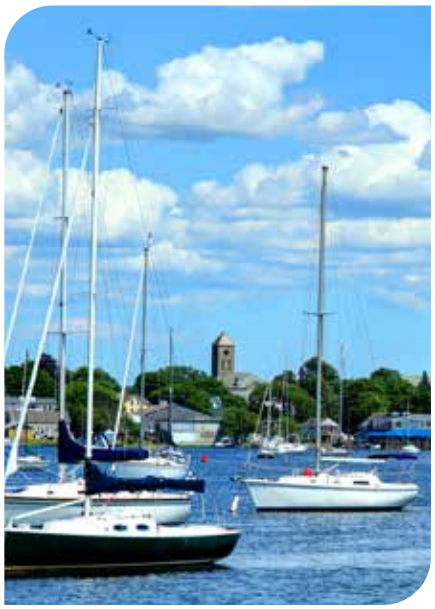
- *In **Dayton, Ohio,** the city's environmental management team has found that census tract-level data help them communicate most effectively with local leaders. When local data are not available, they use data from cities that are familiar to Dayton residents, like Cleveland and Cincinnati.*

- *In **Warren, Minnesota,** the city administrator measured how much money an energy audit program would save individual homeowners, calculated using infrared imagery of heat loss from roofs and windows.*

Identify and support champions

Making progress at the municipal level often goes more quickly and smoothly with help from a champion who can raise the profile of sustainability issues and spearhead cooperation across departments. Effective champions above all are committed to making a local government more sustainable, and his/her efforts can take the form of front-line leadership or behind-the-scenes facilitation. In politically conservative communities, the champion may be a local government employee whose official capacity is not sustainability, but who has a personal commitment to sustainability work. Or, sustainability directors can play the champion role, facilitating coordination between otherwise siloed departments.

On the other hand, the most effective champions may be outside local government. Look for those who have unique expertise, a respected reputation among constituents like business leaders, or who bring an otherwise unique perspective. Different kinds of partners can promote and fund a program, including private individuals and businesses, nonprofit organizations, and federal agencies. Partners can also develop a wide range of voices that support a program and provide political cover for elected leaders.



Sustainability directors can support champions by identifying opportunities where their unique perspective and expertise can be most effective, and arming them with details regarding the effectiveness and impact of proposed programs.

- *In **Warren, Rhode Island**, the waterfront wastewater treatment plant must be relocated by 2065 due to rising sea levels. The city manager is not tasked directly with increasing sustainability, but recognizes the imminent financial strain the new treatment plant will create. She is helping to educate taxpayers in this relatively low-income community about the need to begin saving pennies now to afford the large, imminent expense in the future. Her work is bolstered by groups like the University of Rhode Island's Coastal Resources Center, which provides her with the best available research on sea-level rise and its impacts.*

- *In **King County, Washington,** citizen advocates created a group called People for Climate Action (PCA), which is made up of several smaller city groups. Cities in this region want to act but may not have the expertise or time to determine how. PCA has become a trusted partner for Redmond and other cities' staff by bringing tangible and actionable projects that can increase sustainability and save costs, identifying funding for the projects, and providing examples of other cities that have done the same projects. The group has built credibility and political influence with Redmond elected leaders by building rapport with city council members and those running for office, building a large (40+) group of active members who are respected in the community, and holding regular internal meetings to keep their members engaged. PCA has looked at city planning documents to identify overlooked projects that can improve sustainability and save costs (such as more efficient heating and cooling in schools) and bring them to the city's attention. They also have researched sample policies to help reduce work for city staff, such as sample building codes.*

V. Using Economics to Measure Consequences

Economic analysis and data can help local governments determine whether to pursue adaptation projects, which activities to prioritize, the impacts of adaptation programs, and their effectiveness in meeting strategic goals. The specific analysis method used depends on the type of information decision-makers need and the information and expertise available to conduct the analysis. In many cases, multiple methods can be used to address different audiences' concerns, or to evaluate programs in terms of multiple criteria such as social, ecological, and economic benefits. **Table 2** provides a summary of the methods that are discussed in greater detail below. The best audiences and communications strategies for these methods are described in **Table 1**.

Table 2. Economic methods to support city sustainability programs

Method	Description	Primary Audience	Pros and Cons	Cost & Technical Expertise*	Applications & Examples
Measuring Benefits					
❶ **Benefit-cost analysis using avoided costs**	Describes the benefits of a project in terms of costs *not* incurred if the project proceeds.	Elected officials, department heads, ratepayers	Monetized benefits and costs often are available from engineers. Not all benefits can be monetized. Does not address who receives benefits and who bears costs.	**Cost** - $$ **Technical** - Requires training in benefit-cost analyses and familiarity with relevant data. Engineers may have access to this data; economists may be needed to monetize some benefits.	Large infrastructure investments that mitigate exposure to disasters (such as expanded stormwater capacity), or regulatory investments (such as reduced fines for non-compliance like air quality improvement efforts in San Antonio, Texas).
❷ **Benefit-cost analysis using economic impacts**	Measures the change in the number of jobs and amount of income in a community or region caused by a policy change.	Business leaders	Requires clear baseline and policy change to measure impacts. Can be linked to equity goals if benefits will occur in low-income neighborhoods.	**Cost** - $$$ **Technical** - Requires economic input/output modeling expertise.	Programs that may bring jobs, such as energy efficiency retrofitting. Programs that protect the natural resources that support businesses, such as mangrove conservation that attracts tourists in southwest Florida.
❸ **Benefit-cost analysis using non-market valuation**	Measures seemingly unquantifiable amenities that people value even though they do not pay for them, such as health, clean air, and recreational opportunities.	Agency staff, technical audiences	Required for some federal rulemaking and accepted for litigation, but often not compelling for general audiences and community leaders.	**Cost** - $$$ **Technical** - Requires expertise in unique statistical methods.	Regulations to improve human and/or ecological health through water and air quality improvements can be monetized. At a Lake Erie beach, researchers find users are willing to pay an estimated $6.2 million to restore wetlands and improve beach recreation. The values of ecosystem services (such as stormwater filtration) also can be measured with these methods.
❹ **Cost-effectiveness analysis**	Compares costs of different actions to achieve a specific goal.	Elected officials, department heads	Easier than benefit-cost analysis because it does not require monetization.	**Cost** - $$ **Technical** - Project performance data are likely available from city engineers who also may be able to conduct the analysis.	Actions with specific benchmarks, such as reducing greenhouse gas emissions, water conservation, or reduced health impacts. The climate action plan for Portland, Oregon, evaluates strategies to meet city objectives for emissions, carbon sequestration, and waste reduction.
❺ **Multi-criteria analysis**	Combines available qualitative and quantitative metrics to score and compare potential projects.	Neighborhood leaders, department heads	Flexible evaluation criteria reflect stakeholders' priorities. Scoring criteria vulnerable to manipulation so the process must be transparent.	**Cost** - $$	New York City's adaptation assessment overlaid several methods, including questionnaires for stakeholders, risk assessments that incorporated uncertainty, and strategic incorporation of adaptation strategies into the city budget and fiscal processes.
Beyond Benefits					
❻ **Equity and distribution analysis**	Evaluates how programs will affect underserved individuals and neighborhoods. Distribution analysis evaluates who will bear the costs and receive the benefits.	Elected officials, stakeholders	Complements benefits analyses.	**Cost** - $$ **Technical** - More sophisticated analysis requires geographic specificity of climate impacts and vulnerable populations.	The city of Asheville, North Carolina, overlaid climate impacts maps with maps of vulnerable populations to prioritize action areas using the Center for Disease Control's Social Vulnerability Index.
❼ **Departmental budget and strategic analysis**	Describes how a project will help the department meet its strategic goals, using its performance metrics.	Department heads	Requires working closely with department staff and understanding their processes.	**Cost** - $	Coincides with budgeting and strategic planning processes.
❽ **Economic context**	Shows the trends in employment and income in the community to understand economic drivers and inform prioritization.	Elected officials, business leaders	Data are readily available and are helpful for municipal and economic development plans.	**Cost** - $	Free data can be downloaded from several sites, including the Economic Profile System (for an economic overview) and Populations at Risk (for neighborhood-level data on vulnerable populations).

* $ refers to methods that are doable by city staff without specialized expertise; $$ refers to methods that are doable by city staff with specific training; $$$ refers to methods that require highly specialized training and may require outside experts.

This section describes the methods most relevant to cities attempting to make well-informed decisions about adapting to climate change. We divide the methods into two main categories: first, methods used to measure benefits; and second, methods that expand project evaluation beyond benefits.

Measuring Benefits

Making a case for a climate adaptation initiative often requires a description of the benefits the project will provide. Also useful is a description of *who* benefits. Benefits can be monetized (e.g., dollars saved on heating costs), quantified (e.g., tons of emissions reduced), or qualitatively described (e.g., improved quality of life).

Monetizing benefits, also called benefit-cost analysis, translates the impacts of a project into dollar terms, helping to identify projects for which the benefits exceed the costs. Project costs usually are already measured in dollars. Project benefits, on the other hand, often need to be translated into dollars. Several methods (see the first three described below) translate benefits into dollar values, allowing benefits to be compared to costs in the same units.

Benefit-cost analyses compare the benefits and costs over the expected lifetime of the project. Costs often are incurred immediately. Benefits, however, may be enjoyed over many years or several years in the future in the case of projects anticipating a different future climate regime. Benefit-cost analyses typically include total costs and benefits incurred over the next 20 years, with future costs and benefits discounted to reflect people's preference for a dollar today rather than a dollar tomorrow. The U.S. Office of Management and Budget's Circular A-4 Guidelines contain detailed technical information.

One shortcoming of the benefit-cost analysis approach is that benefits or impacts that cannot be monetized will not be included directly in the analysis and therefore may be overlooked. Other methods to measure and prioritize benefits, like cost-effectiveness and multi-criteria analysis, may be more appropriate when the bulk of benefits cannot be monetized. Benefit-cost analysis also does not explicitly address *who* receives the benefits (that is, it weighs all recipients equally).

Some benefit-cost analyses describe benefits that accrue to residential or commercial properties, but the cost of infrastructure is borne by the public. When the entity bearing the cost (often the public) and the entity receiving the benefit (e.g., private landowners) differ, the analysis may be less compelling to the public.

The choice of monetization method depends on the type of project being considered and what information would be most compelling for decision-makers.

❶ Benefit-cost analysis using avoided costs

Avoided cost analysis describes the benefits of a project in terms of costs that will *not* be incurred if the project proceeds.

Avoided cost analysis is commonly used to justify investment in large projects such as green infrastructure and stormwater management, energy efficiency upgrades, and flood mitigation. The audiences for this analysis are elected officials, city managers, department heads, and taxpayers. Avoided costs can show local government leaders and department heads how a project can help them meet their budgets.

Example 1: *In* ***Buffalo, New York****, more frequent large rainfall events are resulting in untreated water being discharged into waterways. The city is required by state and federal law to reduce these overflow events. As the city develops its 19-year, long-term combined sewer overflow plan, the city is measuring the benefits of investments in green infrastructure in terms of avoided fines and costly upgrades to its sewer system, as it also prioritizes human and environmental health.*[10]

Example 2: Miami-Dade County, Florida*, conducted a benefit-cost analysis of the cost of protecting county-owned assets from sea level rise. The analysis found that the cost of protecting the most vulnerable properties would be $6.3 million but would avoid $24 million in potential damages.*[11]

Municipal Fiscal Applications of Benefit-Cost Analysis

The changing climate is affecting cities' fiscal outlook due to rising costs of providing services, decreasing property tax revenue, higher borrowing costs, disruption of economic activity, and potential population loss as residents seek less vulnerable communities.[14] The effect of natural disasters on a community's tax base can be devastating: in Toms River Township, New Jersey, the tax base was reduced by $2 billion or 12.4% of the total tax base after Hurricane Sandy hit the area.[15]

An evaluation of the effects of increased flooding, wildfire, or other extreme events on the value of property, and subsequent effects on property tax revenue and ability to provide city services, is an avoided cost analysis specifically targeted at city budgets.

For example, an analysis by First Street Foundation and Columbia University found that coastal homes in the city of Newport, Rhode Island, are already valued $2.9 million below where they would be valued without sea-level rise.[16] As the city considers how to adapt to more frequent inundation, this type of parcel- and neighborhood-level analysis can inform decisions about updating infrastructure and moving or protecting historic homes.[17]

In addition, municipal bond ratings—which governments rely on for infrastructure projects—are increasingly tied to sustainability practices. Beginning in 2015, the major credit rating companies began incorporating a city's climate resilience into its bond ratings. Moody's and S&P, for example, consider a community's exposure to extreme weather events as well as the city's plans to reduce its exposure and progress toward implementing those plans.[14, 15] In the Toms River example, Moody's downgraded its bond rating from Aa2 to Aa3 six months after Hurricane Sandy.

Downgraded bond ratings come with a substantial cost. Although the exact change in interest payment varies depending on the original bond rating, principal amount, and other factors, on average the rate could increase from 0.06% to 0.87%, or between $600 and $8,700 per $1 million borrowed.[20] In dramatic cases like Chicago's general obligation bonds in 2015 (unrelated to climate issues), it faced a downrating to junk bond status that would have cost the city $2.2 billion in accelerated payments.[21]

Initiatives to lower a city's exposure to extreme weather events could pay for themselves by avoiding higher borrowing costs. Hampton Roads municipalities in Virginia and Miami-Dade County took steps to reduce risk from sea-level rise and were both able to avoid downrating.[15] According to a survey by Moody's of the 28 cities with the largest outstanding debt, 82% are expected to have a climate risk action plan in place in 2019 to reduce the long-term risks from climate, and associated effects on the cities' credit.[22]

Detailed information on rating agencies' evaluation criteria, however, are not available at this time, making precise estimates of bond ratings' financial impacts impossible. As climate change impacts are increasingly formalized into bond ratings—and cities' financial outlooks—borrowing for more vulnerable cities will become more expensive. Cities with higher climate-related risks may be well served by investing in expensive adaptation projects before these risks are more formally incorporated into bond ratings and borrowing costs increase.[23]

"In our view, all else being equal, municipal issuers that have plans—and reasonably attempt to provide funding for those long-term plans, including emergency preparedness— will most likely exhibit relatively less risk to creditworthiness from exposure to climate change."

– S&P Global Ratings[11]

❷ Benefit-cost analysis using economic impacts

Economic impact analysis measures the change in the number of jobs, amount of income, and local tax revenue in a community or region due to a policy change.

Economic impact analysis is commonly used to justify programs that are expected to bring jobs to the community, such as energy efficiency retrofitting or protecting natural resources that support important business sectors. This type of analysis can be persuasive with business leaders and other community members interested in taxpayers' return on investment. It is particularly useful in communities seeking economic development opportunities.

Example: *In* ***southwest Florida****, the regional planning commission measured the economic impact of tourists visiting the area's mangrove forests. It used the estimate of jobs and income brought to the area by tourists visiting the mangrove forests to justify the costs of conservation easements and other measures to protect these natural areas.*[12]

❸ Benefit-cost analysis using non-market valuation

Non-market valuation measures seemingly unquantifiable values that benefit people even though they do not pay for them—benefits such as health, clean air, and recreational opportunities. Non-market valuation methods commonly measure ecosystem services—the benefits people gain from a healthy, functioning ecosystem—such as stormwater absorption by wetlands. Researchers apply statistical methods to measure how much people value selected environmental qualities and then translate that value into dollars. For example, researchers use surveys to present respondents with two hypothetical scenarios: one with higher air quality at a higher cost, the other with lower air quality at a lower cost. Using statistical methods to compare the tradeoffs many people make between improved air quality and higher cost, researchers can estimate people's willingness to pay for better air quality. These "non-market values" can then be incorporated into benefit-cost analyses.

Non-market valuation is frequently used to determine whether the benefits of a regulation justify its costs. This method is frequently used in efforts to protect or improve water and air quality. Because the methods and concepts behind non-market valuation are highly specialized, they are compelling to more technical audiences like agency staff. It is commonly used in benefit-cost analyses for major new federal regulations.

Example: *Non-market values have been used in benefit-cost analyses to support federal regulations such as the Safe Drinking Water Act and Clean Air Act. Economists compared the cost of implementing an environmental regulation to monetized estimates of lower risk of death or illness.*[13]

❹ Cost-effectiveness analysis

When a community has a specific goal such as reduced incidence of flooding, reduced tons of emissions, or saved gallons of water, cost-effectiveness analysis (CEA) can help a community identify which projects meet their goal for the lowest cost. For example, when a city is looking to reduce its greenhouse gas emissions, it may improve heating and cooling efficiency, or switch vehicle fleets to electric vehicles, or increase use of renewable energy. A CEA divides the cost of each program by the tons of emissions reduced to determine the cost per ton of emissions reduced. This facilitates comparison across potential programs.

Cost-effectiveness analysis is a compelling tool for department heads and elected officials who need to meet a community's strategic goals on limited budgets. Because CEA does not require all benefits to be monetized, it can be easier to implement than benefit-cost analysis.

Example: *In the* ***River Thames basin****, high phosphorous levels threaten water quality for London. Comparing the cost of a range of treatment options to their effectiveness at lowering phosphorous levels for several future climate scenarios, the authors find the most cost-effective strategy is a combination of reducing fertilizer use upstream and treating water to a high standard.*[24]

❺ Multi-criteria analysis

When the benefits of a project cannot all be monetized or quantified, multi-criteria analysis (MCA) provides a framework to identify strategies and priorities. With MCA, stakeholders identify the project's objectives and score how well each strategy meets criteria in terms of "low," "medium," and "high" or on a numeric scale (e.g., 1 to 5). For example, adaptation strategies can be measured against cost, feasibility, reduced vulnerability to flooding, and reduced vulnerability for households with lower income. If one criterion is particularly important, analysts can place a heavier weight on it. The end result is a ranking of the different strategies by how effectively they meet the community's objective.

Advantages of MCA are that it provides a means of including social and environmental priorities that may be difficult to incorporate into cost-benefit or cost-effectiveness analysis. It also can be conducted by stakeholders and does not necessarily require outside analysts. The process can be vulnerable to manipulation by weighting, scores, or criteria used, so it does require transparency and participation by a representative group.

Example: New York City *combined information from scientific assessments of climate risk with surveys of department heads to understand infrastructure and city assets as well as any planned maintenance or upgrade projects. They developed a climate risk matrix that combined this information, and weighed adaptation strategies according to cost, feasibility, timing, efficacy, resiliency, and any additional benefits it provided.*[25]

Beyond Benefits

Benefits assessments are not the only economic methods available to evaluate climate adaptation strategies. The following section describes several methods that may more effectively address decision-makers' concerns or can provide additional context and supporting information for a program.

❻ Equity and distribution analysis

Benefits assessments consider overall net benefits and net costs, but do not explicitly address who bears the costs and who receives the benefits of a project. While this is useful for a community-wide evaluation, a deeper look at the distribution of benefits can help ensure sustainability programs are addressing the needs of all residents. Equity analyses can bring decision-makers' attention to the individuals, households, and neighborhoods most likely to be affected by a program. This kind of analysis also can help identify potential stakeholders and champions for programs.

The impacts of a changing climate will be borne disproportionately by areas that historically have been underserved by city services, particularly households with lower incomes, substandard housing quality, lack of health care, lack of access to transportation, and household members who are elderly or disabled.[26,27] Communities with fewer resources are less resilient and more vulnerable to climate-related threats, displacement, and subsequent economic and social disruption. Many communities recognize these outsized impacts, as well as the historic legacy of racism and segregation, and have incorporated goals of improving equity as part of broader city strategic plans. Equity analyses show how an adaptation project will reduce the impacts of climate change on underserved neighborhoods or populations, and thereby contribute to broader community goals and prioritize resources to the people and neighborhoods who need it most.

Example: *When the City of* ***Asheville, North Carolina,*** *conducted its climate resilience assessment, it used spatial analysis to overlay exposure to primary threats from flooding, landslides, drought, extreme heat, and wildfire with measures of socioeconomic vulnerability like poverty, unemployment, families enrolled in food stamps, and reliance on public transportation at the census block scale. Due to a history of red-lining that delineated where black residents were allowed to live (often in low-lying or otherwise undesirable places), many of the populations particularly vulnerable to flooding tend to be people of color. This overlay enabled the analysts to identify the number of parcels that are particularly exposed to different hazards and that are more likely to have difficulties recovering from natural disasters.*

The Asheville Office of Sustainability has used this analysis strategically to support work in several other areas of city government. By becoming involved in strategic planning and budget processes, the Office of Sustainability was able to fold the climate resilience assessment into the city comprehensive plan. The Office of Sustainability has also shared the results of the resilience assessment with the emergency management teams to inform emergency response plans and ensure the teams have plans to reach those in the greatest need.

The Office of Sustainability has worked closely with the city's Office of Equity and Inclusion to align their initiatives and amplify both departments' efforts.

❼ Departmental budget and strategy analysis

Given city departments' limited staff time and budget, leadership of those departments will need to understand how a program will affect their mission and budget. With a department-specific cost-effectiveness approach, an analysis can show how a program will help the department meet its strategic goals and can define the budget and staff resources needed to meet them. Incorporating the department's performance metrics makes it easier for leadership to see how an adaptation program fits into their broader mission.

Example: *In* ***Asheville, North Carolina,*** *the sustainability director has been able to gain support of department heads by first understanding the departments' goals and planning processes. The director also has an in-depth understanding of key departments' budgets, including programs and staff commitments, to recognize where the sustainability department's programs can help other departments meet their performance goals while also supporting sustainability initiatives. Initiating conversations to coincide with budget approval processes as well as larger planning processes has resulted in the incorporation of several sustainability initiatives into departmental operations.*

⑧ Economic context

Economic context is important for recognizing a community's economic assets that must be protected as well as the stressors that can make adaptation more challenging or urgent.

Community leaders can better prioritize areas to protect, infrastructure to upgrade, or other investments to make when they understand local economic drivers such as the biggest employers, income sources, and trends in major industries. Recognizing these priority sectors and describing how projects will make them more resilient to a changing climate can build support among the business community and community leaders who prioritize economic development.

Example 1: *In* ***Nashville, Tennessee,*** *flooding overtopped a levee, inundating parts of the city including two major tourism destinations: the Grand Ole Opry House and Gaylord Opryland Resort. This caused more than $200 million in damage to the buildings and temporarily laid off 1,800 workers. These properties account for 20% of the city's hotel tax revenue, so closure created a major budget impact. Recognizing the economic contribution of tourism to these sites, the city invested $17 million to build a floodwall around these properties.*[28]

Example 2: *The city of* ***Warren, Minnesota****, is looking for strategies to recruit millennials to move to the city as an economic development strategy. The city's administrator has found city leaders more receptive to sustainability projects when she highlights projects' value in distinguishing Warren and increasing its appeal to potential new residents.*

Caveats and Limitations

Although the economic methods described in this report can be powerful decision-support and communication tools, they all inherently include some limitations.

Uncertainty

There is uncertainty around the magnitude of climate change impacts, the timing of impacts, and the effectiveness of different adaptation strategies, which makes planning for and adapting to climate change an unavoidably uncertain endeavor. Several strategies can help cities make well-informed adaptation decisions despite uncertainty. The Center for Climate Strategies' *Adaptation Guidebook* has a detailed description of approaches to identify and select adaptation strategies in the face of uncertainty.[29] The City of New York's *Adaptation Assessment* incorporated several approaches, particularly around using risk management to set adaptation priorities.

Incorporating these approaches to complement the economic assessment can build credibility and buy-in from department and city leadership. Inherent uncertainty does not mean cities do not have enough information to act.

Double Counting

The analytical methods described here identify several options depending on data availability and audience. While multiple methods can be used to evaluate different aspects of a program, because the results measure different aspects of the same benefit, they cannot be added together for a "total benefit."

VI. Conclusions

Many local governments recognize the growing urgency of climate change and have plans in place to adapt and increase resilience. Yet tight budgets and limited staff capacity mean implementation of these plans often has not kept pace. This report highlights how local government staff and supporting organizations (e.g., nonprofits, research groups, state and federal agencies, and universities) can build broader support for and ultimately implement sustainability initiatives using economic data and tools.

This report describes the economic methods most relevant for local governments, incorporating lessons learned in places that have used economics to implement sustainability projects. In addition to using economic tools to compare benefits to costs, economic data also can be used to help practitioners identify neighborhoods most at risk to changing climate and prioritize which projects to implement.

This report is intended to help bridge the gap between technical and academic literature and adaptation practitioners, highlighting the most relevant methods and when they might be useful for cities. Rather than outlining methodological details, this report focuses on when to use which methods most strategically.

Local governments have successfully used these methods by utilizing the GIS and other technical expertise among city staff in different departments; partnering with RISA teams, universities, nonprofit organizations, and citizen groups; and hiring consulting firms that specialize in these methods. A clear understanding of the project's goals and the most compelling information for the audience that can implement the project will ensure that the resources spent on these analyses are used efficiently.

Cities interested in pursuing the methods highlighted in this report can find detailed technical guidance on these methods in Further Reading, below.

VII. Further Reading

This report provides an overview of economic methods that can be used to evaluate and support climate adaptation activities. The following resources provide details on economic analyses, data sources, and how economic methods have been applied.

Benefit-Cost Analysis:

- Office of Management and Budget's Circular A-4 Guidelines describes best practices for benefit-cost analyses, adopted as the standard across federal agencies.
- Federal Emergency Management Agency's Benefit Cost Analysis Reference Guide describes its requirements for benefit-cost analyses and how they apply to FEMA-related projects.
- EconAdapt's Toolbox provides technical summaries and examples of the methods discussed here, and others. It has a European focus but the information is relevant to U.S. cities.

Non-market valuation:

- The Environmental Protection Agency includes a detailed "Frequently Asked Questions" page describing the reasoning and latest research related to monetizing human health risks.
- Ocean Economics provides a database of non-market values, searchable by location and type of activity valued.

Examples of how people have used the methods described in this report:

- Urban Land Institute's Returns on Resilience: The Business Case describes the payback for climate resilience projects in 10 cities.
- New York City's Adaptation Assessment Guidebook describes lessons learned from its adaptation planning process as a guide for other cities.
- The National Flood Insurance Program has a Community Rating System that rewards communities for voluntary projects to reduce flood losses and mitigate hazards. Participating communities get discounts of 5% to 45% on flood insurance premiums.
- National Institute of Building Sciences and the Federal Emergency Management Agency conducted benefit-cost analyses of hazard-related building codes, including river flooding, hurricane surge, earthquake, wildfire, and wind. They found a benefit of $11 for every $1 invested, which varies depending on the specific hazard.
- Miami-Dade County monetized the vulnerability of county property to sea-level rise and storm surge, comparing the potential value of potential losses to the cost of infrastructure improvements to protect county properties.

Climate Adaptation Finance:

- How Cities are Paying for Climate Resilience describes innovative strategies being used by eight cities to increase local climate resilience.

Strategic communication:

- Spitfire, a communications consulting firm, has a blog with helpful tips across many communications topics.

Endnotes

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