Considerations for Benefit-Cost Analysis

WHO	This guidance is for the practitioner in Step 4.
WHAT	This section defines Benefit-Cost Analysis (BCA) and gives recommendations for how economics and BCA are applied in setting priorities and selling projects to decision makers and funders. Additional background reading materials are linked at the end of this resource.

What is Benefit-Cost Analysis?

The viability of any enterprise, investment, or business can be described as the difference between the costs (expenses) incurred and the benefits (revenues or values) obtained. For any entity looking to invest in a resilience/adaptation project, they would like to see that the benefits outweigh the costs. This is the basic definition of a Benefit-Cost Analysis (BCA), also called a Cost Benefit Analysis (CBA) by some.

Benefits can be either quantified (monetized), or qualitatively described. It's important to keep in mind that there are limitations of BCA. For example, benefits can't always be monetized and a BCA does not address who receives benefits and who bears the costs. The practitioner should therefore strive to make BCAs for every option as comparable as possible and to address equity issues.

A simple equation looks at taking the expected benefits accrued from the investment and dividing it by the sum of all necessary costs incurred. If the benefits equal costs, then the Benefit-Cost Ratio (BCR) is 1:1. Most investors look for a BCR that is greater than 1:1. For example, FEMA requires a BCR greater than 1:1 and the US Army Corps of Engineers require a BCR of 2:1 or greater. Studies by FEMA and the National Institute of Standards and Technology (NIST) show BCRs for resilience of 4:1 and up to 11:1[1]. These studies clearly show that it makes good economic sense to invest in resilience; therefore, BCA and BCR are good measurements that can be used to show other stakeholders and funders the importance of investing in resilience.

Work Beyond BCA

Of course, a simple equation does not deal with the realities of uncertainty, changing climates and other things including the time value of money. Dollars are often invested months, years, or even decades before a full set of benefits are incurred. Therefore, the time value of money invested must be considered. This is often referred to as the Expected Net Present Value (ENPV). Simply put, ENPV takes into account the discounted value of expected benefits compared to the present moment in time.

If there is uncertainty about the escalating risk for the system (and therefore increased benefits over time for avoiding the loss), then these should be taken into account using probability distributions or similar approaches. Importantly, these factors are *not* considered in a standard BCA.

[1] https://www.preventionweb.net/publication/natural-hazard-mitigation-saves-2018-interim-report

Key Resources For Implementing

Research: Headwater Economics

One of the leading groups that studies BCA and how it applies to the climate adaptation field is Headwaters Economics. In one of their key reports, Using Economics to Support Climate Adaptation, they present a table of eight different economic methods used to support community resilience (many of which are variations of BCA):

- Benefit-cost analysis using avoided costs
- Benefit-cost analysis using economic impacts
- Benefit-cost analysis using non-market valuation
- Cost-effectiveness analysis
- Multi-criteria analysis
- Equity and distribution analysis
- Departmental budget and strategic analysis
- Economic context

The report contains many case studies, a great overview of the topic and a section for further reading on the topic. This is a great "first stop" for someone looking to learn more about BCA and other economic methods that are useful for doing resilience valuations. It is also useful for how to deal with avoided costs/benefits that cannot be monetized (especially in an equity-centered reality).

Inequities of BCA

Importantly, Headwaters Economics also identifies downfalls of relying on BCA in their article, "Improving benefit-cost analyses for rural areas." For example, BCA:

- that is used by FEMA and other federal agencies to prioritize funding for flood mitigation and recovery can be a barrier to rural communities.
- are designed to ensure that projects are cost effective - however, they can undervalue the benefits of mitigation projects in lower-capacity and lower-income communities… resulting in an inequitable distribution of funds.
- often requires highly technical information that is beyond the capacity of many smaller communities.
- Even when BCA is completed, the information handicaps rural and under-resourced communities in three ways:
    1. Benefits and costs are defined too narrowly
    2. BCA prioritizes property values over people
    3. BCA contributes to inequitable outcomes

Natural Systems & BCA

Issue. NbS are dynamic systems that provide a multitude of benefits in addition to hazard risk reduction, including values like recreation, wildlife habitat, carbon sequestration, and water quality improvement, which may be more difficult to quantify through benefit-cost analyses. NbS grow and adapt, providing more benefits as time goes on, with the ability to self-repair and adapt to climate stress – qualities that are not currently able to be captured by FEMA's BCA Toolkit calculations. Similar challenges exist with benefit-cost analyses in the Army Corps context. The Corps' BCAs typically do not capture critical benefits provided by natural infrastructure, especially when that infrastructure can lessen the impact of a future storm or natural disaster, and they fail to account for the costs of ecosystem services lost as a result of a project. Additionally, the

agency's BCAs do not equitably evaluate flood damage benefits provided to economically disadvantaged communities and communities of color, including by relying on home prices to value flood damage reduction benefits which can create significant barriers to the approval of critical projects.

Solution. Agencies such as FEMA are working to create a conducive policy environment for nature-based projects, though challenges in terms of BCA remain. For example, although FEMA recently updated its policy to facilitate more complete consideration of ecosystem services benefits in the BCA calculation, the list of ecosystem service benefits available for applicants to utilize in the BCA Toolkit remains somewhat limited. Additional guidance from FEMA and other federal agencies for applicants on how to document feasibility and effectiveness for nature-based projects to improve the quality and competitiveness of applications received will be important. However, practitioners and communities can guide and encourage local feasibility and effectiveness studies that are critical to informing benefit values for use with FEMA's BCA Toolkit. This can be done through partnerships with local universities, public agencies, scientists, and experts to conduct research on the cost-effectiveness of NbS that can support BCAs and justify new investments (Kabisch et al. 2016). For example, Texas General Land Office worked with a technical group composed of experts from public agencies, private companies, and non-governmental organizations to create an Ecosystem Services Benefits Tool. The tool helps evaluate the benefits of ecosystem restoration projects for projects seeking federal grant funding that typically requires traditional BCAs as part of the application.

From: *Incorporating Nature-based Solutions into Community Climate Adaptation Planning*.

BCA In Practice

A few examples of putting BCA into practice include:

- In the paper, *Monetization methods for evaluating investments in electricity system resilience to extreme weather and climate change* (Zamuda et al. 2019), researchers provide detailed lists of how to properly account for all costs and all benefits, including harder to quantify societal benefits.
- Benefit-Cost Analysis | FEMA.gov
    - Benefit-Cost Analysis (BCA) is a method that determines the future risk reduction benefits of a hazard mitigation project and compares those benefits to its costs. The result is a Benefit-Cost Ratio (BCR). A project is considered cost-effective when the BCR is 1.0 or greater. Applicants and sub applicants must use FEMA-approved methodologies and tools—such as the BCA Toolkit—to demonstrate the cost-effectiveness of their projects.
- Justice 40 Initiative
    - The Path to Achieving Justice40
        - BRIC Technical and Qualitative Criteria - really good pdf that describes the criteria and how Justice 40 is applied, it is in the resources folder - fema-BRIC-FY21-Tech-Qual-Criteria9082021.pdf

Tools to Implement a BCA

(Adapted from the *Ready-to-Fund Resilience Guidebook*)

Application Area	Tool
General Benefit-Cost Analysis	FEMA BCA Toolkit - An online software tool that quantifies costs and benefits for a range of major natural hazards and project types, including flood, tornado,

	hurricane wind, earthquake, wildfire, drought, and landslides. The accompanying user guide navigates the platform. This tool is best for users familiar with the FEMA BCA system. While it can quantify the extent to which hazard mitigation measures may reduce injuries, loss of life, hardship, or the risk of future damage and destruction of property, the tool lacks a holistic approach and does not consider other social and environmental factors. More information is available in the *FEMA Report on Costs and Benefits of Natural Hazard Mitigation*.
Power	• The FEMA BCA tool integrates "damage costs of increased injuries and lives lost from degraded critical services during power interruptions." • NREL's REopt model offers resources to evaluate Distributed Energy Technologies. • The Interruption Cost Estimate (ICE Calculator) developed by Lawrence Berkeley National Laboratory tool can help estimate power interruption costs and related reliability benefits.
Green Infrastructure	• A Green Roof Energy Calculator developed by the Green Building Research Laboratory allows any building owner to estimate potential energy savings. • AutoDesk Triple Bottom Line Analysis Tool, available via subscription, analyzes civil infrastructure project design for such factors as public benefits of improved water quality, and increased recreational and property value.
Heat	The City of Phoenix's method for monetizing lost or productivity (morbidity) from the Heat Island Effect includes: • Estimated temperature reduction from change in features. • Estimated heat-related illnesses from the resulting change in temperature. • Estimated cost of each heat-related illness. • Combine, using relevant population for given location.
Air Quality	• Models to quantify ecosystem services: iTree, inVest, and biome-BGC. • BenMAP: software that estimates the health impacts and economic value of changes in air quality.