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New Ways to Get to High Ground

Benefit-cost analysis for sustainability and resilience planning needs new tools to proactively meet community needs and ensure that projects are successful.

When local officials in Port Orford, Oregon, a small coastal town 60 miles north of California, were planning how to address the threat posed by tsunamis, they were surprised to learn that creating new evacuation routes made more sense than the usual and seemingly high-tech solution of retrofitting local buildings. Not only would building new ways to get to high ground in the bluffs surrounding the town be more affordable than retrofits, but the paths would provide myriad other benefits: additional routes to safety in the event of an earthquake, an attraction for tourists, and scenic views for residents. However, such a proposal and its attendant benefits would be difficult to communicate with the benefit-cost analysis (BCA) sheet required by federal agencies such as the Federal Emergency Management Agency (FEMA), which allocate funding for such projects.

Helping communities that face extreme weather events and natural hazards prepare for the future requires proactive investments in resilience and sustainability. However, BCA, the main tool used to make government investment decisions, is not well suited to complex community planning that balances multiple objectives and future uncertainty.

For such planning to be effective, an urgent paradigm shift is needed to assist communities in planning for potential catastrophes—whether driven by development and population growth in vulnerable areas or because of increasingly extreme weather events exacerbated by climate change. Rather than considering resilience and sustainability as separate issues, planners must value them, and the trade-offs between them, in tandem. Policymakers should adopt a variety of enhancements to current BCA methods to build more flexibility into the process and establish systematic data collection to build knowledge about successful approaches. We believe that allowing a wider range of inputs into standardized BCAs will help reduce costs and lead to better planning decisions—helping public money go further and have greater impacts.

Formal benefit-cost analysis identifies the anticipated effects of proposed policies or projects and expresses them in dollars, which is used to consistently evaluate the pros and cons associated with policy interventions. The US federal government, under the direction of presidential executive orders, uses BCA widely to evaluate the costs and benefits of regulatory actions and investment decisions. In local planning, BCA balance sheets are also commonplace due to their ease of use and the allure of "apples-to-apples" comparisons. Many funding bodies and practitioners default to BCAs as offering a "level playing field" for determining the most efficient and cost-effective projects within and between communities.

A broad focus of recent US executive orders and other legislation, including the 2021 Infrastructure

Investment and Jobs Act, is climate resilience. These efforts have multiple objectives: climate adaptation and mitigation, economic and environmental costs, equity considerations, affordability and risk reduction, and short- and long-term sustainability. The infrastructure act alone earmarks an unprecedented $47 billion to help communities prepare for and recover in a new age of extreme weather events. Yet hard choices must be made about which projects most deserve funding, and the challenge will only grow over time. The most recent US National Climate Assessment (2018) estimated that climatological events could cost the country about half a trillion dollars annually by 2090.

Perhaps the greatest shortcoming of benefit-cost analysis is that it treats individual objectives separately, limiting its ability to handle system-level dynamics. Each objective is measured in different ways and is subject to different parameters, occurs on its own spatial and temporal scale, and is sensitive to different incentives. The data for each objective come in different units of measure and are drawn from various data sources and analyzed using different techniques. Furthermore, projects are highly sensitive to discount rates (a way of estimating the present value of future cash flows), which in the United States are prescribed by the White House Office of Management and Budget at the federal level and may not be aligned with local community preferences.

As an example of a complex event, consider the February 2021 winter storms in southeast Texas. These storms brought cascading power outages, loss of heat, broken pipes, road closures, and other economic, social, and public health problems. Planning for such events requires a system-level approach, which cannot be done with today's BCA in isolation. BCA does not easily estimate the costs and benefits associated with climate adaptation scenarios and avoided losses when failures do occur, making it easy for communities to miss opportunities to evaluate climate change mitigation strategies with the greatest "co-benefits," or interconnected, broader gains from adaptation. There is also a tendency to plan for the impacts of disruptive events that are more easily predicted and damages more readily quantified. For instance, planning rarely focuses on convective storms (e.g., thunderstorms, tornadoes, hailstorms, and derechos), even though those storms cost the United States nearly as much—at least $40 billion in 2020—as the $43 billion dollar price tag for hurricanes and tropical storms.

BCA tends to focus exclusively on the biggest hazard and the best option, so it often fails to capture the complexities of local situations—complexities which are exacerbated by the uncertainty around hazard events, uncertain valuations across long time frames, and the need to balance impacts across diverse stakeholders. Rather than focusing exclusively on the best present option, finding routes to adaptation requires looking systemically at a potential sequence of investments and actions, as well as potential damage in the future. Focusing primarily on the most disruptive extreme weather events, as BCA tends to do, can overshadow the cumulative damage of persistent chronic events. For example, while the costs of hurricane-related water damage in Charleston, South Carolina, are well documented through insurance claims and granted FEMA assistance, there is little information on the costs of increased sunny-day tidal flooding—which is expected to become an every-other-day occurrence by 2045.

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Although there are methods that augment or provide alternatives to BCAs, they generally require significant expertise, time, and data. They also frequently fail to readily deliver locally relevant, directly actionable information to communities. For example, input-output analysis, integrated assessment models, multi-sector dynamic modeling, and computable general equilibrium models can look at direct and indirect impacts throughout a regional economy and interconnected systems. These approaches, however, often do not offer the microlevel assessments and spatial granularity to assess risks within a given community at the project level. There are other approaches, such as agent-based models, that look at the interaction of different entities to predict system behavior and address this scale issue. But these approaches also have large computational and data demands and are highly sensitive to the assumptions implicit in the model itself.

BCA's shortcomings have inspired a cottage industry among agencies that are trying to address them. FEMA's Building Resilient Infrastructure and Communities program, for example, is starting to recognize a wider array of co-benefits in the assessment processes used by communities seeking to undertake hazard mitigation projects. The FEMA guide Building Community Resilience with Nature-based Solutions makes the business case for nature-based solutions by summarizing their potential cost savings as well as their non-monetary benefits. Triple bottom line analysis, which considers social and environmental impacts in addition to financial and economic aspects, is frequently used for municipal asset management and investment decisions like water resource management.

The Economic Decision Guide Software (EDGe$) tool from the National Institute of Standards and Technology (NIST) has long considered externalities, co-benefits, and co-costs of potential alternatives by allowing users to vary the discount rate as they explore alternatives that may best fit a business case bringing together multiple funding sources. Beyond that, it encourages consideration of non-disaster return on investments that are predicated around disaster mitigation, and it has been used to consider long-term climate change-induced hazards. Yet, as a kind of "TurboTax" for community resilience economics, the EDGe$ tool requires time and resources for users to obtain and input data specific to, or approximating the situation in, their own community.

We believe BCA can be further improved and expanded to support communities with resilience planning while meeting a diverse set of needs and objectives. For example, including consideration of co-benefits in the analysis of resilience plans can help develop innovative funding and finance strategies in even the most resource-strapped and vulnerable communities. As the researchers Jan Mayrhofer and Joyeeta Gupta point out, the "co-benefits concept implies a 'win-win' strategy to address two or more goals with a single policy measure." One instance is the application of the triple dividend of resilience framework, which recognizes co-benefits and has been employed in developing countries to assess (1) avoided losses when disasters strike; (2) economic and development benefits of reduced disaster risk and impacts; and (3) social and environmental co-benefits to communities more broadly. Such a framework has also been used to evaluate return on disaster risk insurance and early warning systems.

Fully accounting for the net benefits of resilience-oriented projects requires looking closely at the benefits and costs that accrue over time, not just when disaster events occur. New Jersey's Climate Change Resilience Strategy notes the "strong opportunity to capitalize on co-benefits through the alignment of public health and climate resilience goals." Planting and maintaining urban trees to address urban heat island impacts, for example, can provide the co-benefits of better air quality, more stormwater storage, and increased community aesthetics. Urban trees may also encourage residents to spend more time exercising and socializing outdoors.

Some co-benefits may be difficult to assess in a BCA ahead of time and are more easily recognized after a project or policy has been implemented. Sometimes, such co-benefits may create stability for multiple types of disaster situations; we refer to these as *net resilience windfalls*. Projects designed to prevent avalanches in Tutuila, American Samoa, for instance, also maintain critical roadway and emergency routes during flooding events. And indoor air purification systems that were improved to deal with wildfire smoke likely led to enhanced safety during public health emergencies, such as the COVID-19 pandemic.

Going forward, funding agencies should require reporting on the benefits and costs realized after a project's implementation. Such information can be used to guide future decisionmaking within that community or applied to similar cases to help recognize net co-benefits that may result. Better understanding of these dynamics may also help policymaking bodies select projects and frame incentives for resilience planning.

Another area in which BCA can improve resilience outcomes is the treatment of equity. The harms of climate extremes and disasters are experienced unevenly. However, BCA's current practices for planning and investment decisions, such as relying on asset losses, inherently undervalues the consequences for the most vulnerable. This may prioritize efficiency over equity, resulting in decisions that exacerbate inequity and social vulnerability.

One way to explicitly address equity considerations in federal BCA would be to include impact analyses using disaggregated socioeconomic and demographic data. In fact, the Biden administration's Executive Order 14008 directs that certain federal investments must demonstrate that 40% of their overall benefits flow to disadvantaged communities, putting equity considerations at the forefront of economic analysis.

Resilience planning faces significant uncertainty with future climate conditions, especially at the local level. For example, projected precipitation in a region may range from decreases to large increases, posing a major challenge to planners. Resilience strategies therefore need to be robust and flexible under a range of uncertainty levels. Decision making under deep uncertainty (DMDU), an analytical framework, provides a powerful approach to support robust decisions under a wide range of scenarios. DMDU has been applied in contexts such as water resource planning and international development, but more work is needed to integrate consideration of future climate uncertainty in economic analysis. Additionally, pilot programs are now underway that combine the use of the existing EDGe$ method with participatory modeling through tools like Mental Modeler to help communities prioritize their objective beyond resilience planning, and to ensure that the alternatives being assessed in a BCA do not curtail other community goals.

The use of BCA in resilience planning could be further augmented by multi-disciplinary approaches, such as those that incorporate social science methods, developing new tools for data collection and sharing, and allowing the use of narratives to articulate the interconnected goals and considerations that communities share.

In particular, data collection deserves increased emphasis across all project and policy phases. Collecting useful data requires going beyond easily monetized data points to include other information. Such data can help provide insights about costs and benefits that are not well understood, such as the costs of sunny day flooding. Thorough assessment may allow better identification of low-cost, high-impact mitigation and adaptation strategy options, and more data on their benefits may make such best practice options appealing to other communities.

Narrative has an especially intriguing potential role, given the community nature of resilience planning. Although a community may be geographically defined by boundaries and a leadership structure, its values are defined by its shared experiences and the narratives that emerge from it. Narratives are largely communication tools, but they also engage imaginations and, in the words of the economist Robert J. Shiller, "have the ability to produce social norms that partially govern our activities, including our economic actions." For example, in their continued effort to fully relocate from the Alaskan village of Newtok to Mertarvik, a new site nine miles upriver, the Yup'ik people supplement BCA analyses with narrative associated with preservation of their identity as a people who have lived in the area for over 2,000 years.

Regardless of form, all such information should be collected and processed in ways that allow for public distribution and use by other communities, which will save time and effort, especially for those communities that have limited resources.

Boundary organizations have an important role to play in standardizing and storing data, and communities should be incentivized to establish relationships with these organizations. Some of these organizations at the federal level include the National Ocean and Atmospheric Administration's Regional Integrated Sciences Assessment Program, the US Department of Agriculture's Cooperative Extension Service, the US Fish and Wildlife Service's Landscape Conservation Cooperatives, and NIST's Manufacturing Extension Partnership. At the regional level, these organizations include the Southeast Florida Regional Climate Change Compact and the Regional Climate Collaboratives, among others. These boundary organizations are increasingly focused on resilience projects and are creating research-to-practice networks that directly serve community-level decisionmakers. They have a special opportunity to facilitate collaboration, incorporate local and Indigenous knowledge, and enhance information flow across regional and local stakeholder groups.

To enhance the scope and quality of BCA, it must be rebuilt to encompass the social, natural, human, physical, and institutional knowledge of communities. Otherwise, the process risks missing what is really important and failing to distinguish the characteristics that make projects successful. Developing a more flexible and comprehensive approach to resilience planning, especially when BCA is used, will be an important facet of helping communities thrive in an increasingly uncertain world.

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