Green Infrastructure Appraisal Tools

Improving Cost–Benefit Analysis Tools to Encourage City-level Investment

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Opinion Piece

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ABSTRACT
The climate crisis is both an economic and a public health crisis. Responding to the climate crisis requires investment in a range of infrastructure that safeguards individuals, communities, ecosystems, and places. Urban green infrastructure has been suggested as a potential solution to address the climate and health problems in cities and towns. To make the right planning decisions, our decision-making frameworks – public and private – need to take better account of the benefits and costs of urban investments in green infrastructure. These benefits include climate risk mitigation, improved air and water quality, enhanced ecosystems, and improved public health.

At the heart of many decision-making systems are cost–benefit analysis (CBA) measures, which attempt to objectively quantify the benefit–cost ratio (BCR) of proposed investments. A lack of quality information and tools make it difficult to properly quantify the net economic benefits of investments in green infrastructure. This is despite the increasing evidence in a variety of contexts demonstrating links between nature and beneficial outcomes. This creates a risk of systemic underinvestment in nature infrastructure.

We argue for the development of valuation tools that provide robust values to be applied in standard investment situations. This will give municipal and national leaders, funders, and policymakers the ability to assess their proposals and programs in comparable economic terms to promote investment in nature-based urban infra-

structure, which creates long-term value and impact.

INTRODUCTION: THE CLIMATE CRISIS IS A PUBLIC HEALTH CRISIS

The climate crisis is both an economic and a public health crisis, with wide-ranging implications for global systems. The consequences of climate change are already affecting economies across the world, with one study estimating that the global economy could lose up to 10% of its total value by 2050 due to climate change (WEF, 2021).

Climate change also profoundly affects public health, as rising global temperatures contribute to a range of health challenges. The health impacts of climate change – including the spread of infectious diseases, extreme heat-related illnesses, and respiratory problems caused by increased air pollution – threaten to reverse decades of progress in global public health (WHO, 2021). These threats impose additional economic costs due to increased healthcare expenditures, the burden on social services, and lost productivity.

These challenges exacerbate already existing vulnerabilities in densely populated cities. The urban heat island effect leads to increased incidence of heat strokes, dehydration, and other comorbidities, particularly for those in low-income and marginalized communities (WHO, 2021; IPCC, 2022). The exposure of urban populations to higher concentrations of pollutants, such as particulate matter (PM) and ground-level ozone, increases the incidence of asthma, lung disease, and heart attacks, with these effects heightened by extreme heat (Watts, 2021).

INVESTING IN EFFECTIVE RESPONSES

There is an increasing recognition of the importance of green spaces, improved public transportation, and sustainable urban planning in reducing both environmental and health risks (WHO, 2018). Alongside engineered adaptation investments – such as sustainable urban drainage and flood defenses – nature-based solutions (NbS) also play a pivotal role in climate adaptation, augmenting traditional engineering solutions with cost-effective and sustainable possibilities.

In Malmö, Sweden, the Ekostaden Augustenborg program has seen investment in the 32-ha Augustenborg neighborhood to deliver 11,000 square meters of green roofs and improved green spaces. These investments have helped address the storm and flood risk and has reduced urban heat island effects (WWF, 2021). In Medellín, Colombia, the creation of 36 new green corridors helped to manage issues associated with high localized temperatures and heavy rains, but they are also estimated to have prevented 678 heart-related deaths each year (WWF, 2021). Such investments are also catalysts for economic growth, contributing to resilient, healthy, and prosperous communities (World Bank, 2019). In the example of Medellín, it is estimated that US$136 million in benefits will be generated between 2020 and 2030 due to the green corridors.

Despite the availability of potential solutions, a significant funding shortfall threatens the effectiveness and scalability of climate adaptation projects. Global funding for climate adaptation remains insufficient, with estimates indicating that the financing gap for adaptation could reach up to US$300 billion annually by

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2030 (CPI, 2024; UNEP, 2024). On a planetary scale, Waldron et al. (2020) estimate that investment to secure "30% of the planet for nature" would deliver net benefits of between US$977 billion and US$1.34 trillion globally per year by 2050, depending on the scale and type of protection.

There is, therefore, a critical need for greater co-ordination between public and private sectors to mobilize investment in adaptation, and for improved tracking and reporting mechanisms to ensure that funds are directed toward high-impact, evidence-based interventions (IPCC, 2022; WRI, 2021).

To make informed and effective planning decisions, both public and private decision-making frameworks must more rigorously account for the full range of benefits and costs associated with urban adaptation investments. While traditional approaches often focus on immediate financial returns – in part, because these have historically been easier to estimate – this limited view can overlook the long-term advantages of incorporating sustainable solutions into urban environments. Work by Seddon et al. (2020) found that "flawed approaches to economic appraisal lead to under-investment in [nature-based solutions]."

As such, decision-making frameworks must embrace a more balanced and holistic approach, considering not only the short-term economic benefits, but also the long-term climate, ecosystem, health, and social benefits, as shown in the figure below. This shift is essential for ensuring that urban climate adaptation is both sustainable and resilient in the face of the climate crisis.

EXISTING COST–BENEFIT ANALYSIS SYSTEMS ARE INADEQUATE TO ENSURE SUFFICIENT INVESTMENT IN GREEN INFRASTRUCTURE PROJECTS IN CITIES

At the heart of many decision-making systems are cost–benefit analysis (CBA) measures, which attempt to objectively quantify the benefit–cost ratio (BCR) of proposed investments. These forms of analysis are used in different ways in different contexts, but, fundamentally, this form of analysis aims to compare the costs of interventions with the potential benefits arising from investment. By developing this analysis objectively, the aim is to ensure that decision making is robust and that investment is prioritized where it is most effective.

For example, in the UK, public sector investment decisions require business cases, which are developed following guidelines set out in the Treasury's Green Book (HMT, 2022). One element of this is the economic case, which includes the development of a BCR for four shortlisted options. The Green Book is supported by a range of complementary guidance, which

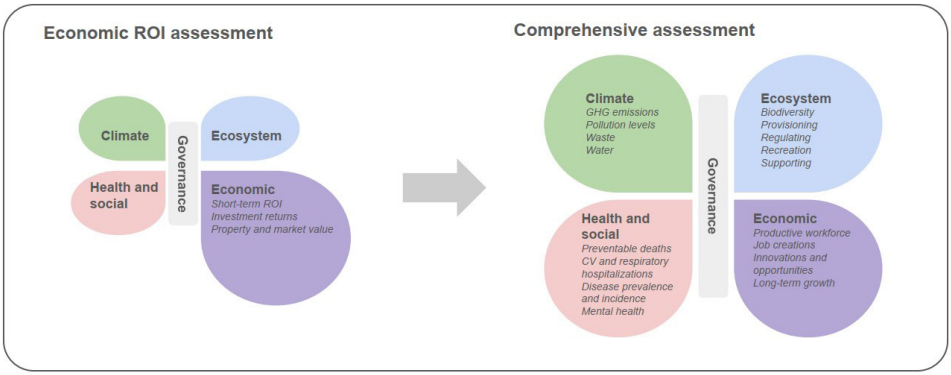

Figure 1: Transition from an econo-centric to a comprehensive assessment framework for climate adaptation
Econo-centric assessments are biased towards short-term economic returns with limited accounting of climate change, ecosystem benefits, health and social benefits. This leads to systematic under-accounting of benefits and low assessed return on investment at the project level. Incomplete information also leads to ineffective governance across the multitude of priorities affecting a community. A comprehensive framework covers the universe of benefits which also leads to long-term economic improvements and improved governance.

is produced by the Treasury and other government departments and agencies. It helps project promoters develop BCRs in a way that is compliant with the aims of the Green Book. For example, the Department for Transport (DfT) has a longstanding Transport Analysis Guidance (TAG) model (DfT 2024), which enables the calculation of economic benefits arising from journey time improvements due to transport investments.

The UK is not alone in having this kind of project appraisal guidance. In the US, the Office of Management and Budget (OMB) produces and maintains Circular A-94, which provides guidance on CBA methods and discount rates (OMB, 2023), alongside more specialist guidance from other agencies. In the EU, the European Commission produces Impact Assessment Guidance as part of its Better Regulation program (EC, 2023). This is alongside theme-specific guidance published by European Commission directorates. Although not formal guidance, the Organization for Economic Co-operation and Development (OECD) also publishes guidance and research into CBA methods (e.g., OECD, 2018). Thus, the use of CBA as a method of valuation and a key factor in investment decision making and evaluations is well embedded into the governance and decision-making structure of many regions.

However, while guidance is well-developed in some areas, when it comes to quantifying the full benefits of investments in green infrastructure, tools are far less

well-developed. In the UK, despite relatively well-developed guidance on how to appraise projects, there is very little formal guidance on the value of natural capital investments, and even less guidance on how these investments might benefit health. The UK Department for Environment, Food and Rural Affairs (Defra) produces and maintains the Enabling a Natural Capital Approach (ENCA) guidance as the main source of valuation data for natural investment. However, as noted by the Natural Capital Committee, while ENCA is a good starting point for the valuation of natural capital, further investment in tools and metrics will be needed to support ENCA as supplementary guidance to the Green Book. ENCA will also need to be better resourced if it is to be used widely across government (NCC, 2020).

In the US, while federal agencies, including the OMB and the Federal Emergency Management Agency (FEMA), emphasize the consideration of non-economic factors in CBA, technical guidance is insufficient to fully incorporate the value of these factors. Since 2013, FEMA has progressively expanded its guidance on incorporating ecosystem services into its grant evaluation framework, culminating in its 2022 update, which provides average ecosystem service values for nine land types. However, urban green spaces remain the only urban land type explicitly considered, and no reference values exist to account for the benefits of investments in sustainable green infrastructure (FEMA, 2022).

A recent federal review further underscored a significant gap in tools, guidance, and technical assistance for implementing nature-based solutions. It found that most available information consists of general case studies and process overviews, with very few technical assistance tools accessible to practitioners. It highlighted the need for more comprehensive resources to support the adoption of nature-based solutions in federal programs. Specifically, this review calls on "agencies with research mandates…[to]…fill gaps in available evidence, *starting with known gaps related to how nature-based solutions affect mental and physical health"* [emphasis added]. (The White House, 2022).

DEVELOPING CBA TOOLS THAT CAN INCORPORATE EVIDENCE AND STANDARDIZE THE PROCESS FOR COMPREHENSIVE BENEFIT EVALUATIONS

Given the above, there is an urgent need for more comprehensive tools to enable better quantification of the benefits relating to climate, health, and ecosystem impacts of urban investments.

Our use of the word "tool" is deliberate. Tools incorporate evidence and standardize processes to help enhance capability and facilitate capacity for complex evaluations. While there is extensive guidance and research that can support economic appraisals, investment cases still require the parsing of the literature and evidence to ensure that they are applicable to the case at hand. The skilled application of the established methodologies requires a body of knowledge of appraisal techniques, which presents a barrier to non-specialists. Tools help to ensure that cities have the capacity to properly evaluate benefits when considering investments in sustainable solutions, particularly at a municipal level, where dedicated expertise for CBA may be limited.

Therefore, tools that encapsulate guidance, established methodologies, and research insights are needed now. These tools can help facilitate the CBA and other decision-making processes for comprehensive investment in decision making at the municipal level, fully incorporating economic and non-economic factors into the assessment of benefits.

We suggest that there are five main principles that should be applied to such tools:

Robustness: The underlying research upon which tools are based must be robust so that its applicability to other contexts is valid.

Transparency: The underpinning assumptions and sources for given multipliers/calculations should be clear.

Clear guidance on applicability: Studies of economic benefit are inevitably place-specific, although the level of "place" may vary, e.g., a local area, urban area, or a whole country. Findings in one area may be more or less analogous to the conditions in other areas. Therefore, tools should aim to be clear about the applicability of their assumptions to different conditions. Where possible, tools should be built with these differing contexts in mind – for example, with different underpinning valuations for urban areas, as opposed to rural areas.

Flexibility: Tools need to be well-designed with users in mind and should support flexible usage – e.g., allowing for different discount rates, timescales for appraisals, conversions between currencies, adjustments for pricing changes over time, and economic benefits that are calculated per calendar year. Given that the health benefits of nature investments are likely to be one strand of benefit assessment, it should be easy for project appraisers to incorporate these calculations into wider modeling efforts.

Developed in partnership with appraising/reviewing agencies: Tools are more effective when they are understood and accepted by those appraising funding bids/investment cases. The best way to ensure this is to develop tools in partnership with these organizations.

Examples of similar standalone tools include FEMA's CBA Tool, which was designed to support grant programs such as the Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC). It includes traditional economic factors, such as avoided damages and loss of life, while also incorporating ecosystem service benefits in certain cases.

Beyond the core requirements for the tools themselves, several operational factors are crucial for their successful long-term deployment. Maintenance is critical to ensure their continued functionality and the upkeep of underlying data to prevent obsolescence. A user feedback loop is vital for continuous improvement. While application-based tools can incorporate active feedback systems, even static tools, such as spreadsheets, can benefit from iterative enhancements through proactive user engagement. These principles are especially important given that many tools of this kind originate as one-off projects or academic initiatives, often without long-term sustainability in mind. Therefore, ensuring that tools are developed with longevity, maintenance, and adaptability in mind is essential for their continued relevance and effectiveness.

It is also important to recognize that there is no universal solution. While the fundamental principles of CBA remain broadly similar across countries, political influences shape policies and regulations, leading to variations in how different jurisdictions incorporate non-economic factors into analytical frameworks. These differences may affect the valuation of environmental, social, and health-related benefits, as well as the weight assigned to qualitative considerations. Given these complexities, we propose the need for tools and present some broad criteria that can help integrate diverse forms of evidence, standardize the CBA process, and facilitate investment discussions, while recognizing differences in the regulations and frameworks that exist at national and subnational levels.

CONCLUSION

The integration of non-economic factors, such as climate, health, social, and ecosystem factors, into subnational investment decision-making frameworks vastly expands the information requirement of the investment analysis. To sufficiently incorporate the comprehensive benefits while adhering to the established methodologies of CBA is a barrier for cities that may have limited capacity to implement such complexity. Thus, it is essential to have tools that help encapsulate information and standardize processes, alleviating some of the burdens on municipalities when considering green infrastructure investment projects.

The absence of such tools to incorporate these factors can lead to systematic under-investment in sustainable green infrastructure by cities. Without the recognition of the full range of benefits that ecosystem services, climate adaptation, and public health contribute to urban resilience, decision makers risk prioritizing short-term economic gains over long-term sustainability and community well-being. Therefore, developing robust tools that facilitate the incorporation of diverse evidence and standardized evaluation processes is essential. This will empower stakeholders to make informed decisions that reflect the true value of sustainable investments.

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