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Does mitigation save? Reviewing cost-benefit analyses of disaster risk reduction

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ABSTRACT

The benefit-cost-ratio (BCR), used in cost-benefit analysis (CBA), is an indicator that attempts to summarize the overall value for money of a project. Disaster costs continue to rise and the demand has increased to demonstrate the economic benefit of disaster risk reduction (DRR) to policy makers. This study compiles and compares original CBA case studies reporting DRR BCRs, without restrictions as to hazard type, location, scale, or other parameters. Many results were identified supporting the economic effectiveness of DRR, however, key limitations were identified, including a lack of: sensitivity analyses, meta-analyses which critique the literature, consideration of climate change, evaluation of the duration of benefits, broader consideration of the process of vulnerability, and potential disbenefits of DRR measures. The studies demonstrate the importance of context for each BCR result. Recommendations are made regarding minimum criteria to consider when conducting DRR CBAs.

1. Introduction

1.1. Mitigation saves: lives, environment, money

Disaster risk reduction (DRR) has long been recognized in the literature for its role in mitigating the negative environmental, social and economic impacts of natural hazards. For example, the US Federal Emergency Management Agency (FEMA), found an average benefit-cost ratio (BCR) of 4 in a review of investments in 4000 mitigation programs in the US [63,54]. Still, DRR benefits are largely under-quantified in comparison to the frequency of disasters and the resulting impacts, especially in developing nations [54]. For example, for flood mitigation in Mozambique, the post-disaster aid request was 203 times the unfulfilled pre-disaster request [55].

Additionally, myths have arisen surrounding BCRs for DRR. The most infamous is the often-quoted ratio that the World Bank is purported to have calculated that DRR saves $7 (sometimes $4–7) for every $1 invested. The 7:1 ratio continues to be used today, often without citing a reference, for example, by top UN officials [80], government organizations (USAID, e.g. [3]), and NGOs (Center for American Progress, e.g. [57]; Oxfam, e.g. [68]). The World Bank no longer promotes that specific statement and recommends that the ratio not be used (Kull, personal communication). The origins of this ratio could not be tracked down, with the earliest citation found so far being [13] stating, without a source, that 'The World Bank and U.S. Geological Survey calculate that a predicted $400 billion in economic losses from natural disasters over the 1990s could be reduced by $280 billion with a $40 billion investment in prevention, mitigation and preparedness strategies'. When each author was contacted, given the length of time that had elapsed since Dilley and Heyman [13] was published, it was difficult for either to provide more information.

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It is also important to note that DRR does not inevitably or necessarily have a favorable BCR, as noted in some studies analyzed throughout this paper. There is also the question about whether or not a hazard must manifest for the BCR to be appreciated. For instance, if flood risk reduction measures are taken inside a property but no flood manifests over the lifetime of that building, are the benefits of the measures accrued and was it worthwhile to take the measures? These risk management discussions are limited in the studies. More could also be discussed regarding co-benefits of DRR measures, so that measures undertaken yield gains irrespective of a hazard manifesting.

Nevertheless, as disaster costs continue to rise and as politics continues to shift towards justifying actions in financial terms, the demand has increased to demonstrate the economic benefit of DRR to policy makers and decision makers [17,2,40,27,53]. If the financial benefits can be shown, a stronger possibility exists for investment in disaster mitigation actions, although that is by no means certain.

Yet, for example, despite FEMA's work [63,54], in the U.S., only 10% of earthquake- and flood-prone households have adopted mitigation strategies [54]. That despite floods from Hurricane Katrina (2005) and Hurricane Sandy (2012) each costing more than $100 billion—with a similar figure expected as the cost of the next major U.S. earthquake whether that strikes Los Angeles, St. Louis, or Boston. Meanwhile, studies cover a wide range of parameters in terms of locations, DRR measures, hazards, and temporal scales, including approaches which might not always be considered as core DRR activities even though they are and should be central to DRR.

For example, Kull [52] utilize a 'people-centered' resilience-driven flood risk reduction approach in India finding greater economic efficiency, lower initial investment costs, and returns that are not sensitive to assumptions traditionally made during CBA (e.g. discount rates, future climate conditions) when compared to structural flood mitigation measures in the region. Khan [47] demonstrates technology interventions, such as a new boat winch system in Vietnam. The Red Cross (2008) presents one of a few examples of evaluating the benefits of training with the inclusion of First Aid training in its CBA for its work in Nepal. Mechler [62] and Kull [52,53] include climate change scenarios in their CBAs, perhaps providing a more comprehensive projection of potential costs. Dedeurwaerdere [12], UNIDSR (2002), and Nepal Red Cross [64] evaluate ecosystem restoration approaches such as reforestation of mangroves and rain forests, which contribute to sustainable livelihoods, ecosystem stability, and reduce risk.

The plethora of studies on, and the concern about, disaster costs has led to studies compiling this information. For example the global and multi-peril databases generated by Munich RE and CRED (the EM-DAT database) span space, time, and hazard types. The equivalent approach for DRR benefits does not exist. This paper is a start towards setting up a framework for comparing DRR BCRs across multiple case studies in space, in time, and for different hazards and vulnerability characteristics.

2. Methods and questions

Cost benefit analysis (CBA) is an established economic tool for comparing the benefits and costs of a given project or activity [50,2,18,82,53]. CBA consist of four primary stages: (i) project definition, in which the reallocation of resources being proposed are identified (ii) identification of project impacts, including assessment of additionality (net project benefits) and displacement ('crowding-out'), (iii) evaluating which impacts are economically relevant, that is, quantifying the physical impacts of the project and (iv) calculating a monetary valuation, discounting, weighting and sensitivity analysis [26]).

As Venton [82] and many other studies demonstrate, the utility of CBA extends beyond a tool for cost comparison to decision support. Referring to an Oxfam study undertaken in El Salvador in 2010, Venton [82] reflects on the finding that the use of community-based silos and storage practices to protect crops were not actually cost-effective, in large part due to cultural barriers to collective storage that dictated the need (and expense) of individual household silos. CBA was instrumental in this case in evaluating alternative measures, better enabling a discussion between community based organizations (CBOs) and the government to find a culturally acceptable and cost-efficient solution.

CBA has limitations that are recognized, some of which are inherent to every analysis. For example, for environmental issues, (i) technical limitations for the valuation of non-market goods, such as wildlife or landscapes, (ii) inability to predict what project impacts will be on ecosystems, (iii) lack of methods for incorporating uncertainty and irreversibility [26]). Other frequent criticisms of CBA for DRR and other purposes are a lack of quantification of the distributional impacts (e.g. who benefits and who pays?) [52], ethical concerns over associating a monetary value to life [60], and quantifying other intangibles [54]. More contextually, CBAs for DRR tend not to quantify social and environmental impacts, while some of these benefits are qualitative and therefore are not quantifiable with CBA—or even comparable in terms of costs and benefits.

Despite these limitations, CBA is still a commonly relied upon metric for communicating benefits to decision makers. CBA can be used to formulate economic arguments for investment in risk reduction, rather than responding to the impacts of a future disaster event [82]. In terms of specific components of the CBA, the benefit-cost-ratio (BCR) is an indicator used to summarize the overall value for money of a specific project.

The examples of CBA for DRR cited above range across hazard types, geographies, scales, and vulnerabilities. These studies rarely report the costs and benefits of these DRR strategies in a systematic manner to facilitate an understanding of which technique might be best in which circumstance.

This study compiles and compares original CBA case studies reporting DRR BCRs, without restrictions as to hazard type, location, scale, or other parameters. To be included here, a study must provide a new, quantitative BCR for a DRR initiative, indicating the savings obtained for the investment. Only studies reporting such numbers, and the methodologies and data used to obtain the ratio, are included. For instance, studies only describing methods or without full data analysis