**Words into Action Guidelines:**
**National Disaster Risk Assessment**
**Special Topics**

# I. Supporting DRR Investment Decision-making

**Key words:**
scenario assessment, cost-benefit analysis, multi-criteria analysis, robust decision making approaches

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Investments in prospective and corrective risk reduction, preparedness, response and recovery have multiple benefits that often exceed the potential reduction in direct and indirect losses arising from a disaster. Although the exact benefit-cost ratio (BCR) varies widely, the United States Federal Emergency Management Agency (FEMA), for example, estimated an average BCR of approximately four in a review of over 4,000 DRR investment projects in the United States.[1][2]

Investing in resilience-building activities such as ecosystem-based DRR interventions and community-based interventions can also yield significant economic, social and environmental co-benefits, even in the absence of a disaster. However, the significant upfront costs required for investment in DRR and resilience-building activities, combined with the long timespan required to witness their benefits, offer limited incentives for decision makers to invest proactively.[3]

DRR policy scenario assessment – evaluating welfare and disaster risk implications with and without DRR interventions – may be incorporated into national risk assessment to assist selection among alternative DRR policy and investment options. The common methodologies for evaluating DRR policy scenarios include cost-benefit analysis, cost-effectiveness analysis, multi-criteria analysis and robust decision-making approaches, with each having distinct applicability in a variety of decision contexts.[4]

- **Cost-benefit analysis (CBA)** supports decision-making based on the efficiency criteria, maximizing net benefits of investment over time, as measured in monetary terms. CBA has been the primary approach for prioritizing among risk reduction investment options in developed countries. Ideally, a CBA includes all relevant impacts, be they physical, social, economic or ecological, analysing both direct or "stock" impacts, such as loss of life and property damage, as well as indirect or "flow" losses including unemployment and reduced income due to direct and

[1] Multihazard Mitigation Council (2005). Natural hazard mitigation saves: an independent study to assess the future savings from mitigation activities. Vol. 1 – Findings, Conclusions, and Recommendations. Vol. 2 – Study Documentation. Appendices. Multihazard Mitigation Council, National Institute of Building Sciences, Washington, D.C.

[2] Rose, A. and others (2007). Benefit-cost analysis of FEMA hazard mitigation grants. *Natural Hazards Review* 8, pp. 97-111.

[3] Kunreuther, H. C. and E.O. Michel-Kerjan (2009). *At War with the Weather: Managing Large-scale Risks in a New Era of Catastrophes*. Massachusetts: MIT Press.

[4] Mechler, R. (2016). Reviewing estimates of the economic efficiency of disaster risk management: opportunities and limitations of using risk-based cost–benefit analysis. *Natural Hazards* 81(3), pp. 2121-2147.

indirect (multiplier effect) business interruption losses.[5][6] Given that CBA necessitates the monetization of every impact, a particular challenge lies in estimating the value of intangibles, including the values of environment, community cohesion and places of significant cultural or historical heritage values. It can also include co-benefits of DRR.[7][8] Monetization of mortality and morbidity risks into a CBA is another key consideration. The common approach is to use"value of statistical life"(VSL) estimates, often quantified based on projections of lost future earnings – an approach not without moral or ethical controversy.

- **Cost-effectiveness analysis (CEA)** identifies least-cost options to meet a certain, predefined target or policy objective (which, in effect, represents the project benefit measured in monetary terms). CEA does not require the quantification of benefits, as the project costs are the key variable of consideration to be minimized. Project goals such as reducing disaster fatalities and losses to a certain level must be determined beforehand.

- **Multi-criteria analysis (MCA)** assesses how well DRR investments achieve multiple objectives such as economic, social, environmental and fiscal goals, as well as co-benefits. Using selected criteria and indicators as verifiable measures for monitoring across time and space, MCA observes and evaluates DRR investment performance in quantitative or qualitative terms. Because MCA does not require the monetization of all values, it is seen as potentially more palatable and flexible than CBA and CEA.[9] A major challenge, however, is assigning weights to the criteria.

- **Robust decision-making approaches (RDMA)** has received increasing emphasis recently, particularly in the context of climate change adaptation. Comprising both quantitative and qualitative methodologies, RDMA draws the focus away from optimal decisions (such as those supported with CBA and CEA) and aim to identify options with minimum regret, that is, minimal losses in benefits of a chosen strategy under alternative scenarios where some parameters are highly uncertain and impacts are potentially

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5 Rose, A. (2004). Economic principles, issues, and research priorities in natural hazard loss estimation. In Y. Okuyama and S. Chang, eds. *Modeling the Spatial Economic Impacts of Natural Hazards.* Heidelberg: Springer, pp.13-36.

6 National Academies of Sciences (2012). *Disaster Resilience: A National Imperative.* Washington D.C.: National Academies Press.

7 Rose, A. (2016). Private sector co-benefits of disaster risk management. In E. Surminski and T. Tanner, eds. *Realising the Triple Resilience Dividend: A New Business Case for Disaster Risk Management*. Heidelberg: Springer.

8 Surminski, S. and T. Tanner, eds. (2016). *Realising the Triple Resilience Dividend: A New Business Case for Disaster Risk Management.* Heidelberg: Springer.

9 Steele, K. and others (2009). Uses and misuses of multicriteria decision analysis (MCDA) in environmental decision making. Risk Analysis 29 (1), pp. 26-33.

devastating or irreversible.[10][11]

These various scenario assessment methodologies are routinely used to inform DRR investment decisions in both developed and developing countries. The following are two recent examples of a DRR policy scenario assessment, in which alternative scenarios – risk- versus non-risk based and pre- and post-DRR investment – are compared to support public decision-making on wildfire and cyclone risk.

## Wildfire DRR options analysis in Australia: an MCA approach

The state of Victoria in south-east Australia is highly prone to wildfires, with recent devastating disasters claiming hundreds of lives. Wildfire fuel management – the controlled burning of vegetation (fuel) – is a critical element of wildfire risk management. Following the 2009 bushfire, the government of Victoria adopted a new policy target of prescribed burning applied to, at minimum, 5 per cent of public land (known as the Victorian Bushfires Royal Commission recommendation 56).

In 2013, however, the Bushfires Royal Commission Implementation Monitor – an official body responsible for monitoring and reviewing the Royal Commission – found that this hectare-based target was "not achievable, affordable or sustainable" and subsequently proposed a wildfire DRR policy scenario assessment comparing two fuel management options.

While the status quo approach prescribed the burning of a proportion of public land annually, the alternative prescribed burning to achieve a certain reduction in wildfire risk. The risk-reduction target is defined in comparison to the scenario of maximum fuel loads (i.e. before fuel management activities are undertaken), as estimated by computer simulation of wildfire behaviour in the landscape using the PHOENIX RapidFire model.[12] The latter approach identified the specific areas for prescribed burning that are most effective at reducing risk, while the former simply identified the total areas to be burned.

As part of the review, external risk experts undertook a policy assessment using a multi-criteria analysis. The two policy options were assessed against

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10 Kalra, N. and others (2014). Agreeing on robust decisions: new processes for decision making under deep uncertainty. Policy Research Working Paper No. 6906. Washington D.C.: World Bank.
Available from www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2014/06/04/000158349_20140604102709/Rendered/PDF/WPS6906.pdf

11 11 Lempert, R. and others (2013). Ensuring robust flood risk management in Ho Chi Minh City. Policy Research Working Paper No. 6465. Washington D.C.: World Bank.

12 State of Victoria (2015). Review of performance targets for bushfire fuel management on public land.
Available from www.igem.vic.gov.au/home/reports+and+publications/reports/review+of+performance+targets+for+bushfire+fuel+management+on+public+land+report

their potential to meet twelve criteria assessing effectiveness (e.g. in terms of reducing risk to human life, infrastructure, economic activities and ecosystems), stakeholder and community engagement, policy sustainability, economic efficiency, and distribution and equity considerations. The alternative policy with the risk reduction objective was found to be superior, and the government subsequently revised its fuel management target based on this recommendation.

The policy scenario assessment was designed to fit the needs of decision makers in terms of policies being assessed (status quo and viable alternative), criteria (derived from existing mandates) and transparency of process (clear and easy to follow). This case study highlights the way in which decision-support methods can be incorporated effectively into a wider policy dialogue.

## Cyclone retrofit options analysis in Indian Ocean Commission countries: a cost-benefit analysis application

As part of UNISDR/ISLANDS Joint Programme On Financial Protection Against Climatic and Natural Disaster Risks, "forward-looking" probabilistic cost-benefit analyses of cyclone retrofitting options were conducted for Madagascar and Mauritius using newly compiled hazard, exposure and vulnerability data. Spatially explicit data on the probability and intensity of cyclone winds were combined with those of location and construction materials of private and public infrastructure and buildings using the open source CAPRA software to yield baseline estimates of economic damage due to cyclones.

These estimates were then revised assuming the likely benefit of housing retrofitting options (i.e. improvement of wooden and unrefined masonry houses from low to medium design quality in Madagascar and iron concrete and wooden houses from medium to high design quality in Mauritius[13][14] to yield the economic damage after DRR intervention. The benefit of DRR intervention – the differences between economic damages before and after DRR – is then compared with the cost of DRR intervention, using an appropriate discounting rate, which yielded decision metrics such as net present value, benefit-cost ratio and internal rate of return.

For example, assuming retrofitting options cost 10 per cent of the total housing value, cyclone wind-proofing at a discounting rate of 5 per cent yielded the benefit-cost ratio of 2.02, while that of unrefined masonry was

[13] United Nations Office for Disaster Risk Reduction (2015a). UNISDR Working Papers on Public Investment Planning and Financing Strategy for Disaster Risk Reduction: Review of Madagascar.
Available from www.unisdr.org/we/inform/publications/43522

[14] UNISDR (2015b). Review of Mauritius. UNISDR working papers on public investment planning and financing strategy for disaster risk reduction.
http://www.preventionweb.net/publications/view/43523

estimated at 1.04 in Madagascar.[15] This case study demonstrated that the probabilistic cost-benefit analysis can be conducted easily with the newly collected risk information, and similar assessments were conducted using “backward-looking”probabilistic cost-benefit analysis based on recently collected DesInventar disaster damage and loss database for Comoros, Seychelles and Zanzibar.

It is generally not advisable to use scenario assessment tools strictly in a prescriptive manner. Instead, analyses using the tools described above should be used as part of a larger process of national disaster risk planning involving all stakeholders. Stakeholders can and should be involved at all stages of disaster risk assessment, such as problem definition and objective setting, identification of alternative investment options, quantification of impacts and analysis and prioritization (Floods Working Group (2012)).

To ensure transparency and accountability of scenario assessment processes, a number of countries have adopted common analytical tools or a system of third-party review such as the FEMA BCA software and a series of “second opinions” provided by the CPB Netherlands Bureau for Economic Policy Analysis.

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[15] UNISDR (2015a). Review of Madagascar. UNISDR working papers on public investment planning and financing strategy for disaster risk reduction. www.unisdr.org/we/inform/publications/43522

## Resources for further information

- Society for Benefit-Cost Analysis https://benefitcostanalysis.org/
- MCA4climate www.mca4climate.info/about/
- Society for Decision Making Under Deep Uncertainty www.deepuncertainty.org/welcome/

## Other substantial peer-reviewed guidelines

- CPB Netherlands Bureau for Economic Policy Analysis (2013). *General Guidance for Cost-Benefit Analysis.* Available from www.cpb.nl/en/publication/general-guidance-for-cost-benefit-analysis
- Organisation for Economic Co-operation and Development (2009). *Integrating Climate Change Adaptation into Development Co-operation: Policy Guidance*. Available from www.oecd.org/dac/environment-development/integrating-climate-change-adaptation-into-development-co-operation-policy-guidance-9789264054950-en.htm
- Federal Emergency Management Agency. Benefit-Cost Analysis programme (tools etc.). Available from www.fema.gov/benefit-cost-analysis
- Floods Working Group (2012). *Flood Risk Management, Economics and Decision Making Support*. http://ec.europa.eu/environment/water/flood_risk/pdf/WGF_Resource_doc.pdf
- United Kingdom Environment Agency (2010). *Flood and Coastal Erosion Risk Management appraisal guidance.* Available from www.gov.uk/government/uploads/system/uploads/attachment_data/file/481768/LIT_4909.pdf
- C. Benson and J. Twigg, with T. Rossetto (2007). *Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations.* Available from www.preventionweb.net/files/1066_toolsformainstreamingDRR.pdf
- R. Mechler (2005). *Cost-benefit Analysis of Natural Disaster Risk Management in Developing Countries (manual).* Available from http://maail1.mekonginfo.org/assets/midocs/0003131-environment-cost-benefit-analysis-of-natural-disaster-risk-management-in-developing-countries-manual.pdf

## Toolboxes and other useful resources

- Econadapt toolbox
  http://econadapt-toolbox.eu/methods/cost-benefit-analysis
- Provia/mediation adaptation platform
  www.mediation-project.eu/platform/
- EcosHaz: economics knowledge base
  www.ecoshaz.eu/site/knowledge-toolkit-2/economics-knowledge-base/
- Open source tools
  http://documents.worldbank.org/curated/en/765581468234284004/pdf/714870WP0P124400JAKARTA0CAN0THO0WEB.pdf

## Successful and well-documented national hazard and risk assessments that have incorporated this topic and with results used in DRR

- Australian Business Roundtable for Disaster Resilience and Safer Communities (2013). Building our nation's resilience to natural disasters
  http://australianbusinessroundtable.com.au/assets/documents/White%20Paper%20Sections/DAE%20Roundtable%20Paper%20June%202013.pdf