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Information Note N° 3
Costs and Benefits of Disaster Risk Reduction

The ISDR secretariat commissioned three papers to guide discussions at the High Level Dialogue of the first session of the Global Platform for Disaster risk Reduction. The notes are provided as background information relative to the three selected topics. The authors of the notes were requested to introduce the topics briefly, to provide some excerpts of cases studies, with figures, as well as highlighting some pressure points that could be addressed by the ISDR system.

The three notes are:

1. Linking Disaster risk Reduction, Climate Change and Development

2. Urban and Megacities Risk – What is at stake and what should be done?

3. Costs and Benefits of Disaster Risk Reduction

Session documents are available on the Global Platform website
http://www.preventionweb.net/globalplatform

3. The Costs and Benefits of Disaster Risk Reduction

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3. Guidance note on the Costs and Benefits of Disaster Risk Reduction

Core Messages

Reviews of available literature coupled with emerging insights from field work on the role of DRR (Disaster Risk Reduction) in relation to climate change and evolving patterns of vulnerability demonstrate:

1. *That investments in DRR can generate high economic returns.* Benefit-cost ratios of 4 and higher are widely documented in the literature.

2. *That not all forms of DRR will perform equally well under evolving contexts:* The ability to generate high returns from investment requires substantive work to identify strategic approaches where returns are likely to be robust despite inherent uncertainties. In the climate case, this issue applies particularly to approaches where returns depend on knowledge of threshold values (such as future flood levels in relation to levy heights). Improvements in understanding of different approaches to DRR and the relative role of *hard resilience* versus *soft resilience* and *directly targeted* versus *systemic* approaches to risk management are essential.

3. *That data, analytical and inherent issues in the valuation of some non-market goods will continue to constrain the widespread applicability of CBA as a decision making tool at the project level.* CBA may, however, be much more useful for identification and evaluation of broad differences in the reliability of returns between strategic approaches.

4. *That making the case for continued investment in disaster risk reduction depends heavily on demonstrating the economic and other returns to investments.* Substantive work by ISDR and others to generate the data and analytical basis to document the costs and the benefits of broad categories of strategies in diverse contexts could meet this objective. In specific, we believe ISDR could contribute through:

    a. *Developing information on the costs and benefits of broad categories of strategies and their likely performance under changing climatic conditions for use at strategic decision-making levels; and*
    b. *Developing process based approaches for using CBA and associated tools at local levels in stakeholder driven decision making contexts.*

This guidance note discusses existing knowledge regarding the costs and benefits of DRR, advantages and limitations of current CBA methodologies, and suggests ways forward for ISDR and other actors. The note is based on a review of the literature combined with preliminary insights from ISET's on-going programs in South Asia.[1]

Overview

Disasters are increasingly recognized as a fundamental factor constraining development and contributing to poverty. The Asian Tsunami and recent Pakistan earthquake have set back

[1] Projects contributing to this note include: *From Risk to Resilience* (supported by DFID); *Adaptation to Climatic Variability and Change: The role of Climate information in coastal and other high vulnerability regions of South Asia* **(supported by NOAA);** *Adaptation and Livelihood Resilience: Implementation Pilots and Research in Regions Vulnerable to Extreme Climatic Variability and Change* (supported by IDRC); and *Community risk Assessment and Climate Adaptation Tools: Developing and Documenting Methods in South Asia* (supported by ProVention).

development among vulnerable populations in affected regions by decades. Approximately seventy percent of disasters are, under current conditions, caused by storms, droughts, floods and other climate related events. As the IPCC report and recent scientific literature clearly demonstrate, the intensity and possibly frequency of such events can be expected to rise as global warming proceeds. Coupled with economic expansion and population growth in regions vulnerable to multiple hazards including climate change, the impact of disaster on development objectives is likely to increase, possibly dramatically.

Disaster risk reduction (DRR) is, as a result, of fundamental importance to achieving *both* basic development objectives *and* responding to the increases in hazards projected as a consequence of climate change.

Making the social case for DRR is relatively straightforward. Numerous case and regional studies demonstrate the fundamental impact disasters have at all levels of society from households to national economies. Demonstrating the economic value of investment in DRR is more complicated – but equally if not more essential. This said, as Benson and Twigg emphasize, despite the difficulties in quantification, "proof of net financial benefits is almost undoubtedly a first, very necessary step in making a case for the importance of analyzing hazard-related risks." (Benson and Twigg 2004: 14).

Decision making in international development contexts is heavily influenced by economic and financial considerations. Investments in DRR must compete for limited public and private sources with a myriad of other potential development investment opportunities. Unless the economic and financial case for such investments can be demonstrated, proponents of DRR will lack the basic information required for informed financial decision making. *As a result, estimates documenting the economic costs and benefits of investments in DRR are of fundamental importance for decision making.*

A major decision-supporting tool commonly used for project appraisal is cost-benefit analysis (CBA). CBA is used to organize, appraise and present the costs and benefits, and inherent tradeoffs of projects taken by public sector authorities like local, regional and central governments and international donor institutions to increase public welfare (Kopp 1997). There is a substantial literature and specific manuals on using Cost-Benefit Analysis and other appraisal methods in the context of natural disaster risk (Benson and Twigg 2004; Benson et al. 2007). The role of economic analysis in decision making for DRR projects is nothing new. In the U.S., cost benefit analysis of flood control projects was mandated by Congress under the Flood Control Act of 1936. In one form or another it has been used for evaluation of risk reduction projects since the publication in 1950 of a government report entitled "*Proposed Practices for Economic Analysis of River Basin Projects*." (Powers 2003: 4). It has, in effect, been standard practice for organizations such as FEMA and the U.S. Army Corps of Engineers for more than half a century. DEFRA and the World Bank also generally advocate the use of CBA but this is not often applied to disaster risk management activities.

Still, data on assessments conducted and returns measured is scarce, particularly in the developing country context. As Benson and Twigg (2004) state, there is more need for this kind of information:

> In the absence of concrete information on net economic and social benefits and faced with limited budgetary resources, many policy makers have been reluctant to commit significant funds for risk reduction, although happy to continue pumping considerable funds into high profile, post-disaster response (Benson and Twigg 2004: 4).

Outlining the benefits of risk management in terms of damages avoided and methods for including risk into project appraisal methodologies such as CBA could change such attitudes. There are two critical areas where the use of CBA in natural disaster risk mitigation can prove invaluable:

1. **Assessing risk management measures**: In the context of scarce resources, conducting CBA for potential risk management projects can help in selecting the most profitable projects in terms of damages avoided and rejecting those projects that are not cost-effective. There is a general lack of information on the costs and benefits and the profitability (net benefits) of such projects.

2. **Mainstreaming risk**: There is a need for incorporating disaster risk and risk management measures in project and development planning, called *mainstreamin*g. Including disaster risk and risk management projects in appraisal methods may help in rendering development more robust. CBA is one tool here, and others include Environmental Impact Analysis, Social Impact Analysis, and Logical Frameworks.

While, as the above bullets emphasize, the CBA can play a critical role, its use and applicability are also constrained by an equally important limitations. Critical limitations (identified below and illustrated in more detail later in the paper) include:

1. **The dynamic (changing) nature of hazards and vulnerability and therefore risk:** Unless future risk patterns are known, the costs and benefits of risk management can not be accurately calculated.
2. **Difficulties in assessing avoided losses and the often non-market nature of benefits from many disaster risk reduction investments:** While techniques exist for quantifying avoided losses and valuing non-market benefits or costs, measurement challenges are major and, more fundamentally, techniques for valuation are often controversial.
3. **Variety coupled with lack of unanimity regarding the types of activities that actually contribute to disaster risk reduction:** The location specific nature of risk patterns coupled with divergent perspectives on the effectiveness of risk reduction strategies complicates evaluation of costs and benefits.
4. **Absence of methodologies for valuing systemic and process based as opposed to targeted, hazard-specific, approaches to risk management:** Most CBA methods focus on risk-specific interventions. Most disaster management programs involve a portfolio of interventions implemented within complex and dynamic developmental contexts. Furthermore the functioning of regional economic, landuse, transport, communication, educational and other systems may have more fundamental implications for exposure, vulnerability and risk than hazard-focused interventions.
5. **The distribution of costs and benefits**. Aggregate cost benefit analyses often ignore or give limited attention to the way costs and benefits are distributed among groups.
6. **Indirect costs and benefits:** Many of the costs and benefits from DRM can be indirect but these can be difficult to identify and quantify for inclusion in CBA.
7. **The lifetime of a mitigation investment:** Particularly with infrequent (but major) hazards, the period over which mitigation investments are likely to be effective has a major impact on potential benefits.
8. **Limited Data availability:** Data are not available in many contexts and, more importantly, on many values. Values where data are lacking are often omitted from CBAs resulting in biased outcomes.
9. **Choice of discount rate:** The choice of discount rates affects CBA results heavily and, despite extensive research and agreement among economists and governmental actors, often remains controversial among other stakeholders.

10. **Limited-familiarity with economic efficiency discourses by donor agencies and field staff.** Care is essential in interpreting the implications of CBA for policy making but many key actors have little exposure to the nuances critical for such interpretation.

Qualifications aside, the limited number of available quantitative studies available on the costs and benefits of DRR clearly document the high returns that can be achieved. Estimates from studies around the world indicate positive return rates across a variety of interventions (see Table 1). Benefit-Cost ratios of 2-4 are common and in some cases substantially higher returns have been documented.

Box 1: CBA - the U.S. Case:

According to a recent report released by the Multi-Hazard Mitigation Council: "On average, a dollar spent by FEMA on hazard mitigation (actions to reduce disaster losses) provides the nation with about $4 in future benefits. In addition, FEMA grants to mitigate the effects of floods, hurricanes, tornados, and earthquakes between 1993 and 2003 are expected to save more than 220 lives and prevent almost 4,700 injuries over approximately 50 years (MMC 2005a). More specifically, the study found that at present values, every dollar spent through FEMA mitigation grants, achieved savings of $3.65 to the Federal treasury in avoided disaster relief and tax revenue losses. The discounted net present value of societal benefits from the $3.5 billion invested in hazard mitigation was estimated as $14 billion – which brings the total benefits up to $4 (MMC 2005a). Applying CBA to such investments has been a key factor in financing decisions for thousands of flood control and other disaster risk reduction projects since the 1950s and may account for the high rate of return estimated.

Although evaluations such as those conducted for FEMA conclusively demonstrate the high economic returns that can be generated by investment in DRR, not all investments in DRR will have high returns. High rates of return depend heavily on the specific nature of the investment. Higher rates of return are much more likely when DRR is implemented as an integral part of existing systems, serves multiple purposes including (where possible) the generation of ancillary benefits, and responds to multiple hazards. Furthermore, estimates of returns are particularly uncertain when they depend on critical assumptions – such as climatic conditions and patterns of vulnerability – that are changing over time.

Despite the long history of use of CBA for assessing the economic efficiency of actions, demonstrating the economic value of DRR is complicated by a number of factors that fall into more technical issues with CBA for DRM and issues with CBA more generally.

Techniques for analyzing the Costs and Benefits of DRR

The main function of CBA is to inform the decision-making process on which projects or policies to pursue, in terms of costs and benefits of the project. CBA takes a utilitarian approach holding that social welfare is an aggregate of individual welfare and changes therein due to projects and policies. Thus, CBA is focused on maximizing social welfare and is not concerned with how the welfare is distributed or other issues of equity. (Dasgupta and Pearce 1978).[2] Because of this, CBA should be used in combination with other appraisals, such as Social or Environmental Impact Assessments, to determine which project is the most efficient and effective option.

[2] Also, no definite aggregation rule exists for aggregating individual preferences to a social welfare function. As Arrow (1963) has shown in the *Impossibility theorem* no such welfare function exists that allows the social ranking of alternative social states from individual preferences given that intuitively plausible criteria of social choice are satisfied. This is a serious restriction to CBA, as a main proposition contends that individual preferences should count in an assessment of social choice. The way out of this impasse usually taken is to introduce normative judgment by means of postulating that a decision-maker or observer seeks to maximize social welfare. This can be the government, a project evaluator or a representative agent (see Dasgupta and Pearce, 1978).

CBA in the context of disaster risk management can be used for three main purposes. It can be employed to evaluate risk management measures for making exposed *infrastructure or other facilities* more hazard-resilient. In addition, it may be used to incorporate disaster risk in project and development planning, called the *mainstreaming* of risk. Mainstreaming risk involves accounting for disaster risk in the economic appraisal and helps with projecting probable shortfalls in project or development outcomes. This allows for better and more robust development planning. Furthermore, outside of the project cycle, CBA can be an important instrument for *awareness-raising and education.* By showing that investment in disaster risk management pays, the decision making process can be enormously influenced when appropriately done.

Traditional cost-benefit analysis approaches essentially attempt to account for all the costs and benefits associated with a particular mitigation project. CBA is used to organize, appraise and present the costs and benefits, and inherent tradeoffs of projects taken by the public sector, NGOs and donors (local, regional and central governments and international donor institutions) to increase public welfare.

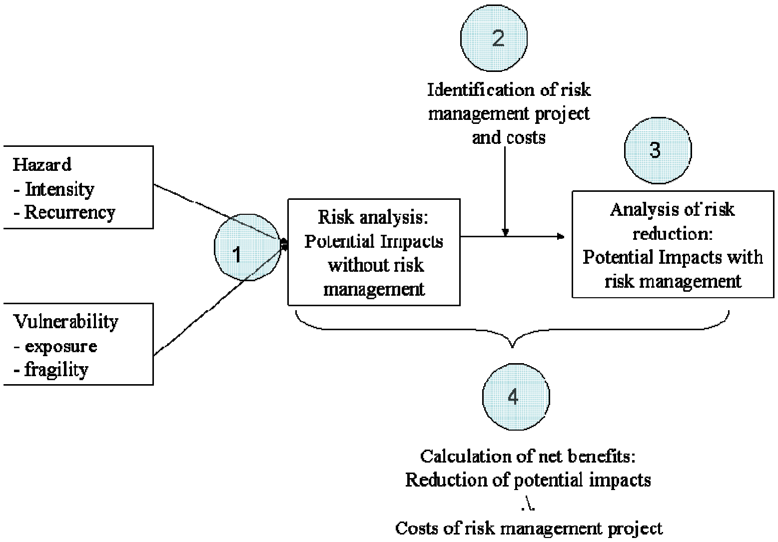
The costs of a project include direct (expenditures on materials, labor, services and long-term maintenance of the project) and indirect (activities or services not charged to the project costs, spillover effects such as reduction in land or property value, and forgone opportunities such as converting land from one economic activity to another) costs. The costs of a mitigation project, barring maintenance, are usually paid upfront.

Calculating the benefits of mitigation activities is even more difficult than calculating costs, as benefits are measured as the avoided losses that would have occurred without the mitigation project. In the case of disaster mitigation activities, *evaluation of benefits must be risk based*. Risk in this case involves probability of an event multiplied by the losses or damage that would occur. It is a function of *hazard*, *vulnerability* and *exposure* and must be *assessed in terms of probability distributions*.

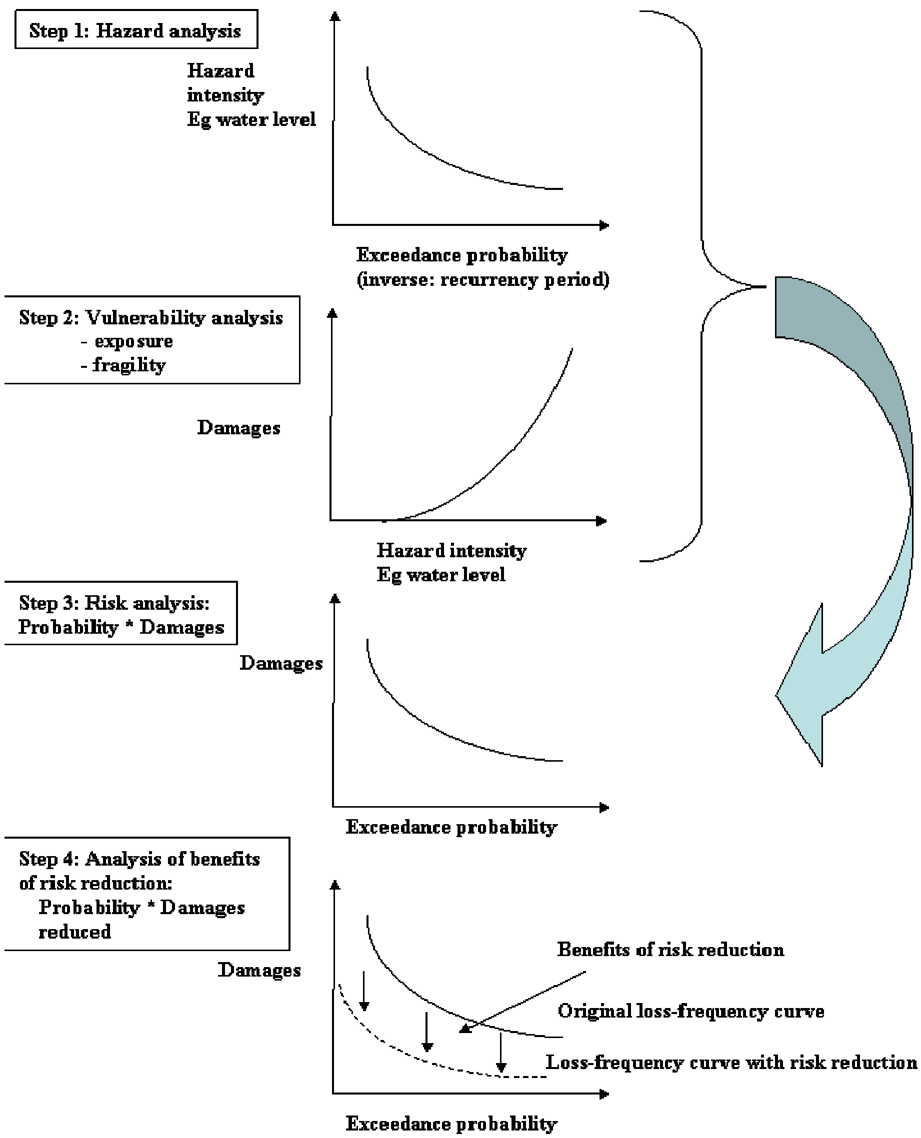
Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible; ***they are the disasters that did NOT happen.*** (Kofi Annan 1999)

Benefits accrue over the lifetime of the mitigation project and might not be completely demonstrated unless a hazard event occurs. Two ways of estimating risks can be distinguished (see Mechler 2005): a forward-looking more risk assessment and a backward-looking more impact-based assessment. In order to calculate benefits using a forward-looking risk assessment, estimates about the frequency and intensity of a potential hazard event are needed, as well as an assessment of vulnerability (potential infrastructure damage under different hazard scenarios and potential casualties or injuries) and possible exposure to the event. It is then possible to calculate a community's overall risk associated with a particular hazard and demonstrate how that risk would be reduced under different mitigation scenarios. From this, the overall benefits of a particular mitigation activity can be estimated. Backward-looking risk estimation relies on damage reports from past events and adjusts those for possible changes in exposure and vulnerability, to arrive at a current risk estimate. Then, as with forward-looking assessments, total risk reduction of various mitigation activities are calculated and the associated benefits are derived. In these calculations, the benefits must be discounted, because it is expected that the worth of the benefits will be different in the future.

As the two diagrams below demonstrate, there are essentially four steps to analyzing the costs and benefits of interventions to reduce risk: (1) risk analysis; (2) identification of risk management options and the costs associated with them; (3) risk analysis with and without project implementation; and (4) estimation of cost and benefit probabilities. All of this should be done in a probabilistic manner – that is in relation to probability that hazard events with given intensities will occur at specific frequencies.



Source: Mechler 2005



When event frequencies and intensities are changing, as they are with the 70% of disasters that are climate related, then accurate calculation of benefits from risk reduction in specific contexts depends heavily on the degree to which frequency-intensity relationships can be projected. Furthermore, with climate change, the frequency and intensity of weather related hazards, such as floods and droughts, is changing. What was once the 500-yr flood in a location might soon become the 100-yr flood. Thus, the benefits of hazard mitigation programs might be underestimated.

Another appraisal method is cost-effective analysis, which involves a comparison of the costs and effectiveness of various mitigation strategies. In this, the desired outcome is defined, such as the goal of protecting a village from the 100-yr flood. The effectiveness and costs of various mitigation strategies are compared to determine which mitigation strategy is most effective in meeting the mitigation goals, such as protecting the village from a particular flood, at the least cost.

Data on impacts, risk and cost of measures

The social and environmental benefits of disaster mitigation activities are well documented, including reductions in loss of life, minimized livelihood disruption, and resilient infrastructure such as power and water (Benson and Clay 2002; Wisner, et al. 2004) Warren et al point out, if proper attention is given "to the principles of sustainable development and disaster resilience, a community should be able to withstand most natural extremes such as floods without experiencing them as "catastrophic" or "disastrous" events" (Warren, et al. 2002).

Apart from Japan, Britain and the USA, CBA is (yet) not widely practiced for NDRM projects. On the other hand, a number of assessments have reported large benefits of risk management measures. These are often evaluations of finished projects. Also, some of these assessments take a hypothetical and deterministic approach: what would have happened if mitigation had been included in the projects. Table 1 presents a summary of the evidence found in the literature as well as calculated in the two case studies conducted for this report. May of the examples are U.S. based because the U.S. government has required cost-benefit analysis to be conducted for each project receiving federal funding and the documentation for the projects is readily accessible.

Table 1: Existing Appraisals of the Costs and Benefits of DRM

Source and type of analysis	**Actual or potential benefits**	**Result/return**
Appraisals (assessment before implementation)		
Kramer (1995): Appraisal of strengthening of roots of banana trees against windstorms	Increase in banana yields in years with windstorms	Expected return negative as expected yields decreased, but increase in stability as variability of outcomes decreased
World Bank (1996): Appraisal of *Argentinean Flood Protection Project*. Construction of flood defence facilities and strengthening of national and provincial institutions for disaster management	Reduction in direct flood damages to homes, avoided expenses of evacuation and relocation	IRR: 20.4% (range of 7.5%-30.6%)
Vermeiren and Stichter (1998): Hypothetical evaluation of benefits of retrofitting of port in Dominica and school in Jamaica	Potentially avoided reconstruction costs in one hurricane event each	B/C ratio: 2.2 – 3.5
Dedeurwaerdere (1998): Appraisal of different prevention measures against floods and lahars in the Philippines	Avoided direct economic damages	C/B ratio: 3.5 – 30
Mechler (2004a): Appraisal of risk transfer for public infrastructure in Honduras and Argentina	Reduction in macroeconomic impacts	Positive and negative effect on risk-adjusted expected GDP dependent on exposure to hazards, economic context and expectation of external aid
Mechler (2004b): Prefeasibility appraisal of Polder system against flooding in Piura, Peru	Reduction in direct social and economic and indirect impacts	Best estimates: B/C ratio: 3.8 IRR: 31% NPV: 268 million Soles
Mechler (2004c): Research-oriented appraisal of integrated water management and flood protection scheme for Semarang, Indonesia	Reduction in direct and indirect economic impacts	Best estimates: B/C ratio: 2.5 IRR: 23% NPV: 414 billion Rupiah

Ex-post evaluations (assessment after implementation of measures)		
FEMA (1998): Ex-post evaluation of implemented mitigation measures in the paper and feed industries in USA	Reduction in direct losses between 1972 and 1975 hurricanes	C/B ratio: ca. 100
Benson (1998): Ex-post evaluation of implemented flood control measures in China over the last four decades of the 20th century	Unclear, probably reduction in direct damages.	$3.15 billion spent on flood control have averted damages of about $12 billion
IFRC (2002): Ex-post evaluation of implemented *Red Cross mangrove planting project* in Vietnam for protection of coastal population against typhoons and storms	Savings in terms of reduced costs of dike maintenance	Annual net benefits: 7.2 mill. USD B/C ratio: 52 (over period 1994-2001)
Venton & Venton (2004) Ex-post evaluations of implemented combined disaster mitigation and preparedness program in Bihar, India and Andhra Pradesh, India	Reduction in direct social and economic, and indirect economic impacts	Bihar: B/C ratio: 3.76 (range: 3.17-4.58) NPV: 3.7 million Rupees (2.5-5.9 million Rs) Andhra Pradesh: B/C ratio: 13.38 (range: 3.70-20.05) NPV: 2.1 million Rupees (0.4-3.4 million Rs)
ProVention (2005): Ex-post evaluation of *Rio Flood Reconstruction and Prevention Project*, Brazil. Construction of drainage infra-structure to break the cycle of periodic flooding	Annual benefits in terms of avoidance of residential property damages.	IRR: > 50%
FEMA (1997): evaluation of National Flood Insurance Program: 18,700 communities adopting floodplain regulations, zoning, building requirement, flood insurance	Reduction or elimination of flood damage and associated costs of recovery.	Annual benefits of $770 million Costs: Program largely funded by insurance premiums
MMC (2005): review of FEMA mitigation programs	Programs to help mitigate effects of multiple natural hazards from 1988-2000.	Average B/C ratio: 4 based on a review of 4,000 mitigation programs.
FEMA (1997): Acquisition/relocation of Castaic School District buildings, California	Relocation of schools away from dam inundation & gas pipeline burst due to earthquakes. Buildings built to earthquake code.	Cost: $27million Estimated benefits: cost of reconstruction, building rental, daily education, 1300 lives saved
MMC (2005): Cost effective analysis of Freeport, New York flood mitigation project	Elevation of homes, businesses, main roads above 100-yr flood level. Electrical lines moved underground. Early warning systems and education programs initiated	B/C ratio averaged over all projects: 12.6
MMC (2005): Cost effective analysis of Jefferson County, Alabama mitigation projects	Early warning systems, vulnerability and hazard maps, education programs	B/C ratio averaged over all projects: 2.6
MMC (2005): Cost effective analysis of Tuscola County, Michigan mitigation projects	Mapping of flood vulnerable areas, improved drainage, acquisition and retrofitting of homes and businesses	B/C ratio averaged over all projects: 12.5

MMC (2005): assessment of the National Earthquake Hazards Reduction Program	Seismic retrofitting of multiple buildings, reduction in fatalities and injuries in US, development of shake maps	B/C ratios: 1.4 – 2.5
Mizina (1999): evaluation of mitigation programs for agriculture in Kazakhstan under climate change scenarios	Projects range from education, capacity building, and reducing soil erosion	Cost effectiveness using ADM range from: 0.65 – 5.5
Fuchs et al. (2006): cost effectiveness of avalanche risk reduction strategies in Davos, Switzerland	Reduction in deaths and damage to infrastructure, better land use planning and zoning, snow fences	B/C ratios range from: 0 – 3.72

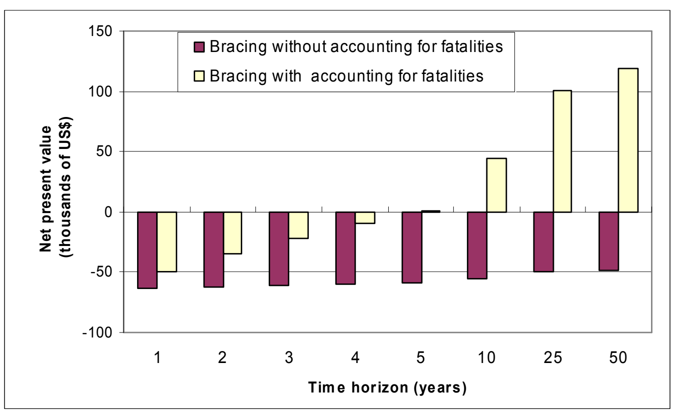
As the wide array of evaluations presented in the table above conclusively demonstrate, *investing in DRR can pay*.

Methods, Gaps and Limitations in Existing Approaches to CBA

Although available cost-benefit analyses of DRR do conclusively demonstrate the returns that can be achieved, many challenges exist in attempting to apply CBA more broadly. Estimating the full costs of disasters and the true benefits of mitigation measures can be difficult. Although a number of manuals exist, such as FEMA's Hazard Mitigation Grant Program Desk Reference or ECLAC's Manual para la evaluación de impacto de proyectos y programas de lucha contra la pobreza, and the literature on CBA and the valuation of lives and other non-market values is extensive, neither the manuals nor results in the literature are fully consistent. (FEMA 1999; Navarro 2005). As a result, in the DRR case there are no fully accepted and institutionalized methods for determining what is a cost, a benefit, how to discount the future or how to value a human life. Furthermore, while many economists might agree on the value of a statistical life or

Box 2: Istanbul Earthquake CBA

Figure 1: Net present value for bracing an apartment house in Istanbul Source: Smyth et al. 2003



In Istanbul, the costs and benefits of investing in bracing in apartment houses as are heavily influenced by both the time horizon considered and the value placed on lives. Because earthquakes are infrequent, the longer the time horizon the more likely a disaster event will occur that generates benefits in terms of damages avoided. If lives aren't valued, however, the NPV of investments in bracing remain negative. If they are valued, then benefits over time horizons longer than five years are strongly positive. The economic "value" placed on life, in this case, completely changes the CBA results. Because of the long-time horizon, the outcome of such calculations is equally affected by the choice of discount rate. In this case, higher discount rates would reduce the future value of lives saved.

where and how discounting should be applied, such calculations are often quite contentious in public policy and stakeholder environments. Values differ among groups and this variation is often difficult to capture with CBA methodologies. The importance of such factors should not be underestimated. Whether or not such factors are effectively considered in a CBA can have, as the case of bracing in apartment houses in Istambul in the accompanying box illustrates, very large implications for the outcomes.

Quantifying the costs of mitigation efforts is substantially easier than calculating the benefits. In the U.S., both the costs of mitigation and disaster losses are measured in terms of direct and indirect expenditures (MMC 2005). Direct costs constitute expenses such as expenditures on labor, capital and material. Indirect costs can comprise things such as changes in real estate values, if they are negative, and other spillover effects. There can, however, be significant disagreement over measuring and documenting costs. In Tamil Nadu, India, for example, proposals to move residences away from vulnerable coastal locations following the Asian Tsunami are often opposed by coastal communities because it affects their ability to monitor fishing opportunities. In this case, the economic costs of risk reduction could be major for specific communities – but would be extremely difficult to document or quantify.[3]

Benefits encompass all the avoided losses that would have occurred if the mitigation activity had not been implemented. They are much more difficult to measure until an actual natural hazard event occurs. Some benefits, such as the elimination or reduction in property damage, are easy to measure. Other benefits, such as reductions in: casualties, homelessness, environmental damage, and direct and indirect business interruption are not easily estimated, simply because data are not often collected on these categories after a disaster. Because of the uncertainties, in the US FEMA has statutory restrictions on what can be included in CBAs and, for these reasons, FEMA is moving away from CBA and toward loss estimation for many financial analyses or incorporating loss estimation into CBA of projects. Loss estimation modeling has three primary goals: 1) to forecast the potential impacts of various hazard scenarios, 2) project losses in an actual event, and 3) assess mitigation activity benefits (MMC 2005: 11). FEMA developed, and is refining, a standardized loss estimation software called HAZUS®MH that can be used in earthquake, flood, and wind modeling.

Despite attempts such as those by FEMA and other organizations to incorporate more factors into cost-benefit estimates, existing methods for CBA are limited with respect to the factors considered. Particular gaps and limitations include:

1. *The dynamic (changing) nature of hazards and vulnerability and therefore risk*: Historically, most hazards have been treated as probabilistic – that is the probability of events with given intensities occurring at a given frequency is treated static and can be determined by historical data. While this may be true with respect to, for example, earthquakes, is isn't true for climate and many other systems. As climate changes, the historical frequency of storms and other events that can cause disaster is changing. Furthermore, vulnerability is also changing as populations settle in exposed regions (such as coastal areas) and as they shift from activities, such as agriculture, that are vulnerable to certain types of hazards and into other activities where the vulnerability profile is different. Risk patterns, the product of hazard and vulnerability patterns are therefore, inherently dynamic.

2. *Difficulties in assessing avoided losses and the often non-market nature of benefits from many disaster risk reduction investments*: In most cases, the benefit from investments in DRR is in the

[3] Personal communication, S. Janakarajan, Madras Institute of Development Studies.

form of income, assets and lives that aren't lost. Indirect benefits may also accrue and may represent a very substantial part of the overall returns from a project (ASFPM 2006). Evaluating benefits requires probabilistic projections of losses with and without DRR coupled with often controversial estimation of value for non-economic elements such as lives and indirect benefits. Indirect costs associated with DRR interventions can also exist and be quite large, while rarely being included in cost-benefit calculations. Where *Non-monetized values* are concerned, there are major ethical as well as technical issues in valuing some forms of benefits such as lives saved, injuries and similar direct benefits from risk reduction. Techniques for valuing lives and injuries based, for example, on projections of lost future earnings, do exist – but these remain controversial because they "value" wealthy, educated individuals over the poor. Even where fundamental ethical concerns are absent, quantifying the economic value of many non-monetized costs and benefits, particularly "softer" environmental and social values is generally difficult. While it is possible to estimate values for many such elements, as the MMC (2005) notes the necessary data often aren't available. In some cases, the data issue can be addressed by using benefit-transfer methods (essentially transferring the "values" identified in the literature to the specific case being analyzed). Both the valuation process and the transfer between cases can, however, be controversial. As a result, non-monetized costs and benefits are often ignored.

3. *Variety coupled with lack of unanimity regarding the types of activities that actually contribute to disaster risk reduction*: Exposure to hazards and the nature of social vulnerability to them is inherently location specific. Strategies for risk reduction reflect this diversity and this complicates evaluation of the overall economic value of DRR. Furthermore, as discussed in detail below, not all forms of DRR are likely to have similar returns under different scenarios regarding development patterns or climate change. As a result, distinctions regarding DRR strategies and the specific types of investment required are essential in order to evaluate likely economic returns.

4. *Absence of methodologies for valuing systemic and process based as opposed to targeted, hazard-specific, risk management interventions:* Current methodologies can, with relative ease, be applied to estimating the costs and benefits of targeted interventions in relation to specific well known hazards. Within regions, however, economic diversification coupled with strengthening of basic systems for communication, transport, banking, organization and education can, however, have far greater impact on the resilience of society in relation to a broad spectrum of events that could cause disaster than more targeted interventions (*Moench and Dixit*, 2004). The role of resilient social systems in reducing disaster impacts has been eloquently documented by Amartya Sen and others in their work on the differing impacts of drought in India and China (Dreze and Sen 1989; Dreze, et al. 1995; Sen 1999b). As a result, the functioning of regional economic, landuse, transport, communication, educational and other systems may have more fundamental implications for exposure, vulnerability and risk than hazard-focused interventions. Similarly, substantive work now documents the importance of processes such as hazard communication for risk reduction. There are, however, no studies documenting the benefits of such approaches (MMC 2005: 14). Benefit-transfer approaches have been used in a few cases to evaluate processes (MMC 2005). It has not, as far as we're aware, been used to evaluate the value of systemic interventions. Cost-benefit analysis sheds light on narrowly targeted interventions. The absence of clear methodologies for quantifying and valuing risk reduction at a systemic level or through process interventions, could detract policy attention from approaches that could be of equal overall effectiveness.

5. *The distribution of costs and benefits*. In many situations, the costs and benefits of risk reduction are not distributed equally across all communities exposed to hazards. This is particularly true in

the case of major structural works related, for example, to flood control. In this case, some groups gain (such as those protected by embankments) while other groups actually lose (those living between embankments or displaced by dams constructed for flood control). Most cost-benefit analyses focus on net benefits. While theoretically those benefiting from a project should be able to compensate those losing, in practice this often does not occur.

6. *Indirect costs and benefits*: Under U.S. government guidelines for some organizations, consideration of indirect costs and benefits is explicitly excluded from formal cost-benefit calculations (ASFPM 2006).[4] These can, however, represent a major component of the real costs and benefits associated with any program. Indirect benefits can range from immediately tangible (and relatively easily quantifiable) returns such as the ability to rent a cyclone shelter for group meetings to far less easily quantified returns such as the esthetic value of an open floodplain. Costs can be equally difficult to quantify. In the Mississippi basin, for example, flood protection and water control structures have reduced sediment transport to the delta. This is a major factor underlying the disappearance of wetlands and loss of land area to the ocean, which contributed to the devastating impact of Hurricane Katrina. The likelihood of such losses was not recognized when flood control structures were constructed. Furthermore, even now measuring physical changes in land areas and conducting the scientific studies necessary to clearly attribute specific losses to specific flood control measures would, at best, be extremely complicated even before they could be valued for input to cost- benefit calculations.

7. *The lifetime of a mitigation effort*: This determines the period over which damages can be expected to be reduced. Where buildings are concerned, standardized lifetimes (50 years for regular buildings, 100 years for lifetime facilities) are available (*MMC*, 2005) for non-structural measures, such as institutions or landuse planning initiatives, however, assumptions regarding sustainability are critical.

8. *Limited data availability*: The statistical data required for probabilistic CB evaluation is often not available. This is a major challenge in regions vulnerable to major but infrequent events (such as major earthquakes that occur every few centuries). Even where more frequent events, such as cyclones, are concerned, however, this represents a major problem even in heavily institutionalized and monitored environments such as the United States. As the MMC notes, estimates of exposure are often crude due to the "overwhelming resources needed to develop an accurate representation" (MMC 2005:12). The challenge is even greater in developing country contexts. It is further compounded when hazard frequencies and/or patterns of vulnerability are changing as they are with climate change and processes of economic development and demographic change. In most CB evaluations, "probabilistic models that consider the relative frequency of past events are generally employed to determine frequency" (MMC 2005). When it is known that past events are unlikely to reflect future frequencies (as in the case of climate change) then this approach is inappropriate. Overall, the validity of CB evaluations is often open to challenge due to data limitations and this can undermine their utility as core elements for decision making.

9. *Choice of discount rates:* Because benefits from DRR projects often accrue gradually over time while costs are often "up-front," the net present value of projects is heavily influenced by the choice of the discount rate. This can be addressed by focusing on internal rates of return. In practice, however, many CB estimates are influenced by decisions on discount rates that are not transparent to those utilizing CB ratios for decision making (see Powers 2003: 25).

[4] This applies to FEMA but not the Corps of Engineers.

10. *Limited-familiarity with economic efficiency discourses by donor agencies and field staff.* CBA is one appraisal tool. A high BC ratio alone doesn't mean too much in many contexts because it doesn't capture distributional effects and may not include many of the non-market or other factors that influence the larger importance of a project. As a result, integration with other approaches to analysis and policy evaluation is essential. The ability to achieve this, however, does require in-depth familiarity with both the uses and limitations of CBA

Some of the limitations facing the use of CBA are fundamental while others can be addressed through improvements in methodologies and expanded data collection. Issues such as the valuation of lives and many other social, environmental non-market values, for example, represent fundamental limitations that, because they involve basic ethical and personal perspectives, cannot be completely resolved through methodological, data or other improvements in approaches to CBA. As a result, while CBA may serve as a valuable input to decision making process, estimates should not be used as the sole criteria for decision making.

The primary value of CBA, as a result, lies in the analytical process itself and the manner in which that can be used to force project proponents to clarify the logic relating proposed courses of action to risk reduction. The U.S. government, for example, now requires states and communities to develop natural hazard mitigation plans, in order to be eligible for funding for pre-disaster and post-disaster mitigation measures. In the U.S., the cost-effectiveness of measures proposed in the hazard mitigation plans must be detailed before states or a community can receive funding from one of FEMA's disaster mitigation grant programs (Disaster Mitigation Act of 2000; OMB Circular A-94, 1992). The methods by which a project or process is evaluated for cost effectiveness are varied – but the process of preparing a plan and evaluating the costs and benefits of each element in it clarifies the relationship between investments, objectives and economic returns.
In addition to clarifying such relationships, the CBA process can be used to identify types of programs where both monetized and non-monetized benefits clearly outweigh costs and other types of programs where benefits are contingent on narrow sets of assumptions regarding future conditions. This last point, as discussed in more detail below, is particularly relevant in the case of climate change.

Suggestions for using CBA for DRR and adaptation

Experiences with the use of CBA for evaluation of DRR projects clearly document both the high rates of return some activities can have. At the same time, widespread application of CBA has faced major constraints. While data on costs are readily available, data on benefits often aren't. In addition, CBA analyses tend to focus on easily quantifiable values while missing or downplaying the importance of non-monetized and/or indirect costs and benefits. When such values are proactively considered, they can fundamentally change CBA estimates. As a result, approaches to CBA that don't account for indirect and difficult to quantify values are both flawed and biased. Other technical factors in CBA analyses, such as the choice of discount rate, can also fundamentally affect results. For these reasons organizations such as FEMA has been moving away from primary reliance on CBA as a day-to-day tool for making decisions on individual disaster mitigation investments and now focuses instead on more narrowly defined loss estimation approaches (MMC 2005).[5]

The above said, CBA can play a critical role in decision making regarding the strategic approaches to disaster mitigation that will, in virtually all situations, generate positive returns while also

[5] Confirmed through personal communication with operational level emergency managers, May 2007.

flagging categories of projects where returns are uncertain or vulnerable to critical climate, discount rate or other assumptions. Used in this mode, CBA can serve as a framework for negotiating the important factors to be considered, placing a relative (not always market defined) value on them and reaching agreement on the overall costs and benefits of a project. To achieve this, key *stakeholders and users* with different objectives and interests can be involved in conducting a CBA. Such stakeholders include:

- representatives from local, regional and national planning agencies may use CBA for informing their planning processes;
- officials from the finance ministry are concerned with budget planning and reserving investment funds for specific purposes;
- disaster risk managers may use it for sensitizing the public and the authorities about the risks a region or city is exposed to as well as the efficiency of preventive measures for reducing those risks;
- development cooperation staff may use results from CBA both for planning their overall priorities as well as specific projects.

Beyond the role of CBA as a framework for negotiating the values affected by a project, on-going work on the costs and benefits of DRR suggests that investment returns are likely to be robust when basic principles are followed. In specific returns from investment are likely to be robust when DRR investments are:

1. *Multi-function, multi-hazard*: Where investments address multiple hazards and serve multiple purposes in addition to their risk reduction function, they are often both more sustainable and capable of generating revenue streams that offset project costs. An early warning system, for example, that functions for all hazards in a region and provides basic communication services is likely to have a higher return than one that is dedicated for a single narrow purpose. In some cases, of course, targeted systems (or system components) are essential – but as a basic principle, multi-function, multi-hazard systems will often have higher returns. This is particularly true when the multi-function element can be used to create revenue streams that offset all or a part of operation, maintenance and capital costs.

2. *Embedded in development programs or designed as part of core public and private systems*: The costs of DRR are likely to be higher and the benefits lower when they are developed and implemented as "stand-alone" activities that are implemented separately or in isolation from existing programs and systems. When DRR is designed as an integral component of existing systems or programs, it is far more likely to be based on a sustainable public or private sector business model and can often generate direct benefits in addition to the risk reduction objective.

3. *Not sensitive to core assumptions and uncertainties*: The returns from many forms of DRR depend heavily on core assumptions, such as flood flow volumes, storm frequencies, discount rates and so on. As a result, policy at the Corps of Engineers "emphasizes concentrating on the uncertainty in variables that are key to project recommendation." (Moser 1996: 31). This is particularly true for investments designed to strengthen the hard resilience of structures and other systems. Returns from other forms of DRR, particularly those that focus on developing robust underlying systems (strengthening soft resilience), are often less sensitive to assumptions and uncertainties. The role of uncertainties and assumptions is critical in relation to climate change and other risk areas where hazards or vulnerabilities are changing. It is also critical in relation programs where a significant

portion of the costs or benefits are non-monetized or difficult to quantify and where distributional issues are large.

A key point to note from the above is that not all "DRR" interventions are likely to be equal with respect to their costs and benefits, particularly in relation to climate change, non-monetized and distributional considerations. Strategic assessment of costs, benefits and the assumptions underlying estimates is, as a result, essential. As discussed further below, distinctions between in the cost-benefit profiles of strategies may depend heavily on the degree to which they rely on soft versus hard resilience strategies and, thus, the vulnerability of projected benefits to critical threshold values.

The Hard-Soft Resilience Distinction

Most activities undertaken in the name of disaster risk reduction fall into two broad categories: (1) the strengthening of physical systems to directly withstand or respond to the specific stresses imposed by earthquakes, storms, floods or other extreme events; and (2) a wide variety of "softer" and indirect measures intended to reduce the impact of events on people and assets, improve relief capacities when events occur, and aid recovery. We refer to these here respectively as "hard resilience" and "soft resilience"

In many disaster mitigation programs, physical strengthening of structures to withstand the direct impacts of floods, storms, earthquakes or other similar events represents the major cost center. This is also true in the case of other hazards, such as drought, where major structural investments are undertaken to secure control over water supplies through the construction of storage and conveyance facilities. Measures such as these, while they do increase the ability of systems to withstand events of specific intensities, are often subject to sudden (brittle) failure when intensities exceed design criteria. They also may not deliver benefits when the type of event that occurs is different from the type anticipated.

The damage that occurred in New Orleans during Hurricane Katrina demonstrates the vulnerability of approaches relying on primarily on protective (hard resilience) strategies. In that case, levies were designed to withstand Category 3 storms but a Category 5 storm occurred. In addition, the levies were designed to withstand the direct impact of incoming storms and did not effectively take account for the complex drainage patterns and differences in soil characteristics that weakened levies so that they failed under the stress of higher than anticipated water levels. The resulting "brittle" failure of the levy system caused massive damages and loss of life. This loss was compounded because, as generally occurs in "protected" areas, individuals and communities had invested over many decades under the assumption that levy systems would protect them.

Virtually all approaches to strengthening the "hard" resilience of protective structures face similar issues. Dykes and levy systems in the Netherlands are extremely vulnerable to the combined impact of sea level rise and increases in storm intensity projected as a consequence of climate change (Kabat, et al. 2005). This is also the case with similar systems in virtually all large river basins and coastal deltas. Although perhaps to a lesser extent, it also applies to non-climate related hazards. The ability to harden structures to withstand earthquakes without damage, for example, is limited and many approaches to risk reduction focus on "soft resilience" interventions such as increasing the flexibility of structures.

What is "soft resilience" as applied to Disaster Risk Reduction? Approaches to strengthening soft resilience for DRR, focus on enhancing the flexibility and elasticity of social, natural and engineered systems in ways that reduce or spread risks. Rather than completely attempting to "control risk" it emphasizes the ability to "live with risk." This is very similar to concepts of resilience now emerging for interlinked ecological and social systems (see boxes 3 & 4).

Where DRR is concerned, strategies for increasing soft resilience and dispersing risks can involve interventions focused both on the *proximate* causes and impacts of specific hazards or at a deeper level on the *underlying systems* that influence how risks are transmitted and responded to across society and how recovery occurs following disruptive events.

Interventions focused on the proximate causes and impacts of extreme events can include a variety of *hazard* and *location specific* measures to

> **Box 3: Resilience concepts**
>
> As defined by the *Resilience Alliance**:
> "Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary….."Resilience" as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:
>
> - The amount of change the system can undergo and still retain the same controls on function and structure
> - The degree to which the system is capable of self-organization
> - The ability to build and increase the capacity for learning and adaptation"
>
> *www.res**alliance**.org

1. spread risks through insurance, diversification and similar mechanisms;
2. develop organizations for relief, recovery and risk identification;
3. develop early warning systems;
4. secure transport systems from disruption;
5. manage landuse and environmental systems for risk reduction; and
6. reduce the vulnerability of specific groups, activities or sections of society.

At a deeper level, however, concepts from systems analysis combined with preliminary analyses of the factors affecting the ability of communities to respond to droughts, floods and other hazards indicate that risks depend as much, if not more, on the functioning of underlying systems as they do on proximate interventions targeted at specific hazards (Gunderson and Holling 2002; Moench and Dixit 2004; Moench and Stapleton 2007; Sen 1999a; 1999b; Wisner et al. 2004). In specific, the ability to respond to risks and surprises as they emerge in diverse local contexts depends on the density, diversification, robustness and penetration of basic systems for:

1. <u>Communications</u> (including diversified media and general weather/hazards information);
2. <u>Transportation</u> (including during extreme events);
3. <u>Finance</u> (including access to banking, credit and insurance products for risk spreading before, during and following extreme events);
4. <u>Economic diversification</u> (access to a spectrum of economic and livelihood options for livelihood diversification);
5. <u>Education</u> (the basic language and other skills necessary to understand risks, shift livelihood strategies as necessary, etc.);
6. <u>Organization and representation</u> (the right to organize, have access to and voice concerns through diverse public, private and civil society organizations); and

7. Knowledge generation, planning and learning (the social and scientific basis to learn from experience, proactively identify hazards, analyze risk and develop response strategies that are tailored to local conditions).

Conceptually, the degree to which all sections of society are able to access and use such systems combined with the underlying robustness of the systems themselves is of fundamental importance to both the transmission of risk and the ability of societies at all levels to identify, mitigate and recover from all forms of hazard as vulnerabilities emerge and evolve in an ever changing world. Strategies to strengthen "soft resilience" – that is the "adaptive capacity" of society – may represent the fundamental entry point for risk reduction in a world where hazards are evolving rapidly as a consequence of climatic and other change processes.

Box 4: Hard and Soft Resiliency in Practice

Hard resiliency focuses primarily on structural measures, whereas soft resiliency incorporates different types of structural measures with process, policy and other types of mitigation measures. In essence, soft resiliency is about learning to live with risk, rather than creating the false assumption that risk can be eliminated.

Hard vs. Soft Resiliency in Flood Mitigation:

Flooding is a common phenomenon in the Gangetic River Basin and cause significant damage in the states of Uttar Pradesh, Bihar and West Bengal.

Flood mitigation approaches in the basin have historically emphasized hard resiliency, in specific the construction of extensive embankment networks and other flood control structures to isolate most land from flooding. However, the embankments led to river siltation, rising of the river beds and clogging of drainage points. Eventually, the embankments fail in surges, inundating the surrounding land, destroying assets and infrastructure, and causing loss of life and livestock.

An alternative approach to flood management in the basin would focus on increasing soft resilience. This approach would involve maintaining as open a flood plain as possible, improving drainage and the development of targeted structural measures to protect smaller, high value, areas from flooding (ring embankments around cities, elevation of villages and buildings, etc.). Such spatial planning and structural flood management elements would coupled with a wide variety of targeted interventions to improve key systems for communication (early warning) and transport in flood zones and to help develop livelihood and other institutional systems that enable local populations to "live with" flooding.

Benefits from the soft resiliency approach are much less vulnerable to the impacts of climate change than hard resiliency measures. Designing embankments requires accurate knowledge of future flood volumes. Because flood waters are constrained, even small increases in total volume can lead to failure. There are specific threshold flood levels at which the system fails and, given changes in climate, how frequently these will occur can not be projected. In contrast, if open flood plains are maintained, flood volumes will be dispersed and the actual depth of flooding that needs to be addressed by structural measures to protect high-value assets will be less under virtually all situations. Furthermore, the benefits from other interventions that play a central role in the "soft resiliency" package do not depend on specific climate projections. As a result, the approach may be far more robust as climate change proceeds.

Beyond Floods

The hard resiliency-soft resiliency distinction applies in virtually all approaches to DRM and the mitigation of climate impacts. In earthquake engineering, for example, design strategies are often divided between physical strengthening of structures (hard resiliency) and changes in structural design to increase flexibility (soft resiliency). Where drought mitigation is concerned, regional approaches often divide between those focused on securing absolutely reliable sources of water (hard resiliency) and approaches that seek to reduce demand, develop drought adapted livelihoods and diversify water sources (soft resiliency). Where coastal areas are concerned, approaches divide between those that emphasize full protection of coastal areas through engineering works (hard resiliency) and those (soft resiliency strategies) that combine: (a) targeted protection of populations and structures; (b) dispersion of storm energy through breakwaters and environmental systems such as mangroves and reefs; and (c) a wide variety of social systems to improve early warning, reduce damages and speed recovery.

It is important to note that the distinction between hard and soft resiliency is not primarily about structural versus social risk mitigation strategies. Instead, hard resiliency approaches emphasize control over risk and full protection of society from hazard impacts. Soft resiliency approaches, in contrast, emphasize flexibility and increases in the ability to live with risk. Soft resiliency will often involve structural measures – but the measures emphasize limited rather than full protection.

Implications for the costs and benefits of DRR in relation to climate change and evolving patterns of vulnerability

What do soft and hard resilience considerations imply for the costs and benefits of DRR in relation to climate change and evolving patterns of vulnerability? Although sufficient data are not available to validate the hypotheses below, we believe three implications are clear:

First, because the specific impacts of climate change in specific locations are often impossible or extremely difficult to quantify with confidence, estimates of benefits from approaches that depend on knowledge of critical threshold values (the maximum probable flood, etc…) may not be robust. Interventions that focus on increasing the hard resilience of protective structures can be prone to sudden failure should events exceed design criteria. As a result, while such measures will be required in many situations, claimed benefits should be subject to sensitivity analysis prior to decision making. Additional factors including the frequent presence of major distributional effects, uncounted costs and reductions in risk avoidance by "protected" populations may make cost-benefit estimates for hard resilience strategies particularly prone to bias.

Second, although the benefits from interventions designed to increase "soft resilience" may be difficult to quantify in specific situations, these benefits may be more robust in relation to climate and other uncertainties than threshold-dependent hard resilience measures. The operation of an early warning system, for example, does not depend as heavily as the functioning of levies on the magnitude or nature of a flood event. As a result, returns from such strategies may be more robust under uncertain and changing conditions than returns from structural measures.

Third, the most robust returns may occur when interventions seek to strengthen the underlying systems that enable societies to respond and adapt to risk. Robust returns are likely with such interventions for several reasons including:

- The close synergy between activities that enable diversification and risk reduction and those that contribute to basic development objectives. The underlying systems that enable societies to respond to risk also contribute to basic development. As a result, the array of benefits is likely to be much greater and the possibilities for developing business models that are self-sustaining (e.g. generate sufficient revenue for operation and maintenance) is much greater.

- The wide variety of hazards they assist societies in responding or adapting to. Interventions designed to strengthen underlying systems should, in effect, enable local communities to identify and respond to hazards as they emerge in local contexts rather than relying on external inputs. In addition, returns from strengthening underlying systems do not depend as much on detailed knowledge within external support agencies regarding highly localized hazards or patterns of vulnerability.

When focused at the systems level, strategies for DRR can support – but remain distinct from – general development activities by focusing on strategic points of entry within systems that respond to broad categories of risk. Within financial systems, for example, interventions which enable risk spreading through insurance or ensure the operation of banking systems immediately following extreme events are disaster specific yet strengthen systems as a whole. Similarly, within educational systems, activities that strengthen knowledge regarding resilient landuse or infrastructure design principles can contribute both directly to disaster risk reduction and to the underlying strength of the educational system as a whole. Identifying points of entry such as these represents, we believe, a very practical mechanism for building synergies between DRR, development and climate adaptation while retaining a distinct risk focused mandate.

Overall, the above analysis suggests the potential for clear differences in costs and benefits between approaches to risk reduction in relation to climate change and evolving patterns of vulnerability. Globally, a variety of case studies conclusively demonstrate that DRR can pay and that it can contribute substantively as part of wider efforts to adapt to climate change. At the same time, not all disaster risk reduction strategies are likely to generate robust returns as conditions evolve. Due to a host of considerations (including data availability, indirect and non-monetized values and scientific uncertainties), attempts to estimate the costs and benefits of all risk reduction projects or, at a more macro-level, the aggregate economic contribution of DRR as a response to climate change are unlikely to be productive. It should, however, be possible to identify broad categories of DRR strategies that have robust economic returns across diverse contexts. In addition, it should be possible to flag broad categories of interventions where returns are sensitive to critical assumptions. Both types of information could be of critical importance as guidance for strategic decision making on DRR and climate risk reduction.

Potential Ways Forward for ISDR

Cost-Benefit Analysis has both strengths and weaknesses as a decision-making tool for investments in disaster risk reduction. Use of Cost-Benefit analysis has conclusively demonstrated the high returns that DRR can generate. At the same time it is difficult to capture distributional effects, non-monetized values and the indirect (which can outweigh direct) costs and benefits of interventions, particularly in contexts where limited data are available or conditions are changing. Furthermore, unless extensive sensitivity analysis is conducted, reliance on cost-benefit ratios can mask critical factors governing the effectiveness of specific strategies in specific contexts. As a result, unless used with care as part of a much wider evaluation of risk reduction strategies, reliance on cost-benefit analysis can bias decision making.

Where ISDR is directly concerned, priority areas for work on the costs and benefits of risk reduction could focus at two levels:

1. Developing the strategic information required for high-level decision making; and
2. Encouraging the development and use of CBA as a process focused framework for analyzing and negotiating alternatives within local decision contexts.

Simply conducting more project-based cost-benefit analyses or refining methods for incorporation in the development and evaluation of all projects will not, we believe, be particularly productive. Data and analytical limitations combined with capacity gaps make it likely that many such CBAs would ignore key values and generate misleading information as a basis for decision making. The above said, making the case for continued investment in disaster risk reduction depends heavily on demonstrating the economic returns to investments. Decisions are required at both strategic and local levels.

Strategic Decision Contexts

When dealing with large or geographically widespread events and the associated funding decisions, responsibilities generally lie with central or provincial governments and the international donor agencies that work with them. At this strategic decision making level, that substantive work by ISDR and others to generate the data and analytical basis to document the costs and the benefits of broad categories of strategies in diverse contexts could address the strategic decision making objective. Solid documentation would provide high-level strategic decision-makers with the types of information they require to guide organizations effectively target investment resources. It would also enable organizations such as ISDR and others that work on DRR to clarify specific points of synergy where their activities support development and adaptation to climate change *without* running a risk of losing the important and unique set of skills that have evolved over decades of work by the hazard management community. Finally, by focusing on the costs and benefits of broad sets of strategies and the identification of specific points of entry for risk reduction at a systems level, information required for decision making could be generated without saddling operational entities with requirements for analyses where they lack both skills and essential data.

What specifically does this suggest for ISDR as potential areas of focus for documenting the economics of DRR? In specific we believe it emphasizes the importance of analytical work to demonstrate the factors contributing to robust returns from different categories of DRR interventions across differing and dynamic contexts. Achieving this would require:

1. Refining understanding *of different categories* of risk reduction interventions (building perhaps off the distinction we've made above between hard and soft resilience measures);
2. Refining cost-benefit methodologies to capture indirect and non-monetized values *for broad categories of interventions*;
3. Generating the probabilistic and other data required for evaluation of *strategies* across a selection of situations and DRR approaches; and
4. Integration of results with other appraisals in appropriate decision contexts. The goal here might be to inject the results of strategic research on CBA into the respective government institutions, such as ministries of health, education, infrastructure and finance via focal points. This issue of integration into decision making needs to be better evaluated by empirical research

In addition, work at a strategic level is required to identify the specific points of entry where targeted interventions within systems can contribute to development and climate adaptation while retaining a clear risk reduction function. This is the critical element required to build synergies between work on climate adaptation and development without losing the distinct role DRR can play.

Local Decision Contexts

In the wake of decentralization, disaster risk management, particularly for small-scale disaster events in many countries has become a task for the district and municipal levels. Central or provincial governments are involved in framing and legislating disaster management guidelines, while prevention of and response to disasters is in the hands of local level authorities. In this context many decisions are being made by local level officials through either their own internal planning processes or in broad consultation with stakeholders.

Given the wide variety of local situations coupled with data and the other limitations on CBAs, the ability of externally conducted "expert-led" CBA's to play a significant role in decision making is extremely limited. For this context, ISDR could contribute by developing process-focused CBA tools that enable local stakeholders to systematically examine the economic and other tradeoffs inherent in different approaches to DRR within their local context. The types of tools required could include:

1. Stakeholder and local decision-maker processes for collecting relevant data and conducting CBAs, evaluating results and applying these results in local level decision contexts.
2. Transparent analytical frameworks that are accessible to stakeholders and local decision-makers for assembling CB data and testing the sensitivity of results to assumptions regarding future conditions using locally available data (numerous models already exist);
3. Equally transparent analytical templates for collecting, organizing and presenting information on non-monetized and other values where data or other limitations constrain inclusion in the CBA.

Developing the above process focused tools and testing them in a variety of local decision-making contexts would contribute to better understand role of CBA in decision-making for DRM. The process focused tools would generate CB ratios for many local projects – but because of data and other inherent limitations in CBA these ratios would be of limited use for decision-making by themselves. Coupled with outputs from analytical templates designed to address non-monetized values social, environmental and other considerations could be taken into account as well.

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