Background Note

Disaster Mitigation is Cost Effective

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Summary

This document is a briefing on cost-benefit analyses (CBA) for disaster risk reduction (DRR) based on studies documented at http://www.ilankelman.org/miscellany/MitigationSaves.rtf

1. The evidence

The most cost-effective forms of DRR investment tend to be non-structural approaches—such as land use planning, warning systems, and household-level changes—but these are often backed by structural measures, making full separation difficult. For instance, for earthquakes, bolting down appliances and securing shelves costs several hundred dollars in order to save several thousand dollars in damage averted. That presumes that the entire building will stand up in an earthquake because it has been engineered with seismic safety measures.

Similarly for floods, the more structural a measure, the less cost-effective it usually is—but structural and non-structural measures are not always separable. For flood damage in Apia, Samoa, Woodruff (2008) calculated benefit-cost ratios of 1.72 to 44 for improved forecasting and raising floors in homes compared to 0.01 to 0.64 for floodwalls. In the Philippines, Burton and Venton (2009) reported results for village floods which were preventing children from going to school, damaging property, and preventing crops from reaching market. For building and maintaining structures, the benefit-cost ratio was 24 for a footbridge, 4.9 for a sea wall, and 0.7 for a dyke.

For weather and water information and early warning systems across Europe, Hallegatte (2012) calculates that benefit-cost ratios would be between 4 and 36, in addition to the lives saved—but only because much of the expensive and large-scale infrastructure needed, namely satellite networks and forecasting models such as those run by supercomputers, exists already. That is, given what is already available, the value added of small investments in non-structural DRR approaches is immense. Starting from scratch, the benefit-cost ratios would be much lower.

Consequently, the general trend stated above is not definitive. Similarly, counterexamples exist. For flood management along Pakistan's Lai River, Kull et al. (2013) reported benefit-cost ratios of 1.3 for floodplain relocation, 1.6 for a warning system, 8.6 for river improvement, 9.3 for a retention pond, and 25.0 for combining the latter two. For floods in Kinshasa, DRC, Setchell (2008) calculated that mainly structural DRR measures, but completed with local labor and materials, saved at least $45.58 for every $1 invested—and this ratio was witnessed each year that floods occurred.

Across numerous countries, Kunreuther and Michel-Kerjan (2012) examined mainly structural measures for earthquakes, floods, and hurricanes/cyclones along with early warning systems for developing countries. The results were mixed. For example, by targeting some, but not all, flood-vulnerable communities for building flood walls, a benefit-cost ratio of 60 was achieved along with saving 20,000 lives. Meanwhile early warning systems yielded benefit-cost ratios of 1 to 5.5, so it is not definite that significant savings result.

The scattering of results amongst various measures and locations highlights the lesson that "context matters". As Godschalk et al. (2009) summarize with respect to DRR grants in the U.S.A.: "each

dollar spent on mitigation grants saves society an average of $4 in real resource costs. As expected, benefit-cost ratios varied across hazards, reflecting individual hazard characteristics and local mitigation priorities." That is, results are usually neither generalizable nor transferable elsewhere.

For a volcano, Newhall et al. (1997) analyze the 1991 eruption of Mount Pinatubo in the Philippines. They give the monitoring and response costs at $56.5 million while the amount of property damage averted as a result of these actions is estimated to be a minimum of $500 million, not including over 5,000 lives saved. The equipment and lives saved, though, included those evacuated from two U.S. military bases which were severely damaged by the eruption. Not every location has such affluent assets at risk.

As well, the nature of the vulnerability sometimes dictates the nature of the DRR intervention. IADB et al. (2005) list examples of infrastructure destruction by tropical cyclones across four Caribbean islands, concluding "In all cases, the cost of rebuilding after the disaster was more than double the mitigation cost, and in the case of the Manley Library, reconstruction costs came to 20 times the mitigation cost". In each instance, engineering measures were the only mitigation measures possible to keep the buildings and bridges standing during winds and floods.

2. Quality of the evidence

A high quality and credibility of evidence is seen for two study categories: (i) studies published in peer-reviewed academic journals (e.g. Godschalk et al., 2009) and (ii) studies which provide the detailed calculation methods and numbers (e.g. Setchell, 2008). These types of studies are used for the above discussion. Other studies and reports simply quote a ratio without providing sources, citations, or details. These studies are not used in the above analysis because the quality of that work is inadequate, leading to major misunderstandings.

As a prominent example, many politicians and reports quote the World Bank as having calculated that DRR saves $7 (sometimes $4-7) for every $1 invested. One variation is that the World Bank and U.S. Geological Survey showed that $40 billion invested in DRR would have reduced disaster losses during the 1990s by $280 billion. No original, verifiable citations, calculations, or methods have yet been found, so the World Bank no longer promotes these numbers.

The high quality of studies with peer-review or full calculations must be tempered with limitations on the CBA method itself. Many subjective decisions must be made to reach the final ratio. Examples are the discount rate, the value of life and health, the opportunity cost of resources used for DRR, and which intangible costs and benefits to include.

CBA as a method demands numbers. Some of the arguably most important benefits (e.g. feeling of security and preserving life) and arguably most significant costs (e.g. the emotional burden of selling and moving from one's home to be out of a high risk zone) are not readily quantifiable. Often, the decision is simply not to consider these costs and benefits, as noted in the analyses by Newhall et al. (2007) and Setchell (2008). That severely reduces the quality of the evidence, but more positively provides a minimum benefit-cost ratio that can be used as a baseline.

3. Barriers to enacting DRR savings

The main reason why DRR savings are not always enacted is because political capital is rarely gained from cost-effective DRR measures. There are three principal dimensions to this challenge:

i. Those in power seek visible and tangible outcomes for expenditure, where they can point to something concrete (literally and figuratively) that they have achieved for their constituents. Flood walls, avalanche barriers, and other structures demonstrate that visibility.

ii. Those in power also tend to seek visibility for themselves. They gain more political capital with post-disaster aid than with less visible, longer-term DRR measures (Healy and Malhotra, 2009).

iii. More political capital is usually gained by doing something for constituents than by asking constituents to act. Large-scale visible measures, such as structures and post-disaster aid, give something to constituents without asking for much in return. Many cost-effective DRR measures require the constituents to act for themselves, such as obeying warnings or retrofitting.

In fact, those three dimensions apply to DRR in general. That is, the reality is that political capital is rarely gained from implementing DRR, except in cases where it is visible and tangible and so it might not have a benefit-cost ratio greater than 1—and might not even be the most effective DRR approach. In contrast, there are political advantages to hoping that a major catastrophe will not happen while a leader is in office—but then, if a catastrophe does occur, responding with full resources, irrespective of the cost.

To overcome such biases, subsidies for individual DRR measures alongside high-profile launches for the subsidy schemes could be effective. That is, DRR measures could be designed and implemented with explicit aspects included which gain political capital through the DRR measure. Some practitioners might have ethical concerns with deliberate application of this strategy—to be balanced with the ethics of needing to implement DRR.

The examples of DRR examined here were not investigated with respect to the political capital implications, such as which decision-makers gained or lost and why. It would be useful to expand this analysis beyond the numbers in order to delve deeper into each study to determine why each DRR measure was approved and by whom. Comparators would be needed with cases where DRR measures were suggested but not implemented. Key process questions are:

- Who were the drivers to enact DRR? Who facilitated the work and who imposed barriers?

- Did individuals or organizations take any credit or blame for the work done or not done?

- Did individuals or organizations gain or lose political capital due to the DRR measure being implemented or not?

- When the DRR measure was tested by a potential disaster, or when a disaster struck which the DRR measure could have mitigated or prevented, did individuals or organizations gain or lose political capital?

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