GENERATING MULTIPLE RESILIENCE DIVIDENDS FROM MANAGING UNNATURAL DISASTERS IN ASIA

OPPORTUNITIES FOR MEASUREMENT AND POLICY

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CONTENTS

TABLES AND FIGURES

TABLES

FIGURES

BOX

ABSTRACT

Despite solid evidence regarding the large benefits of reducing disaster risk, it has remained difficult to motivate sustained investment into disaster risk reduction (DRR). Recently, international policy debate has started to emphasize the need for focusing DRR investment toward actions that generate multiple dividends, including reducing loss of lives and livelihoods, unlocking development, and creating development cobenefits. We examine whether available and innovative decision support tools are fit-for-purpose. Focusing on the Asia region, we identify evidence of multiple dividends crafted using expert-based methods, such as cost–benefit analysis for selecting and evaluating "hard-resilience-type" interventions. Given a rising demand for "softer" and systemic DRR investments in projects and programs, participatory decision support tools have become increasingly relevant. As one set of tools, resilience capacity (capital) measurement approaches may be used to support actions and decisions throughout all stages of the project cycle. Measuring capacity for resilience dividends, not outcome, such tools can serve as participatory decision support for organizations working at community and other levels for scoping out how development and disaster risk interact, as well as for supporting the cogeneration of multiple resilience dividend-type solutions with those at risk.

Keywords: decision support, disaster risk, multiple dividends, resilience

JEL codes: O21, O22, Q56

I. INTRODUCTION: HOW TO CLOSE THE DISASTER RISK REDUCTION INVESTMENT GAP?

The burden from unnatural disasters is large and rising, particularly in the Asian region. Especially the uneven distribution across the region is noticeable and insurance penetration is overall low at under 5% (compared to 40% in developed countries) (UNESCAP 2017). Inadequate government funds, as well as a lack of private risk financing options have meant that from 2006 to 2015, countries in the Asia and Pacific region received approximately $5 billion in humanitarian assistance. While this number seems large, it is just around 10% of the average annual losses from natural disasters (UNESCAP 2017).[1] The long-term implications are substantial. A study by Koetsier (2017) found a large positive relation of disaster risk linked to natural hazards and level of government debt. At the same time, ex ante risk investment for reducing risk continues to be dwarfed by ex post spending. Many analysts, practitioners, and policy advisors have thus been wondering how to close the disaster risk reduction (DRR) investment gap.

A lot of focus has been put on just increasing ex ante investment in DRR (and climate change adaptation [CCA]) with some mixed success. Increasing attention is now being paid to approaches that link DRR with CCA and further with development interventions, which implies a policy-integrative and systemic investment approach. Not incidentally, 2015 saw a series of global disaster-climate risk-sustainable development negotiations leading to important compacts (Mysiak et al. 2015). The Sendai Framework for Action (SFA) presented a new blueprint for the global community for reducing and managing the burdens from disasters. While the predecessor conference in Kobe in 2005 already had lead-ins into "development," the SFA strongly focused on policy integration. Five out of the seven SFA targets establish links to development aspirations in terms of reducing poverty, promoting sustainable cities and communities, and managing climate change, while a specific target calls for better coordination of DRR with development and other sectorial policies (United Nations 2015).

The Sustainable Development Goals (SDGs) were passed as well in 2015, constituting a universal set of 17 goals and 169 targets that define development aspiration and ideally transformation up to 2030 for all signatory countries collectively (SDSN 2015). Disasters and climate-related impacts are mentioned in four SDG definitions explicitly and in many other goals more implicitly. The Paris climate agreement (UNFCC 2015) calls for limiting global warming to 1.5°C and asked the Intergovernmental Panel on Climate Change (IPCC) for a report on its feasibility. The IPCC in its recently published report has suggested that the ambitions for the 1.5°C limit require climate mitigation and adaptation, transformation supported by close integration of resilience-building as part of charting out climate-resilient development pathways (IPCC 2018).

These agreements have, to an important extent, been fostered by scientific input. Figure 1 shows how the international disaster risk discourse has moved over the last years and identifies three larger lines of evolution ranging from early constructions of disasters as “acts of god” to a current understanding of risk in terms of shaping development challenge and opportunity (adapted from Mechler, Mochizuki, and Hochrainer-Stigler 2016). The first line of evolution we identified is the transition toward dealing with “unnatural” disaster risks, involving understanding of the shaping of risk, as well as identifying options for managing risks. Still located within this transition focus (and visually identified as a next step in the evolution of the broad debate, while broadening to comprehensive risk

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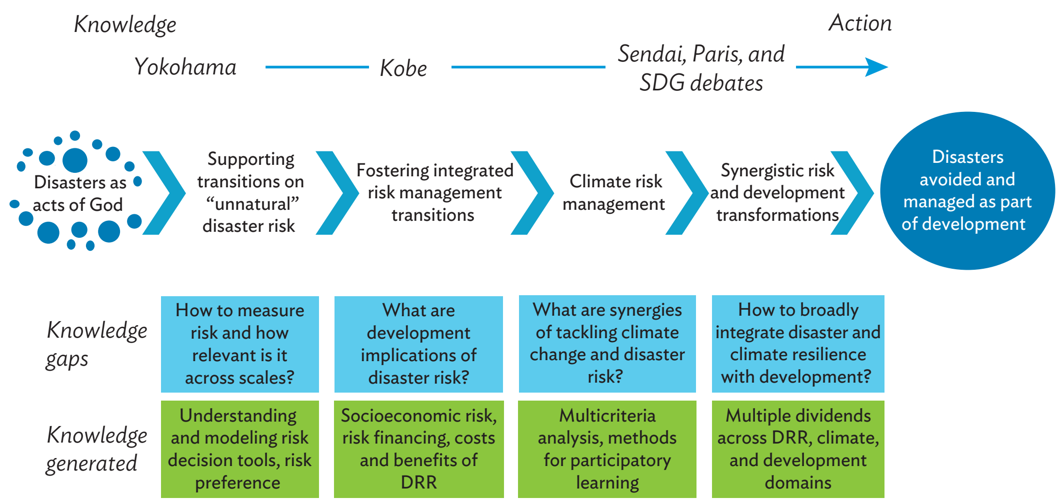
[1] While the literature is not consistent, a distinction is often made between *losses* associated with irreversibility (such as loss of life) and *damages* as impacts that can be alleviated or repaired, such as damages to buildings and other assets (see Boyd et al. 2017). We follow this distinction.

management), increasingly, stakeholder debate has received important emphasis in working toward managing socioeconomic risk and identifying novel risk financing and sharing tools. A second line of evolution is that, around the late 2000s, research and policy has started to focus strongly on shaping a joint perspective on managing risks associated with climate variability and change also involving multimetric decision-making as well as adaptive management and learning. Finally, in the more recent work, risk science for informing the post-2015 agenda and reaping multiple risk dividends have been the focus involving broad-based discourses (including a role for justice and transformational approaches).

Figure 1: Evolving Disaster Risk Reduction Discourse: Toward a Multiple Disaster Resilience Framing



DRR = disaster risk reduction, SDG = Sustainable Development Goal.
Source: Adapted from Mechler, Reinhard. 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): 2121–47.

Concurrently with this shifting discourse, decision-makers have been requesting actionable information and integrated metrics for understanding the benefits generated from managing risk, fostering climate adaptation, and building resilience. Understanding that "only" reducing damages and losses to lives and assets and to efficient recovery is not enough to trigger the requisite shift in DRR investments. A number of approaches have been proposed to pursue a multiple resilience dividend approach going beyond the standard rationale for DRR. This debate and framing has not been fully novel in terms of substance and has been discussed as part of cobenefits agendas; what has been innovative is the packaging and messaging, which basically develops a broad (social) business case for national treasuries, political decision-makers, and nongovernment organization (NGO) workers charged with building resilience (Vorhies and Wilkinson 2016). One prominent approach is the "triple disaster resilience dividend" approach. The framework (Surminski and Tanner 2016) suggests DRR spending, policy, and implementation should focus on deriving the following dividends: (i) avoiding and reducing direct and indirect disaster risk, damages, and losses; (ii) reducing background risk for unlocking development; and (iii) generating cobenefits that are not dependent on the occurrence of disaster events.

While discourse and rhetoric have progressed, concrete assessments of spending on and impact assessment around the three dividends has been far and few between, but with interesting insights. As one example, a recent study on community-based flood risk management in Viet Nam shows important dividends. The investments into community-owned infrastructure, livelihood capacity building, and training for flood response to strengthen resilience to climate shocks led to dividends in terms of reduced mortality and morbidity, avoided work-time loss, and minimized food purchases postdisaster for the community (first dividend), increased profits to self-help group from investments into pig rearing and rice trading (second dividend), and rainwater storage (third dividend). At the same time, the study suggests that infrastructure investments, particularly, require ongoing community maintenance (mostly labor), which the analysts see on track as target communities have seen the multiple benefits from the investment, and the decision-making process has been participatory and inclusive (Yaron 2017).

Our paper aims to lay out the rationale for and critically understand any evidence around the dividends. We organize our chapter along these two lines of focus: (i) multiple resilience dividend evidence and (ii) relevant accommodating decision-making processes for understanding and effectively generating the dividends. Throughout the examination, we pay ample attention to the case for building resilience in Asia, globally the most disaster-prone region, yet also a region with massive good and best practices to learn from.

The discussion is organized as follows. In section II, we first examine key aspects of the discourse in terms of the cobenefits suggestions taken forward in DRR, CCA, and SDG discussions before we present the multiple and triple resilience dividend proposition. Section III examines the evidence on disaster risk spending and activities. Section IV then presents decision support tools, metrics, and data for understanding outputs and outcomes from investments into resilience, which leads into a short discussion; and conclusions in section V.

II. COBENEFITS AND RESILIENCE: REVIEWING THE LITERATURE

There are two ways to approach the multiple dividend proposition. Approaching it from a (sectorial) disaster risk management view means making sure that DRR or CCA investments are set up so that cobenefits are created in other policy domains. IPCC defines cobenefits, also referred to as ancillary benefits, as "the positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the total benefits for society or the environment (IPCC 2018)." Starting from the (other) sectorial perspective, the mainstreaming proposition implies that CCA or DRR are integrated into "development" investments. For example, the Mekong River Commission (2013) proposes that "the potential impacts of climate change are considered and appropriate adaptation measures are integrated as normal practice within ongoing programme activities." We shortly discuss how cobenefits (mainly) and mainstreaming have been taken up in the debate, before we proceed to proposals for defining resilience dividends.

A. Discussion across Policy Domains

1. Disaster Risk Reduction

The Hyogo Framework for Action already saw DRR managed concurrently with development policy. The SFA builds on this and targets one to four (out of seven) have close links to SDGs 1 (poverty), 11 (sustainable cities and communities), and 13 (climate change); the 5th target itself calls for better coordination of DRR with development and other sectorial policies (United Nations 2015). Sendai is thus strongly integrative, yet it remains strongly on the side of the first dividend, particularly in terms of the progress indicators developed that are supposed to track Sendai achievements. Dividends beyond losses and damages are not mentioned directly, and the European Union's review report on DRR science in 2017 discussed the potential cobenefit from DRR, suggesting that solid evidence would indeed be highly desirable.

> Identifying suitable investments is not enough. Presenting evidence of additional dividends to policymakers and investors could provide a narrative reconciling short- and long-term objectives. This will improve the acceptability and feasibility of DRM investments, enhancing the business case for investment in prevention and mitigation (Poljanšek et al. 2017).

The next global opportunity for exchange is in mid-2019 at the Global Platform, which as part of the biennial review of the SFA, will focus on the "Resilience Dividend: Towards Sustainable and Inclusive Societies."

2. Climate Change Adaptation

In the climate space, a focus on identifying and prioritizing adaptation needs at national levels predominant in the early 2000s has been enhanced by a need to monitor and evaluate more strongly project and local adaptation interventions, which have been taken forward since adaptation has increasingly seen implementation during the 2010s. As well, a need to monitor achievement of the global adaptation goal set out by the Paris Agreement in 2015 has been identified (see Moehner 2018). As Noble et al. (2014) in IPCC's Fifth Assessment Report note, climate adaptation options generally are no longer supposed to address climate risks or opportunities alone, but rather options should make use of a cobenefits approach. This has meant that embedding climate change considerations in broader government policy, as well as private sector activities, has seen ample attention for addressing multiple, interacting stresses from climate and nonclimate sources. It has been well understood, however, that financial and other constraints may imply trade-offs and limit pursuing such multiobjective strategies. As well, the literature has documented that climate aspiration may also lead to maladaptation. In general, climate change research and policy have recognized that adaptation option scoping, selection, and monitoring require an iterative and sufficiently inclusive process (see Klein et al. 2014).

3. Sustainable Development Goals

The SDGs were passed as well in 2015, constituting a universal set of 17 goals and 169 targets defining development aspiration and ideally, transformation for all signatory countries collectively (SDSN 2015). The SDG debate casts an integrated and indivisive perspective on development: "integrated," as it requires a synergistic look across these broad development goals; "indivisive," as it involves all signatories (Dodds, Donoghue, and Roesch 2016). Achieving the United Nations' 17 SDGs would result in many ecological, social, and economic benefits that are interrelated. Risk is fundamental here in many regards. The compact and adopted indicators identify disaster risk management and climate adaptation as crucial channels toward achieving the SDGs for climate change, poverty, settlements, and health (SDSN 2015). These downside risks to be avoided and managed (disasters and climate-related impacts) are thus mentioned in four SDG definitions explicitly and in many other goals more implicitly. Overall the SDG process can be described as a process that puts increasing emphasis on a risk-taking lens, that is, enabling risk-taking into revenue and profit garnering activities to help lift people out of poverty.

B. Defining the (Resilience) Dividends

How can disaster and climate extreme cobenefits be maximized? In line with the disaster-climate-development nexus discussion, resilience definitions have seen evolution as well. Resilience theory and methods have been developed in the 1970s, importantly coined by thinking on ecological resilience, the resilience discourse has recently been strongly revived, partially also triggered by the aftermath of the financial crisis and by a recognized need to take forward new approaches to disaster and climate issues. Emphasis in this field has been particularly put on identifying synergies with developmental challenges, systemic risks, and actions (Keating et al. 2014). While some consider resilience the "new sustainability," it remains to be seen how this promising, if broad, conceptualization may help to stimulate necessary action on climate change and disaster risks, while seeking to foster an integration of social, ecological, and economic dimensions of sustainability challenges. As it is well understood that disasters increasingly impair sustainable development, the concept of resilience provides a chance to tackle prospective risk creation by integrating notions of upside and downside risk avoidance and management with upside risk-taking. A definition by Keating et al. (2016) builds on the ongoing evolution in the (un)natural disaster risk community toward embracing a forward-looking concept of resilience and suggest the following conceptualization of resilience.

> The ability of a system, community or society to pursue its social, ecological and economic development and growth objectives, while managing its disaster risk over time in a mutually reinforcing way (Keating et al. 2016).

This dynamic perspective may colloquially also be framed as "bouncing forward" in contrast to the original stability-focused resilience framing of "bouncing back" (Holling 1973).

As well, resilience discussions have led to a distinction between "hard" and "soft"" measures (see Moench, Mechler, and Stapelton 2007). Hard resilience refers to the strengthening of structures and physical components of systems to brace against shocks imposed by extremes such as earthquakes, storms, and floods. In contrast, soft resilience can be built by a set of less tangible and process-oriented measures, as well as policy, such as bolstering preparedness, raising risk awareness, and improving risk governance, to robustly cope with events as they occur and minimize adverse outcomes. It may be argued that the key distinction is learning to live with risk, rather than assuming risk can fully be eliminated. Of course, a balanced approach of interventions seems most useful, and IPCC's special report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* has suggested the following:

> Effective risk reduction generally involves a portfolio of actions to reduce and transfer risk and to respond to events and disasters, as opposed to a singular focus on any one action or type of action (*high confidence*). Such integrated approaches are more effective when they are informed by and customized to specific local circumstances (*high agreement, robust evidence*). Successful strategies include a combination of hard infrastructure-based responses and soft solutions such as individual and institutional capacity building and ecosystem-based responses (IPCC 2012).

1. The Triple Dividend Approach

The Triple Dividend approach (see Surminski and Tanner 2016) builds on this ongoing evolution in the resilience and disaster–climate–development literature and suggests a broad case of DRR investment that returns benefits even in the case of no disasters occurring. It defines three resilience dividends as follows (Figure 2):

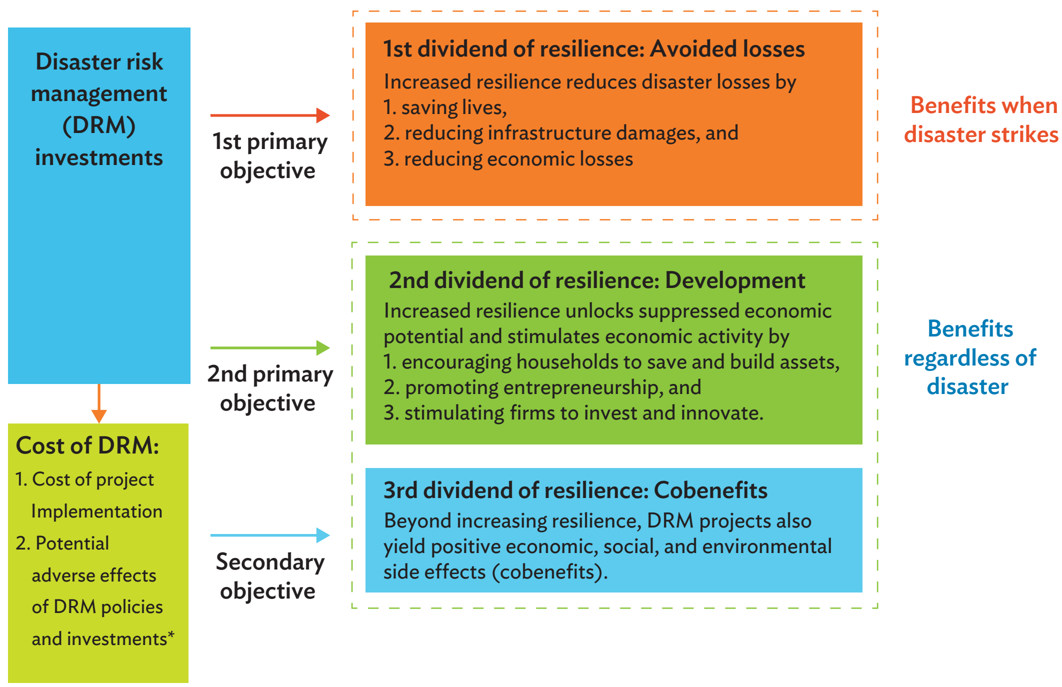
(i) *avoiding and reducing direct and indirect disaster risk and losses* to lives, livelihoods, and private and public assets by bolstering DRR and CCA downside risk management;

(ii) *reducing background risk for unlocking development* through comprehensively managing disaster risk to minimize development impacts and risks (including upside risk management benefits from shifted risk profiles, through risk financing insurance and social protection at micro and macro levels); and

(iii) *generating development cobenefits that are not dependent on the occurrence of disaster events*. This means pursuing a synergistic strategy of managing disaster risks and promoting development by way of systemic investments.

These types of benefits can be compared to the cost of project implementation (spending) and any adverse effects created (cocosts) to calculate net dividends (benefit–cost ratio and other metrics).

Figure 2: Triple Disaster Resilience Dividends Framework



Note: *For example, rising land prices due to land use restrictions may harm the poor.
Source: Surminski, Swenja, and Thomas Tanner, eds. 2016. *Realising the 'Triple Dividend of Resilience.' A New Business Case for Disaster Risk Management*. Heidelberg: Springer.

While the debate has been going forward in terms of definitions and concepts, there is little in the way of a literature that documents evidence on the multiple (or triple) dividend framing in terms of investments and sectorial application. The volume by Surminski and Tanner (2016) presents some anecdotal evidence in terms of qualitative case studies on Jamaica, the Lao People's Democratic Republic, Mexico, the Philippines, and Viet Nam (Vorhies and Wilkinson 2016). One cost–benefit analysis of flood risk management in Myanmar by Yaron (2017) builds explicitly on the three dividends. Weingaertner, Simonet, and Caravani (2017) discuss the applicability of the framework for climate and disaster insurance as one of the few contributions.

III. PROJECT AND PROGRAM SPENDING: IN LINE WITH A MULTIPLE DIVIDENDS LOGIC

We now turn to examining institutional and national frameworks and spending to see how these may align with dividend rhetoric and approaches. Due to data availability and interest, we mostly focus on the risk management portfolio in DRR and CCA of the Asian Development Bank (ADB).

A. Disaster Risk Reduction

Kellet and Caravani (2013) reported that globally about 87% of disaster spending had gone into response and relief, and only about 13% into risk management and prevention. This was considered a small shift in the balance, which had been 90% and 10%, respectively a decade earlier. According to the Organisation for Economic Co-operation and Development (OECD) Creditor Reporting System (OECD 2018a), of the overseas development assistance (ODA) for the period 1997–2016 across the four disaster risk management categories (flood prevention and control, emergency response, reconstruction and rehabilitation, disaster prevention and preparedness) for all of Asia, 61% was spent on emergency response, 23% on reconstruction and rehabilitation, 8% on flood prevention and control, and 8% on disaster prevention and preparedness. This makes ex post ODA for Asia 84%, while 16% of ODA was spent ex ante. However, information on DRR spending is generally fragmented. According to an OECD study, out of the 17 OECD countries asked, only half responded that they knew the amount of public spending (the dominant source of funding) to manage disaster risks in their countries (OECD 2018b). A corresponding survey revealed that only a small number of them collected detailed information about yearly expenditure for DRR, including Austria, Colombia, France, Japan, and Turkey. This lack of adequate country spending information on DRR and CCA makes it difficult to work toward a broader view on DRR and CCA investments.

As ADB (2012) shows, development organizations are more active and along the Hyogo Framework for Action (HFA) priorities have shown a lot of focus on mainstreaming and policy interaction along HFA 1, 4, and 5 with work areas comprising: mainstreaming of DRR into urban planning, management, and governance; reducing underlying risk factors by building disaster resilience of critical infrastructure, land use planning, environmental and resource management, and climate change adaptation; and integrating DRR into the education sector (Table 1).

Table 1: Disaster Risk Reduction Activities of Development Organizations along Hyogo Framework for Action Priorities

Areas of Work in DRR (Corresponding to HFA Priorities)	ADB	AusAID	GIZ	JICA	UN OCHA	UN Habitat	UNDP/BCPR	USAID	World Bank
HFA 1: Making disaster risk reduction a policy priority, institutional strengthening									
Integrate DRR into national and local plans		*	*				*		*
National and local disaster risk management and action plan formulation		*		*			*	*	

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Table 1 *continued*

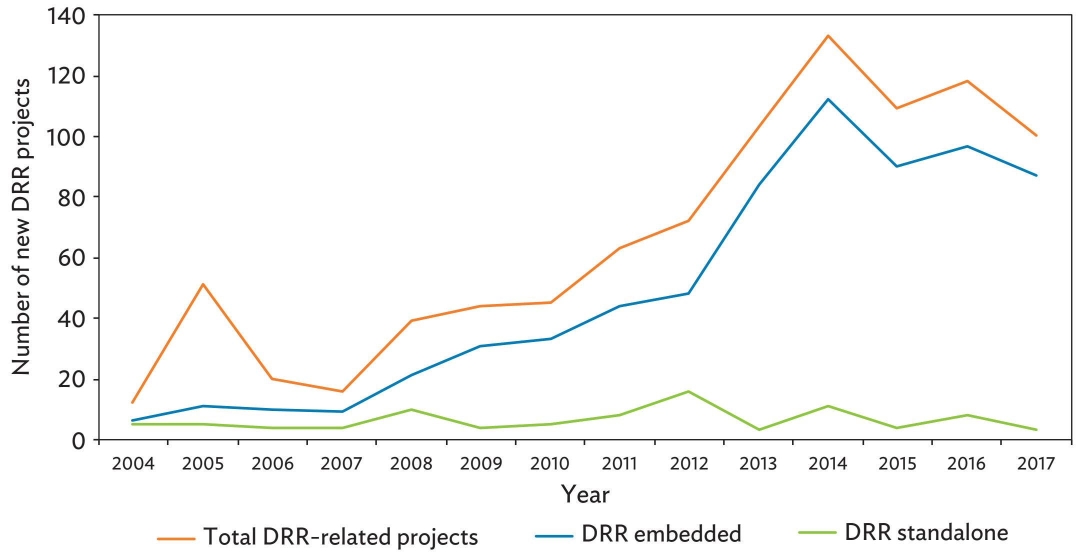
Areas of Work in DRR (Corresponding to HFA Priorities)	ADB	AusAID	GIZ	JICA	UN OCHA	UN Habitat	UNDP/BCPR	USAID	World Bank
Strengthening national and local government institutions and legislative framework for DRR	*		*	*					
Integrate DRR into urban planning, management, and governance		*				*			
HFA 4: Reducing underlying risk factors									
Building disaster resilience of critical infrastructure, low-income housing, public buildings and facilities, and economic activities	*	*	*	*	*				*
Urban disaster risk reduction	*	*		*		*	*		*
Land use planning		*	*	*					
Environment and natural resource management	*		*	*					*
Climate change adaptation	*	*	*		*		*		
HFA 5: Preparedness for effective response									
Integrating disaster risk management into the education sector	*	*	*						

ADB = Asian Development Bank; AusAID = Australian Agency for International Development, now Department of Foreign Affairs and Trade; BCPR = Bureau for Crisis Prevention and Recover; DRR = disaster risk reduction; GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit; HFA =Hyogo Framework for Action; JICA = Japan International Cooperation Agency; UNOCHA = United Nations Office for the Coordination of Humanitarian Affairs; UN Habitat = United Nations Human Settlements Program; UNDP = United Nations Development Programme; US AID = United States Agency for International Development.
Source: Adapted from Asian Development Bank. 2012. *ADB's Response to Natural Disasters and Disaster Risks.* Special Evaluation Study. Manila.

The World Bank's portfolio for disaster risk management has increased by nearly 50% over the fiscal years 2012–2016 from $3.7 billion to $5.4. billion. A main focus has been to mainstream disaster risk management into development efforts through a combination of financing, technical assistance, capacity building, and knowledge sharing activities. The World Bank has supported client countries with innovative tools to identify risk and financial products to protect national budgets (World Bank 2017).

Since crafting its Disaster and Emergency Assistance Policy in 2004, ADB has increasingly been addressing DRR particularly through embedding it into its portfolio of development loans and projects, encouraging development planners to include risk reduction activities in their projects and programs. While the number of stand-alone projects focused on DRR remained somewhat constant over the period 2004–2017, at about 6–7 projects per year, development projects that embedded at least one DRR component increased strongly from about 10 projects annually in the later 2000s to about 30–40 per year around 2010 and close to 100 projects per year recently. By far, the majority of the DRR-related projects were conducted to support flood risk management holistically, as part of water resource management, irrigation, and drainage efforts (Figure 3).

Figure 3: Number of Disaster Risk Reduction Projects Run by the Asian Development Bank, 2004–2017



DRR = disaster risk reduction.
Source: Asian Development Bank. Database on DRM-Related Projects for 2004–2017 (accessed 20 December 2018).

B. Climate Change

At ADB, climate change spending has become the dominant source for risk management spending, represented by 87 technical assistance operations and more than half of spending for the period 1995–2011. ADB, in its Climate Strategy 2017–2030, focuses on strengthening sustainability and building resilience. As to climate adaptation, spending has increased over the last few years from about $750 million in 2011 to about $1,200 million in 2016. Managing "unnatural disasters" features prominently in ADB's climate change operational framework for the period 2017–2030. The framework overall has a strong focus on cobenefits, as it aims at integrating climate change adaptation with disaster risk management and the broader sustainable development agenda. It seeks "to optimize multiple benefits from actions in response to the Paris Agreement, the SDGs, and the Sendai Framework Monitor." (ADB 2017). The approach suggests to create regional public goods and cobenefits with regard to gender equity (SDG 5), health (SDG 3), water (SDG 6), and ecosystems (SDG 15). The strategy aims to build resilience across agriculture and natural resource management, in integrated water resources management in rural areas and in the urban space, particularly in small and medium-sized cities where development is just about to happen. Also, a cornerstone of the strategy is to foster solutions at community levels that are demand driven and empowering, such as livelihood diversification, ecosystem-based adaptation, and stronger early warning systems. Overall, however, the proposed results framework for monitoring the implementation over the period 2017–2030 seems to still be mostly focused on the first dividend, and outcomes are defined as reducing loss of life and assets.

C. The Nongovernment Organization Perspective on Disaster Risk Reduction Operations

Humanitarian and development NGOs are being challenged to pick up multiple dividend framing for programming and implementation. For example, Practical Action, a development NGO, sees the challenge as

> … the nagging feeling that a disaster could wash away generations of hard work by a community in seconds. The limitation for the humanitarian sector is a focus on urgent needs and getting the community back on track, without having the luxury of remaining with the community as they start to rebuild their lives. Thus, the transition from Disaster Risk Preparedness/Management into Community Development, that is ideally sustainable and long-term, is widely recognized as a critical challenge in international development. At the same time, for communities around the world wellbeing is dependent on the ability not only to respond to hazards but also to make the right choices about their future development (Mechler et al. 2018).

Investments have followed rhetoric along disaster development lines. As one example, NGO partners of the Zurich Flood Resilience Alliance, a multiactor partnership launched in 2013 to enhance communities' resilience to flooding at local to global scales have strongly focused on generating cobenefits in their activities. Of the 129 communities worked in a first project phase from 2013 to 2018, a substantial amount of activities were undertaken, which can be said to follow a multiple dividend path of logic.

Box: Flood Resilience Alliance Resilience Portfolio, 2013–2018

Humanitarian and development nongovernment organizations of the Flood Resilience Alliance, which has a strong presence in Asia (Afghanistan, Bangladesh, Indonesia, Nepal, and Timor-Leste) implemented the following flood risk management projects at the community level. Particularly second and third dividends are being considered as follows:

Second resilience dividend: Unlocking development

- end-to-end early warning systems integrated with weather boards; and
- hydroponics in 275 locations serving 20 communities, providing a source of food during and after floods, as well as potential new livelihood strategies (generating new income).

Third resilience dividend: Disaster risk reduction and development benefits

- strengthening community-based waste management to reduce flood risk caused by garbage that disrupts drainage systems;
- 67 small-scale physical flood mitigation works, such as the improvement of roads, bridges, culverts; and
- construction of four multipurpose evacuation and community centers as safe shelters during floods.

Source: Zurich Flood Resilience Alliance. 2018. *The Zurich Flood Resilience Program – Phase 1 from 2013–2018. Stocktaking and Impact Evaluation Report*. www.zurich.com/_/media/dbe/corporate/knowledge/docs/report-the-zurich-flood-resilience-program.pdf.

IV. DECISION SUPPORT, METRICS, AND EVIDENCE ON RESILIENCE DIVIDENDS

The call for measuring multiple dividends and the shift in resilience from hard to soft (or integrated hard–soft) interventions requires appropriate decision support methods and tools. We discuss evidence in terms of tools available and applied to inform action on resilience dividends.

A. Decision Support for Project Investment and Evaluation

A number of decision support tools, which can inform different stages of the decision cycle, can be distinguished. Particularly in climate research, as a response to the substantial uncertainties and complexities found in socioecological systems interacting with climate-related stressors, analysts have been emphasizing iterative and adaptive decision-making and learning processes for fostering transitions from ex-post to ex-ante action (see Chambwera et al. 2014, Lavell et al. 2012, O'Brien et al. 2012, Jones et al. 2014, Noble et al. 2014). Decision-making on adaptation and climate risk management has broadened from expert-based tools, such as cost–benefit analyses, that identify "best economic adaptations" to decision tools that conduct multimetric evaluations with stronger consideration for nonmonetary and nonmarket measures, risks, equity issues, barriers, and limits as well as cobenefits of actions (Chambwera et al. 2014). Table 2 lists relevant decision tools, and Figure 3 organizes those around the logic of a project cycle.

Table 2: Applicability of Decision Support Tools for Resilience Option Assessment

Tool	Opportunities	Challenges	Typical Application	Multiple Dividends
Expert-focused tools for option selection				
Cost–benefit analysis	Rigorous framework based on comparing costs with benefits	Need to monetize all benefits; difficulty in representing intangible impacts, such as value of life	Well-specified hard-resilience projects with economic benefits (e.g., flood risk prevention)	Yes, but most suitable for hard resilience assessment
Cost-effectiveness analysis	Ambition level fixed, and only costs to be compared; intangible benefits, particularly loss of life, do not need to be monetized	Ambition level needs to be fixed and agreed upon	Well-specified interventions with important intangible impacts, which should not be exceeded (loss of life, etc.)	Difficult, cost-effectiveness analysis requires well-specified single objective
Robust decision-making approaches	Addresses uncertainty and robustness	Technical and computing skills required	Projects with large uncertainties and long time frames (context of climate change where flood return periods may become more uncertain)	In principle, yes, in practice difficult, as these require well-specified objective definition and quantitative data
Participatory tools for informing iterative risk management decisions assessment, selection, and monitoring and evaluation				
Multicriteria analysis	Consideration of multiple objectives and plural values	Subjective judgments required, which hinder replication	Multiple and systemic interventions involving plural values (e.g., investing in infrastructure and education)	Yes, strongly participative
Adaptation pathways	Scenario-based decision-making at decision points depending on future system changes	Considerable investment into scenarios and stakeholder interaction	Portfolios	Yes, can also be supported by decision tools with quantitative outcomes

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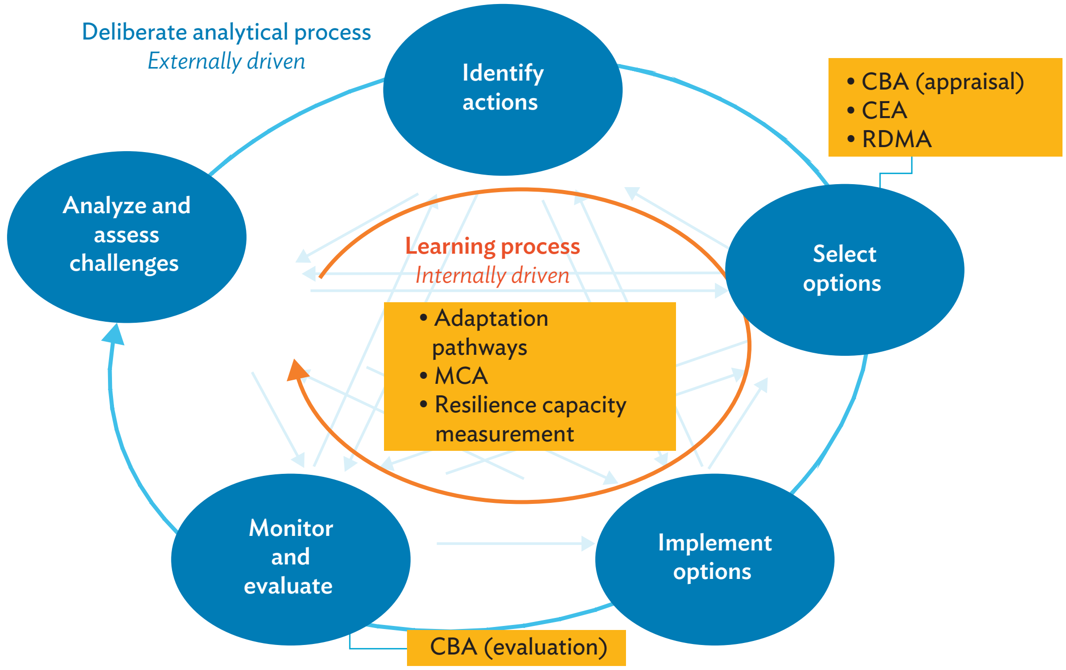
Table 2 *continued*

Tool	Opportunities	Challenges	Typical Application	Multiple Dividends
Capacity and resilience assessments (vulnerability capacity assessments, flood resilience measurement for communities tool)	Measure and monitor capacity change over time; aligns with community-based decision process	Cannot be linked to individual intervention assessment, but program-level activities	Community-level resilience assessment	Yes

Source: Authors' own.

The table lists key decision tools to be used for the project cycle. We distinguish between more strongly expert-focused tools for option selection (cost–benefit analyses [CBA], cost-effectiveness analyses [CEA], and robust decision-making approaches [RDMA]) and more participatory methods for informing iterative risk management decisions in terms of assessment and selection, as well as monitoring and evaluation. We organize these decision tools in an exemplary fashion according to a project cycle logic including (i) assessment of the system, capacities, and needs; (ii) identification of possible actions; (iii) selection of most suitable actions; (iv) implementation; and finally (v) monitoring and evaluation. The cycle can essentially be driven internally by community learning and externally by analytical processes and support. We discuss how decision tools can be used to support this cycle so that multiple dividends are considered and eventually realized. Tools at the fringes of the cycle are more expert oriented; those inside are considered more participatory (Figure 4).

Figure 4: Project Cycle and Decision Support Tools



CBA = cost–benefit analysis, CEA = cost-effectiveness analysis, MCA = multicriteria analysis, RDMA = robust decision-making approaches.

Source: Adapted from International Institute for Applied Systems Analysis and Zurich Insurance Company. 2015. *Turning Knowledge into Action Processes and Tools for Increasing Flood Resilience.* Zurich.

B. Decision Tools for Project Selection

CBA is a widely used decision support tool to assess economic efficiency of DRR (and CCA) at the project and the program levels. CBA is based on the economic efficiency criteria of maximizing net benefits over time, which can be measured by the benefit–cost ratio and other metrics (see Mechler 2016). There has been a push for using it in DRR and CCA applications, and over time critical technical issues have been taken care of, such as probabilistically accounting for disaster risk. A review of CBAs in 2016 on assessments used to assist in either ex ante implementation (appraisal) or to justify their investment ex post (evaluation) found that the evidence indeed supported a strong economic case for DRR. The review identified that across a range of hazards and interventions, DRR benefits outweigh costs by a ratio of 4:1 (Mechler 2016). While considering direct, indirect, and systemic benefits, the study did not specifically build on a dividend perspective. Taking this review forward and extending the database to 65 studies, we identify 15 studies that can be said to have examined interventions along the multiple dividends logic. A recent study by Yaron (2017) even builds explicitly on the three dividends. The 15 studies (out of 65) that had taken a multiple-resilience-benefits type of approach show a variety of analyses taken addressing extreme weather, flooding, earthquake, coastal floods, and drought. Seven analyses are appraisals examining potential benefits (selection stage) and the other eight evaluate interventions and actual benefits (monitoring and evaluation stage) (Table 3).

Table 3: Overview of Cost–Benefit Analyses Following a Multiple Dividend Logic

Focus	Author (Year)	Type	DRR Intervention	B/C Ratio	Costs Considered	Benefits Considered
Meteorological services, People's Republic of China	Guocai and Wang (2003)	E/H/ D1,3	Meteorological services	1.4	Cost of nonstructural interventions	Economic benefits gained through (public) utilizing weather services and avoiding losses; (government, business) disaster planning
Flood control policies, Netherlands	Brouwer and van Ek (2004)	A/H+S/R D1,3	Traditional dykes versus floodplain restoration, multifunctional land use, and biological diversity	n.a.	Cost of land use changes, damage to crops, protection of infrastructure, operation and maintenance	Avoided economic, social, and environmental impacts; recreational benefits; positive effects on public safety; landscape and nature conservation; benefits of system functions of wetlands
Water management and flood protection scheme, Indonesia	Mechler (2005)	A/H/R D1,3	Integrated water management and flood protection scheme	2.5, range: 1.9–2.5	Improved floodway construction, dam construction, drainage system construction	*Direct*: avoided damage to buildings, assets, machinery, roads, in residential, public, and economic sectors, loss of life. *Indirect*: avoided loss of services, loss of purchasing power, disease and poverty
Climate risk screening, India	Tanner et al. (2007)	A/H/R D1,3	Rainwater harvesting in primary school in Eastern Rajasthan	1.14	Building water collection tank	Reduced water shortages, reduce water bills
Ethiopian livelihood plan against drought risk	Hess, Wiseman, and Robertson (2006)	E/S D1,2,3	Contingency finance for livelihoods and productive assets against weather shocks	4, range: 1–6	Costs of disbursed triggered funds to beneficiaries and setting up a livelihood protection plan	Relief through food safety nets and food aid, emergency relief costs, education gains by keeping children in school

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Table 3 *continued*

Focus	Author (Year)	Type	DRR Intervention	B/C Ratio	Costs Considered	Benefits Considered
Drought risk management, India	Mechler et al. (2009)	A/H/R D1,3	Irrigation and (subsidized) microinsurance	1.9–2.0	Irrigation: cost of borehole for groundwater pumping; investment in seeds and pumping; government insurance subsidies, farmer premium	Stabilization of income and consumption, reduced relief expenditure
Flood mitigation in the lower Bagmati Basin, Nepal and India	Dixit et al. (2008)	A/H/ D1,3	Various flood risk reduction strategies in the lower Bagmati River basin across the Nepal Terai and into Northern Bihar, India	Embank ment likely in-efficient	Costs of specific measures and interventions as well as inclusion of the cocosts of measures when applicable	Benefits for different population groups: secure access to food, shelter, drinking water, clothes, and energy; affordable health services and sanitation; access to education; and access to reliable education systems
Oxfam America disaster preparedness, El Salvador	Oxfam America (2010)	E/H+S D1,3	Improved evacuation shelters, training for communities on improved preparedness and evacuation	0.97	Cost of shelters, supplies, and training	Mostly indirect benefits: decrease in loss of school days; reduction in diarrhea as a result of clean water; improved general health; and better evacuation of household goods and animals
Costal afforestation for disaster risk reduction, Viet Nam	IFRC (2011)	E/H/ D1,2,3	Mangrove afforestation along coastline, bamboo planting between river banks and dykes, tree planting along coastline	3.1–18.6	Afforestation cost	Flood protective benefits of mangroves: avoided direct and indirect losses, economic benefits to planters' income; increased yields; ecological benefits (carbon value, nutrient retention, sediment retention, biodiversity habitat)
Community-based disaster risk reduction, Bangladesh	Eucker, Bolte, and Rahmadana (2012)	E/H+S D1,2	Community planning (household plinths), livelihood support (rice distribution), emergency training	range: 1.2–4.9	Material for plinth construction, road construction, seed provision, cash grants, fishing and livelihood materials	*Direct benefits only*: reduction in household damage from plinths; yield increase from rice seed provision
Earthquake mitigation, Nepal	Khan et al. (2012)	A/H/R D1,3	Utilizing straw bale in building construction instead of using brick	2	Constructing of straw bale houses, cheaper than the traditional brick houses; maintenance costs	Direct: reduction in lives lost, reduced price of building materials. Indirect: Reduced heating and/or cooling costs, straw bale structures are resistant to earthquakes (reduced lives lost), use less child labor (common for brick construction); improve air quality
Climate risks, Viet Nam	Khan et al. (2012)	A/H/R D1,2	Installation of a boat wench system	3.5	Investment cost includes building and implementing the new wench system	Reduction in sunken boats and ships, damaged boats and ships, damaged houses, cost of livelihood disruption from false alarms

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Table 3 *continued*

Focus	Author (Year)	Type	DRR Intervention	B/C Ratio	Costs Considered	Benefits Considered
Early response and disaster resilience, Ethiopia and Kenya	Venton et al. (2012)	E/S/ D1,2	Late versus early humanitarian response, and under various disaster resilience implementation	Kenya 2.9, range: 0.4–5.5. Ethiopia 2.8	Cost of response and resilience	Livelihood protection: ensure survival, access to basic services, achieve minimum standard of living
Flood reduction under changing climate conditions: Rohini River Basin, India, and Nepal	Kull et al. (2013)	E/H+S/R D1,2	2 options: 1. Hard resilience - Flood embankments 2. Soft resilience - "People-centered" approach	Ave: 2, 1–4 resp. 2–2.5	Embankment costs and cocost (for hard resilience): waterlogging; Egalitarian strategy: more capital costs due to more interventions	Direct: reduction in crop, livestock, housing, assets, public infrastructure, health, and wage losses; Indirect: benefits to agricultural productivity, community grain, and seed bank
Myanmar	Yaron (2017)	E/H+S D1–3	Community planned infrastructure, livelihood capacity building and training for flood response to strengthen resilience to climate shocks	5.5 (2.4 3.2, 10.8)	Home gardening, organization of self-help groups, rainwater storage, cyclone shelter, flood embankment, pig breeding program, school flood proofing	Saving in food purchase for community, returns self-help group investments (profits), avoided mortality and morbidity, reduced direct flood damages, avoided worktime loss

A = appraisal to select project, B/C = benefits to costs, D = deterministic, DRR = disaster risk reduction, E = evaluation done ex post, H = hard resilience, IFRC = International Federation of Red Cross, ISET = Institute for Social and Environmental Transition, n.a. = not available, R = risk-based analyses, S = soft resilience.

Note: Shading indicates evidence from the Asia region.

Source: Own database extended from Mechler, Reinhard. 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): 2121–47.

Two studies report cocosts such as on agriculture through flood embankment-induced waterlogging. Out of 15, eight analyses had taken a specific risk approach. Only two studies examined soft resilience interventions, while five compared soft and hard resilience options, and eight analyses focused on hard, infrastructure interventions. Only one study focused on an OECD country, while the other analyses are located in a development context. As a synthesis, Table 4 summarizes representative studies and the reported resilience dividends. Evidence across the various hazards relates strongly to dividends 1 and 3, whereas dividend 2 has been more difficult to capture, requiring some advanced economics expertise to elicit the change in background risk and improved enabling environment so that development in a broad sense is stimulated.

Comparing dividends for the selected studies to the whole sample of analyses from our database, we find an average benefit–cost ratio of 6.7 compared to the average cost–benefit of around 5.1. Two caveats need to be brought in: the small sample exhibits a wider range of estimates (ratios for individual studies between 2.3 and 28). Another issue is that the robustness of the estimates compiled is not clear, as only less than half truly estimate risk based on probability, which renders estimates a bit questionable (in the whole sample, more than 80% use a probability-based approach). The review overall demonstrates that using CBA as a decision tool for assessing hard resilience interventions is feasible (with caveats), while soft resilience is more difficult to measure, and reported results on the dividend need attention. The case of the Rohini River (Kull et al. 2008; Kull, Mechler, and Hochrainer-

Stigler 2013) exemplifies the challenges of considering intangibles and soft resilience issues. This study focused on the river system in India and Nepal, implementing actions on the reduction in crop, livestock, housing, assets, public infrastructure, health and wage losses (dividend 1). Also, agricultural productivity is enhanced generally (dividend 2), as are community grain and seed banks (dividend 3). Yet, cocosts through waterlogging have to be factored in as well (Appendix 1 explains this case in more detail).

Table 4: Reported Resilience Dividends in Representative Cost–Benefit Analysis Studies

Risk Management Intervention	Dividend 1: Losses and Damages Avoided and Reduced	Dividend 2: Unlocking Development	Dividend 3: Cobenefits
Meteorological services	Avoided mortality, improved preparedness from weather extremes		Utility from weather predictions
Alternative flood control approach	Avoided economic, social, and environmental impacts		Recreational benefits, positive effects on public safety, landscape and nature conservation, benefits of system functions of wetlands
Flood management under climate change	Reduction in damages to crops, livestock, housing, assets, public infrastructure, health, and wages but cocosts through waterlogging	Agricultural productivity enhanced generally	Community grain and seed bank
Drought risk management	Reduced relief expenditure	Stabilization of income and consumption	Benefits from installed irrigation infrastructure
Mangrove afforestation against coastal flooding	Avoided direct and indirect flood damages	Economic benefits to planters' income, increased yields	Ecological benefits (carbon value, nutrient retention, sediment retention, biodiversity habitat
Earthquake-proof construction using straw bale	Reduction in lives lost		Reduced price of building materials. Indirect: Reduced heating and/or cooling costs, decrease in child labor (common for brick construction), improved air quality

Source: Own database extended from Mechler, Reinhard. 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): 2121–47.

Finally, how much of the reported CBAs have informed decisions remains unclear. While in OECD countries the usage of CBA is often required for investment decisions that use government funds, this is not the case for development interventions. A World Bank review in 2010 showed that the usage of cost–benefit analysis for informing decisions on projects has been declining. CBA seems often only to have been done after key decisions had been taken with the technical analysis often prepared by consultants, while senior project staff appeared to be more interested in aspects related to project safeguards, procurement, and financial management. As another consequence, the potential of CBA to support learning during project appraisal and implementation has been considered very limited (World Bank 2010).

1. Other Expert-Based Decision Tools

Quantitative tools that circumvent the monetization problem include CEA and RDMA. CEA is a special case of CBA used to identify least cost options to meet a certain, predefined target or policy objective. It may also be used when the benefits of alternative options are assumed to be similar enough that only costs need to be calculated. As the project costs are the key variable of consideration and subjected to finding lowest cost solutions, CEA does not require the quantification of benefits (which are fixed and/or decided beforehand as a target, such as reducing disaster fatalities and losses to a certain level). Thus, an advantage of CEA is that there is no need to monetize benefits of DRR. One example is an assessment of the cost-effectiveness of seismic retrofit in Romania conducted by the World Bank (World Bank 2004). The analysts selected projects guided by the achievement of certain safety levels (indicated as loss of life per events) while minimizing the cost of retrofitting.

RDMA have been increasingly emphasized recently, particularly in the context of climate change adaptation. This set of approaches builds largely on given system states running a set of quantitative scenarios into the future. Drawing away from optimal decision-making (such as supported with CBAs), the selection of options is based on *minimum regret*, that is, minimal losses in benefits in a chosen strategy where some parameters have been uncertain. As one example, Lempert et al. (2013) discuss the case of managing flood risks in Ho Chi Minh City. This RDMA engaged stakeholders to evaluate the robustness of various flood risk reduction options. Computational runs simulated 1,000 scenarios with a spread of socioeconomic and climatic uncertainty. The plan identified by more traditional risk reduction processes was identified to be fairly robust for future population and economic trends. However, the analysis found that it was not robust to increases in rainfall intensity and river rise that have a good chance of occurrence due to climate change. The process allowed for the identification of additional measures to reinforce the plan in case of rainfall increase and river rise. While in theory the method can be applied to a multiple dividend set-up, in practice, given the need to simulate a large set of quantitative data, a specific objective with few variables is required.

C. Decision Support for Soft Resilience and Adaptive Management

Given a stronger call for soft resilience assessments and participatory techniques, other decision support tools have a role to play. As an incremental step forward, qualitative CBA as suggested by Vorhies and Wilkinson (2016) may involve simply drawing up lists of direct benefits, cobenefits, and costs. The authors provide evidence of cobenefits using this approach for a number of cases, including drought risk in Jamaica, flood protection in Mexico, livelihood related instruments in the Lao People's Democratic Republic, secure housing program in the Philippines, and mangrove planting in Viet Nam. This intuitive approach, while not leading to quantifiable estimates, may serve as an organizing principle and can be used to feed into more methodological approaches, such as multicriteria analysis (MCA) and adaptation pathways.

1. Multicriteria Analysis

MCA refers to a flexible set of decision processes ranging from exercises that conduct informal weighting of values to the use of computerized algorithms for ordering options. A key application consideration revolves around who determines the weights. If weights are determined by one analyst or a small group of experts, then the analysis may have internal consistency and defendable fundamentals, but may lack public acceptance and legitimacy. The potential for MCA to be used in a stakeholder setting is a key strength and MCA can be a powerful tool for stakeholders to jointly articulate values and explore potential trade-offs. Typically, MCA is employed where the benefits are not easily quantifiable. MCA is seen as an attractive and important decision support methodology in environmental decision-making in particular (Steele et al. 2009) as it is perceived as more palatable and flexible than CBA (and CEA) because it allows for a systematic exploration of options without the need to monetize all values, which is often seen as contentious when applied to environmental or social assets and human lives (for an example see Appendix 2).

2. Adaptation Pathways

Particularly in the climate change domain, the adaptation pathways method has seen due attention for adaptive decision-making in the context of risk and uncertainty. The approach is steeped in today's decision problem space and charts out possible pathways into the future by considering decision moments, relative costs of options, and potential coeffects. The method is fully flexible and can thus embrace CBA and MCA information and cobenefits: Yet a defining characteristic is the sequential decision-making along a series of decision points contingent on alternative external developments over time (see example in Appendix 3). At those points, decisions may be taken in a more expert-based mode or may build strongly on deliberative process (Haasnoot et al. 2011, 2015).

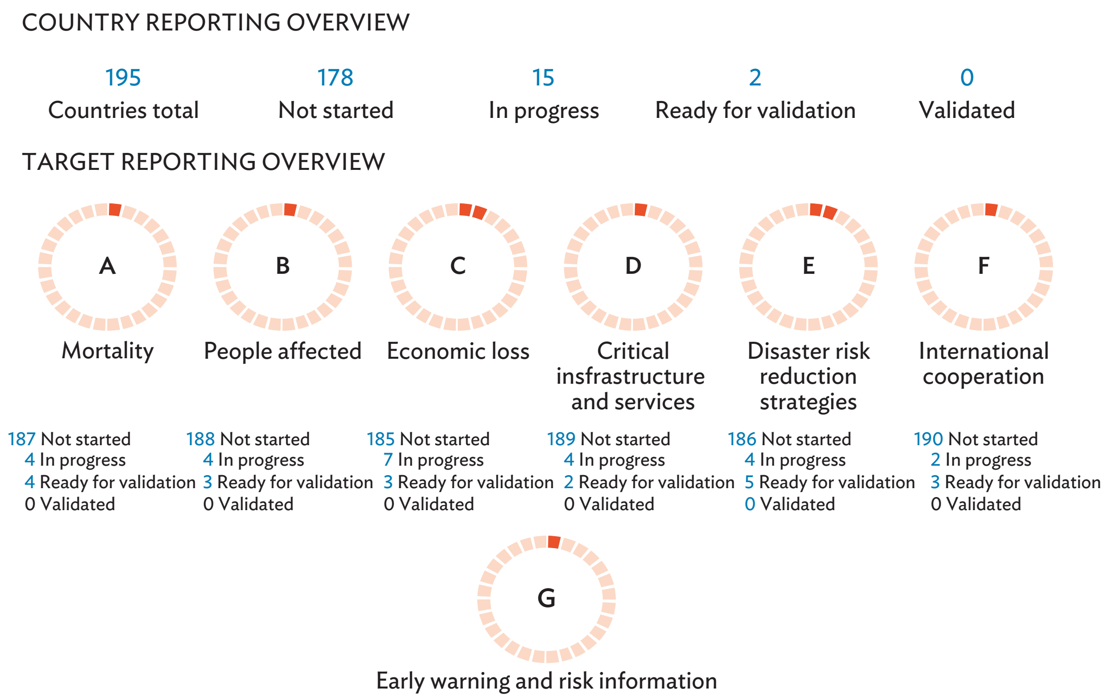
D. Supporting Decisions along the Project Cycle: Measuring Resilience Capacity

While the decision support tools discussed so far mostly focus on options selection (ex ante), but also evaluation (ex post), an approach focused more on systems- and resilience-supporting actions and decisions throughout the stages of the project cycle may build on measurements of resilience. A review of the literature by Winderl (2014) finds that the following purposes have been addressed by various resilience measurement frameworks:

- **Assessing well-being before and after a disaster event**. The *Baseline Resilience Indicators for Communities* uses indicators to measure conditions before disaster events in communities (see Bakkensen et al. 2017).
- **Measuring vulnerability.** The *Prevalent Vulnerability Index* by the Inter-American Development Bank builds on a composite indicator of a number of economic and social variables (IDEA 2005).
- **Measuring resilience capacity.** The Flood Resilience Measurement for Community (FRMC) tool measures community resilience capacity and gaps (Keating et al. 2017).
- **Monitoring and evaluation of projects programs, or agreements.** The Sendai Framework Monitor tracks compliance with the global SFA targets based on country self-reporting (UNISDR 2005–2019).
- **Measuring outcomes: direct and indirect damages.** The Sendai Framework Monitor lists quantitative estimates of disaster losses, mortality, and people affected.

Some of the frameworks and systems mentioned are supposed to link directly to action, such as the Sendai Framework Monitor. Others are broadly informing actions (Figure 5).

Figure 5: Status of Progress Reporting on the Seven Sendai Targets



Source: United Nations International Strategy for Disaster Reduction (UNISDR). 2005–2019. Sendai Framework Online Monitoring Tool. https://sendaimonitor.unisdr.org.

The Sendai Framework Monitor has a strong focus on the first dividend outcomes, except for target D, where damage to critical infrastructure and basic services is reported. Yet, the framework has only partially been populated with self-reported data, with 93 countries having reported, 1 in progress, while 88 have not yet started (as of 12 December 2018). At community levels, a closer connection with action can be achieved by linking up to vulnerability capacity assessments or participatory capacity and vulnerability assessments, which are established community-based risk assessment and decision support tools widely used by NGOs and donor organizations (see Appendix 4 for more detail).

Building on this, the Flood Resilience Alliance developed the FRMC framework and tool, mentioned above, to generate actionable resilience metrics. The FRMC serves as a decision support tool for organizations working with communities to scope out the interaction of development and flood risk, to understand flood resilience strengths and weaknesses before actual events, to understand resilience after events, and overall, to support the crafting of solutions with communities. Particularly, it can be used for benchmarking and tracking the underlying sources of resilience and the long-term outcomes (see Keating et al. 2017). The FRMC has been applied to more than 100 communities in 10 countries around the globe. Out of those, it has been applied to more than 80 communities in five Asian countries: Afghanistan, Bangladesh, Indonesia, Nepal, and Timor-Leste (see also Laurien and Keating [2019] on the Asian experience with the FRMC).[2] Five lines of evidence—including household

[2] As implemented by Concern Worldwide, International Federation of the Red Cross, Mercy Corps, Practical Action, and the United States National Academy of Sciences.

surveys, community consultations, key informant interviews, focus group discussions, and third-party sources—inform the grading of the 88 sources (indicators) that then can be aggregated by experts into an overall score (from 0 to 100) for five different capacities and/or capitals—human, social, natural, physical, and financial—of the framework. The framework has been specially designed to think about and inform action on multiple resilience dividends (yet not directly the triple dividend approach) and builds on the resilience definition of Keating et al. (2017) of "bouncing forward" discussed above.

Table 5 lists some examples of FRMC sources grouped according to the triple dividends and five capacities and/or capital approach, for which we indicate the number of sources in brackets. The sources thus measure the state of the system (community) at specified points in time.[3] The Zurich Flood Resilience Alliance generates an endline assessment following about 2 years after the baseline assessment. If certain events happen in communities, event analyses are organized to provide additional data and insight.

Table 5: Exemplary Flood Resilience Management for the Community Sources according to Triple Dividends and Five Capacities and/or Capital

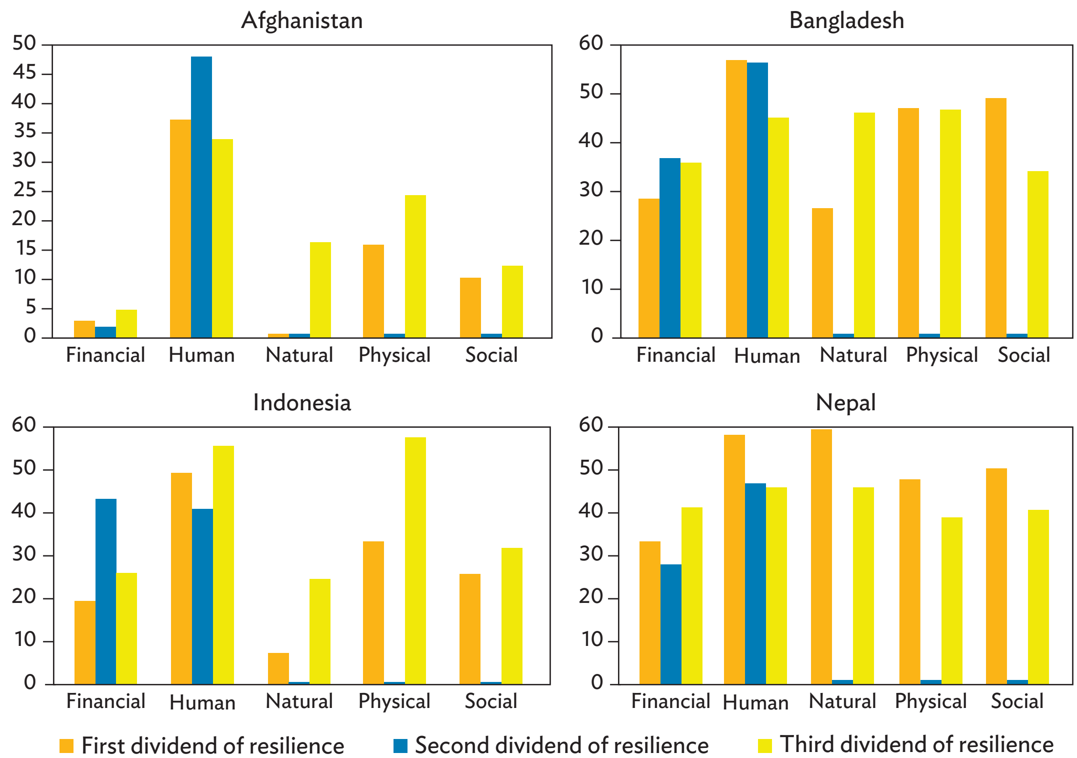
Dividend	Human	Social	Natural	Physical	Financial
1st dividend	Flood protective behavior and knowledge [6]	Flood regulation and local enforcement [6]	Natural habitats maintained for their flood resilience services [1]	Communal flood protection (Flood controls) [6]	Household flood insurance [6]
2nd dividend	Nonerosive flood recovery knowledge [1]	-	-	-	Household income continuity strategy [7]
3rd dividend	Population health status [9]	Social norms and security of assets [27]	Sustainable use of natural resources [5]	Lifelines infrastructure [10]	Government appropriations for infrastructure maintenance [4]

Note: Parentheses contain the number of source indicators.
Source: Authors' own using data from Flood Resilience Measurement for Community application to Asia.

Figure 6 shows results from aggregating (i.e., averaged) community-level results to country levels (with multiple NGOs working in the same countries, but different communities). Capacity indicators that signal the ability to create resilience dividends can be identified for all three dividend types.

3 Indicators can be distinguished whether they describe the state, inputs, outputs or process of affecting the state via specific actions, and whether they measure outcome, that is, achievement of targets.

Figure 6: Dividends of Resilience and Flood Resilience Measurement for Community Capacity and/or Capital Grades for Four Selected Asian Countries



Source: Authors' own using data from Flood Resilience Measurement for Community application to Asia as discussed in Laurien, Finn and Adriana Keating. 2019. "Evidence from Measuring Community Disaster Resilience in Asia." *Asian Development Bank Working Paper.* Manila: Asian Development Bank.

The tool may be used to compare strengths and weaknesses with regard to resilience capacity across countries. Bangladesh and Nepal receive solid resilience grades across all capitals and dividends, while Indonesia lags behind, particularly for natural capital. Afghanistan comes next due to lower grades for all capitals and dividends. Another fruitful use of the tool and its data is to compare changes in capacity over time at the program level for portfolios of actions. It is less fruitful to do so at the project level for individual interventions, for which the grading procedure may be too burdensome. Assessing results at the country scale, we see that high grades along one dividend dimension do not mean that other dividends score similarly, indicating that indeed the source indicators measure different underlying concepts. Also, low grades for specific capitals and dividends point out that capacity gaps may be taken care of with targeted programs. We see that human and physical capacities are highest for the first dividend as well as the third dividend. The results for the four countries indeed show that the second as well as third dividends of resilience are important and should not be neglected, making a case for the multiple dividend perspective. Particularly for the second dividend, focused on unlocking development, where, for example, the CBA assessment showed knowledge gaps, indicators may be used that lead to graded information.

V. DISCUSSION, CONCLUSIONS, AND POLICY IMPLICATIONS

Disaster damages and losses appear to be increasing globally as well as in the Asian region, and there is ample evidence regarding the significant development impacts of disasters; yet, it remains difficult to motivate decision-makers in the public, private, and civil society spheres to further invest significantly into disaster risk reduction. The disaster risk reduction investment gap—broadly perceived as inadequate funding for ex ante risk reduction compared to the large spending for ex post relief and recovery (which of course remains essential to deal with the aftermath of disasters)—has shrunk a little bit over the last few years, particularly in Asia, yet remains large.

Policy debate over the last few years has focused on the disaster-risk–climate–development nexus. Rhetoric and global agreements on disaster risk (Sendai), climate change (Paris) and the Sustainable Development Compact in 2015 have suggested that a synergistic strategy of managing disaster risk with multiple climate and developmental benefits in mind (cobenefit approach) may lead the way to both deal with the disaster burdens and help achieve needed development outcomes across a long set of global targets. This has been termed a multiple resilience dividend approach.

As one prominent example, the triple dividend framework has picked up on the discourse and presents a broad business case for DRR, where the ambition would be to generate three types of dividends: reducing damages and losses to lives, livelihoods, and assets (first dividend); unlocking development (second dividend); and garnering development cobenefits (third dividend). The framework has seen due attention, yet, as our discussion showed, surprisingly little work has been done on gauging and communicating evidence.

In terms of spending on DRR and CCA, these two policy domains are seeing integration and embedding is taking place at donor institutions, such as the World Bank and ADB. At ADB particularly, water management that considers flood risk management has been recognized as a promising investment area with substantial cobenefits. At country levels, however, reporting remains fragmented, with only a few countries providing detailed spending information.

In terms of gauging multiple dividends, we examined the evidence on the costs and cocosts of investing into DRR as well as its multiple dividends. We distinguished between more strongly expert-focused tools for option selection and evaluation stages of the cycle (CBA, CEA, RDMA) and more participatory methods for informing iterative risk management decisions in terms of assessment and selection, as well as monitoring and evaluation (MCA, adaptation pathways, resilience measurement frameworks).

We discussed evidence of cost–benefit analyses that have aimed at estimating the multiple dividends of resilience. Globally, 15 out of 65 studies (11 conducted in the Asian region), mostly carried out in a development context, can be considered to have taken such an approach (only one study aligned explicitly to the triple dividend framework). Half of the CBAs conducted appraisals examining potential benefits (selection stage) and the other half evaluated interventions and actual benefits. Two studies reported cocosts, such as in agriculture through flood embankment-induced waterlogging.

The dividends, as calculated via the benefits–cost ratio metric, appear large and in line with estimates of benefits across other studies that do not consider benefits beyond the first dividend, for which the average cost–benefit for the whole sample has been calculated at 2–5 on average for various hazards; yet confidence in the estimates is only from low to medium, due to the small sample that also exhibited a wide range of estimates (ratios for individual studies were between 2.3 and 28). Also, only about half of other studies considered risk probabilistically (i.e., they differentiated between frequent; low-impact; and rare, high-impact events), compared to more than 80% of examinations that did so for the whole sample. Across the various hazards, evidence has been reported on dividends 1 and 3, whereas dividend 2 has been more difficult to capture.

The lack of rigor in terms of risk analysis is no coincidence. While eight analyses focused on hard infrastructure interventions, for which risk estimates are often available and amenable, only two studies examined soft resilience-type interventions, i.e., interventions with more intangible and process-based outcomes, while five analyses compared soft with hard resilience options. CBA remains attractive as a tool for deciding on "hard-resilience-type" interventions (such as building embankments) and indeed there is potential to integrate the decision support tool with the multiple dividend logic. Other expert-based tools, such as RDMA and CEA, help with the issue of monetizing the intangible benefits, but are constrained to fully capture the multiple dividends, due to their focus on a single-objective function and their need for ample data to project future scenarios.

Given a rising demand for "softer" and systemic (disaster risk management) investments in projects and programs, such as through bolstering preparedness, raising risk awareness, working out appropriate risk reduction enabling factors, and improving risk governance, other decision support tools become relevant to tackle the challenge of nonmonetary benefits and proper representation of process and participation.

MCA sets out a broader universe of criteria—including effectiveness, acceptability, and distributional and environmental impacts—and allows for a systematic exploration of options without the need to monetize all values. The potential for MCA to be used in a stakeholder setting is a key strength. Similarly, the adaptation pathways methodology has seen increasing usage. This decision support method, steeped in today's decision problems, charts out possible pathways into the future, and includes decision moments, relative costs of options, and potential coeffects. The method is flexible and can actually also embrace CBA and MCA information.

Finally, resilience capacity measurement approaches may be used for disaster resilience dividend assessments to support actions and decisions throughout the stages of the project cycle—in contrast to decision support tools that focus on selecting and evaluating options. While measuring capacity rather than outcome, such assessments can serve as decision support for organizations working with communities to scope out the interaction of development and flood risk, to understand flood resilience strengths and weaknesses before actual events, to understand resilience after events, and overall, to support crafting solutions with communities. We presented insights by way of the FRMC framework and tool.

The FRMC has been specially designed to think about and inform action on multiple resilience dividends (yet not the triple dividend approach). It has been applied to more than 80 communities in Asia over the last 5 years. Capacity indicators that are likely to create resilience dividends can be identified for all three types. The results for the four Asian countries presented—which comprised information from more than 80 communities—indeed showed that the second and third dividends of resilience are important, making another case for the multiple dividend perspective. Particularly for the second dividend on unlocking development, where CBA assessments showed gaps, indicators can be used that lead to graded information. The tool may be used to compare results across countries, but even more so, to compare changes in capacity over time at a program level (such as an NGO's portfolio for a country it works in); less so at project levels.

Our findings lead to a number of policy implications and suggestions as follows.

Upgrade focus and communication of multiple disaster resilience dividends

The insights identified on methods, metrics, and evidence indicate gaps and a strong potential for making more use of a multiple dividends business case, which has been widely taken forward by international disaster risk policy (such as, through the triple dividend approach). This holds particularly true for the Asian region, where most of the good practices identified have been generated. It is important to communicate to local, national, and regional decision-makers the resilience dividends linked to managing disaster risks, unlocking development, and creating cobenefits. The effort seems well worth making to motivate increased and sustained investments into DRR and CCA, integrated with development considerations.

Support reporting on spending at national to local levels

While donors and some NGOs have been reporting synergistic spending on DRR integrated with climate and development concerns, countries may need to follow suit. This is also strongly recommended through the Sendai Framework Monitor, especially to track progress in resilience and for determining most appropriate actions under current and emerging risks.

Foster understanding of resilience dividends using applicable methods and tools

Fostering learning—including applicable methods and tools for specific resilience dividends—is essential. Dividends of avoiding and reducing damages, as well as from generating development cobenefits, can be garnered with existing expert-based tools, as well as tools and methods that have a strong participatory component, where those most vulnerable to natural hazards can be meaningfully included in the process. Expert-based decision tools, such as CBA remain attractive to decide on “hard”-resilience-type interventions (such as building embankments) and indeed there is potential to integrate the decision tool with the multiple dividend logic.

Given a rising demand for “softer” and systemic (disaster risk management) investments in projects and programs, such as through bolstering preparedness, raising risk awareness, working out appropriate risk reduction enabling factors, and improving risk governance, decision support tools with a stronger participatory and process-based component have become increasingly relevant. Approaches that measure resilience capital and/or capacity may be used to support actions and decisions throughout the stages of the project cycle, in contrast to decision support tools that focus on selecting and evaluating options. While measuring capacity not outcome, such capacity assessments can serve as decision support for organizations working at community and local scales to scope out the interaction of development and flood risk, foster understanding of flood-resilience strengths and weaknesses before actual events, gauge resilience after events, and overall, support the crafting of solutions with communities.

Support further research on resilience dividends that are harder to gauge

Resilience dividends from unlocking development and understanding the distributional implications are harder to gauge and need more attention. Evidence at the project level exists, such as from early warning systems integrated with weather boards, so that downside risk to lives and livelihoods is managed, but upside risk investment opportunities for wiser decisions are generated as well, such as when to sow seeds, given weather variability. Appropriate evidence of these dividends and benefits is essential to successfully communicate a broad disaster resilience business case.

APPENDIXES

Appendix 1: Challenge for Assessing Hard and Soft Resilience—Studying the Net Benefits and Cocosts in the Rohini River Basin in India and/or Nepal

The Rohini River is part of the Gangetic Basin, located primarily in the Gorakhpur and Maharaganj districts of Uttar Pradesh State, India. Starting in Nepal, the river flows approximately north to south, ending at its junction with the Rapti River near Gorakhpur City. Like all of eastern India, the Rohini is prone to floods during the monsoon. The primary flood risk reduction strategy in the Rohini Basin, which started in the 1970s, has been to reduce the hazard through the construction of embankments. These fail frequently, often due to insufficient maintenance, while sometimes their designs simply are exceeded. The question addressed in this case was what can be said ex post about embankment performance including engineered flood risk prevention, continued operation and maintenance of the 113.1 kilometers of existing embankments along the Rohini River and how can performance be made more resilient. As an alternative, a decentralized "people-centered" and "soft" resilience strategy was also designed and analyzed for projected economic performance. The multiple interventions of this strategy, including the types of flood risks they were assumed to reduce, are listed in Figure A1. Flood risk was first estimated based on two recent large-scale events, updated to current conditions, and then adapted to incorporate downscaled climate change projections to localized scales.

Figure A1: Interventions and Potential for Quantifying Reduced Risks

Interventions	Housing	Assets	Crops	Seeds	Livestock	Fodder	Debt servicing	Wages	Health and medical	Food and grain	Infrastructure
Level											
Raise house plinth	■	■			■	■				■	
Raise fodder storage unit					■	■					
Water and sanitation package							■		■		
Community level											
Early warning		■									
Elevated hand pumps and toilet					■				■		
Flood shelters		■			■				■	■	
Community grain bank							■				
Community seed bank							■				
Maintain key drainage points	■	■	■	■	■	■	■	■	■	■	■
Self-help groups							■				
Purchase community boat								■			
Societal level											
Flood adapted agriculture			■								
Strengthen overall health care							■	■	■		

Sources: Kull, Daniel, Praveen Singh, Shashikant Chopde, and Shiraz A. Wajih. 2008. "From Risk to Resilience. Evaluating Costs and Benefits of Flood Reduction Under Changing Climatic Conditions: Case of the Rohini River Basin, India." Risk to Resilience Working Paper 4. Edited by M. Moench, E. Caspari, A. Pokhrel. Kathmandu: ISET, ISET-Nepal and ProVention. Geneva: Provention Consortium; Kull, Daniel, Reinhard Mechler, and Stefan Hochrainer-Stigler. 2013. "Probabilistic Cost–Benefit Analysis of Disaster Risk Management in a Development Context." *Disasters* 37 (3): 374–400.

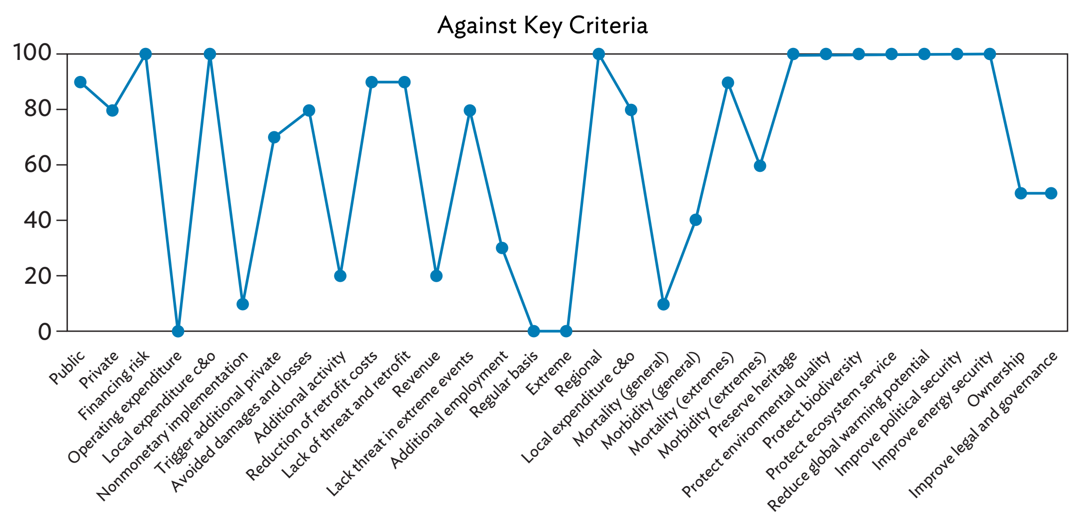
A key focus and learning from this study was the ability to derive realistic parameters and assumptions through a participatory process to arrive at robust results. While the strict flood engineering estimate showed high benefit–cost ratios, when rendering the analysis more realistic by considering a host of other and intangible effects, the assessed project became less economically efficient. Traditional engineering analysis of infrastructure projects tends to ignore cocosts (disbenefits) and often does not capture all societal costs. While the strict engineering analysis arrived at a benefit–cost ratio of about 4.6, indicating high economic efficiency, when refining the analysis, however, the economic efficiency reduced greatly. By considering real land compensation costs, the benefit–cost ratio was about halved.

Further, in an assessment of embankment performance caused by insufficient maintenance (as also reflected in the costs) leading to failures, the benefit–cost ratio reduced to about 1.6. When these cocosts, plus the cocosts of not being able to divest of beneficial water flows from recurrent flooding, were explicitly taken into account, the embankments became economically inconclusive (benefit–cost ratio of 1.0). Considering that all cocost assumptions and computations were conservative and reflecting on the many uncertainties within this probabilistic analysis, it thus cannot finally be concluded with confidence that the performance of embankments in this case has been truly economically viable. As an alternative, a "soft" resilience strategy focuses on community responses. Figure A1 exhibits the different types of interventions at individual, community, and societal levels, as well as the frequent data gaps, where no solid data is available to estimate the returns to these strategies. Here, data gaps are particularly pronounced for intangible and indirect risks, as well as for the impacts related to softer options and more systemic interventions, such as strengthening self-help groups or enhancing flood-adapted agriculture, compared to hard-resilience interventions, such as maintaining flood drainage points. The range for the people-centered strategy finally was 2.0–2.5, although there are many (co)costs and (co)benefits that could not be monetized.

Appendix 2: Example of a Multicriteria Analysis for Flood and Earthquake-Proof Building Codes in Mumbai, India

A multicriteria analysis (MCA) has been applied to disaster risk reduction in the United Nations Environment Programme (UNEP) project Multicriteria Analysis for Climate Change (MCA4Climate), commissioned to provide practical assistance to developing country governments to identify and examine policy options for climate change that are low cost, environmentally effective, and in line with national development priorities (see UNEP 2011). One case study looked at increasing structural resilience in Mumbai, India. One of the options explored was the improvement of building codes to amend existing building regulations and where necessary, the introduction of new regulations to ensure that in 20 years' time all floodplain buildings are on stilts, and earthquake-proof. Figure A2 below shows how the building codes option stacked up against the criteria identified by the stakeholders. The option is measured against each criterion on a scale of 100 (perfect fit) to 0 (no fit at all). The criteria range from public sector costs for creating additional employment, and reducing mortality to improving legal context, to governance. Some criteria would clearly apply to most flood management decisions worldwide and are quantifiable, for example, mortality and public sector cost. Other criteria are especially context-specific and much more subjective, such as "improve political stability," which was a consideration in this case, due to the impact of flood management measures on informal settlements and the social and/or political ramifications that stem from this. A key strength of MCA is the capacity to include these types of intangible impacts if they are identified as important by stakeholders. The project and the analysis specifically had the multiple dividend in mind (without calling it this). The universe of criteria included dividend 2 types, such as revenue-raising, additional employment, regional and local value added, as well as dividend 3 types, such as cultural heritage, environmental quality, and biodiversity.

Figure A2: Using Multicriteria Analysis to Score Achievement of Building Code Options



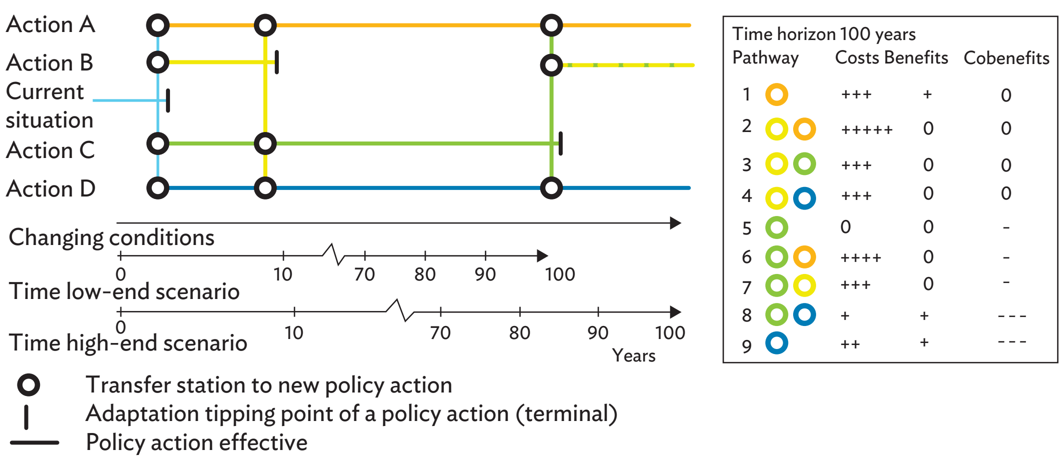
c&o = capital and operational spending.
Source: United Nations Environment Programme. 2011. *A Practical Framework for Planning Pro-Development Climate Policy, MCA4Climate Final Report.* Milan. https://wedocs.unep.org/bitstream/handle/20.500.11822/7998/Planning_Pro-Dev.pdf.

MCA in this project appeared to be a promising process-based tool for achieving buy-in and the interest of policy advisers and/or policy makers: Yet, as the figure shows, there is a high degree of subjective judgment involved. As a consequence, it may be difficult to replicate the evaluation route taken and the choices made by analysts. In this regard, the methodology is more comprehensive, but less rigorous than cost–benefit analysis.

Appendix 3: Adaptation Pathways for Adaptive Delta Management in Bangladesh

By evaluating different pathways, considering path-dependency of actions and visualizing those in a pathways map, an adaptive plan can be designed that includes short-term actions and long-term options (Figure A3). The plan is monitored for signals that indicate when the next step of a pathway should be implemented or whether reassessment of the plan is needed. It is not only important to identify what to monitor, but also how to analyze it. From a policy perspective, it seems evident to select signposts that are related to norm or design values, since these are the values upon which the policies are evaluated. However, alternative indicators (i.e., average river flow in the summer half year, instead of the 1:10 year return flow)—not necessarily policy related—can be used additionally to get timely and reliable signals for adaptation action. Different levels of assessment are possible to design pathways, from qualitative expert-based pathways to more comprehensive quantitative model-based pathways.

Figure A3: Example of an Adaptation Pathways Map and a Scorecard Presenting the Costs and Benefits of the Nine Alternative Pathways Presented in the Map



Source: Botzen, Wouter, Laurens M. Bouwer, Paolo Scussolini, Onno Kuik, Marjolijn Haasnoot, Judy Lawrence, and Jeroen C. J. H. Aerts. 2018. "Integrated Disaster Risk Management and Adaptation." In *Loss and Damage from Climate Change. Concepts, Methods and Policy Options,* edited by Mechler, Reinhard, Laurens Bouwer, Thomas Schinko, Swenja Surminski, and JoAnne Linnerooth-Bayer, 289–317. Cham: Springer.

An adaptive plan could exist of first implementing action C, monitoring the changing condition, and switching to action D if the future unfolds according to the high-end scenario. Action B is potentially a lock-in or regret option, as already after 10 years other actions are needed. Whether this is the case depends on the amount of the investment compared to the timing of the tipping points and therefore functional lifetime of the action. Adaptation pathways have been adopted in the national coastal guidance for Bangladesh inspired by the adaptive delta management approach used in the Netherlands. The plan is to ensure long-term water and food security, economic growth, and environmental sustainability, while effectively coping with natural disasters, climate change, and other delta issues. The Bangladesh Delta Plan focuses on *enabling* socioeconomic development and food security, and thus on investments for achieving development goals that should be robust or adaptive under uncertain changing conditions. In addition to flood risk, criteria such as poverty, health, and gender are considered in Bangladesh. The adaptive plan presents preferred strategies and/or pathways that exist for the short term (<2030), the midterm (2030–2050) and long term (2050–2100). While the Bangladesh Planning Commission has published initial results, the Bangladesh Delta Plan pathways are still under construction.

Appendix 4: Resilience Capacity Assessment: Participatory Vulnerability Capacity Assessments as Entry Point into Holistic Decision-Making at Community Level

For working with communities on implementing disaster risk management activities among development and humanitarian organizations, the International Federation of the Red Cross and Practical Action use participatory assessment processes to gather, organize, and analyze information on the vulnerability and adaptive capacity of communities, which can subsequently be used for joint decision-making. These processes are broadly referred to as participatory vulnerability capacity assessments (PVCA). To measure vulnerability of communities and households, Anderson and Woodrow in 1989 developed the capacity and vulnerability analysis matrix. This largely qualitative, participatory, and monitoring approach came to be widely accepted and used by many nongovernment organizations in their work on disaster risk management (see ActionAid 2005, Davis 2004). The participatory approaches are particularly valuable in helping to understand the key challenges involved in inclusive and iterative community-based risk management and adaptation: (i) the multitude of benefits and local values attached to these; (ii) the historical perspective not only in regard to major disasters but also the less intense but recurrent minor shocks and stresses; and (iii) providing an opportunity to link community perceptions, including locally derived knowledge with what science and policy makers are predicting to occur in the future due to existing underlying issues and climate change. Overall, vulnerability capacity assessments and/or PCVAs aim to support communities to (i) identify key vulnerabilities of communities, (ii) understand communities' perceived and actual risks, (iii) analyze the resources and capacities available to reduce said risks, and (iv) develop action plans to address identified vulnerabilities and risks. In working with communities on implementing disaster risk reduction activities, Practical Action has been identifying and estimating the historic and potential natural hazard situation and has been working with communities to estimate the social, environmental, and economic losses expected in the area of interest through their PCVA processes. These are usually completed with the collection of secondary information to provide a baseline for communities' risks to different hazards.

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Generating Multiple Resilience Dividends from Managing Unnatural Disasters in Asia

Opportunities for Measurement and Policy

Despite solid evidence of the benefits of reducing disaster risk, it remains difficult to motivate investment in disaster risk reduction. International debate emphasizes investments that generate multiple dividends—through reducing loss of life and livelihoods, unlocking development potential, and creating development cobenefits. Focusing on Asia, the authors report multiple dividend evidence using, for example, (i) cost–benefit analyses for evaluating "hard-resilience-type" interventions and (ii) participatory decision-support tools including resilience capacity measurement approaches, which measure systemic benefits. The authors emphasize the latter set of tools, which can support participatory decision-making with those at risk and identify interactions between development and disaster risk.

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