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Generating multiple resilience dividends for managing unnatural disasters in Asia? Opportunities for measurement and policy

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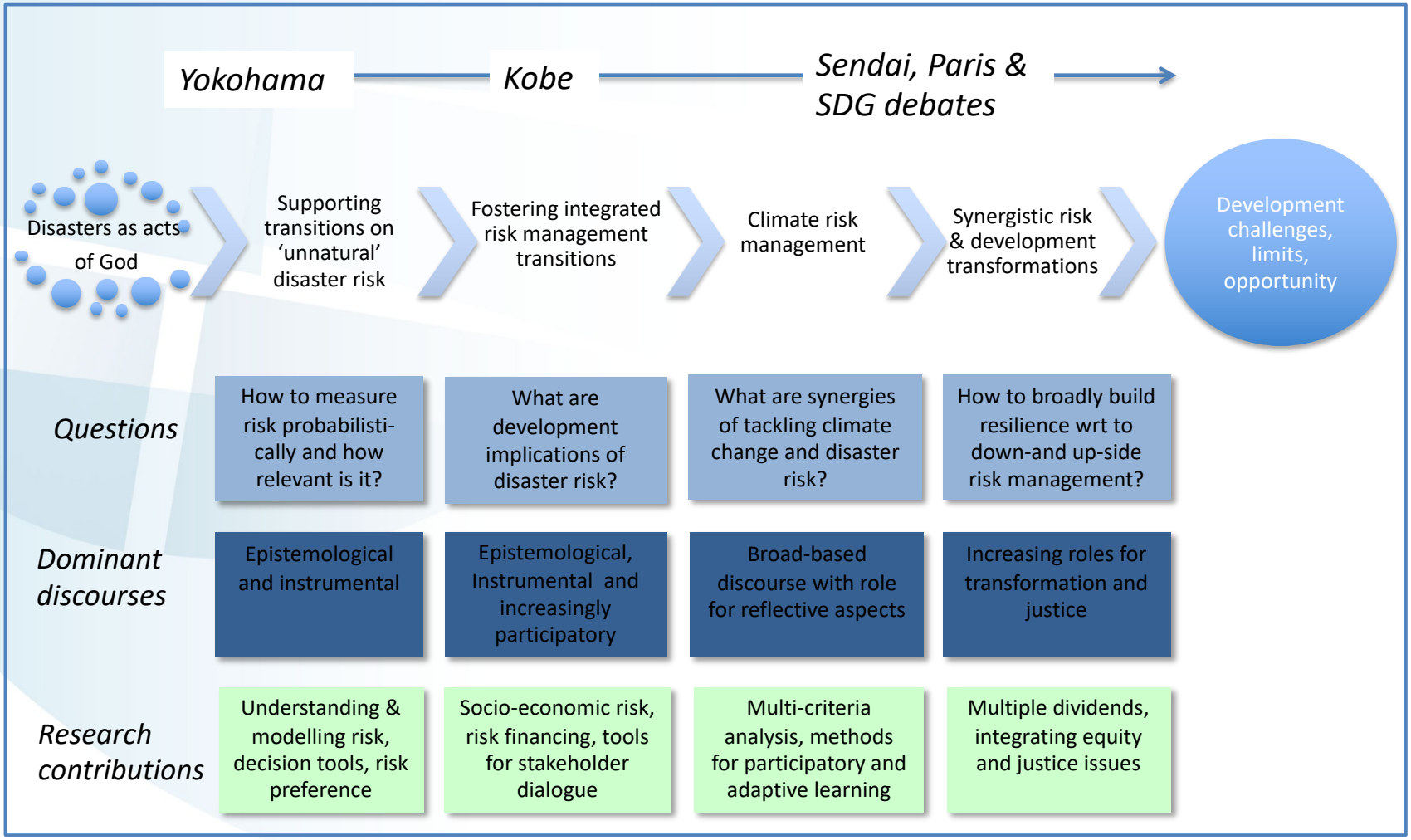
Resilience to natural hazards: assessments, frameworks and tools

EGU 2020

Evolution of the DRR discourse



Towards generating multiple resilience dividends

- Disaster dividend: reducing loss of life, assets and livelihoods
- Multiple dividends: development –short to long-term
- Triple dividend framework (Surminski and Tanner, 2016)

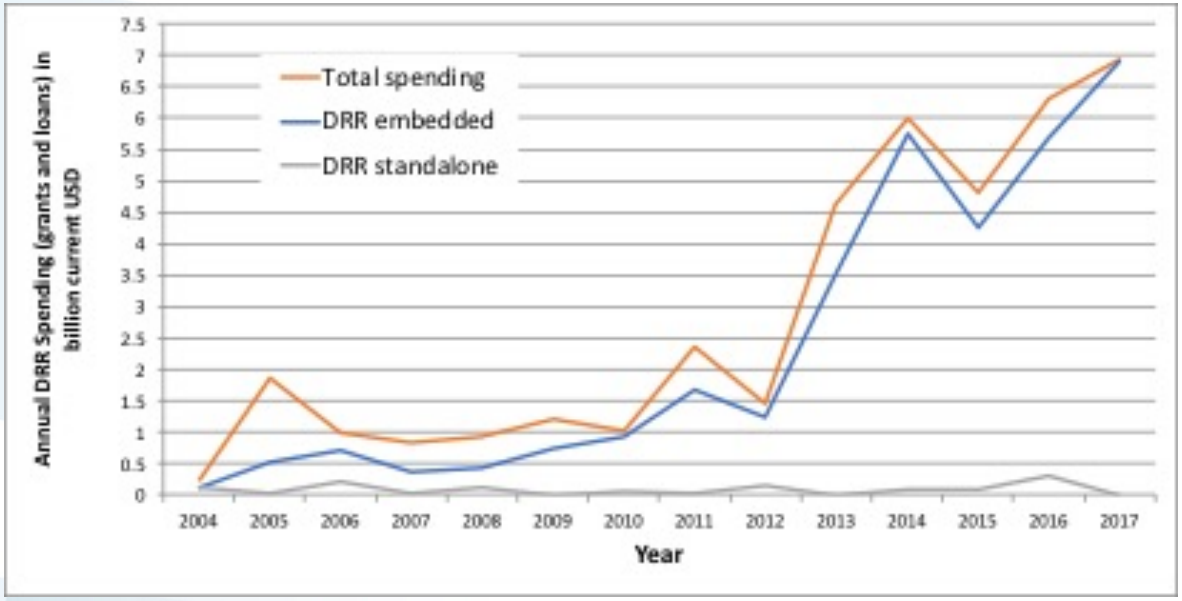
1. Avoiding and reducing direct and indirect disaster risk and (actual) losses
2. Reducing background risk for unlocking development
3. Generating development co-benefits that are not dependent on the occurrence of disaster events

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., 2017)

Questions

- What is the evidence around the dividends proposition?
- What are relevant decision-making processes for understanding and effectively generating the dividends?
- With attention to Asia, globally the most disaster-prone region, yet also a region with massive good and best practice to learn from.

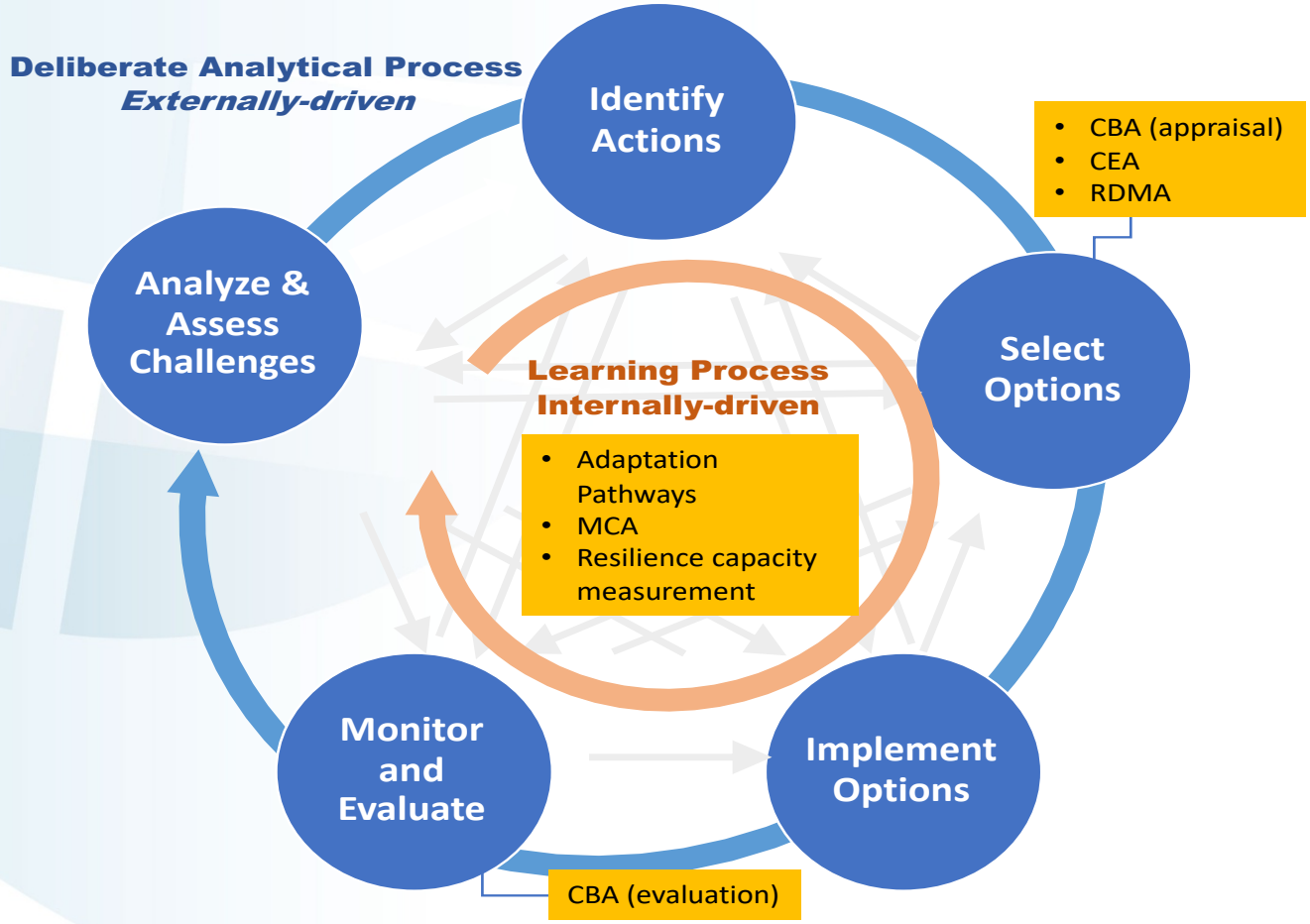
Evidence: ADB investments focus on mainstreaming



Total annual spending (loans and grants) of ADB on for DRR standalone and embedded projects from 2004 to 2017. Source: ADB 2018

ADB 217, Climate Change Operational Framework 2017–2030.
"to optimize multiple benefits from actions in response to the Paris Agreement, the SDGs and the Sendai Framework." (ADB, 2017).
ADB Approach builds on creating regional public goods, and creating co-benefits with regard to gender equity (SDG 5), health (SDG 3), water (SDG 6) and ecosystems (SDG 15) and other SDGs

Decision-support tools for informing adaptive risk management: the DRR project cycle



Decision-support tools for informing the DRR project cycle

Tool	Opportunities	Challenges	Typical Application	Multiple Dividends
Expert-focused tools for option selection				
Cost-Benefit analysis (CBA)	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 (CEA)	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, CEA requires well specified single objective
Robust approaches (RDMA)	Addresses uncertainty and robustness	Technical and computing skills required	Projects with large uncertainties and long timeframes (context of climate change where flood return periods may become more uncertain)	In principle, yes, in practice difficult, as requires well-specified objective definition and quantitative data
Participatory tools for informing iterative risk management decisions assessment, selection and monitoring and evaluation				
Multi Criteria Analysis (MCA)	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
Capacity & resilience assessment (VCA, FRMC)	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

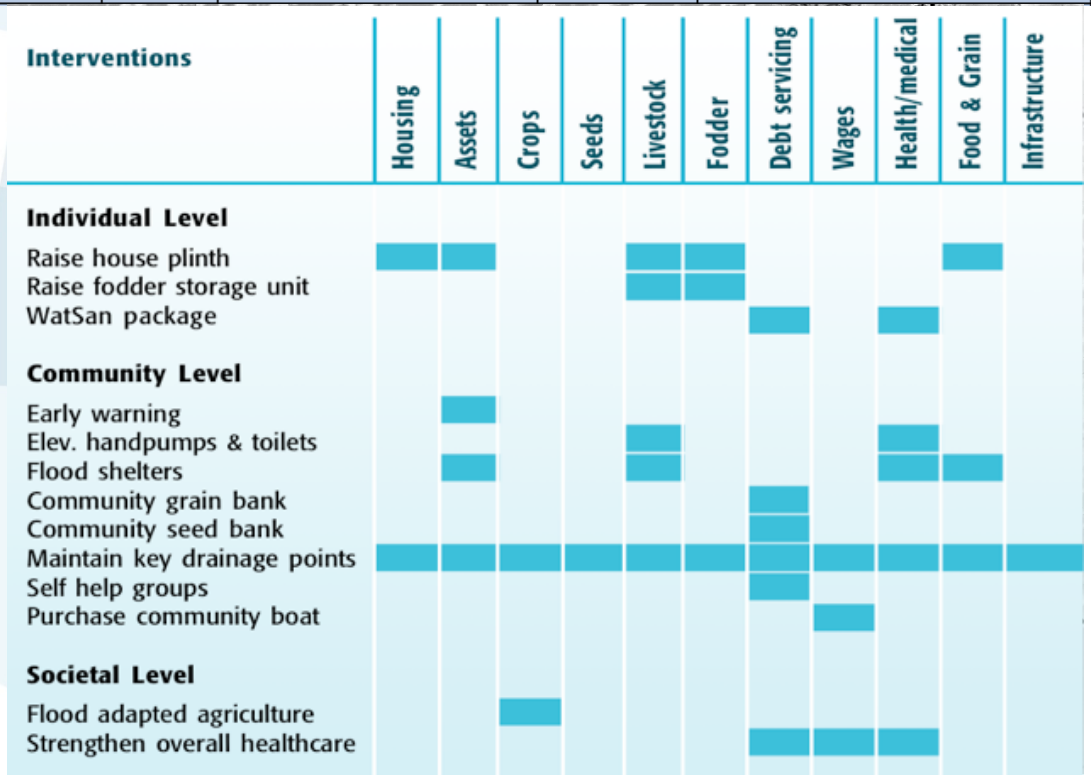
Reference			Basic Information				Results			Advanced								Notes	
Title	Year	Authors	Region	Hazards	Pre/ Post	DRR measure	B/C	B/C average (where an average makes sense)	NPV	Costs considered	Benefits considered	Indirect?	Risk analysis	Type: Backward/ Forward	Lifespan	Risk layered period	Climate change	Data used	Limitations & Issues
Costs and Benefits of Hazard Mitigation for Building and Infrastructure Development: A Case Study in Small Island Developing States	1998	Vermeiren and Stichin	Jamaica, Dominica	Tropical cyclones	Post	Evaluation of benefits of consideration of risk prevention in design and construction of port (Dominica) and school (Jamaica)	NS: results suggest large savings in terms of reconstruction had measures been considered in original design		NS	construction, engineering, management costs	saved reconstruction costs		D		NS	NS		estimated damages from one event respectively for Dominica and Jamaica	Deterministic analysis, use investment needed to prevent damages from one event. No consideration of other events and their potential damages
Benefits of Flood Mitigation in Australia	2002	BTRE	5 case studies in Australia: Katherine (Northern Territory), Thuringowa (Queensland), Bathurst (New South Wales), Tamworth (New South Wales), Waggamba Shire (Queensland)	Flood	Post	Structural and non-structural urban riverine flood prevention measures: Land use planning, building controls, voluntary purchase, levees, road sealing, preparedness	NS: results suggest significant overall benefits to measures		Range per project	*Direct*: capital costs: agricultural, residential, commercial, infrastructure. *Indirect*: ER, alternative accommodation, business disruption, clean up, network disruption, public service disruption. *Intangible*: Health, death, environmental, dislocation, memorabilia, culture and heritage	avoided costs		E	Backward looking	NS	1% exceedence, 100 year event			Dated risk curves for property damage, difficulty in measuring indirect and intangible costs and benefits. Questionable applicability of CBA for
	2002	IFRC	Vietnam	Tropical cyclones	Post		52.00		7.3 Million USD per year	1.1 million USD for planting the mangrove forests	reduction in dyke maintenance costs		D						
Disaster preparedness programmes in India: A cost benefit analysis	2004	Venton & Venton	India: 2 Villages: Dharbanga district, Bihar; Khammam district, Andhra Pradesh	Floods	Post	Combined disaster mitigation and preparedness	Bihar: **3.76** Andhra Pradesh: **13.38**	3.76	Bihar: 46,000 pounds Andhra Pradesh: 26,330 pounds	Direct: loss of assets	Direct: reduced loss of households, possessions, livestock. Indirect: reduced ER. Intangible: reduced health problems and loss of life	Y	D		Bihar: 20 years Andhra Pradesh: 15 years	NS		questionnaires regarding losses in villages with and without the DMP measures	no probabilistic risk assessment. Benefits calculated from responses from inhabitants in villages with DMP against those without DMP.
MMC (2005): Grant program studies	2005	MMC	5,479 grants for DRR project in the United States, 136 of which were randomly sampled to acquire results	Flood, Wind, earthquake	Post	Structural and non-structural DRR projects, details depending on the specifics of each project	**Overall: 4.0, EQ: 1.4 Flood: 5.1 Wind: 4.7 Overall range: 0.05-50**	**1.40**	range depending on the project	costs based on the specific projects	Direct: damages to property, private, business, loss of life, clean up, emergency response. Indirect: business disruption. Environmental, non-market damage	Y	E		50 years for most projects	NS	N		sampling and modelling uncertainties
MMC: Flood mitigation project - Freeport, New York (USA)	2005	MMC	Freeport, New York, USA	Flood	Post	Early warning,education, awareness, risk prevention via retrofitting, drainage system, all activates to protect roads and private residences against 100 years flood	**3.9**, range: 0.2-12.7	3.90		costs associated with 13 different aspects of the overall project	Direct and indirect (cleanup, disruption of business, emergency costs) losses reduced	Y	E			100 year	N		
MMC: Flood mitigation projects - Jefferson County, Alabama (USA)	2005	MMC	Jefferson County, Alabama, USA	Flood	Post	local mitigation strategy, information systems upgrade county emergency response operations, upgraded early warning system	**1.8**, range: 0.4-3.6	1.80			Direct and indirect (clean-up, disruption of business, emergency costs) losses reduced	Y	E						
MMC: Flood mitigation projects - Tuscola County, Michigan (USA)	2005	MMC	Tuscola County, Michigan, USA	Flood	Post	Property buyout and risk prevention	**12.5**, range: 2.8-24.9	12.50			Direct and indirect (clean-up, disruption of business, emergency costs) losses reduced	Y	E						
MMC: Flood mitigation projects - Jamestown	2005	MMC	Jamestown, USA	Flood	Post	Flood risk prevention and early warning: storm run-off, digital flood maps, community emergency shelter, equipment provision, training for fire and police depts	**1.6**, range: 0.1-9.7	1.60		costs associated with 2 submitted and received mitigation grants	Direct and indirect (clean-up, disruption of business, emergency costs) losses reduced	Y	E			NS	N		
MMC:EQ mitigation projects - Hayward, California (USA)	2005	MMC	Hayward, California, USA	Earthquake	Post	Seismic retrofit and preparedness, communication systems, mitigation of hazardous material spills,	**7.3**, range: 2.0-15.6	7.30		costs associated with 4 submitted and approved grants	Direct and indirect (cleanup, disruption of business, emergency costs) losses reduced, reduced death, and loss to illness and injury	Y	E			NS	N		
MMC: Multihazard risk management - Horry County (USA)	2005	MMC	Horry County, USA	Flood, Wind, earthquake	Post	Property buyout, preparedness, wind and flood retrofit	**2.2**, range: 0.6-4.2	2.20		costs associated with 8 submitted and approved grants	Direct and indirect (cleanup, disruption of business, emergency costs) losses reduced	Y	E			100 year event flood event, not specified for other hazards	N		
MMC: Landslide mitigation projects - Multnomah County, Oregon (USA)	2005	MMC	Multnomah County, Oregon, USA	Landslides	Post	Property buyout and preparedness	**1.2**, range: 0.1-11.7	1.20			Direct and indirect (cleanup, disruption of business, emergency costs) losses reduced	Y	E						
MMC: EQ mitigation projects - Orange (USA)	2005	MMC	Orange, California, USA	Earthquake	Post	Seismic retrofit	**2.0**, range: 0.4-5.0	2.00			Direct and indirect (cleanup, disruption of business, emergency costs) losses reduced	Y	E						
A Cost-Benefit Analysis of the New Orleans Flood Protection System	2006	Ballegate	New Orleans, USA	Hurricanes	Pre	construction of category system to protect against category 5 hurricane. Shows how results change when climate change, indirect and intangible loss are taken into account	Not specified. When climate change, indirect avoided damages, and discount rate are reconsidered, building the system is can be seen as cost efficient		NS	material and physical costs of building a category 5 hurricane protection system	damages avoided by the new system, human life, regional lack of function, psychological and social destabilization	Y	D	Deterministic (Katrina)	NS	150 years (category 5 hurricane)	Y	Data comes from Katrina physical losses, assumption that 1 human life= 5 million USD	deterministic analysis using the loss from Katrina as the reference point
Avalanche hazard mitigation						Wide variety of 16 measures from								Lacks at only losses					

CBA evidence: hard resilience!

Risk management intervention	Dividend 1: Loss	Dividend 2: Unlocking Development	Dividend 3: Co-benefits
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 co-costs 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 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/cooling costs, decrease in child labor (common for brick construction), improved air quality

Evidence
15 out of 65 CBA studies with multiple dividend information

Flood Reduction under Changing Climate conditions: Rohini River Basin, India/Nepal	Kull et al. (2013)	E/H +S/ R D1,2	2 options: 1. Hard resilience- Flood embankments 2. Soft-resilience "People-centred" approach	Averag e: 2, 1-4 resp. 2-2.5	Embankment costs and **Co-cost (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



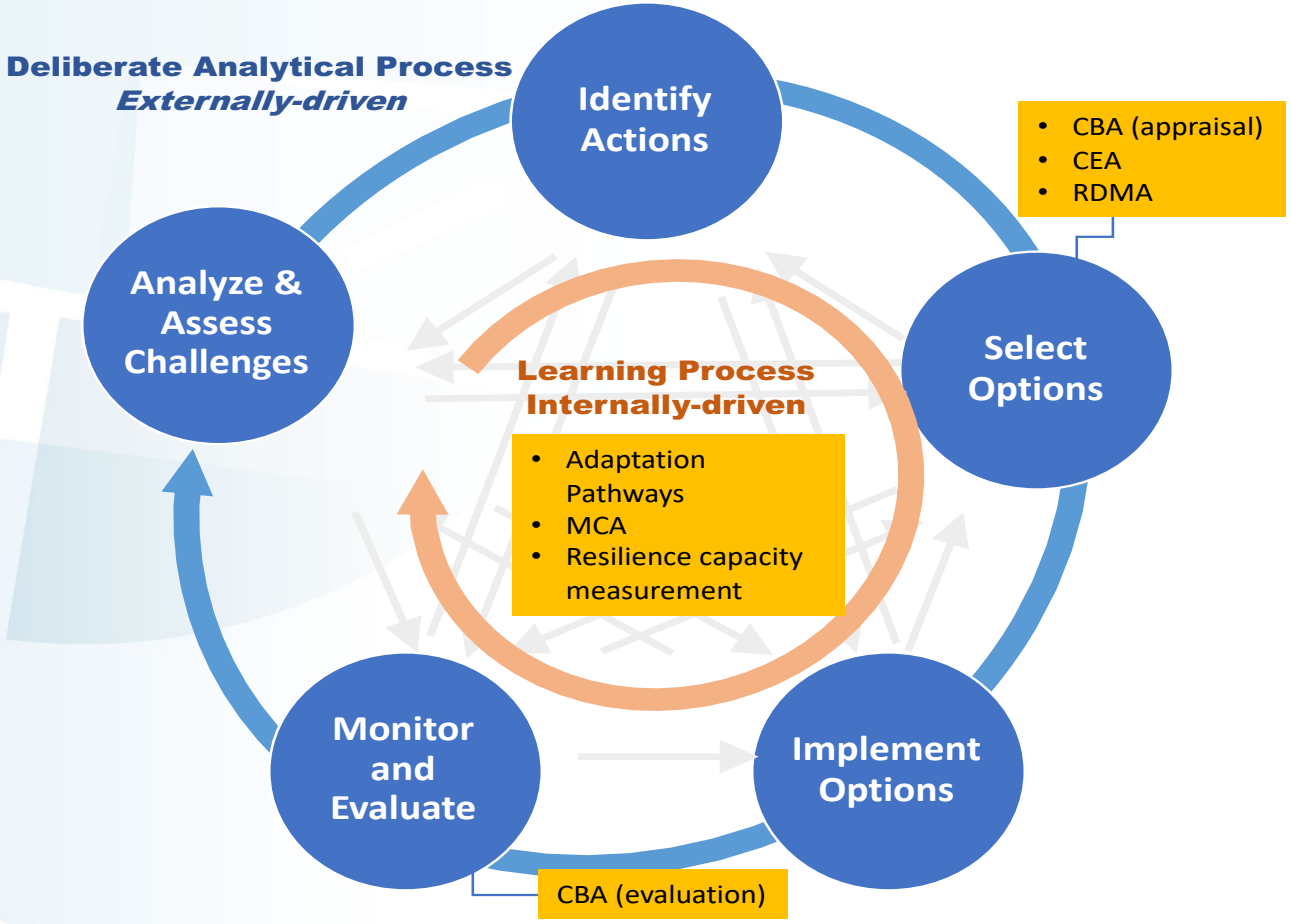
Sizeable dividends
BC ratio of 6.7 compared to the average cost-benefit of around 5.1 for all 65 studies *(low confidence)*

Kull et al., 2013

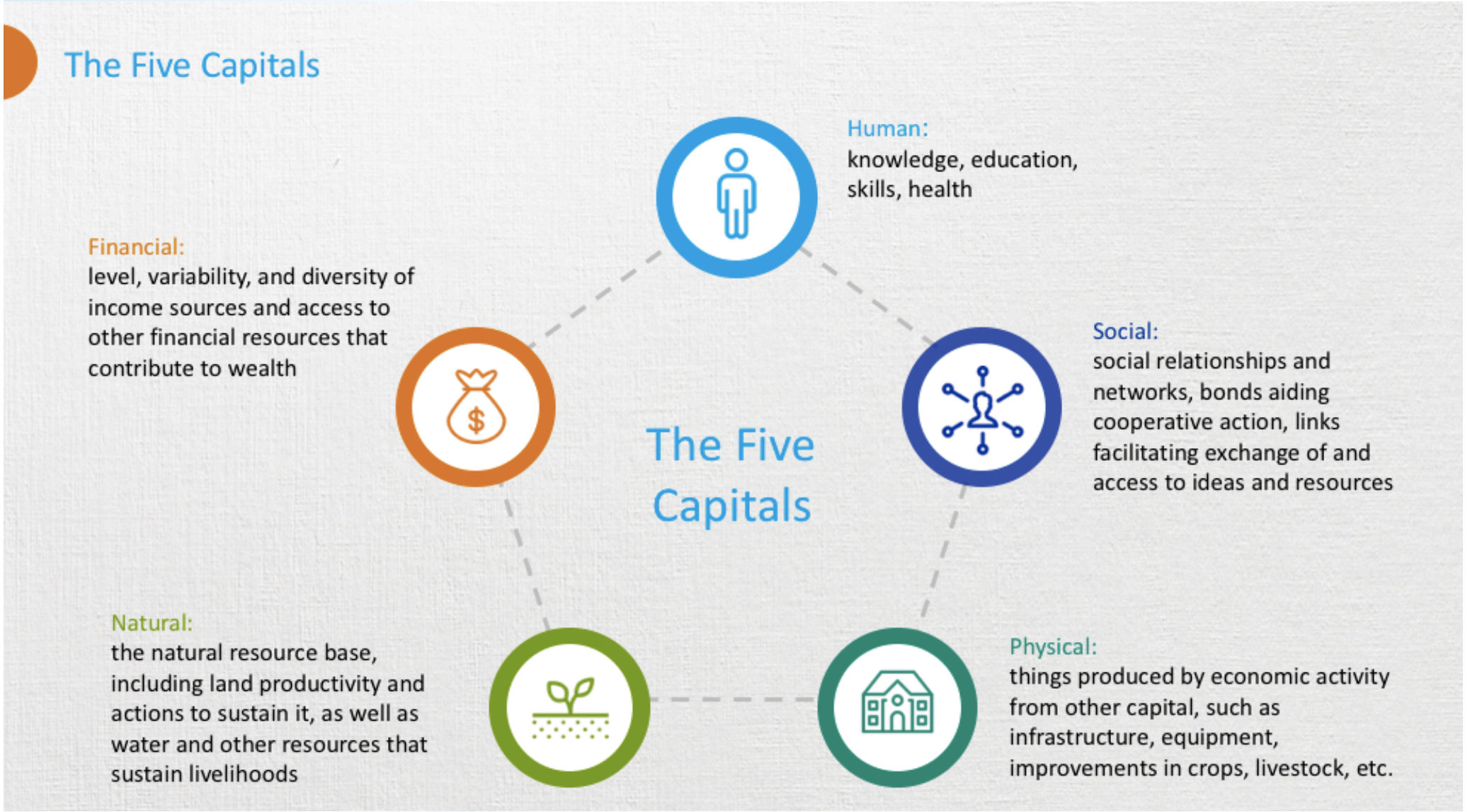
Decision-support for soft resilience and adaptive management

- MCA
- Adaptation Pathways
- **Measuring resilience (capacity)**

Decision-support tools for informing the DRR project cycle



Flood Resilience Measurement for Communities framework and tool (FRMC)

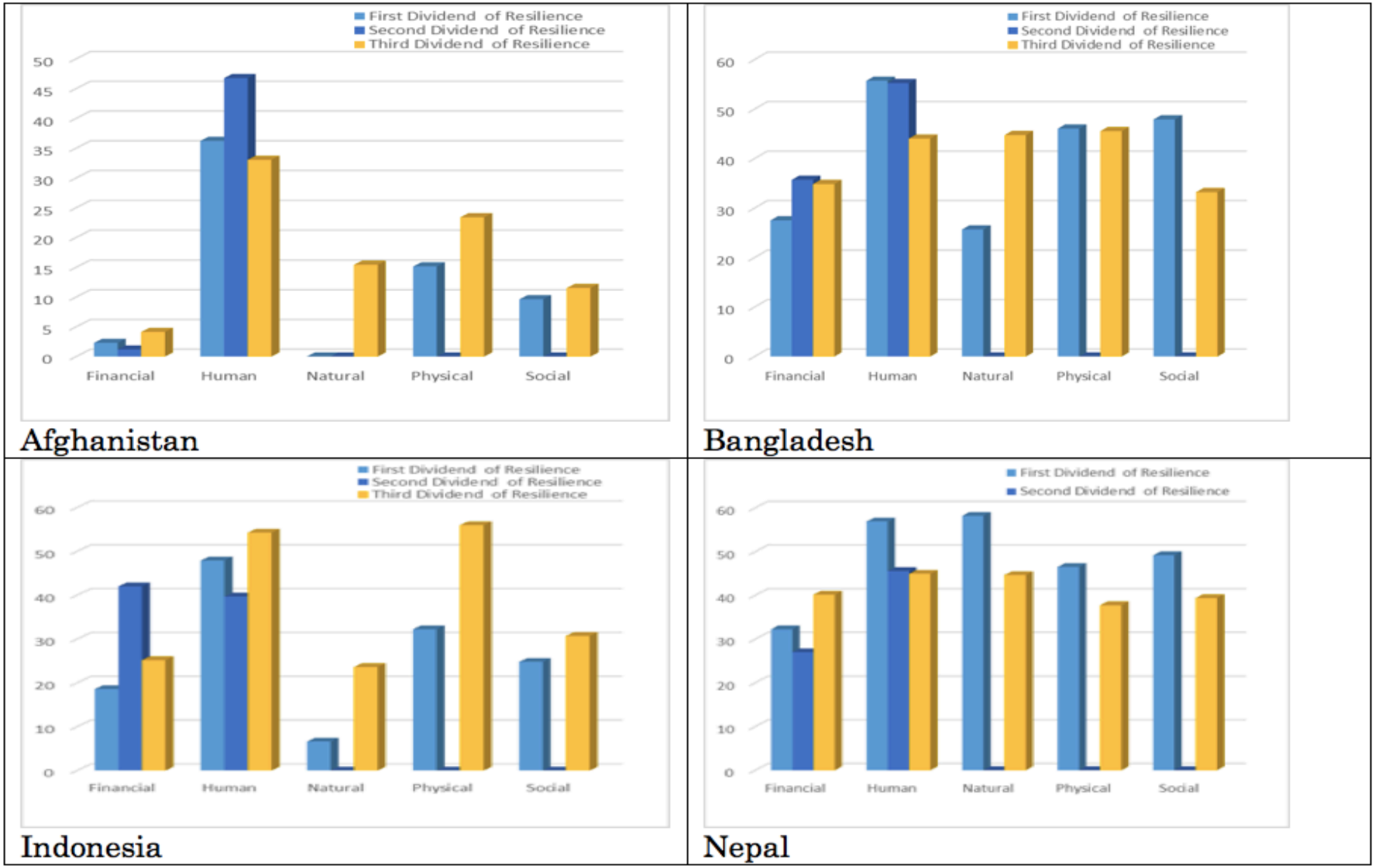


Szoenyi, 2018

FRMC and the dividends

Dividend	Human	Social	Natural	Physical	Financial
1st dividend	Flood protective behaviour 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	Non-erosive flood recovery knowledge (1)	(0)	(0)	(0)	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)

Dividends of Resilience and FRMC capacity/capital grades for four selected Asian Countries



Policy implications and suggestions

- Upgrade focus and communication of multiple disaster resilience dividends
- Support reporting on spending at national to local levels
- Foster understanding for resilience dividends using applicable methods and tools
- Support further research on resilience dividends that are harder to gauge