Role of Academic, Public and Private Sectors in Disaster Risk Quantification: Demand, Applications, and future trends

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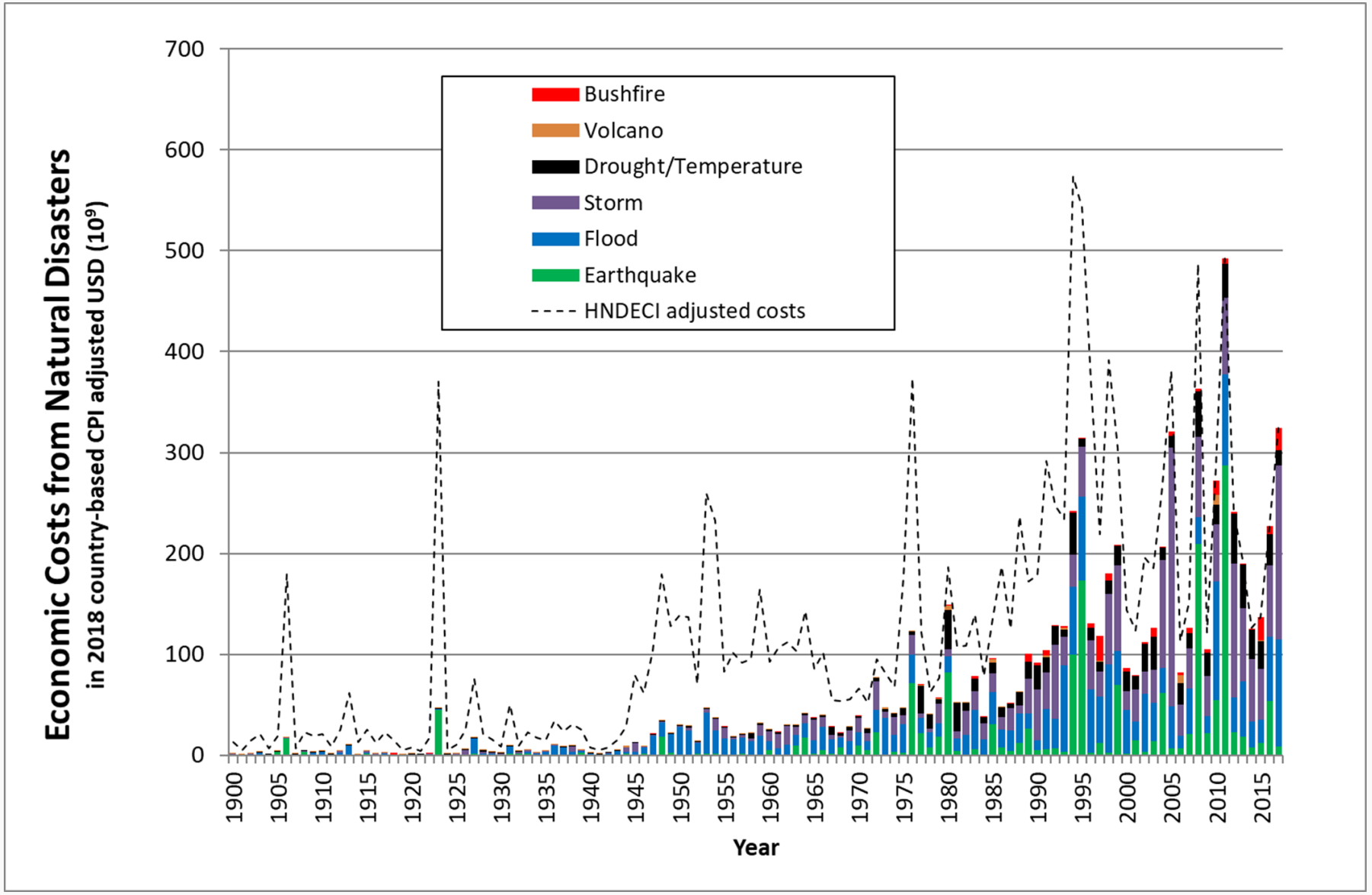
WORLD BANK GROUP
Social, Urban, Rural & Resilience

D-RAS
DISASTER RISK RESILIENCE ANALYTICS AND SOLUTIONS
KNOWLEDGE SILO BREAKER

Credit: Terremoto en Perú, ICA (15 de agosto de 2007 https://okdiario.com/img/2016/10/13/catastrofes-naturales-terremoto-620x349.jpg; Daniell et al., (2018), Top 100 fatal earthquakes, 16ECEE)

Historical losses not a good indicator for future losses



Source: Daniell et al (2018), EGU, Vienna.

Are we prepared? - Impact of seismic codes – but compliance?

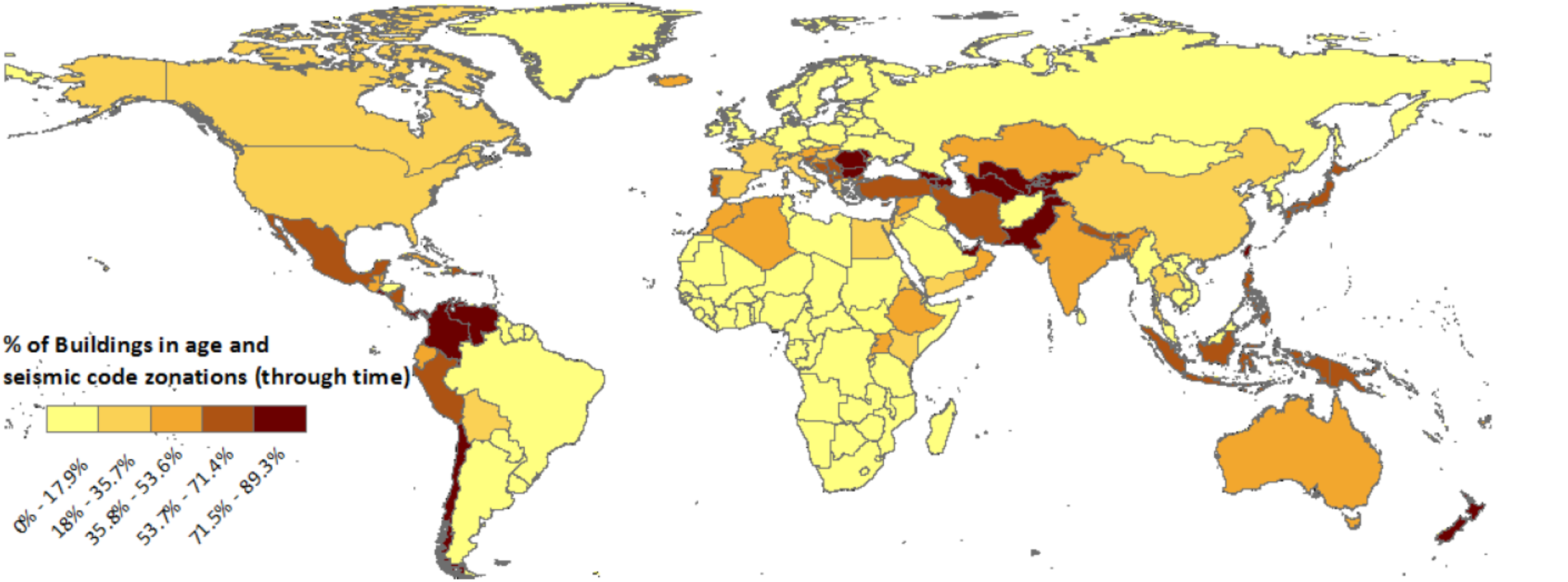


Figure 2. The percentage of buildings in each country that should have been built under a seismic resistant code (excluding small building provision)

Ecuador Earthquake Apr 2016

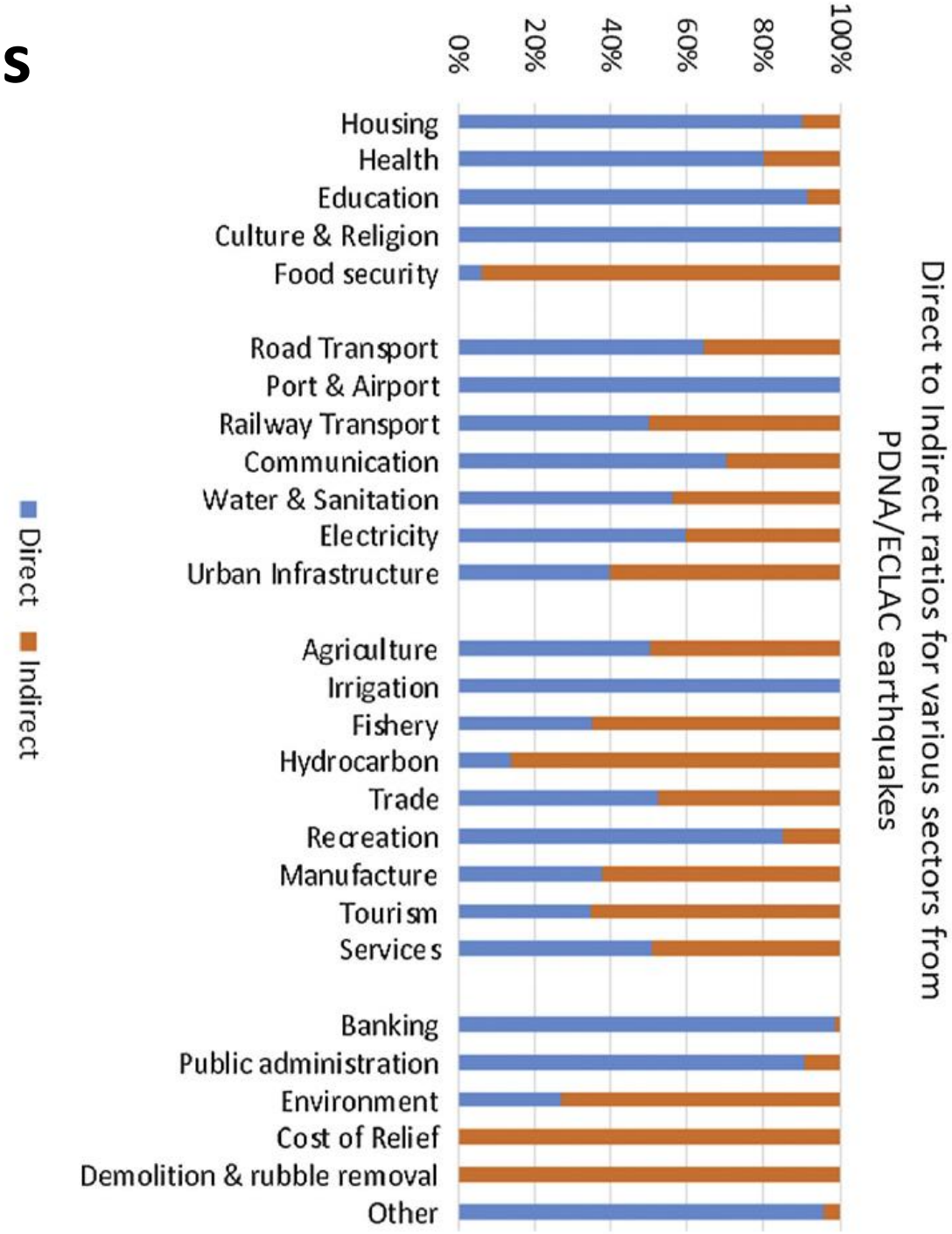
Direct and Indirect Economic impacts

Social Sectors

Infrastructure Sectors

Productive Sectors

Cross-cutting Sectors



We all have a role to play in DRM:

-Academic, Public and Private sectors

Quantify Risk
- Use of Technology

Developing Policies and Regulations

to reduce physical and fiscal vulnerability

Community Preparedness and Education

Academic, Public and Private sector

Private and Govt. assets inventory determination and protection

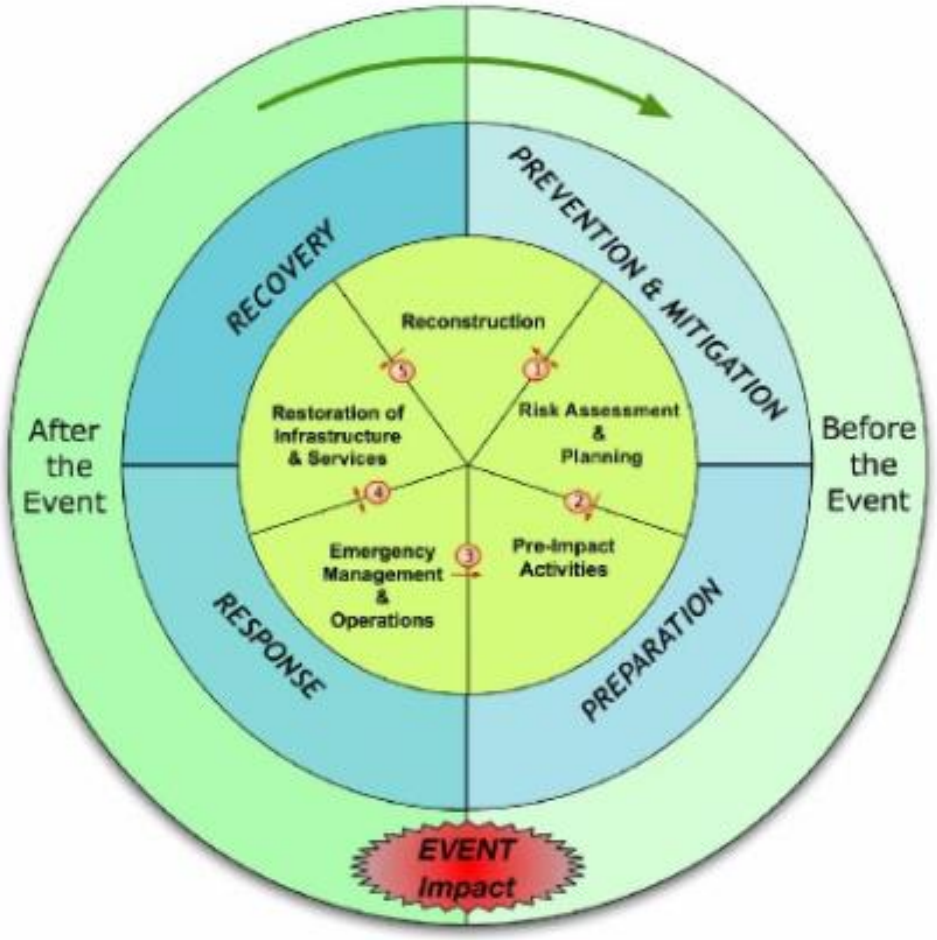
Business Continuity planning

Conversations between Government, (I)NGOs, Universities and industry e.g. PPPs

PPPs to can benefit public and private sector

Need for Disaster Risk Quantification

- Disaster (or catastrophic) events can jeopardize the financial stability of companies and national, provincial governments.
- Before – Poor identification of extremes – no geography, no science, no engineering
- Key questions *before* an event with respect to management of disaster risk are:
- **How much is at risk?**
- **What would it take to reduce the risk?**
- **Where and what can we prioritize as interventions?**
- **What are their costs and benefits?**



Source: Atkinson et al. (2006)

Solution - Disaster Risk Quantification!

COUNTRYDISASTER
RISK PROFILES WORLD BANK GROUP

EL SALVADOR Earthquakes and Hurricanes RISK PROFILE

What is a country disaster risk profile?

An estimation of the potential economic losses to property caused by adverse natural events.

Country Disaster Risk Profile

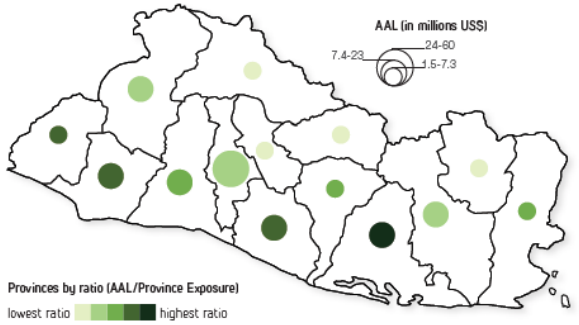
Applications

- **Develop** key baseline data
- **Evaluate** impact of disasters
- **Promote and inform** risk reduction
- **Inform** disaster risk financing

Country At-A-Glance

GDP US$	Population	Total Building Exposure US$ (Replacement Value)
25.2 billion	6.4 million	37.1 billion

Two representations of earthquake risk



Absolute Risk: The larger the circle, the higher the Annual Average Losses that the province could potentially incur over the long term.

Relative Risk: The darker the color, the higher the ratio of AAL/Province Exposure. The darkest color represents the province of Usulutan which has a higher proportion of vulnerable structures due to construction types and/or potentially higher earthquake intensity.

Snapshot

- The **earthquake risk** in El Salvador is more significant than the **hurricane risk**.
- Annual Average Loss (AAL) from **earthquakes** is **US$ 175.93M (0.70% of GDP)** and from **hurricanes** is **US$ 2.94M (0.01% of GDP)**.
- The Probable Maximum Loss for **earthquakes** (250 year return period) is **US$ 3.9B (15.5% of GDP)** and for **hurricanes** (250 year return period) is **US$ 374M (1.5% of GDP)**.
- Single-family, residential houses constructed with reinforced masonry bearing walls are the buildings most vulnerable to **earthquakes** **accounting for over 31% of AAL.**

What is Disaster Risk Quantification

A **quantification** of the likelihood (probability) of estimated property, infrastructure, monetary or casualty losses caused by adverse natural event in a specific area.

Hazard

Exposure

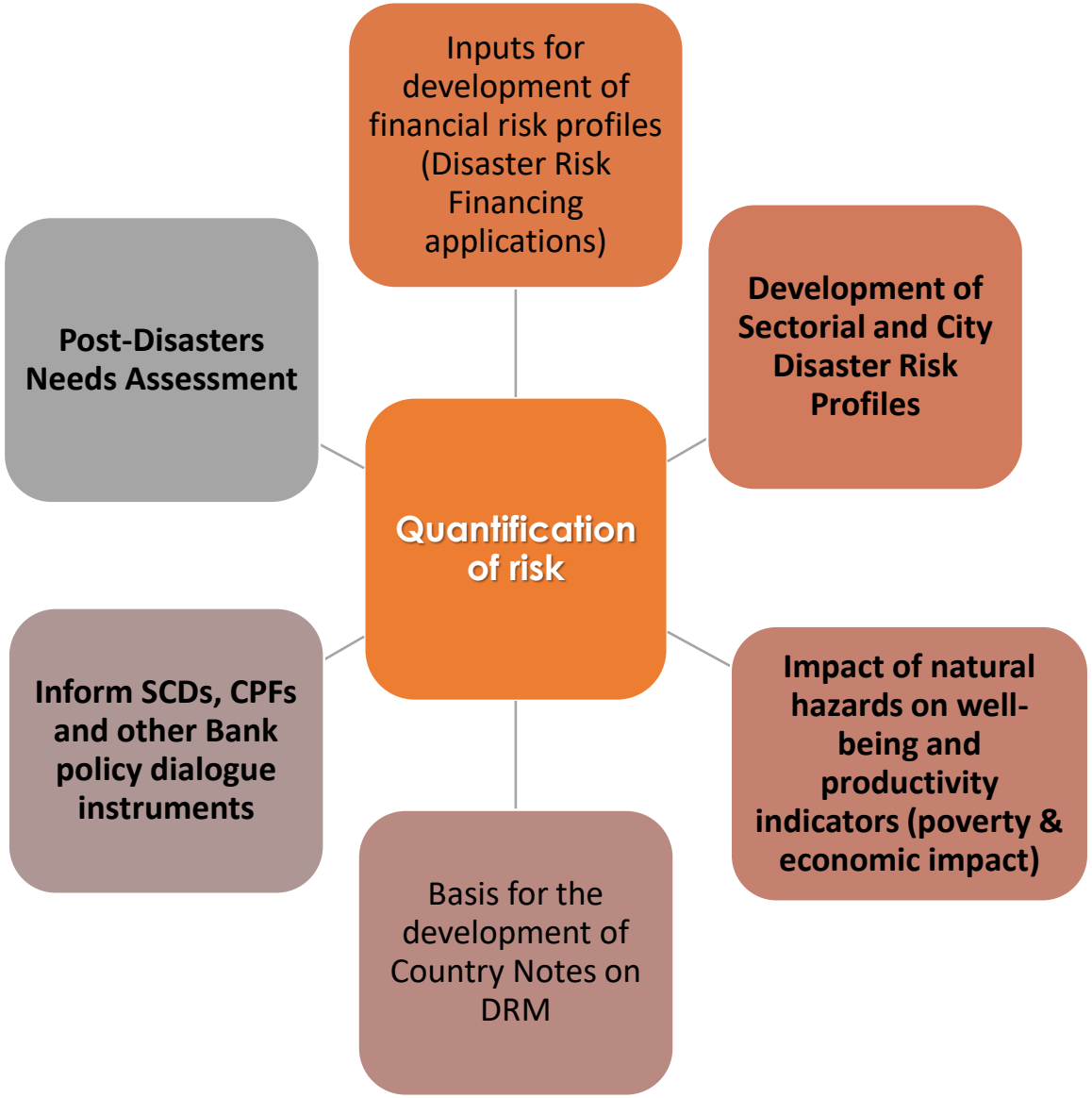
Vulnerability

Fatalities, injuries, displaced persons

Damage to buildings, infrastructure, financial loss

Impact

What can we do with this information?



Product	Purpose	Scale	Data Requirements	Cost
Qualitative national risk profile	For advocacy and initiation of DRM dialogue	National	Low: Requires global, regional, and/or national data sets	$
Community-based disaster risk assessment	To engage communities, communicate risk, and promote local action	Community level	Low: Typically based on historical disaster events	$
Quantitative national risk profile	For advocacy and initiation of DRM dialogue based on quantitative assessment	National	Low-moderate: Requires global, regional, and/or national data sets	$$
Asset-level risk assessments, including cost-benefit and engineering analysis	To inform design of building-level/asset-level risk reduction activities and promote avoidance of new risk	Building / infrastructure level	Moderate-high: Requires high-resolution local data for large spatial areas with clear articulation	$$
Macro-level risk assessment for risk reduction, including cost-benefit analysis	To inform urban/regional risk reduction measures	Urban, regional, national	Moderate-high: Requires moderate to high resolution across large spatial areas	$$$
Risk identification to identify critical infrastructure and establish early warning systems	To inform preparedness and risk reduction, based on understanding of potential damage at the regional/local level	Urban, regional, national	Moderate-high: Requires asset-level information across large spatial areas	$$-$$$ [broad range depending on geographic scope]
Catastrophic risk assessment for financial planning	For financial and fiscal assessment of disasters and to catalyze catastrophe risk insurance market growth	National to multi-country	High: Requires high-resolution, high-quality data of uncertainty	$$$

Residential Exposure model for Social Protection Analysis

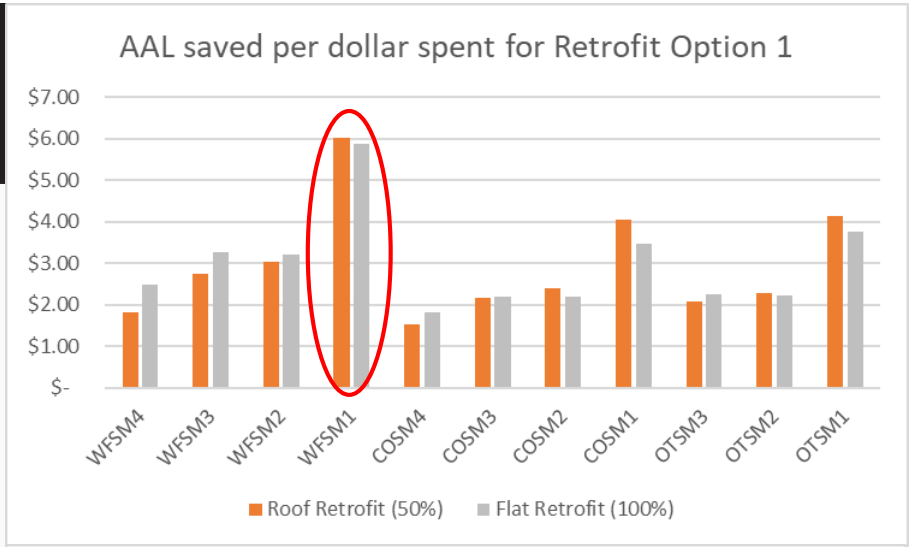
Proposed 2017 Exposure Model Input Values

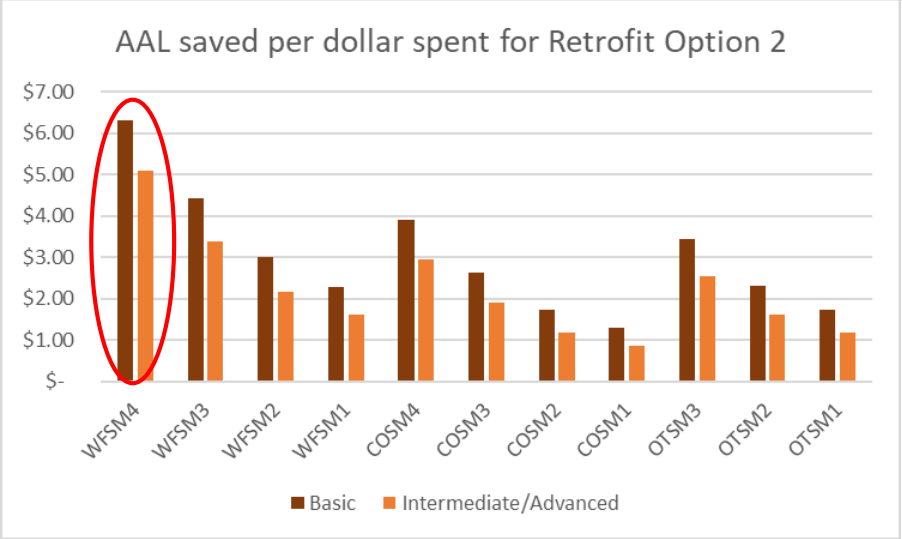
Social-Structural Vulner. Class	Housing Unit Floor Area (m2)	Unit Cost of Construction (USD/m2)
WFSM4	50	50
WFSM3	55	100
WFSM2	62	155
WFSM1	70	390
WFSH3	60	125
WFCO1	75	400
COSM4	60	75
COSM3	67	150
COSM2	78	245
COSM1	90	540
COSH3	70	175
COSH1	100	570
COCO4	64	90
COCO3	72	180
COCO2	80	280
COCO1	125	635
OTSM3	56	115
OTSM2	62	180
OTSM1	78	425
OTSH3	59	140
OTSH1	81	450
OTCO3	64	150
OTCO2	70	260

Outer Walls	WF= wooden structure
	CO = concrete blocks or panels
	OT = other types of outer wall
Roof Cover	SM = sheet metal roof
	SH = roof shingles
	CO = concrete roof (slab)
Socio-economic Group	4 = extremely poor
	3 = poor
	2 = Not poor, but Vulnerable
	1 = Not poor, Not Vulnerable

- 23 TYPOLOGIES (combination of outer wall, roof cover & socio-economic vulnerability group)
- 2007 LIVING CONDITIONS SURVEY (socio-economic vulnerability data)

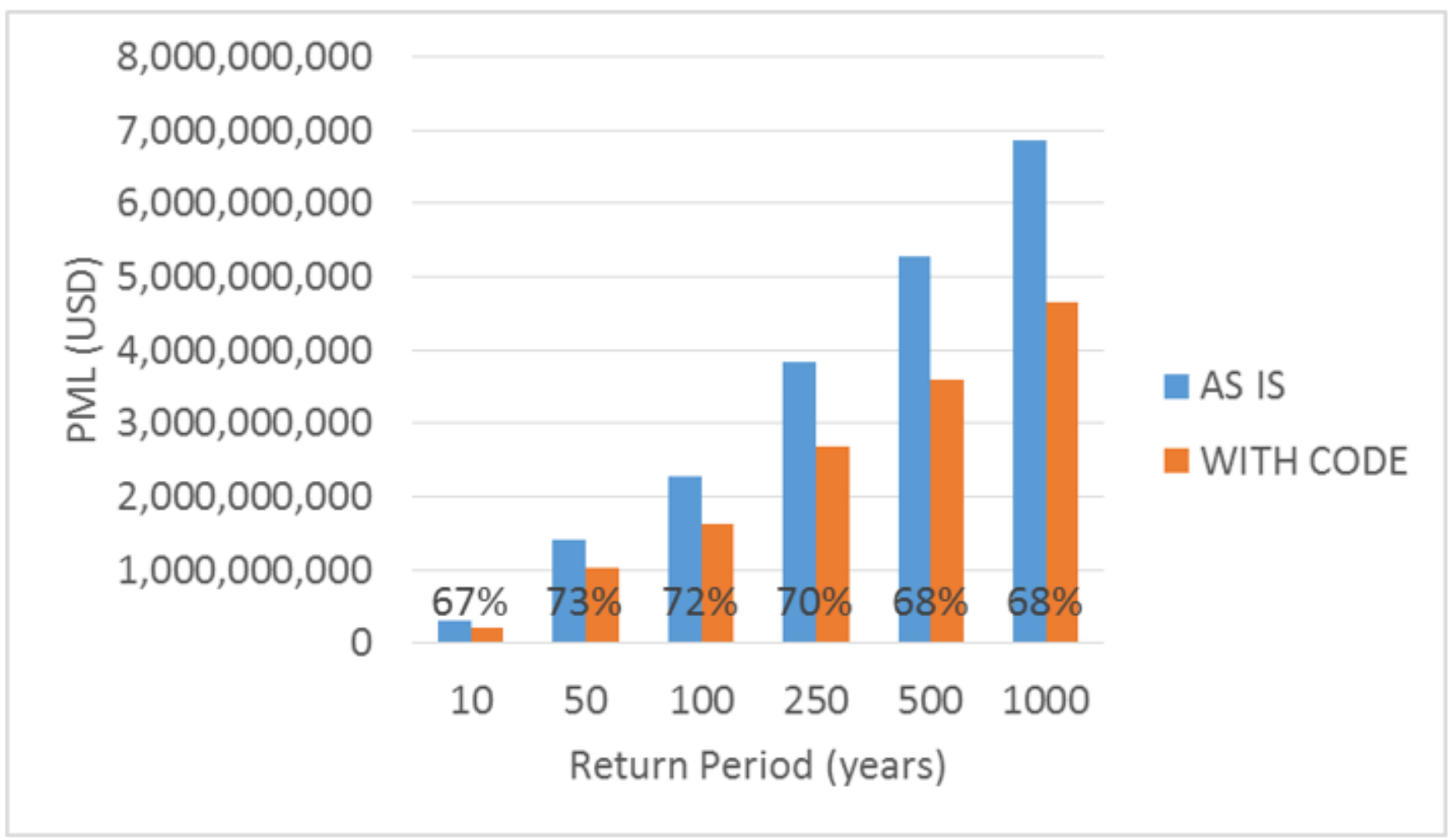
What would it take to reduce the risk?





A comparison of the “to code” and “as is” runs: Probable Maximum Loss Curve in El Salvador

In terms of the PML (probable maximum loss), the total run is around 67-73% of the original “as is”. For a 500 year event, it could be expected that a reduction of close to $2 billion would be expected with full code influence.



PML in terms of loss for Concreto-Mixto classes: blue = “as is” run, orange: “to code” run

Use of profiles in LCR region (side benefits)

- City level risk assessments
  - Stock value distribution and analysis
  - Down scalable method
- Sectorial risk assessments
  - Exposure and transport profiles
  - Private and sovereign liability distribution

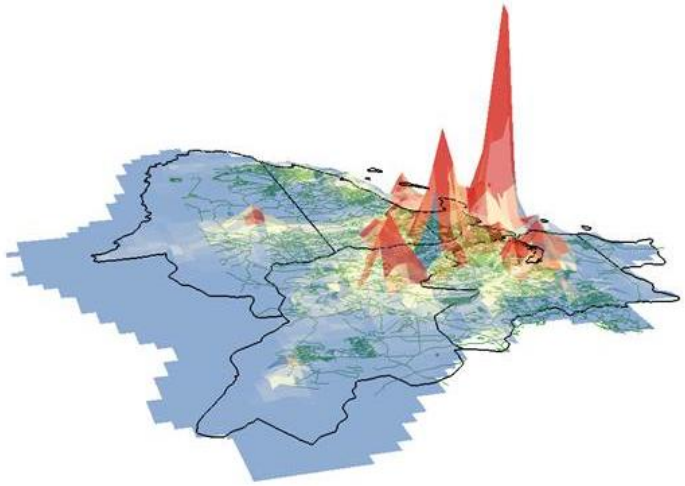
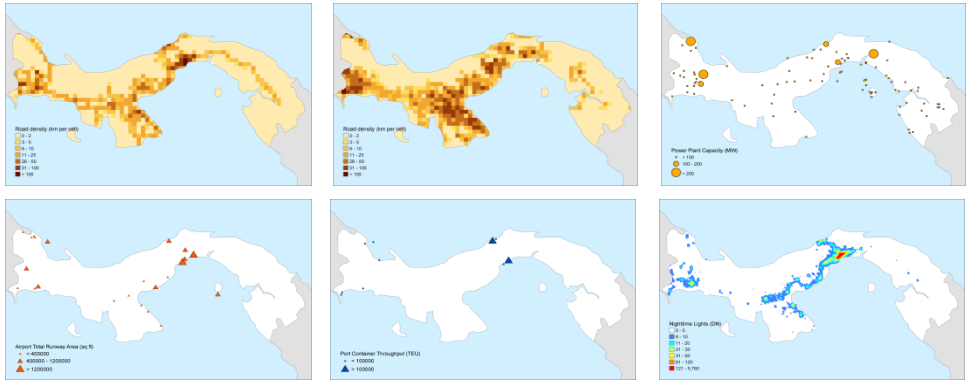


Figure: Dar es Salaam – building stock value distribution (Source: Africa Anchor; GSURR)

Figure: Panama non building infrastructure distribution



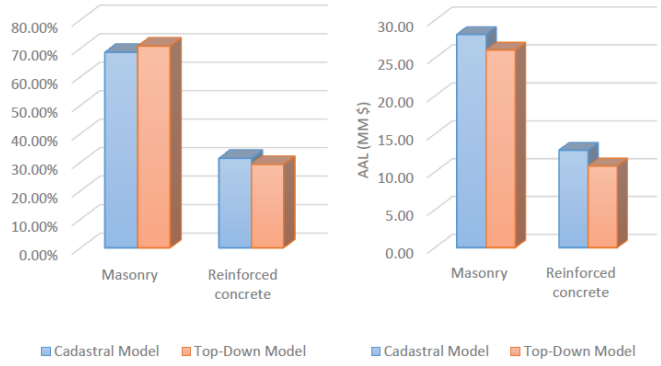
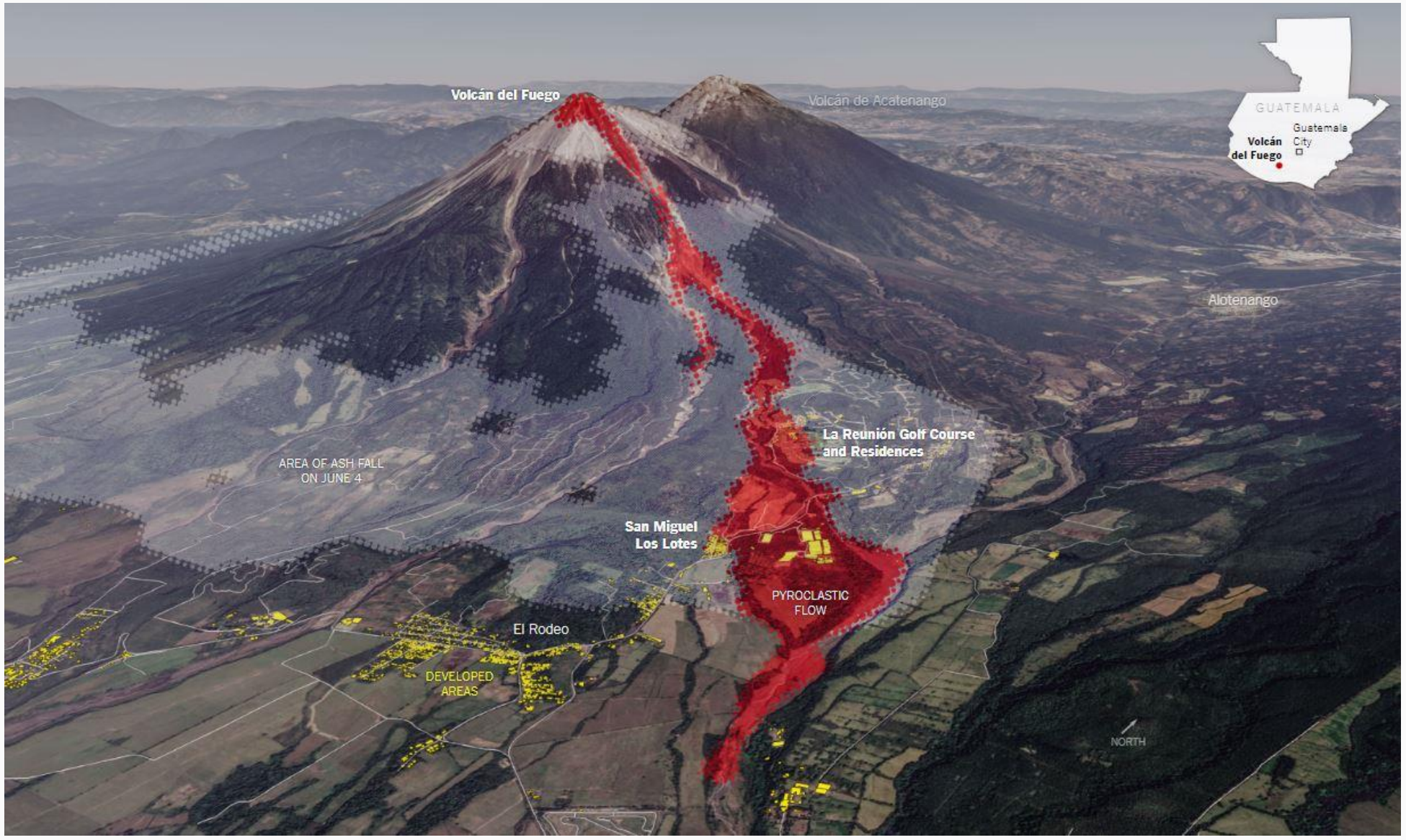


Figure 37 AAL in terms of the residential and nonresidential splitting of the Cuenca buildings. Left: In relative terms of each, model (cadastral and Top-Down). Right: in absolute values of AAL in millions dollars

DISASTER RESPONSE:
Guatemala Volcano Fuego Eruption (Jun 2018) Pyroclastic flow in perspective



Common misconceptions in the media such as that of El Rodeo being destroyed stem from the fact that the village San Miguel Los Lotes (with around 260 buildings destroyed or severely damaged) is part of El Rodeo. However, the main part of El Rodeo is unaffected by the pyroclastic flows and lahars and only received some ashfall.

Source: nyt

Quantifying damage and implications

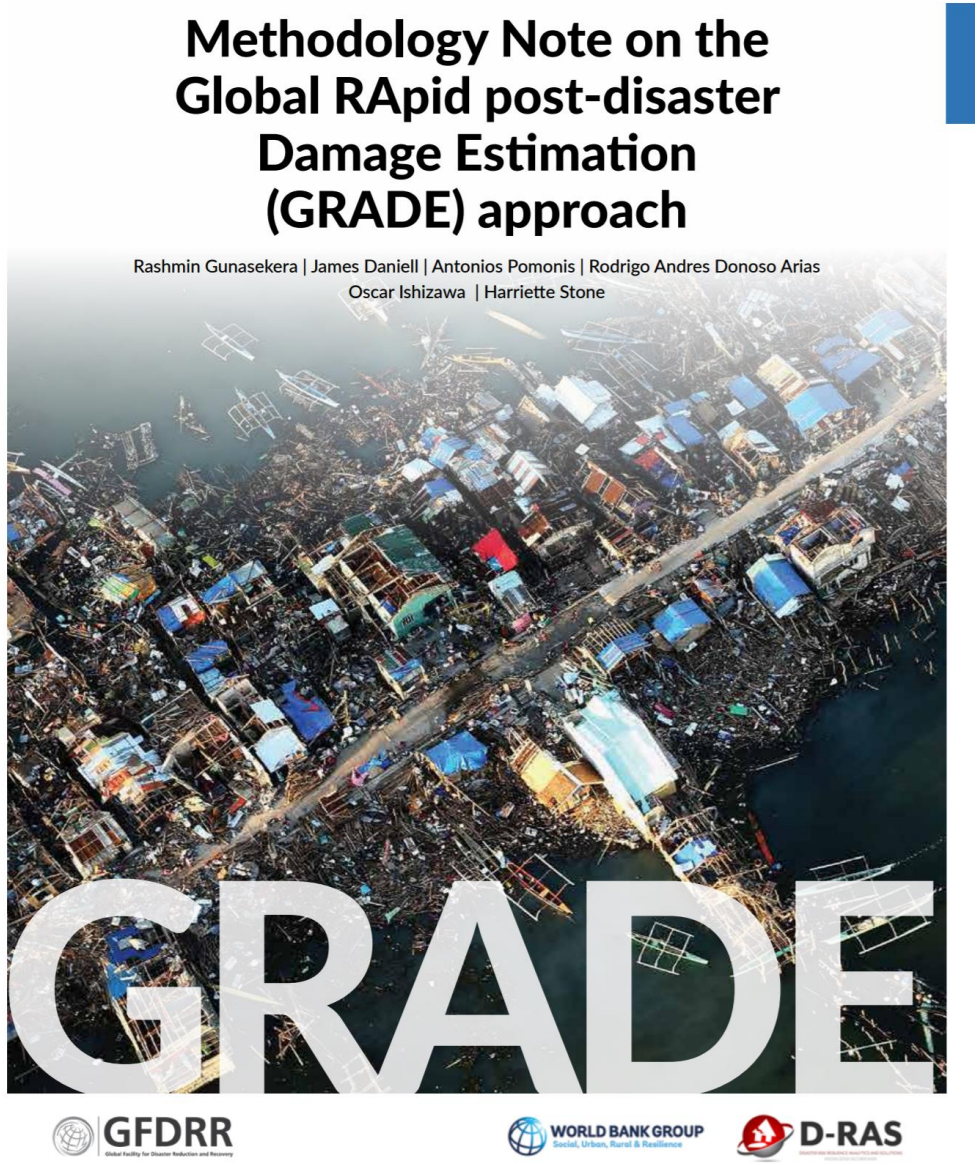
San Miguel Los Lotes (depth of PF material)

Source: UK daily express

San Miguel Los Lotes in parts buried under 1-2 m of pyroclastic material (vulnerability of building stock)

Risk: Ash fall – Critical infrastructure

Code:			D0	D1	D2	D3	D4	D5
Description:			No damage	Cleaning required		Repair required		Beyond economic repair
CRITICAL INFRASTRUCTURE TYPE:	Airports	Function	Fully functional	Closure of runway				Indefinite closure
		Damage	No damage (but loss of revenue costs)		Possible runway surface degradation	Collapse of critical buildings; possible runway surface degradation [3]		Complete burial
		Thickness	0 mm	>0 mm				>500 mm
	Power	Function	Fully functional	Temporary disruption, e.g. flashover of insulators		Disruption requiring repair		Permanent disruption
		Damage	No damage	No damage to components		Damage to critical components; long delays in receiving replacement components.		Structural damage
		Thickness	0 (0-20) mm	5 (1-20) mm		20 (2-100) mm		>500 mm (100-1000 mm)
	Railways	Function	Fully functional	Reduced visibility and traction	Signals disrupted	Loss of traction making operation unsafe; Possible derailing through ash accumulation		Impassable
		Damage	No damage		Possible abrasion and/or corrosion of signal components and track			Complete burial
		Thickness	0 (0-5) mm	0.5 (0.1-10) mm	1 (0.1-20) mm	30 (2-100) mm		100 (50-200) mm
	Roads	Function	Fully functional	Reduced visibility and traction	Road markings obscured	2WD vehicles obstructed	4WD vehicles obstructed	Impassable
		Damage	No damage		Possible road surface and marking abrasion	Road surface and marking abrasion		Complete burial
		Thickness	0 (0-5) mm	0.5 (0.1-10) mm	2 (1-20) mm	50 (10-100) mm	150 (50-300) mm	n/a [4]



Report Available Online at:
https://www.preventionweb.net/publications/view/57947

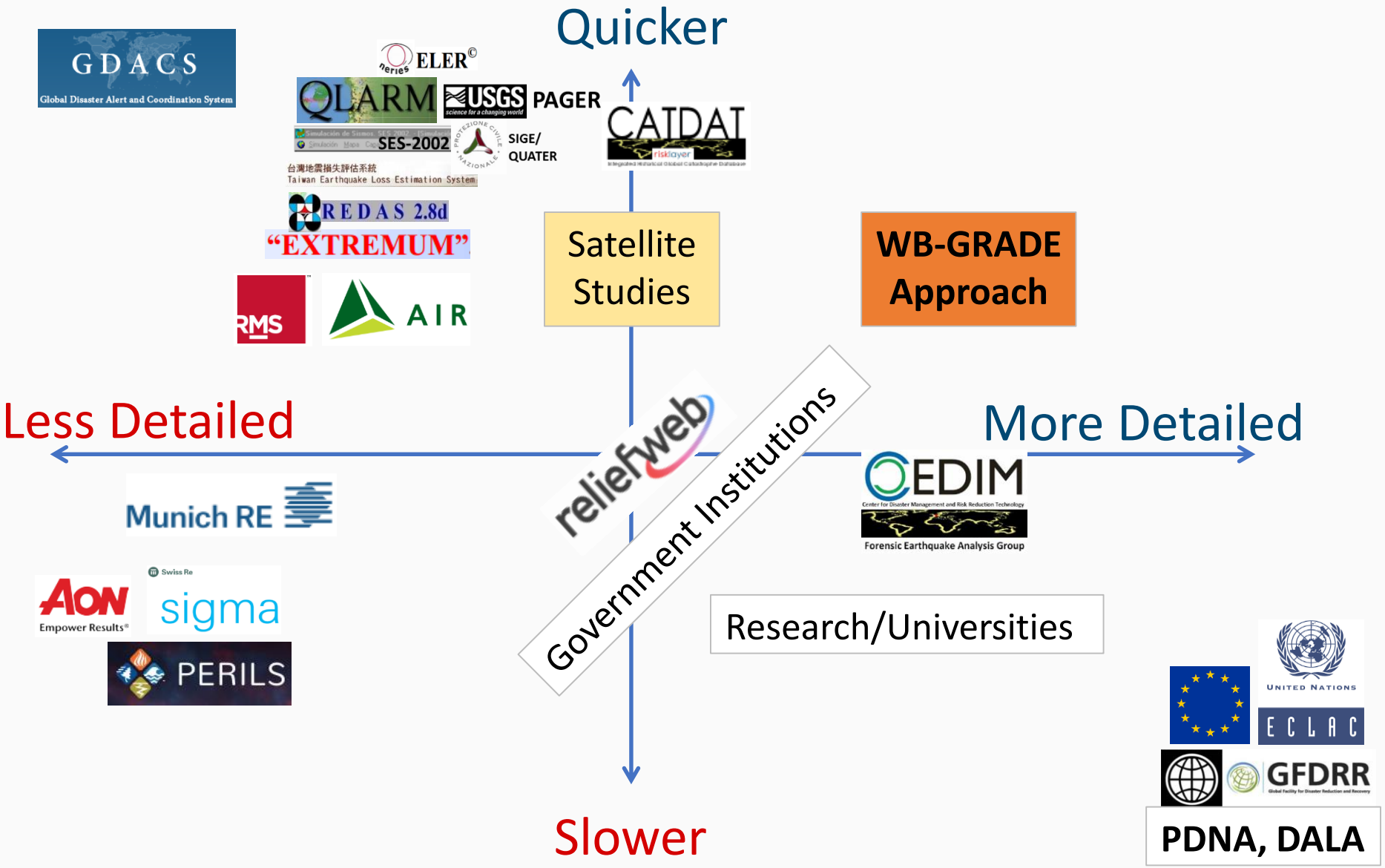
The day after, Government grappled with questions such as:

How do we assess damages?

Where are the damages distributed?

What is the socio-economic impact?

Existing Post-Disaster Tools



The Solution:

Global **Rapid** Post disaster damage assessment (GRADE)

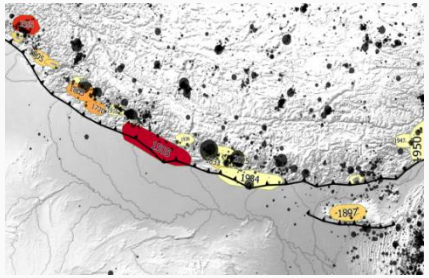
Existing Methods

2 months

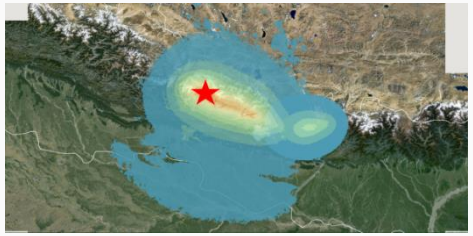
GRADE

2 weeks

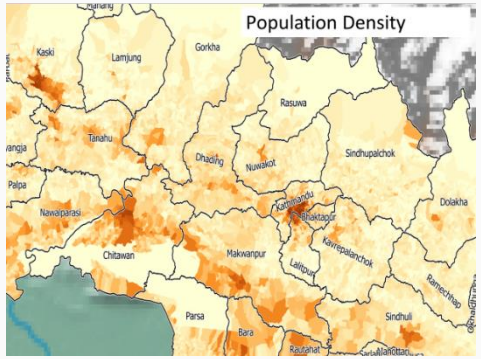
Data sets in its Analysis



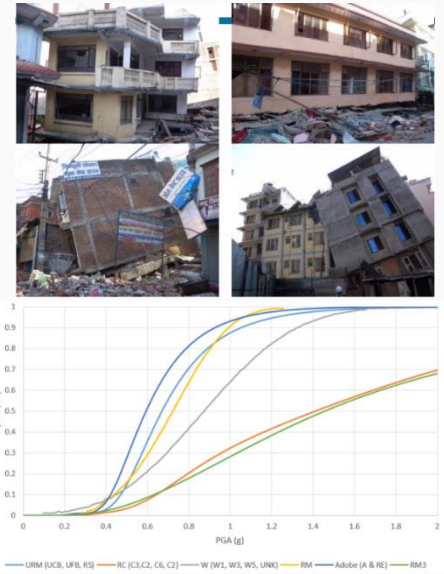
Historical damage data



Event scientific data



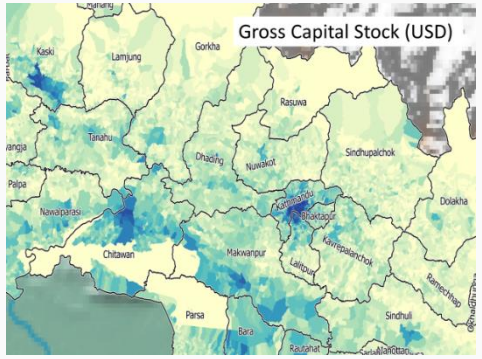
Census data



Vulnerability/Built Data

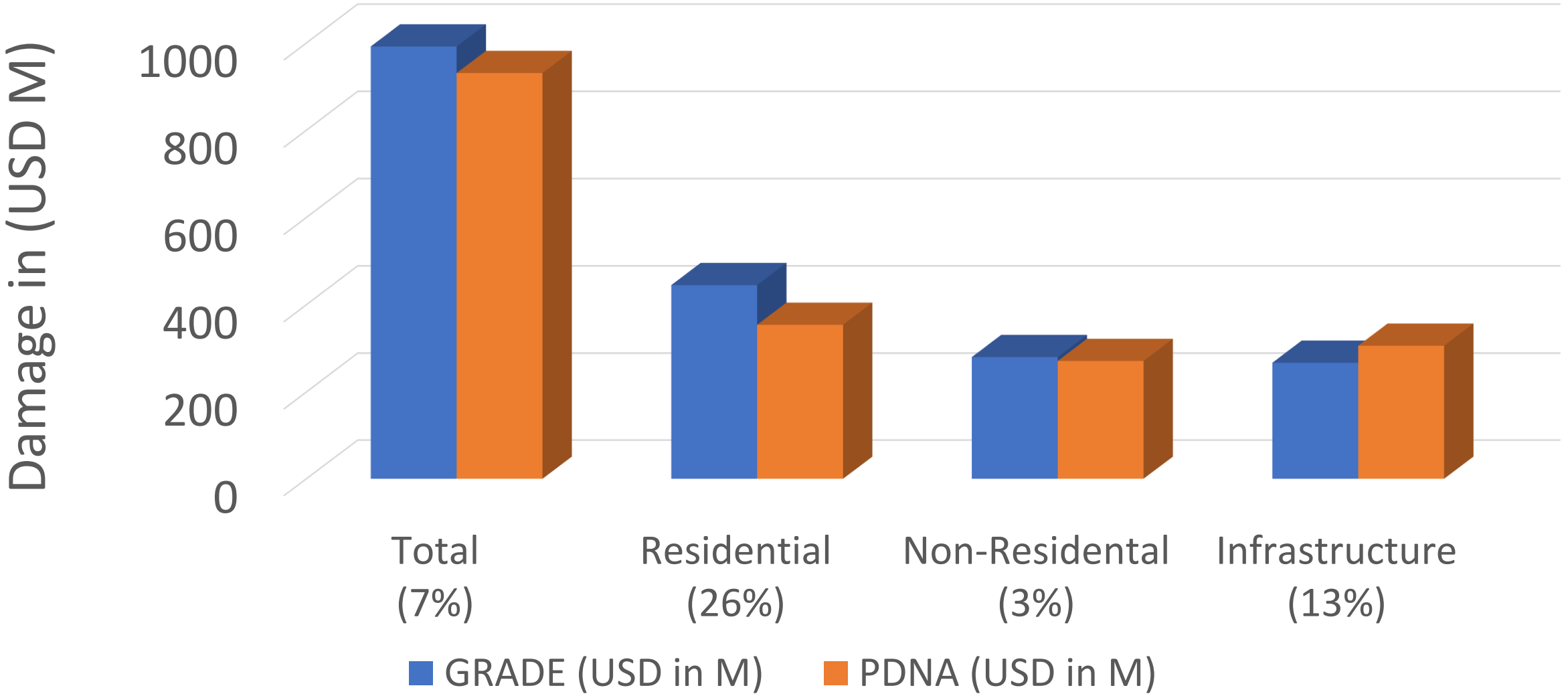
Expert knowledge

Remotely-sensed data / Social Media



Socioeconomic data

Dominica - HU Maria – Sept 18th 2017
GRADE (**6 days**) vs PDNA (**58 days**)



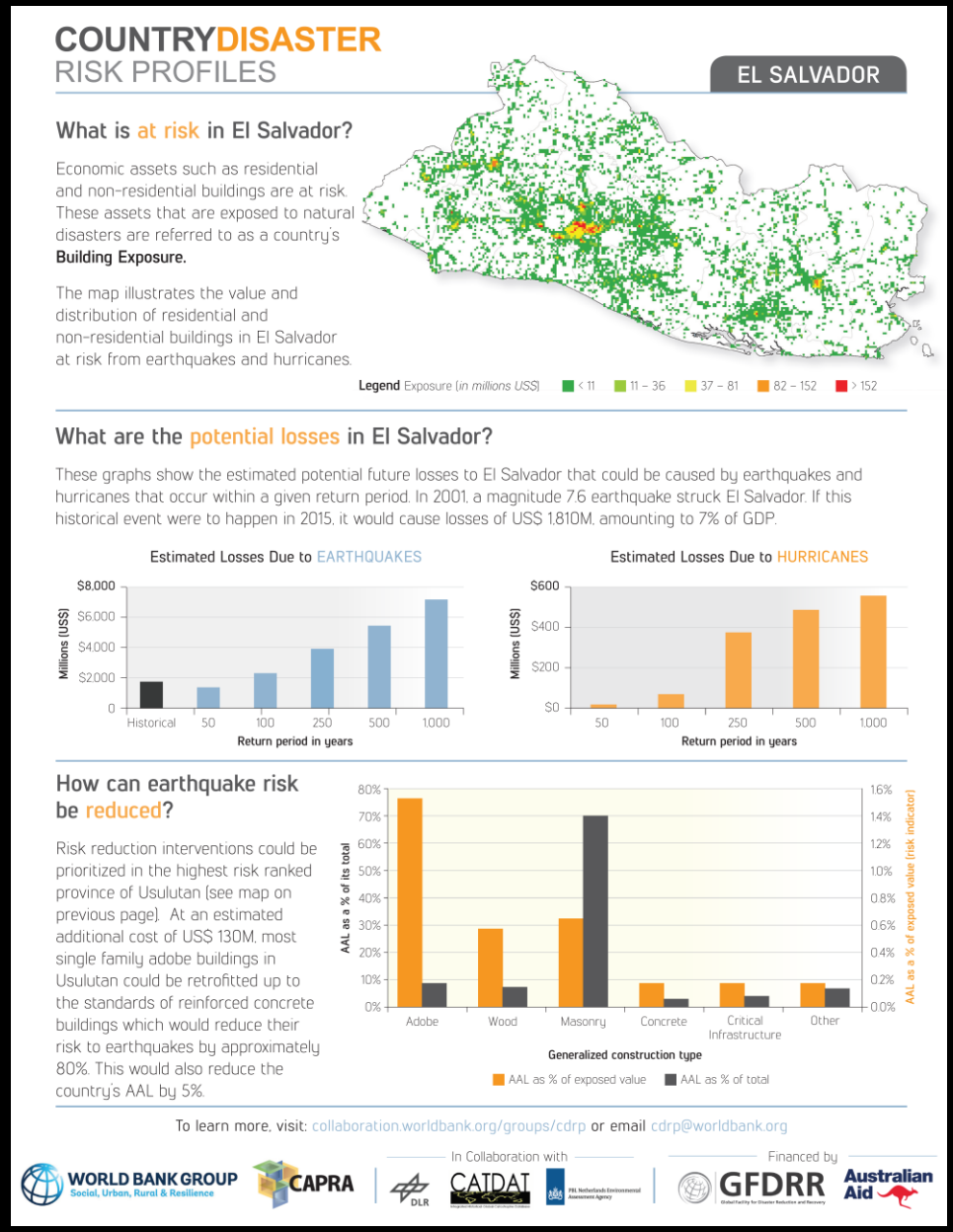
Future Related Activities:

Scaling up to other sectors/ countries

Collaboration with the Private Sector

Build critical information to increase resilience to climate-related risks

Contact: cdrp@worldbank.org



Thank you!

(For: Vasiliki, Hans and Soma)

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