

3WCDRR: UN GAR Global Risk Assessment

GAR

Global Assessment Report
on Disaster Risk Reduction

2013 Prevention for Risk, Strengthen Resilience for the Future of Our World



GAR

Global Assessment Report
on Disaster Risk Reduction

2015 Making Development Sustainable
The Future of Disaster Risk M



UNISDR

The United Nations Office for Disaster Risk Reduction



World Conference on
Disaster Risk Reduction



CAPRA

Scoping Meeting Agricultural Risk Assessment

*Incorporating drought and the agricultural sector in
the GAR Global Risk Model*

7 - 9 February 2017 - Boulder, Colorado

GAR Global Risk Assessment : At Glance

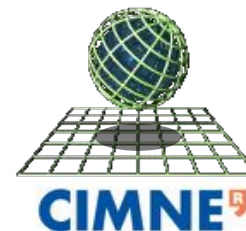
MULTI-HAZARD FULLY PROBABILISTIC RISK ASSESSMENT RESULTS AT GLOBAL LEVEL

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National University of Colombia at Manizales
Representative



International Centre for Numerical Methods in Engineering



&
INGENIAR LTDA



Why a Global Risk Assessment ?

- ✓ *Measuring is essential to decide; what is not dimensioned cannot be administrated*
- ✓ *An operational picture of risk improves risk knowledge and provides an overall risk landscape*
- ✓ *Risk assessment is key to aware but also to concern decision-makers of their responsibility*
- ✓ *Disaster risk is a contingent liability and therefore a sovereign risk for the society*
- ✓ *Risk reduction and prevention are duties for risk governance and for the nations' accountability*
- ✓ *Track DRM progress over time means considering the development transformation trade-offs*





COMPREHENSIVE APPROACH TO PROBABILISTIC RISK ASSESSMENT

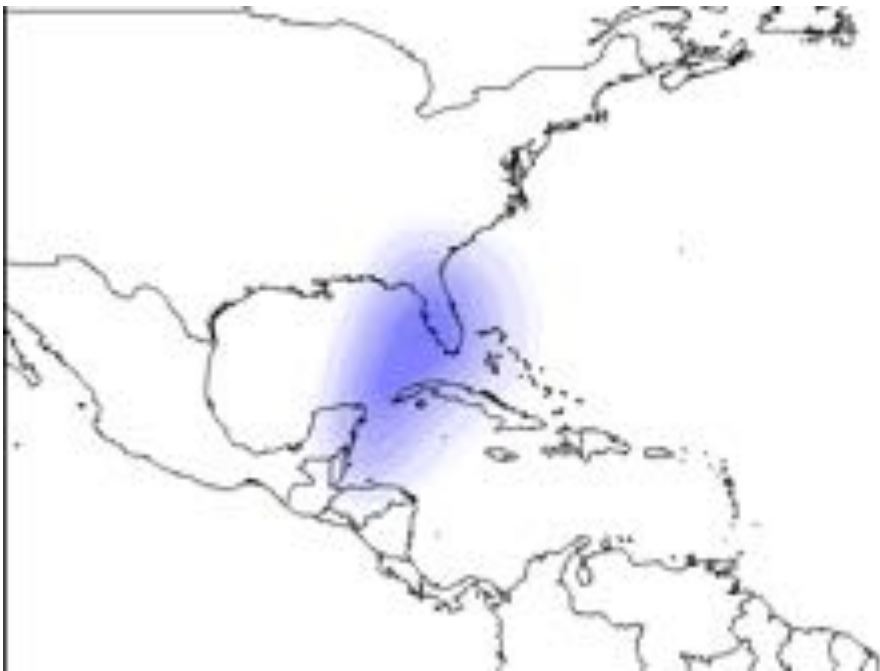
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Cyclonic Wind and Seismic Hazard

Set of stochastic scenarios

- ✓ *Mutually exclusive*
- ✓ *Collectively exhaustive*
- ✓ *Admit probabilistic representation*

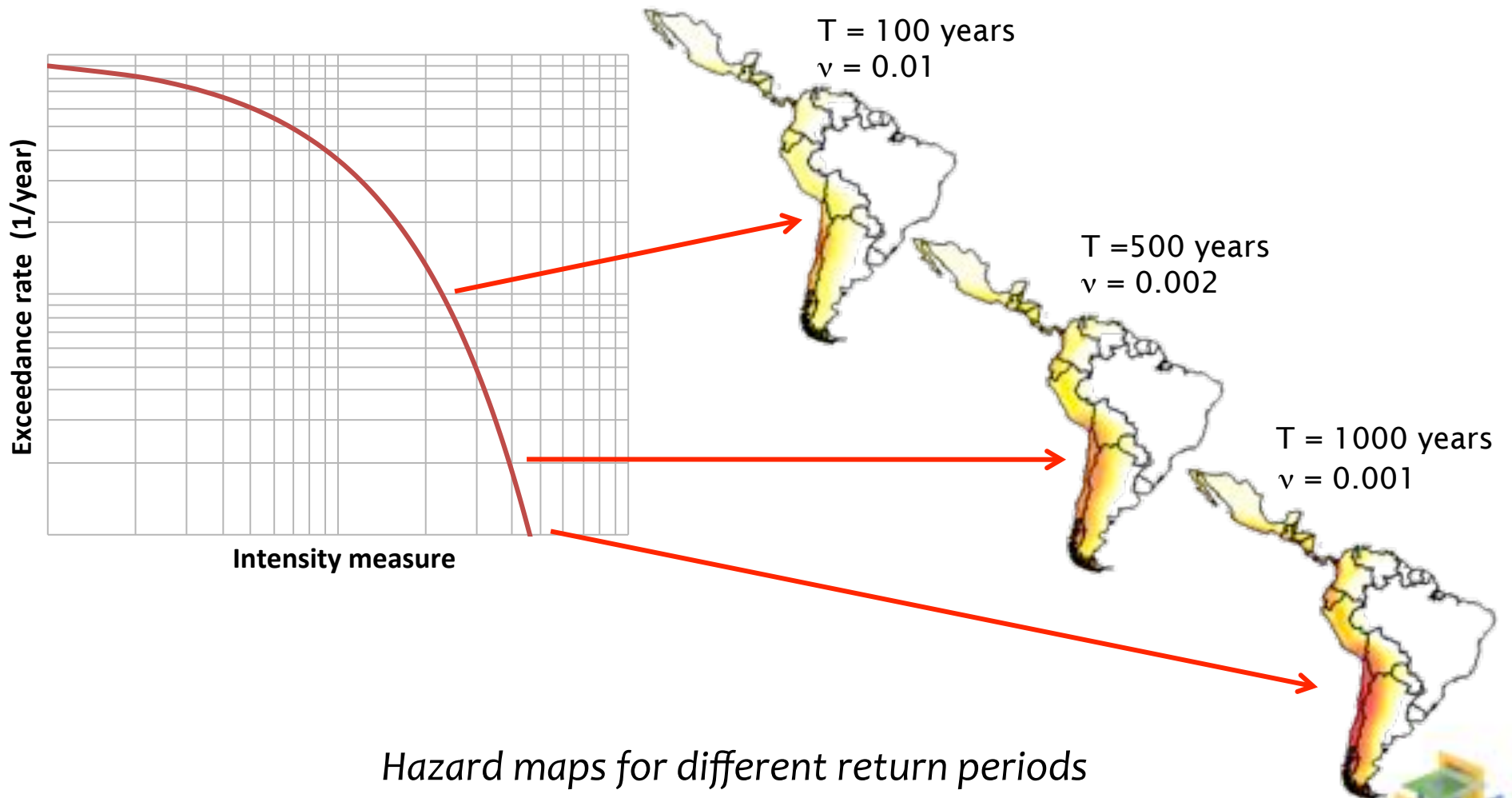


.AME FORMAT



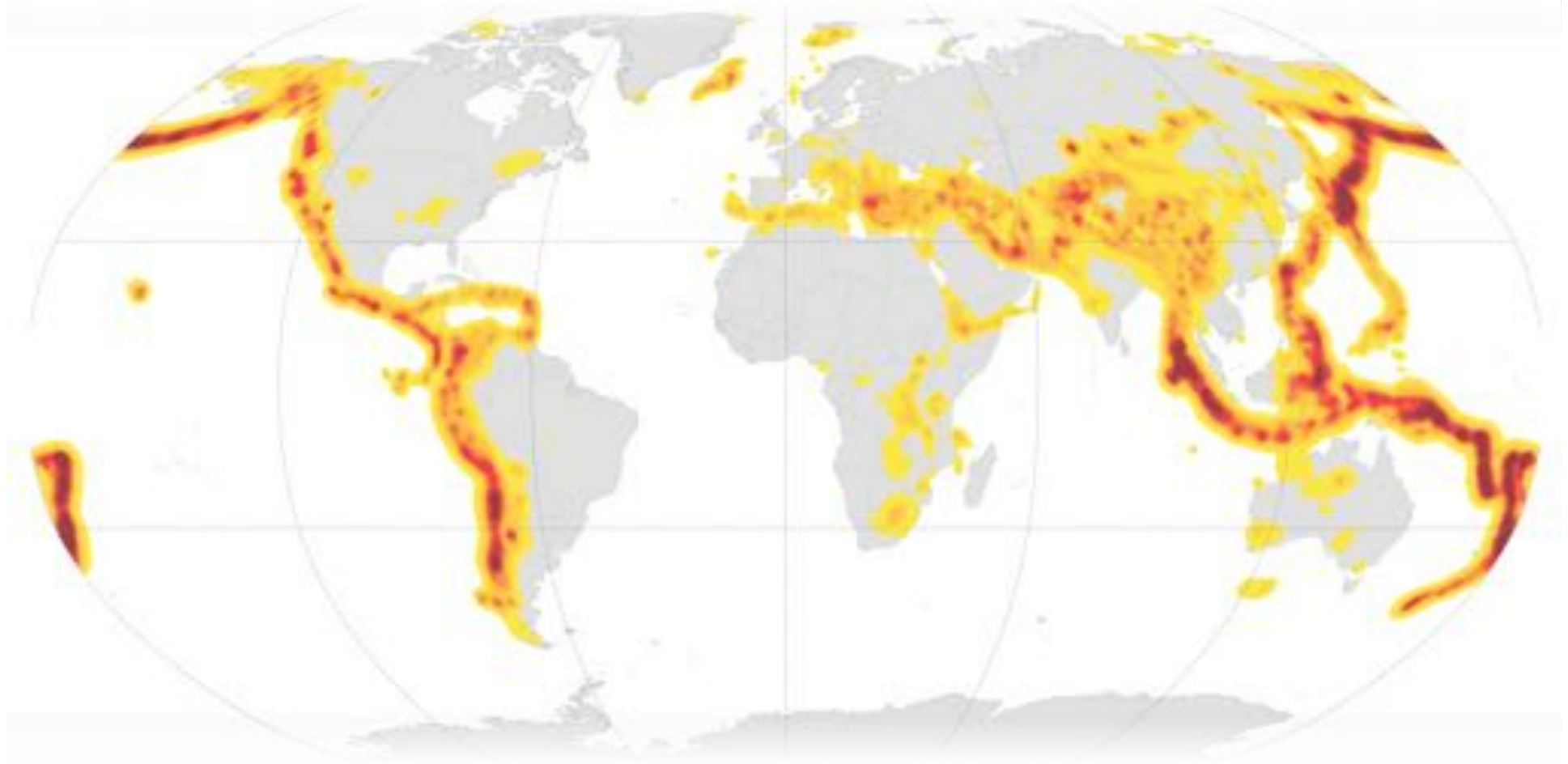
Seismic Hazard Assessment

Intensity exceedance curves in each node of the global grid

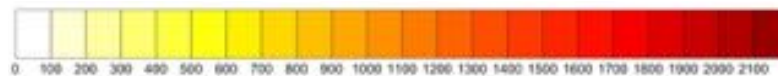


Seismic Hazard Assessment

Earthquake Hazard Maps



Cardona et.al. (2015)



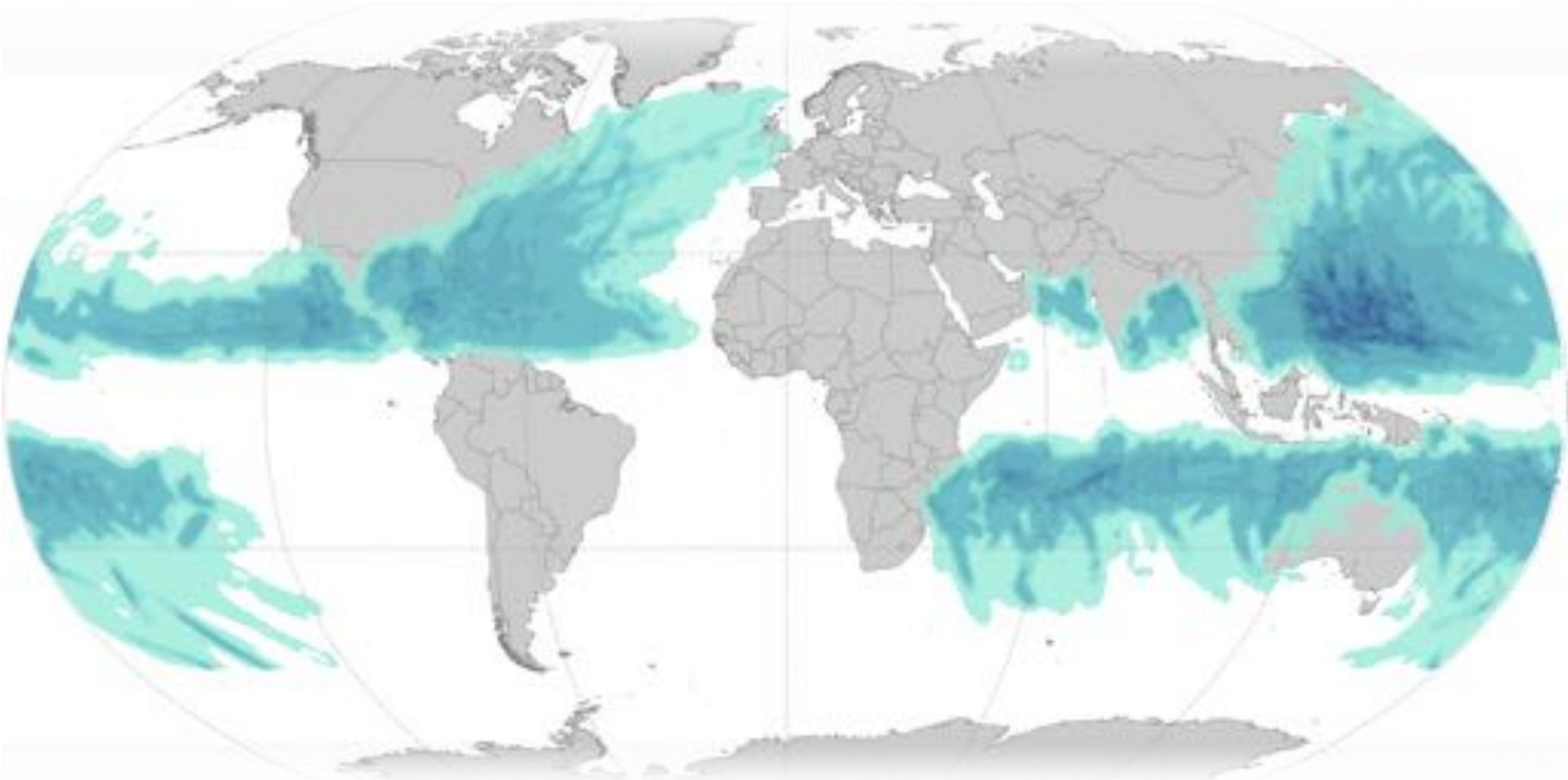
$T = 0.5 \text{ sec}$, $T_r = 475 \text{ years}$

INGENIAR CAD/CAE Ltd. Cardona, O.D., Bernal, G. (2017). Scoping Meeting Agricultural Risk Assessment. Boulder, CO, 7-9 February 2017

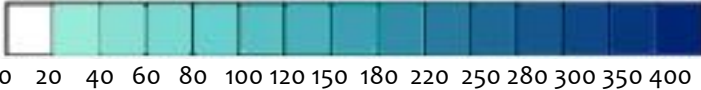


Cyclonic Wind Hazard

Tropical Cyclone Wind Hazard Maps



Cardona et.al. (2015)

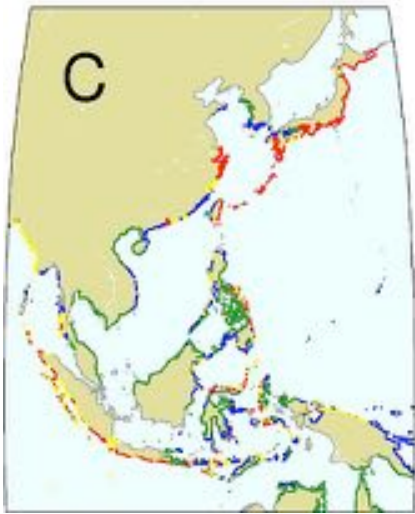


Tr=100 years

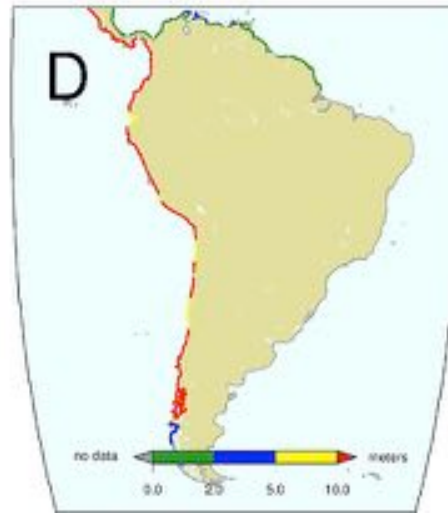


Other Probabilistic Hazards

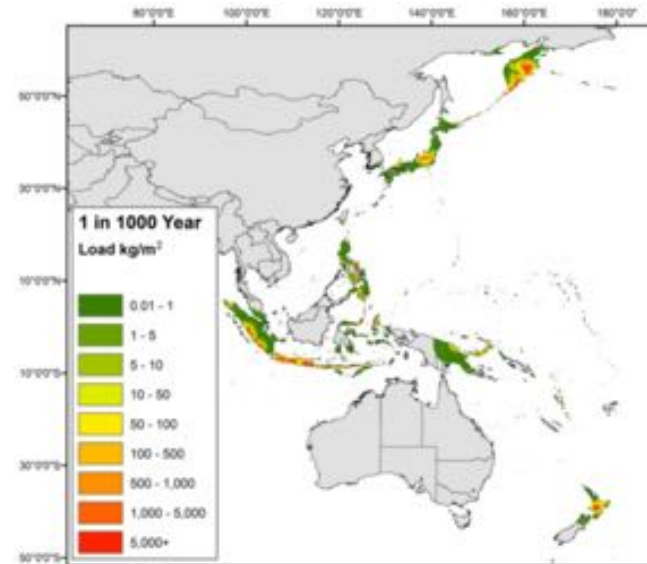
Tsunami, Floods, Volcanic Ash, Storm Surge, Climate Change Scenarios



Tsunami: Run-up height for Tr 500 years

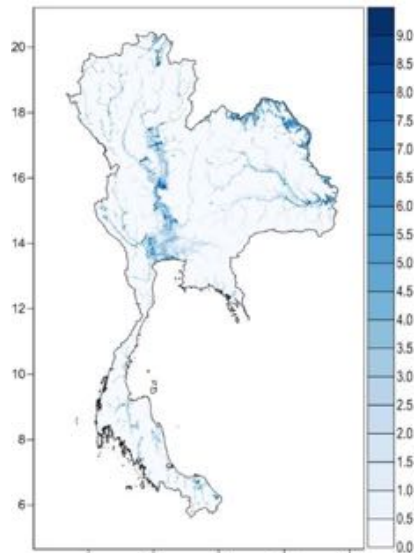


Løvholt et.al. (2014)



Volcanic ash load for Tr 100 years

Bear-Crozier et.al, 2014



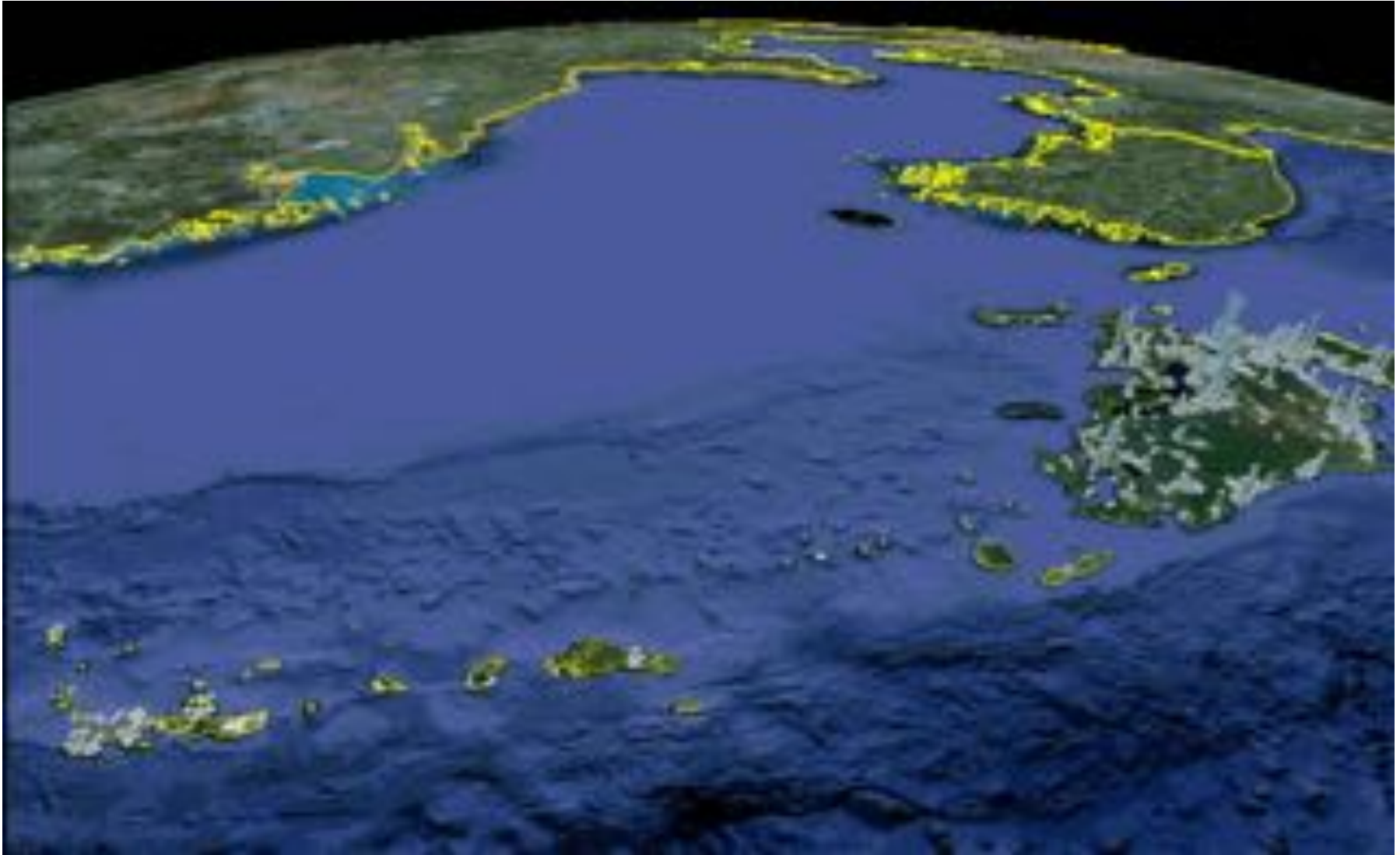
Floods for Tr 1000 years

CIMA (2014)



Global Exposure Database

5x5 km grids & 1x1 km in the coasts



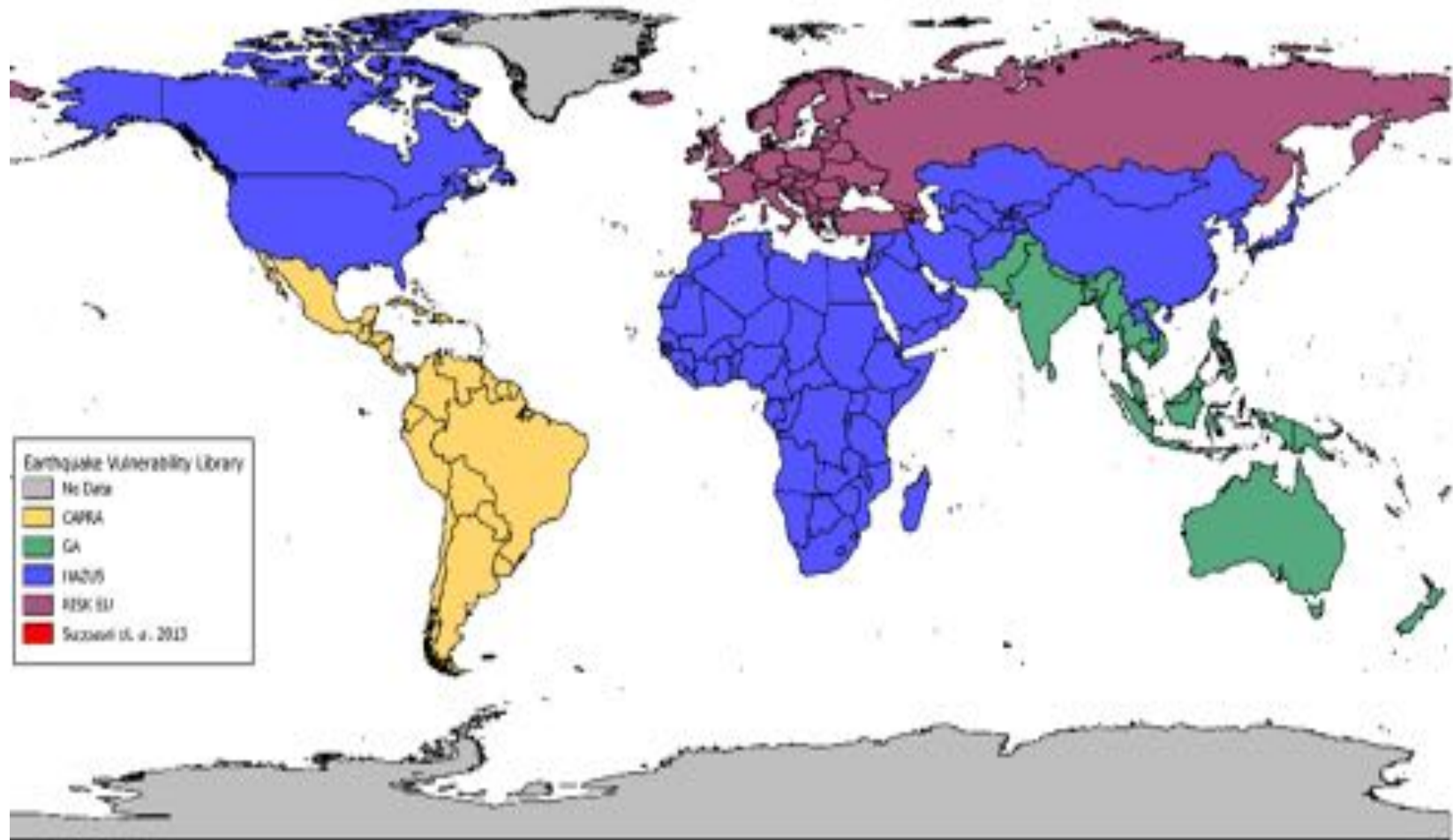
GRID, UNEP (2014)

INGENIAR CAD/CAE Ltd. Cardona, O.D., Bernal, G. (2017). Scoping Meeting Agricultural Risk Assessment. Boulder, CO, 7-9 February 2017



Vulnerability

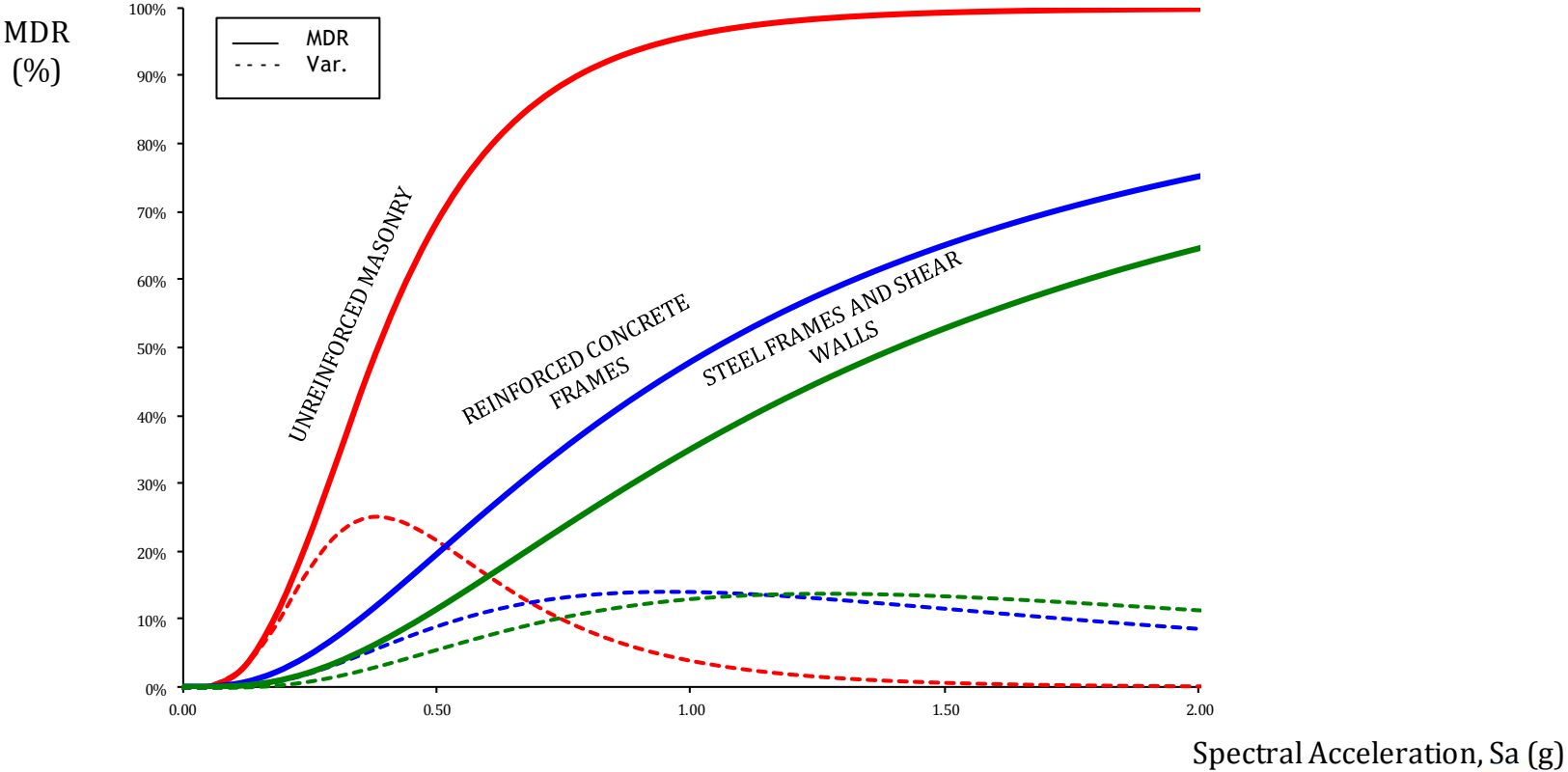
Vulnerability functions for different hazards



Vulnerability

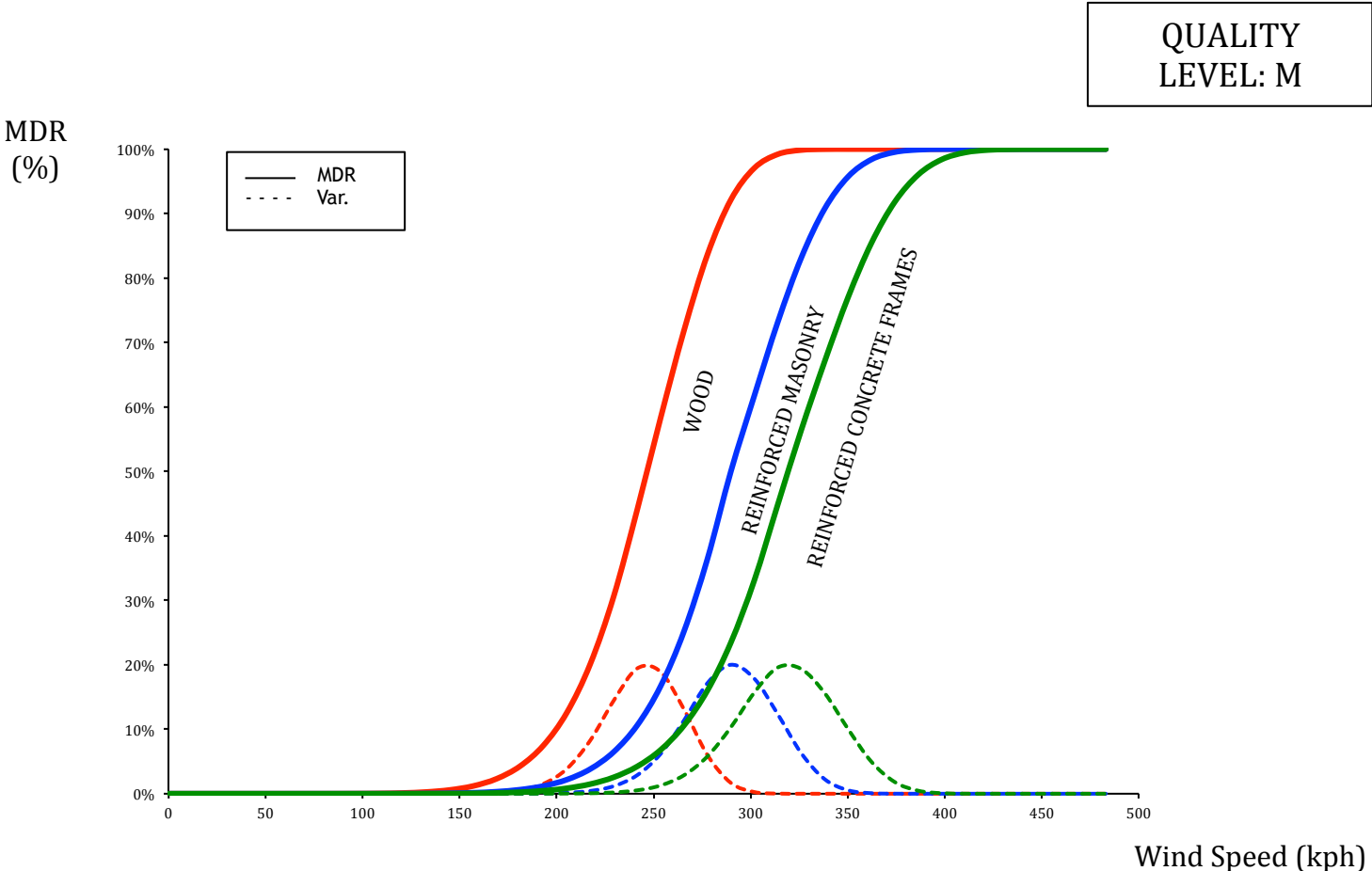
Vulnerability functions for earthquakes

SEISMIC DESIGN
LEVEL: M



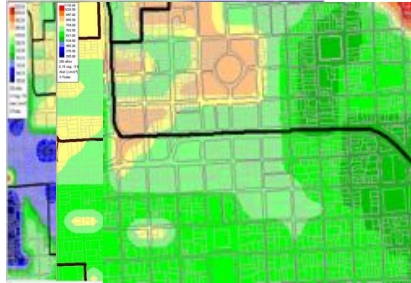
Vulnerability

Vulnerability functions for wind



Risk Modeling: Loss Assessment

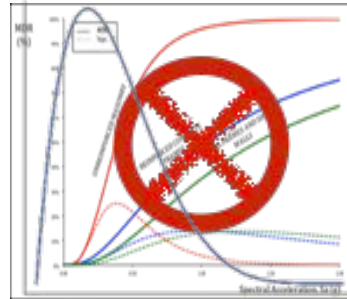
Hazard



Exposed Assets



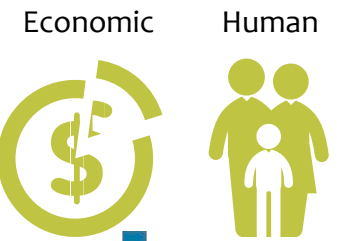
Vulnerability



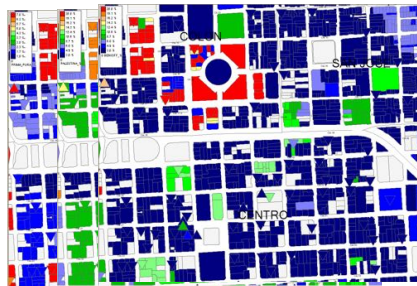
Risk



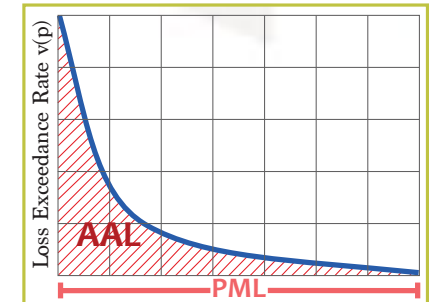
Losses



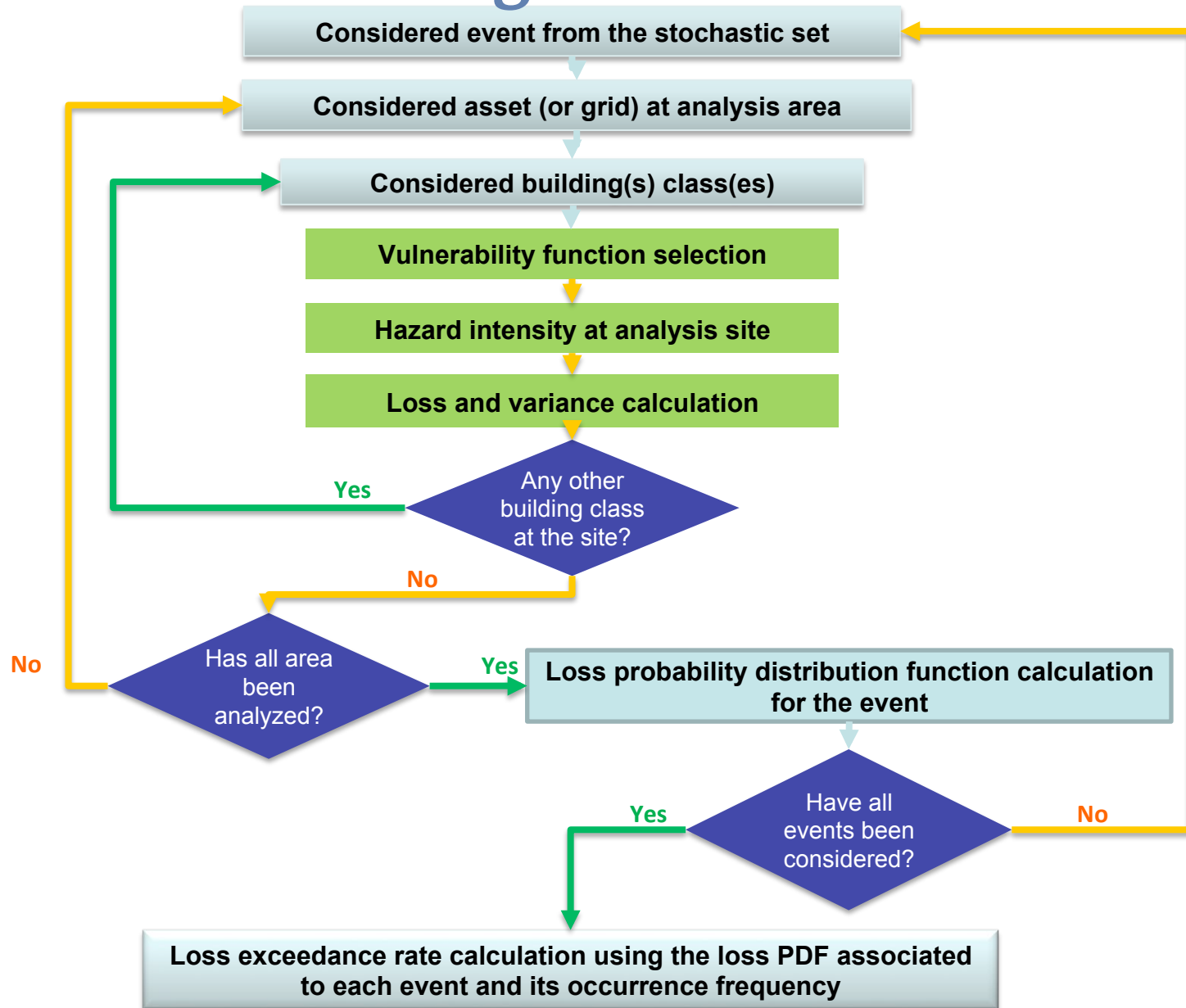
Loss



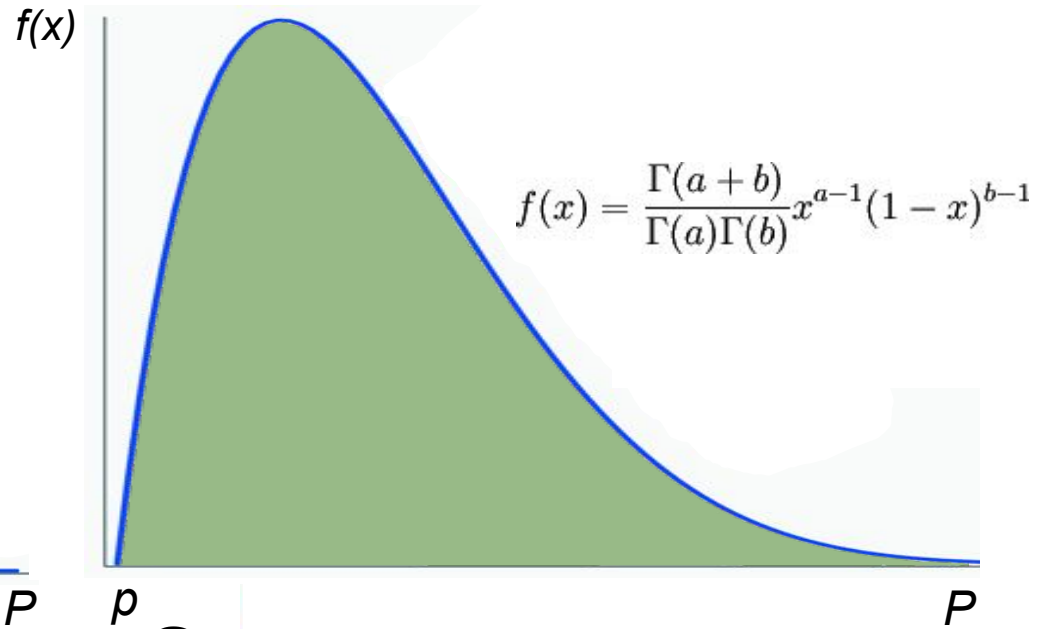
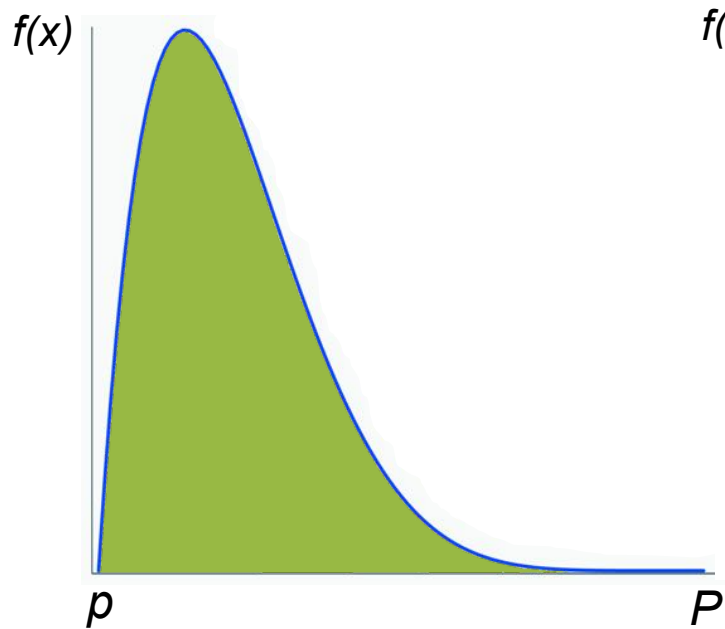
LOSS EXCEEDANCE CURVE
PROBABLE MAXIMUM LOSS
AVERAGE ANNUAL LOSS



Risk Modelling: Loss Assessment



$$f(l | Event i) = \int_0^{\infty} \underbrace{f(l | Sa)}_{\text{Vulnerability}} \underbrace{f(Sa | Event i)}_{\text{Hazard}} dSa$$



Loss exceedance rate (#/year)

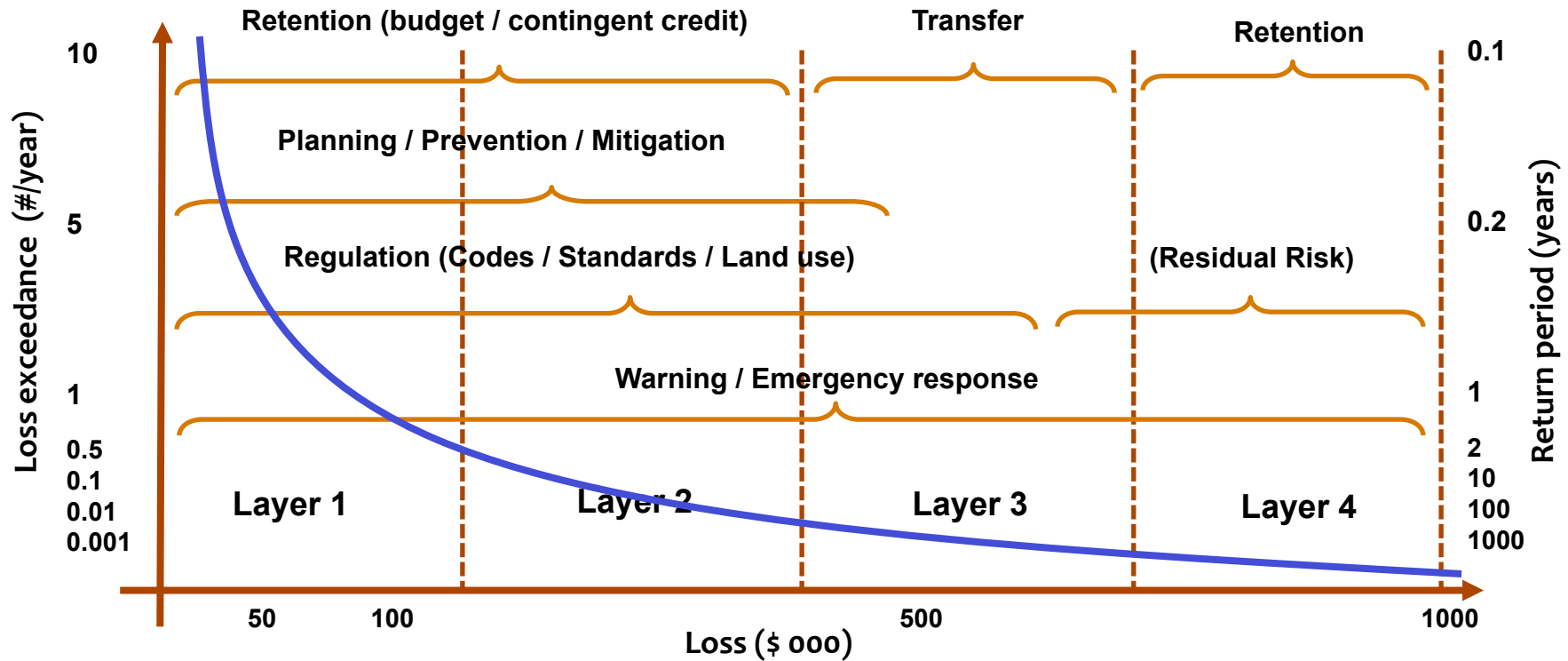
$$v(p) = \sum_{i=1}^{\text{Events}} \Pr(l \geq L | Event i) \cdot F_A(Event i)$$

Losses



Loss Exceedance Curve

Governments need to define a risk reduction/financing strategy

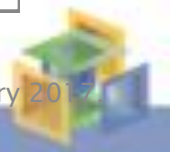
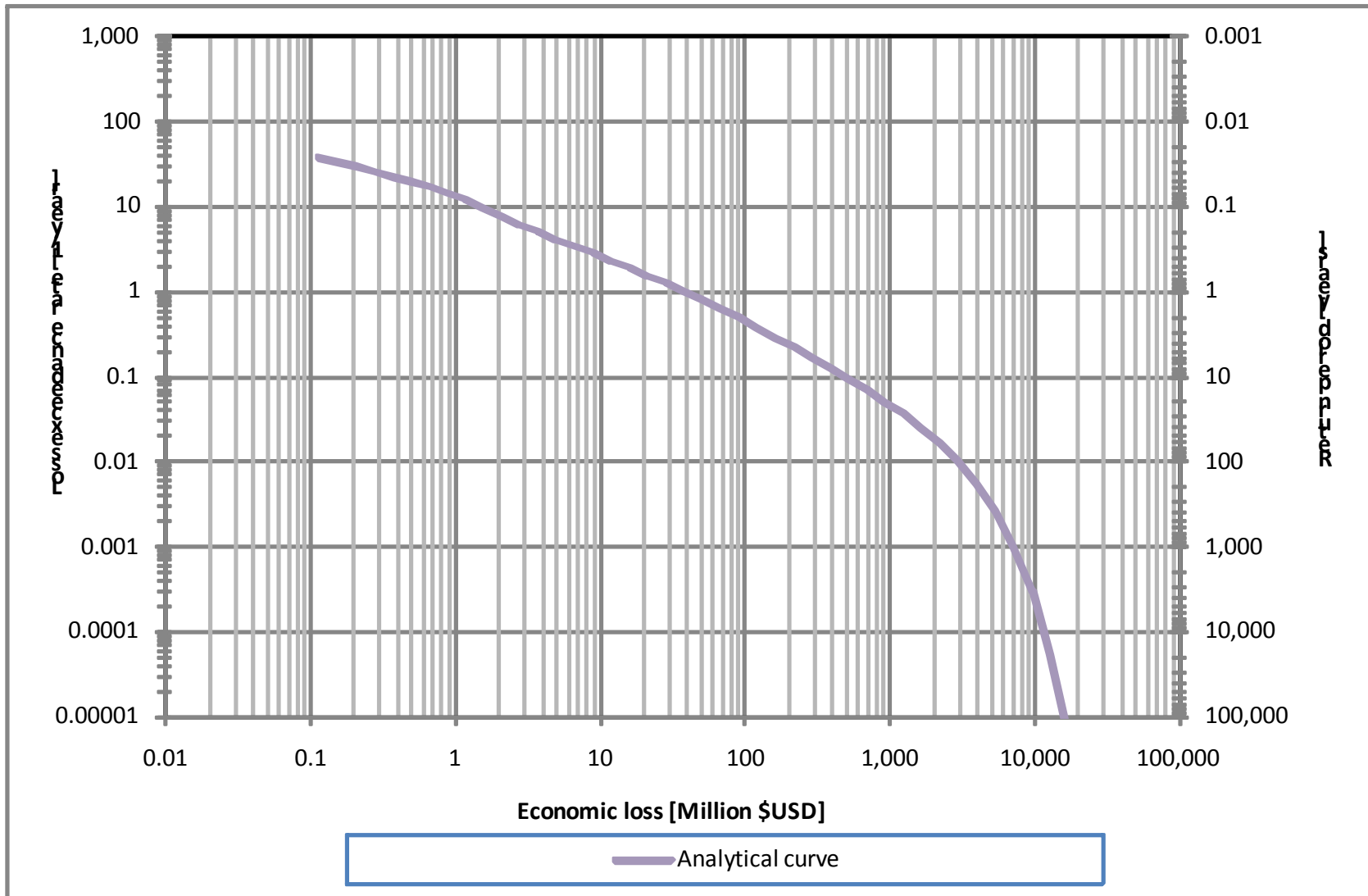
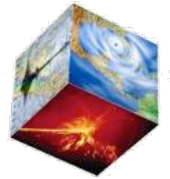


- 1 = High probability & low/moderate losses
- 2 = Medium probability & moderate/high losses
- 3 = Low probability & high losses
- 4 = Very low probability & very high losses



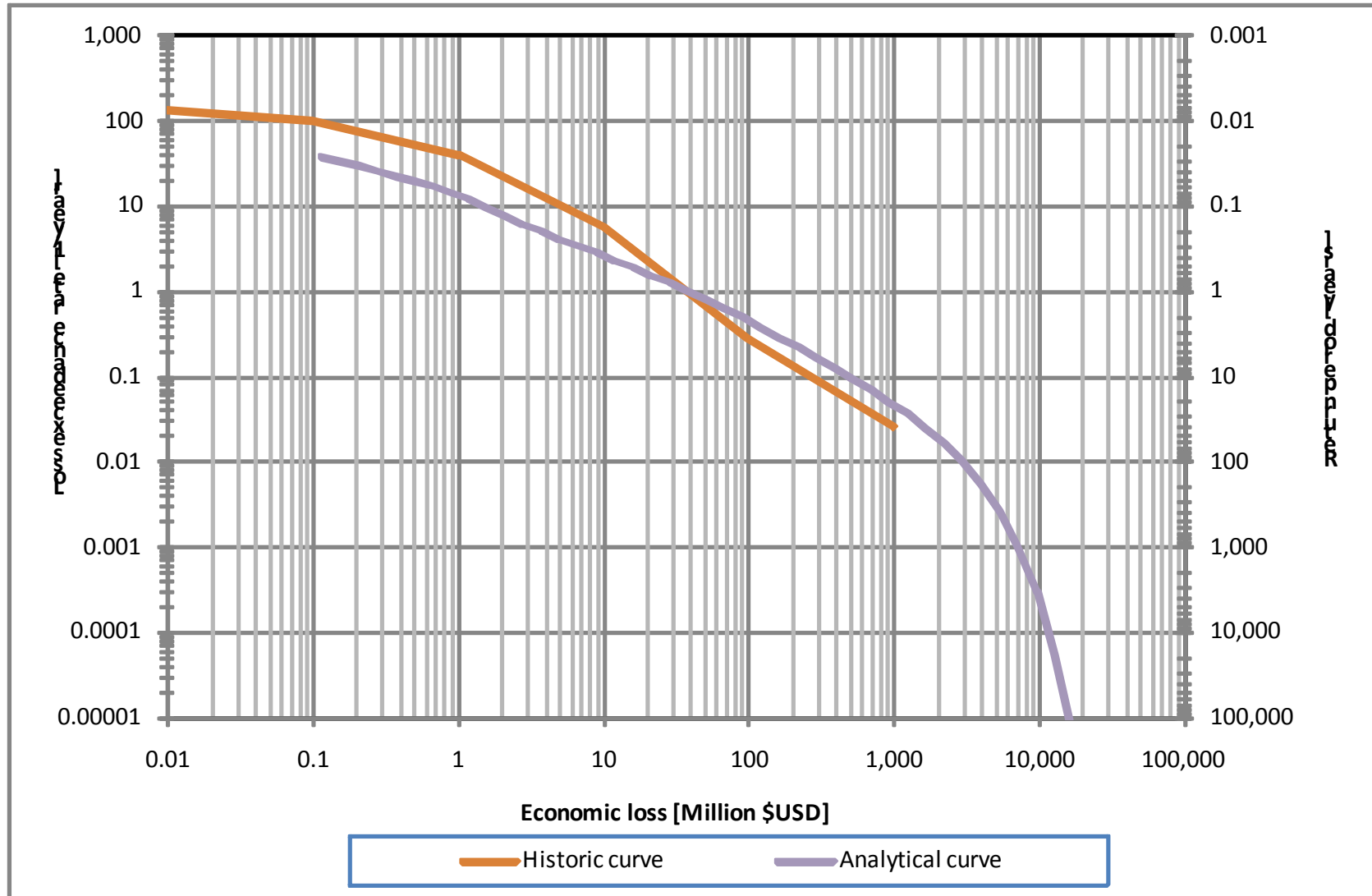
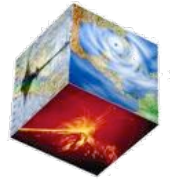
Extensive and Intensive Risk Assessment

Analytical (propective) Loss Exceedance Curve

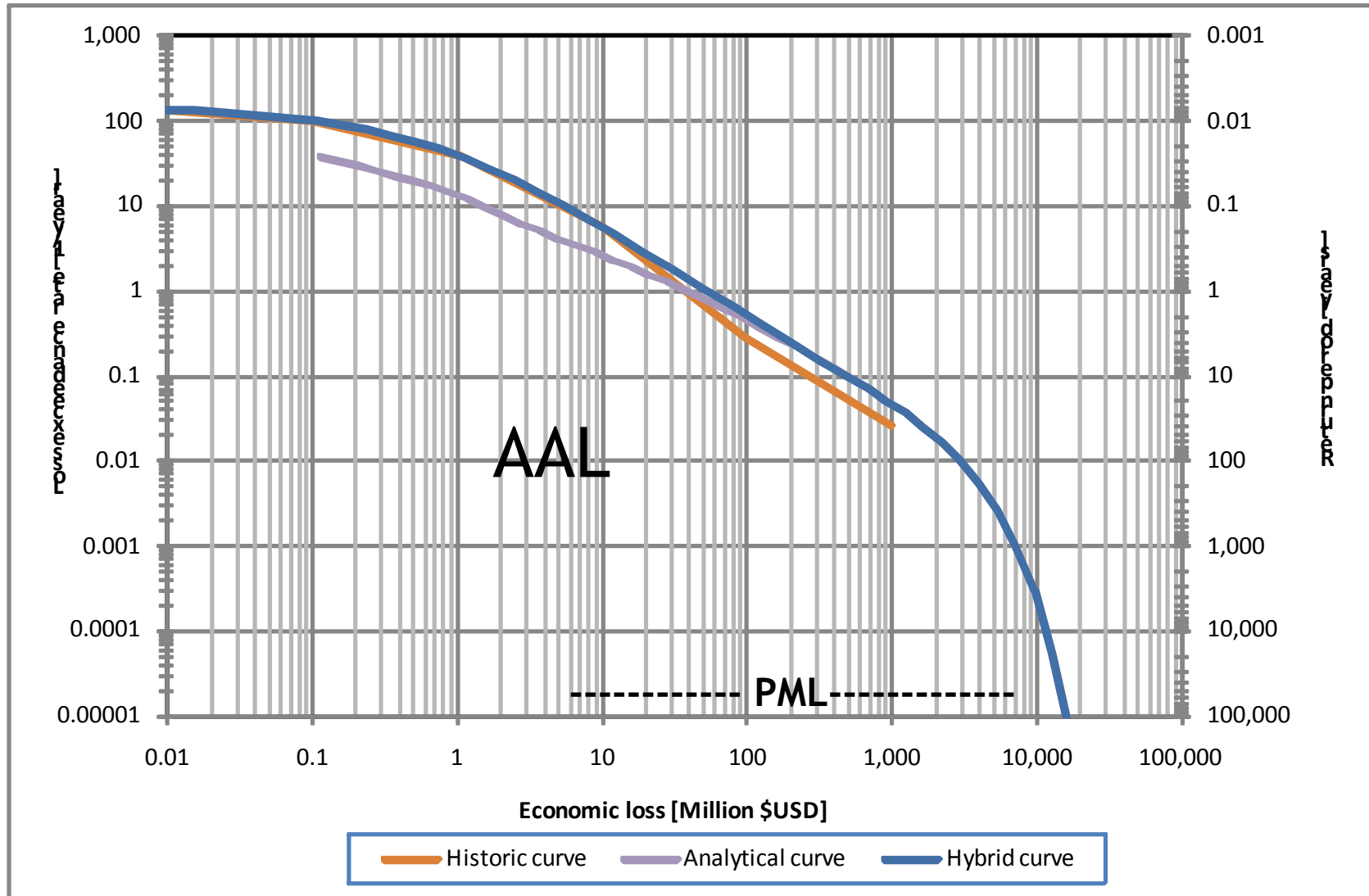


Extensive and Intensive Risk Assessment

Empiric (retrospective) Loss Exceedance Curve

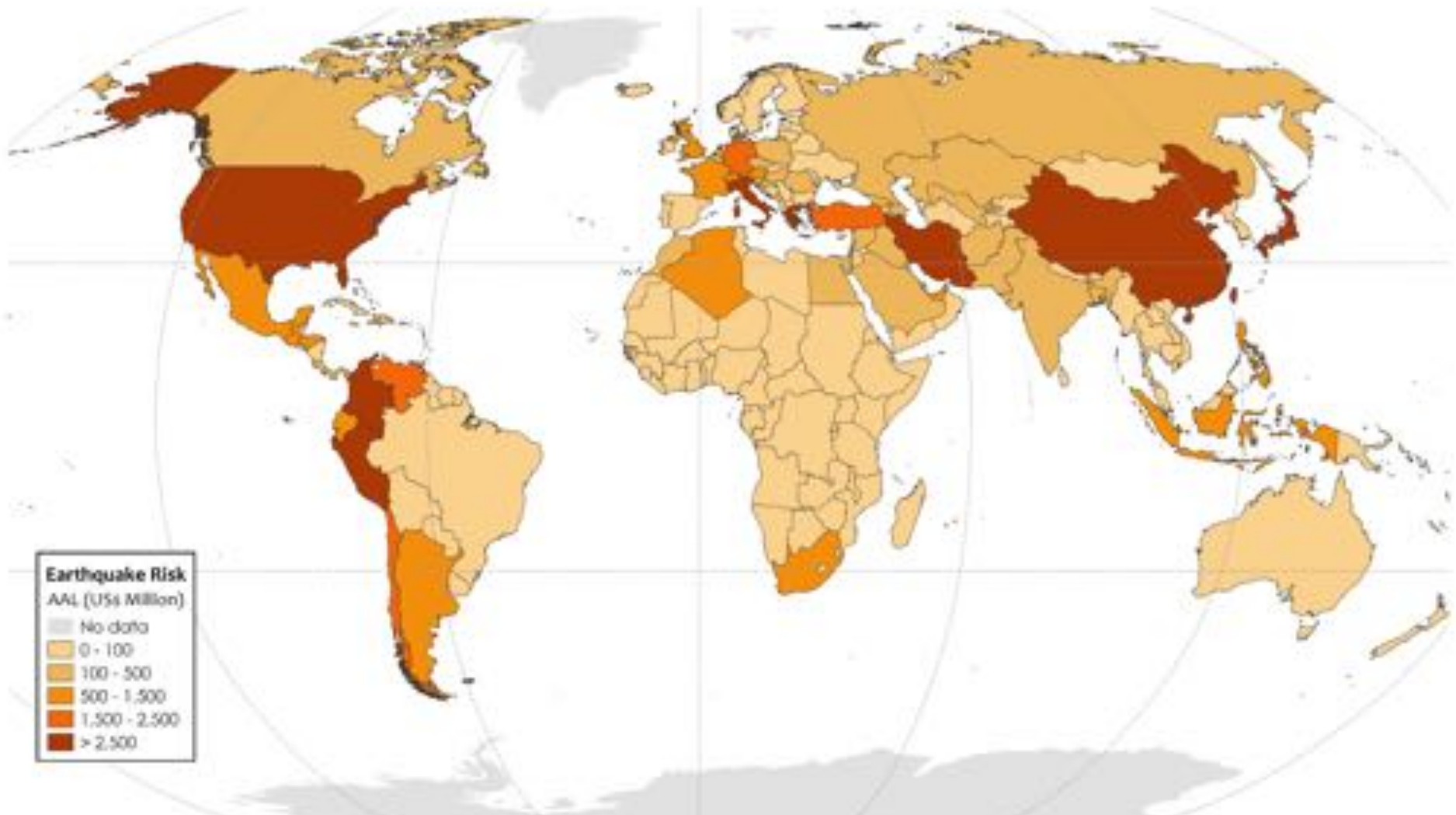


Proposal of a “Hybrid” Loss Exceedance Curve



Seismic Risk Assessment

Risk Maps

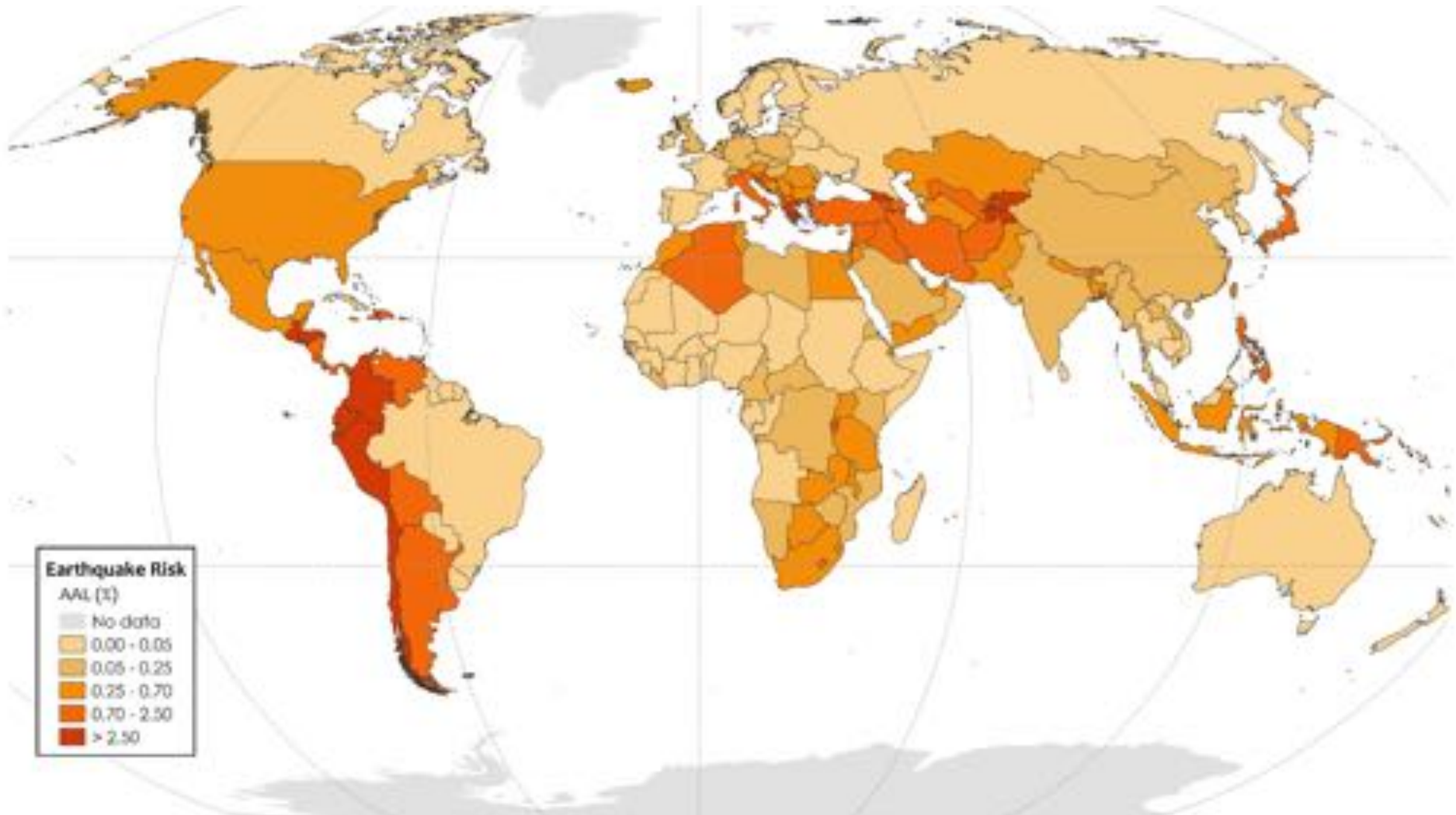


Distribution of AAL by country, US\$ millions



Seismic Risk Assessment

Risk Maps



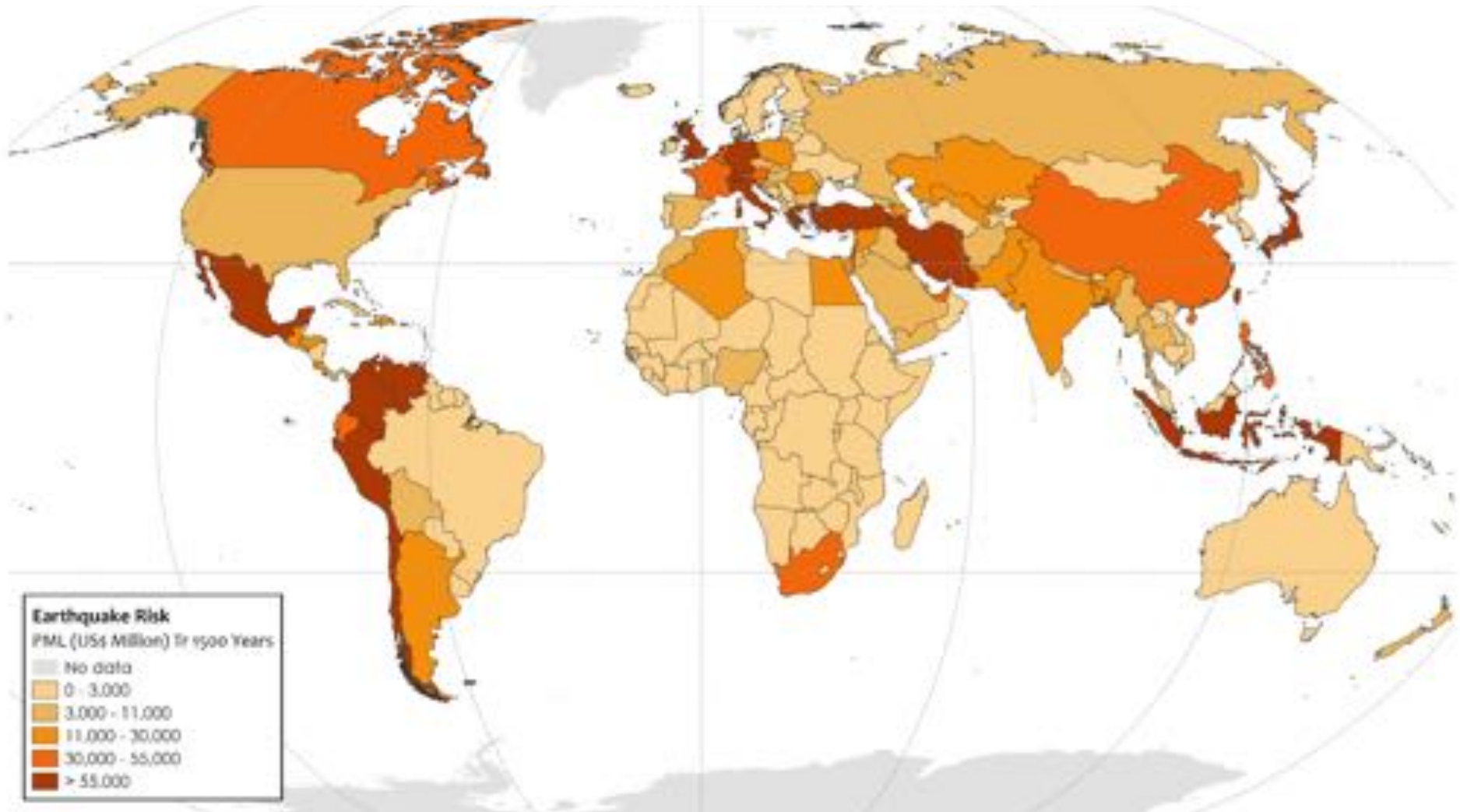
Distribution of AAL relative to the exposed value by country

INGENIAR CAD/CAE Ltd. Cardona, O.D., Bernal, G. (2017). Scoping Meeting Agricultural Risk Assessment. Boulder, CO, 7-9 February 2017



Seismic Risk Assessment

Risk Maps

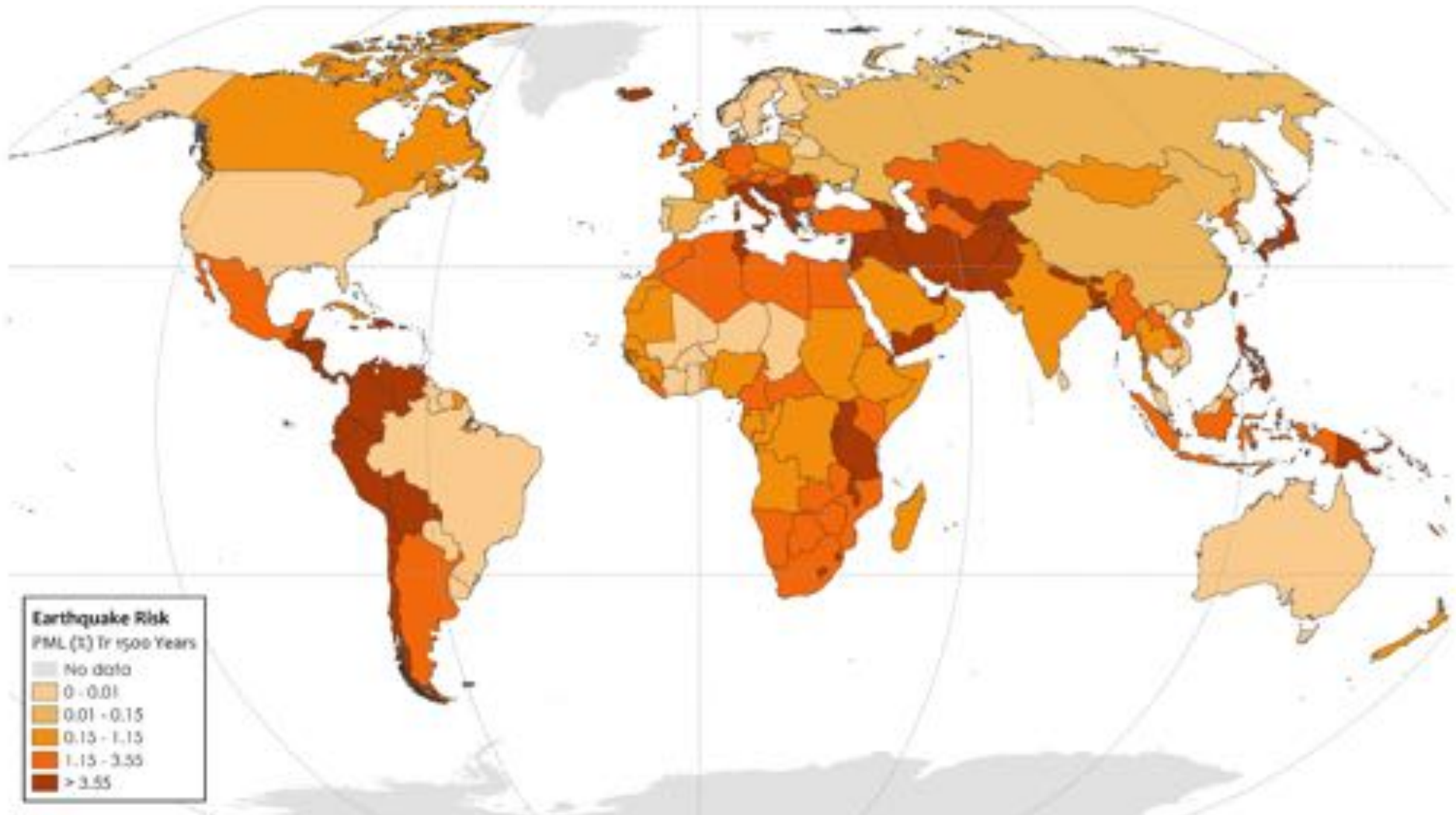


Distribution of PML₁₅₀₀ by country, US\$ millions



Seismic Risk Assessment

Risk Maps



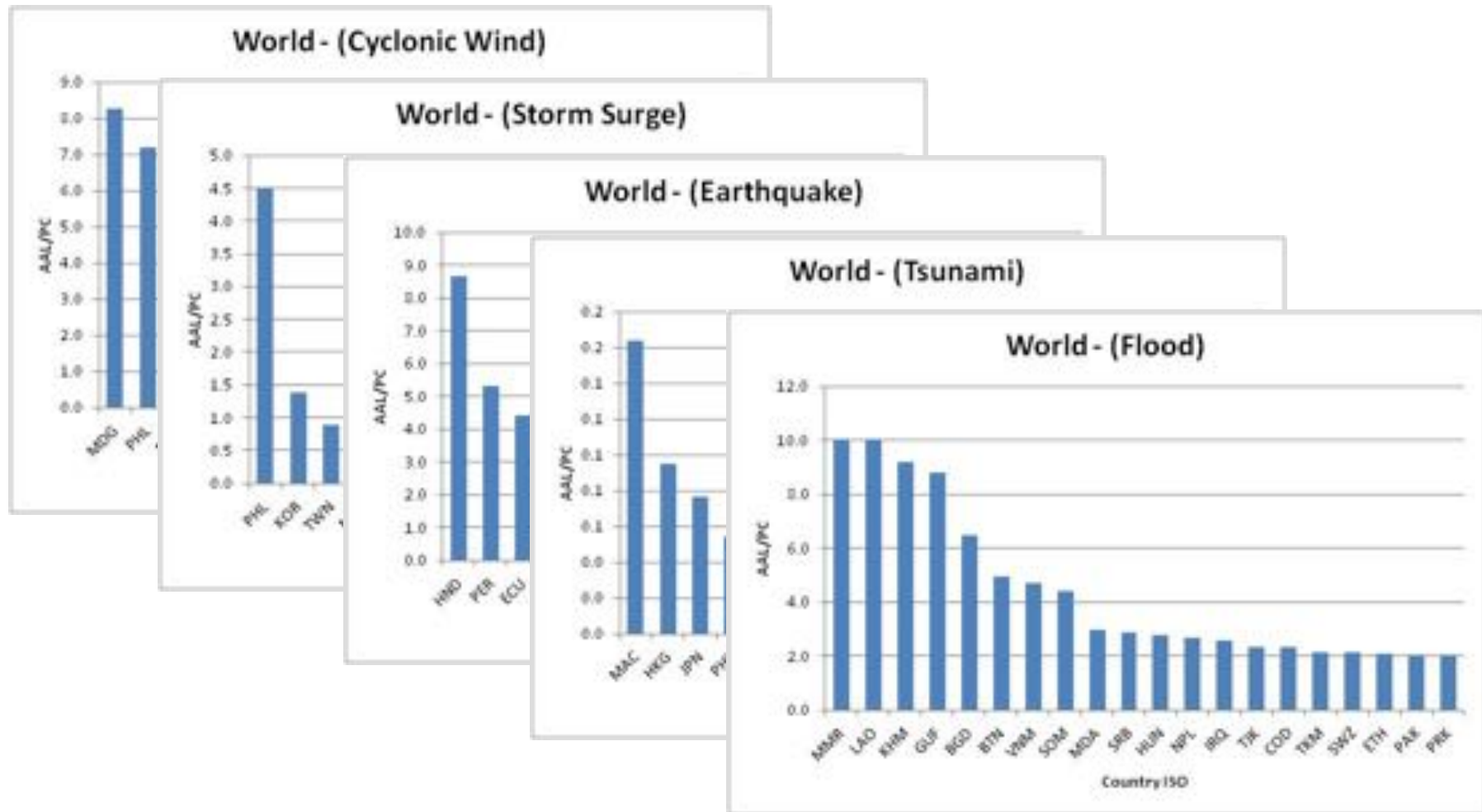
Distribution of PML_{1500} relative to the exposed value by country

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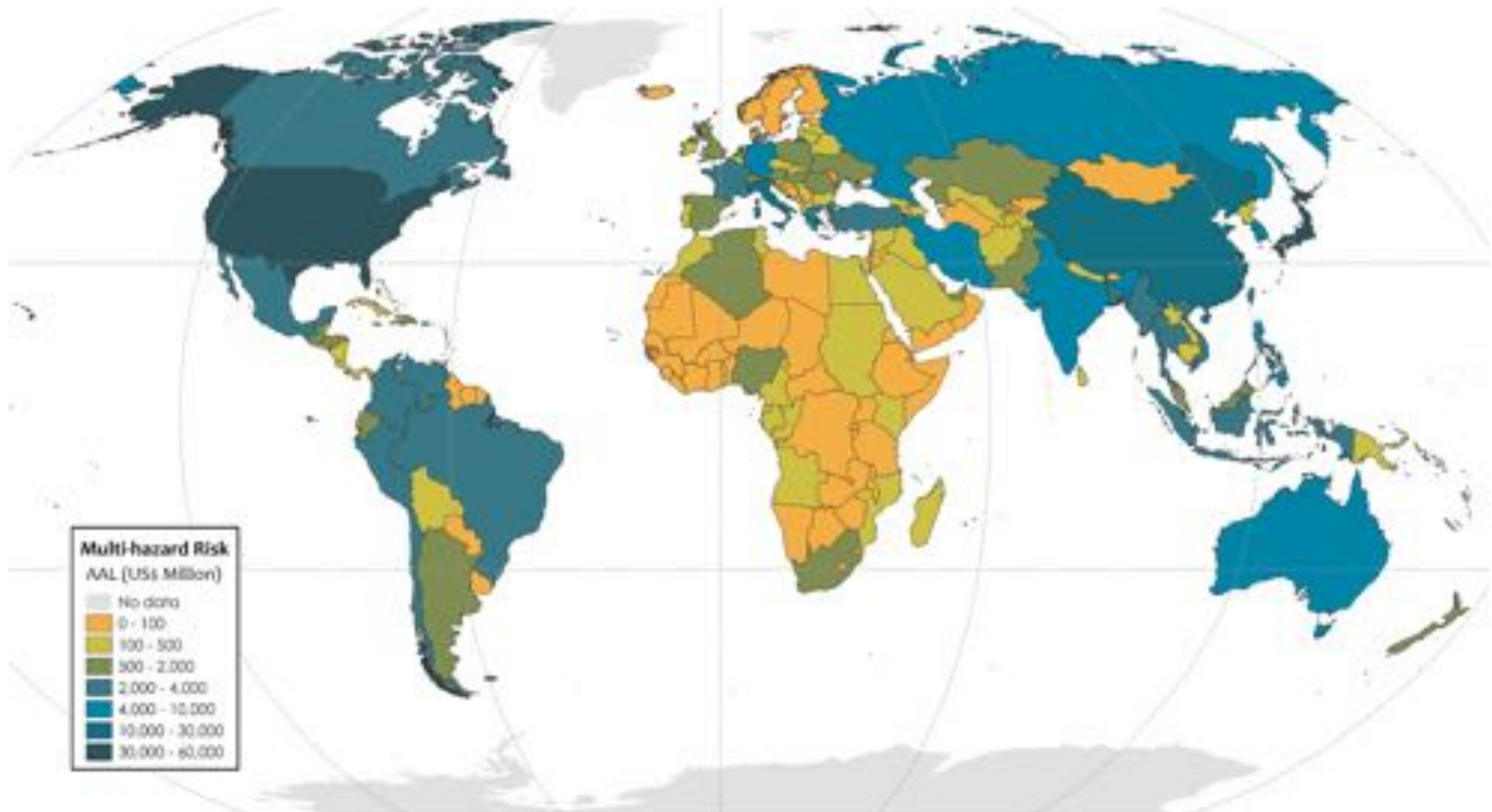
Risk Rankings of Countries

Using Average Annual Loss (AAL) results



Multi-hazard Risk Assessment

Risk Maps

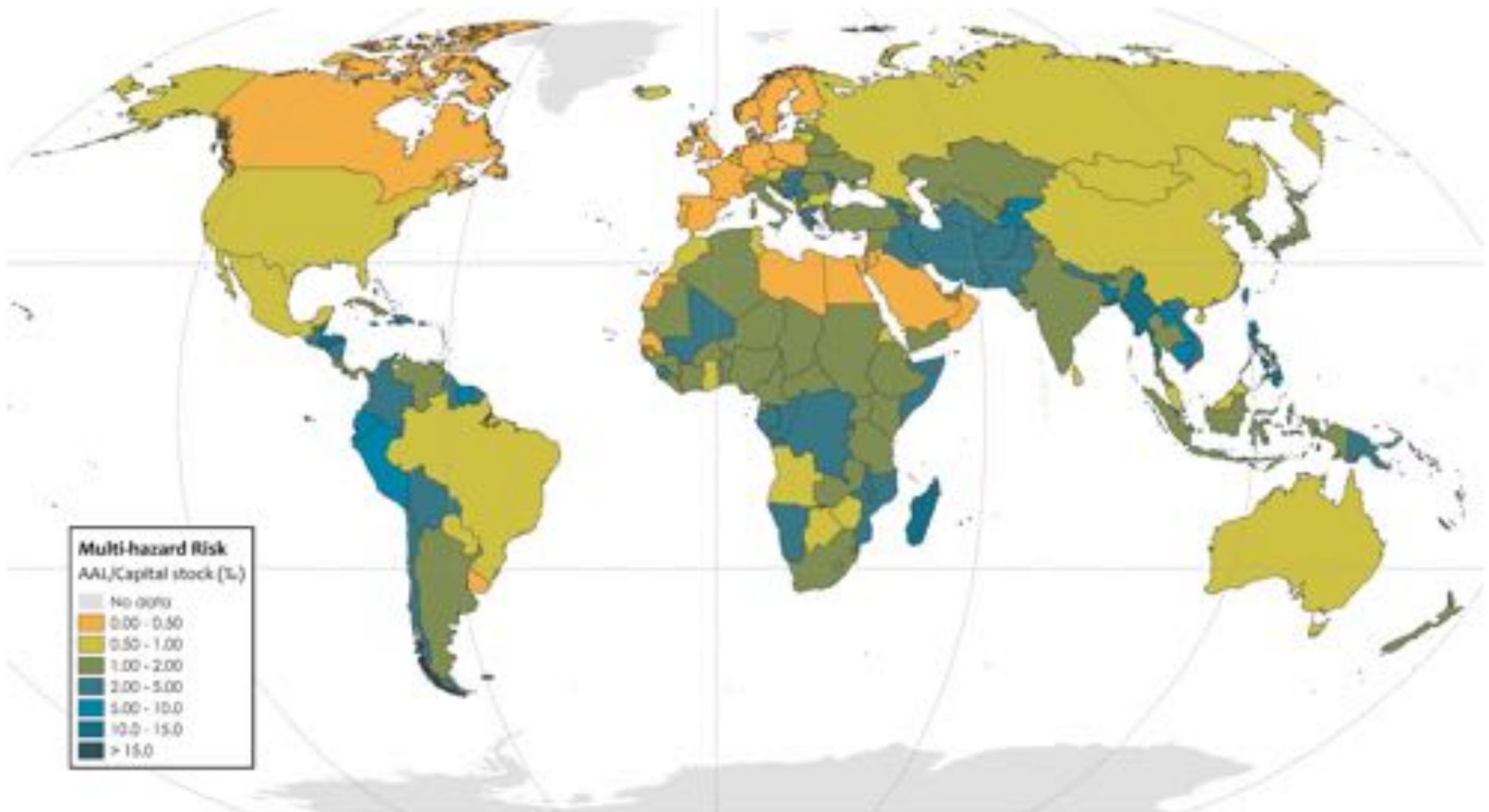


Distribution of AAL by country, US\$ millions



Multi-hazard Risk Assessment

Risk Maps

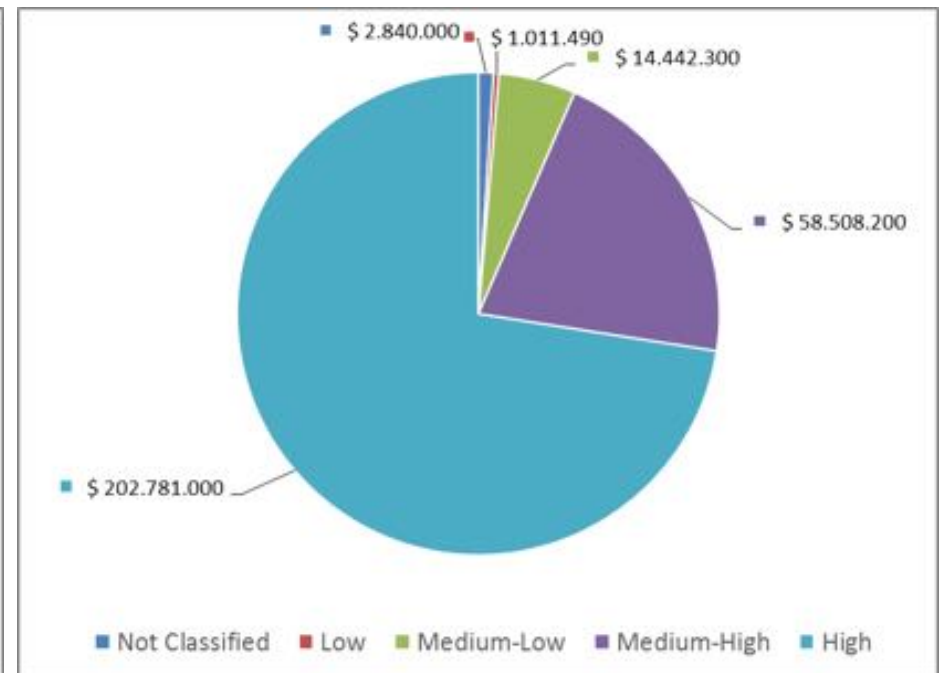
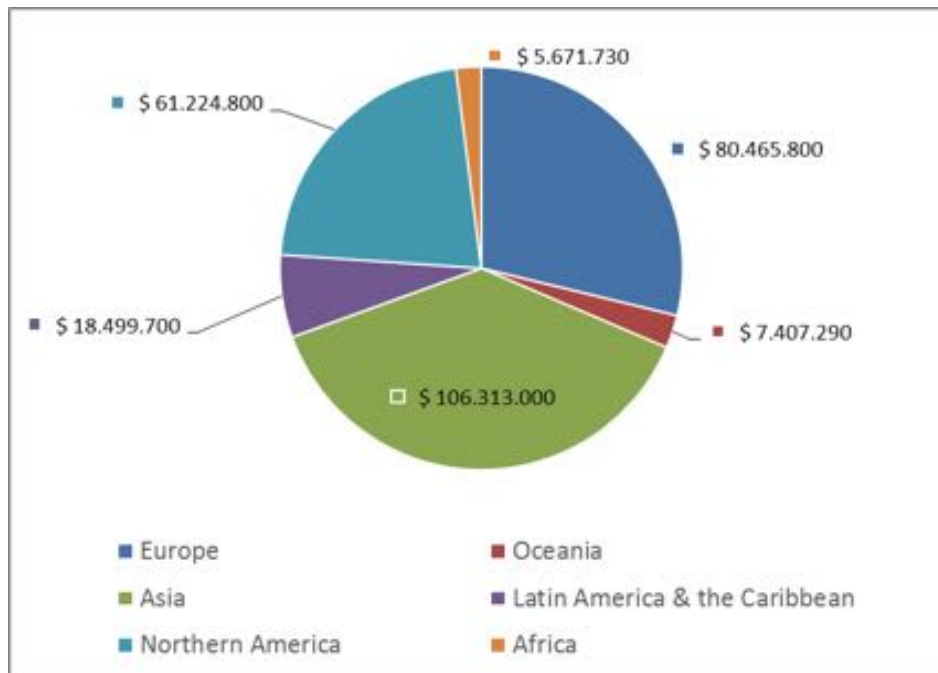


Distribution of AAL relative to the exposed value by country



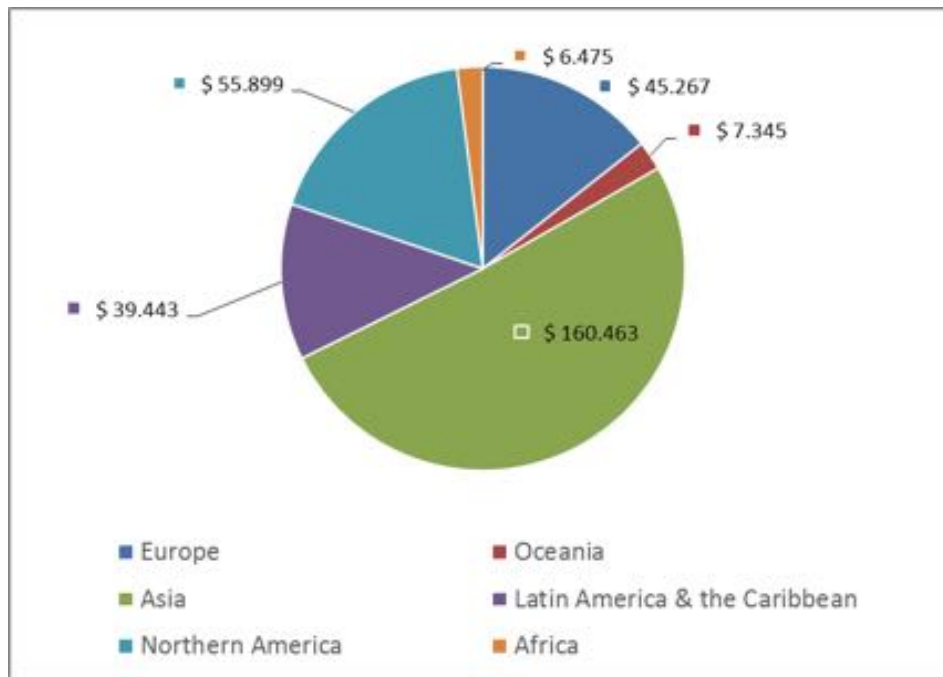
Some Global Figures by Region and Economy Level

Exposure Value (PC)

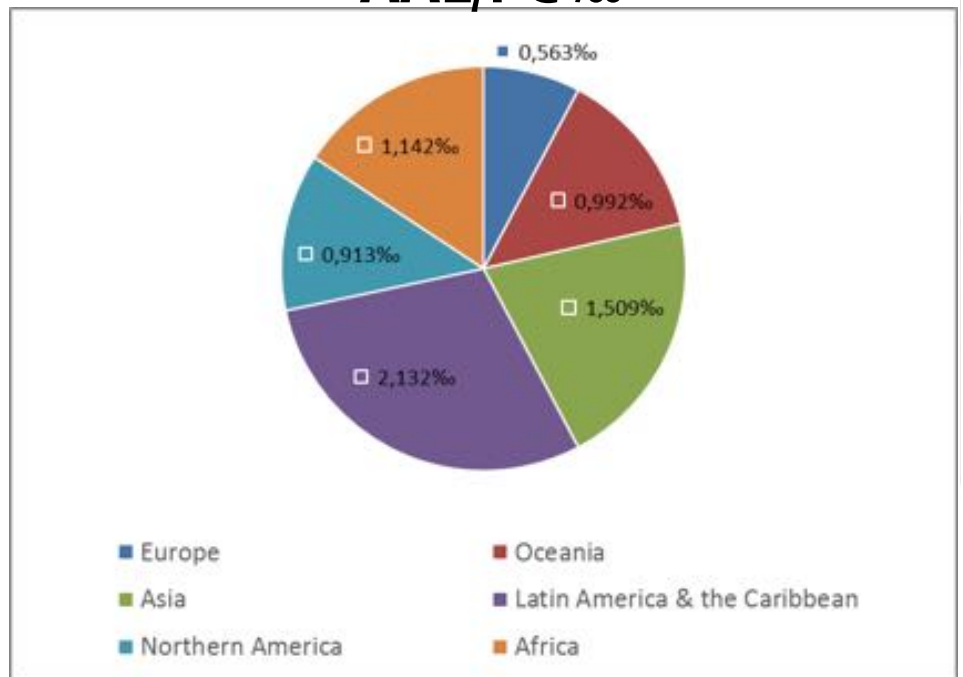


Some Global Figures by Region (Multi-hazard)

AAL Value

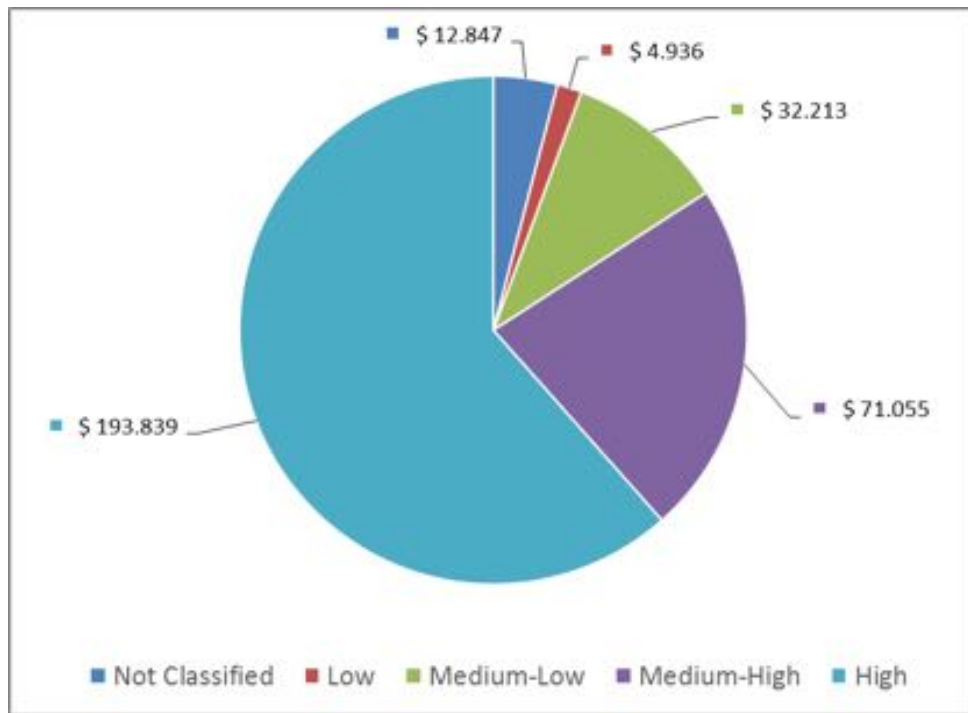


AAL/PC %

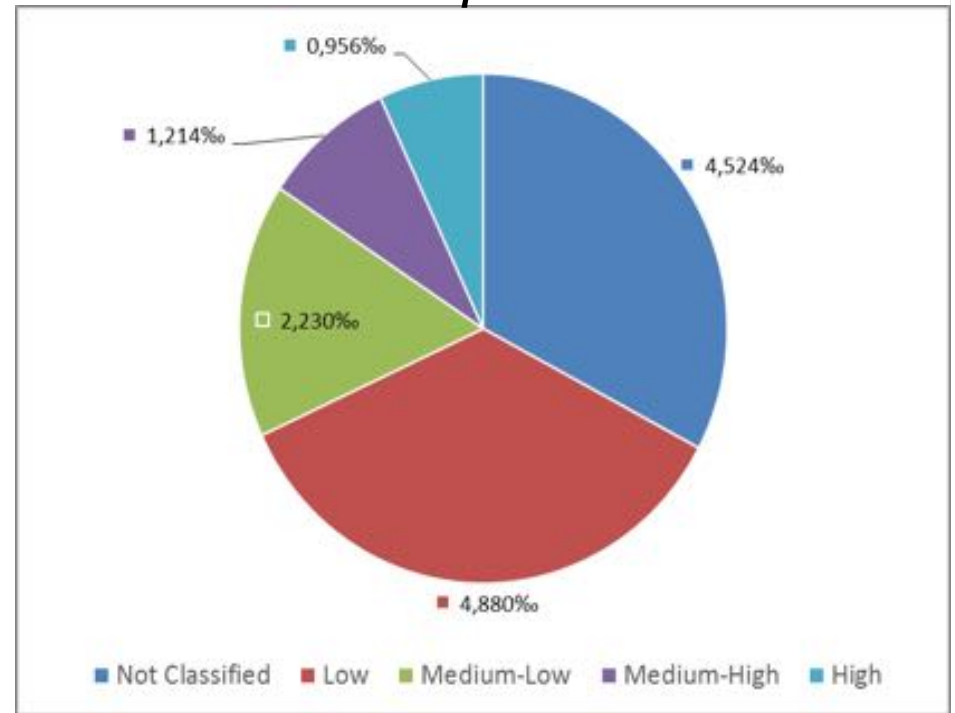


Some Global Figures by Economy Level (Multi-hazard)

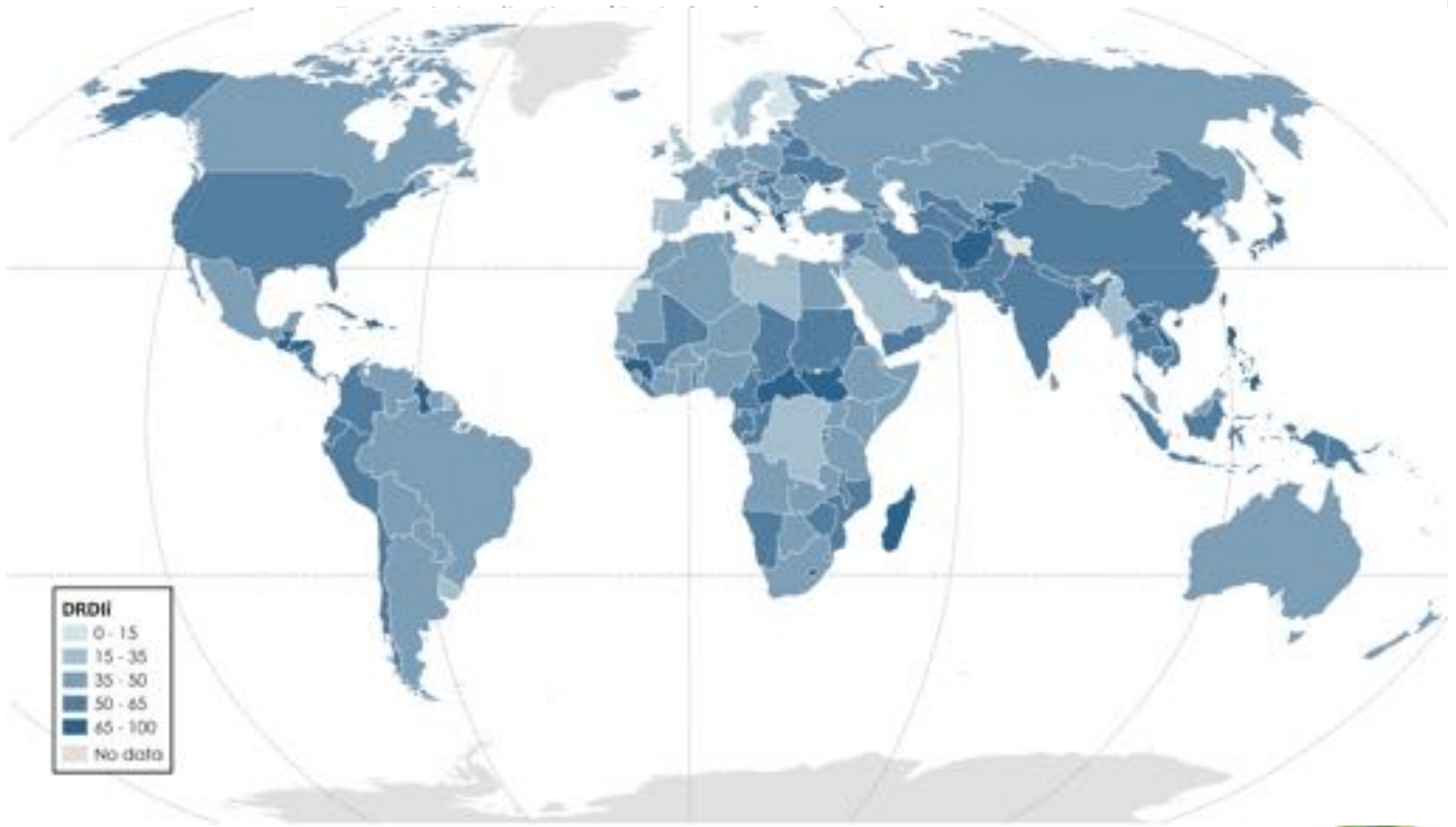
AAL Value



AAL/PC %



Disaster Risk Development Implications Index (DRDI)



Belize

Latin America and the Caribbean

Brief Country Risk Profile

National Information

Population	2014	451,000
- Urban	%	44.1
- Rural	%	55.9
Land area	2013	22,813.0
Pop. Density	2013	19.8
GNI	2014	21.15
HDI	2014	0.732
Exposed value		1,791
- Flood		3.8

Economic Indicators

GDP (base Domestic Product)	2014	1,043.3
GDP per capita	2014	4,903.0
GNI (base Domestic Product)	2014	1,733.2
SE sector		399.0
GDP (base Fixed Capital Formation)	2014	985.0
TR Total Revenue	2014	602.8
Public spending on education	2014	0.8
Health Expenditure	2014	3.8



National & Fiscal Portfolio

Hazard	Average Annual Loss		Probable Maximum Loss (PML)	
	Value	Percent	Value	Percent
Earthquake	0.7	0.06	68.0	6.5
Cyclonic Wind	26.1	2.50	2,182.0	209.0
Storm Surge	15.8	1.50	1,681.0	
Flood	0.1	0.01	0.0	0.0
Total	42.7	4.07	4,531.0	435.0

AAL Distribution by Hazard



Disaster Risk Development Implications



Exposure & Risk Summary (Earthquake & Cyclonic Wind)

Sector	Exposure	Exposed value (million USD)	Average Annual Loss (million USD)	PML (million USD)
Residential (Private)	Low	599.0	0.8	8.76
Residential (Public)	Medium-High	1,178.0	0.4	3.08
Services	High	68.4	0.3	0.8
Services (Commercial)	High	1,441.0	0.2	0.7
Services (Industrial)	Low	199.0	0.0	0.0
Education	Private	2,091.0	0.4	0.8
Education (Public)	Low	379.0	0.1	0.2
Health	Private	0.8	0.00	0.0
Health (Public)	Low	0.1	0.00	0.0
Government	Low	0.0	0.0	0.0
Total		5,991.0	1.9	11.8

AAL Distribution by Sector



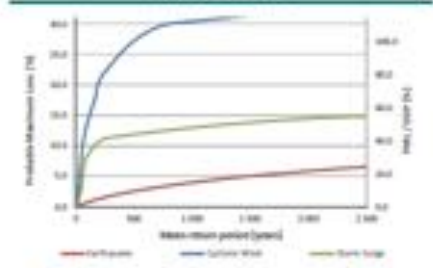
SDGI Components

Exposure Risk Contribution	AAL/PE	SDGI
Exposure Risk Contribution	0.15	78.8
Exposure Risk Contribution	0.11	78.8
Exposure Risk Contribution	0.10	78.7
Exposure Risk Contribution	0.17	78.7

Risk Indicators

Indicator	0.0	0.25	0.5	0.75	1.0
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08
AAL/PE	0.00	0.08	0.08	0.08	0.08

Probable Maximum Loss



Country risk profile

BELIZE

LAC BASIC COUNTRY STATISTICS AND INDICATORS

Population (million)	2014	9
Population density (inhabitants/km ²)	2014	144
GDP (base Domestic Product) (billion USD)	2014	1,001
GDP per capita (USD)	2014	4,894
Capital stock (billion USD)	2014	3,394
GDP (base Fixed Capital Formation) (billion USD)	2014	985
Total expenditure (billion USD)	2014	300
Urban population (million)	2014	16.7
Urban population (% of total)	2014	46.1
Priority well inequality (GPI Index 0-100)	2014	53.1
UN capability at birth (new)	2014	13.3
For job at national priority (new)	2014	12.4
Social expenditure (% GDP)	2014	12.4
Government efficiency (0-100)	2014	4.45
Government effectiveness (0-100)	2014	4.11
Trust and accountability (0-100)	2014	3.75
Control of corruption (0-100)	2014	0.03
Urban population growth (%)	2014	1.3
Pop. living in slums (% of urban pop.)	2014	16.7
Urban population (million)	2014	16.7
Ecological footprint (global hectares/capita)	2014	1.3
Environmental performance index (0-100)	2014	50.1
Forest change (% of land area)	2014	-4.3
Resilience vulnerability in economic situation	2014	5.7
Climate change	2014	0
Electricity production from renewable energy (% of total)	2014	0
CO2 emissions (million tonnes/capita)	2014	1.27

DISASTER RISK

Average Annual Loss (AAL) by hazard

Hazard	Value (million USD)	AAL/Capital stock	AAL/SDGI	AAL/Social expenditure	AAL/Total revenue	AAL/Gross savings
Earthquake	0.7	0.05	0.25	1.48	0.75	1.47
Cyclonic Wind	26.1	0.47	0.31	1.86	0.99	1.07
Storm surge	15.8	0.26	0.24	1.48	0.81	1.08
Tsunami	0.0	0.00	0.00	0.00	0.00	0.00
Flood	0.1	0.00	0.00	0.00	0.00	0.00
Total	42.7	0.78	0.80	3.80	2.55	3.62

Risk and Development Implications

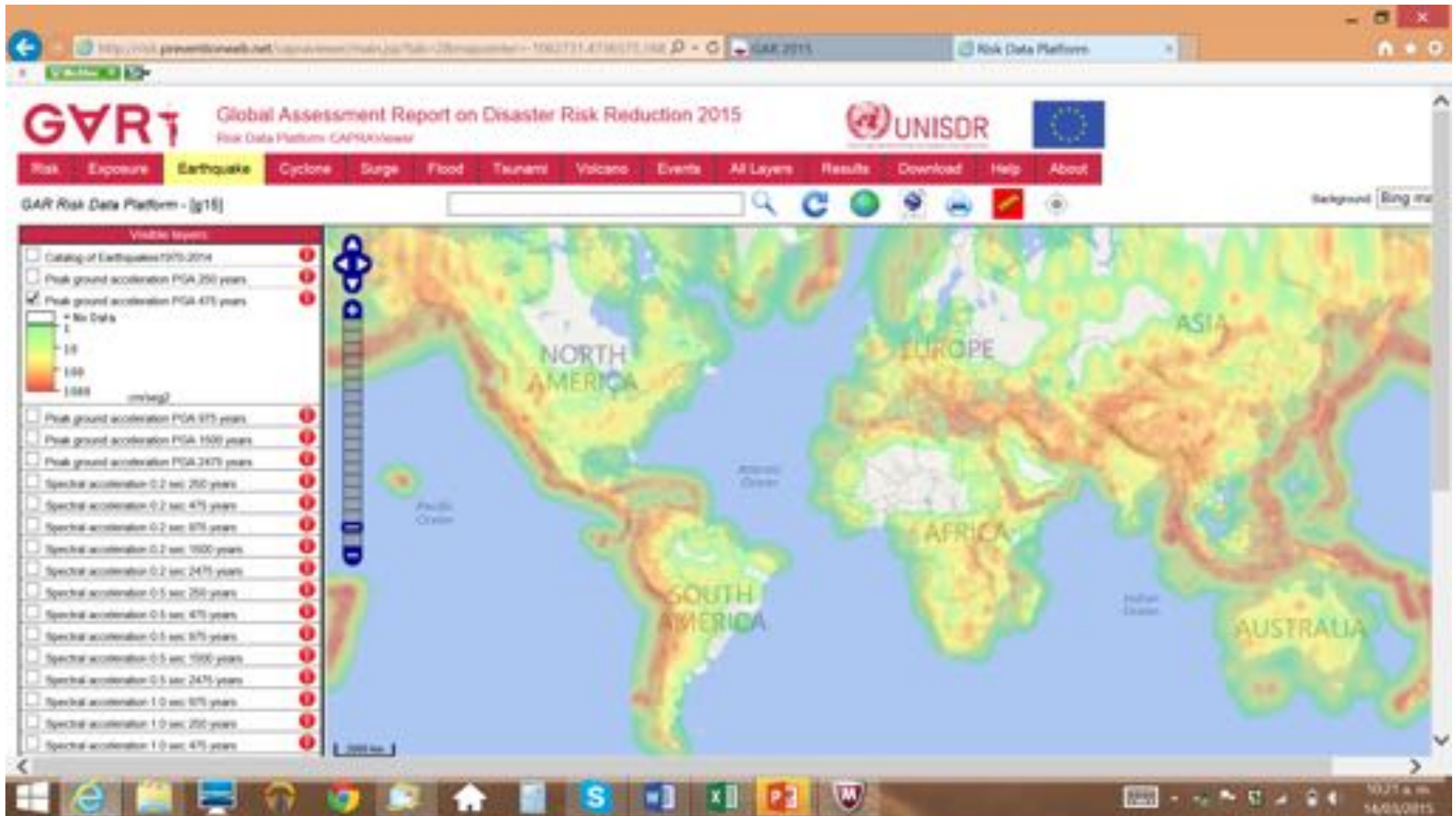
Multihazard AAL results by sector (Earthquake and cyclonic wind)

Sector	Sub Sector	Capital stock (million USD)	Average Annual Loss (AAL) (million USD)
Residential	Private low	145	0.78
Residential	Private high	1,273	0.80
Services	Commercial	680	0.34
Services	Industrial	0	0.00
Services	Public	1,342	0.24
Education	Private	730	0.79
Education	Public	1,211	0.79
Health	Private	0	0.00
Health	Public	0	0.00
Public buildings		0	0.00
Government		1,791	0.27
Total		5,991	1.73

Probable Maximum Loss - PML* (million USD)

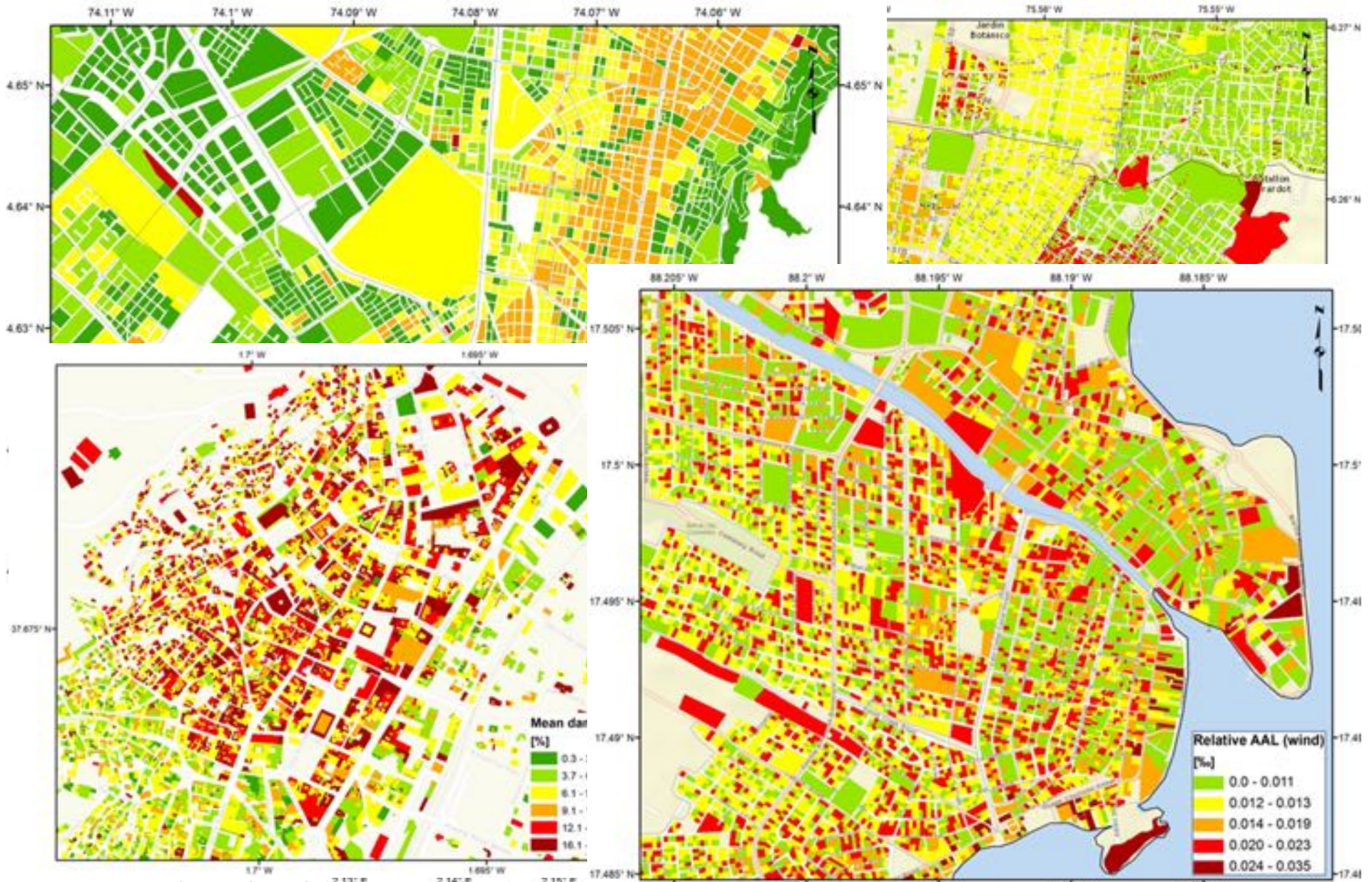


Seismic Risk Assessment Risk Maps



CAPRA-Viewer

The Challenge: From Global to Local



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Regarding the GAR's Global Risk Model:

- ✓ *A fully probabilistic multi-hazard risk assessment has been conducted at global level. Results are useful for comparisons and rankings among countries*
- ✓ *In the past, risk had been estimated mainly based on historical records. The GAR's Global Risk Model takes into account “events that have not yet occurred”. This is a key issue for SFA follow-up.*
- ✓ *Countries must carry-out risk assessments with higher resolution at sub-national and local level when the required information is available.*
- ✓ *From global to local: the same “arithmetic” can be used for any resolution level.*



Global Risk Assessment (Model):

*Earthquakes,
Tsunami,
Tropical Cyclones (w and w/o cc),
Riverine floods,
Volcanic ash-fall,
Droughts ?*



Understanding probable losses due to hazard events (not only disasters) creates powerful incentives for countries to develop planning options and tools to cope with risk, including allocating the sustained budgetary resources necessary to reduce the potential damage and safeguard the transformation of development.



It is necessary to explore how probabilistic risk models and holistic models can be integrated in an effort to develop a methodology that can provide the true benefits of aggregation and disaggregation of hard and soft risk drivers to identify the corrective and prospective interventions to be done.





UNDERSTANDING RISK

Innovation in Disaster Risk Assessment

“Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise”

John W. Tukey

