Probabilistic Modelling of Natural Risks at the Global Level:

The Hybrid Loss Exceedance Curve

DEVELOPMENT OF METHODOLOGY AND IMPLEMENTATION OF CASE STUDIES

PHASE 1A: COLOMBIA, MÉXICO AND NEPAL

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Loss exceedance curve?

Because correlates economic loss with annual occurrence frequency

Because display "All" plausible events

Hybrid loss exceedance curve?

Because correlates economic loss with annual occurrence frequency

Because display "All" plausible events

Because use two different universal sets
- *Retrospective: from disaster database's*
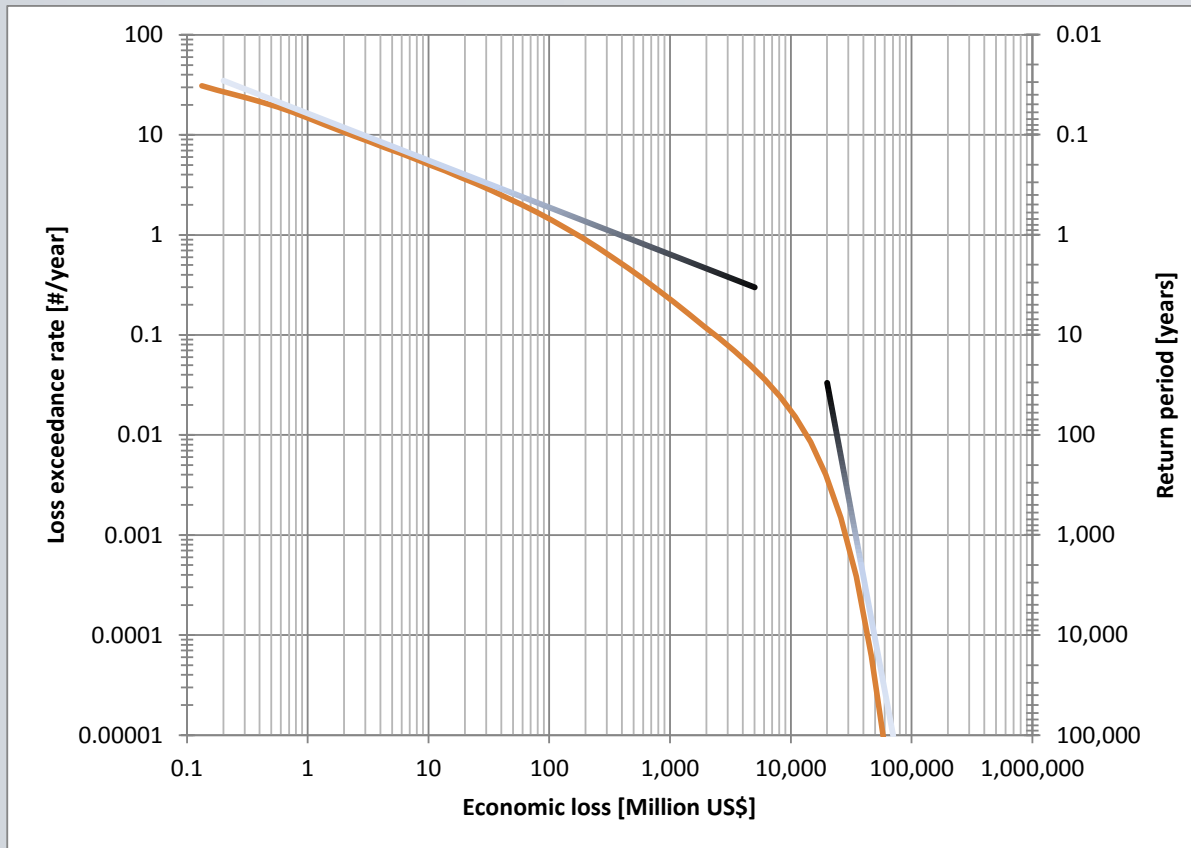- *Prospective: from disaster models*

Loss Exceedance Curve

✓ *Correlates event frequency with expected economic loss*

Retrospective Analysis:
Minor events (low affectation)
High frequency

Prospective Analysis:
Mayor events
Low frequency

Retrospective Analysis

Analysis of what happen before.

Take into account minor events which can't be modeled, due the complexity of the hazard models and the level of detail required for the exposure and vulnerability.

Useful for disasters with high frequency and low impact in assets, like:

➢ *Hydro-meteorological*
➢ *Landslides*

Retrospective Analysis

Requirements:
- ❑ Exhaustive inventory of past events.
- ❑ Detailed report of disaster consequences.
- ❑ Reports starting from one affected element.

DesInventar database
- www.desinventar.org
- www.desinventar.net

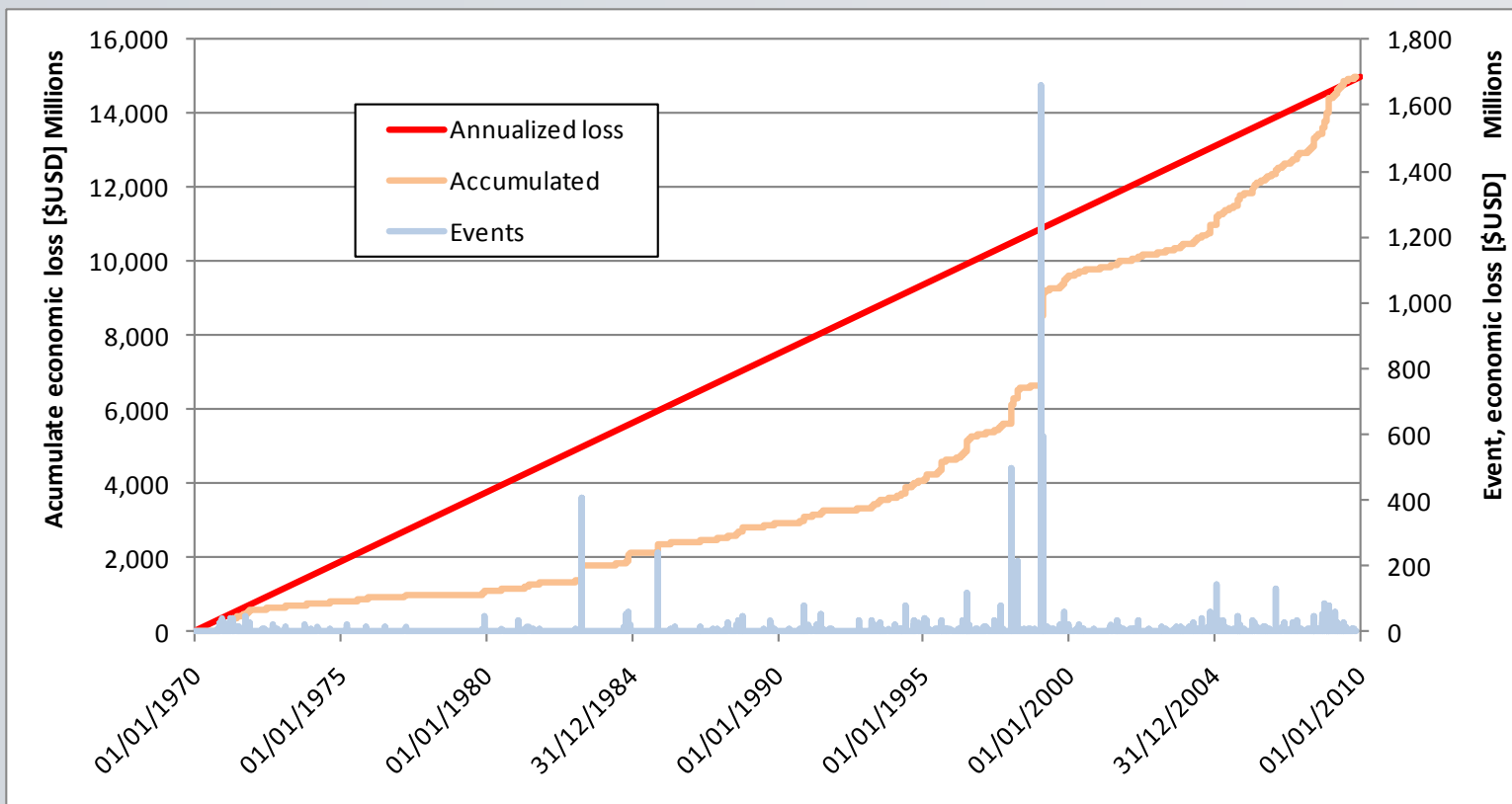# Retrospective Analysis

DesInventar database

- ✓ Reports disaster consequences in a third political level.
- ✓ Reports human and material affectation.
- ✓ Uses several event types.

Economic model

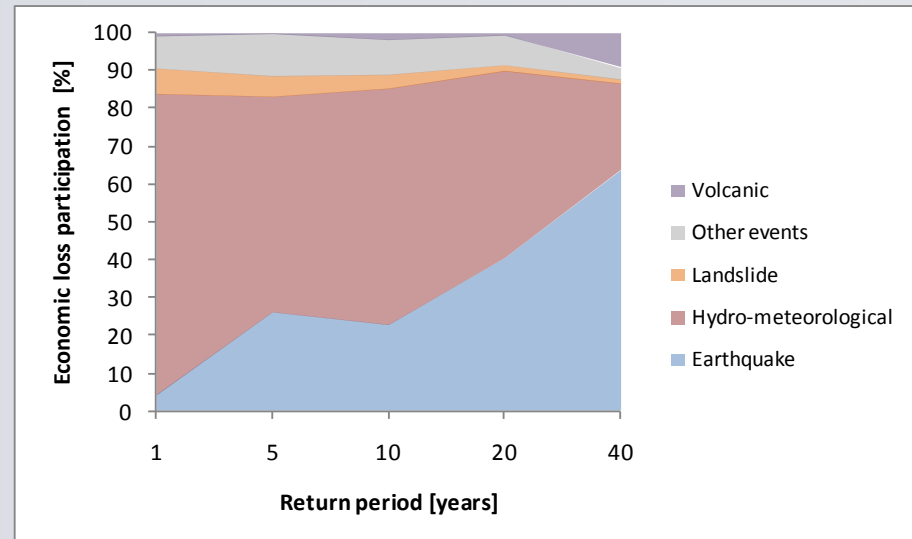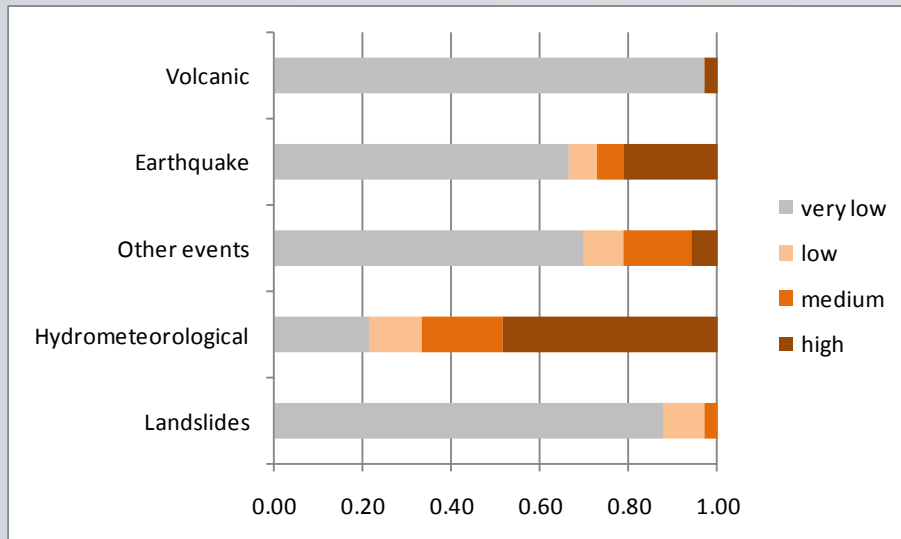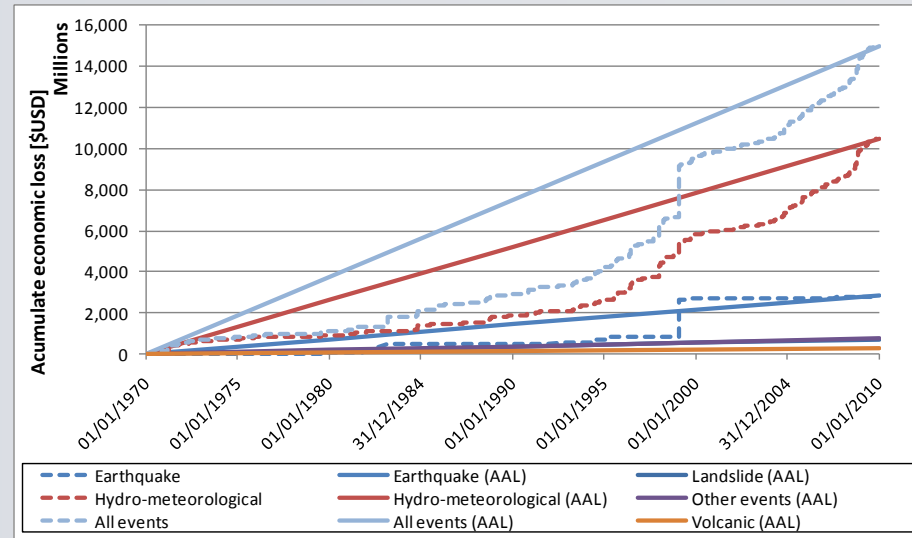Manual for Assessment of the Socio-economic and Environmental Impact of Disasters (2003; ECLAC, UN, WB).
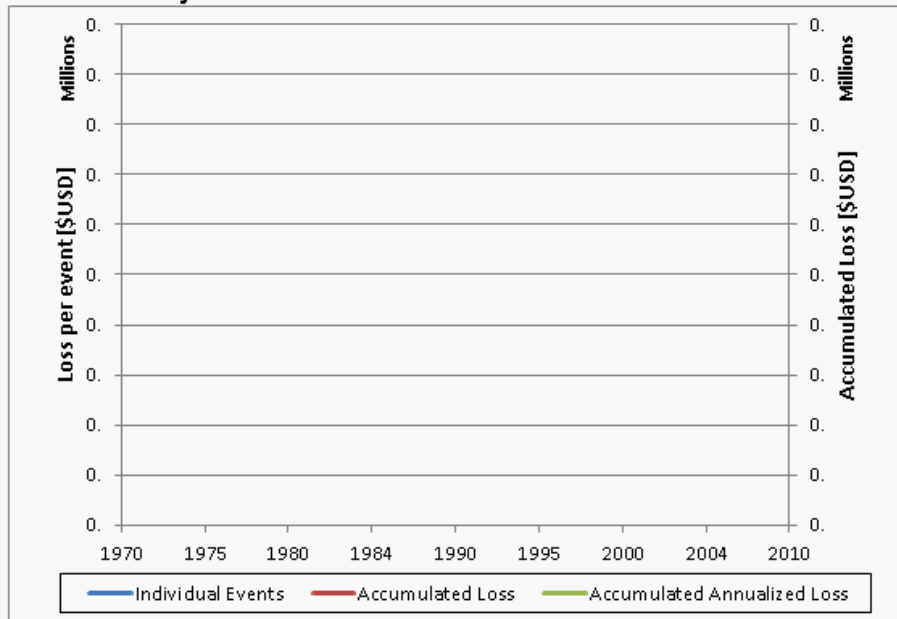
Retrospective Analysis

Colombia

Retrospective Analysis

Colombia

Hystorical Events Losses and Accumulated Loss

Millions

Loss per event [$USD]

0.
0.
0.
0.
0.
0.
0.
0.
0.
0.
0.

1970   1975   1980   1984   1990   1995   2000   2004   2010

Millions

Accumulated Loss [$USD]

0.
0.
0.
0.
0.
0.
0.
0.
0.
0.
0.

—Individual Events   —Accumulated Loss   —Accumulated Annualized Loss

New Event	1/0/1900
Category	0
Affectation	
Physical	
Damaged houses	0
Destroyed houses	0
Human	
Injured	0
Killed	0
Economical loss	0

Time frame	
	years
	1
Accumulated loss	
	million USD
	0
Anual Average Loss	
	million USD
	0

Loss exceedance frequency

Economic loss [USD]	Events Number	frequency [times/year]	Period [years]
≥ 10,000	0	0.000	
≥ 100,000	0	0.000	
≥ 1,000,000	0	0.000	
≥ 10,000,000	0	0.000	
≥ 20,000,000	0	0.000	
≥ 50,000,000	0	0.000	
≥ 100,000,000	0	0.000	
≥ 200,000,000	0	0.000	
≥ 500,000,000	0	0.000	
≥ 590,000,000	0	0.000	
≥ 1,657,650,000	0	0.000	

Loss exceedance curve (LEC)
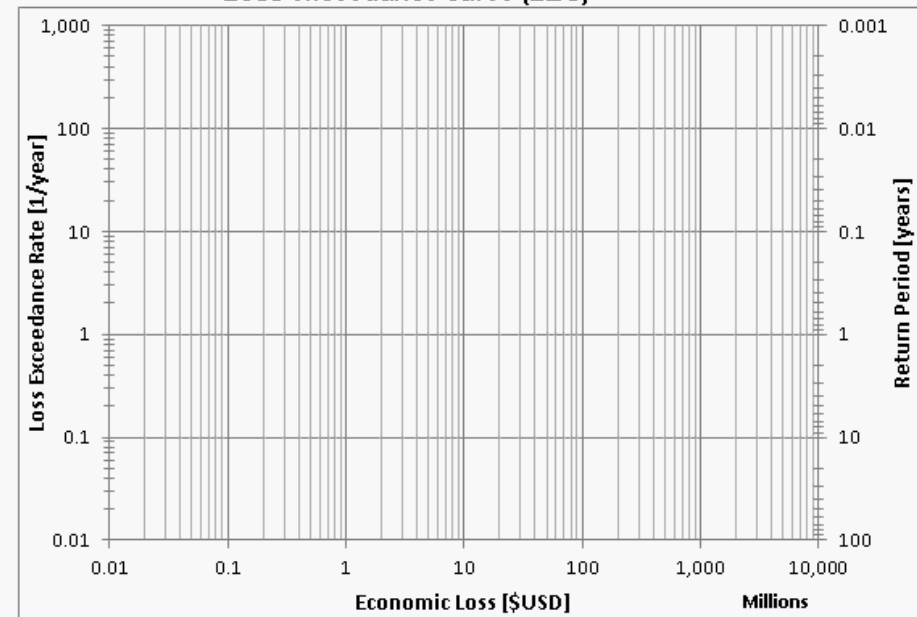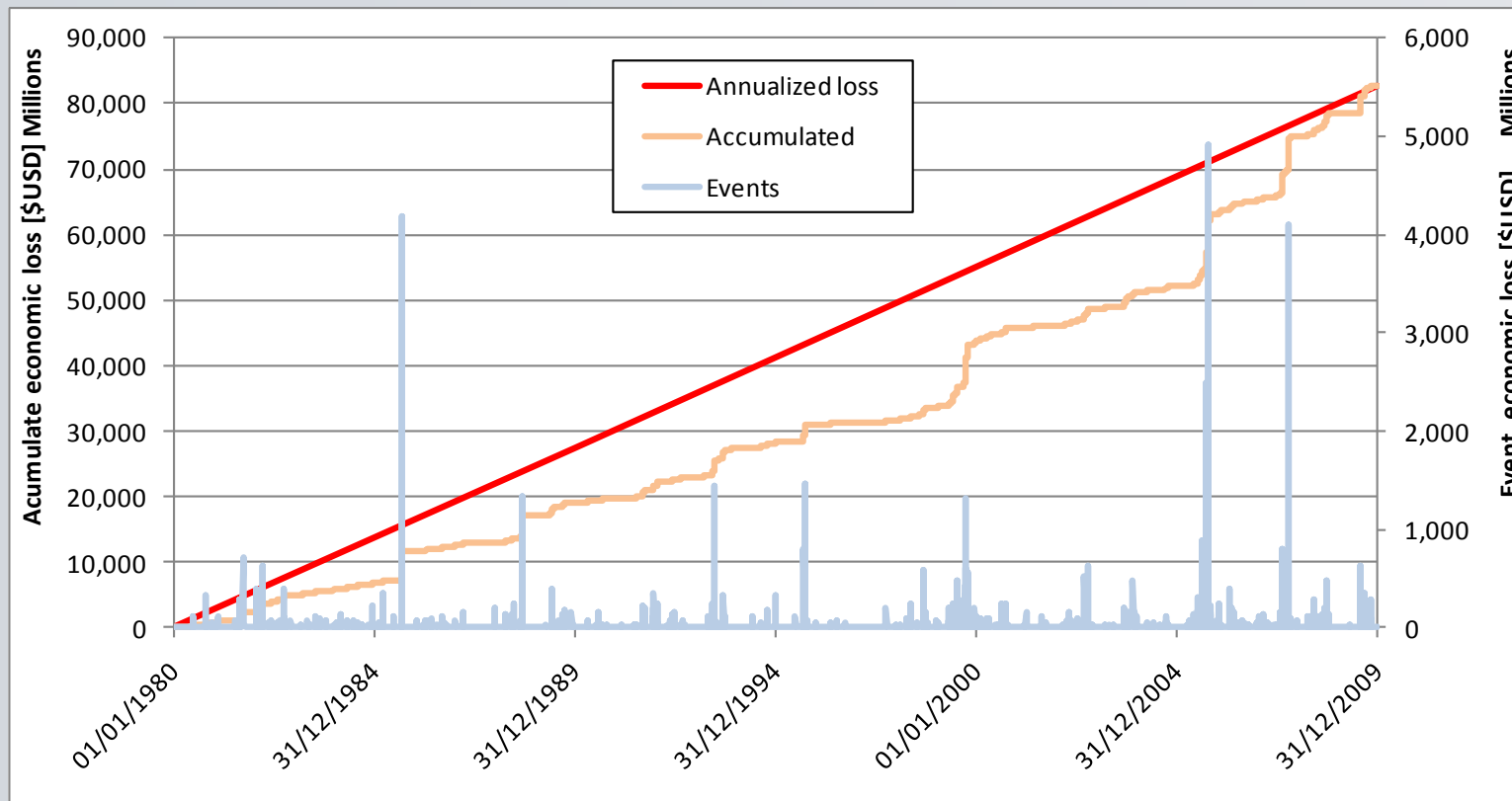
Loss Exceedance Rate [1/year]

1,000
100
10
1
0.1
0.01

Return Period [years]

0.001
0.01
0.1
1
10
100

0.01   0.1   1   10   100   1,000   10,000

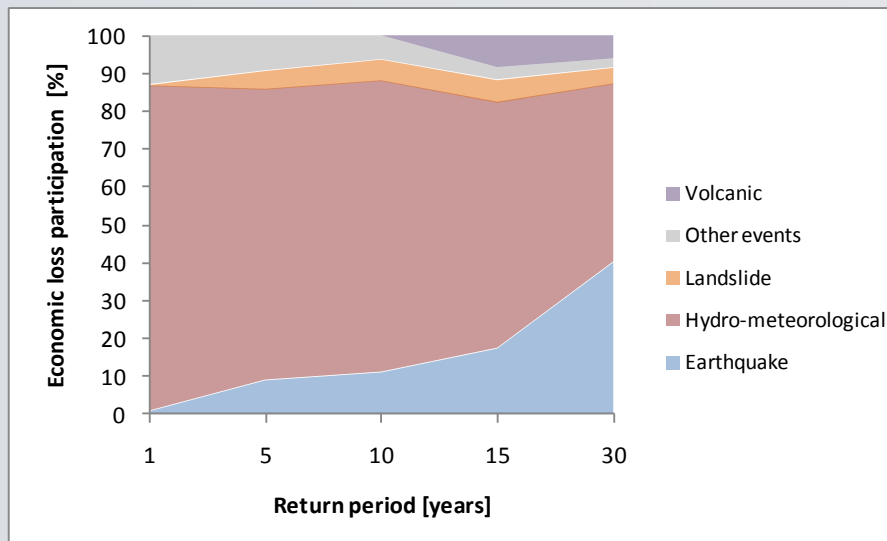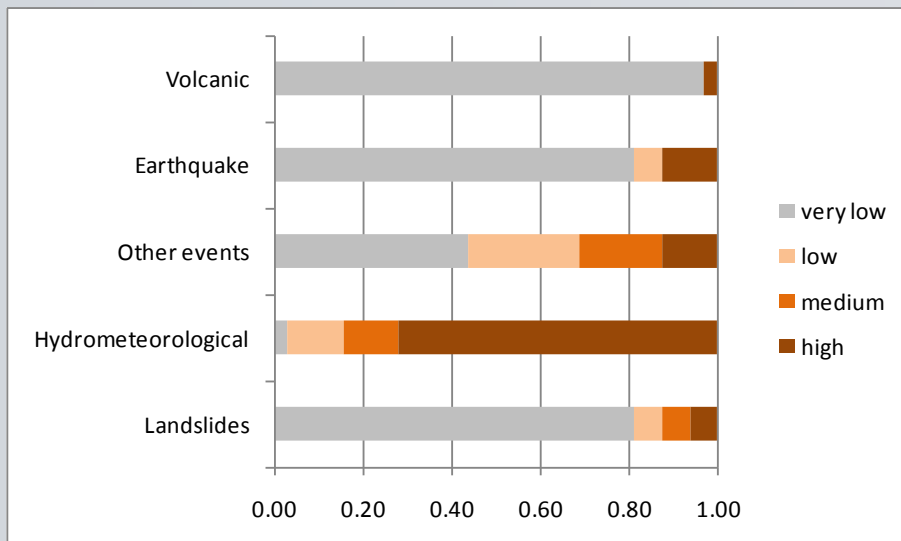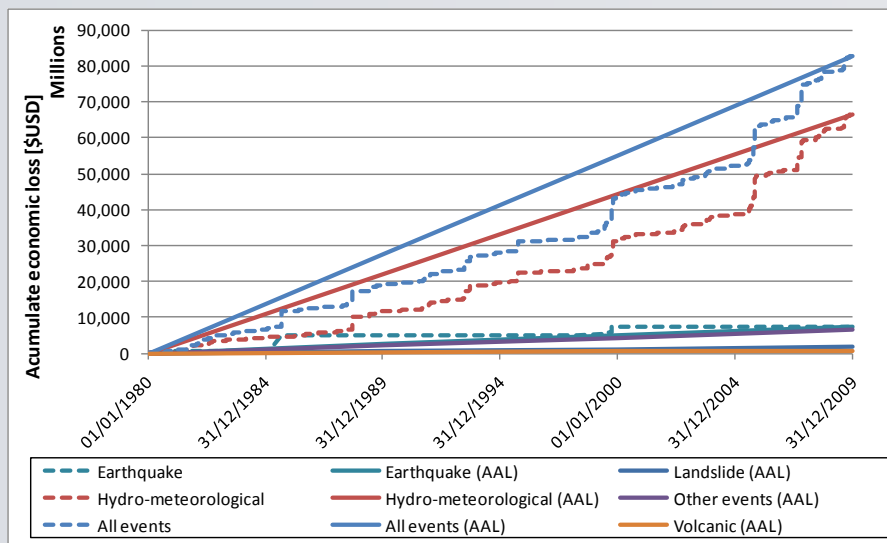Economic Loss [$USD]   Millions
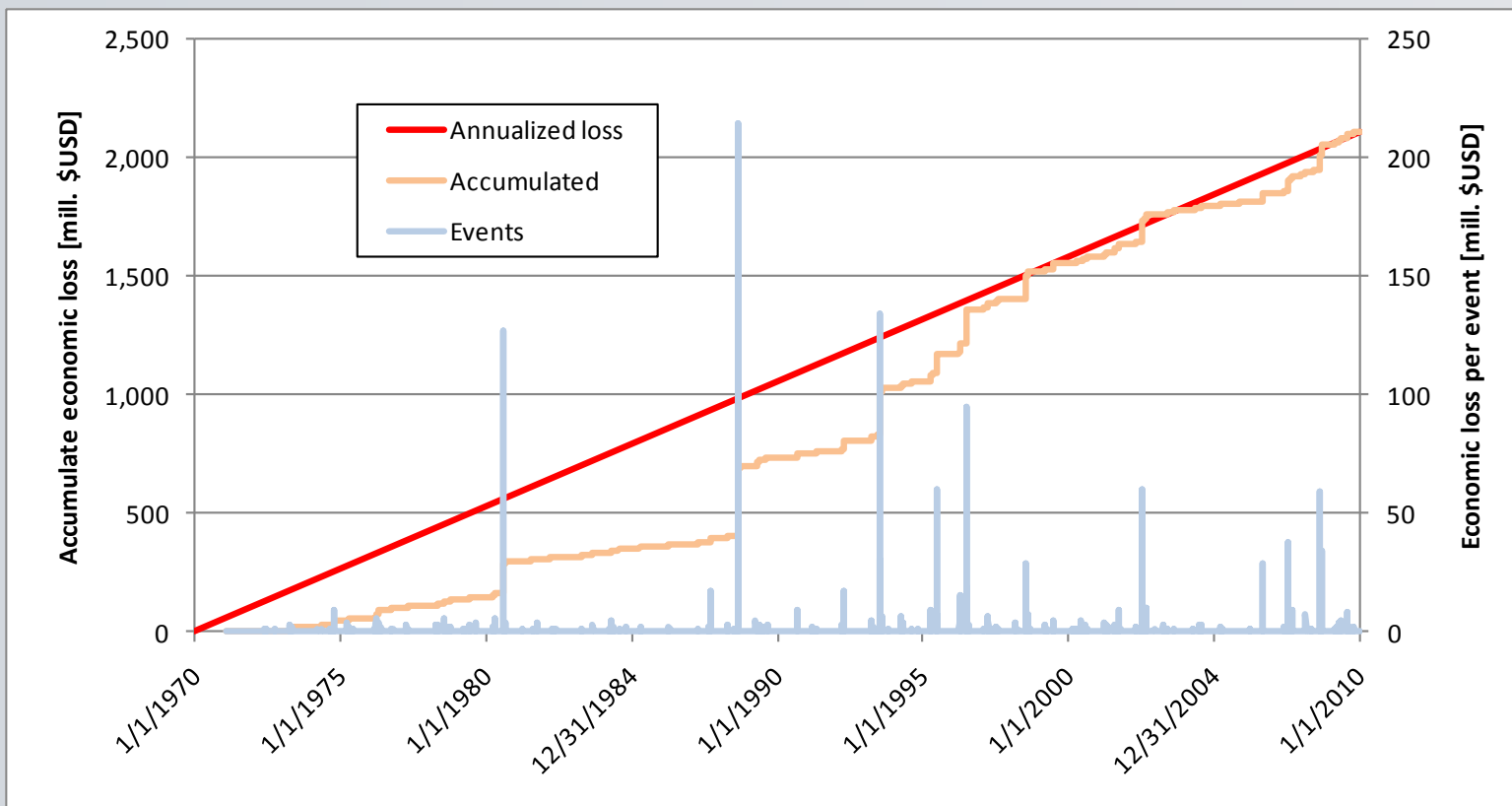
Retrospective Analysis

México

Retrospective Analysis

México

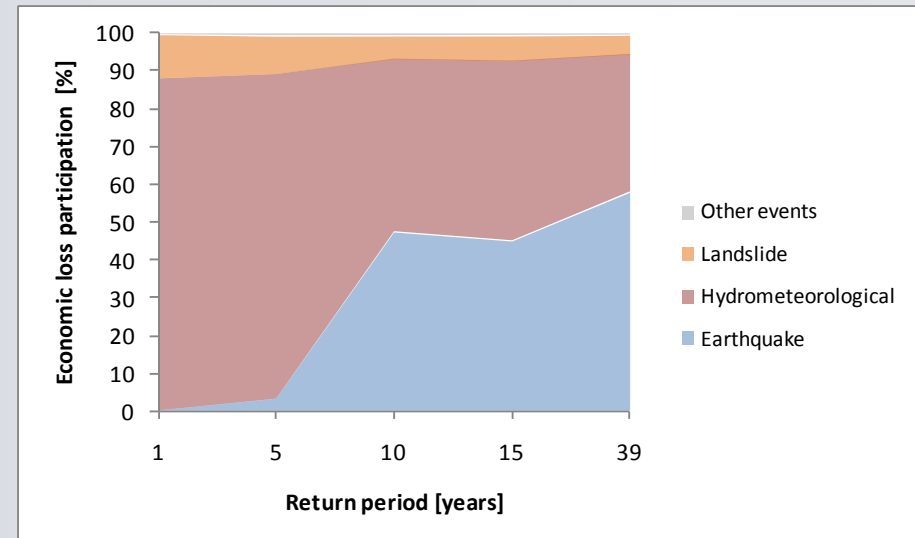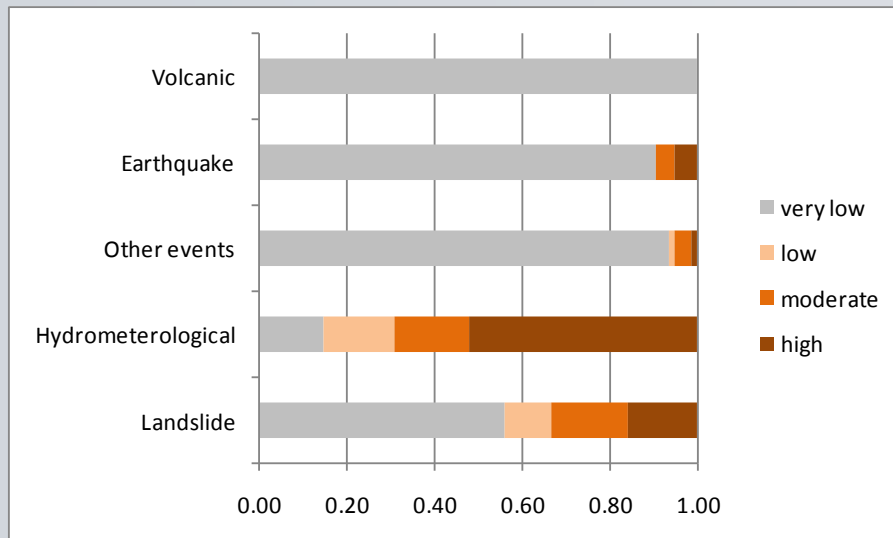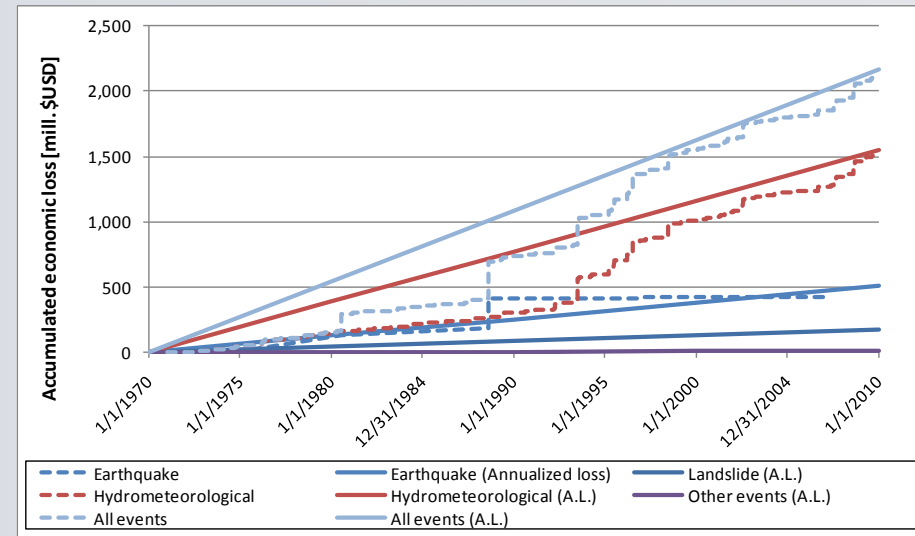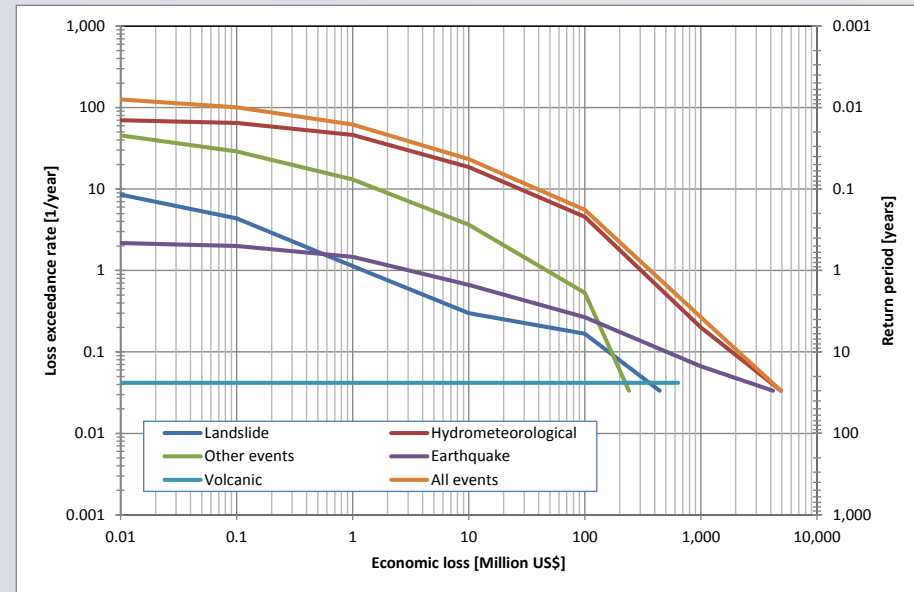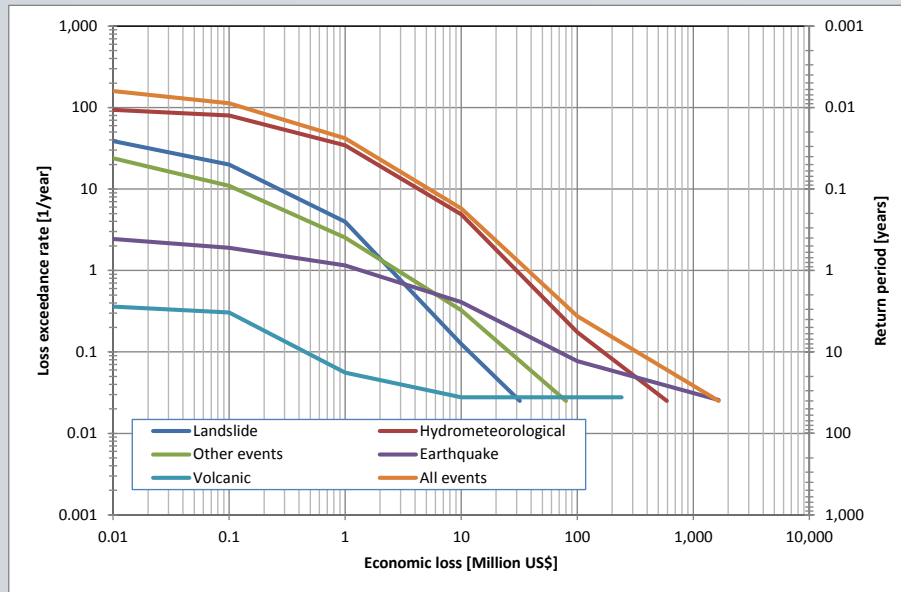# Retrospective Analysis

Nepal

Retrospective Analysis

Nepal
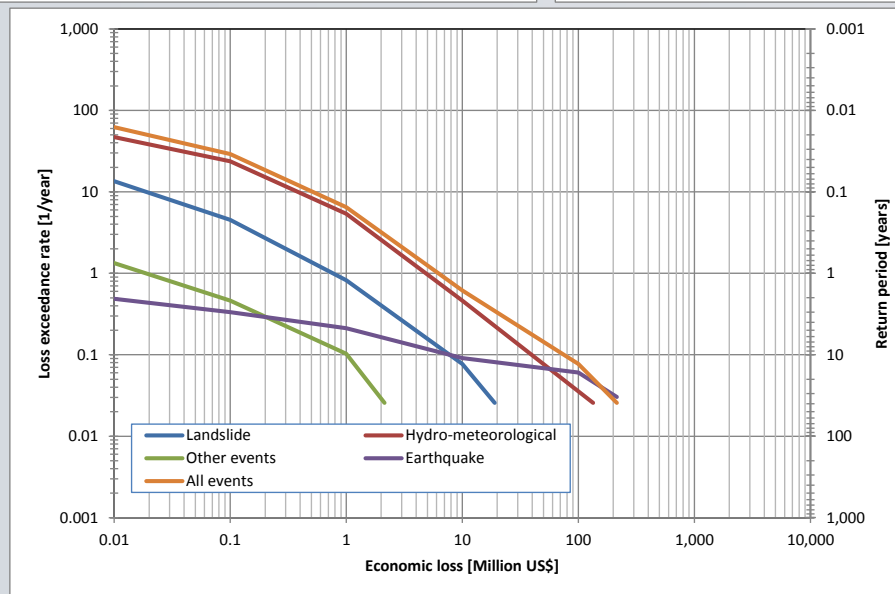
Retrospective Analysis

Colombia

México

Nepal

Retrospective Analysis
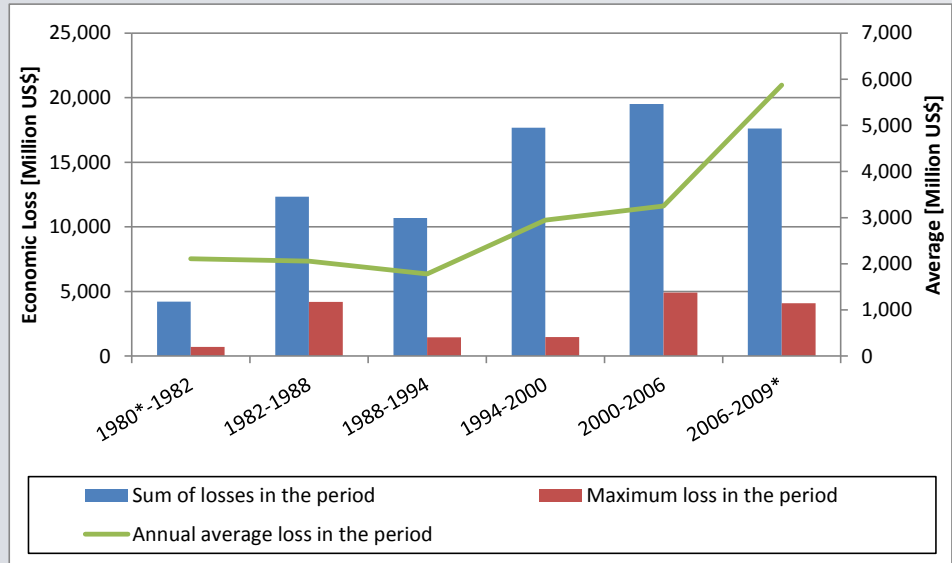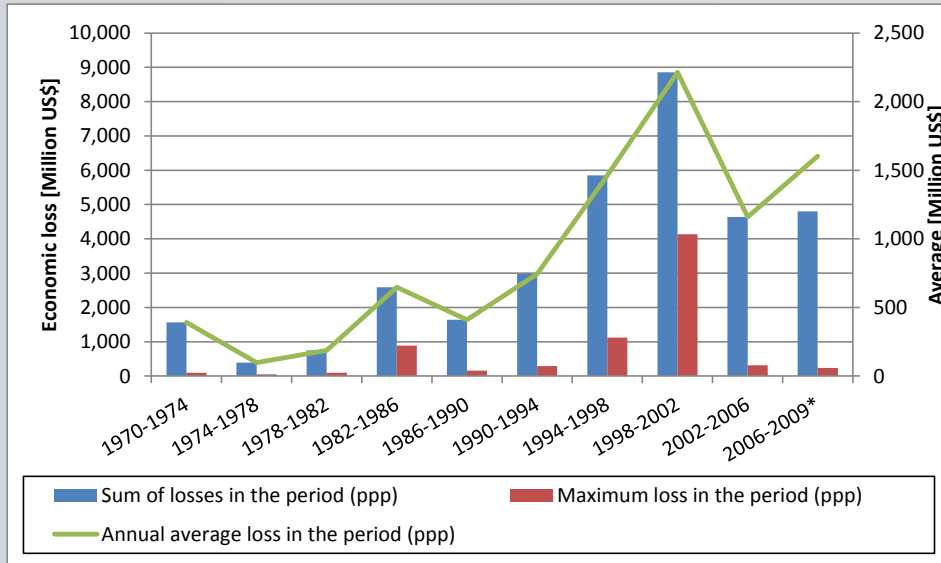
Colombia
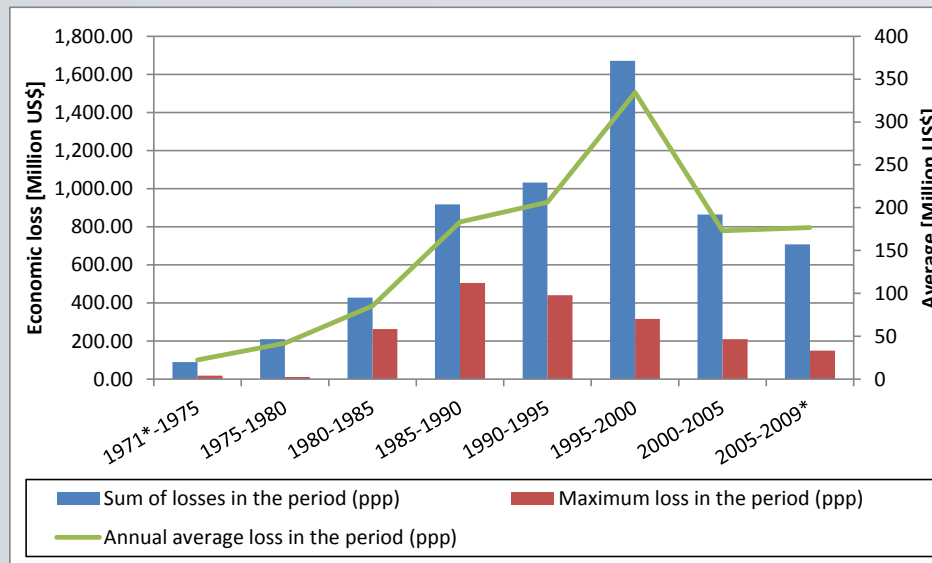
México

al

Prospective Analysis

Analysis of expected events.

Predicts future major events using well-characterized hazard models, using actual exposure and vulnerability.

Useful for disasters with low frequency and important impact in assets, like (mostly):
- *Hurricanes*
- *Earthquakes*

Prospective Analysis

Requirements:
- ❑ *Hazard Model.*
- ❑ *Exposure database.*
- ❑ *Vulnerability models.*

CAPRA Platform
- *www.ecapra.org*
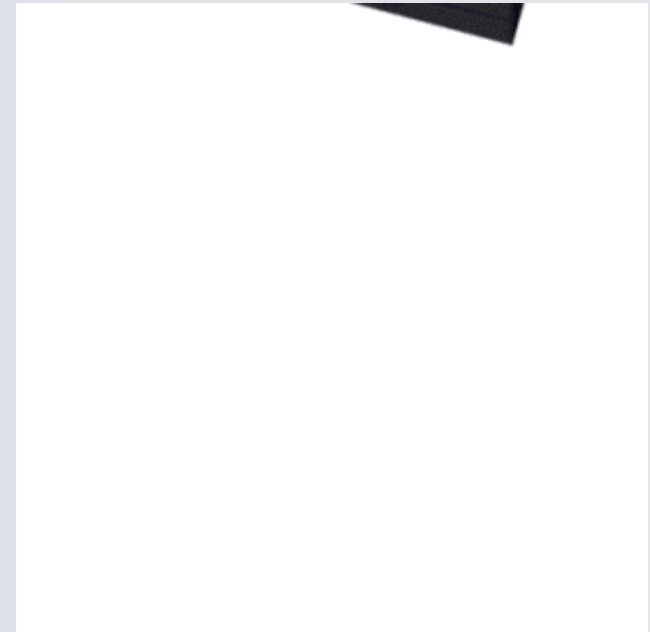
Prospective Analysis

Hazard Model

- ✓ Exhaustive catalogue of events.
- ✓ Mutually exclusive.
- ✓ Probabilistic representation.

Exposure Model

Assets in the threatened area, including economical and human expose value.

Vulnerability

Behaviour model for each different structural system defined in the exposure database

Prospective Analysis
hazard model

Colombia

México

Nepal

PGA [gals]

Prospective Analysis

Exposure Model - Colombia
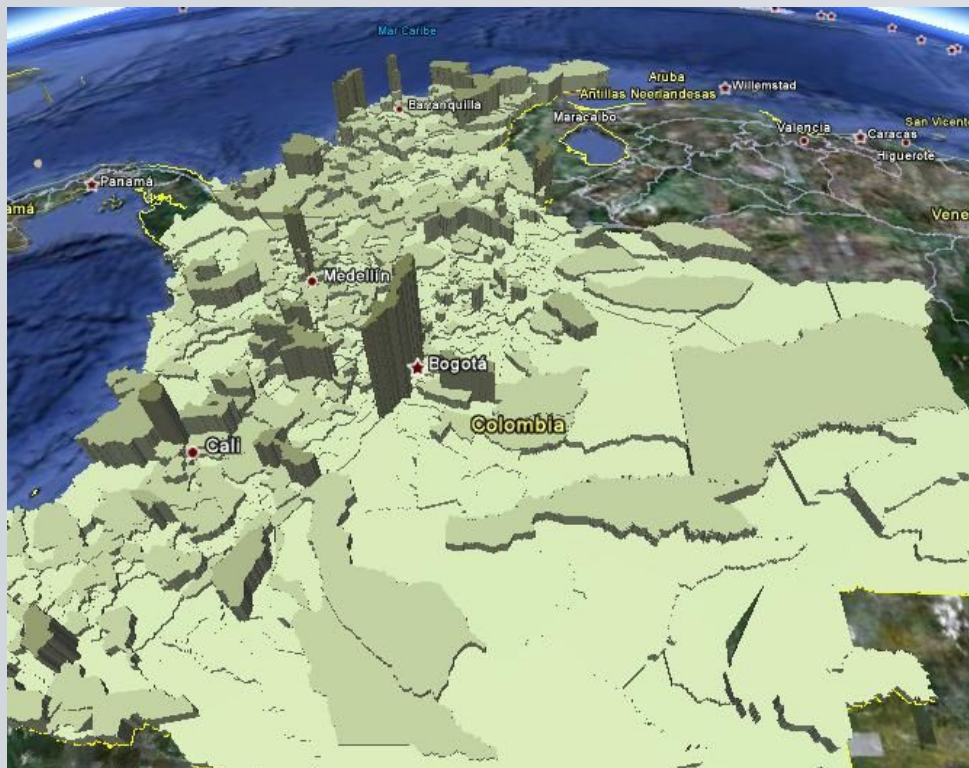
Distribution of exposed value of constructions

Built area and economic evaluation of urban construction

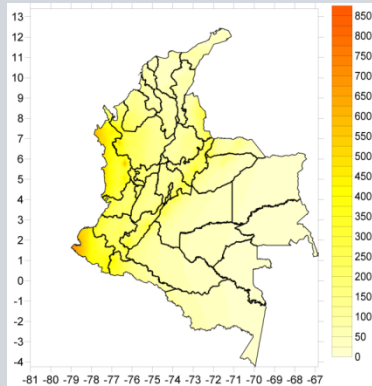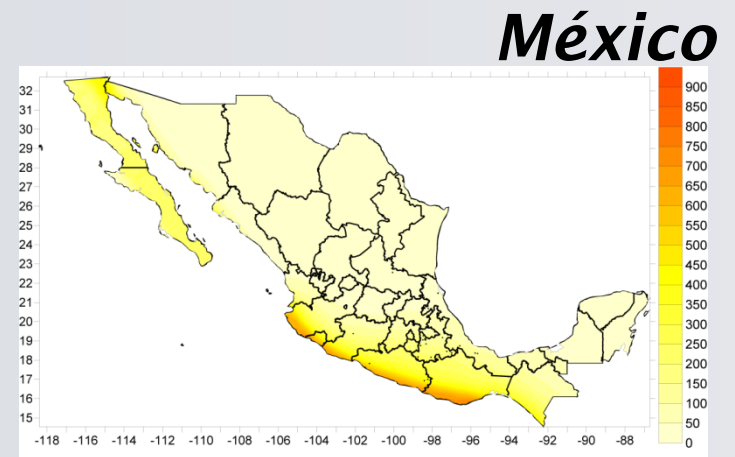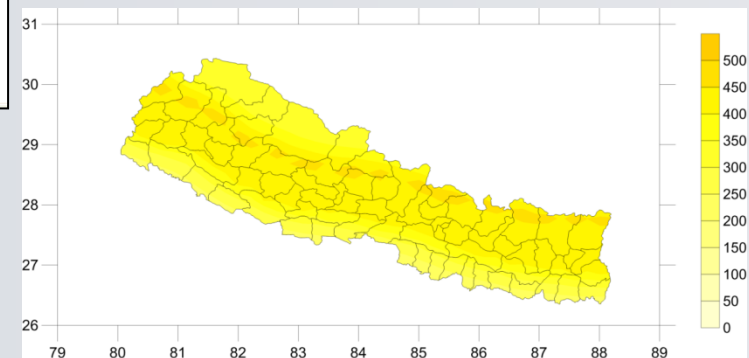| Use group	Construction area [$m^2 \times 10^3$]	Economic value [US$ $\times 10^6$]	Construction area / population from use group	
			Unit	Value
Residential LP	81,123	17,259	m^2/Inhab LP	4.1
Residential MP	297,168	172,987	m^2/Inhab MP	13.7
Residential HP	27,700	25,572	m^2/Inhab HP	23.5
Commercial	234,469	129,370	m^2/WF	20.0
Industry	129,840	114,624	m^2/WF	50.0
Private Health	263	269	m^2/1000 Inhab	6.1
Private Education	27,844	16,603	m^2/Stud	2.2
Public Health	232	181	m^2/1000 Inhab	5.4
Public Education	84,111	47,031	m^2/Stud	6.8
Government	4,776.6	2,636	m^2/PE	5.0
Total	**887,527**	**526,531**	**m2/Urban Pop**	**27.3**

LP: Low-income population; MP: Medium-income population; HP: High-income population

Prospective Analysis

Exposure Model - México

Distribution of exposed value of constructions

Built area and economic value of urban constructions

Use group	Construction area [m²x10³]	Economic value [US$x10⁶]	Construction area / population from use group	
			Unit	Value
Residential LP	212,714	23,947	m²/Inhab LP	4.1
Residential MP	678,280	210,066	m²/Inhab MP	13.9
Residential HP	161,015	81,388	m²/Inhab HP	24.1
Commercial	536,644	156,528	m²/WF	20.0
Industry	401,059	187,786	m²/WF	50.0
Private Health	359	192	m²/1000 Inhab	3.4
Private Education	49,245	15,025	m²/Stud	1.5
Public Health	359	154	m²/1000 Inhab	3.4
Public Education	249,655	73,942	m²/Stud	7.5
Government	9,662.7	2,832	m²/PE	5.0
Total	**2,298,991**	**751,858**	m²/Urban Pop	**28.2**

LP: Low-income population; MP: Medium-income population; HP: High-income population

Prospective Analysis

Exposure Model - Nepal

**Built area and economic value of urban constructions**

Use group	Construction area [m²x10³]	Economic value [US$x10⁶]	Construction area / population from use group	
			Unit	Value
Residential LP	37,211	1,805.1	m²/Inhab LP	4
Residential MP	239,044	23,482.5	m²/Inhab MP	13
Residential HP	22,606	3,447.0	m²/Inhab HP	23
Commercial	59,760	5,896.2	m²/WF	20
Industry	53,409	7,893.2	m²/WF	50
Private Health	6	0.86	m²/1000 Inhab	0.2
Private Education	33,057	3,572.0	m²/Stud	4
Public Health	60	7.10	m²/1000 Inhab	2
Public Education	54,810	5,156.6	m²/Stud	6
Government	6,960	664.8	m²/PE	7
Total	**506,922**	**51,925.5**	**m2/Urban Pop**	**99**

LP: Low-income population; MP: Medium-income population; HP: High-income population

Distribution of exposed value of constructions

Prospective Analysis
vulnerability models

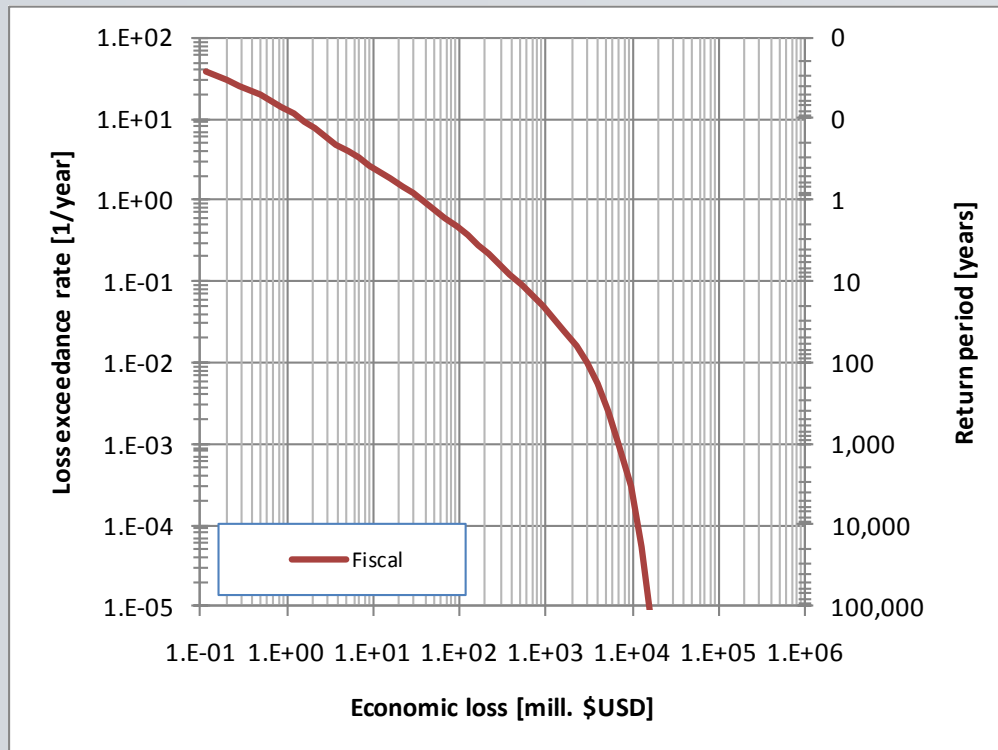Non-reinforced masonry
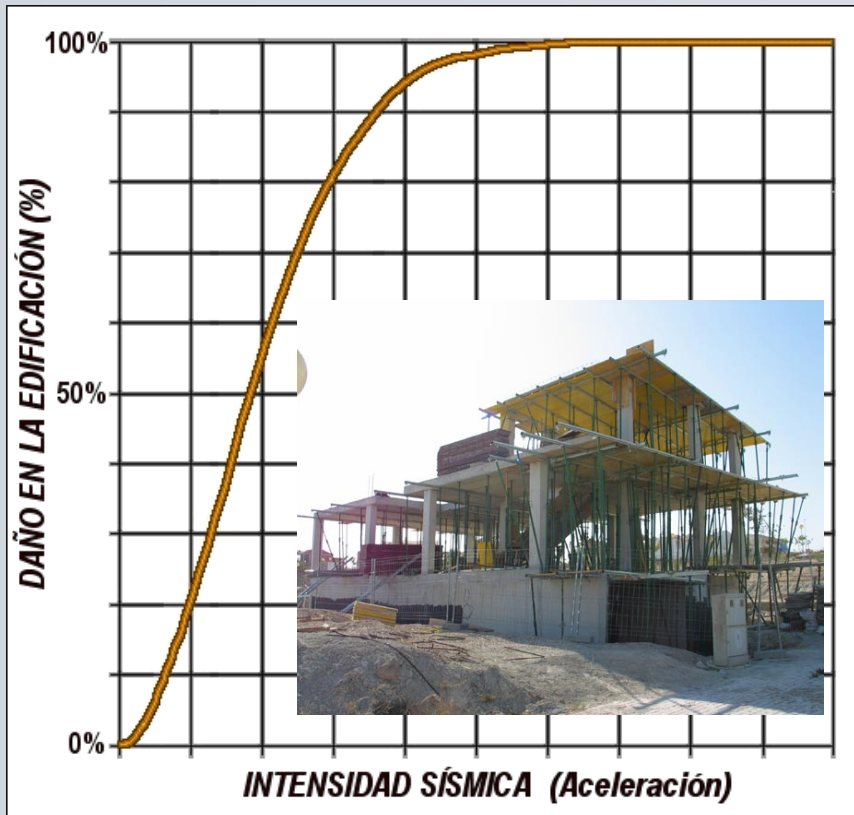
Reinforced concrete frames
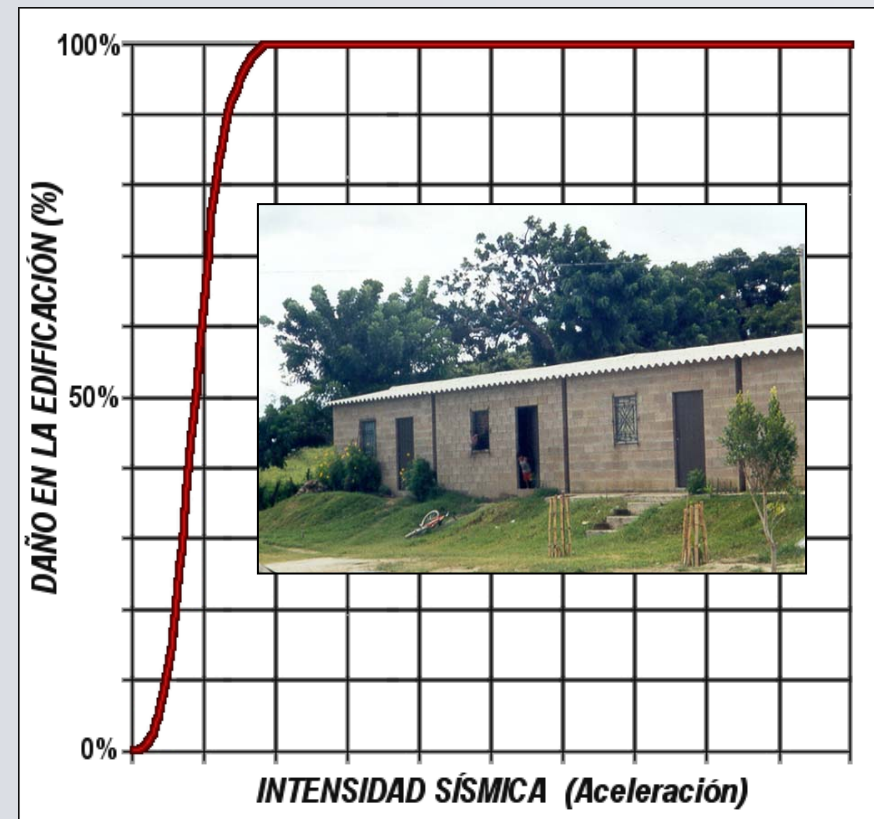
... and several more.

Prospective Analysis

Summary Fiscal Sector Risk - Colombia
Fiscal, public and low income sector assets

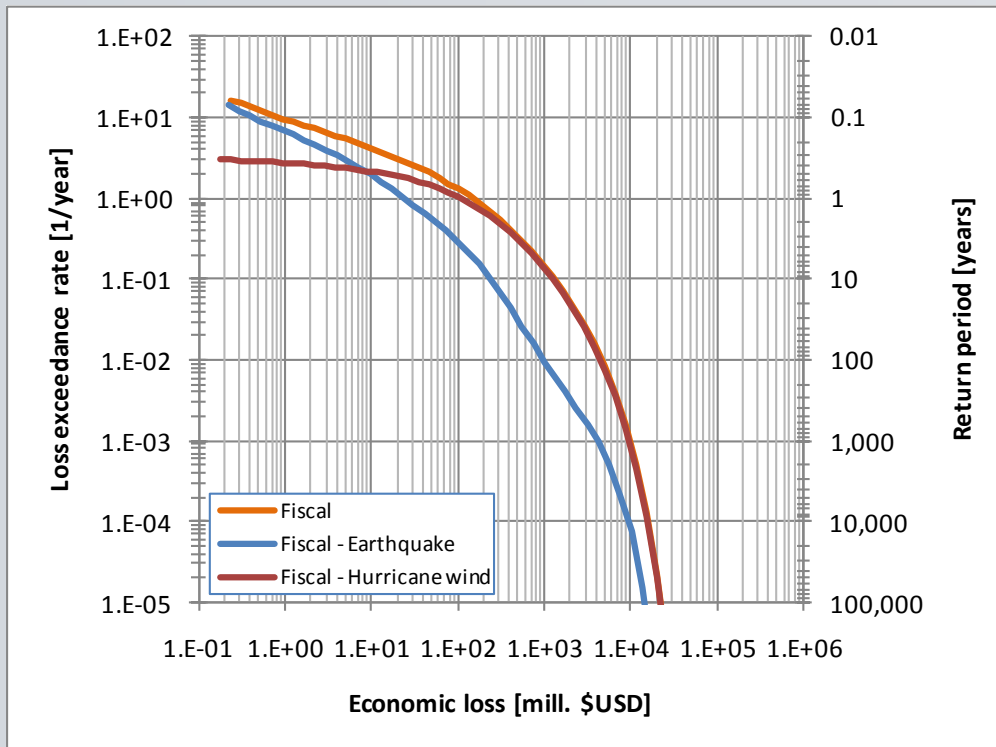Loss exceedance curve for the fiscal portfolio of Colombia
(Seismic risk)

Summary of seismic risk results for the fiscal portfolio of Colombia

Results		
Exposure value	US$ mill.	$173,226
Annual average loss	US$ mill.	$316
	‰	1.8
PML		
Return period	Loss	
years	US$ mill.	%
100	$2,976	1.7%
250	$4,417	2.5%
500	$5,655	3.3%
1,000	$7,126	4.1%
1,500	$7,625	4.4%

Prospective Analysis

Summary Fiscal Sector Risk - México

Fiscal, public and low income sector assets

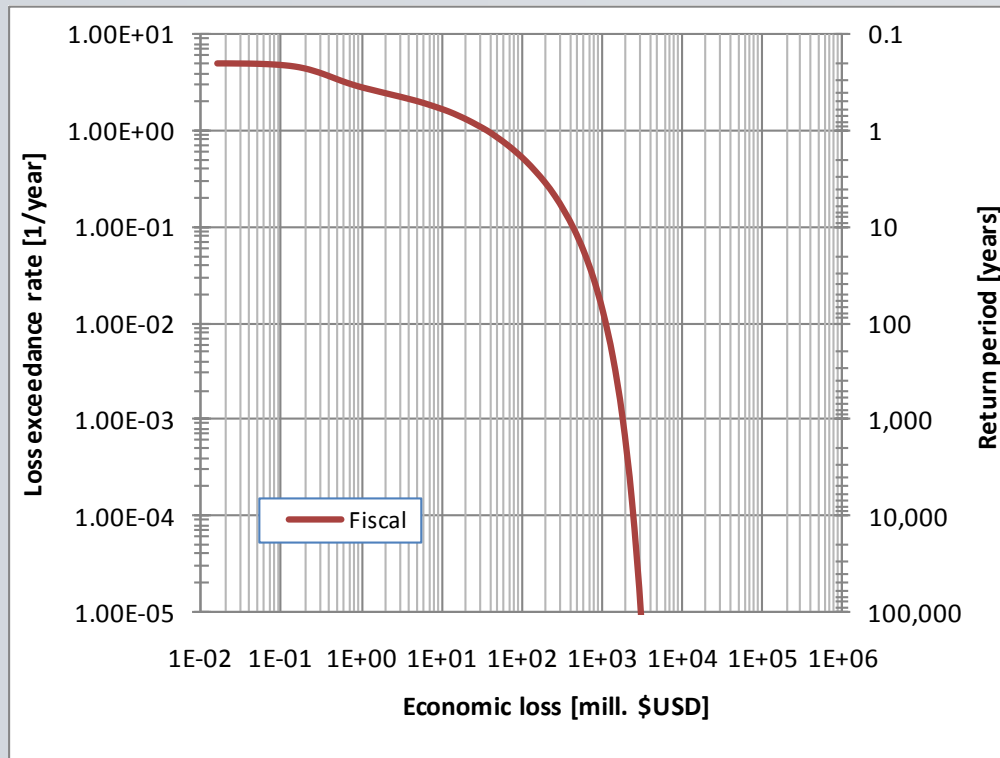

Loss exceedance curve for the fiscal portfolio of Mexico

Summary of risk results for the fiscal portfolio of Mexico

Results		
Exposure value	US$ mill.	$330,101
Annual average loss	US$ mill.	$803
	‰	2.43
PML		
Return period	**Loss**	
years	US$ mill.	%
100	$2,090	0.6%
250	$3,406	1.0%
500	$4,658	1.4%
1,000	$6,644	2.0%
1,500	$8,090	2.5%

Prospective Analysis

Summary Fiscal Sector Risk - Nepal
<u>Fiscal</u>, public and low income sector assets

Loss exceedance curve for the fiscal portfolio of Nepal

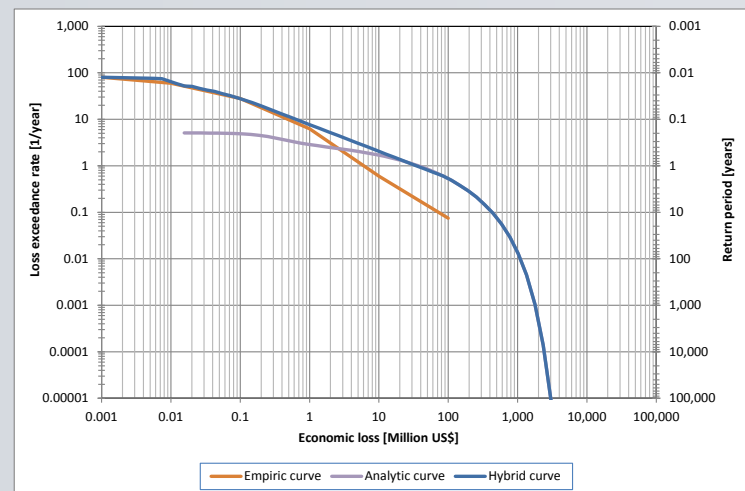Summary of seismic risk results for the fiscal portfolio of Nepal

Results		
Exposed value	US$ mill.	$15,479
Average annual loss	US$ mill.	207
	‰	13‰
PML		
Return period	**Loss**	
years	US$ mill.	%
100	$1,071	6.9%
250	$1,365	8.8%
500	$1,512	9.7%
1,000	$1,784	11.5%
1,500	$1,829	11.8%

"Hybrid" loss exceedance curve
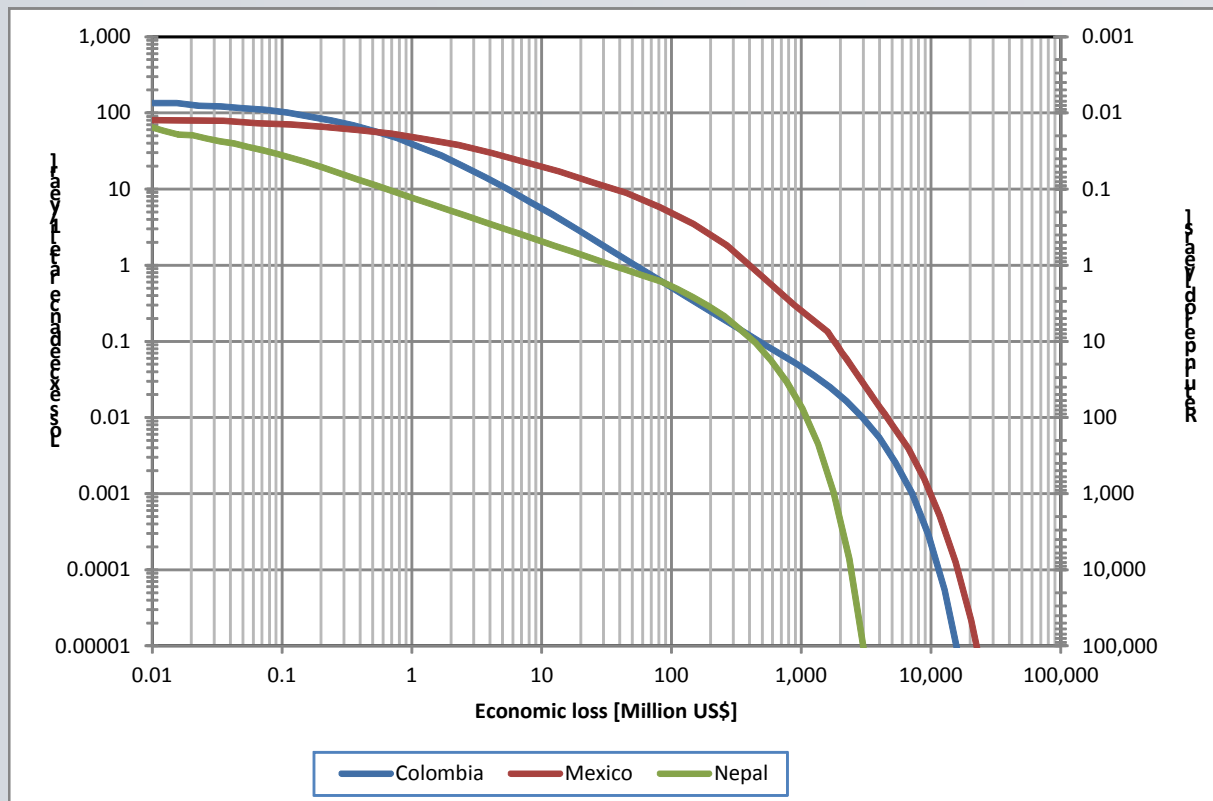

Colombia
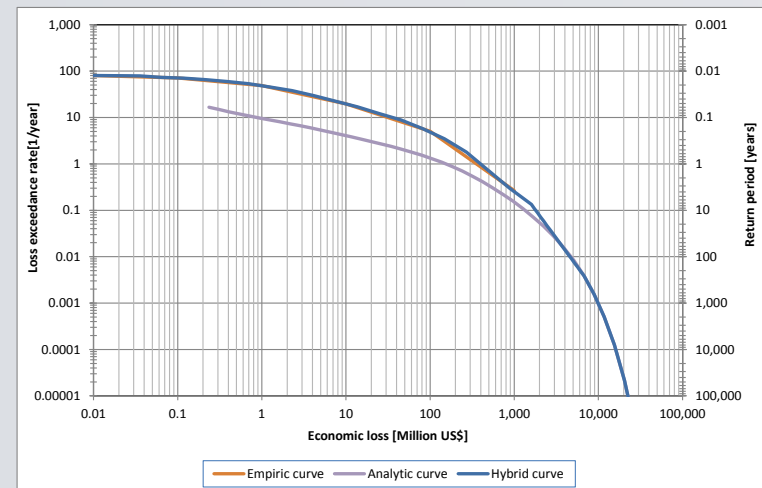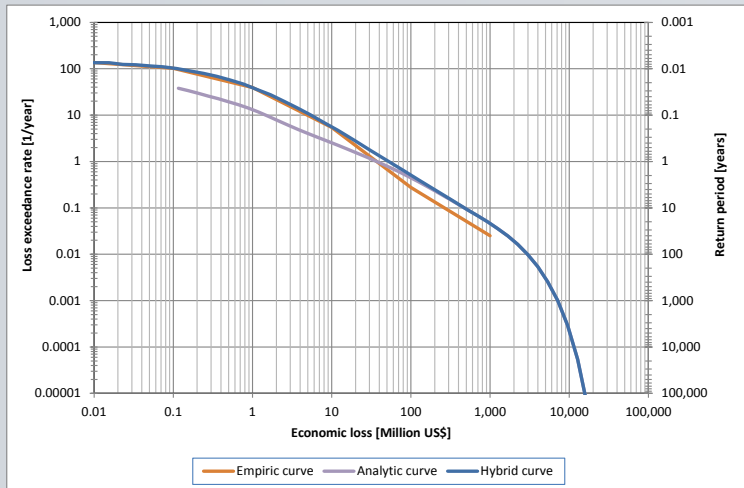
México

Nepal

"Hybrid" loss exceedance curve

AAL Comparative

	DesInventar All events [US$ millions]	DesInventar Without other events [US$ millions]	Catastrophic analysis Fiscal sector [US$ millions]	Hybrid curve [US$ millions]
Colombia	380	360	316	490
Mexico	2,760	2,540	810	2,424
Nepal	54	52	207	235