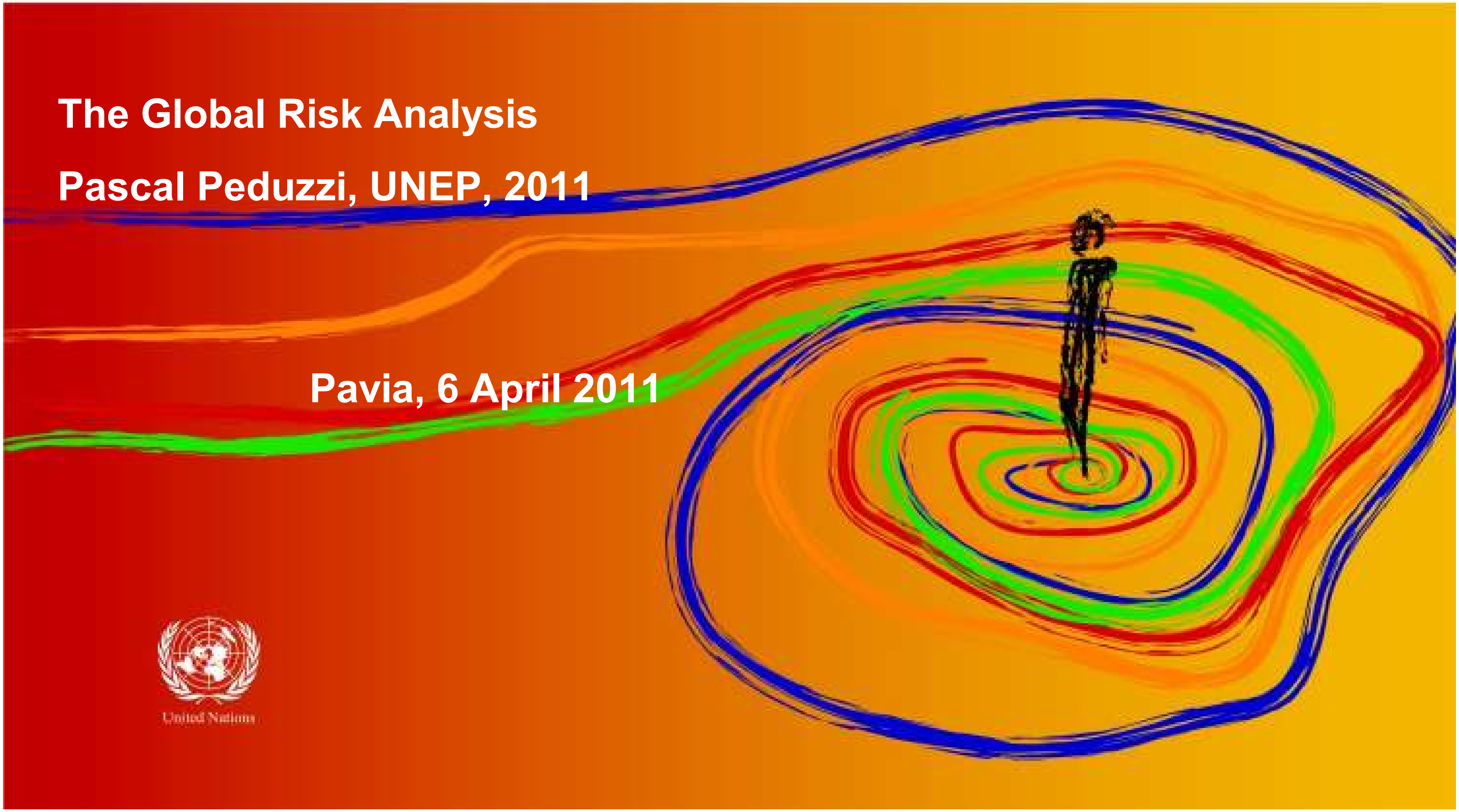
2009 Global Assessment Report on Disaster Risk Reduction

Risk and poverty in a changing climate

Invest today for a safer tomorrow



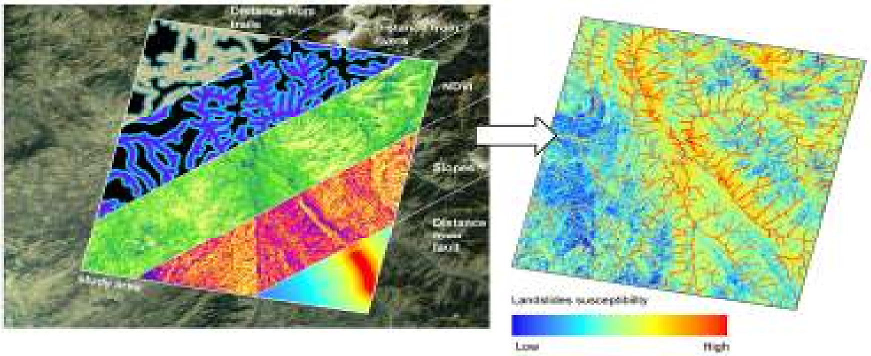
The Global Risk Analysis

Pascal Peduzzi, UNEP, 2011

Pavia, 6 April 2011

Global Change & Vulnerability Unit

Spatial analysis (GIS)



Statistical analysis

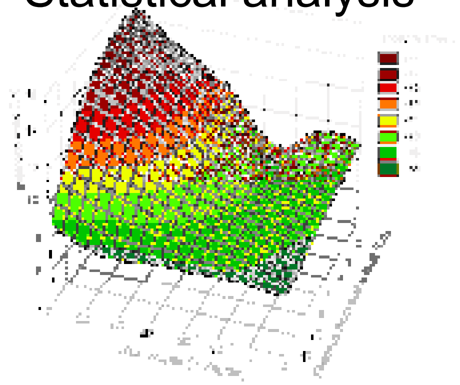
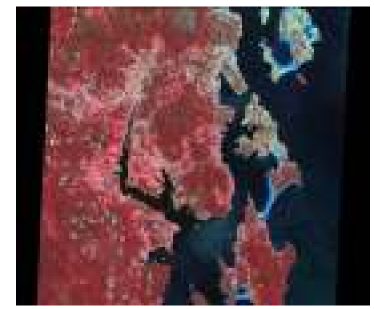
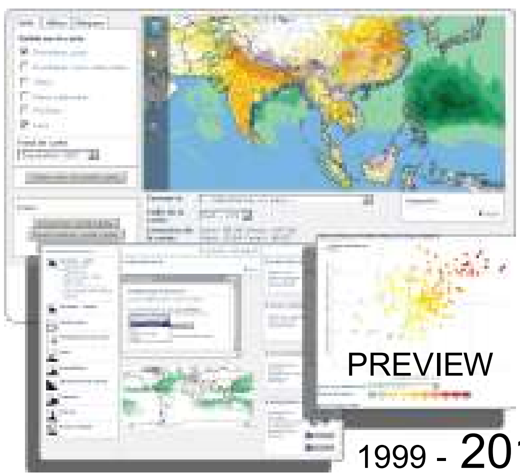


Image analysis



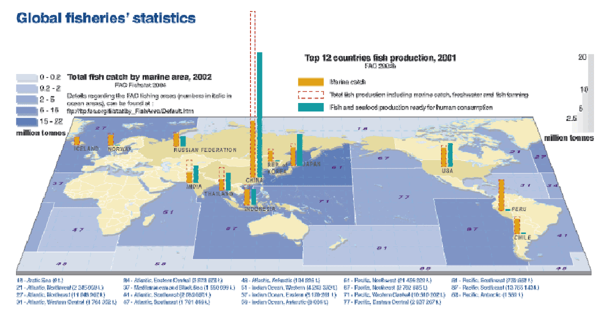
Data (SDI)



1999 - 2010

Field data collection

Maps & Info



The Global Risk Analysis is…

…one of the component of the **2009 Global Assessment Report on Disaster Risk Reduction**. It focus on intensive mortality and economical risk from natural hazards world-wide.

It aims to address the following questions:

- Spatial distribution of seven natural hazards and associated human and economical exposure
- Identification of risk/vulnerability drivers
- Spatial risk ditribution patterns (human and economical)
- Index for comparing countries at risk
- Risk trend analysis
- Provide full access to data for end users

A collaborative effort

UN/ISDR, UNEP/GRID-Europe World Bank (GDP, economical risk), Columbia University, Norwegian Geotechnical Institute.

Contributions from many partners:
- Dartmouth Flood Observatory, United States Geological Survey…

Supported by:

- UNDP/BCPR, UN/ISDR, UNEP, World Bank and NGI.

- Reviewing process (on hazard modelling) 24 independants reviewers selected by UNESCO and WMO.

Inputs: 1.6 million US$ and 12 months for development and analysis

70 contributors including 20 developers. 1.5 Tb of Data

The Global Risk Analysis uses the latest datasets

High resolution data with global coverage

- Land cover : GlobeCover ESA, 300 m resolution, 2008
- Population: Landscan 2007, 1 km resolution, 2008
- Elevation: SRTM, 90m resolution, 2002
- GDP: World Bank, 1 Km resolution, 2008
- Hydroshed, USGS/WWF, 90m resolution, 2009.
- More than 5000 earthquakes, USGS, Shake maps, 2008
- Floods: more than 600 past floods events as detected by satellite sensors, 250m resolution, DFO, 2008
- More than 2500 past tropical cyclones data from 1975 to 2008 (as modelled by UNEP/GRID-Europe
- GAR 2011: IBtracks for tropical cyclones (1970 – 2009) More than 4180 events

Equation of risk used in the GAR

Risk = Hazard x Exposure x Vulnerability

The probability of "potential losses" for some particular cause, place and period.

Hazard — *Expected frequency of occurrence of different intensities and types of threats (e.g. cyclones, floods, earthquakes,…) for a specific area.*

Exposure — *People, assets, present in the hazard area.*

Vulnerability — *Percentage of exposure losses should an event of a specific type and severity occur (varies between 0 and 1). In this study, also includes coping capacity.*

Many scientific approaches

GAR approach

Community / social sciences approaches

Risk =	Hazard x	Exposure	x Vulnerability

What’s new on hazard ?

Tectonic Hazards

Earthquakes
MMI for 10% in 50 years

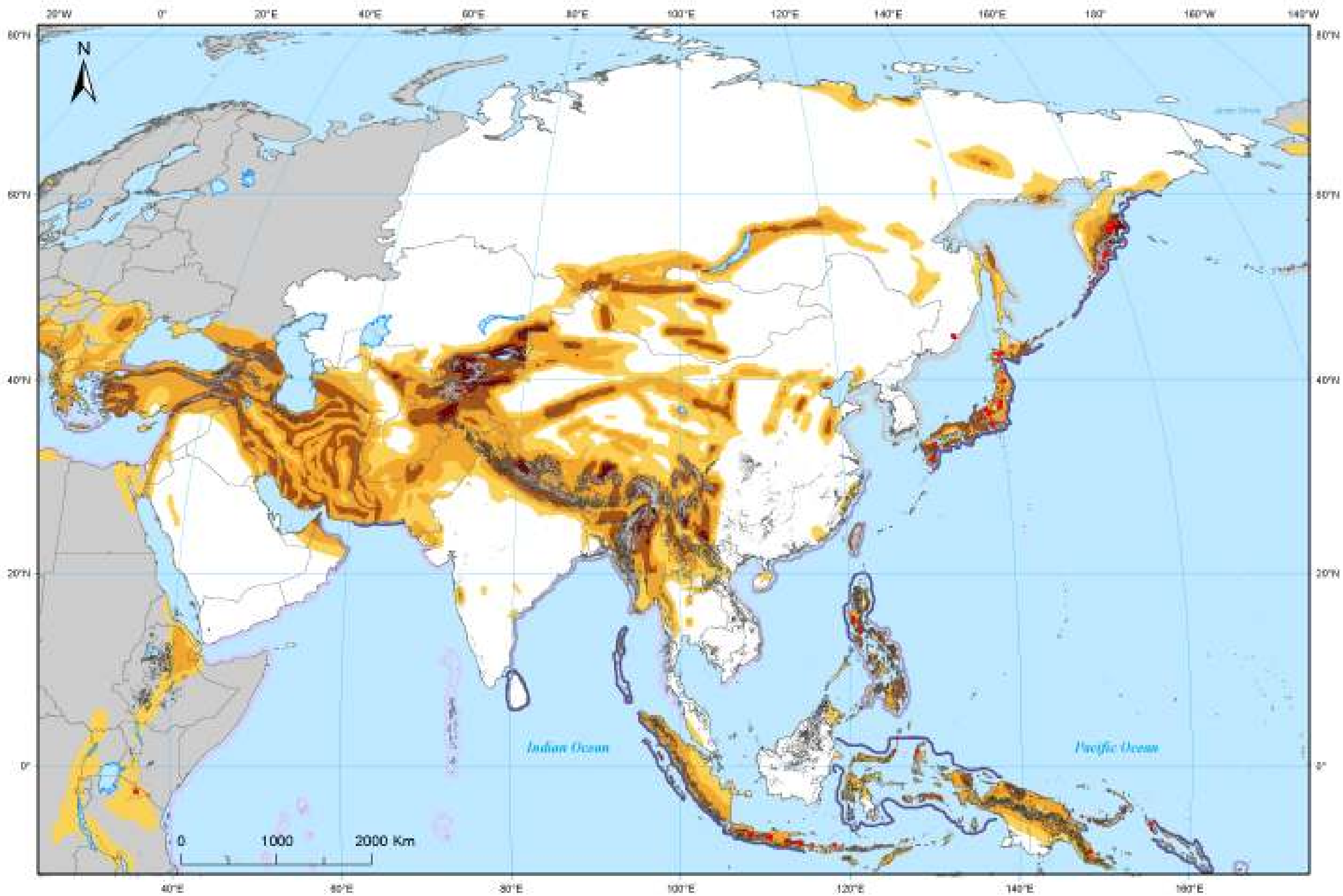
- 5
- 6
- 7
- 8

Landslides
Intensity & frequency

- Medium
- High
- Very high

Tsunami height
Exp. 10% in 50Years

- Above 5m
- 2 - 5 m
- Below 2 m
- Not studied

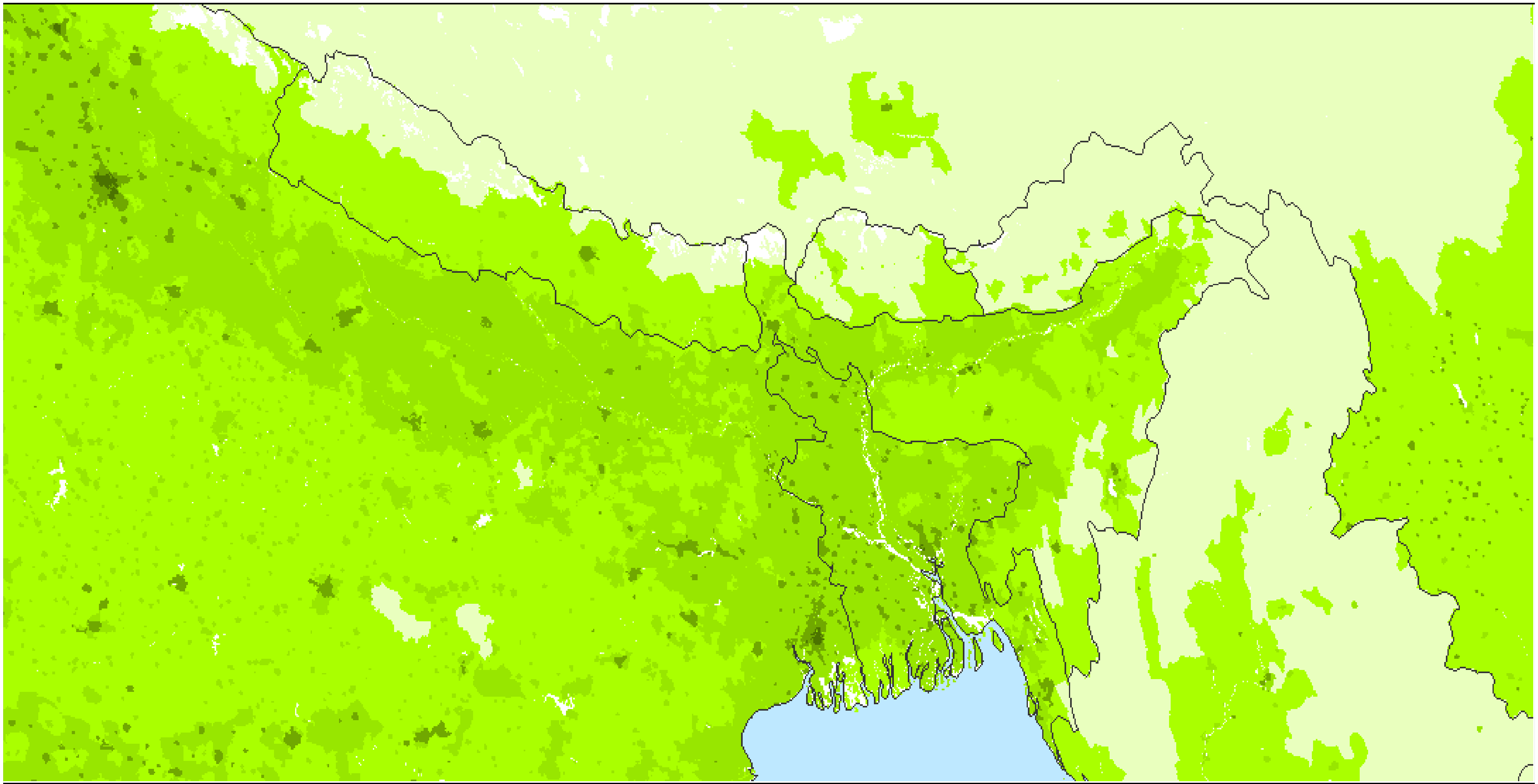


Hazards: probabilistic approach?

	Yes	No	CC.	Remarque
Drought		🔴	🟠	Based on 1960 – 2000 precipitations
Earthquakes	🟢	🟠		Based on GSHAP 1:475 years
Floods	🟢		🟠	Based on 200 years returning period
Trop. Cyclones	○	🔴	🟠	Based on 1970 – 2009 detected events
Landslides (Eq)	🟢			Based on GSHAP 1:475 years
Landslides (Pr)	○	🔴	🟠	Based on 1960 – 2000 precipitations
Tsunamis	🟢			Based on GSHAP 1:475 years
Forest fires		🔴	🟠	Based on 1997 – 2010 detected events

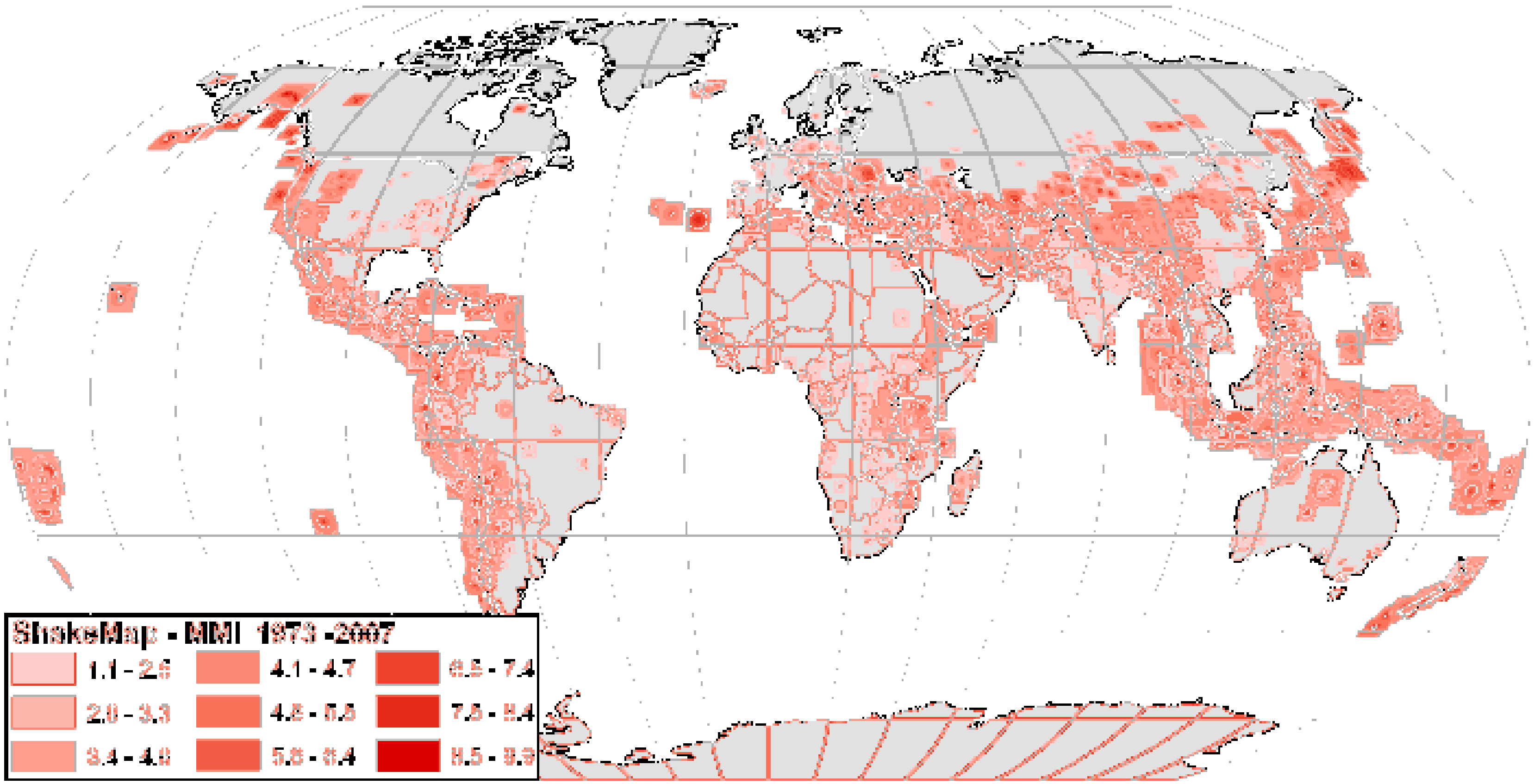
New exposure at 1 x 1 km (human & economical)

Population and GDP distribution Models made for every years from 1970 to 2010



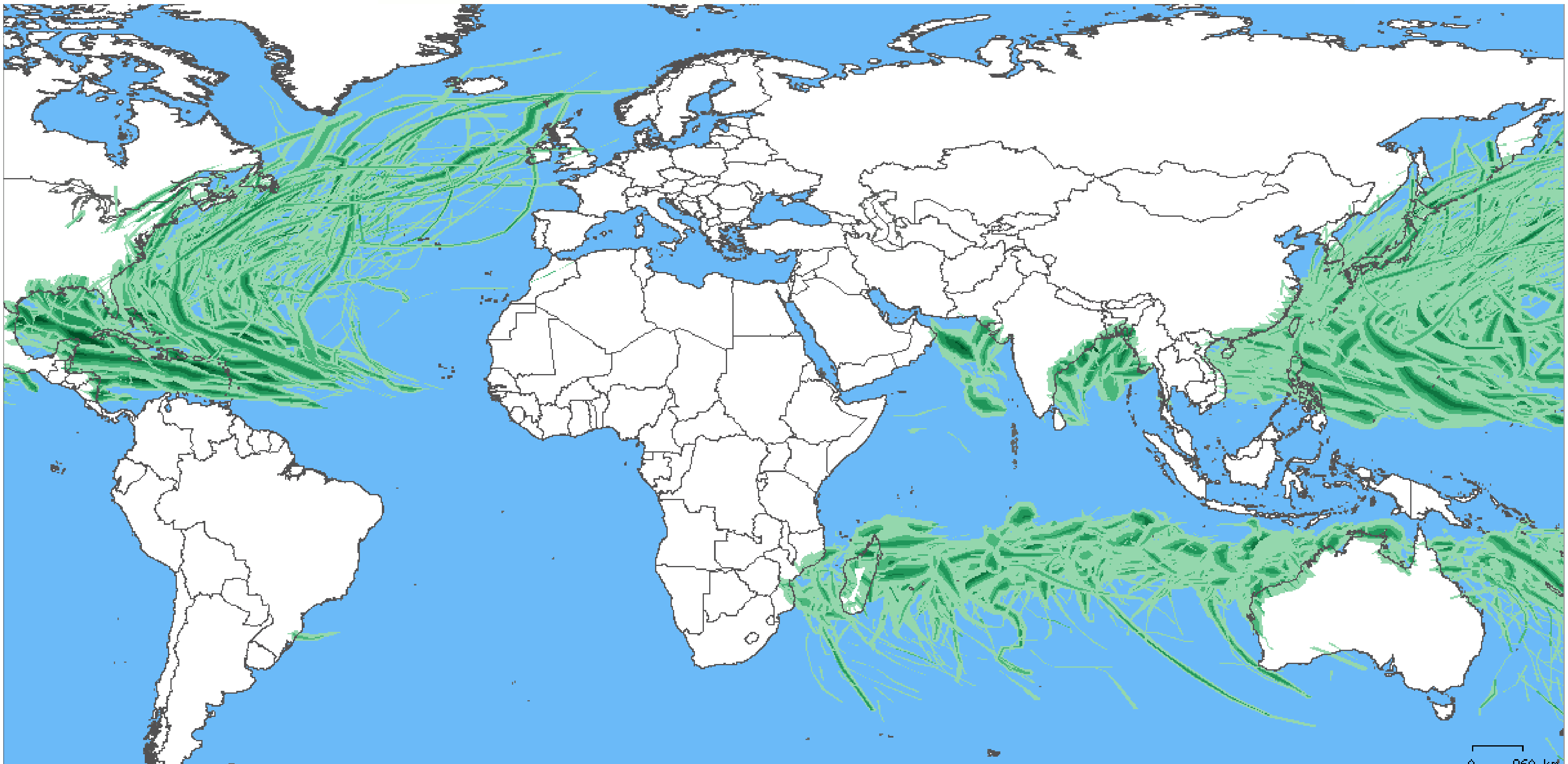
Data compilation

- 5686 events downloaded over the period 1973-2007

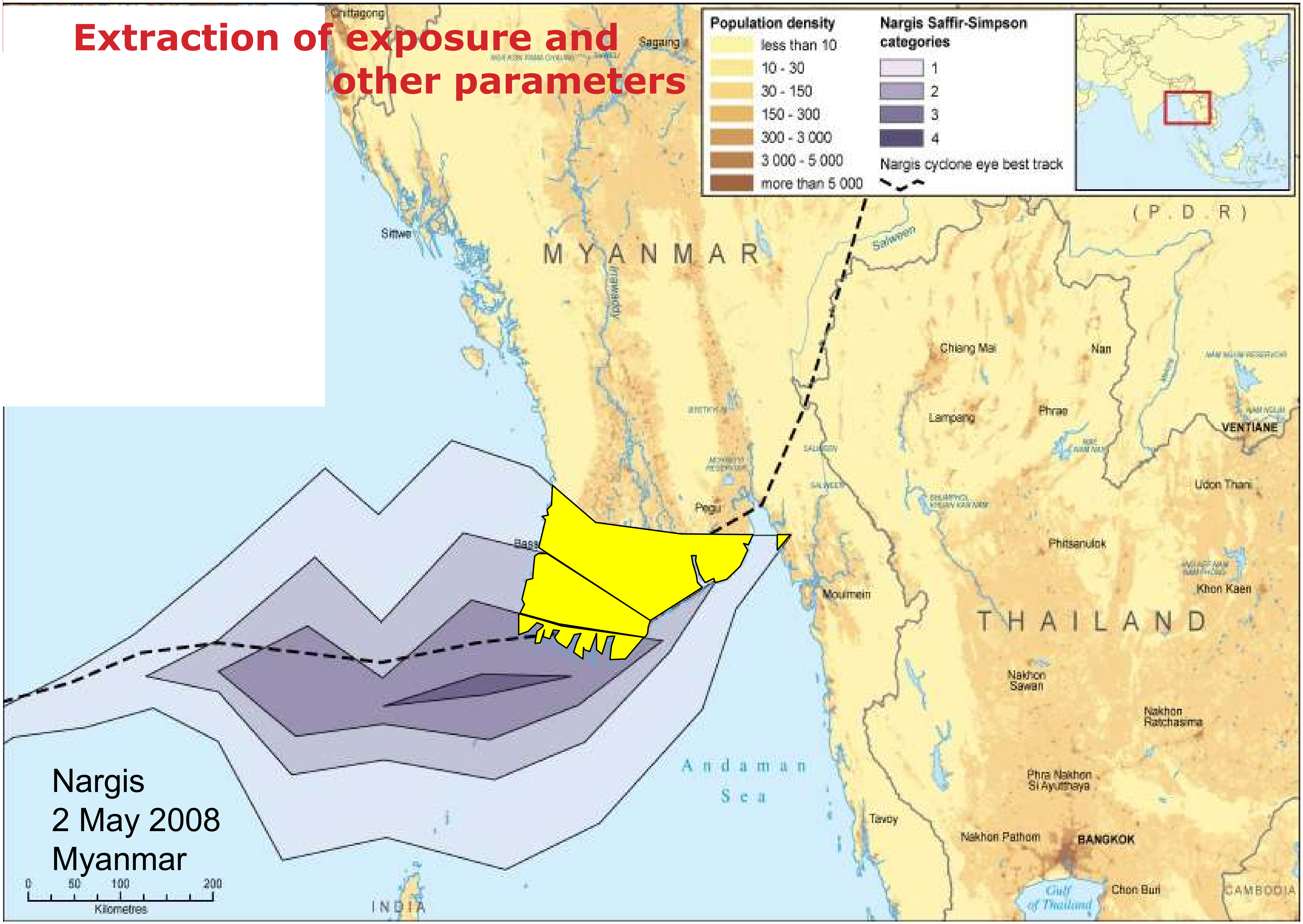


Individual past hazardous events modelling

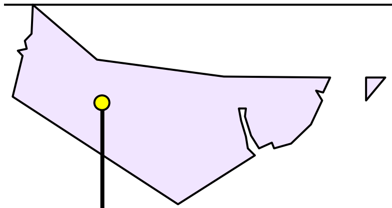
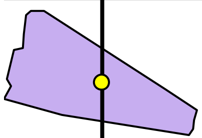
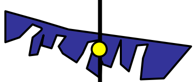
>4182 tropical cyclones events were processed
Global coverage for the period 1970 to 2009.



Extraction of exposure and other parameters



Nargis
2 May 2008
Myanmar

Footprints	Category	Pop. exp.	GDP exp.	Pop.Urb exp.	GDP Urb. exp	…
	1	10,500,000	43,000,000	4,800,000	32,500,000	
	2	1,500,000	3,500,000	1,400,000	525,000	
	3	400,000	800,000	375,000	150,000	

Country: Myanmar
Iso3: MMR
Date: 02 May 2008
Killed: 138,366
Damages: 4,000 US$ millions
GDPcap: 1,227 US$
Voice & acc.: -2.16
Governance efficiency : -1.608
Radio/inhabitant: 99.68%
HDI: 0.592
…
Urban growth: 2.55%

Preview Tropical Cyclones Database

Date
Iso3

EM-DAT, CRED

Date
Iso3
Killed
Est. damages

Vulnerability Database 43 indicators

Date
Iso3
GDPcap
Voice & acc.
Governance efficiency
Radio/inhabitant
HDI
…
Urban growth

List of vulnerability parameters considered

43 indicators on:
Economy,
Demography,
Environment,
Development,
Early Warning,
Governance,
Health,
Education,
…

1	AIDS estimated deaths, aged 0-49 (% of tot. pop.)
2	non GLC2000 bare land
3	Arable and Permanent Crops - % of non GLC2000 bare land
4	Motor vehicles in use - Passenger cars (thousand)
5	Motor vehicles in use - Commercial vehicles (thousand)
6	Physical exposure to conflicts
7	Corruption Perceptions Index (CPI)
8	Arable and Permanent Crops - Total
9	Arable and Permanent Crops - Percent of Land Area
10	Control of Corruption
11	Deforestation rate
12	% of population with access to electricity
13	Forests and Woodland (% of Land Area)
14	Gross Domestic Product - Purchasing Power Parity per Capita
15	Gross Domestic Product - Purchasing Power Parity
16	inequality (Gini coefficient)
17	Human Induced Soil Degradation (GLASOD)
18	Government Effectiveness
19	Human Development Index (HDI)
20	Per capita government expenditure on health (PPP int. $)
21	# of hospital beds per 100,000 habitants # of doctors
22	infant mortality and malnutrition (though are also factored into HDI)

No data on structural vulnerability, but…

People don't build badly just for fun!

Badly designed structures comes from:

- Lack of resources → poverty [GDPcap]
- Lack of Know-how → low education [illiteracy rate, school enrolment]
- Lack of building codes, law [governance, rule of law]
- Lack of enforcement [voice and accountability, corruption]

These are proxies for building quality.

Equation of risk used in the study *

Risk = Hazard x Exposure x Vulnerability

Hazard	Exposure	Vulnerability
Calibrated using past disasters; Modelled based on physical and geographical datasets	Population or assets as extracted using GIS	To be identified using multiple regression analysis:

Events footprints (8762 physical events): 5686 Earthquakes, 1106 floods, 4182 tropical cyclones). For which we extracted exposure and socio-economical contextual parameters: a database of 124,000 records (over 40 years, 208 countries, 43 parameters, in theory > 375,000 data cells, but “some” no data : 124,000 data cells).

Events with reported losses successfully georeferenced:
718 Earthquakes, 620 floods, 1525 tropical cyclones).

* UNDRO (1979), Natural Disasters and Vulnerability Analysis in *Report of Expert Group Meeting*

A multiplicative model

Simplifying the equation

$$R = H \cdot Exp \cdot V \qquad => \qquad R = PhExp \cdot V$$

Introducing the factors and their weights

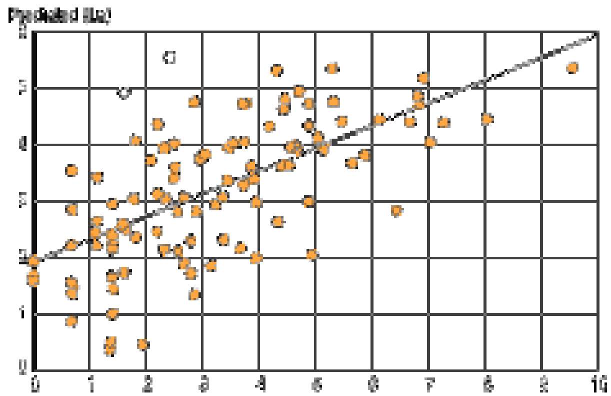
$$R = C \cdot PhExp^{\alpha 0} \cdot V_1^{\alpha 1} \cdot V_2^{\alpha 2} \ldots \cdot V_n^{\alpha n}$$

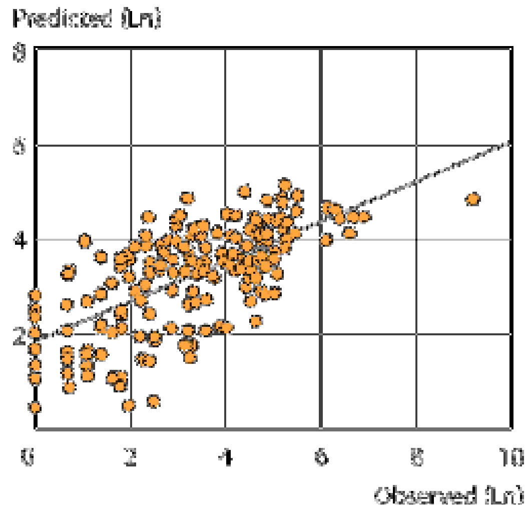
Where:

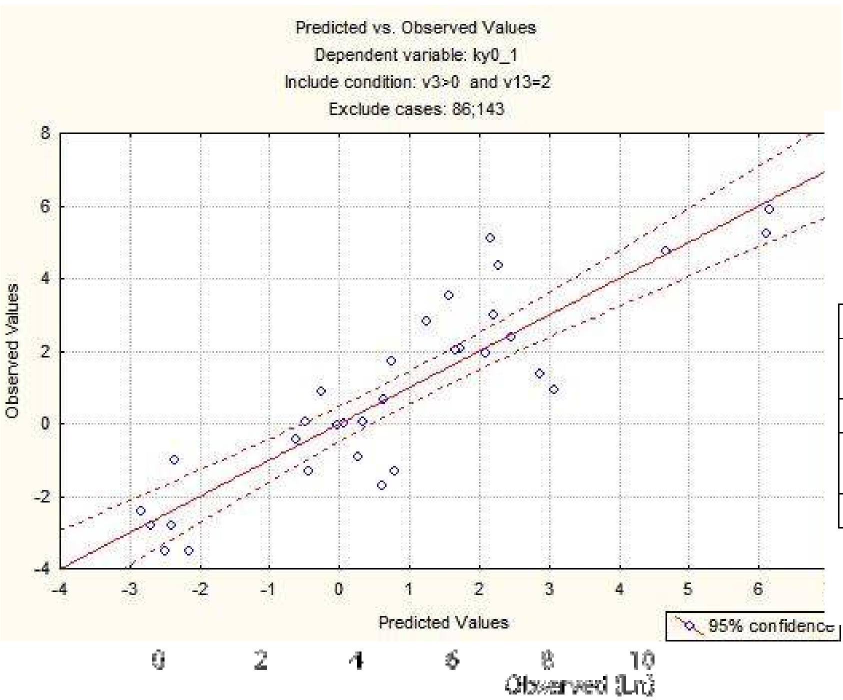
R	= risk of losses from a specify hazard type
C	= multiplicative constant
PhExp	= physical exposure, i.e. the population exposed per year to a specific hazard
V_i	= vulnerability factors (socio-economical parameters)
α_i	= exponents of PhExp and Vi

Taking the logarithms

$$\ln(R) = \ln(C) + \alpha_0 \cdot \ln(PhExp) + \alpha_1 \cdot \ln(V_1) + \alpha_2 \cdot \ln(V_2) \ldots + \alpha_n \cdot \ln(V_n)$$







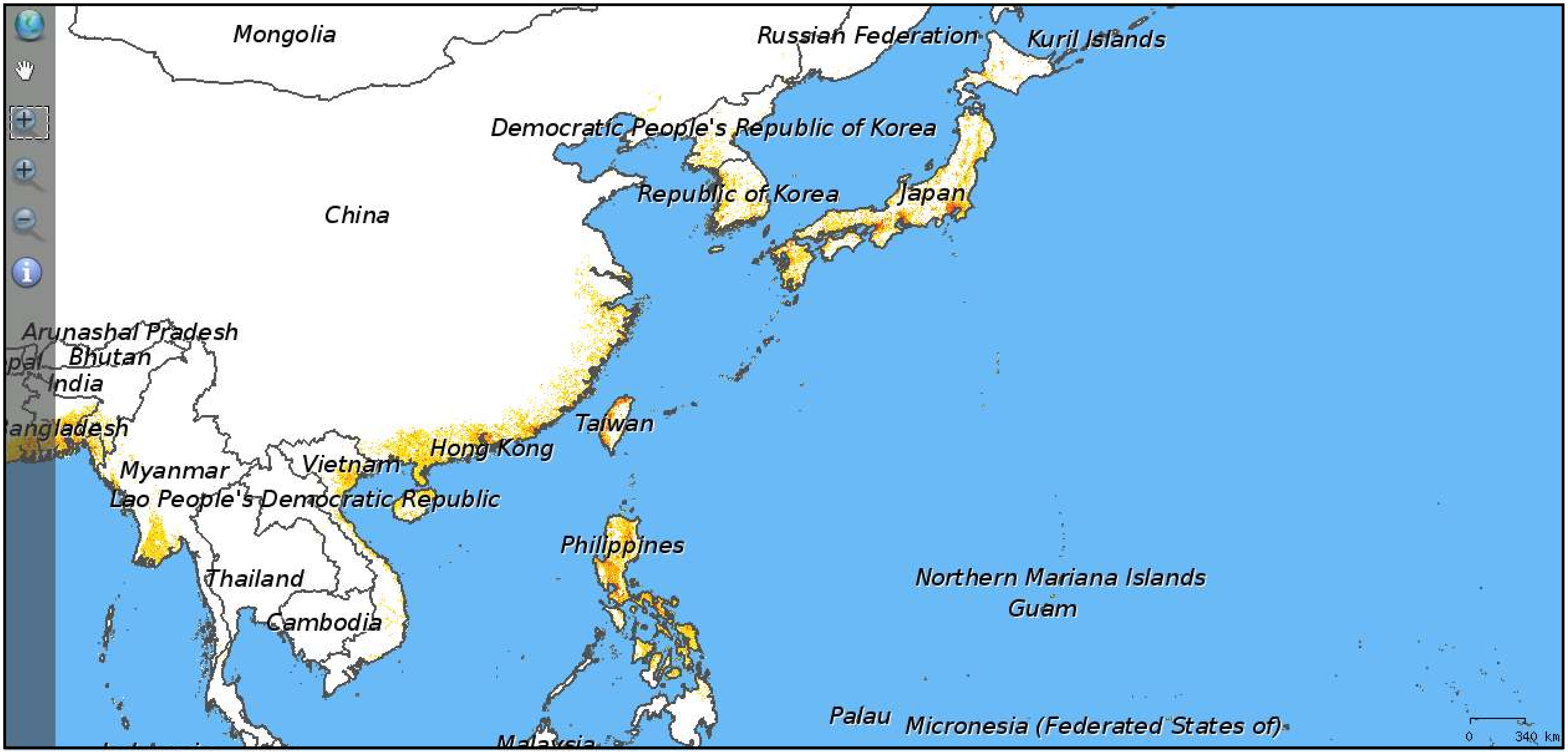
Regression Summary for Dependent Variable: ky0_1 (data_eq_iso3.sta)
R= .88261298 R²= .77900567 Adjusted R²= .75532770
F(3,28)=32.900 p<.00000 Std.Error of estimate: 1.3019
Include condition: v3>0 and v13=2
Exclude cases: 86;143

N=32	Beta	Std.Err.	B	Std.Err.	t(28)	p-level
Intercept			-9.586	1.638	-5.853	0.000
LSC_TOT_MAX_1	0.512	0.107	0.718	0.150	4.774	0.000
Day_1	-0.350	0.108	-2.057	0.636	-3.235	0.003
urbg3_0	0.360	0.090	0.640	0.160	4.011	0.000

What are the main factors increasing risk?

- The severity of hazards
- The exposure
- Poverty (low GDP per capita)
- Poor governance (low voice and accountability)
- Rapid urban growth, when associated with low development and low governance (for earthquakes)
- Remoteness (for floods)

From hazardous events to frequency and exposure



Aggregation of human exposure at country level

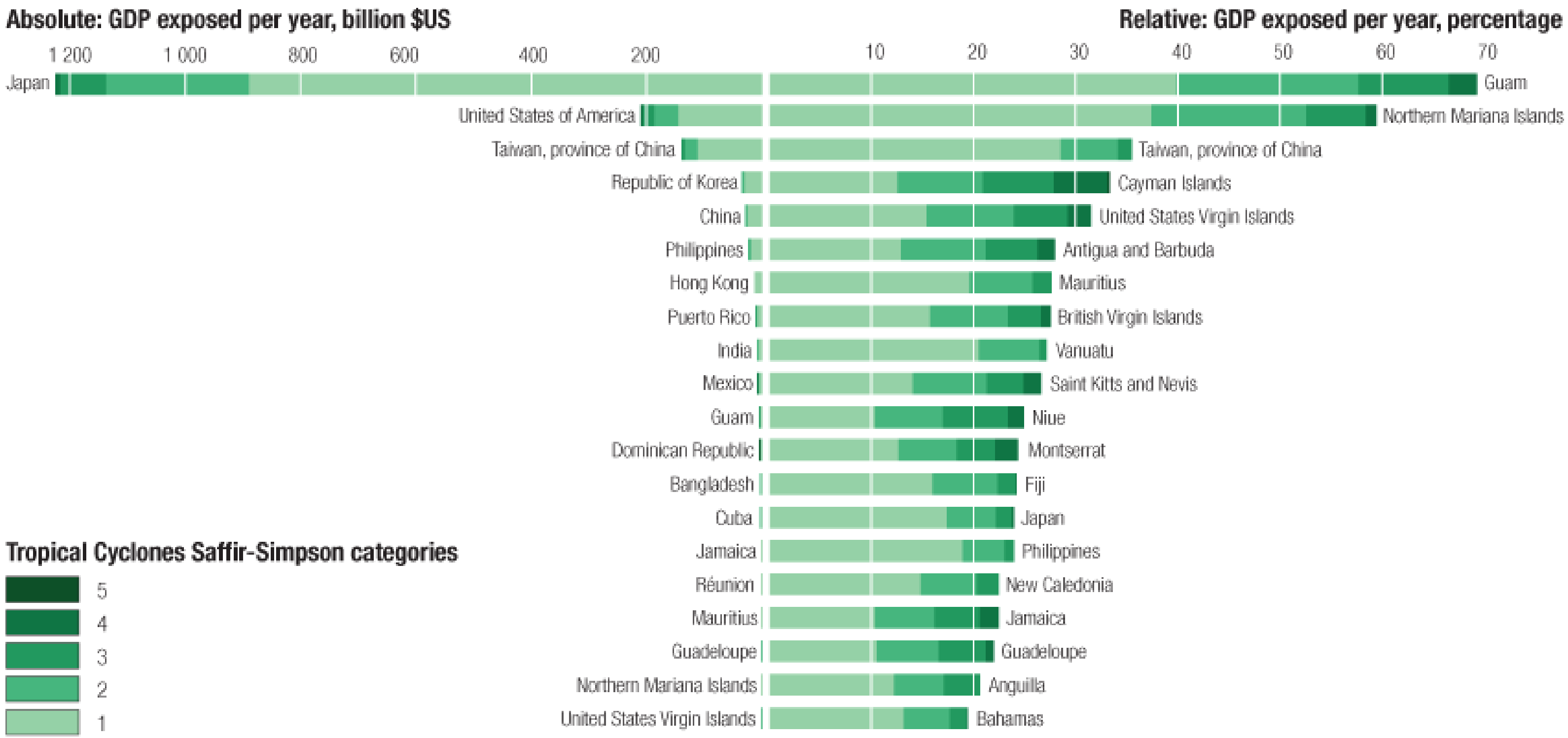
Absolute: people exposed per year

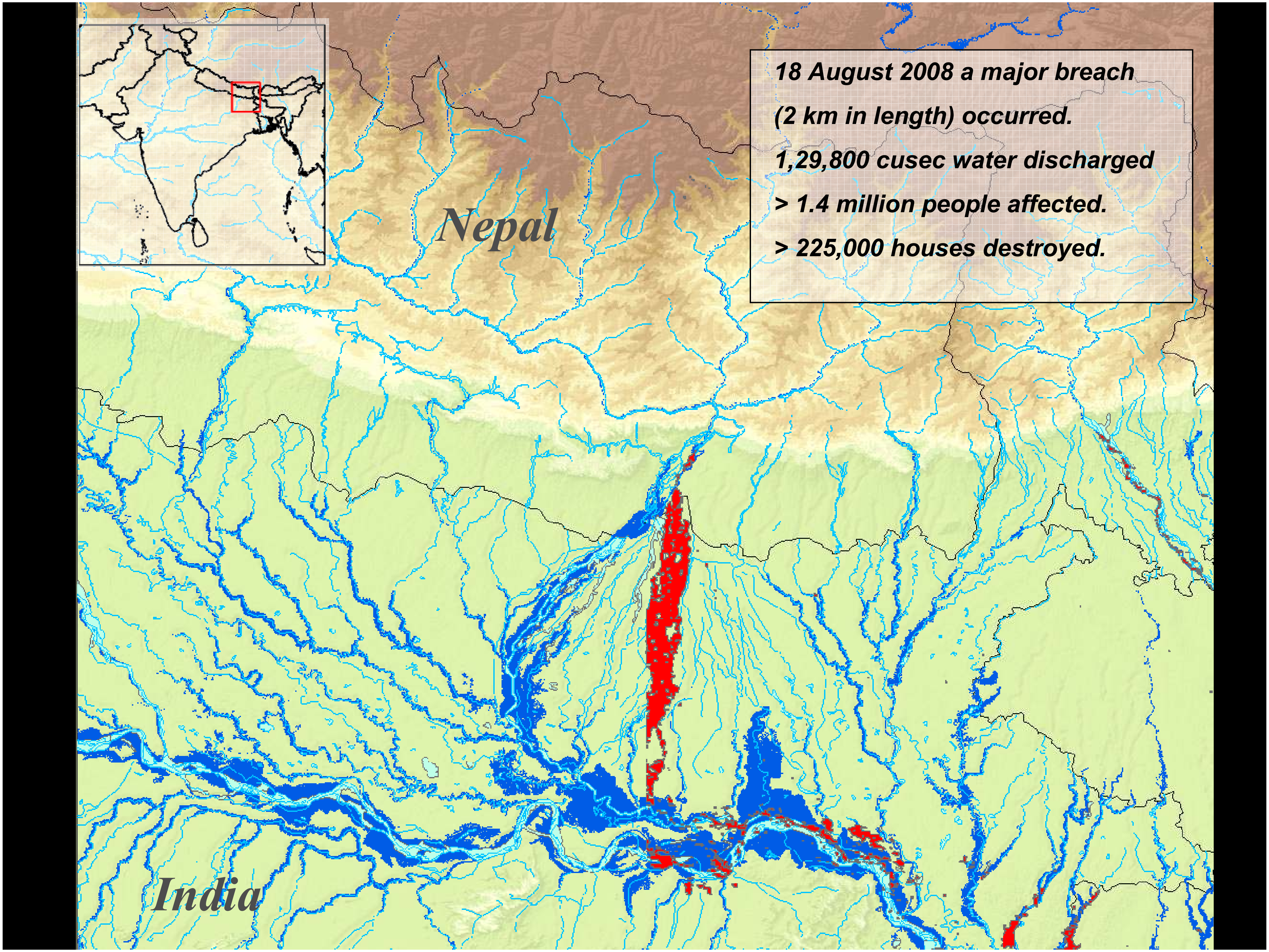
25 000 000 20 000 000 15 000 000 10 000 000 5 000 000

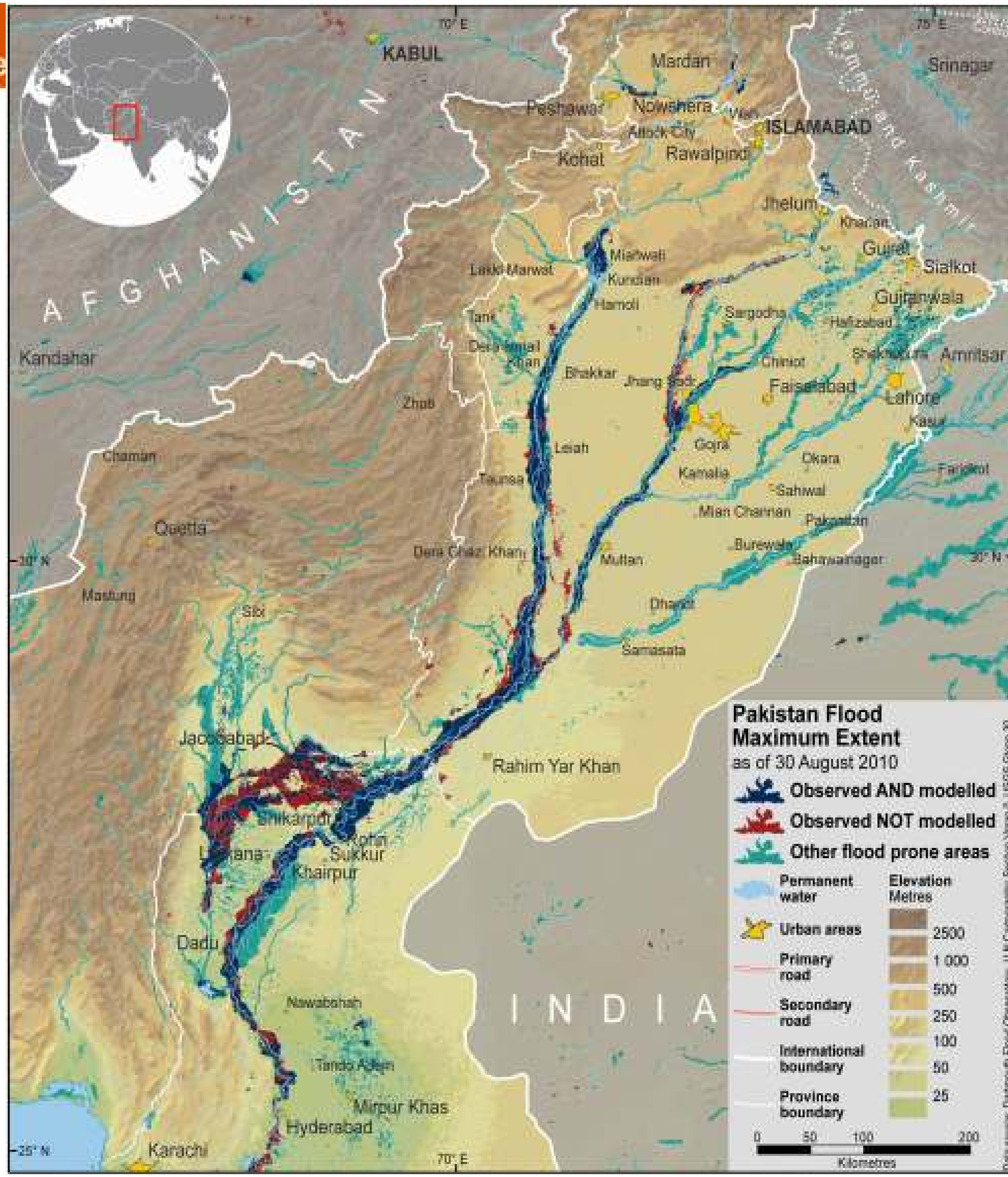
5 10 15 20 25 30 35 40

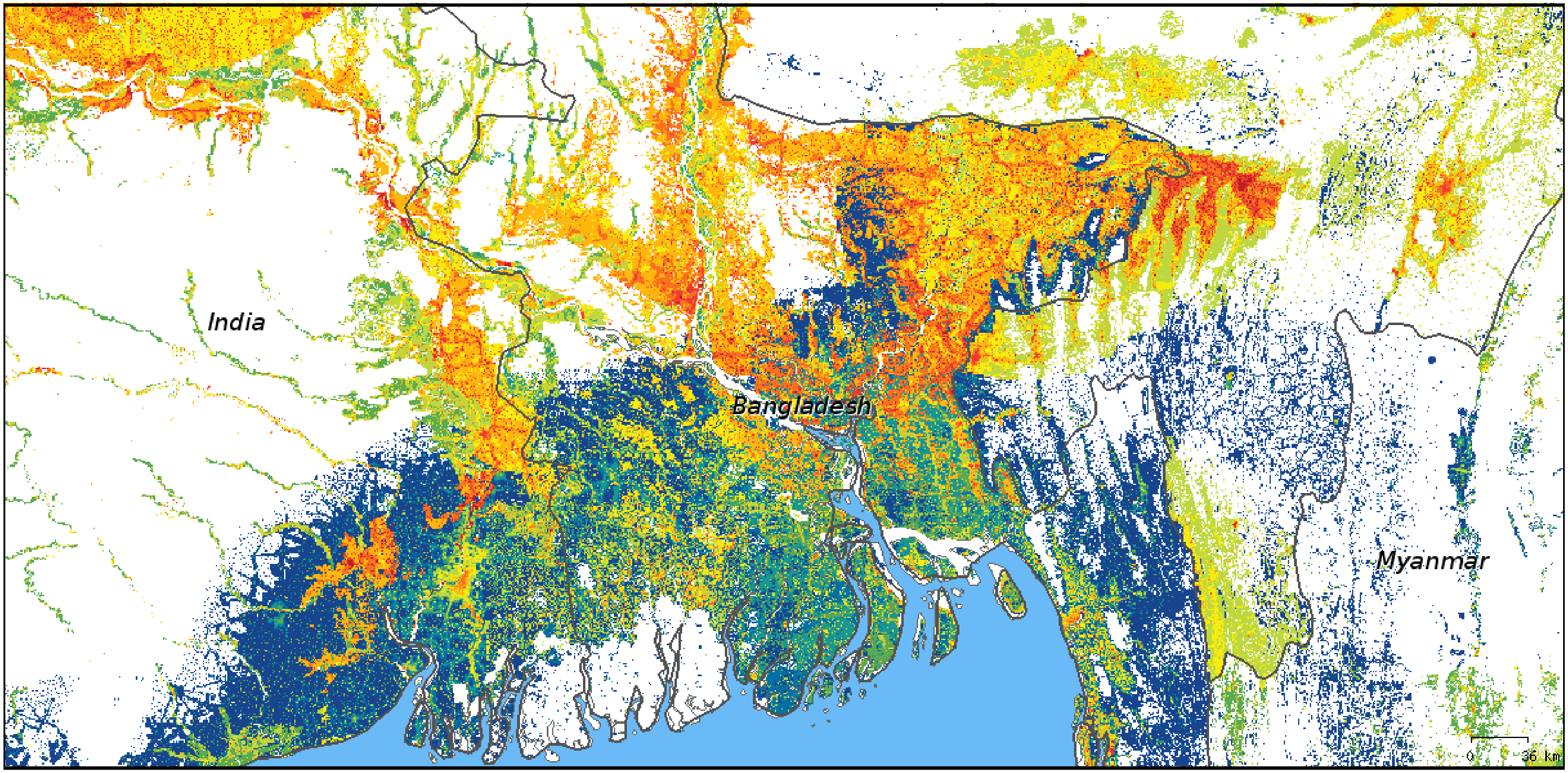
Relative: people exposed per year, percentage

Aggregation of economical exposure at country level




18 August 2008 a major breach
(2 km in length) occurred.
1,29,800 cusec water discharged
> 1.4 million people affected.
> 225,000 houses destroyed.
Nepal
India


Pakistan Flood
Maximum Extent
as of 30 August 2010
Observed AND modelled
Observed NOT modelled
Other flood prone areas
Permanent water
Urban areas
Primary road
Secondary road
International boundary
Province boundary
Elevation Metres
2500
1 000
500
250
100
50
25
0
50
100
200
Kilometres
AFGHANISTAN
INDIA
KABUL
ISLAMABAD
Kandahar
Quetta
Peshawar
Mardan
Nowshera
Rawalpindi
Kohat
Jhelum
Srinagar
Jammu and Kashmir
Gujrat
Sialkot
Gujranwala
Lahore
Amritsar
Faisalabad
Multan
Dera Ghazi Khan
Rahim Yar Khan
Jacobabad
Shikarpur
Sukkur
Khairpur
Dadu
Nawabshah
Mirpur Khas
Hyderabad
Karachi
Chaman
Mastung
Sibi
Zhob
Mianwali
Kundian
Bhakkar
Leiah
Jhang
Gojra
Okara
Sahiwal
Kasur
Samasata
70° E
75° E
30° N
25° N



risk

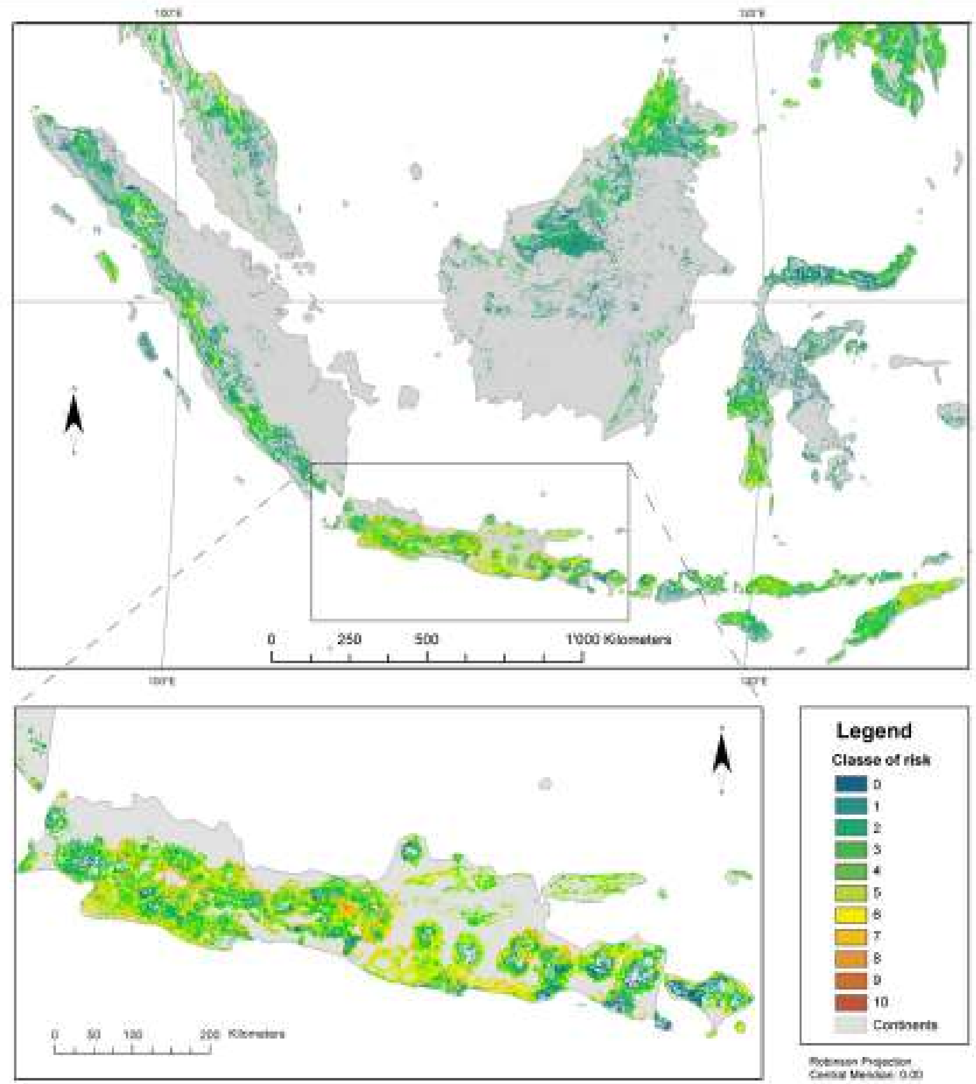
Landslides risk

Landslides (modelled for both precipitation and earthquakes)

About 2.2 million people are exposed to landslides worldwide.

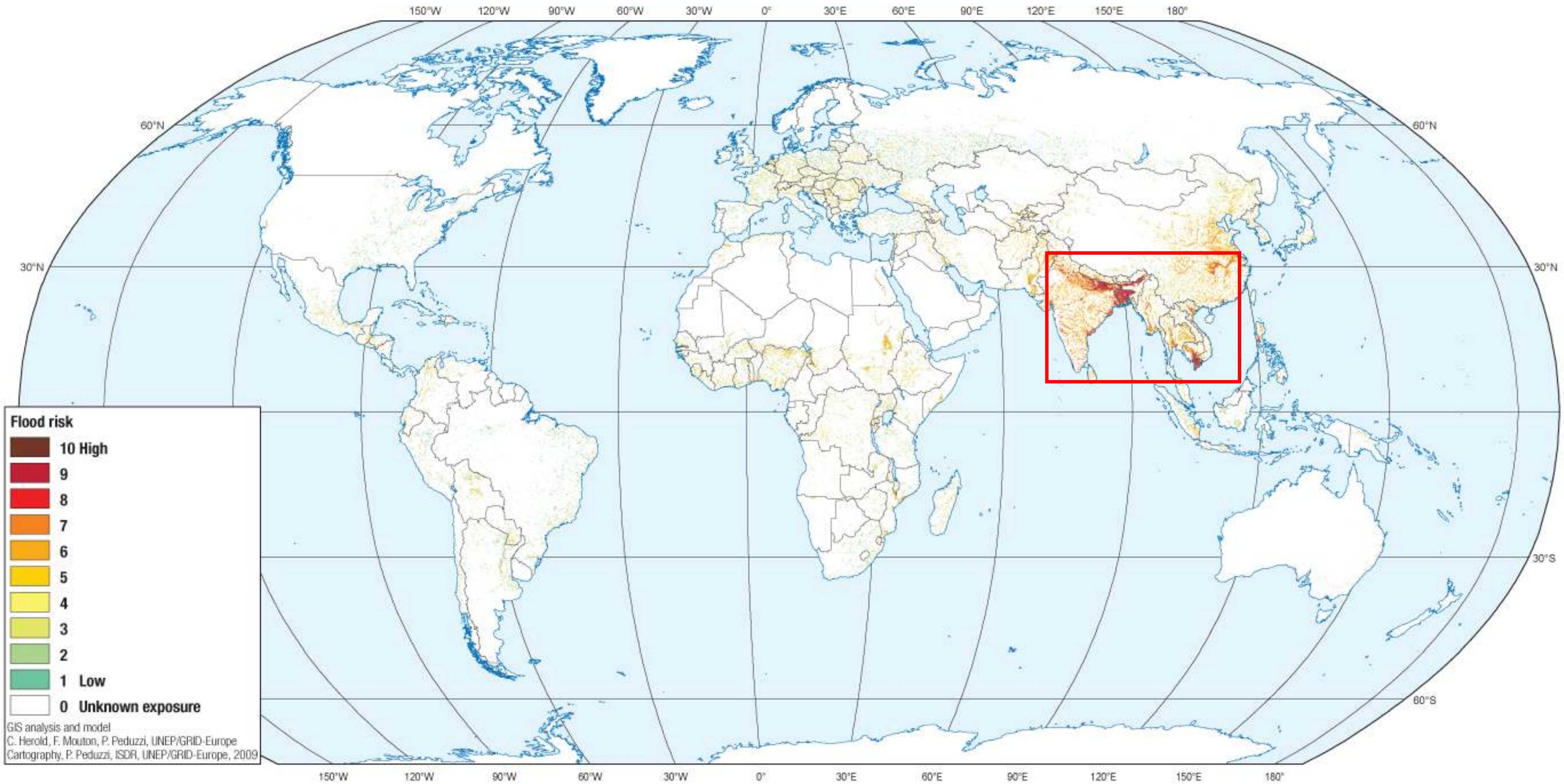
55% of mortality risk is concentrated in 10 countries, which also account for 80% of the exposure.

Comoros, Dominica, Nepal, Guatemala, Papua New Guinea, Solomon Islands, Sao Tome and Principe, Indonesia, Ethiopia, and the Philippines



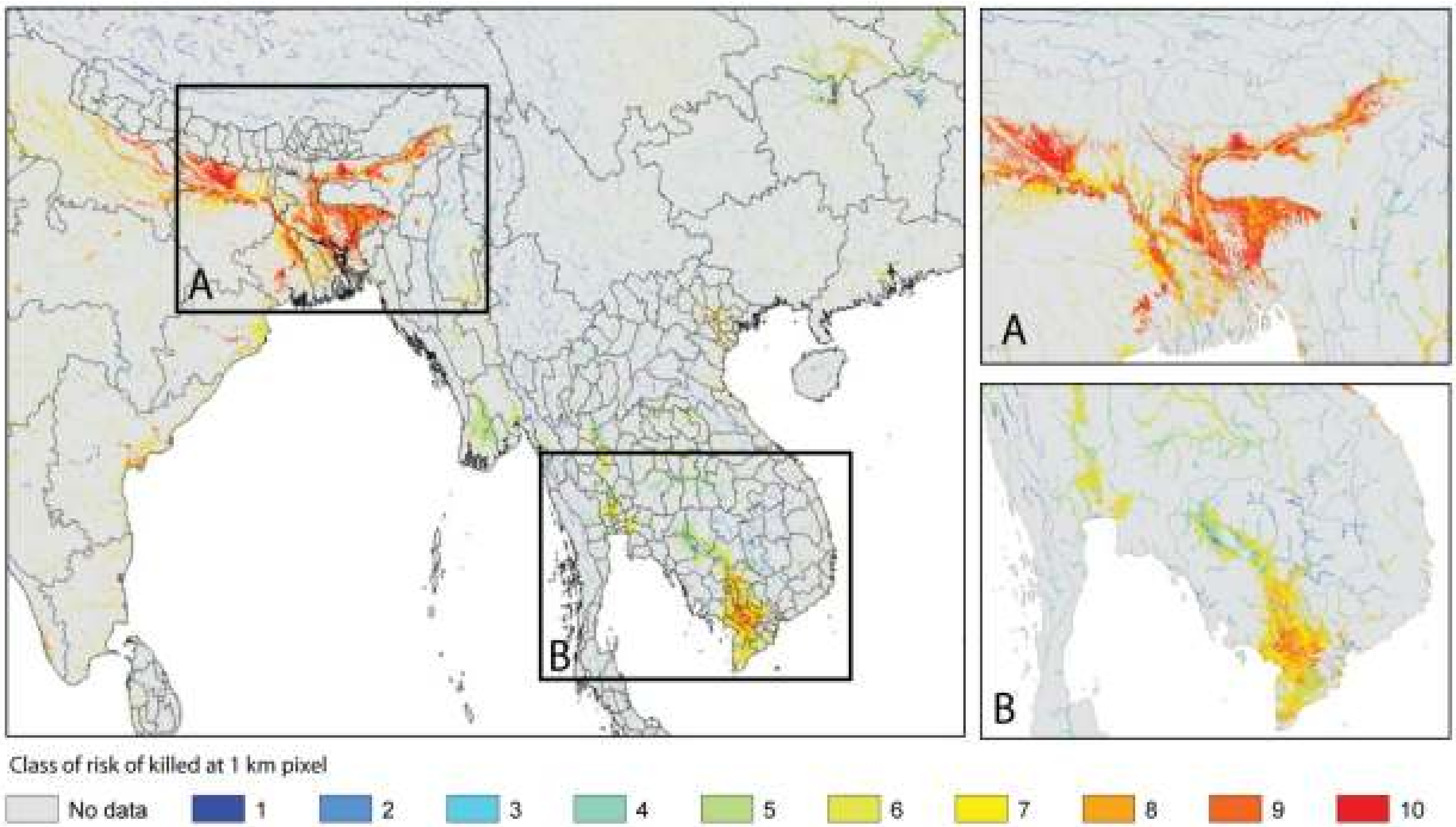
Cartography and risk analysis, P. Peduzzi (UNEP/GRID-Europe, UNISDR, 2008)

Flood risk


150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
180°
60°N
30°N
0°
30°S
60°S
Flood risk
10 High
9
8
7
6
5
4
3
2
1 Low
0 Unknown exposure
GIS analysis and model
C. Herold, F. Mouton, P. Peduzzi, UNEP/GRID-Europe
Cartography, P. Peduzzi, ISDR, UNEP/GRID-Europe, 2009

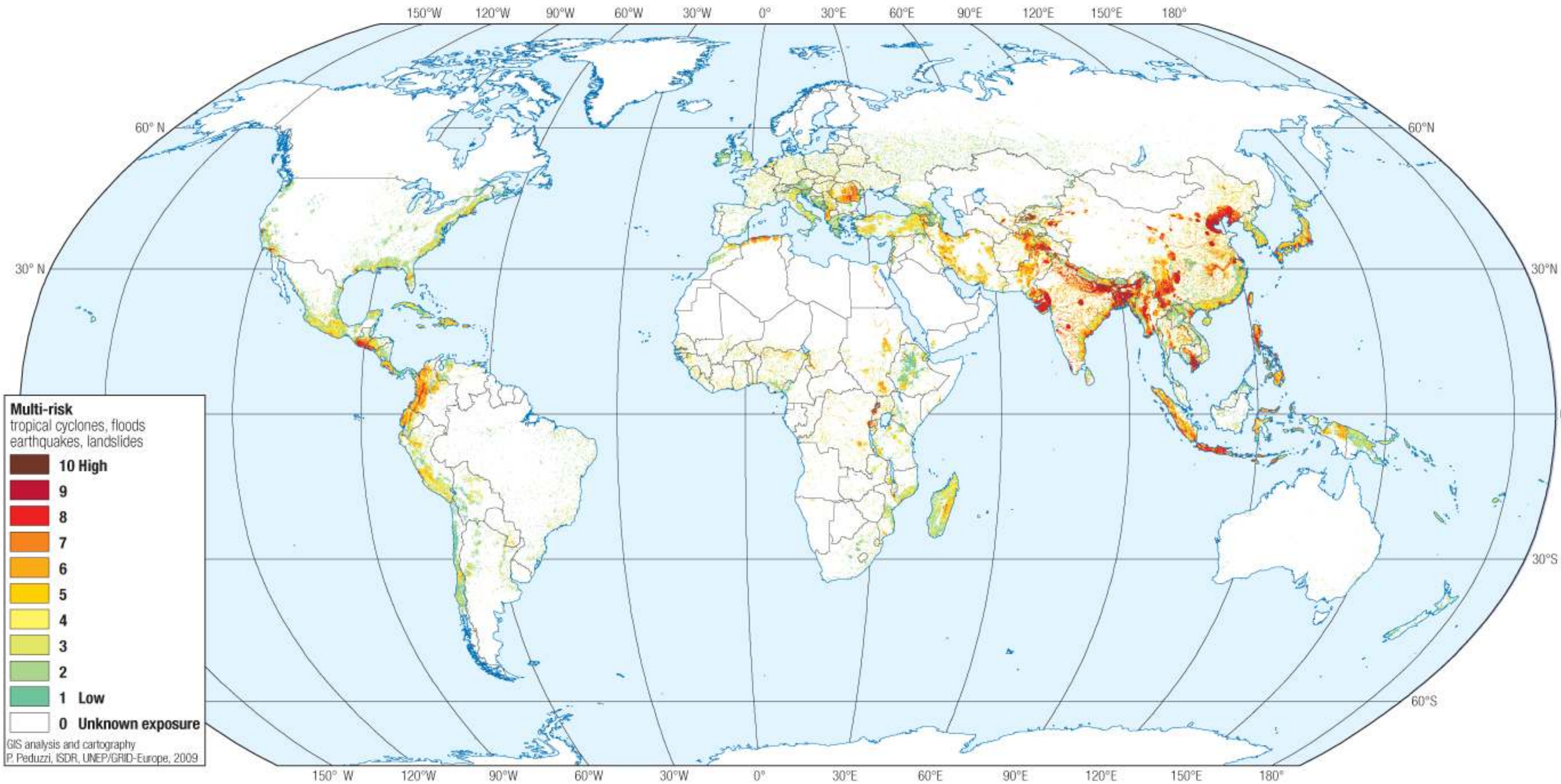
Disaster risk is intensively concentrated

Regions of high flood mortality risk

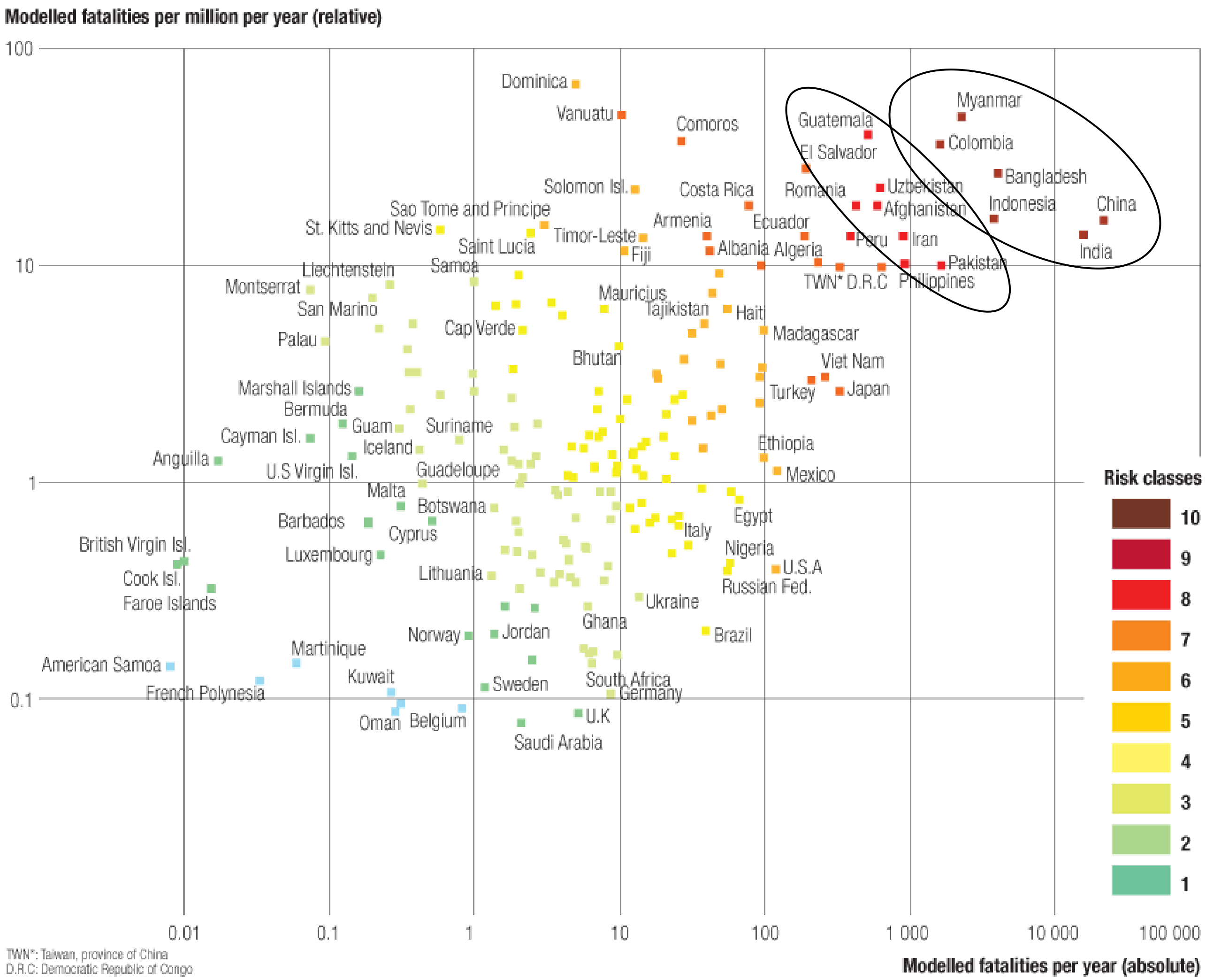


Analysis and cartography: P.Peduzzi (UNEP/GRID-Europe, UN/ISDR), 2008

Multiple Risk



Multi Mortality Risk Index (MRI)



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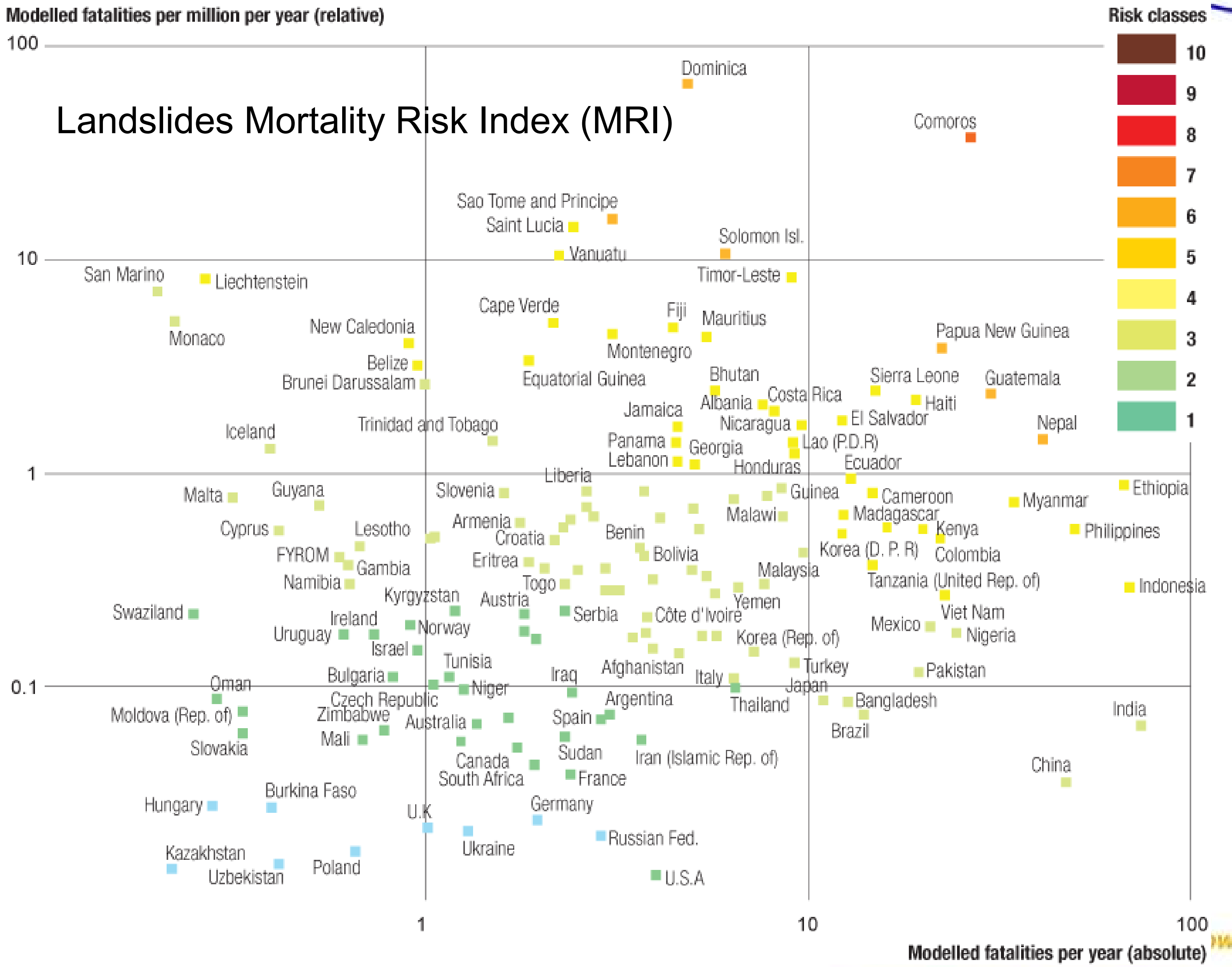
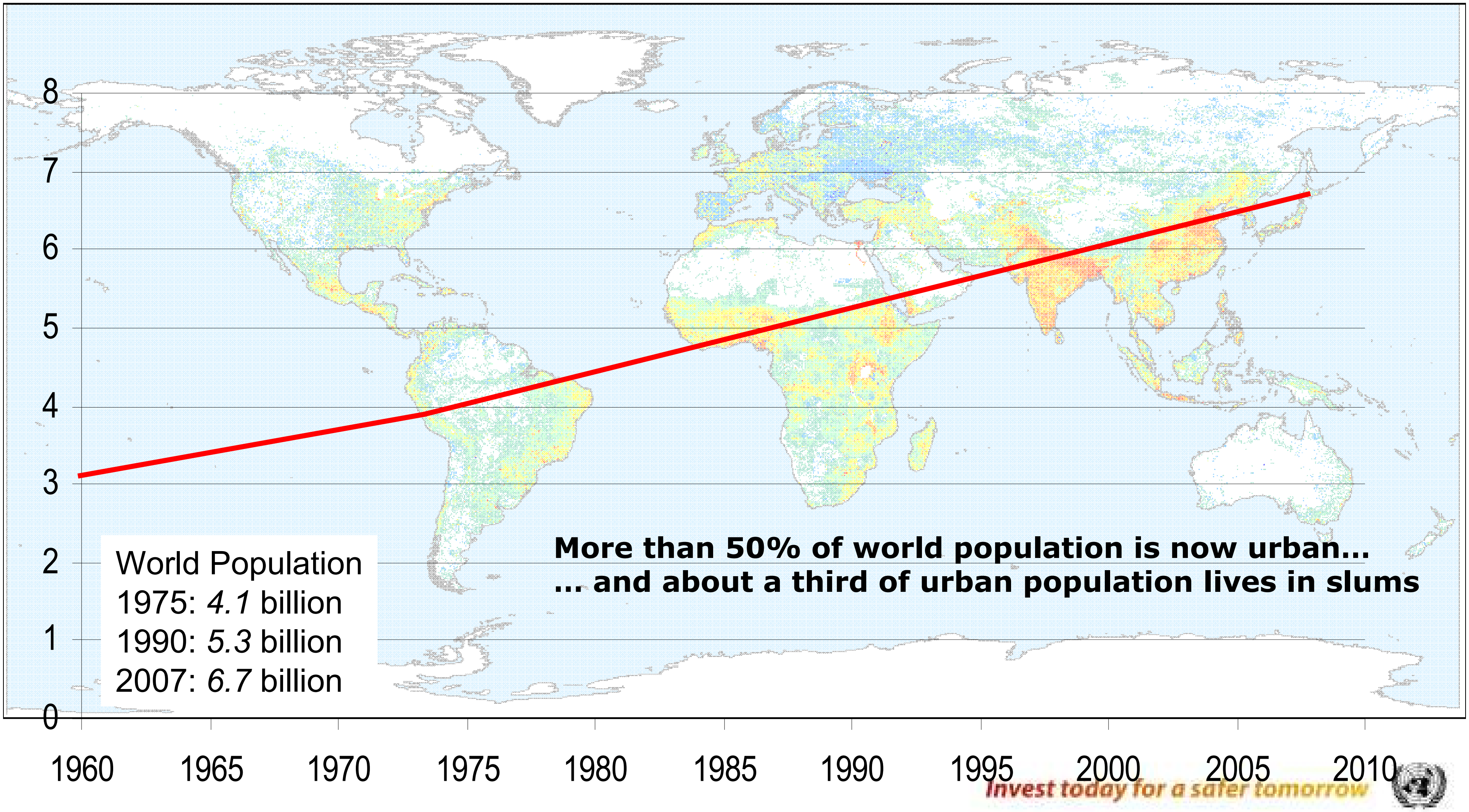
Landslides Mortality Risk Index (MRI)

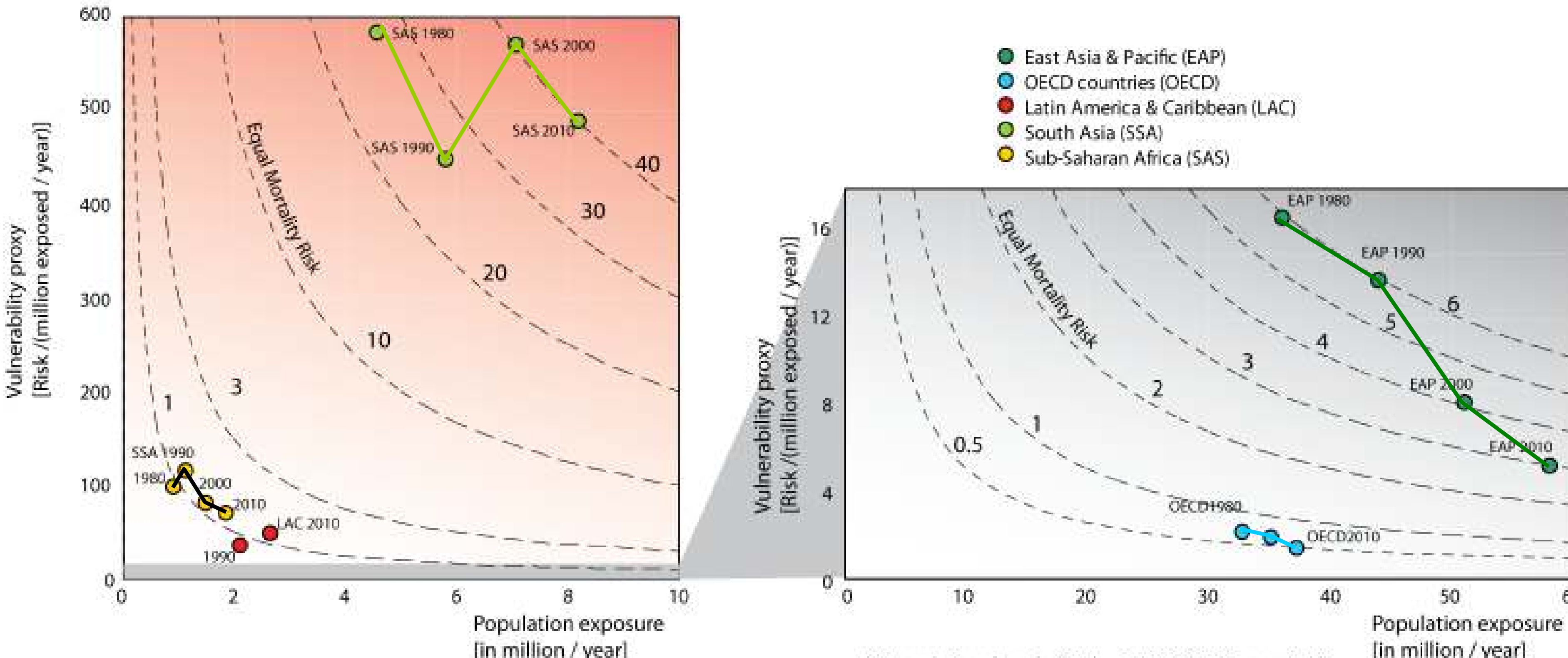


Is exposure increasing ?

Population distribution change between 1975 and 2007



Risk trend analysis



Data analysis and graph: P. Peduzzi, UNEP/GRID-Europe, 2010.
Data sources: PREVIEW Tropical Cyclones global model (UNEP/GRID-Europe). Population from landscan 2008 (Oak Ridge Laboratory), extrapolation 1970 to 2010 (UNEP/GRID-Europe).

Some limitations

- Despite used of detailed datasets, this is still based on global models and should not be used for local land planning
- Earthquakes is a « realized risk » exercice.
- Drought and tsunami risk could not be computed
- Vulnerability parameters mostly at national level
- Reports on economical losses still not very accurate
- GDP as a mesure of asset is limited (revenu not assets)
- Mortality not necessarily the best proxy (livelihood would be better)

Obvious improvements

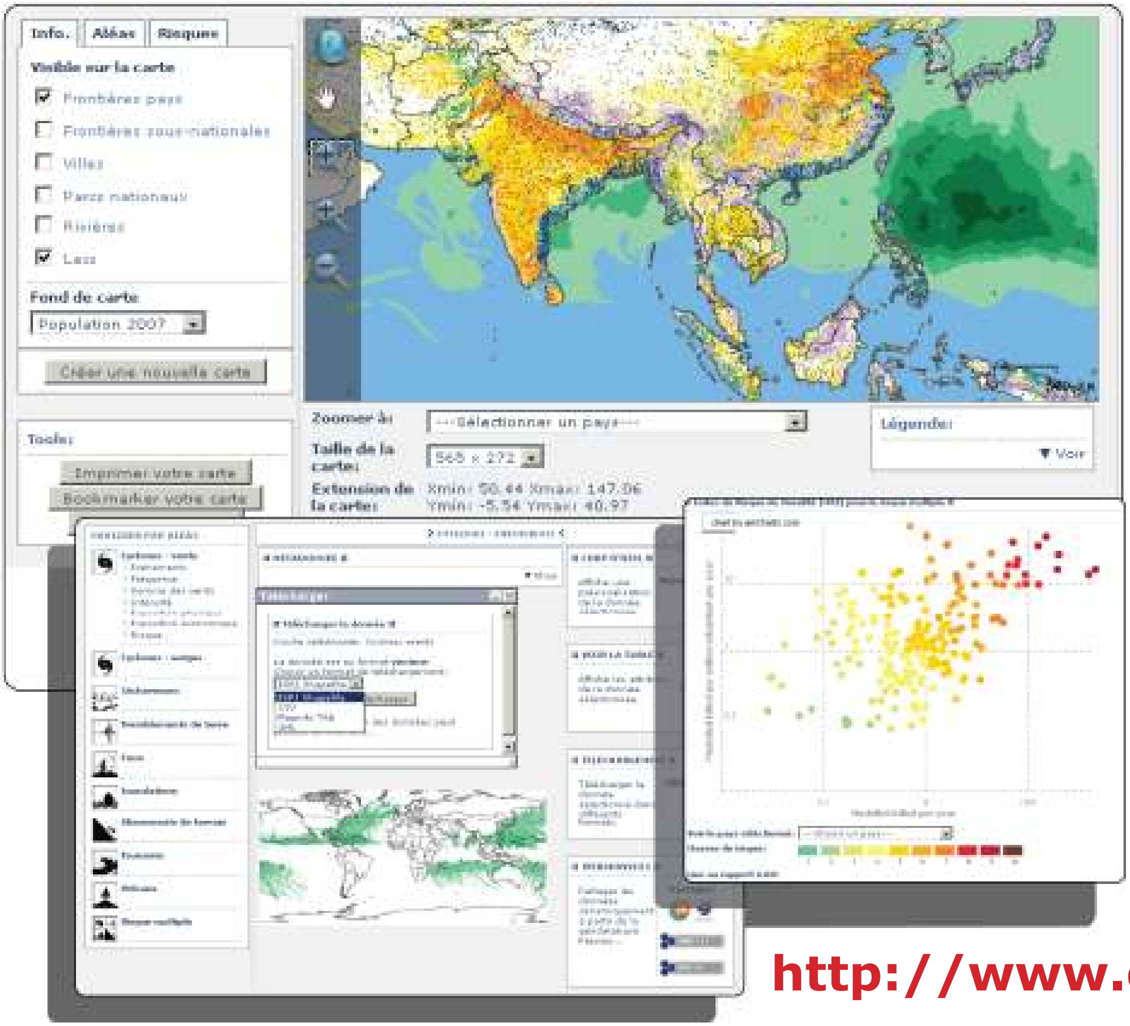
k
easy

AR).
e

- The Fukushima effect: need to take into account secondary hazards, especially nuclear and chemical plants

How to access the data ?

The PREVIEW Global Risk Data Platform



http://www.grid.unep.ch/preview

2009 Global Assessment Report on Disaster Risk Reduction

Risk and poverty in a changing climate

Thank you

www.preventionweb.net/gar09

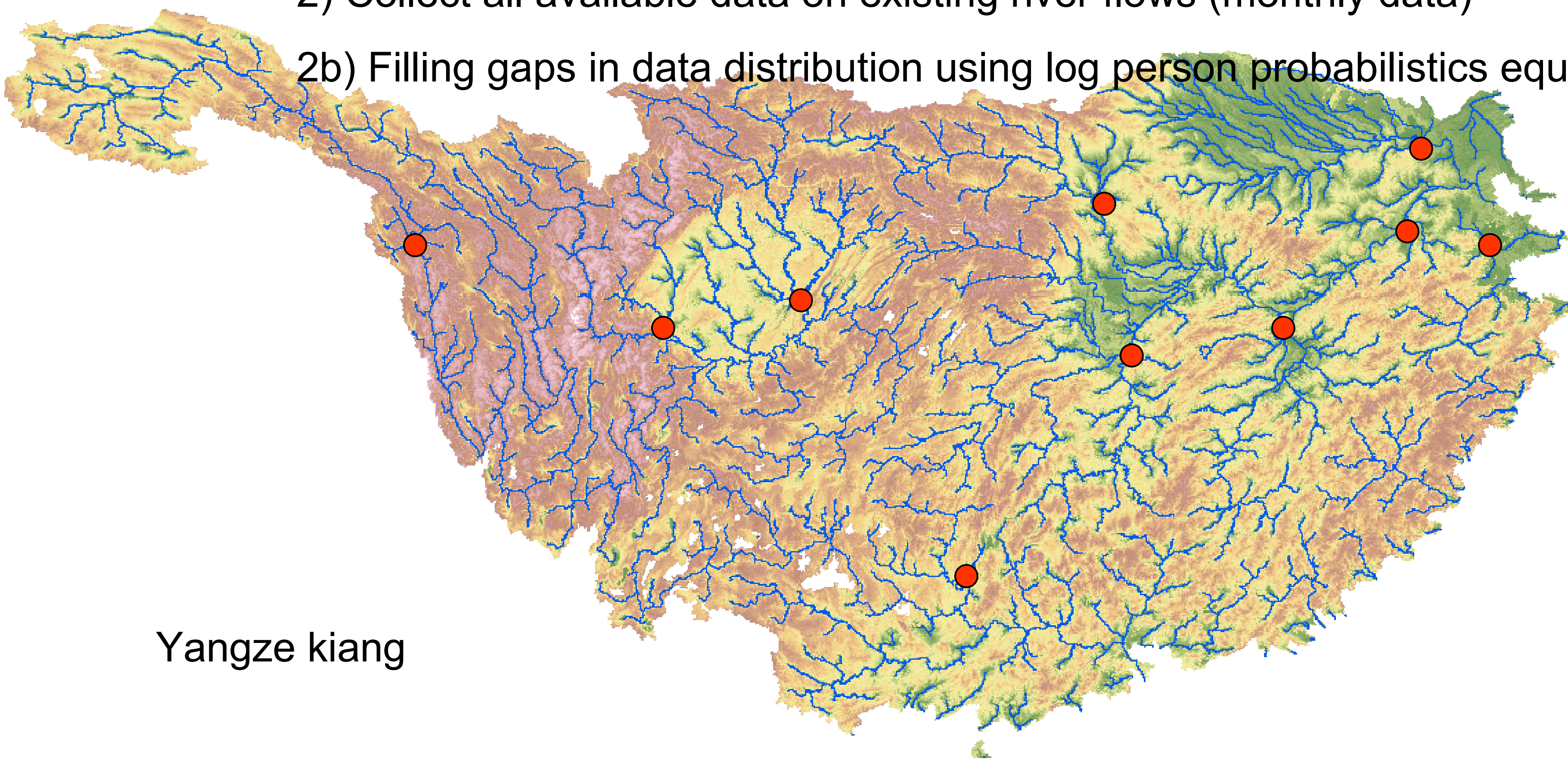
Invest today for a safer tomorrow

[redacted]

1) Generate all rivers flows using Hydroshed (90m based on SRTM) for the whole world (except USA, Canada).

2) Collect all available data on existing river flows (monthly data)

2b) Filling gaps in data distribution using log person probabilistics equati



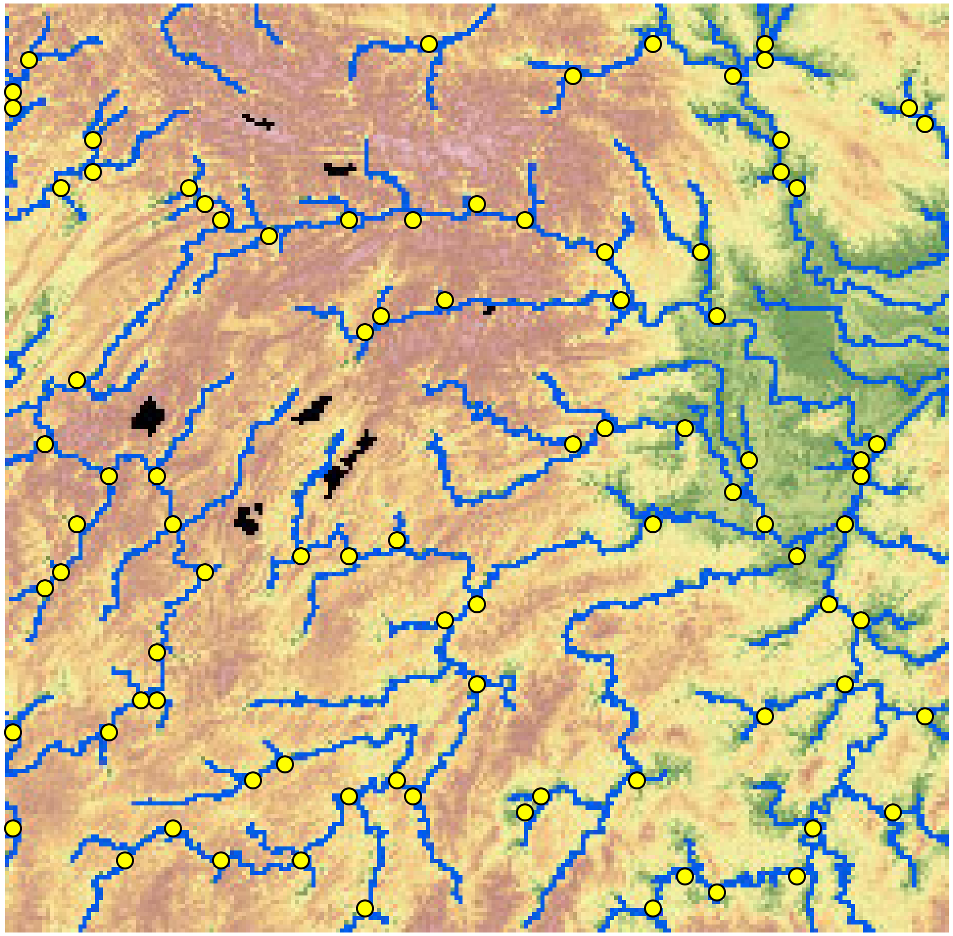
Yangze kiang

3) For each watershed where data on riverflows exists, extract all features potentially associated with rivers flows (e.g. watershed area, precipitation, landcover, slopes, …)

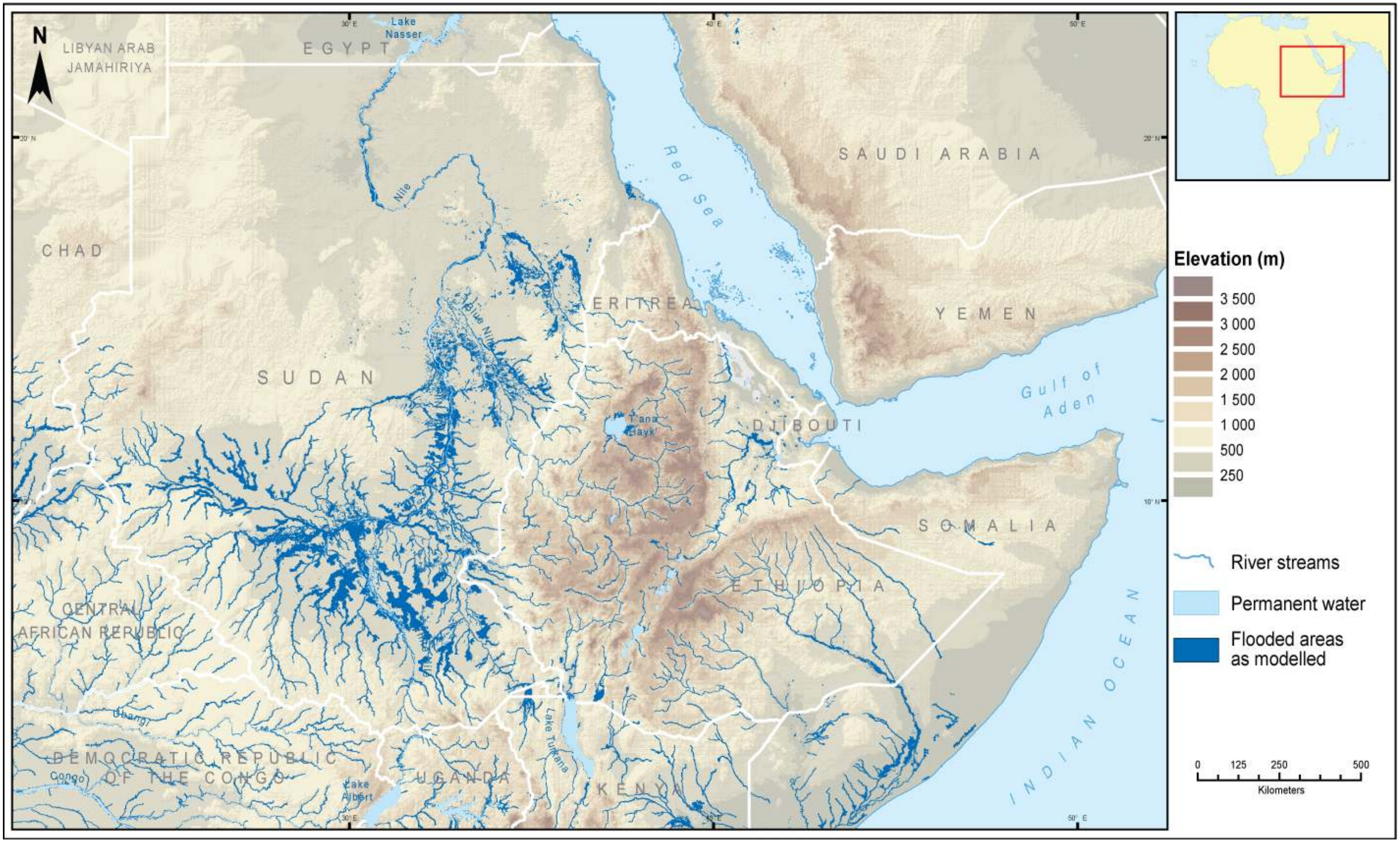
4) Group similar watersheds (using bioclimatic variables) for multiple regression analysis

5) Find statistical models that best explains the riverflows.

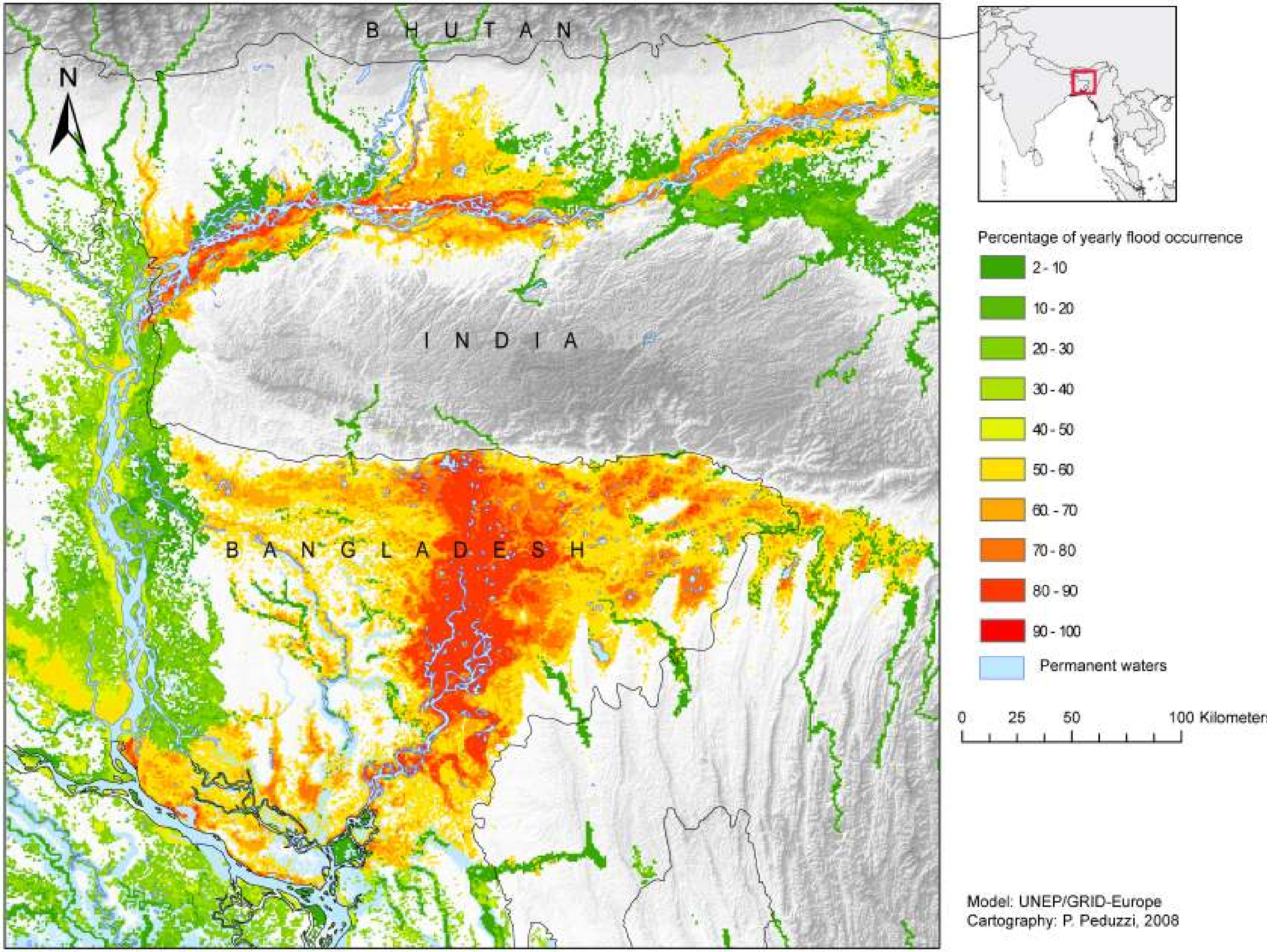
6) Generate virtual stations at each river intersection, apply modelled river flows to these virtual stations.



8) Using a flood model developed by USGS, compute all potential flood area for 100 years returning period.

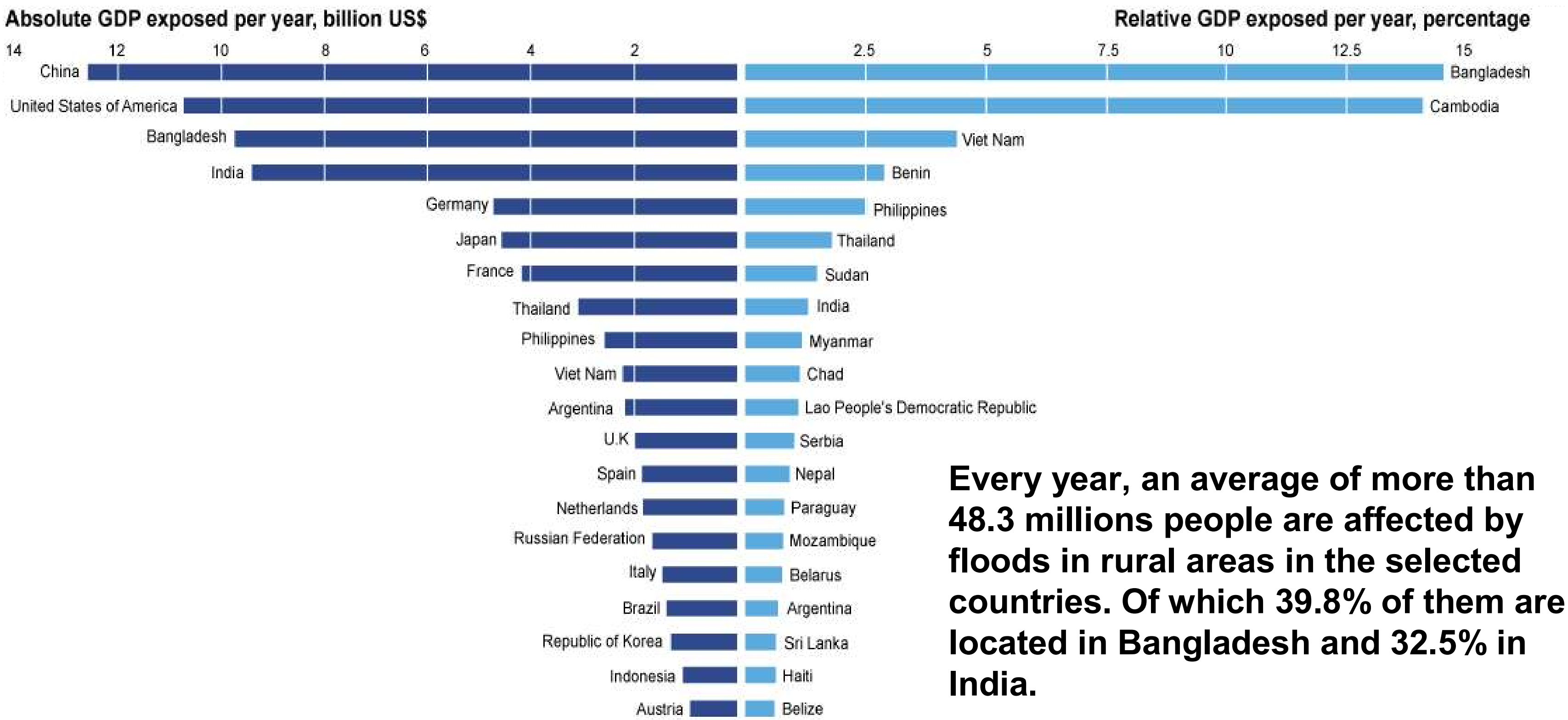


9) Correct for observed frequencies using PREVIEW flood model



Floods : exposure

India, Bangladesh and China. concentrate 75% of the modelled annual global mortality



Every year, an average of more than 48.3 millions people are affected by floods in rural areas in the selected countries. Of which 39.8% of them are located in Bangladesh and 32.5% in India.