Past research on drought

Scoping meeting, Boulder 2017

Dr Pascal Peduzzi

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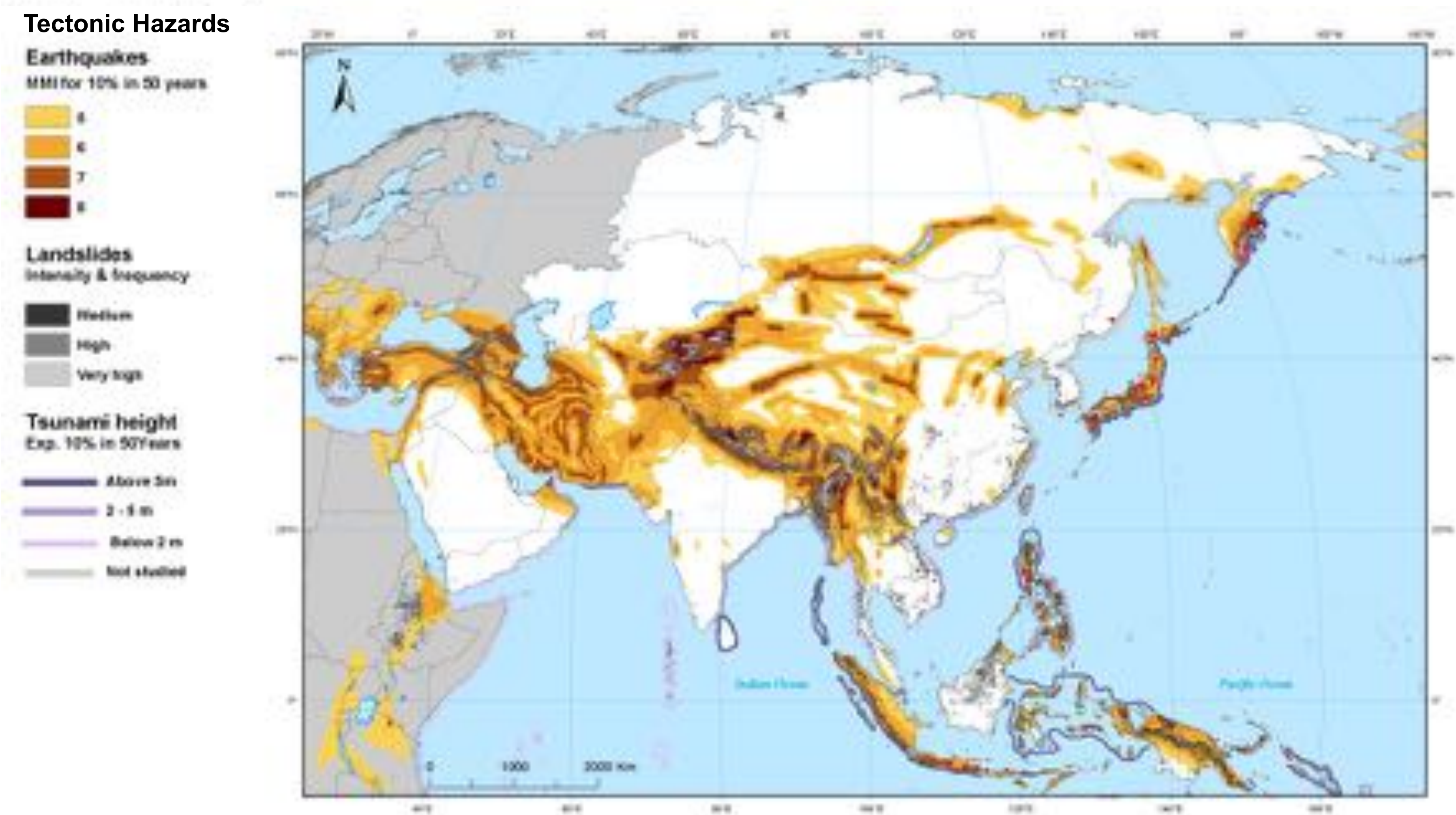
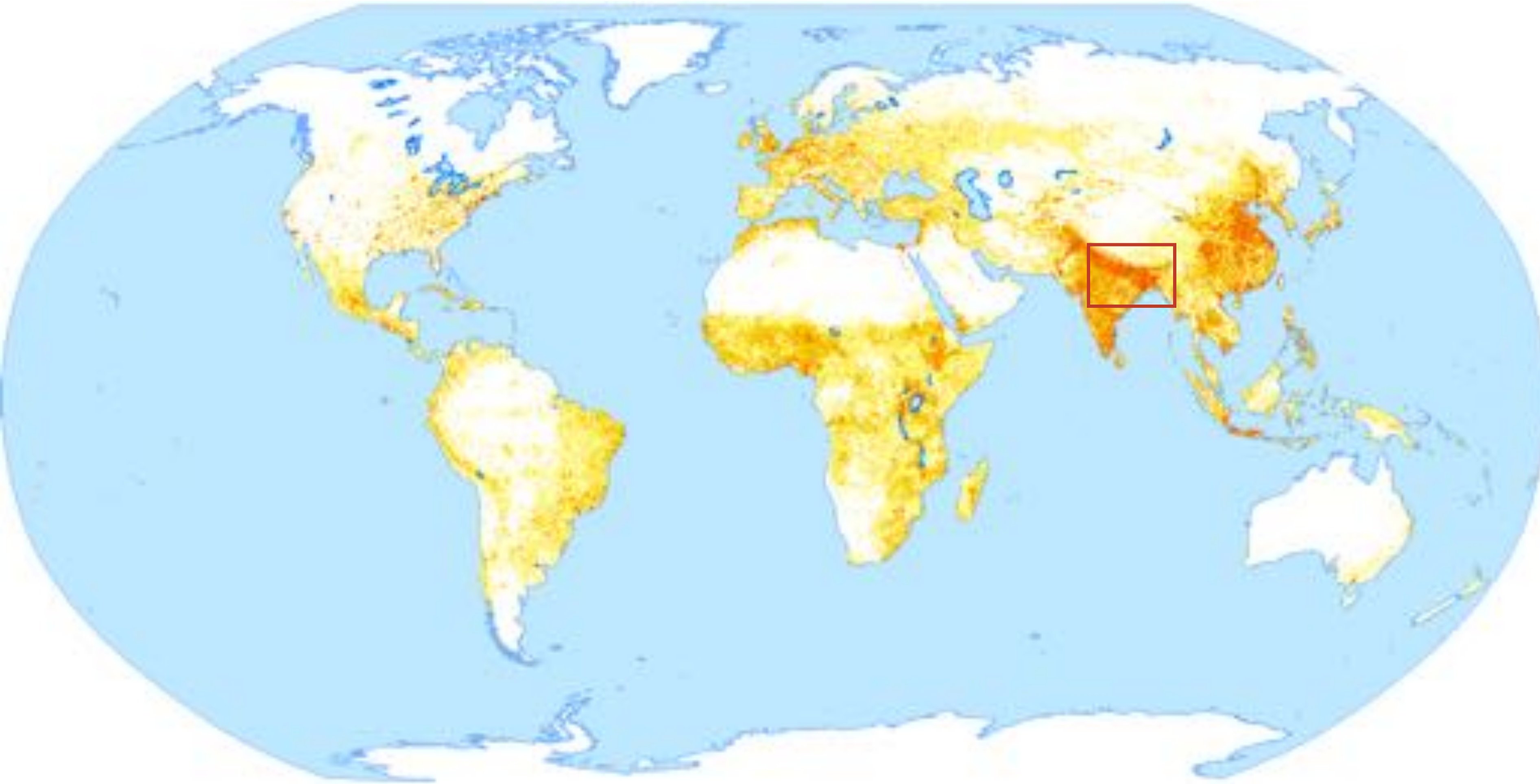
A 16-years Journey

New Global Hazard Datasets created for GAR 2009



New Human & Economic exposure datasets (1 x 1 km

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



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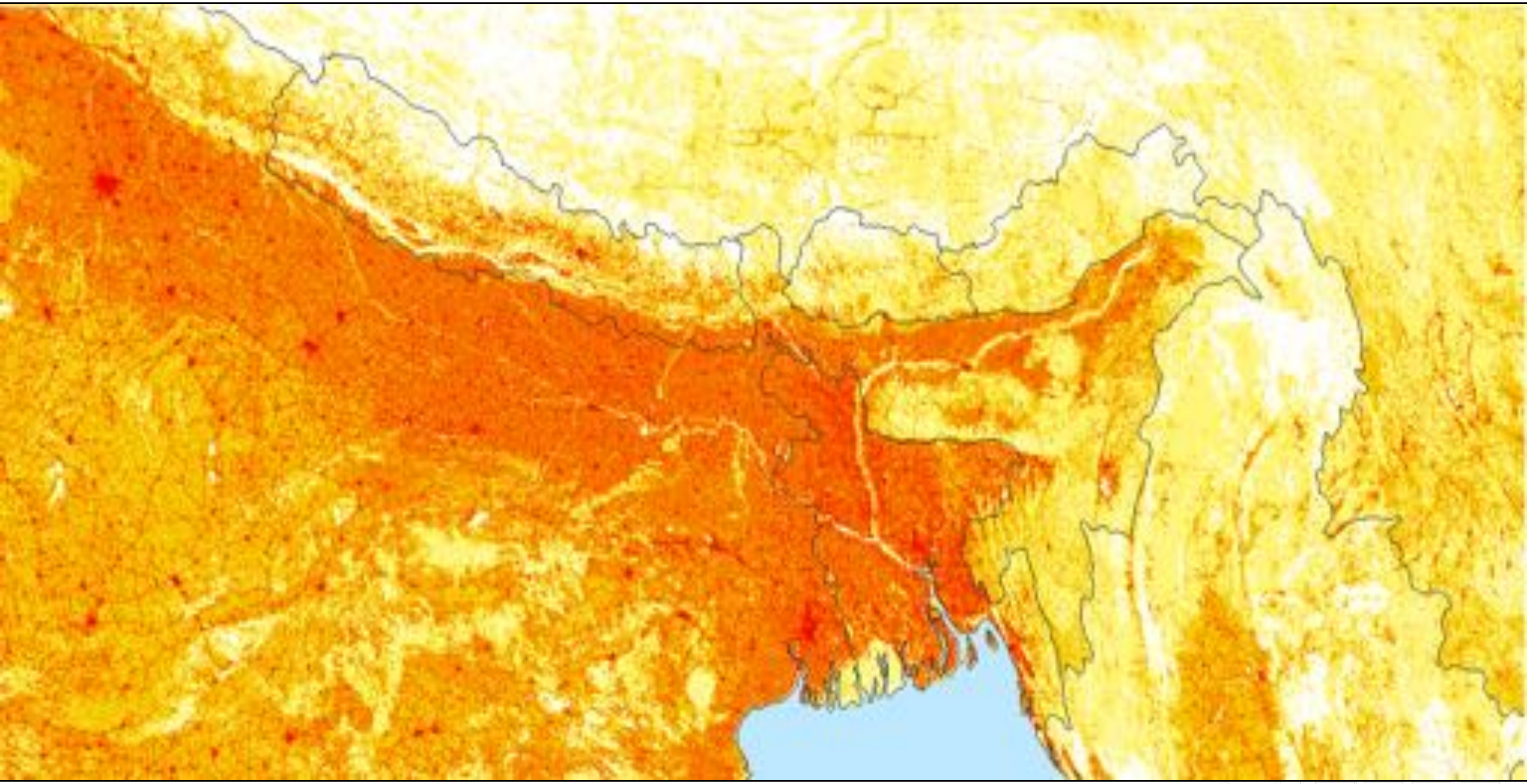

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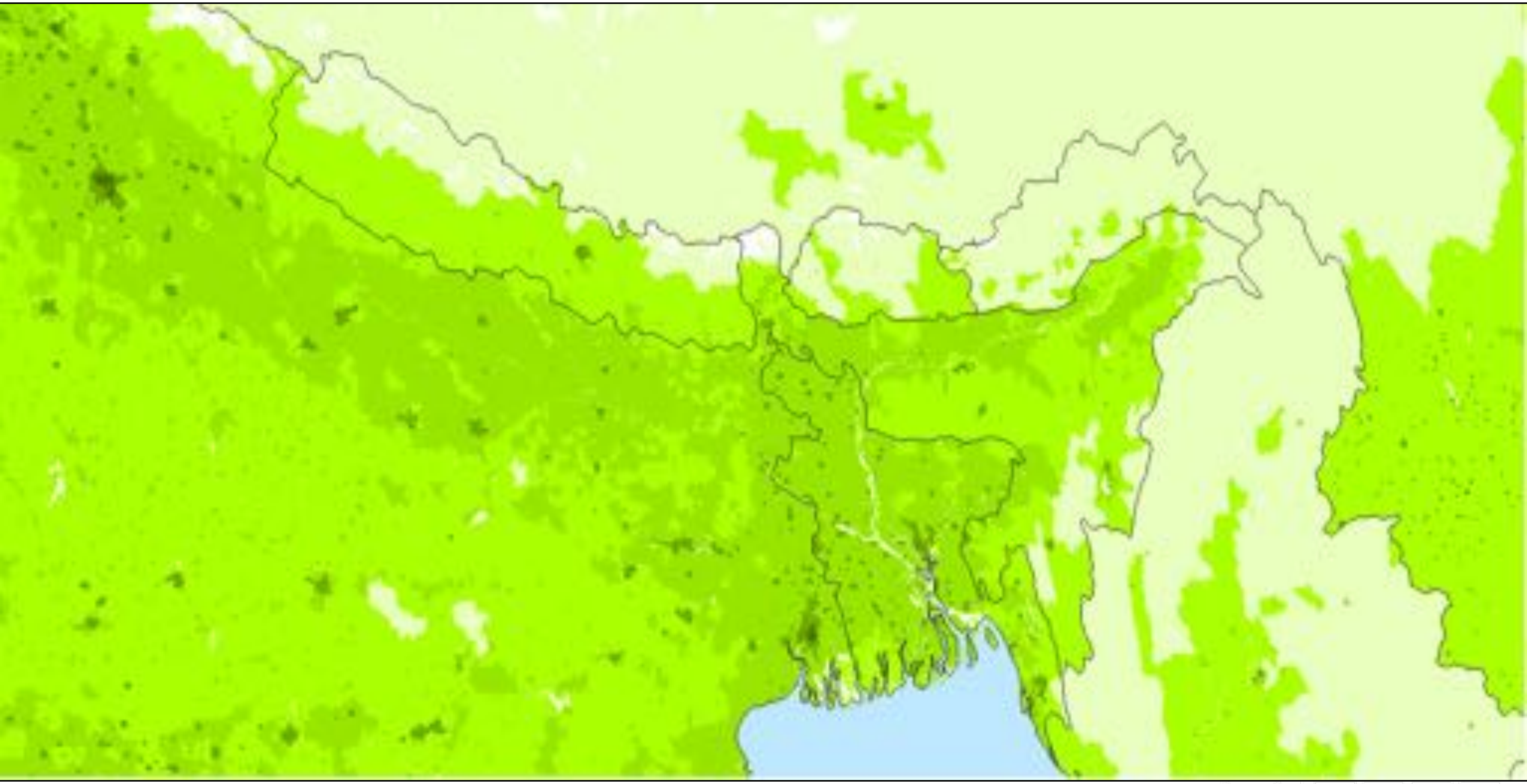
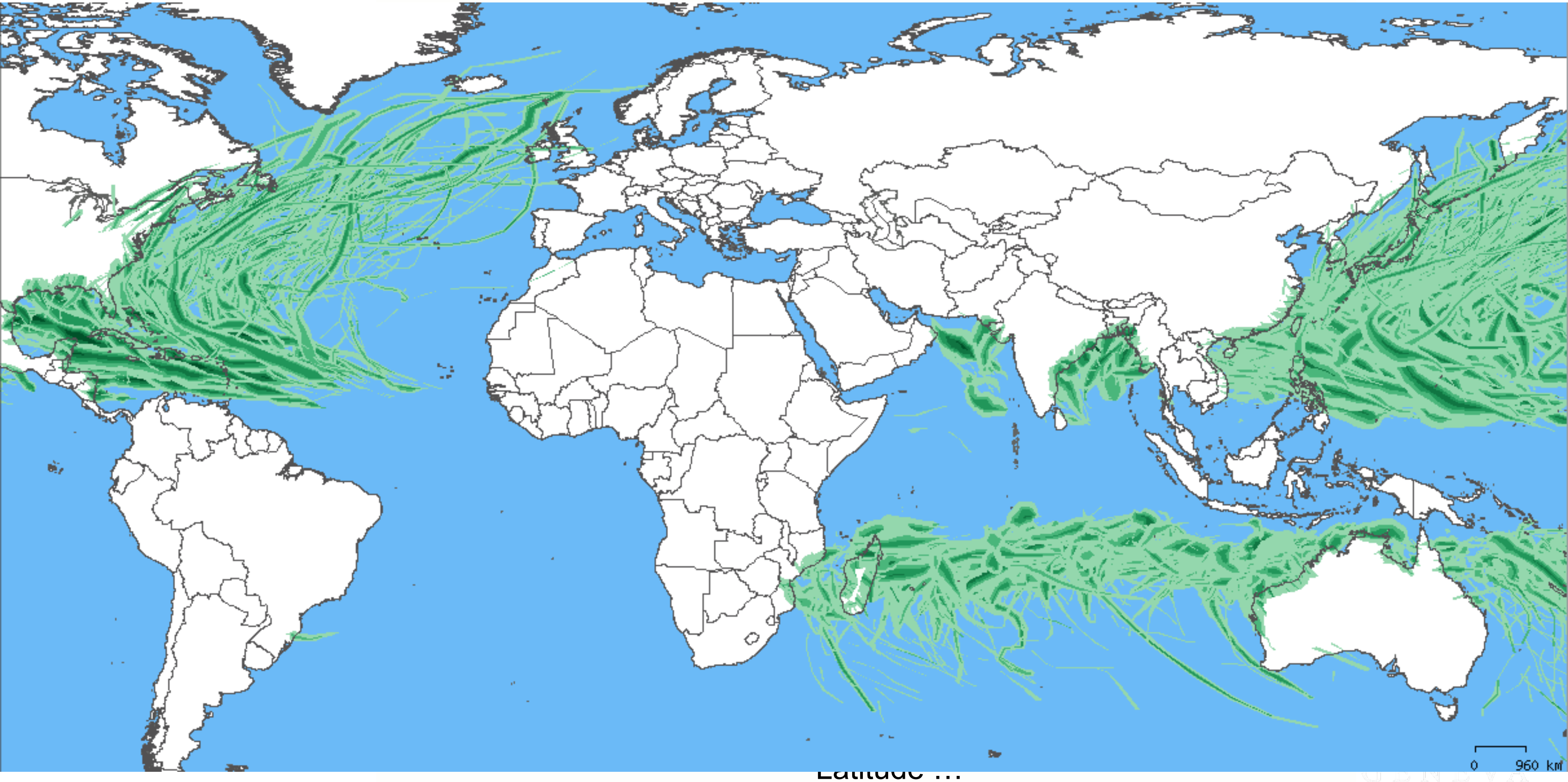
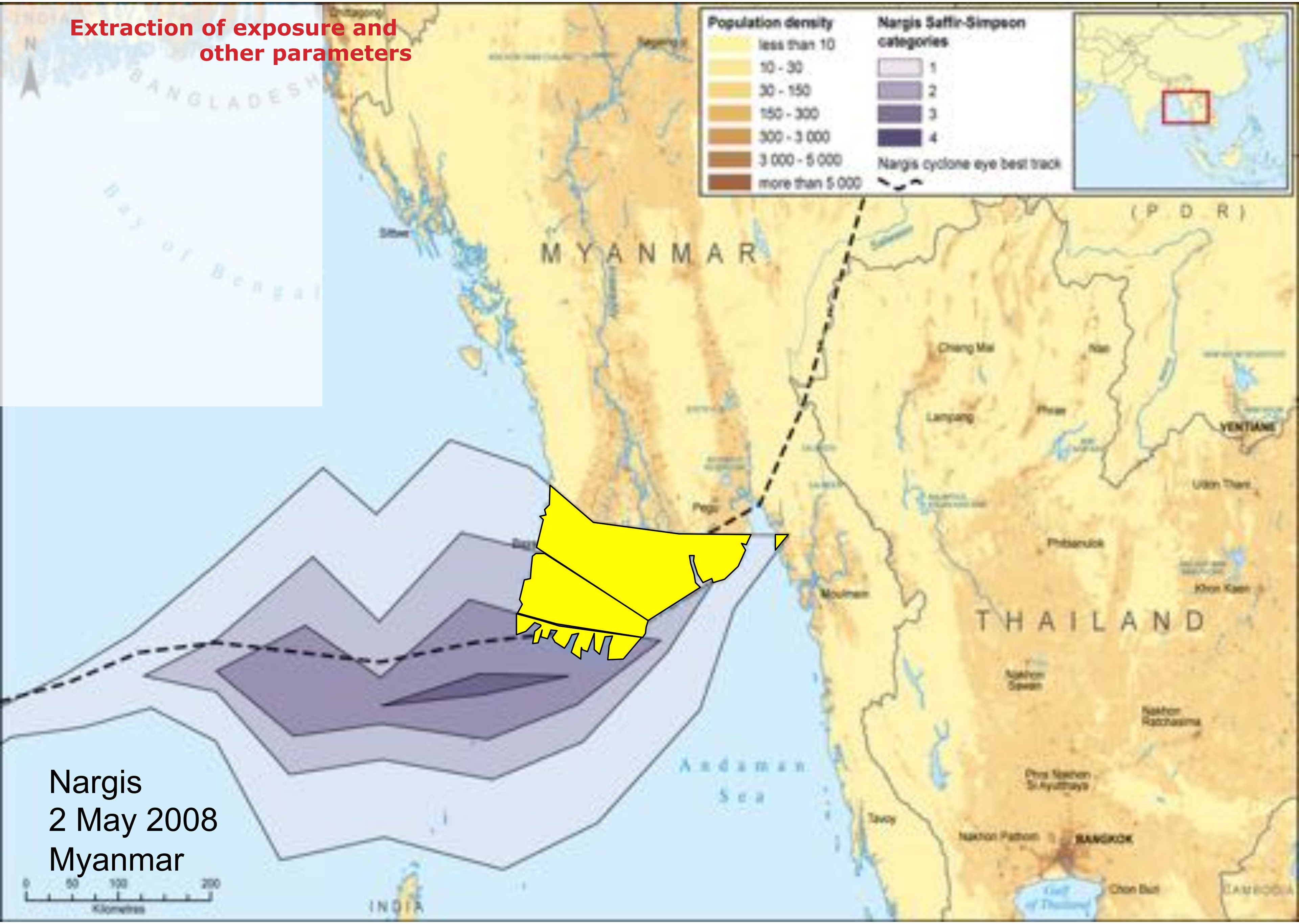


Individual past hazardous events modeling

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

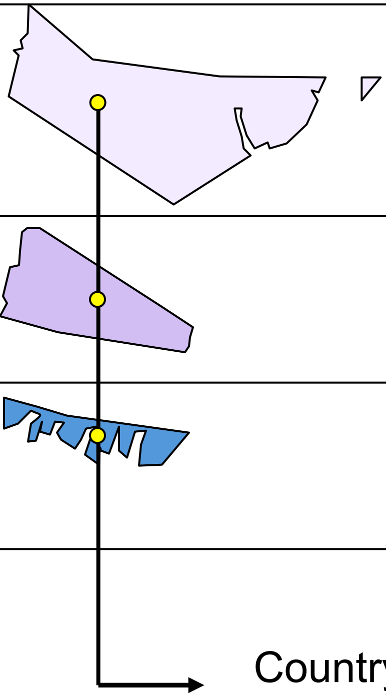


Extraction of exposure and other parameters

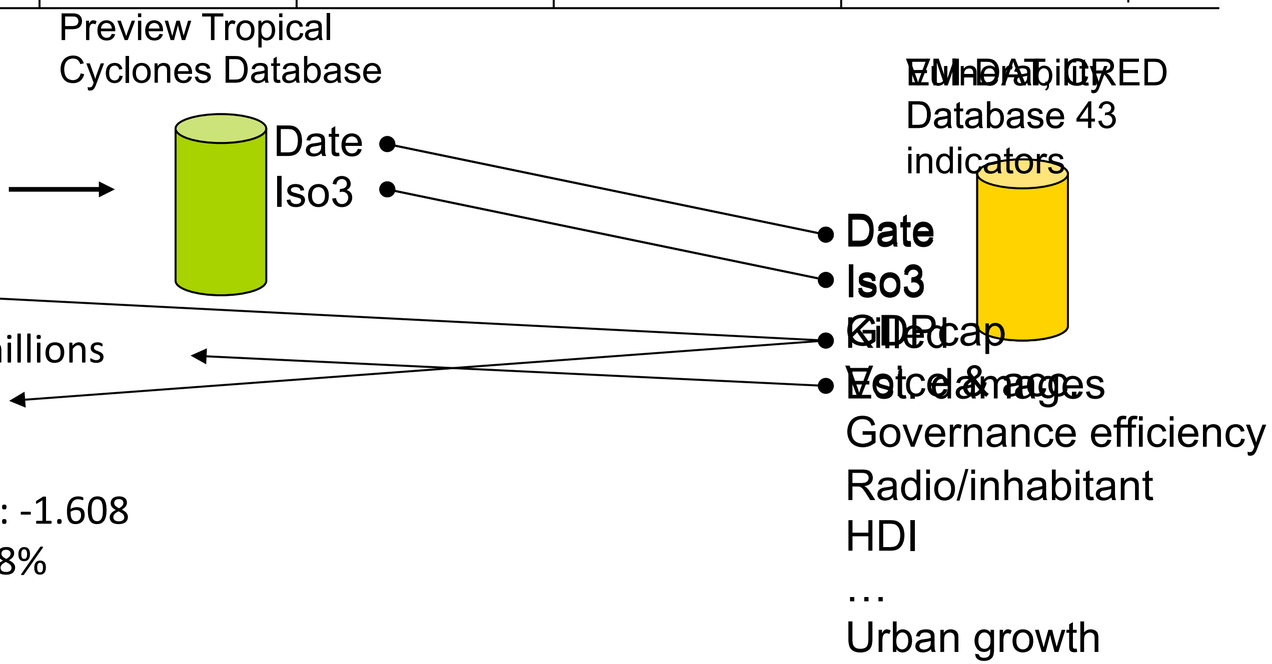


Nargis
2 May 2008
Myanmar

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%



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)

Landslides risk

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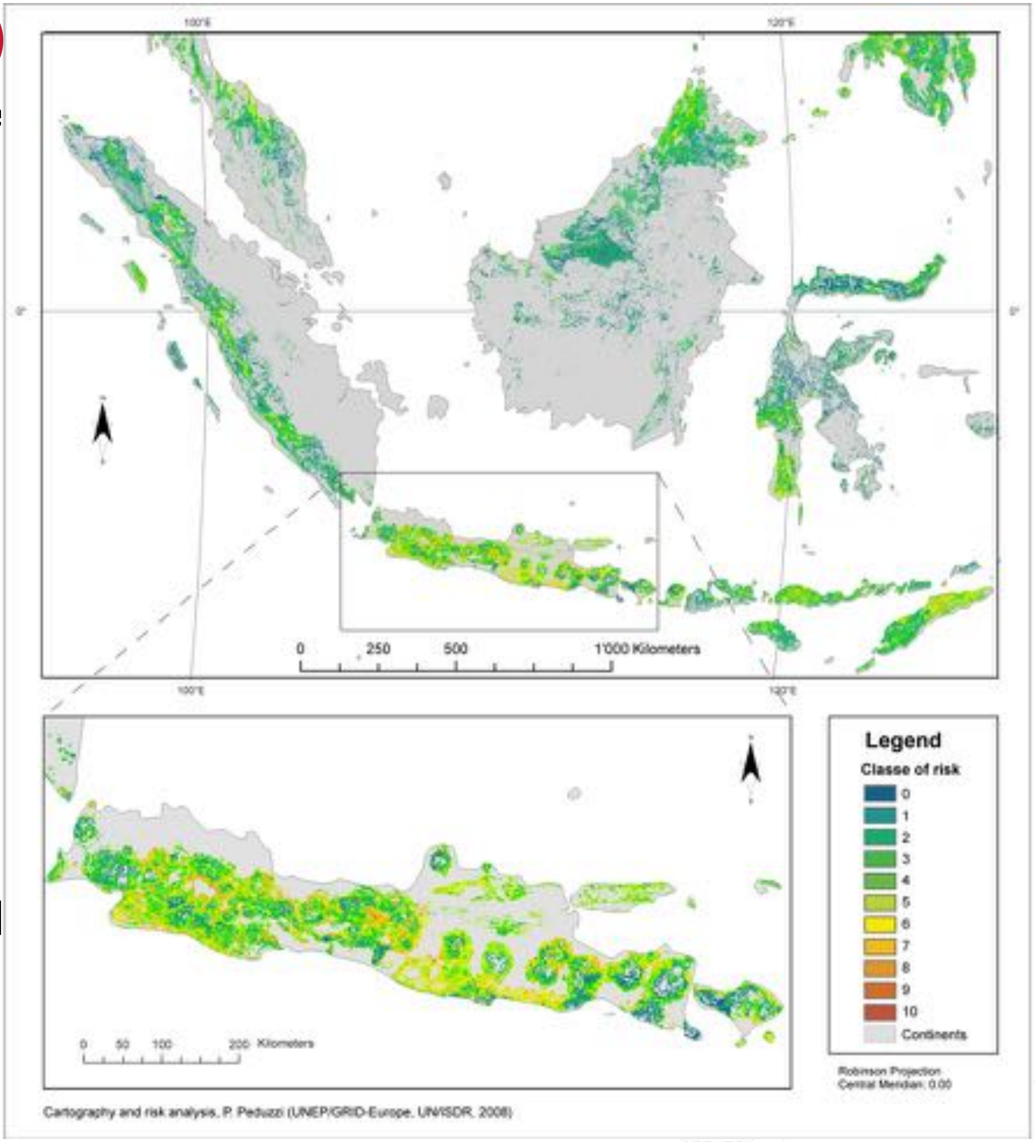
Landslides (modelled for both precipitation and earthquakes)

About 2.2 million people are exposed to landslides worldwide.

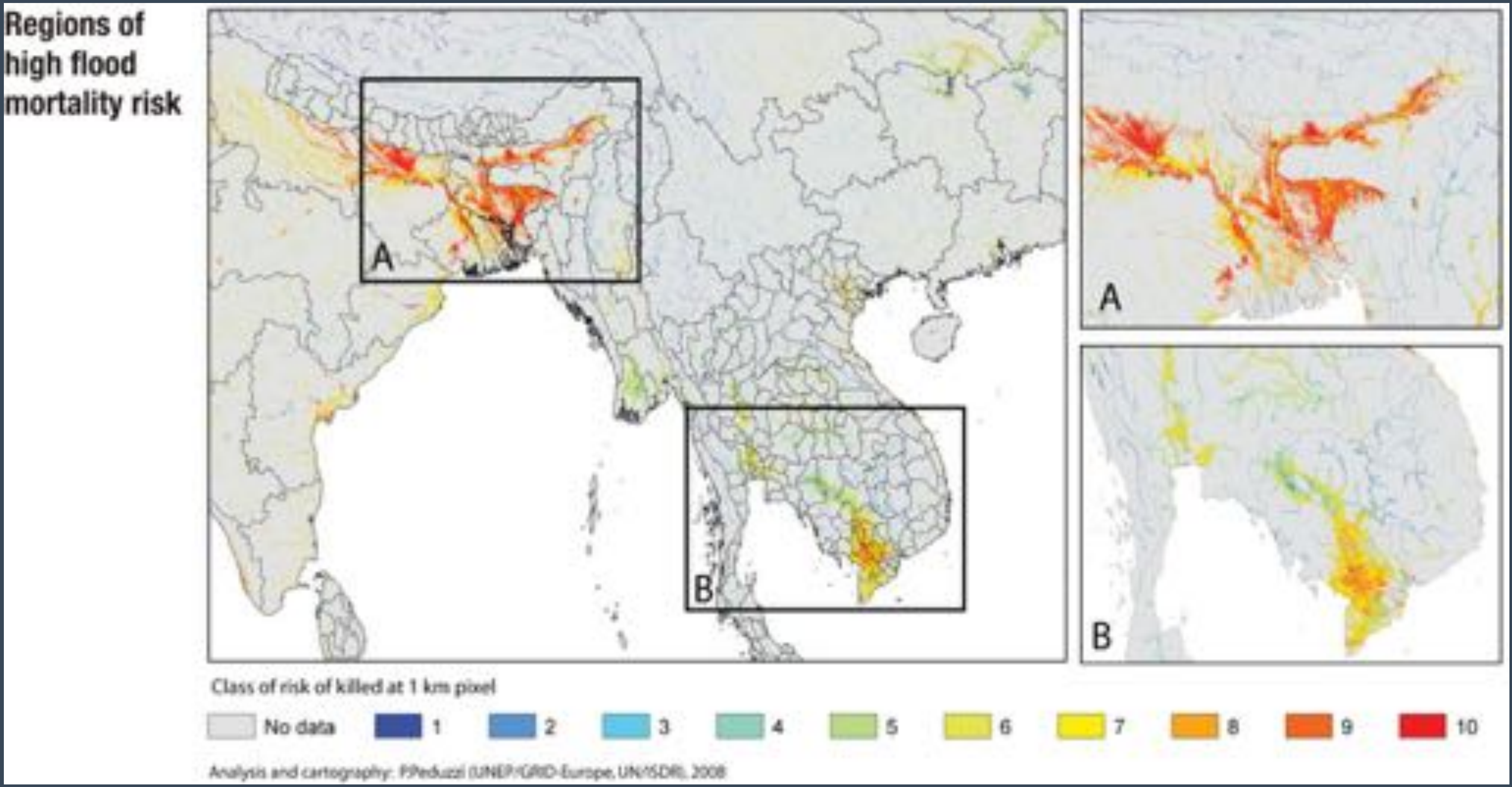
55% of mortality risk is concentrated in 10 countries, which also account for 80% of the exposure.

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



Flood risk

Disaster risk is intensively concentrated



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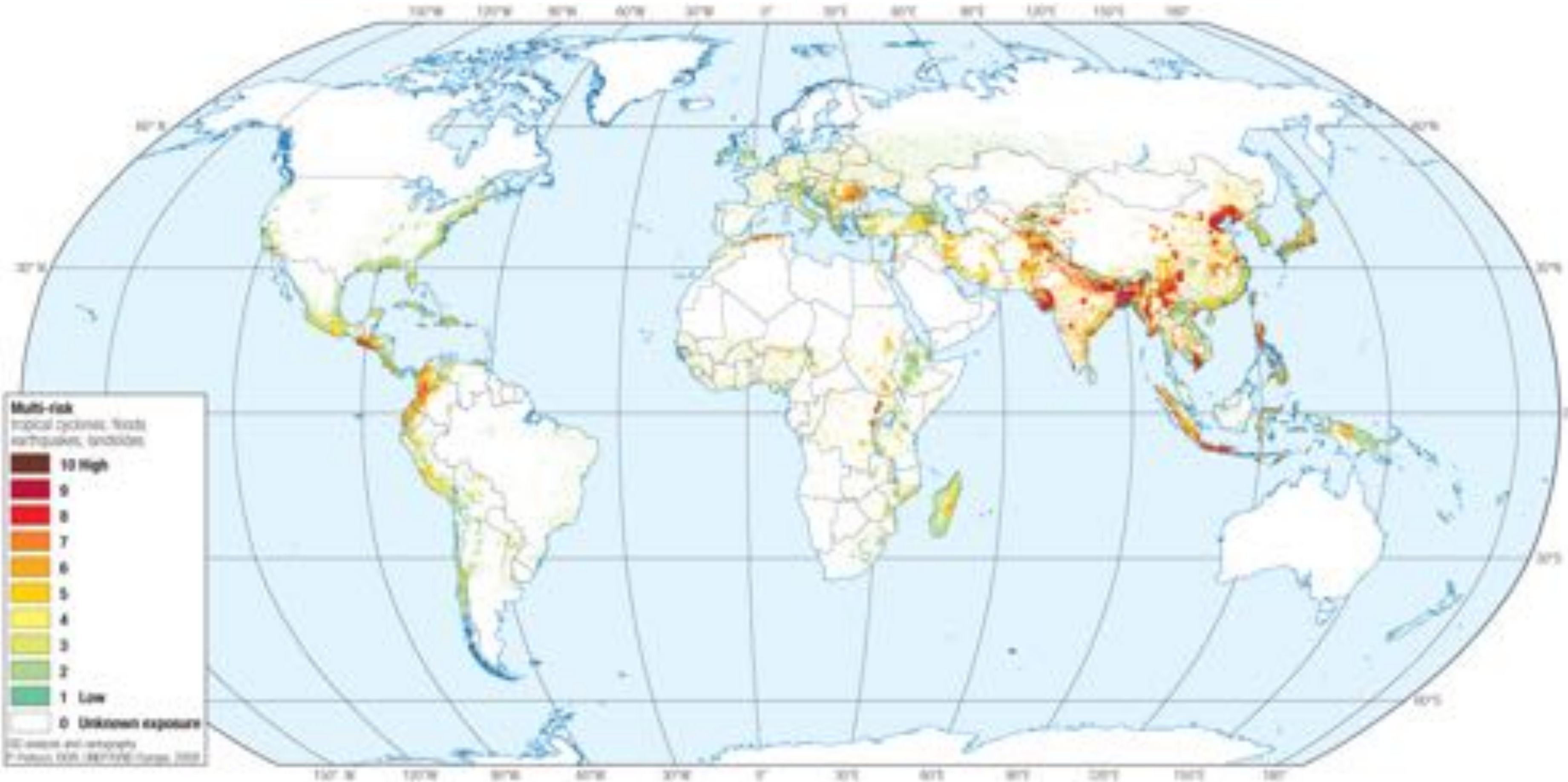
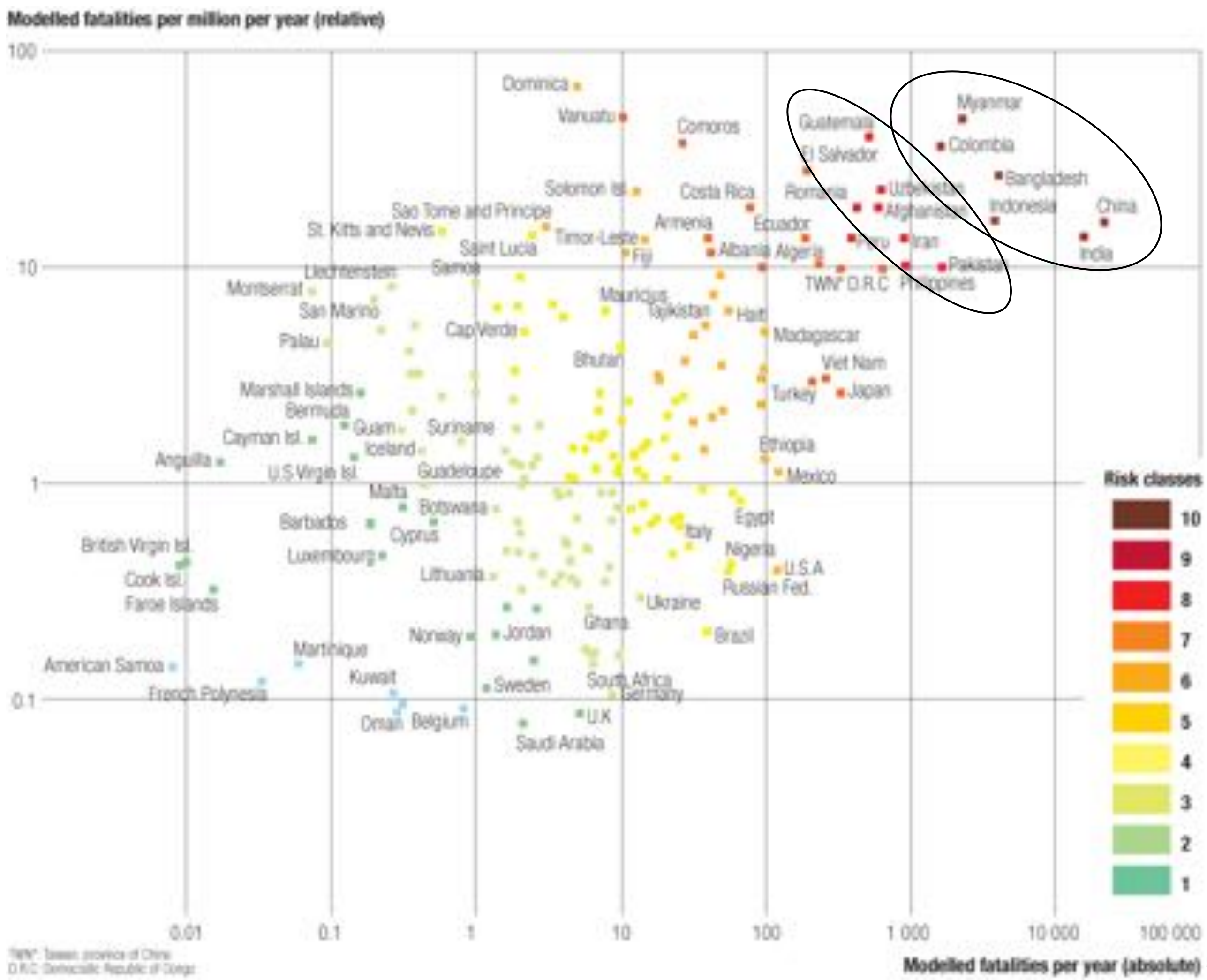
Multiple Risk



Multi Mortality Risk Index (MRI)



TWN*: Taiwan, province of China
D.R.C: Democratic Republic of Congo

Previous attempts

- Hotspots project 2005: used (3 and 6 months) and shortage of precipitation (50%, 25% and 10%) at 2.5 resolution. Didn't work for the UNDP report (reducing Disaster Risk, 2004)
- GAR 2009: SPI + SMI (3, 6, 12 months, and 50%; 25%; 10%), 2.5° cell. No correlations were found.

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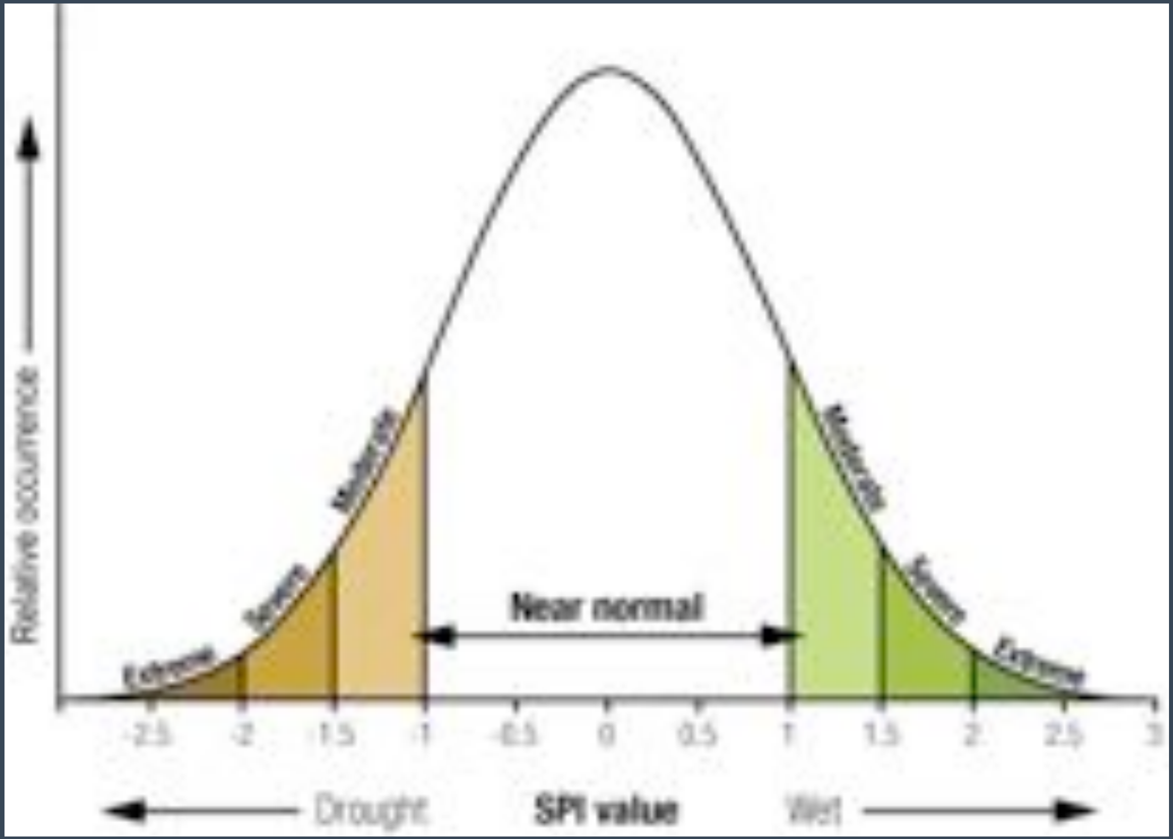

This analysis was performed at the grid point level and runs in the SPI time series, when index values fell below different truncation levels (in the present study -1.0 and -1.5), were evaluated

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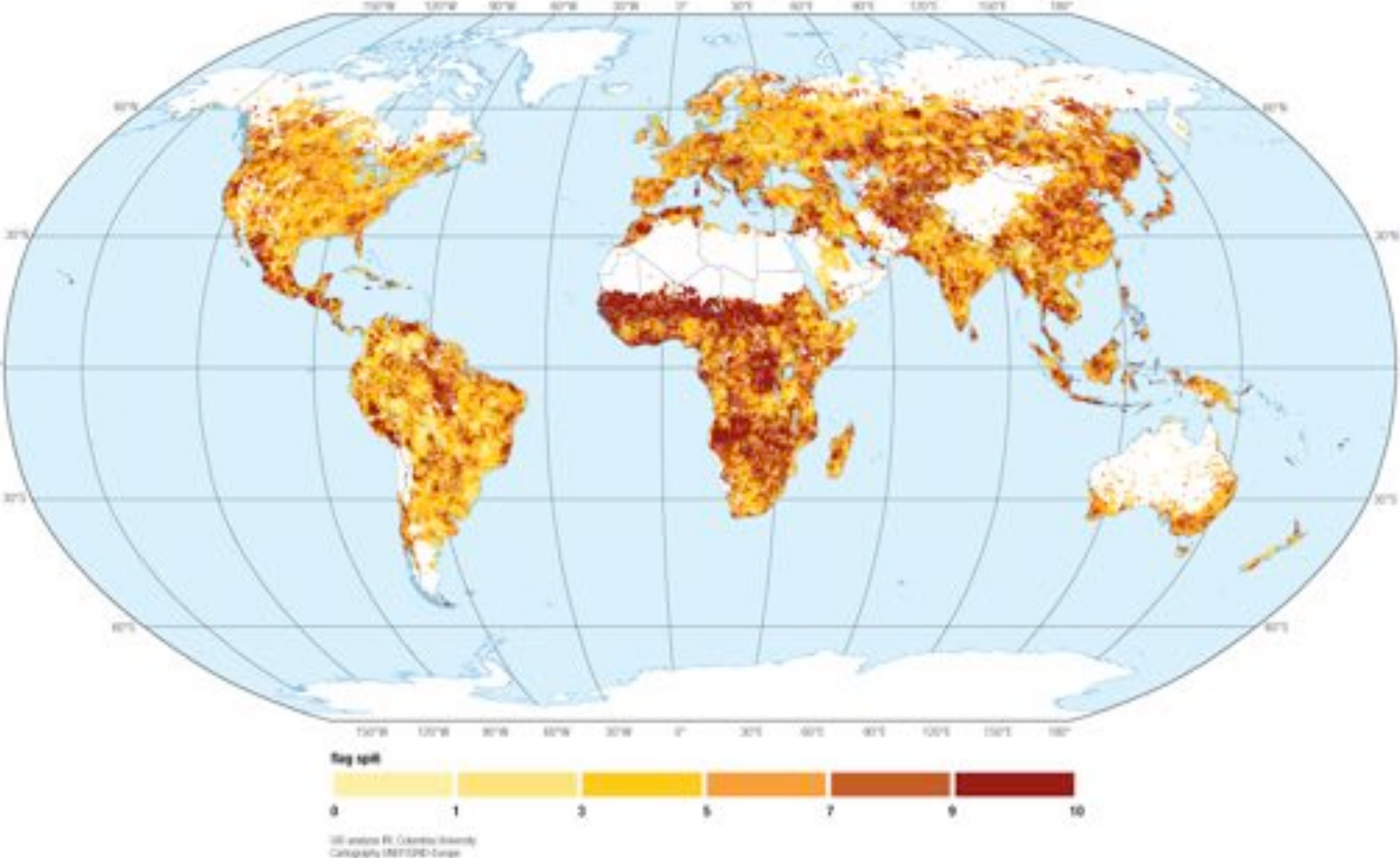
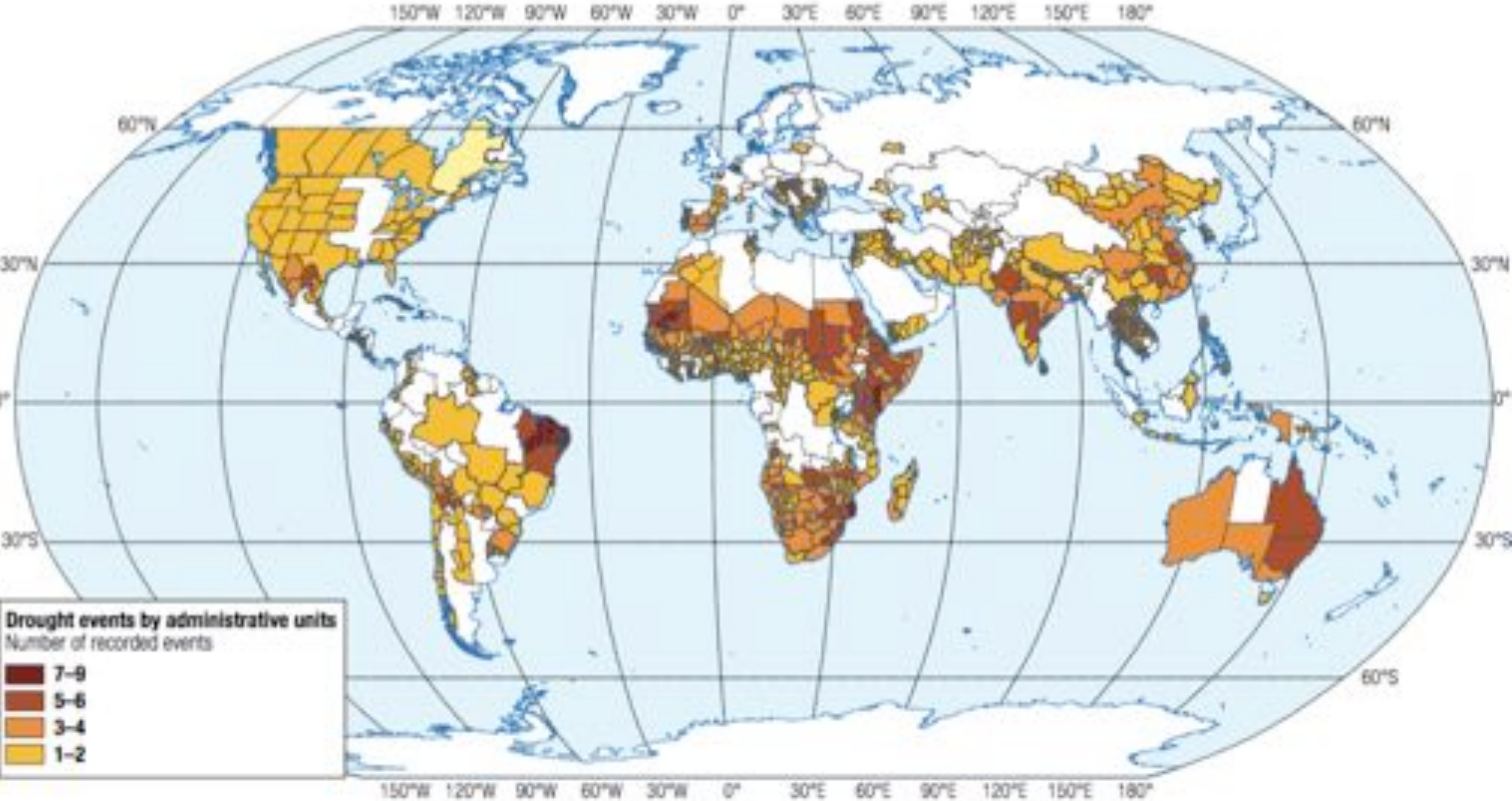
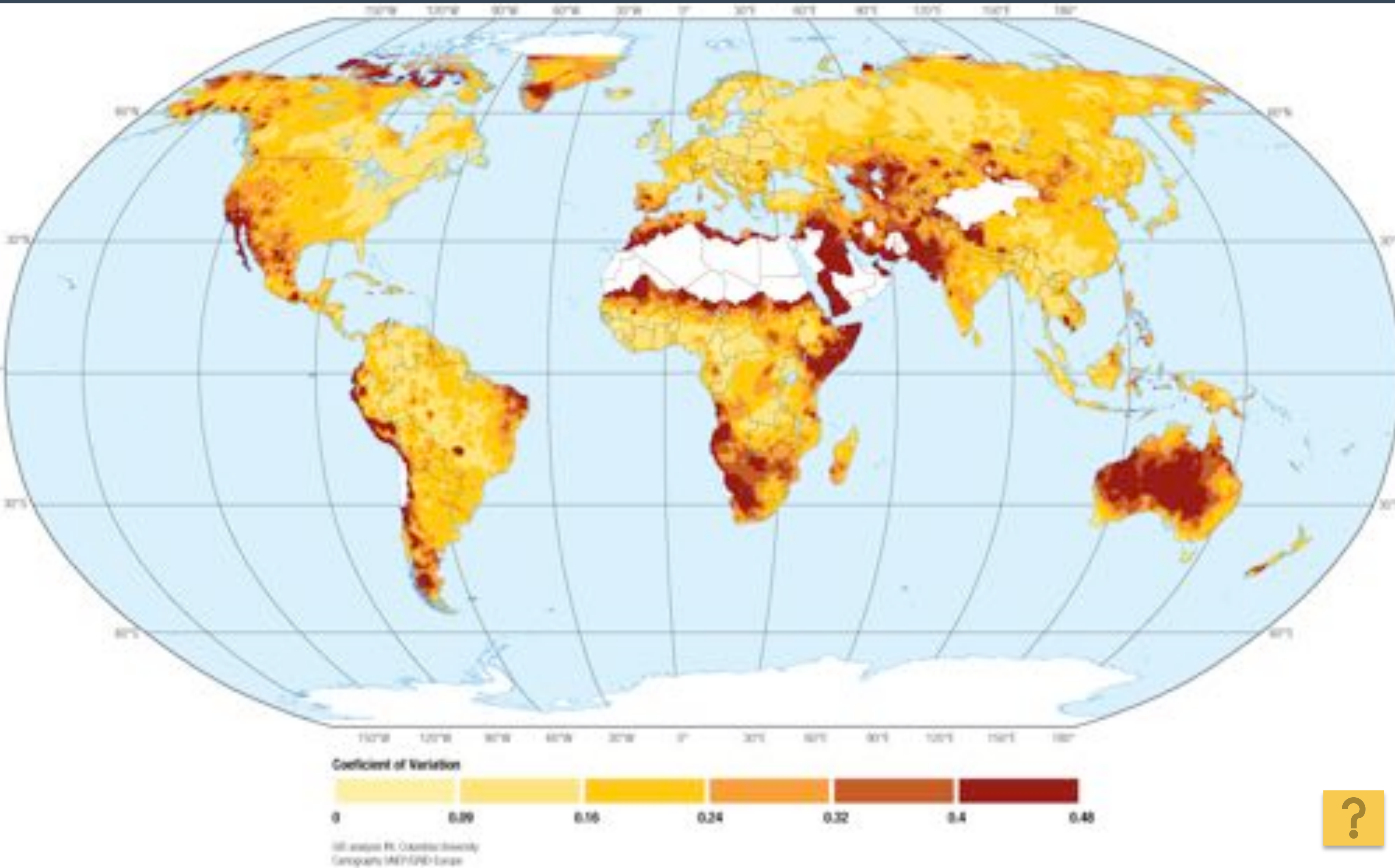
GAR 2009: Global distribution of drought frequency




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
Drought events by administrative units
Number of recorded events
7–9
5–6
3–4
1–2

GAR 2009 Global distribution of Coefficient Variation (1970-2000)



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Why this was tough

- Drought have fuzzy boundary in time and space
- Drought during fallow or growth periods is not the same
- Irrigation, snow melting and other contexts needs to be considered
- Requires geospatial data on crops types
- One model does not fit all (e.g. 50% decrease not necessary the same impacts for places with 1200 mm and 600 mm.
- Using the calendar year as the period in which drought events are identified may hide occurrence of events that develop near the start, or end, of a given year.

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Previous attempts

- Peduzzi et al. 2009, used 0.5 resolution raster dataset from the Climatic Research Unit (University of East Anglia, Norwich). 50% of precipitation shortage during a period of 3 months. Physical exposure was computed on a cell-by-cell basis using Eq. (2) and was further aggregated at the national level. This was used for Mortality risk.

$$\text{PhExp} = \sum_{i}^{n} F \text{ Pop}_i \quad (2)$$

where:

PhExp = yearly average physical exposure for the spatial unit [exposed population/year].

F annual frequency of a given magnitude event [event/year].

Pop_i = total population living in the spatial unit for each event "i" [exposed population/event].

n = number of events considered

The original figure for percentage of arable land came from the FAO database. It was modified in order to take into account the percentage of arable land excluding deserts.

$$\text{mAL\_pc} = \frac{\text{ALA}}{(\text{TA} - \text{DA})} \quad (9)$$

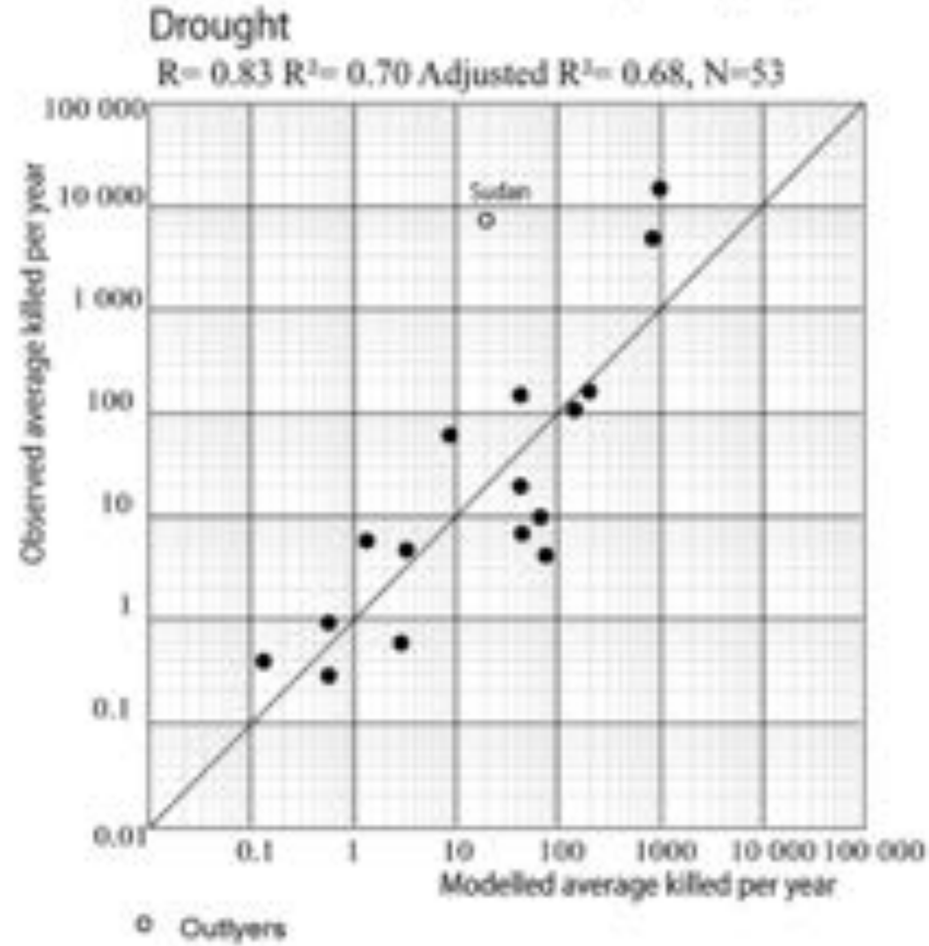
where:

mAL_pc = modified percentage of arable land.

ALA = arable land area (in km^2).

TA = total area (in km^2).

DA = desert area (in km^2).



$$\ln(K) = 1.373 \ln(\text{PhExpDr}) - 1.322 \ln(\text{mAL\_pc}) - 4.535 \ln(\text{GDPcap}) + 10.536 \quad (10)$$

where:

K = number of estimated killed.

PhExpDr = physical exposure to drought.

GDPcap = GDP purchasing power parity per capita.

mAL_pc = modified percentage of arable land.

Sources: Peduzzi, P., Dao, H., Herold, C., Mo
vulnerability towards natural hazards: the Di
1149-1159.
http://nat-hazards-earth-syst-sci.net/9/1149

Land cover changes

Deforestation

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Deforestation

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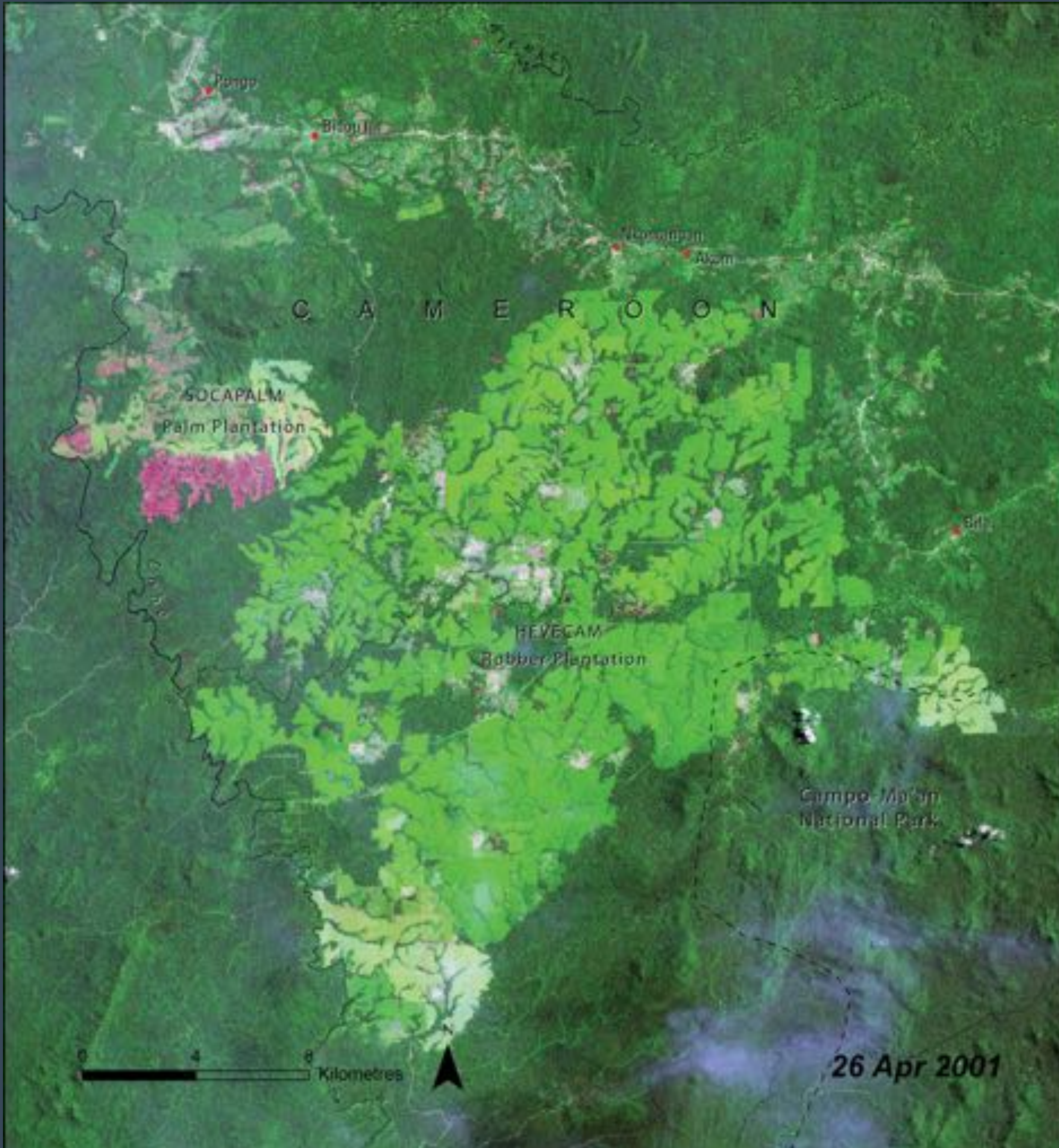
Monitoring deforestation (Bolivia)



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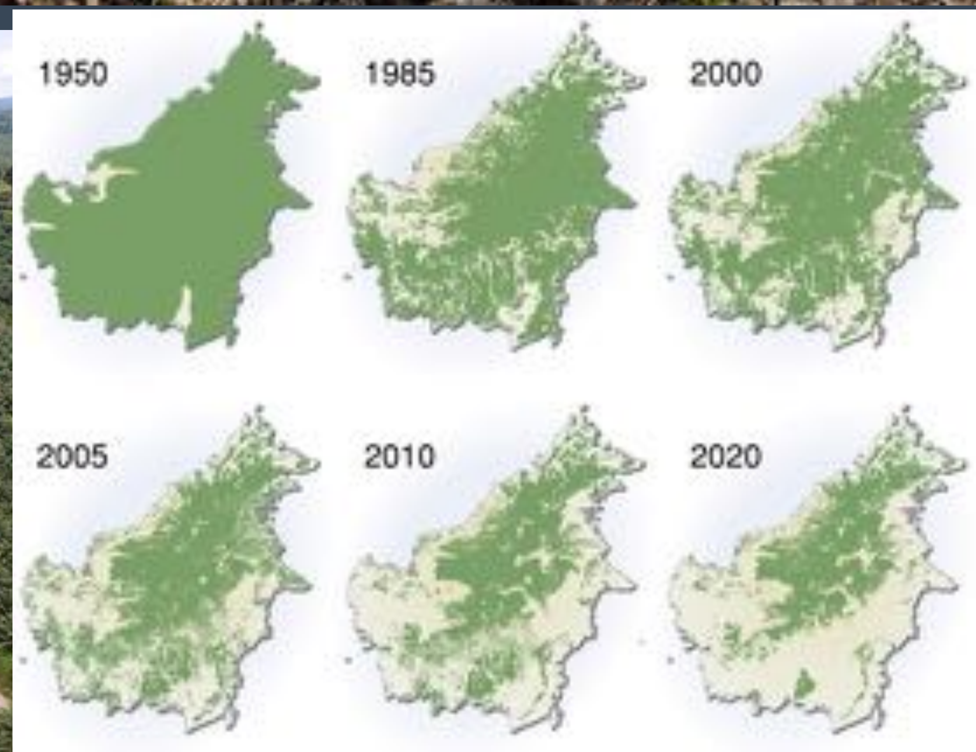
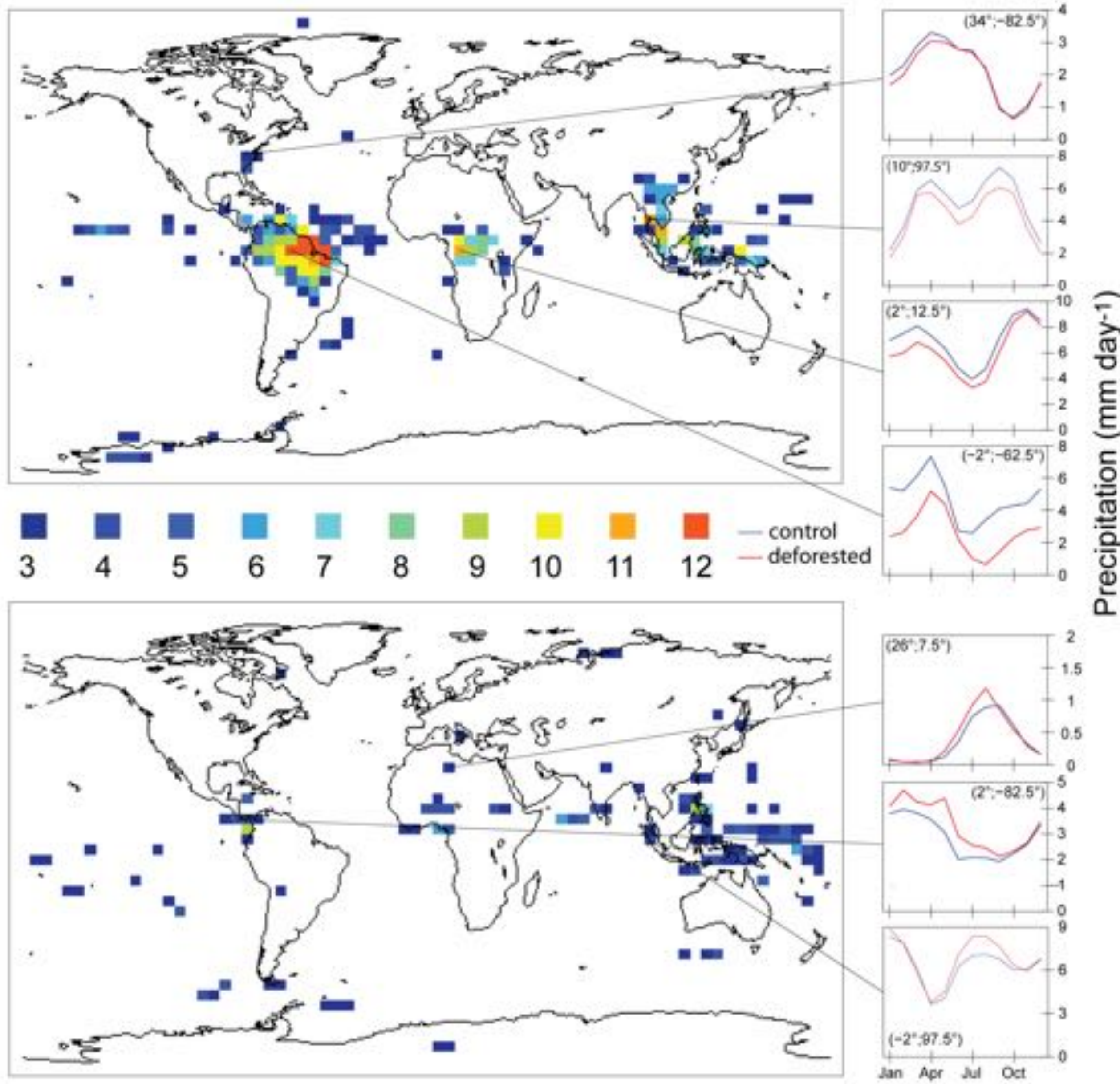

1950
1985
2000
2005
2010
2020

Most models show that deforestation will decrease precipitation in tropical areas.

(e.g Hasler N., Werth D. and Avissar R., 2009).



Pascal Peduzzi, UNEP, 2011

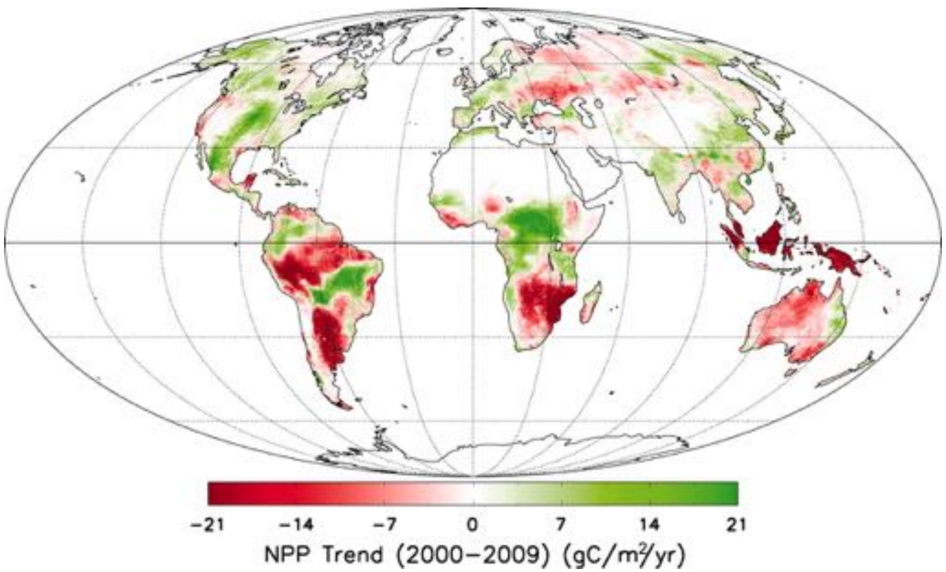


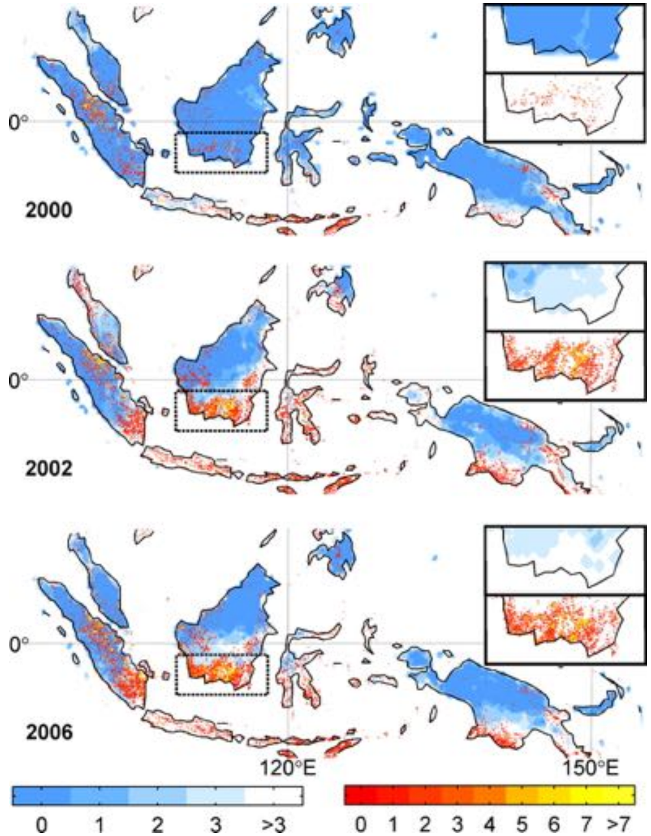
Figure 2 Spatial pattern of terrestrial NPP linear trends from 2000 through 2009
sources: with kind permission of Zhao and Running, 2010.

We thought that with more CO_2, there would be more photosynthesis, thus more biomass (Nemani et al. 2003). But it is not the case. Water might be the limitation factor (Zao & Runnin, 2010), nitrogene is another limitation.

More CO_2 was supposed to increase photosynthesis (Nemani et al., 2003). But recent measurements on the warmest decades (2000-2009) show that the creation of biomass is slower. (Zao & Running, 2010)

Photosynthesis also request H_2O, which may be the limiting factors

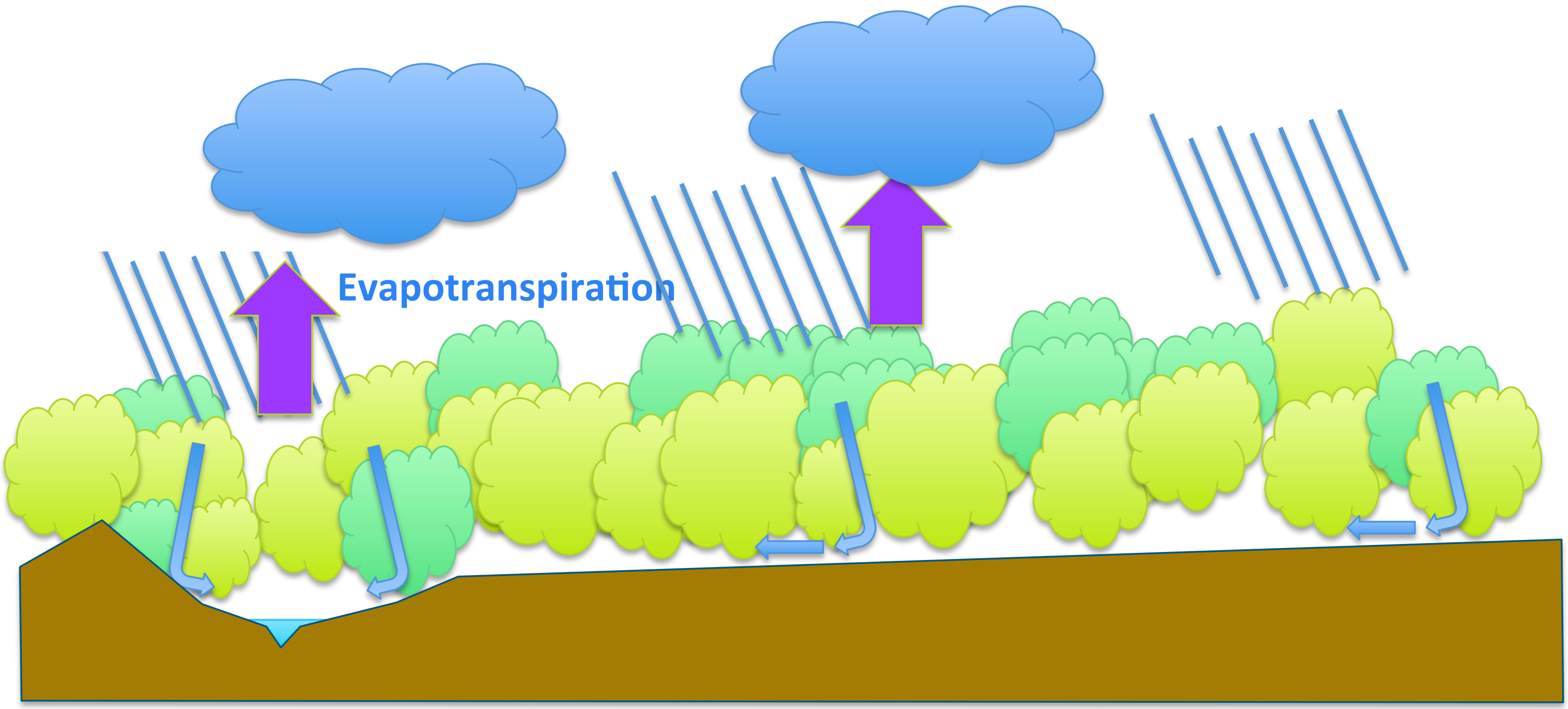
Pascal Peduzzi, UNEP, 2011



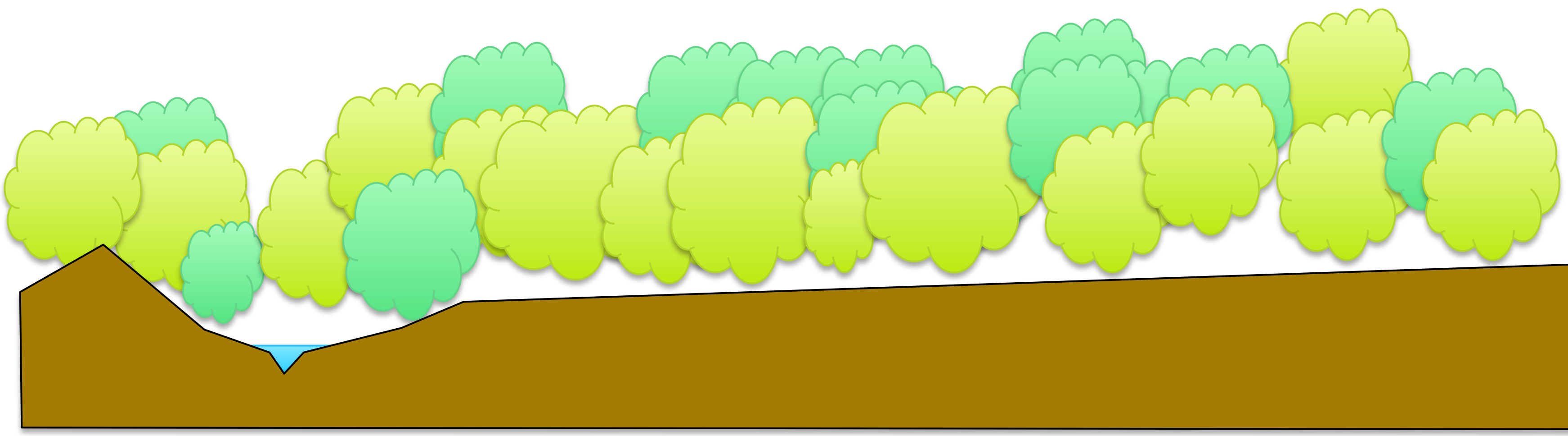
More drought, more forest fires (Van der Werf et al. 2008)

More drought more forest fires.
From Van der Werf et al., (2008), reproduced with kind permission from the authors and courtesy of National Academy of Science.

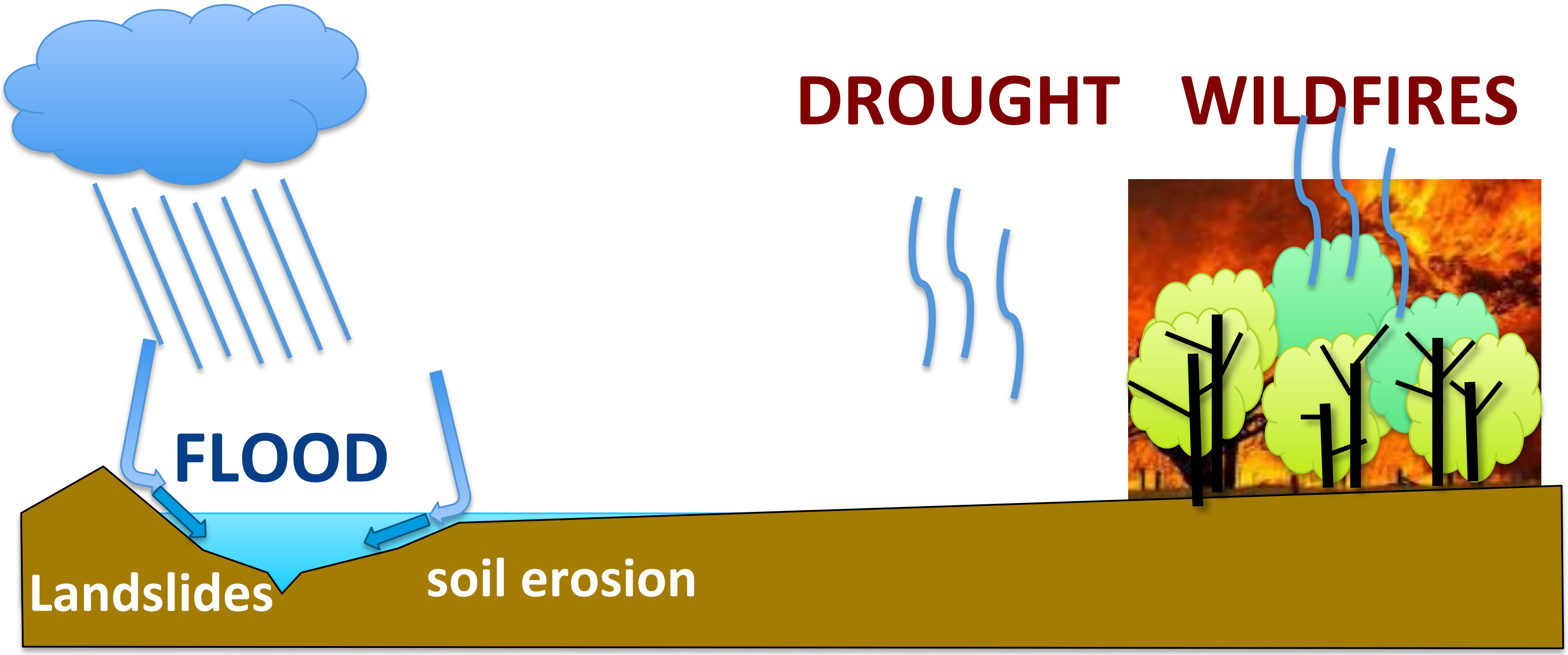
Forest helps the rain to go further inland,…



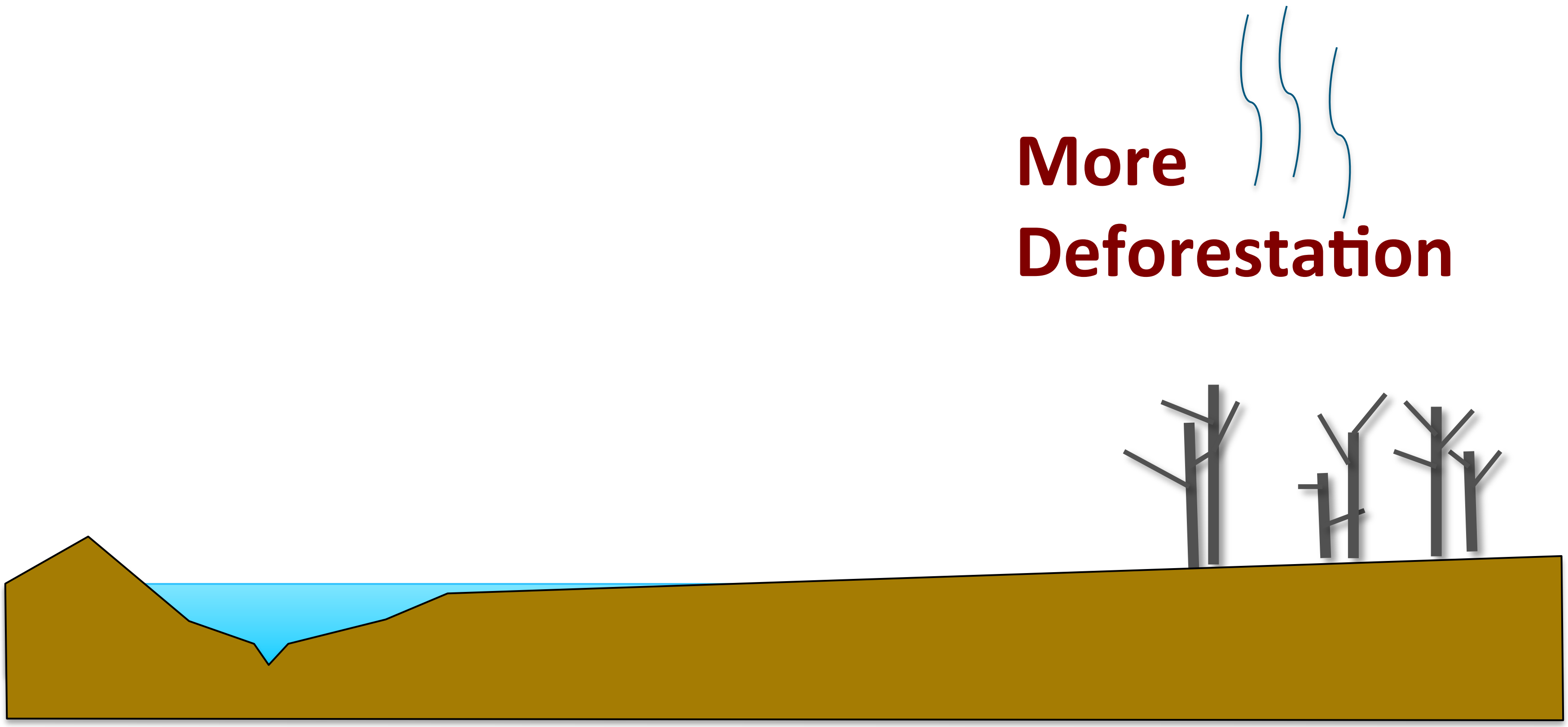
… but with deforestation,…



… extremes events are more frequent & intense



this process enters a loop, expending it further



Hasler N., Werth D. and Avissar R., 2009
Van der Werf et al. 2008
Zao & Runnin, 2010

Drought can be a factor contributing to human-ignited forest fires, which can lead to widespread deforestation and carbon emissions (IPCC, SREX p.252)

Deforestation

Due to the interrelated nature of forest fires, deforestation, drought, and climate change, isolating one of the processes fails to describe the complexity of the interconnected whole.

(IPCC, SREX)

A new Global GAR Exposure Model for 2017-2020

Dr Andrea de Bono UNEP/GRID-Geneva

(already discussed in 2012!)

Critical facilities: crops

provisioning services: production value per crops (GAEZ 2012)

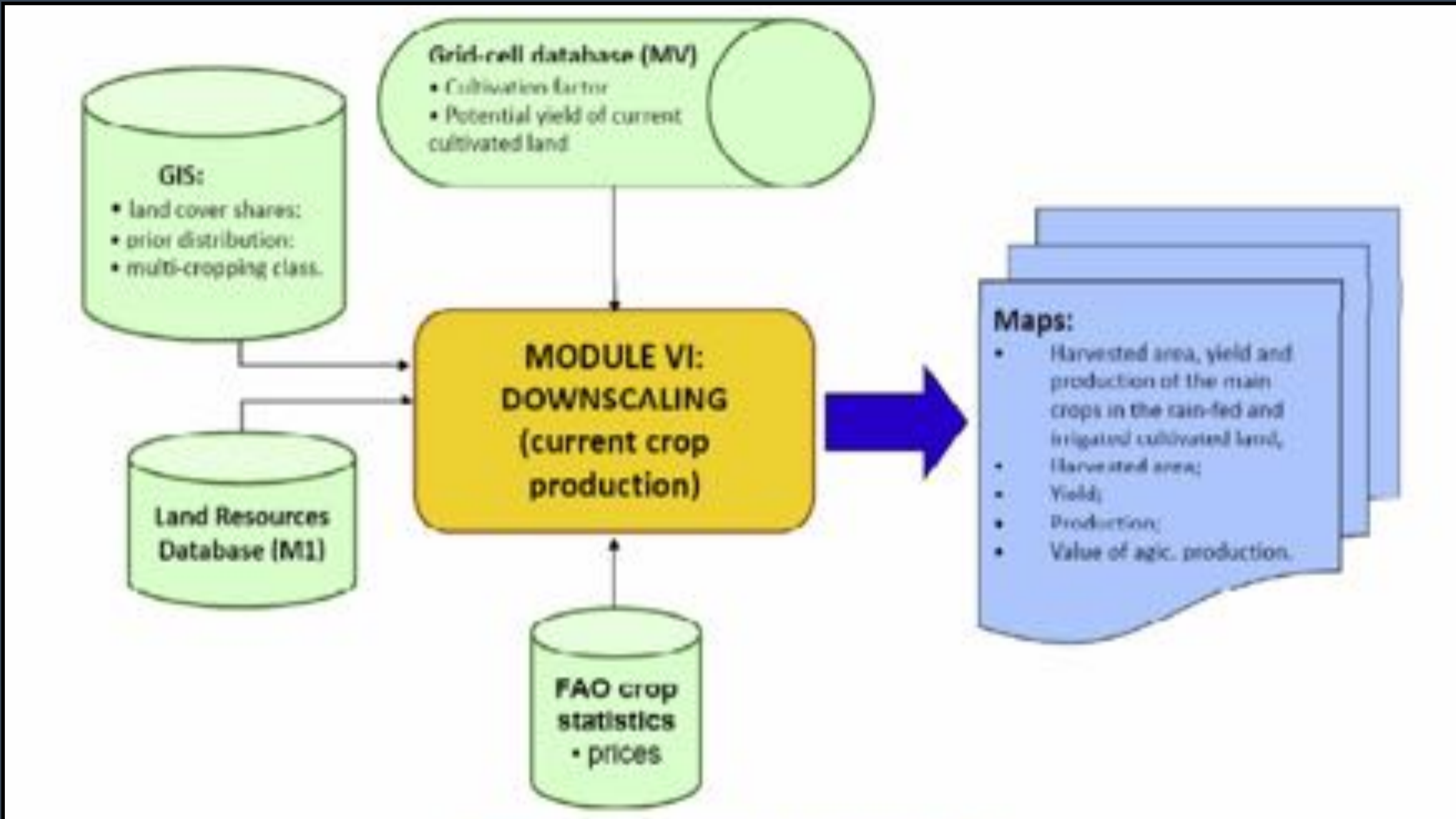


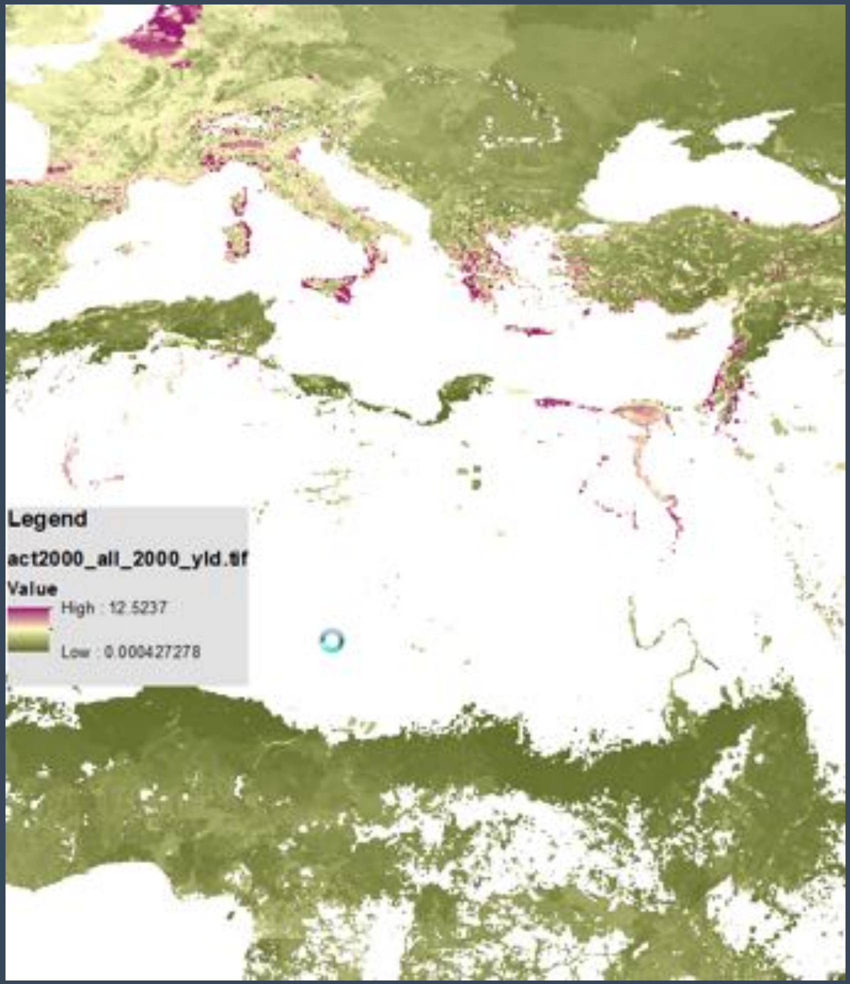
Figure 8-1 Information flow of Module VI

Critical facilities: crops

Provisioning services: production value per crops (GAEZ 2012)

Crop production value is expressed in Geary Kharmis dollars (GK$)* i.e., an international price weight (year 2000), used by UN, to compare different commodities in value terms.

* The Geary-Khamis approach that has been chosen by the UN to define the international prices and exchange rates derived from the data through a system of interdependent equations. In the equation system international prices of commodities are weighted averages of national prices converted into a common currency and weighted by national outputs. Exchange rates are equal to the ratio of the value of production of a given country at international prices divided by the value of production of the same country in national currency. When one currency is chosen as the numeraire, the system can be solved and has a unique solution. Exchange rates of the other currencies and international prices can be expressed in terms of the currency chosen as the reference. The set of international prices and exchange rates thus obtained can enter directly the computation of price and quantity index numbers



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Thank you