Natural Disaster Hotspots: A Global Risk Analysis

Risk Identification for Disaster Risk Management

Maxx Dilley
International Research Institute
for Climate Prediction

Linking Science to Society

INTERNATIONAL RESEARCH INSTITUTE

Foreseeable risk

- risks of losses associated with major hazards
- risks of specific outcomes
- relative risk levels
- geographic distribution of risk at sub-national resolution
- multi-hazard risks

Sponsors and partners

- implemented through an MOU between the Earth Institute at Columbia University and the World Bank Hazard Management Unit
- funded by DFID through the ProVention Consortium
- additional funding from USAID, Norwegian Ministry of Foreign Affairs, Columbia University
- coordination through ISDR Working Group III
  - UNDP's *Reducing Disaster Risk* report
  - UNEP's Disaster Risk Index
  - IADB/IDEA Indicators for Disaster Risk Management in the Americas

INTERNATIONAL RESEARCH INSTITUTE

Global analysis (+ case studies)

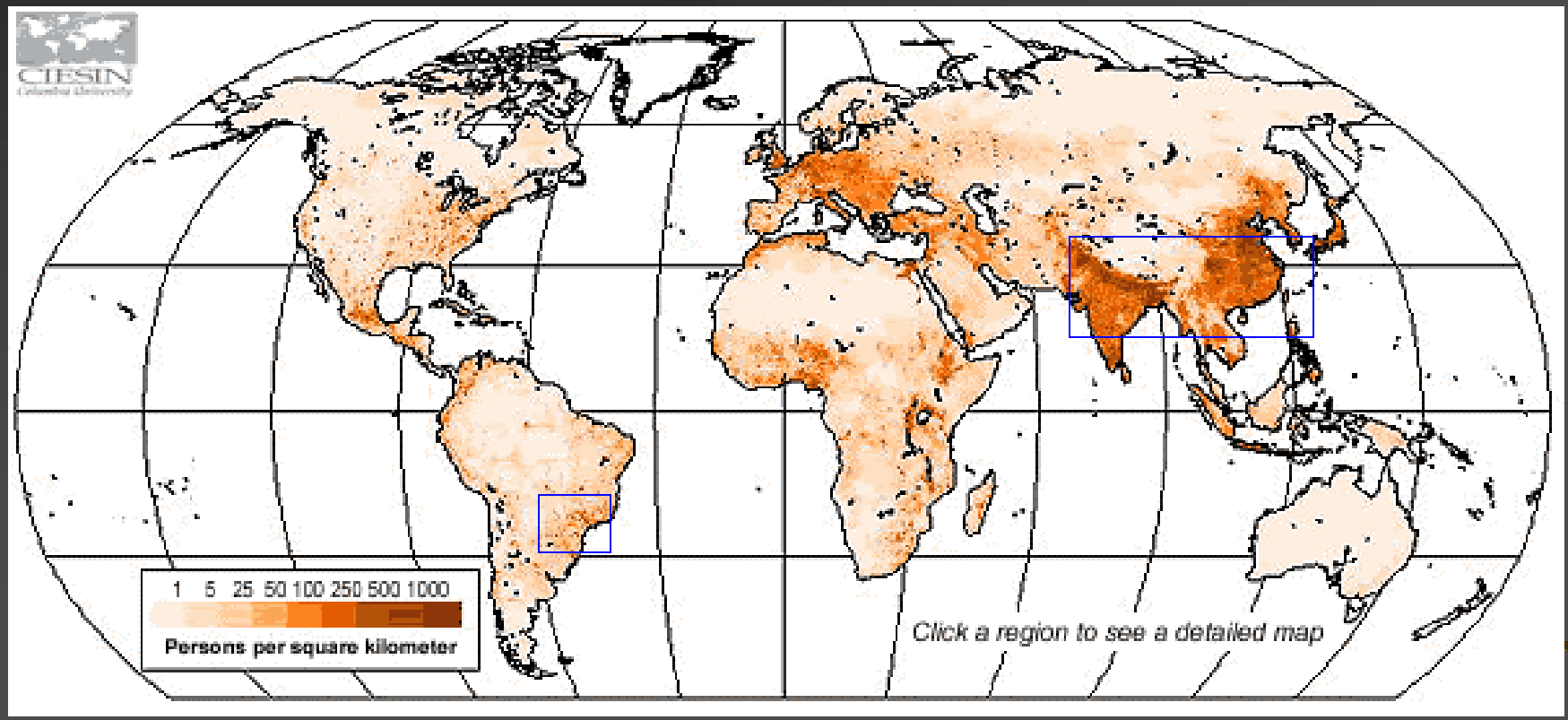
- six major hazards
  - drought
  - earthquakes
  - floods
  - landslides
  - storms
  - volcanoes
- relative risks of two outcomes
  - mortality
  - economic loss
    - GDP per unit area
    - proportion of GDP per unit area

Methodology

INTERNATIONAL RESEARCH INSTITUTE

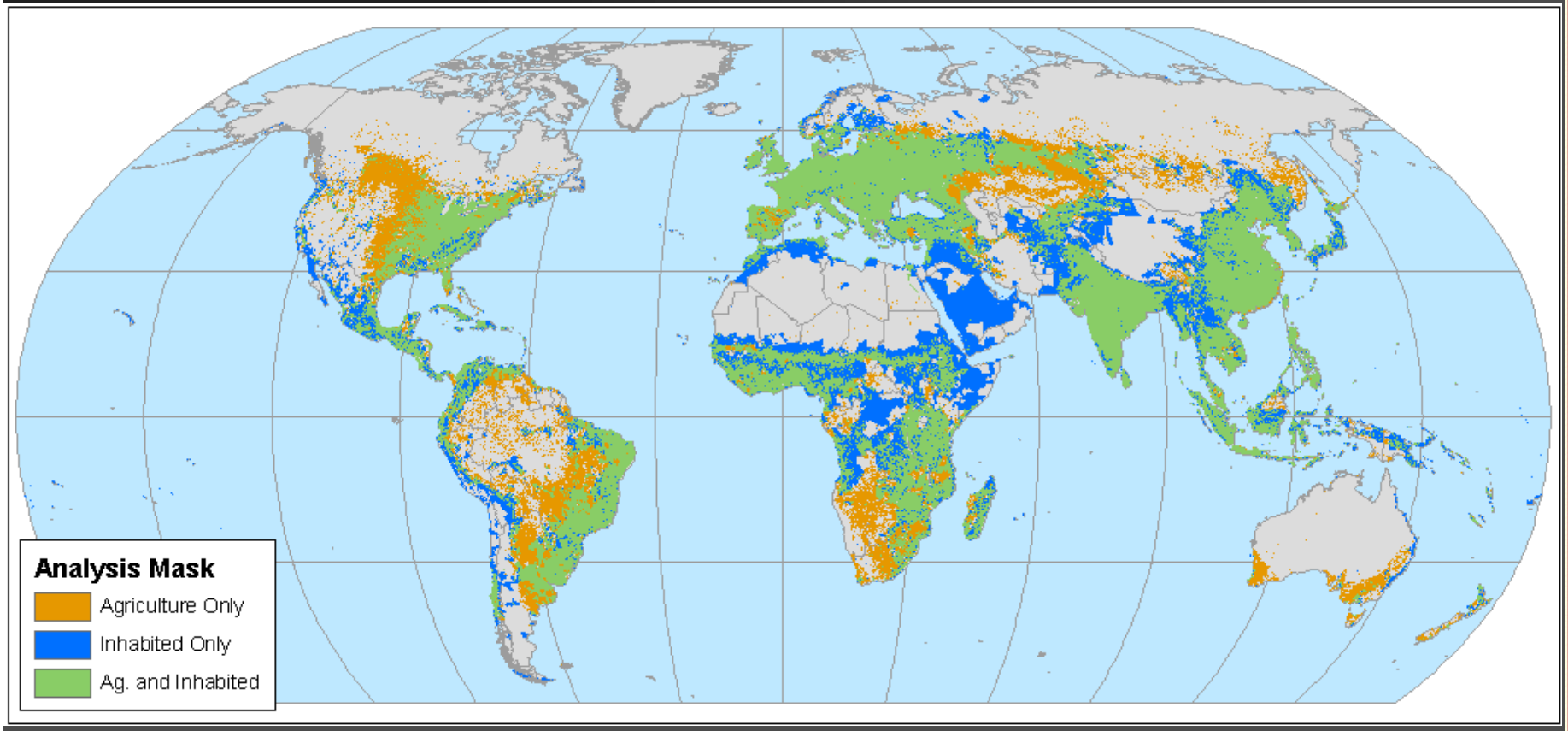
Gridded global data on elements at risk

- GPW population for mortality risks (CIESIN, below)
- GDP per unit area for economic loss risks (WB, not shown)



INTERNATIONAL RESEARCH INSTITUTE

Mask out low population, non-agricultural grid cells



INTERNATIONAL RESEARCH INSTITUTE

Hazard exposure for each grid cell = hazard frequency x pop (or GDP)

Hazard	Hazardousness Parameter	Period	Resolution	Source(s)
Storms	Frequency by wind strength	1980-2000	30”	UNEP/GRID-Geneva PreView
Drought	Precipitation less than 75% of median for a 3+-month period (WASP)	1980-2000	2.5°	IRI Climate Data Library
Floods	Counts of extreme flood events	1985-2003*	1°	Dartmouth Flood Obs. *World Atlas of Large Flood Events*
Earthquake	Expected PGA (10% prob. of exceedance in 50 years)	n/a	sampled at 1’	Global Seismic Hazard Program
	Freq. of earthquakes > 4.5 on Richter Scale	1976-2002	sampled at 2.5’	Smithsonian Institution
Volcanoes	Counts of volcanic activity	79-2000	Sampled at 2.5’	UNEP/GRID-Geneva and NGDC
Landslides	Estimated annual prob. of landslide or avalanche	n/a	30”	Norwegian Geotechnical Institute

INTERNATIONAL RESEARCH INSTITUTE

Risk = (pop or GDP hazard exposure x vulnerability)

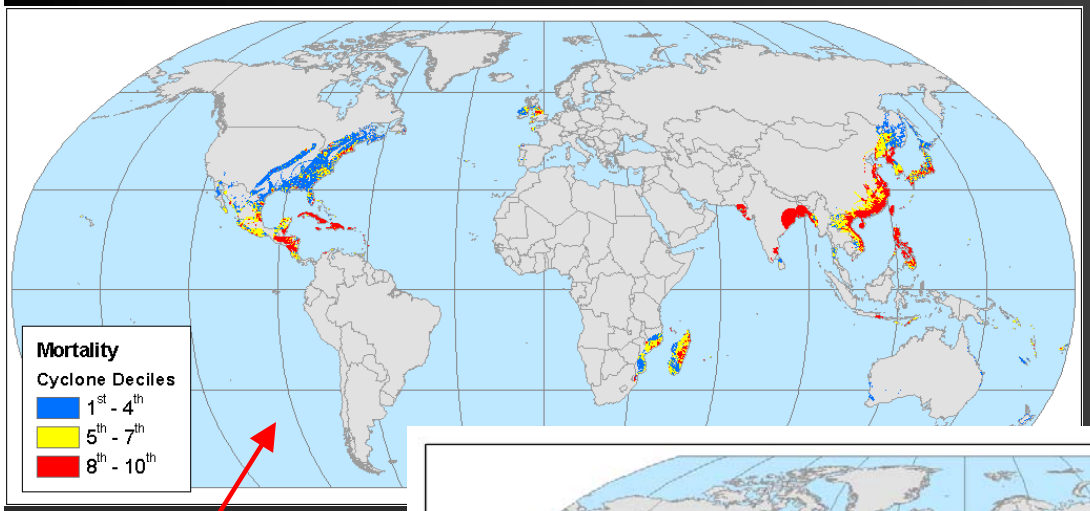
- vulnerability = damage rates by hazard for each combination of World Bank region and country wealth class
  - population vulnerability ← EM-DAT mortality rate per hazard event
  - GDP unit area vulnerability ← EM-DAT economic loss rate per hazard event
- damage rates rescaled across hazards so that the calculated losses in each group equal the total recorded EM-DAT losses

Relative risks

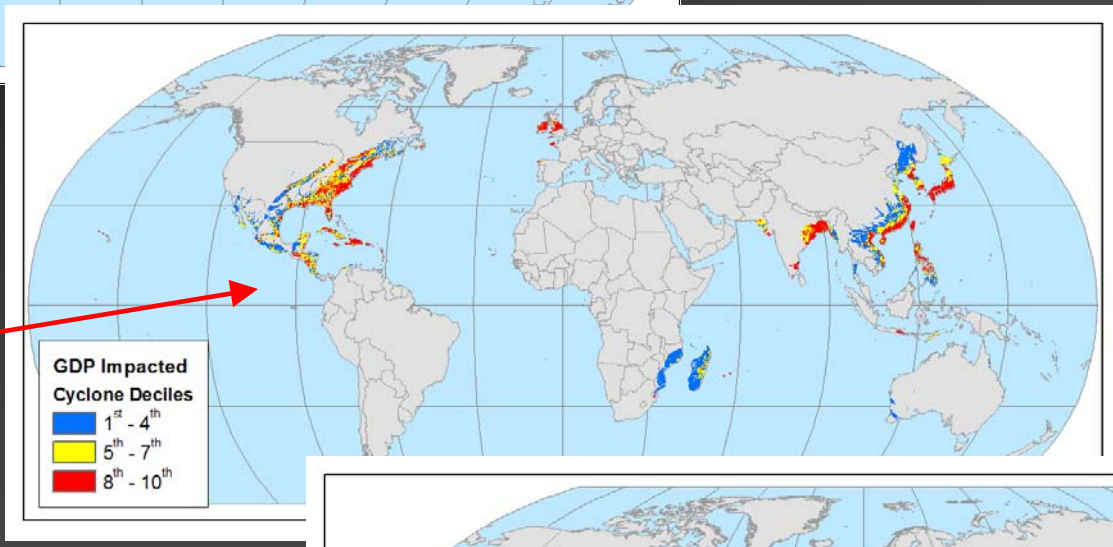
- Outcomes for each grid cell
  - mortality risk index (population hazard exposure x historical mortality rate)
  - economic loss risk index (GDP per unit area exposure x historical economic loss rate)
    - Total economic losses
    - Proportional to GDP per unit area
- Risk levels
  - sort all grid cells
  - top 30% = red
  - middle 30% = yellow
  - lowest 40% = blue

Results

Cyclone

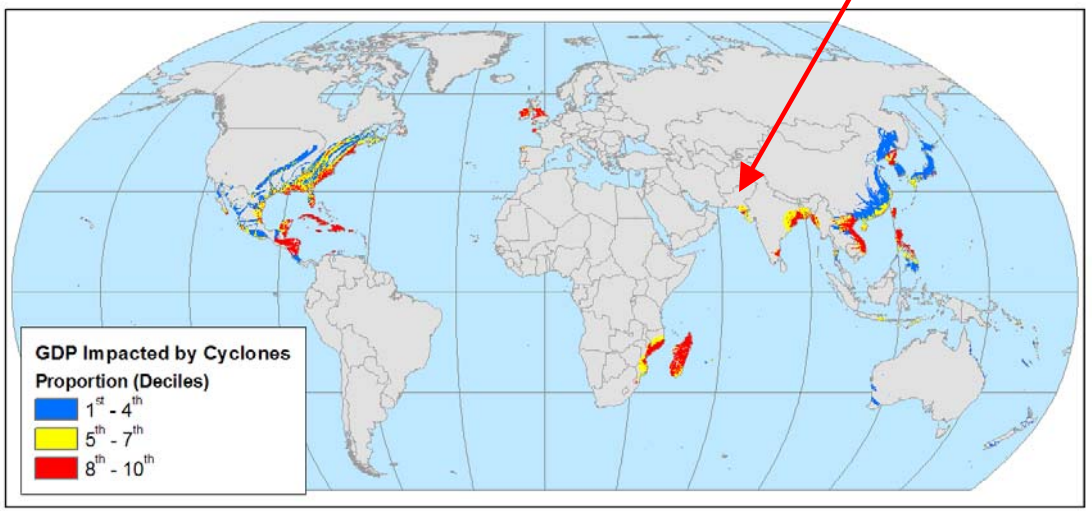


Mortality



Total economic losses

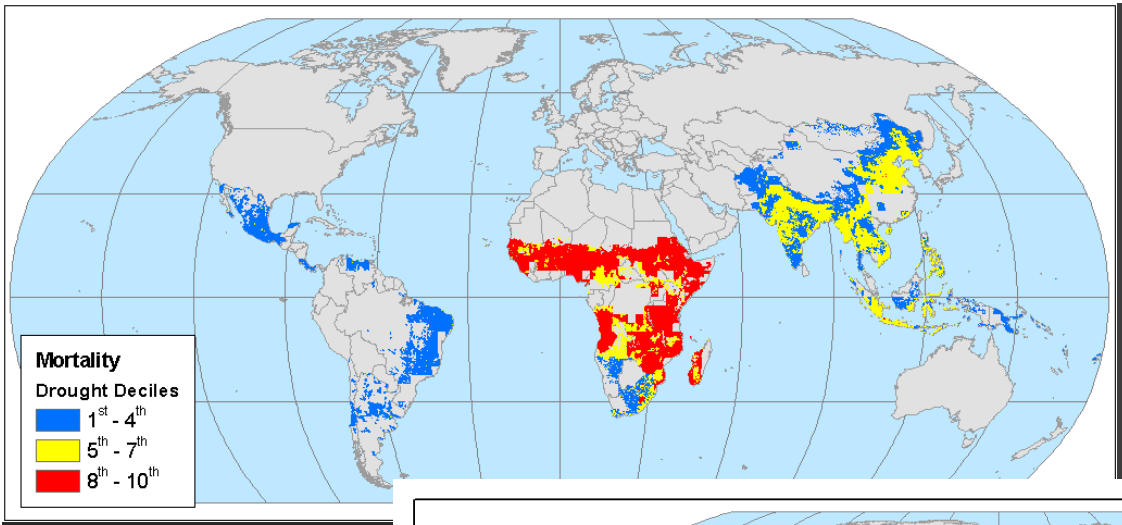
Economic losses in proportion to GDP per unit area

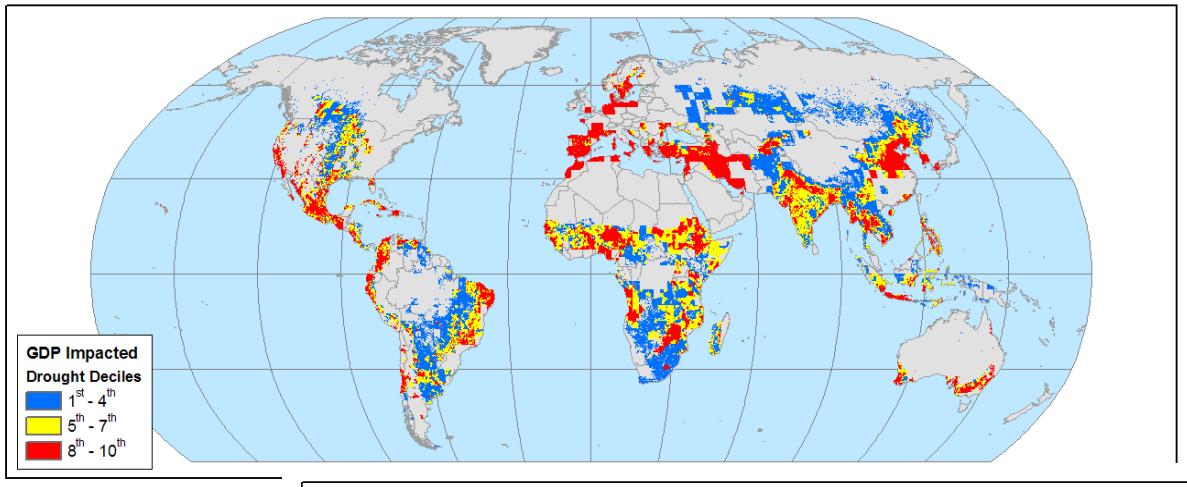


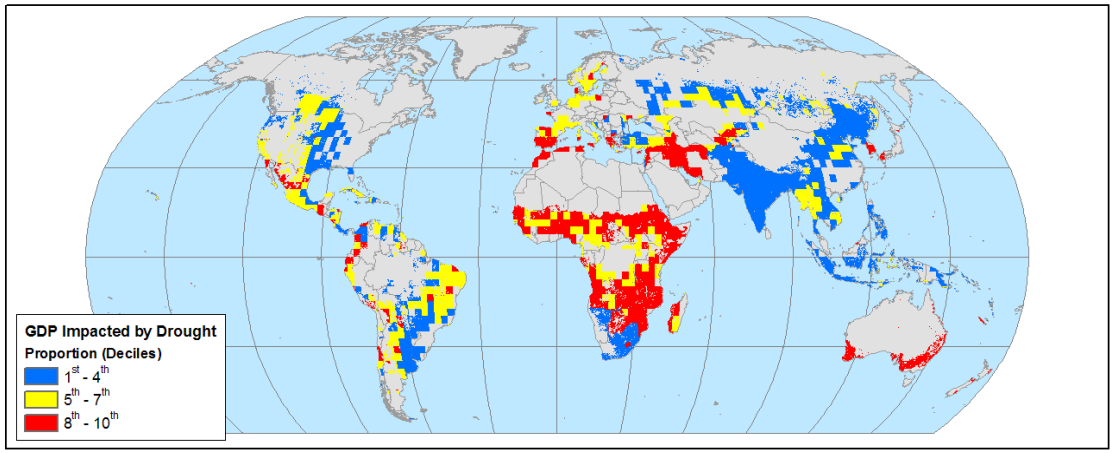
disaster risk hotspots

INTERNATIONAL RESEARCH INSTITUTE

Drought



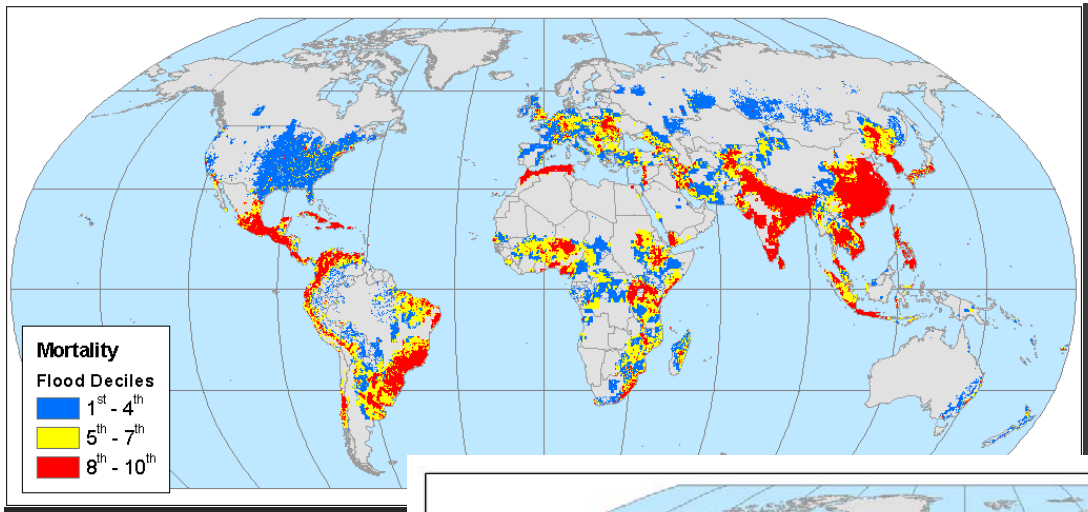


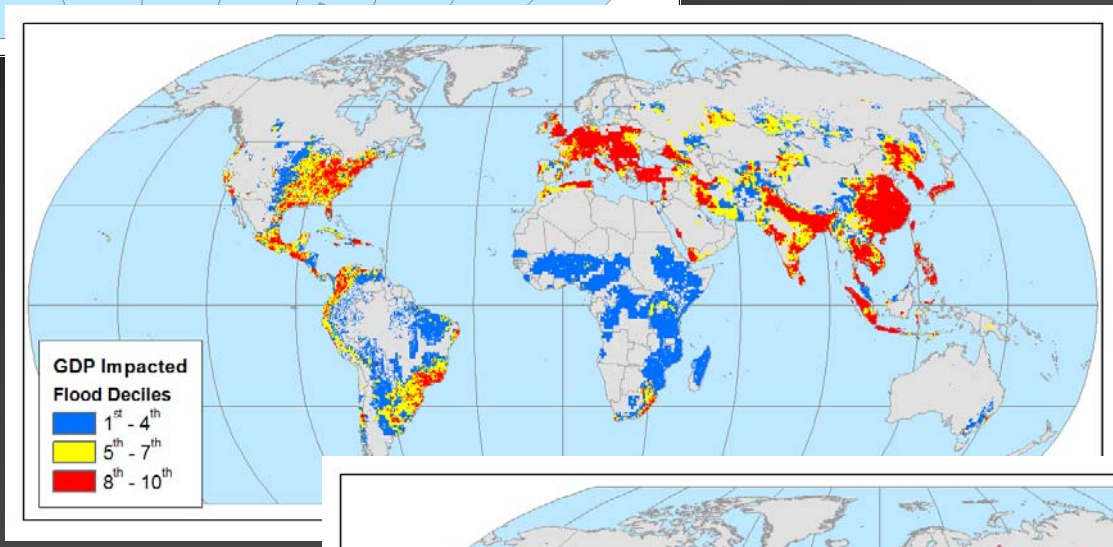


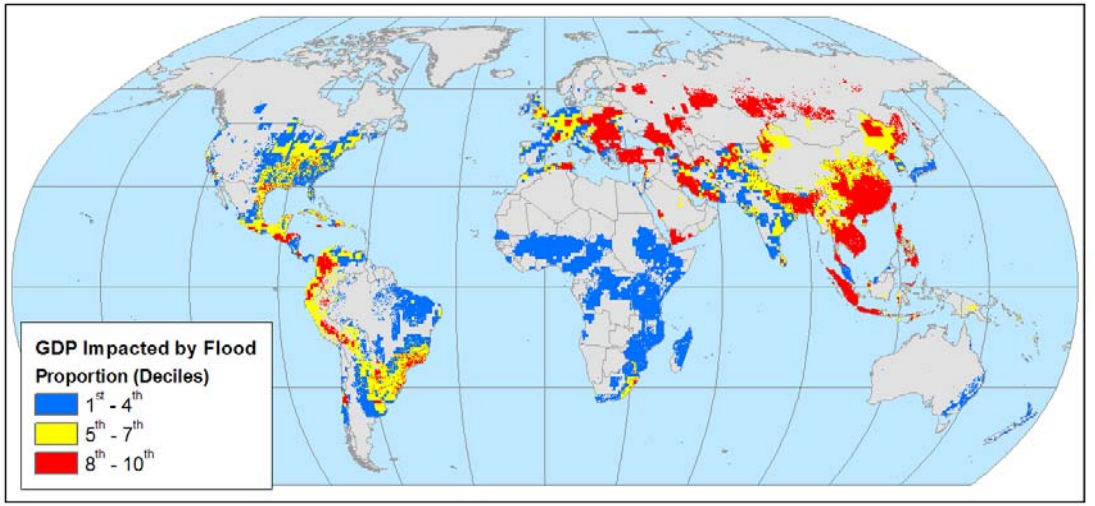
disaster risk hotspots

INTERNATIONAL RESEARCH INSTITUTE

Flood



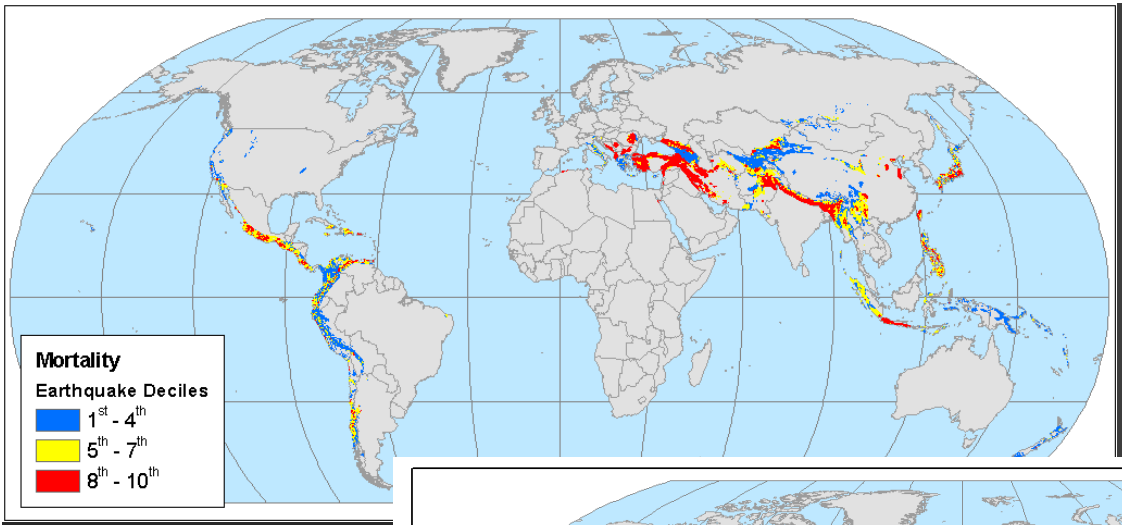


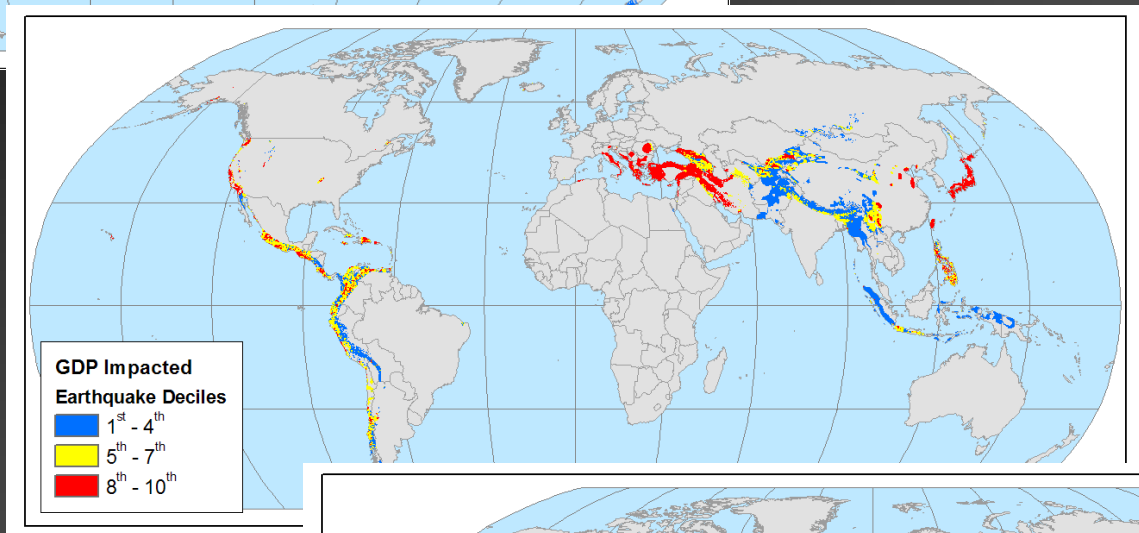


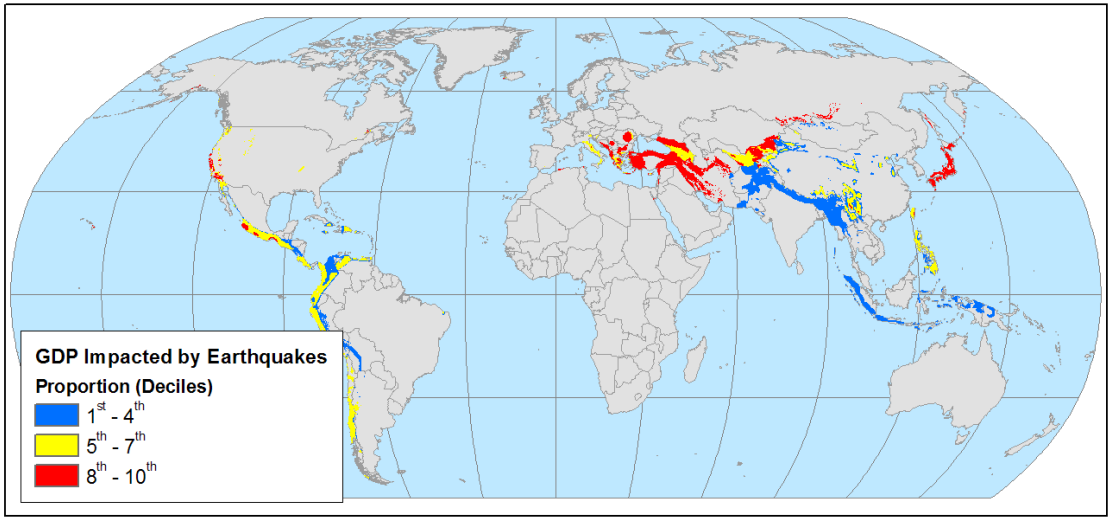
disaster risk hotspots

INTERNATIONAL RESEARCH INSTITUTE

Earthquake



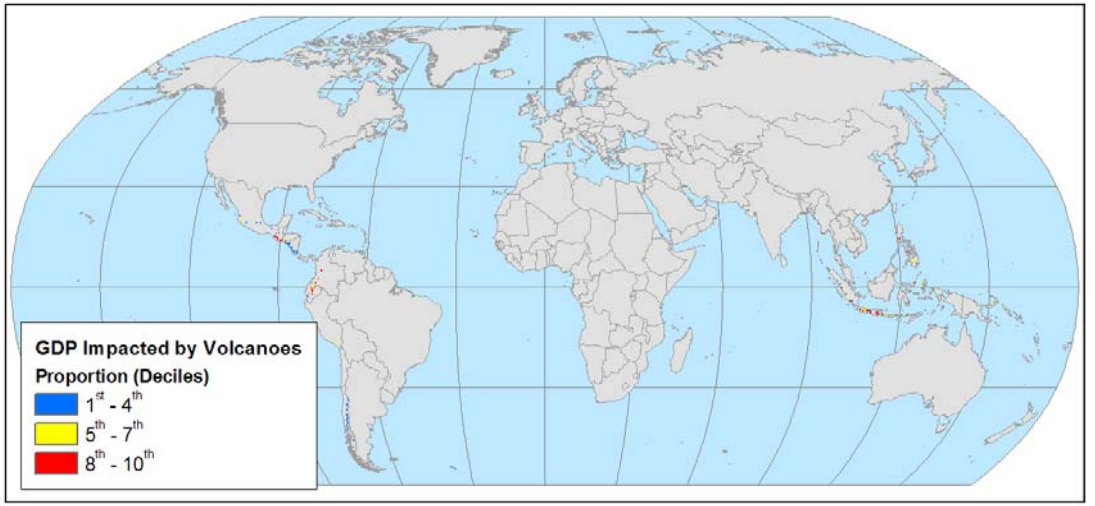




disaster risk hotspots

INTERNATIONAL RESEARCH INSTITUTE

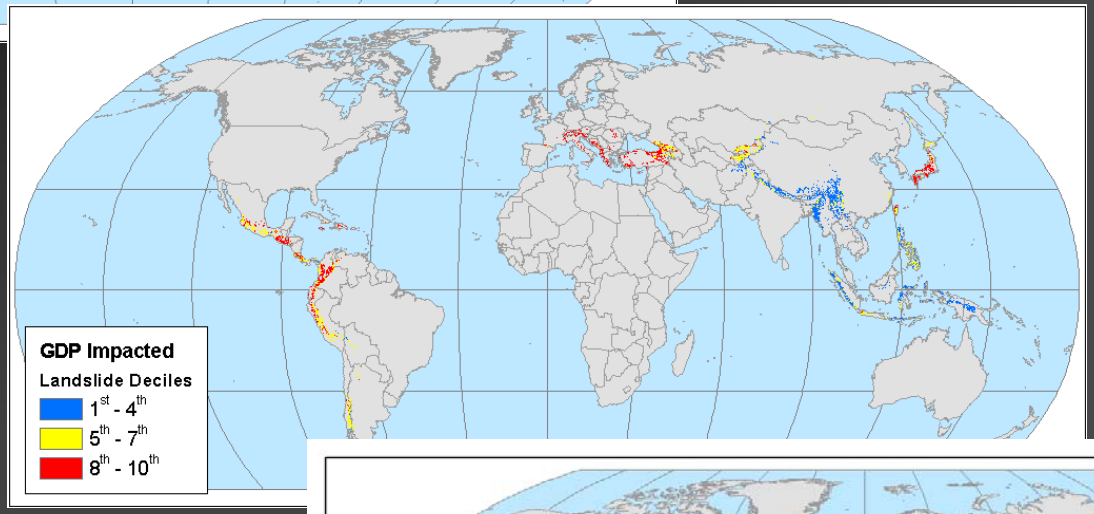
Volcano

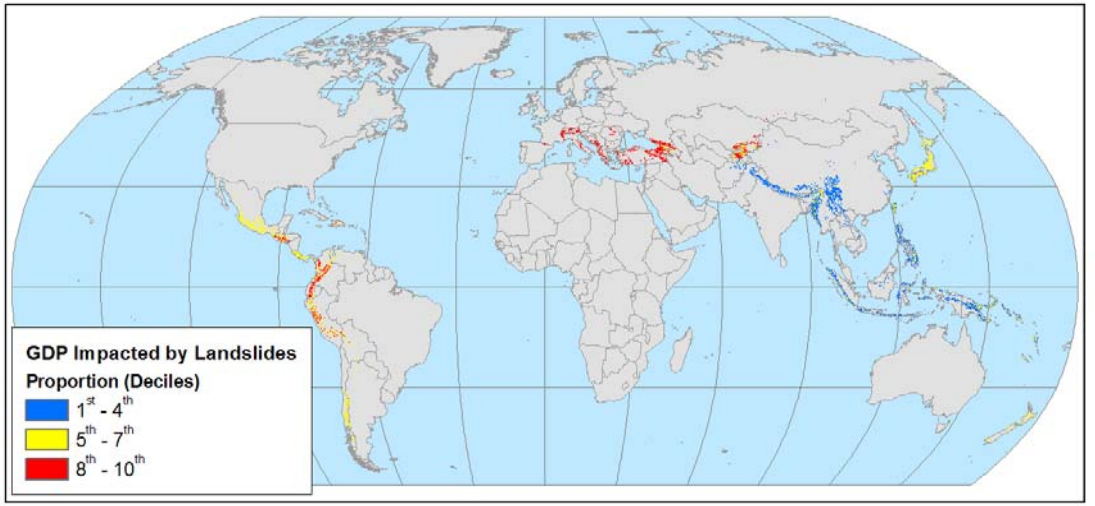


disaster risk hotspots

INTERNATIONAL RESEARCH INSTITUTE

Landslide

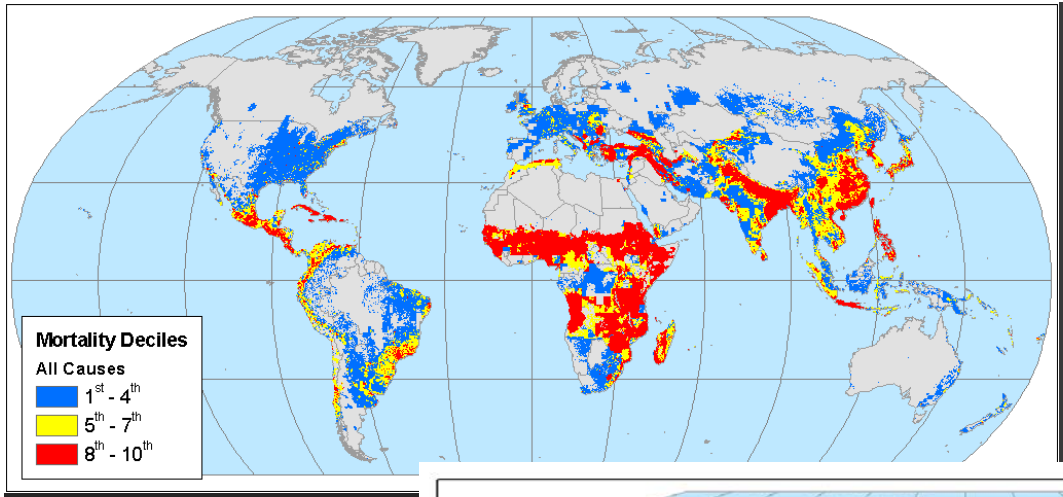




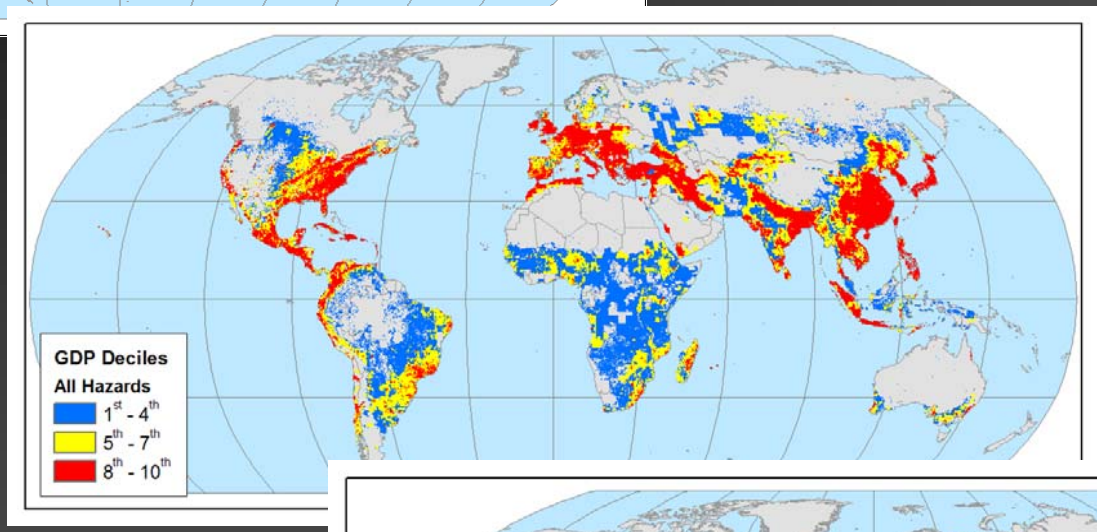
disaster risk hotspots

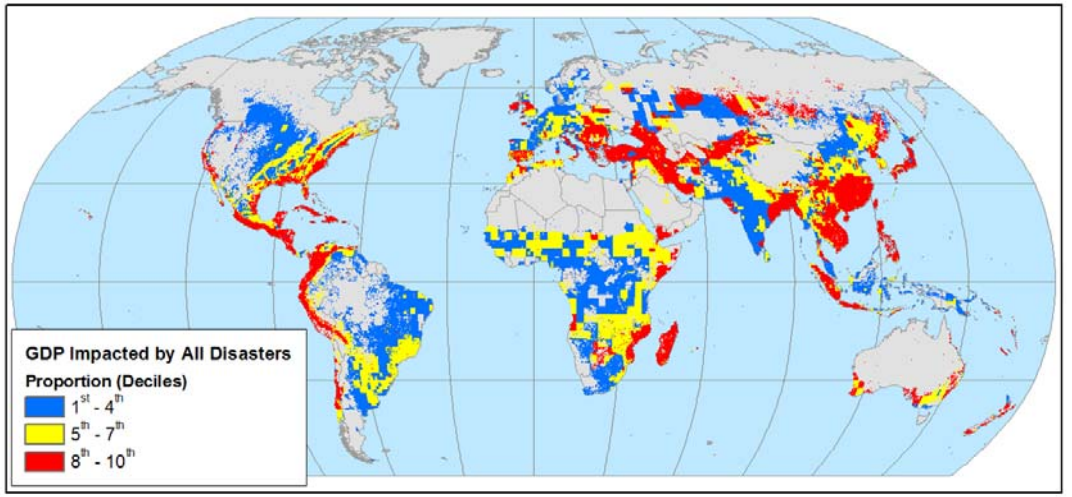
INTERNATIONAL RESEARCH INSTITUTE

All hazards



disaster risk hotspots





INTERNATIONAL RESEARCH INSTITUTE

Interpretation

INTERNATIONAL RESEARCH INSTITUTE

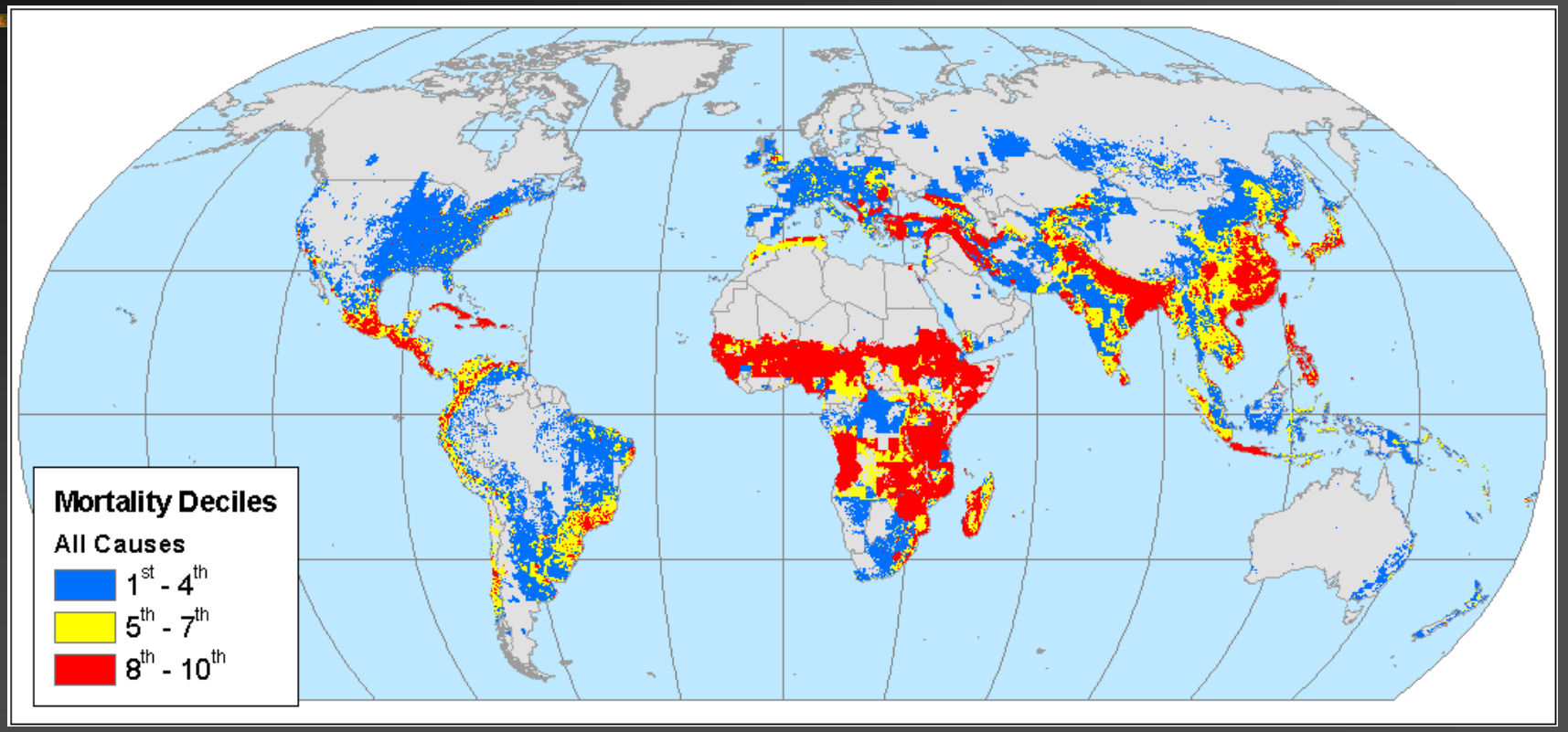
Linking Science to Society

Relief costs and emergency lending

- Relief costs
  (OCHA Reliefweb FTS)
  - total relief costs from 1992-2003: $2.5 billion
  - of this, $2 billion went to the top 20 countries

- Emergency Lending
  (World Bank)
  - total emergency lending and loan reallocation from 1980-2003: $14.4 billion
  - of this, $12 billion went to the top 20 countries

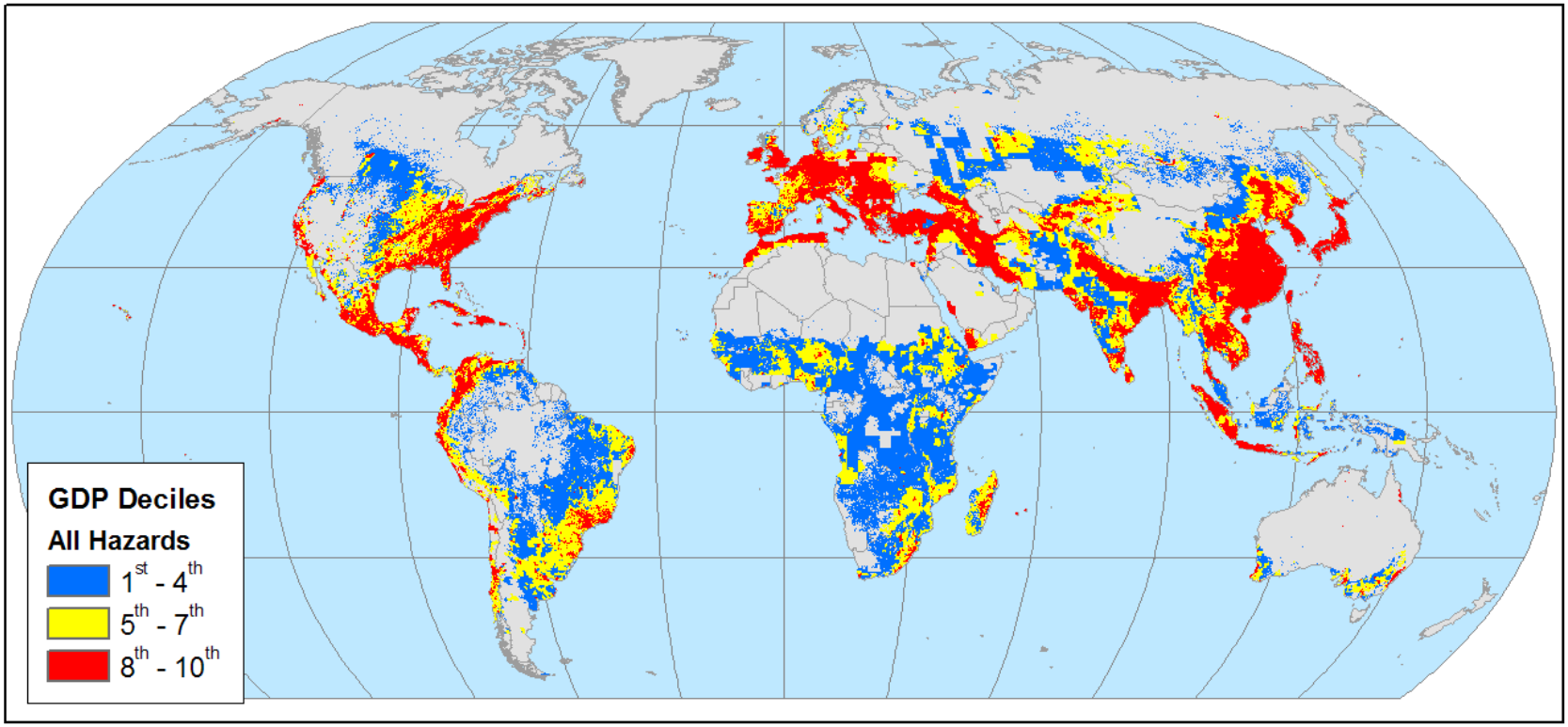
All-hazard mortality risk hotspots: Top 20 in relief costs



China, India, Bangladesh, Egypt, Mozambique, Turkey, Afghanistan, El Salvador, Kenya, Iran, Pakistan, Indonesia, Peru, Democratic Republic of Congo, Poland, Vietnam, Colombia, Venezuela, Tajikistan, Cambodia

INTERNATIONAL RESEARCH INSTITUTE

All-hazard total economic loss risk hotspots: Top 20 in emergency loans



India, Turkey, Bangladesh, Mexico, Argentina, Brazil, Poland, Colombia, Iran, Honduras, China, Chile, Zimbabwe, Dominican Republic, El Salvador, Algeria, Ecuador, Mozambique, Philippines, and Vietnam

INTERNATIONAL RESEARCH INSTITUTE

Total direct and indirect losses

(ECLAC, World Bank)

Hazard	Year	Location	Social sectors (10^6 US$)	Infrastructure sectors (10^6 US$)	Productive sectors (10^6 US$)	Environment and other (10^6 US$)	Total (10^6 US$)
Earthquake	1999	Turkey (Marmara)	2,187	739	1,850	0	4,776
Earthquake	2001	India (Gujarat)	1,302	334	440	55	2,131
Earthquake	2001	El Salvador	472	398	275	68	1,212
Hurricane	2000	Belize	38	44	165	407	655
Flood	2000	Mozambique	69	133	281	5	488
Drought	2001	Central America	*124*	*3*	*83*	*0*	*210*
		TOTAL	*4,192*	*1,651*	*3,094*	*535*	*9,472*

INTERNATIONAL RESEARCH INSTITUTE

Selected next steps in global risk analysis

- World Bank to publish Hotspots global analysis and case studies in two volumes (Jan. 2005)
- create internet access to Hotspots input data
- compare Hotspots and Disaster Risk Index results
- improve global drought, flood and landslide hazard data and assess tsunami risks
- improve global loss data, especially economic losses
- begin to move from static to dynamic risk assessment for disaster early warning