Identifying Global Natural Disaster Hotspots

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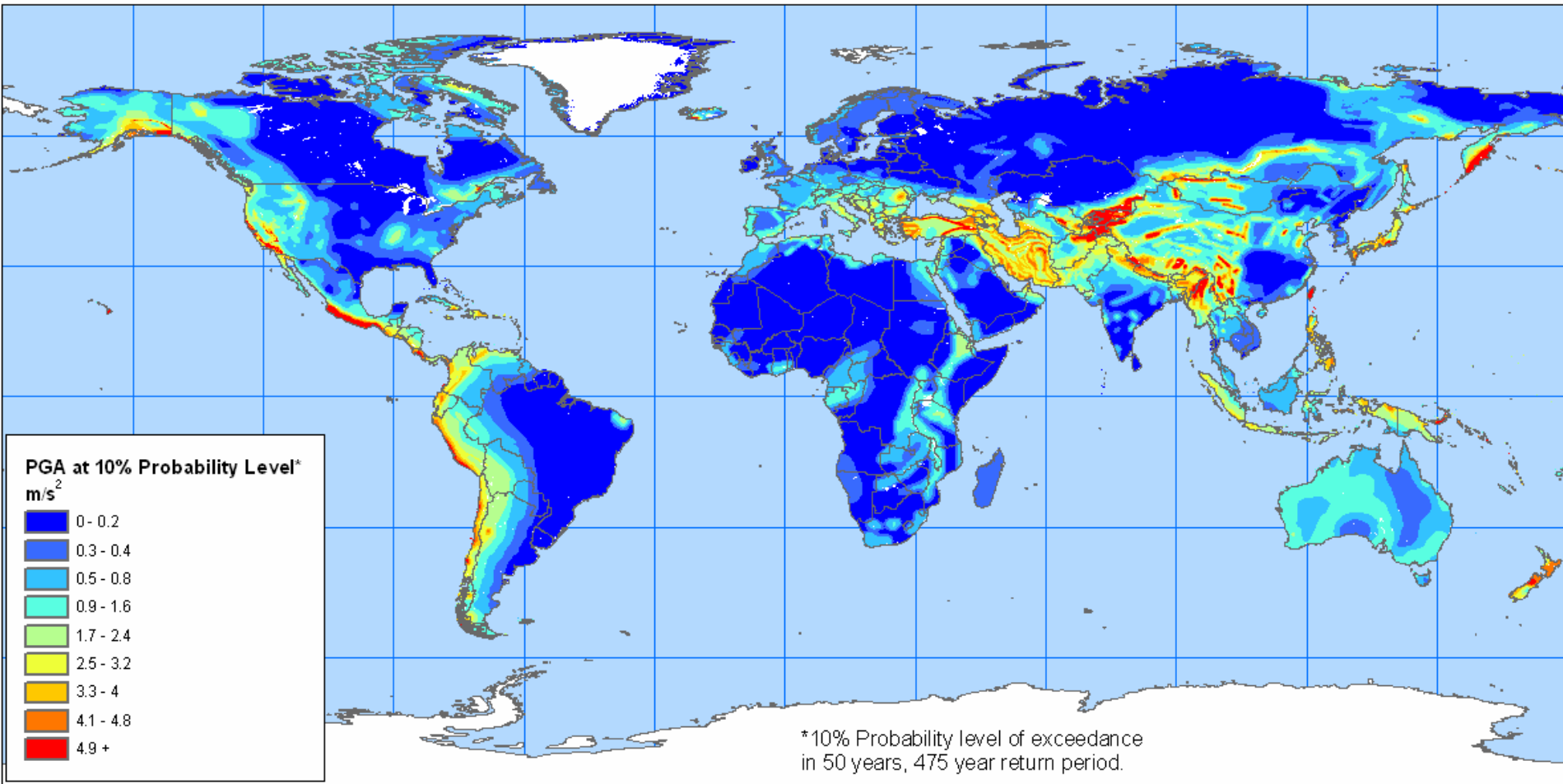Network (CIESIN), Columbia University

Abstract

- The World Bank and Columbia University have developed a report on and global database of natural disaster 'hotspots' (areas where the risk of natural disasters are particularly high). The report assesses two outcomes – mortality and economic losses – based on the global distribution of six hazards: earthquakes, volcanoes, landslides, floods, drought, and cyclones. The database includes the sub-national geographic distribution of the six hazards, population, and economic productivity, as well as national-level hazard-related mortality and economic impacts. This presentation will describe the layers collected in the database, methods used in the integration of these layers, and summarize the results.

Data Inputs

- Hazards:
  - Earthquakes
  - Volcanoes
  - Landslides
  - Floods
  - Drought
  - Cyclones

- Exposure
  - Land Area
  - Population
  - Economic Activity
  - Agricultural Activity
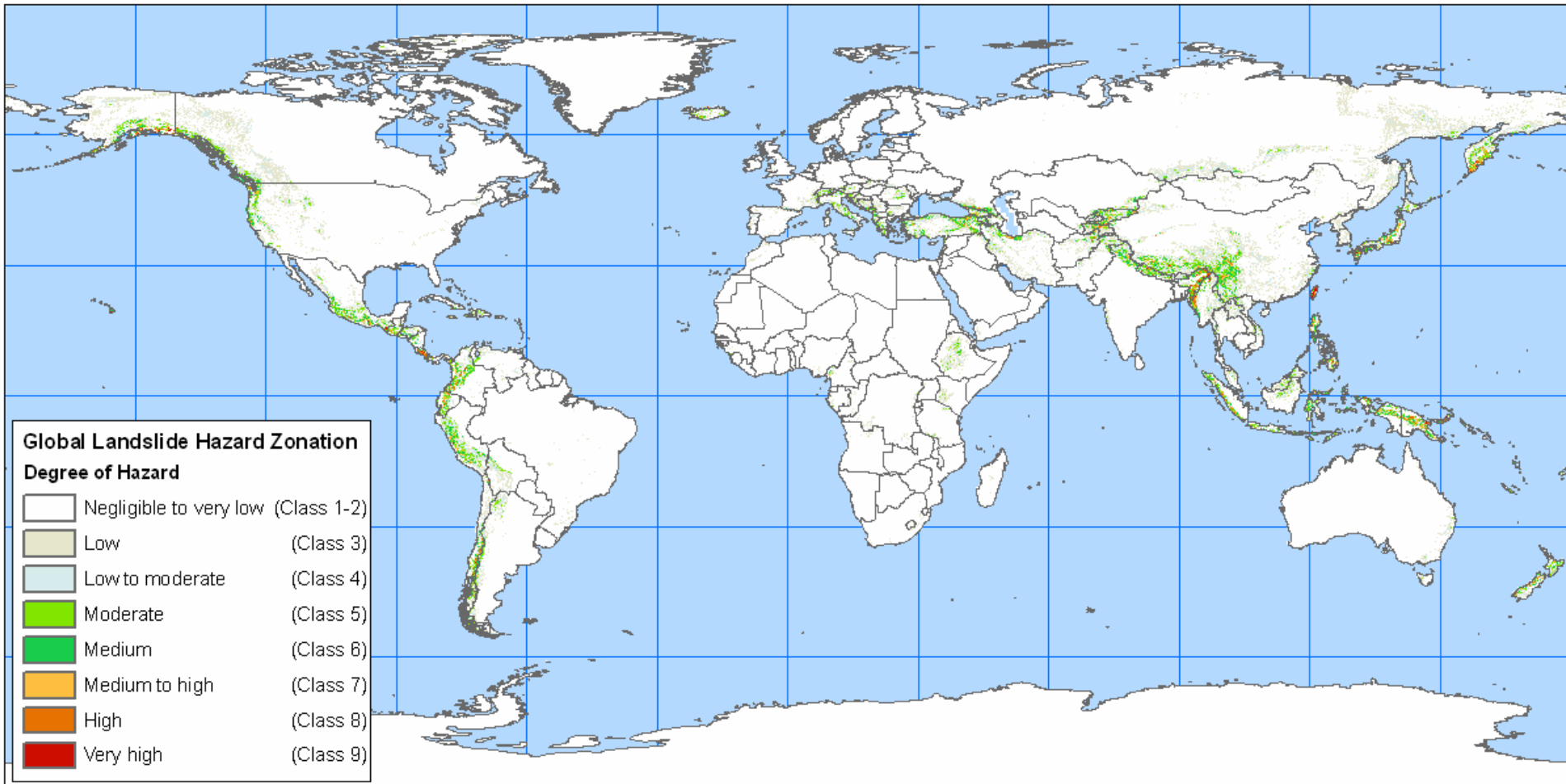 - Transportation Density

Earthquakes

PGA at 10% Probability Level*
m/s²

■	0 - 0.2
■	0.3 - 0.4
■	0.5 - 0.8
■	0.9 - 1.6
■	1.7 - 2.4
■	2.5 - 3.2
■	3.3 - 4
■	4.1 - 4.8
■	4.9 +

*10% Probability level of exceedance
in 50 years, 475 year return period.

Source: Global Seismic Hazard Assessment Program

Volcanoes

Magnitude
Volcanic Explosivity Index
- 1 - 2
- 3 - 4
- 5 - 7

Source: National Geophysical Data Center

Landslides

Global Landslide Hazard Zonation
Degree of Hazard

Negligible to very low	(Class 1-2)
Low	(Class 3)
Low to moderate	(Class 4)
Moderate	(Class 5)
Medium	(Class 6)
Medium to high	(Class 7)
High	(Class 8)
Very high	(Class 9)

Source: Norwegian Geotechnical Institute

Floods

Floods 1985-2003*
- Flood Events - Points
- Flood Events - Polys

*Missing years: 1992, 1996, and 1997.
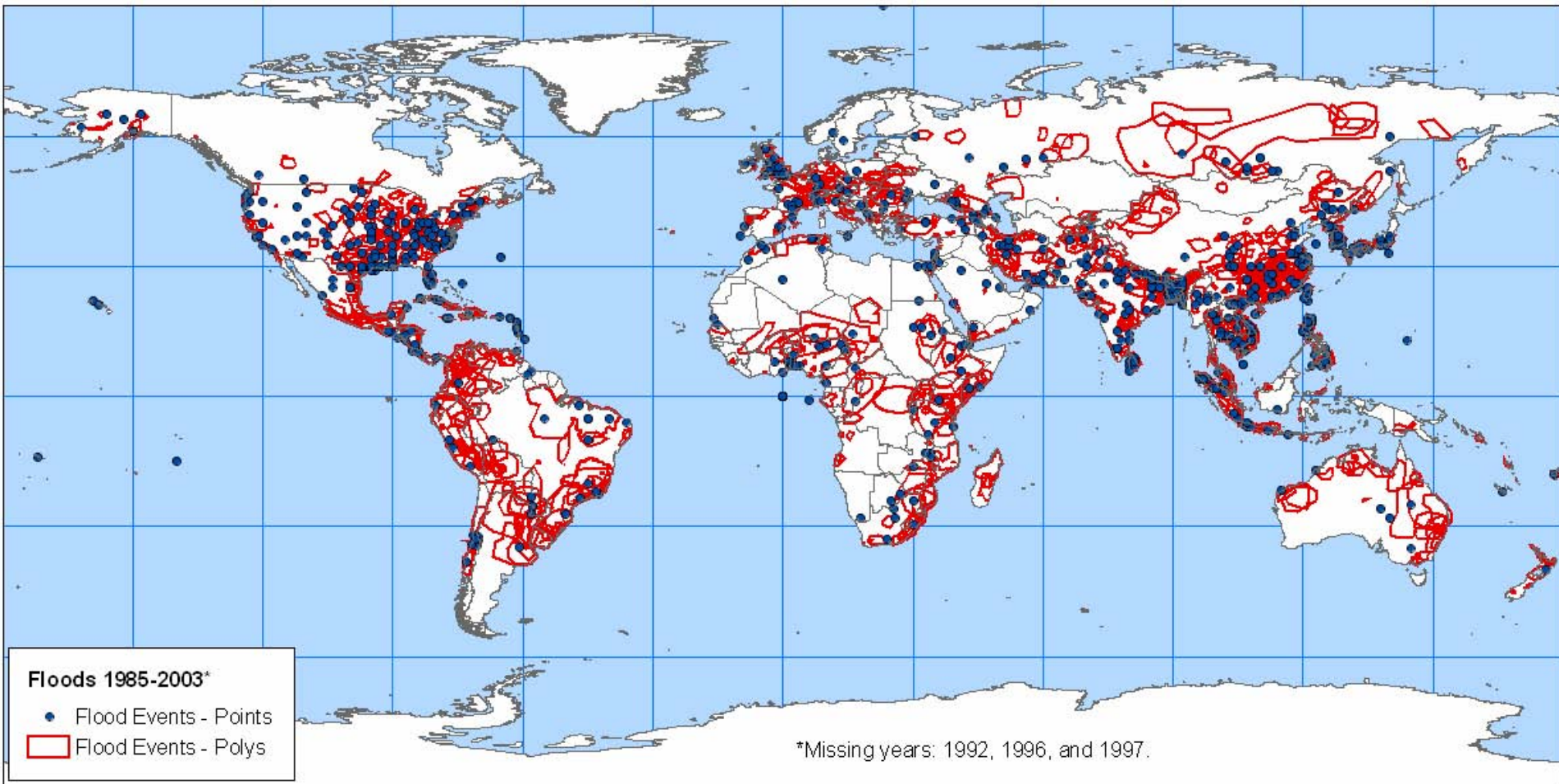
Source: Dartmouth Flood Observatory

Drought
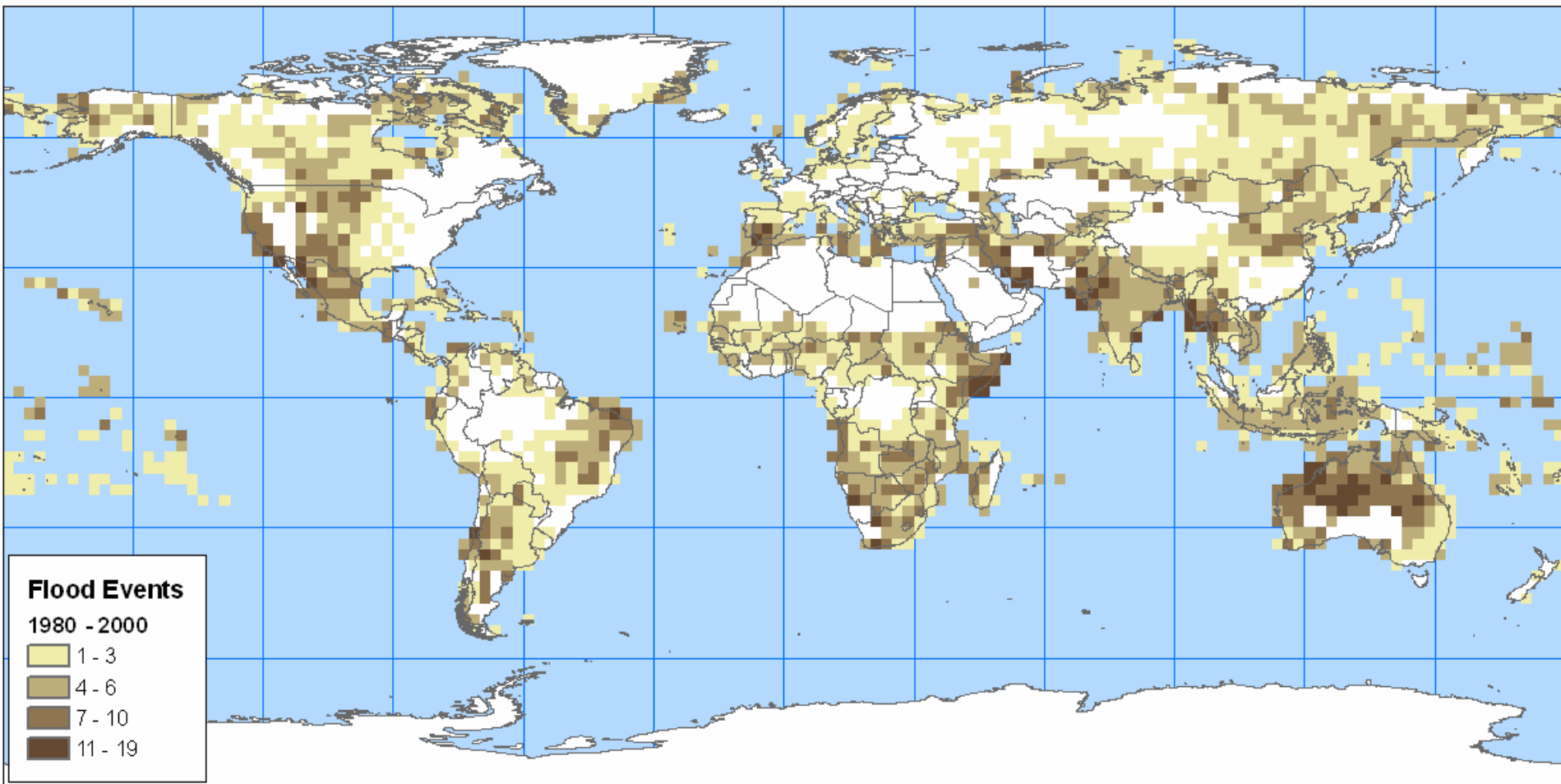
Source: International Research Institute for Climate Prediction

Cyclones
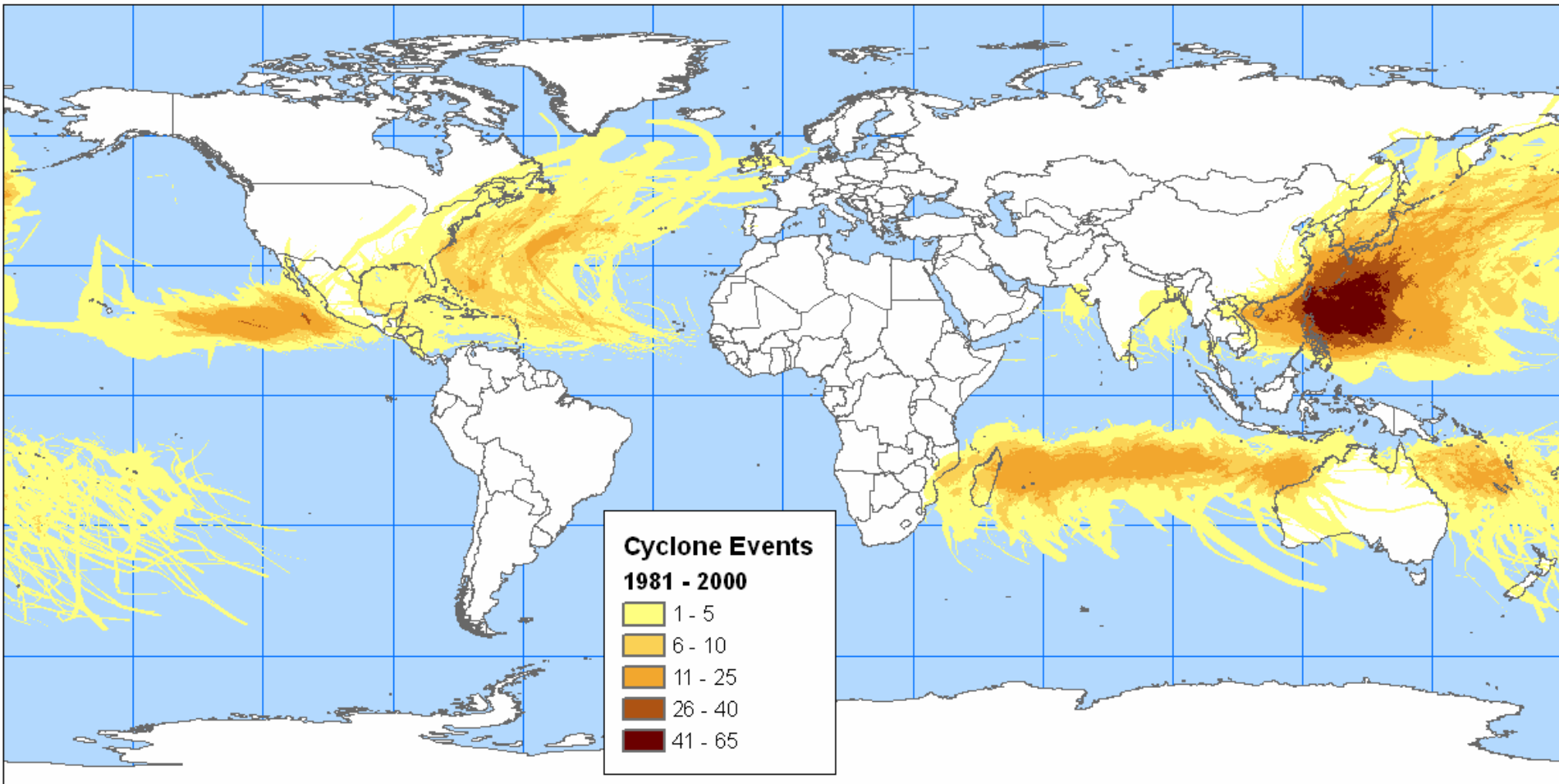
Source: UNEP/GRID PreView Project
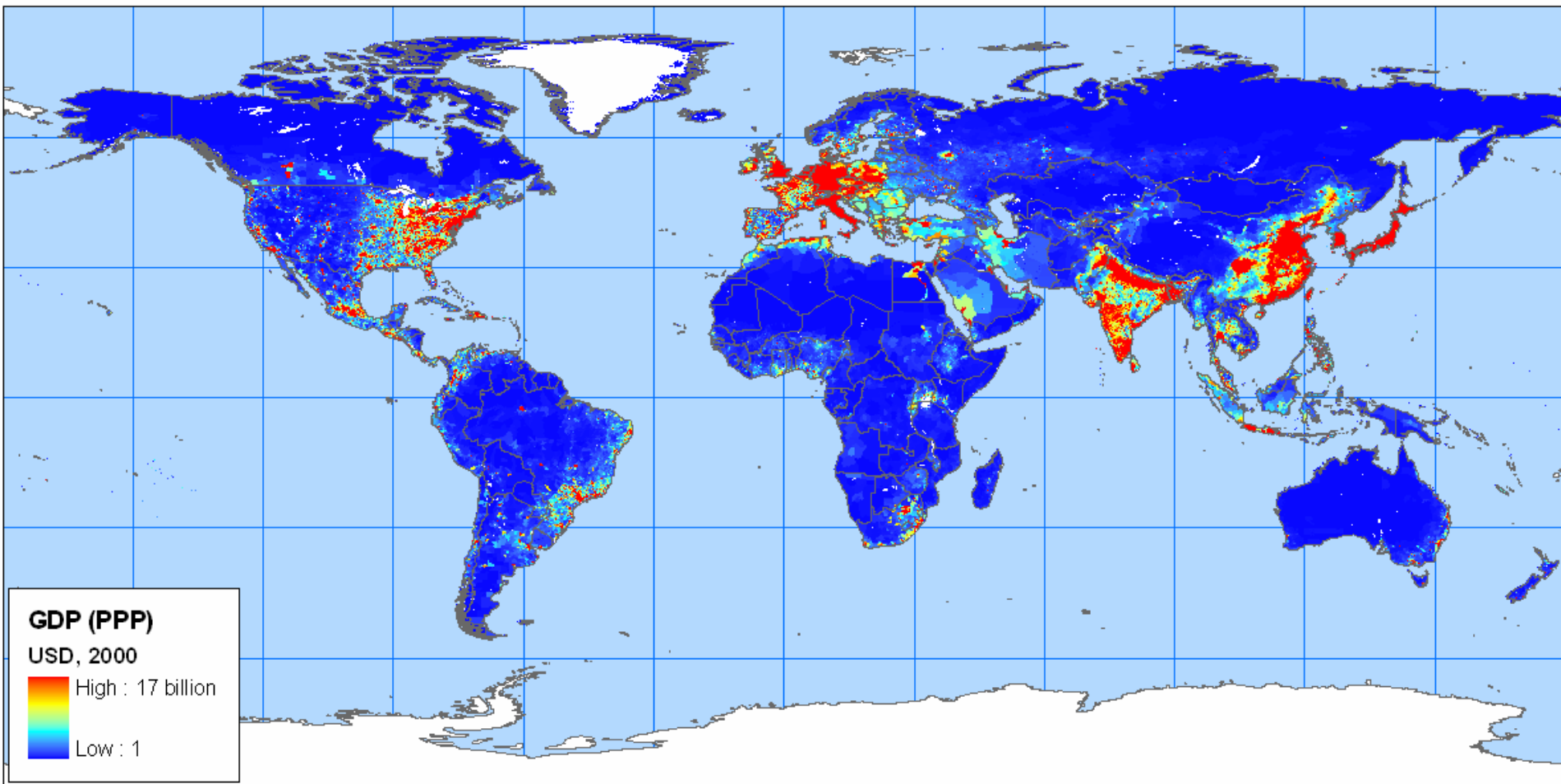
Population

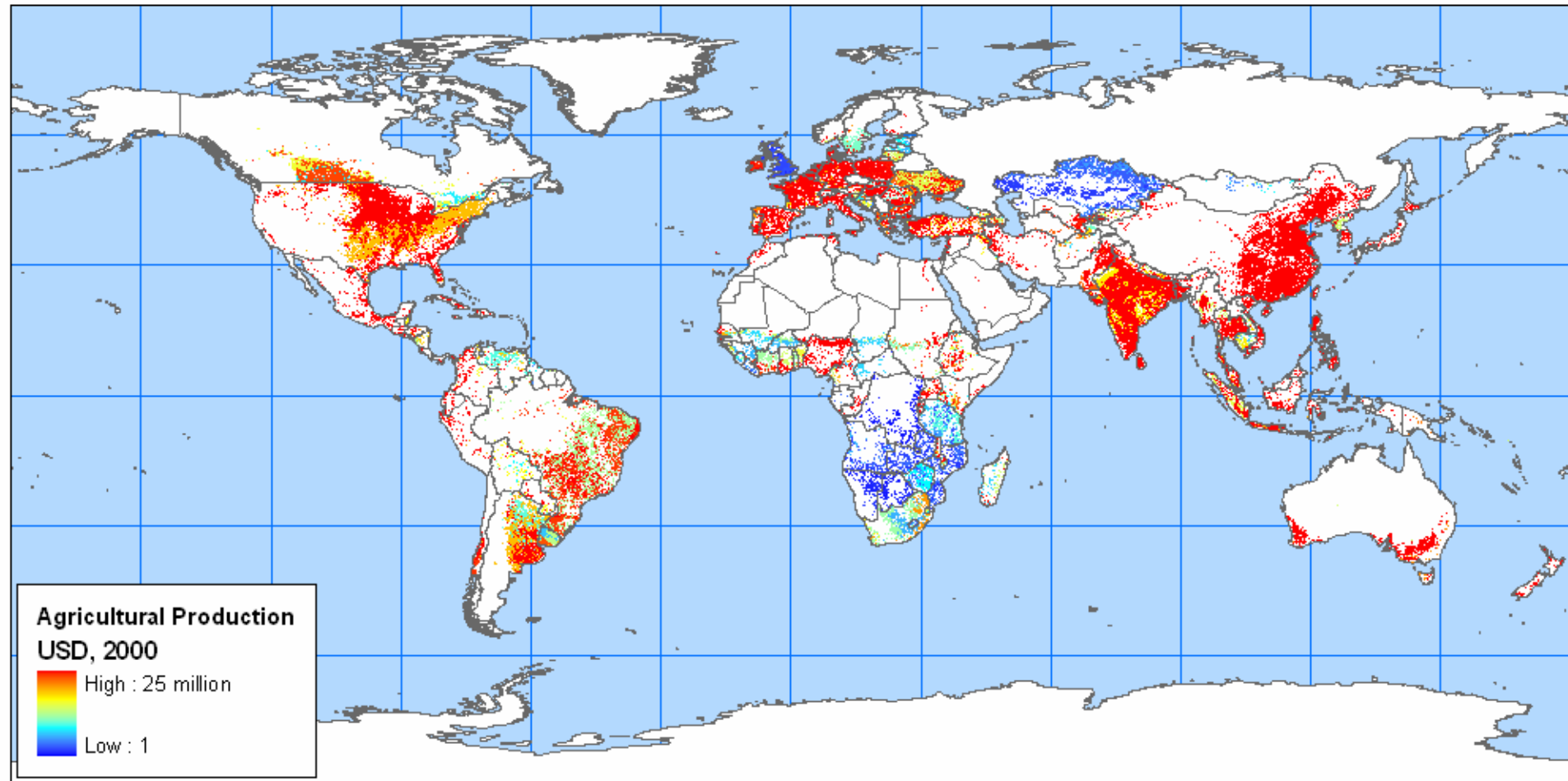Population Density
Persons / km²

- 0 - 1
- 2 - 4
- 5 - 24
- 25 - 99
- 100 - 249
- 250 - 999
- 1,000 +
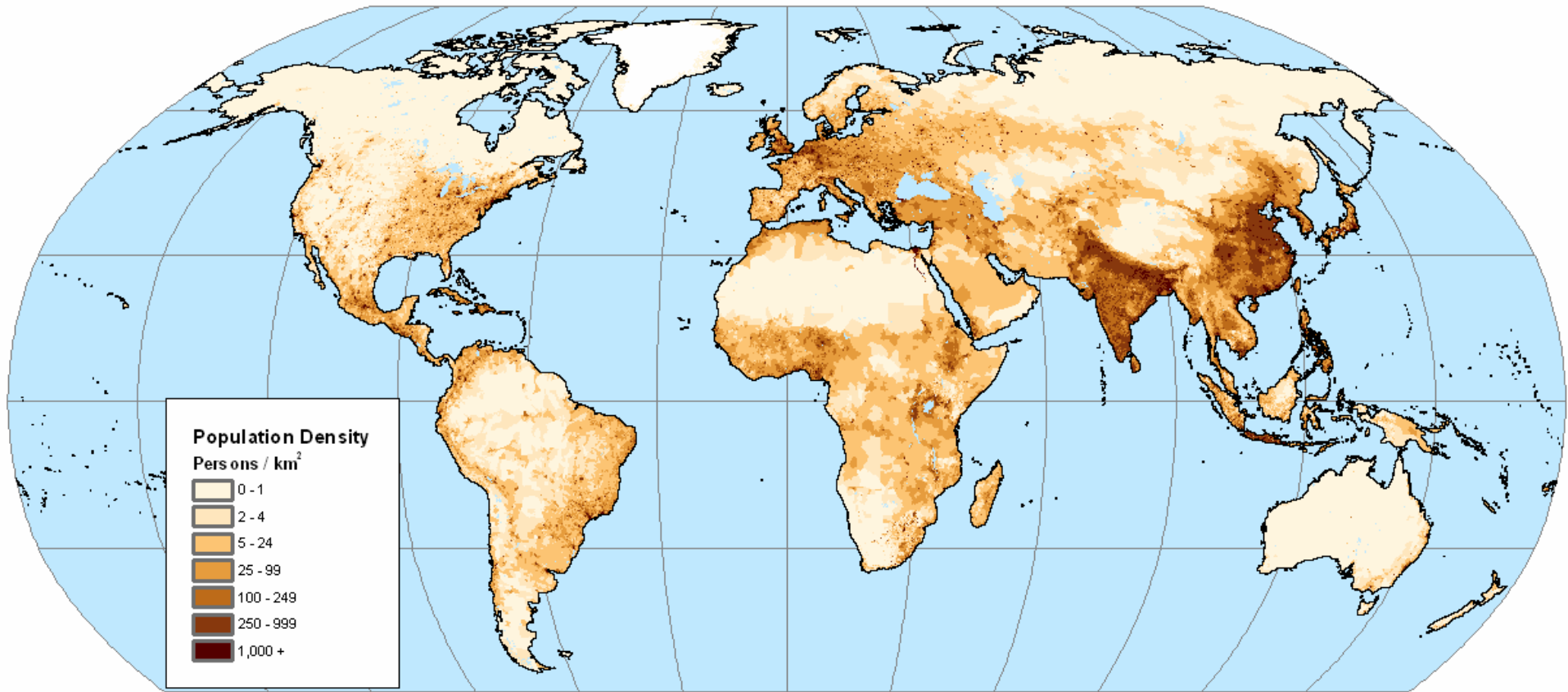
Source: CIESIN's Socioeconomic Data and Applications
   Center (SEDAC)

Economic Activity

GDP (PPP)
USD, 2000
High : 17 billion
Low : 1

Source: The Earth Institute at Columbia University and The World Bank

Agricultural Activity

Agricultural Production
USD, 2000

High : 25 million

Low : 1

Source: The Earth Institute at Columbia University and The World Bank

Transportation Density

Length of Rail and Road
km

- 2.5 - 50
- 50.1 - 100
- 100.1 - 250
- 250.1 - 634.8
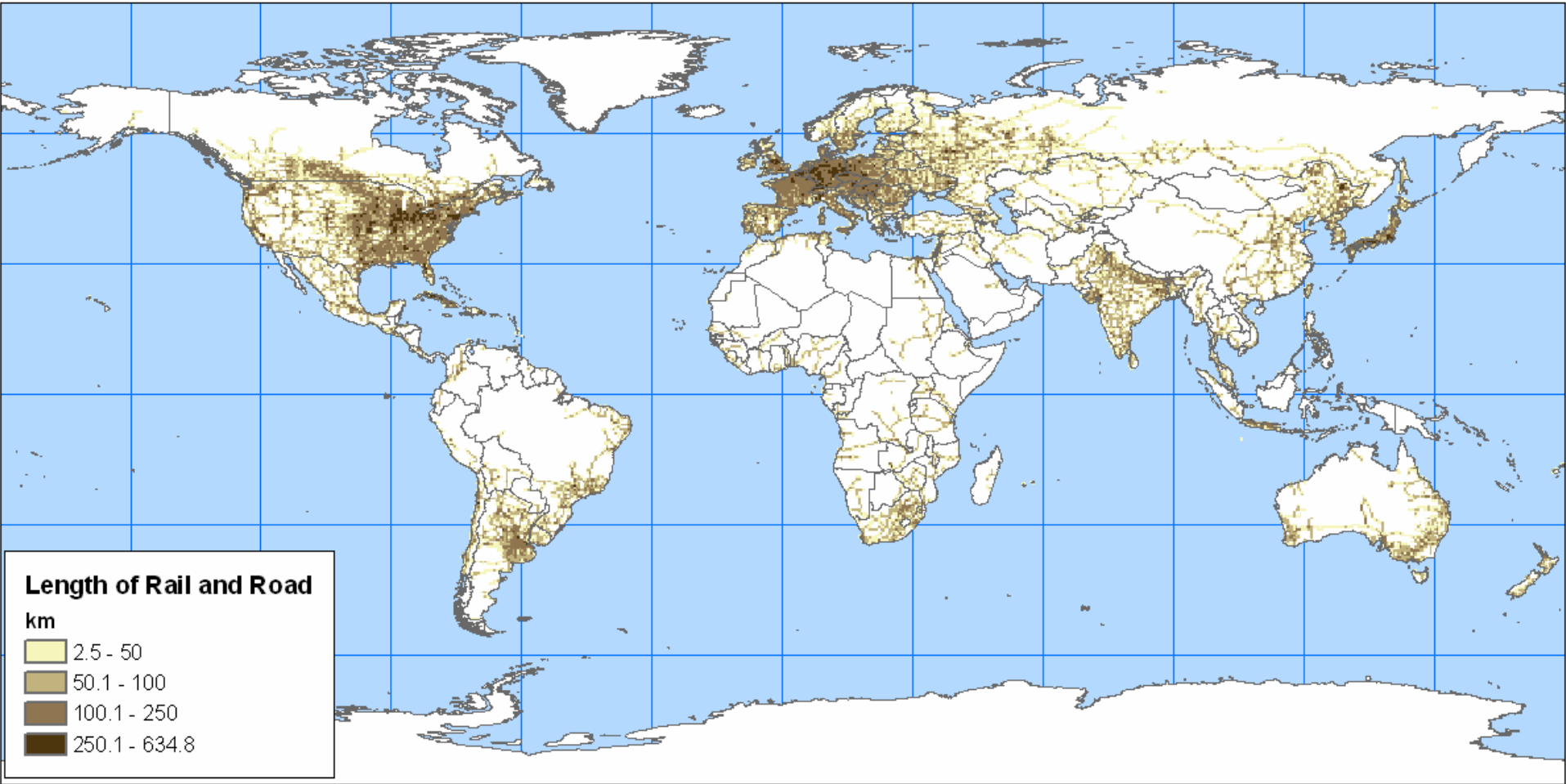
Source: VMAP Level 0

Input Data Transformations

- Hazard data:
  - Vector data were gridded as count surfaces
  - Raster data were resampled to a common resolution (2.5 arc-minutes)
  - Masked to include only inhabited or agricultural areas
  - Sliced into deciles (SLICE function in GRID with equal area option)

- Exposure data:
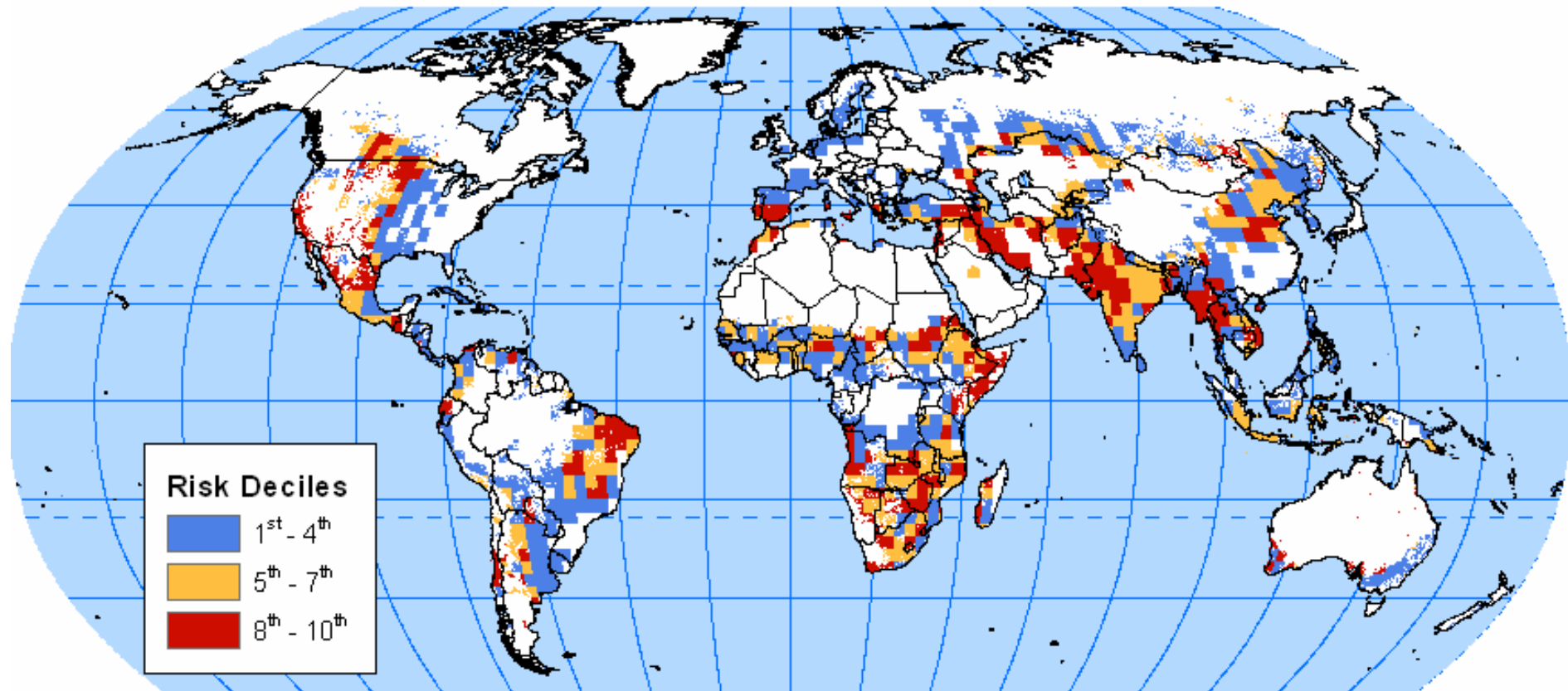 - Resampled to common resolution (2.5 arc-minutes)

Analysis Mask

Analysis Mask

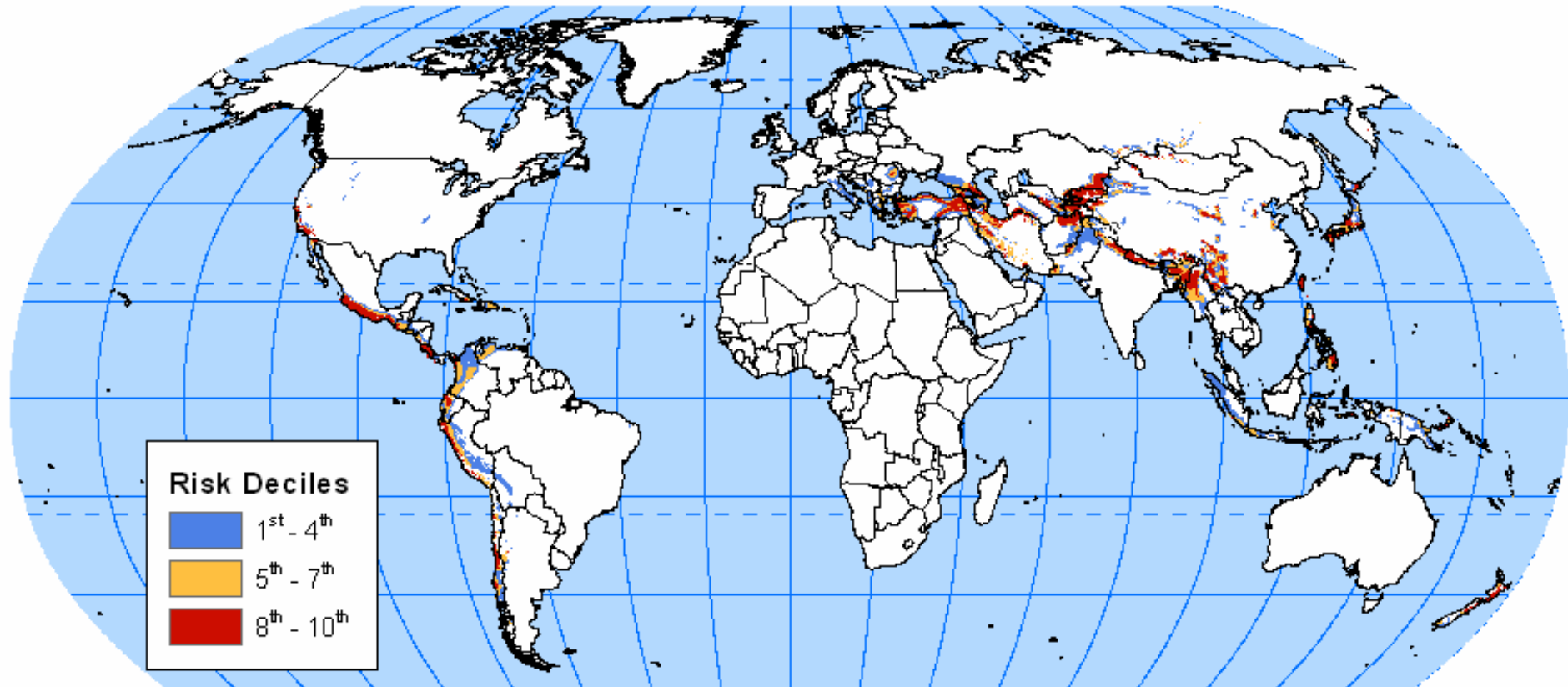- Agriculture Only
- Inhabited Only
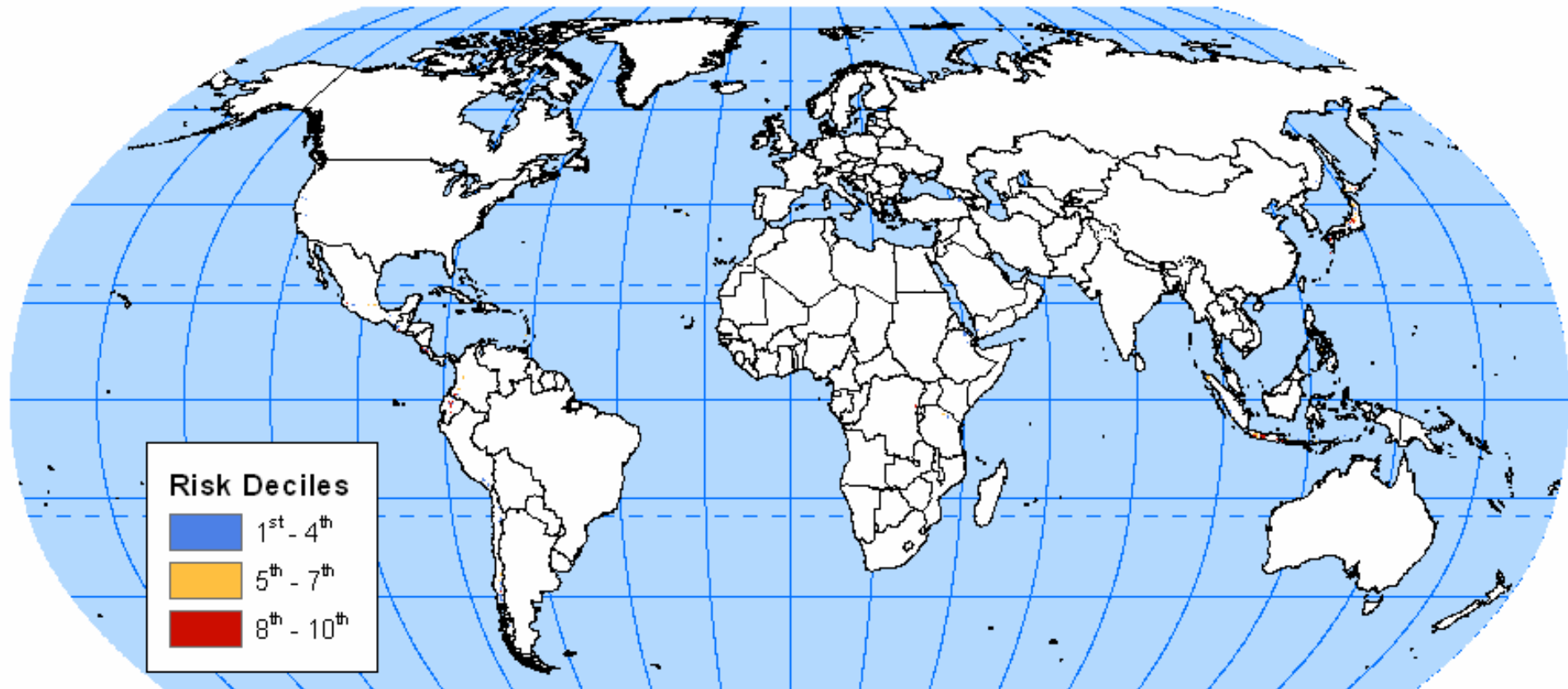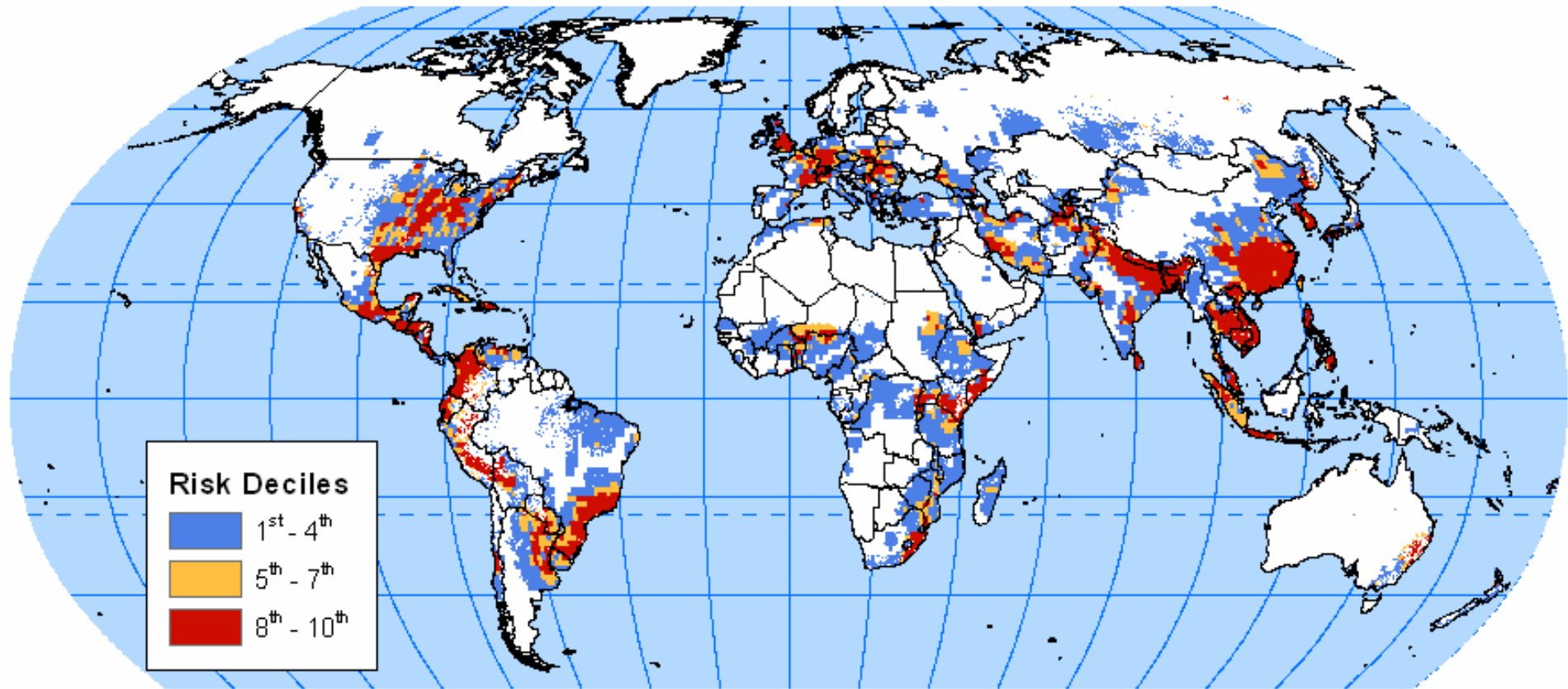- Ag. and Inhabited
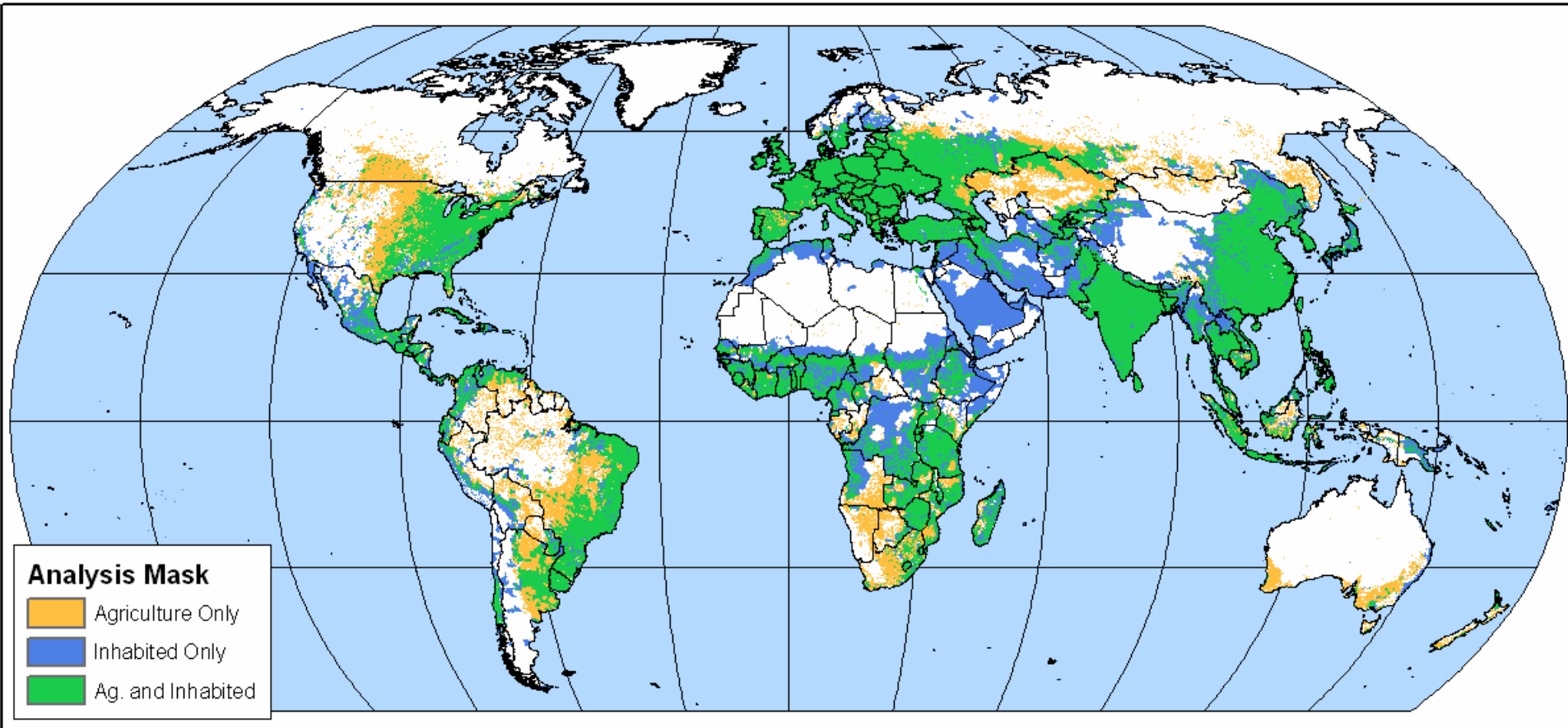
Cyclone Deciles
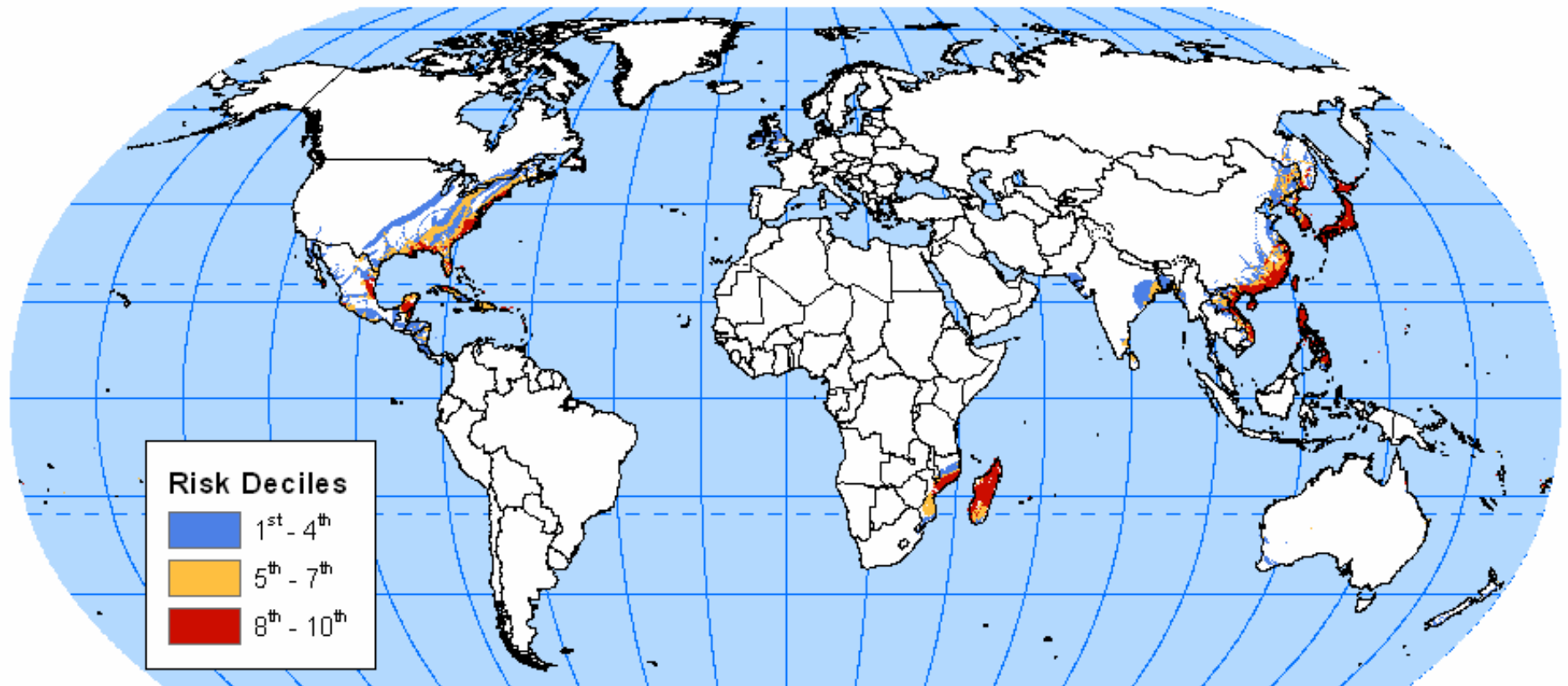
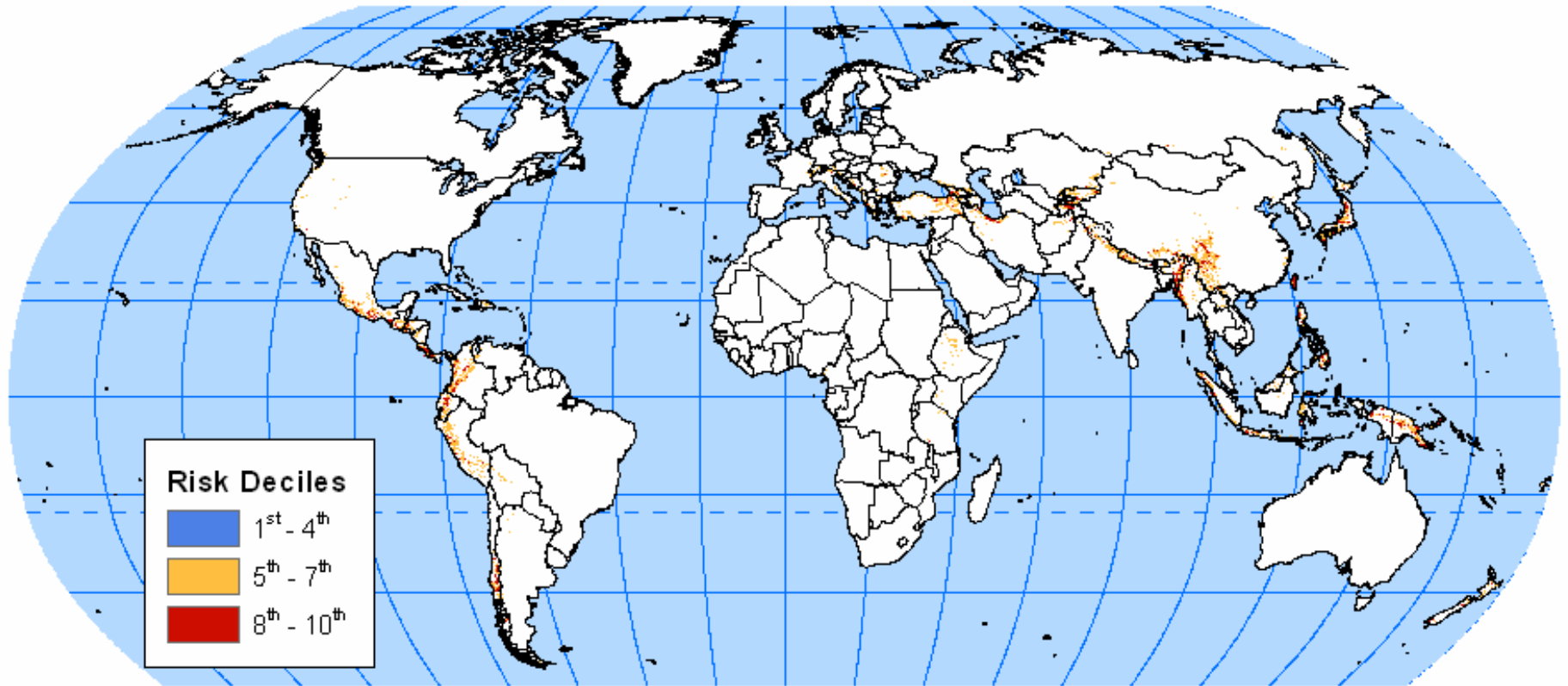# Drought Deciles

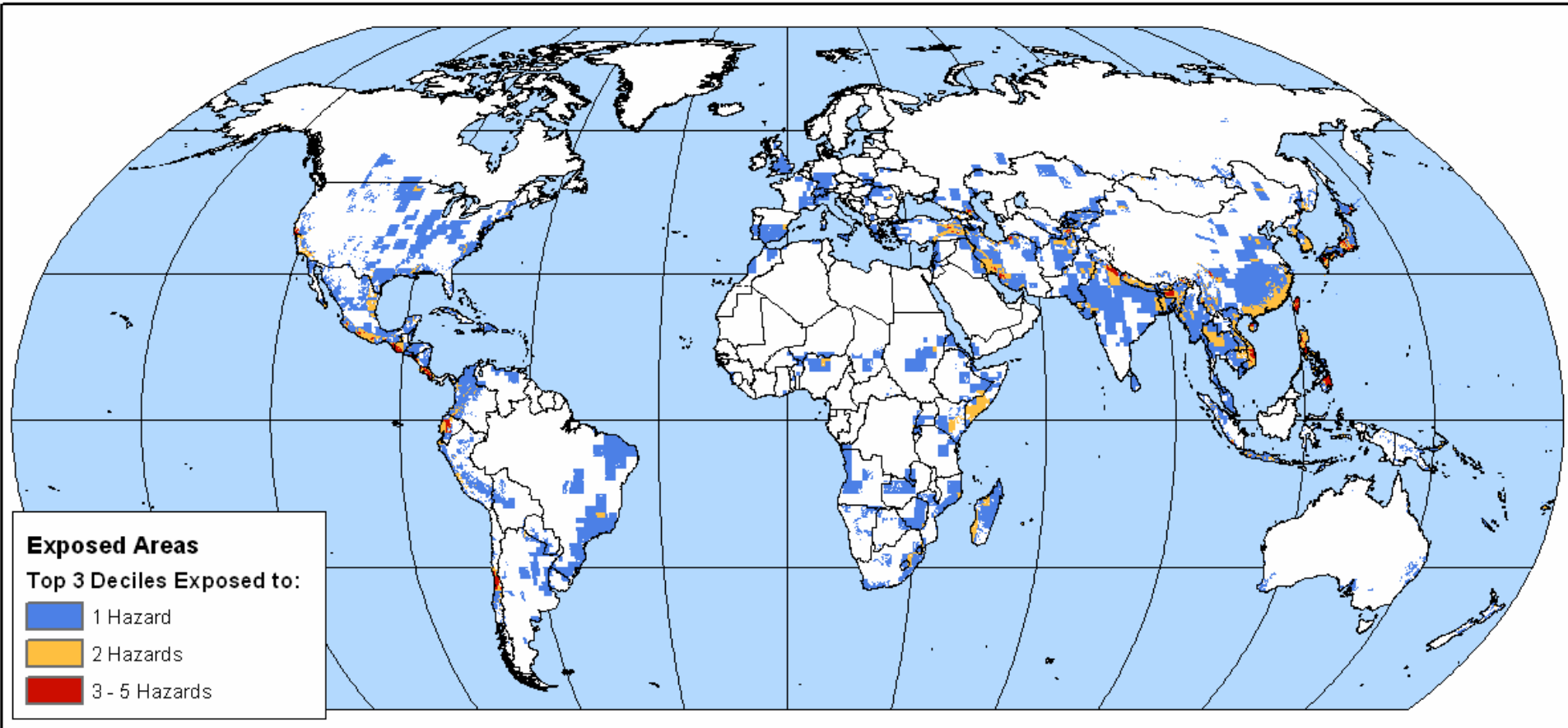# Earthquake Deciles

Volcano Deciles
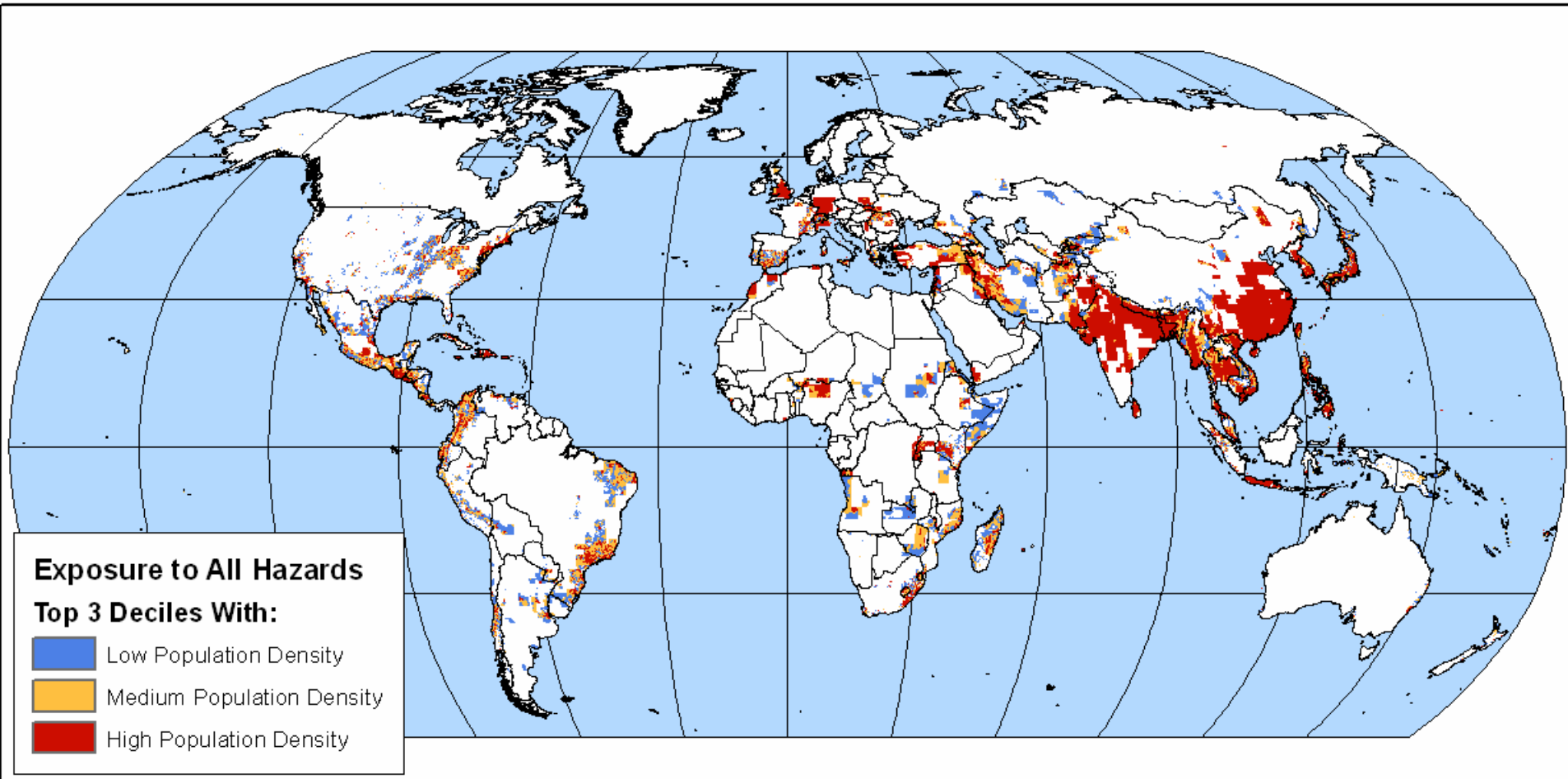
Flood Deciles

Landslide Deciles

Identifying Multihazard Areas

- All 6 hazard deciles were combined (COMBINE function in GRID).

- Only the top 3 deciles (extremes) were kept.

- Exposure values were calculated using the ZONALSTATS functions (number of persons, GDP value, Agricultural GDP value, land area, and linear km of road and rail exposed to each hazard).
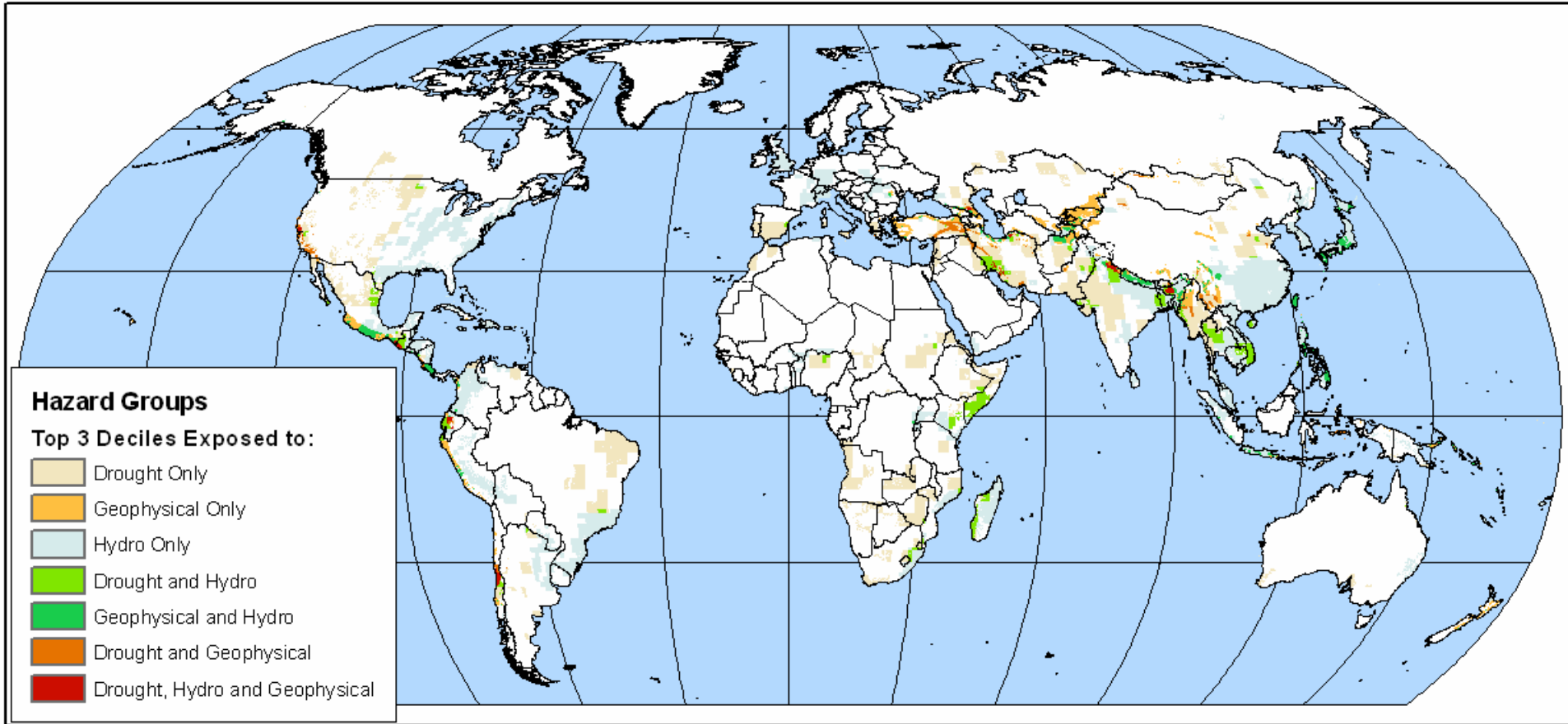
Multihazard Areas

Exposed Areas

Top 3 Deciles Exposed to:

1 Hazard
2 Hazards
3 - 5 Hazards

Population Exposure

Exposure to All Hazards
Top 3 Deciles With:

- Low Population Density
- Medium Population Density
- High Population Density

Low: 5-14.49, med: 14.5-51.49, high: 51.5 + persons per km^2

Hazard Groups

Hazard Groups
Top 3 Deciles Exposed to:
- Drought Only
- Geophysical Only
- Hydro Only
- Drought and Hydro
- Geophysical and Hydro
- Drought and Geophysical
- Drought, Hydro and Geophysical

Geophysical includes volcano and earthquake hazards; hydro includes cyclone, flood, and landslide hazards.

Disaster Risk: Mortality

- Hazard-specific regional mortality rates (per 100,000 persons) were derived from EM-DAT.

- These rates were applied on a per-hazard basis to the population of grid cells in exposed areas to produce single-hazard mortality layers.

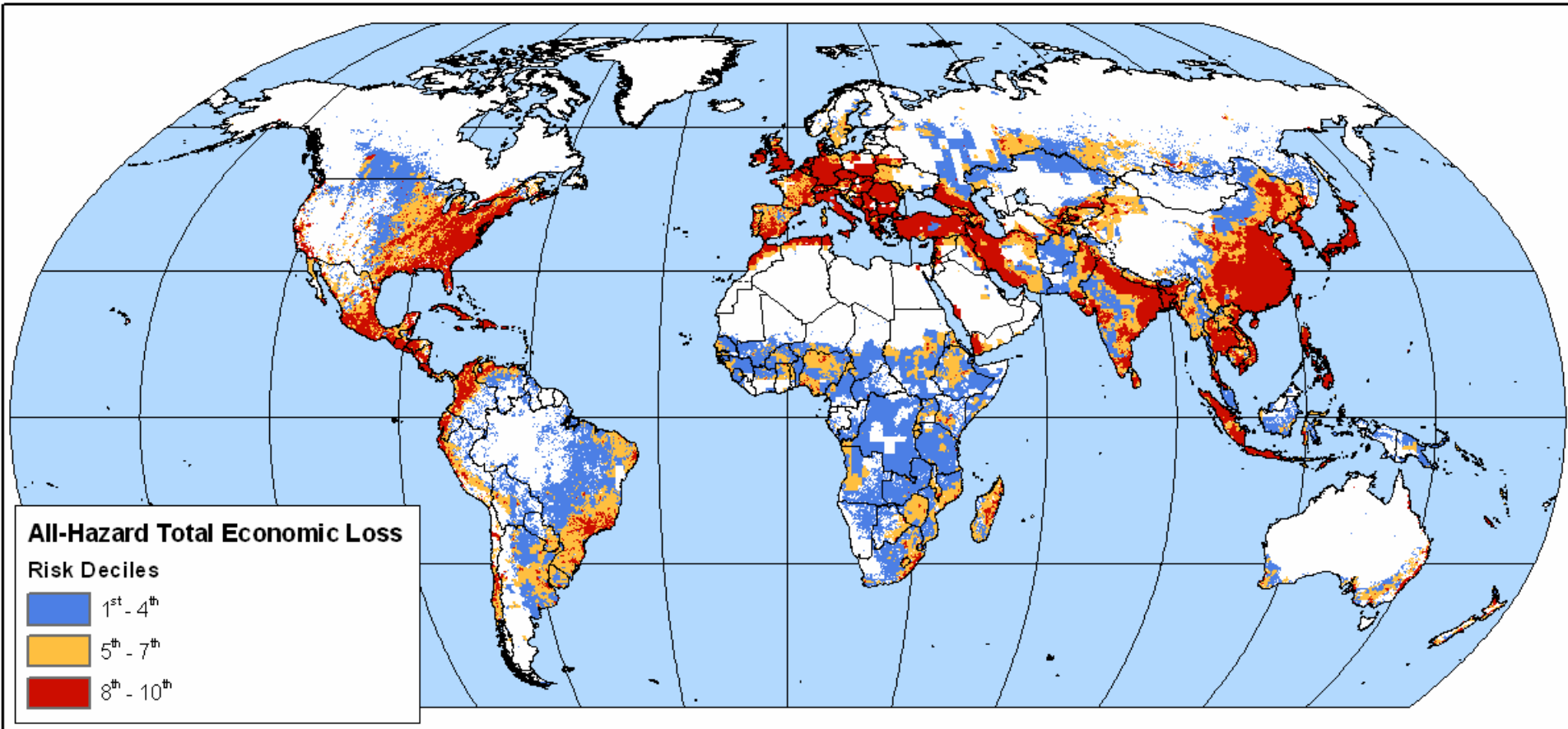- The single-hazard results were summed to estimate mortality from all 6 hazards.

Disaster Risk: Mortality

All-Hazard Mortality

Risk Deciles

- 1st - 4th
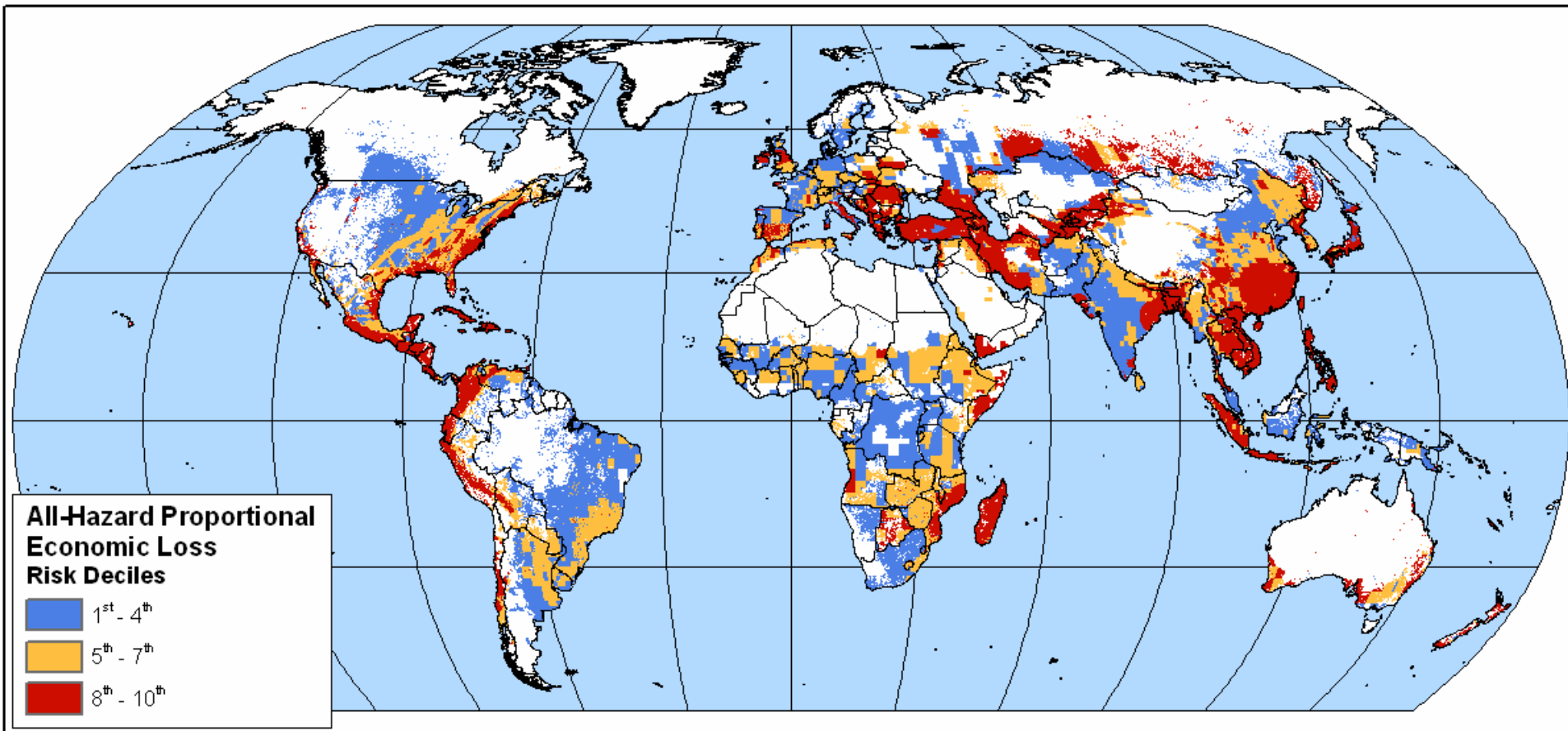- 5th - 7th
- 8th - 10th
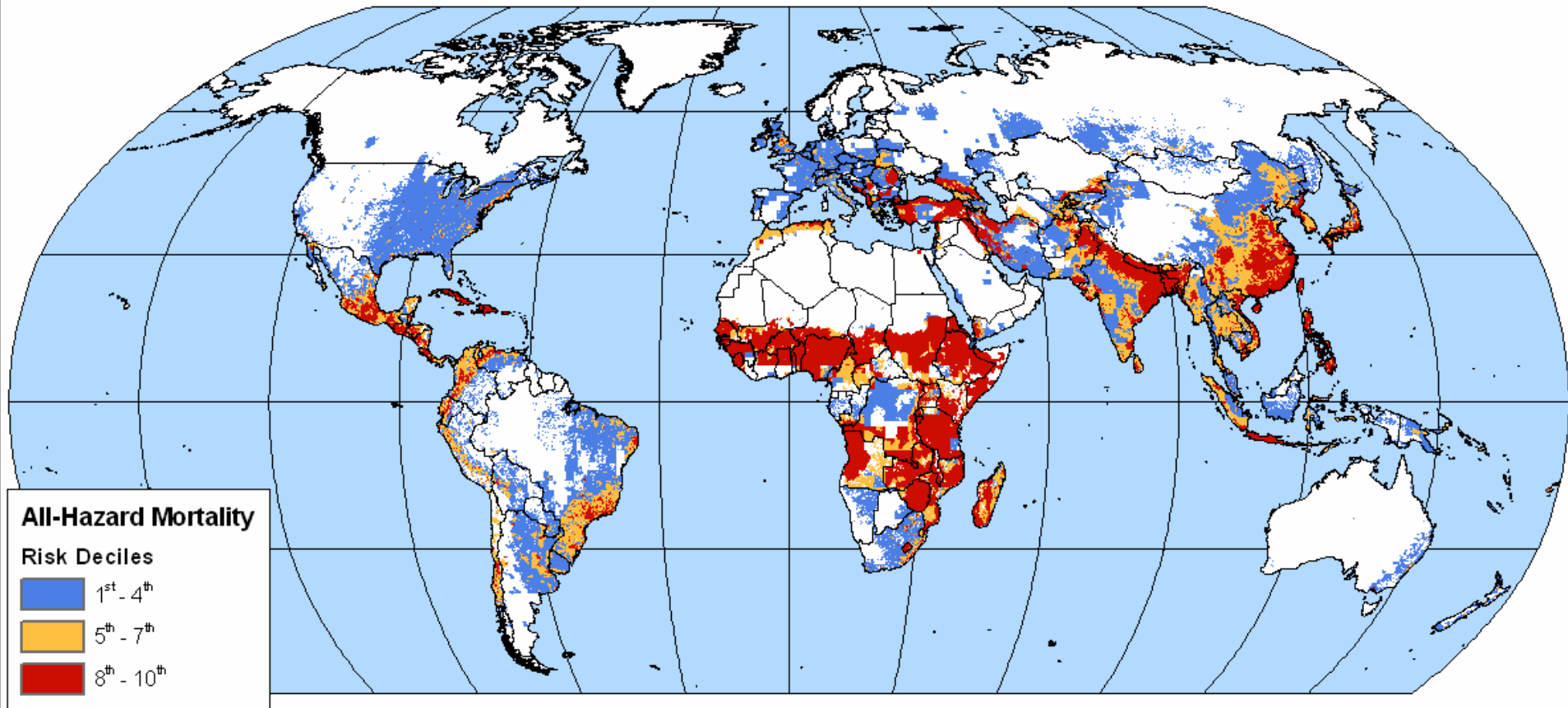
Disaster Risk: Economic Losses

- Hazard-specific economic loss rates were derived from EM-DAT.

- These rates were applied on a per-hazard basis to the GDP of grid cells in exposed areas to produce single-hazard economic loss layers.

- The single-hazard results were summed to estimate economic loss from all 6 hazards.

Economic Loss Data

All-Hazard Total Economic Loss

Risk Deciles

- 1st - 4th
- 5th - 7th
- 8th - 10th

Proportional Economic Loss

All-Hazard Proportional Economic Loss
Risk Deciles

- 1st - 4th
- 5th - 7th
- 8th - 10th

For More Information
and Data Access:

Center for Hazards & Risk Research

at Columbia University

http://www.ldeo.columbia.edu/chrr/research/hotspots/

hotspotsdata@ciesin.columbia.edu

For the Full Hotspots Report:

http://publications.worldbank.org/ecommerce/catalog/product?item_id=4302005

Data Sources

- Global Seismic Hazard Assessment Program: Earthquakes
  - http://www.seismo.ethz.ch/GSHAP/
- National Geophysical Data Center: Volcanoes
  - http://www.ngdc.noaa.gov/seg/hazard/volcano.shtml
- Norwegian Geotechnical Institute: Landslides
  - http://www.ngi.no/english/default.asp
- Dartmouth Flood Observatory: Floods
  - http://www.dartmouth.edu/~floods/
- International Research Institute for Climate Prediction: Drought
  - http://iri.columbia.edu/
- UNEP/GRID PreView Project: Cyclones
  - http://www.grid.unep.ch/activities/earlywarning/preview/

Data Sources

- CIESIN: Population and Land Area
  - http://beta.sedac.ciesin.columbia.edu/gpw/index.jsp
- Center for Research on the Epidemiology of Disasters: EM-DAT
  - http://www.em-dat.net/
- National Geospatial Intelligence Agency: VMAP Level 0
  - http://geoengine.nima.mil/geospatial/SW_TOOLS/NIMAMUSE/webinter/rast_roam.html
- Earth Institute and World Bank: GDP and Agricultural Productivity data
  - http://www.Ideo.columbia.edu/chrr/research/hotspots/

Acknowledgements

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References

- Dilley, M., R. Chen, U. Deichmann, A. Lerner-Lam, and M. Arnold, with J. Agwe, P. Buys, O. Kjekstad, B. Lyon and G. Yetman, 2005. **Disaster Risk Management Series No. 5: Natural Disaster Hotspots, A Global Risk Analysis**. The World Bank, Washington, D.C.

- PreView: Project of Risk Evaluation, Vulnerability, Information & Early Warning
  - http://www.grid.unep.ch/activities/earlywarning/preview/