Risks of Exposure and Vulnerability to Natural Disasters for World's Major Urban Areas

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Views expressed in the presentation are solely of the author and do not reflect those of the United Nations

Outline

1. Rationale & Objectives
2. Data Sources and Methods
3. Major Findings
4. Summary & Limitations

World's Major Urban Areas and Natural Disasters

1. Home for 55%f of the world's population (UN, 2018)

Global urban and rural populations

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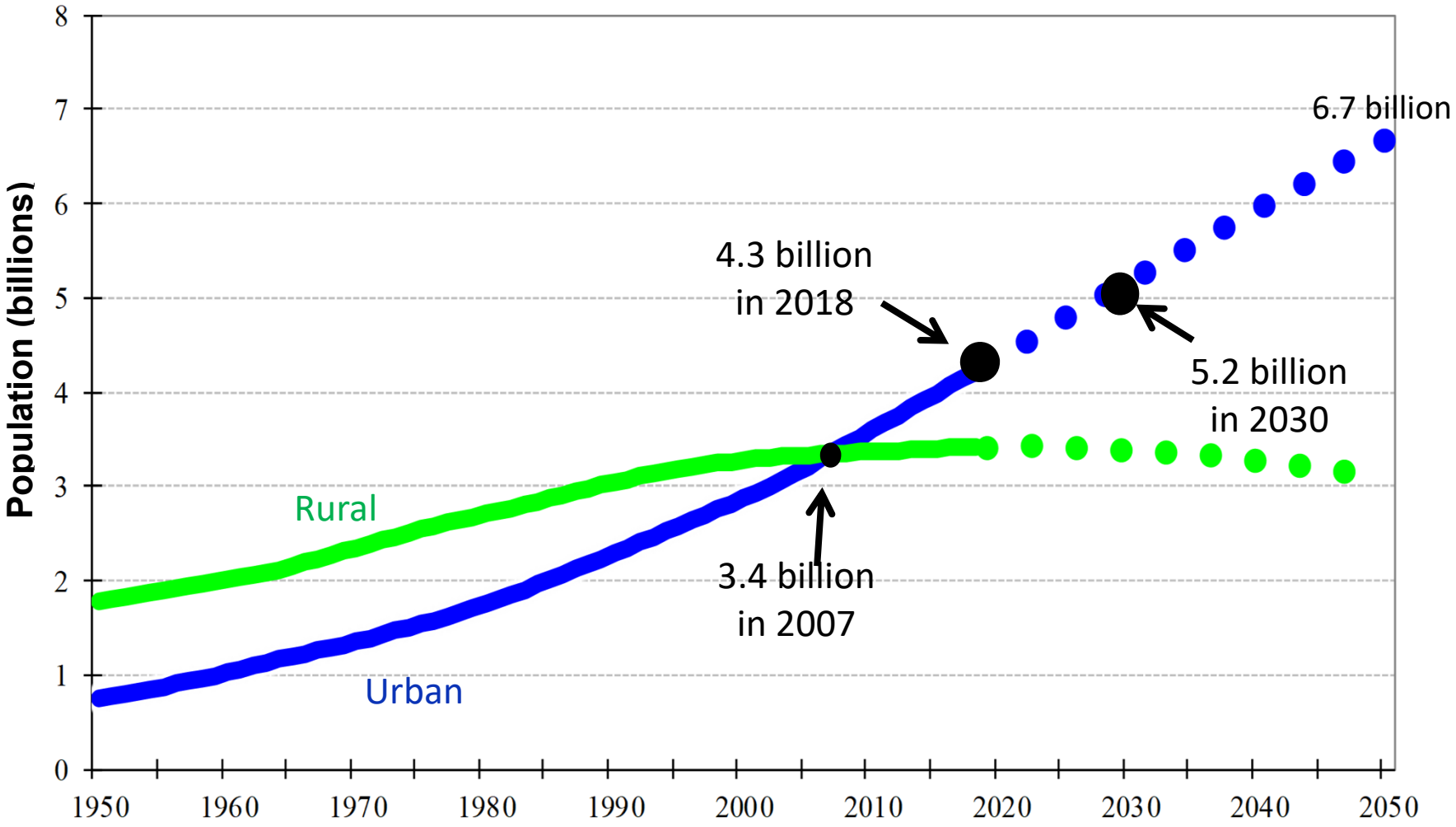
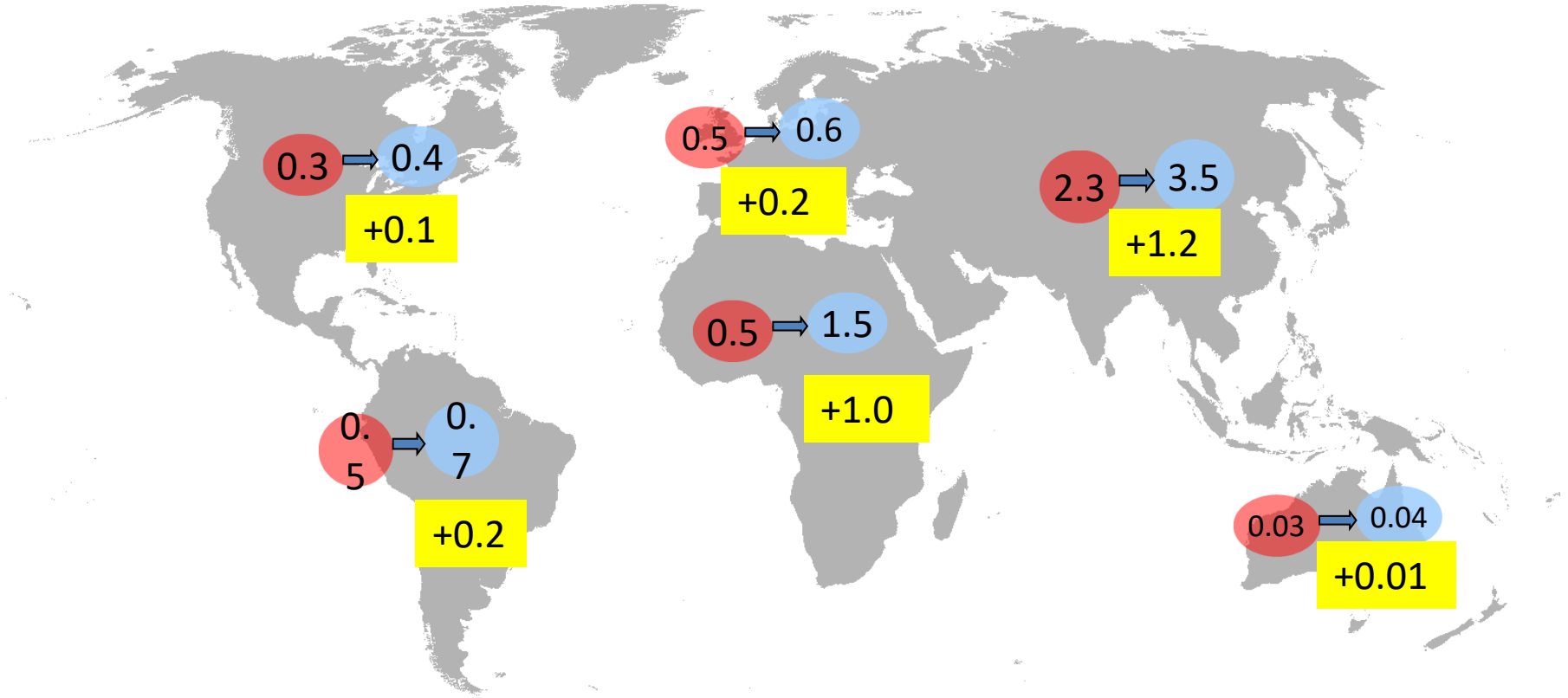


Source: UN (2018), World Urbanization Prospects: The 2018 Revision.

Urban population by region (billions)



Source: UN (2018), World Urbanization Prospects: the 2018 Revision.

Major Urban Areas and Natural Disaster

1

1. Home for 55% of the world's population (UN, 2018)
2. Centers of productive activities in industries and services;
   - 70-80% of GDP produced in urban areas
     (Weiss, 2001; Dobbs et al. 2011).

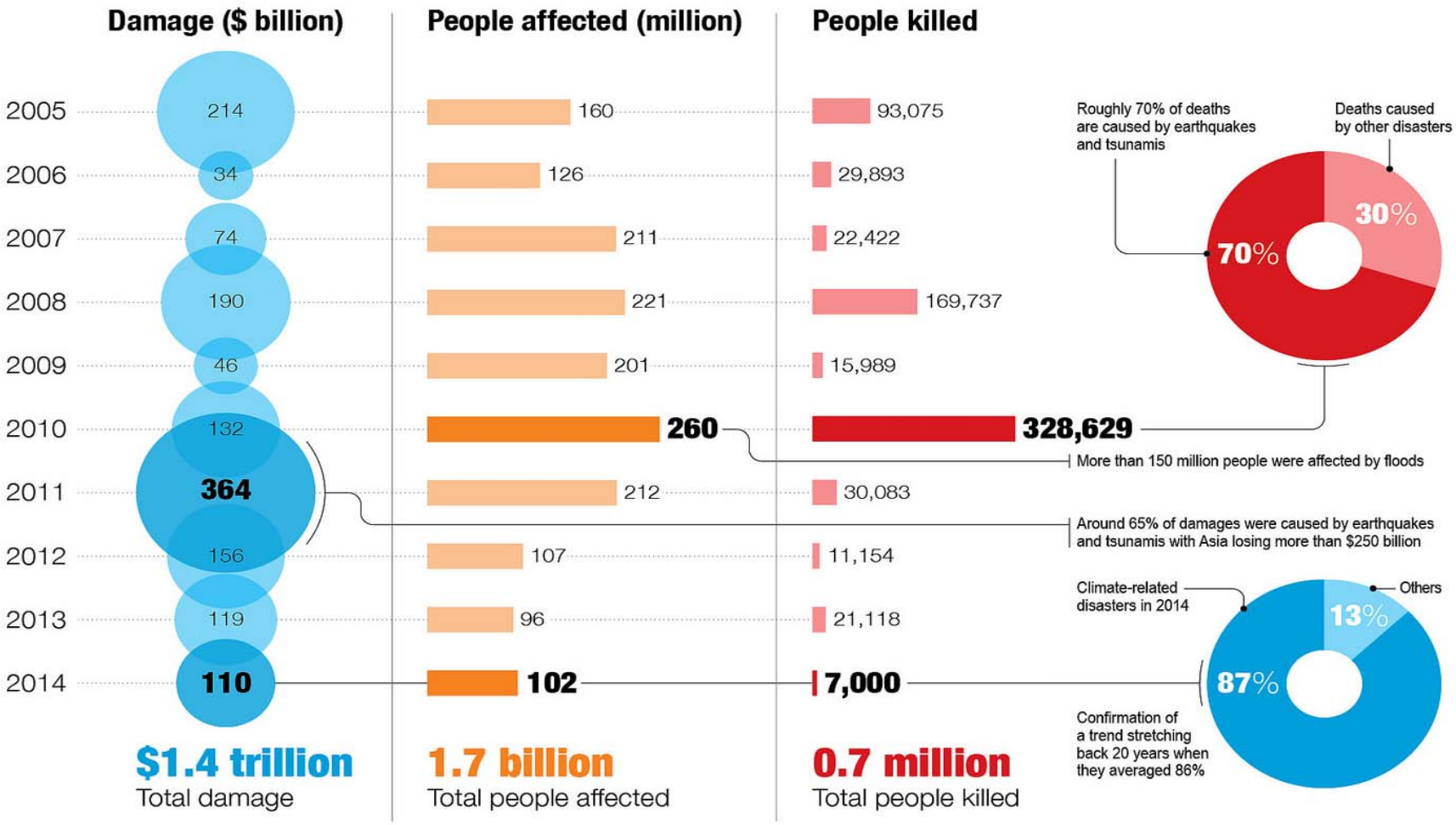
causing environmental problems

   - 75-80% of emissions of carbon dioxide by cities (Satterthwaite, 2008).

3. Natural hazards: 2000-2012, 2.9 billion people affected and 1.2 million killed, US$1.7 trillion (damage) (UNISDR, 2013)
   - $73 billion in the 1960s, and $630 billion in the 1990s (Guin & Saxena, 2005)
   - 42 million years lost annually from 1980-2012 (UNISD, 2015)
   - $250-300 billion lost annually since 2000 (UNISD, 2015)

4. Insufficient knowledge and awareness about risks of exposures of world's urban populations to natural hazards, environmental degradations, and climate change

Economic and human impact of disasters. 2005-2014



Source: UNISDR (2015).

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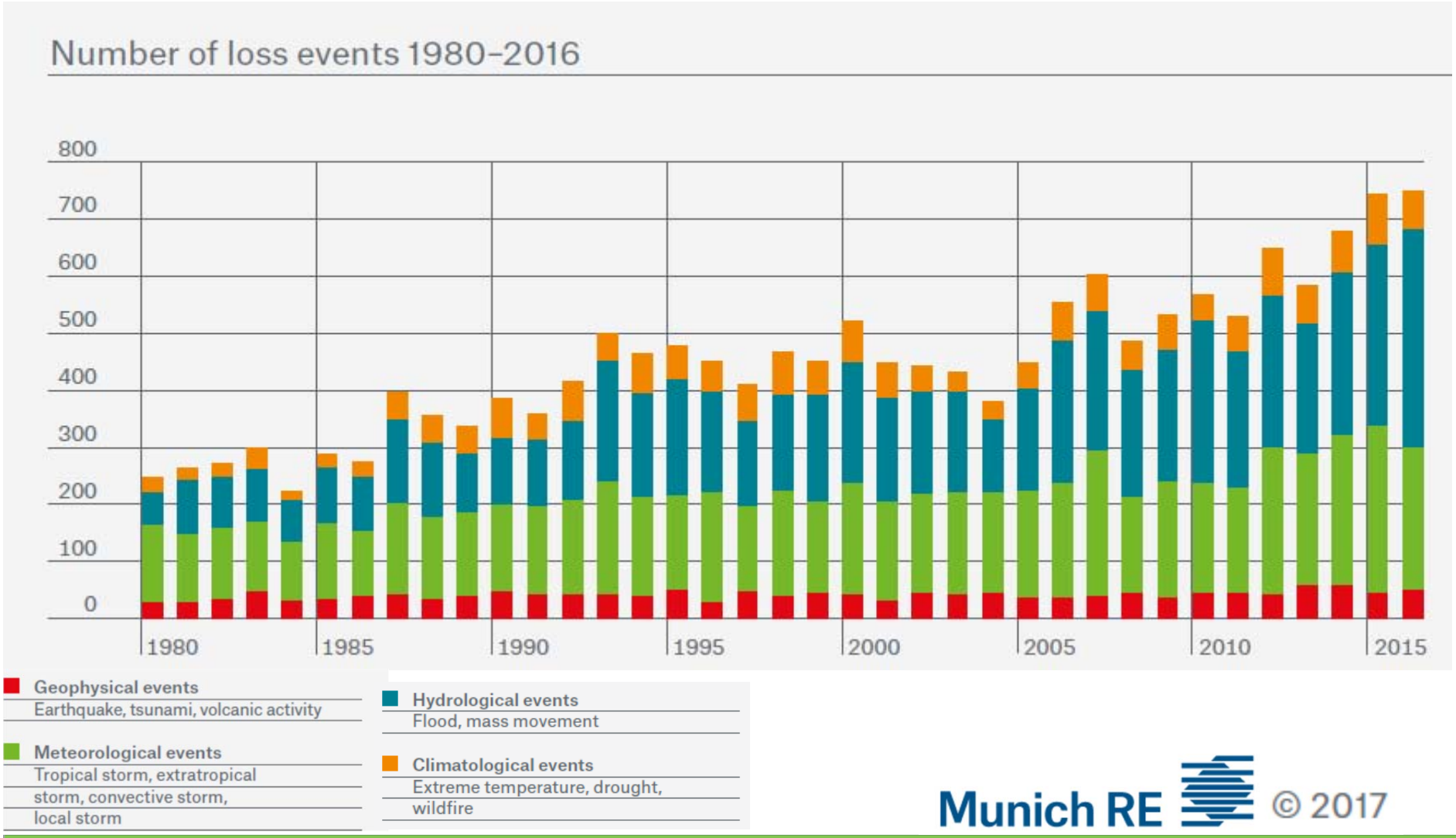

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Indicators of sustainable development goals (SDGs) relevant to disaster reduction

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1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters
Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030
Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

Source: UNISDR (2018).

Objectives

1. Investigate potential risks of exposures of world's major urban areas to natural disasters.
2. Investigate vulnerability of mortality of world's major urban areas to natural disasters.
3. Investigate vulnerability of economic losses of world's urban areas to natural disasters.

Data Sources & Methods

1. City population: World Urbanization Prospects: 2018 Revision

>> 1,860 cities with 300K+ inhabitants on 1 July 2018

2.5 billion people **(~60% of world's total urban population)**

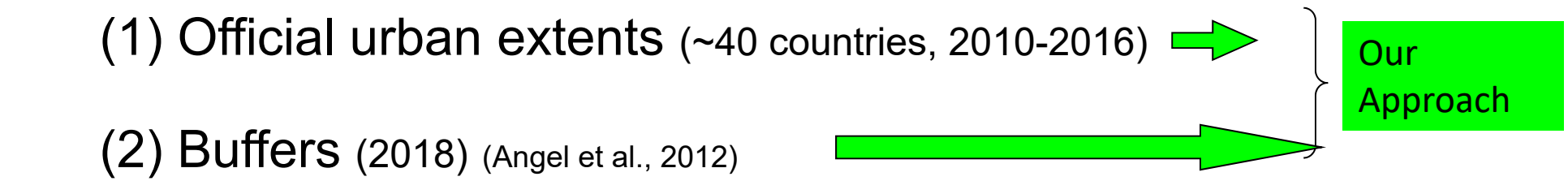
2. Urban extents

(1) Official urban extents (~40 countries, 2010-2016)

(2) Buffers (2018) (Angel et al., 2012)

(3) MODIS Landcover 500m (~2000)

(4) GRUMP (~2000)



Data Sources & Methods

3. Hotspots of Natural Disasters (mainly in 1980-2000)

>> Dilley et al. (2005). Natural Disaster Hotspot: A Global Risk Analysis

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

-- CIESIN (Center for International Earth Science Information Network)

>> Center for Hazards and Risk Research (CHRR); International Research Institute for Climate Prediction (IRI); Lamont-Doherty Earth Observatory (LDEO) at Columbia University; Hazard Management Unit (HMU); World Bank Group.

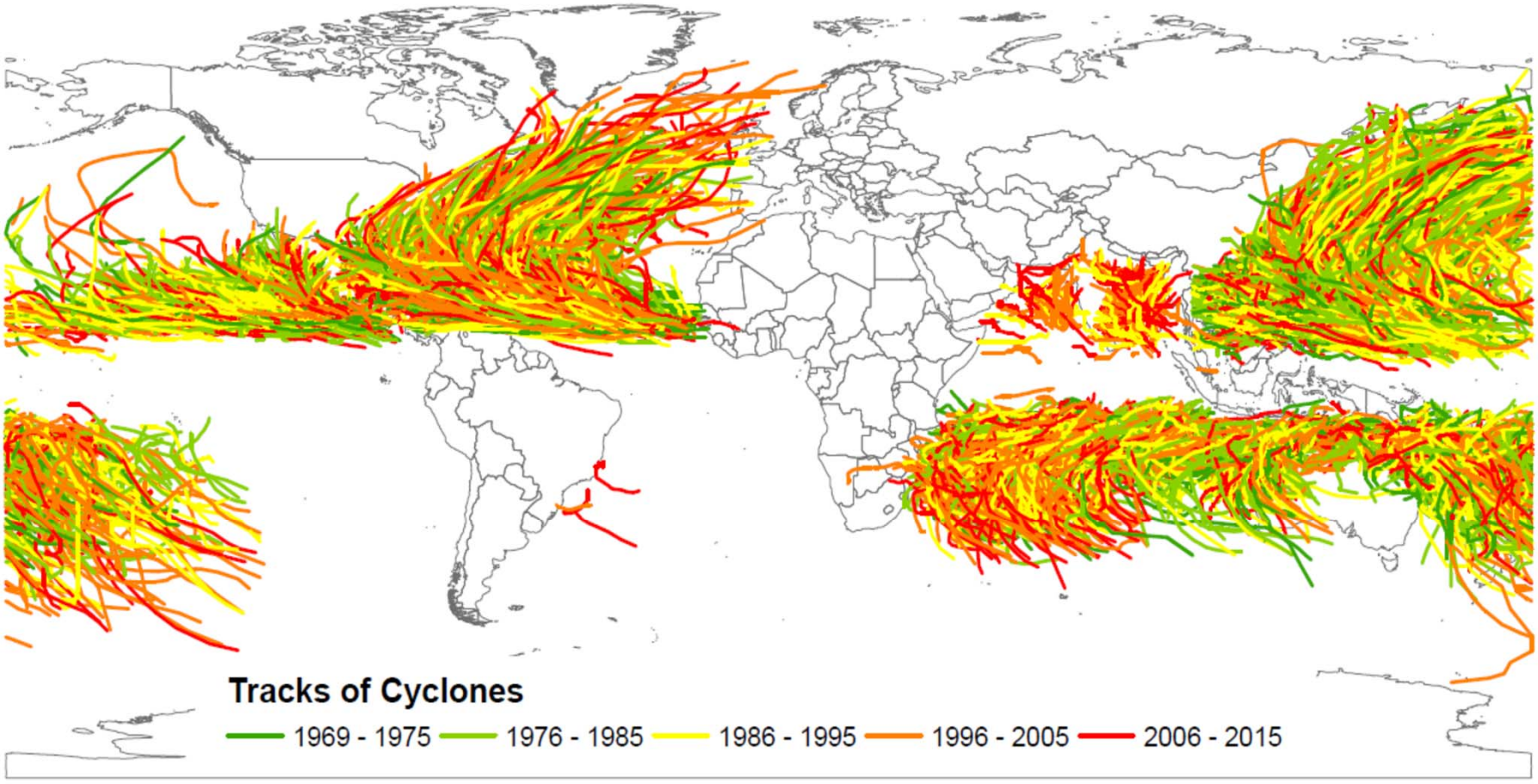
- **6 types of disasters: Cyclones (30”X30”), floods (1°X1°), droughts (2.5° X 2.5°), earthquakes (2.5’X2.5’), volcanoes (2.5’X2.5’), landslides (30”X30”)**
  - **--- Risk of exposure (event frequencies)**
  - **--- Vulnerability of economic losses**
  - **--- Vulnerability of mortality risk**
- **grid cells (affected areas) are divided into deciles**:
  - -- high risk: **8-10th** decile
  - -- medium risk: **5-7th** decile
  - -- low risk: **1-4th** decile

4. Disasters’ return period

>> UNISDR (2015)

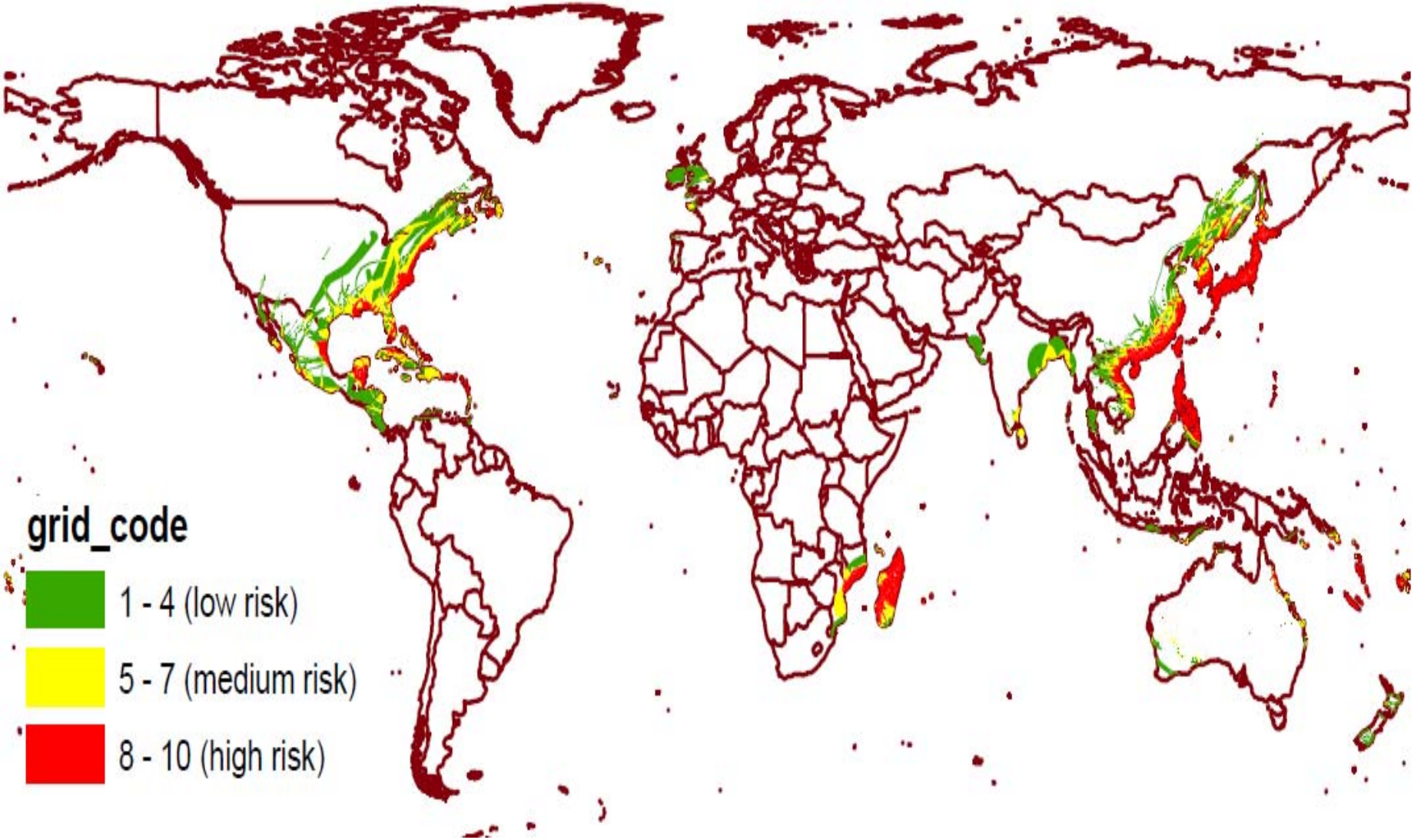
- Cyclones (1975 to 2007)[30”X30”];
- Floods (1980-2012)[0.05° X0.05°];
- Earthquakes (1975-2008)[0.05° X0.05°]

Tracks of Cyclones, 1969-2015



Relative frequency of cyclones by decile of grid cells, 1980-2000

2



Comparison of different criteria of urban extents

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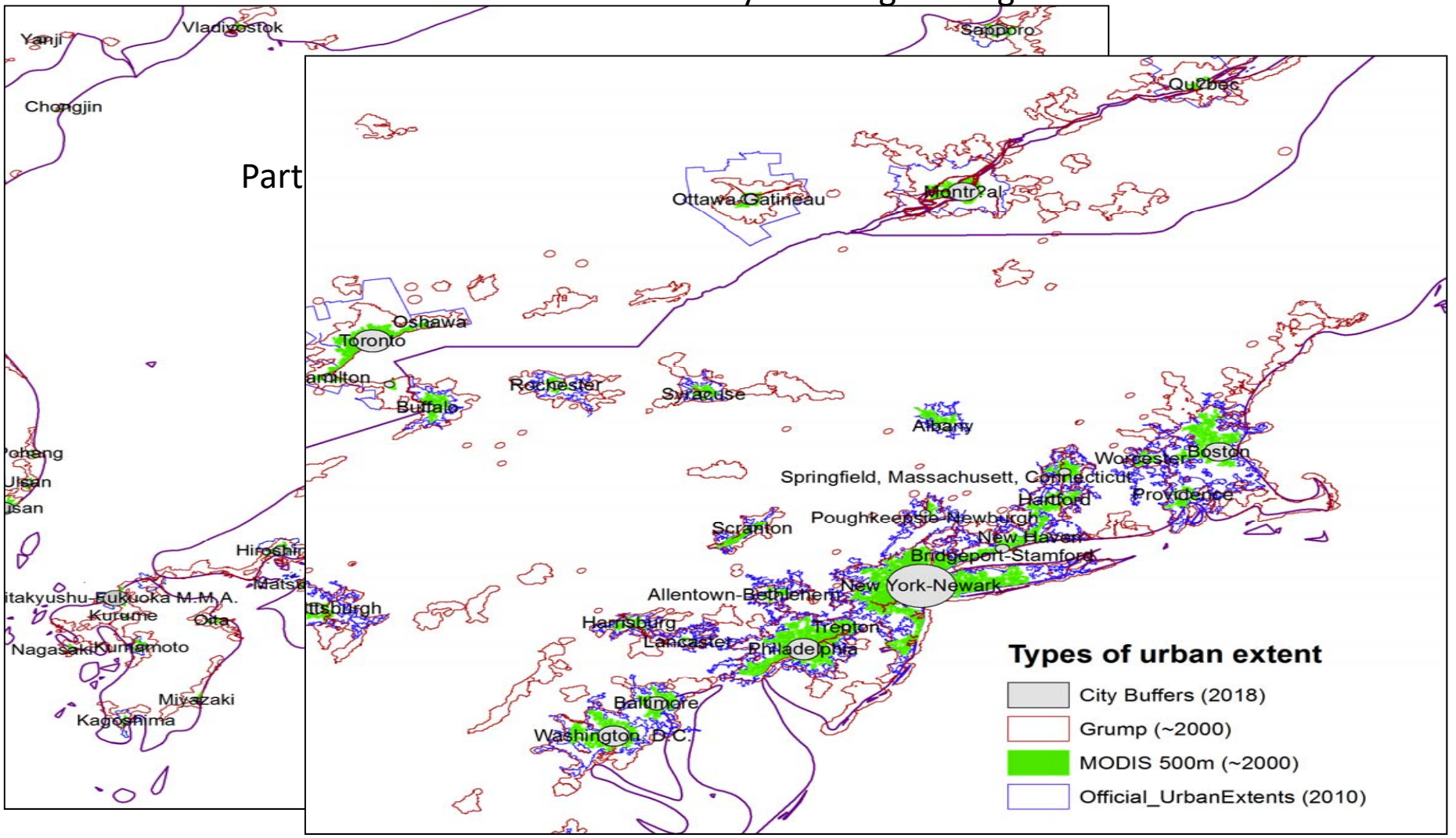
New York City and neighboring states



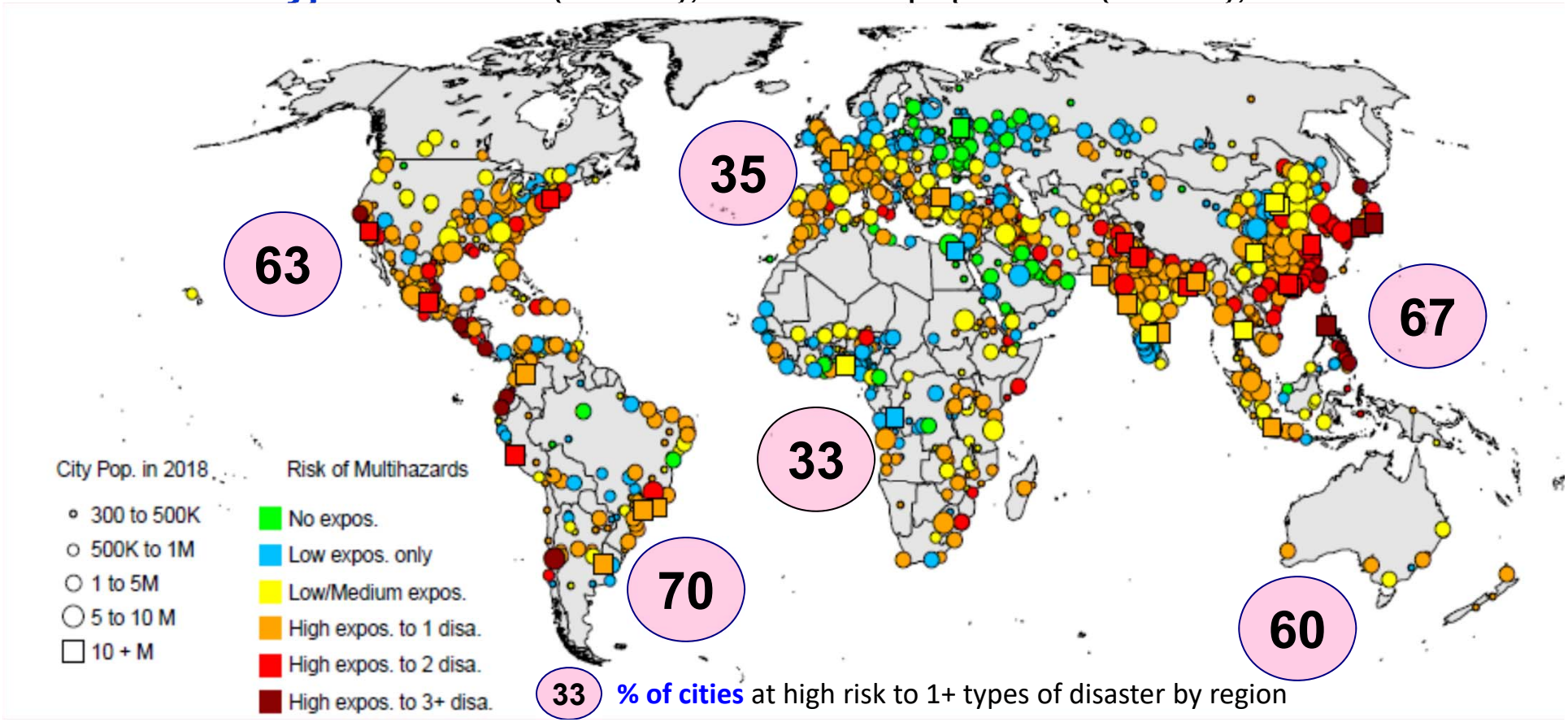
Comparison between different criteria of urban extents by disasters risk of decile of grid cells (sensitivity analysis)

		0	1-4	5-7	8-10
buffer + official polyg. VS. buffer only					
	Frequencies	98.7	91.7	90.8	100.0
	Losses	98.7	100.0	97.6	100.0
	Mortality	98.7	100.0	93.3	100.0
buffer + official polyg. VS. Landcover 500m					
	Frequencies	99.0	86.5	90.8	99.1
	Losses	99.0	96.0	92.0	100.0
	Mortality	99.0	100.0	87.9	99.4

1. Most big cities are at risk to natural disasters

(1) Risk of exposure to natural disasters

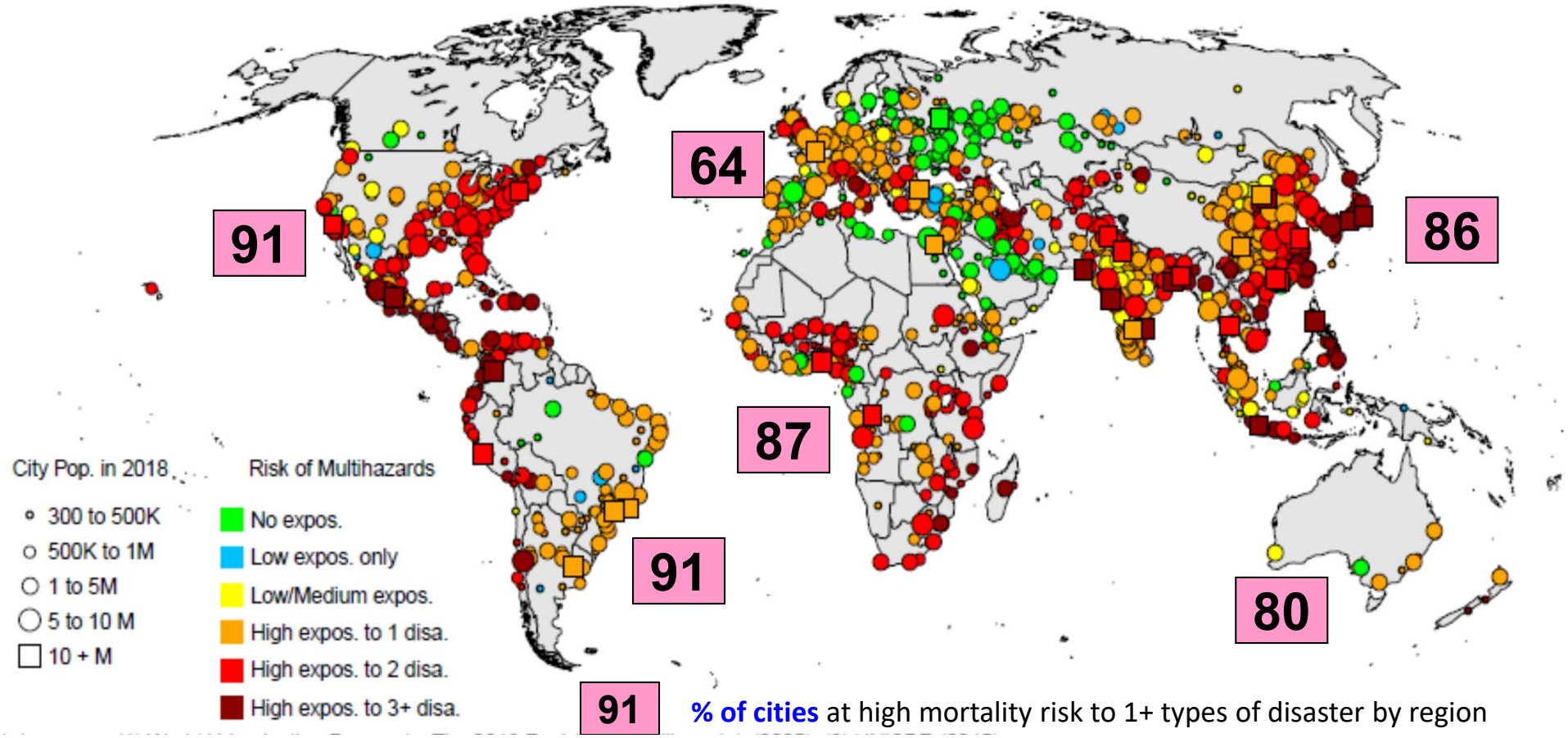
- In 2018, nearly **58% of cities** or **64% of city pop.** worldwide were at high risk of exposure to 1+ of 6 types of natural disaster
  - **1+ type**: In 2018, 1,087 of **1,860** cities (~58%), 1.6 billion of 2.5 billion city populations (~64%);
  - **2+ types**: 301 cities (~16%) , 592 million population (~24%)
  - **3+ types**: 45 cities (~2.5%), 124 million population (~5.0%);



(2) Vulnerability of mortality to natural disasters

- **84% of cities** or **89% of city populations** were at high mortality vulnerability to 1+ of 6 types of natural disaster in 2018;

- **1+ type**: 1,559 of 1,860 cities (~84%) or 2.2 billion of 2.5 billion people (~89%)
- **2+ types**: 799 cities (~43%) or 1.3 billion (~54%)
- **3+ types**: 175 cities (~9%) or 400 million (~16%)



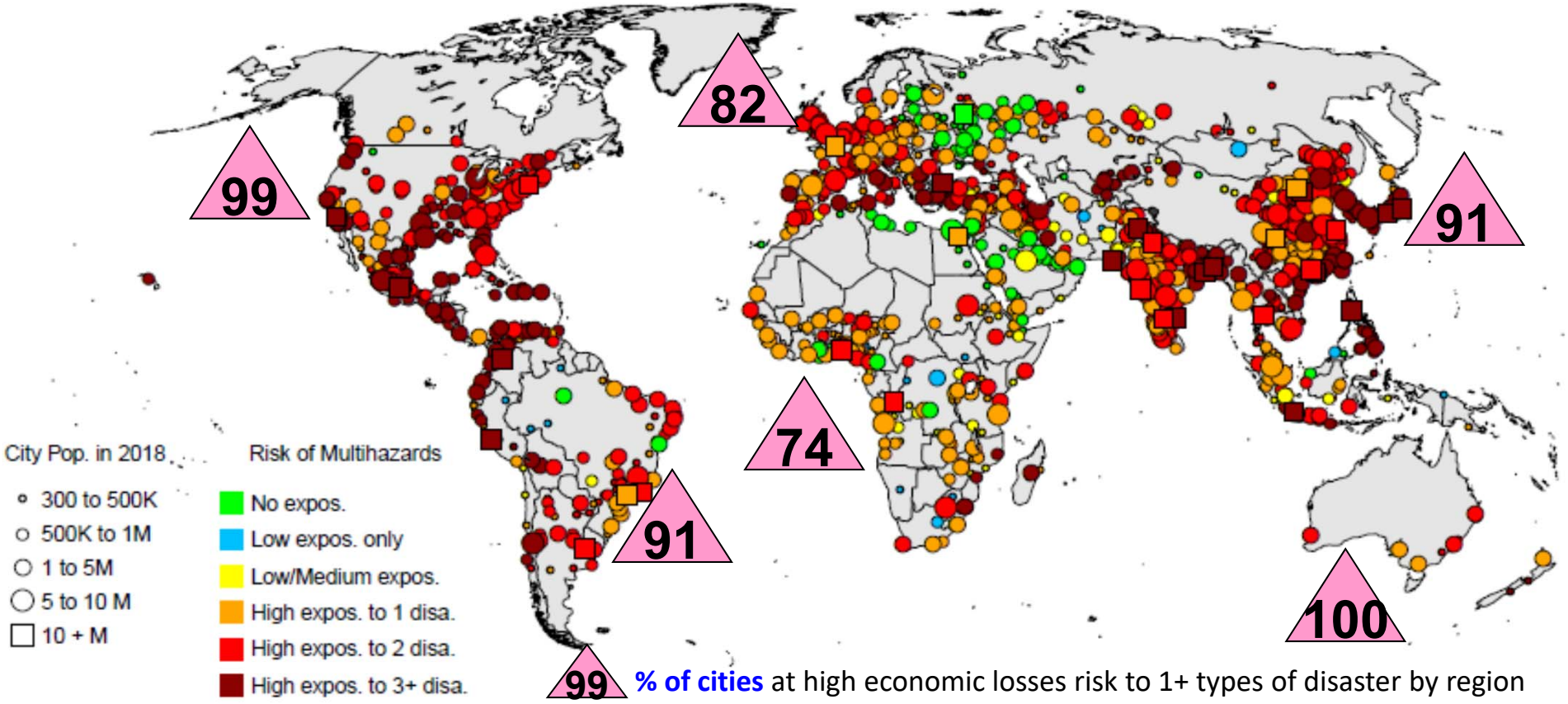
% of cities at high mortality risk to 1+ types of disaster by region

(3) Vulnerability of economic losses to natural disasters

3

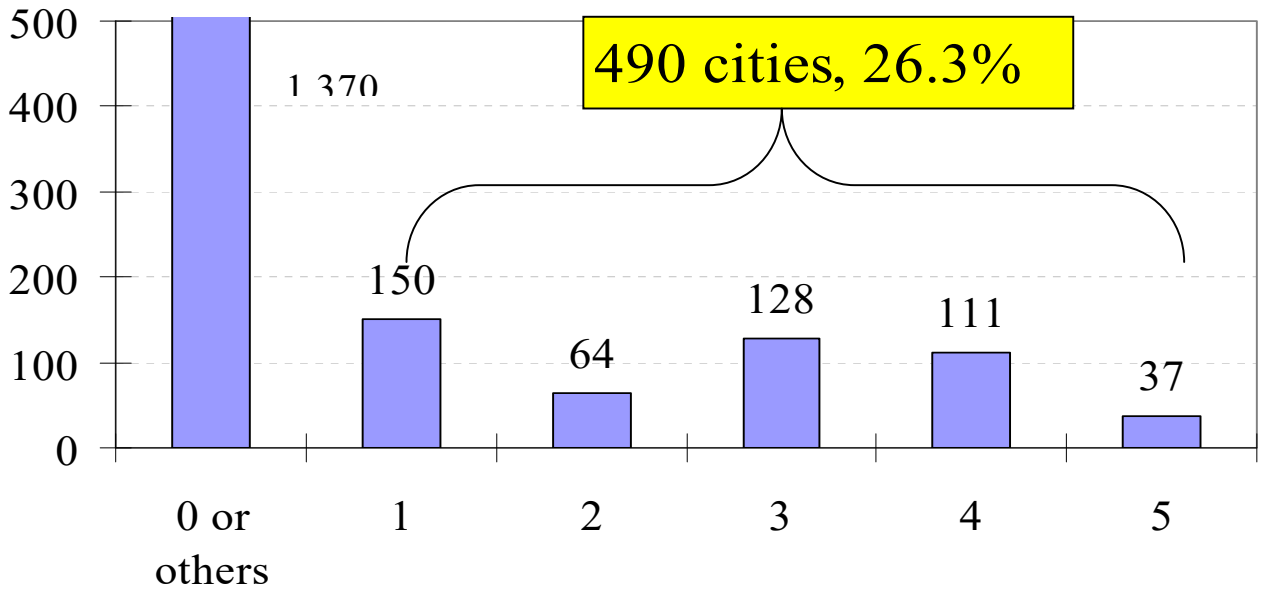
- **89% of cities** or **94% of city populations** were highly vulnerable to economic losses from 1 type or more of natural disasters.

- **1+ type**: 1,655 of 1,860 cities (~89%) or 2.3 bn of 2.5 bn people (~94%)
- **2+ types**: 1,142 (~61%) or 1.7 billion (~70%)
- **3+ types**: 418 (~22%) or 743 million (~30%)



% of cities at high economic losses risk to 1+ types of disaster by region

Risk of cyclones attacking 100-year return period



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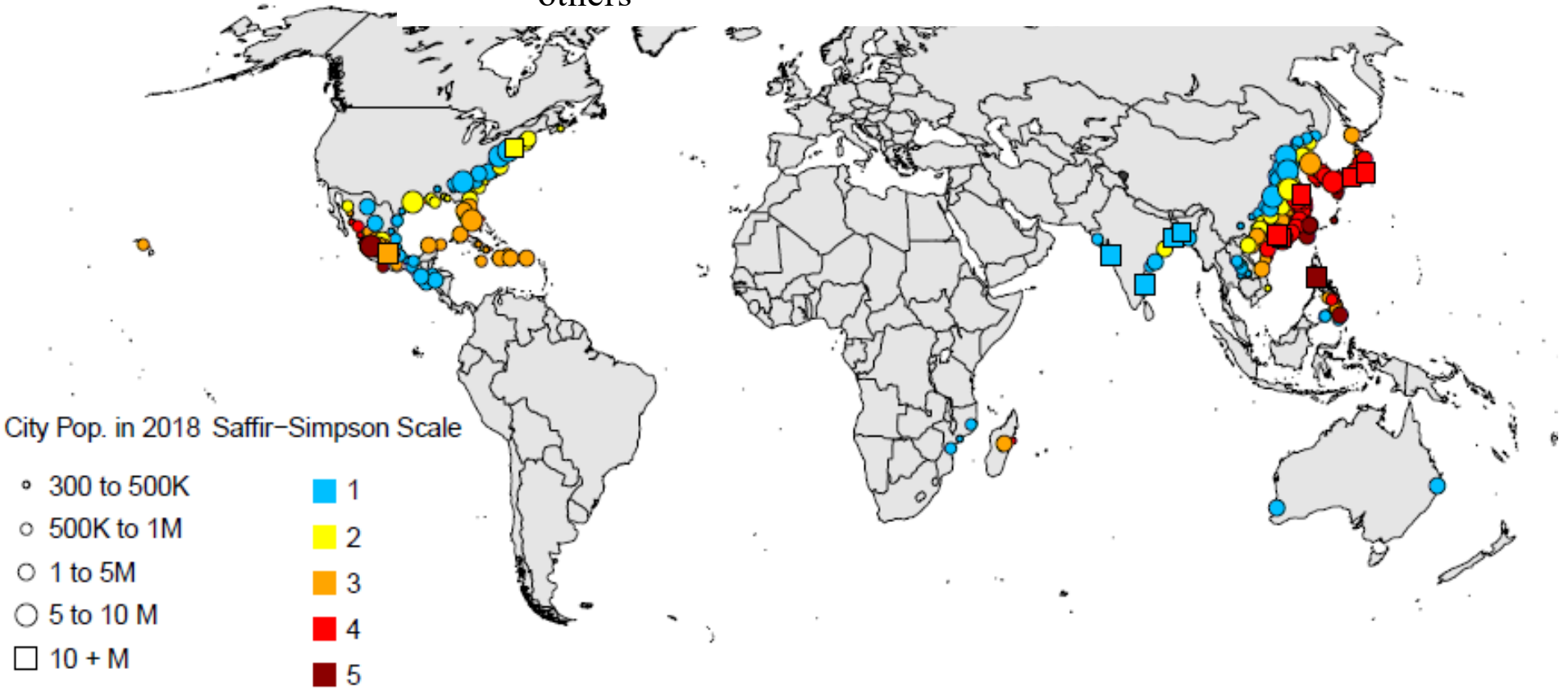
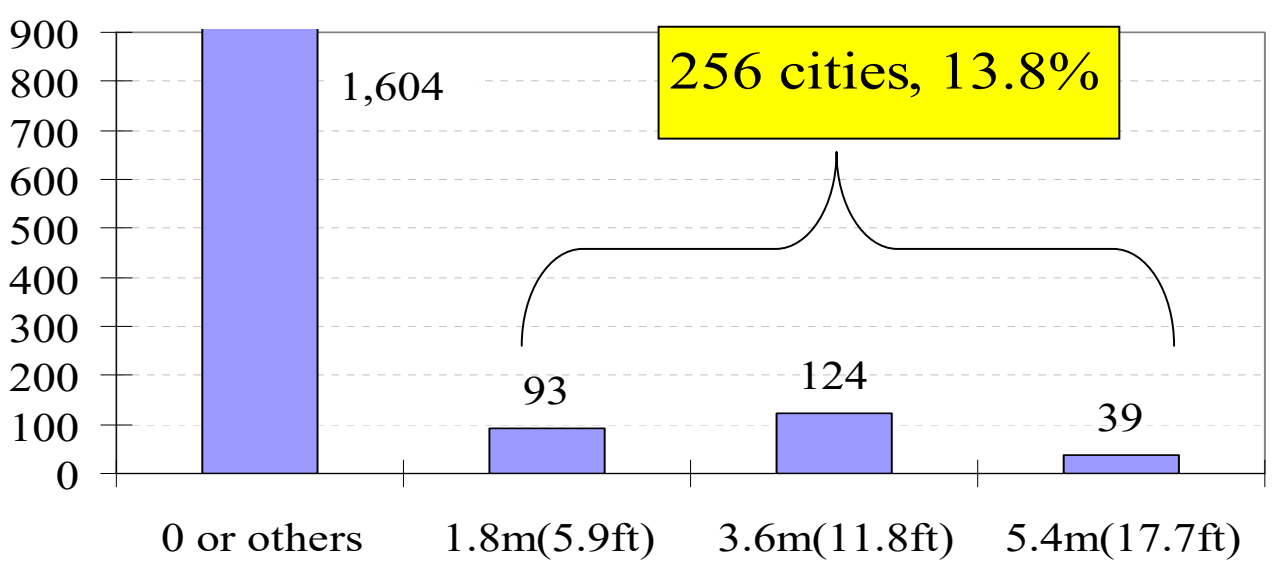


Risk of flooding striking of 50-year return period



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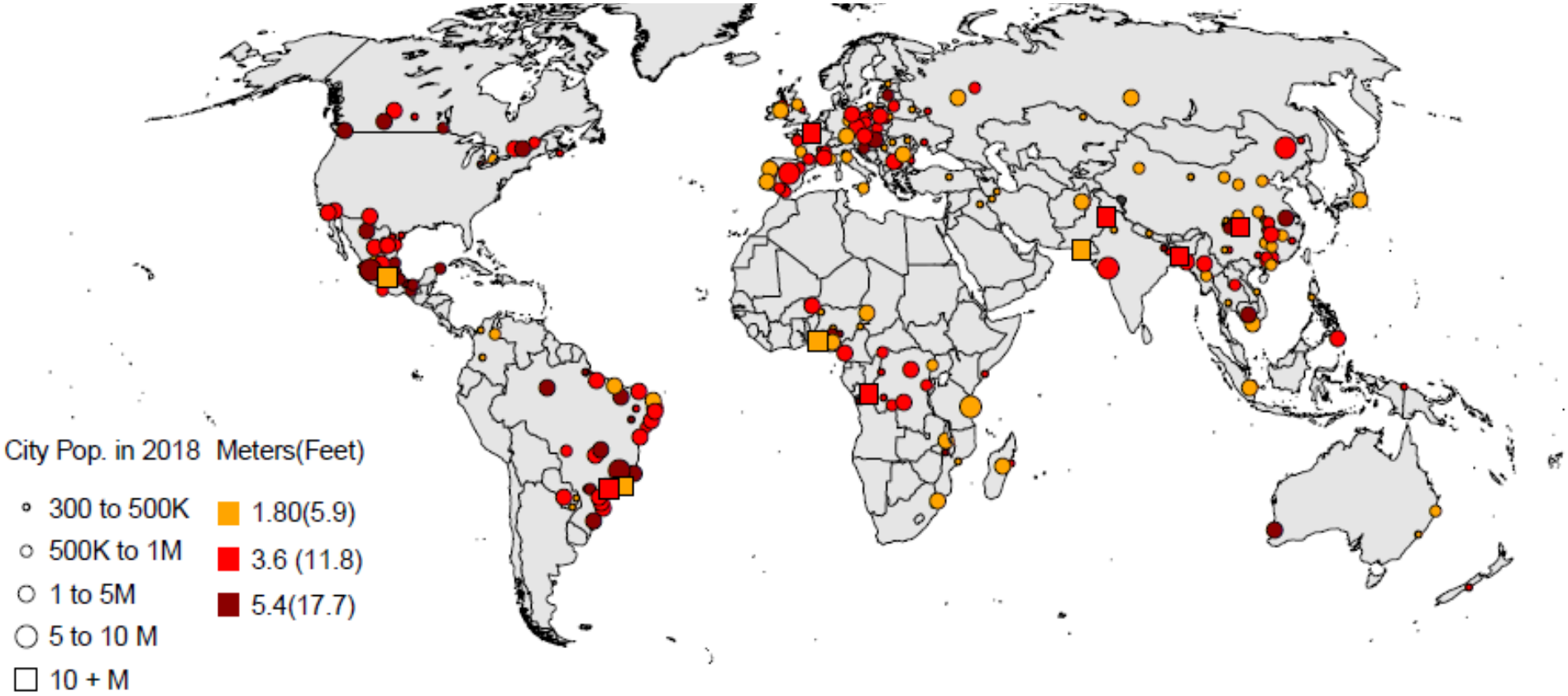
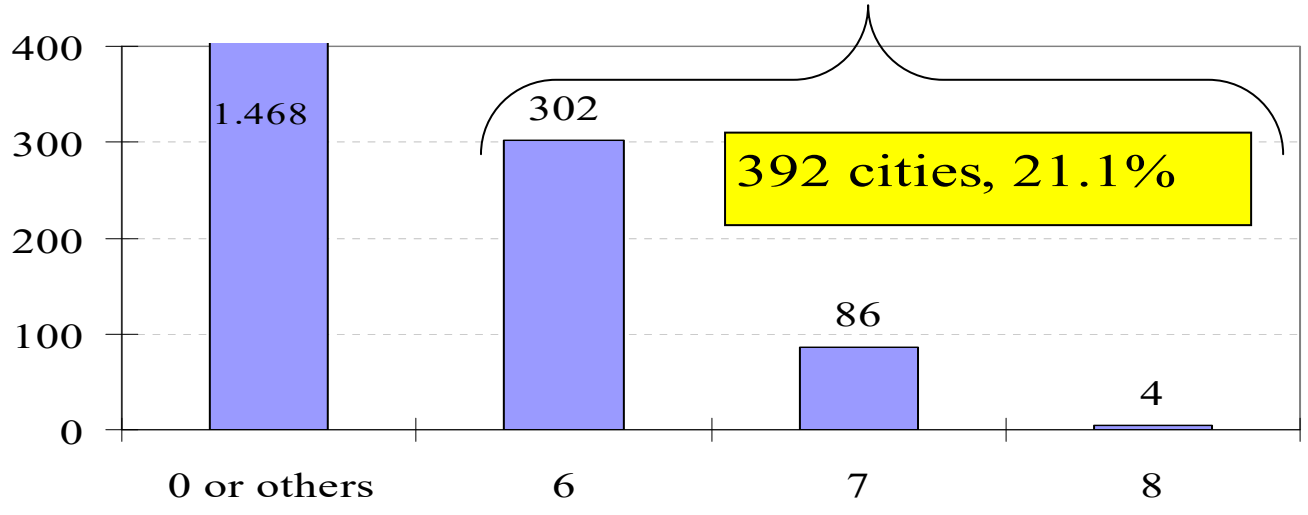


Risk of earthquakes of 250-year return period



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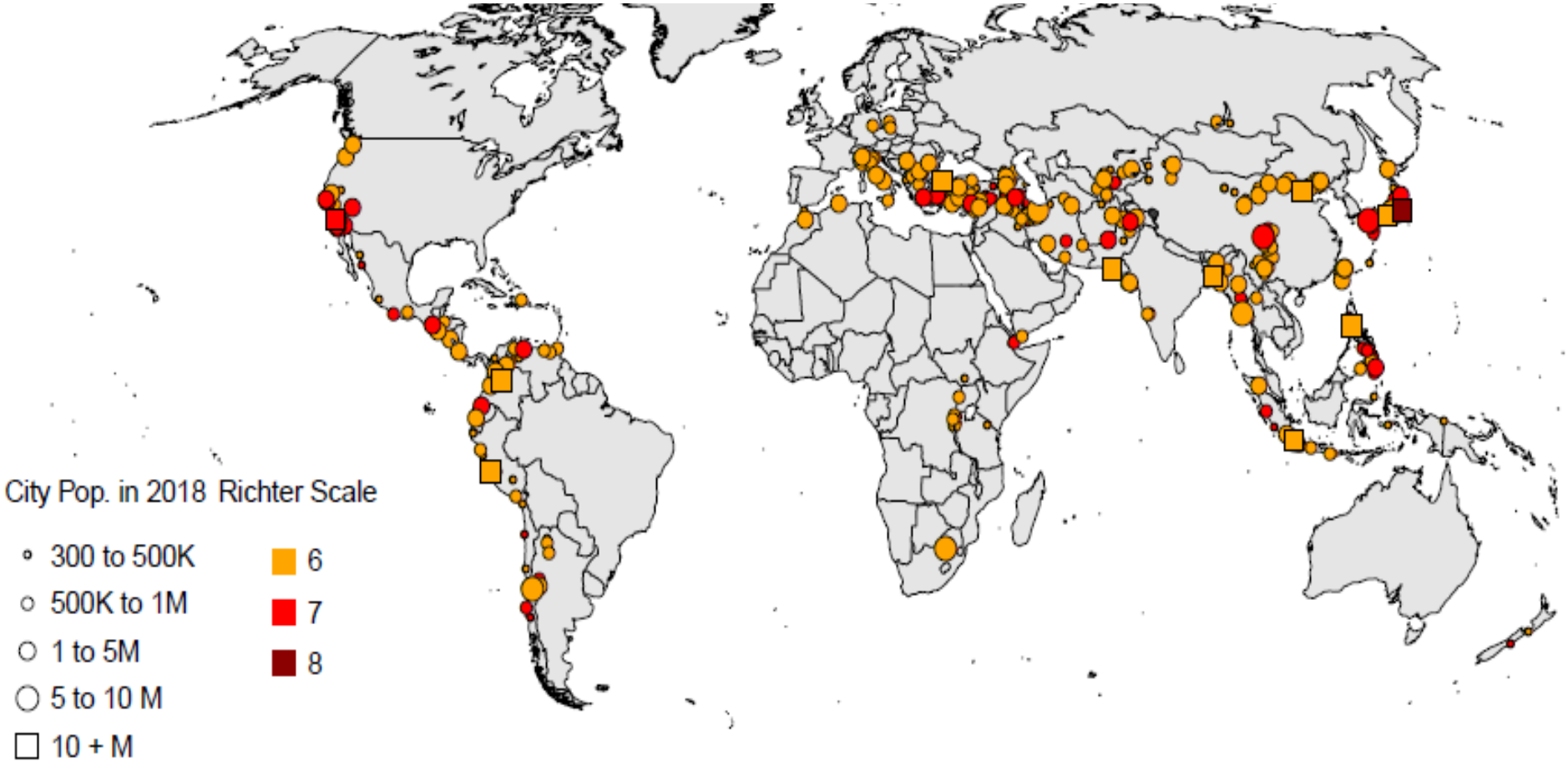
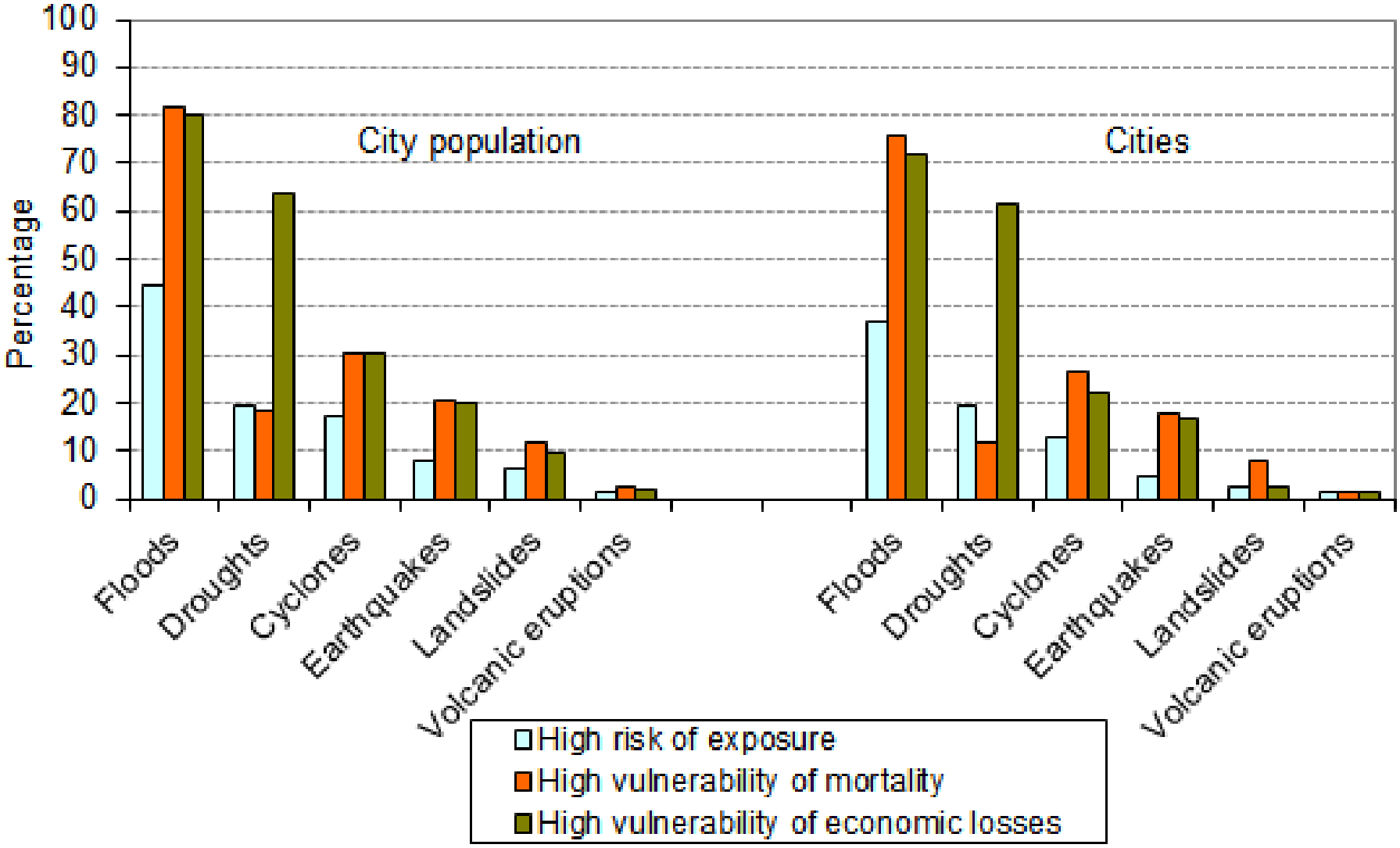


2. Floods, droughts, and cyclones are the most devastating disasters

City populations and cities with a high exposure and high vulnerabilities to each of six types of natural disasters



3. Megacities are more likely to be highly exposed to disasters and are more vulnerable

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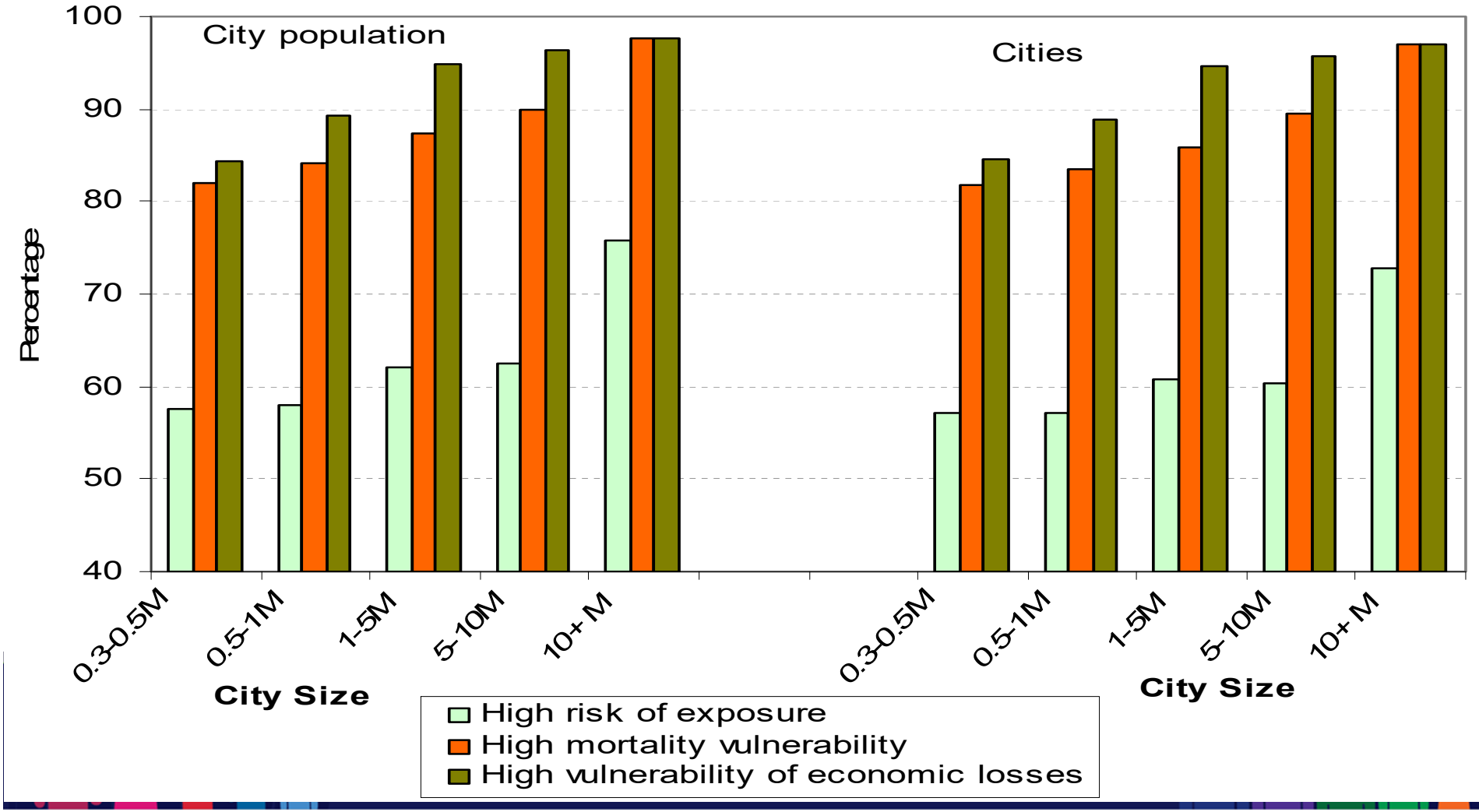
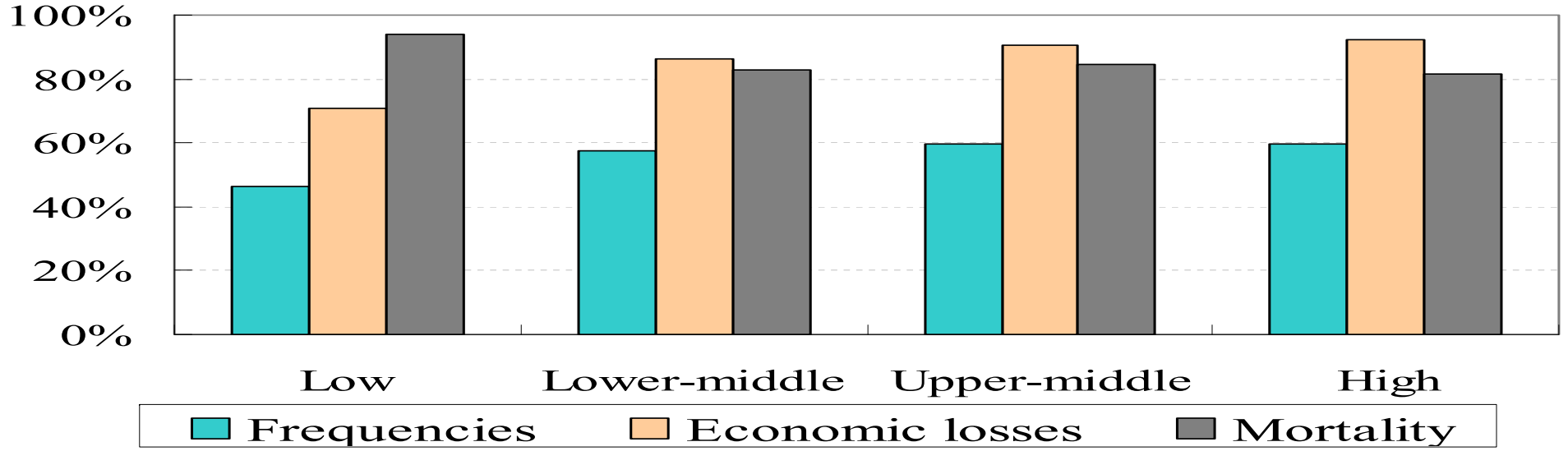
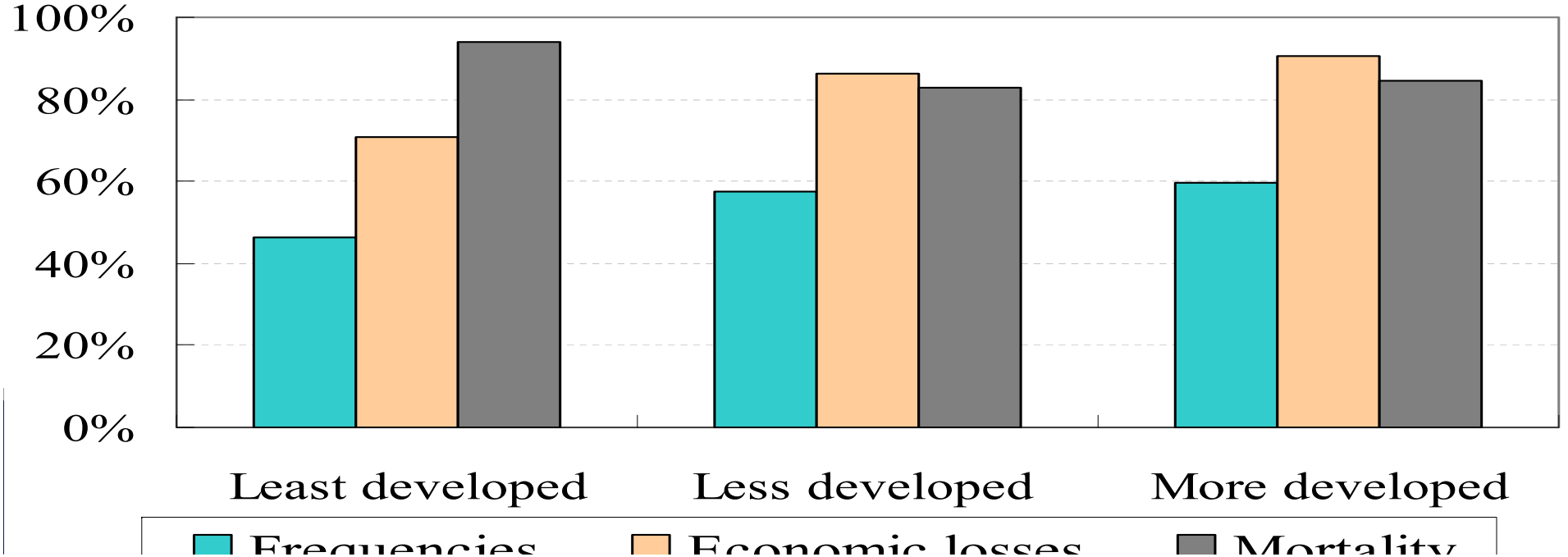
City populations and cities with a high exposure and high vulnerabilities to 1+ type of disasters by city population size



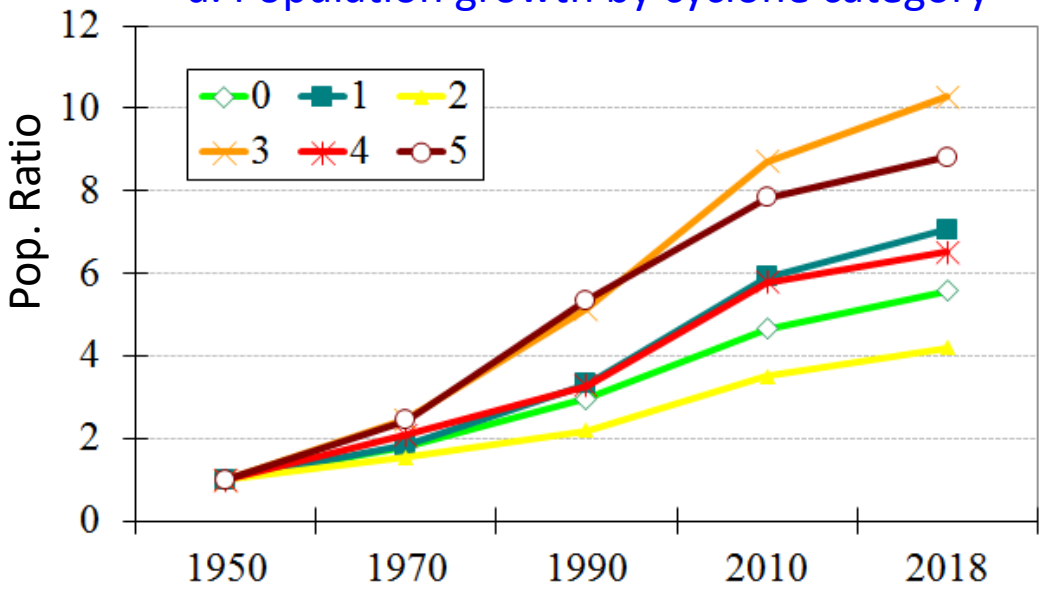
4(1). Cities from lower income countries or less developed regions are more likely to be located in high mortality risk areas



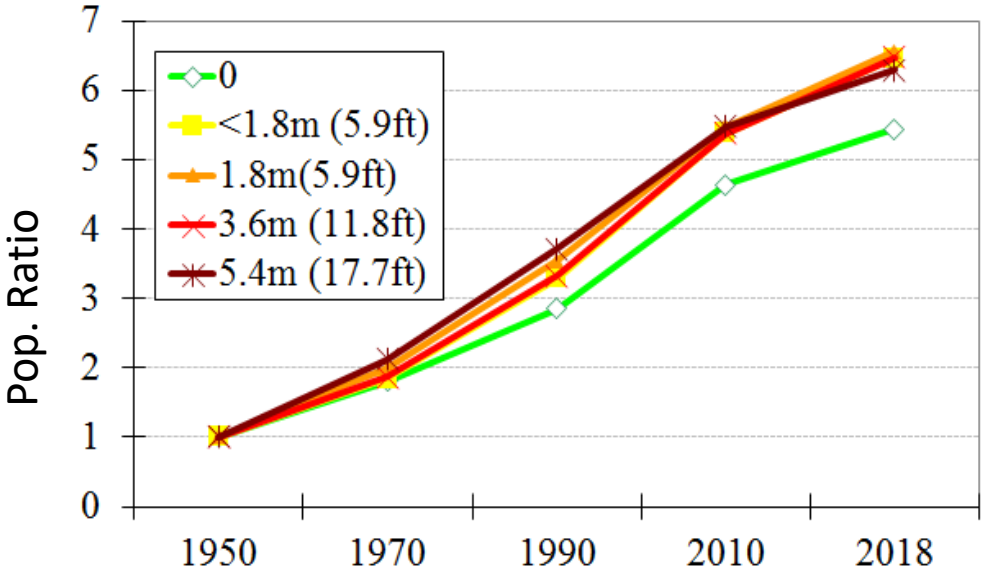


4(2). Urban population grows faster in higher-risk-prone areas

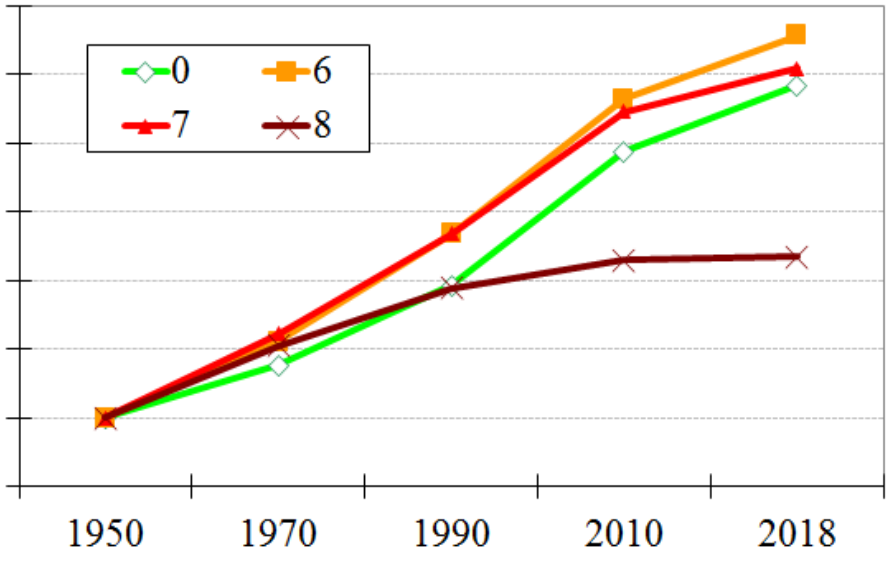
a. Population growth by cyclone category



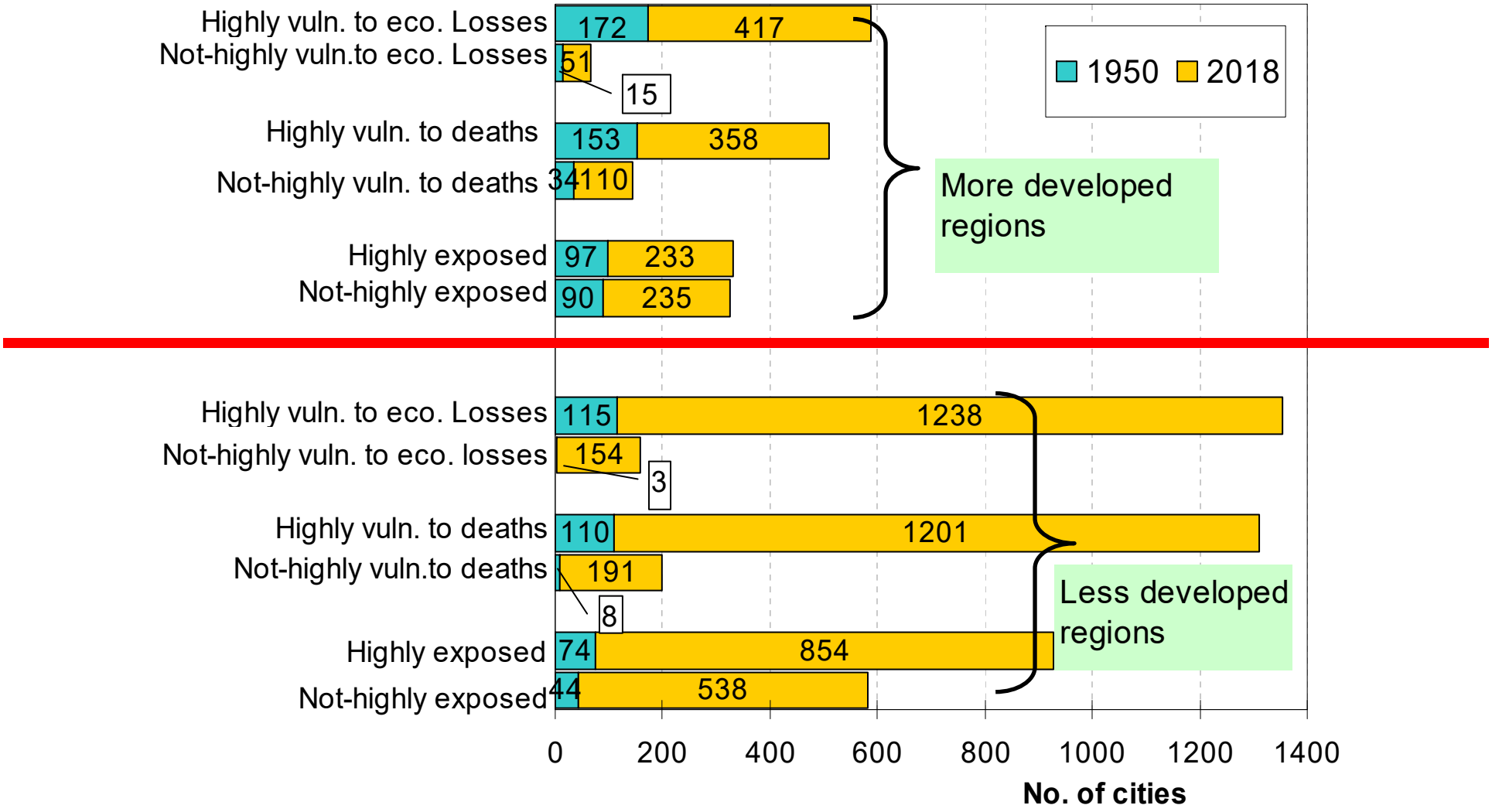
b. Population growth by flooding size



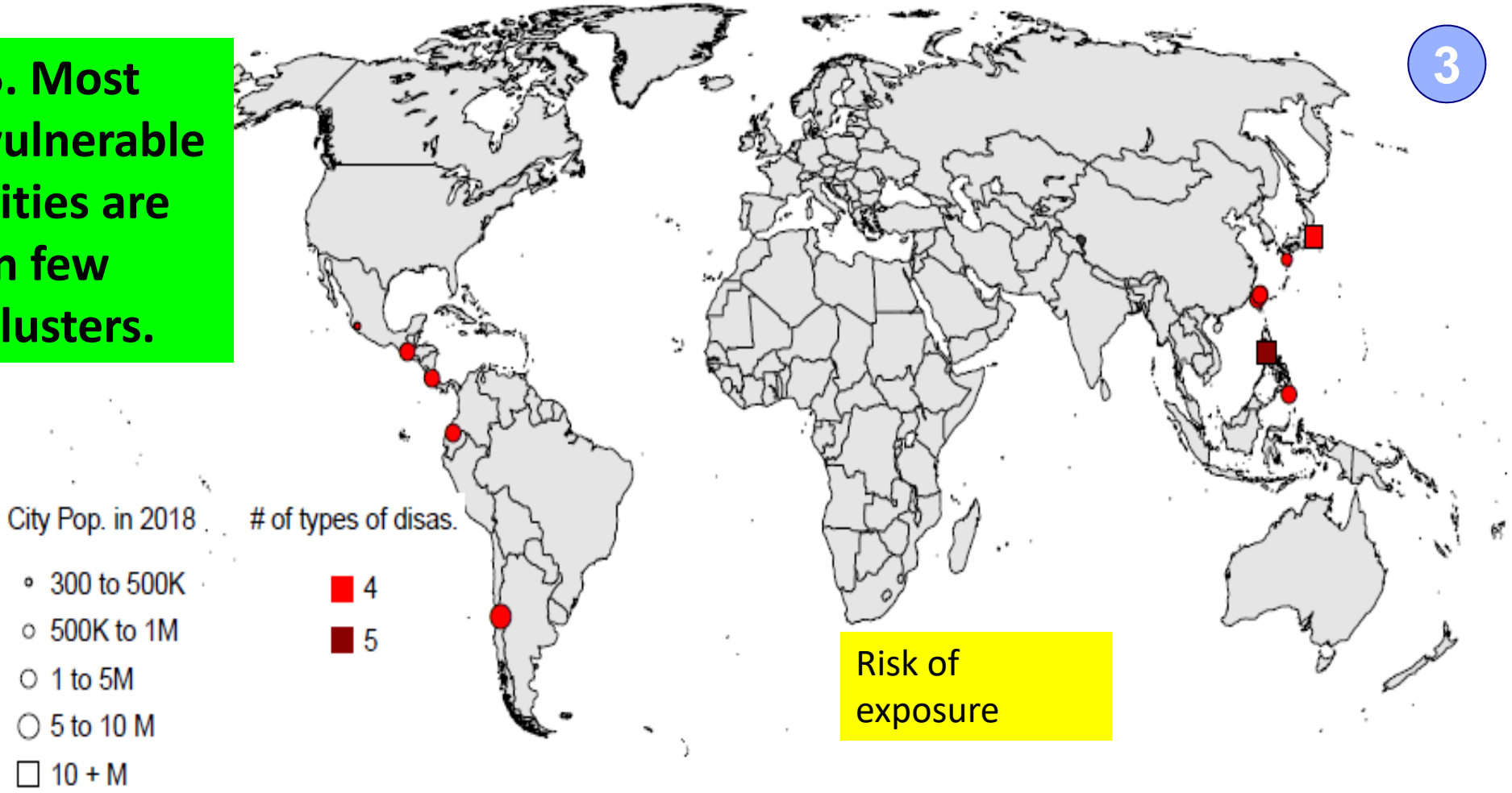
c. Population growth by earthquake size



of cities with 300K in 1950 versus in 2018 by development group and risk level to disasters

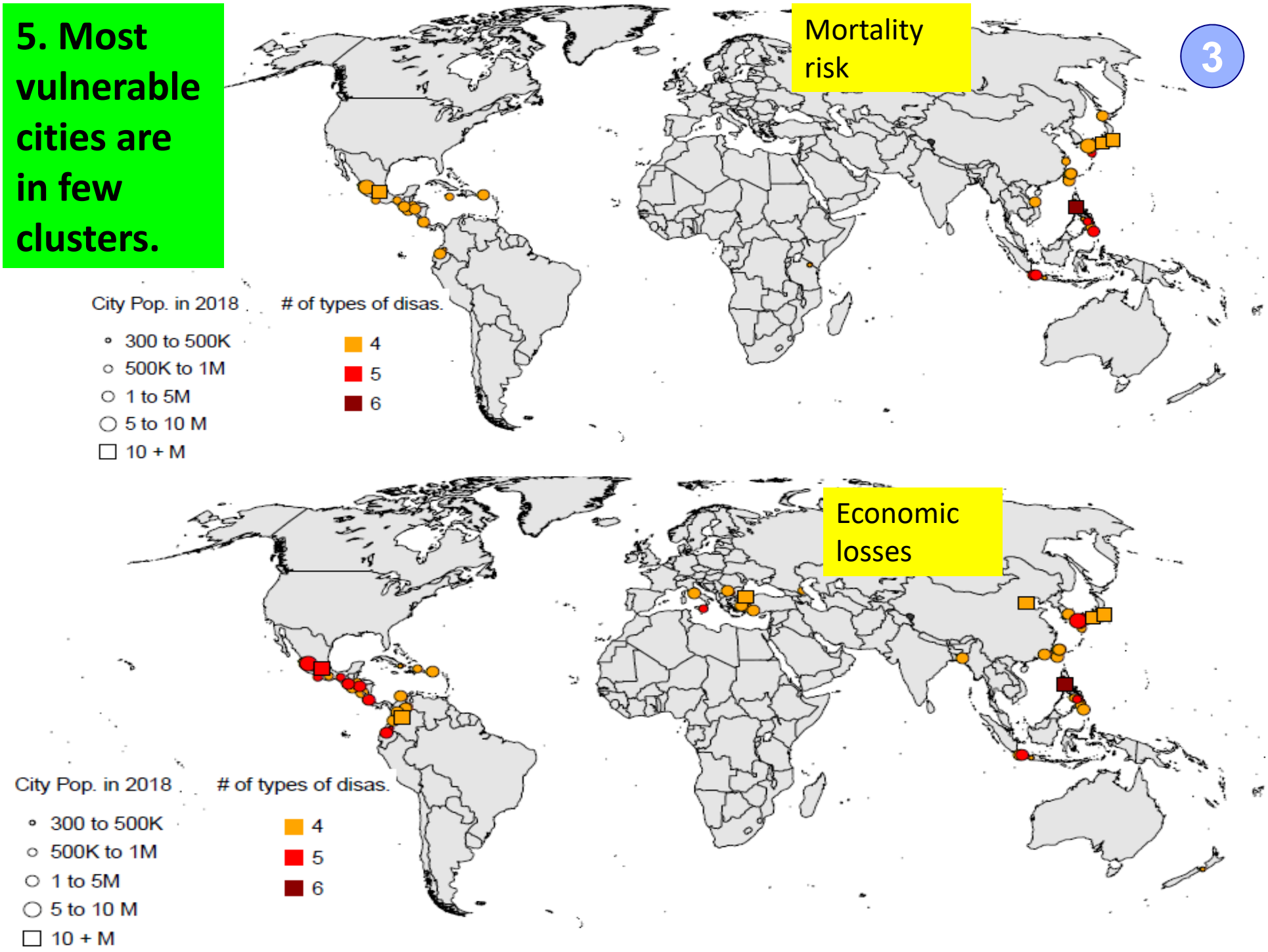


5. Most vulnerable cities are in few clusters.



City	Country/area	Pop2018	Multi-hazards	Cyclones	Droughts	Earthquakes	Floods	Landslides	Volcanic Eruptions
Manila	Philippines	13,482	5	10	4	8	10	8	9
Tokyo	Japan	37,468	4	10	0	10	8	10	0
Santiago	Chile	6,680	4	0	10	9	10	8	0
Xinbei	Taiwan, China	4,325	4	10	0	10	10	10	0
Guatemala City	Guatemala	2,851	4	1	10	10	10	8	0

5. Most vulnerable cities are in few clusters.



Summary & Limitations

Summary

1. **Most populated cities in the world are at risk of natural disaster**
   - ~60% of large cities or city populations are located in areas with a high exposure to 1+ type of disaster.
   - 85-90% cities or city populations are located at areas with a high mortality vulnerability to 1+ type of disaster.
   - >95% cities or city populations are located at areas with a high economic vulnerability to 1+ type of disaster.
   - Regional differences are substantial
2. **Floods, droughts, cyclones are the three most devastating types of disaster**
3. **Megacities are more likely to be highly exposed to disasters and are more vulnerable.**
4. **Cities in less developed regions or lower income countries are more likely to be exposed and more vulnerable to natural disasters, and are growing faster.**

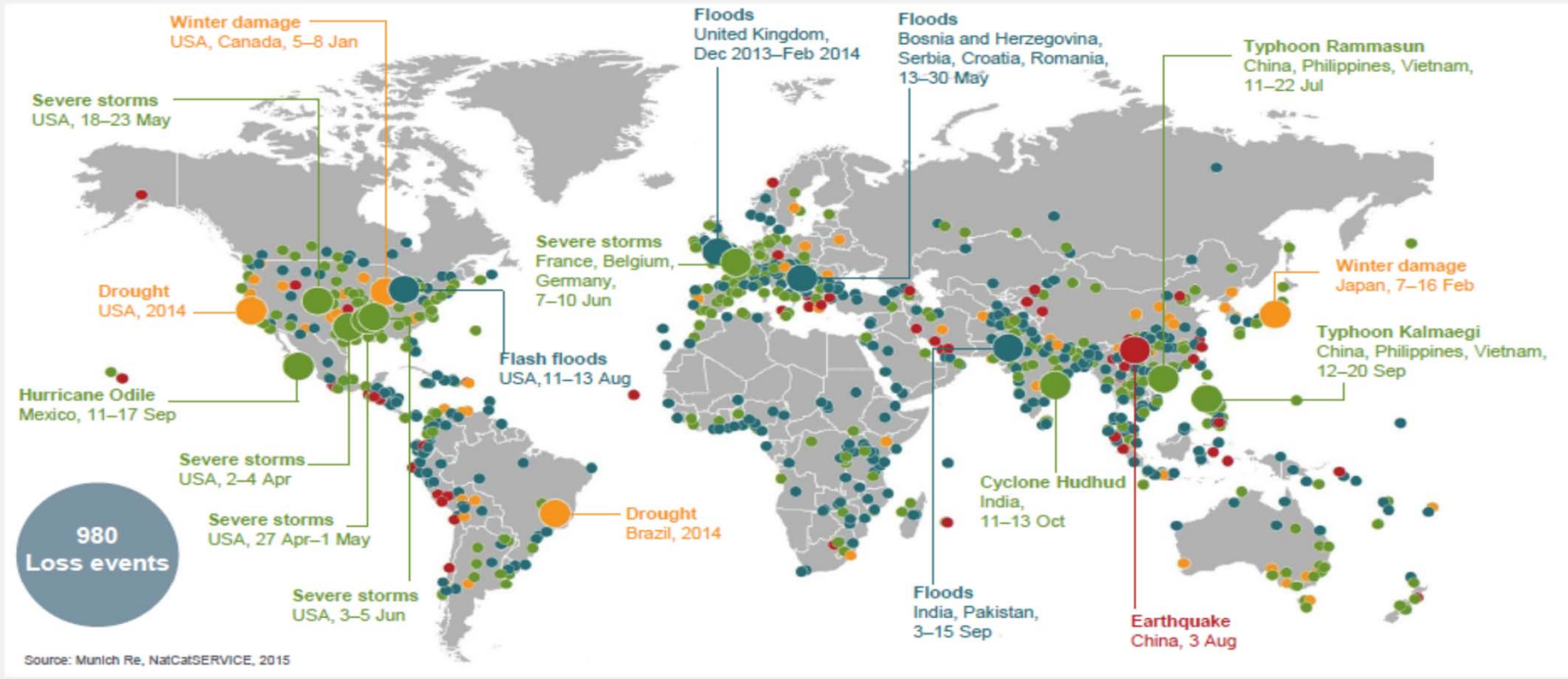
Limitations

1. Limited global datasets on natural disasters with lag of 5-10 years.
2. Improvement of data quality of natural disasters (lower resolution, underestimation).
3. Not inclusion of other types of natural disasters.
4. Only inclusion of cities with 300K+ inhabitants on 1 July 2018.
5. Urban extents not for all countries.

A

Subsequent slides are only for possible questions.

Munich RE: Loss events worldwide 2014: Geographical overview



- Loss events
- Selection of catastrophes
  Overall losses ≥ US$ 1,500m
- Geophysical events
  (Earthquake, tsunami, volcanic activity)
- Meteorological events
  (Tropical storm, extratropical storm, convective storm, local storm)
- Hydrological events
  (Flood, mass movement)
- Climatological events
  (Extreme temperature, drought, wildfire)

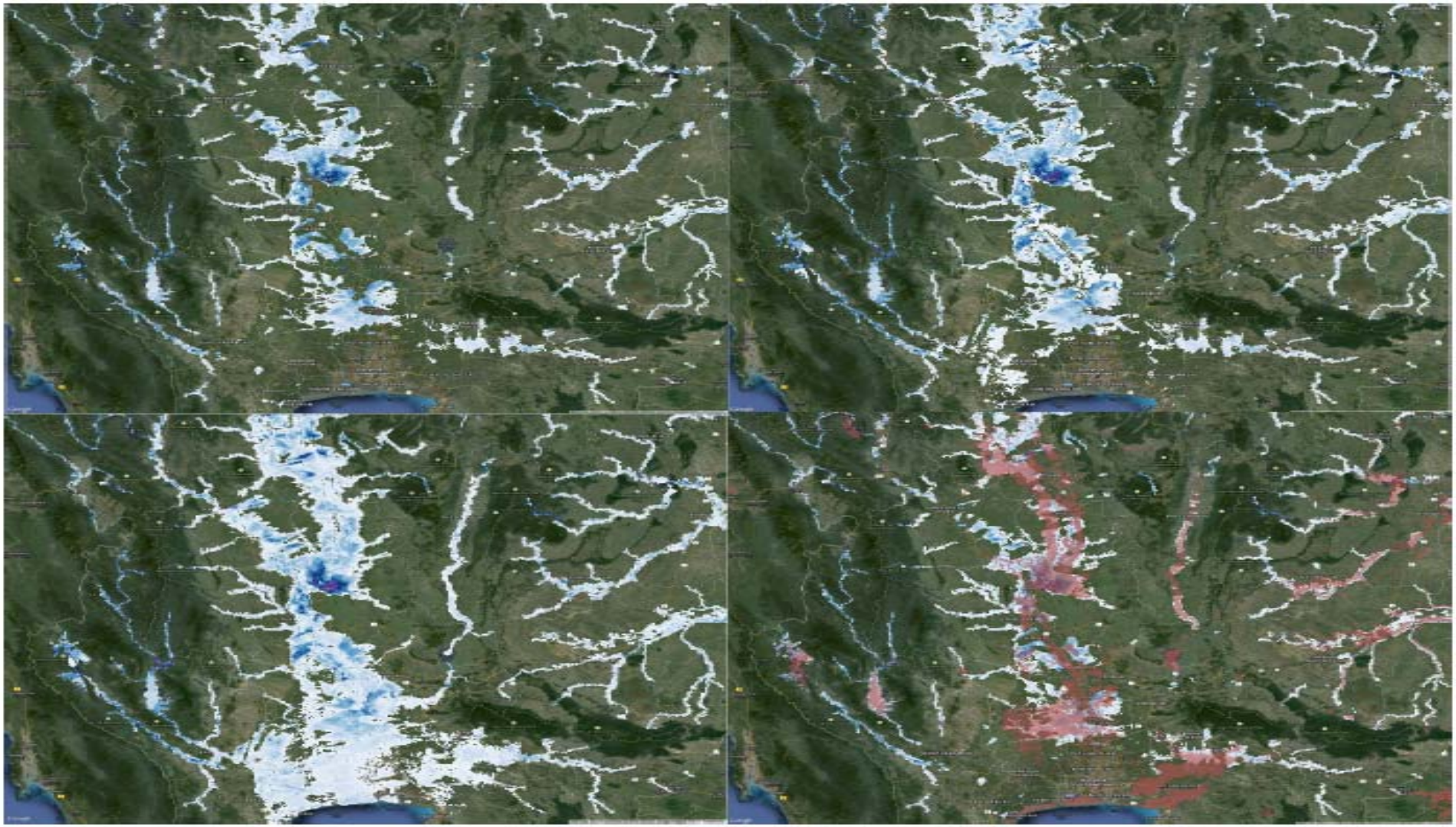
Munich RE

A

Flooding in Thailand, 2011

REUTERS © 2011

Fig. Flood maps for Thailand for three different return periods (from left to right from top to bottom: T =25, 200, 1000 years) and bottom right panel DFO flood footprint envelope layered on the flood map for T = 100 years. Reconditioned DEM in the background.



Source: UNISDR (2015: Figure 26): GAR assessment report.