A Risk Index for Megacities

Stephen Voss (Munich Re Japan Services K.K.)

05 September 2006
at the Institute of Actuaries Japan (IAJ)

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Introduction – Trend of growing cities

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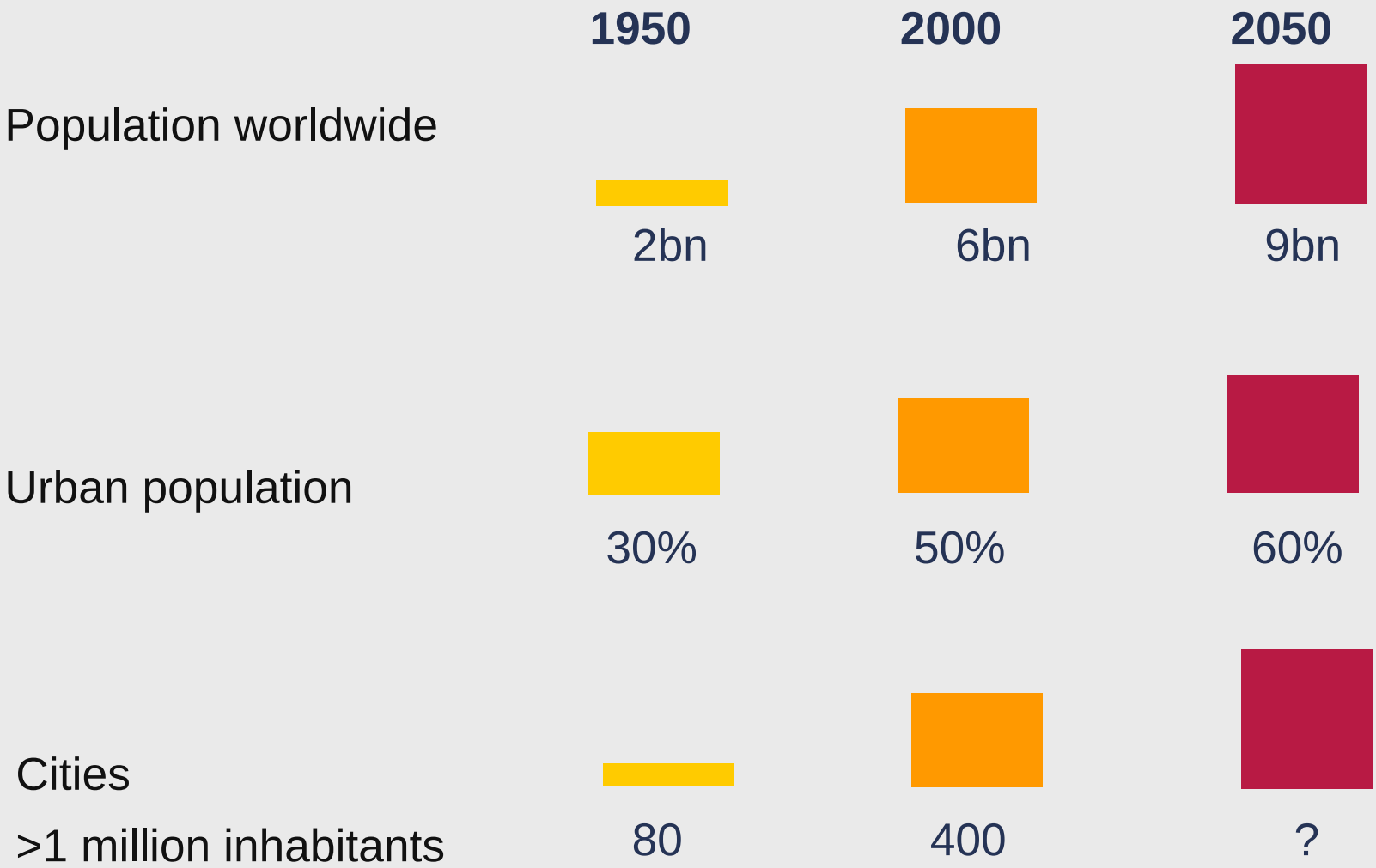

A Risk Index for Megacities, S. Voss (05 September 2006, at IAJ)

Introduction – Trend of growing cities, cont'd

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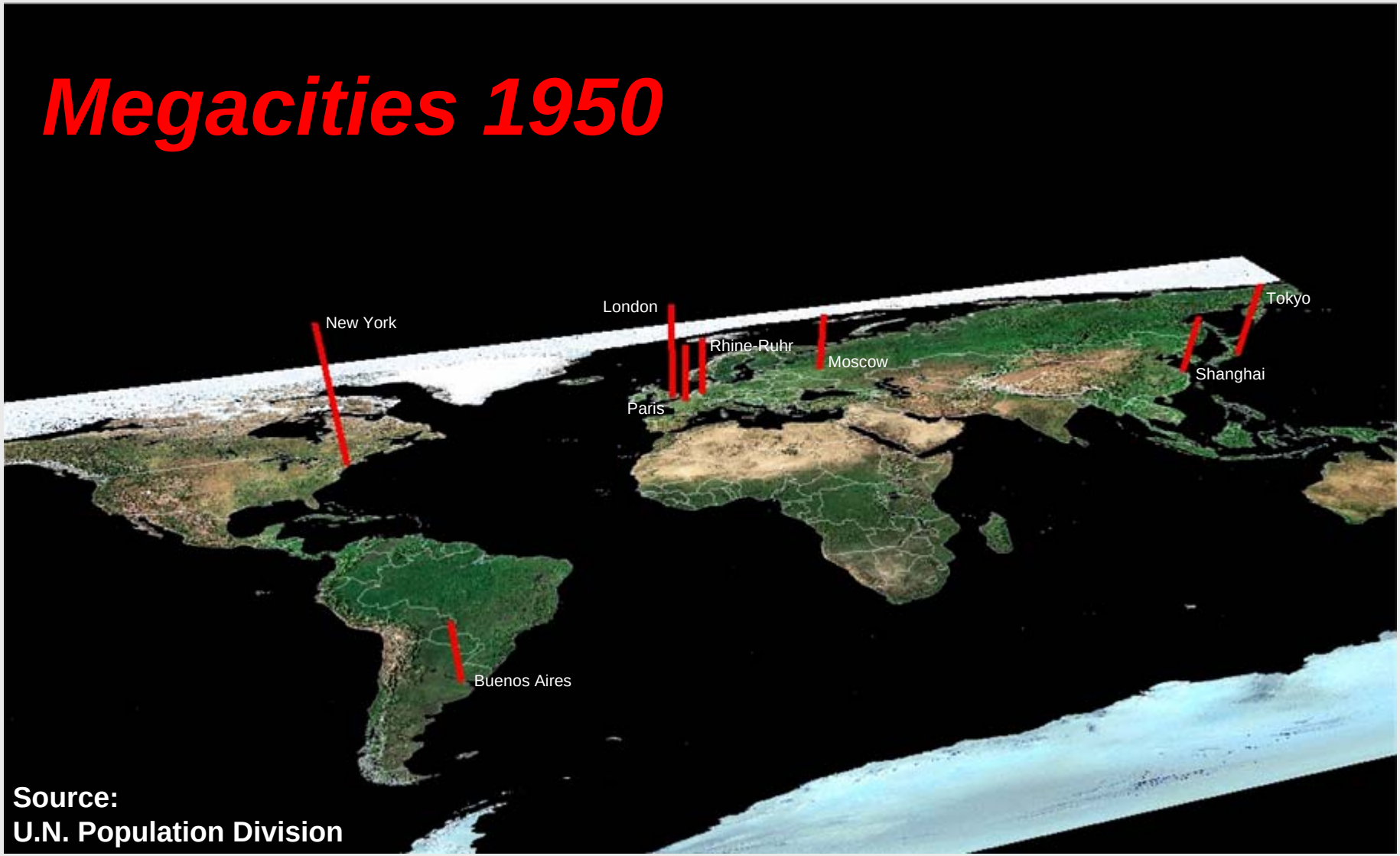

Introduction – Trend of growing cities, cont'd

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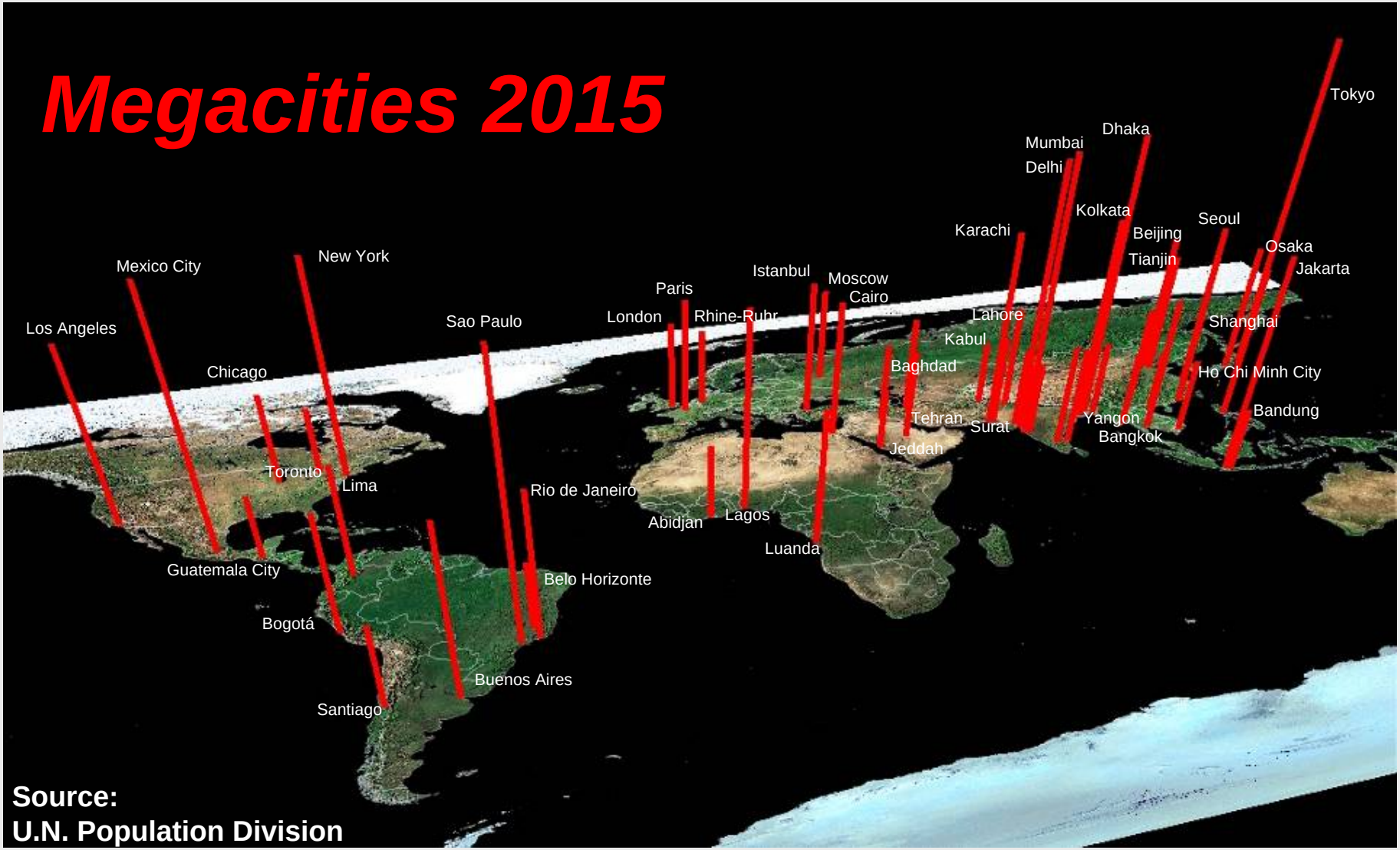

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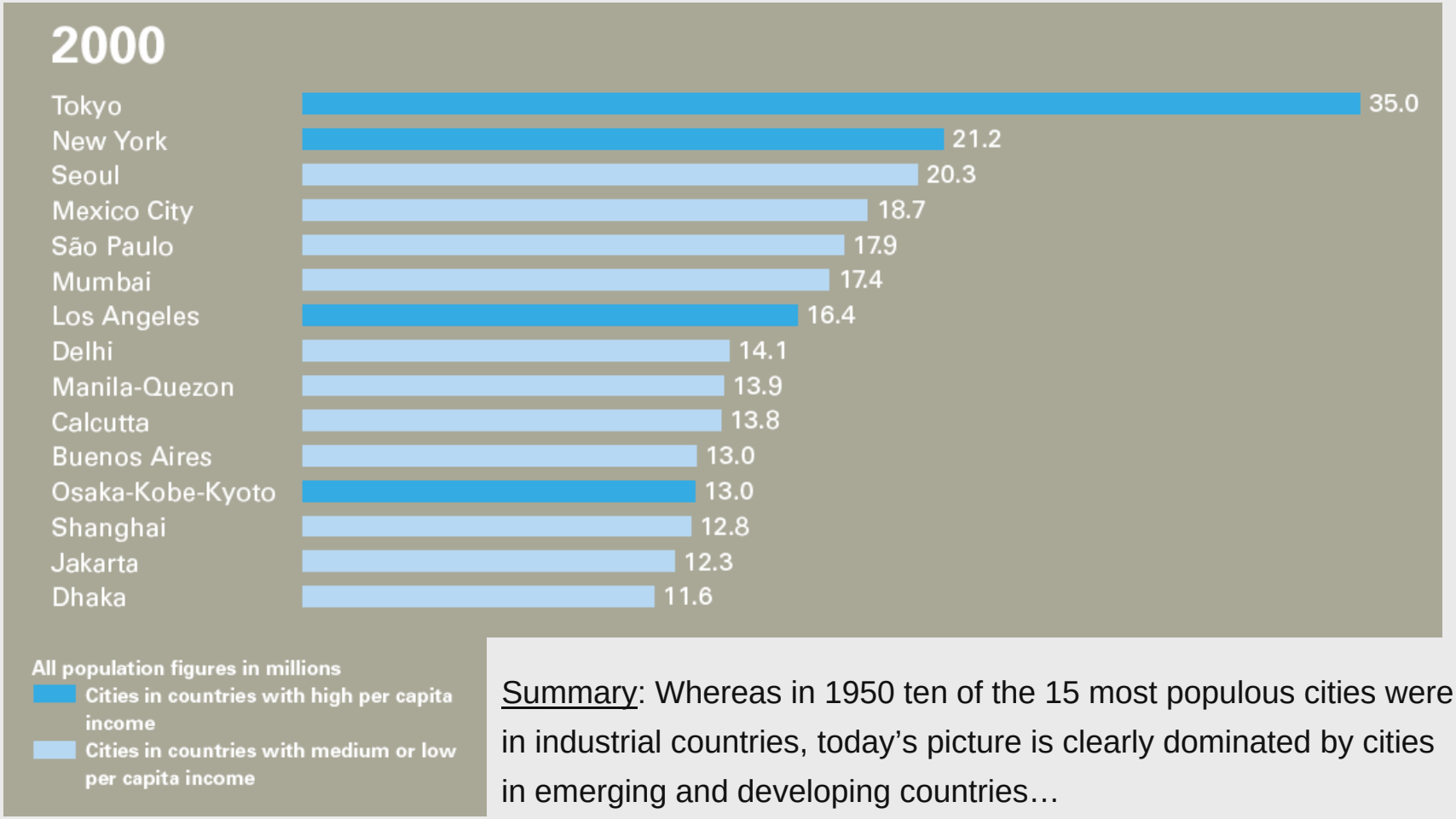

Summary: Whereas in 1950 ten of the 15 most populous cities were in industrial countries, today's picture is clearly dominated by cities in emerging and developing countries…

Source: United Nations, 2004

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Characteristics of megacities

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Common features of megacities:

- High **concentration** of
  - people
  - values
  - infrastructure
- High **interconnectivity** within region / country / continent / world
  - close **interdependence** between flow of goods, finance and information
  - global cities are **gateways** (interaction between regional markets and global flow of information / goods)

➔ **Global impact** of megacities

Example 1: Greater Tokyo – A megacity

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Tokyo today:

- A gigantic concentration of values and people
- Very high density of buildings
- Worldwide interconnection in trade and business

Picture of modern Tokyo

Example 1: Greater Tokyo – A megaRISK

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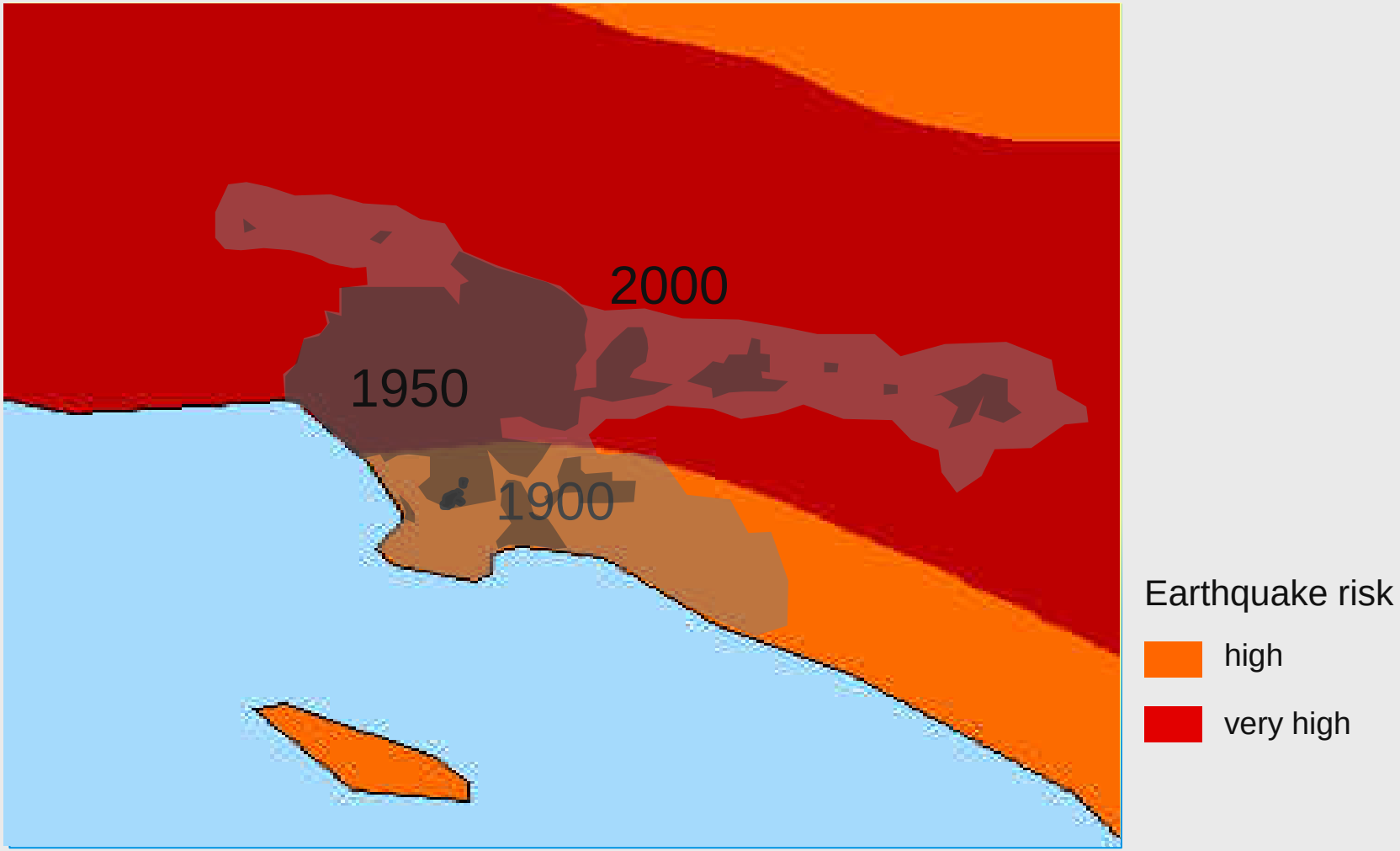
Tokyo 1923:

- 143,000 victims
  (incl. missing persons)

- 2.8 bn USD economic loss

Example 2: Los Angeles

Development of the City of Los Angeles from 1900 to 2000



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Special risk situation: Climate

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- Higher air temperatures (above all evenings and nights)
  - so-called "**heat island effect**" with a difference in temperature with as much as 10 degrees Celsius, example Shanghai
- Generally, lower air speeds in megacities
  - however, straight canyon-like streets generate jet effects with high wind speed
- Higher risk of torrential rain in the lee area of the city
- Greater risk of thunderstorms (lightning strokes)
  - high-rise buildings act like magnets and attract lightning
- Increased air pollution (ozone, dust, soot)
  - often formation of summer smog

Special risk situation: Potential risks

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- Natural catastrophes,
  some examples: Earthquake in San Francisco (1906), heat wave during the summer (global warming), hurricane Katrina that hit New Orleans
- Technological and infrastructural catastrophes,
  e.g. explosion of ammonium nitrate store in Toulouse in September 2001
- Social / political risks and terrorism,
  as in the past in New York (2001), Madrid (2004) and London (2005)
- Epidemics and infectious diseases,
  as SARS in 2003 in Asian cities, bird flu

Special risk situation: Accumulation risk

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Various classes of business may be affected:

- Life, health and workers' compensation insurance
- Liability (e.g. industrial lines)
- Property insurance (private, commercial, industrial lines)
  - Property damage and business interruption

➔ **"Challenges" versus "opportunities" for insurers**

Special risk situation: Risk management

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Approaches to **solving or mitigating** the accumulation problem:

Risk evaluation

- Assessment using appropriate scenarios and tools (“geocoding”)

Risk limitation

- Limits of liability
- Exclusion of risks (certain hazards, objects, areas)

Balance of risks (regional)

- Growing need for insurance in metropolises in developing countries

➔ **Risk prevention and reduction**

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The Munich Re risk index for megacities

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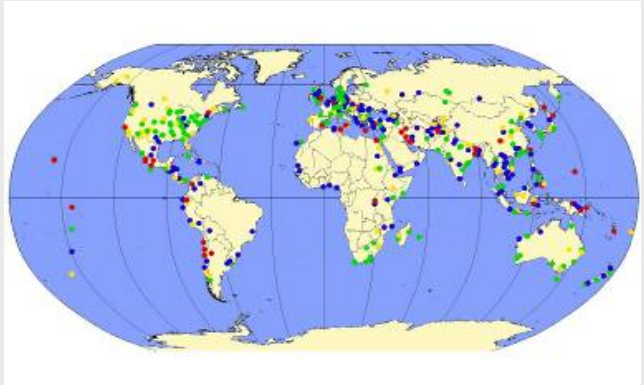
Analysis

with focus on **natural hazards** due to:

- Data availability
- Modeling capability



Risk assessment

- Interregional comparison
- Risk modeling

The Munich Re risk index: Data sources

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- **Online** databases and information systems
  (e.g. Internet, Reuters Insurance Briefing)

- **Media** reports
  (press, radio, television)

- Worldwide **network of contacts**
  (scientists, official agencies, companies, technical seminars, workshops, expert opinion)

- Technical **literature**
  (scientific reports, essays, conference papers, etc.)

- Munich Re **connections**
  (subsidiaries, branch offices, liaison offices, service companies, clients in more than 150 countries)

The Munich Re risk index: Data sources, cont'd

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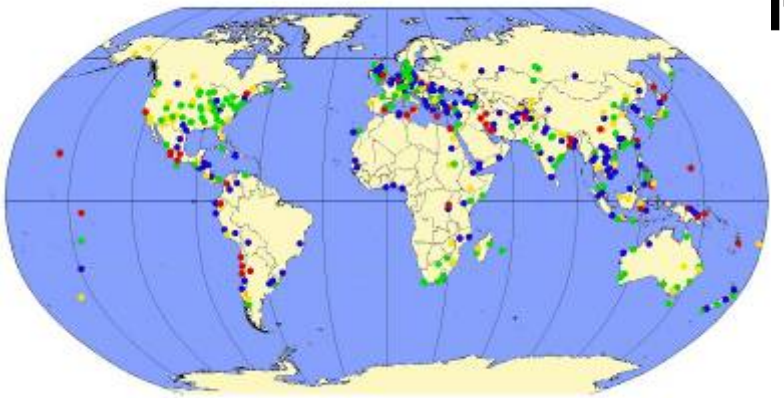

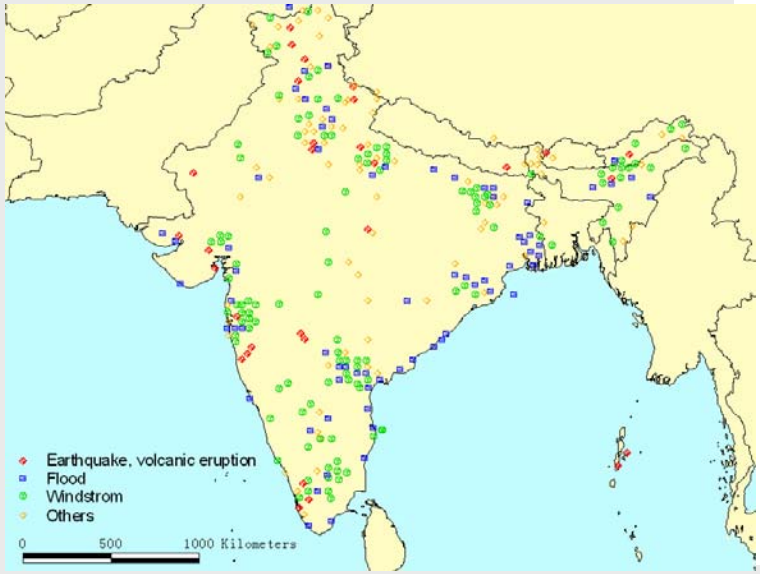

MRNatCat SERVICE

Date	Area affected	Loss Event
24.-27.8.2003	Mexico: W, Baja California, Los Cabos, La Paz, Loreto, Comondu; Sinaloa	**Hurricane Ignacio** **MR200308B027** Wind speeds up to 150 km/h, gusts up to 185 km/h, torrential rain (approx. 500mm in La Paz), landslides. >300 homes flooded/damaged, cars, boats damaged. Highways, roads blocked. Ports, airports closed, flights cancelled. Trees, power lines downed, communication cut off. Water supply affected. Evacuated: 13,500, affected: >15,000, missing: 2. Deaths: 6 Economic losses: US$ 150m Source: OCHA; R; AP; EFE News
22.-23.9.2003	Mexico: NW, Baja California, Los Cabos, La Paz	**Hurricane Marty** **MR200309B005** Wind speeds up to 165 km/h, torrential rain, floods. River burst its banks. Hundreds of homes flooded, cars damaged. Highways, streets flooded, 35 boats destroyed, >100 damaged, ports closed. Trees, power lines downed. Water supply disrupted. Homeless: 13,500, affected: 6,000, evacuated: 10,000. Deaths: 10 Economic losses: US$ 300m Insured losses: US$ 40m Source: R; WR; dpa; AFP, Stuttgarter Zeitung; EFE News
5.-23.9.2003	Mexico: C, Querétaro, Jalisco, Guanajuato, Nayarit, Michoacán, Veracruz,	**Floods, severe storm** **MR200309C006** Severe rain storms, thunderstorms, torrential rain (60mm/24h), landslides. lightning. 3,000 homes damaged. Roads blocked. Crops destroyed.

The Munich Re risk index: Basics

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- Objective: Comparative evaluation of the risk of **material losses / loss potential**
- Synoptic view of **all relevant natural hazards**
  - Earthquake + secondary effects (incl. tsunami)
  - Windstorm
  - Flood
  - Other hazards (volcanic eruption, bush fire, frost)

Munich Re World Map of Natural Hazards; sub-components: ground motion, shaking, subsoil conditions

Munich Re World Map of Natural Hazards; sub-components: tropical storms, extratropical storms, local storms

Development of new classification system; sub-components: river flooding, flash floods, torrential rain, storm surge

…under consideration of rare and frequent occurrences (**PML** and **AAL**)

The Munich Re risk index: Basics, cont'd

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- Overview over **all index components**

  - **Hazard**
    Earthquake, windstorm, flood, other hazards

  - **Vulnerability (or loss susceptibility)**
    Predominant type of residential construction, code compliance / construction standard, disaster preparedness, building quality and building density

  - **Exposed values**
    Average value per household, GDP, global economic significance

The Munich Re risk index: Basics, cont'd

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Index for hazard (max. value 10)

(= Weighted sum of AAL's (per risk) x 0.8 + highest PML x 0.2)

Index for vulnerability (max. value 10)

(= Sum of all sub-components)

Index for exposed values (max. value 10)

(= Sum of all sub-components)

Total risk index (max. value 1,000)

The Munich Re risk index: Result

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City	Index as a whole1) 2)	Hazard *)	Susceptibility to loss *)	Values*)
Tokyo	710	10.0	7.1	10.0
San Francisco	167	6.7	8.3	3.0
Los Angeles	100	2.7	8.2	4.5
Osaka	92	3.6	5.0	5.0
Miami	45	2.7	7.7	2.2
New York	42	0.9	5.5	8.3
Hong Kong	41	2.8	6.6	1.9
Manila	31	4.8	9.5	0.7
London	30	0.9	7.1	4.8
Paris	25	0.8	6.6	4.6

To be updated regularly

[1]) Risk = Hazard × Loss susceptibility × Values

[2]) Total material loss, not the insured share

*) Scaled to max. value = 10

The Munich Re risk index: Result, cont'd

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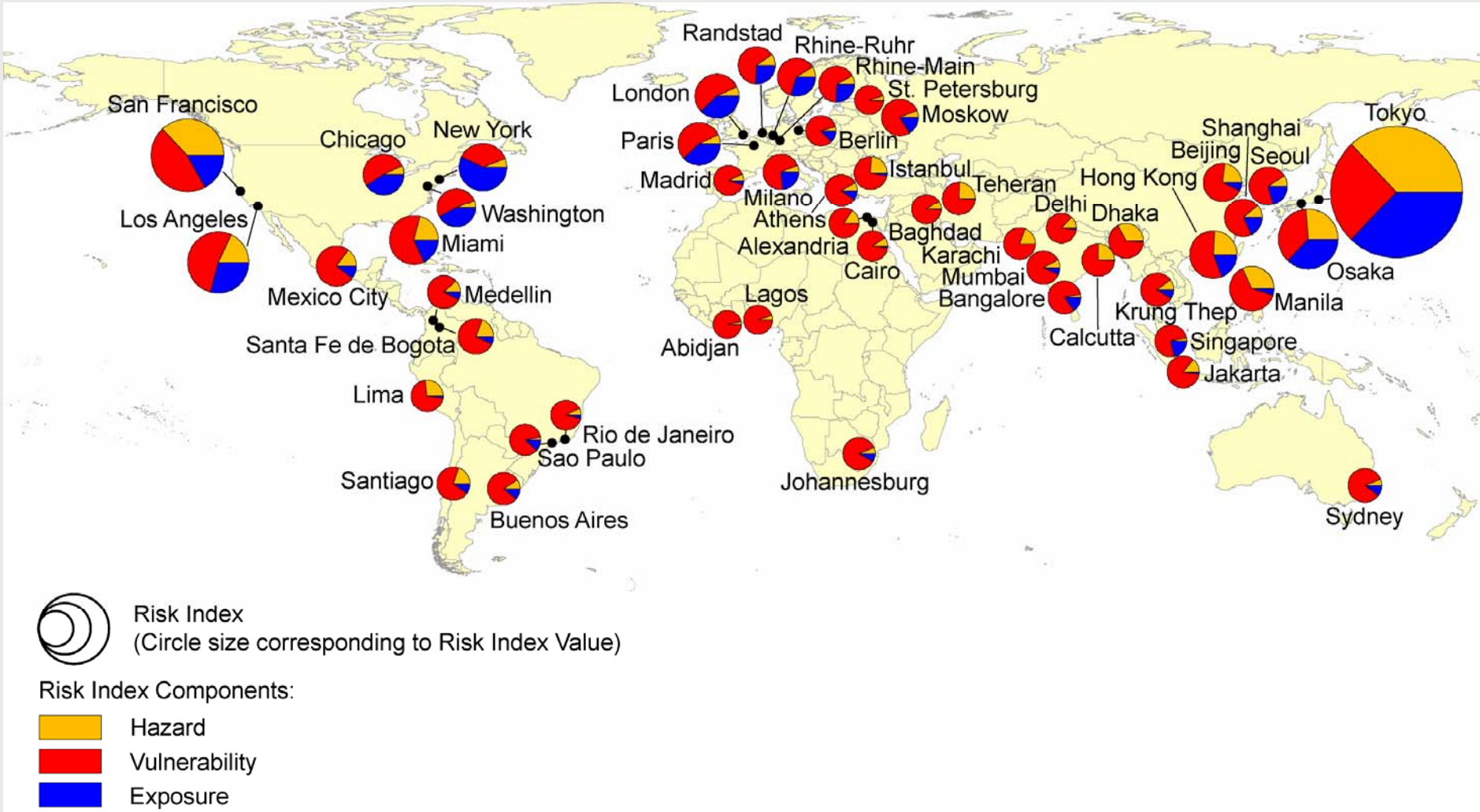

The Munich Re risk index: Result, cont'd

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Reasons for Tokyo's high ranking

- Very **high exposure**, i.e. absolute values and global meaning
- Extremely **high hazard from multiple perils** (EQ, Typhoon, Volcanic Eruption)

Relative ranking of top 6 megacities according to selected criteria

	City	Hazards (combined)	Density	High rise buildings	Household value	City GDP
1	Tokyo-Yokohama-Kawasaki	1	1	2	1	1
2	San Francisco-Oakland-San Jose	2	3	3	5	5
3	Los Angeles-Riverside-Orange county	4	6	5	4	4
4	Osaka-Kobe-Kyoto	3	2	4	3	3
5	Miami-Fort Lauderdale	4	5	6	6	6
6	New York-Northern New Jersey-Long Island	6	4	1	2	2

Remark: Ranking in each selected criterion does not necessarily represent the absolute ranking of the respective city in the context of all 50 megacities. The ranking only depicts the position of each of the top 6 cities in relation to each other.

The Munich Re risk index: Conclusion

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1) In spite of **several limitations** and **open issues** …

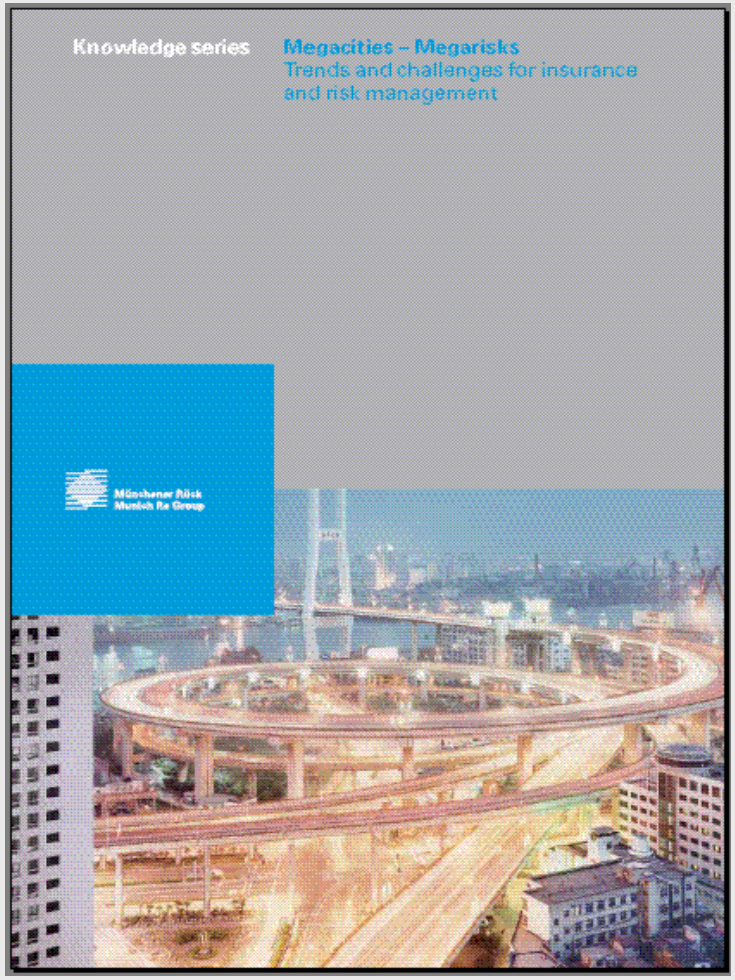
- *Insufficient data (flood hazard, preparedness, determination of city area)*
- *Predominance of earthquake*
- *Relative weight of main components*

… Munich Re's risk index for natural hazards gives a **realistic comparison** between the loss potentials of various megacities and can be taken as an **initial indicator** for the analysis of risk potential!

2) **Megacities =**

- Centers of developments with **impact on the rest of the world**
- New risks, new markets and **new insurance solutions**

Munich Re's brochure "Megacities – Megarisks"



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Thank you very much for your interest!

Stephen Voss, Munich Re Japan Services K.K.

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