Disasters in the Anthropocene - Perspectives and Challenges for Risk Management

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Disasters in the Anthropocene - Perspectives and Challenges for Risk Management

Anthropocene and 'Natural Disasters'

Major Challenges of the 21st Century

- Growing damage by natural disasters
- Implications of Climate Change
- Implications of Urbanization

The Megacity Issue

- Changing Risks
- Complex Vulnerabilities
- Difficulties with Disaster Risk Reduction

Challenges

CEDIM

Universität Karlsruhe (TH)
Forschungsuniversität • gegründet 1825

Engineering: Structural, Electrical, Mechanical, Communication
Water Ressource Management
Economic engineering
Logistic Engineering
Geological Hazards

GFZ
POTSDAM

Geological Hazards
Flood Risk
Early Warning Systems
Satellite Technology
Geoinformation Management

Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

Meteorology and Climate Research
Decision Support
Sustainability Analysis
Emergency Medicin

www.cedim.de

CEDIM

Successful **risk reduction** requires risk assessment and analysis, risk communication and risk management.

- CEDIM creates scientific knowledge, technologies and intelligent tools in these fields by developing synergies between the expertise of its supporting institutions.
- CEDIM co-operates closely with national risk and crisis managing agencies but also contributes to key international challenges such as the impact of disasters on megacities and under climate change conditions.
- CEDIM communicates its experience into the academic and professional sector with the aim of mainstreaming disaster risk reduction in education.

Anthropocene

Crutzen, P. J., and E. F. Stoermer, "The 'Anthropocene'".
***Global Change Newsletter* 41, pp. 17-18, 2000.**

Pleistocene (2.6 Mio to 12.000 years) recent period of repeated glaciation, ends with last retreat of continental glaciation (= end of the paleolithic period)

Holocene (since 12.000 years) begins with the retreat of continental glaciers

Anthropocene marks the beginning of significant global impact of humans on climate and eco systems
Begin: Industrial revolution (invention of steam engine by James Watt 1784)
or Neolithic revolution (W. Ruddiman, 8.000 years BP)

Anthropocene

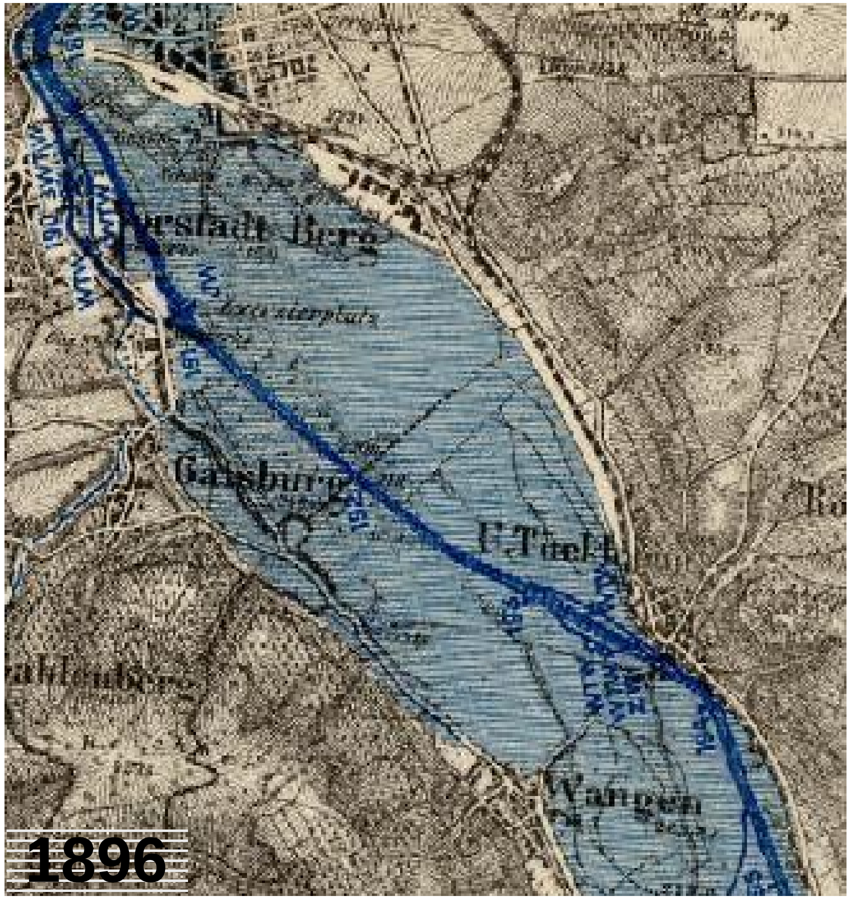
View on Isteiner Klotz, today

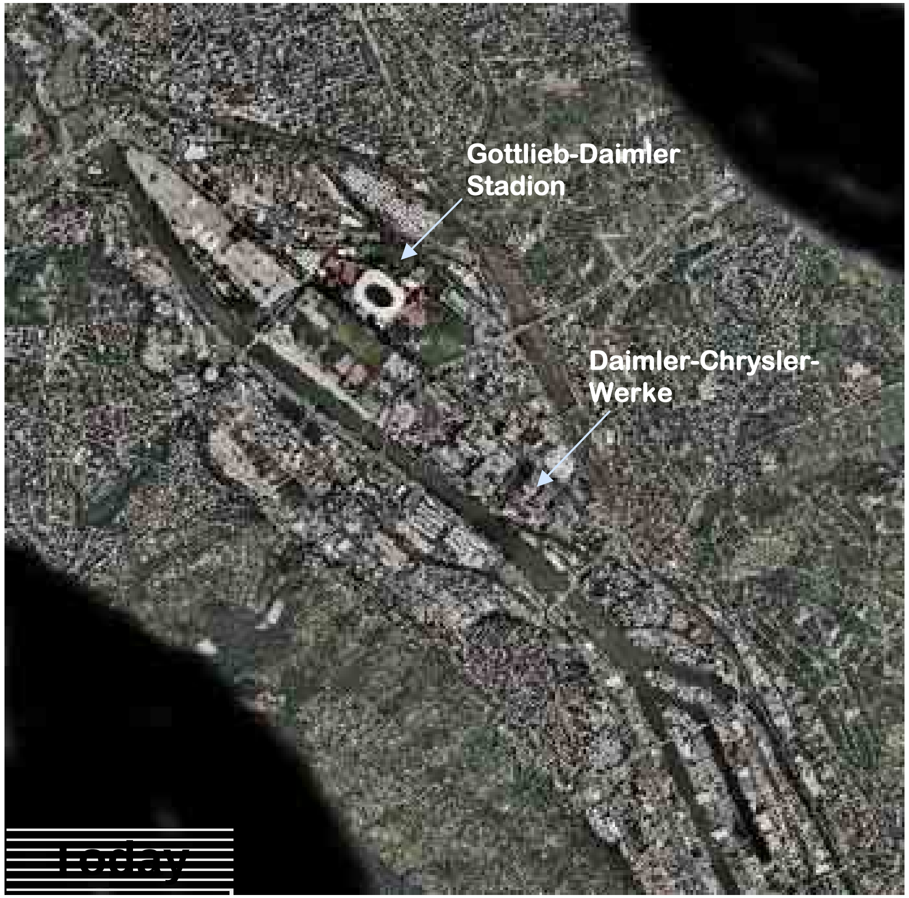
"Blick vom Isteiner Klotz, rheinaufwärts gegen Basel"
Peter Birmann (around 1820), Art Museum Basel

F. Nestmann (KIT)

Anthropocene

Development of setteld areas between 1896 and today
in Stuttgart –Cannstatt (Neckar)





F. Nestmann (KIT)

Anthropocene

Social Scientists always denied the existence of natural disasters as they are caused by the interaction of nature with society!

hazards (nature)

exposure (society, built environment)

vulnerability (level of development)

result in risks as potential for loss

Anthropocene

Floods – from natural phenomen to catastrophy

Damaged Infrastructure

Ecological Damage

Destroyed goods

Damage to life

Mental stress

F. Nestmann (KIT)

Anthropocene

hazards (influenced by men and nature)

growing exposure (society, built environment)

growing vulnerability (developing countries)

result in new risks that change rapidly

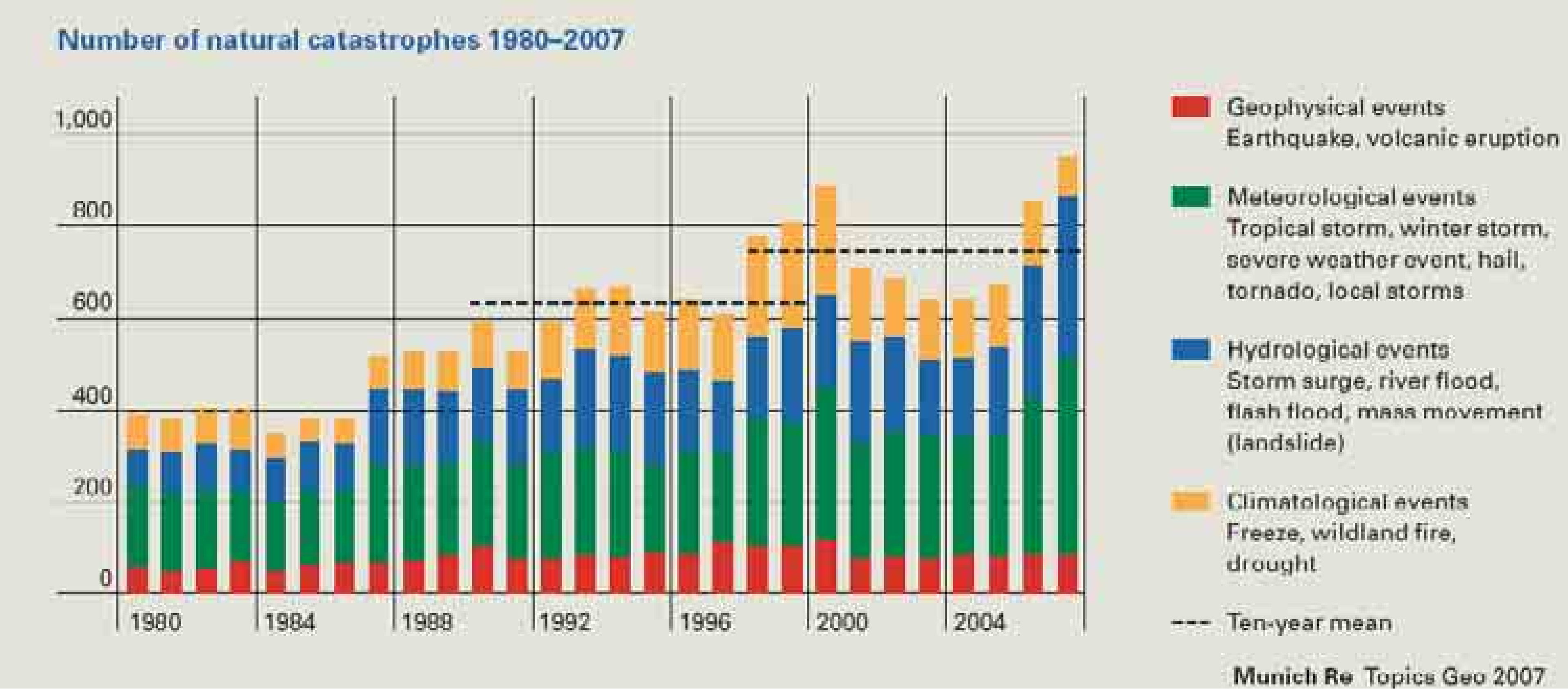
Climate change and urbanization generate a new 'risk landscape' with

New hazards (permafrost, droughts, hail, flood patterns, …)

New risks (for urban environments and coastal areas)

Changing risks with time

Risk and Climate Change



Natural disasters 1980 - 2008

10 costliest natural disasters ordered by overall losses

Date	Loss event	Region	Overall losses* (US$m)	Insured losses* (US$m)	Fatalities
25-30.8.2005	Hurricane Katrina	USA	125,000	61,600	1,322
17.1.1995	Earthquake	Japan: Kobe	100,000	3,000	6,430
12.5.2008	Earthquake	China: Sichuan	85,000	300	70,000
17.1.1994	Earthquake	USA: Northridge	44,000	15,300	61
6-14.9.2008	Hurricane Ike	USA, Caribbean	38,000	15,000	168
May - Sep 1998	Floods	China	30,700	1,000	4,159
23.10.2004	Earthquake	Japan: Niigata	28,000	760	46
23-27.8.1992	Hurricane Andrew	USA	26,500	17,000	62
June - Aug 1996	Floods	China	24,000	450	3,048
7-21.9.2004	Hurricane Ivan	USA, Caribbean	23,000	13,800	125

* Original values
As at January 2009

UN Disaster Statistics 1991-2005

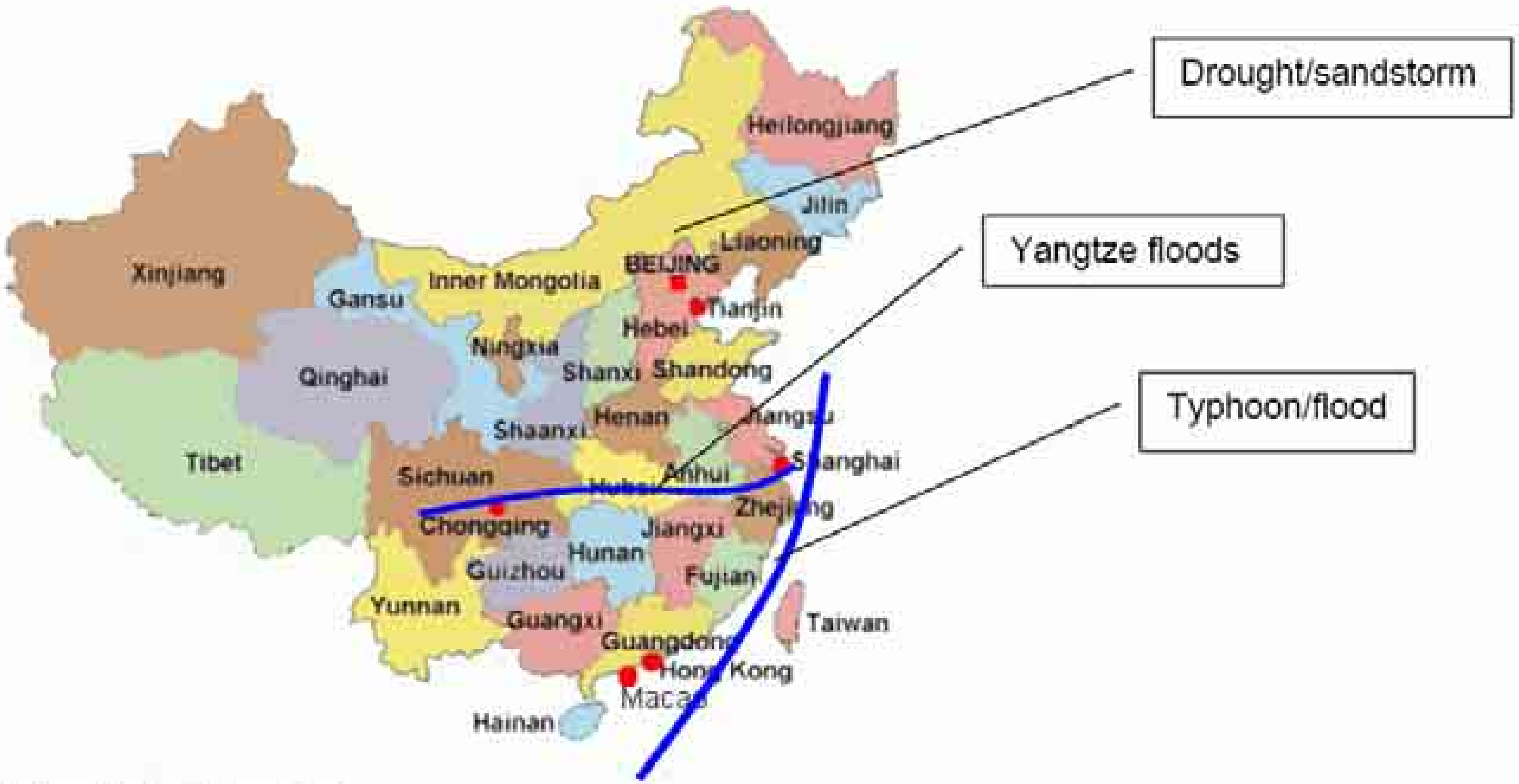
Human Losses

About 1 million people were reported killed
3.5 billion people were affected
about 200 million people affected per year (6times more than conflicts)
600,000 people are exposed to natural hazards each day.
On average, about 200 deaths per day are recorded in different parts of the world.

Economic losses were

Total about $1.2 trillion
Average about $120 billion per year,
or about 300 million per day

Climate Hazards in China



Author: Andrew Dlugolecki
Source: CII Study "Coping with Climate Change"

Risk and Climate Change

Flood Damages 2002 (MunichRe)
Germany: 9.200 Mio. €
Europe: > 20.000 Mio. €

Potential Flood Damages at the river Rhine for extreme events (IKSR)

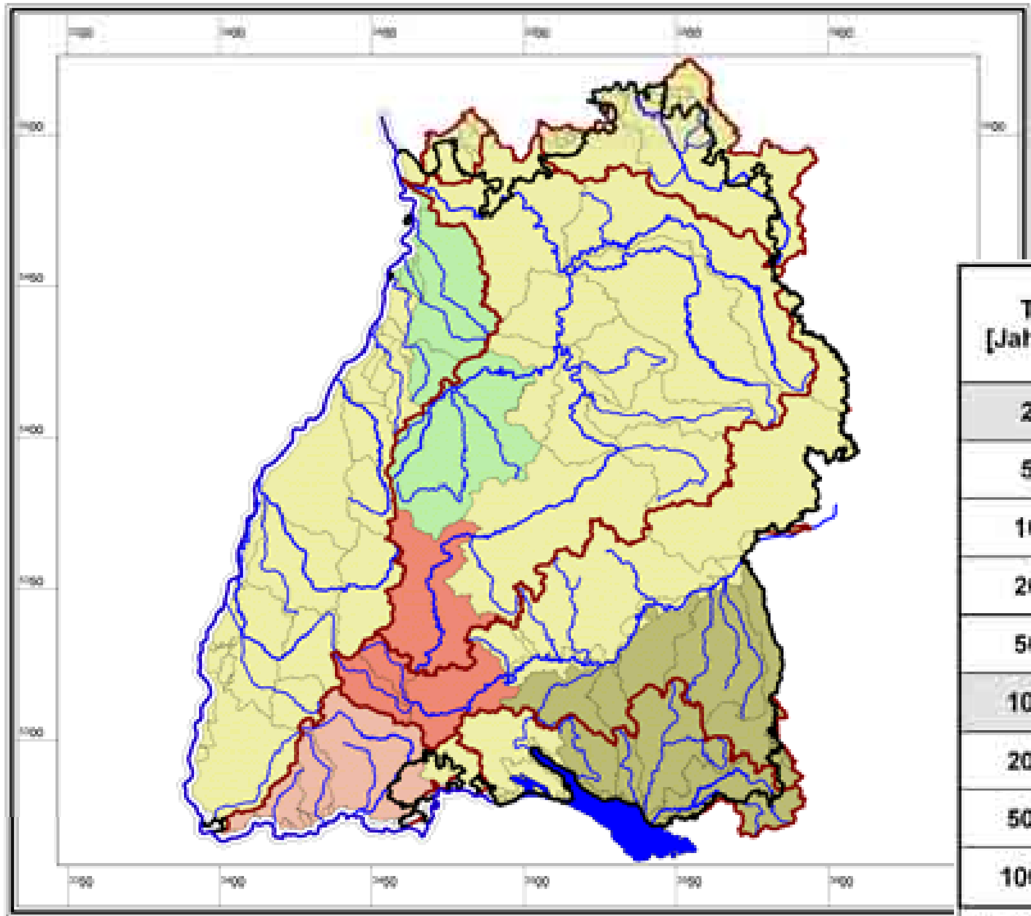
Upper Rhine	11.978 Mio.€
Lower Rhine:	20.333 Mio.€
Rhine Delta:	130.866 Mio.€

F. Nestmann (KIT)

Hydrological change due to climate change

Nestmann, (2007)

Climate factors Baden-Württemberg (regionalised)



Institut für Wasserwirtschaft und Kulturtechnik
Abteilung Hydrologie
Universität Karlsruhe (TH)

T [Jahre]	Klimafaktoren				
	1	2	3	4	5
2	1,25	1,50	1,75	1,50	1,75
5	1,24	1,45	1,65	1,45	1,67
10	1,23	1,40	1,55	1,43	1,60
20	1,21	1,33	1,42	1,40	1,50
50	1,18	1,23	1,25	1,31	1,35
100	1,15	1,15	1,15	1,25	1,25
200	1,12	1,08	1,07	1,18	1,15
500	1,06	1,03	1,00	1,08	1,05
1000	1,00	1,00	1,00	1,00	1,00

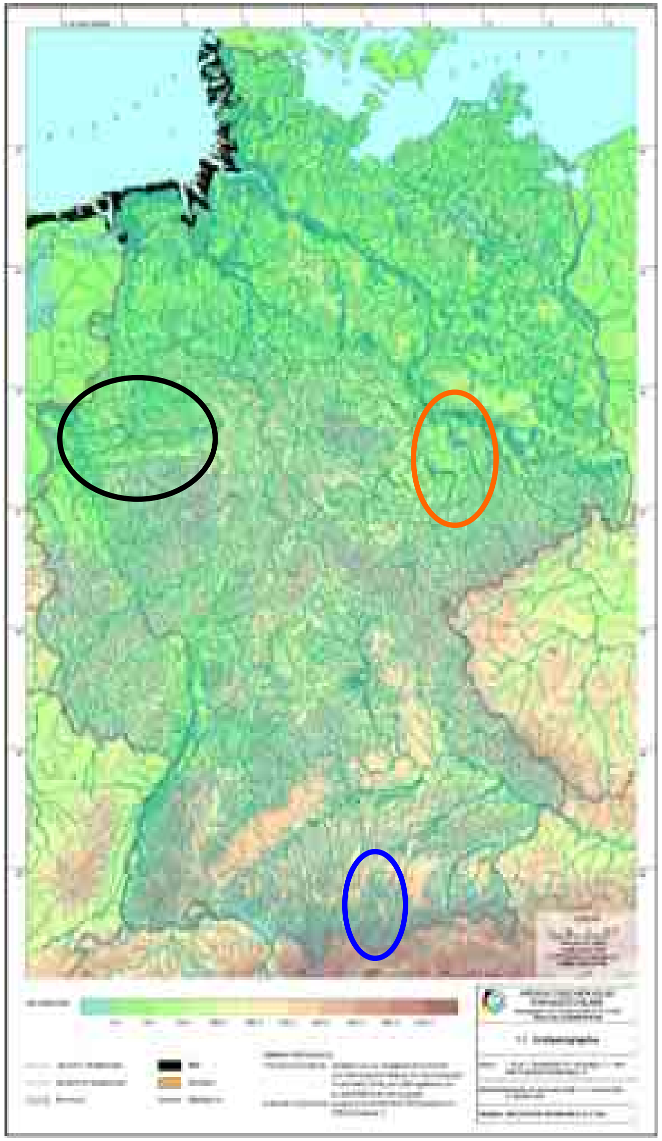
Bemerkung: für Jährlichkeiten T > 1000 a ist der Faktor gleich 1,0

Risk and Climate Change

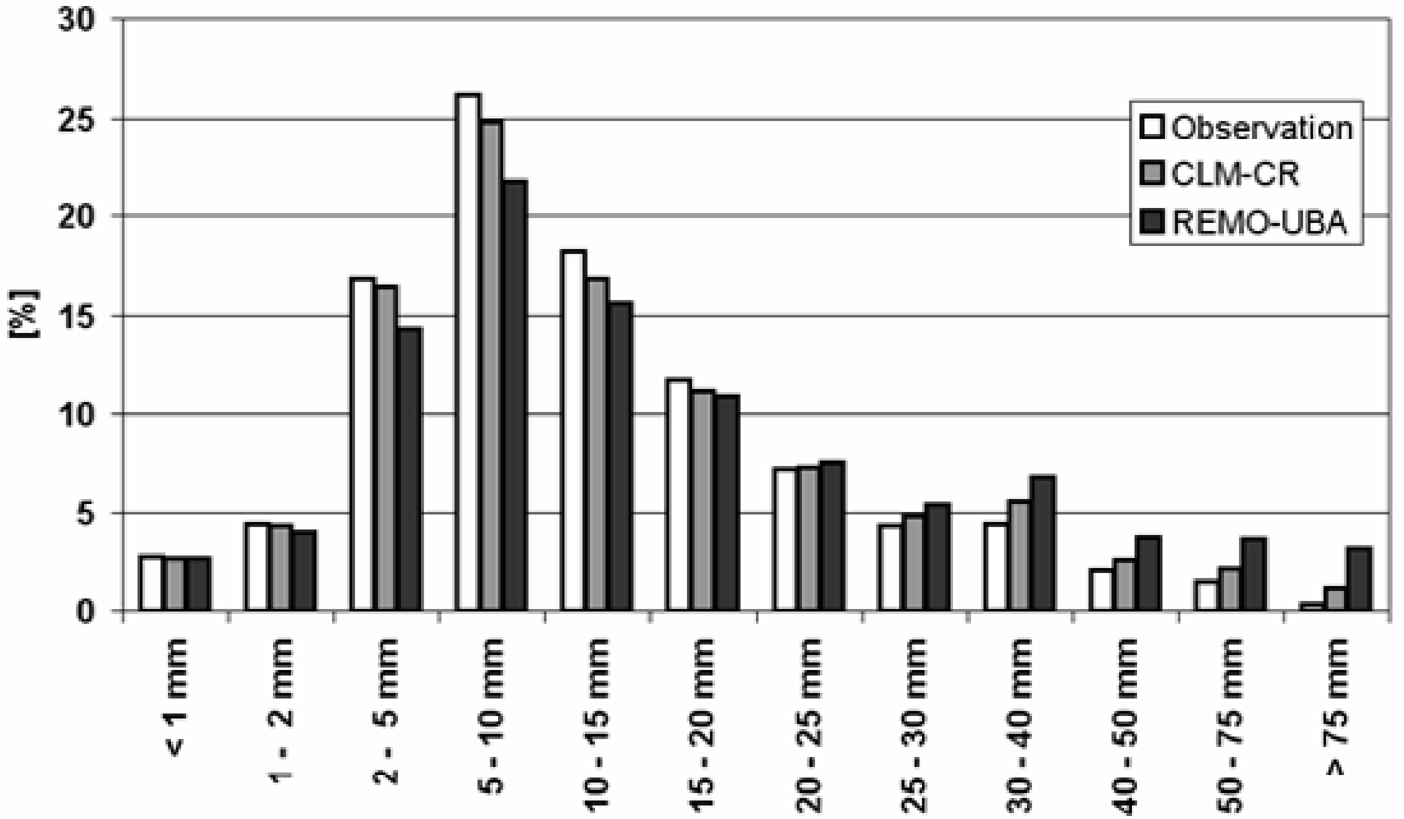
Objective: Quantify change of flood risk in small to medium size catchments (Ammer, Mulde, Ruhr)

Method: Combine regional climate models driven by global models with regional/local hydrological models and observations

Application: Three typical river systems
30 years control time series (1971-2000)
30 years prognosis for 2030-2060)

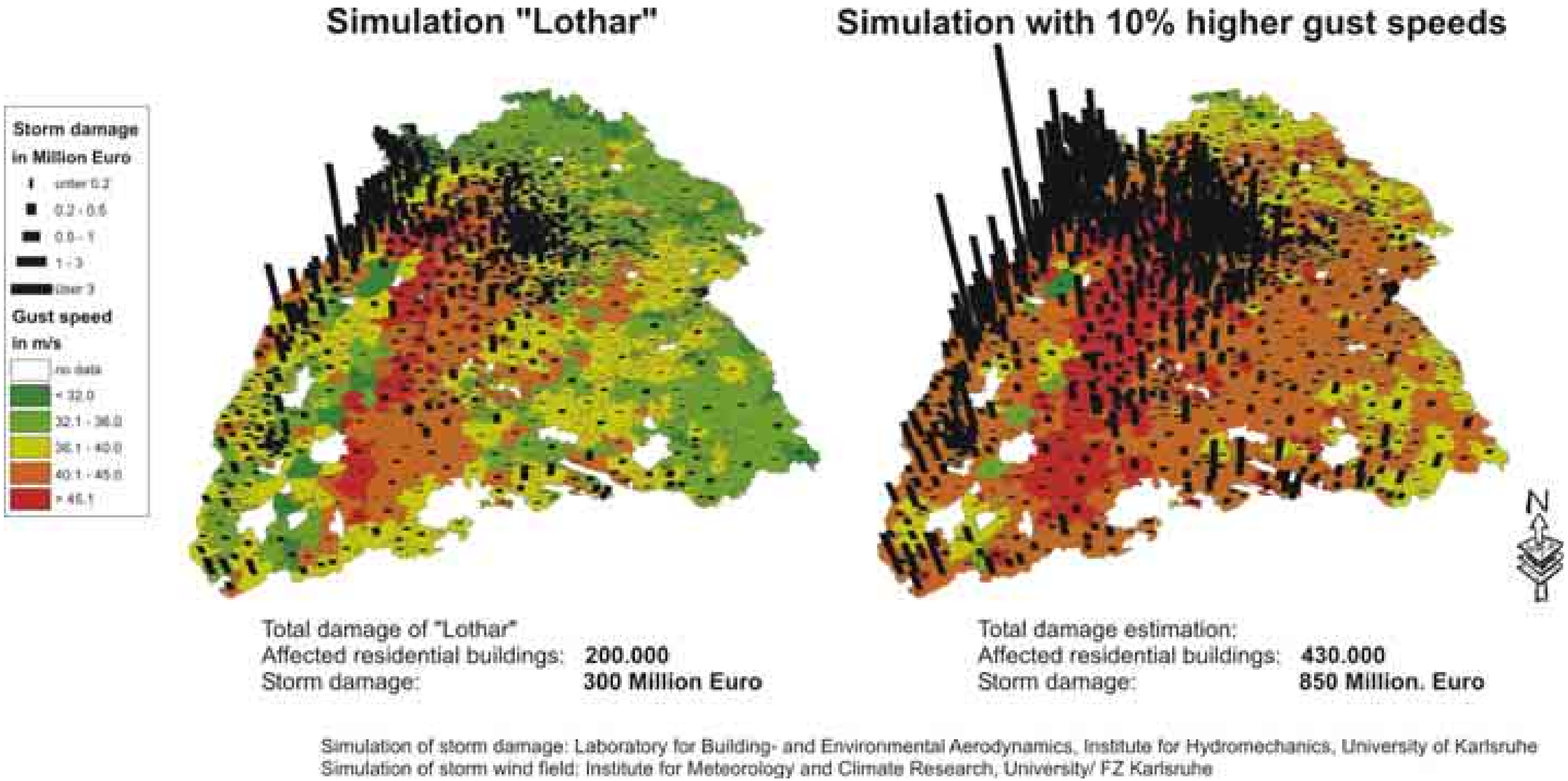


Risk and Climate Change



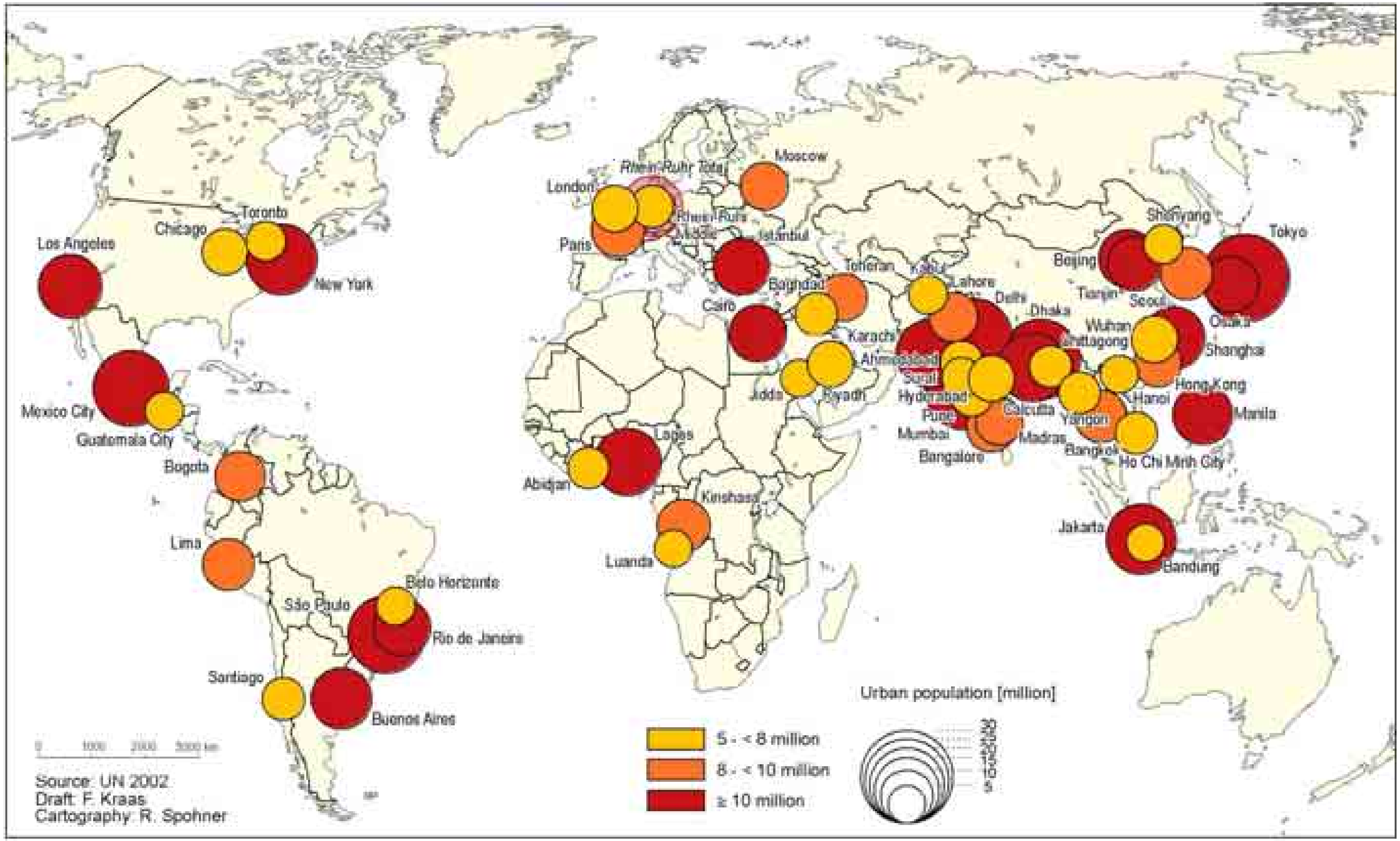
Percentage contribution of each class to the total precipitation from observations (white), CLM-CR (grey) and REMO-UBA (black) for Baden-Württemberg.

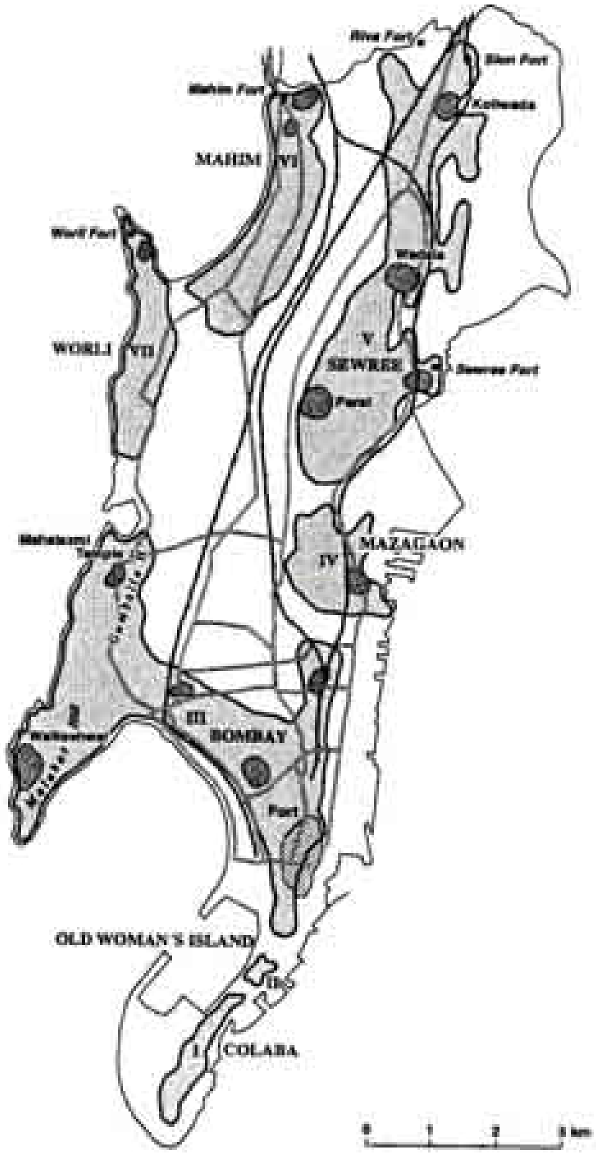
Winterstorm Lothar 26.12.1999



Ch. Kottmeier, P. Heneka, B. Ruck, T. Hofherr (KIT)

Urbanization





Mumbai

1780: 100,000 people

1951: 2.96 Mio. peope

1971: 5.97 Mio. people

1991: 9,93 Mio. people

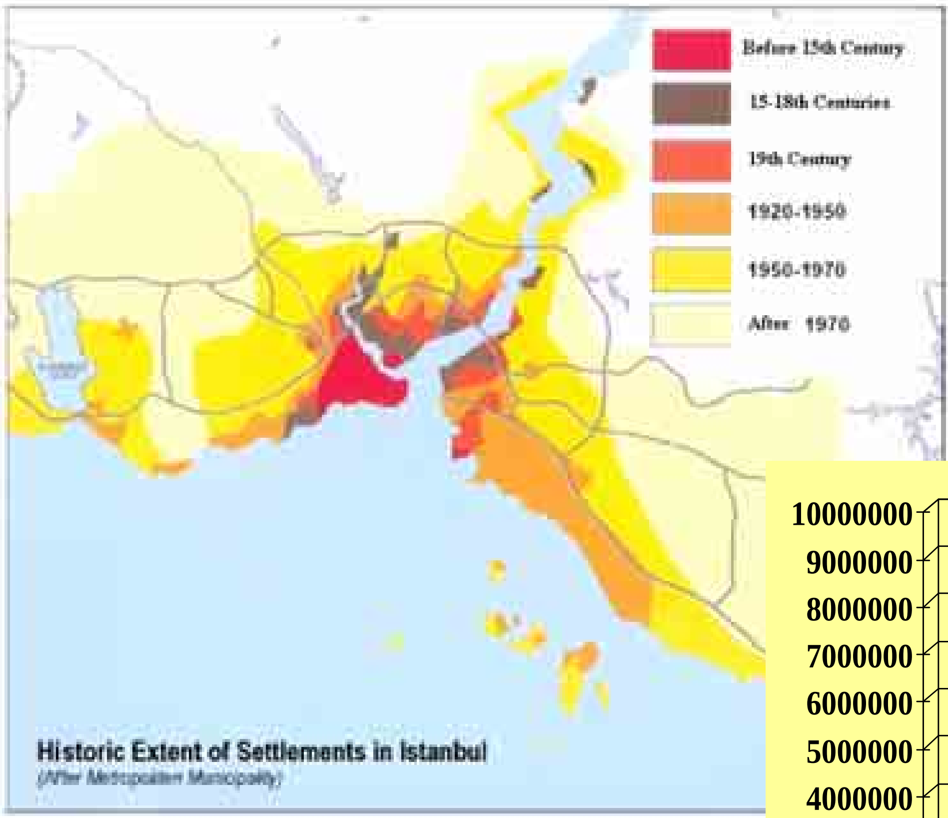
2001: 11.9 Mio people

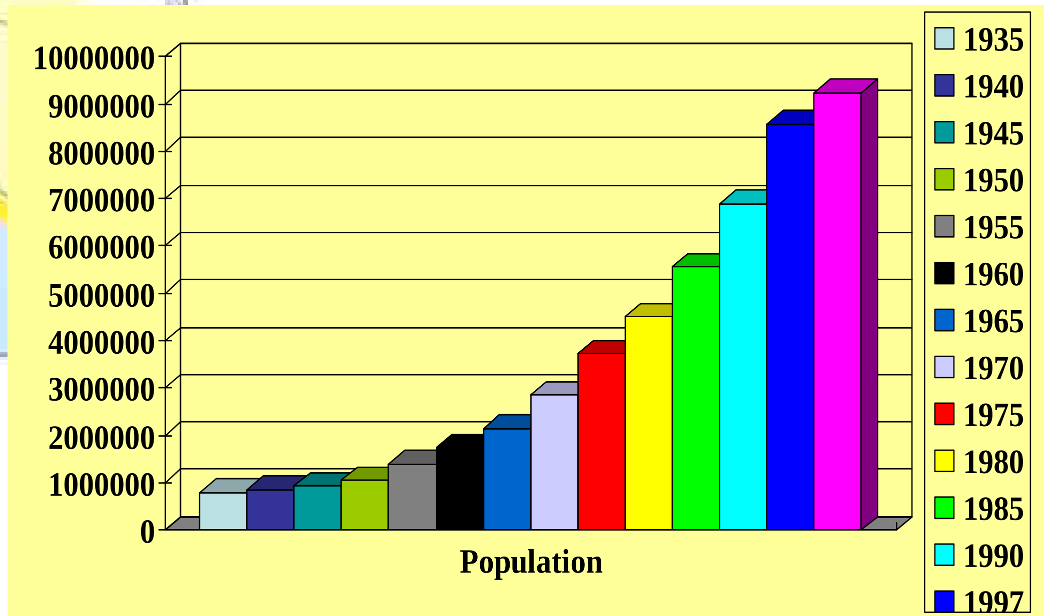
27,200 per km^2

60% in informal settlements (slums)

Megacities

Istanbul





Megacities

Whereas European cities had often centuries to grow to their current size, cities in the developing world grew within a few decades after World War II by migration of rural population without adequate development of infrastructure and social structure. This circumstance forms the key to the high vulnerability of those megacities.

The vulnerability of megacities stems from a mix of factors that are all interacting:

Natural factors (geologic, hydrologic, geomorphic, ...)

Material factors (infrastructure, economic base, housing, ...)

Environmental factors (pollution, …)

Socio-economic factors (income, nutrition, social structure, ...)

Psychological factors (perception of environment, anxiety ...)

Tangshan 1976

28. Juli 1976, Tangshan

Locale time: 3:42

M = 7.8

Observed Intensity: X

Expected Intensity: VI

240,000 people killed

760,000 people injured

Number of inhabitants:

ca. 1,500,000

Challenge: Urban Earthquakes

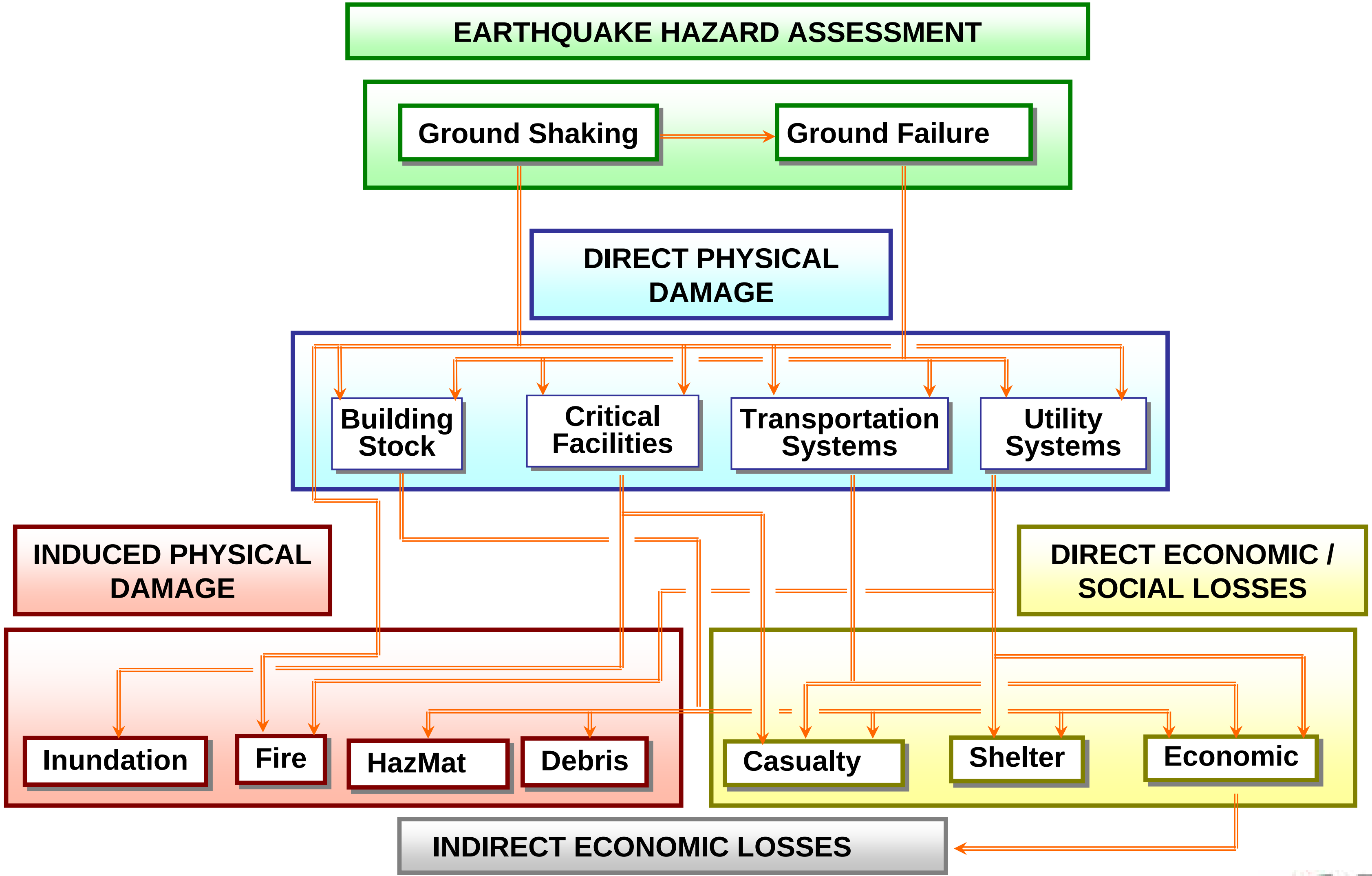
Istanbul: M7.5 hitting Istanbul is expected to kill 70,000 persons; about 300,000 injured will require hospitalization and a staggering 400,000 households require shelter. A total of about 40,000 buildings would be collapse. Another 300,000 more would have moderate to severe damages. The direct monetary losses due to building damage alone would add up to USD 60 billion.

Tehran: The North Tehran and Mosha faults situated towards the northern side of Greater Teheran and the Ray Fault on the southern limits of the city have the potential to generate Mw= 7.2 and 6.7 respectively, which according to the earthquake scenarios developed under the JICA-CEST, 1999-2000, could produce a death toll of 120.000 to 380.000 if any of the two faults were to rupture.

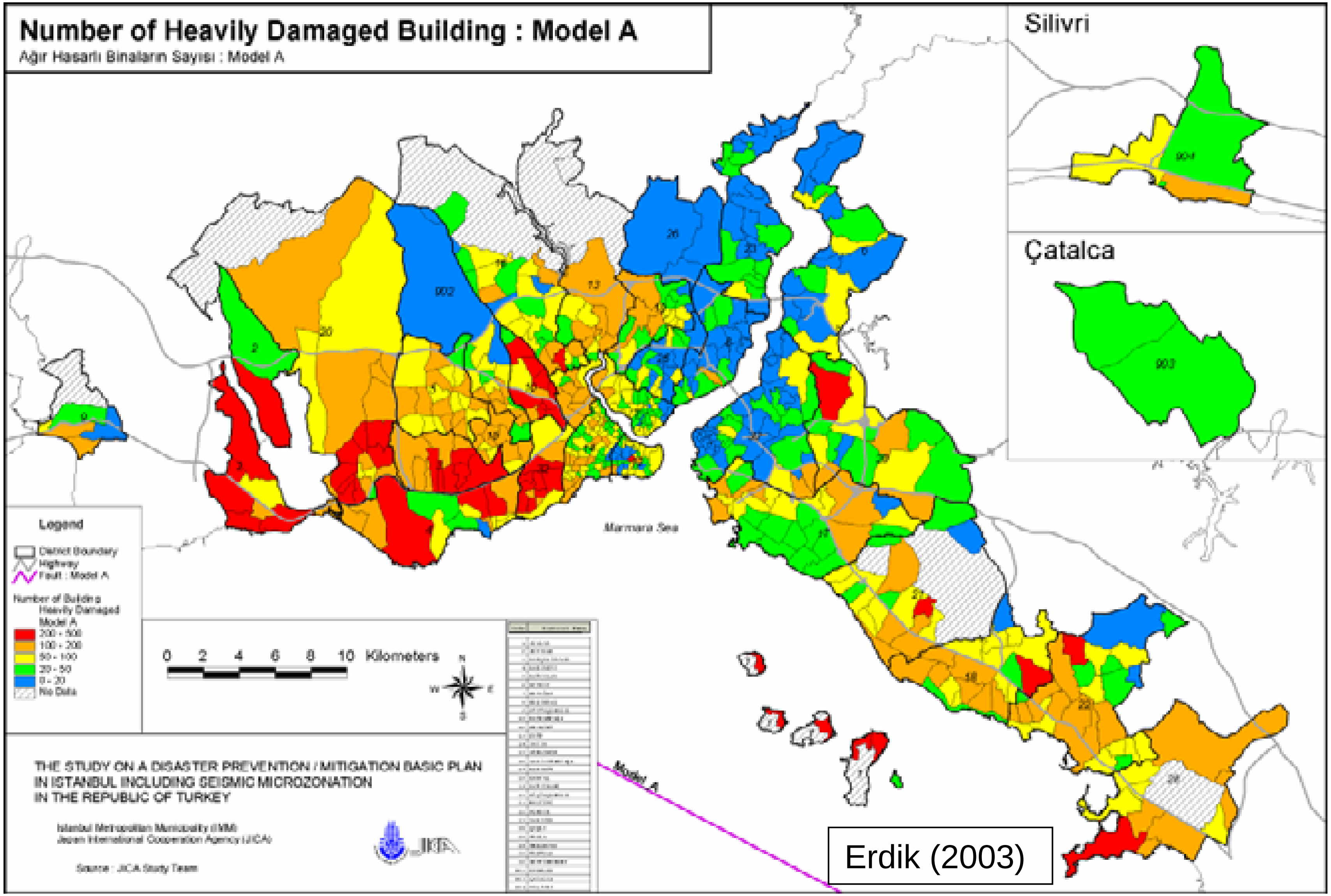
Mumbai: Several studies predict that a moderately low earthquake intensity level of VII (MSK scale) in the city could produce a dead toll of 34,000 and another 95,000 injured if it was to happen early in the morning.

Kathmandu: Scenario projections indicate that a repeat of the 1934 Bihar-Nepal earthquake would produce a death toll between 22,000 and 40,000 and about 60% of all buildings in the Valley will be heavily damaged, many beyond repair. 90% of the water pipes would be seriously damaged and about half of the bridges would be closed due to damage.

URBAN EARTHQUAKE LOSSES

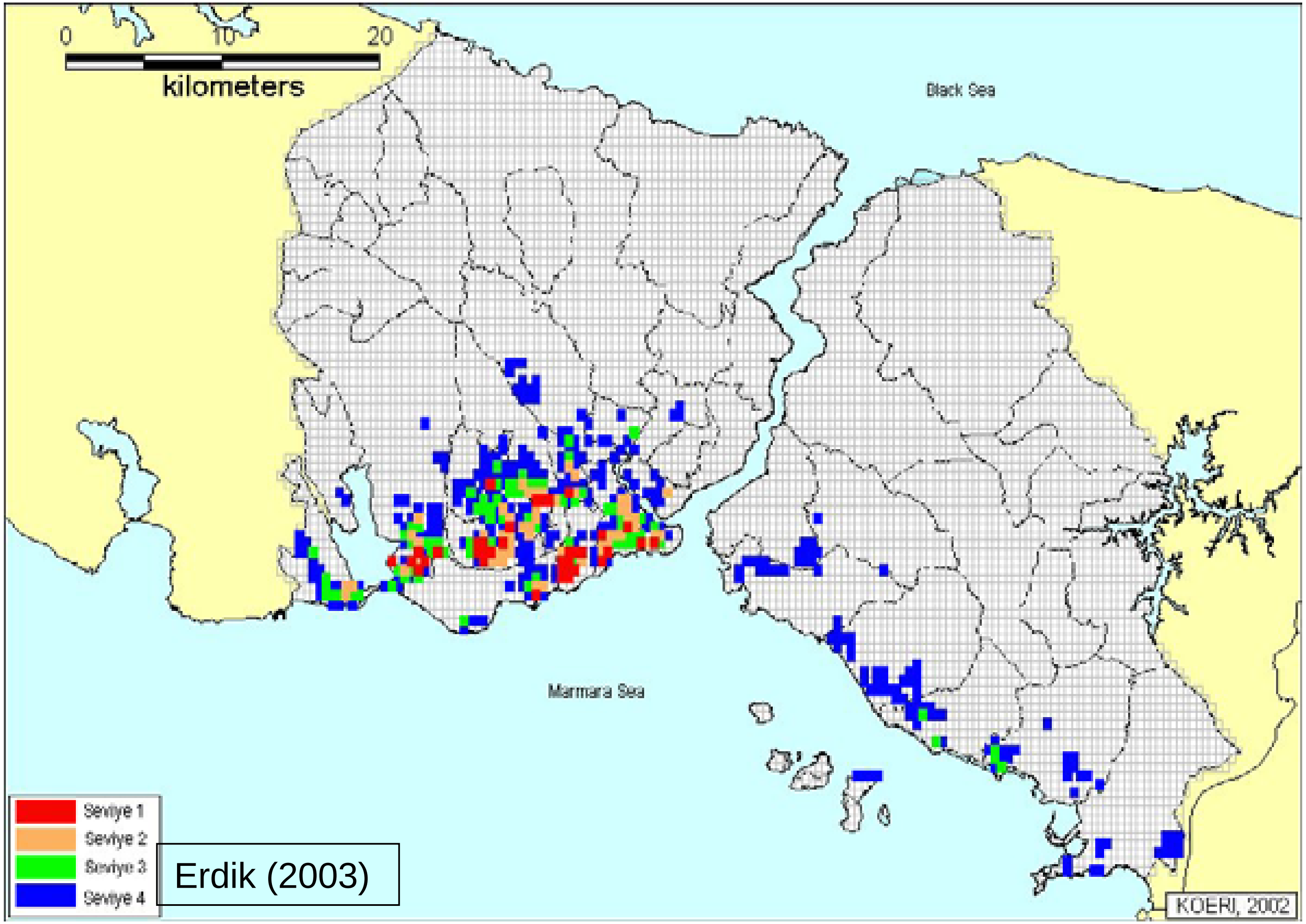


Megacities



Number of Heavily Damaged Building : Model A
Ağır Hasarlı Binaların Sayısı : Model A
Silivri
Çatalca
Marmara Sea
Legend
District Boundary
Highway
Fault : Model A
Number of Building Heavily Damaged Model A
200 - 500
100 - 200
50 - 100
20 - 50
0 - 20
No Data
0 2 4 6 8 10 Kilometers
THE STUDY ON A DISASTER PREVENTION / MITIGATION BASIC PLAN IN ISTANBUL INCLUDING SEISMIC MICROZONATION IN THE REPUBLIC OF TURKEY
Source : JICA Study Team
Model A
Erdik (2003)

Megacities



Erdik (2003)

CELLS WITH HIGH RISK OF CASUALTY

Megacities

Damage estimations for a M = 7.5 earthquake in the Mamara Sea

- 70,000 death (0.8%)
- 5,000 totally collapsed buildings
- 60,000 heavily damaged buildings (7.1%)
- 120,000 severely injured (1.4%)
- 2,000,000 temporarily homeless (20%)
- 1600 damage points on water supply system
- 13 damage points on natural gas lines and 29,000 damaged service boxes
- Probability of falling of 20 bridges
- 60 ± 20 billion US$ loss (30% GNP)

Erdik (2003)

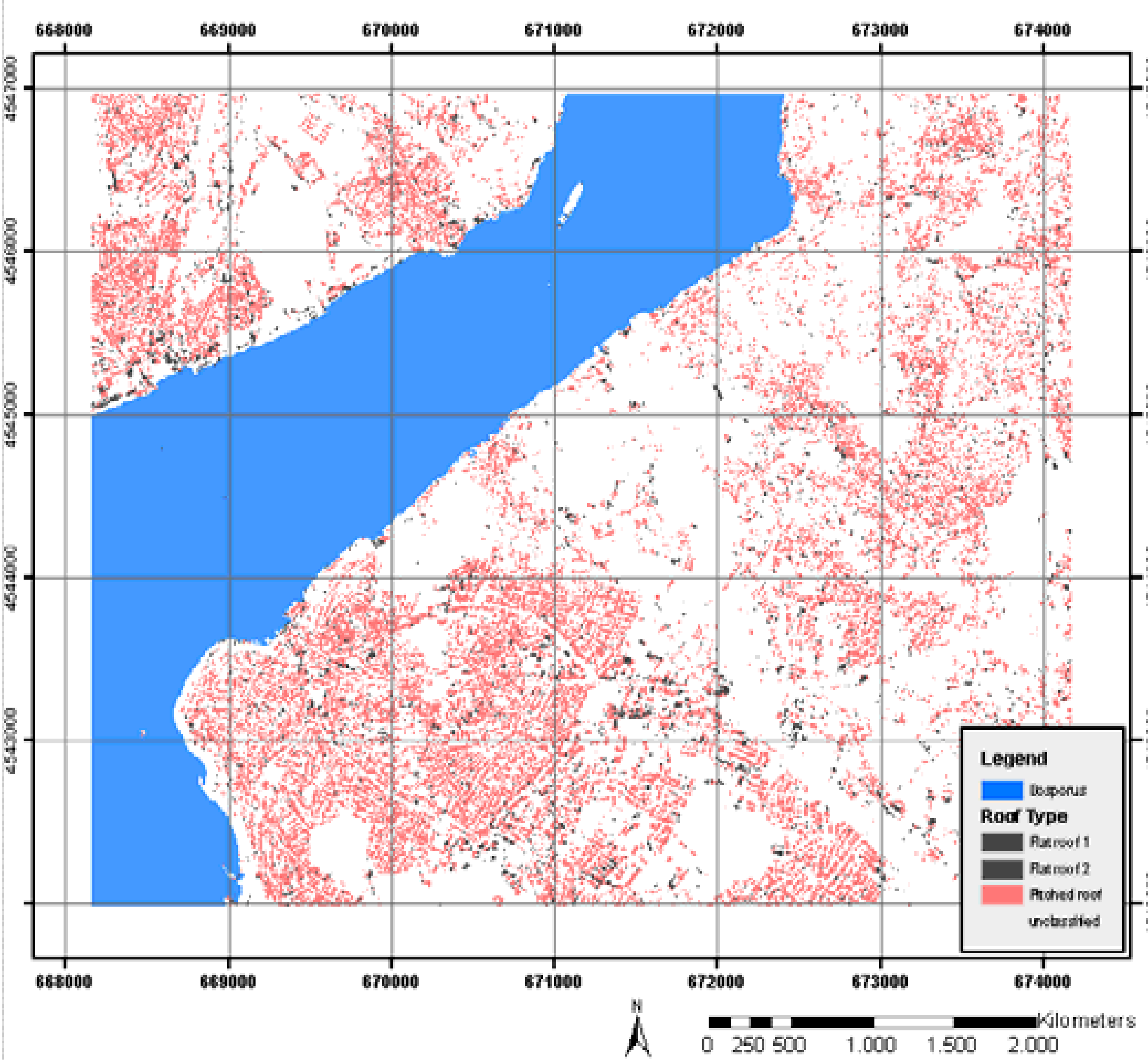
Critical Infrastructure - Lifelines

Modern life became highly dependent on networked infrastructure systems such as transportation, energy and water supply, and communication. Each of them is critical for societies to function, can cause significant, although mostly **indirect losses**, but is largely unexplored so far for multi-hazard impact.

Elbe Flood 2002
Infrastructure Damage

Estimated total damage in Germany:	9,2 Mrd. €
Rail Infrastructure:	850 Mio. €
Estimated damage in Saxony:	6,2 Mrd. €
Infrastructure damage:	2,3 Mrd. €
Share of roads and bridges:	25 %

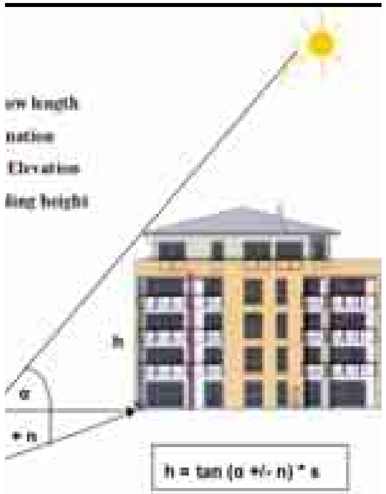
Physical vulnerability - Structural vulnerability



Land cover

Building height

classification



dense built-up area
dense built-up area
loose dense built-up are
open space
open space
ral dense built-up area
ral high dense built-up
ral loose dense built-up
ral open space
ral open space
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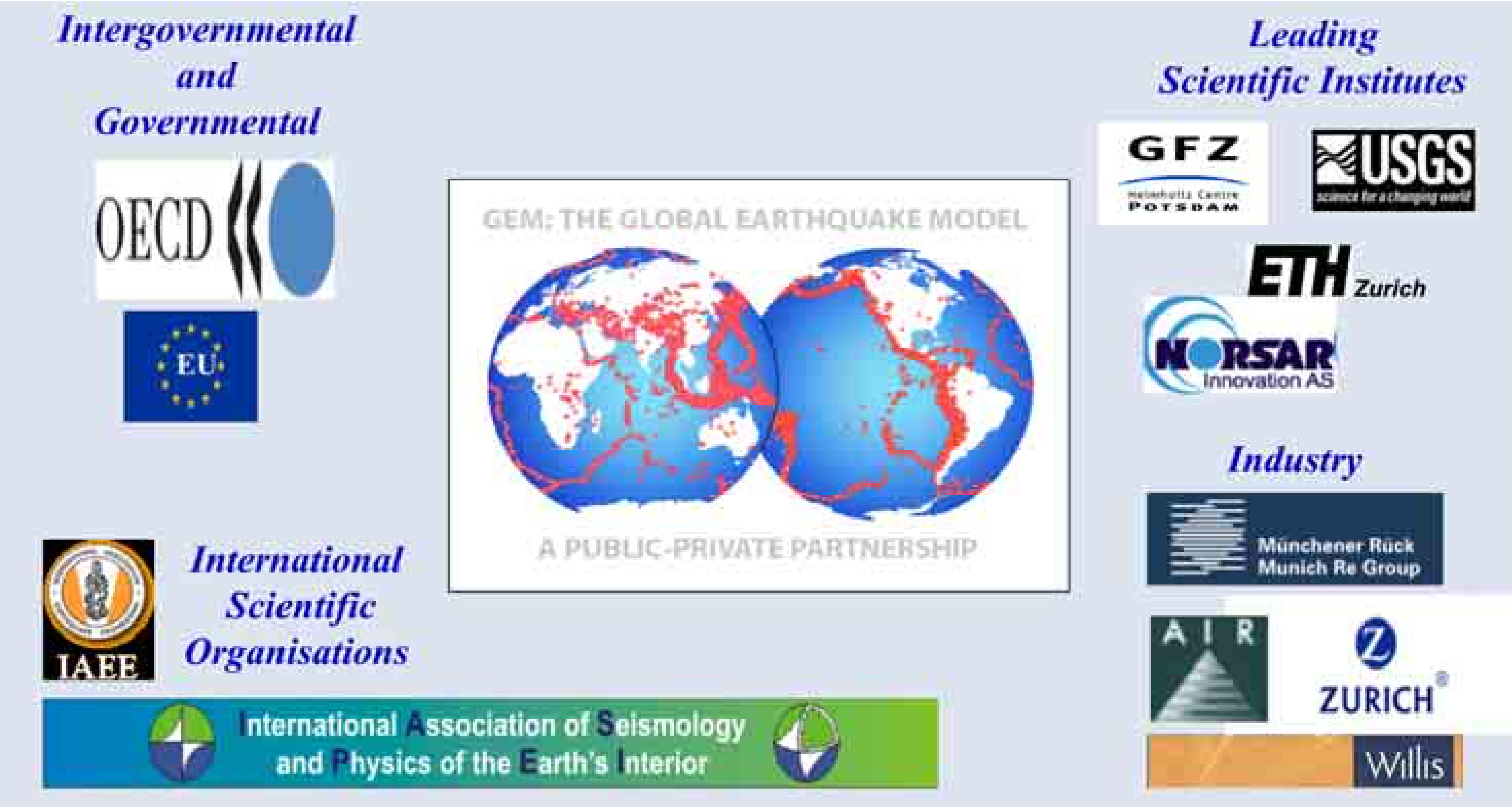
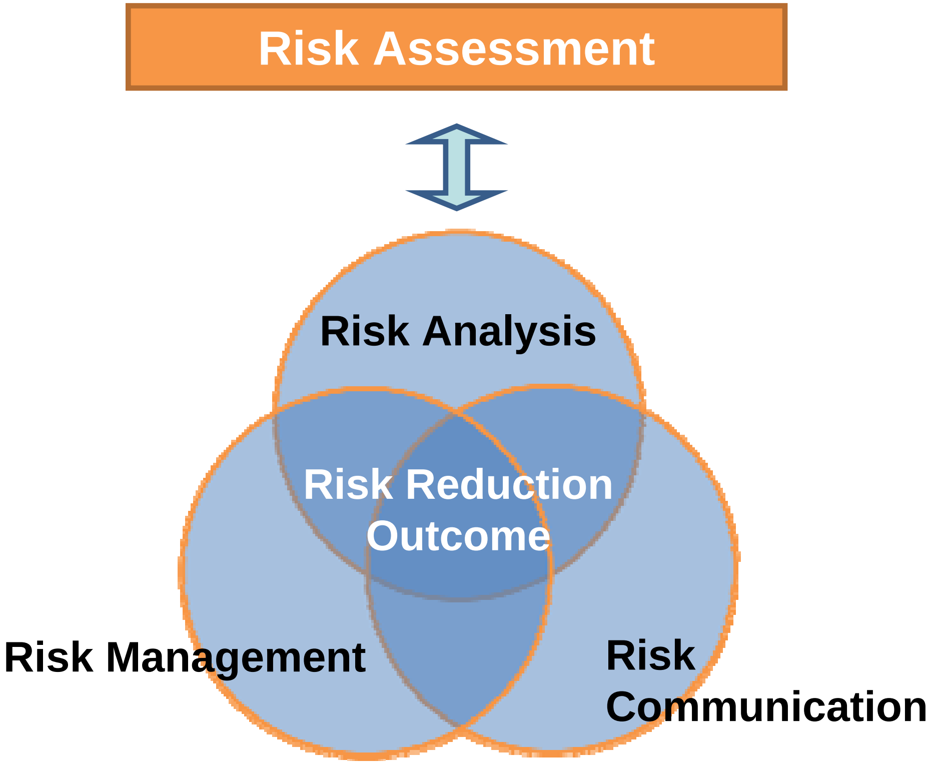
Global Risk Assessment



From Risk Assessment to Risk Reduction



EMI Earthquakes and Megacities Initiative

An international scientific organization dedicated to the reduction of disaster risk in complex metropolises

Global network of partner institutions (academic and professional organizations)

20 city partners and 2 observers:

- ***East Asia***: Kobe, Manila, Shanghai, Seoul, Tianjin, Jakarta
- ***South & Central Asia***: Mumbai, Dhaka, Kathmandu, Tashkent, Beijing
- ***Americas***: Bogota, Los Angeles, Mexico, Quito, Lima
- ***Euro-Mediterranean***: Naples, Istanbul, Tehran, Cairo , Algiers

  Observers: Amman, Karachi
- Partnership with local government organizations (UCLG, METROPOLIS, CITYNET, ICLEI) , RICS, and PDC
- Member ProVention Consortium
- World Bank GFDRR Partner

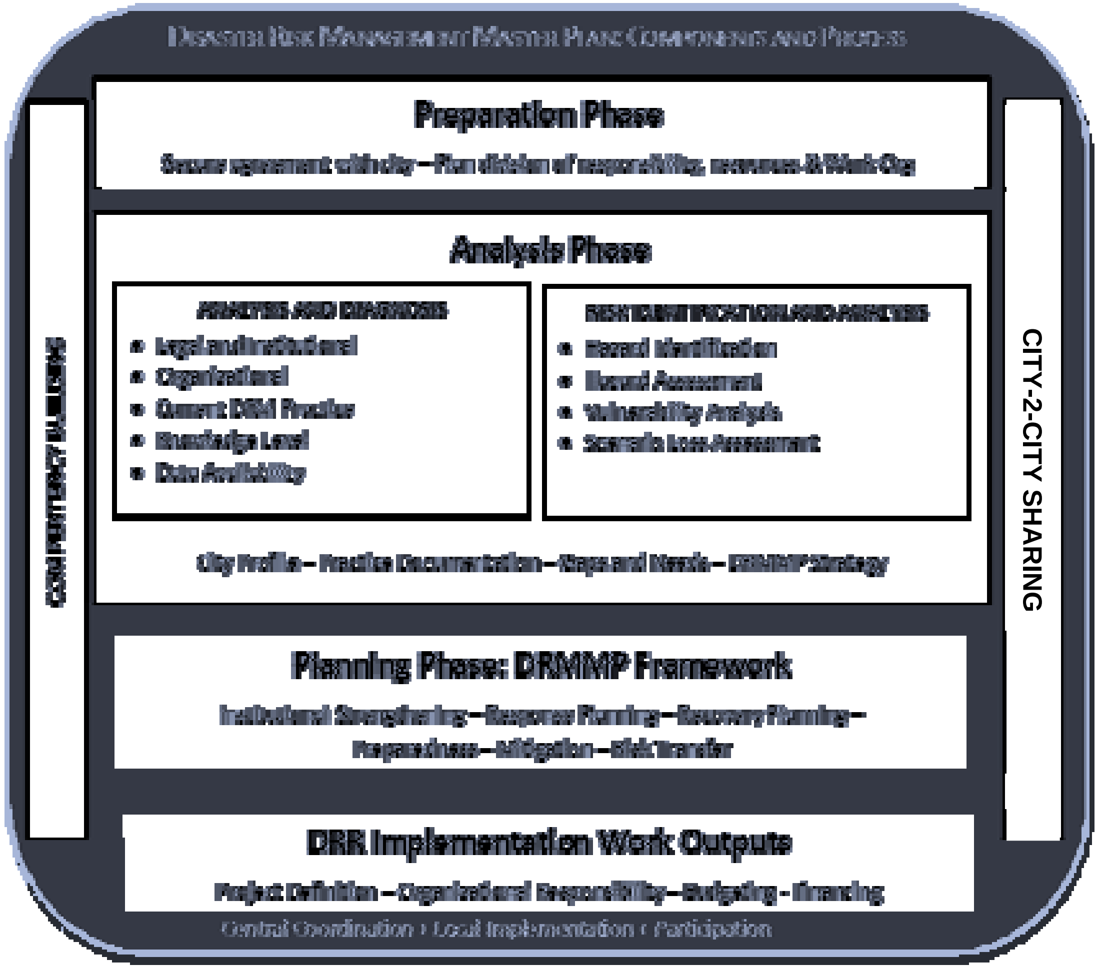
A member of the U.N. Global Platform for Disaster Risk Reduction

Risk Reduction

DISASTER RISK MANAGEMENT MASTER PLAN MODEL

DRMMP is EMI's analytical model for linking DRM to a city's physical and urban development planning strategies

Implemented in four cities: Istanbul, Metro Manila, Kathmandu and Amman and developed for Mumbai



Scientific Challenges

The implications of extreme natural events for large urban agglomerations (megacities) representing complex physical and social systems of high exposure and vulnerability are only marginally understood. Hazard, exposure, vulnerability and thus risk change with time in dynamic and non-linear ways. Methodologies allowing quantitative prognoses are very limited.

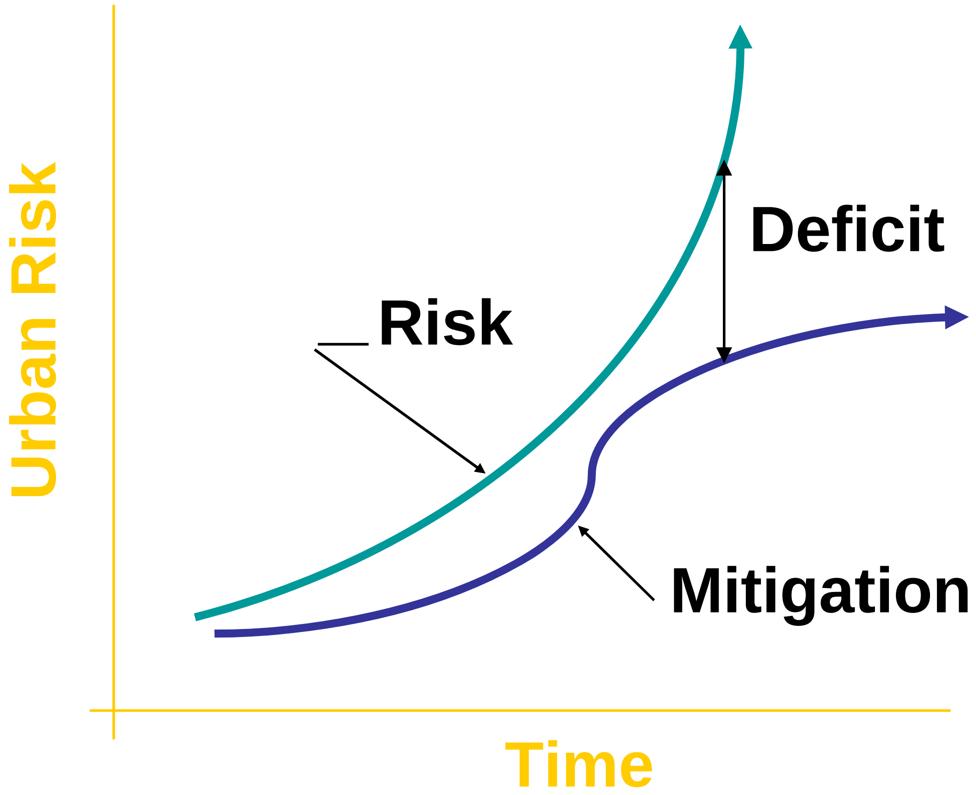
Challenges are:

- Development of those methodologies
- Time-dependent risk for complex systems: From risk assessment to risk monitoring
- Development of risk communication methodologies
- Development of tools for decision making under uncertainty
- Develop the science of implementation

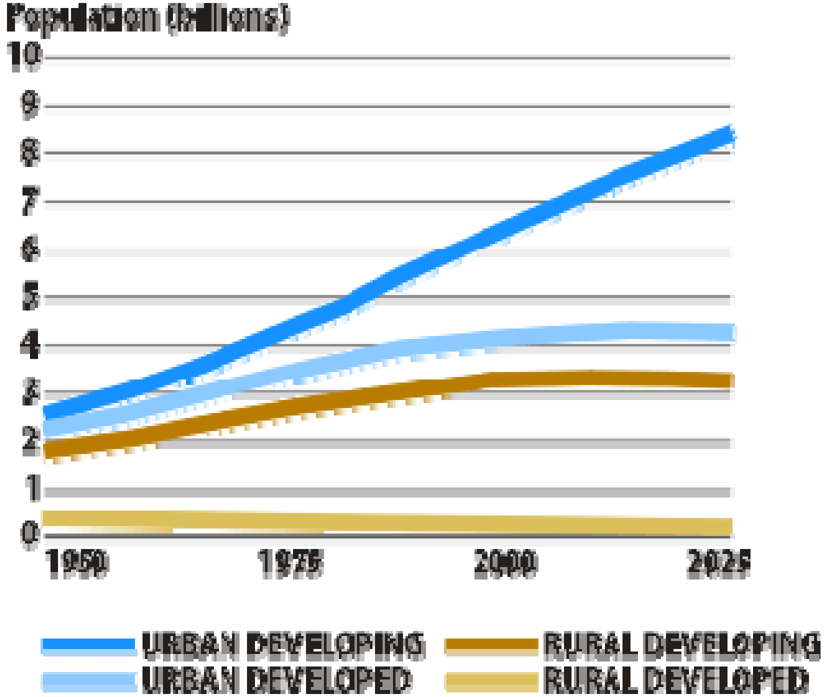
Technological/Management Challenges

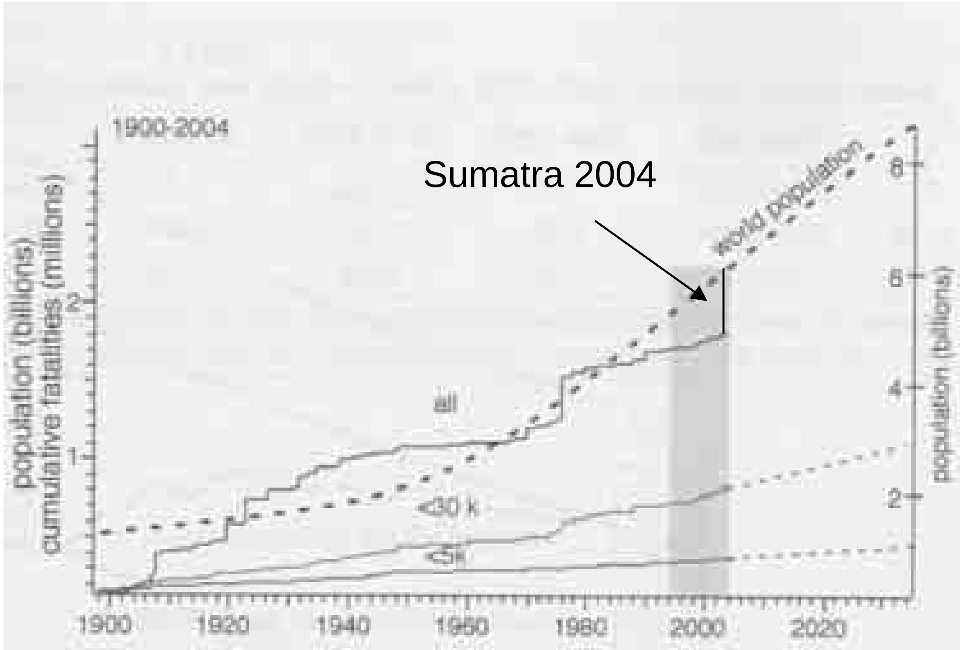
- Development of adaptation and mitigation strategies on global, regional and local levels under conditions of limited knowledge and uncertainty
- Develop human ressources in the risk reduction sector
- Develop models of disaster risk management in complex urban environments
- Develop cost-benefit estimation schemes

Technological/Management Challenges



Population Growth/Urbanization

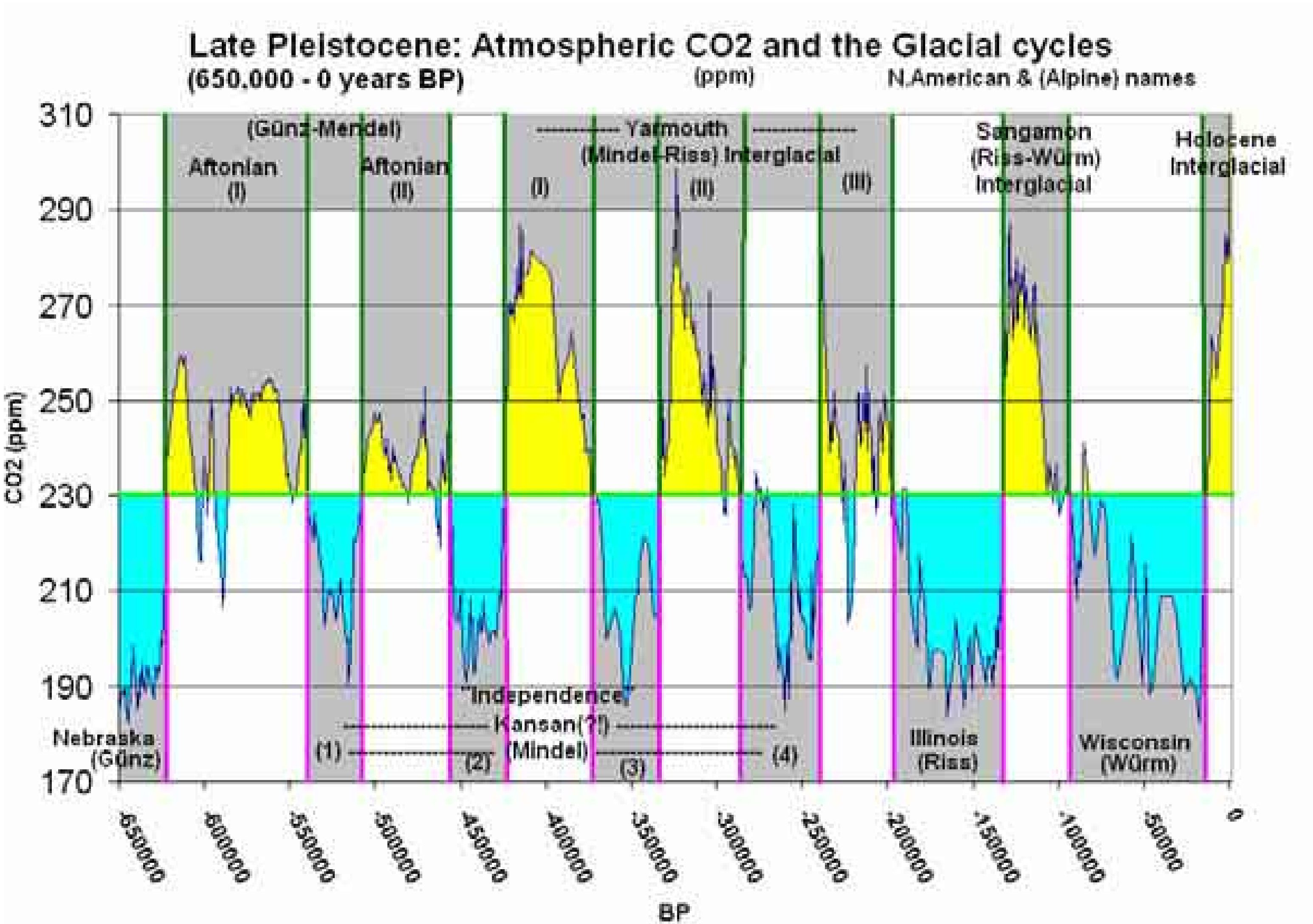




UN Population Statistik 2000

R. Bilham, 2004

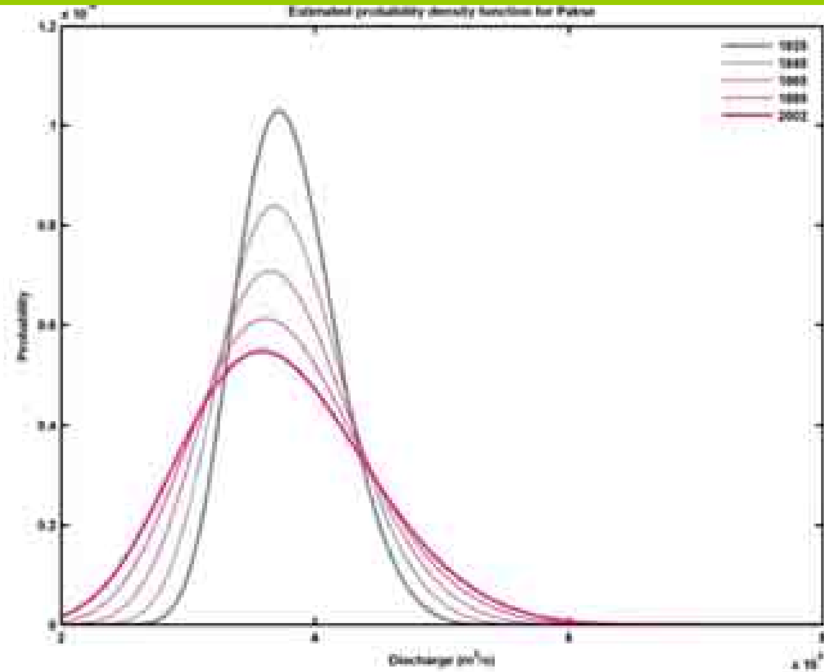
Anthropocene

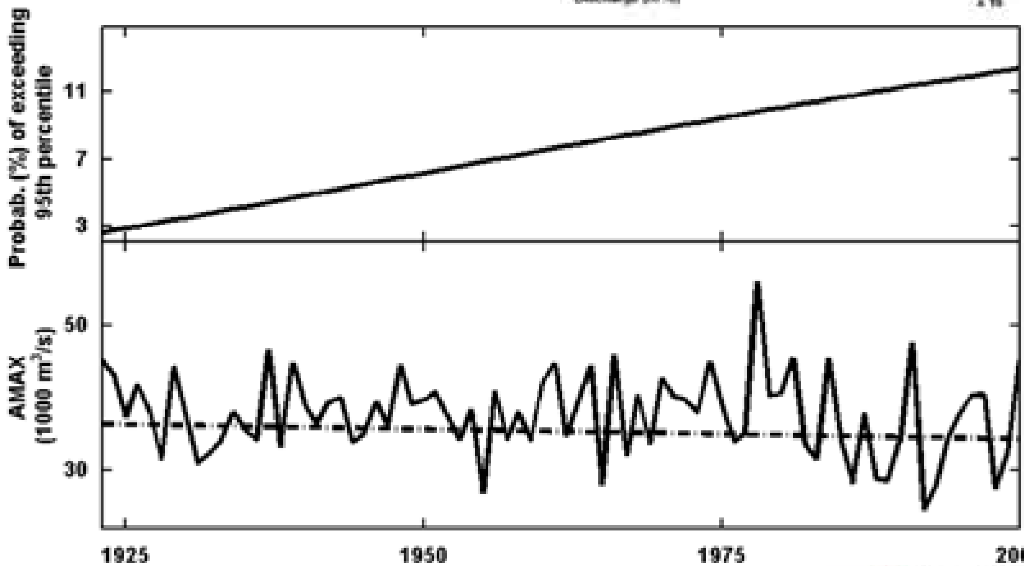


Ice ages as reflected in atmospheric CO_2, stored in bubbles from glacial ice of Antarctica

Risk and Climate Change

Mekong Floods





non-stationary GEV

- Allows to separate average trend and variability
- Negative average trend
- Increase in variability

$$f_{GEV}(HQ) = g(HQ, \mu(t), \sigma(t), \xi)$$