Meeting the Challenges of Earthquake Risk Dynamics and Globalisation

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The Messages

Earthquake risk is highly dynamic and currently exhibits significant global change!

Monitoring earthquake risk is a great scientific challenge!

An integrated natural risk monitoring programme on a global scale is overdue!

Jochen Zschau, GFZ Deutsches GeoForschungsZentrum, Potsdam
It is mainly effecting the developing world!
It is followed by a dramatic increase of vulnerability and risk!
In the Industrialized World:
Growing Networking of Infrastructure and Economy!
The seismic risk globalises and increases exponentially!

San Francisco 1906
US$ 180,000,000

San Francisco 20??
US$ 260,000,000,000?

Tokyo 1923
US$ 2,800,000,000

Tokyo 20??
US$ 2,000,000,000,000?

Risk Dynamics and Global Change
A Burning Scientific Challenge: “Monitoring” and “predicting” global change of earthquake risk.
Risk Dynamics and Global Change

They occur at the contact between man and nature!

Risk dynamics is determined by both hazard and vulnerability!
Seismic Hazard Assessment
State of the Art

Hazard (Intensity with 10% probability over the next 5 decades)

Germany

Hazard Germany
Intensity (EMS)

III
IV
V
VI
VII
VIII

Statistical, stationary approach!
The hazard is treated as time-independent!
Not appropriate for "monitoring" hazard!

GLOBAL SEISMIC HAZARD MAP

Meeting the Challenges
Earthquake Interaction:
An important reason for time-dependent hazard!

Coulomb stress $[\text{MPa}]$ around the NAF - 2010

$Istanbul$
Probability of an earthquake with $M>7$ in the next 3 decades

Coulomb stress = shear stress - $\mu$ (normal stress - $P$)
where $\mu$ = coefficient of friction
$P$ = pore pressure
btw: 1 MPa = 10 bar

from LORENZO-MARTIN (2006)
Many More Reasons For Time-Dependent Earthquake Hazard

Seismic Aftershocks

Earthquake-Volcanoe Interaction

Decreasing Ice Loading

Glacier Induced Silent Earthquakes

Triggered Seismicity (Geothermal Drilling, .......)
Risk
(Damage with 10% prob. over the next 5 decades)

Vulnerability- and Risk Assessment
State of the Art

Some cities, only a few national examples, not homogeneous, not cross-boundary, not global!

Risk Potential (in Mio. EUR)

- 0 - 1
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 500
- 500 - 1000
- 1000 - 1200

No monitoring tool for earthquake risk in place!

Italy
Masonry and RC buildings

Crowley et al., 2006

Tyagunov et al., 2006
„Monitoring“ Vulnerability and Risk
The capability has to be built up!

New Tools are needed!

Ground based panoramic street view with mobile 3D-camera

satellite remote sensing
Street View for the Assessment of Structural Vulnerability

Vulnerability Related Parameters
- Height
- Number of Storeys
- Shape, Volume
- Windows
- Soft/Weak Storeys
  ...

Bishkek/Kirgistan

Geometrical Features
Structure from Motion
Texture and Colour segmentation
3D-Information

Street View for Analysis of Structural Vulnerability

Pittor & Wieland (GFZ)
The Many Facettes of Vulnerability

However, an INTEGRATED VULNERABILITY AND RISK MODELLING AND MONITORING PROGRAMME, in particular on a global scale, is not in place! They are important and in common for practically all types of natural hazards!
GEM
The Global Earthquake Model
A public/private partnership for mapping, monitoring, predicting and communicating complex earthquake risk globally

Governments, industry, Science organisations, OECD, World Bank, EAUK, UNESCO, >150 scientific institutions!

Initiated by the OECD - Global Science Forum
Started from the GFZ in Potsdam
Secretariat in Pavia/Italy
Official start March 2009

However:
An integrated programme is needed!
- Governments, industry,
- Science organisations, OECD,
- World Bank, EAUK, UNESCO,
- >150 scientific institutions!

- Raise awareness!
- Stimulate mitigation!
- Reduce damage!
- Save lives!
- Secure our common future!