



UNIVERSITY OF TWENTE.

WHERE TO BUILD-BACK-BETTER?

ANALYZING CHANGING MULTI-HAZARD RISK FOR POST-DISASTER RECONSTRUCTION PLANNING

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UNIVERSITÉ
DE GENÈVE

CERG-C

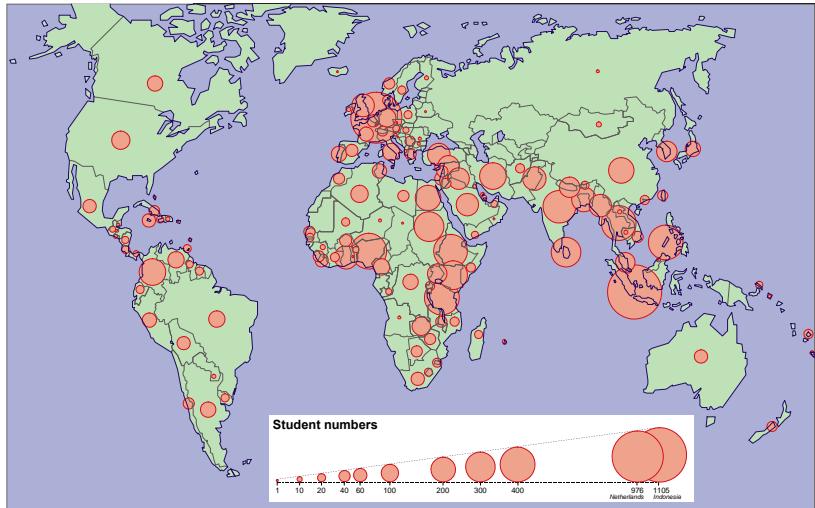
1st IAVCEI/GVM Workshop

From Volcanic Hazard to Risk Assessment
Geneva, 27-28 June 2018



FACULTY OF GEO- INFORMATION SCIENCE AND EARTH OBSERVATION

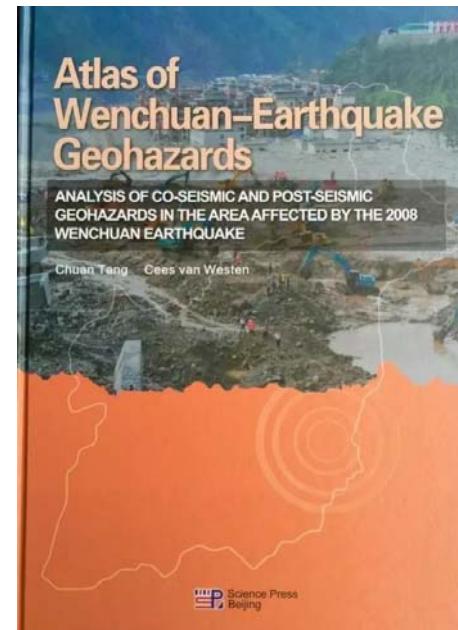
OUR PERSPECTIVE



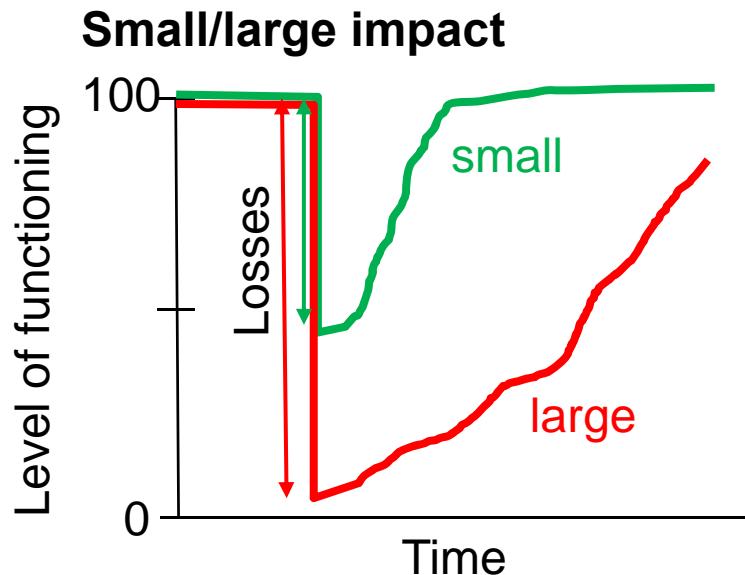
- ITC provides international postgraduate education, research and project services.
- International capacity building and institutional development in developing countries and emerging economies
- Geo-Information Science and Earth Observation.
- 120 staff, 120 PhD students



https://issuu.com/ceesvanwesten/docs/atlas_of_wenchuan_earthquake_geohaz



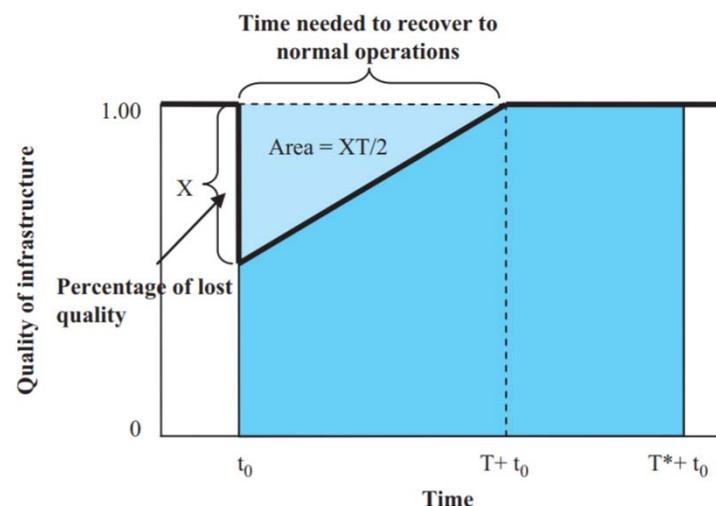
Analyzing resilience and post-disaster recovery



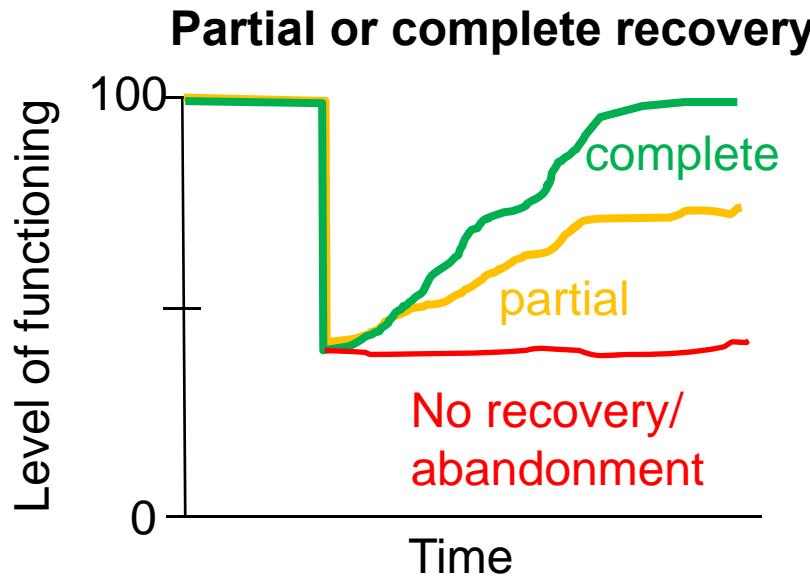
Zobel, C.W. and Khansa, L. (2014)
Characterizing multi-event disaster resilience.
<https://doi.org/10.1016/j.cor.2011.09.024>

Resilience:

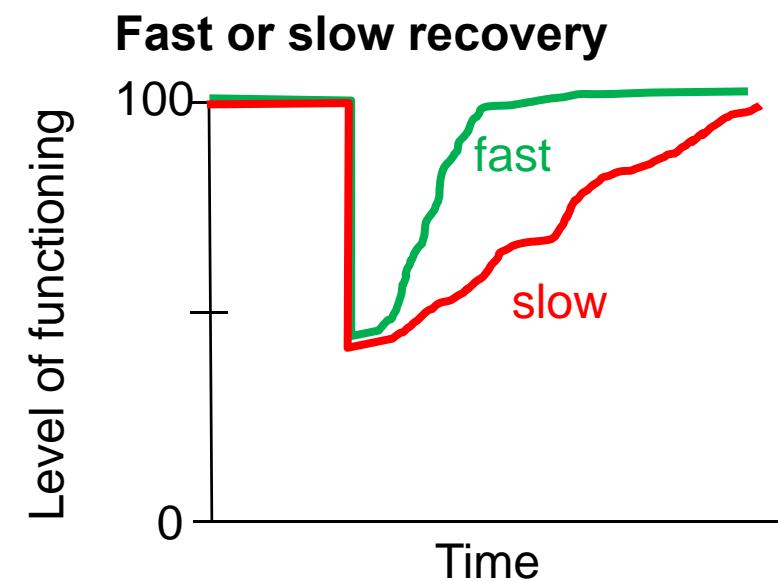
The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. (UNISDR, 2017)



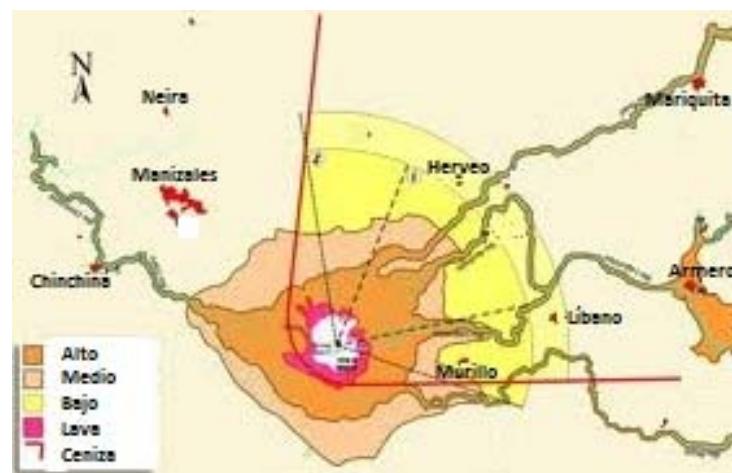
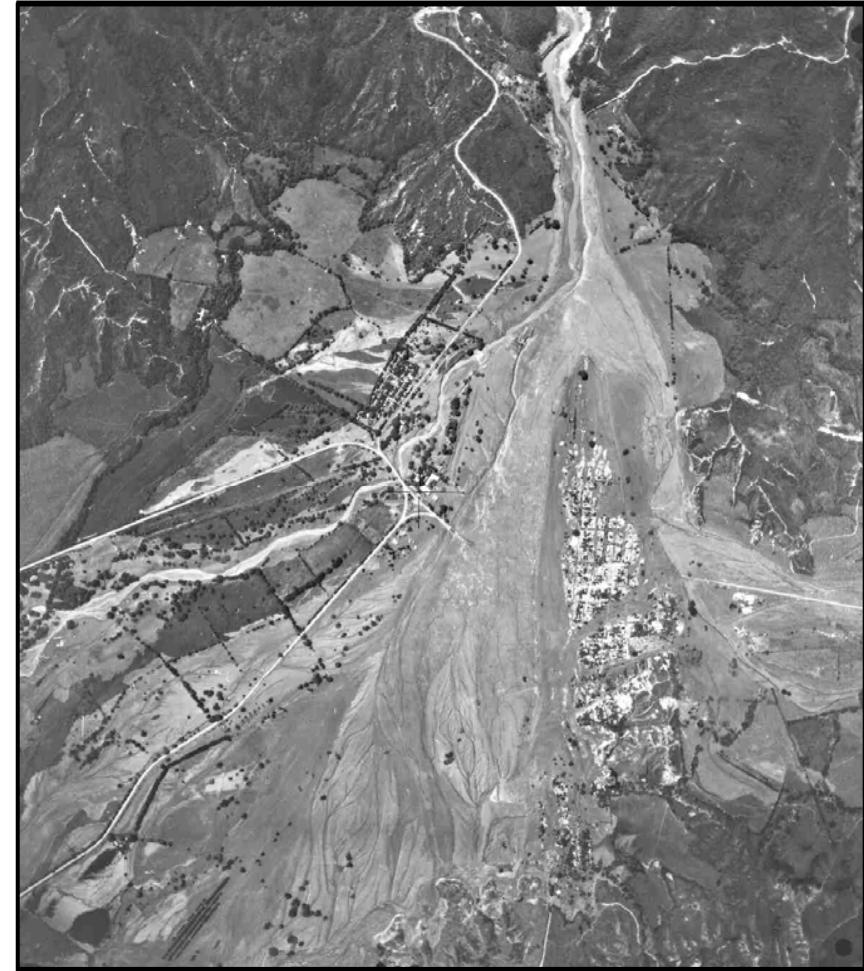
Analyzing resilience and post-disaster recovery



Risk Governance
Level of funding
Level of coordination
Resources

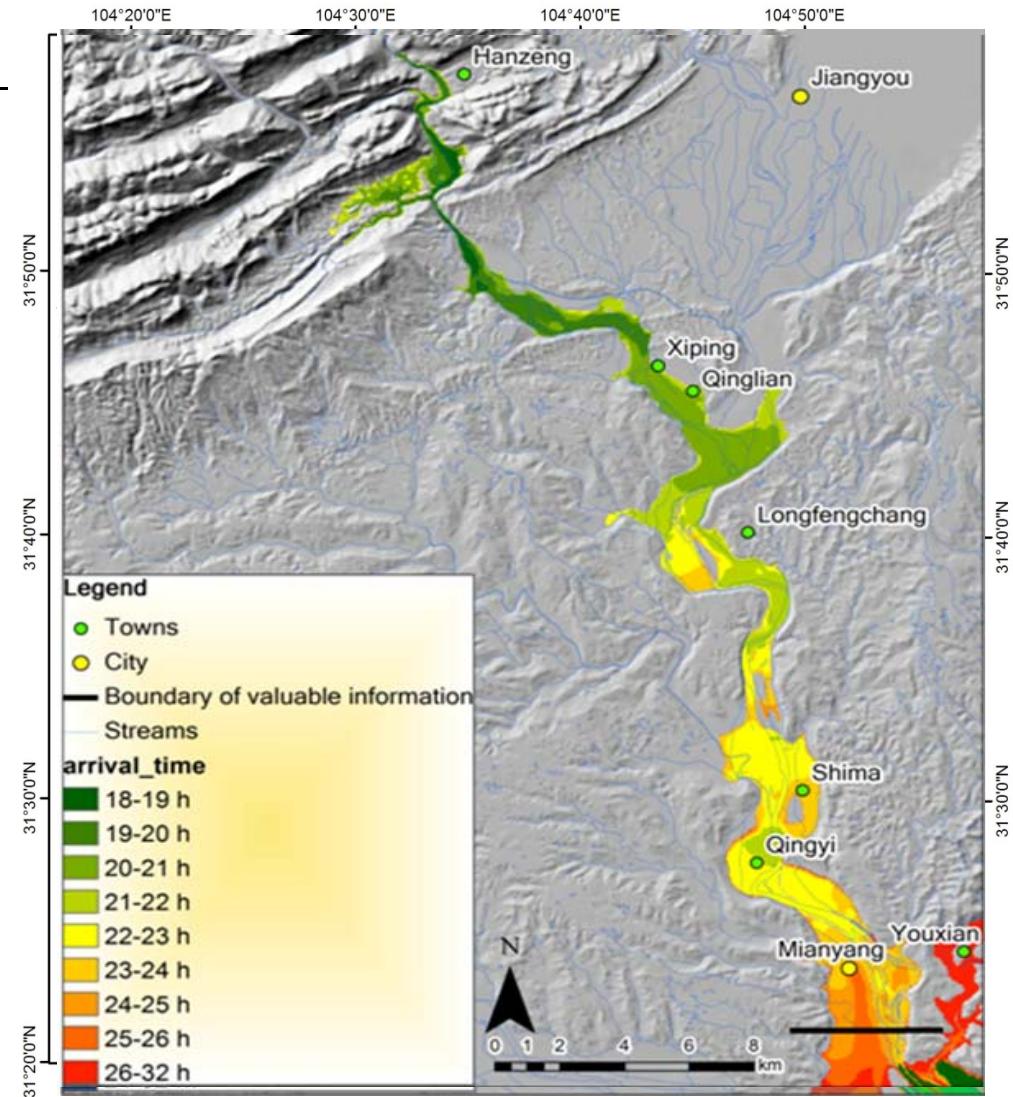
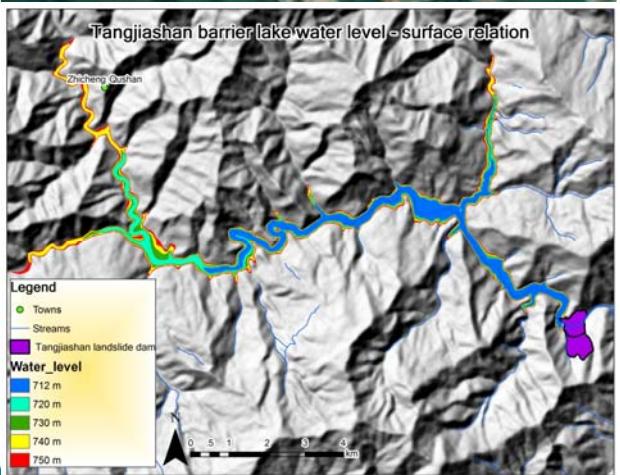


Abandonement of Armero, after the eruption by the Nevado del Ruiz, Colombia

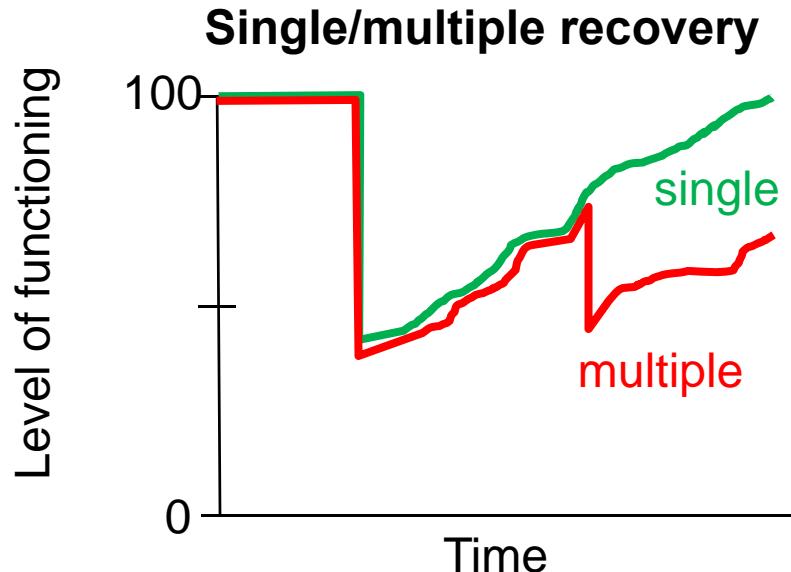


Very fast decision should be taken, which often cannot be based on extensive hazard & risk modelling

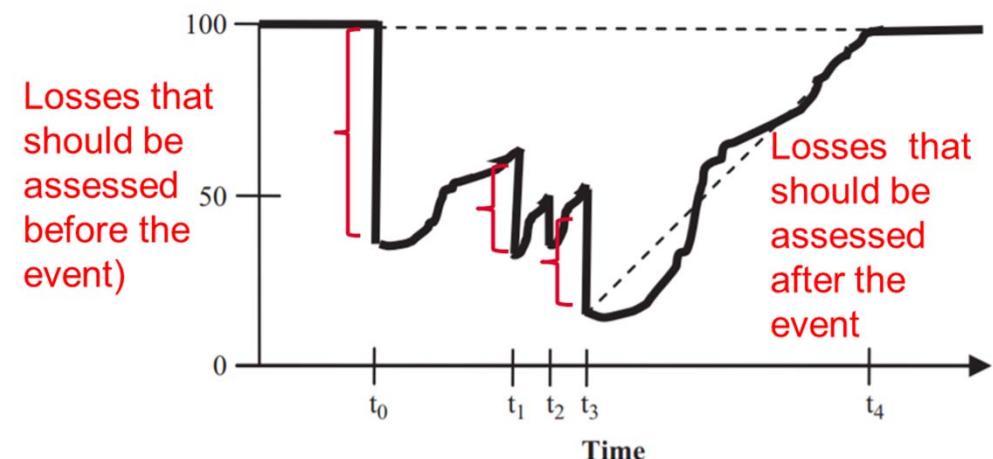
Earthquake → Landslide → flood



Analyzing resilience and post-disaster recovery

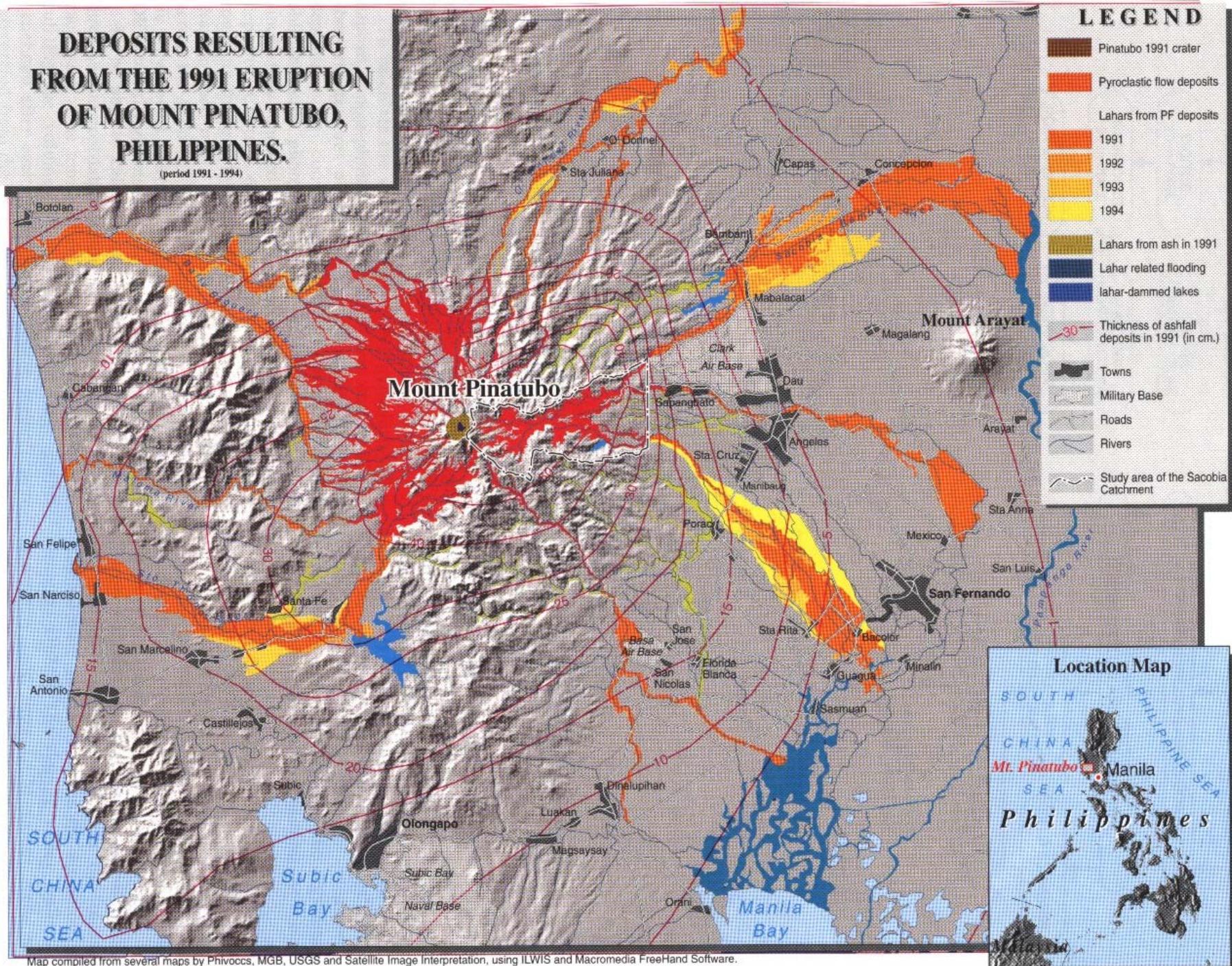


First time I heard the term:
“Re-reconstruction planning”



DEPOSITS RESULTING FROM THE 1991 ERUPTION OF MOUNT PINATUBO, PHILIPPINES.

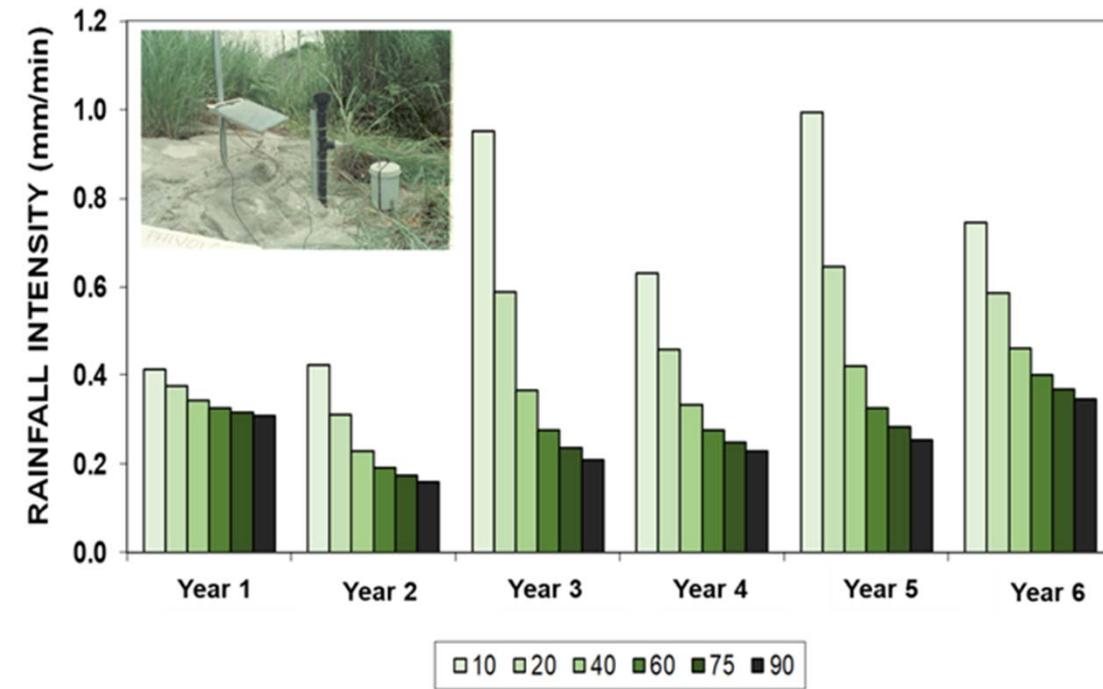
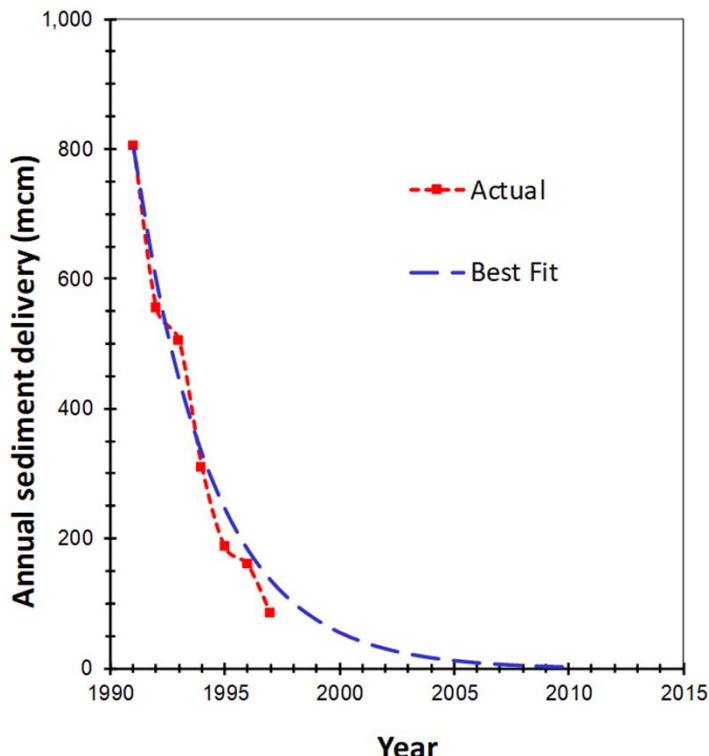
(period 1991 - 1994)



Map compiled from several maps by Phivoccs, MGB, USGS and Satellite Image Interpretation, using ILWIS and Macromedia FreeHand Software

Post-eruption lahars: Pinatubo eruption, Philippines, 1991

Volume estimations using multi-temporal DEMs



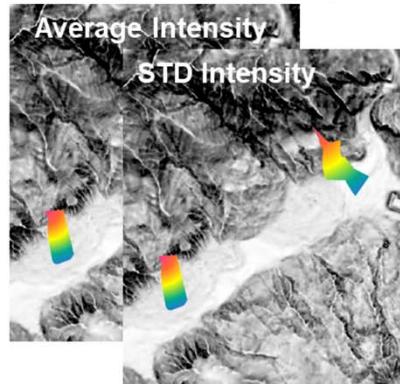
Risk assessment

Risk components: hazard, vulnerability, elements-at-risk

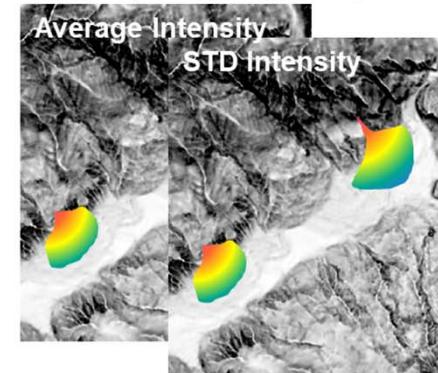
- **Hazard:**

- Type
- Frequency
- Intensity

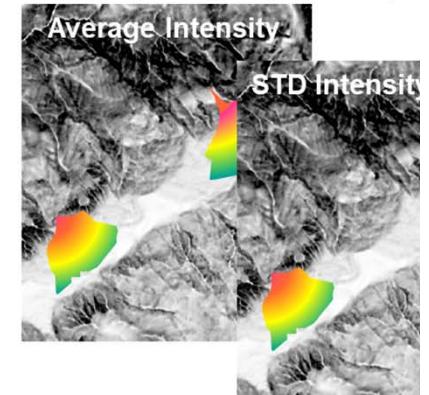
Hazard scenarios
Return period: 10 (8-12)



Return period: 50 (40-55)



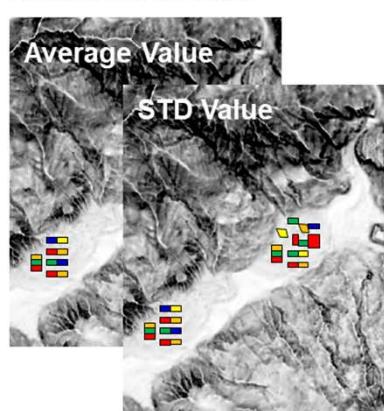
Return period: 100 (89-120)



- **Elements-at-risk:**

- Type
- Quantification

Elements-at-risk

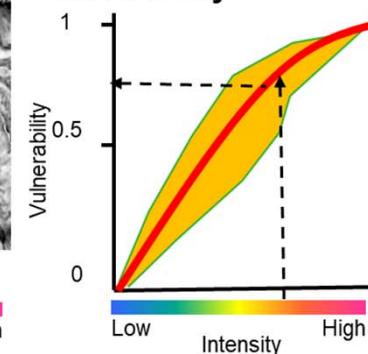


Low Intensity High

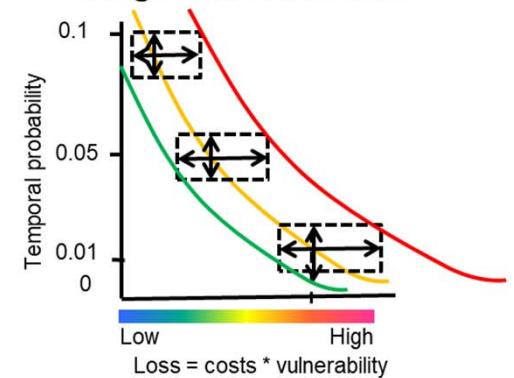
- **Vulnerability:**

- Type
- Quantification

Vulnerability with uncertainty



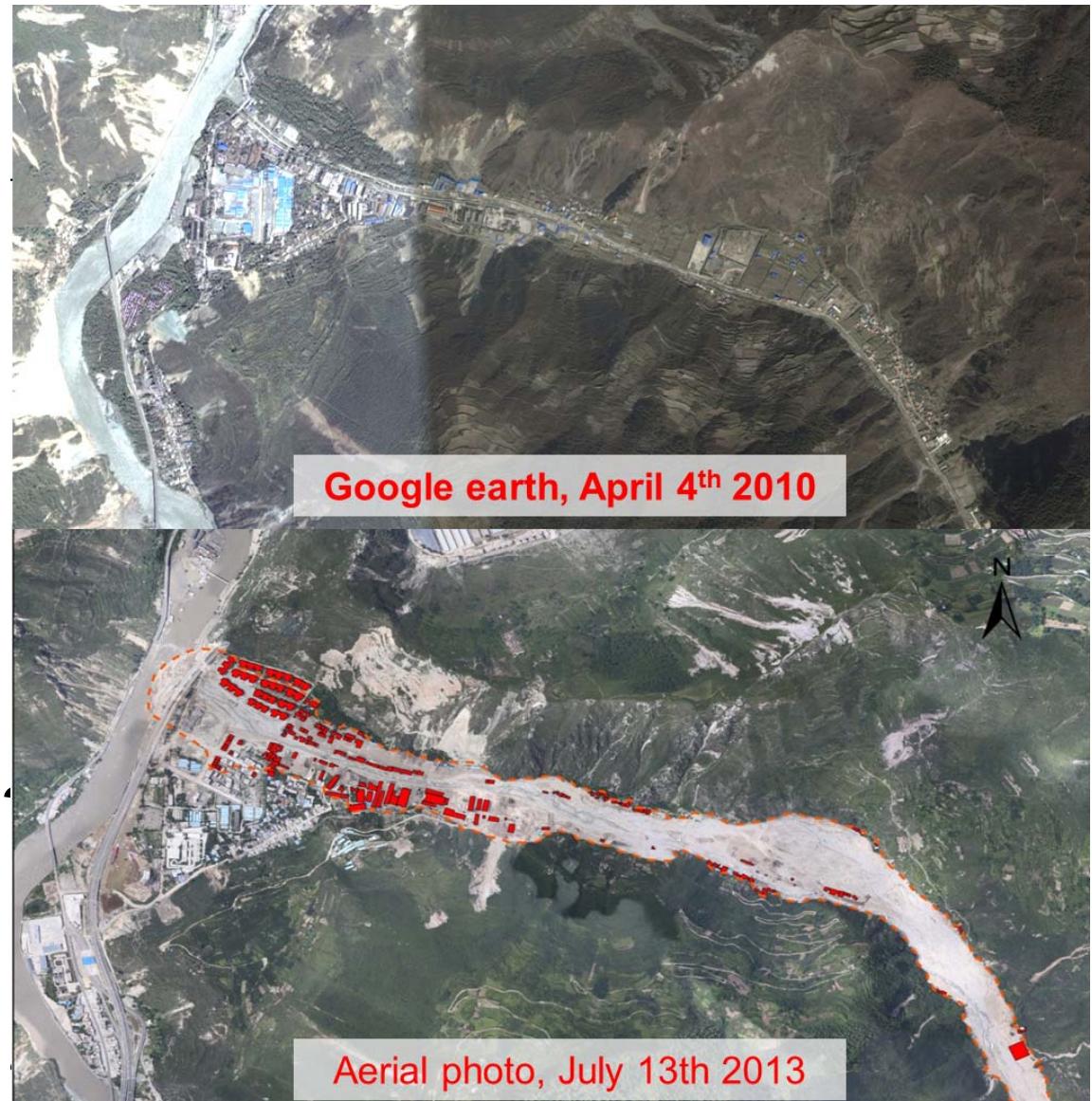
Risk curves: minimum, average and maximum



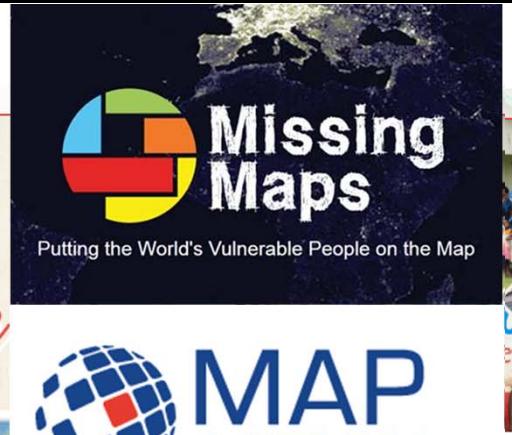
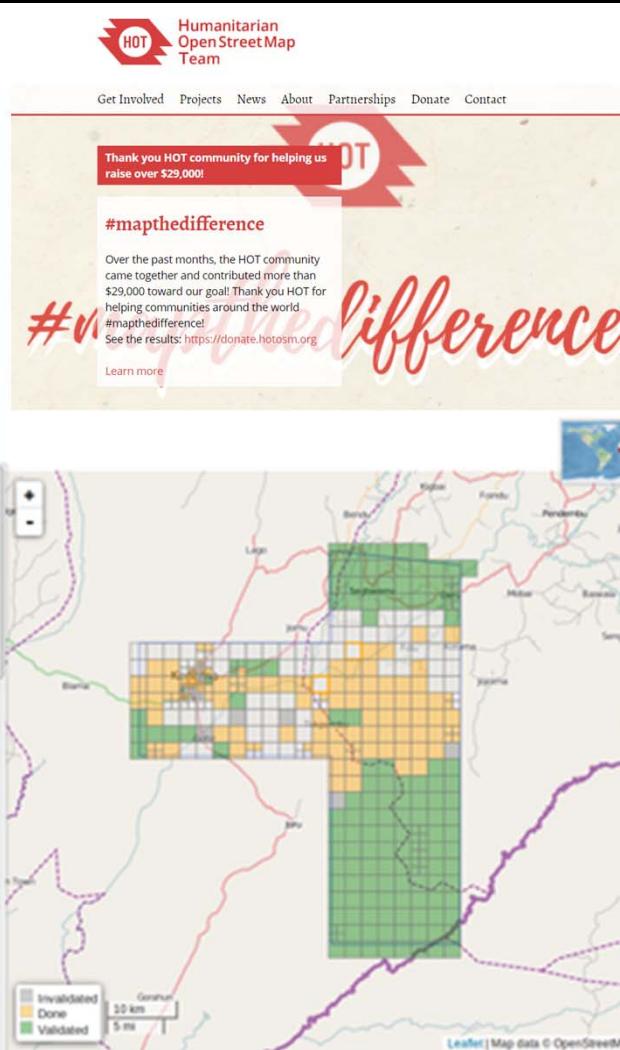
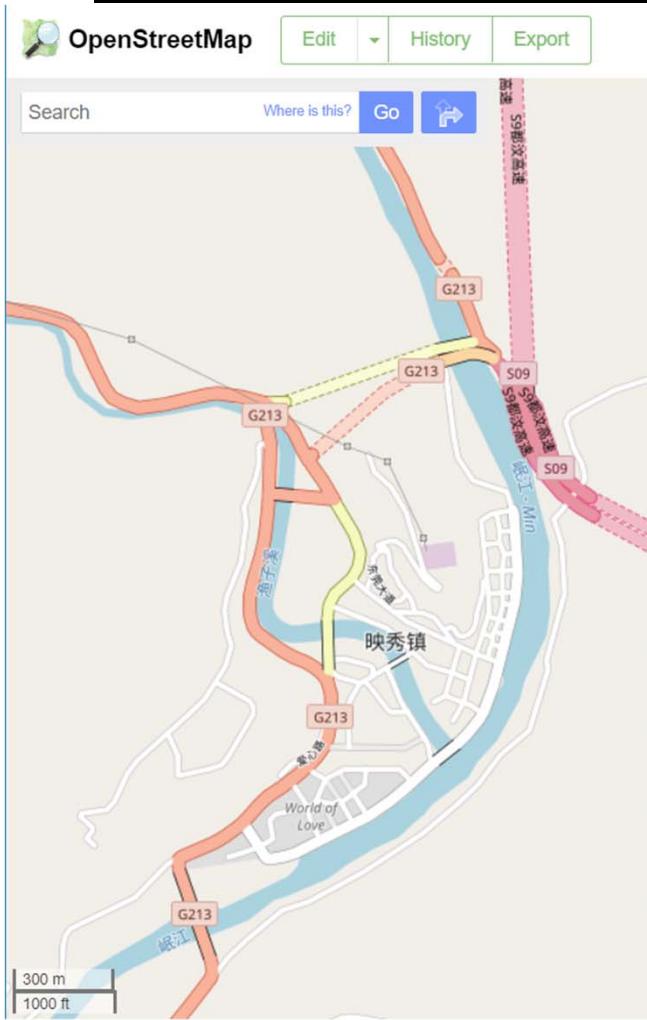
Changing Risk Components after a disaster

Elements-at-risk changes

- **Response phase**
 - Damage mapping
- **Rehabilitation phase**
 - Temporary shelters
- **Reconstruction phase**
 - Building reconstruction
 - Transportation reconstruction
 - Land cover change
- **Reconstruction scenarios**
- **Risk reduction alternatives**
 - Which one best ?



Voluntary mapping initiatives of buildings and roads to support humanitarian operations



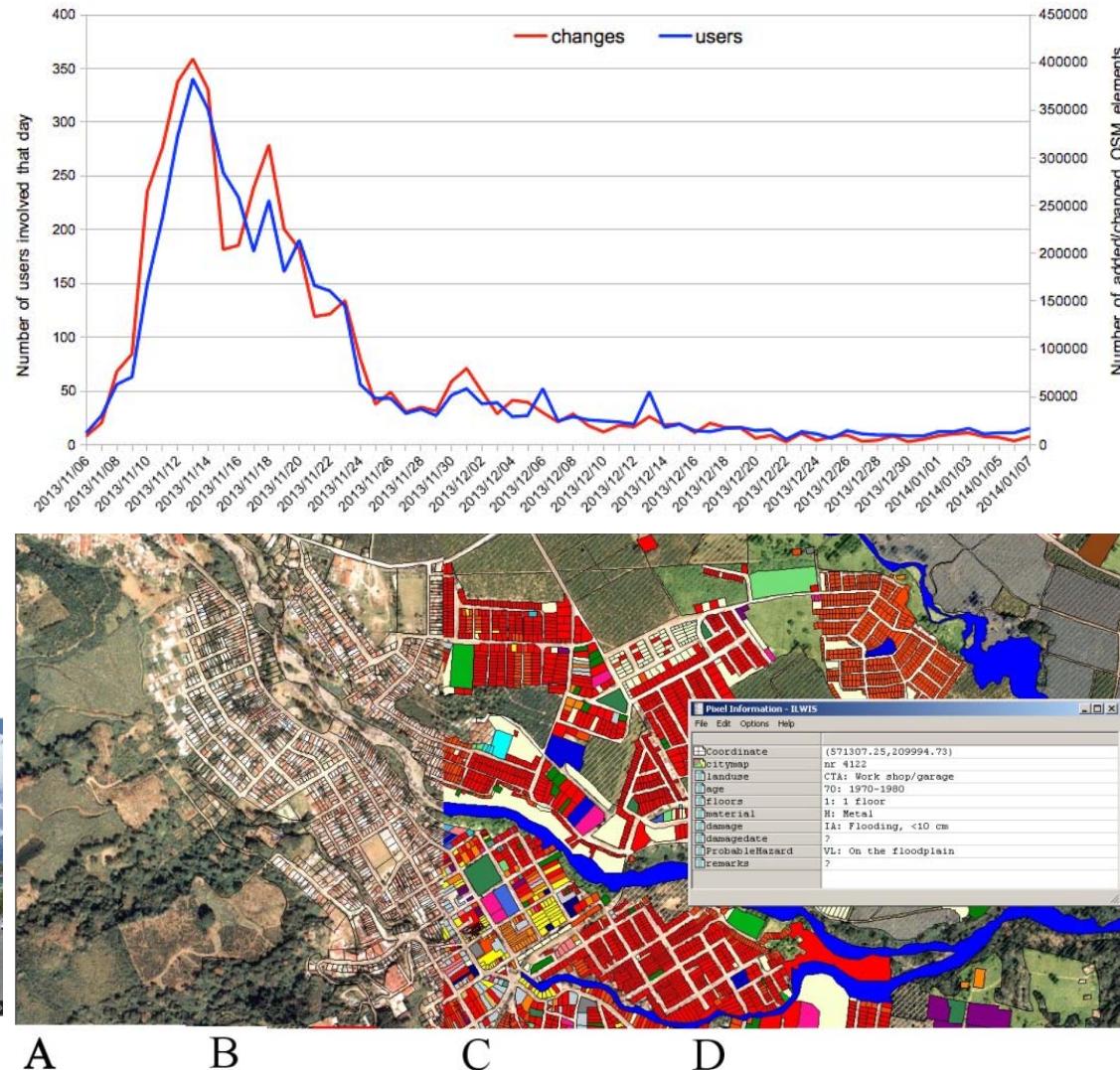
- Mapping changes after a disaster

Problems in using voluntary mapping for post-disaster recovery monitoring

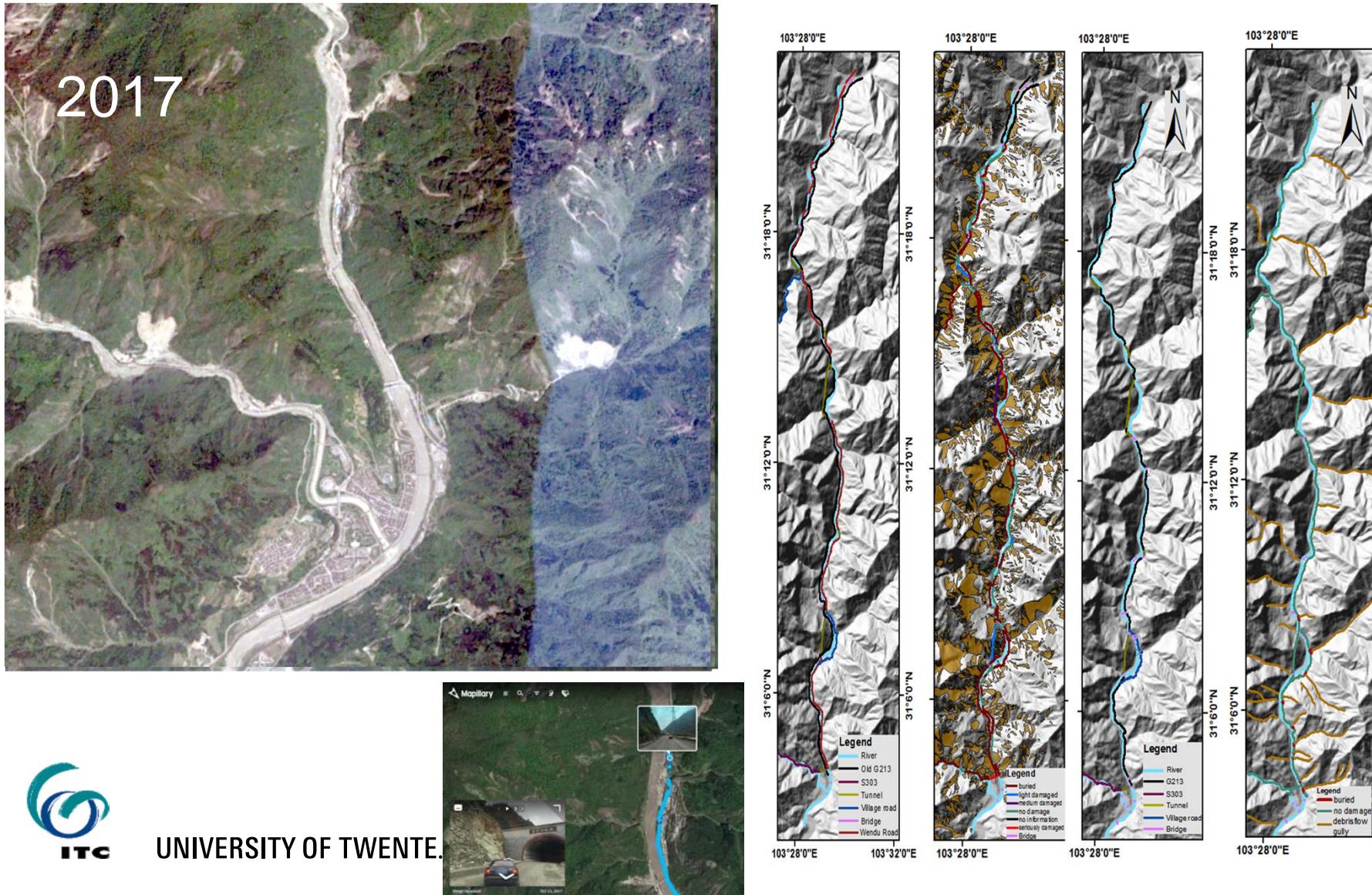
- Volunteers loose interest after the response phase
- Updating OSM data for several periods during the recovery phase is problematic

Solutions:

- Use of satellite images
- Use of LIDAR data
- Use of Drones



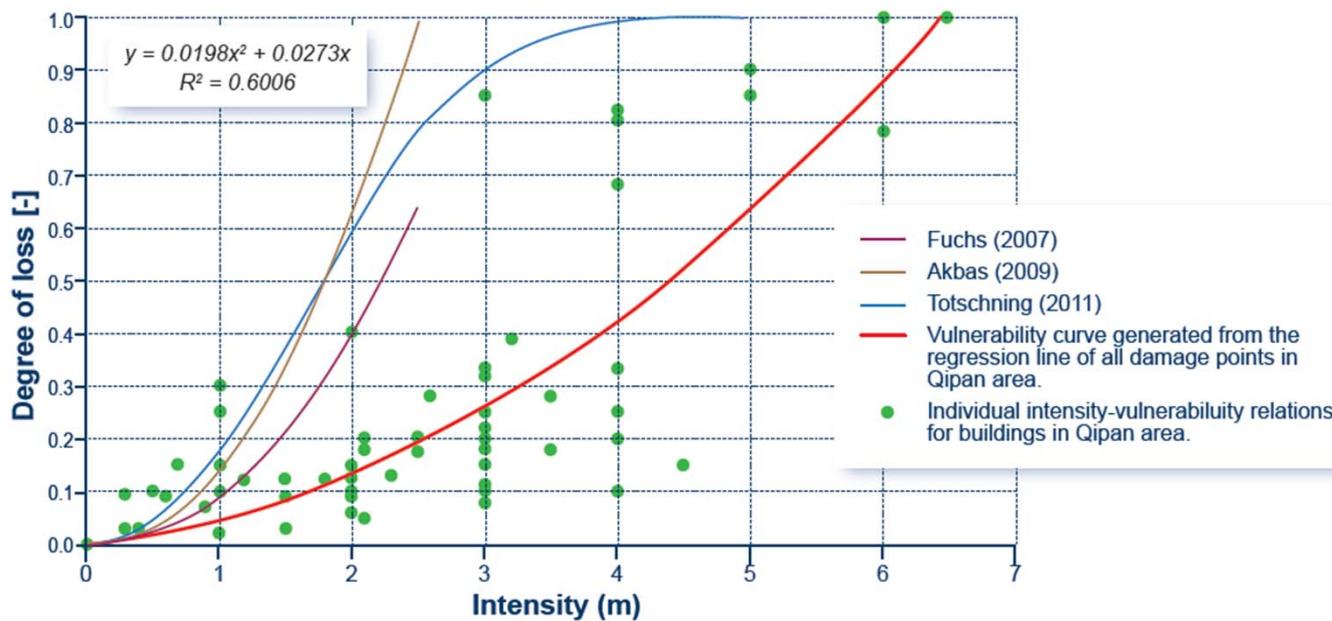
Changing Elements-at-Risk after a disaster transportation infrastructure & vegetation



Changing Risk Components after a disaster

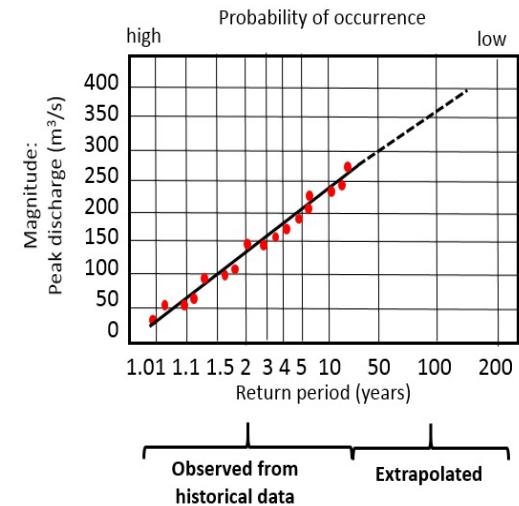
Changing vulnerability during post-disaster phases

- **Physical vulnerability:**
 - Vulnerability of temporary shelters
 - Reinforced buildings are less vulnerable
 - Few existing curves / high variability.
- **Social vulnerability:**
 - Changing population patterns
 - Loss of social coherence
 - Few existing curves / high variability.



Hazard characteristics

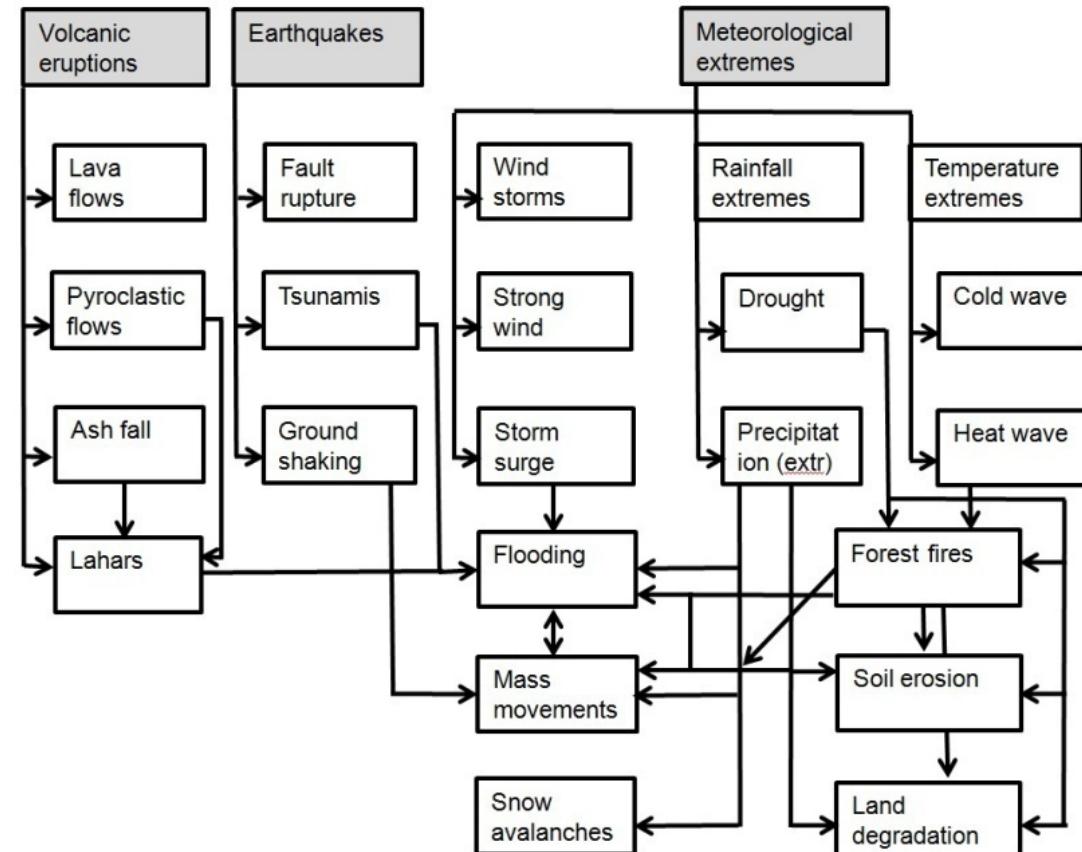
- **What?** Hazard types
- **Where?** Hazards are spatially different
- **How often?** Temporal probability.
- **How severe?** Hazard intensity
- **How much area?** Hazard footprints
- **How long does it last?** Duration
- **How long before do we know?** Warning time



Changing Risk Components after a disaster

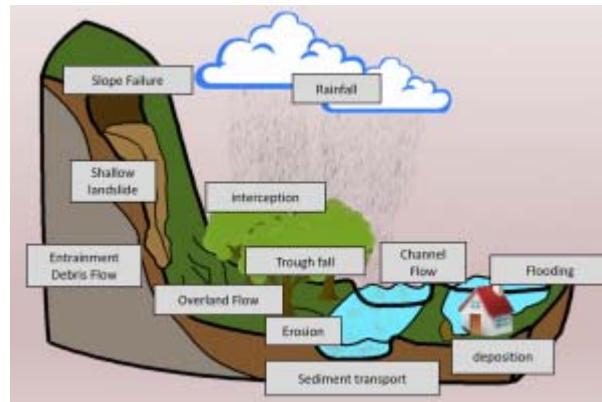
Hazard changes

- **Independent events**
 - Triggering event do not interact
- **Coupled events**
 - same trigger, may affect same area
- **Conditional**
 - One hazard changes conditions for the next
- **Domino or cascading hazards**
 - First one, then next then third

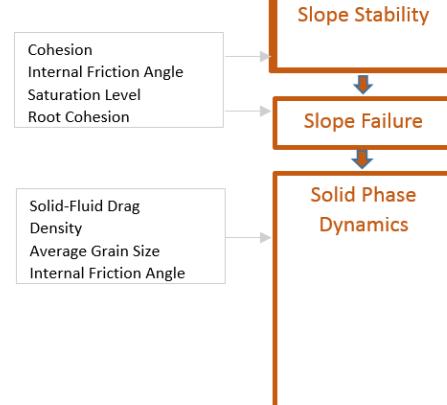


Integrated multi-hazard modelling OpenLISEM:

<https://blog.utwente.nl/lisem/>

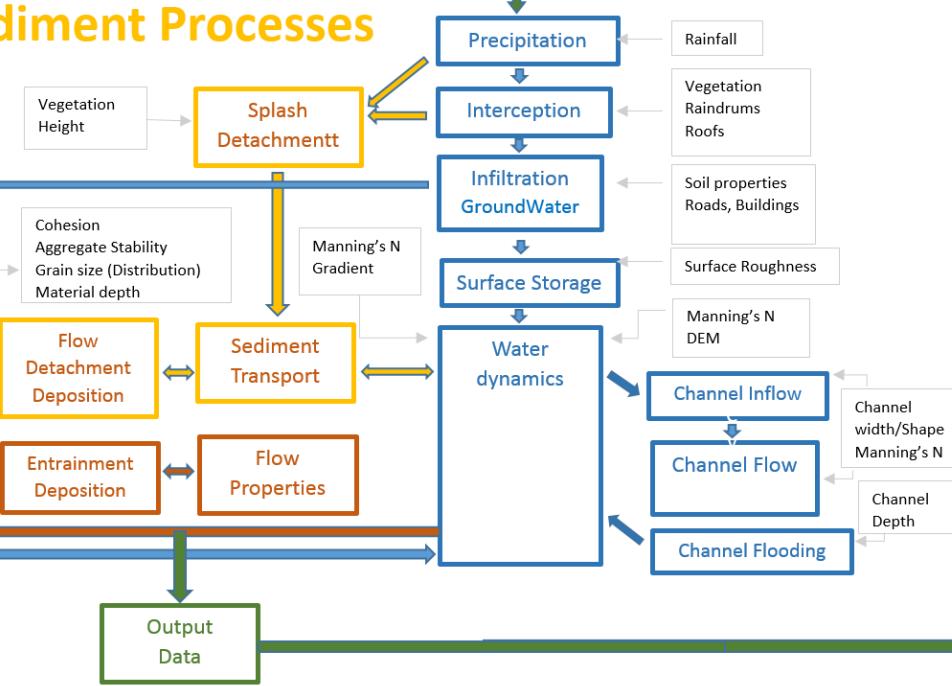


Solids Processes



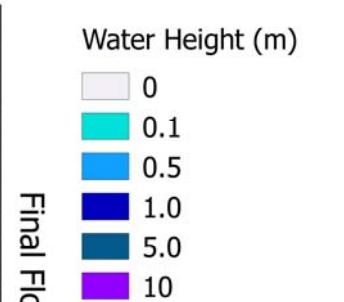
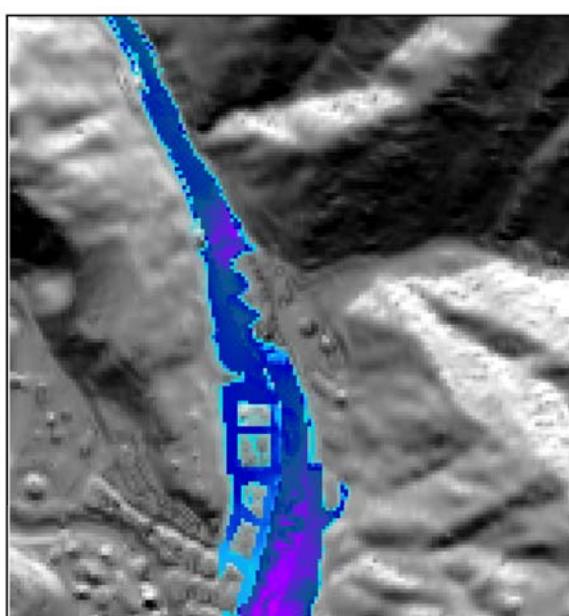
Water Processes

Sediment Processes

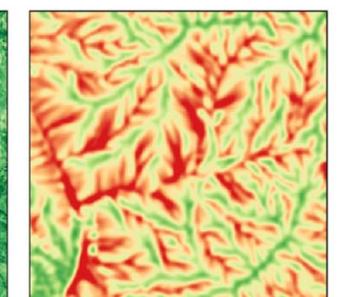
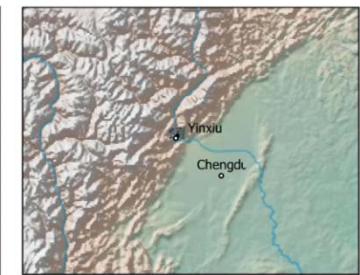
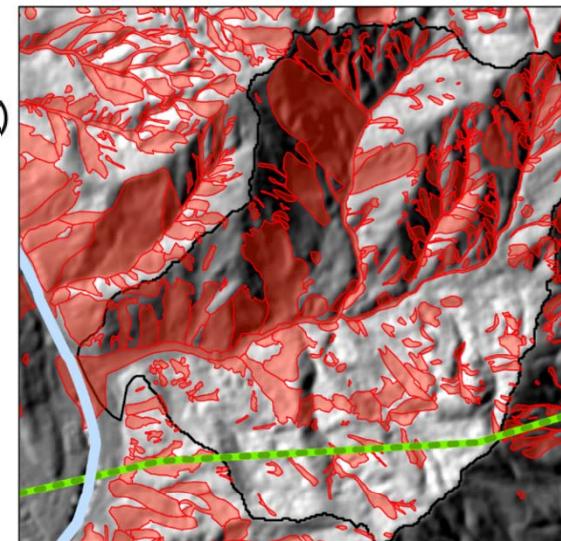


Integrated multi-hazard modelling: OpenLISEM

Simulating the 2010 events in Hongchun gully



Final Flooding



Elevation (m)



NDVI (-)

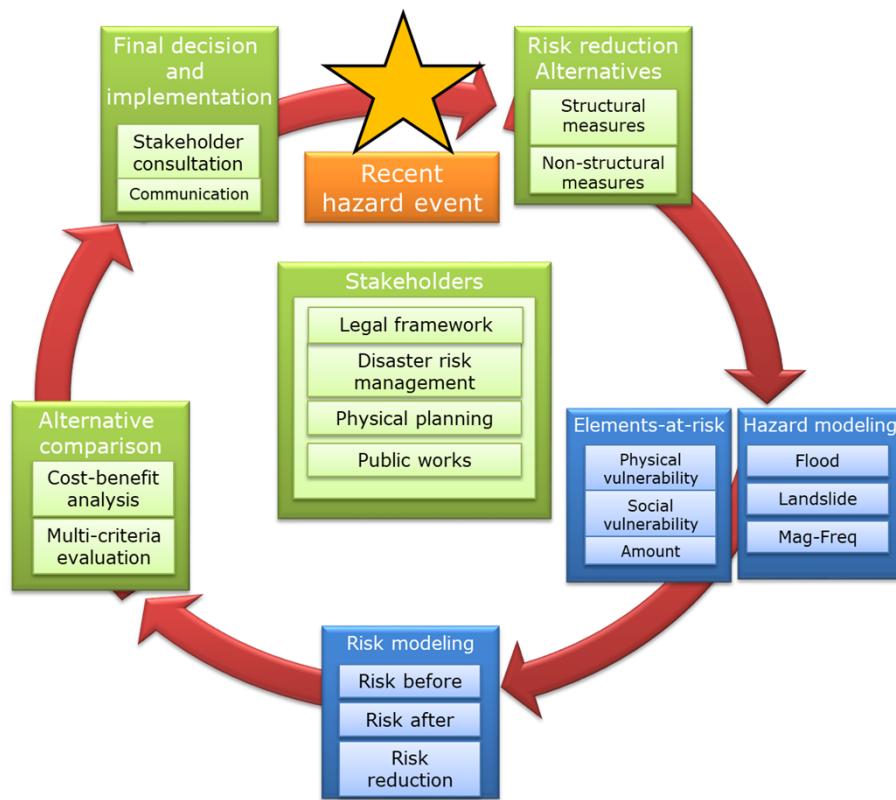


Soil Depth (m)



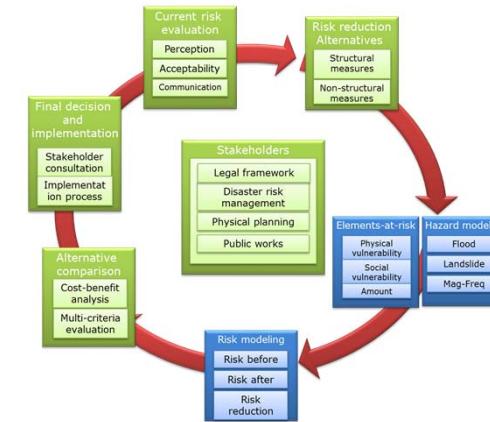
Risk assessment for Decision Making

How do hazards and risk change after a disaster?

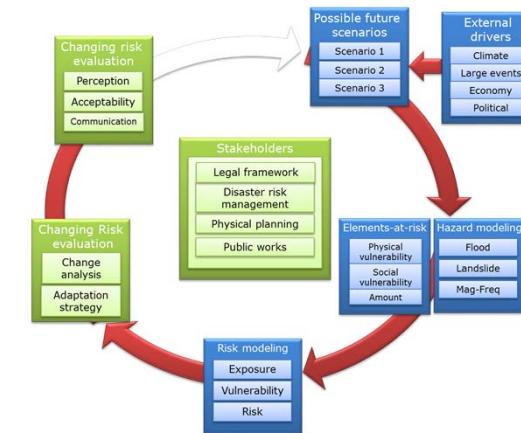


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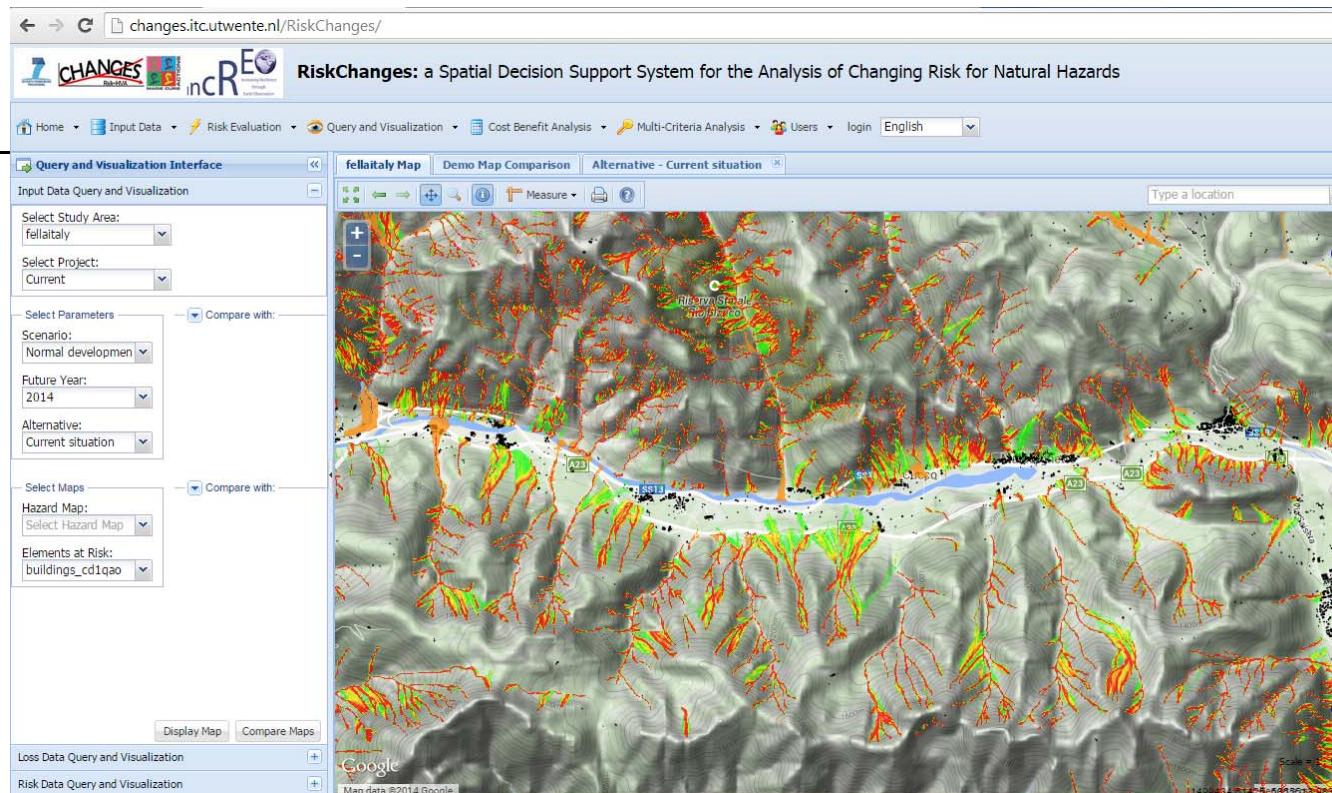
Analysis optimal risk reduction alternatives



Analysis of changing risk for possible future scenarios. Which risk reduction measure behaves best under possible future scenarios?



Spatial decision support system



Documentation: http://www.charim.net/use_case/46

Online SDSS: <http://sdss.geoinfo.ait.ac.th/>

<http://www.charim.net/>
<http://charim-geonode.net/>



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Caribbean Handbook on Risk Information Management

The Countries section contains specific information (maps, reports) for the 5 target countries

The Methodology Book contains the theoretical background on how hazard and risk is assessed, and used

The Use Case Book contain many examples of typical activities related to spatial planning, critical infrastructure

The Data Management book explains how spatial data is collected, managed, analysed and shared for Risk Information Management

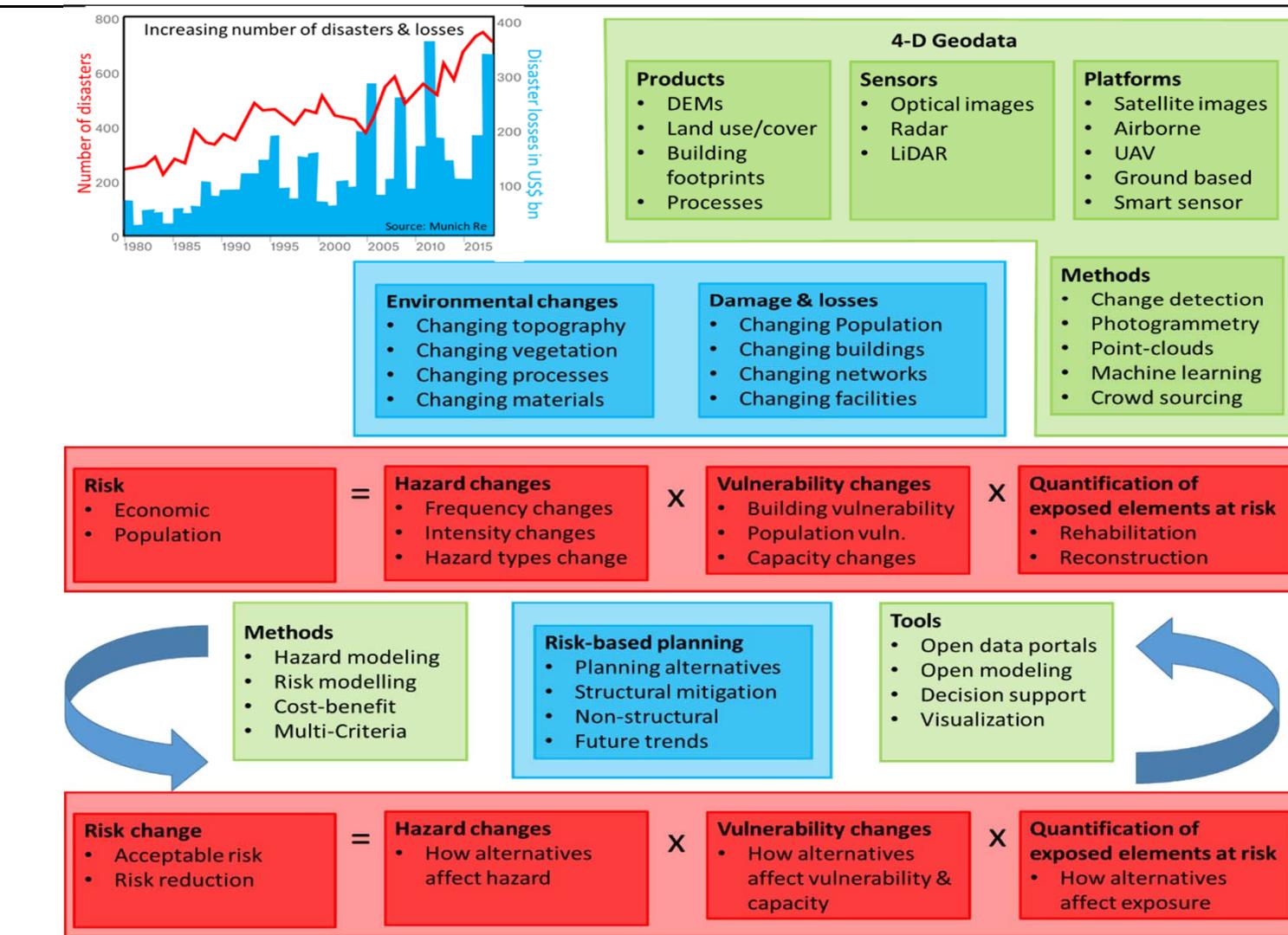
The GeoNode is the data sharing platform where you can find the spatial data.

Log in

ACP-EU GFDRR ACP-EU Natural Disaster Risk Reduction Program An initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR

World Bank LAC opportunities for all

In conclusion: post-disaster risk assessment for recovery planning is a major challenge, but many new tools are available



Conclusions

Hazards

- Multi-Hazards
- New hazards
- No historical data.
- Limited input data
- Limited time
- Extensive areas
- Lack of capacity

Elements-at-risk & vulnerability

- Very dynamic
- Types
- Who is collecting?
- Monitor and prediction
- Data sharing is essential
- Capacity building / involvement of local authorities



19 JUN 2018

PROFESSOR (0,4 FTE) SPATIAL RESILIENCE FOR DISASTER RISK REDUCTION

The proposed Chair will Initiate, coordinate and execute research in rural and/or urban resilience for disaster prevention and preparedness, specifically related to climate change. You focus on spatial relations between stakeholder groups, and stakeholders and their environment. You aim to develop...

<https://www.utwente.nl/en/organization/careers/vacancy/1/professor-04-fte-spatial-resilience-for-disaster-risk-reduction/188136>