Resilience and vulnerability – ambivalent and „obscure“ economic phenomena ?

C. Pfurtscheller / R. Schwarze

- introduction
  - Economic resilience and vulnerability
  - Flooding 2005 in the province of Tyrol, Austria
- study design – methods and data
- results
- summary and outlook

$$\text{Risk} = f\left[P, DP, S(R, V)\right]$$

Economic losses are not part / outcome of a „black box“

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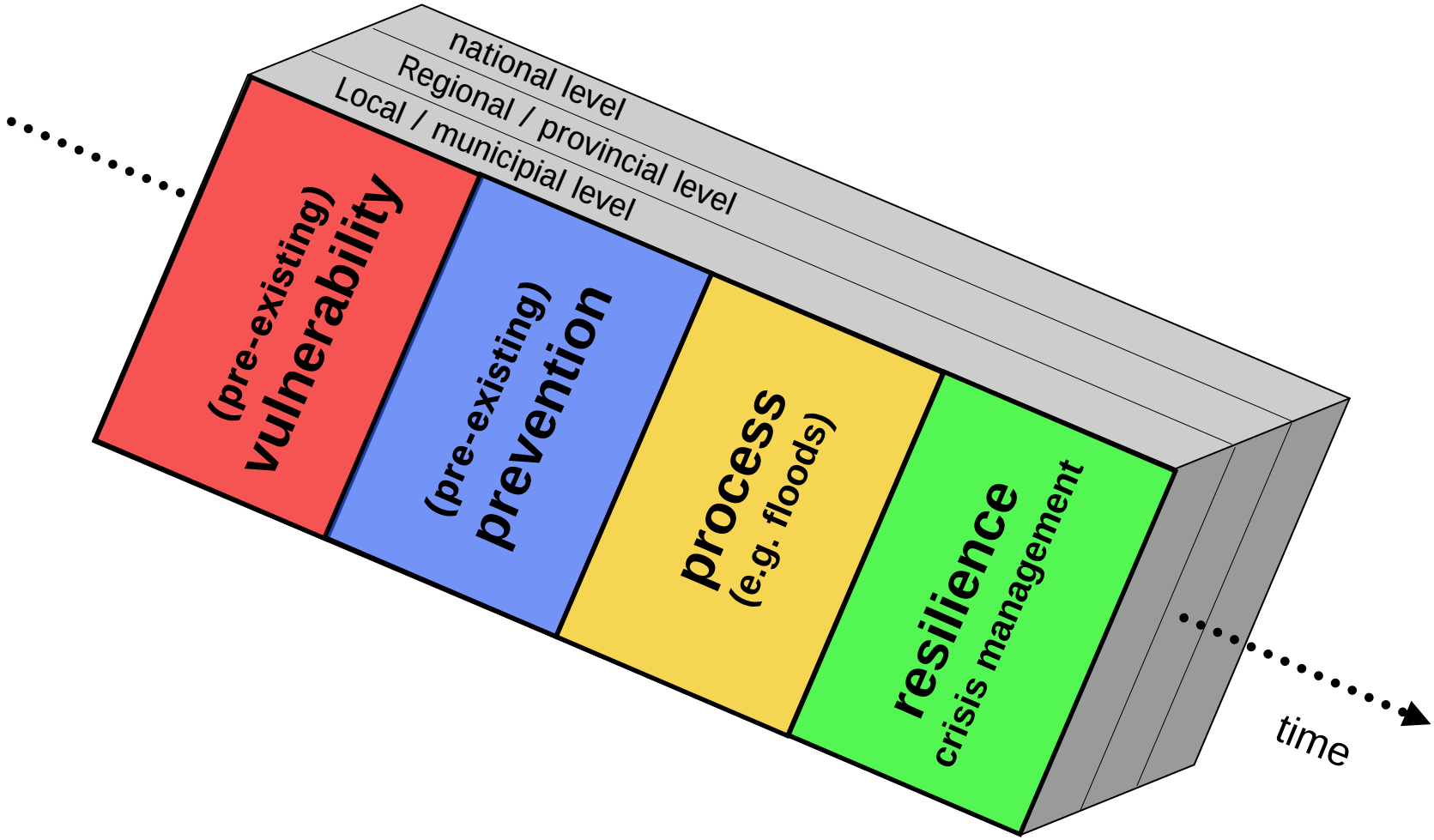

adjusted after Buckle et al. 2001

- Analysis of (economic) vulnerability and resilience
  - basis for recommodations and alternatives in *natural hazard mitigation and management*
  - Austria: quasi-compulsory *cost-benefit-analysis* for protective structures
  - *evacuation* plans
  - prepare *budget* for public hazard and crisis management
  - *risk awareness* at the local / municipal level

Shares of total economic losses – flooding 2005 Tyrol / Austria
"**alpine damage structure**"

economic loss of 410 mill €
2.1% of the gross regional product

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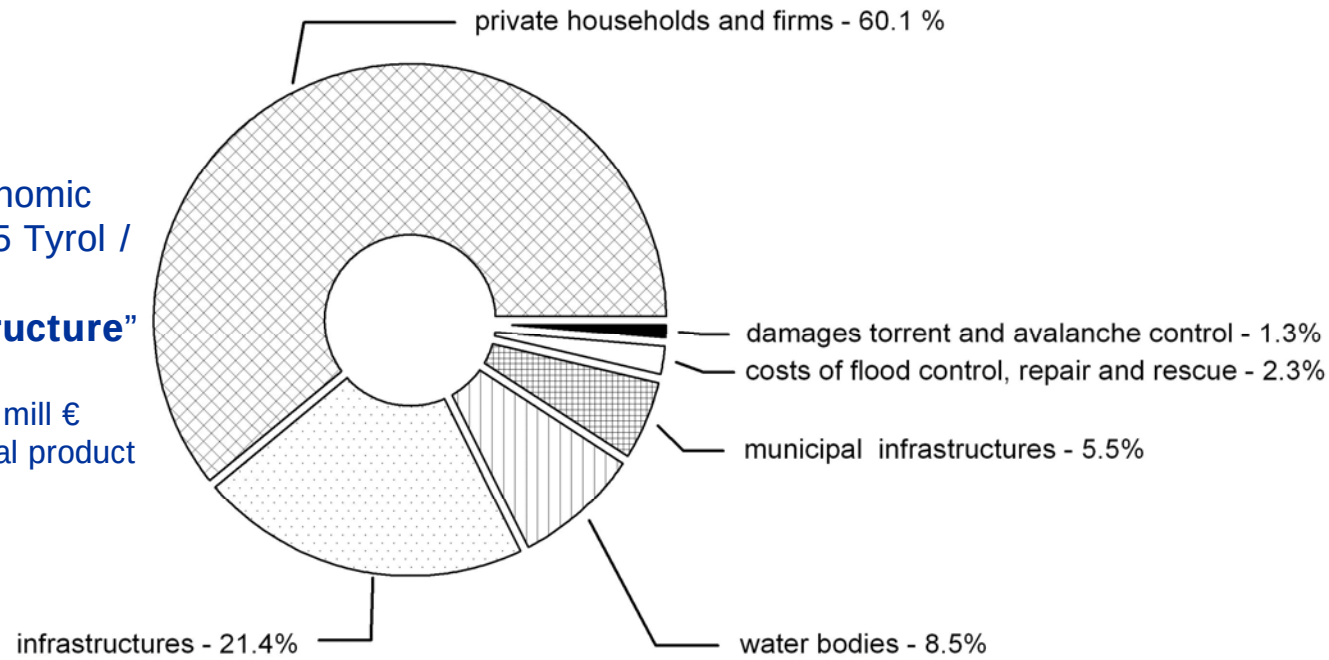

„types“ of most dominant processes and economic losses – flooding 2005, Tyrol / Austria

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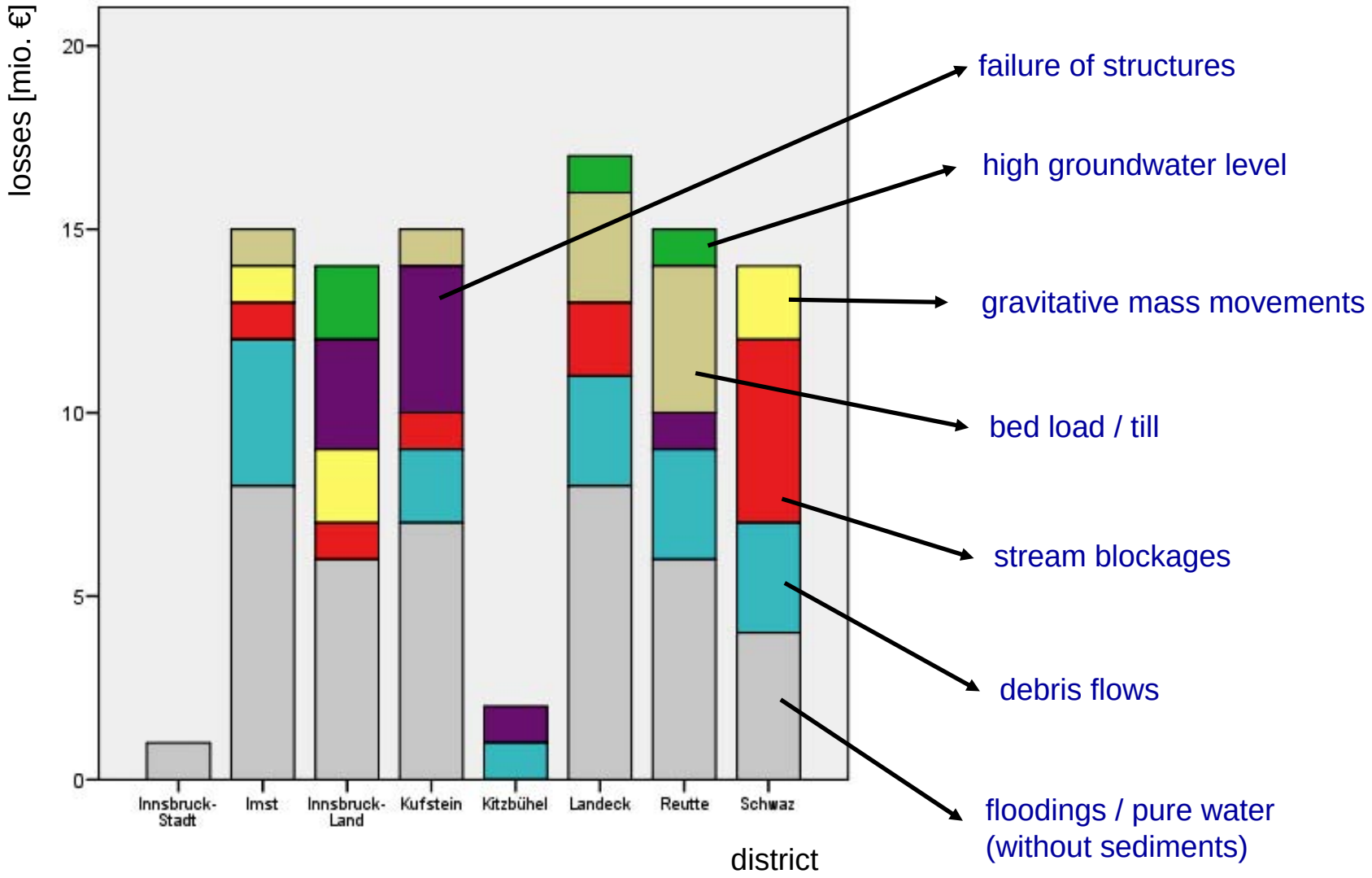
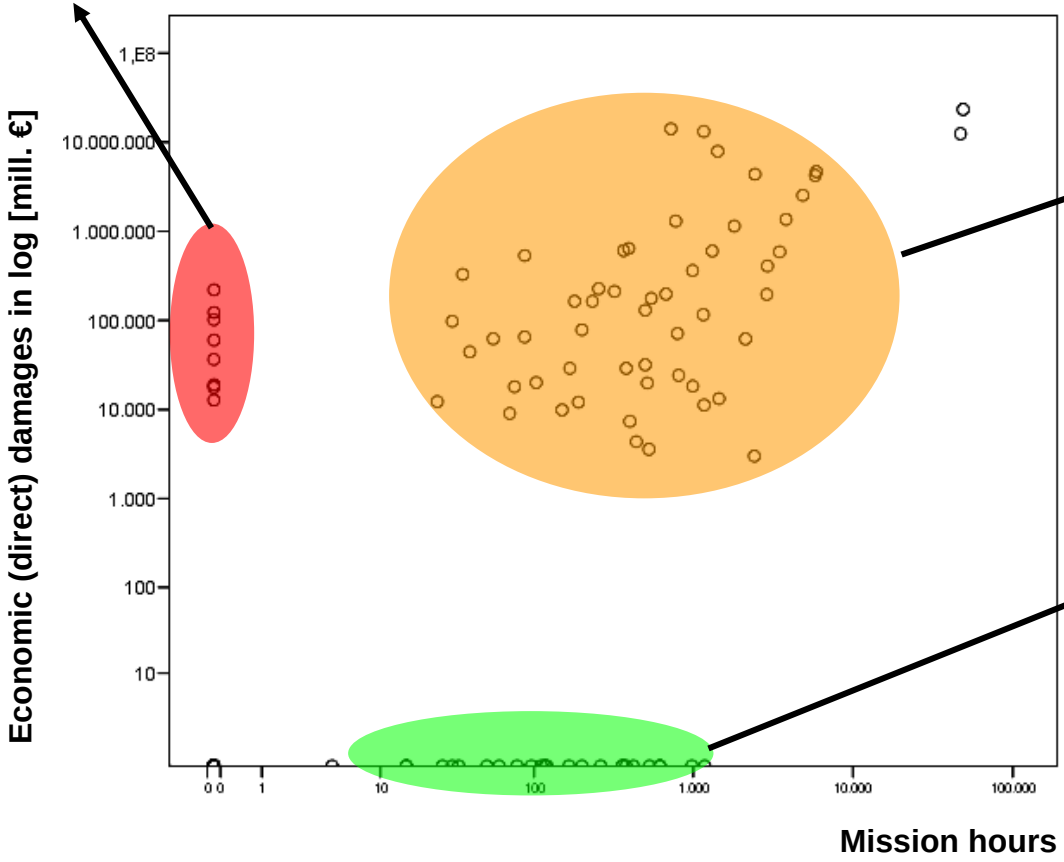


overlapping processes – subsumed under the term „flood“

- Estimations for emergency costs - these costs can exceed public funds!
- costs of emergency services are costs borne by both, statutory and voluntary organizations, that aim to protect property and life from damages due to a natural disaster
- choice of risk management strategies
- accounting the avoided cost of emergency services – comprehensive understood cba (tangible and intangible assets)
- range of publicized percentages of costs for emergency varies from 2.2% up to 14.7 % of total economic losses (Tyrol 2005 – up to 37%)
- empirical basis for estimating these costs are weak

Ineffective and unsuccessful defence

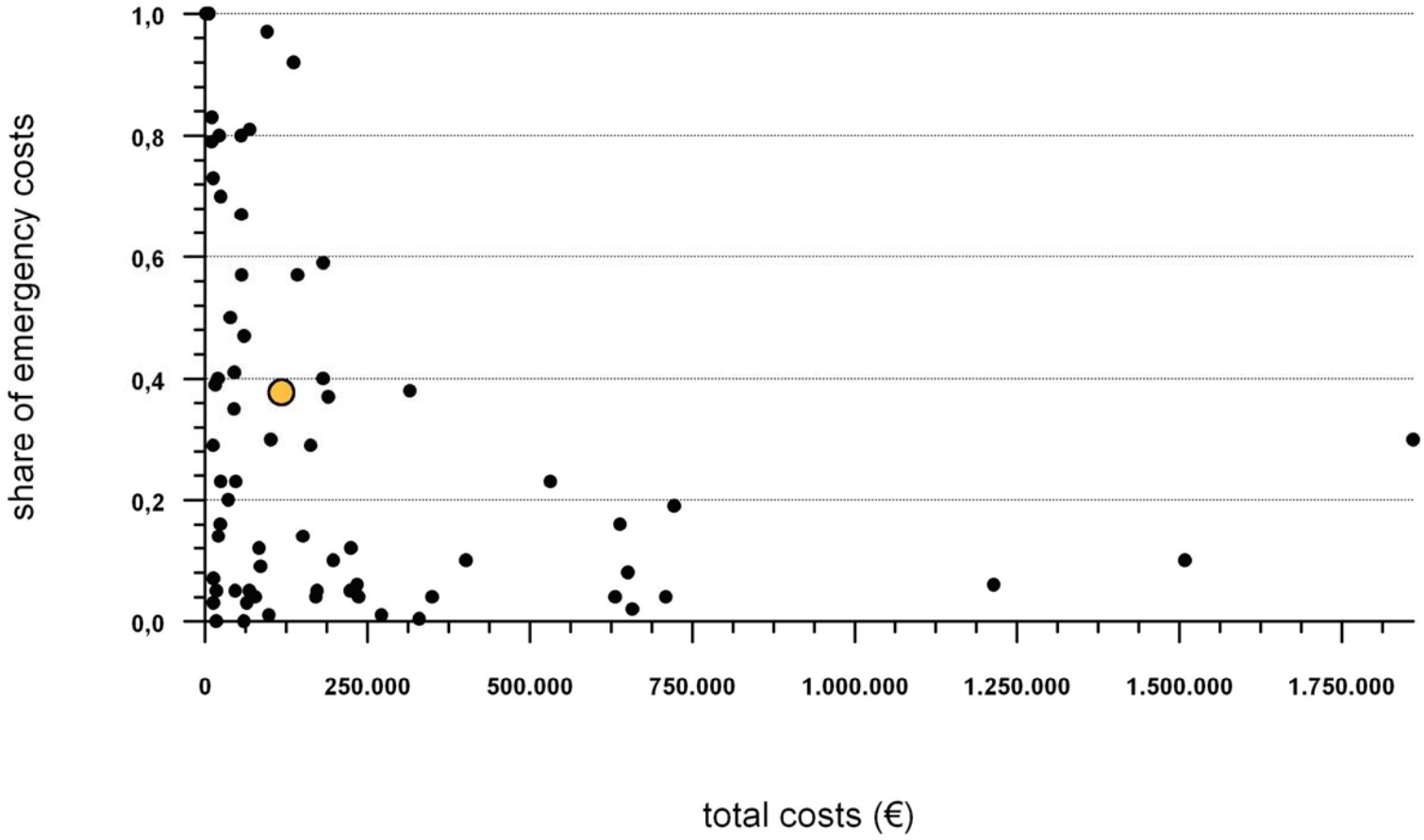
„multihazards“



Most cases: moderate defense

Effective and successful defence

- average values can be misleading as a rule of thumb to establish the costs of emergency services



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- maximum likelihood estimates to investigate the **regional / local** effects of a single flood event on
  - 1. total economic losses (vulnerability)
  - 2. total service hours of emergency service (resilience)
- based on empirical data
  - survey – fire brigades: primary resilience-infrastructure
  - official statistics of emergency services and losses
- statistics and charakteristics of municipality
  - Austrian danger zone mapping
  - permanent settlement area
- description of the process
  - Return periods of all gauges at major and minor rivers as result of extreme statistics
  - inudation areas (GIS-data)

Total economic losses flooding 2005 – Tyrol, Austria - vulnerability

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- e.g.
  - **log (sum_damages) = 4,99 + 0,003return_per*** + 0,33perm_settle + 0,02 procent + 3,34multiple*** + 0,19spatial_loc*****
  - ***** significant at the 10 %-level, R^2 = 50,41**
- No significant influence
  - quality / actuality of risk mapping
  - inudation areas
- significant influence – strong impact
  - „multihazards“ – the frequent occurance of multiple hazards (e.g. combination of flooding and debris flows because of high intensities of precipitation, etc.)
  - return periods (100 years, etc.)
    - But: actual statistics required
  - failure of structures / overwhelming dams
    - Change of spatial and natural conditions
  - Spatial location
    - alpine lateral vs. glacialformed low valleys
  - Duration of the flood event

„*Multihazards*“ and alpine lateral vs. glacialformed valleys

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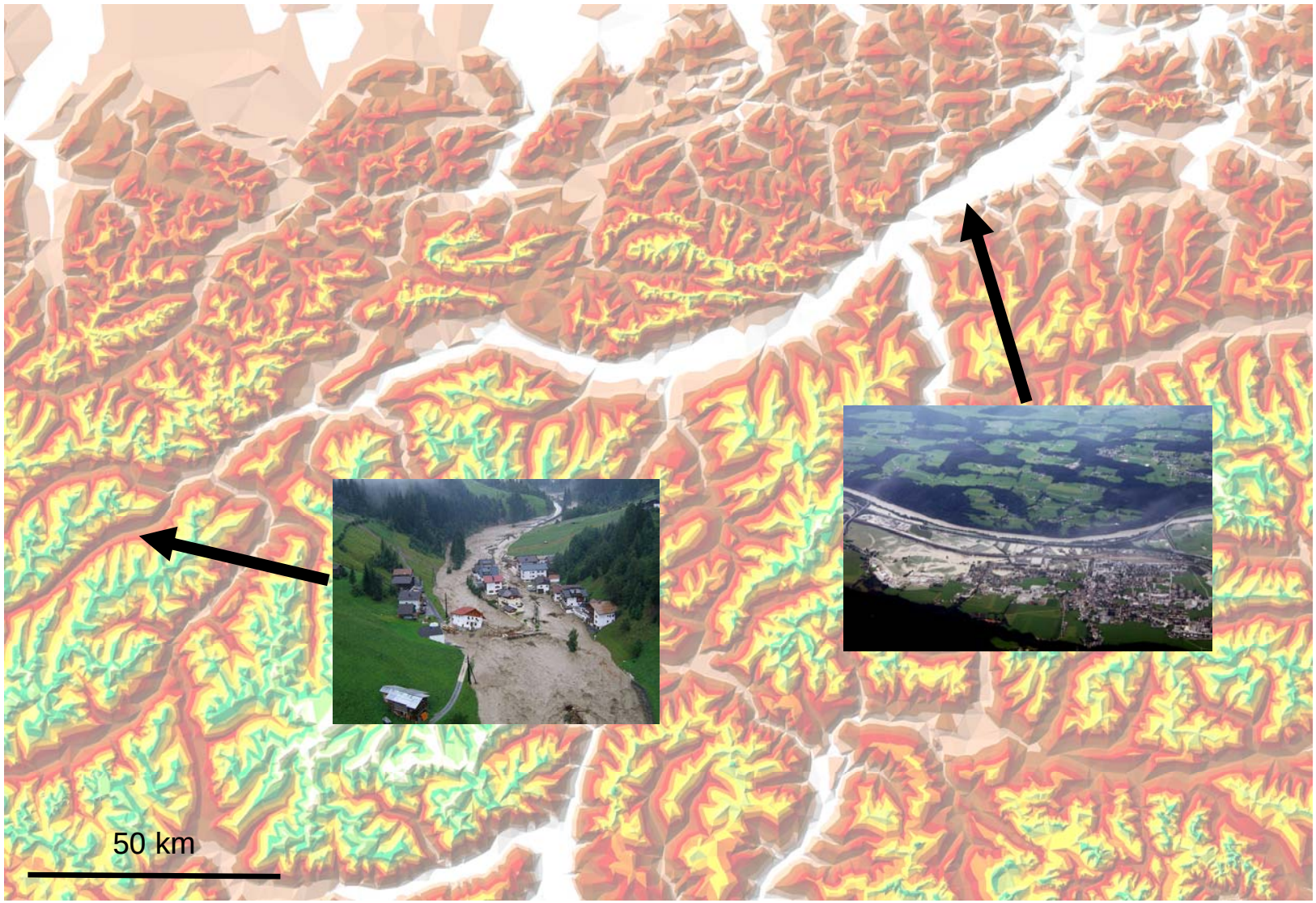

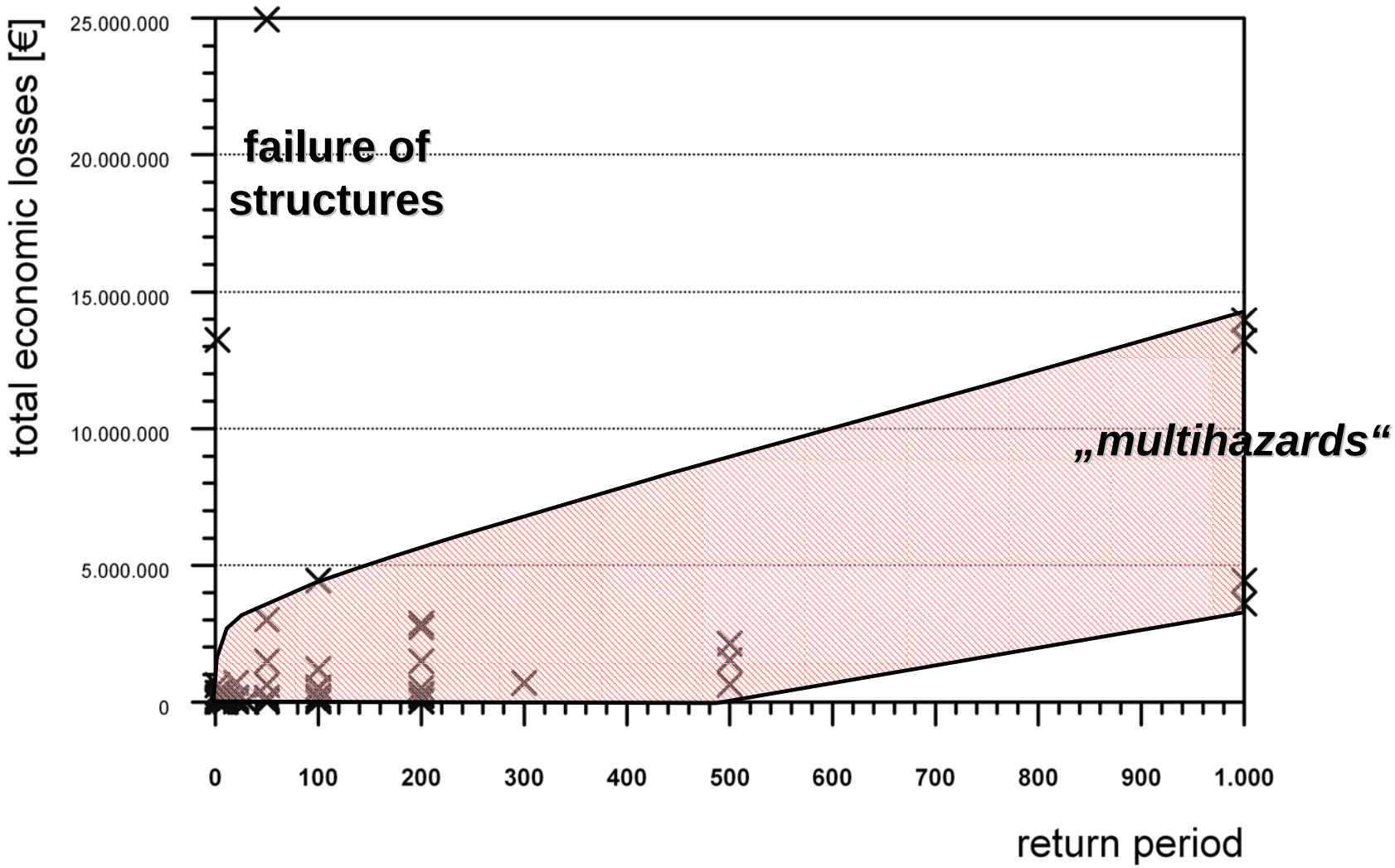
total economic losses [€]
25.000.000
20.000.000
15.000.000
10.000.000
5.000.000
0
failure of structures
„multihazards“
0
100
200
300
400
500
600
700
800
900
1.000
return period

- summary
  - alpine regions are specifically exposed to natural hazards
  - (ex-ante) economic management of risk combines both, resilience *and* vulnerability
  - frequent coincidence of the appearance of *multiple hazards* in alpine lateral valleys
  - increasing quantity and quality of observed losses
  - greater homogeneity of flood measures and loss statistics

- outlook
  - improvement of the estimations
  - spatial expansion of the analysis
  - comprehensive survey – flood-affected households, companies and emergency service institutions
  - generation of *alpine damage functions* for structures and public infrastructure which include different processes (bed load, debris flows, etc.)

- Clemens Pfurtscheller
  - alpS Centre for Natural Hazard and Risk Management, Innsbruck – Austria
  - pfurtscheller@alps-gmbh.com
- Prof. Reimund Schwarze
  - Department for Public Finance, University of Innsbruck, Austria
  - DIW, Berlin, Germany
  - Reimund.Schwarze@uibk.ac.at