EGU2020-1572

Mountain hazards and Building Back Better (BBB) – focus on the Austrian Alps

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Major hazards in mountain areas

Storms

Dynamic inundation

Static inundation

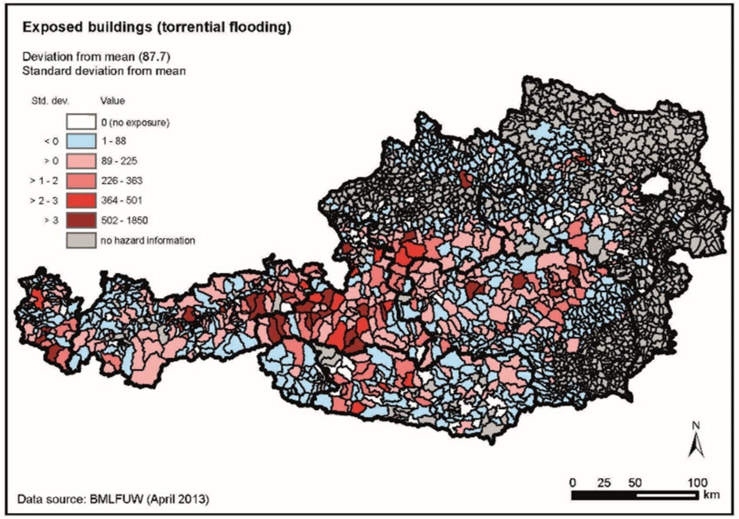
Debris flows

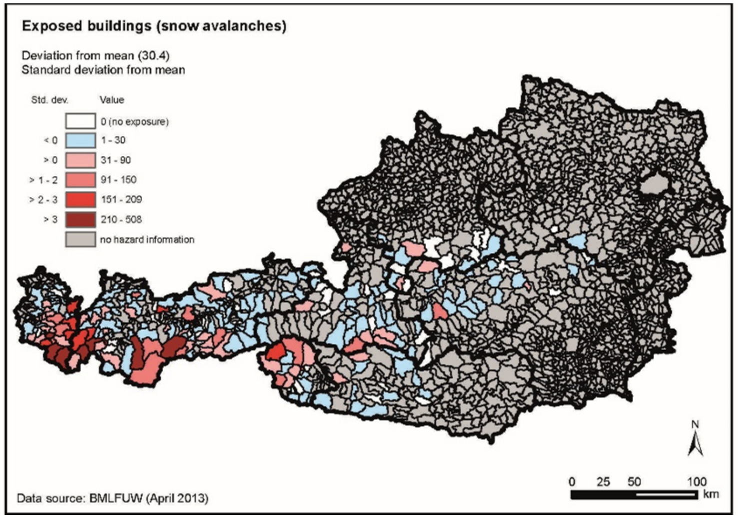
Heat wave

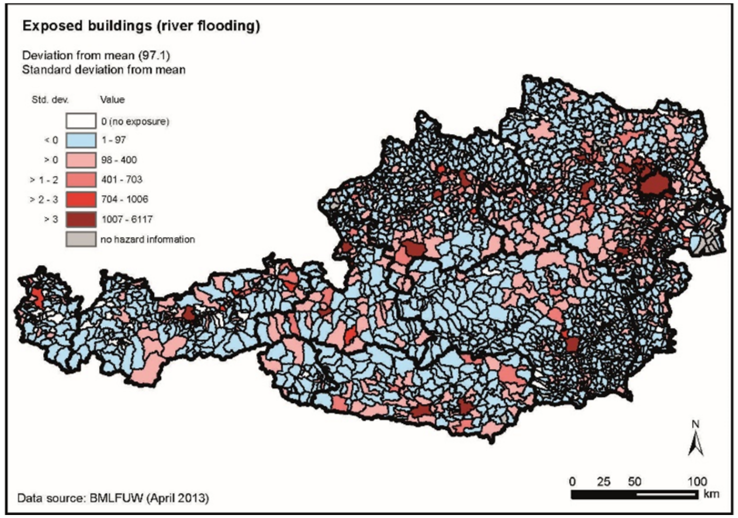
Snow avalanches

Image sources: different, protected

Exposure in Austria
– the built environment





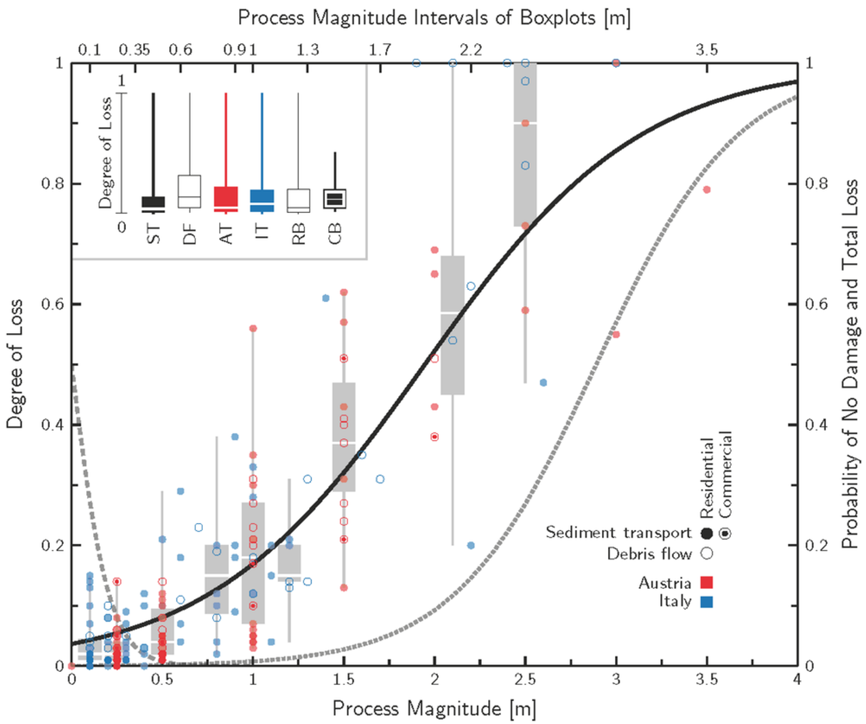


- Around 5 % of all buildings are exposed to torrential flooding and snow avalanches,
- and around 9 % to river flooding,
- with around 1 % of the buildings stock being multi-exposed.

Fuchs, Keiler, Zischg (2015): A spatiotemporal multi-hazard exposure assessment based on property data. *Natural Hazards and Earth System Sciences* 15 (9): 2127-2142

Physical vulnerability

- Exposition of values against process impact, **relation between degree of loss** and **process intensity**.
- High loss → considerable **economic vulnerability**.



Fuchs, Heiser, Schlögl, Zischg, Papathoma-Köhle, Keiler (2019): Short communication: A model to predict flood loss in mountain areas. *Environmental Modelling and Software* 117: 176-180

Build Back Better

RECOVERY IS AN OPPORTUNITY TO BUILD RESILIENCE

Build Back Better (BBB): The use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment (United Nations General Assembly, 2016).

Vulnerability reduction…

1. Conventional mitigation
   - permanent structures such as retaining/filtering barrier, retention basin,…

   → costly, tax-payer‘s money

2. Property-level mitigation
   - enhanced constructions, sealed openings

   → very cost-efficient, private investment

Attems, Thaler, Genovese, Fuchs (2020): Implementation of property level flood risk adaptation (PLFRA) measures: choices and decisions. *WIREs Water* 7 (1): e1404

Local structural protection…

Local structural protection can be complemented by an overall structural concept of

building protection (Build Back Better)

→ some regulations, but not quantified sufficiently

Earlier works: Prototype

- Prototype of reinforced building based on design loads on the building envelope

Holub, Suda, Fuchs (2012): Mountain hazards: reducing vulnerability by adapted building design. *Environmental Earth Sciences* 66 (7): 1853-1870

Earlier works: Prototype

- Additional expenses: + 8%

Measure	Increase in construction costs [%]
Reinforcement of the hillside outer wall	+ 17
Reinforcement of the structural slab	+ 30
Reinforcement of the truss	+ 10
Reduction of eaves (decrease in roof area)	- 16
Avalanche-proof window and window shutter	+ 67
Above flood-level light shafts	+ 23
Total costs of the prototype reinforced building	**+ 8**

Holub, Suda, Fuchs (2012): Mountain hazards: reducing vulnerability by adapted building design. *Environmental Earth Sciences* 66 (7): 1853-1870

Quantification of opportunities

Method	Advantages	Shortcomings
Vulnerability matrices	Qualitative method, no need for ex-ante data or detailed information	Results may not be translated into monetary loss. Assessment of damage under specific intensities or process characteristics is objective
Vulnerability curves	The method is quantitative and may “translate” an event into monetary cost	Important characteristics of the natural process (e.g. velocity, duration, direction etc.) as well as the element at risk (number of floors, construction material) are ignored. Highly-demanding in ex-post information
Vulnerability indicators	Characteristics of the element at risk are taken into consideration	The intensity of the process is not considered, demanding in data (detail, amount quality)

Fuchs, Keiler, Ortlepp, Schinke, Papathoma-Köhle (2019): Recent advances in vulnerability assessment for the built environment exposed to torrential hazards: challenges and the way forward. *Journal of Hydrology* 575: 587-595

The case of Pfunds (Austria)

Stubenbach, Pfunds (Austria)

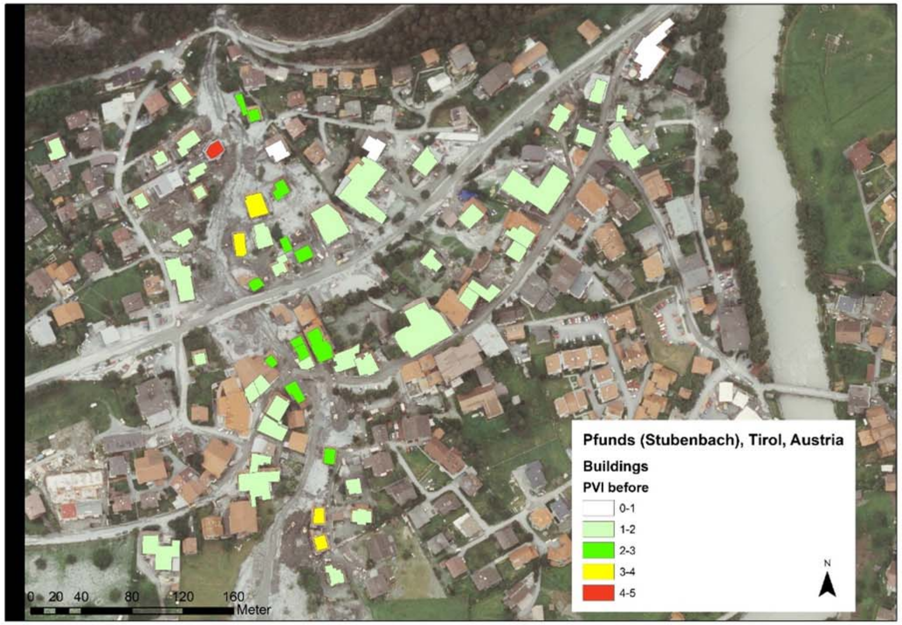
Event:

August 2005

No of damaged buildings: 60

Reported loss: 11,300,000 €

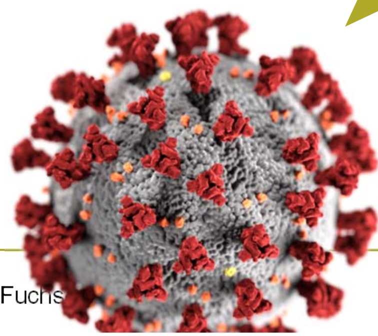
We use a Physical Vulnerability Index (PVI) (Papathoma-Köhle et al., 2019) to assess the physical vulnerbility of the buildings at the time of the event (PVI before, Figure on the left) and currently (PVI after, Figure on the right).



Papathoma-Köhle, Schlögl, Fuchs (2019): Vulnerability indicators for natural hazards: an innovative selection and weighting approach. *Scientific Reports* 9: 15026

Quantification of opportunities

- Due to COVID-19 we are not ready with our survey…



- Distribution of PLFRA measures
- Incentives for PLFRA measures

Conclusion

- Recent advances in vulnerability assessment methods for buildings threatened by mountain hazards clearly show that there is still a need for further research in this field.
- Existing mitigation concepts will be improved with the availability of PLFRA measures such as local structural protection.
- Prescribing PLFRA measures will contribute to the enhanced assessment of risk and to the design of adequate risk reduction strategies, and, at the same time, will contribute to safe public money.

Additional references (others are given on respective slides)

- Papathoma-Köhle, Cristofari, Wenk, Fuchs (2019): The importance of indicator weights for vulnerability indices and implications for decision making in disaster management. International Journal of Disaster Risk Reduction 36. Article 101103
- Sturm, Gems, Keller, Mazzorana, Fuchs, Papathoma-Köhle, Aufleger (2018): Experimental analyses of impact forces on buildings exposed to fluvial hazards. Journal of Hydrology 565. p. 1-13
- Papathoma-Köhle, Gems, Sturm, Fuchs (2017): Matrices, curves and indicators: a review of approaches to assess physical vulnerability to debris flows. Earth-Science Reviews 171. p. 272-288
- Fuchs, Thaler (2018): Vulnerability and resilience to natural hazards. Cambridge University Press