Modelling direct tangible damages due to natural hazards

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CONHAZ Costs of Natural Hazards

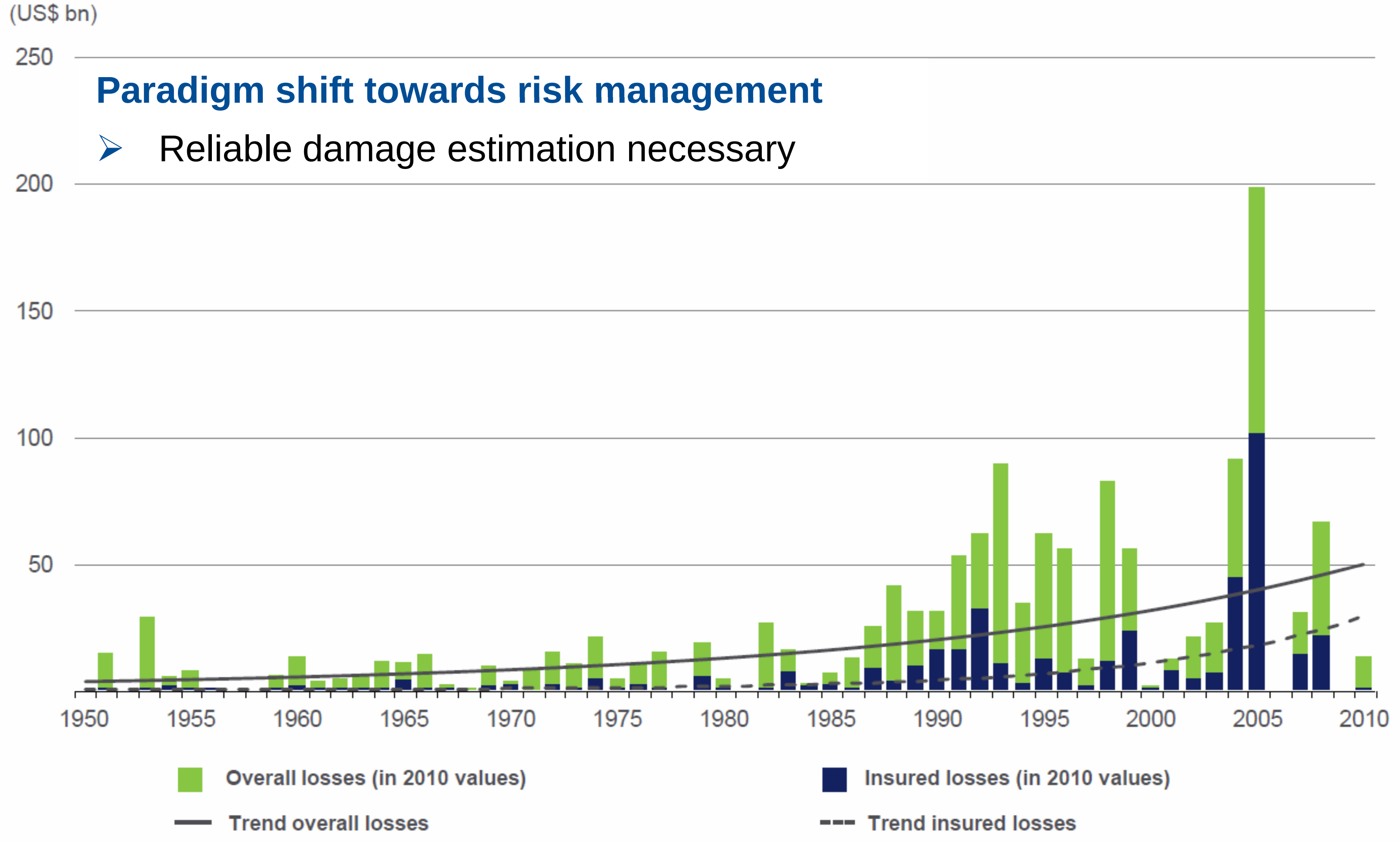
HELMHOLTZ GEMEINSCHAFT

NatCatSERVICE

Great weather catastrophes worldwide 1950 – 2010

Overall and insured losses with trend

Munich RE



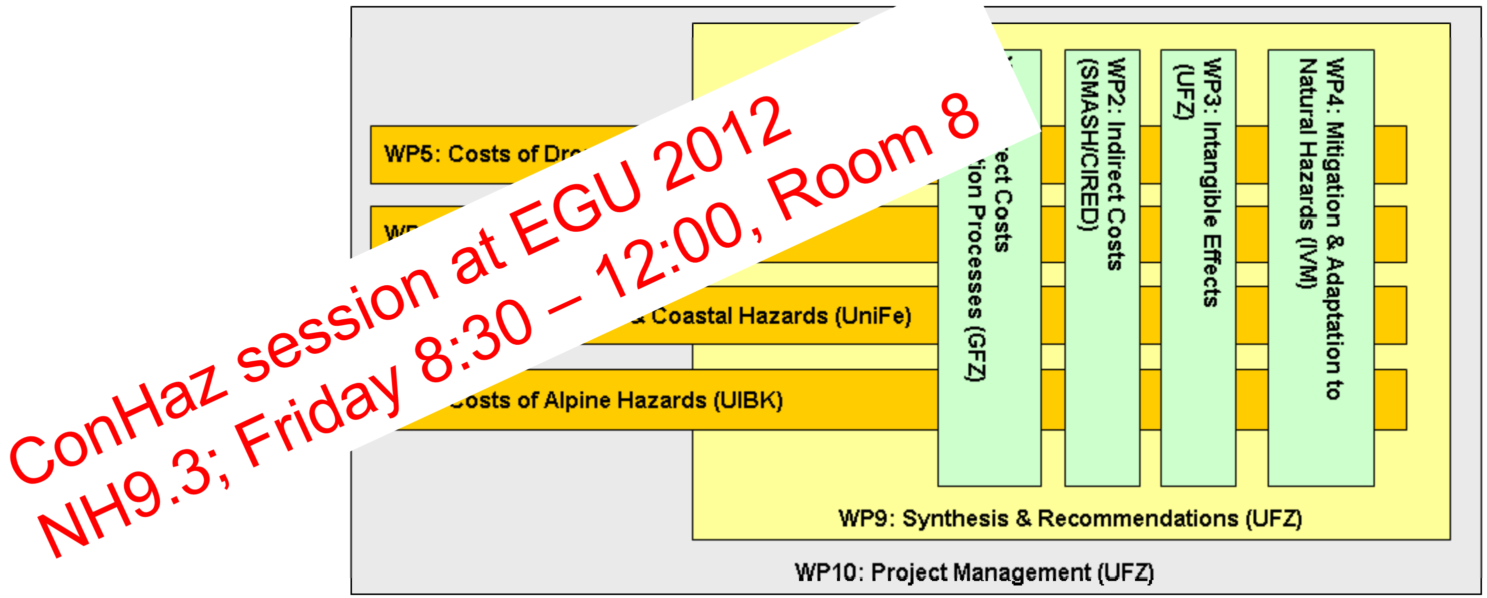
Paradigm shift towards risk management

- ➢ Reliable damage estimation necessary

The EU Project “Costs of Natural Hazards” (http://conhaz.org)

Objective:

- Compilation and systematisation of state of the art methods and terminology for the modelling of losses due to **floods, droughts, alpine hazards and coastal hazards**
- Synthesizes the results and define and identify best practice methods
- Identify knowledge gaps and research needs



Compilation of methods for damage modelling

ConHaz-Report: "Natural Hazards: direct costs and losses due to the disruption of production processes" by Philip Bubeck and Heidi Kreibich

http://conhaz.org/project/cost-assessment-work-packages/wp1-8-final-reports/CONHAZ%20REPORT%20WP01_2.pdf

Table 4: Approaches for the assessment of direct drought damages.

	Country	ex ante / Ex-post	economic sectors covered	Loss determining parameters	Validation	Data needs
Martin-Ortega and Markandya (2009)	Spain	Ex post	Irrigators, Swimming pool providers and related sector, gardening and flowers, Hydroelectric production	Comparison drought to non-drought years Reported cost figures	Reported damage figures partly compared with other cost estimates	Primary studies (reported cost figures)
Benson and Clay (1998)	Africa	Ex post	Agriculture GDP	Comparison drought to non-drought years	n.a.	Sector specific and national GDP
Horridge et al. (2005)	Australia	Ex post / ex ante	Agriculture, livestock, trade, transport, construction	Input-output tables, changes in stock price elasticity	n.a.	Input-output tables, trade matrices, matrix of commodity tax revenues, input factors values, stock changes of domestic output and imports.
Holden and Shiferaw (2004)	Ethiopia	Ex post / ex ante	Agriculture Livestock	Crop yield, soil erosion, production characteristics Commodity prices, labour and capital prices	n.a.	Biophysical data, socio-economic data, market prices for agricultural products
Corti et al. (2009)	France	Ex post / ex ante	Residential buildings	Soil moisture deficit index	Yes (Corti et al., 2009	Soil moisture data, population density
COPA-COGECA (2003)	Europe	Ex post	Agriculture Forestry Livestock production	Reported cost figures	n.a.	Primary studies (reported cost figures)

Direct economic costs – preliminary analysis

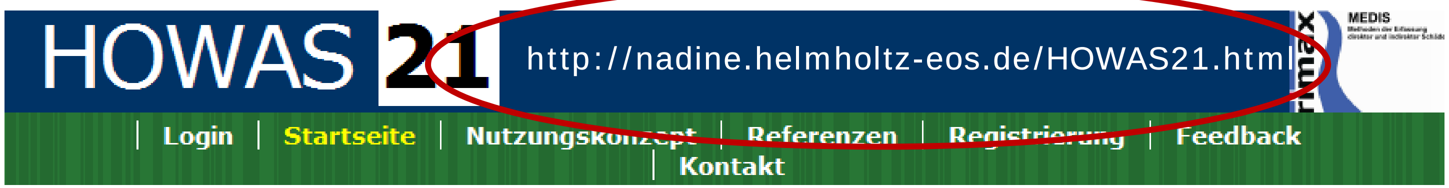
- In comparison with advancements in hazard modelling, there is still much research effort needed for cost assessments.
- There is a relatively strong focus on modelling of direct economic costs, since this is an important indicator for the severity of an event
- A serious lack of detailed damage data hampers model development and validation
- Significant diversity in cost modelling makes it difficult to compare costs
- Modelling of costs is associated with high uncertainties, validations are difficult and scarce
- Comparing the 4 natural hazards dealt with in ConHaz, flood damage modelling is most advanced

➡ Example: Flood damage modelling

example

Improvements of the data base

- United Kingdom:
  - Since 70s, comprehensive, detailed surveys of synthetic damage data (What-if analyses) with regular updates – data base of Flood Hazard Research Centre
  - Good documentation of flood events – Environment Agency + FHRC
- Germany:
  - HOWAS data base initiated by the Working Committee of the German Federal States' Water Resources Administration (LAWA) (about 1970 – 1990)
  - Comprehensive damage data surveys after floods in 2002, 2005 and 2006 and set up of the HOWAS 21 data base (> 5900 damage cases)



example

Detailed data analyses

principal component analysis

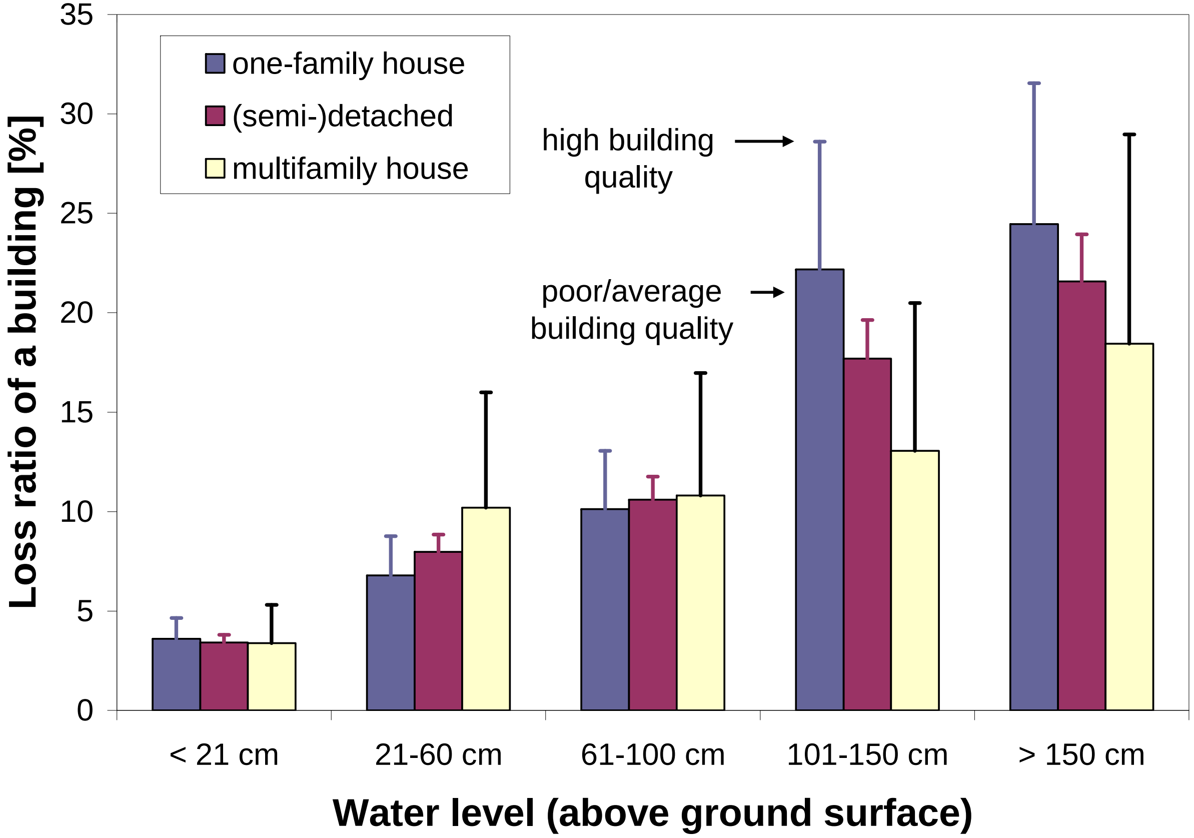
	Component loadings for variables that probably influence residential building damage	Components (n = 707) * 1	2	3	4	5	6
Flood impact	water level above top ground surface [cm]	0.02	-0.03	**0.75**	-0.04	-0.14	-0.10
	flood duration [h]	0.01	-0.06	**0.51**	-0.05	0.08	0.00
	indicator of flow velocity [-]	-0.01	-0.15	-0.02	-0.12	0.09	**0.56**
	contamination of flood water [-]	0.03	-0.02	**0.73**	0.03	-0.06	-0.07
Precaution	indicator of emergency measures [-]	-0.01	0.04	-0.30	0.22	0.22	-0.30
	indicator building precaution [-]	-0.02	0.09	-0.20	**0.56**	0.03	-0.21
	efficiency of private precautionary measures [-]	-0.09	-0.14	**0.50**	-0.04	0.17	0.37
	indicator of flood experience [-]	-0.01	-0.07	-0.09	**0.78**	-0.03	0.06
	knowledge of flood hazard [-]	-0.04	-0.07	0.15	**0.80**	-0.02	0.08
Building	number of flats in the building	**0.87**	-0.04	0.04	-0.01	-0.15	-0.03
	total floor space of the building [m^2]	**0.96**	0.06	0.02	0.00	0.10	0.00
	quality of buildings	0.01	0.13	-0.11	0.20	-0.19	**0.68**
	estimated building value [Euro]	**0.95**	0.06	0.02	0.00	0.11	0.01
Household	age of the interviewed person [a]	-0.06	**-0.73**	0.11	0.08	-0.09	0.06
	household size [number of persons]	-0.01	**0.87**	-0.02	0.02	-0.01	-0.05
	number of children (younger than 14 years)	0.00	**0.83**	-0.08	0.00	-0.08	0.00
	ownership structure [-]	**-0.56**	-0.01	0.09	0.13	0.45	0.00
	monthly net income [Euro]	0.10	0.27	-0.08	-0.06	**0.66**	-0.06
	socio-economic status after Plapp [2003] [-]	-0.12	-0.27	0.02	-0.01	**0.81**	0.00
		Coefficient of correlation (Pearson) (n = 623) * **					
	absolute damage to buildings [Euro]	**0.31**	-0.02	**0.49**	**-0.11**	**-0.09**	-0.02
	loss ratio of buildings [-]	**-0.14**	**-0.09**	**0.55**	**-0.11**	**-0.14**	-0.03

Method: varimax rotation; total variance explained: 59.28%, number of valid cases: 707
** Bold variables are marking variables with absolute loadings > 0.5.*
*** Bold correlation coefficients are significant on a level of 0.05 (two-sided)*

(Thieken AH, Müller M, Kreibich H, Merz B (2005) Water Resour. Res., 41(12), W12430)

example

Development of multi-factorial models



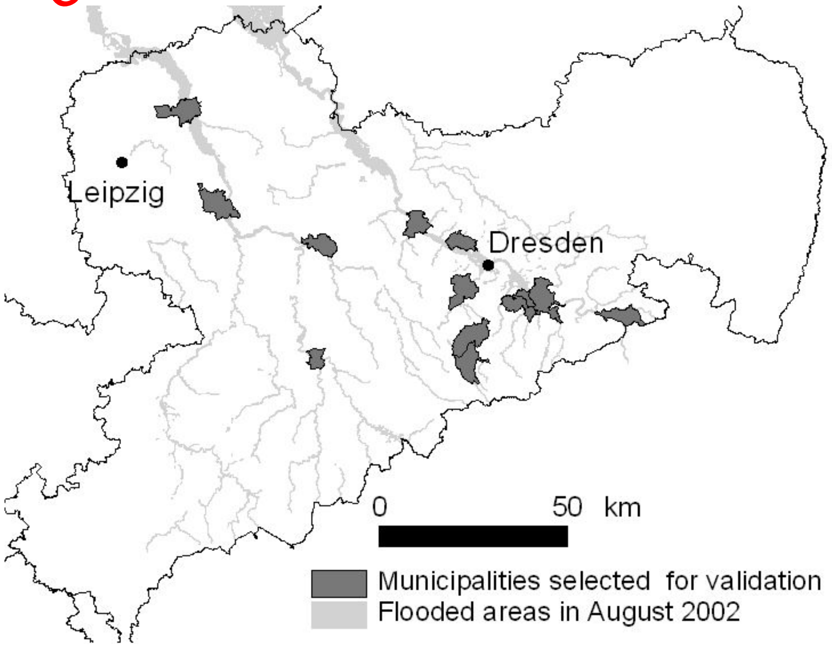
Flood Loss Estimation MOdel FLEMOps for residential buildings

(Büchele et al. (2006) -NHESS :485-503)

		Private precaution		
		none	good	very good
Conta-mina-tion	none	0.92	0.64	0.41
	moderate	1.20	0.86	0.71
	severe	1.58	---	---

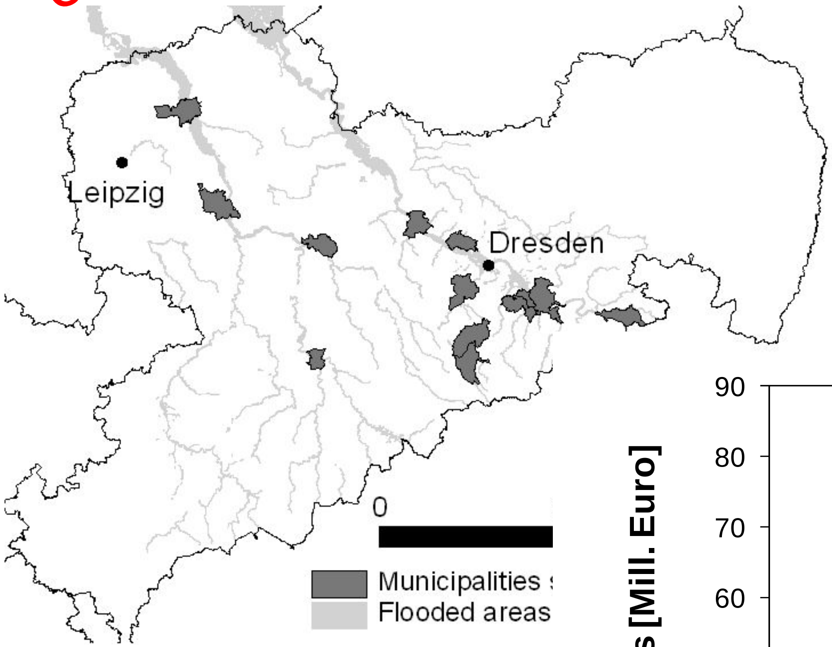
example

Model validation on the meso-scale

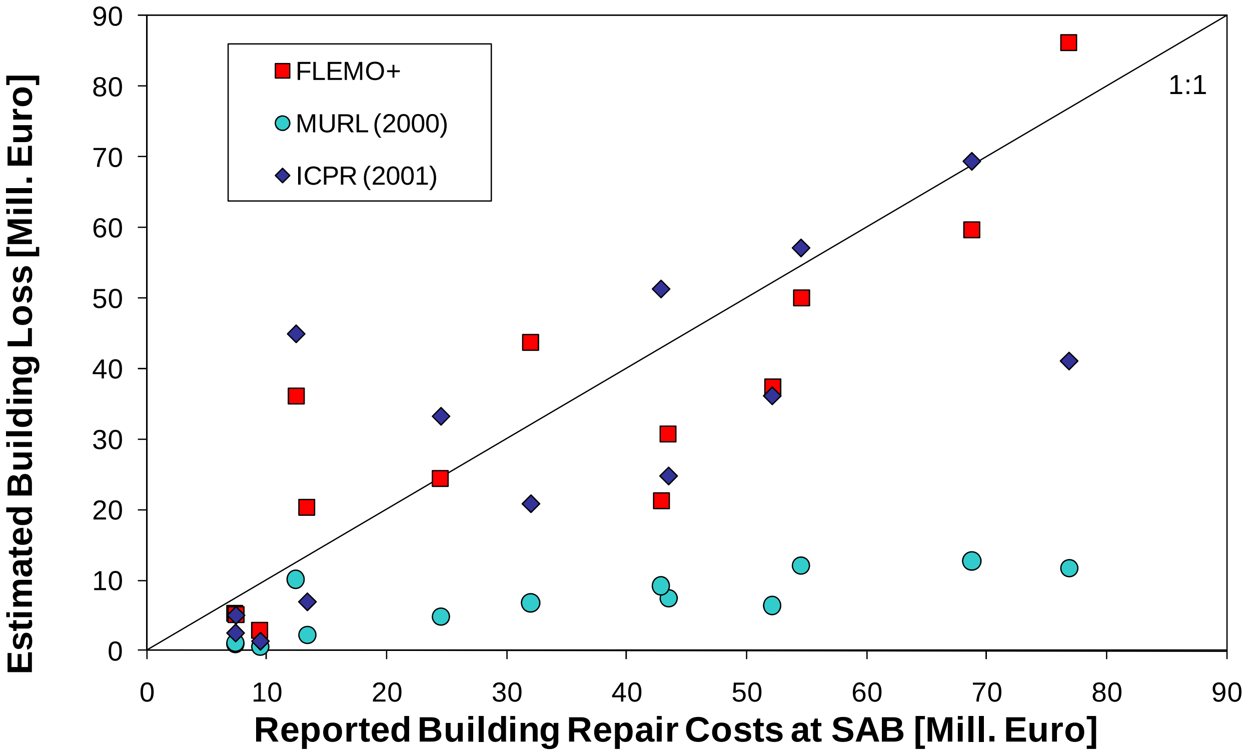


example

Model validation on the meso-scale



	MURL (2000)	ICPR (2001)	FLEMO+
MBE [Mill. €]	-27.6	-3.9	-1.7
RMSE [Mill. €]	34.0	16.1	11.9
MAE [Mill. €]	27.6	12.0	9.7
MRE	79%	54%	42%



Summary of example

- Comprehensive detailed database is essential for model improvement
- Models which include precaution as parameter are important for the assessment of mitigation and adaptation strategies
- Validations show, that multi-factorial models are an improvement
- Validations and uncertainty analyses are difficult, but necessary

Cross-hazard learning

- Multi-parameter models (floods, avalanches) should be developed also for other natural hazards (e.g. coastal hazards, Alpine floods, droughts)
- Synthetic damage functions or combined empirical-synthetic approaches (floods) could be a promising option also for other hazard types (e.g. landslides, avalanches, storm surges)
- Integrate several sector and hazard specific damage models under a consistent modelling framework

Most important recommendations

- **Improve empirical and synthetic data collection and the documentation of events**
  - Continued, consistent and detailed surveys of damage data including influencing factors
- **Improve damage models through more knowledge of damaging processes**
  - Intensify multi-variate data analyses and take more important damage influencing parameters into account, e.g. precaution
  - Validation of models, uncertainty analysis