Calculation of building damage due to high groundwater levels with the model GRUWAD

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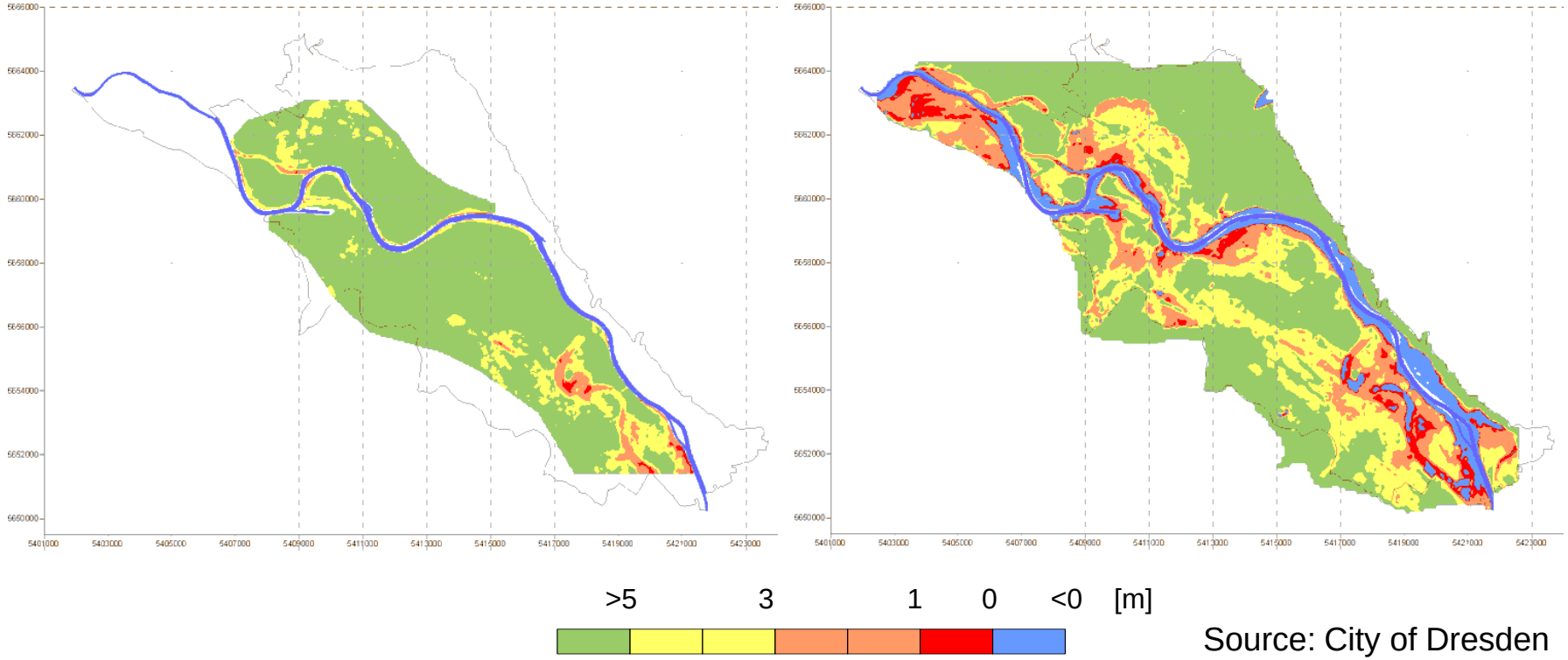
MULTISURE "Development of Multi-Sequential Mitigation Strategies for urbanised areas with risk of groundwater inundation"

Groundwater situation in the city of Dresden

- Groundwater-surface distance at different times

11/2000 (MW)

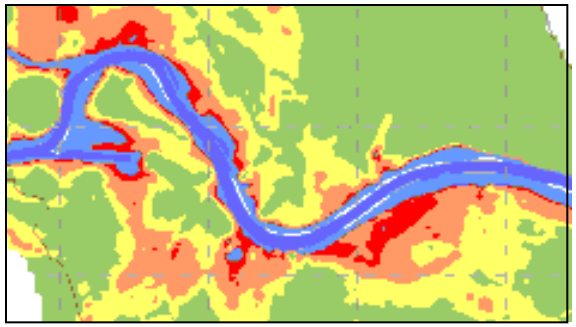
08/2002



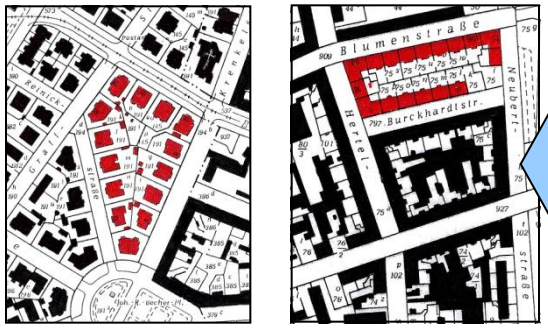
Source: City of Dresden

Structural Model GRUWAD

groundwater dynamics

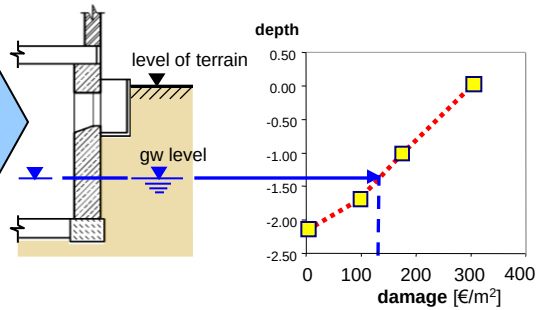


urban structure



vulnerability of buildings

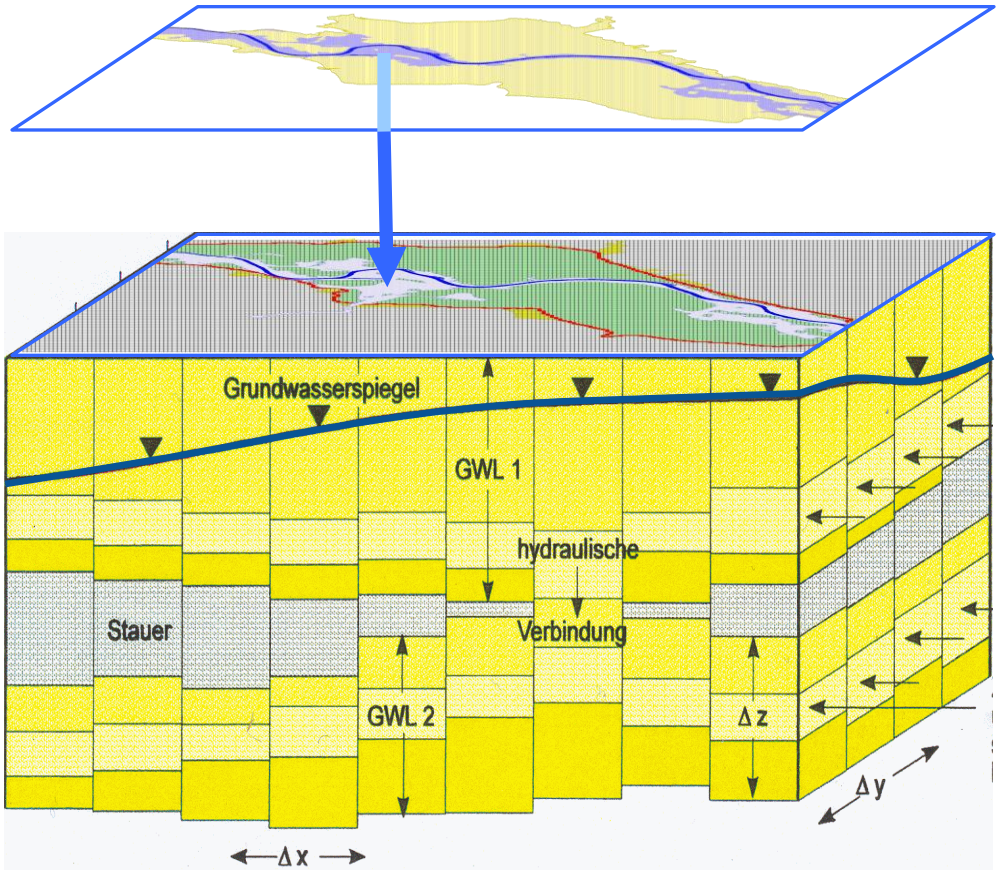
due to groundwater inundation



calculation module (GRUWAD)

vulnerability of the urban area due to groundwater inundation

Groundwater flow model



River flood:

Boundary condition of groundwater flow model

Rising groundwater:

Groundwater flow are calculated
- in consideration of the river flood
- by finite-volume method
- in 3 dimensions (PCGEOFIM)

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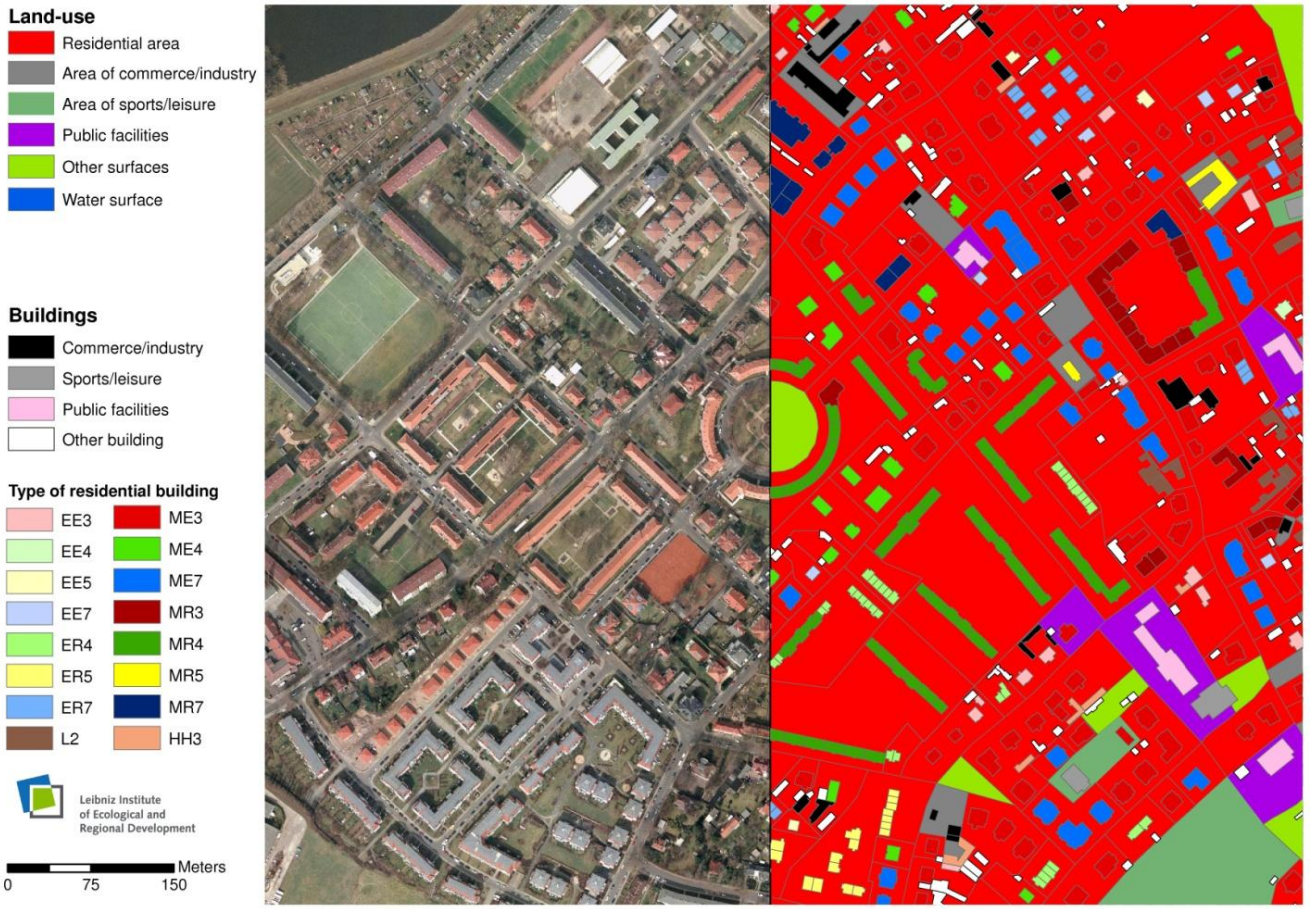
Source:
Dresden Groundwater Research Centre (DGFZ e.V.)

Identification of building types



Residential building: fraction of floor area

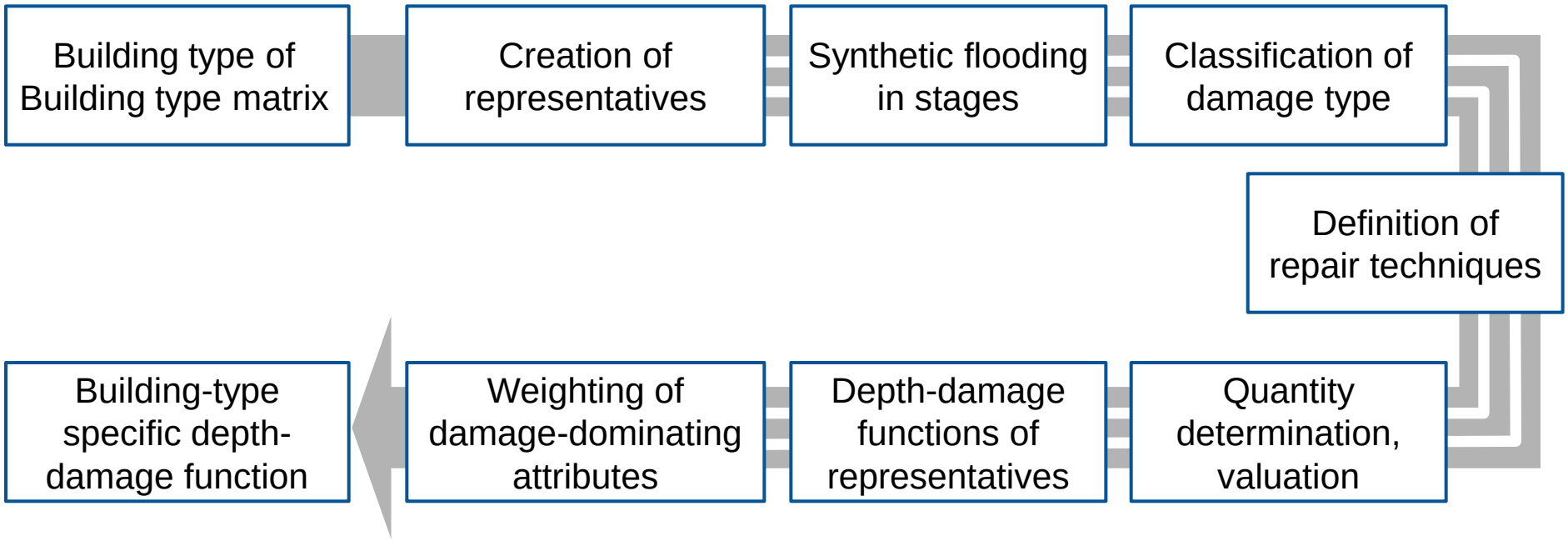
		Urban-Structure-Type						
		free standing buildings (with one main entrance)				lines and blocks of buildings (each with one entrance)		
		single unit	multi unit			single unit	multi unit	
		EE	HM	L	ME	ER	MRG	MRO
before 1870 timber frame construction	**1**							
before 1870 brickwork	**2**			L2				
1870-1918 brickwork	**3**	EE3			ME3		MR3	
1919-1945 basically brickwork	**4**	EE4			ME4	ER4	MR4	
1946-1990 brickwork	**5**	EE5					MR5	
1970-1990 prefab. concrete building	**6**				ME6		MR6	
after 1990 basically brickwork	**7**	EE7			ME7	ER7	MR7	

fraction of floor area differentiated by building types:

- >5 %
- 2 - 5 %
- 1 - 2 %
- ≤ 1 %
- no relevance

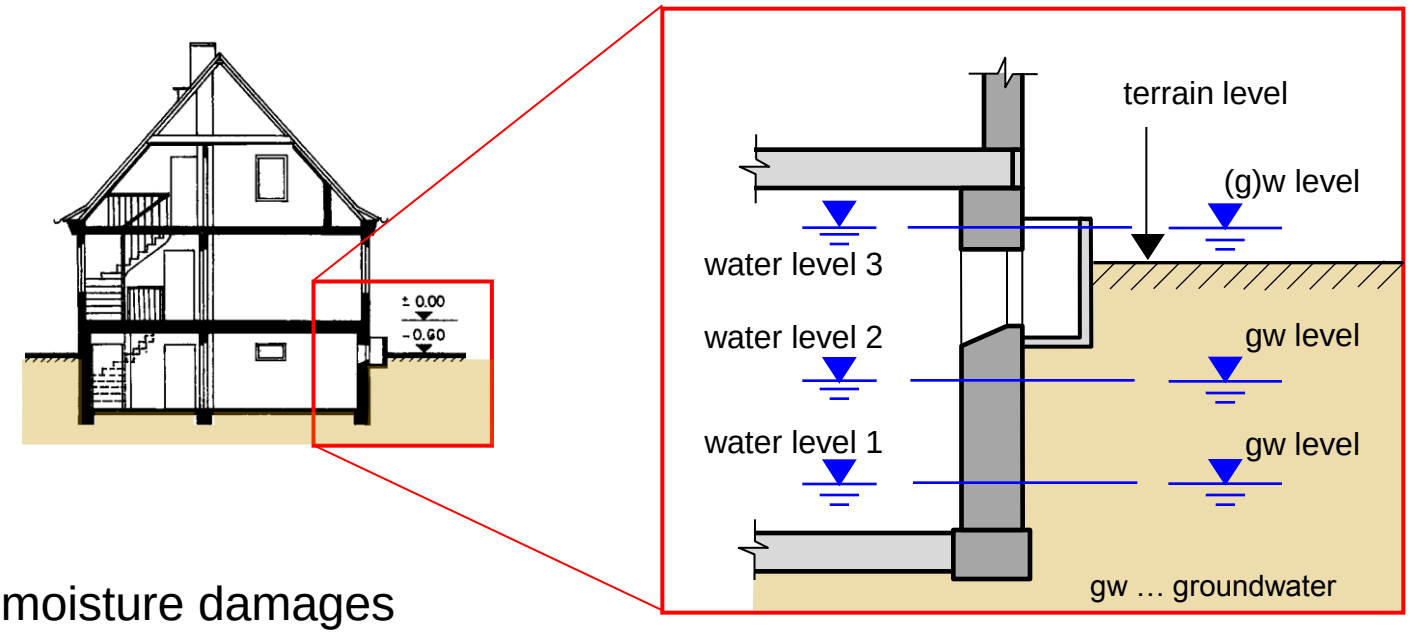
Depth-damage function due to groundwater inundation

- Procedure to generate the depth-damage functions



Depth-damage function due to groundwater inundation

- floodsteps groundwater



water and moisture damages

due to groundwater inundation caused by:

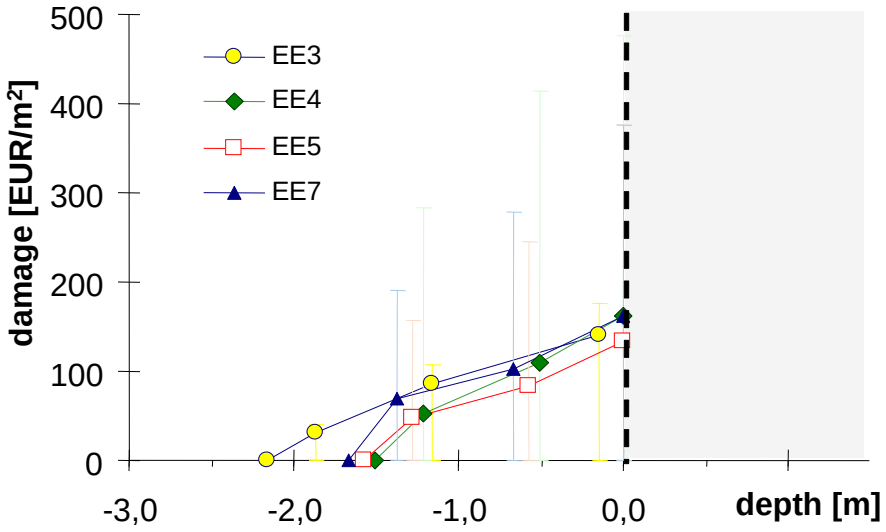
- leakage through basement wall, bottom of cellar
- leakage on house service connections

Depth-damage function of residential building

- examples of single and multi family houses

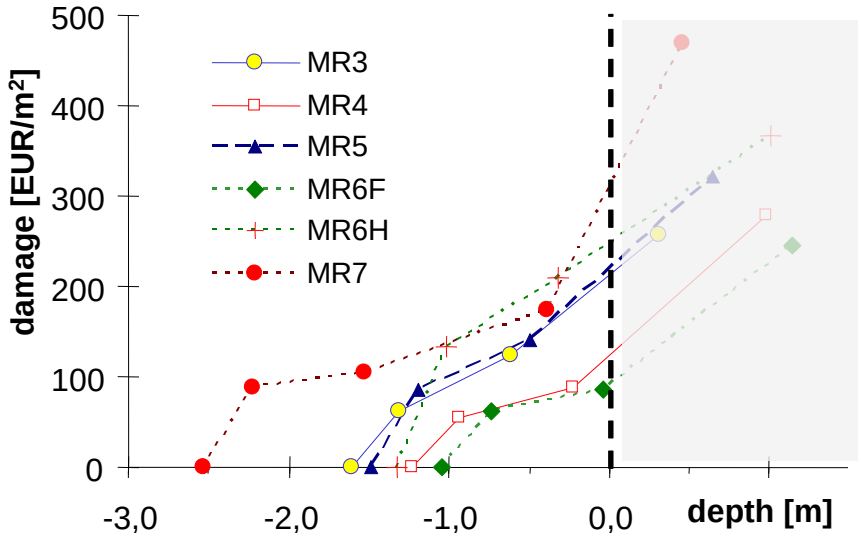
EE

- single family, detached houses
- differentiate by construction period



MR

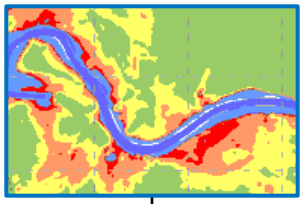
- multi family, terraced houses
- differentiate by construction period



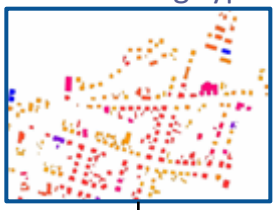
Calculation Module of GRUWAD

results of input modules

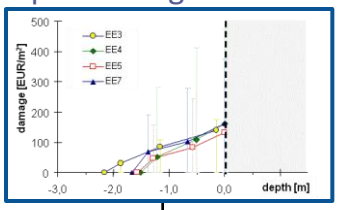
depth to the groundwater surface



map of building with building types



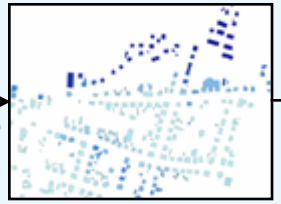
depth-damage functions



calculation of the damages

join

depth to the groundwater surface on the building polygon

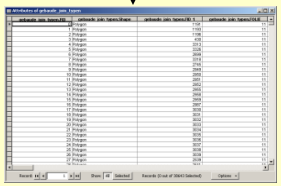


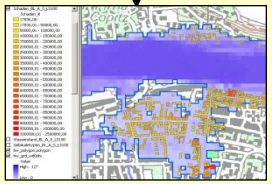
join

statistical analysis

calculation building area * damage)

damage per reference unit (e.g. statistic block, administrative areas or building types)



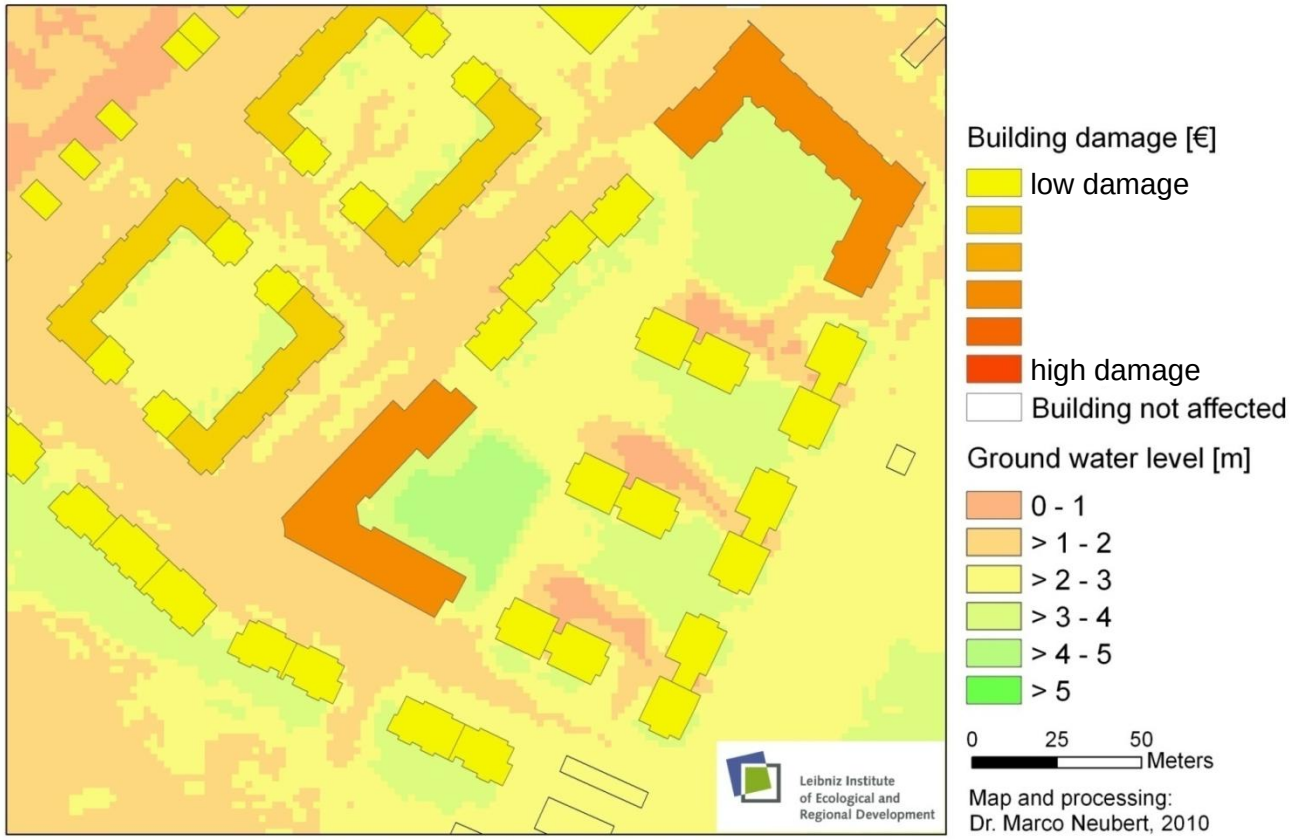


maps of damages caused by high groundwater level

results of the calculation

Subterranean building damage

- caused by groundwater inundation



Conclusions

- Damage calculation with the model GRUWAD is based on the level of building polygon → high spatial resolution of the damage simulation
- The risks of groundwater inundation may be determined for different intensities and frequencies of surface water floods.
- The calculation of depth-damage function based on a synthetic method. The advantages are especially site specific formulation, consistency of the calculation of refurbishment as well as the possible implementation of mitigation measures.
- The results of damage modelling are a basis for cost benefit analysis.
- The modular system can be adapted to the available database and to specific objectives.

Bundesministerium
für Bildung
und Forschung

Thanks for your attention!

The presentation is based on results of the project MULTISURE - Development of Multi-Sequential Mitigation Strategies for Urbanised Areas Prone with risk of groundwater inundation. We thank the city of Dresden for the data supply as well as the German Ministry for Education and Research (BMBF) for the financial support (Project No. 0330755).