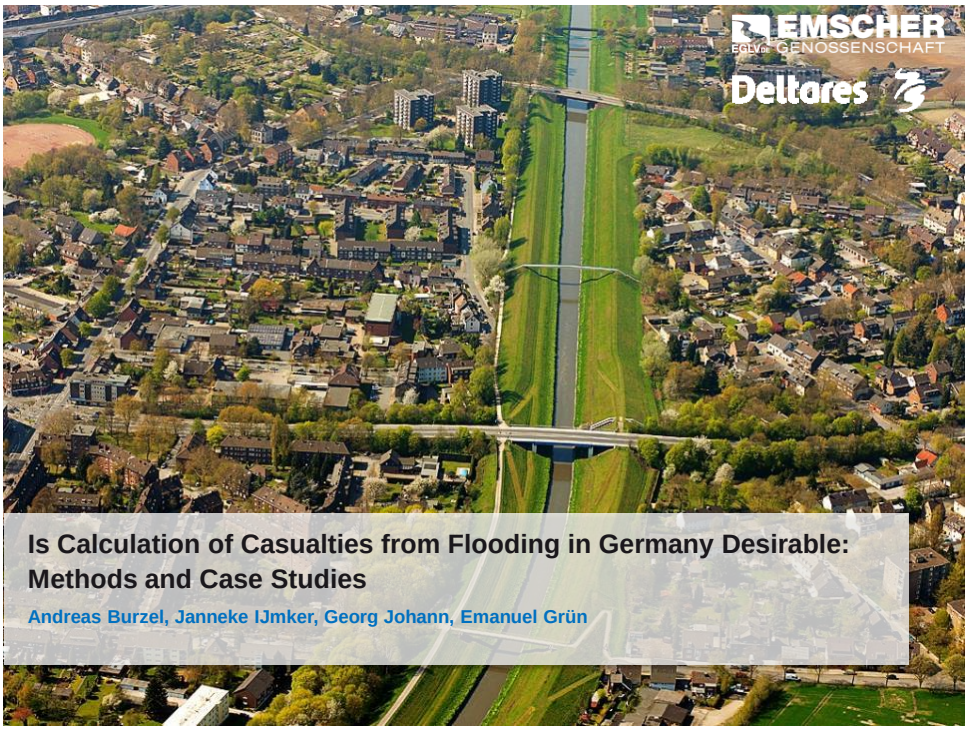
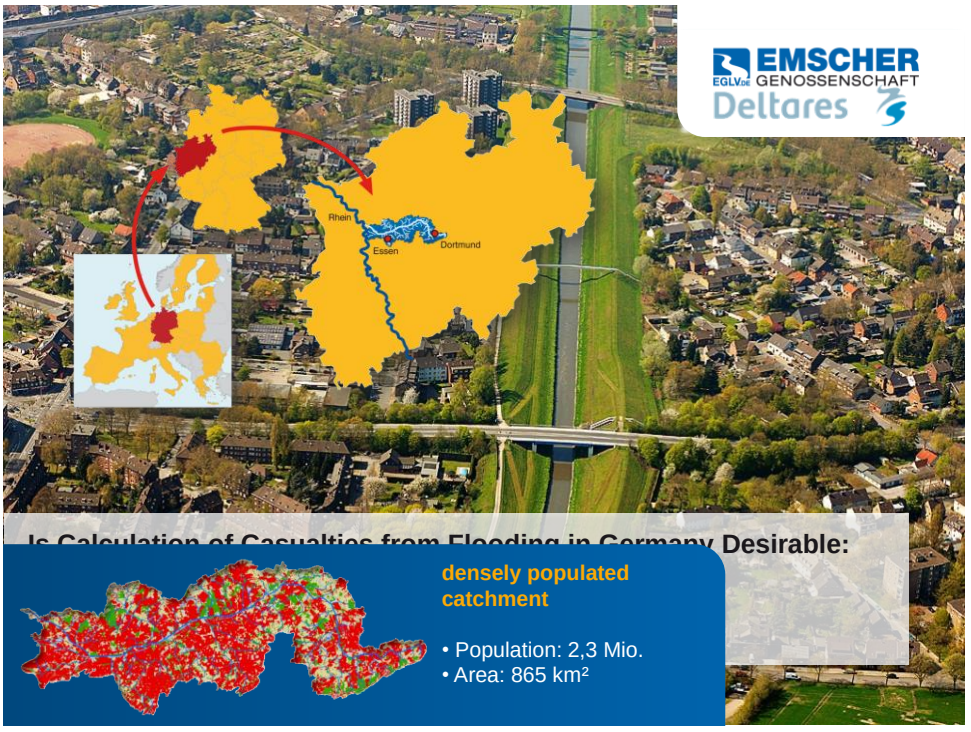


Is Calculation of Casualties from Flooding in Germany Desirable: Methods and Case Studies

Andreas Burzel, Janneke IJmker, Georg Johann, Emanuel Grün



Is Calculation of Casualties from Flooding in Germany Desirable:

densely populated catchment

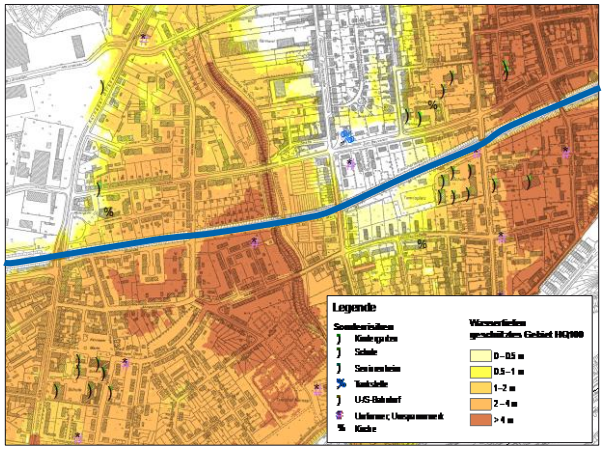
- Population: 2,3 Mio.
- Area: 865 km²

Subsidences by coal mining in the Emscher region

Schwarzbach in Gelsenkirchen-Rotthausen

Flood hazards and risks

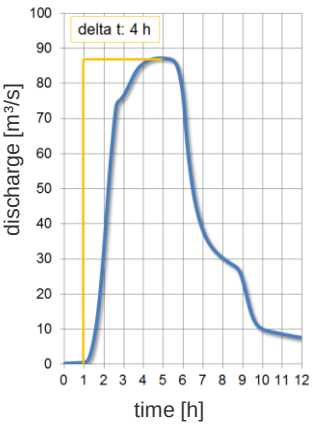
Alte Emscher in Horst HQ 100



rate of waterlevel rise

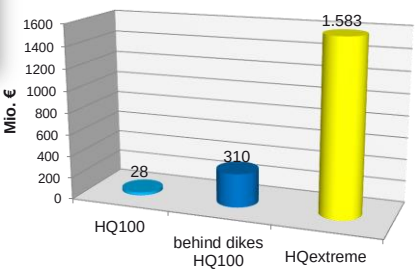
- 2,5 m/h with 5,90 m maximum water depth

Example of a flood wave HQ_{100}



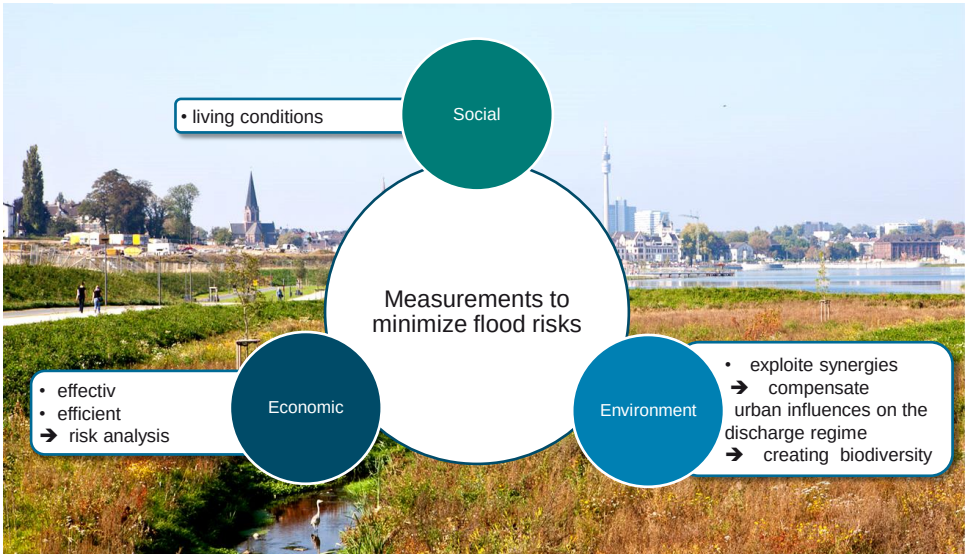
Elements of flood risk management in the Emscher region

Potential damage by flooding in the Emscher region

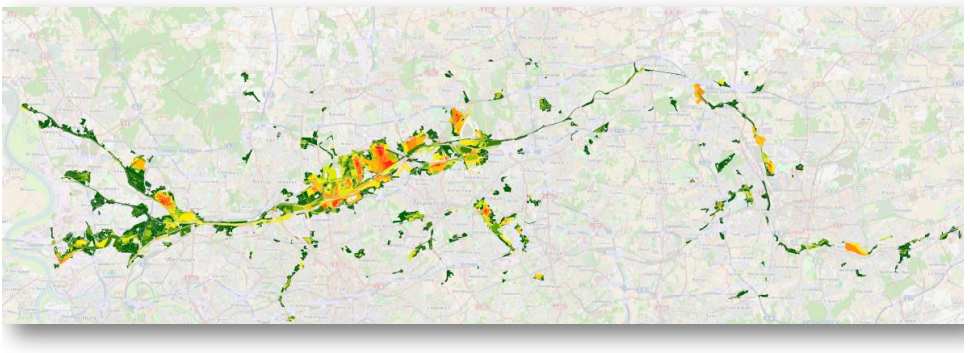


Sustainability
Our guiding principle of our flood management

Is the analysis of the potential damage enough?

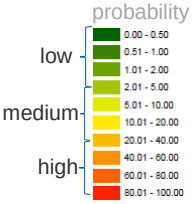


Casualties from flooding at an extreme event without flood protection

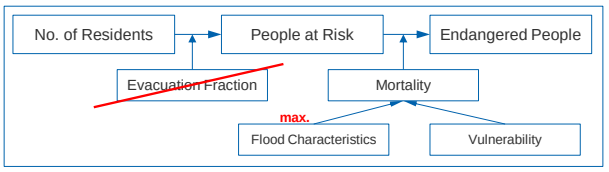


Impact on the people

probability of mortality

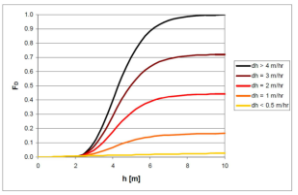


Evaluation of consequences at the Emscher
Methodology for a „worst-case“ analysis



Mortality

$$\begin{cases} F_D = \Phi_N\left(\dfrac{\ln(h) - 7.60}{2.75}\right), & \text{if} \quad h < 2.1\ \text{m} \quad \text{or} \quad dh < 0.5\ \text{m/hr} \\ F_D = \Phi_N\left(\dfrac{\ln(h) - 1.46}{0.28}\right), & \text{if} \quad h > 2.1\ \text{m} \text{ and } dh > 4.0\ \text{m/hr} \end{cases}$$



Flood Scenarios for analysis

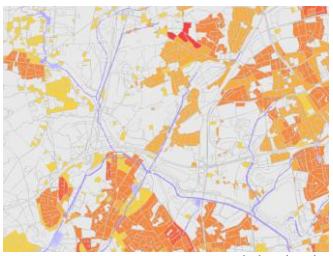
		Probabilities		
	Scenarios	P_e	$P_{f,cond}$	P_{flood}
1	Emscher_1_100_M	0,0100	0,0000	(0,0100)
2	Emscher_1_500_M	0,0100	0,2000	0,0020
3	Emscher_1_1000_L	0,0010	1,0000	0,0010

Evaluation of flood fatalities

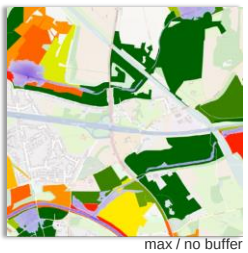
- according to Jonkman (2007) and the Dutch Standard Assessment Approach in HIS-SSM

Evaluation of consequences at the Emscher
Input data and first conceptual results

- Flood characteristics
  - water depths (events 1/100, 1/500, 1/1000)
- Landuse characteristics
  - Predominant landuse
  - No. of residents (population densitiy)



population density



max / no buffer

mean / incl. buffer

→ Qualitative assessment of social flood risks

A spatial loss-of-life model for Hamburg

Integrated Coastal Flood Risk Analysis „XtremRisK“

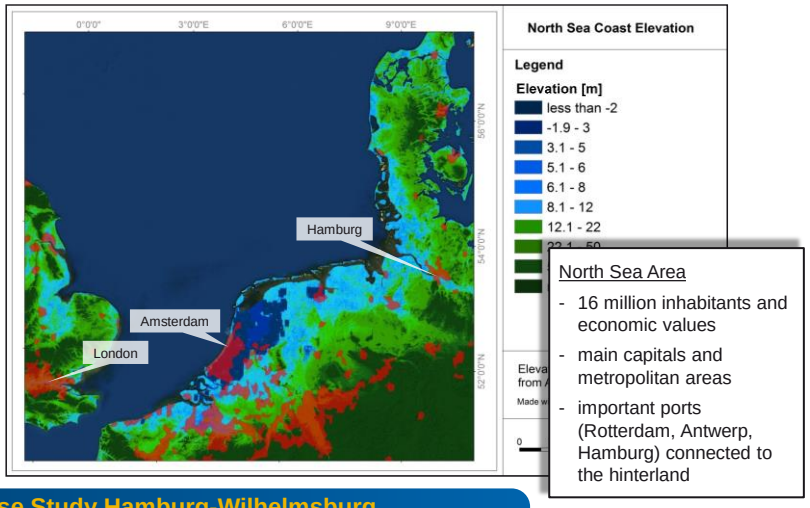


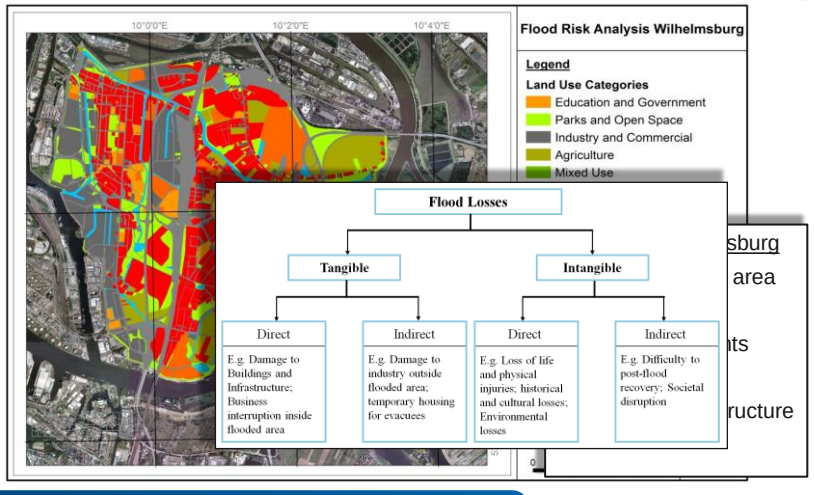
Figure: after SafeCoast (2008)

Case Study Hamburg-Wilhelmsburg

- analysis of tangible (economic) and intangible (social, cultural, enviromental) losses and risks

Study area Hamburg-Wilhelmsburg

Flood prone urban living quarter



Reference: Dassanayake et al., State-of-the-Art Report, 2010

Research question:

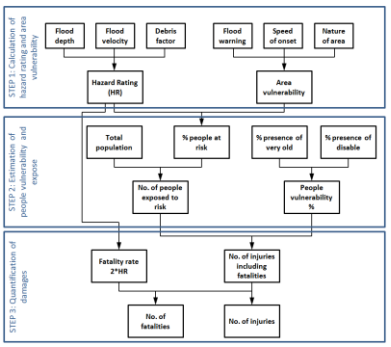
- how significant are intangible losses compared to direct and indirect tangible losses?

Implementation of the loss-of-life model
Methodology

- Modelling of intangible losses in Hamburg-Wilhelmsburg
  - Social losses, i.e. loss-of-life and physical injuries, cultural losses
  - Model for the assessment of loss-of-life and injuries (cf. Dassanayake et al., 2010)
- Input parameter for rating (selection)
  - flood depth
  - flow velocity
  - speed of onset
  - total population
  - number of storeys
  - evacuation measures

$$HR = h_w \cdot (v + 0.5) + DF$$

$$N(I) = N_Z \cdot \frac{HR \cdot AV}{100} \cdot PV \longrightarrow N = N(I) \cdot \frac{2 \cdot HR}{100}$$

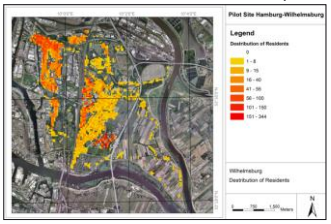


Reference: Dassanayake et al., 2010

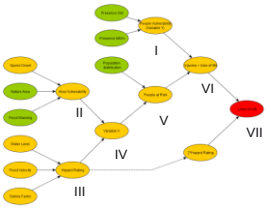
loss-of-life model implementation
- modular implementation in a GIS for the scenario-based flood risk assessment

Spatial Modelling Approach
Cellbased Risk Assessment (CRA) Concept

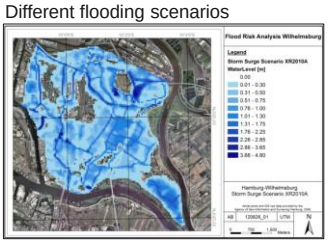
a) Generation or transformation of input data



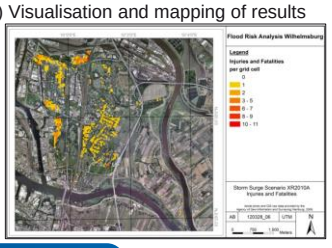
b) Development of a geoprocessing workflow



c) Different flooding scenarios

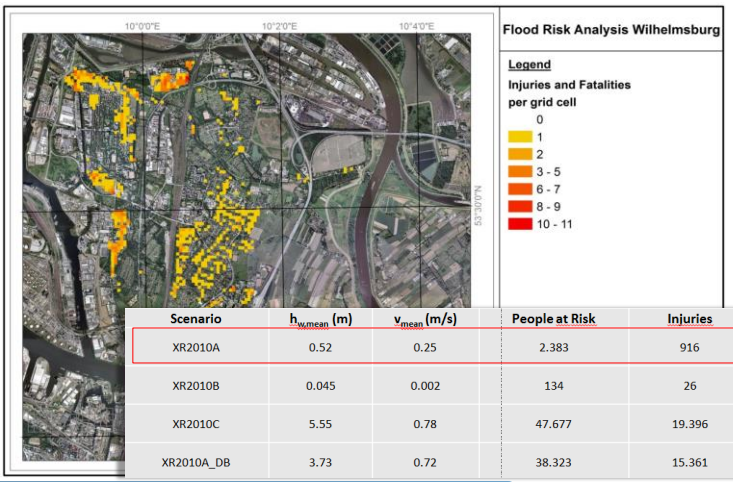


d) Visualisation and mapping of results



General spatial modelling concept
- polygon based representation of spatial data in the CRA concept

Results of the Integrated Risk Analysis
Injuries and Fatalities

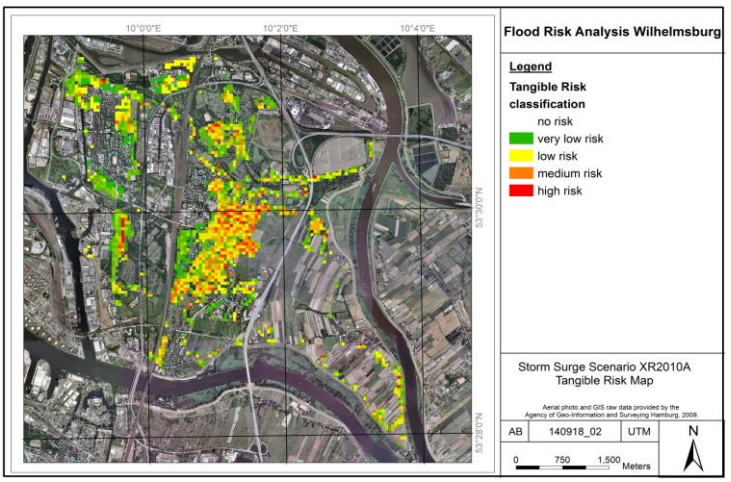


Scenario	$h_{w,mean}$ (m)	v_{mean} (m/s)	People at Risk	Injuries	Fatalities
XR2010A	0.52	0.25	2.383	916	2
XR2010B	0.045	0.002	134	26	0
XR2010C	5.55	0.78	47.677	19.396	5.826
XR2010A_DB	3.73	0.72	38.323	15.361	3.750

Social flood risk is very significant

- storm surge scenarios can lead to severe social consequences in the study areas

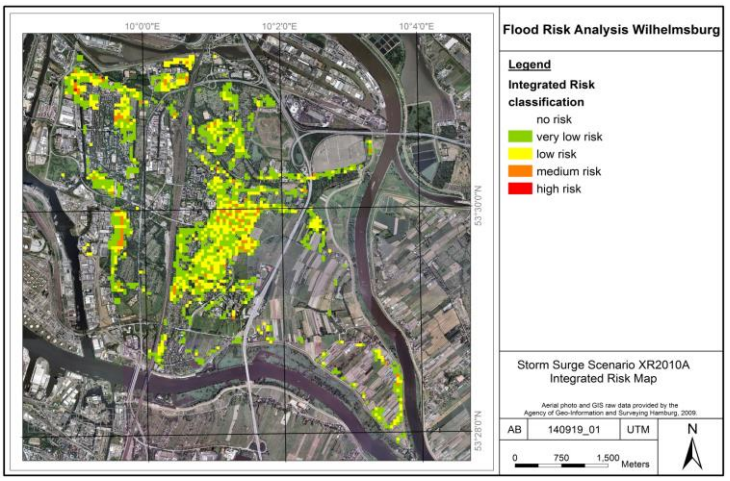
Results of the Integrated Risk Analysis
Tangible Risk Mapping



Tangible risks meaningful enough?

- Economic risks give an incomplete picture of the overall flood risk in urban areas

Results of the Integrated Risk Analysis
Integrated Risk Mapping



Integrated Risk for Hamburg-Wilhelmsburg

- all losses are consistently aggregated into the integrated risk (cf. Dassanayake et al. 2012)

Implications from the Case Studies
Social risk as an elementary part of flood risk

- Is the calculation of casualties from flooding desirable?
  - social flood risk is an essential part of the overall flood risk
  - assessment of potential casualties gives another *perspective* on flood risk
- Different models might give different results
  - dealing with major uncertainties in flood fatality models
  - results should rather been seen as a relative evaluation than absolute numbers
    - areas with higher risk versus areas with lower risk
- How to use these results in the most beneficial way?
  - Risk communication: raising awareness rather than raising concerns
  - Risk measures: Consideration the value of statistical life in cost-benefit analysis?