http://hsbs-play.ning.com

Risk

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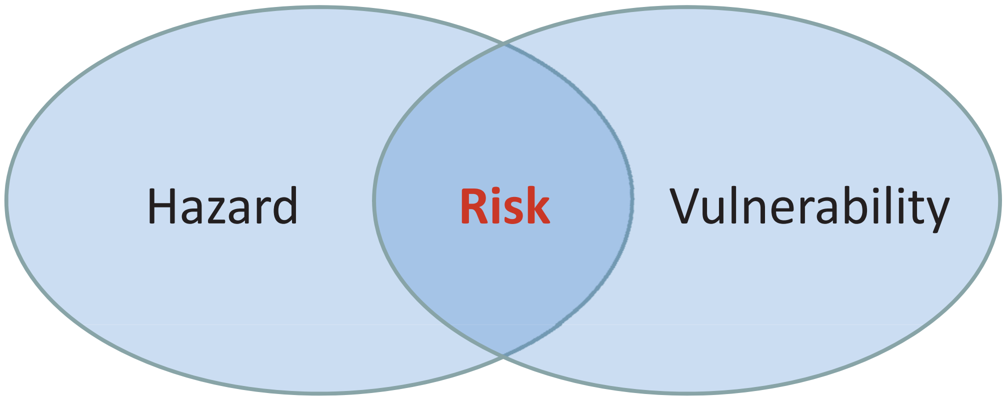
Course: Integrated Water Resources Management
Module: Ecology & Water Resources

WATENV International Master Programme

Lecture:

1 Introduction
2 Hazard Probability
3 Vulnerability
4 Integrated Risk Management

1 Introduction



Definition

ISO31000:2009 Risk Management Standard

- The ISO 31000 (2009) /ISO Guide 73:2002 definition of risk is the 'effect of uncertainty on objectives'. In this definition, uncertainties include events (which may or not happen) and uncertainties caused by ambiguity or a lack of information. It also includes both negative and positive impacts on objectives. Many definitions of risk exist in common usage, however this definition was developed by an international committee representing over 30 countries and is based on the input of several thousand subject matter experts.

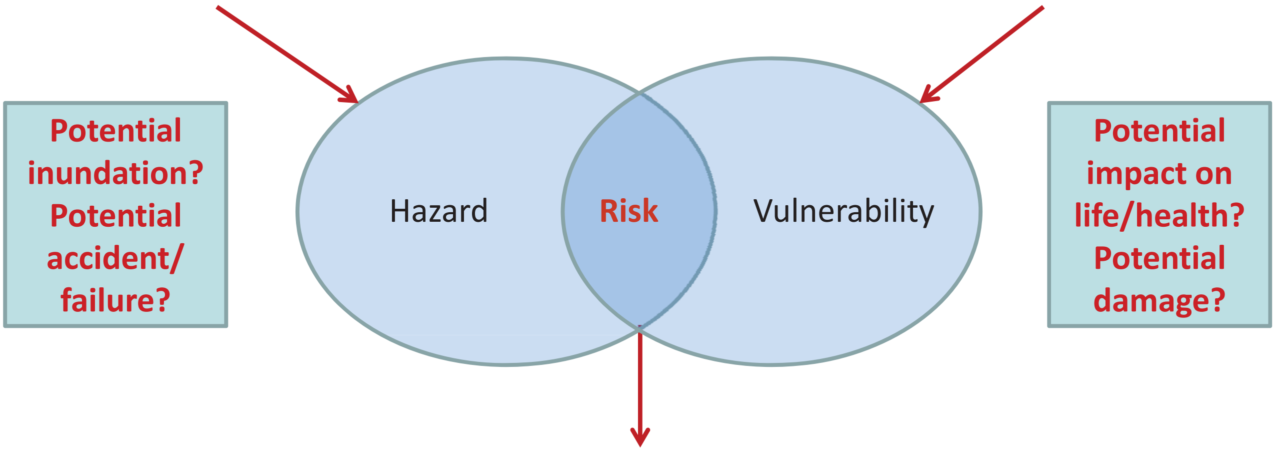
Definitions

Source, driver: danger from environmental events and from human activities

- intensity
- probability

Receptor, impact: loss of life/things

- exposition
- susceptibility
- capacity



Resilience (elasticity):

ability of a system to reach prior state or at least equilibrium after a breakdown

Definitions

- Risk *RI* (continuous)

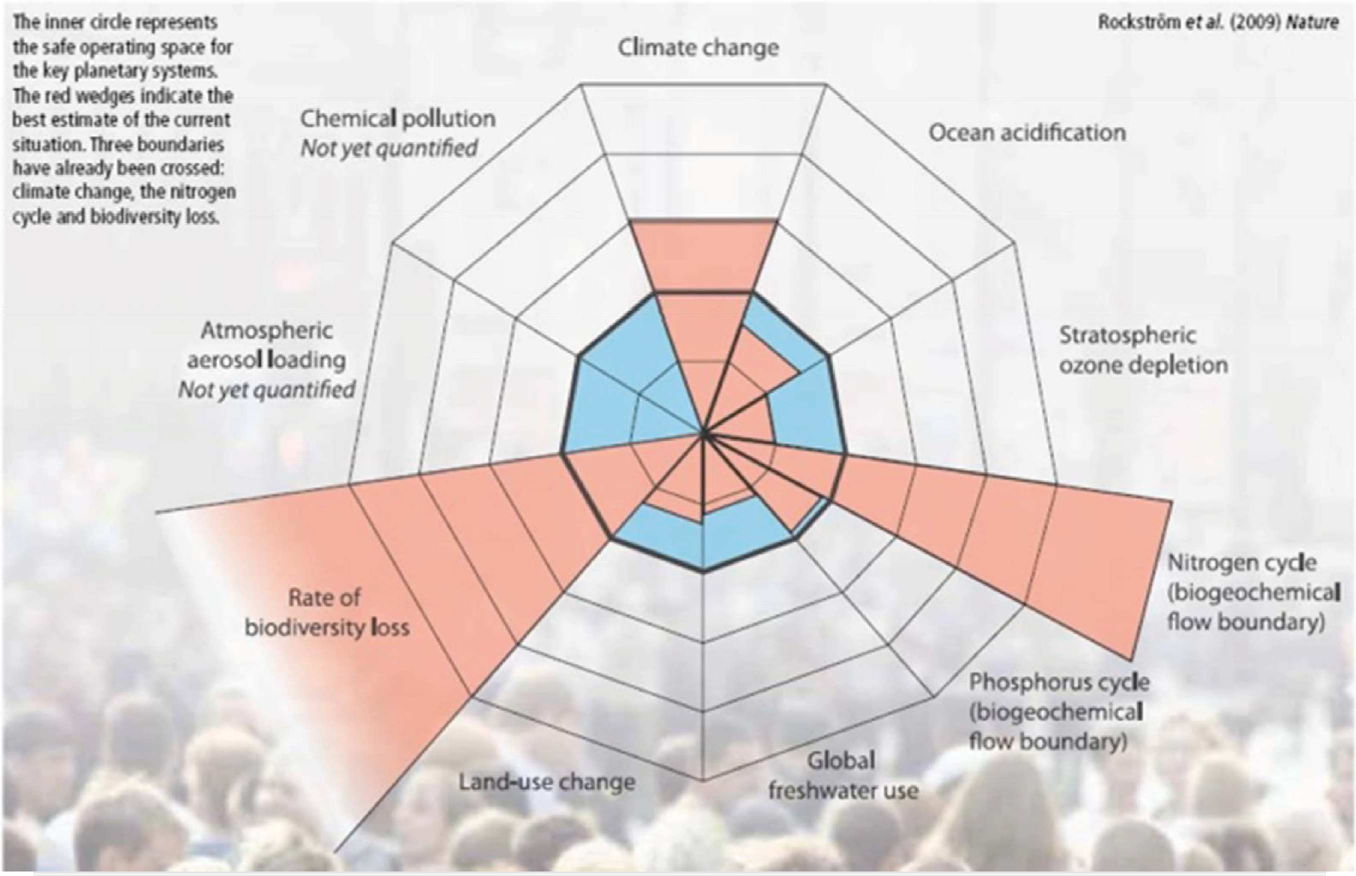
$$RI = \frac{E\{D\}}{\Delta t} = \frac{1}{\Delta t}\int D\, f_D(D)\, dD \quad \left[\frac{\text{damage}}{\text{time}}\right]$$

- Risk *RI* (discrete)

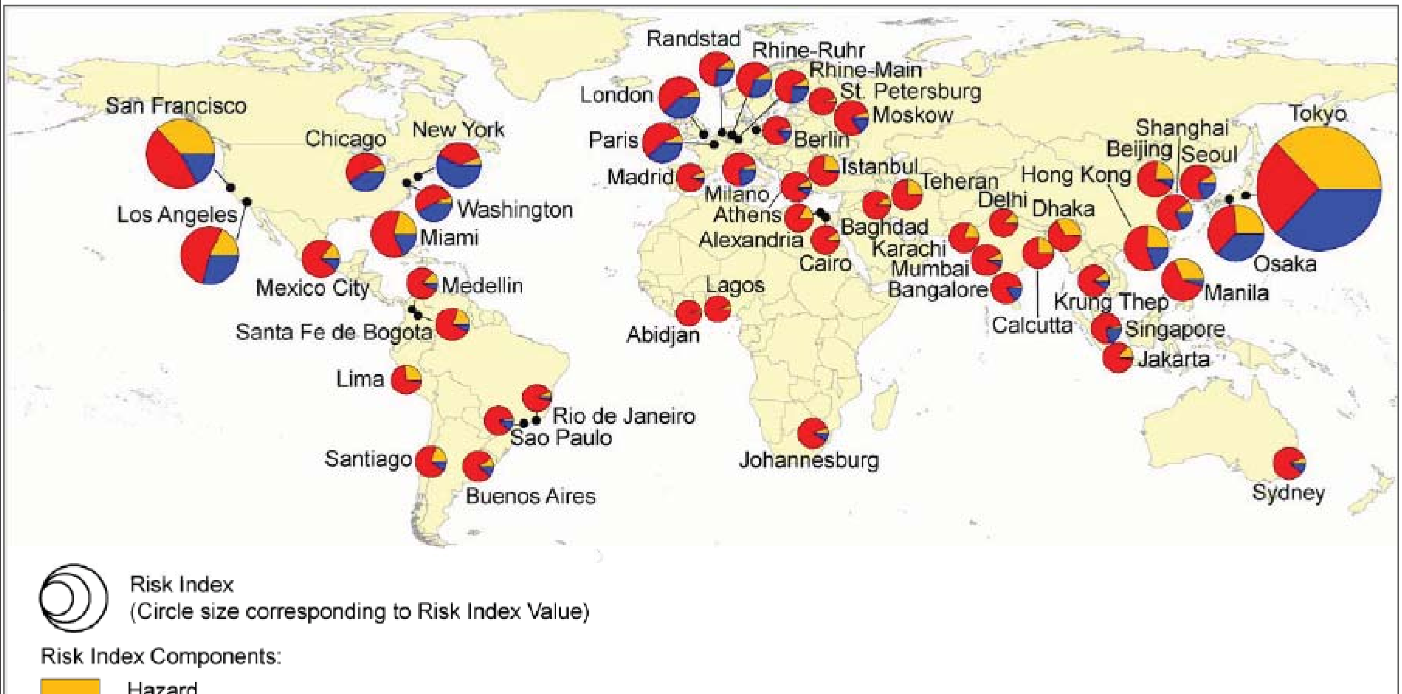
$$RI = \sum_{i=1}^{k} P_i D_i \quad \left[\frac{\text{damage}}{\text{time}}\right]$$

$E\{D\}$	expected damage
t	time
D	damage
$f_D(D)$	probability density function of damage D
D_i	damage of single event i ($1 \ldots k$)
P_i	probability of D_i

Nine indicators of stability of the earth system



Megacities Risk Index of Munich RE



Source: Voss S (2006) A risk index for megacities. Münchener Rück, Munich RE Group

Large hydro-met-climatic catastrophes worldwide

Between 1950 and 2008:

- 71 hydrological events (including floods)
- 116 meteorological events (storms etc.)
- 16 climatic events (droughts, fire etc.)

Number of events (Number of hydrologic events):

- 1950-59: 13 (6) relatively stable
- 1960-69: 16 (6) relatively stable
- 1970-79: 29 (8) strong increase
- 1980-89: 44 (18) strong increase
- 1990-99: 74 (26) strong increase
- 2000-09: 30 (8) what happened?

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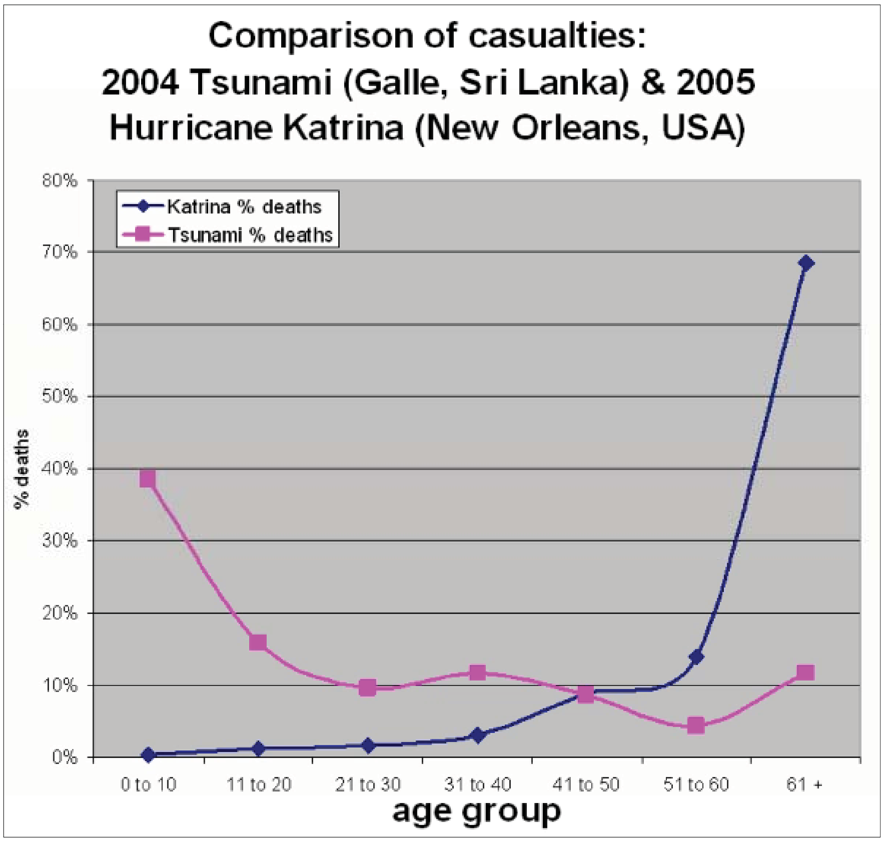
Vulnerability defines the losses



- Are our societies able to adapt to face unfamiliar environmental conditions?
- Do we account for the role of social networks when considering the impacts of disasters – e.g. differences in mortality distribution among age and ethnic groups, gender and class?

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Need for a paradigm shift?

Old Paradigm

Focus on natural hazards and their quantification

From the „security society“

→

New Paradigm

Add the assessment and ranking of vulnerability

To the „risk society“

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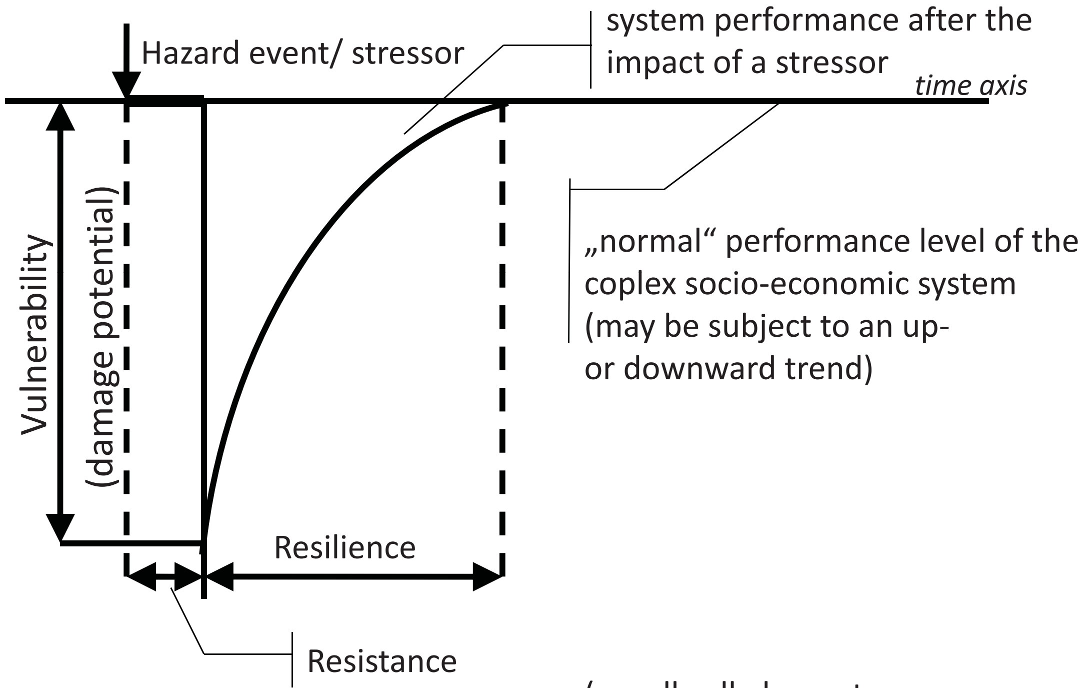
Visualization of the Concept of Vulnerability



(usually all elements are multidimensional)

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2 Hazard Probabilities

This is topic of many lectures in hydrology (floods, droughts) and sanitary engineering (water quality)!

Time series analysis (statistics)

probability/recurrence period – design values

Modelling (processes)

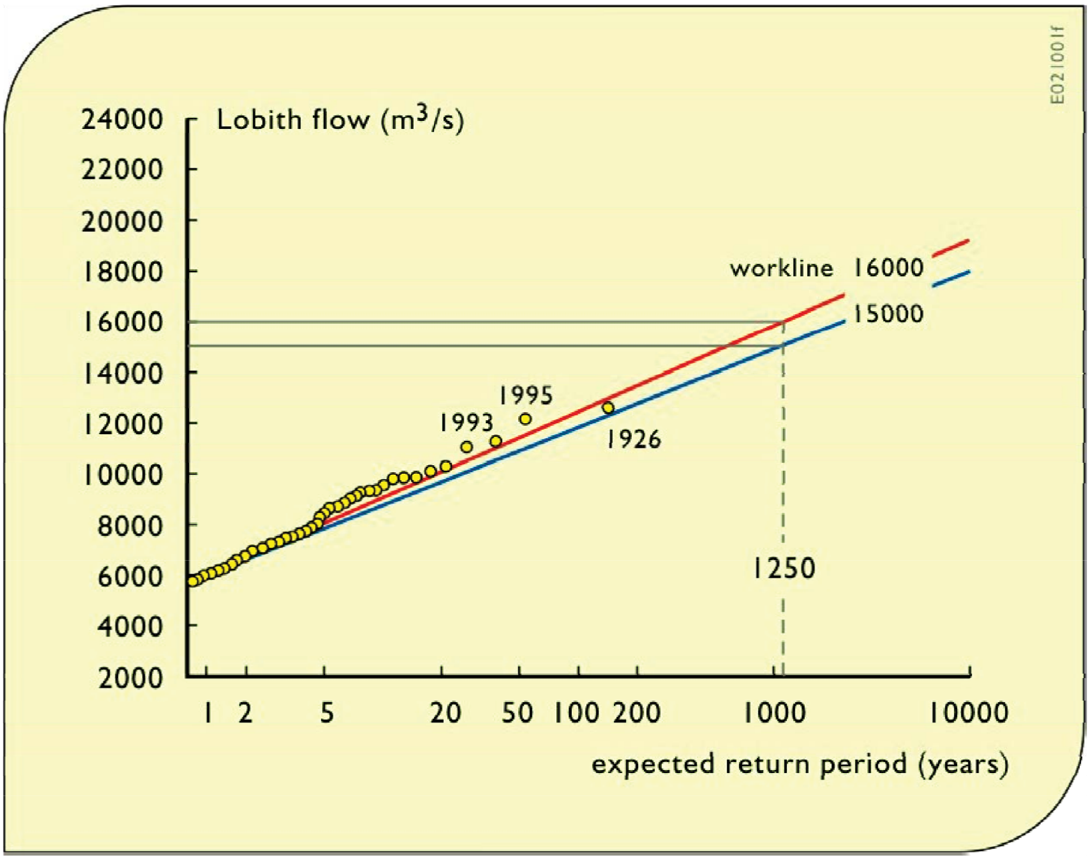
precipitation – runoff – inundation

http://www.pensionriskmatters.com

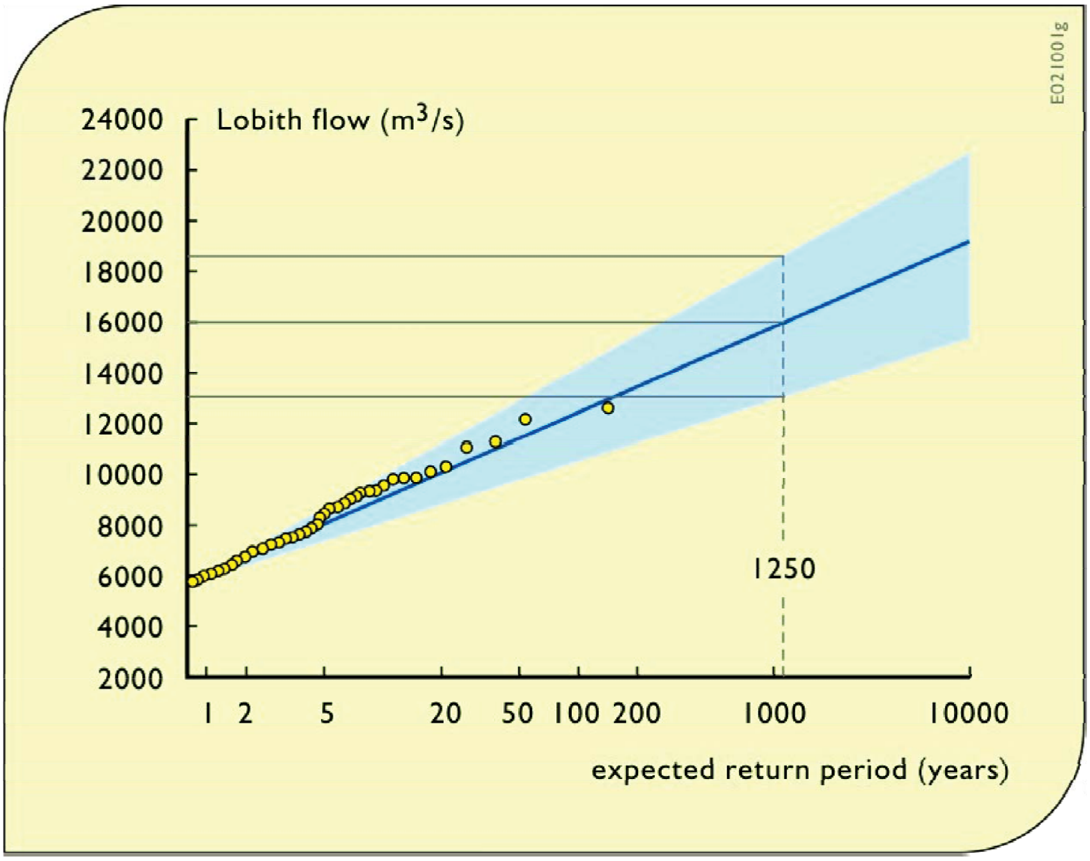
Planning and Operational Dimension of the Hazard

- Long term
  - Long time series of the hazards available
  - Averaging of the history
  - Long-term change prediction (climate change)
  - Planning/strategic decision making
- Short term
  - Forecast of the actual hazard available (e.g. weather forecast), comparison with past possible (classification of the event)
  - Real time situation
  - Operating/operational decision making

Design Flood Uncertainty: Rhine at D/NL Border (Lobith)

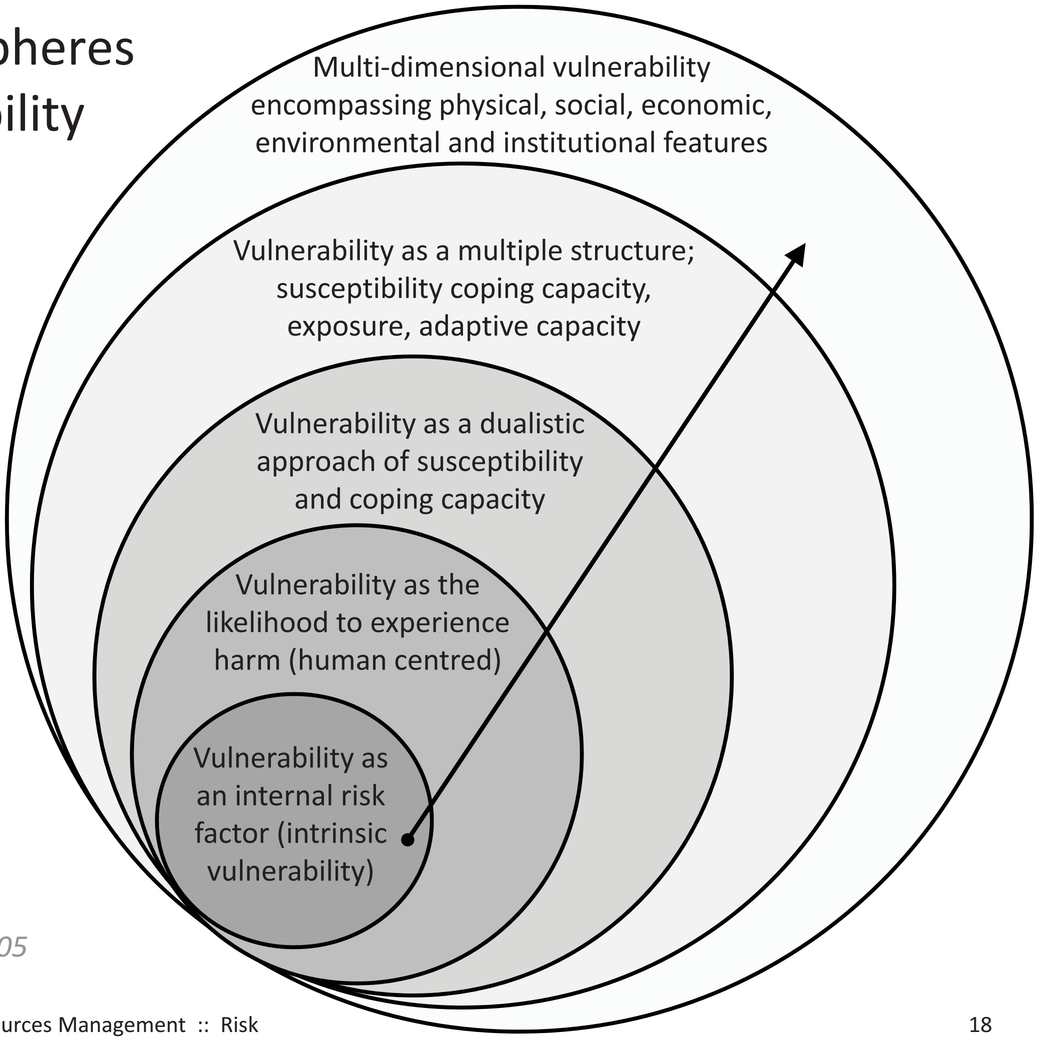


Design Flood Uncertainty II: Uncertainty Band



3 Vulnerability

Potential Spheres of Vulnerability



Source: Birkmann, 2005

Dimensions of Vulnerability

- Social Dimension
  Vulnerability of different social groups
  Role of social networks (coping)
- Economic Dimension
  Vulnerability of different economic sectors and critical infrastructure
- Environmental Dimension
  Environmental fragility (groundwater, land)
  Dependency on environmental services
- Institutional Dimension
  Effectiveness and failure of structures and institutions

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Ignorance as Source of Vulnerability

- We are not prepared because we do not want to remember
- Time factor
- Headline factor (media)
- Unwarranted optimism
- Political shortsightedness
- …

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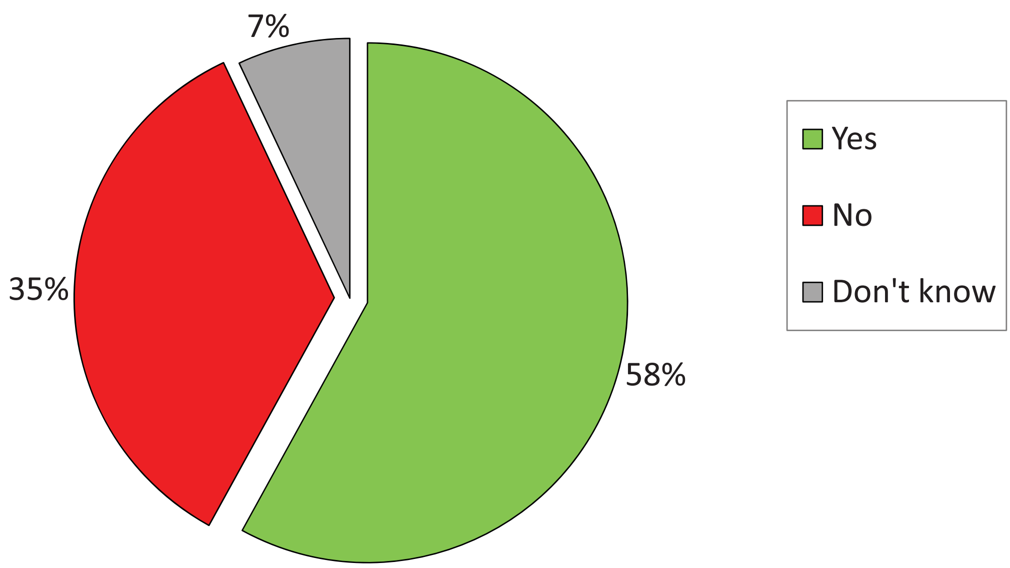
Subjective Versus Actual Exposure

Is your house located in a a flood-prone area in Cologne?

(All households of this group are located in flood-prone area (HQ 100))



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Conceptual Framework for Vulnerability and Risk

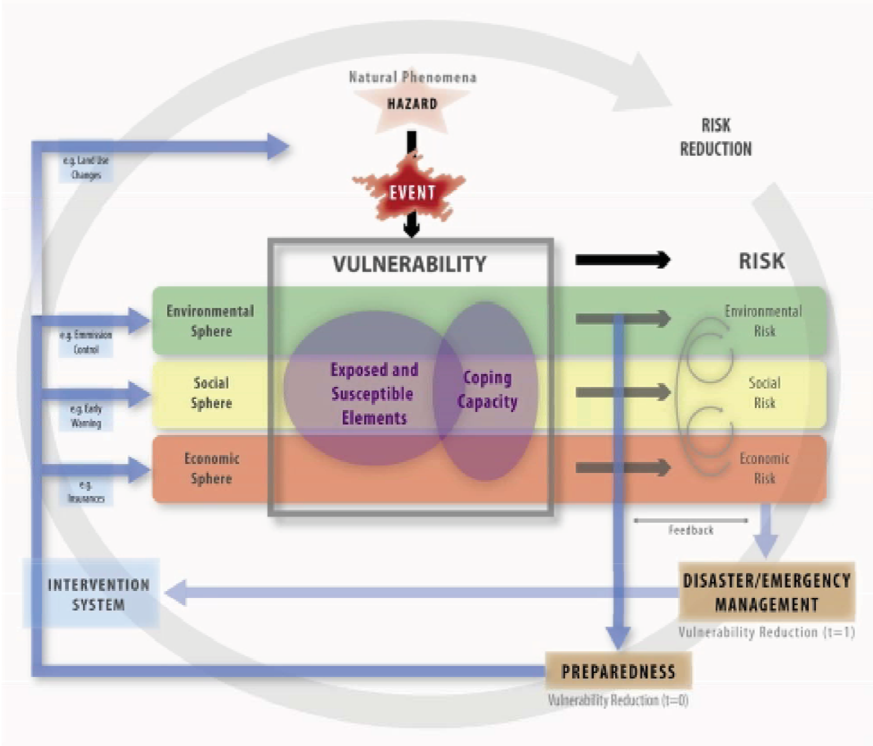
Disaster Risk =
f (Hazard, Vulnerability)

- **Flood duration**
- **Inundation height**
- **Stream velocity**

- **Internal stressors**
- **Adaptation measures**
- **Ecosystems characteristics**

Definition of Vulnerability:
„Vulnerability is an inherent property of each social ecological system and determines the degree to which a system or subsystem is likely to experience harm“ (Turner et al. 2003).

„BBC“ Framework (Bogardi/Birkmann/Cardona)



„BBC“-Framework (UNU-EHS) Bogardi/Birkmann (2004) and Cardona (1999/2001), as cited in Birkmann 2006, layout modified by Kienberger 2009

Strengths

Vulnerability dimensions

Integrative view

Temporal phases

Limitations

Exposure delineation

Susceptibility – capacities separation

Infrastructure and institutional vulnerability

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Vulnerability Assessment: A Challenge with 3 Problems

Vulnerability Assessment should be the basis to justify investments in disaster preparedness and risk reduction.

- The dimension problem
  - social, economic, environmental, institutional, physical and critical infrastructure
- The scale problem
  - household, social group, community, region, nation, global
- Data non-homogeneity problem
  - Climate change, land use change, change in exposure (dynamic behaviour), observation accuracy, method

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Methods of Vulnerability Assessment

- There are no unique prescribed tools yet
- What we currently use:
  - Sustainable livelihood approach (Social, Natural, Human, Physical, Financial, Capitals)
  - Questionnaires
  - Remote Sensing
  - Survey of critical infrastructures
  - Census data
  - Specific, in-depth surveys
  - Proxies (indicators, indices)/ deductive and inductive approaches

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Indicator Set - Agriculture

Agricultural Sector

Component	Sub-component	Indicator
Exposure	Ecological system	% of farmland
	Social system	% of people employed in agricultural sector
Susceptibility	Human condition	Unemployment rate district
	Ecological condition	Soil erosion potential
		Water quality index
		Potential contaminating sites
Capacities	Ecosystem robustness	Water retaining capacity
		Filter and buffer capacity
		Dominating land use
	Coping capacities	GDP per capita of Federal State
		GDP per capita of district
		% of farmers with side income
	Adaptive capacities	% of organic farming
		% of protected areas

- 14 indicators selected
- Susceptibility is influenced by internal socio-economic and environmental stresses
- trend indicators included /cross-scale influences
- not all categories could be covered

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Composite Indicator Developement

1. Data Collection: various data sources Statistic Regional, CORINE 2000; ESDB, ATKIS, LAWA
2. Descriptive and explorative analysis
3. Normalization of variables
4. Weighing of indicators
5. Aggregation: weighted sums technique

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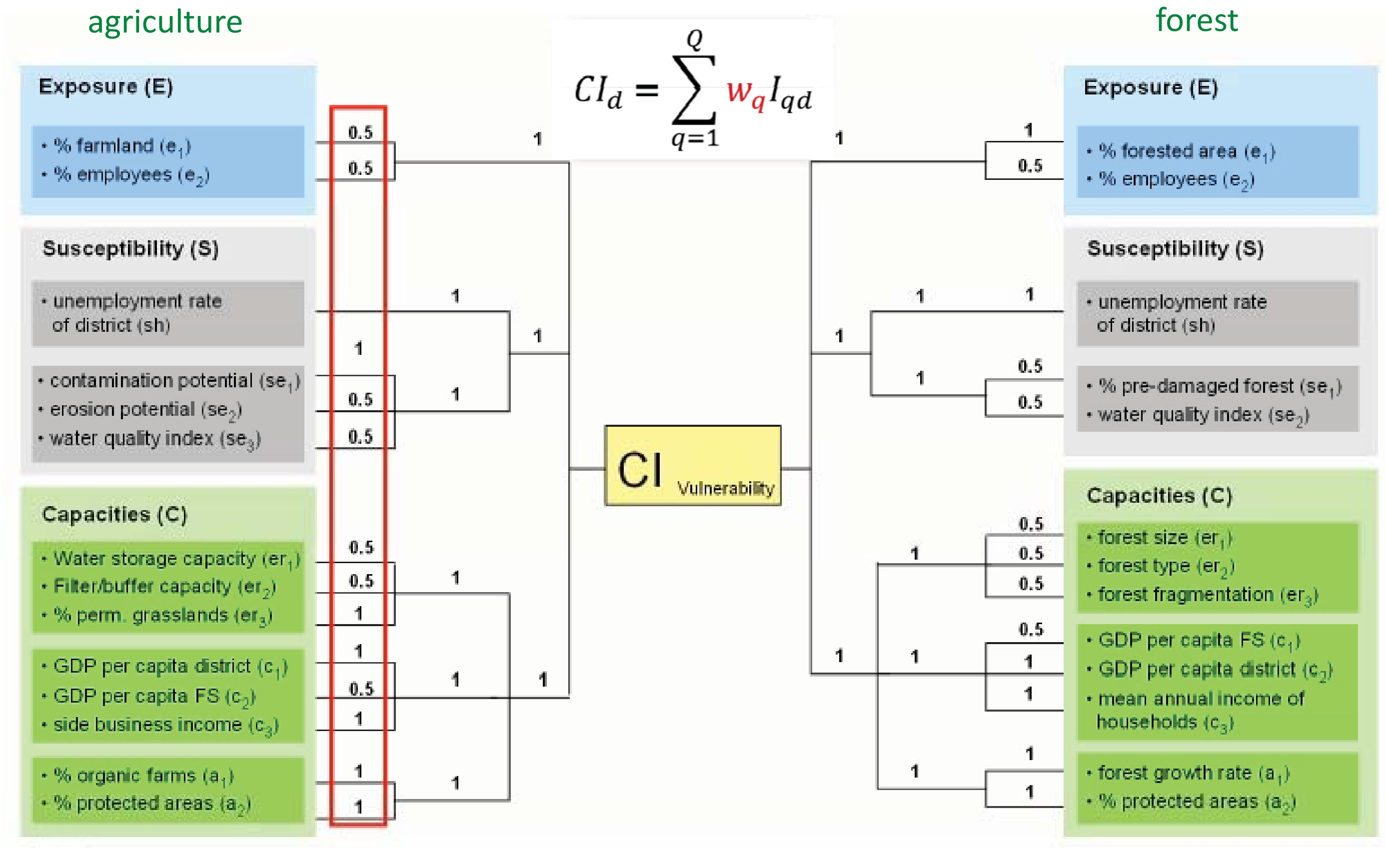
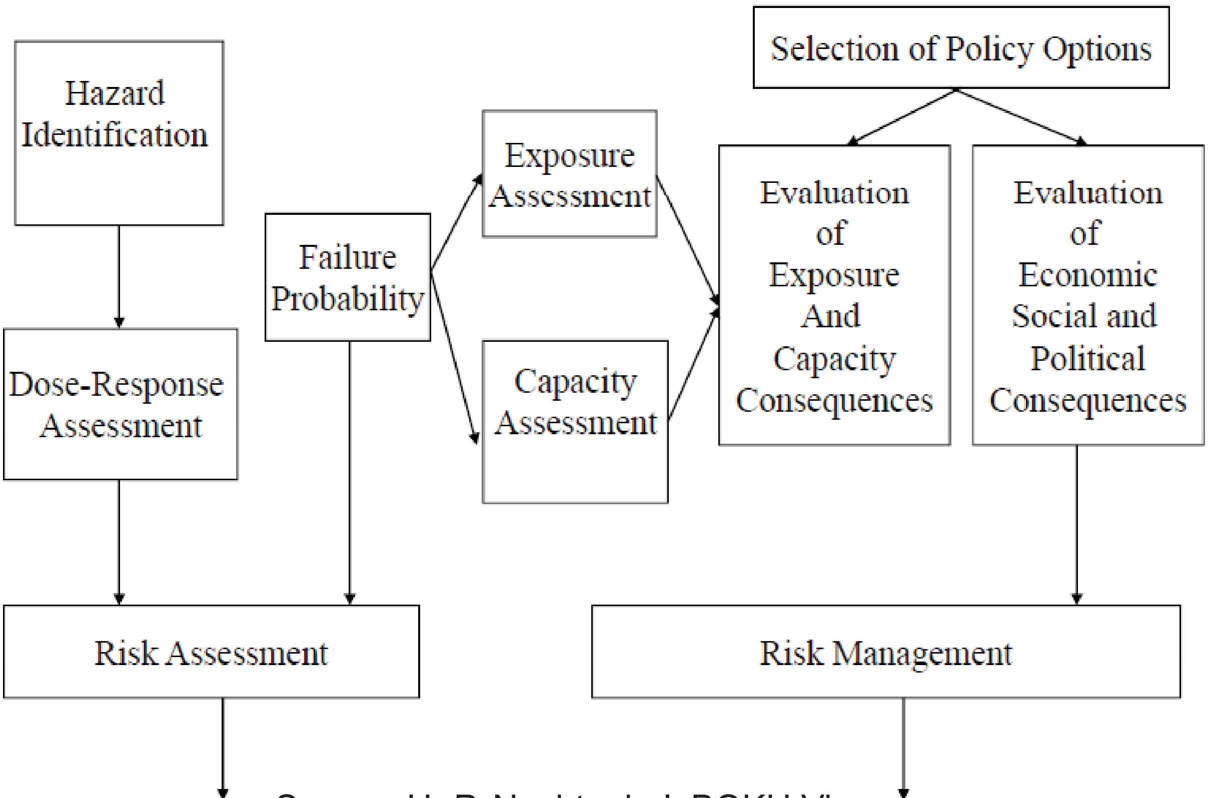
Weighting and Aggregation of the Composite Indicator



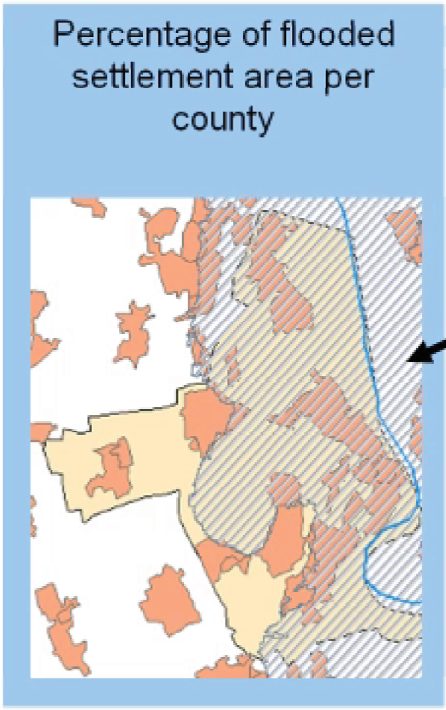
3 Integrated Risk Management

Definitions



Source: H.-P. Nachtnebel, BOKU Vienna

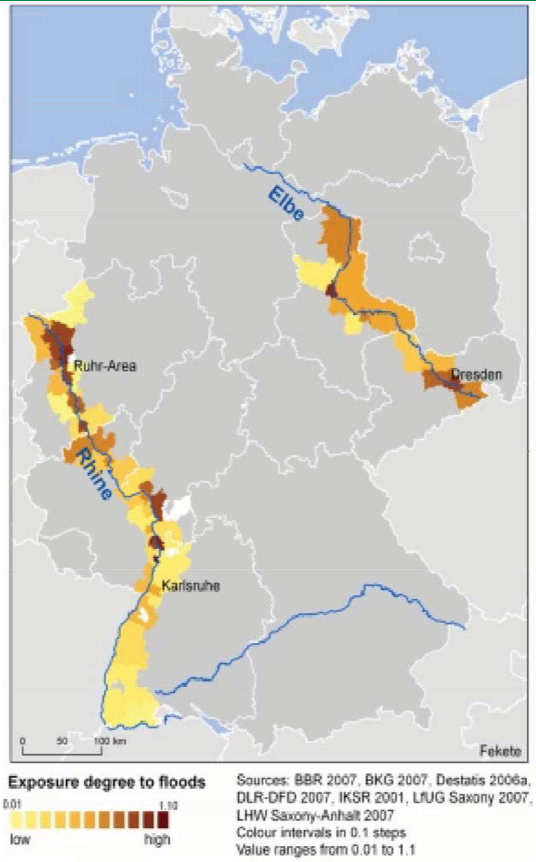
Elbe/Rhein Case Study: Exposure to Flood Hazard



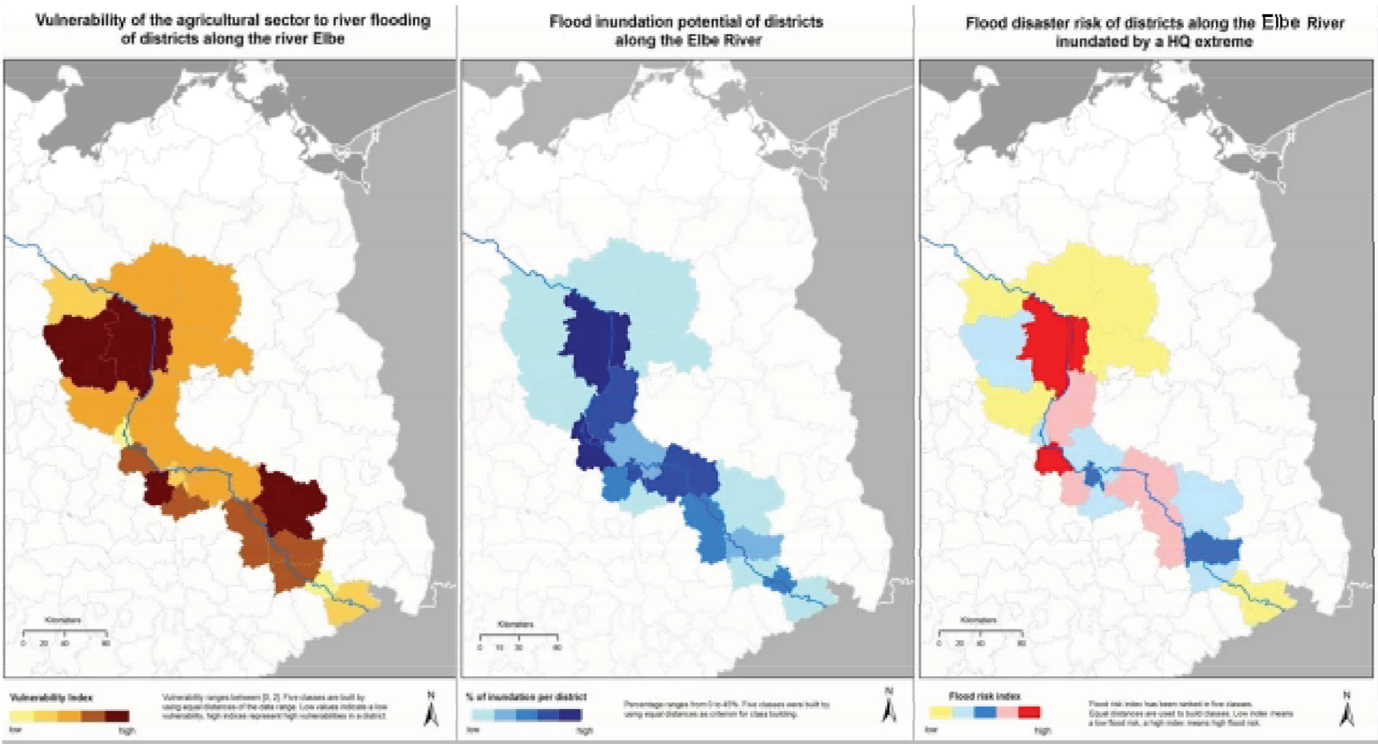
Data: CORINE 2000, HQ extreme
IKSR 2001

Extreme flood scenario maps

Legend
Flood map
Settle-ment area
County

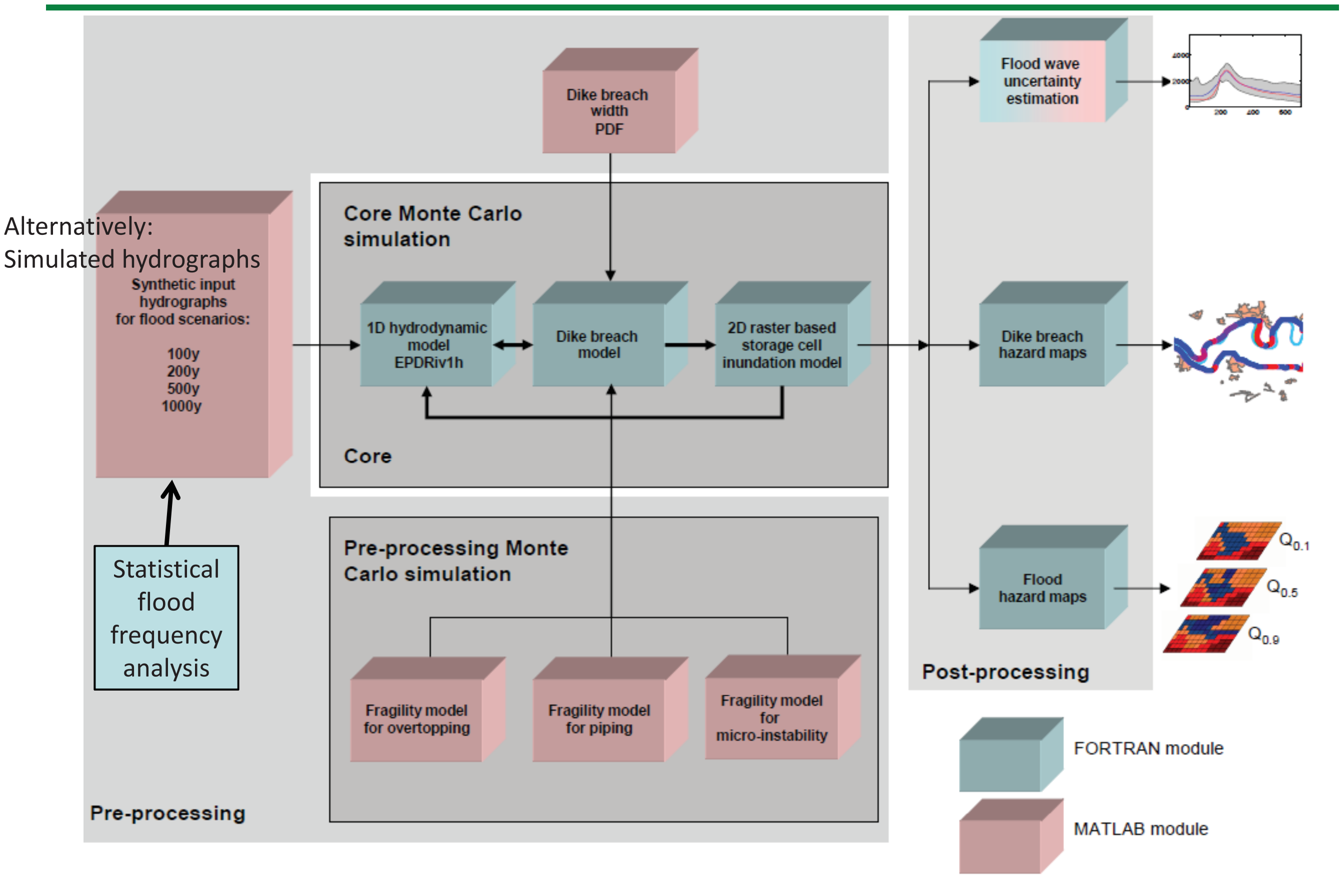


Elbe/Rhein Case Study



vulnerability hazard risk

Inundation Hazard Assessment Model



Vorogushyn 2008

Risk Calculation: Estimation of flood damage

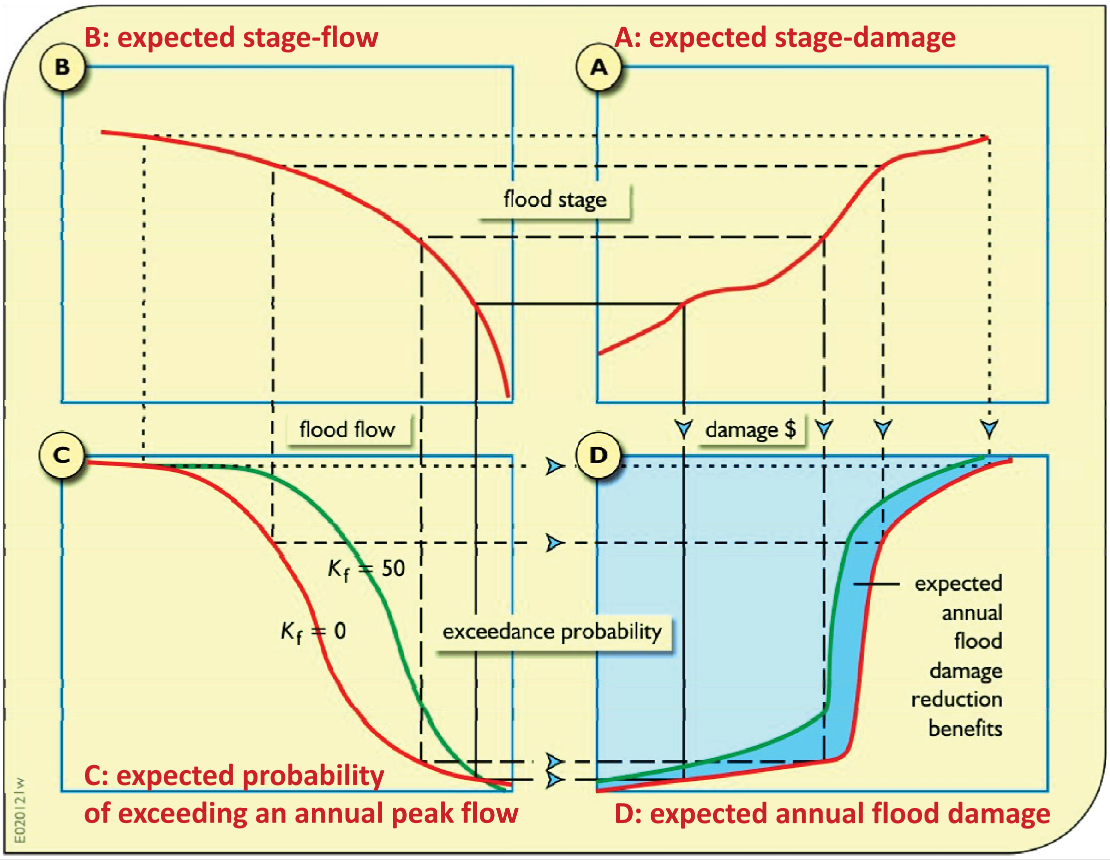
- Procedure:
  1. Hydrological flood frequency analysis -> exceedance probability for design flood
  2. Hydraulic calculation of associated flood stages HW (water depth) and inundation areas A
  3. Assessment of the damage potential and setting up a damage function depending on flood stage HW, inundation area A, etc.
  4. Calculation of the expected damage S based on the frequency of floods above the design flood and on the damage function

HQ → **HW, A** → **S=f(HW,A)** → **E[S]**

$$E[S] = \int_{Q_A}^{Q_{max}} S(Q_S)\cdot f(Q_S)\, dQ_S \qquad (3.2)$$

E[S]	Expected flood damage
$S(Q_S)$	Damage for $Q_S>Q_A$
$f(Q_S)$	Damage frequency
Q_A	Design flood
Q_{max}	Maximum observed flow

Expected Annual Flood Damage and Benefit of Actions



References

- Bogardi, J. (2012): Vulnerability. http://www.iwrm-education.org. *Acknowledgements: The lecture is based to a large extent on research which has been carried out in the United Nations University Institute for Environment and Human Security (UNU-EHS). Many PowerPoints are based on the dissertations of Dr. M. Damm and Dr. A. Fekete respectively. Contributions of Dr. J. Birkmann and Dr. F. Renaud are acknowleged with thanks. Research results presented in this lecture have been obtained in the DISFLOOD project supported by the Helmholtz Society.*
- Merz, B. (2006): Hochwasserrisiken. Schweizerbart, 324 pp.

Thank you for your attention!

Risk

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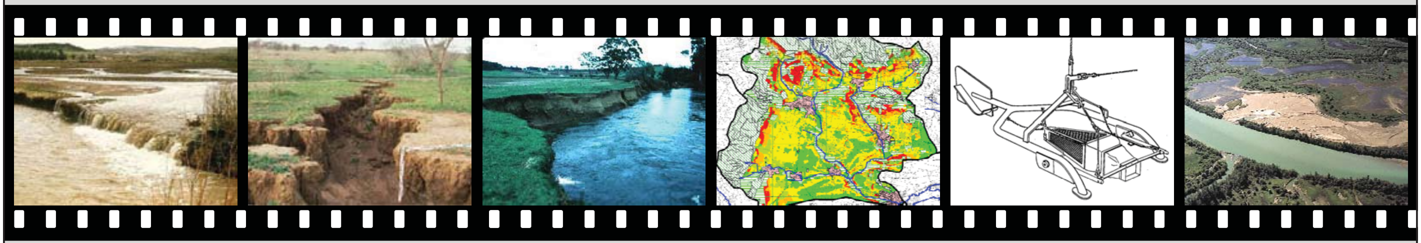

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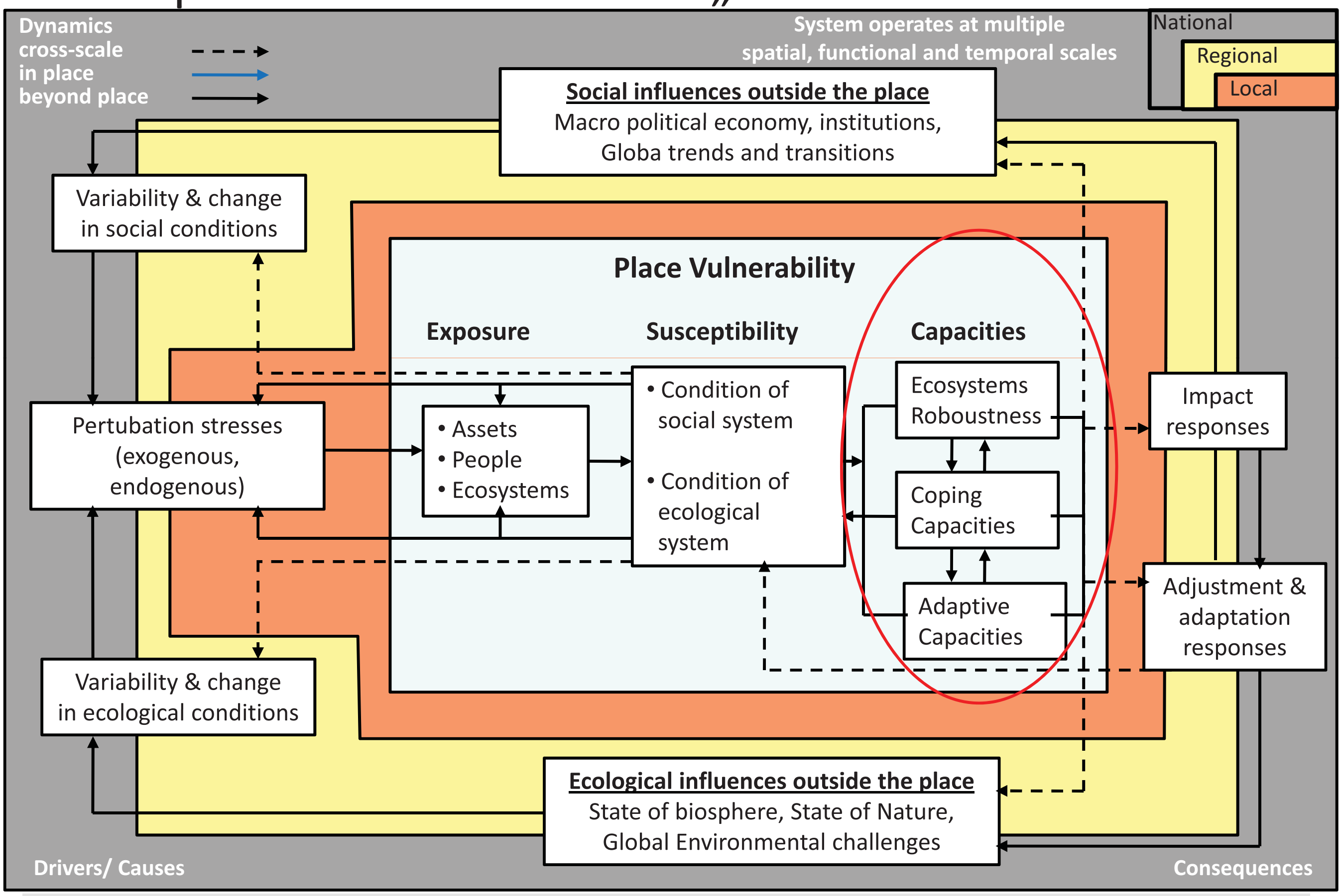
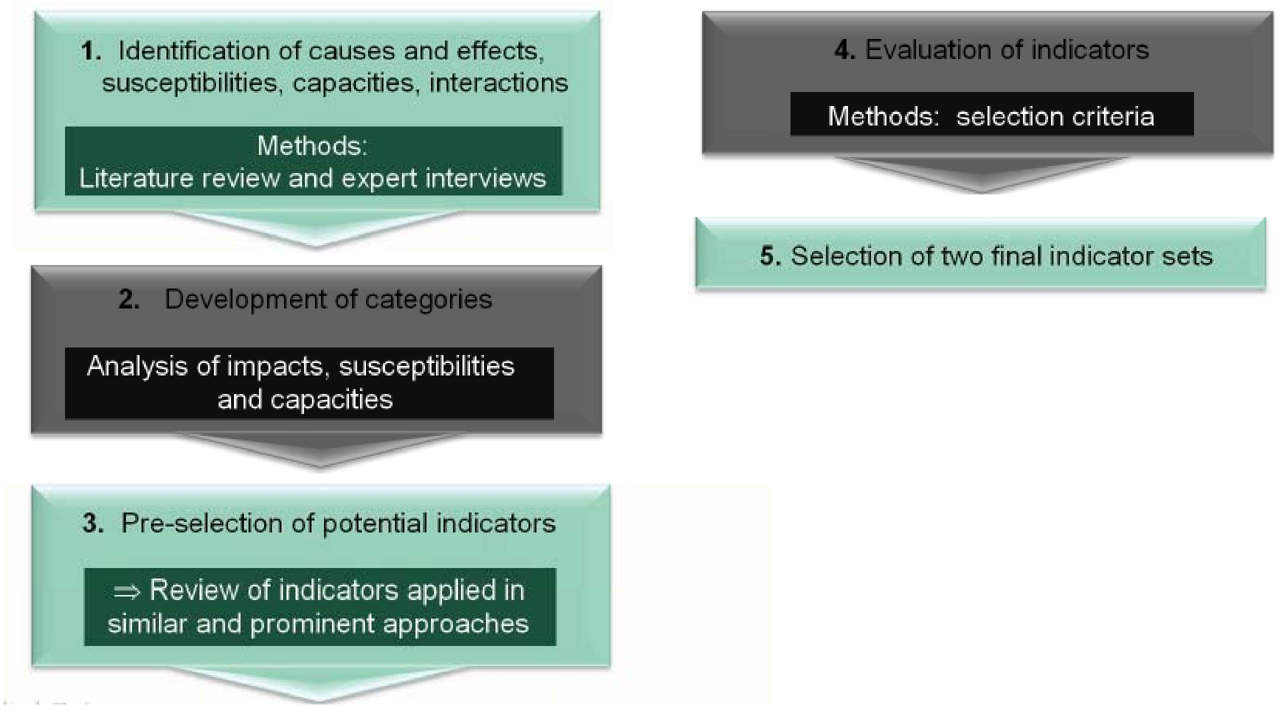
Conceptual Framework of the „Turner Model“



modified from Turner et al., 2003

Indicator Development for the „Turner Model“



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Safety or Risk?