



## Decision making subject to aversion of low frequency high consequences events

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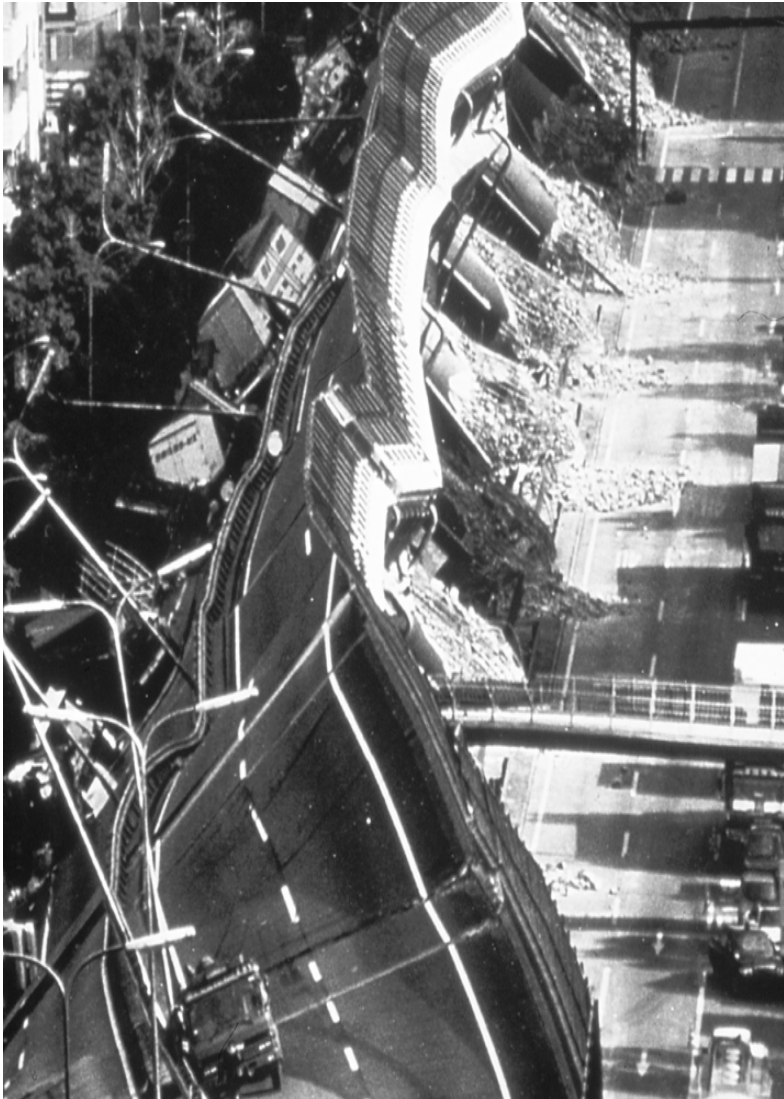
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## Overview

- *Introduction*
- *Definition of the system*
- *Risk perception and aversion*
- *Aversion factors*
- *Consequence model*
- *Conclusion*

## What is the difference between decisions in regard to **high frequency and low consequences** and **low frequency and high consequences** events?

- Experience
- Knowledge

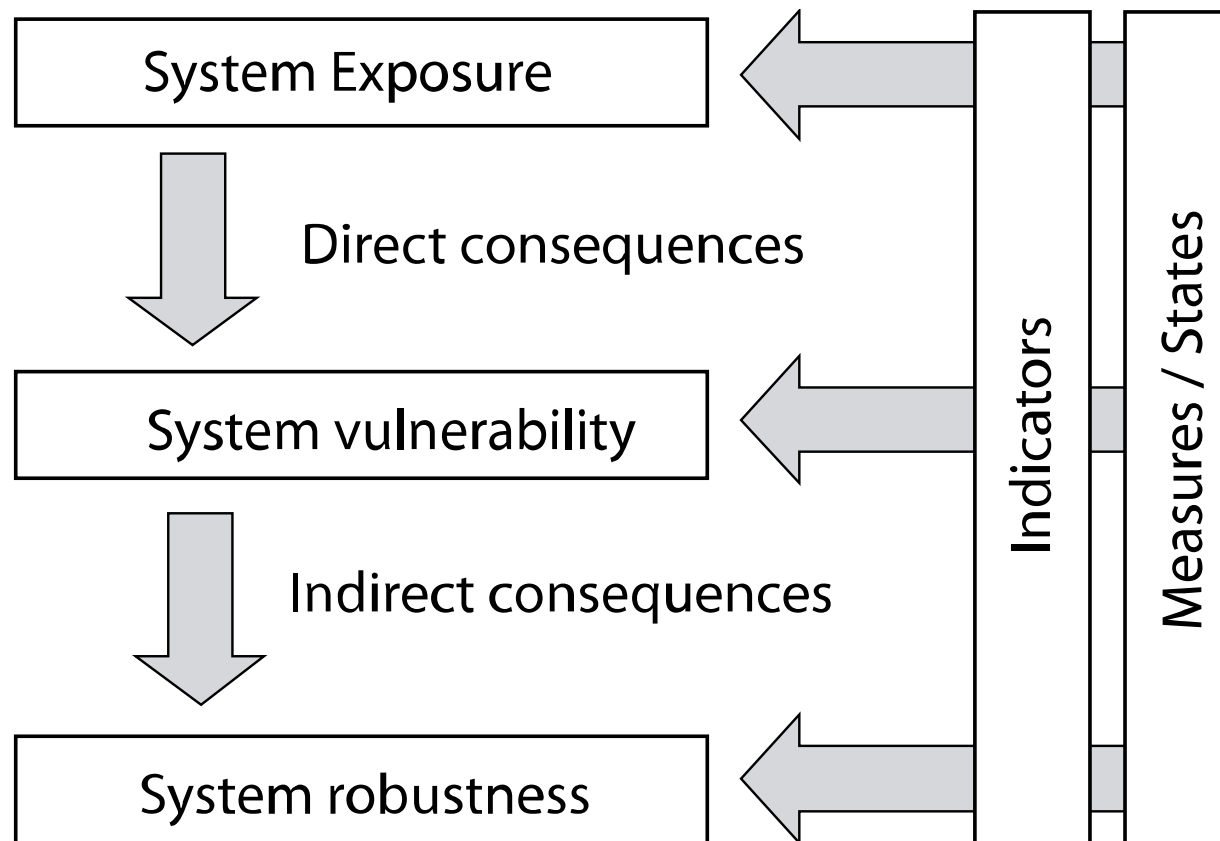
**The decision maker may feel uneasy with the application of the expected utility theory.**

- Can the introduction of aversion factors help to find the decision?

## System representation

- Representation of physical components, causal relations and interrelations between components.
- Including all relevant consequences.
- Including all options, which are relevant for the decision making process.
- It has to be spatially and temporal explicit.

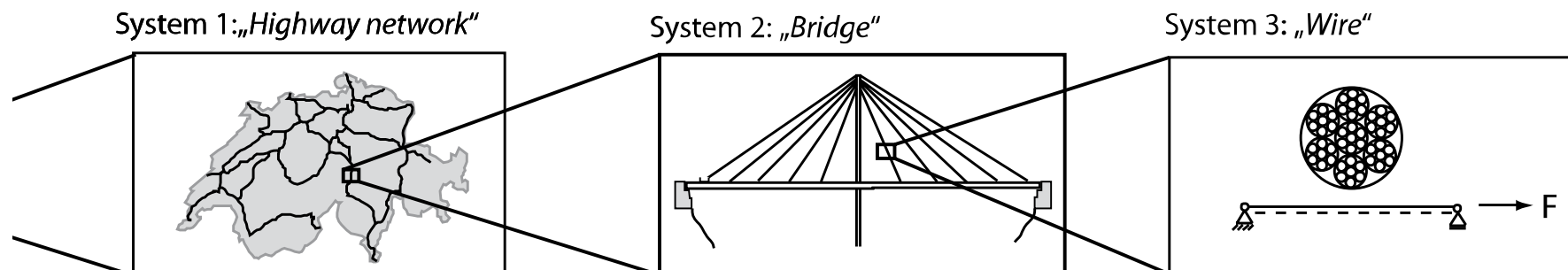
## Risk analysis framework



## Risk analysis framework

### Level of detail should facilitate

- the risk assessment
- comparability of risks
- ranking of alternatives



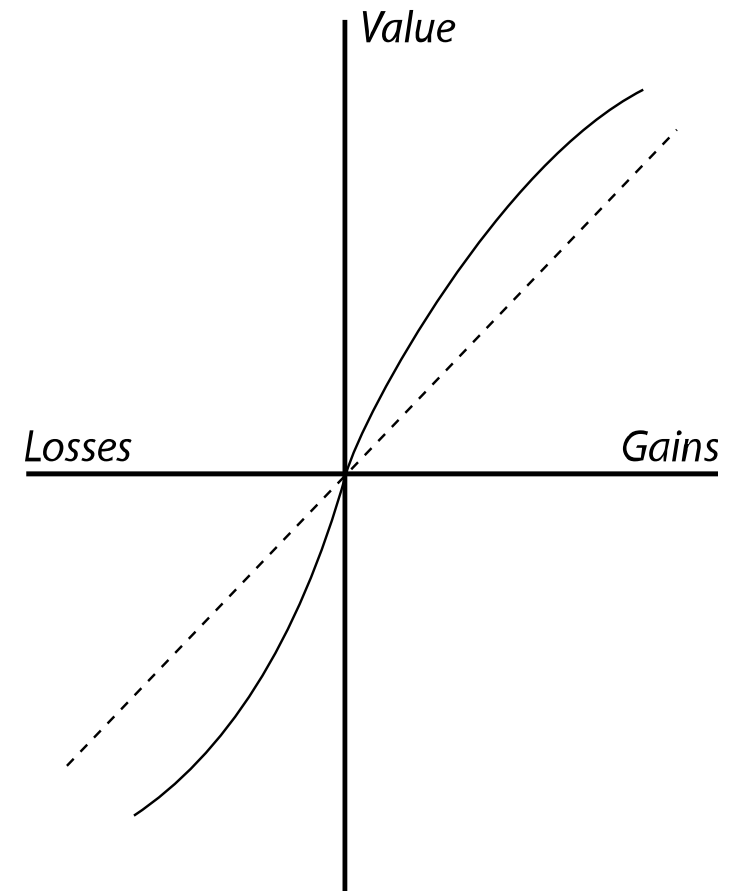
## Risk Perception

- Risk are perceived differently in society
- Public and media are attracted after spectacular events
- Societal pressure on decision maker
- Decision makers behave "*irrational*"



## Normative and descriptive models for decisions under risk

- *Normative model* → Expected utility theory  
*Basis how decision makers should behave to maximize their benefit*  
→ **only normative model should be used for risk based decisions**
- *Descriptive model* → Prospect theory  
*Description how (uninformed) decision makers behave*



## Aversion factors in the context of decision making

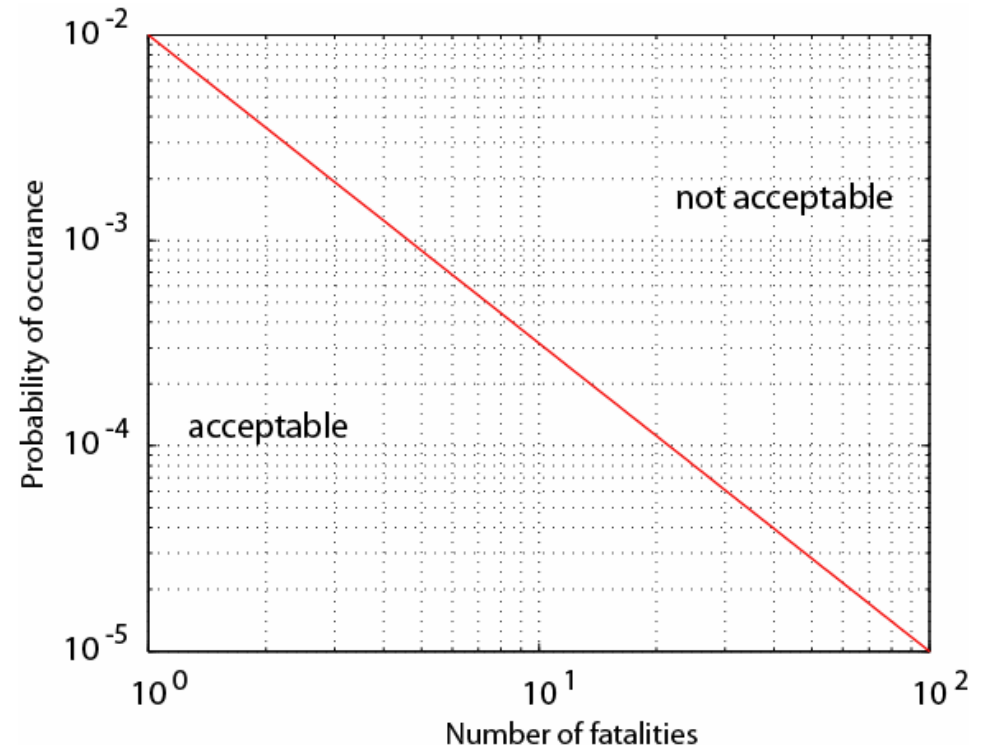
In societal decision making implicit and explicit aversion is used. → approximation of the total risk

Implicit:  $F-N$  diagrams

$$F(N_{PE}) = m N_{PE}^{-b}$$

Explicit: Aversion factors

$$R = \sum_{i=1}^n p_i N_{PE,i} \varphi(N_{PE,i})$$



## Illustrative examples

- Eschede train disaster in 1998

101 fatalities; 88 persons injured  
Failure of the impacted overpass  
Train was totally destroyed  
Total financial loss: EUR 150 mio.



- River Oder Flood in 1997

114 fatalities  
Hundred of kilometres  
of dikes were destroyed  
Total financial loss: EUR 4.1 bill.



## Illustrative examples

- Here: Use of aversion factors lead to the same total risk – independent on the aversion factor.
- The number of fatalities is not a consistent indicator for the total risk.
- Using aversion (implicit or explicit) does not facilitate the comparison and the aggregation of risk.
- Difficult to identify measures to reduce the financial consequences.



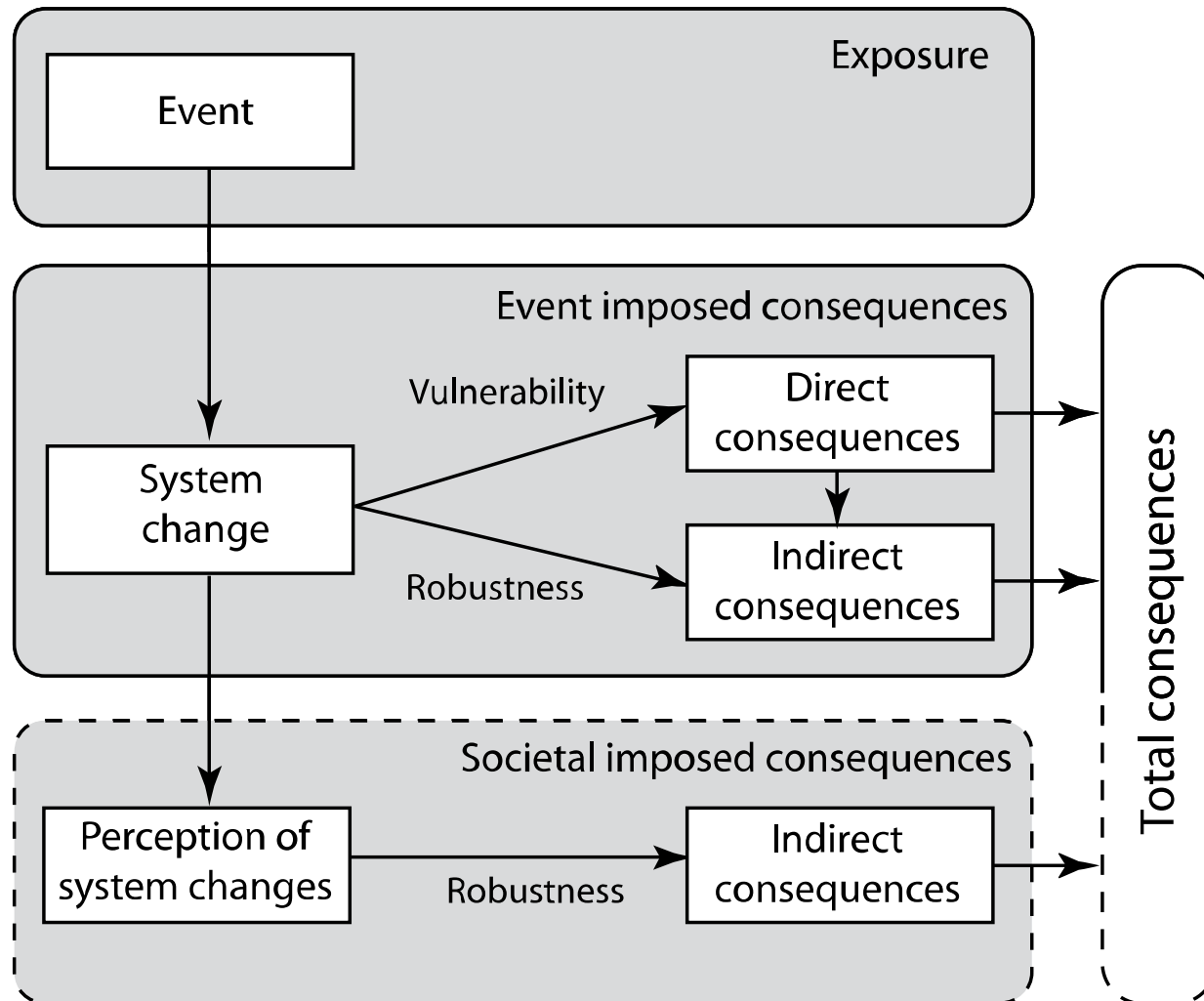
## Discussion on aversion factors I / II

- The error introduced by aversion factors is unknown
- Simple models such as a power law cannot model complex causal relations of systems
- The approximation of the total risk by one indicator implies that all risks are lumped together – level of detail is not appropriate

## Discussion on aversion factors I / II

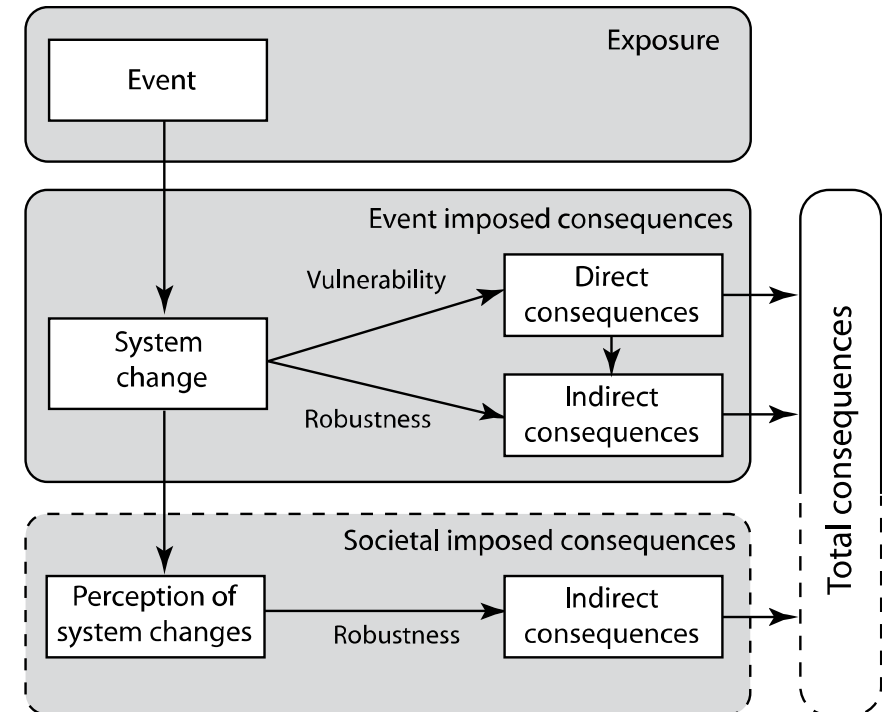
- In most applications there is no clear definition of which consequences are considered by the aversion factors.
- Risk aversion factors may only be derived for a simplified risk assessment if the system is clearly defined / well understood / experience is not extrapolated.
- Uneven distribution of societal resources for life saving activities

# Consequence Model



## Consequence Model - Societally imposed consequences

- Reactions from society
  - Uninformed decision making by individuals in society
  - Partly avoidable by *risk communication* and the establishment of a *risk culture*
- Long term objective



## Conclusion I/II

- The use of aversion factors for the normative decision making is problematic → Especially for low frequency / high consequences events.
- The concept of aversion contradicts a principle of engineering modelling - Knowledge should not be extrapolated beyond the experience.
- The concept of aversion can only be scrutinized for well understood systems.
- For events with high frequencies and low consequences the use of aversion factors might provide a first approximation of the total risk.

## Conclusion II/II

- For a detailed risk assessment and for the purpose of normative decision making the differentiation between three types of consequences is suggested:
  - direct consequences
  - event imposed indirect consequences
  - societally imposed indirect consequences.



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of low frequency high consequences  
events**

*Thank you for your attention*