Decision making subject to aversion of low frequency high consequences events

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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

System Exposure

Direct consequences

System vulnerability

Indirect consequences

System robustness

Indicators

Measures / States
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

Event → System change → Perception of system changes

Event imposed consequences:
- Vulnerability → Direct consequences
- Robustness → Indirect consequences

Societal imposed consequences:
- Perception of system changes → Robustness → Indirect consequences

Total consequences:
- Exposure

Overview  Introduction  System  Perception  Aversion factors  Consequence model  Conclusion
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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Thank you for your attention