# SPECIAL MOBILITY STRAND

## GENERAL RISK THEORY

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## *What is a Hazard?*

*„A Hazard is a potential source of harm or adverse health effect on a person or persons.“*

*„A hazard is any agent that can cause harm or damage to humans, property, or the environment.“*

*„A hazard is something that can cause harm, e.g. electricity, chemicals, working up a ladder, noise, a keyboard, a bully at work, stress, etc.“*

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## *What is a Risk?*

*„Risk is the likelihood that a person may be harmed or suffers adverse health effects if exposed to a hazard.“*

*„Risk is the possibility of losing something of value.“*

*„A risk is the chance, high or low, that any hazard will actually cause somebody harm.“*

*„In daily conversation risk is a rather common notion used interchangeably with words like chance, likelihood and probability to indicate that people are uncertain about the state of the activity, item or issue under consideration.“*

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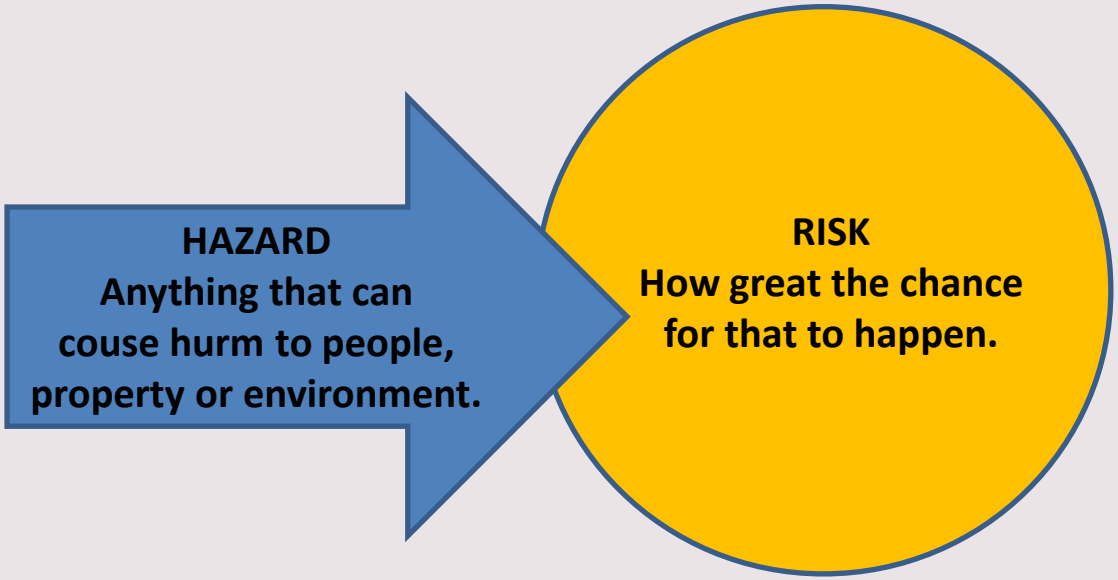
*Difference between a „hazard" and a „risk"*

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# *Hazards Classification*

**Based on energy source**

*Biological*
*Chemical*
*Ergonomic*
*Mechanical*
*Physical*
*Psychosocial*

**Based on origin**

*Natural*
*Anthropogenic*
*Technological*
*Sociological*
*Environmental*

**Based on effects**

*Health*
*Safety*
*Economic*
*Environmental*

*Possible statuses of a hazard:* ***dormant, armed and active***

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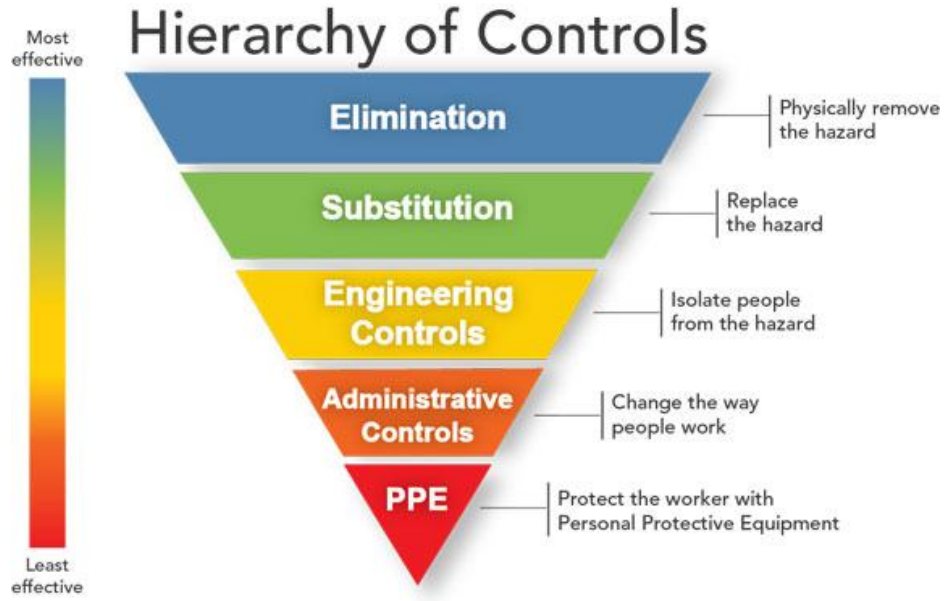


*NIOSH, 2015*

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## *Concept of Risk*

*Base principle: the strength of the chain is the same as the strength of the weakest link.*

*Evaluation of the risk of technical systems is developing relatively late in relation to other areas (start of industrial era - 30th year). The first analyzes relate to the research of the lifetime of ball bearings in the railway (beginning of the 20th century).*

*Risk is more than calculated numbers. Risk acceptability and tolerability cannot be defined based on risk assessments alone. A balance has to be struck between different concerns, like social, cultural, economical etc.*

*It is impossible to restrict the risk evaluation to simple comparisons between numbers. Uncertainties beyond the probabilities need to be taken into account.*

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## *The Tools*

*Quantitative analysis*

- *Some formal methods (probability of event, statistics, ect.)*

*One of the first mathematical concepts used was* ***expected value***
*It is obtained by multiplying each possible outcome with the associated probability, and summing over all possible outcomes.*
*Average value converges to the expected value when the number of experiments goes to infinity.*

***The expected value is a key concept in risk analysis and risk management. It is***
***common to express risk by expected values.***

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# *The Tools*

*Risk equals uncertainty*

*Risk refers to uncertainty of outcome, actions and events. This perspective is most common in business contexts (risk = uncertainty). The idea that risk equals uncertainty seems to be based on the assumption that the expected value is the point of reference and that it is known or fixed. Risk does not exist independently of the assessor, as the uncertainties are somebody's uncertainties.*

*Risk is equal to an event*

*Risk is a situation or event where something of human value (including humans themselves) is at stake and where the outcome is uncertain (risk = event or a consequence of an event).*

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## *Different approaches to risk*

*Two perspectives are evident in considering approaches to risk. First,* ***discipline-based*** *(Althaus, 2004, 2005; Aven & Kristensen, 2005), and second,* ***model-based*** *(Renn, 1992; af Wåhlberg, 2001; Renn & Klinke, 2002).*

*These four basic approaches, each originating from an independent disciplinary tradition:*

1. *Technic*
2. *Economic*
3. *Cultural*
4. *Psychrometric*

*Meta-approaches: Political, Socio-emotional, Adaption, Evolutionary*
*The different approaches to risk illustrate the multifaceted nature of risk and emphasize the need to take a multidisciplinary approach to understanding and managing risk.*

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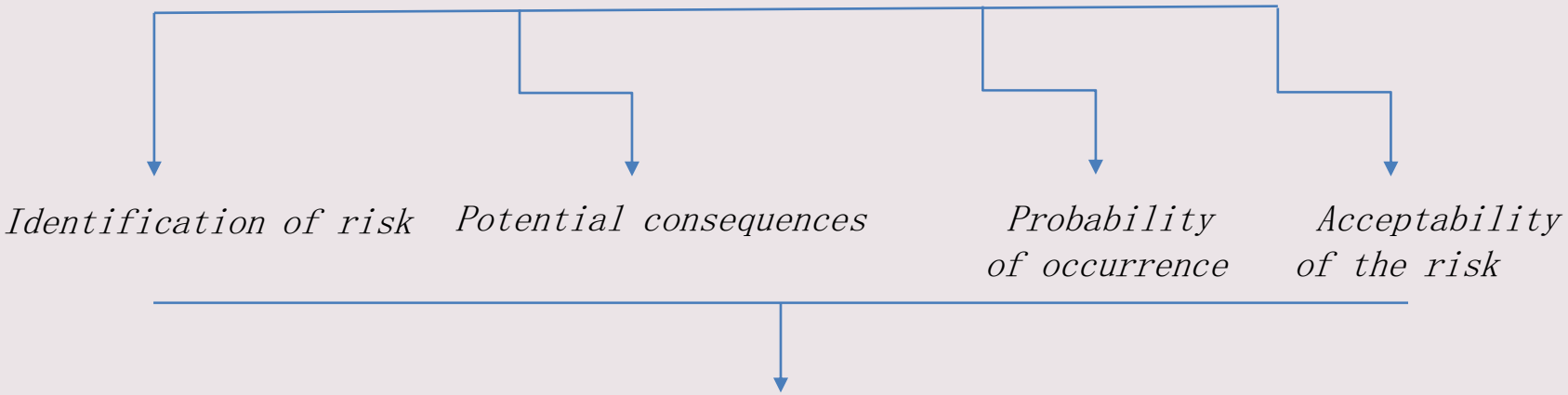
## *Concept of Risk assessment*

*After the hazard is detected, risk assessment takes place.*

*Risk assessment consists of an objective evaluation of risk in which assumptions and uncertainties are clearly considered and presented.*

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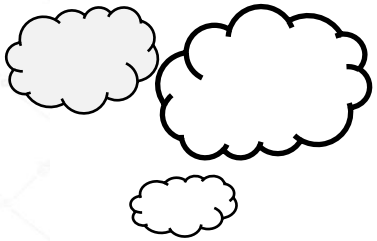
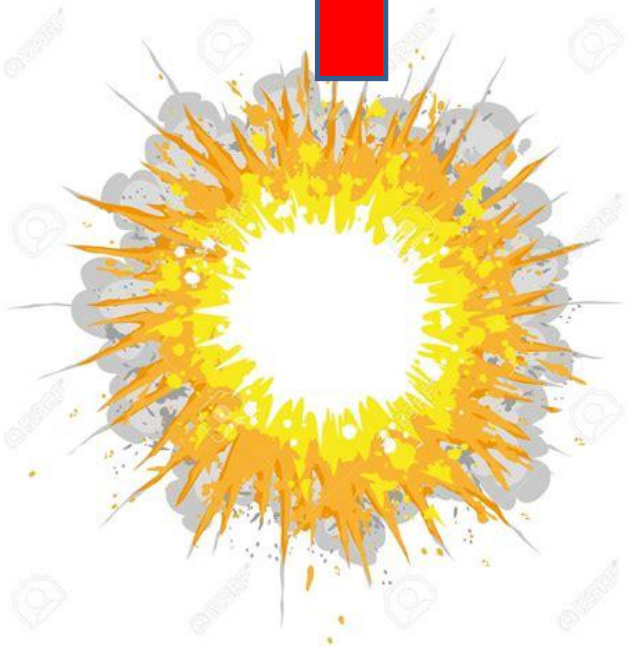
# Concept of Risk assessment

Low Hazard

High Risk



Harmless substance

Flour Dust

Dust Explosion

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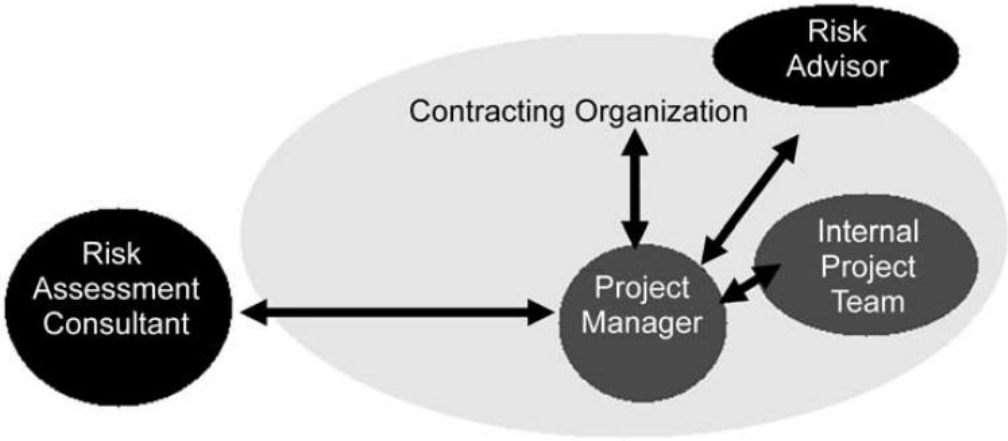
## *Concept of Risk assessment*

*Risk assessment is a mandated science. Neither pure science nor pure public policy, risk assessment reports are a hybrid of both.*

*The result of the risk assessment process is a document, also termed a risk assessment, which presents risk findings and describes how they were generated.*

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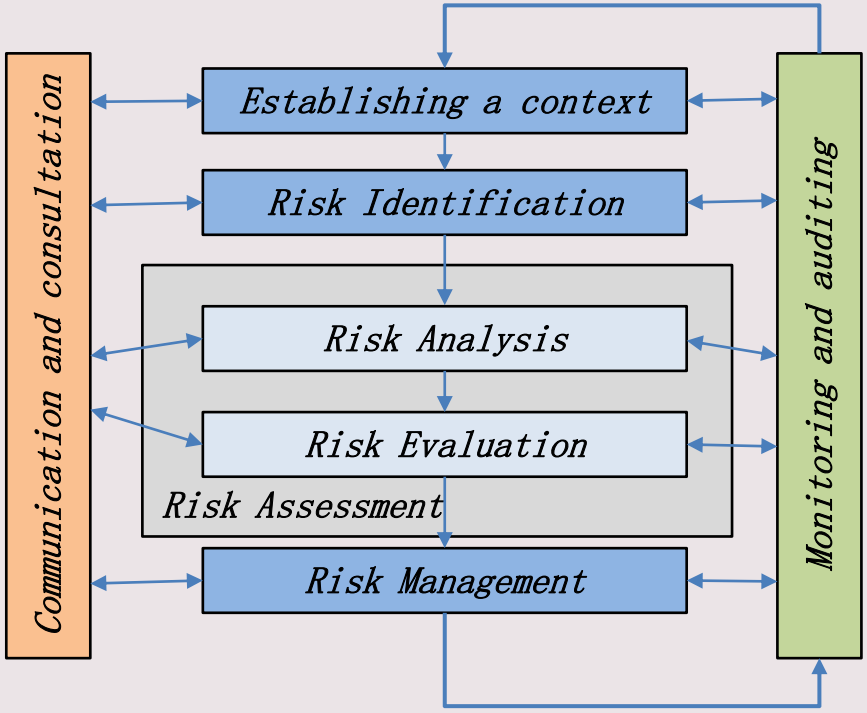
## Concept of Risk assessment




*Managing the Risk:*

- *Limiting exposure*
- *Risk-reduction measures*

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## *Environmental Risk assessment*

*Environmental risk assessment is an organized process used to describe and estimate the likelihood of adverse health outcomes from environmental exposures to chemicals. Steps of (environmental) risk assessment:*

1. *hazard identification,*
2. *dose-response assessment and categorization*
3. *prevention, control and reduction*
4. *avoiding unacceptable*
5. *Intervent response*
6. *Risk transfer (insurance).*

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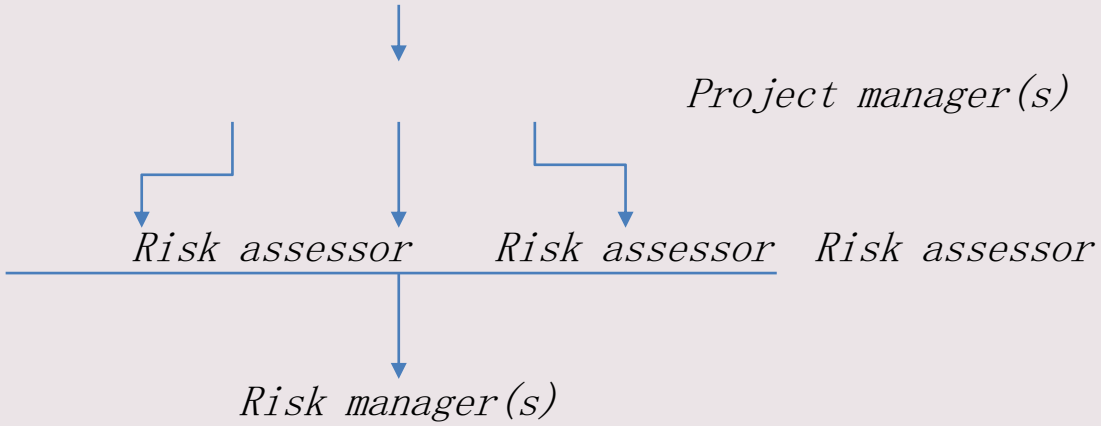
# *Environmental Risk assessment*

*Risk management*

*(The process of identifying, evaluating, selecting, and implementing actions to reduce risk to human health and to ecosystems)*

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*Environmental Risk assessment*

*What are we managing? – probability and consequences of the realization of hazards.*

*Disaster risk management* ⟷ *Natural hazards (dynamics of events)*

***The goal of risk management is scientifically sound, cost-effective, integrated actions that reduce or prevent risks, while taking into account social, cultural, ethical, political, and legal considerations.***

*ISO 31000: Risk Management – Principles and Guidelines on Implementation*

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## *Environmental Risk assessment*

1. *Preliminary (Process) Hazard Analysis (PHA),*
2. *Hazard and operability study (HAZOP)*
3. *Failure mode and effects (FMEA)*
4. *Human Reliability Analysis (HRA)*
5. *Probabilistic Safety Analysis (PSA)*
6. *Tasks Analysis (TA)*
7. *Human Error Identification (HEI)*
8. *Human Reliability Quantification (HRQ)*
9. *Job Hazard Analysis (JHA)*
10. *Failure mode and effects analysis (FMEA),*
11. *Event tree analysis (ETA),*
12. *Fault tree analysis (FTA),*
13. *Fault Modeling, Analysis of Effects and Critical Conditions*
14. *Consequences Modeling*
15. *Block Reliability Diagram*
16. *Comparative Analysis*
17. *Simulations*
19. *Empirical Analysis*
20. *Delphi methods etc.*

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## *Environmental Risk assessment*

*Preliminary (Process) Hazard Analysis (PHA)*

| Probability of occurrence | Consequences | | | | |
|---|---|---|---|---|---|
| | Insignificant 1 | Low 2 | Medial 3 | Significant 4 | Catastrophic 5 |
| A | H | H | E | E | E |
| B | M | H | H | E | E |
| C | L | M | H | E | E |
| D | L | L | M | H | E |
| E | L | L | M | H | H |

*E – Extreme Risk = need to act immediately*

*H – High Risk = need careful management*

*M – Significant Risk = management responsibilities must be specified*

*L – Low Risk = managing the usual procedures*

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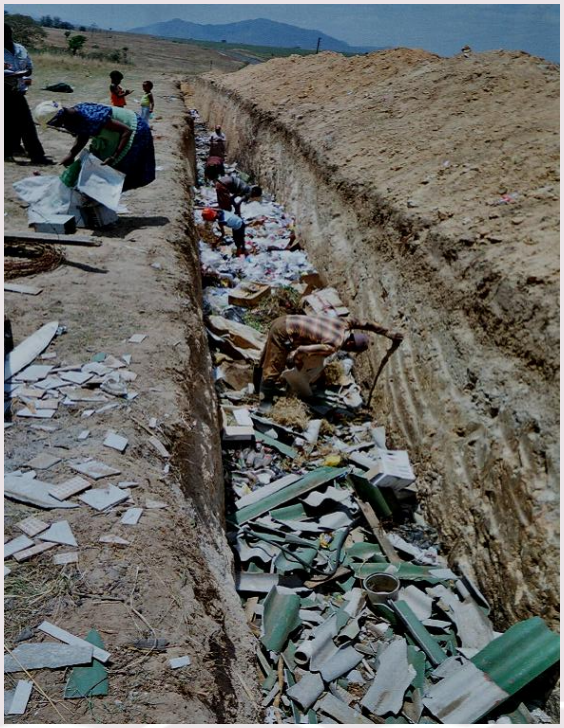
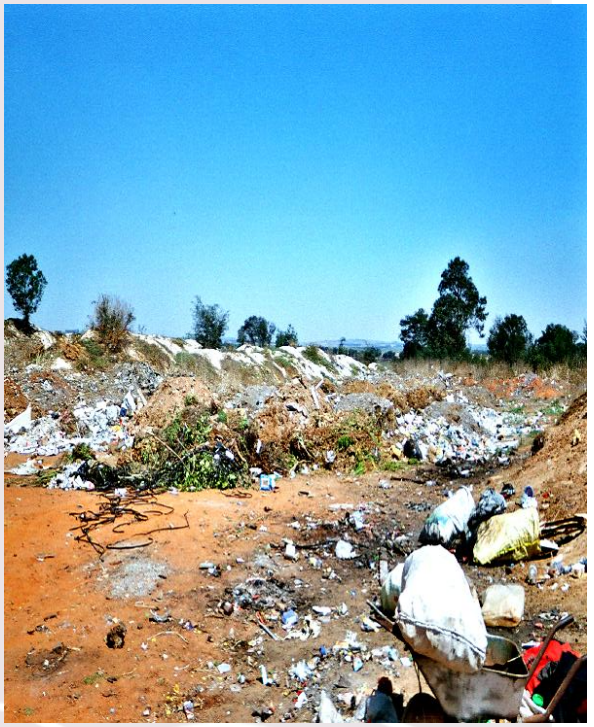
# *Environmental Risk assessment*

## *Example 1: Wild Landfills*





*Landfill No. 1*

*Landfill No. 2*

*Landfill No. 3*

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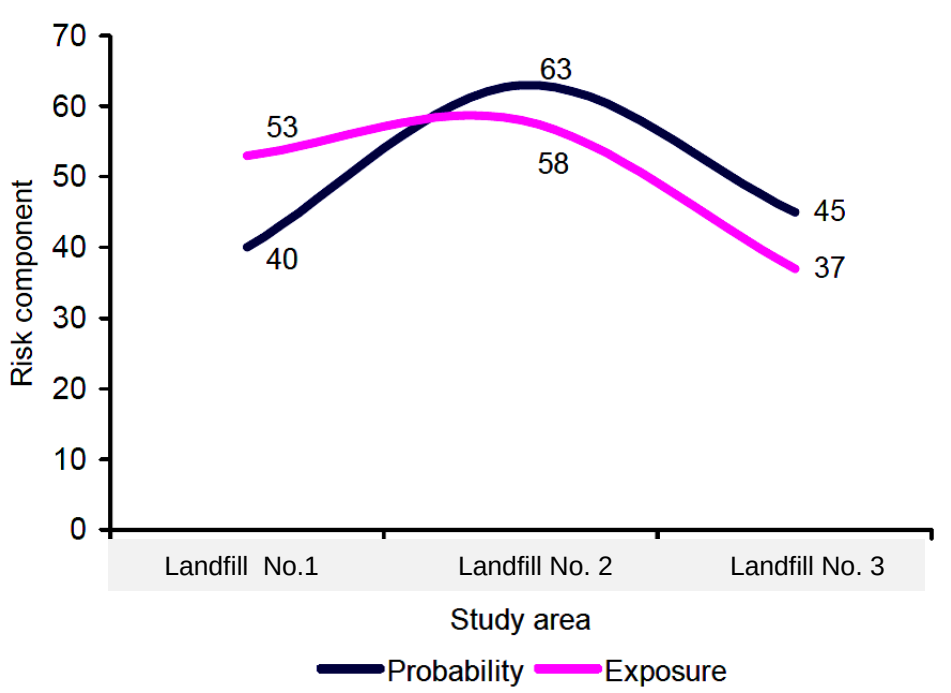
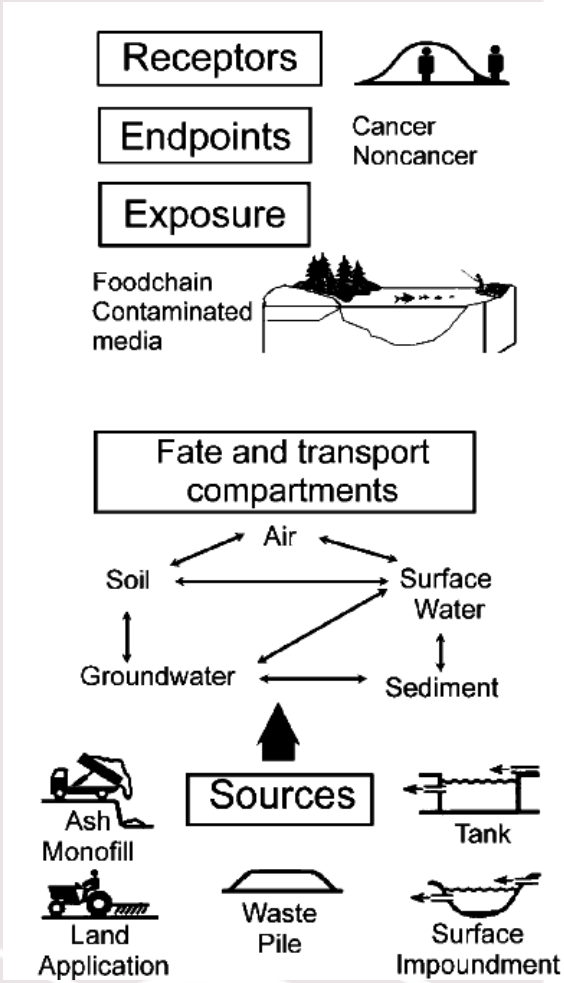
# *Environmental Risk assessment*

*Example 1: Wild Landills*




*Public perceptions on the probability of the various exposure pathways*

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## *Environmental Risk assessment*

*Example 1: Wild Landills*

| *Landfill No.* | *Calculation* | *Assessment* |
|---|---|---|
| *1* | *40 x 53 = 2120* | *Extreme Risk* |
| *2* | *63 x 58 = 3654* | *Extreme Risk* |
| *3* | *45 x 37 = 1165* | *High Risk* |
| *Formula R = F x S* | *F = Frequency or Probability* | *S = Severity* |

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## *Environmental Risk assessment*

*Example 2: Flood Risk management*

***Flood risk** is the product of **hazard**, i.e. the physical and statistical aspects of the actual flooding (e.g. return period of the flood, extent and depth of inundation, and flow velocity), and the **vulnerability**, i.e. the exposure of people and assets to floods and the susceptibility of the elements at risk to suffer from flood damage. (EU Floods Directive (2007)*

*Meteorological, hydrological, and hydraulic investigations to define the hazard and estimation of flood impact to define the vulnerability can be performed separately in the first place, but have to be combined for the final risk analysis.*

*Today, this kind of analysis required the application of different data or specialized software.*

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# *Environmental Risk assessment*

*Example 2: Flood Risk management*


*Land use in the model area*

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# *Environmental Risk assessment*

*Example 2: Flood Risk management*

## *1. Determination of flood intensity*

$$\mathrm{FI} = \begin{cases} 0 \rightarrow d = 0\ \mathrm{m} \\ d \rightarrow d > 0\ \mathrm{m}, v \leq 1\ \mathrm{m/s} \\ d.v \rightarrow v > 1\ \mathrm{m/s} \end{cases}$$

## *2. Determination of flood hazard*

| Flood intensity (FI) | Hazard categories | Description |
|---|---|---|
| $FI > 1$ | High | It is recommended not to allow new or extend existing buildings in which people or animals live. For existing buildings, it is necessary to implement the design of flood protection measures to ensure adequate risk mitigation or to process program of relocation of these buildings. |
| $0.3 < FI \leq 1$ | Medium | Construction is possible with restrictions which are based on a detailed assessment of the necessity of object functions in the endangered area and from the potential flood hazard of these objects. Improper is the construction of sensitive objects. It is not recommended to extend existing areas which are intended for construction. |
| $FI \leq 0.3$ | Low | Construction is possible, but the owners of the land and buildings should be warned about the potential flood hazard. For sensitive objects, it is necessary to adopt special measures e.g. in terms of crisis management. |

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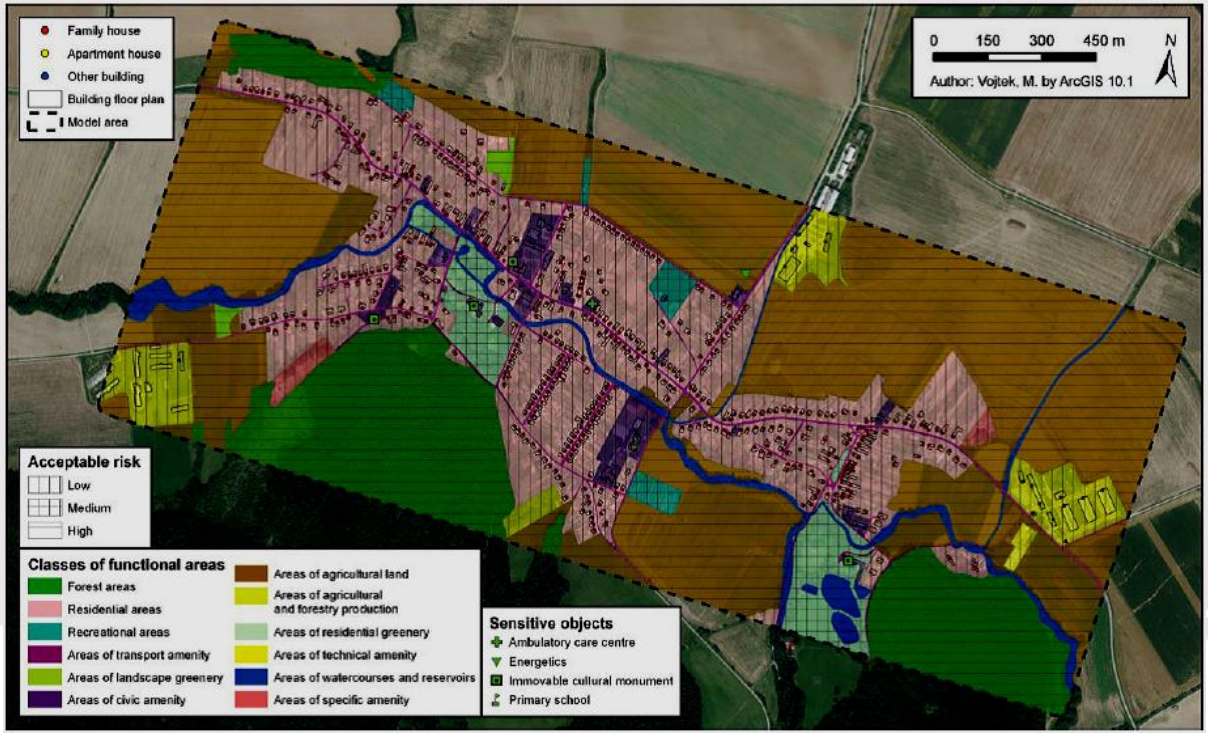
# *Environmental Risk assessment*

*Example 2: Flood Risk management*

## *3. Determination of vulnerability and determination of flood risk*




*Vulnerability map of the model area*

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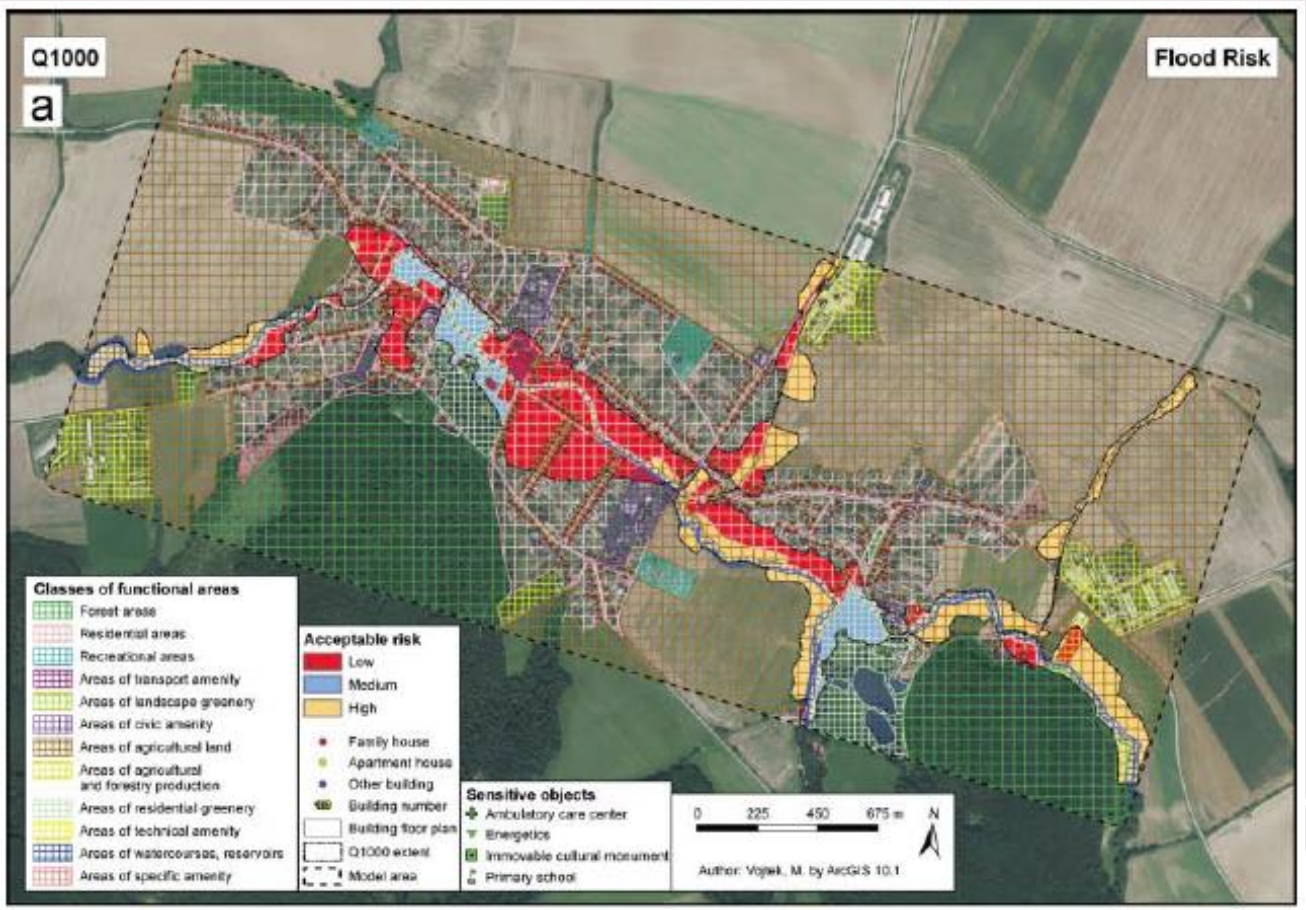
# *Environmental Risk assessment*

*Example 2: Flood Risk management*

## *3. Flood Risk maps*




*Flood risk in the model area*

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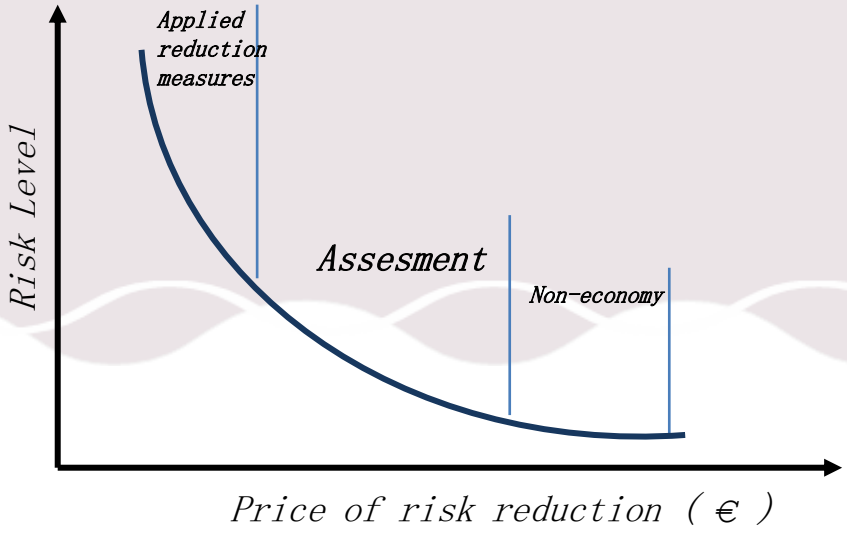
## *Conclusions*

- *Acceptable Risk (safety) level – technical & „political" decision*
- *Risk and Percepcion of Risk are not always in line*
- *What are the effects of risk management?*

*It is possible to find out only if we do not manage the risks – the results can be difficult to measure and prove.*

- *What is the price of risk management?*

*The best answer is another question: what is the cost of non-risk management?*

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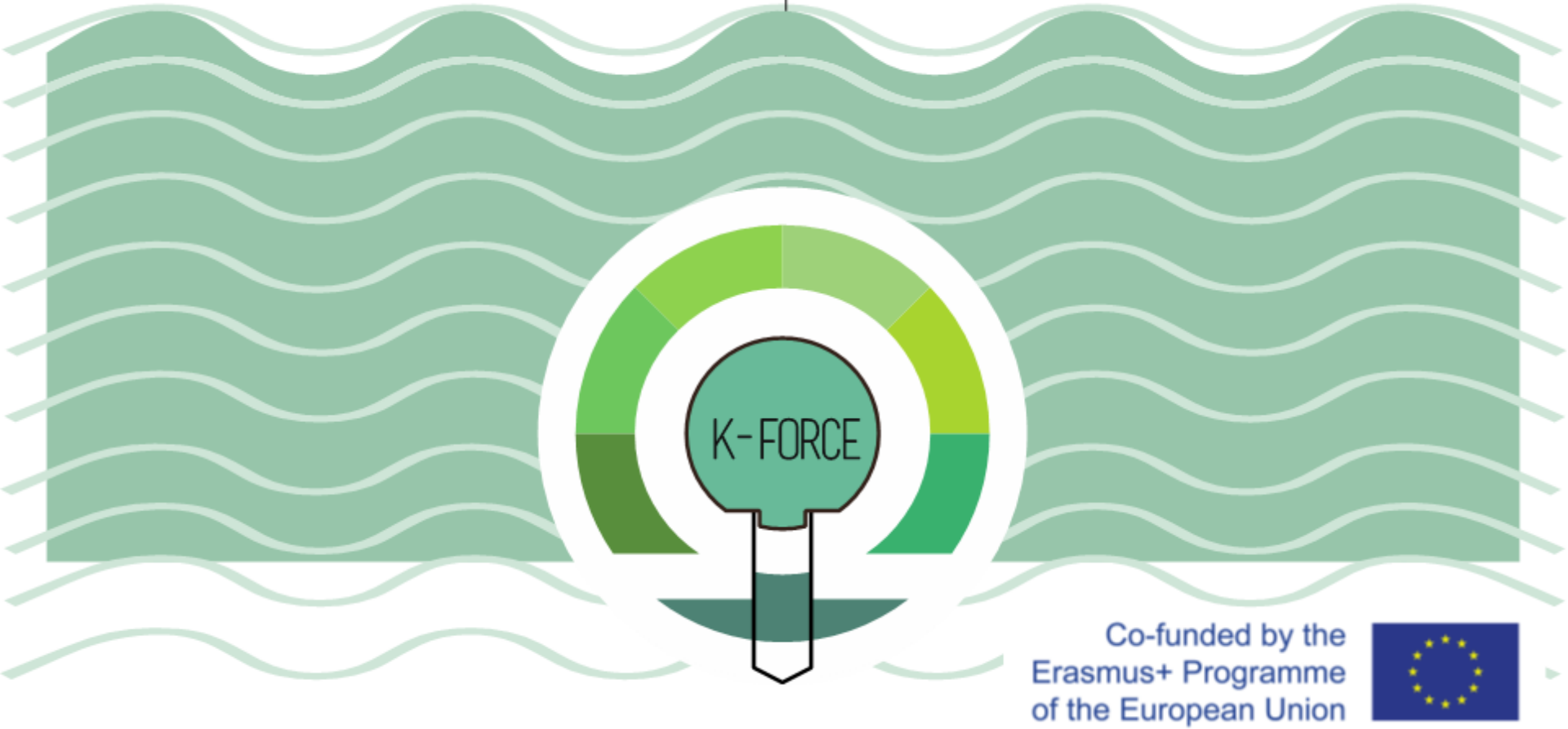


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# Thank you
# for your attention

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