

Risk and safety

Part 1: Risk, safety and risk analysis

EPA1132 – Technology development and impact assessment

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Challenge the future

Overview

1. Definitions
2. Risk analysis

Definitions

Risk and safety

- What is risk?
- What is safety?
- (What is security?)

Risk

'The probability of something happening multiplied by the resulting cost or benefit if it does'

Risk involves the triplet $\langle p_i; s_i; c_i \rangle$: probability(i) of scenario(i) with consequence(i), defined by Kaplan and Garrick

Different types of risk

			LARGE
probability		Traffic Falls Smoking Skiing ...	Famines Epidemics Earthquakes Floods ...
		Bee-sting Lightning ...	Explosions Toxic clouds Falling aircraft (Floods) ...
	SMALL		consequences

Safety

'The state of being safe; exemption from hurt or injury; freedom from danger'

Consider

- How safe is safe enough? When we feel safe?
- Safety is a basic need, but it may conflict with another basic need or desired activity

Hazard (danger, threat)

'A situation that poses a level of threat to life, health, property, or environment'

- Intrinsic property of a material, activity, situation
- Hazards have to be controlled to remain safe
- Hazards threaten a target (life, health, property, environment)

Examples of hazards

- Driving a car
- Producing, transporting and storing chemicals
- Having a nuclear power plant
- Flying
 - Being in an airplane
 - Having aircraft flying over our heads
- Going up and down stairs or ladders

Safety vs. security

If you are interested in **safety**

- Focus on PLAUSIBLE hazard scenarios
- Focus on a set of control measures to get to an acceptable risk level

If you are interested in **security**

- Focus on INTENTIONAL actions to 'activate' a system failure
- Focus on how one can 'create' large consequences (human casualties, material assets but also reputation)

Consequences and comparability

Risk definition(s) have no common denominator:

- Results in multiple different measuring units
- Complicates comparison of different fields of application

Probability and consequences: mortality

Smoking	$5 * 10^{-3}$
Traffic	$8 * 10^{-5}$
Lightning	$5 * 10^{-7}$
Natural gas	$4 * 10^{-7}$
Bee-sting	$2 * 10^{-7}$
Dam failure	$1 * 10^{-7}$
Schiphol	$2 * 10^{-8}$
Chemical industry	$6 * 10^{-9}$

Probability and consequences: winning lotteries

Smoking	$5 * 10^{-3}$
Traffic	$8 * 10^{-5}$
Lightning	$5 * 10^{-7}$
Natural gas	$4 * 10^{-7}$
Bee-sting	$2 * 10^{-7}$
Dam failure	$1 * 10^{-7}$
–State lottery	$1 * 10^{-7}$
–Bank lottery	$4 * 10^{-8}$
–Lotto	$2 * 10^{-8}$
Schiphol	$2 * 10^{-8}$
–Postal code lottery	$1 * 10^{-8}$
Chemical industry	$6 * 10^{-9}$
–Sponsor lottery	$3 * 10^{-12}$

Why use people killed as measurement unit

- Because people can agree on it
- It has proven to be a good proxy
- However, not a good proxy for disaster abatement
 - Need numbers wounded
 - Need extent of material damage

Risk analysis

Risk analysis

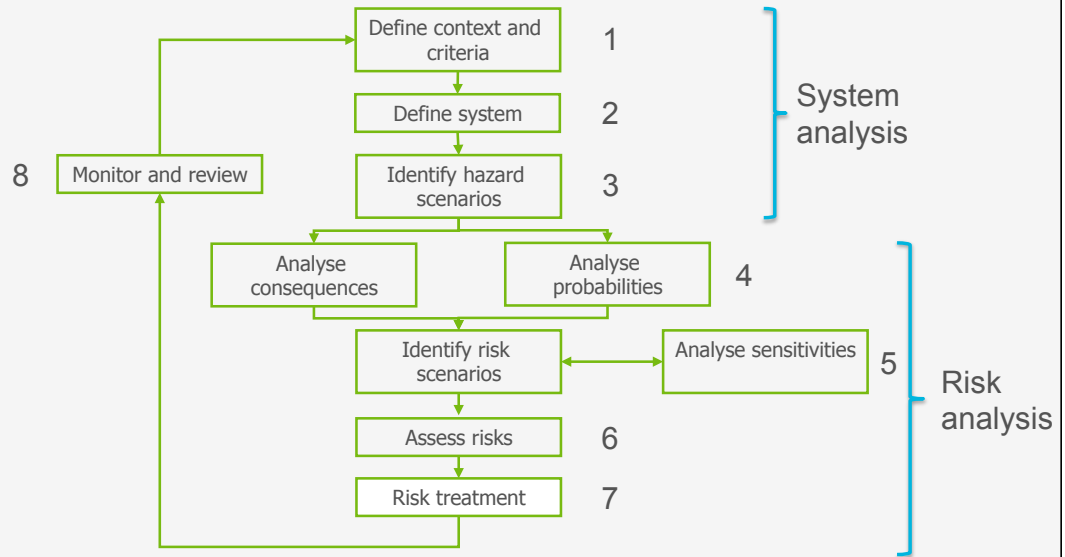
Basic questions

- What can go wrong? And how? > scenario
- What is the likelihood of that happening? > probability
- What can be the consequences? > consequence

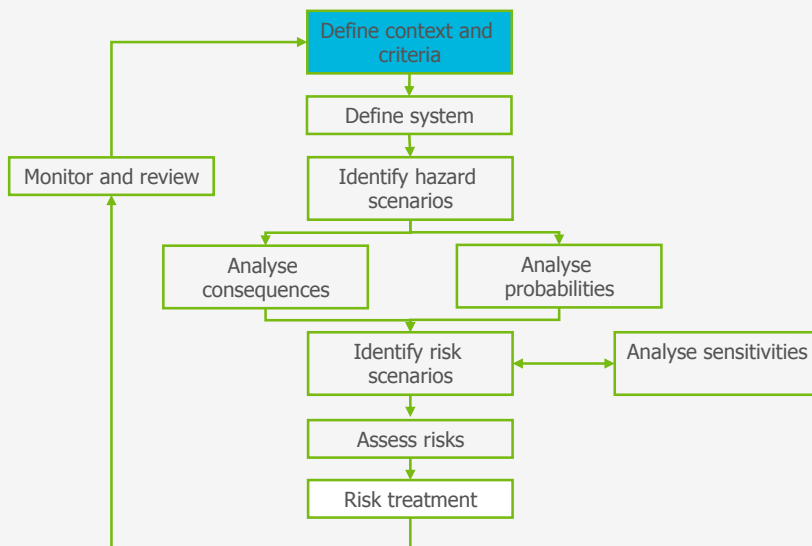
Approaches

- Deterministic: often limited to MCA (maximum credible accident)
- Probabilistic: all 'conceivable' accidents in relation to their probability of occurrence

Risk based decision analysis



Definition of context and criteria



Why carry out a risk analysis?

- Acceptability of activity, e.g. with new designs, technologies or modifications of design, use
- Choice of system, its boundaries and environment
 - Activities with which risks are associated
 - Parties of interest
- Criteria to assess outcome of the analysis

Risk assessment: object of study

- **Internal safety:** safety of all people involved in an activity > occupational safety
- **External safety:** accidents causing harm to people present in the environment

External safety criteria

Individual risk

- Probability per year a person at the same place is killed; replaced by

Localised risk

- Alternative for individual risk where an imaginary person is assumed (this allows to take account for potential future new living areas)

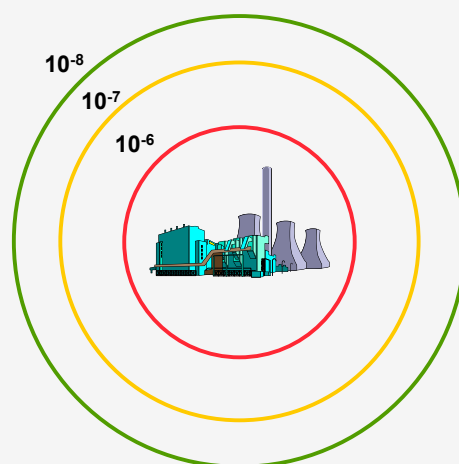
Group (or societal) risk

- Probability per year an accident happens with at least a certain number (N) of casualties

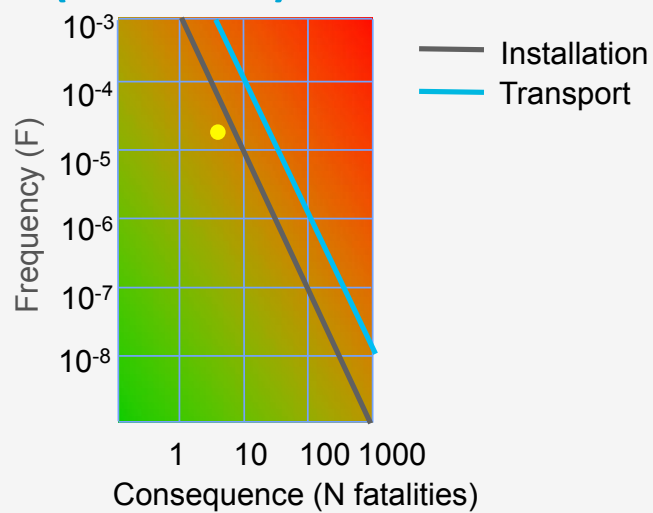
Expectation value

- Average number of deaths per year

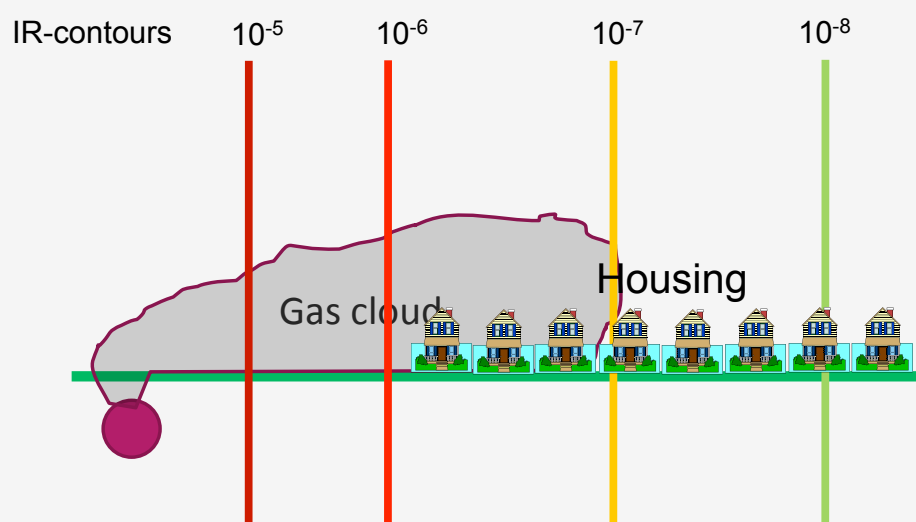
Individual or localised risk



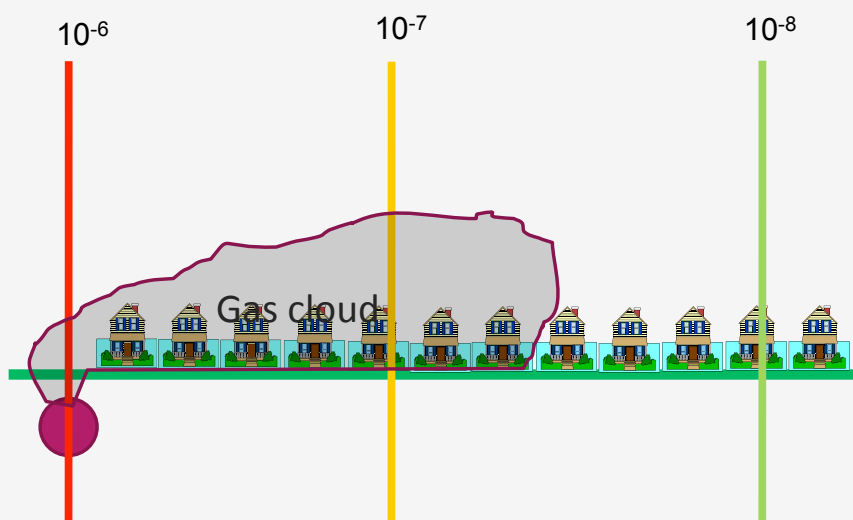
Group risk (FN-curve)



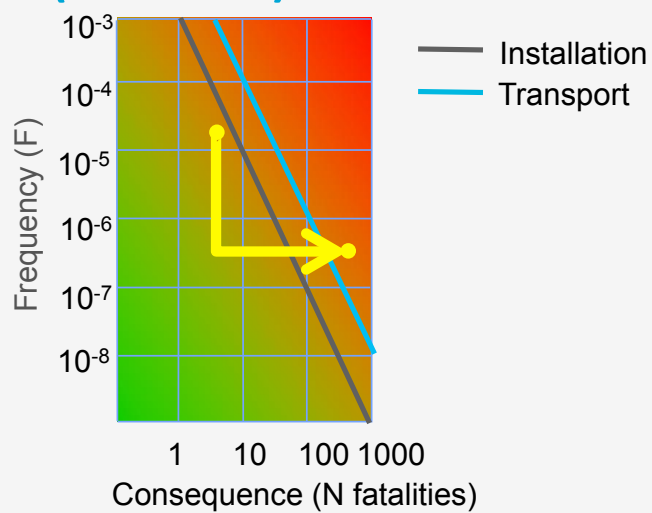
Tension IR and GR => P vs. C

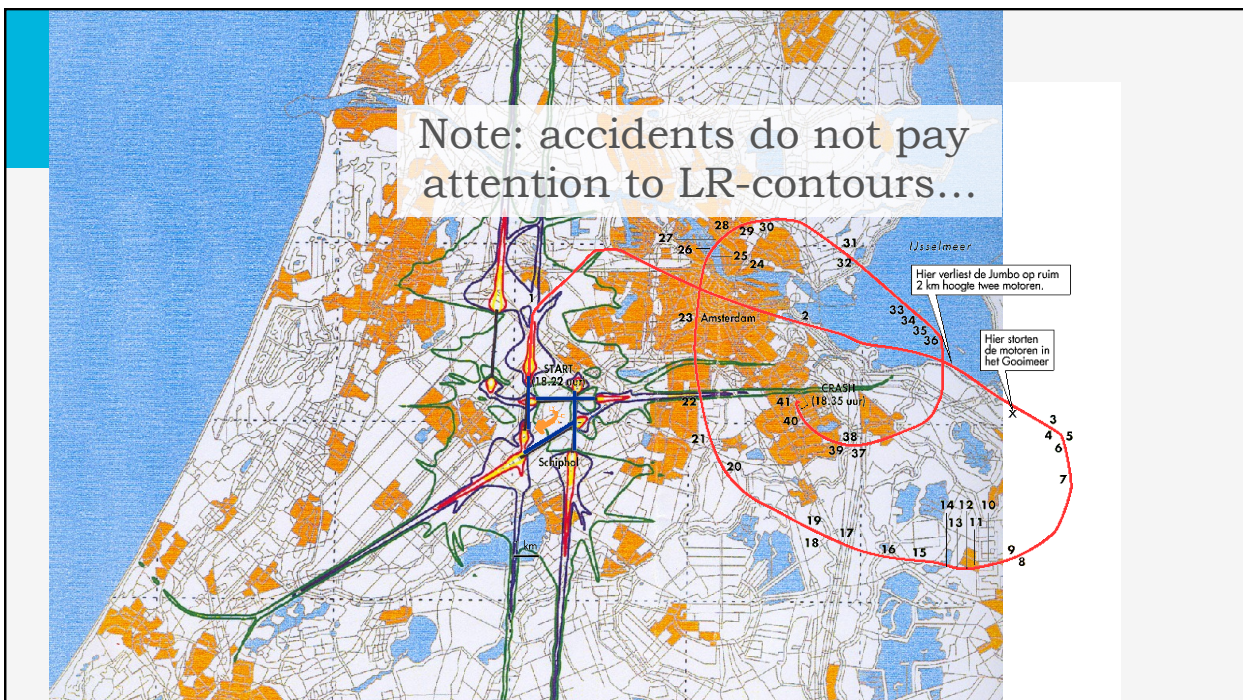


New IR contours; function land use



Group risk (FN-curve)





Thank you for your attention!