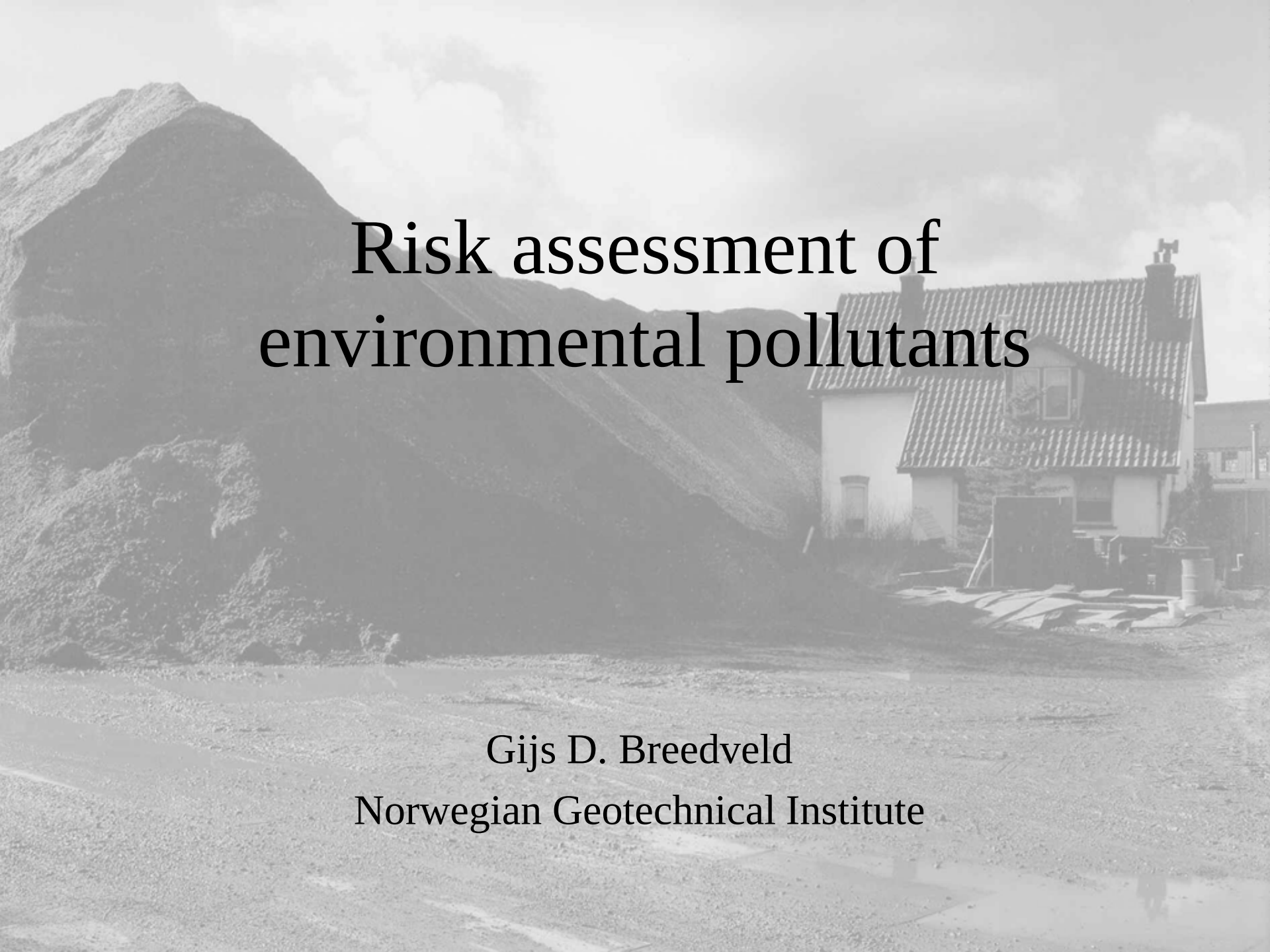

Risk assessment of environmental pollutants

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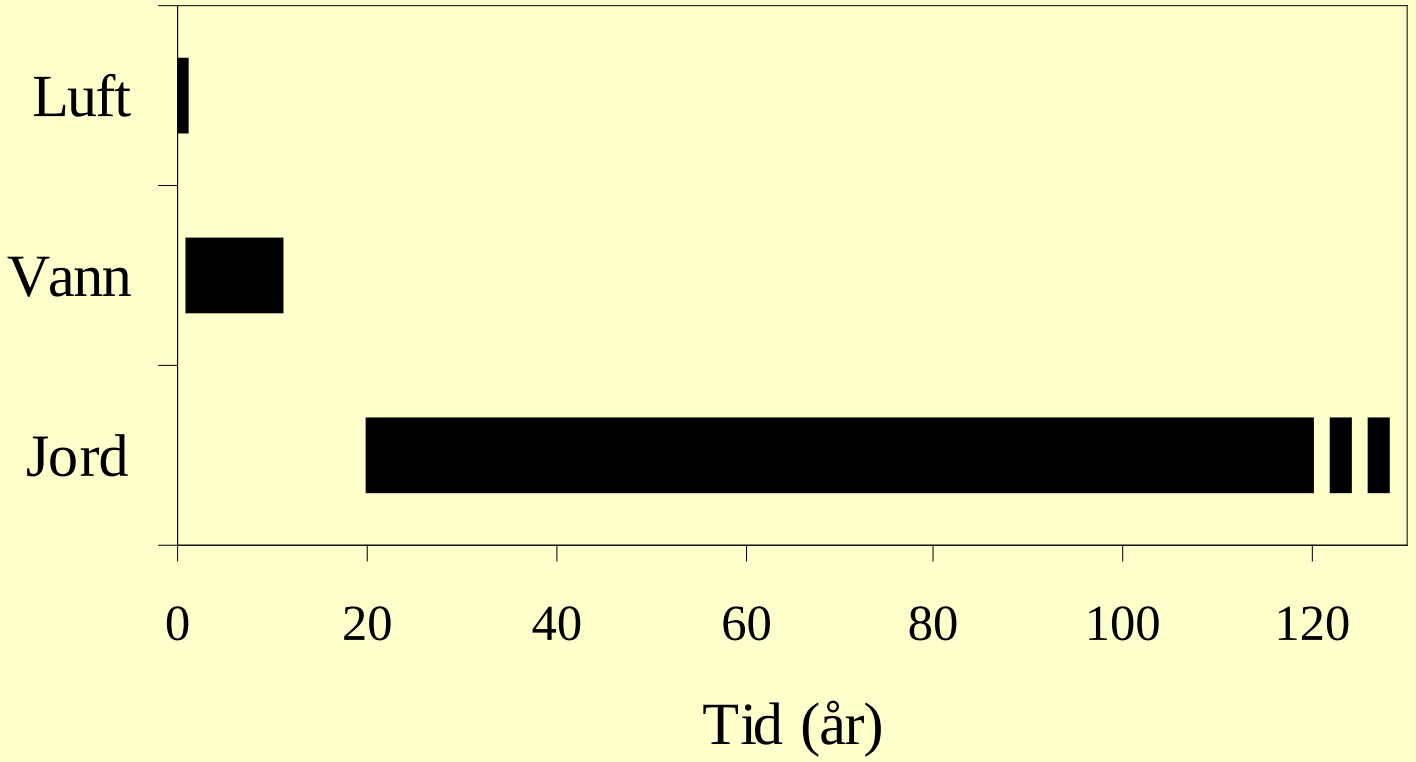
Norwegian Geotechnical Institute


Wout Berger

Risk assessment

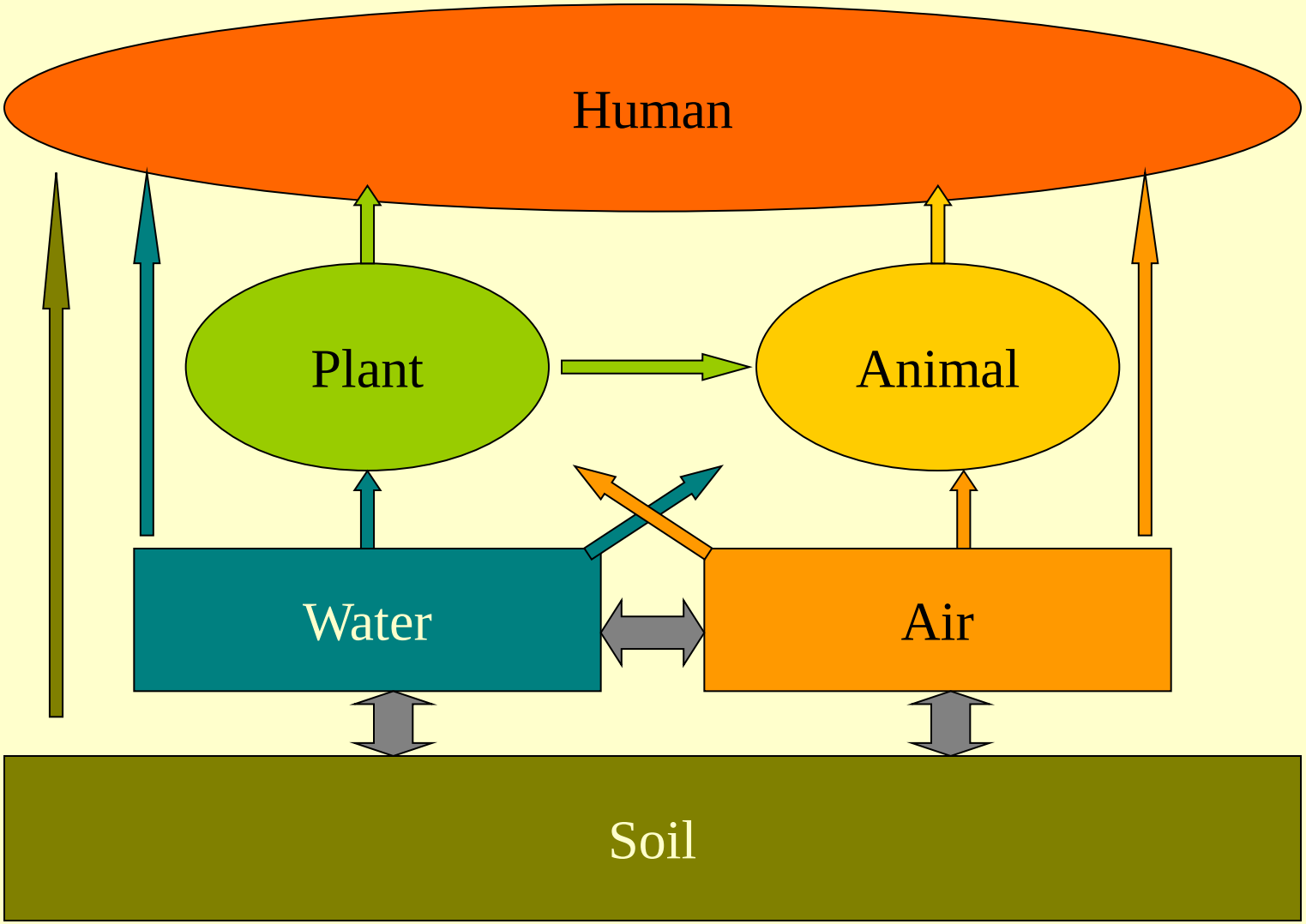
Source	Path	Target
Composition	Advection	Exposure
Dissolution	Dispersion	Uptake
Evaporation	Sorption	Effect

“Out of sight, out of mind”



Human health

Exposure routes



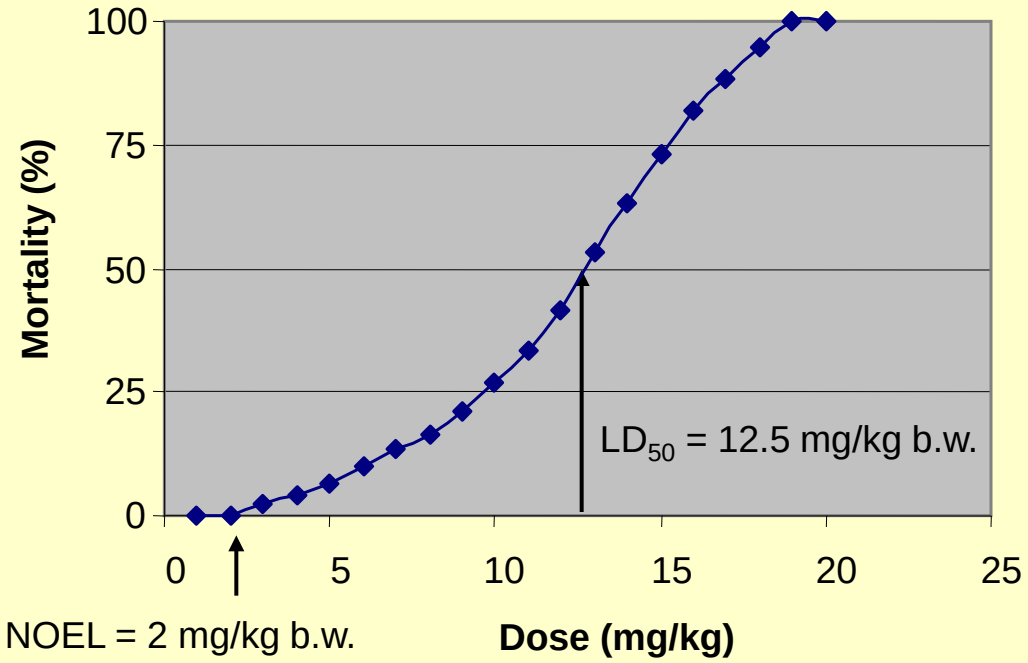
Example exposure dose

Trichloroethylene in soil at 1 mg/kg

Exposure route	Exposure Child	Dose mg TCE/kg b.w./d
Intake soil	150 mg soil/d	1×10^{-5}
Inhalation	7.6 m^3 air/d	0.15
Intake water	1L water/d	0.007
Total exposure		0.16

Dose - effect relationship

- LD_{50}, LC_{50}
  (Lethal dose or lethal concentration for 50% of test organisms)
- No Observed Effect Level (NOEL) (mg/kg body weight/day)
- Cancer risk (standard use $1/100.000 = 10^{-5}$)



Toxicological reference value (TRV)

- No observed effect level (NOEL)
- Level for acceptable carcinogenic risk (e.g. 10^{-5})
- Security factors for:
  - Interspecies (10), rat to human
  - Intraspecies (10), adult to child/old age
  - Limited toxicological data (up to 10)
- Maximum tolerable daily intake (MTDI)
  (mg/kg body weight/day)

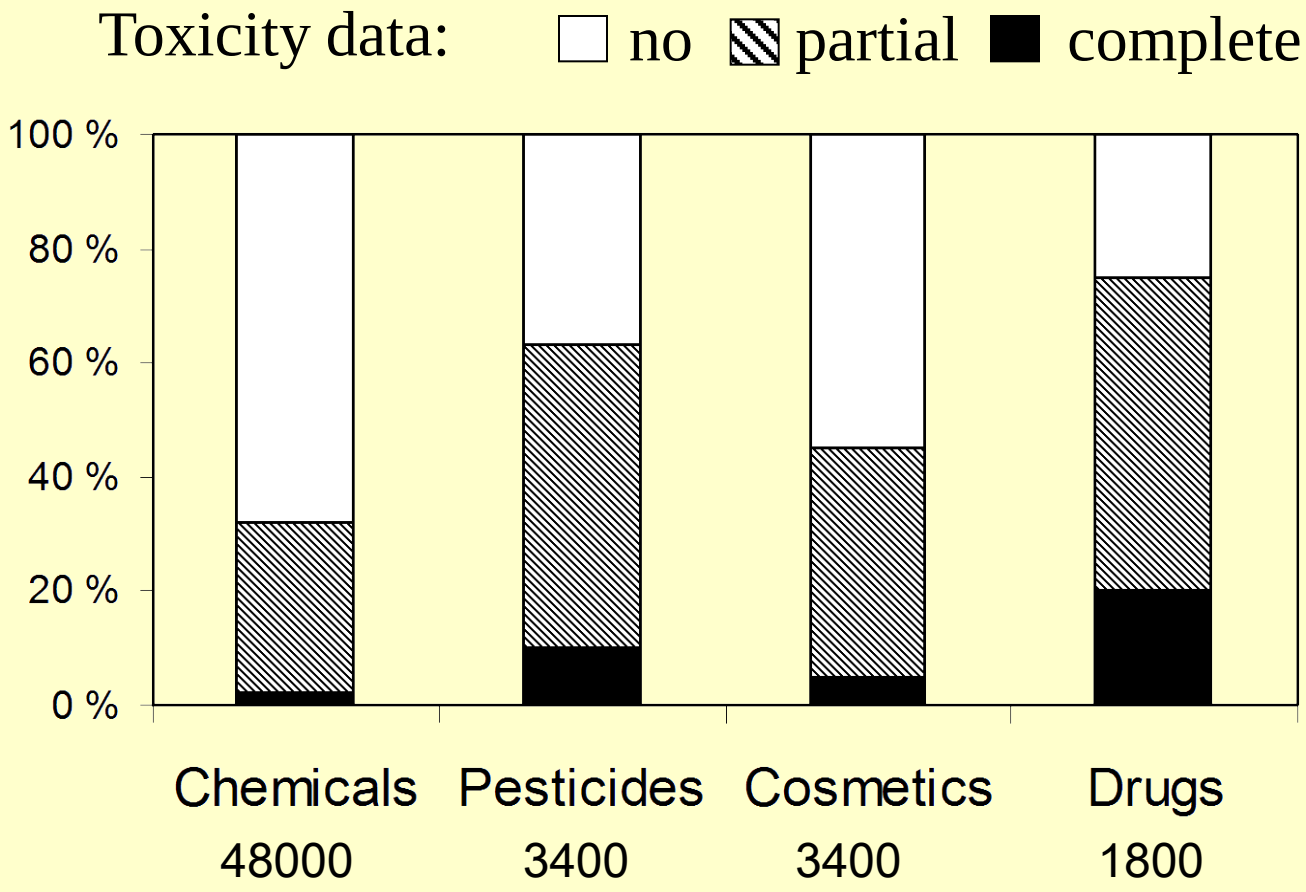
Example: soil quality criteria

Trichloroethylene (TCE)

- TRV maximum tolerable daily intake
  - 2.4×10^{-2} mg TCE/kg b.w. /d (~0.4 mg/child/d)
- direct ingestion
  - 2400 mg TCE/kg soil
- drinking water
  - 4.34 mg TCE/kg soil

- How do we take care of multiple exposure routes?
- How do we handle multiple contaminants?
- What is the real bioavailability ? (< 100%)

Hazardous chemicals?



After US Academy of Science, 1985

Ecological functions

Physical support for human activity

Plant production

Groundwater filter

Resource for gravel sand and clay

Residence for soil living organisms

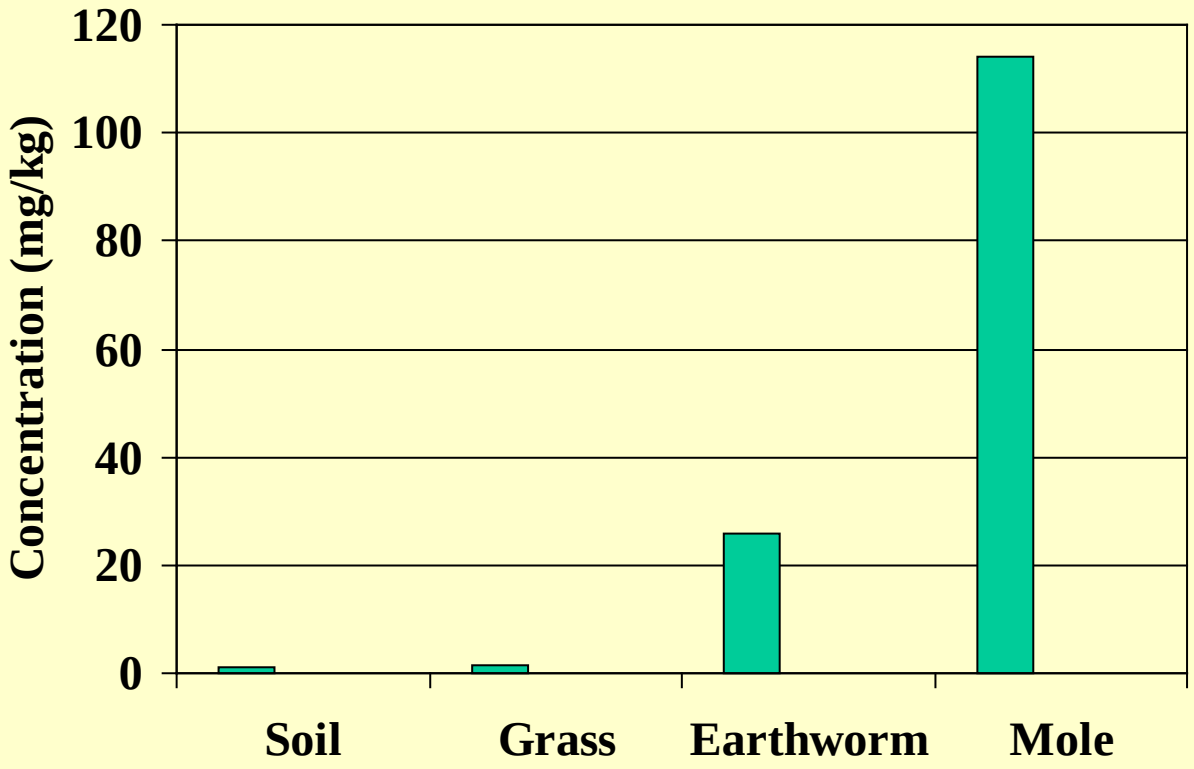
Element cycling

Terrestrial organisms

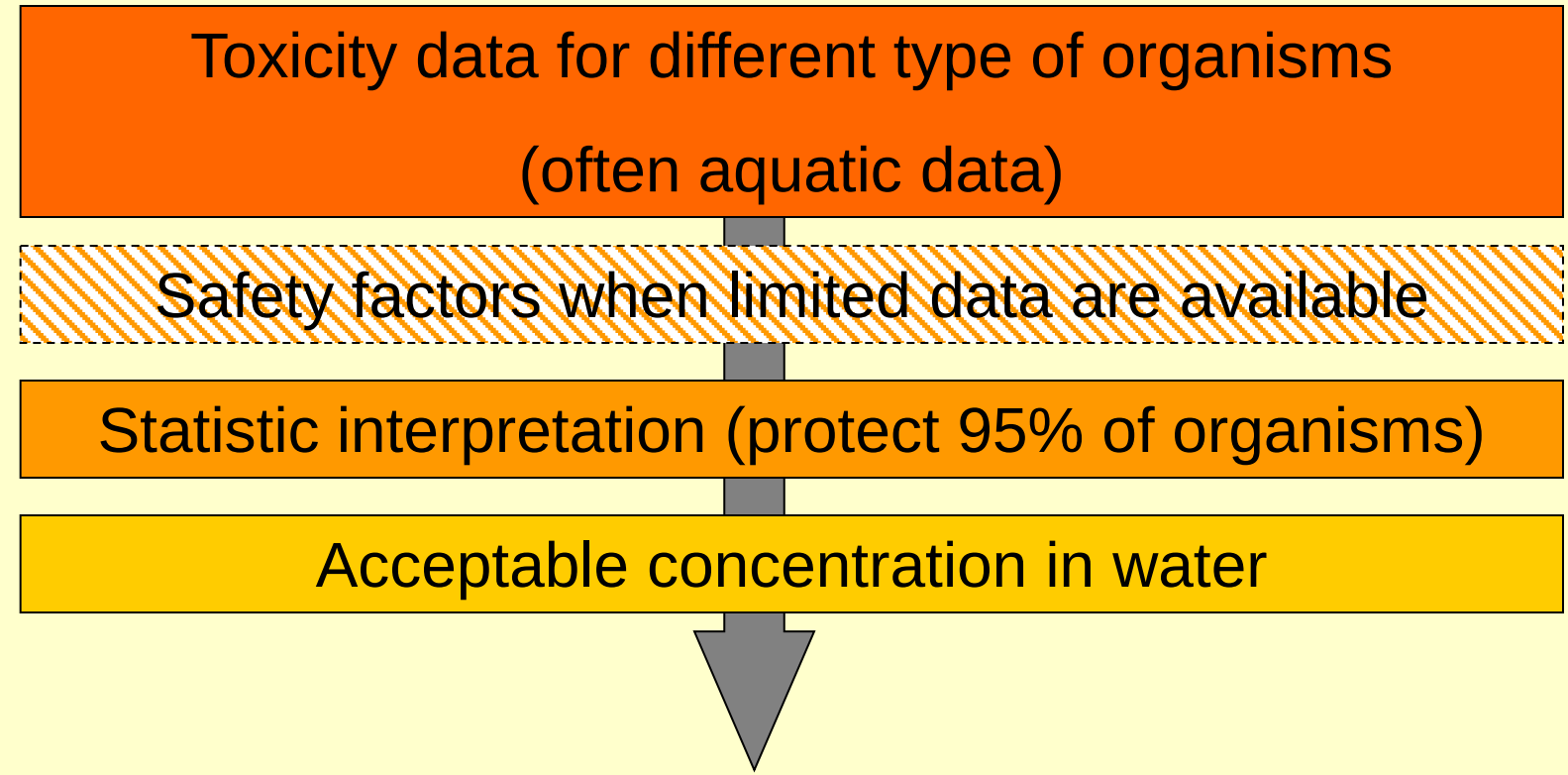
- Protect soil living organisms to ensure soil functioning
- What should we test for:
  - Growth, survival, reproduction
- Limited knowledge available:
  - Effect of chemicals on different organisms
  - Critical organisms for soil functioning
  - Relation of soil functioning to land use
- Find: **Predicted No Effect Concentration** (PNEC)

Bioaccumulation

Cadmium concentration near Zinc smelter



Deriving PNEC



Aquatic toxicity Cd

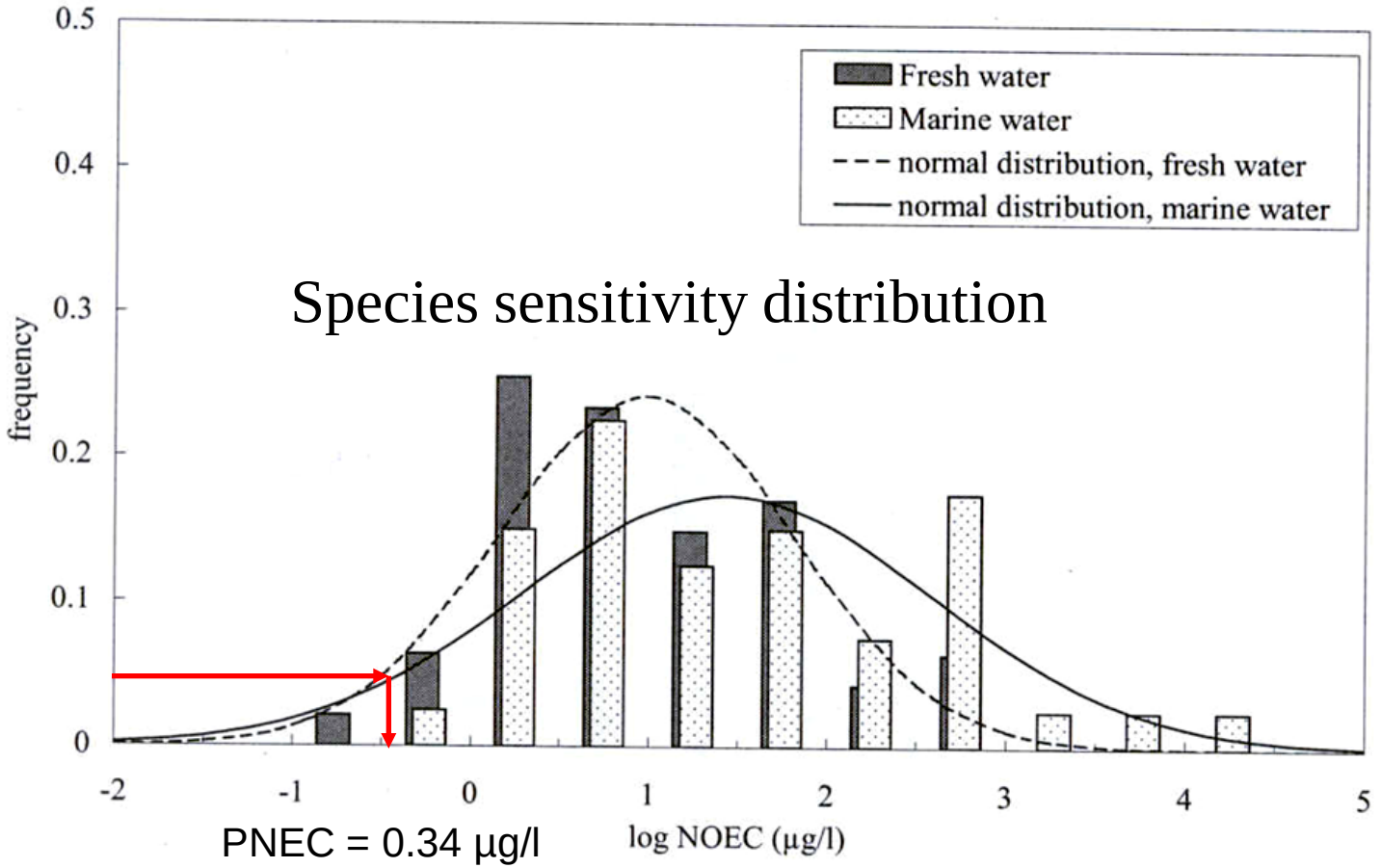
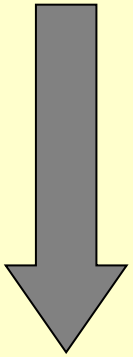


Figure 3.5: Cadmium: Distribution of chronic toxicity data for aquatic species and estimated sensitivity distributions for fresh water species ($n = 47$, $\bar{x} = 0.98$, $s = 0.82$) and marine species ($n = 40$, $\bar{x} = 1.43$, $s = 1.15$).

Distribution coefficient

Toxicity – based aquatic quality criteria

Cd: 0.34 µg/L



Generic Kd

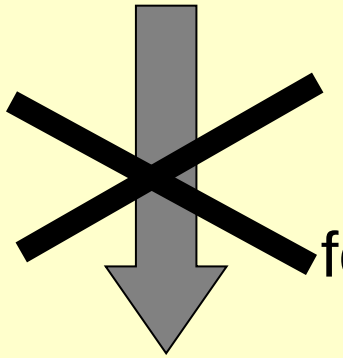
Cd: 85000

Soil/sediment quality criteria

Cd: 29 mg/kg

However.....

Toxicity – based aquatic quality criteria



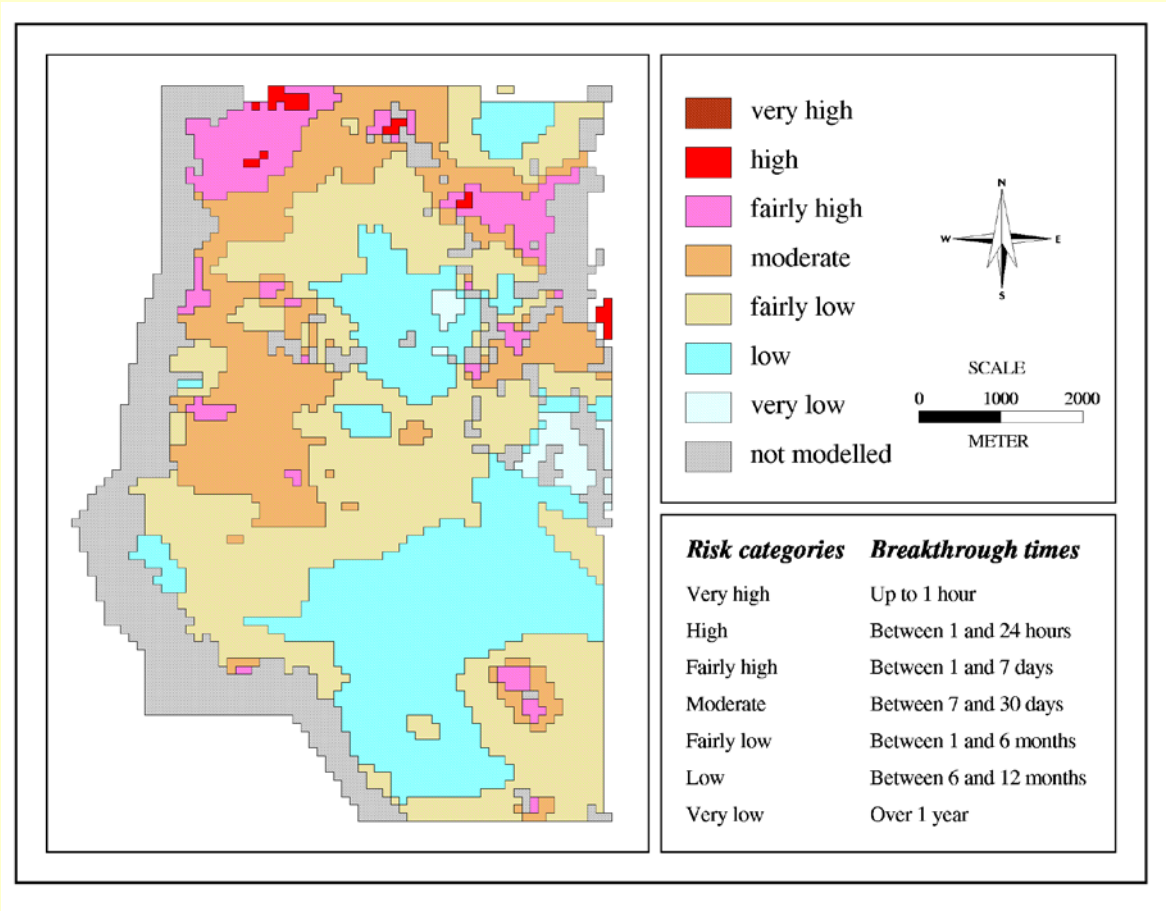
Kd varies
by factor 100-1000
for a given compound

Total sediment contents bear no

relation to toxic effects!

Groundwater contamination risk

Gardermoen



Wong, PhD thesis, UiO 2003