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ENVIRONMENTAL RISK ASSESSMENT OF CONTAMINATED SITES

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Introduction

- Environmental risk of chemicals
  - Amount of damage x probabaility of occurrence
- Environmental Risk Assessment (ERA)
  - Characterizes risk
    How? Discursive, qualitative, quantitative
- Site specific ERA
  - Considers characteristics of the site
    Which? Environmental elements, contaminants, interactions, land uses, exposures, etc.
- Quantitative ERA
  - RQ = PEC/PNEC and HQ = ADD/TDI
- Integrated Risk Model
  - Unifies the transport- and the exposure models
- Aims of ERA:
  - to quantify risk
  - to compare it to acceptable risk,
  - to reduce risk to an acceptable level,
  - to determine site specific target value

Environmental Risk Assessment: a tool for environmental management

1. HAZARD IDENTIFICATION
2. RISK ASSESSMENT
Generic / site specific
Qualitative / quantitative
Ecological / human health risk

1. PREVENTION
2. REMEDIATION
3. RESTRICTION

Management of contaminated sites

NATIONAL REMEDIATION PROGRAMMES

USA: SUPERFUND

GERMANY: ALTLASTEN

HUNGARY: NATIONAL REMEDIATION PROJECT

NEW ATTITUDE

- Problem related assessment
- Risk based remediation
- Inherited contaminated sites
- Prevention of new contamination

LEGISLATION, REGULATION

- UK: 1990 + Guideline
- Denmark: 1983 + 1993
- Germany: 1999 + uniform RA
- NL: 1980 multifunctionality of soil., A,B,C values
- 1997 land use specific
- F: 1993
- HU: 2000/33

Management of contaminated sites

Principles (CARACAS)

- To prevent future pollution
- Polluter pays
- Precaution
- Risk based decision making, RB priority setting, RB remediation

Scientific basis: Integrated quantitative risk assessment

- Assessment of soil and subsurface water, sampling, analyses,
- Exposure modeling,
- Ecotoxicology and toxicology
- Cost-benefit assessment

CARACAS

Concerted Action Initiative on Risk Assessment for Contaminated Sites

International information networks in Europe

CARACAS

Concerted Action on Risk Assessment for Contaminated Land (1996-1998)

- Participants: scientists and legislators from 16 European countries
- Topics: research and development on the field of
  - human toxicology
  - ecotoxicology,
  - transport and fate of contaminants in the environment,
  - survey of contaminated sites, sampling and analytical issues,
  - modeling,
  - environmental quality criteria,
  - ERA methodology
- Result: two books: scientific basis and practice

CLARINET

Contaminated Land RehabilitationNetwork for Environmental Technologie in Europe (1998-2001)

- Identifies key-elements for decision making and the necessary research for the management of contaminated sites
- Participants: scientists, researchers, consultants, govenrment/experts, owners of contaminated land, engineers from 16 EU countries
- Topics: brown/field development, protection of water-base, decision/supporting systems,remediation technologies, ecological and human aspects of land uses, cooperation of RTD programmes in Europe.

NICOLE: Network for Industry Contaminated in Europe (1996-99-)

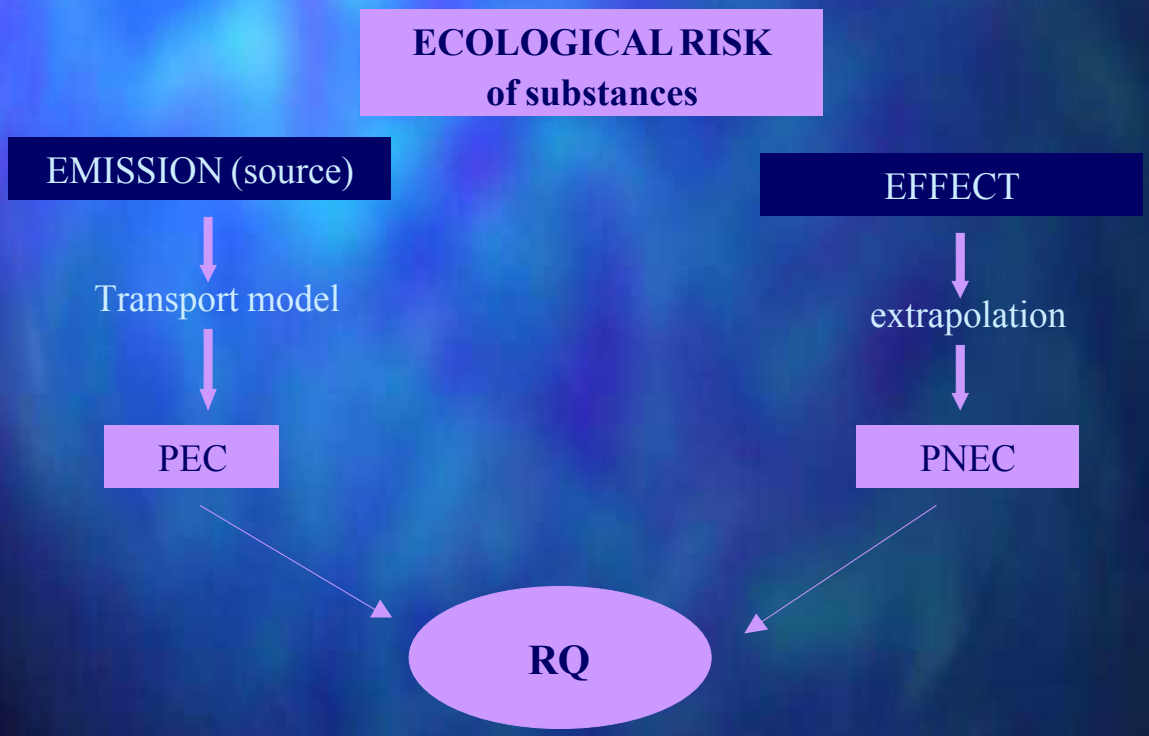
RACE: Risk Abatement Center for Contaminated Soil in CEE Countries

Environmental Risk Assesment of Substances

EU TGD

Technical guidance document for environmental risk assessment of new and existing substances, Brussels, 1996

It supports the orders of EC 1488/94 and EEC 793/33

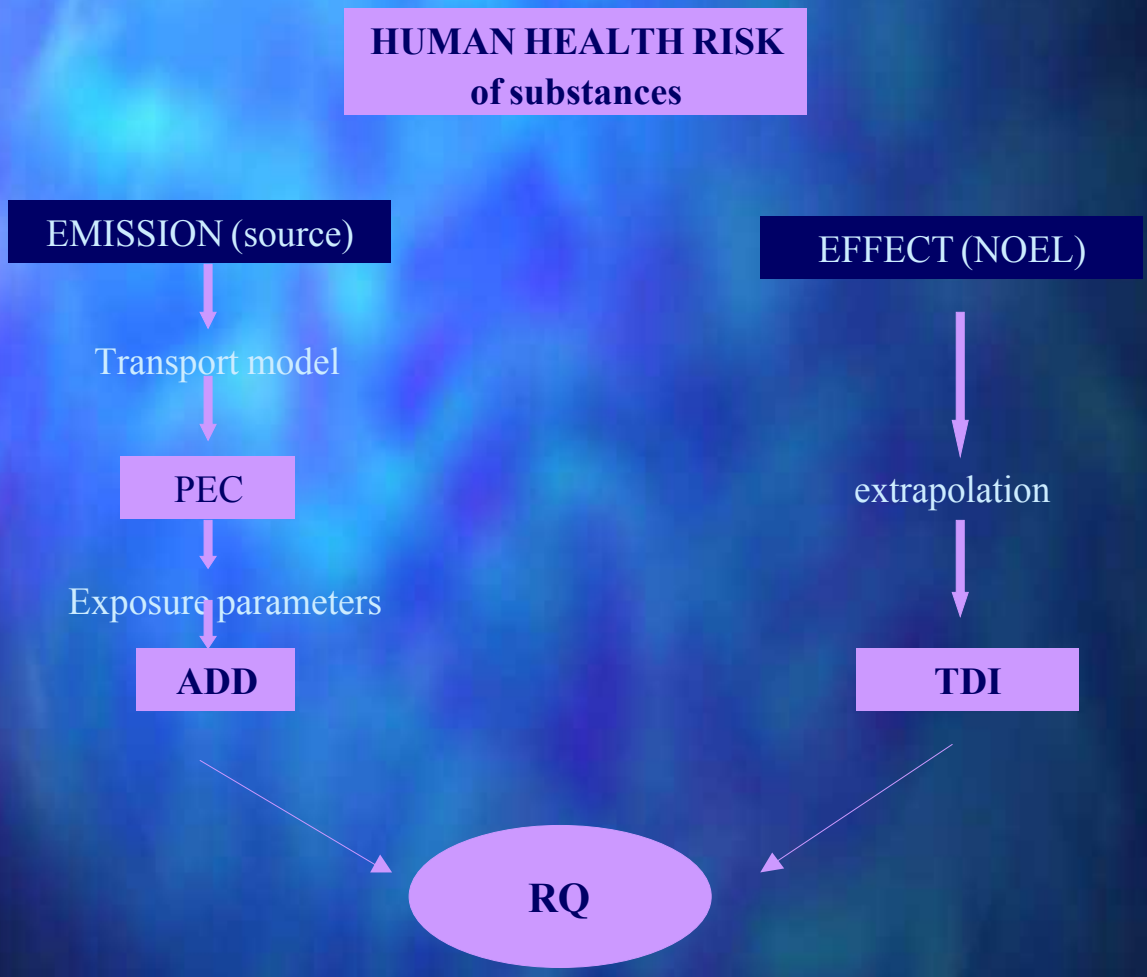


PEC: Predicted Environmental Concentration of a chemical substance

PNEC: Predicted No Effect Concentration of a chemical substance

Gruiz, K.- Tool of Sustaninability - Environmental Risk Assessment

Environmental Risk Assesment of Substances



ADD: Average Daily Dose taken in by humans from the chemical substance

TDI: Tolerable Daily Intake by humans from the chemical substance, in question

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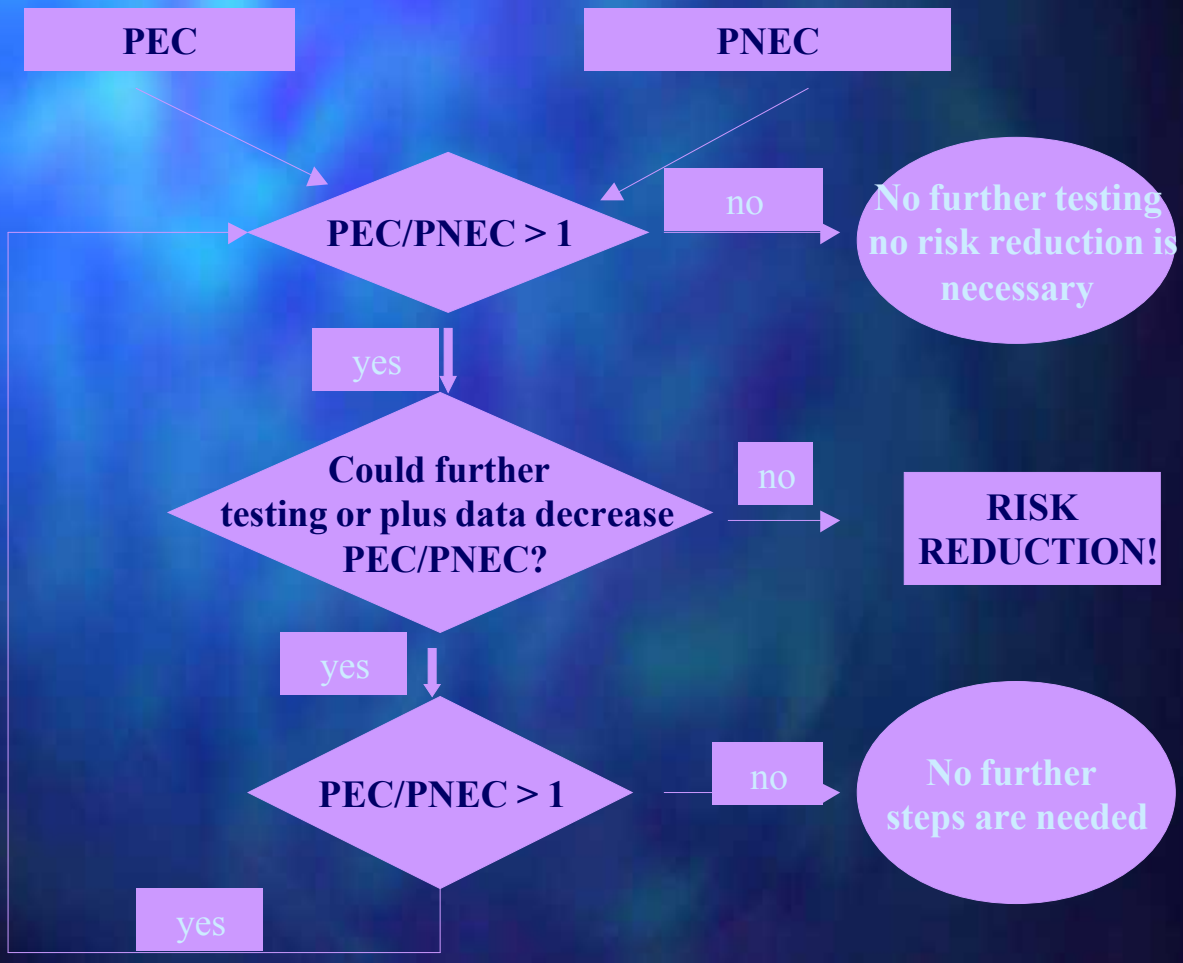
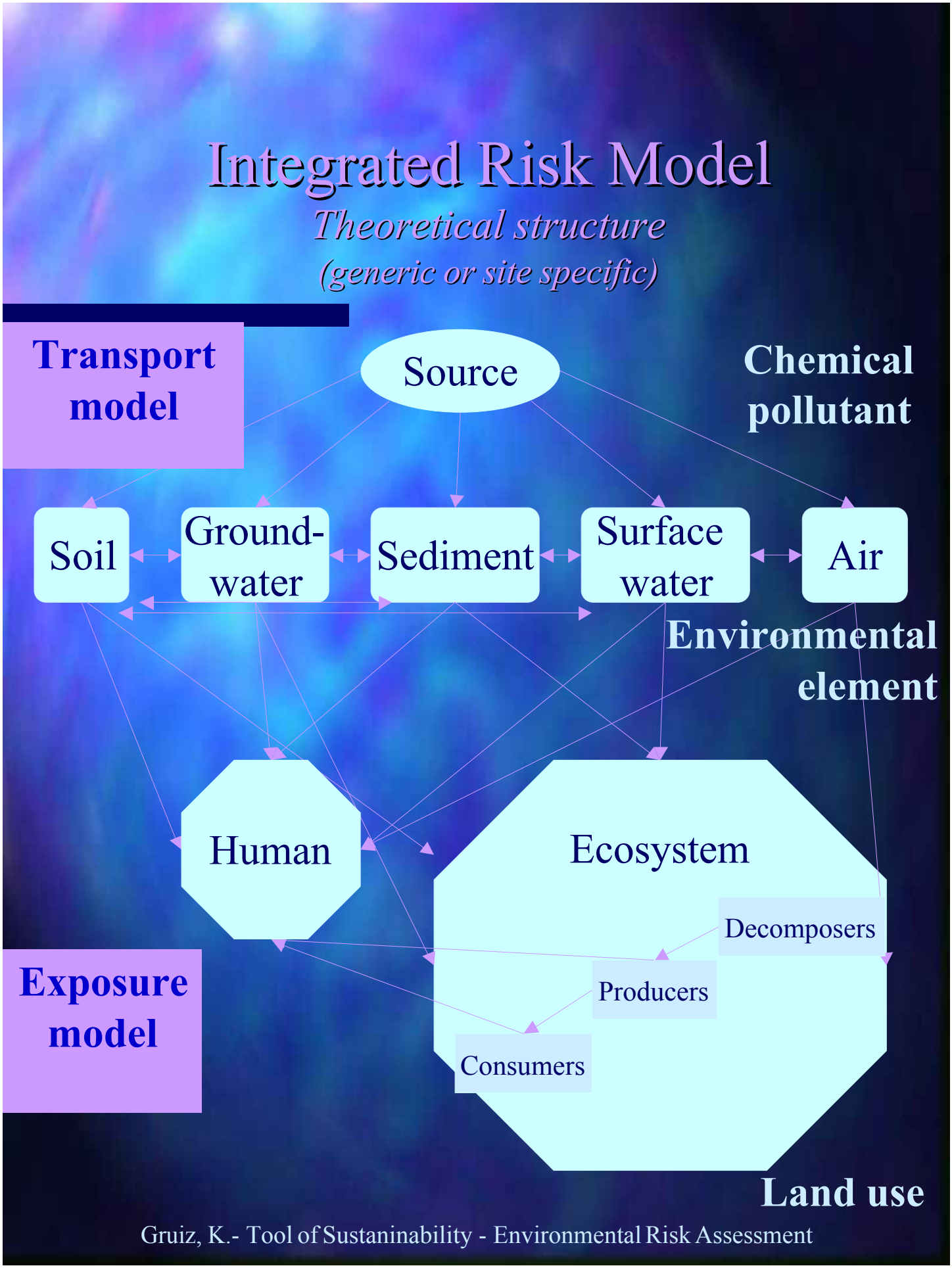
Quantitative environmental risk assessment of substances

Characteristics:

- gradual procedure (cost effective),
- iterative
- it uses worth case estimation (pessimistic model)
- it works also in case of lack of data (exclusion)




Integrated Risk Model
Theoretical structure
(generic or site specific)
Transport model
Source
Chemical pollutant
Soil
Ground-water
Sediment
Surface water
Air
Environmental element
Human
Ecosystem
Decomposers
Producers
Consumers
Exposure model
Land use
Gruiz, K.- Tool of Sustaninability - Environmental Risk Assessment

Qualitative environmental risk assessment and ranking of contaminated sites

CHARACTERISTICS OF QUALITATIVE ERA

- Also called **relative risk assessment**
- Characterizes the risk with points or marks or %
- Useful in case of many contaminated sites to compare them
- Priority setting and ranking is possible with its help

The system used for preliminary risk assessment of contaminated sites in the Hungarian National Remediation Programme:

$$P = \Sigma\ T_i \times S$$

P = Priority number

T_i= Evaluating parameter, its value: 1-3

(1. targets: human health, environmental elements, ecosystem, any activities; 2. hazard of the contaminant; 3. amount of the contaminant; 4. contamination in soil; 5. contamination in subsurface water

S = Weight, its value can be: 1-10

Quantitative risk assessment of contaminated sites

CHARACTERISTICS OF QUANTITATIVE ERA

- Also called **absolute risk assessment**
- Characterizes the risk with real quantities (with unit of measure)
- Its result can be generic or site specific
- Useful for single or more contaminated sites
- Its result is suitable for decision making on Risk Reduction (RR)
- Risk can be reduced by decreasing PEC or increasing PNEC (TDI)
- Risk result gives the target value of remediation or other type RR activit
- It is a stepwise procedure: preliminary or for detailed assessment
- It works with worth case estimation: excludes the negative sites during the procedure as soon as possible
- It works with a gradual iterative methodology: cost effective
- It is a coservative approach: overestimation of the risk and exclusion only of the safe negatives

Stepwise site specific ERA

PEC estimation and its refined assessment (for all environmental phases)

1. **Maximal measured concentration (in the contamination source)**
2. **Application of a simple transport model, which considers emission and decrease of the concentration between source and receptor**
3. **Application of a refined transport model considering partition and biodegradation**
4. **Special needs, eg. food chain effects: bioconcentration, biomagnification**

PNEC estimation and it refined assessment

1. **Application of generic PNEC, eg. limit values, or EQC for most sensitive land use**
2. **Site specific land uses and residents**
3. **Direct ecotoxicity and toxicity testing → site sp. PNEC**

Ecotoxicity testing: the proper tool for ERA

Problems of testing of environmental samples:

- mixture of contaminants
- interactions between contaminants, matrix and biota
- medium: extract, whole sample

Problems of testing of soil samples from contaminated land

- mixture of contaminants: sinergism, antagonism
- biotransformation: effect of products
- biodegradation
- availability: physico-chemical and biological availability differs
- analytical programme includes only part of the really occurring chemicals
- biotic and abiotic composition of the environmental sample influence the results

Ecotoxicity testing: the proper tool for ERA

Ecotoxicity testing gives solution for some of the problems

- integrates interactions between toxicants
- integrates interactions between toxicant and matrix
- measures bioavailable ratio of the contamination
- measures chemically not measurable toxicants by their effect
- measures effects of chemicals not included into the analytical programme

Expectations:

- ecological relevance
- reproducibility
- reliability
- robustness
- sensitivity