From hazard to risk assessment of contaminated soils: from single chemicals to chemical mixtures

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FACTORS AFFECTING SOIL ECOSYSTEMS

HUMAN PRESSURE

- CHANGES IN LAND USE
- INVASIVE SPECIES
- CLIMATE CHANGE
- CHEMICAL POLLUTION

PESTICIDES

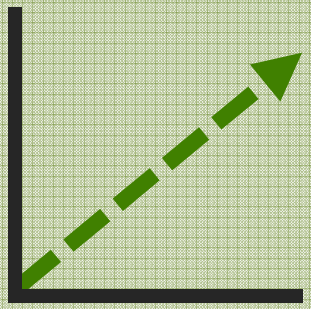
+

Improve Crops (performance)

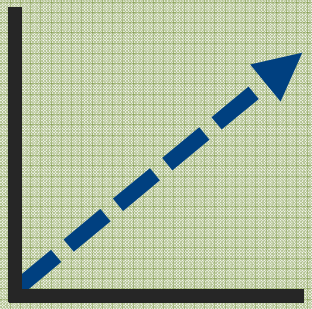
&

Fertilizers

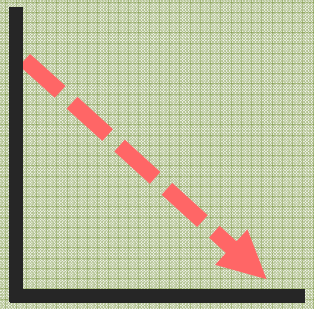
“GREEN REVOLUTION”



Yield



Application



Costs

How is evaluated soil quality and what are the constraints?

#1 Constraint…

No specific soil regulation or legislation (similar to the Water Law or the Water Framework Directive)

Ontario Ministry of the Environment de 2011

#2 Constraint…

Chemical **hazard** assessment **one-by-one basis**
Independently from **climacteric conditions, soil type**

#3 Constraint…

It's Hard to Assess Hazard accurately!

Case Study #1: Repeated Application

Folsomia candida

AIM: Study on effects of molluscicide baits (metaldehyde)

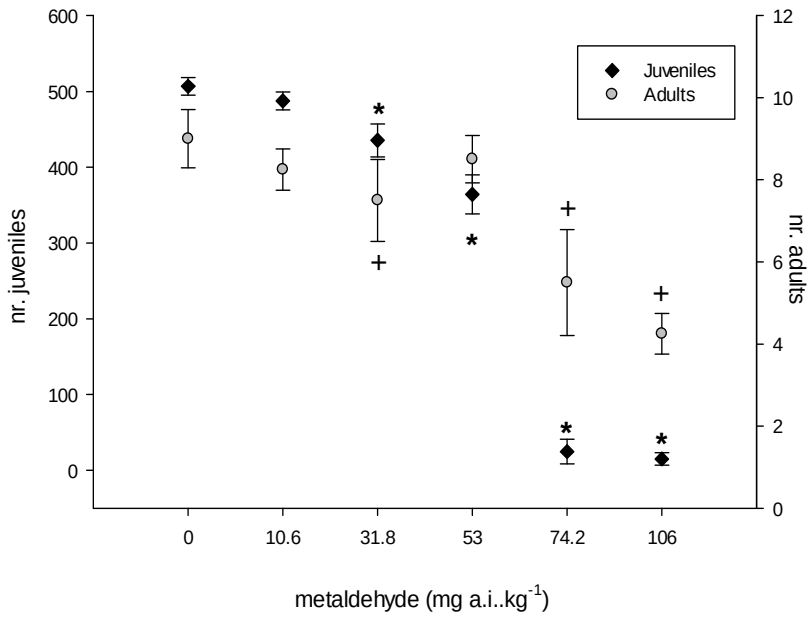
APLICATION: Surface; repeated accordingly to the manufacturer

Usual HAZARD ASSESSMENT: soil incorporation and single dose

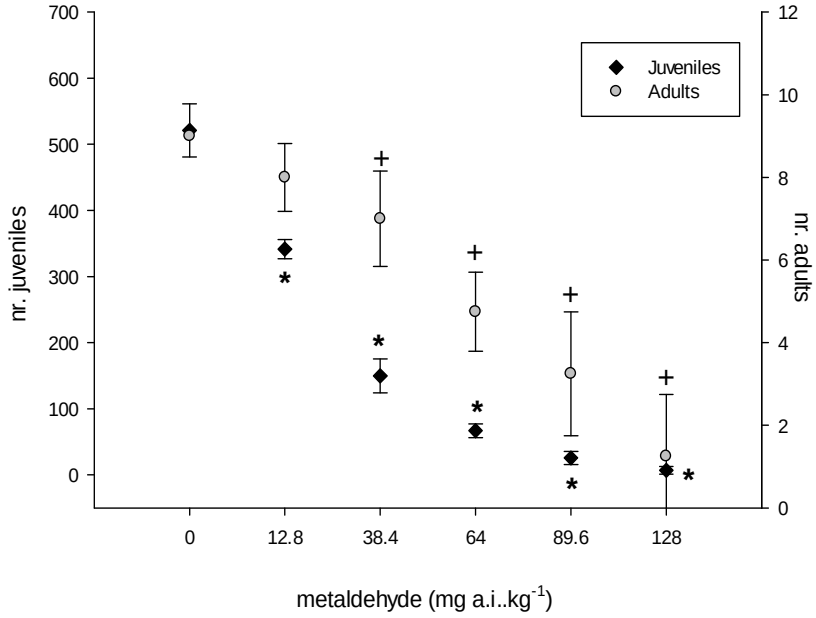
New Approach: double application

Cardoso et al (2015) Chemosphere, 132: 1-7

APLICATION #1



APLICATION #2



Case Study #2: Pesticides and Climate

Porcellionides pruinosus

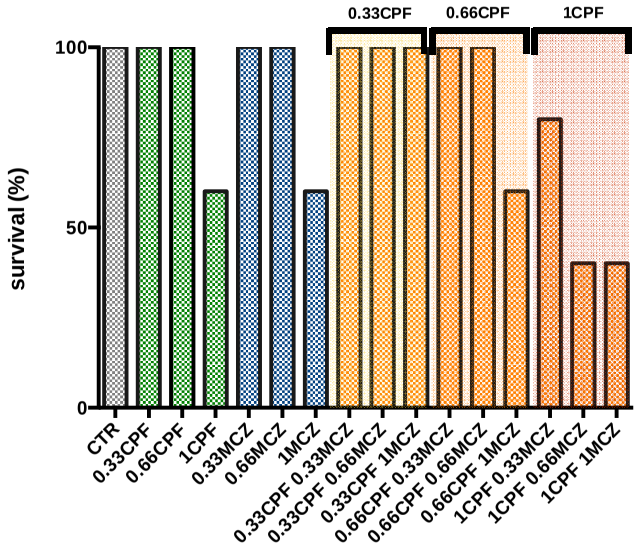
AIM: Study how temperature influences the effects of pesticides chlorpyrifos and mancozebe

Usual HAZARD ASSESSMENT : optimum laboratory conditions

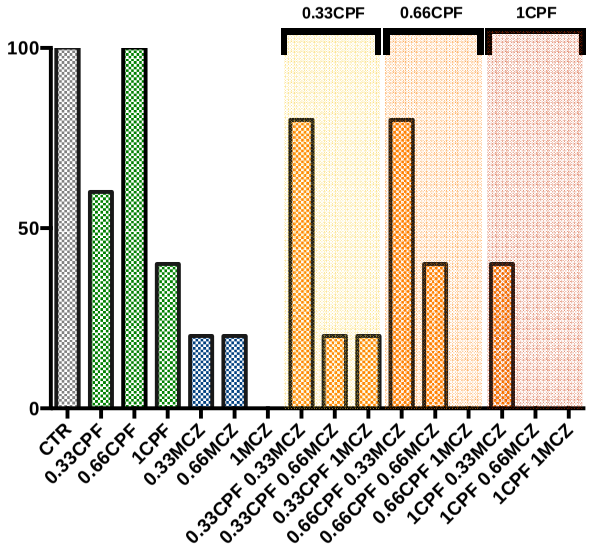
single chemical exposure

New Approach: Temperature fluctuation and Binary mixtures assessment

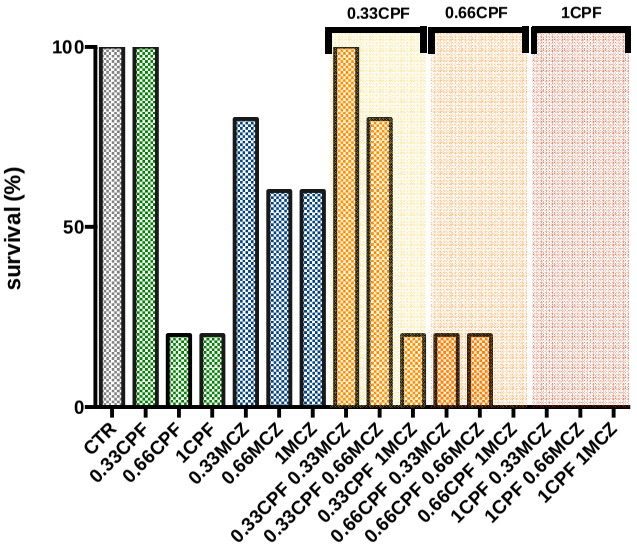
15 ºC – 25 ºC



5 ºC – 15 ºC



25 ºC – 35 ºC

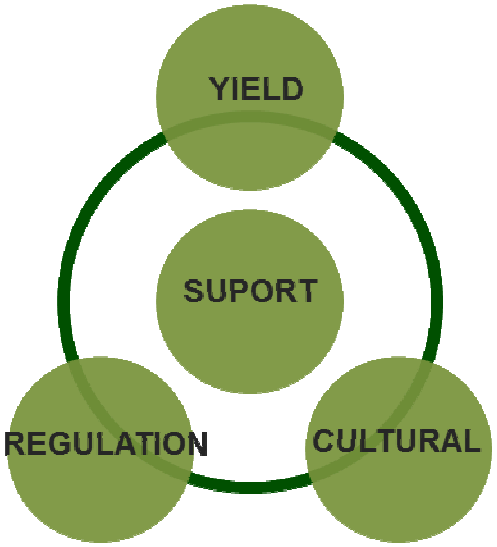


Case Study #3: Agro-ecology and Ecosystem Services

AIM: Study agroecosystem services, integrating parameters

Usual HAZARD ASSESSMENT : species toxicity

New Approaches: integrate parameters evaluating soil support, regulation, biodiversity and yield.



INTEGRATE SEVERAL SERVICES

INDICATORS

- Soil OM
- Carbon
- Nitrogen
- Soil aggregation
- Photosynthetic capacity
- Radicular system
- Functional Biodiversity
- Microbial Biomass
- Bait-Lamina
- Field traps for invertebrates

SUPORT and REGULATION

- Fertility
- Soil Formation
- Biological Activity
- Disease and Pest control
- Primary Production
- Nitrogen Cycle

YIELD

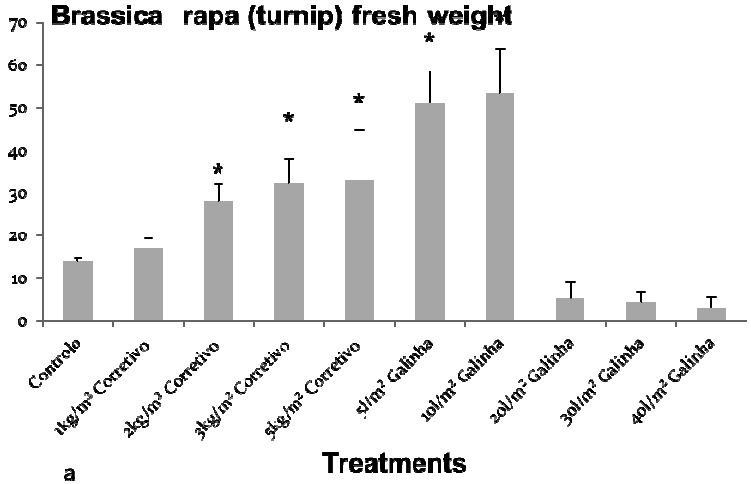
- Yield
- Sustainability
- Profit

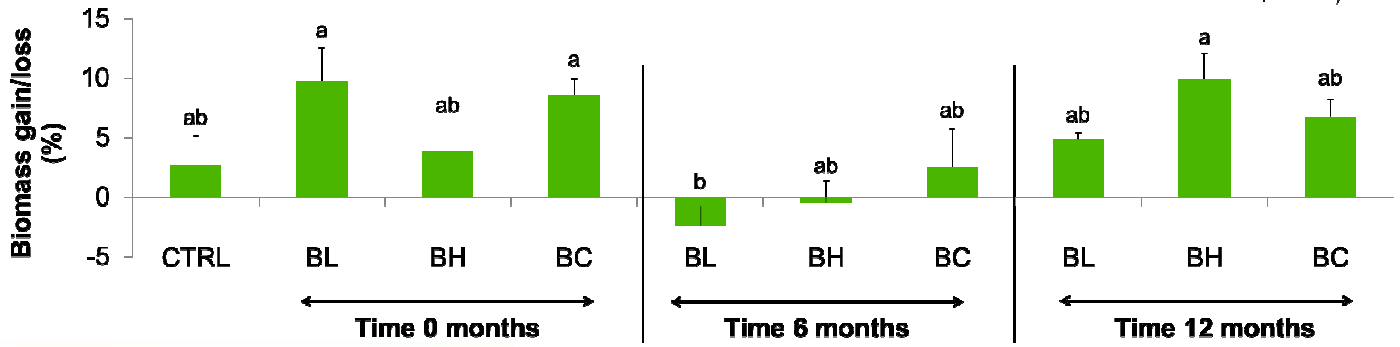
Case Study #4: Improving Soil Quality

Fertilizers and biochar with or without pesticides

Usual HAZARD ASSESSMENT : No Assessment

New Approach: integrate exposure and assessment





How to deal and integrate chemical mixtures In Environmental Risk?

#1 Constraint…

No specific threshold concentrations for comparison with hazard outputs

Ontario Ministry of the Environment de 2011

#2 Constraint…

Risk Coefficient Calculation on a chemical **one-by-one basis**
Independently from **climacteric conditions, soil type**

#3 Constraint…
Risk is Underestimated! Not even additive!

PNEC- Predicted No Effect Concentration

- Based on **hazard assessment and standardized tests**
- Different traits/trophic level-position
- NOEC
- Application of safety factors

HC_5- Hazard Concentration 5% species

- Based on **hazard assessment and Species Sensitivity Distribution**
- Number of species (>8)
- NOEC, EC_{10}, EC_{50} (lack of data)
- Application of safety factors

Constraints:

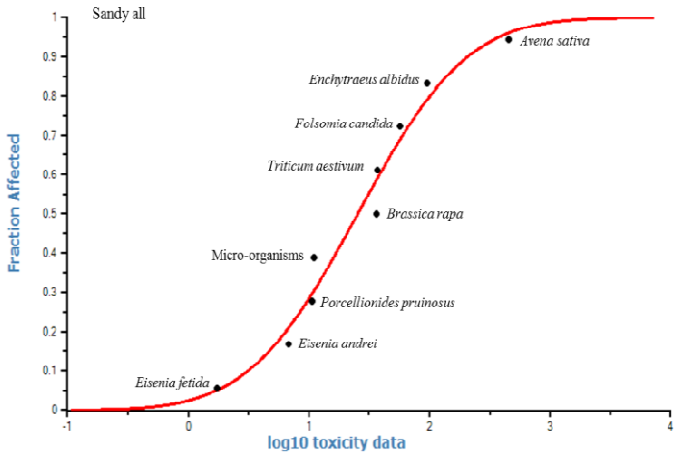
-long-term tests (compared with water)

-Lack function assessment

-Lack integration

-Lack applied strategy

-Lack of data (reliable data)



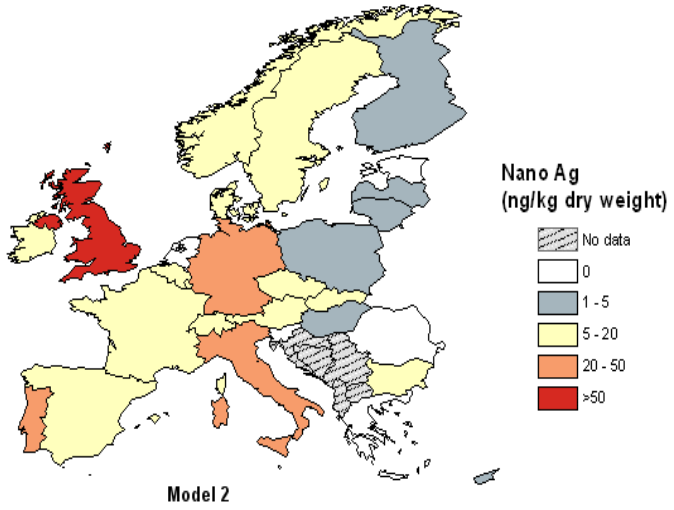
PREDICTED NO EFFECTS CONCENTRATION – PNEC (or HC_5)

Mapping risk

NOEC, EC_{10}, EC_{50}

- **PREDICTED ENVIRONMENTAL CONCENTRATION**
- **MEASURED ENVIRONMENTAL CONCENTRATION**

$$Risk = \frac{PEC_i}{PNEC_i}$$



What is Cumulative Risk?

Cumulative risk is the combined risks from aggregate exposures to multiple agents or stressors, which may include chemicals, biological or physical agents.

Cumulative risk assessment (CRA) is an analysis, characterization, and possible quantification of the combined risks to human health or the environment from multiple agents or stressors.

Source: U.S. EPA. 2003. Framework for Cumulative Risk Assessment. U.S. EPA/ORD/NCEA, Washington, DC. EPA/600/P-02/001F.
Available at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54944.

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Response Addition Method

$$R_m = \sum_{i=1}^{n} r_i$$

Where:

R_m = mixtures risk

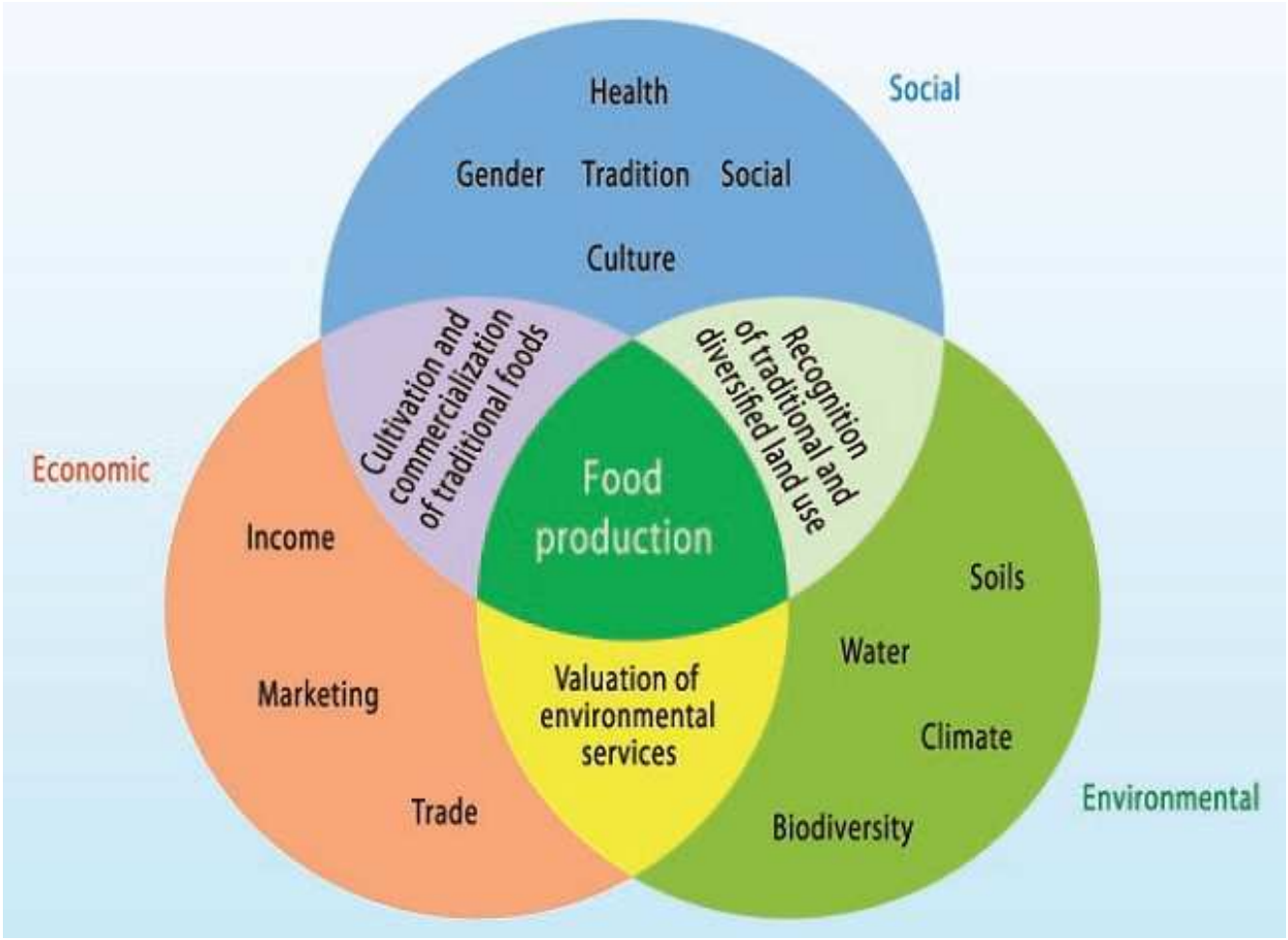
n = number of components

r_i = component risks

Needs to be implemented!

ECOSYSTEM SERVICES

Sustainable Agriculture



http://www.groundswellinternational.org/

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR Portugal

PORTUGAL 2020

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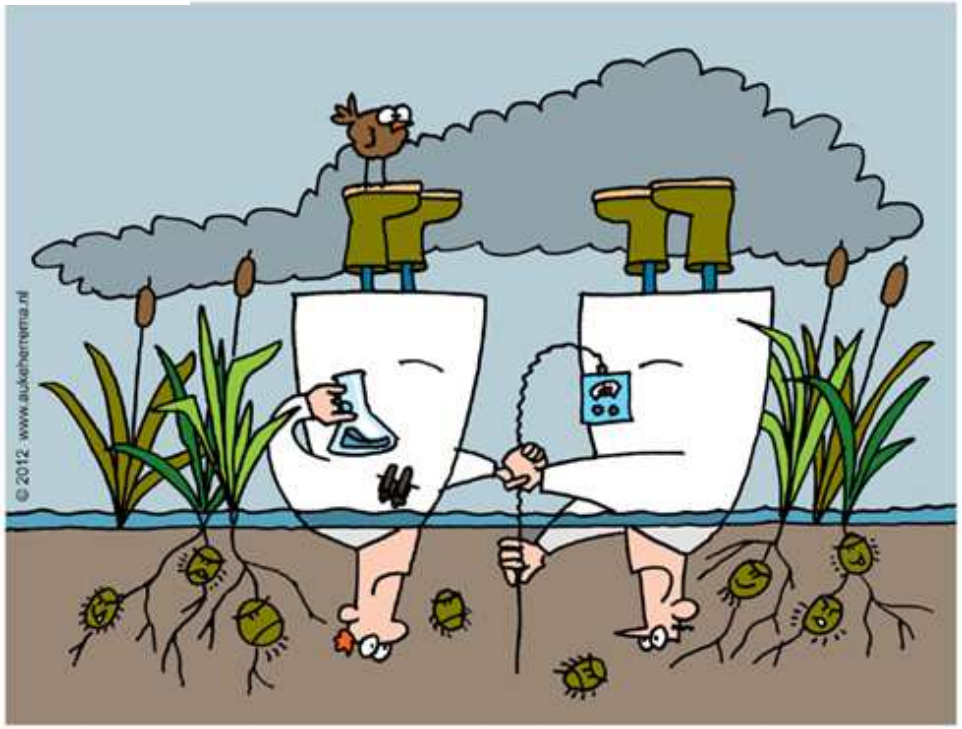

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