MŰEGYETEM 1782

Budapest University of Technology & Economics
Faculty of Chemical Engineering and Biotechnology
Department of Applied Biotechnology & Food Science

BME is the most significant University of Technology in Hungary, and it is one of the oldest Institutes of Technology in the world. BME was the first institute in Europe to train engineers at university level.
It was founded in 1782. It has 1,100 employees and 24,000 students.

Eight faculties:
Civil Engineering (1782)
Mechanical Engineering (1871)
Architecture (1873)
Chemical Engineering and Biotechnology (1873)
Electrical Engineering and Informatics (1949)
Transportation Engineering (1955)
Natural Sciences (1998)
Economic and Social Sciences (1998)

Nobel-prize holders:
Dénes Gábor, inventor of holography: 1971 Nobel Prize in Physics
George Oláh: 1994 Nobel Prize in Chemistry
Wigner Jenő: 1963 Nobel Prize in Physics
Fülöp von Lénárd: 1905 Nobel Prize in Physics

Faculty of Chemical Engineering and Biotechnology

Chemical engineering (first diploma:1907)

Bioengineering (1976)

Environmental engineering (1999).

Department of Applied Biotechnology and Food Science

Founded in 1909 as the Department of Agrochemistry and Soil Science, later it was called Agricultural Chemical Technology, covering biotechnology from the very beginning.

The building is the oldest building of the University from 1904.

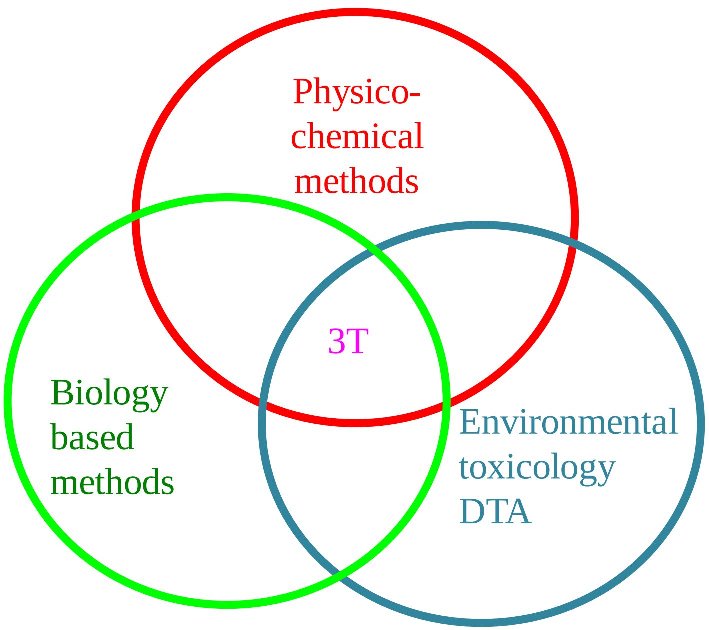

Research Group of Environmental Microbilogy & Biotechnology

Biotechnology in environmental science and technology

COMPLEX RISK MANAGEMENT TOOL

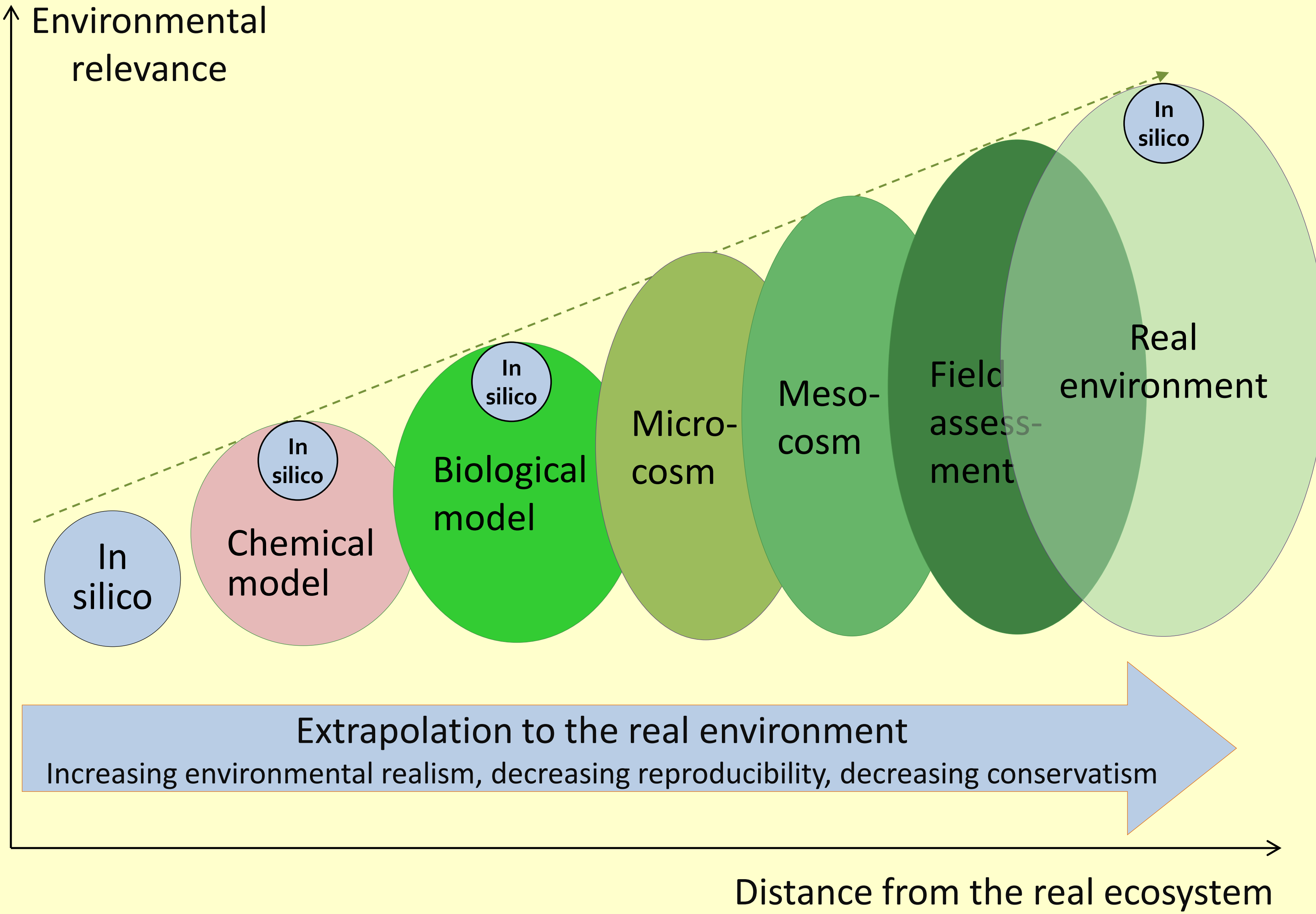
INTERPRETATION TOOLS

Assessment & monitoring tools



- TRANSPORT AND FATE MODELING
- GIS-BASED MODELING
- GENERIC RISK ASSESSMENT
- TARGETED RISK ASSESSMENT
- STATISTICAL TOOLS

- CONCEPTUAL MODELS
- TOOL BATTERIES FOR ASSESSMENT AND MONITORING
- REMEDIATION OPTIONS: EVALUATION, VERIFICATION
- DATA EVALUATION INFORMATION KNOWLEDGE
- DECISION SUPPORT TOOLS


Environmental relevance
In silico
Chemical model
In silico
Biological model
In silico
Micro-cosm
Meso-cosm
Field assess-ment
Real environment
In silico
Extrapolation to the real environment
Increasing environmental realism, decreasing reproducibility, decreasing conservatism
Distance from the real ecosystem

RESEARCH AND DEVELOPMENT IN EMB GROUP

ENVIRONMENTAL ASSESSMENT AND MONITORING

- In situ assessment and testing
- Biomimetic chemical extraction
- Development of new ecotoxicological methods:
    - Agar-diffusion method for screening of metals in soil
    - Microcalorimetry for toxicity assessment
    - Tetrahymena, the single cell animal fo toxicity testing
    - Mesuring the endpoint of heart-rate of Daphnia
    - Rapid plant bioaccumulation test
    - Several direct toxicity testing methods for soil
    - Testing of a realistic worth case by simulation
    - Microcosm testing

RISK ASSESSMENT

- Tiered approachfor contaminated site asessment
- Risk assessment of contamination from point and diffuse sources
- Generic and targeted risk assessments
- Qualitataive and quantitative risk assessments
- Examples: Zn-Pb mine, trasformer oil contaminated sites, red mud flooded area

RESEARCH AND DEVELOPMENT IN EMB GROUP

RISK REDUCTION

- In situ soil/groundwater remediation: hydrocarbons, chlorinated solvents, metals
- Bioremediation methods
  - Aerob biodegradation based methods, phytoremediation
- Combined chemical and bioremediation
  - CDT: cyclodextrine enhanced mobilization & biodegradation based remediation
  - CCP: combined chemical and phytostabilization of metal contaminated sites
- Waste management combined with soil enhancement and remediation
  - SOILUTIL Project: waste utilization for soil, databases, technologies, e.g.
    - Flay ash for the stabiliztaion of metal contaminated soil
    - Red mud for metal stabilization in soil
    - Organic waste for amending soil structure, water and nutrient regime

RISK MANAGEMENT

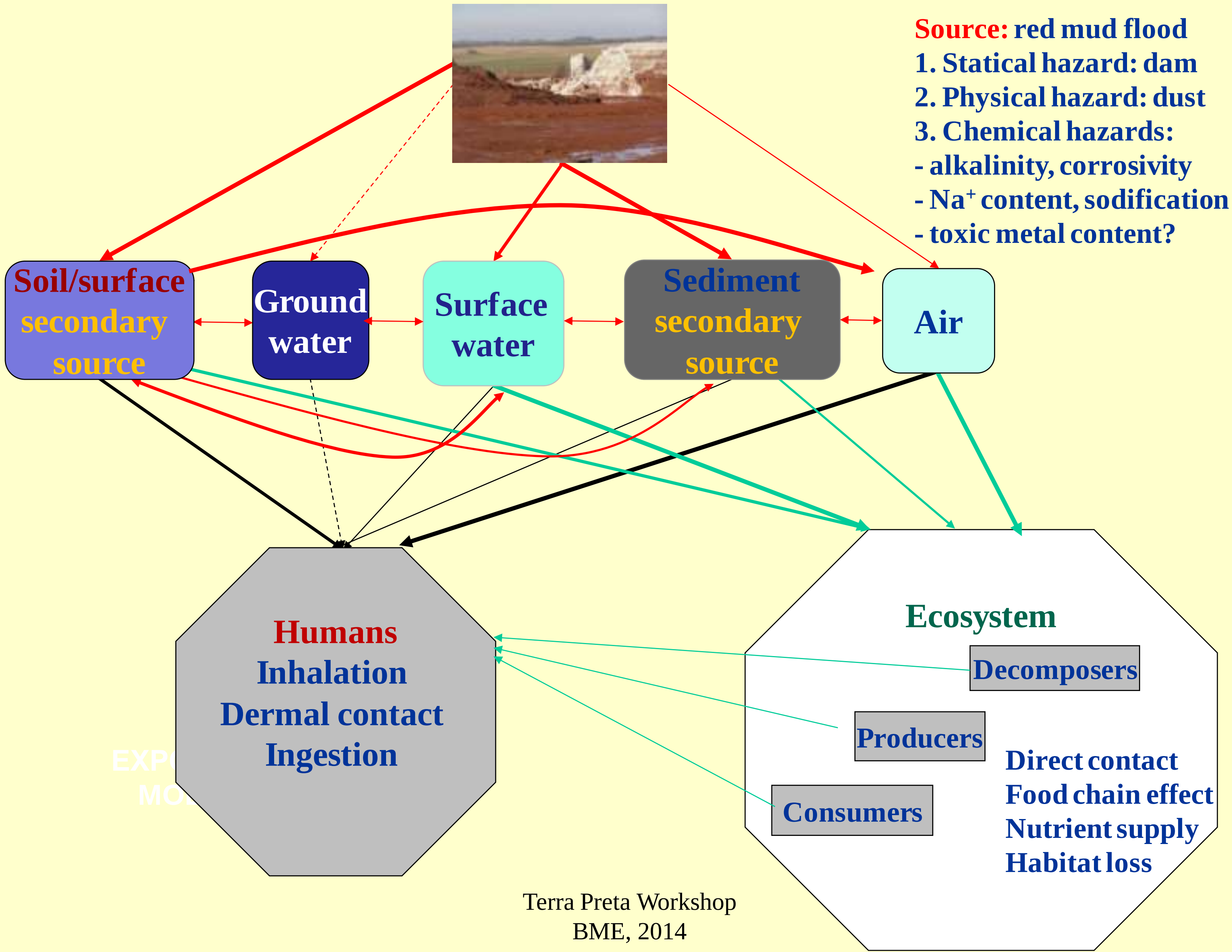
- Development of decision support tools
- Databases, knowledge bases
- Complex evaluation & verification of management tasks in prospective and retrospective ways

LEGISLATION

- Chemicals
- Contaminated land

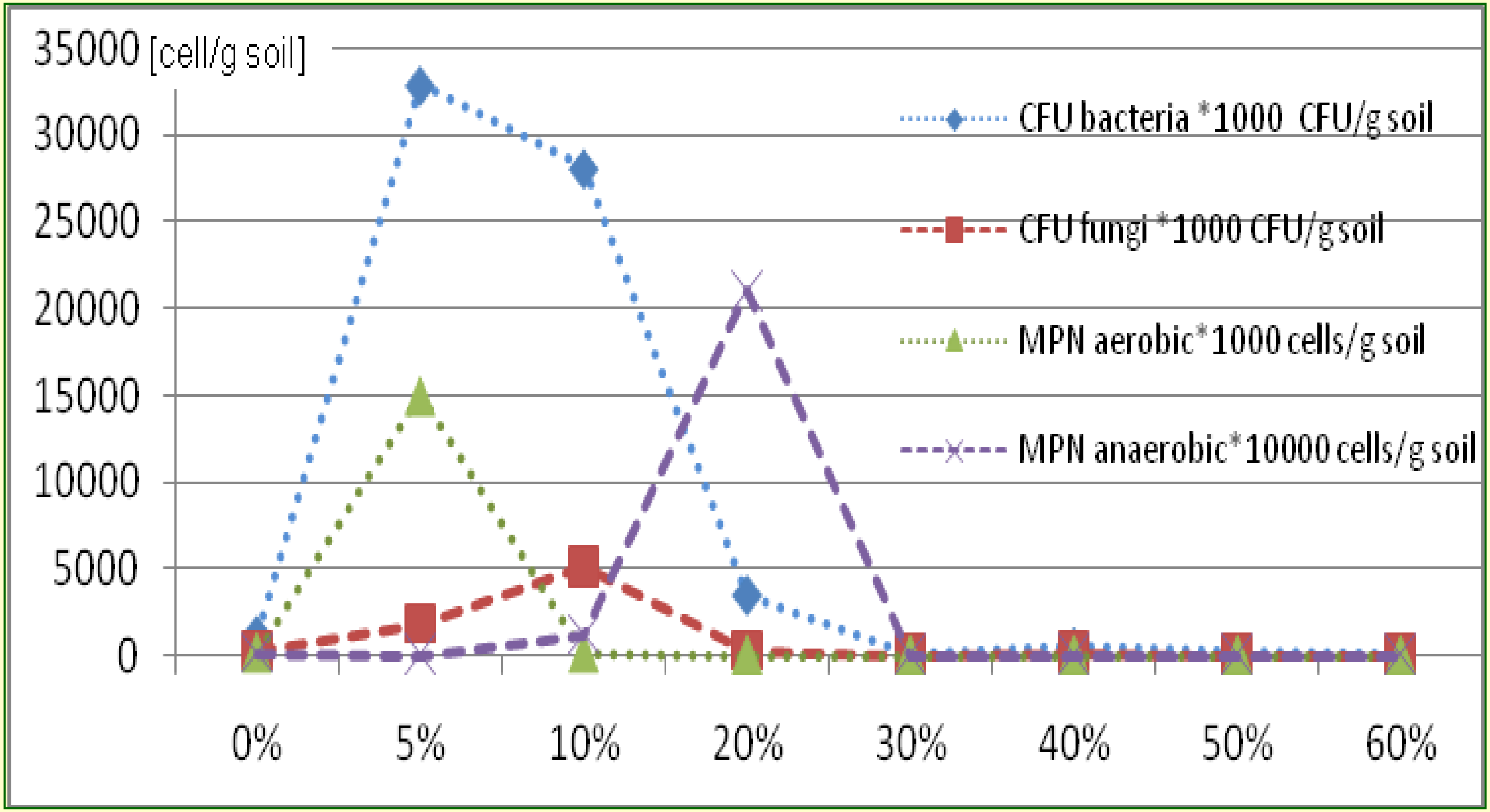
The red mud flood of Ajka – Kolontár

The red mud flood of Ajka – Kolontár

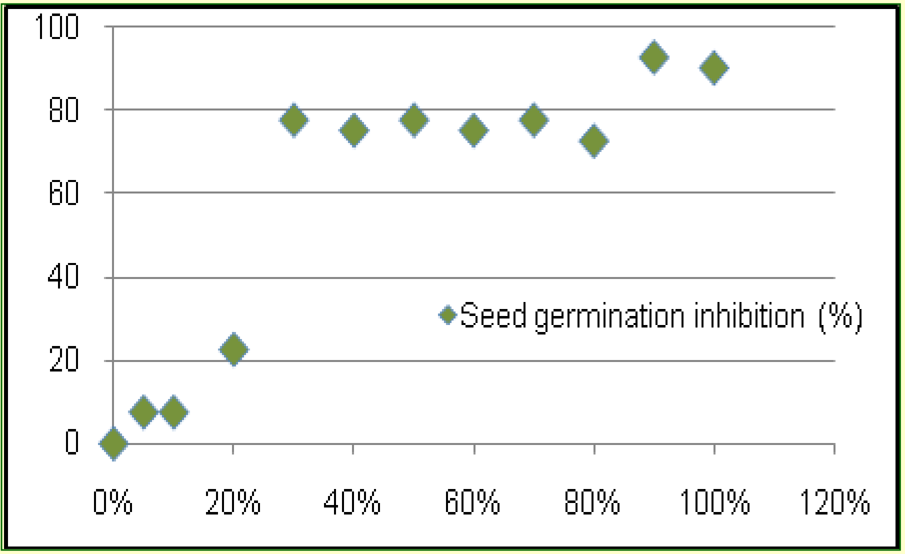


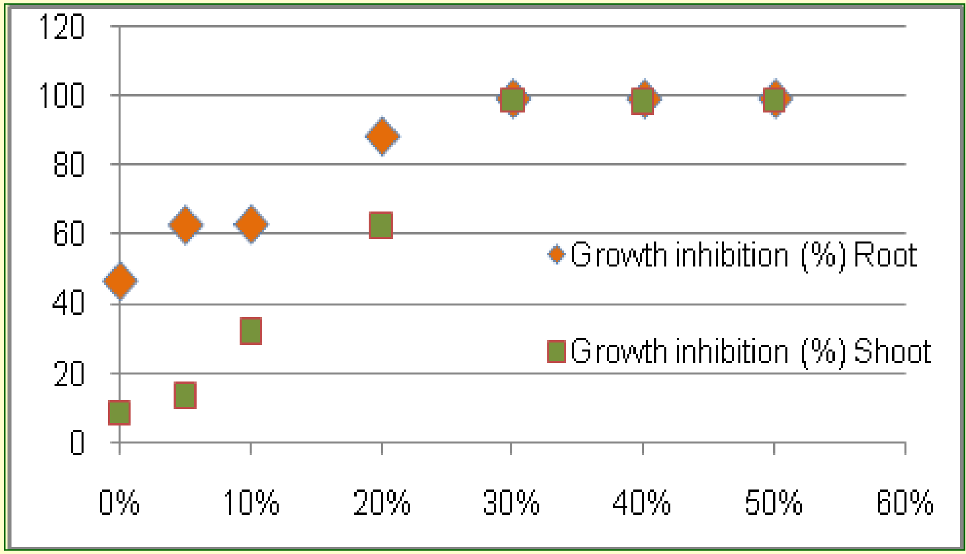
Source: red mud flood
1. Statical hazard: dam
2. Physical hazard: dust
3. Chemical hazards:
- alkalinity, corrosivity
- Na^+ content, sodification
- toxic metal content?

Microbial cell numbers in soil after RM incorporation in 0–60%

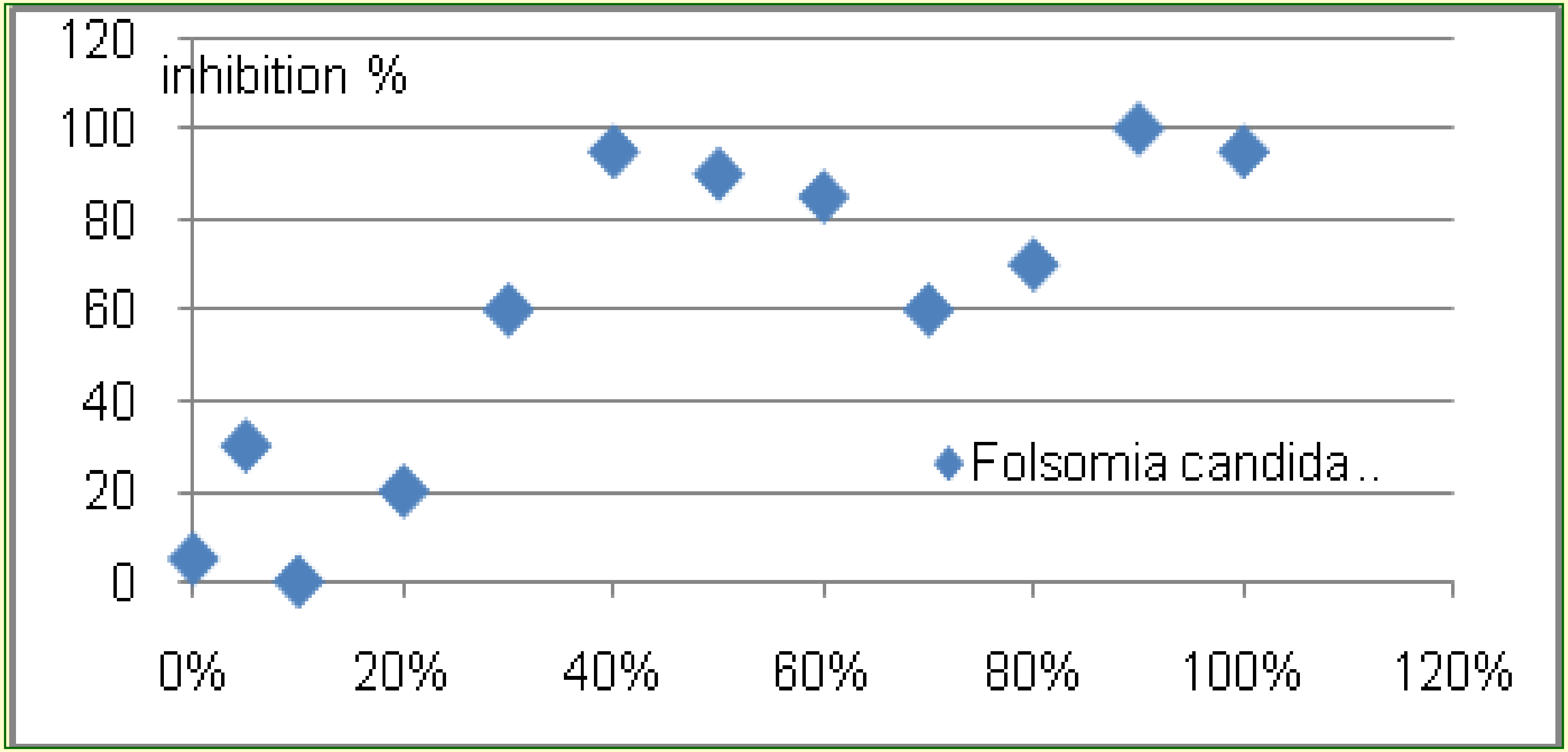


Inhibition of seed germination and plant root and shoot growths in soil after RM incorporation in 0–60%





Inhibition of collembola in soil after RM incorporation in 0–100%

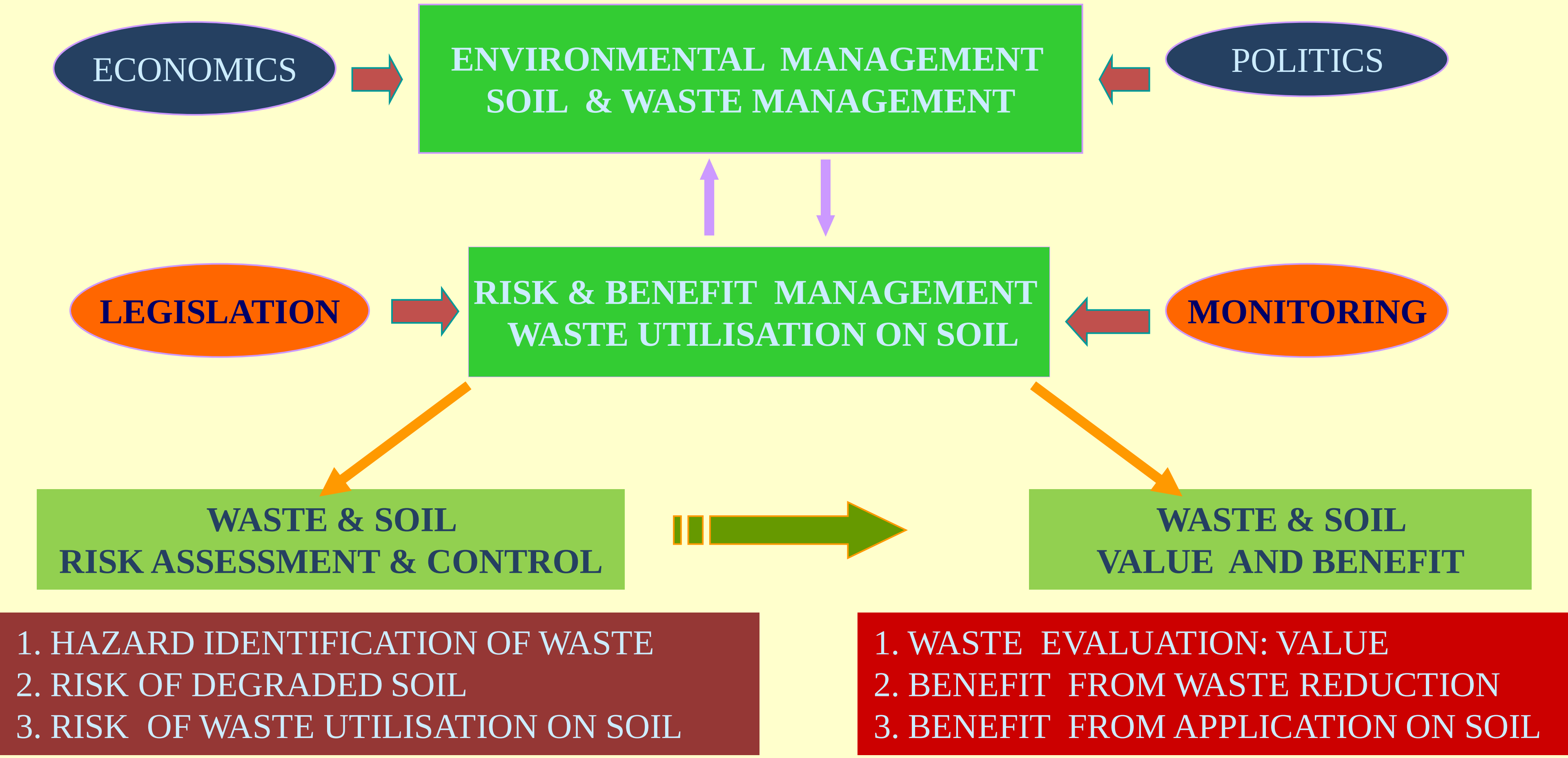


SOILUTIL

Waste application on soil – management concept and results

Research and Development Project 2009–2013

RISK MANAGEMENT OF WASTE UTILISATION ON SOIL

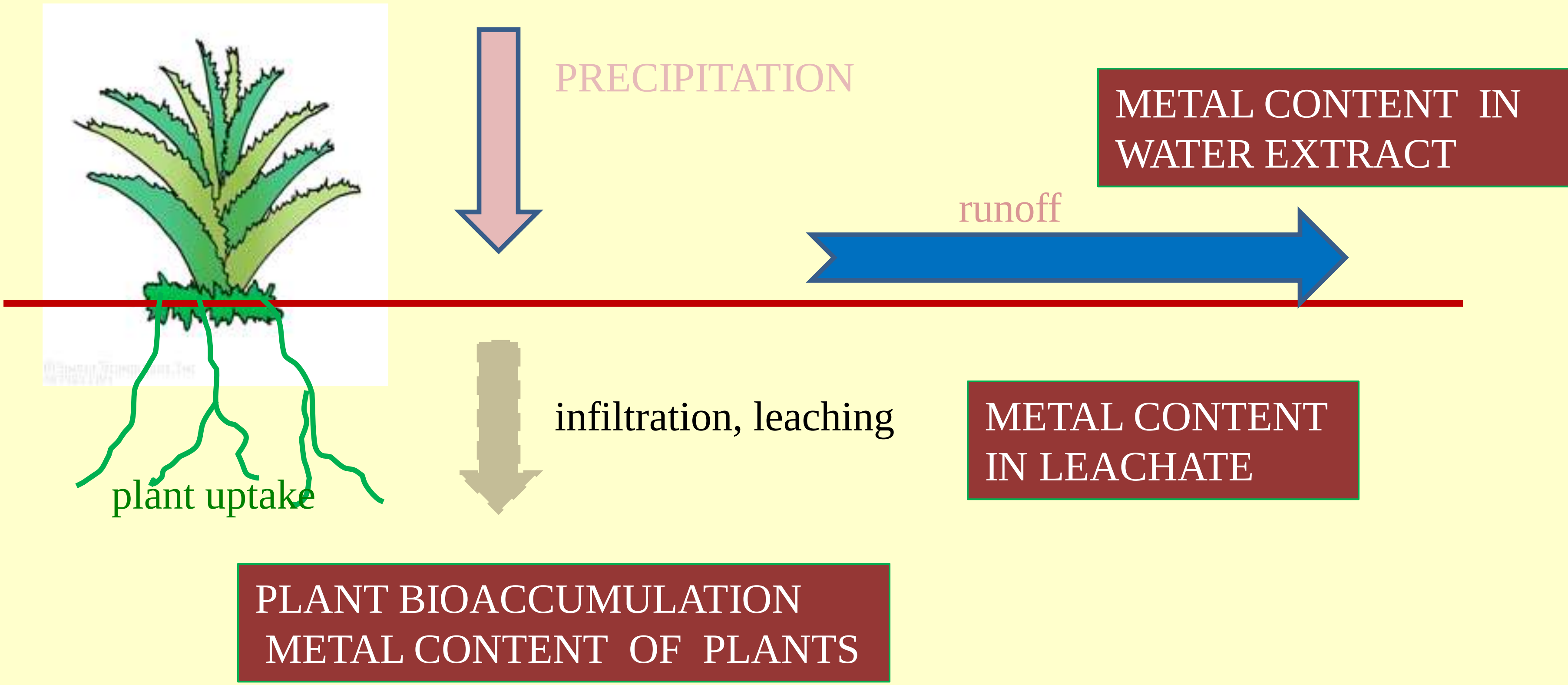


WASTE UTILISATION ON SOIL

- Waste pre-treatment: comminution, selection, fractionation
- Soil amelioration: sandy soil, compacted soil, low humus soil
- Soil amelioration : low nutrient soils
- Nutrient supply: for plants with special needs
- Erosion control by physical stabilisation: soil-texture development
- Erosion control by biological stabilisation: humus-content & vegetation
- Remediation of contaminated soil
- Soil remediation by chemical stabilisation: metal contaminated soil
- Cultivation medium from waste
- Geotechnical constructions: for water-permeable sealing
- Geotechnical constructions: capillary barriers and capillary layers
- Waste elimination in the soil by biological CO_2 sequestration

FLY ASH TREATMENT OF METAL CONTAMINATED AND DEGRADED ACIDIC SOIL/ROCK

RISK EVALUATION



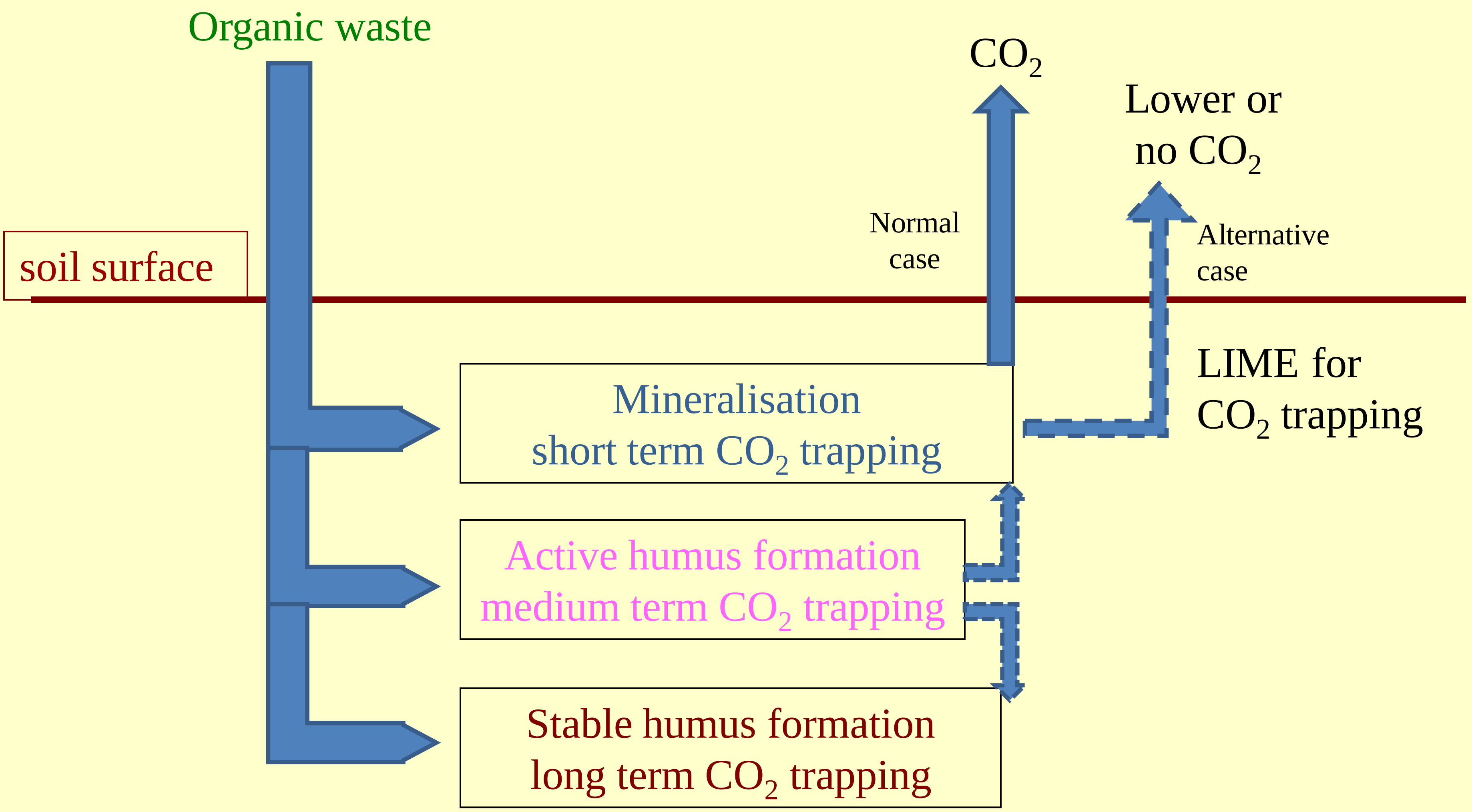
FLY ASH TREATED METAL-CONTAMINATED AND DEGRADED ACIDIC SOIL/ROCK FIELD DEMONSTRATION

	Water extract (mg/kg soil)				Plant bioaccumulation in bioassay (mg/kg dry plant)				Naturally grown grass metal uptake (mg/kg dry plant)			
Treatment	Cd	Zn	Pb	As	Cd	Zn	Pb	As	Cd	Zn	Pb	As
Control	0.24	25.7	0.56	132	1.9	345	11.3	0.8	2.8	561	117	13.0
5% fly ash	0.01	0.06	0.06	40.5	0.3	85	3.5	0.8	0.5	190	2.0	0.8

RED-MUD TREATED METAL-CONTAMINATED AND DEGRADED ACIDIC SOIL/ROCK MICROCOSM TEST

	Water extractable metal in soil mg/kg		Contaminated soil plant uptake in bioassay mg/kg plant	
	Cd	Zn	Cd	Zn
Control	0.01	0.48	2.2	119
5% red-mud	<0.004	0.10	0.35	88

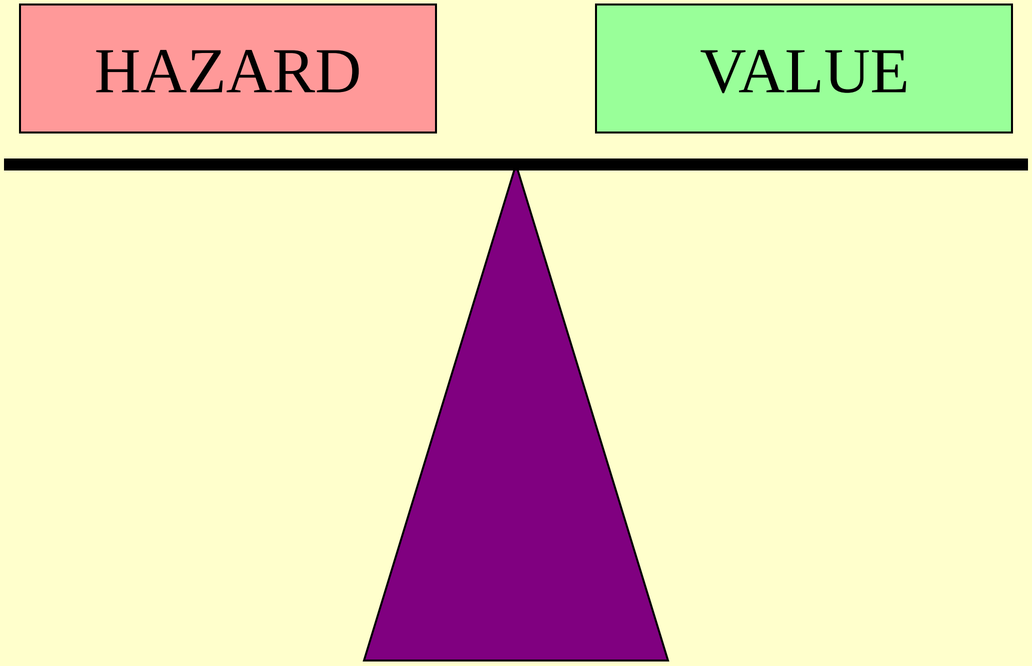
BIOLOGICAL CO_2 SEQUESTRATION



CO_2 PRODUCTION AND CELL CONCENTRATION
OILY WASTE APPLICATION ON SOIL

Treatment	CO_2 discharge (mmol)	Cell-concentration (cell/g soil)	Specific CO_2 discharge (mmol/cell 10^{10})
Control	1.0	9.0×10^6	2.0
5% oily waste	1.9	7.5×10^7	0.5
5% oily waste + lime	1.2	2.3×10^8	0.1

EVALUATION OF WASTES



DIFFERENTATION BETWEEN HAZARD AND RISK

Wastes are handled today based on their default hazard, which is in contrast with the risk based approach.

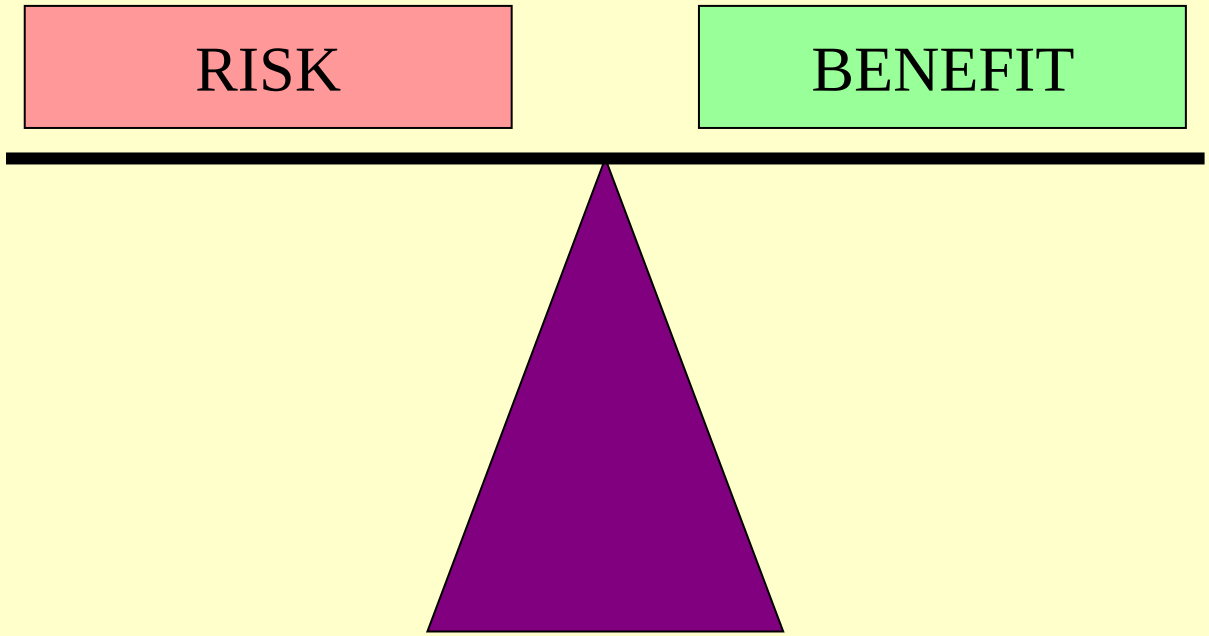
The same (hazardous) waste pose different scale of risk depending on soil type and land use.

Time is an important factor too for biodegradable waste and waste applied as plant nutrients.

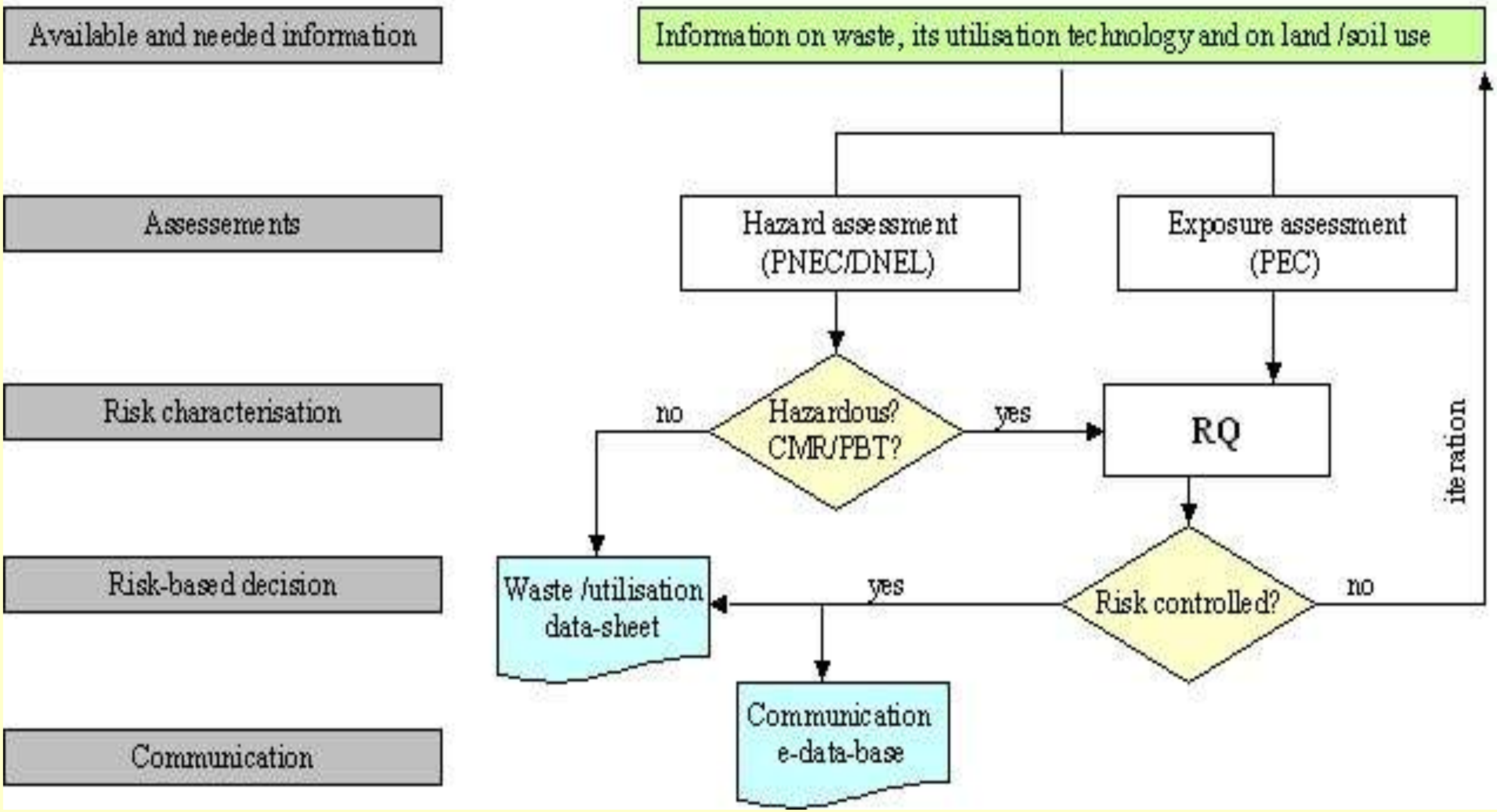
The right decision can be made only based on the quantified risks and benefits of the waste at the place of application.

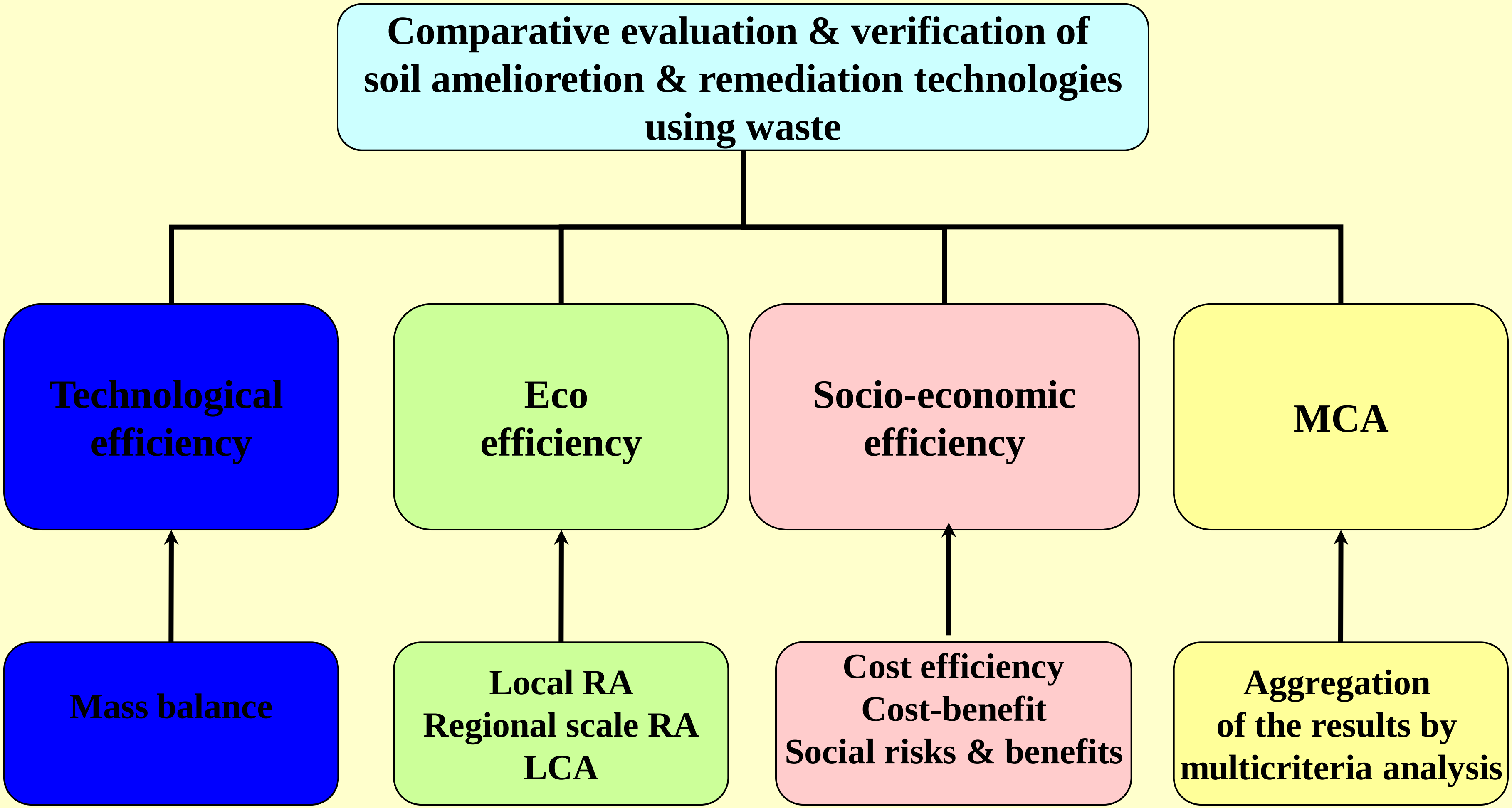
Risks and benefits can be calculated based on the substance/material contents of the waste. It means that similar to chemical substances (under REACH regulation) the existing risk should be controlled.

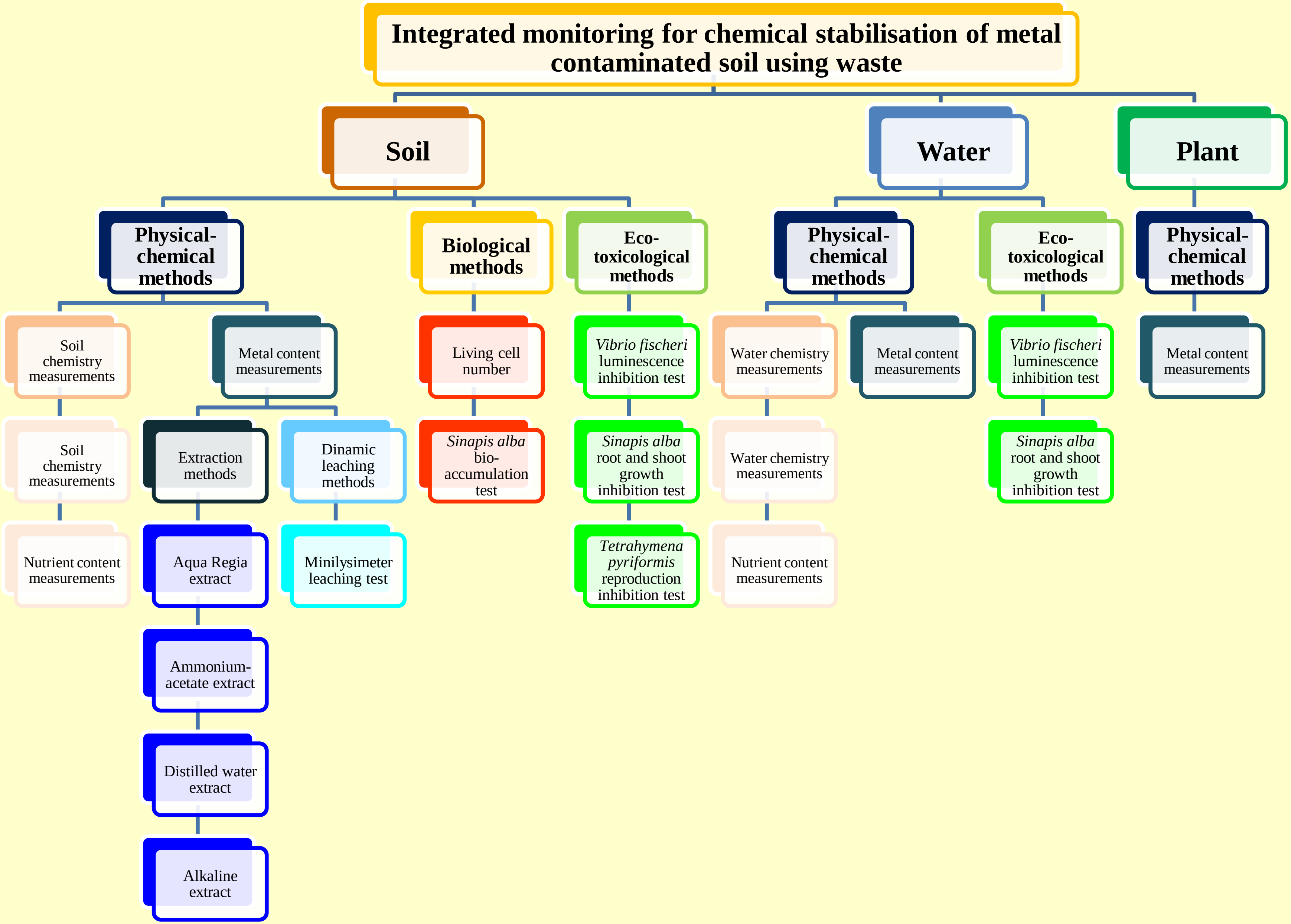
ASSESSMENT OF WASTE APPLICATION ON SOIL



Environmental risk management of waste utilisation on soil




Comparative evaluation & verification of
soil amelioretion & remediation technologies
using waste
Technological
efficiency
Eco
efficiency
Socio-economic
efficiency
MCA
Mass balance
Local RA
Regional scale RA
LCA
Cost efficiency
Cost-benefit
Social risks & benefits
Aggregation
of the results by
multicriteria analysis



Terra Preta Workshop
BME, 2014

Deliverables

INVENTORY OF SOIL DEGRADATION AND THREATS

SOIL EVALUATION MAPS – DATABASE

INVENTORY OF WASTE PRODUCTION

WASTE MAPS – DATABASE

DEMO & INVENTORY OF TECHNOLOGIES & APPLICATIONS

INTERGRATED TECHNOLOGY MONITORING

VERIFICATION OF WASTE APPLICATION ON SOILS

LEGAL BACKGROUND: RISK BASED WASTE MANAGEMENT

INSTEAD OF WASTE: SUBSTANCE, PRODUCT, BY-PRODUCT

THANKS FOR YOUR ATTENTION

Metal contaminated soil and mine waste stabilization with red mud

Treated medium	Soil	Mine waste
Red mud (%)	5	5
pH untreated	6,5	6,9
pH treated	**7,1**	**7,1**
Acetate extracted Cd (mg/kg)		
Untreated	1,24	3,28
Treated	1,03	1,87
Decrease (%)	**13**	**40**
Acetate extracted Zn (mg/kg)		
Untreated	187	354
Treated	97	128
Decrease (%)	**46**	**62**
Water extracted Cd (mg/kg)		
Untreated	0,020	0,042
Treated	0,010	0,006
Decrease (%)	**48**	**85**
Water extracted Zn (mg/kg)		
Untreated	2,27	2,38
Treated	0,645	0,331
Decrease (%)	**70**	**85**

Treated medium	Soil	Soil
Red mud (%)	2	5
Plant root growth (mm)		
Untreated	8.6	8.6
Treated	9.8	12.1
Increase (%)	14	41
Plant shoot growth (mm)		
Untreated	17.9	17.9
Treated	19.1	26.0
Increase (%)	7	45

MANAGEMENT PHASE I.

SOIL EVALUATION

HAZARD: Type of degradation, contamination or other threat

NEEDS: Parameters, substances required

LOCALITY

WASTE EVALUATION

HAZARD: hazardous substance content and consequent limitations

VALUE: of waste from the point of view of the soil

PRODUCED AMOUNT AND LOCALITY

RISK EVALUATION of waste application on soil

SITE SPECIFIC RISK of waste application on soil

REGIONAL AND GLOBAL RISKS, SUSTAINABILITY