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The use of local species as a cost effective method of soil remediation in developing economies

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Sponsors:
European Union
Polish Ministry of Environment
Polish Ministry of Science

Site characteristic

Metal soil content
- Pb – 8643 mg/kg
- Cd – 480 mg/kg
- Zn – 9192 mg/kg

Existing plant cover

Dominating plant species

Deschampsia cespitosa
(Tufted Hair-grass)

Silene inflata
(Bladder Campion)

Melandrium album
(White Campion)

Cardaminopsis arenosa
(Tall rock-cress)

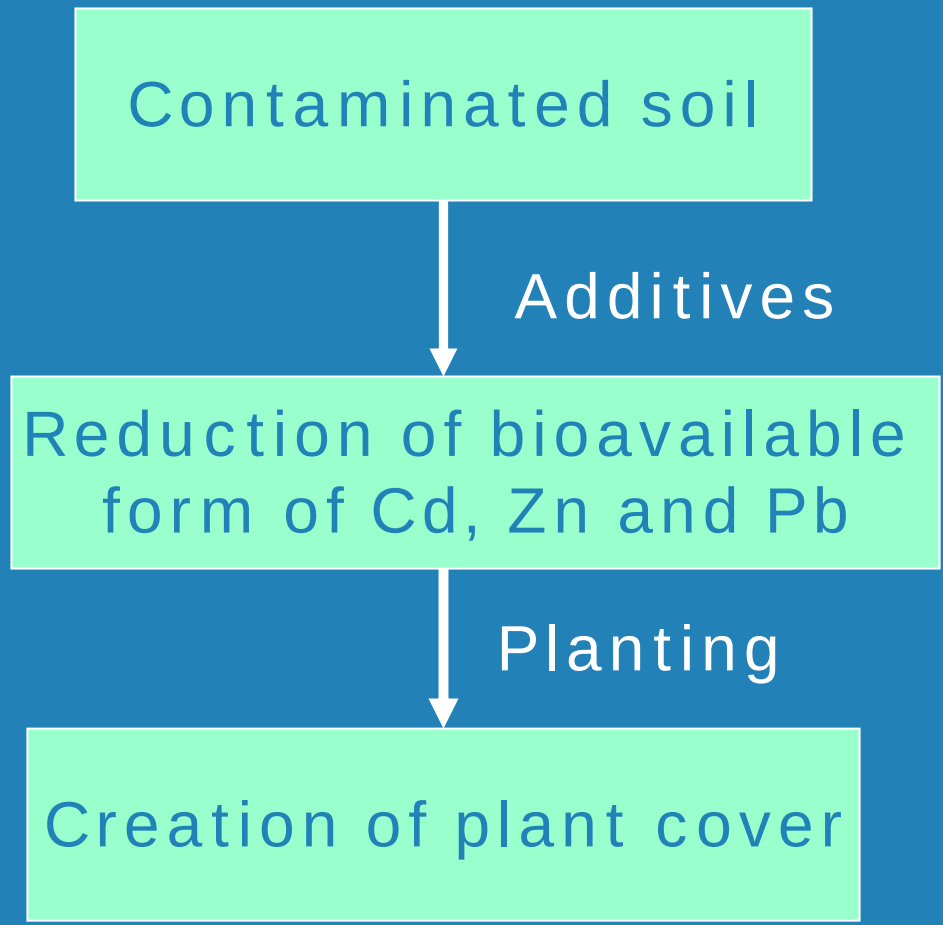
Present site performance

- Poor plant cover
- Susceptible for erosion
- Presence of hyperaccumula-tors

Realistic expectations

- Good plant cover
- No erosion process
- No hyperaccumu-lators

Proposed approach - PHYTOSTABILIZATION



Metal binding additives

- Zeolite
- Mixture of dolomite and zeolite
- Lignite
- Superphosphate ⟵

High reduction of bioavailable form of metals (about 80%)

- Ammonium nitrate
- Sewage sludge
- Hard coal waste

Toxic effect of metals on plants

- *Agrostis capillaris*
- *Festuca rubra*
- *Poa pratensis*
- *Helianthus tuberosus*
- *Salix viminalis*

Screening for local species

Deschampsia cespitosa
(Tufted Hair-grass)

Melandrium album
White Campion

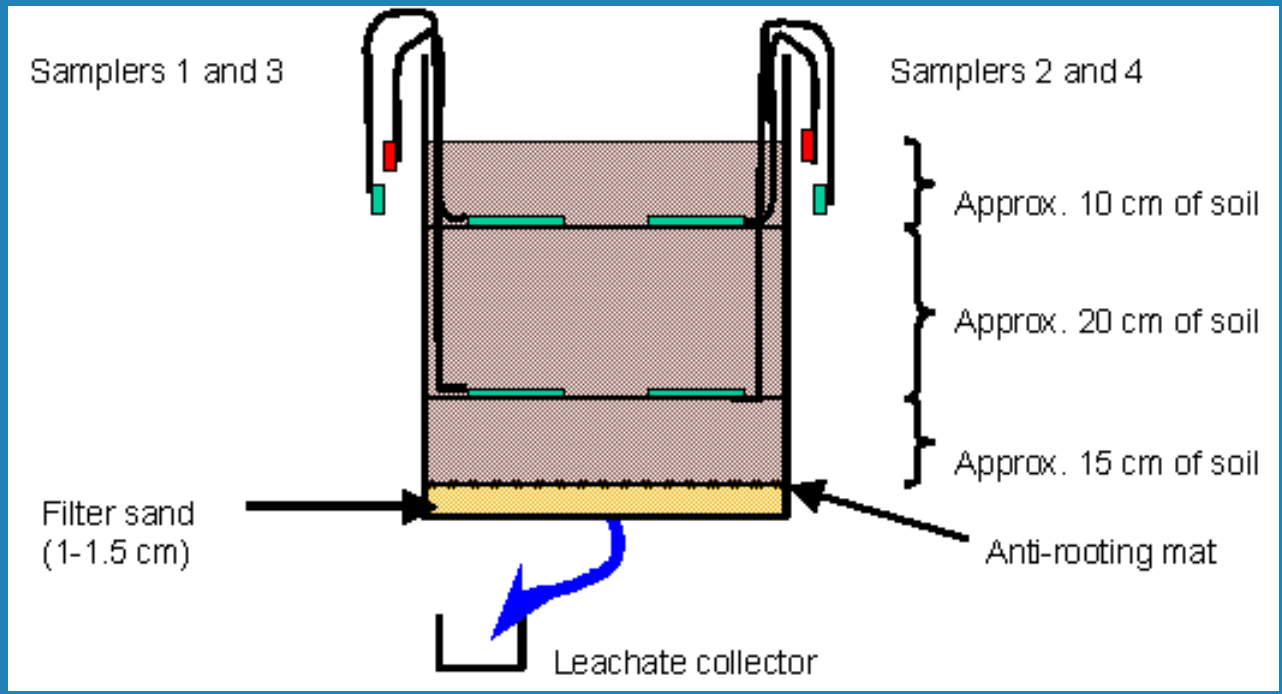
Silene inflata
(Bladder Campion)

Cardaminopsis arenosa
(Tall rock-cress)

Requirements

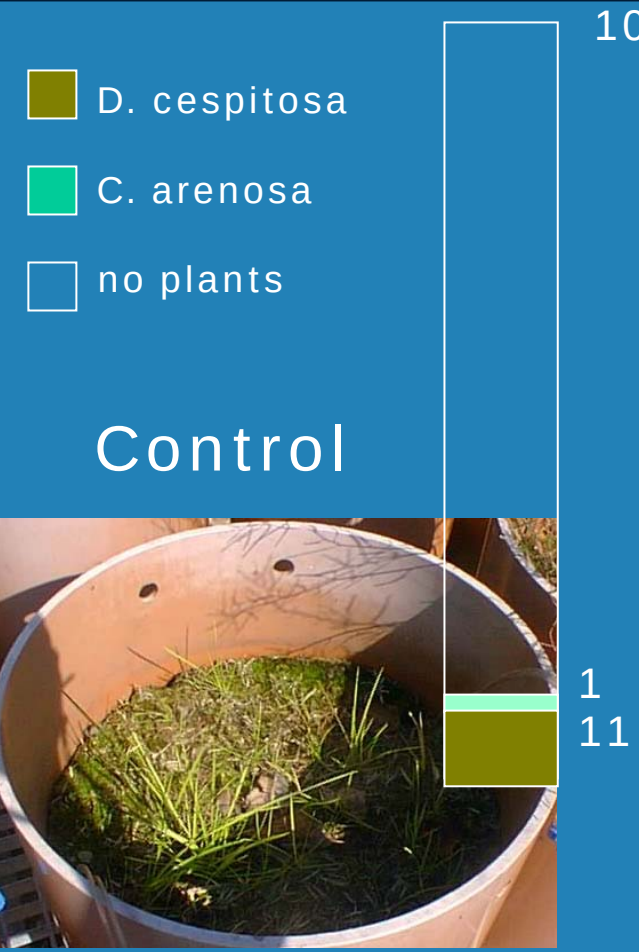
- Strong root system
- Avoidance by animals
- Metal accumulation in underground part of plant
- Domination in local plant population

Mesocosm design

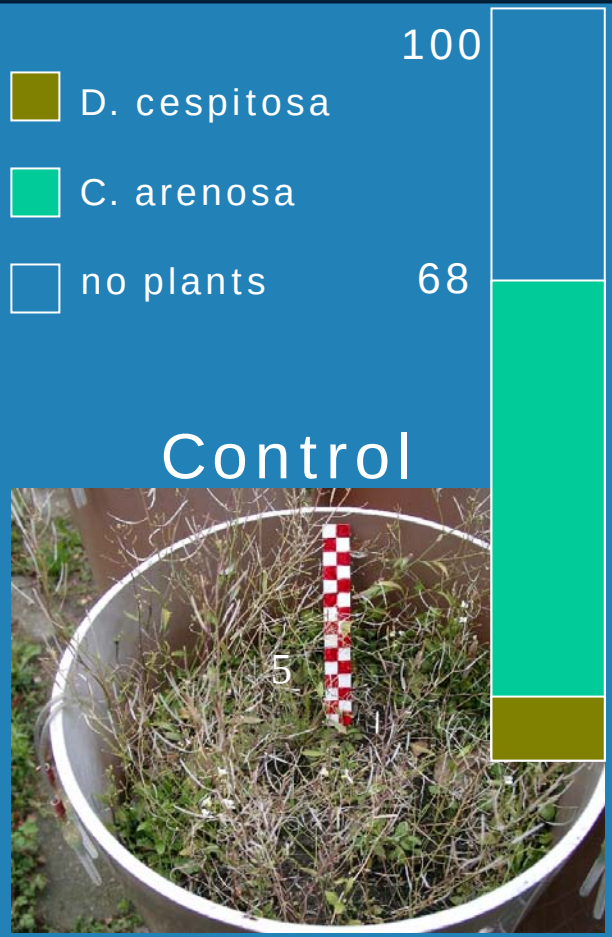


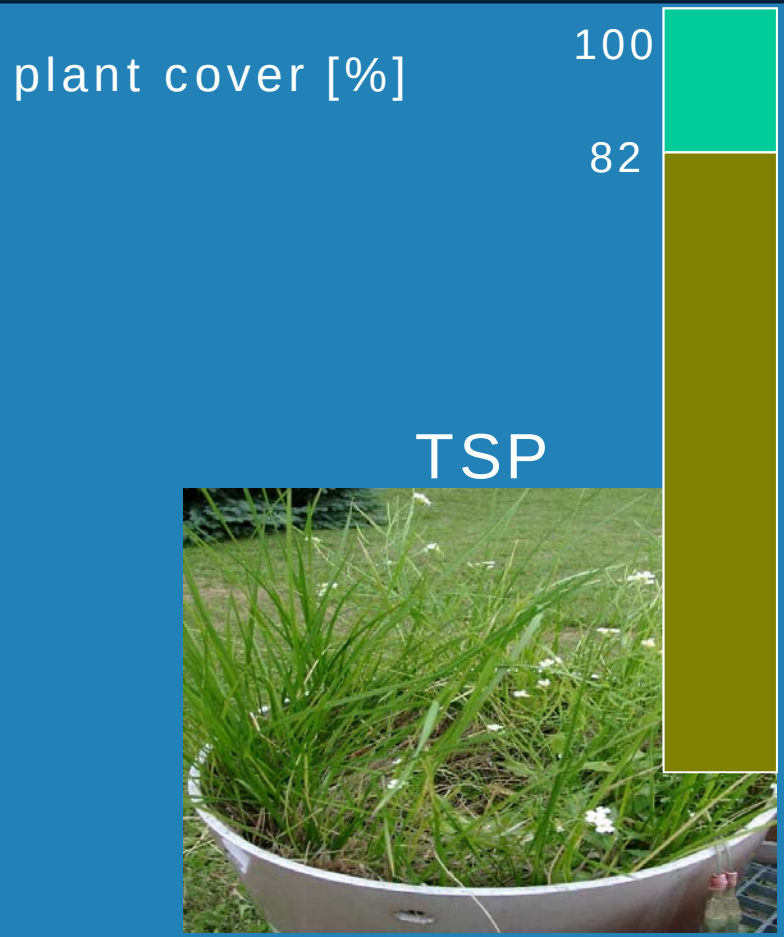
http://www.alterra-research.nl/pls/portal30/docs/folder/phytodec/mesocosm.htm

Mesocosm experiment
Year I

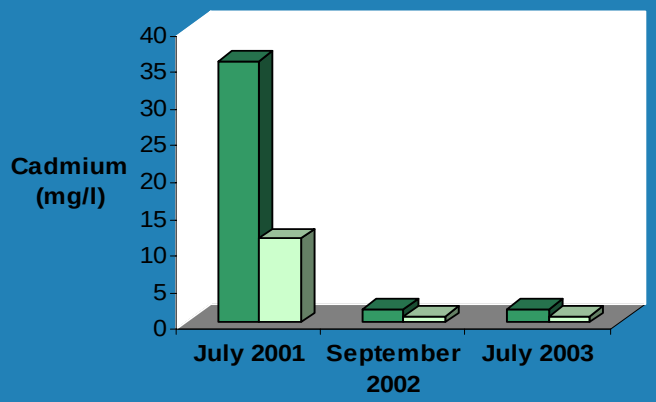


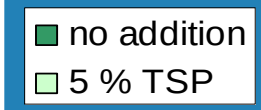
Mesocosm experiment
Year II

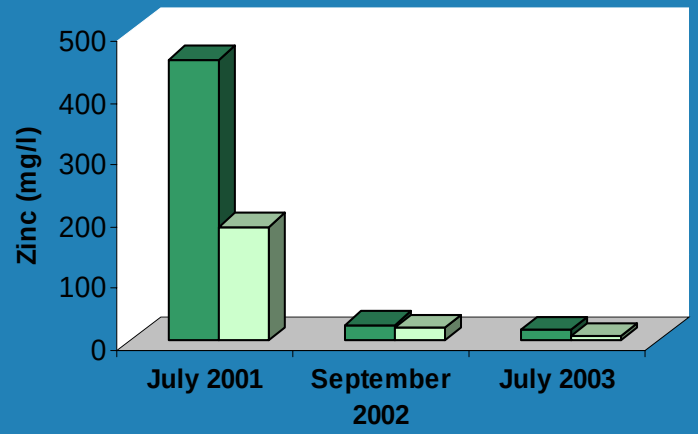


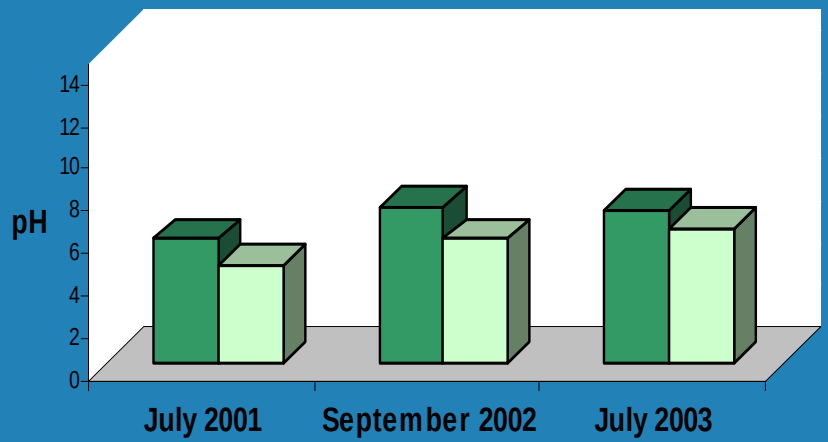


Metal concentration and pH in mesocosm leachates

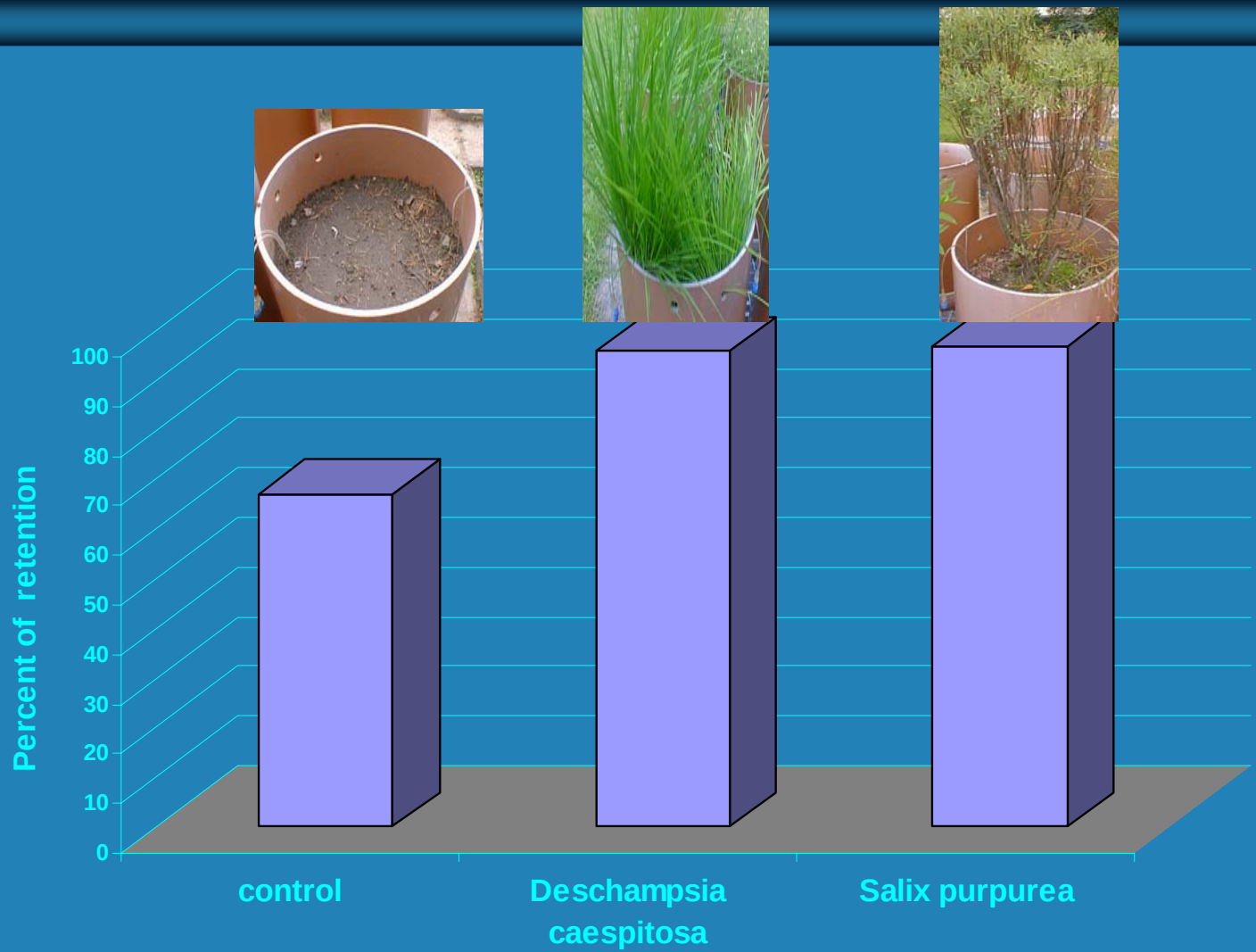








Water retention in mesocosms in relation to plant cover



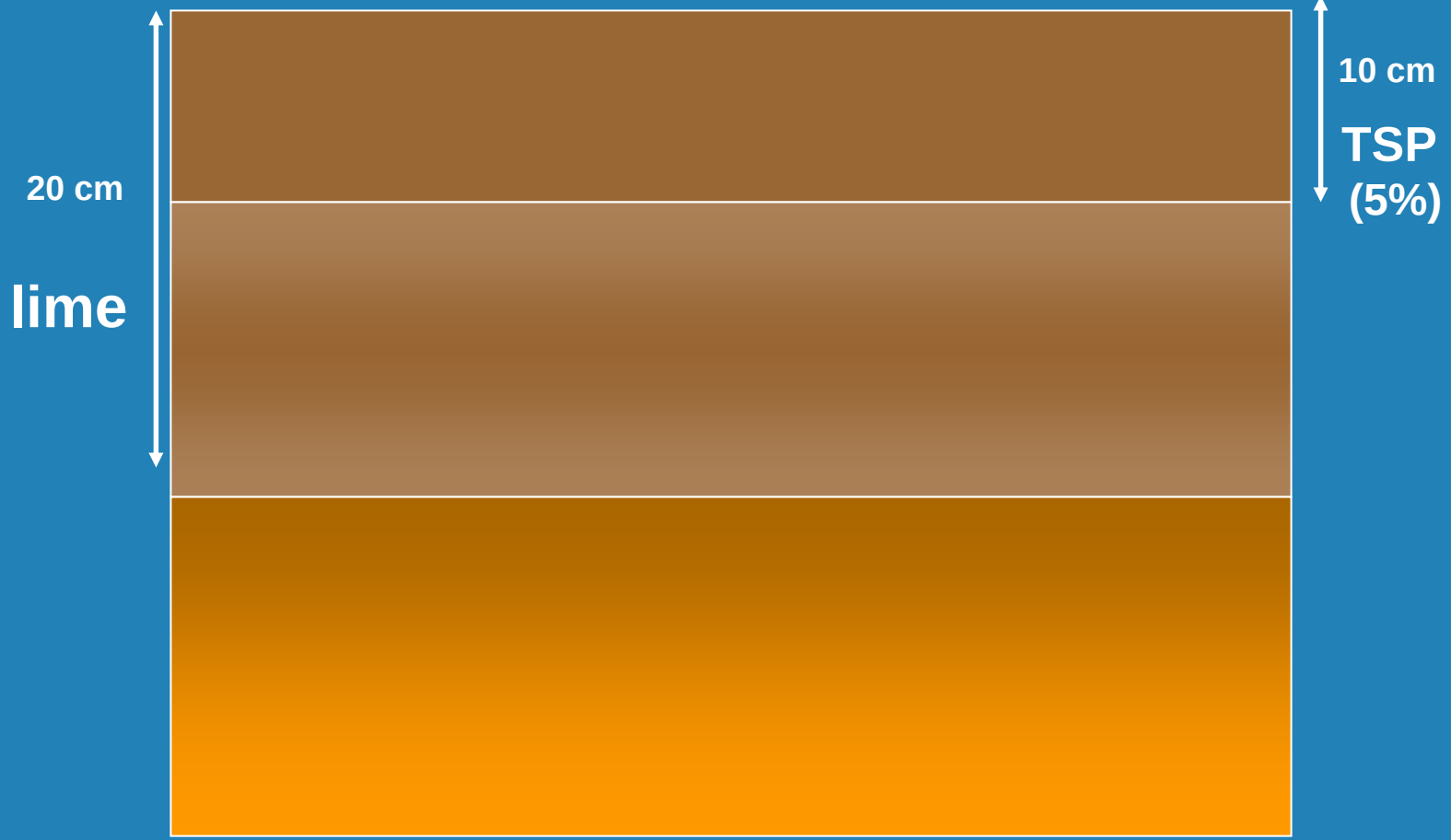
Mesocosm experiment conclusions

- Reduction of bioavailable forms of metals is needed
- Local species of plants is recommended
- Verification of results at a field scale is required

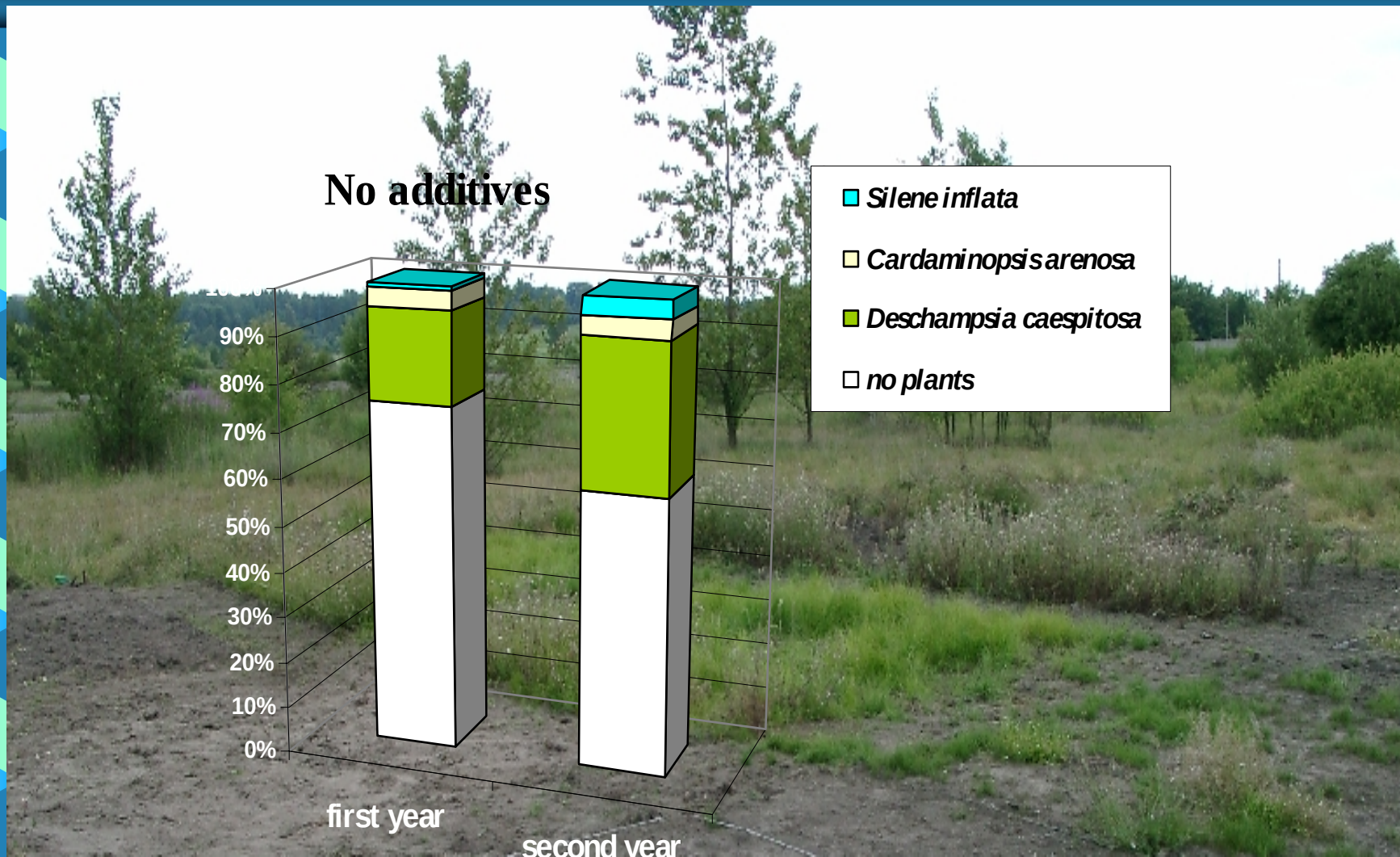
Field experiment design

- Control (no plants, no additives)
- *Deschampsia cespitosa*, superphosphate (5%)

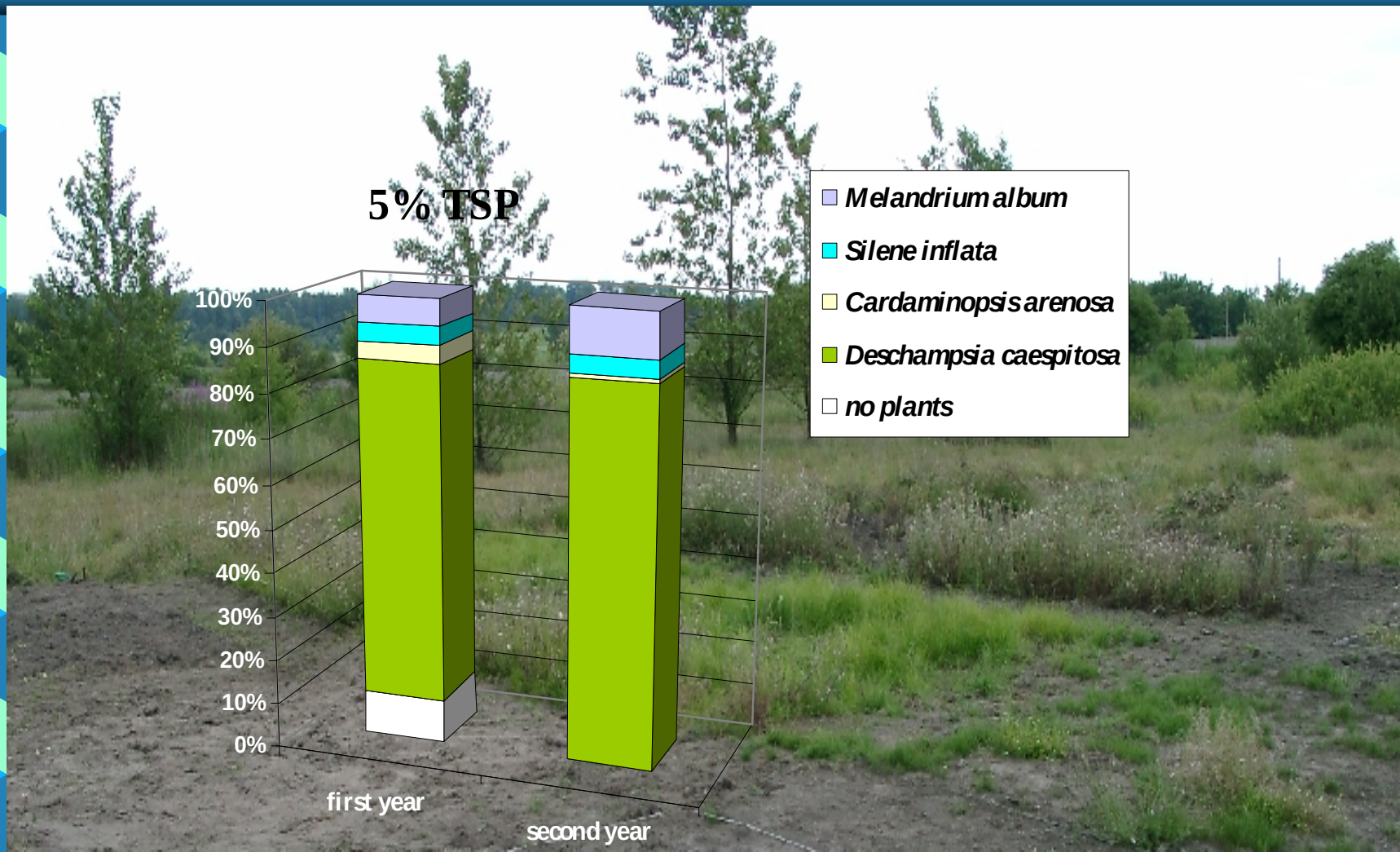
Lime and superphosphate amendment scheme



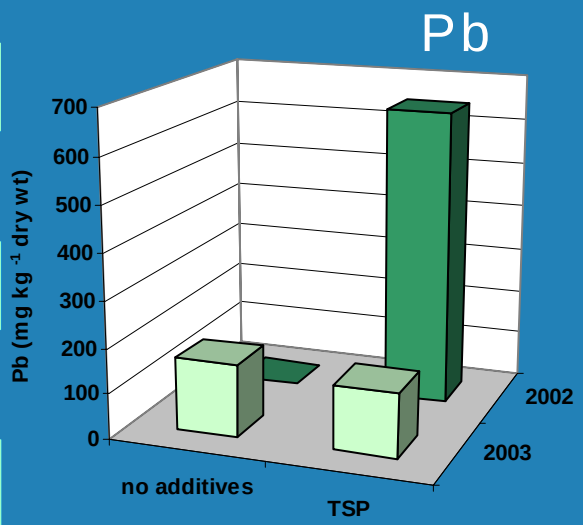
Changes in plant cover

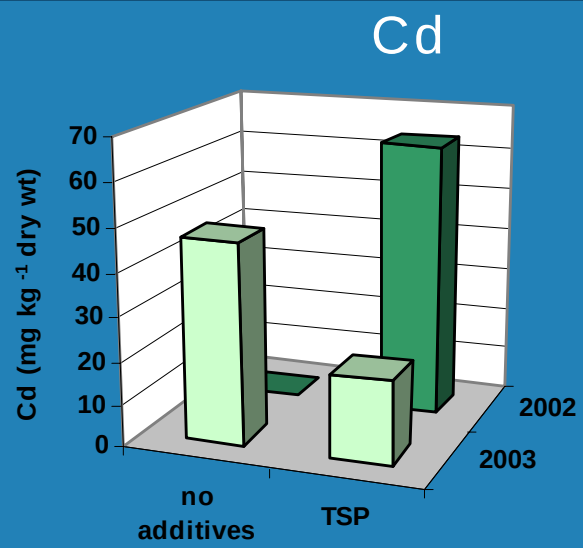


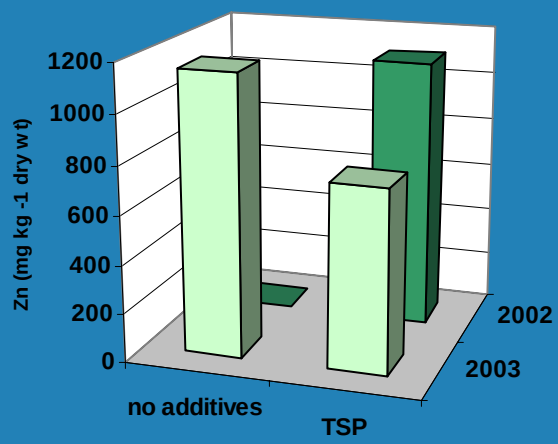
Changes in plant cover



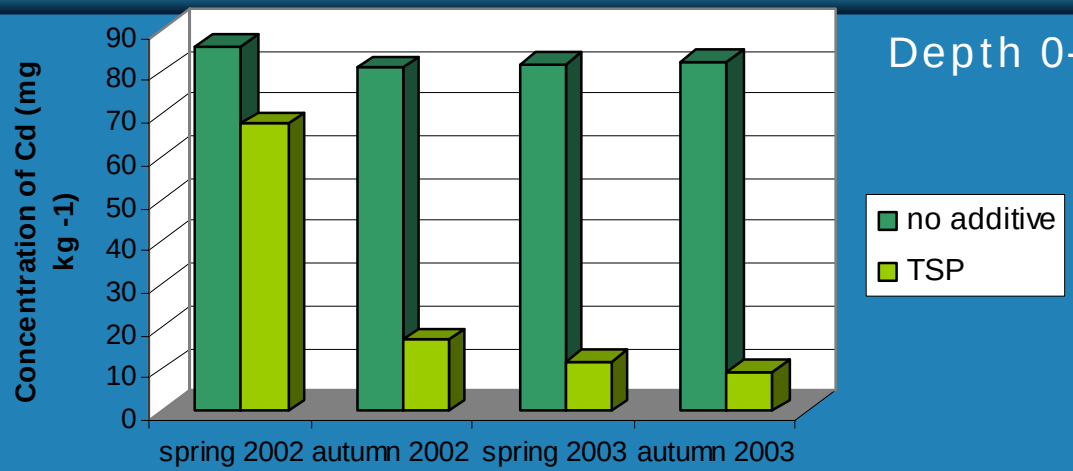
Pb, Cd and Zn concentration in *D. cespitosa* shoots

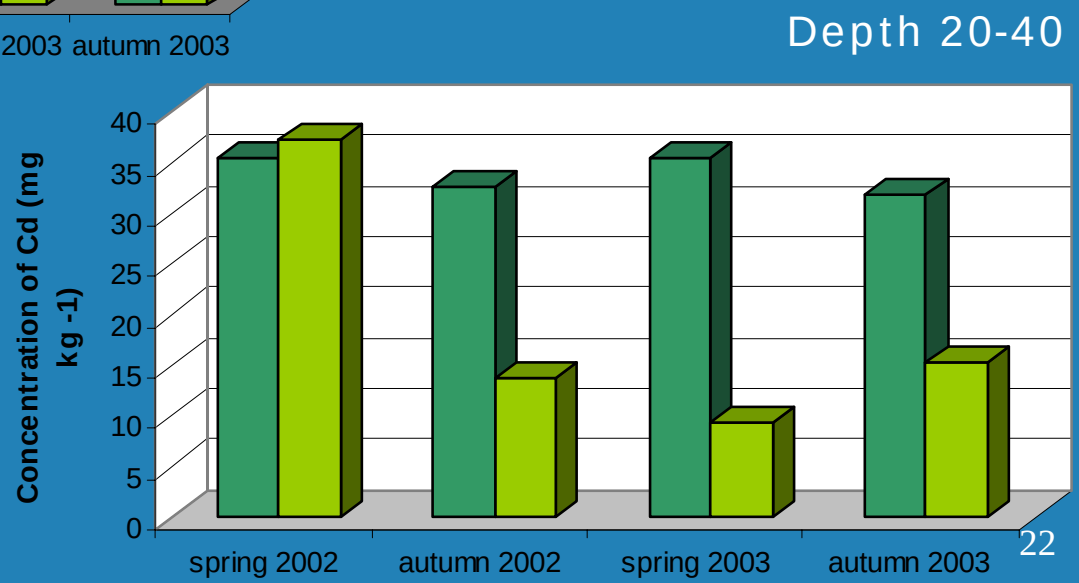






Bioavailability of cadmium in soil profile after TSP addition





D. cespitosa root system

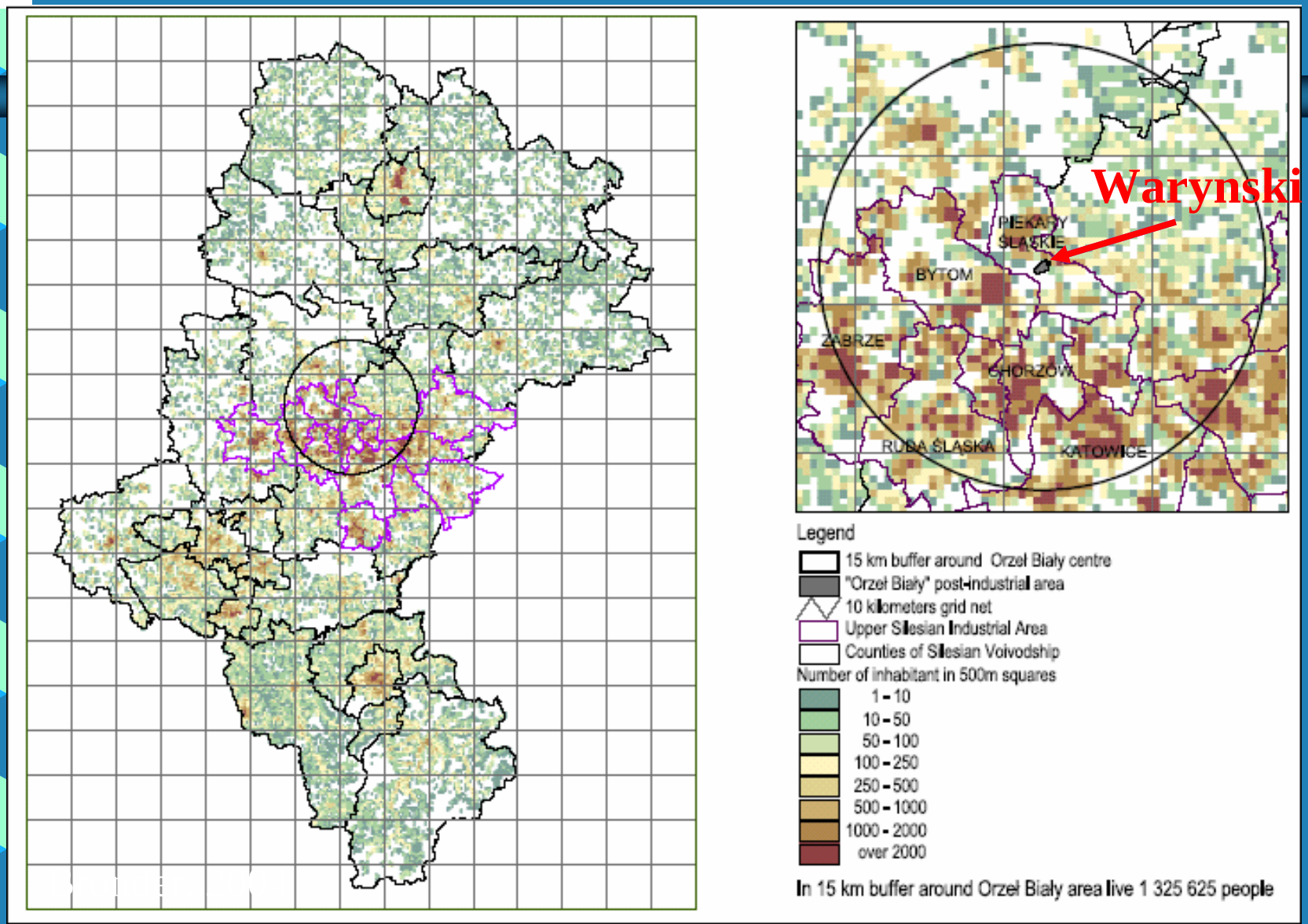
Control

TSP added

The rationale of using local plant species

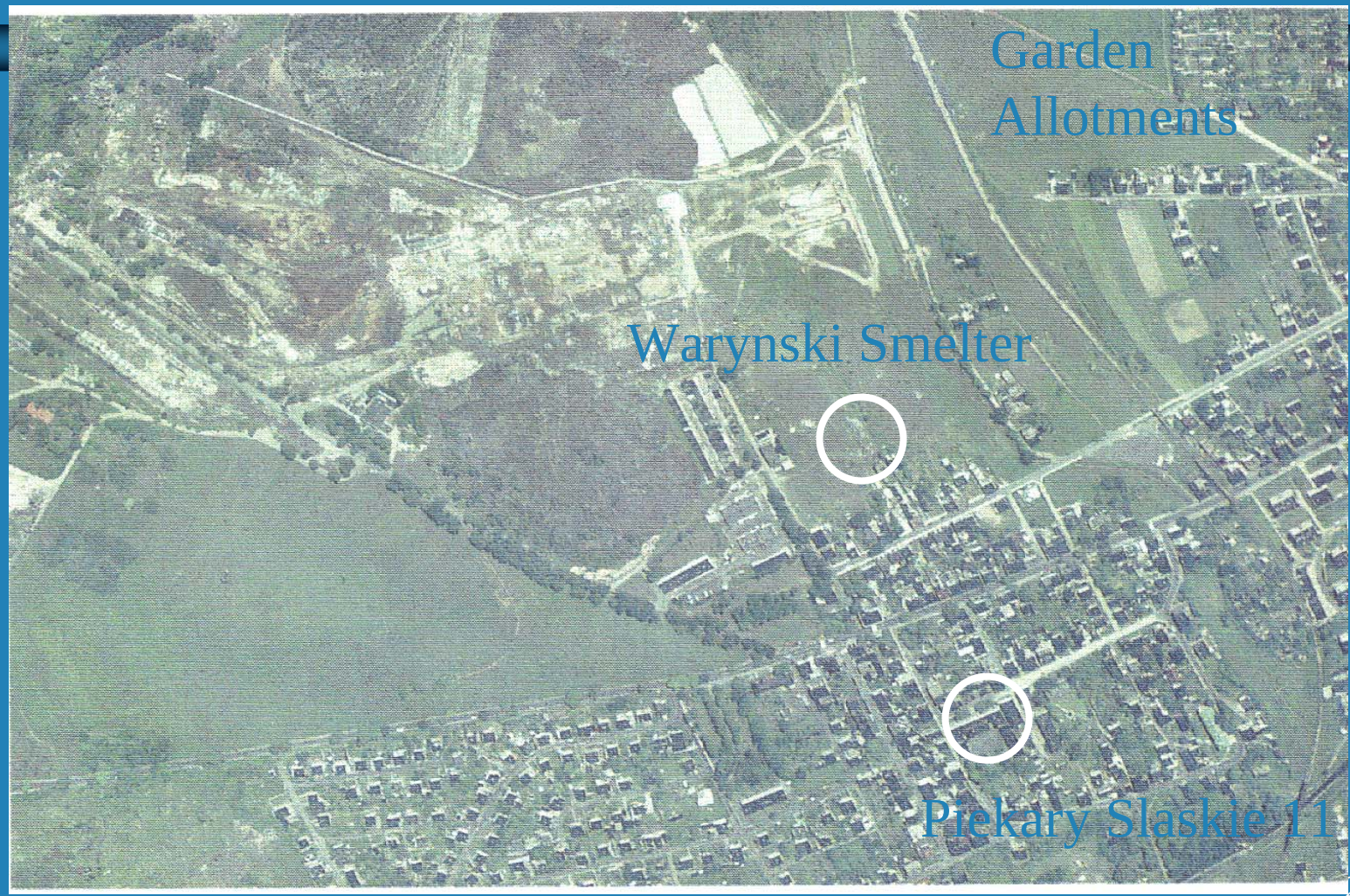
- No problems with adaptation to local climate
- Low cost of seeds
- Good growth on local soils

Major Population Centers Near Warynski Smelter

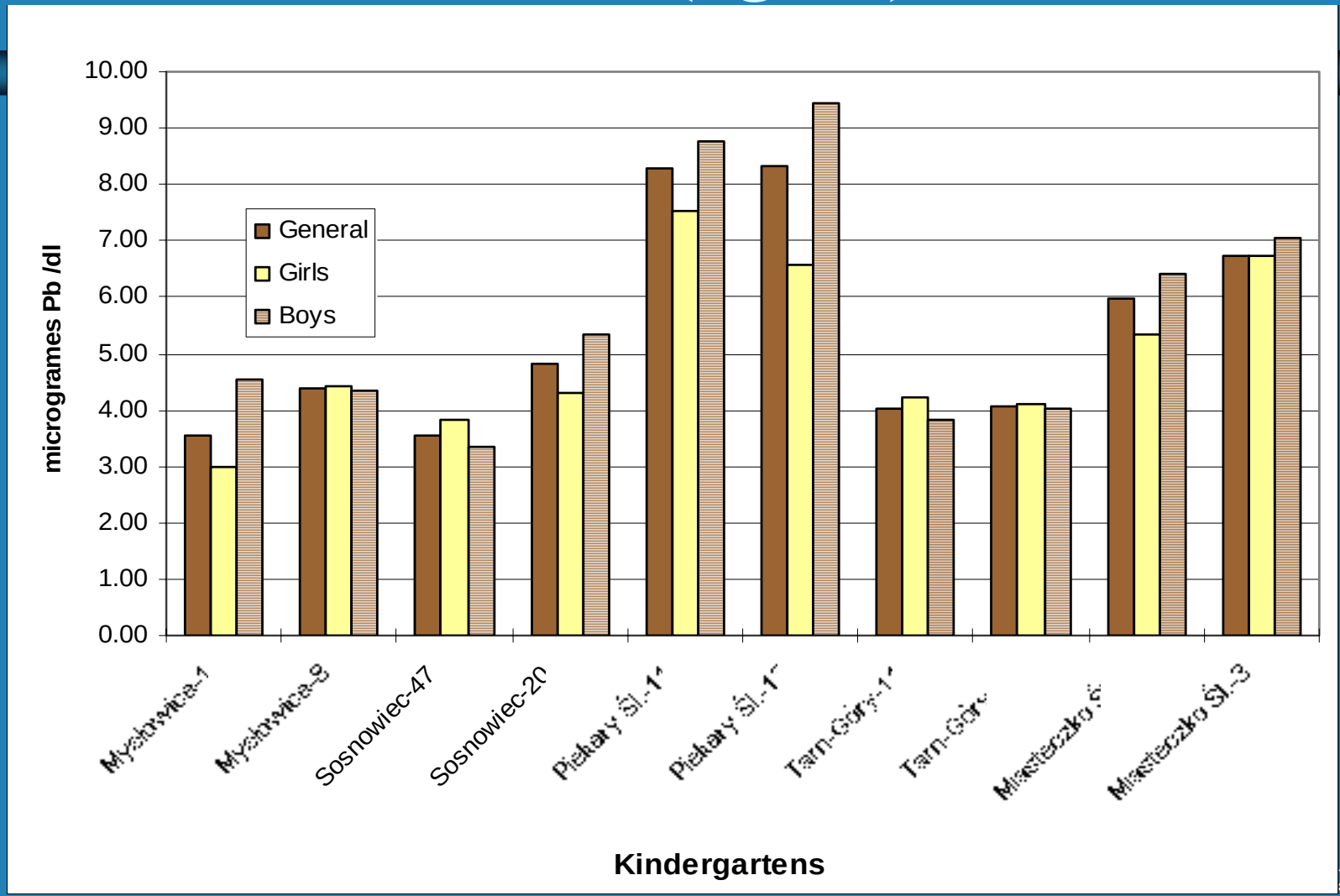


Warynski Zinc Smelter

Warynski Smelter Site

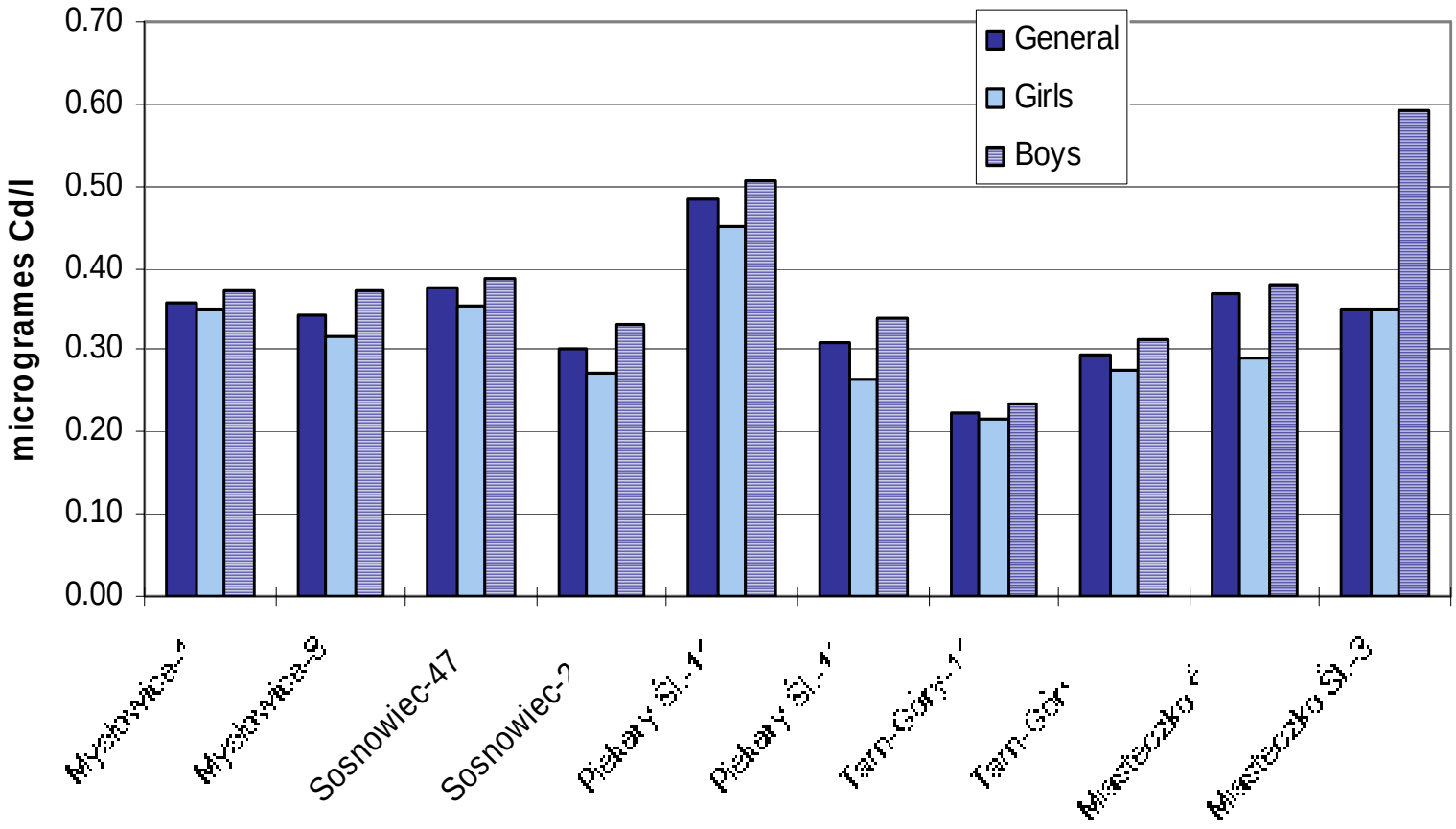


BLL in USIR Children 1999 (ug/dL)



Kulka, 1999

BCL in USIR Children 1999 (ug/dL)



Kulka, 1999