
SK EU2016
Slovak Presidency of the Council
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GENTLE REMEDIATION OPTIONS (GROs) ON PB/ZN CONTAMINATED SITES THE GREENLAND-PROJECT

Wolfgang Friesl-Hanl, AIT Austrian Institute of Technology GmbH, Austria,
wolfgang.friesl@ait.ac.at
Petra Kidd, Instituto de Investig. Agrobiològicas de Galicia, CSIC, Spain
Grzegorz Siebielec, Institute of Soil Sci. and Plant Cultiv., IUNG, Poland

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Main Topics

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FP7 KBBE – GREENLAND-project (www.greenland-project.eu)

Gentle remediation of trace element contaminated land

Introduction .

- GRO´s Gentle remediation options

3 Stages of IMPACT of Pb/Zn-ore-treatment on the environment

- A - Influence by Mining — Spain (Rubiais in Lugo)
- B - Influence by Smelting Waste — Poland (Piekary Slaskie)
- C - Influence by Smelting Emissions — Austria (Arnoldstein)

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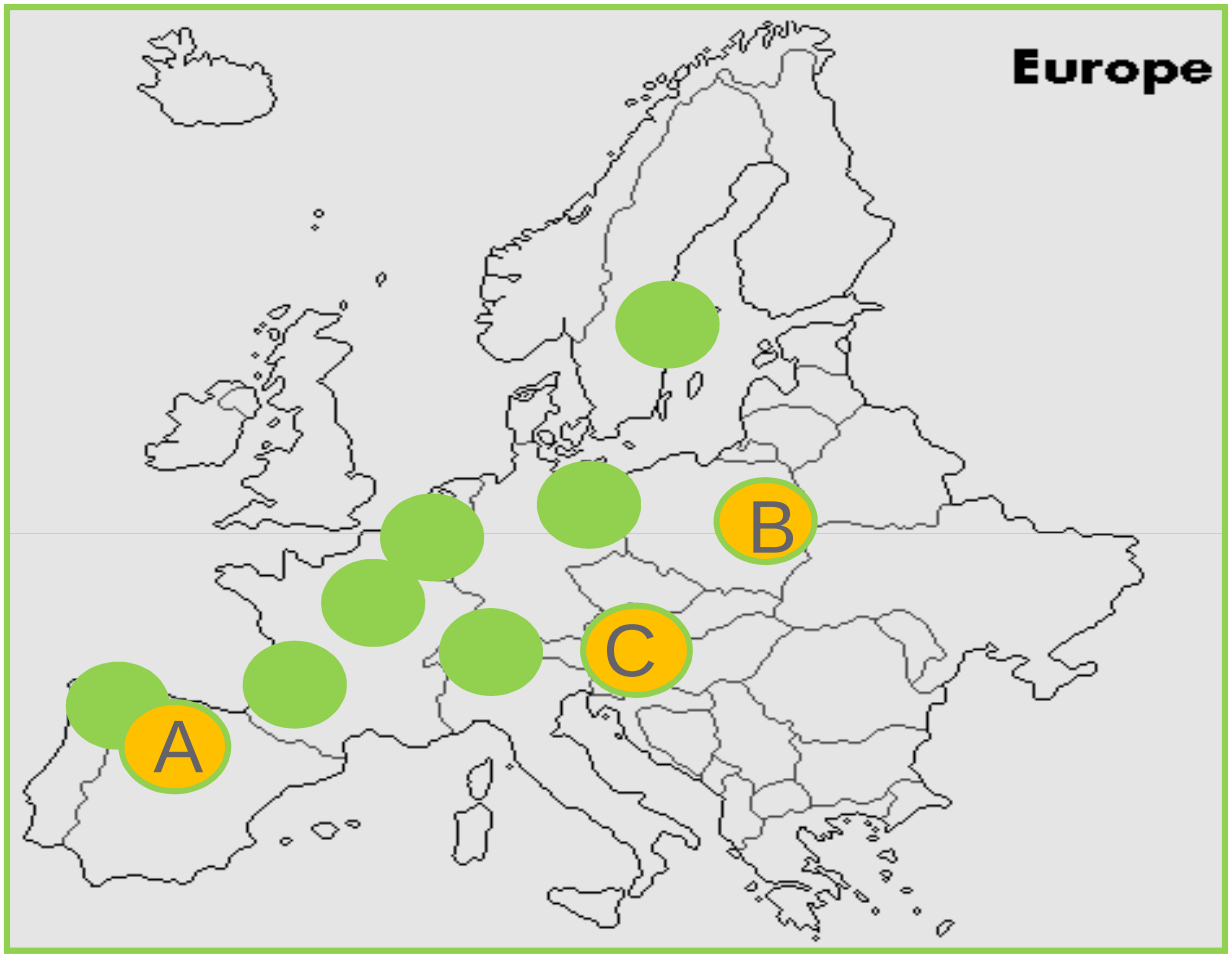
Field sites in the GREENLAND- project

17 partners **13 field sites**



The GREENLAND-project

- Assess the efficiency of GRO via long-term field trails
- Test the possibility of biomass valorization of TE contaminates sites
- Evaluate a set of soil tests to assess GRO performance or “success”
- Enhance the efficiency of GRO (e.g. selecting plants, PGPM, agronomic practices)
- Develop a decision support system

Key outputs of the GREENLAND-project

- (1) multi-lingual best practice guidance – designed to encourage wider consideration of use of GROs as part of effective risk management strategies
- (2) a practical decision support tool – designed to support stakeholder engagement, site options appraisal and decision making.

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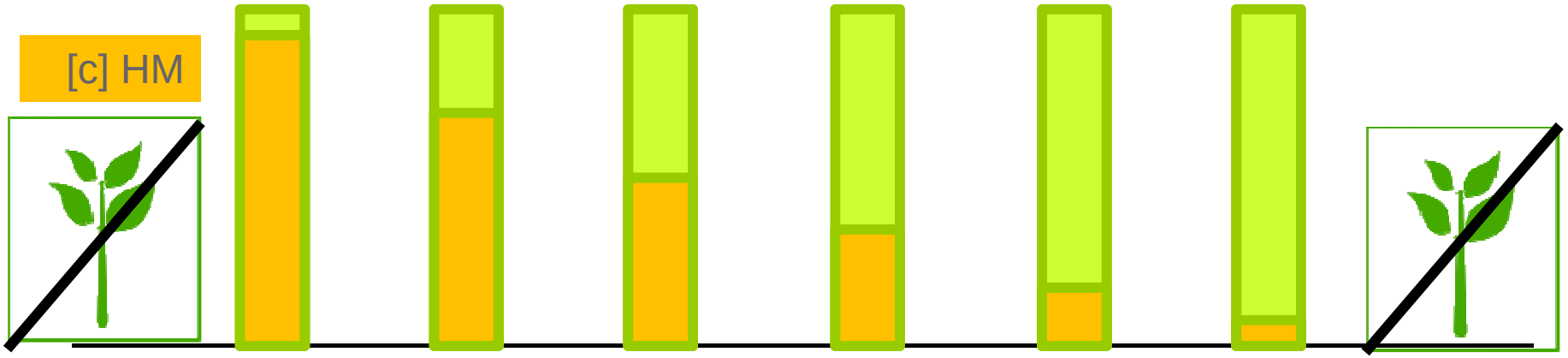
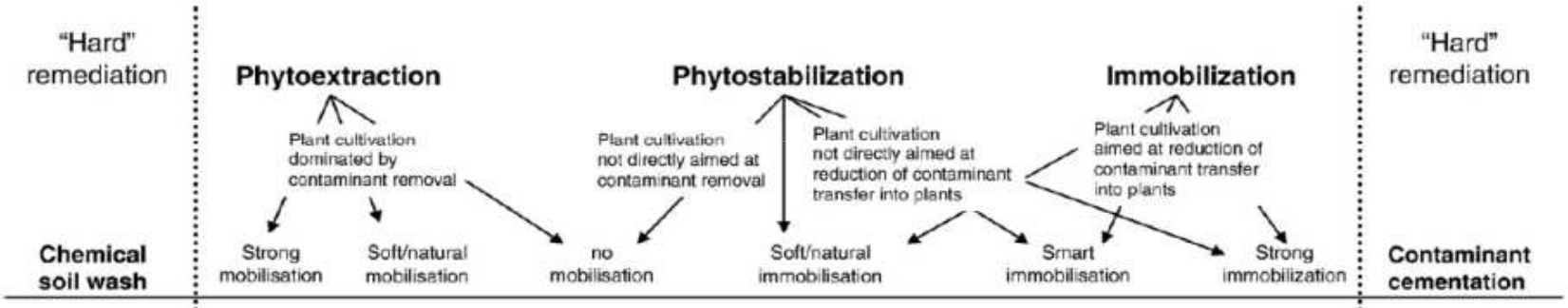
„Gentle remediation options – GRO“ for heavy metal (HM, TE) contaminated sites



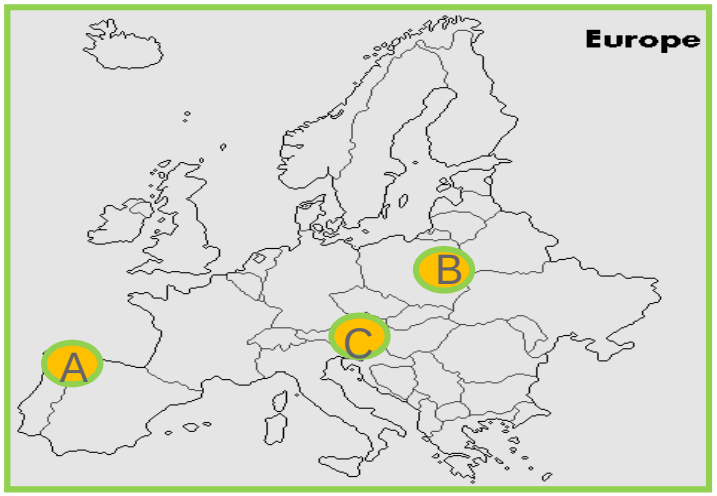
K. Onwubuya et al. / Science of the Total Environment 407 (2009) 6132–6142 6133



- **Advantages:** keeping soil functions alive, low impact, for large areas, even solar driven (plants), reducing erosion (wind and water), immediately effectiv (IMMO)

Different GROs

- Phytoextraction (HA, SRC, high biomass crops)
- Phytostabilisation (Plant roots, Amend., Vegetation cover)
- In situ Immobilisation (Amendments/Phytoexclusion)

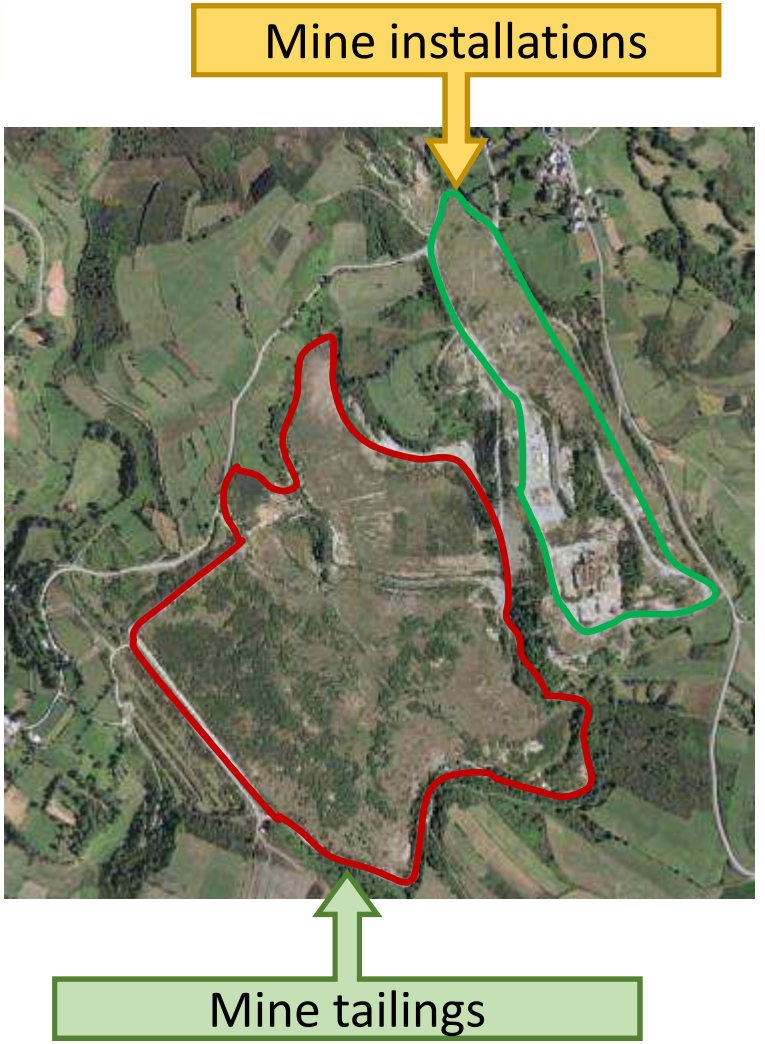


- A - Spain (Rubiais in Lugo)
- B - Poland (Piekary Slaskie)
- C - Austria (Arnoldstein)

- Phytoextraction / Phytostabilisation
- Aidded Phytostabilisation
- In-situ Immobilisation / phytoexclusion

A - SPAIN – Galicia - Rubiais in Lugo (Pb/Zn)

- 1977 – 1990 active
- Mine installations – 11 ha
- Mine tailings – 30 ha
- Metal deposits rich in sulphides: sphalerite (ZnS) and galena (PbS)
- Heterogeneity in metal content
- Principal metals: Cd, Hg, Pb, Zn

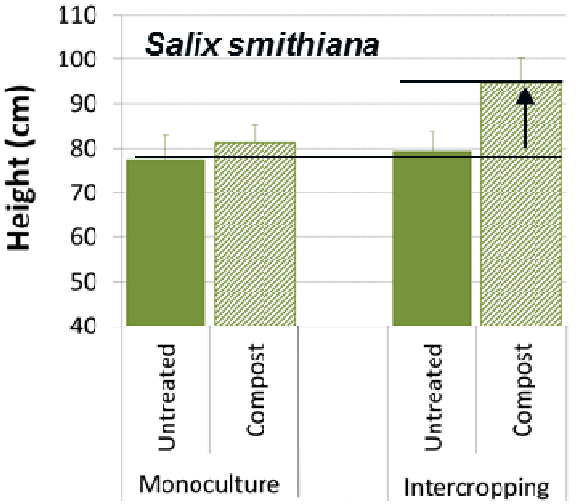


Aims

- Phytoextraction
- Phytostabilisation (vegetation cover)
- Biomassproduction (High biomass annual crops, woody tree species, hyperaccumulating plant species)

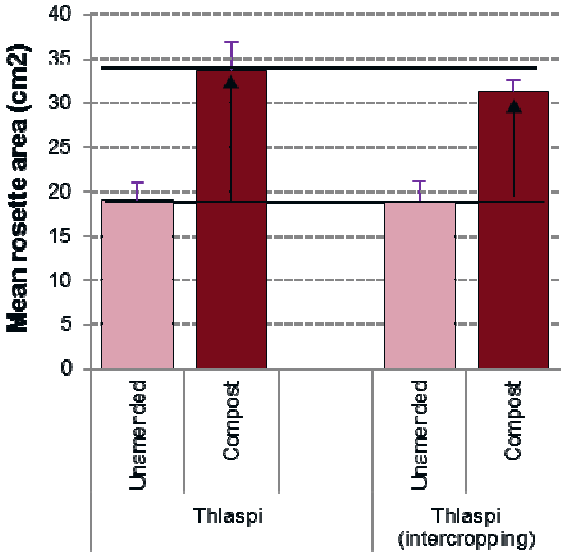
A Best results – woody crops

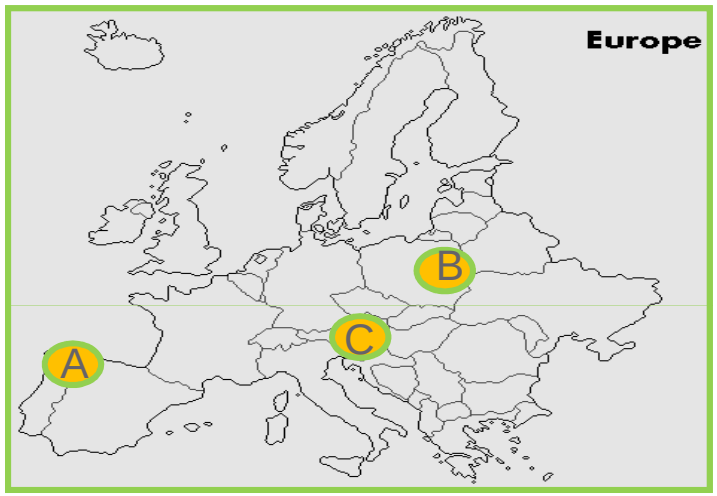
- Highest Cd/Zn accumulation in *Salix smithiana* (800–1200 mg Zn kg-1; 10–15 mg Cd kg-1)
- Improved growth in compost-amended plots, inter-cropped with N2 fixing *Alnus glutinosa*
- Improved nutrition and higher Cd/Zn accumulation in inter-cropped plants



Best results - hyperaccumulator

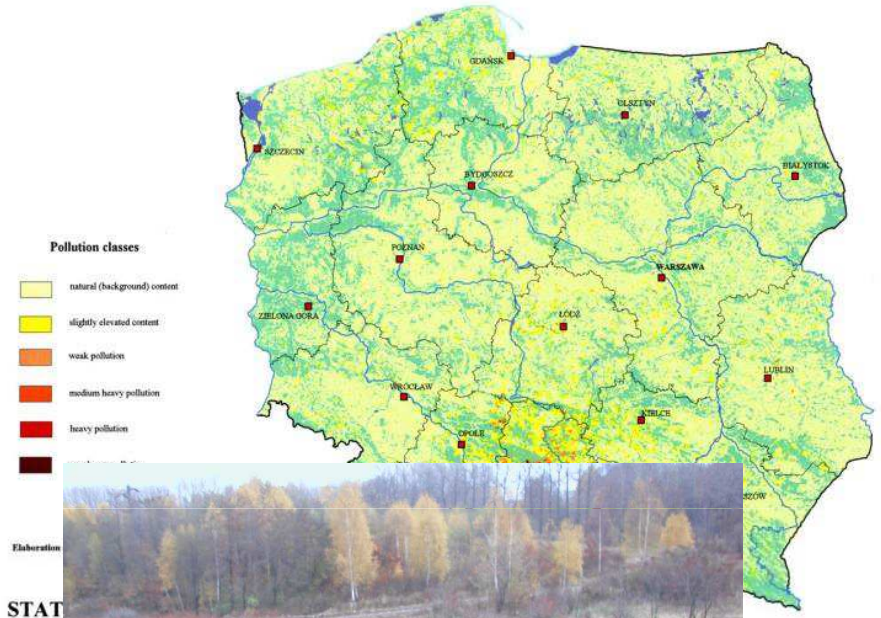
- Highest Cd/Zn accumulation in hyperaccumulators (4000–10000 mg Zn kg-1; 100–180 mg Cd kg-1)
- Improved growth in compost-amended plots
- Inter-cropping with N2 fixing *Lotus corniculatus* alters metal mobility, increases Cd/Zn accumulation, improves nutrition




Europe
A
B
C

B – POLAND – Silesia – Piekary (Pb/Zn)

- In early 1990s toxic smelter waste sites were known to contain more than 87 million tons of waste. Each year this amount was increasing by approximately 400,000 tons. It stopped in mid-1990s.
- In 1992 – 1993, health-risk assessment for the area of former Katowice Province was conducted (US EPA)
- Smelter waste sites were found to have a significant effect on nearby populations through water and wind erosion.
- At the same time disposal of sludge from municipal wastewater treatment plants was one of the identified subjects.



Aims

- Phytostabilisation (vegetation cover)
- Reduction of wind and water erosion
- Pilot implementation of waste (biosolids and waste lime) management strategy for reclamation of smelter wastelands

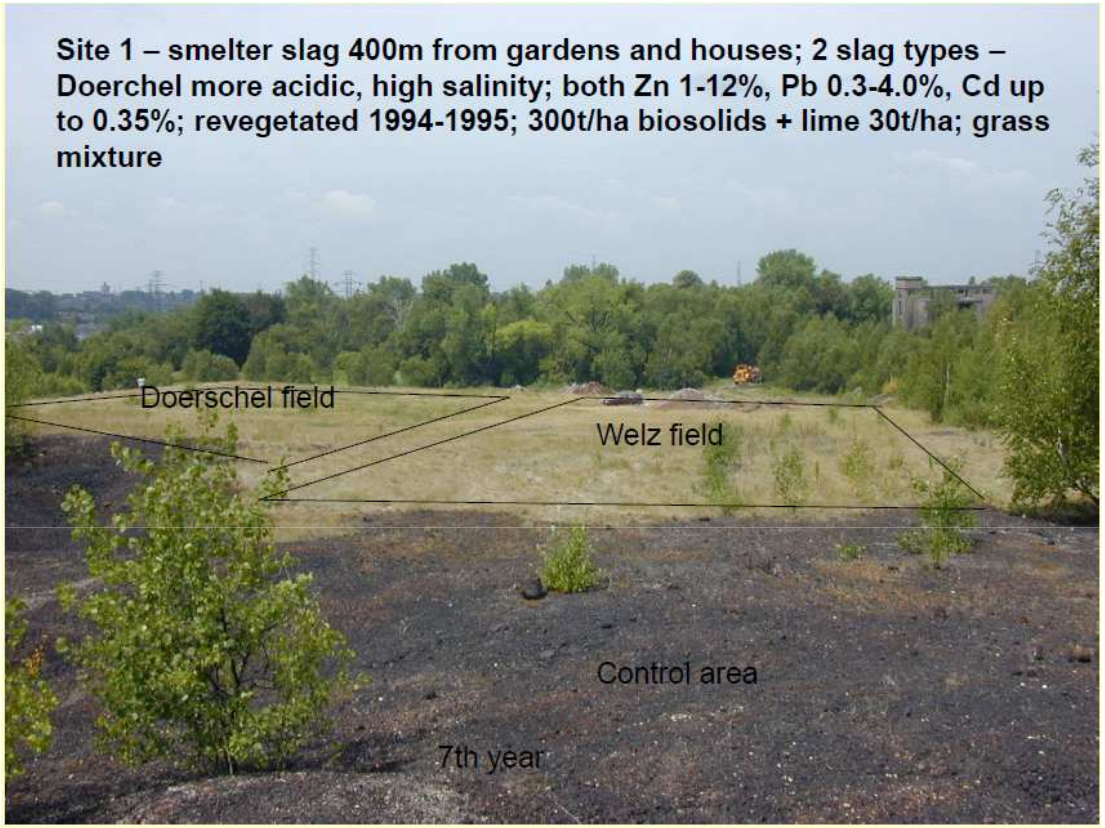
B

Best results – welz waste

- 300 t/ha BS
- +30 t/ha L
- +grasses

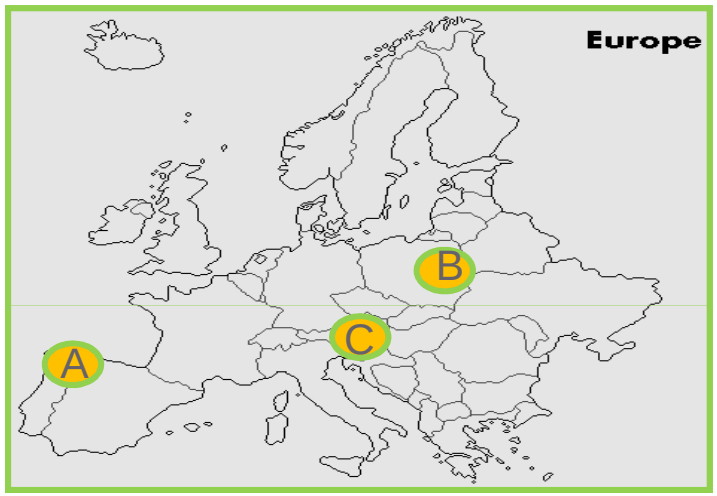
Best results – doerschel waste

- 300 t/ha BS
- +30 t/ha L
- +grasses



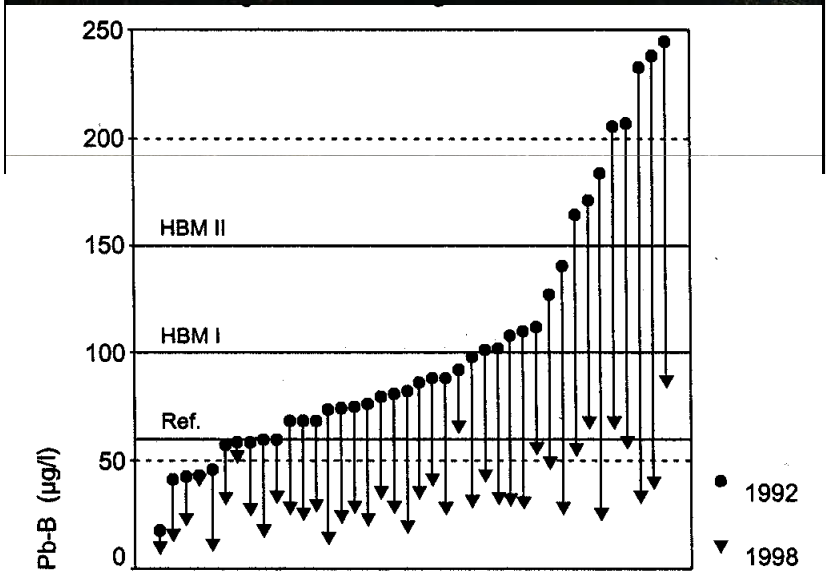
- Additionally lime (30 cm cap of by-product lime)
- Additionally biosolids (300 t/ha)

GRO ?


Europe
A
B
C

History of Arnoldstein

- since 1495 roasting and smelting of Pb
- 1882 production increase
- 1950 production of Zn, Cd, Ge, H2SO4
- production of different substances (fertilisers, dyestuffs etc.)
- 1992 liquidation of the whole industry
- ~ 500 years of immissions



Aims for the surroundings

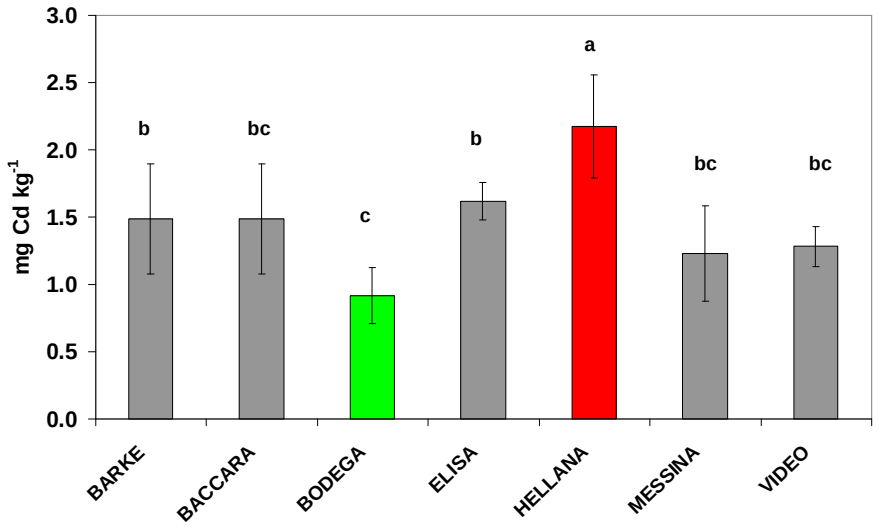
- In-situ immobilization
- Phytoexclusion
- Application techniques on grassland

Experimental level (IMMOBILIZATION + PHYTOEXCLUTION) on arable land

• Batch	Screening of amendments
• Hydroponic	Screening of cultivars
• Pot	Best amend. + culti.
• Field (smal scale)	Optimised for the field
• Field (upscaling)	Optimised for the farmer

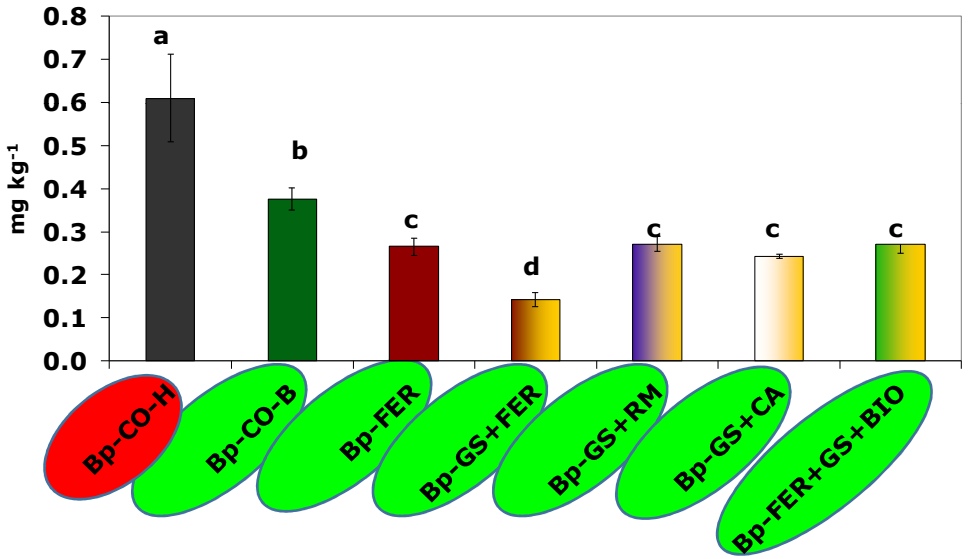
Hydroponic experiment (Barley leaf)

- **HELLANA** = accumulating cultivar
- **BODEGA** = excluding cultivar

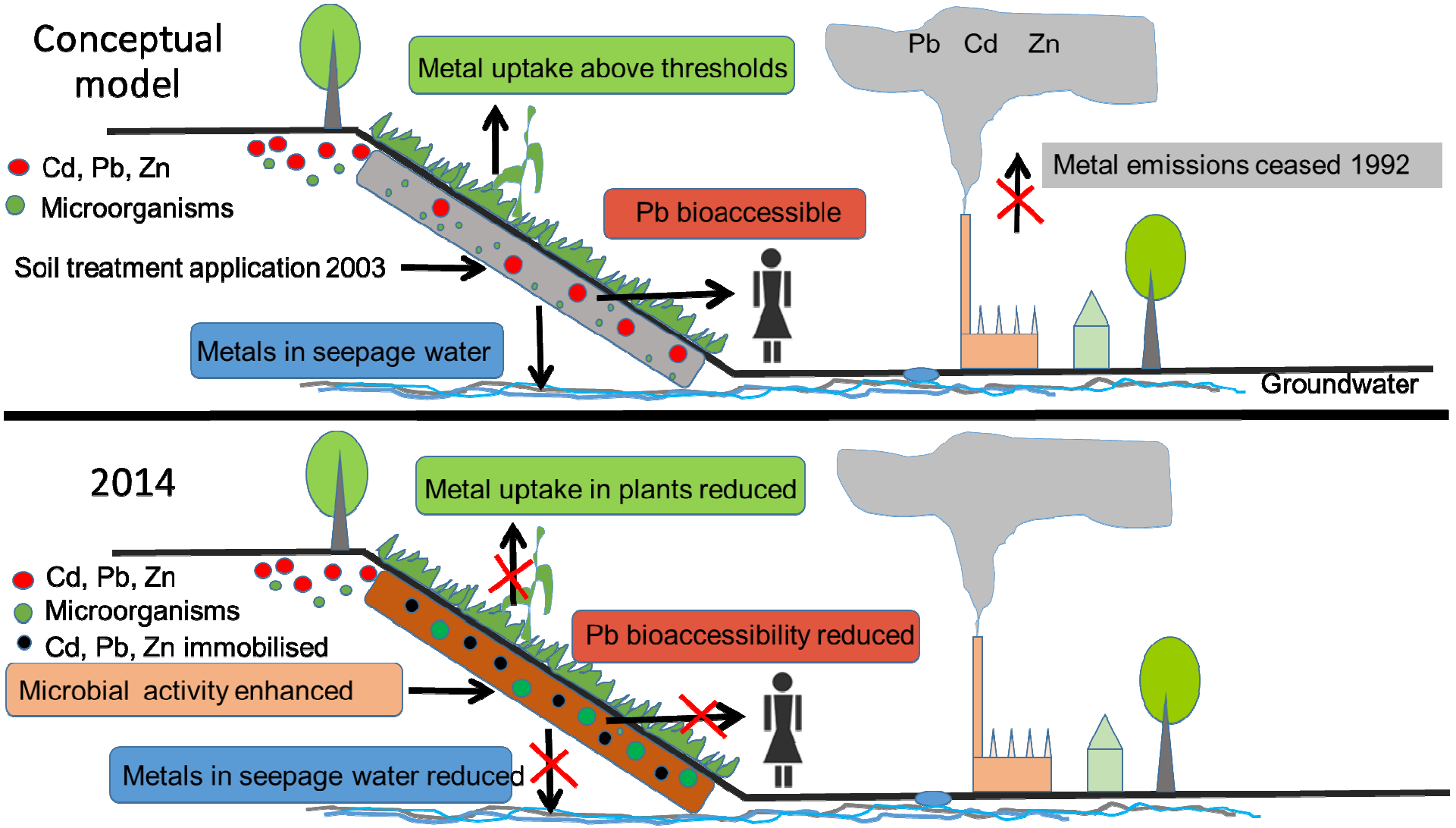


Pot experiment (Barley grain)

- Cultivar selection … > - 30 % Red.
- GS and Fe …… > - 40 % Red
- Sum >>>>>>>> **~ 75 % Reduction**



GRASSLAND (Application techniques IMMOBILIZATION)



(Friesl-Hanl et al, 2016; http://dx.doi.org/10.1016/j.jenvman.2016.08.068)

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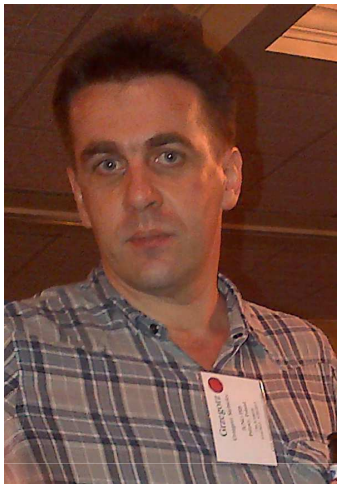
Summary and conclusions

- Gentle remediation options (GROs) are risk management strategies which provide wider benefits
    - Environmental benefits (e.g. restoration of plant/microbs community; keeping soil functions alive, water and soil quality improvement, greenhouse gas mitigation)
    - Economical benefits (e.g. economic returns for biomass production, renewable energy, reuse of abandoned land)
    - Social benefits (e.g. amenity and recreation, provision of green space)

- On the whole chain of Pb/Zn mining and processing GROs are applicable
    - Phytoextraction/Phytostabilisation (Spain)
    - Phytostabilisation/Waste management (Poland)
    - Immobilisation/Phytoexclusion (Austria)

Thank you for your attention!



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- http://www.greenland-project.eu