Boron in sediments from Cecina basin (Tuscany, Italy) and preliminary results from phyto-removal

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Phytoremediation Research and Feasability Test at ISE-CNR in Pisa

- Research: develop strategies to increase phytoremediation efficiency

- Feasability: site specific test to verify the feasability of the technology

Feasability Test

Phase 1. Site specific investigation for local characteristics, contaminants and native plants.

Phase 2. Microcosmo-Mesocosmo Test : Plant species selection and soil/plant treatment selection.

Phase 3. Pilot Test “in situ” or in “scale-up” to verify the best strategies identified in Phase 2.

Feasability test
Site Specific

The problem: *Boron contamination in sediments in the area of Cecina river basin (Tuscany); limiting its diffusion in the environment*

Boron contamination in soil, sediment, water:

- **natural release from silicate minerals (e.g. colemanite);**
- **anthropogenic release in waste from borate mining, glass and ceramic production and borate-containing fertilizers, herbicides and detergents.**

Geothermal zone of Larderello (Tuscany, Italy):

- **includes most of the Cecina basin**
- **100 years of mining activity and the geothermic industry spilled boron in tributaries of Cecina River until 1970s**

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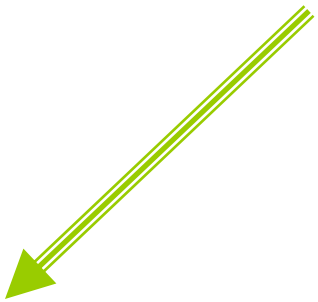
Investigating for a solution

Environmental Ministry program for recovery and remediation of ex-mining and industrial sites in the Cecina basin

The Ministry includes the Cecina basin and the Tiber basin in the EU “Pilot basin project ” for experimental application of Directive *2000/60* to protect internal runoff water, ground water



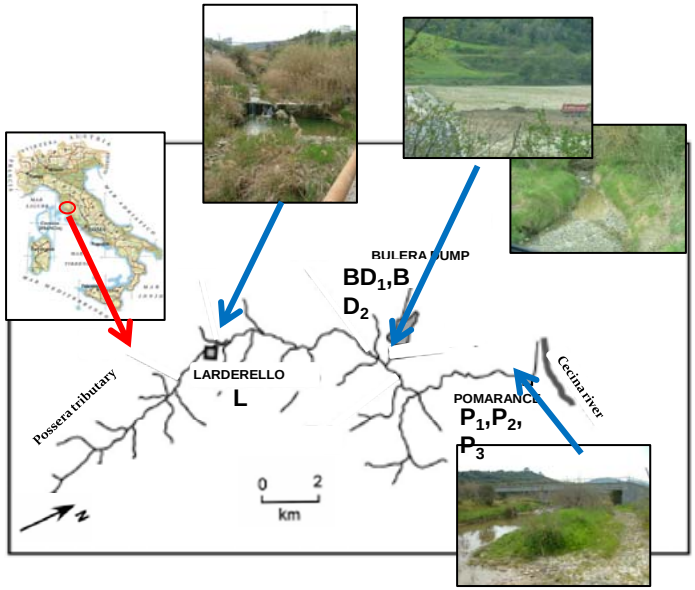
Investigation of pollution characterization in the area.

Test of different remediation technologies even innovative ones such as phytoremediation.

Phase 1
Preliminary investigation in the site

- **collection of native plants colonizing three contaminated areas along the Possera tributary of Cecina river**

- **collection of the respective sediment samples in Larderello (L), Bulera dump (BD1,BD2) and Pomarance (P1,P2,P3) areas**



Sediment characteristics (phase 1)

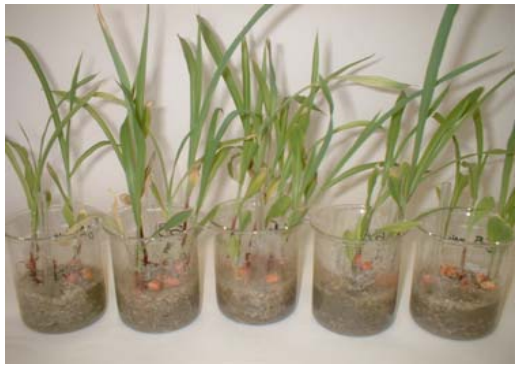
Sample	pH	C.E.C. (meq $100g^{-1}$)	O.M. (%)	Sand (%)	Silt (%)	Clay (%)	B_{total} (mg kg^{-1})	$B_{available}$ (mg kg^{-1})
P_1	8.5	13.9	2.2	81.0	13.6	5.5	44	1.3
P_2	8.3	16.3	2.4	81.4	13.7	4.9	47	2.6
P_3	8.2	15.6	1.9	70.0	20.3	9.7	43	3.7
BD_1	8.2	16.3	1.2	63.4	19.1	17.5	57	17
BD_2	8.3	16.0	1.3	72.8	11.6	15.5	77	40
L	8.5	8.1	0.6	97.4	1.5	1.0	14	3.1
C	8.2	19.3	5.4	49.1	39.2	11.7	26	1.3

High boron availability especially in sediment samples from the Bulera stream near the landfill

Boron content in collected plant species

Plant sample	B (mg kg^{-1})	Plant sample	B (mg kg^{-1})
Taraxacum officinale		*Euphorbia sp.*	
Leaves	60 (7.8)	Leaves	82 (4.8)
Stem	26 (2.6)	Stem	24 (3.9)
Roots	32 (1.6)	Roots	n/a
Brassica napus		*Rumex crispus*	
Leaves	86 (2.9)	Leaves	425 (10)
Stem	37 (6.7)	Stem	73 (1.8)
Roots	16 (4.5)	Radice	56 (3.5)
Crepis bulbosa		*Poa spp.*	
Shoots	64 (3.9)	Shoots	203 (8.4)
Roots	40 (3.7)	Roots	154 (7.1)
Phragmites australis			
Shoots	82 (4.9)		
Roots	n/a		

Test in microcosm (Phase 2)



Zea mais

Helianthus annus

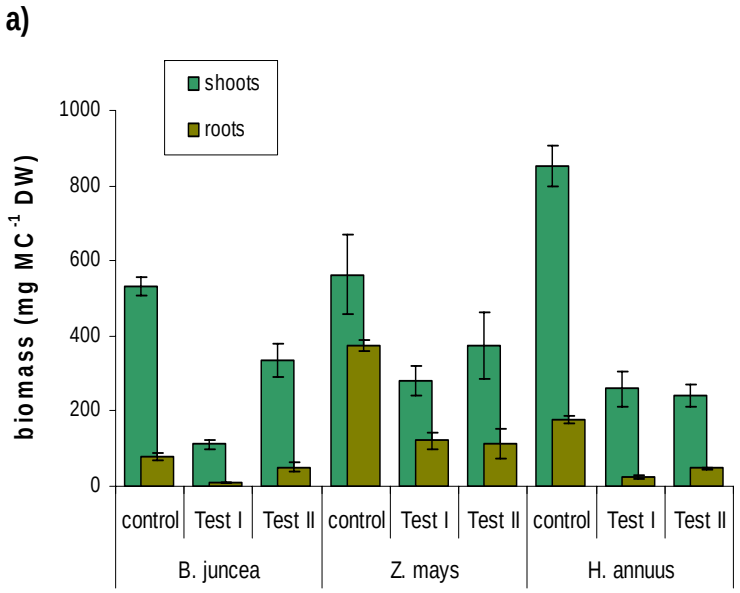
Brassica juncea

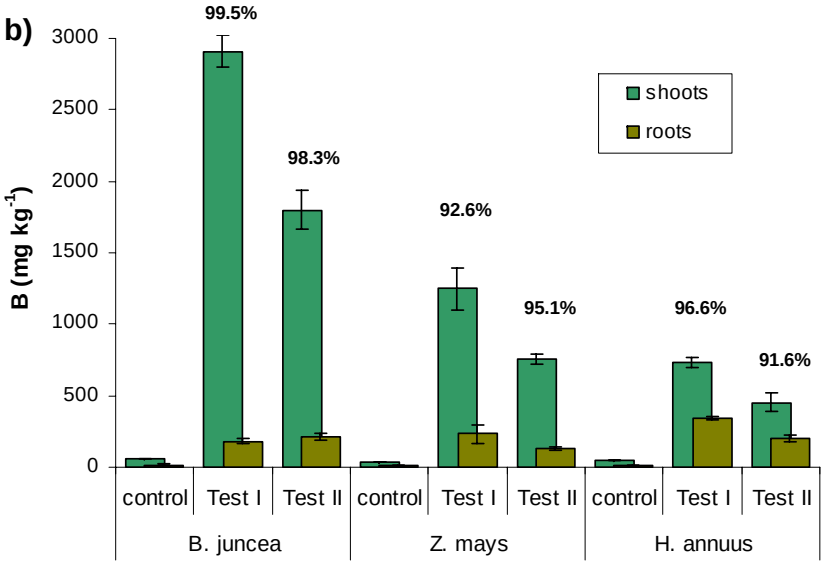
Test microcosm – Results
Biomass (a) – B uptake (b)

Two consecutive growing cycles by the same plant species!

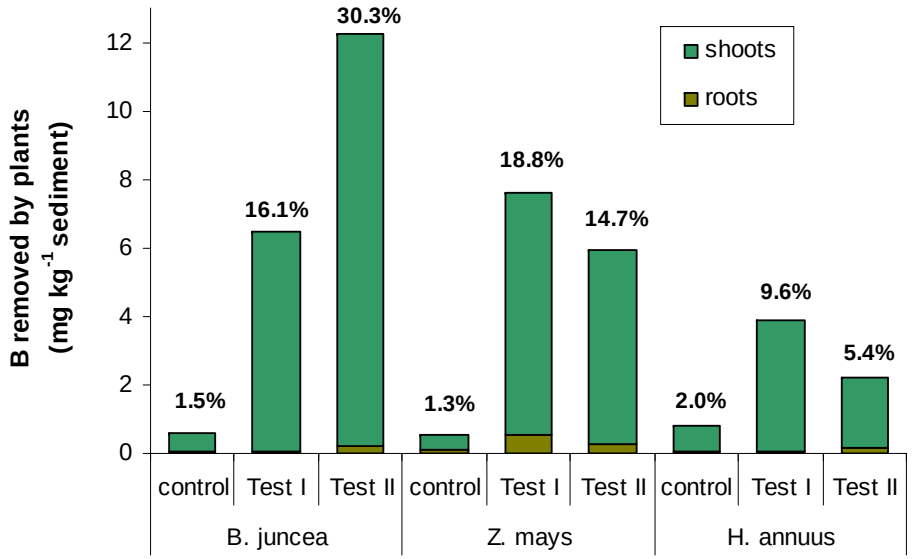
a) Biomass production.
Lower than in control microcosm

b) B accumulation and % of traslocation root to shoot





Test microcosm – result
Phyto-extracted Boron



The percentage represents the B removed by plants after each growing cycle compared to available fraction of B in the sediment.

Test in scale up – lisimiter (Phase 3)

- Still running, will test the best plants investigated in microcosm test (*Brassica juncea* - *Zea mais*)
  - Agronomic input to increase biomass
  - Will provide more realistic data on boron phytoextraction efficiency on sediments.

Test in scale up - lisimiter

Leachate collecting

Located on the CNR campus
Still running!!

Brassica juncea

Use of boron-rich biomass

- Compost for soil with low boron content
- Boron bio-fortified feed

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Thank you for your attention!!