Learning from our mistakes: achievements and misfortunes in phytotechnology

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Case study: Phytoremediation of brownfields

Situation

- Mixed contamination with heavy metals (Cu, Pb and Zn) and various organic compounds
- Urban setting; compacted and mineralized soils

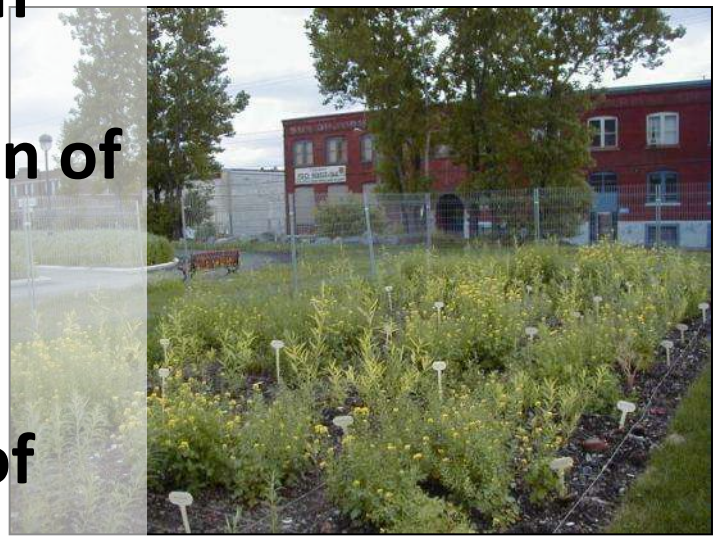
Solution

- Use of hyperaccumulator plants vs two willow species
- Treatment with chelates (EDTA) to encourage translocation of contaminants

Case study: Phytoremediation of brownfields

Results

- Very good establishment and performance of *B. juncea* (Indian mustard)
- EDTA has a positive effect on absorption and translocation in *Brassica* only
- Good capacity for accumulation of Cu and Pb in aerial parts of *Brassica*
- Willow highly efficient for absorption and translocation of Zn



Case study:
Phytoremediation of brownfields

Problems

- **Edaphic conditions hindered plant establishment**
- **We estimate that it will take several decades to remove some of the less mobile contaminants from the area**

Case study: Phytoremediation of brownfields Tanneries Alley

Situation

- Urban site contaminated with heavy metals
- Mixed garbage dump
- Compacted, mineralized soils; presence of large debris

Solution

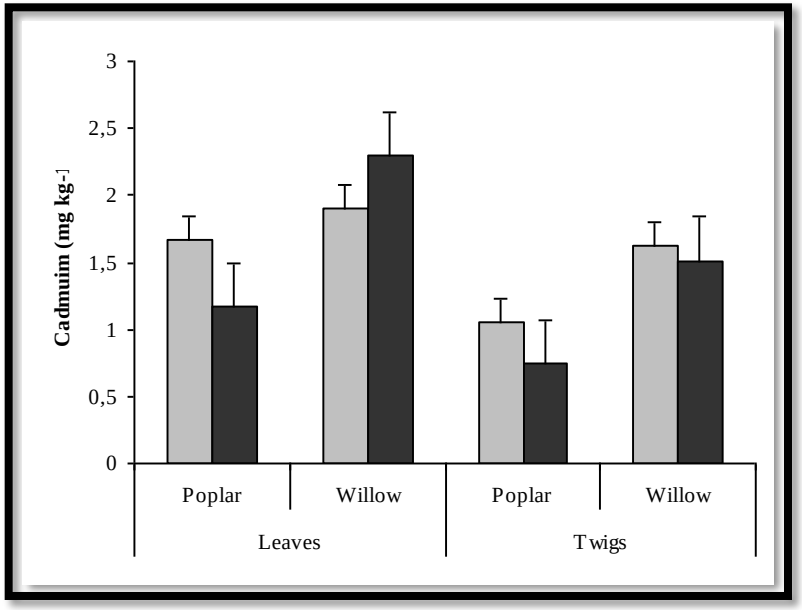
- Use of fast growing plants (poplars and willows)
- Use of micorrhizal inoculum (*Glomus intraradices*)

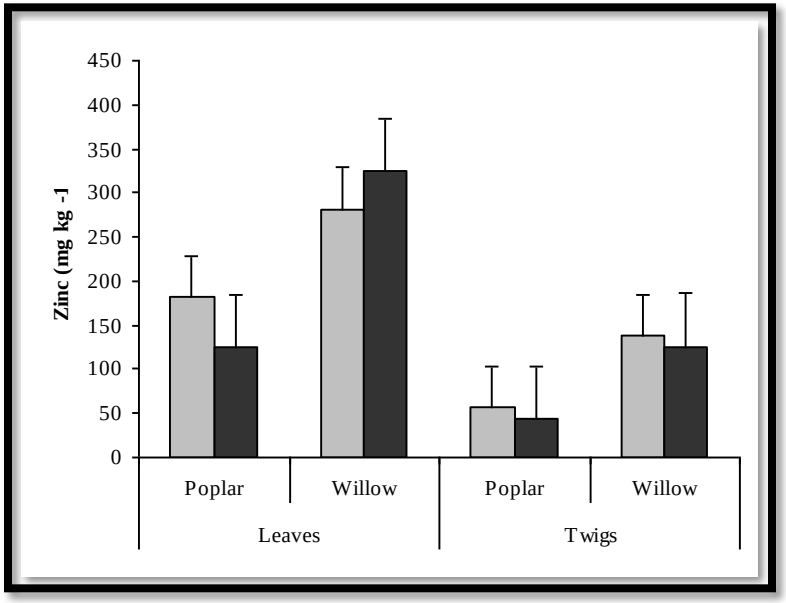
Case study: Phytoremediation of brownfields Tanneries Alley

Results

- Use of willows and poplars generates vegetation cover rapidly
- Use of AM inoculum: positive effect on establishment but not on absorption of pollutants
- Efficiency of plants at accumulating metals increases over time

Figure 1. Comparison of concentrations of heavy metals in stems and leaves after one season





■ With inoculum ■ Without inoculum

From Bissonnette et al. 2010. Plant and Soil.

Results of paired t-tests comparing *S. viminalis* and *P. x generosa* aboveground plant heavy metal concentration in leaves and stems of inoculated (Gi) and non-inoculated (Ctrl) plants between the first (1) and second (2) year of growth in the field.

Clones	Tissues	Inoculation	Metal concentration			
			Cd	Zn	Cu	Pb
P. × generosa	Leaves	Gi	1=2	1=2	1=2	1=2
		Ctrl	1=2	1=2	1=2	1=2
	Stems	Gi	1=2	1=2	1=2	1=2
		Ctrl	1=2	1=2	1=2	1=2
S. viminalis	Leaves	Gi	1=2	1=2	1=2	1<2**
		Ctrl	1=2	1=2	1=2	1<2*
	Stems	Gi	1<2**	1<2**	1<2**	1=2
		Ctrl	1<2*	1<2**	1<2*	1=2

From Bissonnette *et al.* 2010. Plant and Soil.

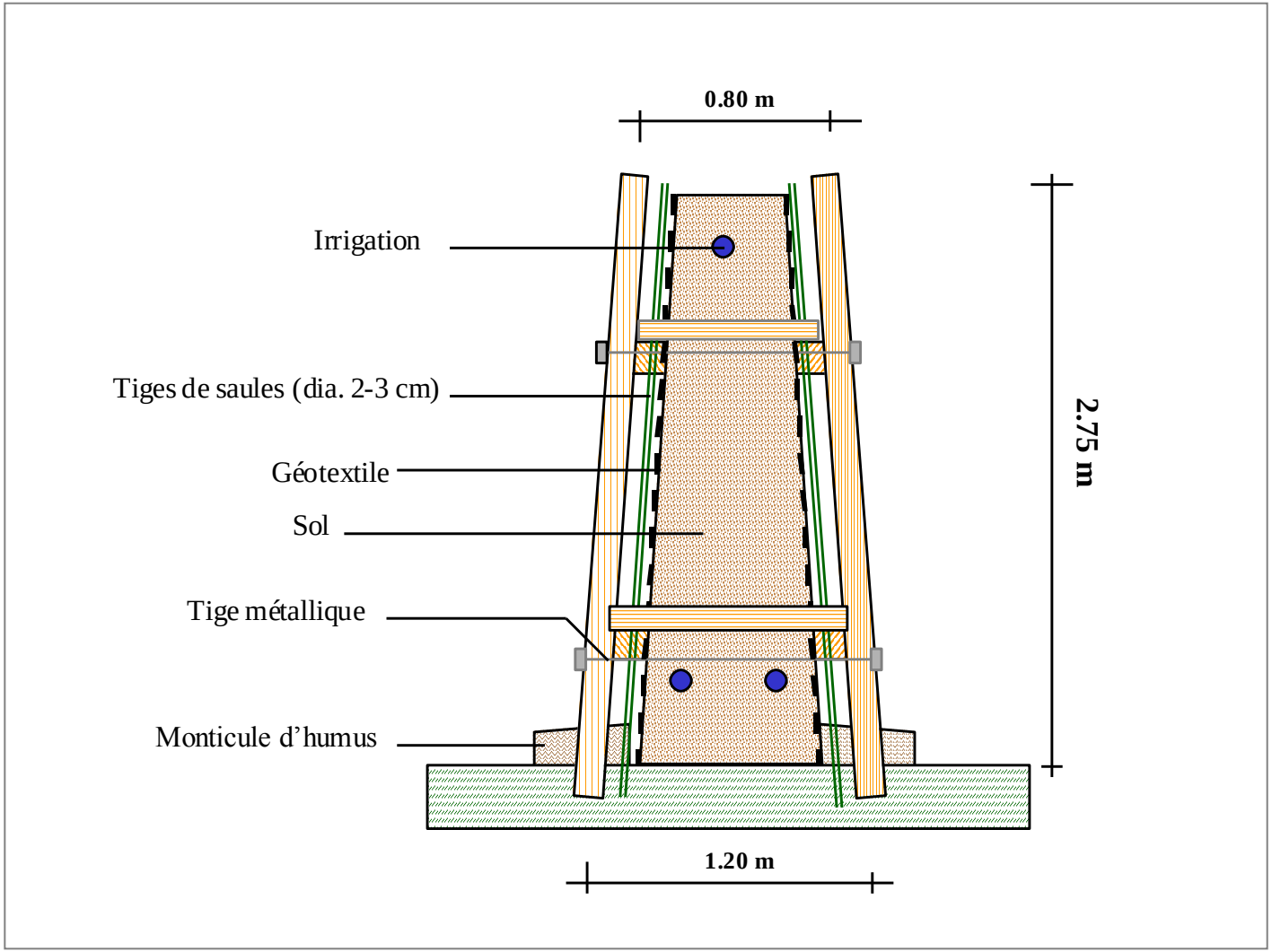
Case study:
Phytoremediation of brownfields
Tanneries Alley

Other problems

- Aphid infestations inhibited plant growth
- Significant mortality in some plots
- Follow-up could not be continued beyond two years, due to lack of funding

Case study: Living walls

Construction principles



Advantages of living walls

- Ecological substitute for cement walls
- Highly efficient as a sound barrier
- Rapid establishment and immediate impact
- Aesthetic, improve landscaping
- CO2 sequestration (5 to 6 kg m^{-1})
- Graffiti-proof
- High level of social acceptance

Case study: Living walls
Situation

- Living walls several kms long have been constructed along highways in Quebec and Ontario
- Satisfaction is generally very high
- But…

Case study: Living walls Problems

- Durability is as yet unknown
- Structures are not immune to disease and pests
- Problems with freezing and winter mortality
- Other problems…

Case study:
Sites contaminated by petroleum activities

Situation

- Abandoned site that was used until recently for petroleum refining
- Extremely variable levels of contamination, but also high levels of contamination in some areas
- Contaminated to a depth greater than 2 m by various volatile organic compounds (VOCs): 1,2-dichloroethane, 1,1,2-trichloroethane and vinyl chloride
- Very high water table

Case study:
Sites contaminated by petroleum activities

Solution

- **Planting long willow and poplar cuttings in holes 2.5 m deep**

DOWNING
4

Case study:
Sites contaminated by petroleum activities

Results and problems

- **Significant plant mortality due to very poor rooting in the conditions imposed by the site**

- **Reasons**
  - **Contamination?**
  - **Anoxia?**

Case study:
Sites contaminated by petroleum activities

Case study:
Sites contaminated by petroleum activities

Case study:
Sites contaminated by petroleum activities

Another solution undertaken in 2010

- Work continued in 2010 with new methods that take into account the results obtained from in situ and ex situ experiments
- Planting of long rooted cuttings

Case study:
Sites contaminated by petroleum activities

Preliminary results

- Mixed results: some plants seem to have established well, in other sectors… it's a catastrophe…

Conclusions

- Phytotechnologies rely on plants, which necessarily implies managing risks associated with using living material
- Follow-up and maintenance are required to ensure best results
- Too many projects are undertaken over too short a time span. Conclusions are sometimes drawn too hastily.
- Phytotechnology is a young science, we lack information about the functioning of the plants used in such circumstances.

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