Phytostabilization of Metallurgical Landfills: Combined Effects of Soil Amendment and Plant Assemblage (PHYSAFIMM project)

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Problem and objectives

Figure 1: general view of the study site.

The use of phytostabilization can represent an attractive alternative option for the remediation of metal-contaminated soils. Conventional technologies such as soil removal or soil washing are usually expensive, labor intensive and they are unsuitable to treat large areas or soil volumes. Thus the greatest advantages of phytostabilization are its **potential use for large scale areas and its reduced cost**, together with **soil preservation or restoration** (). However, growing plants onto contaminaVangronsveld et al., 1995; Wong, 2003; Mench et al., 2010ted soils is not a trivial task and the success of a phytostabilization project depends not only on the type and concentration of contaminants, but also on the proper choice of initial plant community (Remon et al., 2005) and soil amendment. This work aimed at identifying **key-factors** for successful revegetation and striking of pollutant linkages at a former metallurgical landfill.

Figure 2: partial view of the experimental plots six months after sowing.

Strategy

The site is a metallurgical landfill (Fig. 1) located near Lyon (Rhône, France). It has been long-term used from about 1850 to 2001 to dispose of foundry wastes, and extend over nearly **15 ha**. Main agronomic properties of the soil (**"foundry technosol"** type) are given in Table I, and trace metals contents are given in Table II.

Table I: main agronomics properties of the study site

Texture	pH	OM (g kg-1)	Ntot	C/N	P2O5 (g kg-1)	K20 (g kg-1)
Sandy	10.8	31	0.3	63.5	0.02	0.08

1 *THE REVEGETATION OF A SANDY SOIL WITH VERY HIGH pH AND VERY LOW NUTRITIVE CAPACITY*

Table II: Soil conccntrations of thc main tracc mctals (total content, mg/kg^{-1}) at the study site.

Ba	Cd	Cr	Cu	Ni	Pb	Zn
208	3	2570	405	1330	120	615

2 *WITH TRACE METAL CONTENT UP TO 500-FOLD HIGHER THAN IN A NORMAL UNCONTAMINATED SITE*

The experimental design was a factorial combination of **three types of soil amendments X three assemblages of plant species**. This experiment was performed both on ***in situ* plots** (5 mX 10m) and in **constructed lysimeters** (5m x 10m x 1.5m), resulting in eighteen 50 m^2 experimental plots (Fig. 2).

The following amendments were compared **(1) ramial chipped wood** (RCW) used as a 5 cm depth layer, **(2) composted sludge** (CS) applied at 150 t DM/ha and **(3) inorganic fertilization** (NPK) with ammonium nitrate, superphosphate and potassium sulphate at 200, 220 and 200 kg/ha respectively.

The selected plant assemblages were:

(1) a "regular" species mix commonly used for land and roadside revegetation (composed of *Dactylis glomerata*, *Festuca arundinacea*, *Lolium perenne*, *Coronilla varia*, *Lotus corniculatus*, *Onobrychis viciifolia*, *Trifolium repens*, *Plantago lanceolata* and *Sanguisorba minor*),

(2) an "optimized" species mix with mostly metallicolous and/or calcicolous plant species (composed of *Brachypodium pinnatum*, *Bromus erectus*, *Festuca ovina*, *Anthyllis vulneraria*, *Medicago lupulina*, *Achillea millefolium*, *Centranthus ruber* and *Valeriana officinalis*), and

(3) no sowing i.e. waiting for spontaneous plant colonization. Sowing was performed in April 2010

Results (Fig.3) & Discussion

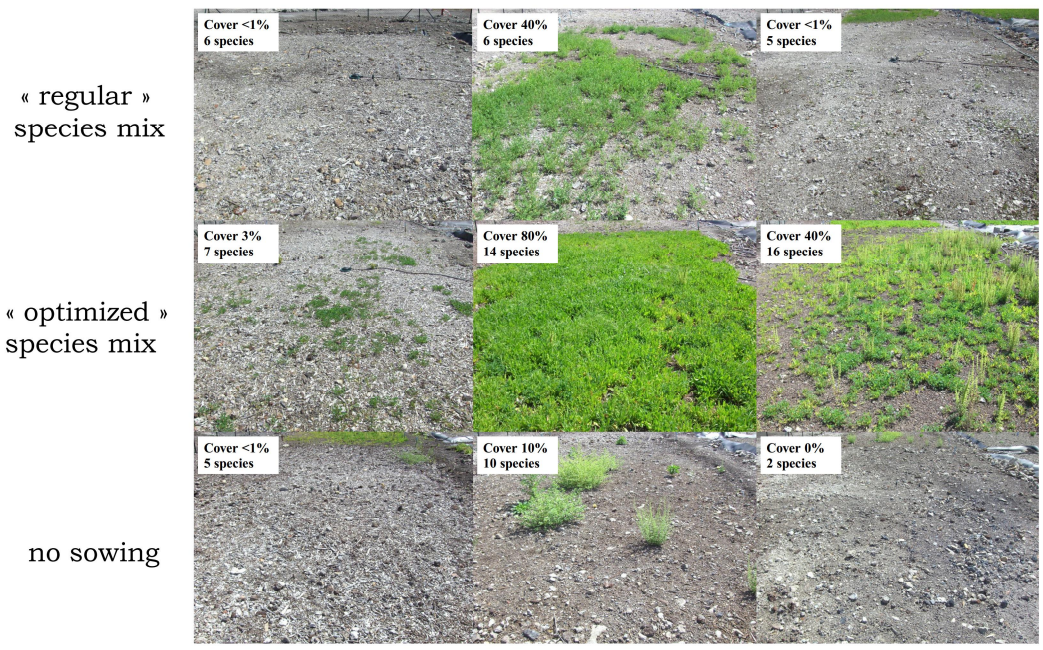

Figure 3: Vegetation development for the nine tested modalities, as observed six months after sowing.

Key-factors were

(1) substrate enrichment with composted sludge, quite cheap but very efficient material.

(2) The use of an "optimized" species mix [that is, a **trade-off between "the best reconstructed plant community"** (assumed to tolerate the high ecological constraints they will have to face on a foundry technosol), and **seeds' availability on the European market**].

3 *CAN BE ACHIEVED PROVIDING A SUITABLE ASSEMBLAGE OF PLANT SPECIES AND THE SELECTION OF AN EFFICIENT SOIL AMENDMENT.*

But an ecologically-sound aided phytostabilization system does not only rely on revegetation.
Its main objective is to promote the immobilization of trace metals.

In the PHYSAFIMM program we are now investigating the effects of plant development on the reconstruction of a functional soil, metal(loid) immobilization, plant succession, and leaching from the root zone.

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