



Using a multidisciplinary approach for phytoremediation of abandoned mine site: the case study of Sardinia

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Introduction

Mediterranean biogeographical region is considered as **one of the most historically devoted region to mining exploitation** since pre-roman times.



Nowadays many sites are abandoned all over the **Mediterranean Basin**.

The waste materials were often left to weathering without reclamation.



Scars on the environment, landscapes, biodiversity, and the well-being of local communities

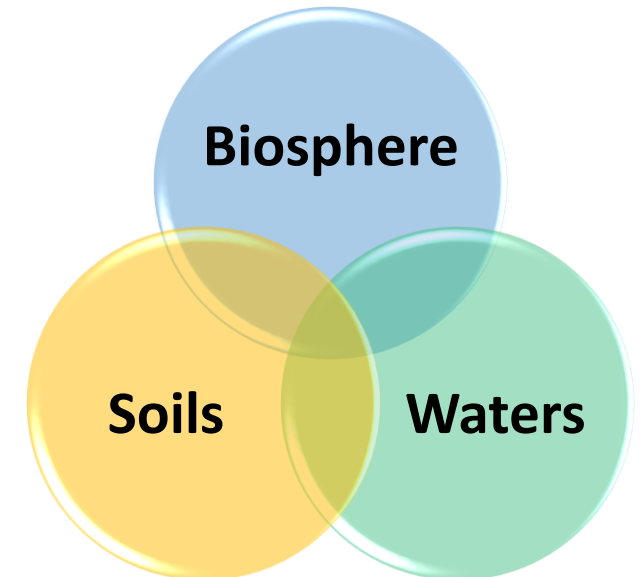
Mine waste materials are unfavourable environments for plant life:



33 As Arsenic 74.92	48 Cd Cadmium 112.21
80 Hg Mercury 200.6	30 Zn Zinc 65.38
82 Pb Lead 207	51 Sb Antimony 121.76

- ❖ absence of top soil;
- ❖ lack of nutrients (K, N, and P);
- ❖ lack of organic matter;
- ❖ high concentration of metal(loid)s.

Metal(loid)s contamination of



Introduction – Restoration of abandoned mining areas

Conventional technologies

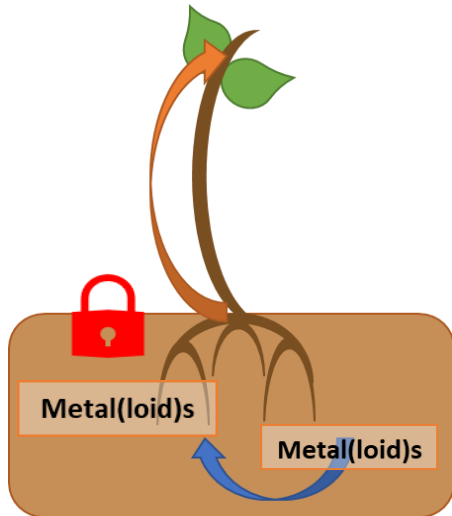


Biotechnologies



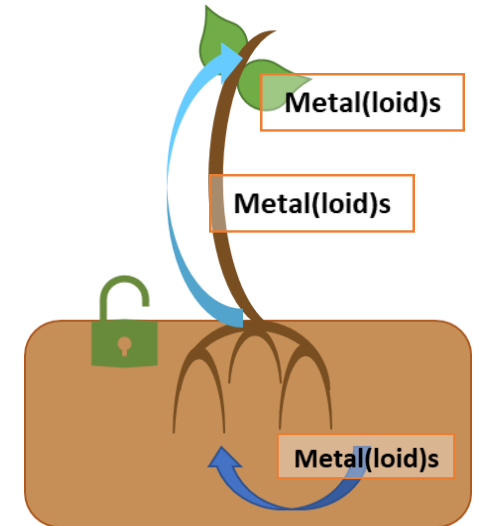
Phytoremediation

Technology that uses plants able to reduce contaminants dispersion



Phytostabilization

Excluder species



Phytoextraction

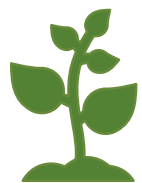
Accumulator species

Introduction – The Sardinian mine context

Sardinia was one of the most important mine poles in Europe during the 20th century.

However, huge quantities of waste materials were left abandoned without reclamation.

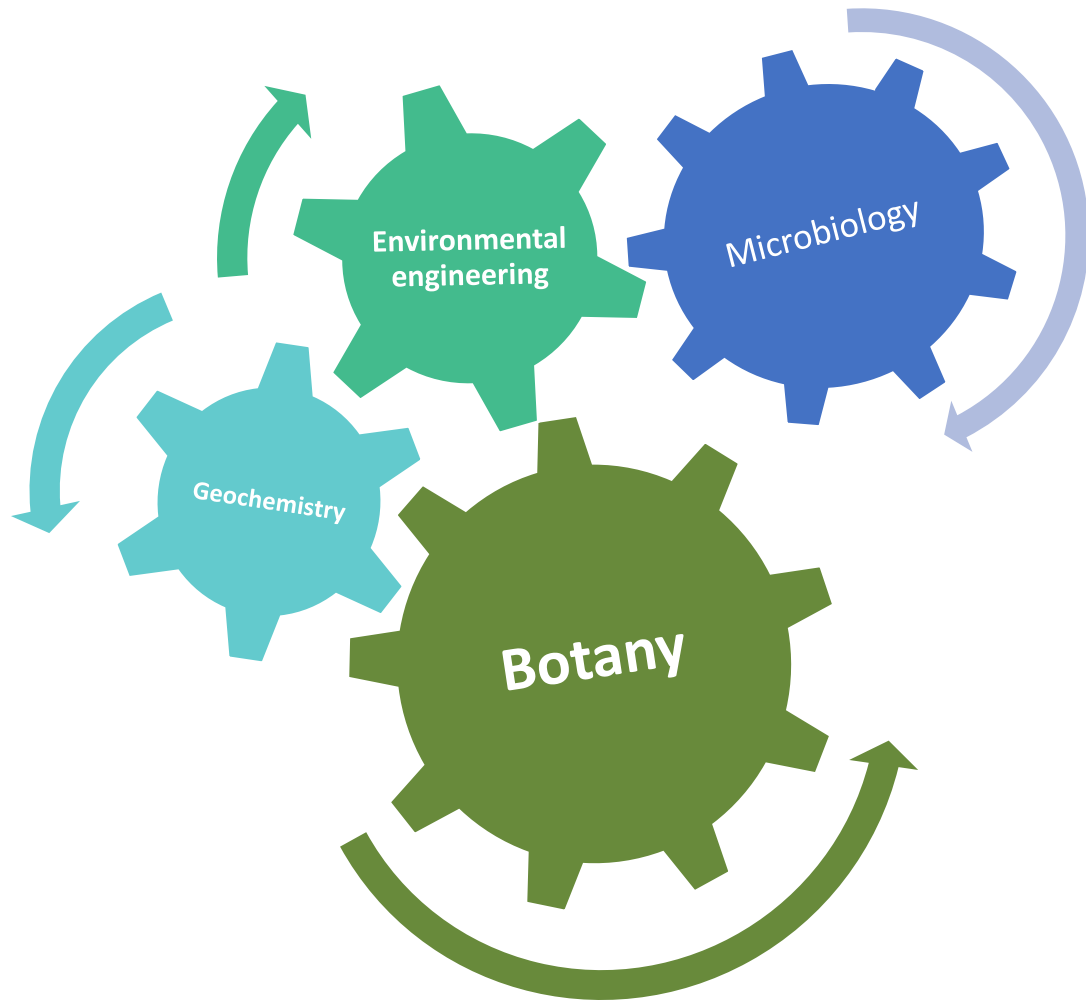
 70 million of m³ of
polluted materials 



Different native species are able to grow in these environments and suitable for phytoremediation








The multidisciplinary approach



A **multidisciplinary approach** for seeing the matter from **different points of view**.

The Sardinian experience

Along the last 15 years, several studies were carried out on the Sardinian mine context using a multidisciplinary approach.

- Field sampling campaigns 
- Mineralogical investigations 
- *In situ* experiments 
- *Ex situ* experiments 
- Germination tests 



Pistacia lentiscus L.



Helichrysum microphyllum
Cambess. subsp. *tyrrhenicum*
Bacch., Brullo & Giusso

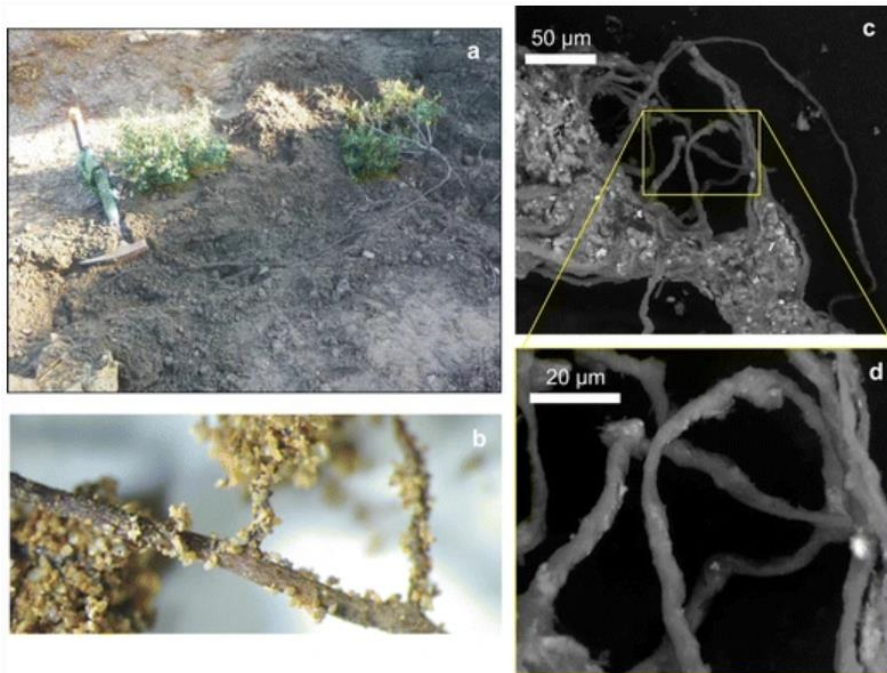
The field sampling campaigns

- **Fundamental step** in order to know the behavior of a plant species.
- On specimens of *Pistacia lentiscus* (Concas et al. 2015) and *Helichrysum microphyllum* subsp. *tyrrhenicum* (Bacchetta et al. 2018).
- **Metal tolerant species.**
- **Suitable for phytostabilization**

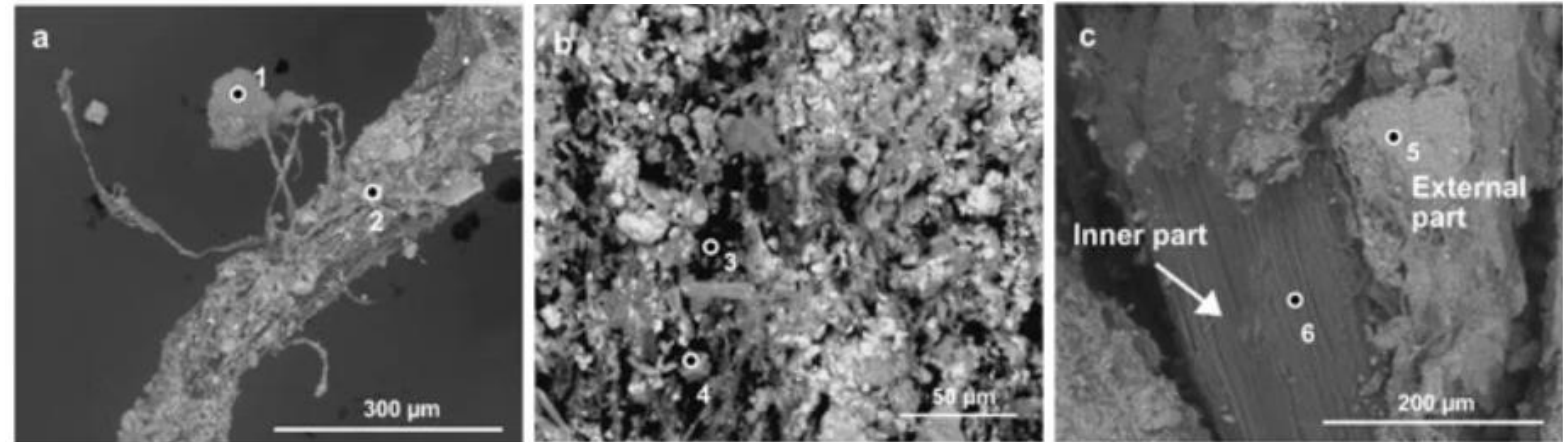


Mineralogical investigation

- Studies on the **process occurring at the substrate - roots interface**.
- *Pistacia lentiscus* and *Helichrysum microphyllum* subsp. *tyrrhenicum* roots take up Zn, Al and Si from rhizosphere minerals, building **biominerals** (Boi et al. 2020; De Giudici et al. 2015)
- **Mechanism of exclusion** from the excess of Zn play by these two species.



Pistacia lentiscus



Helichrysum microphyllum subsp. *tyrrhenicum*

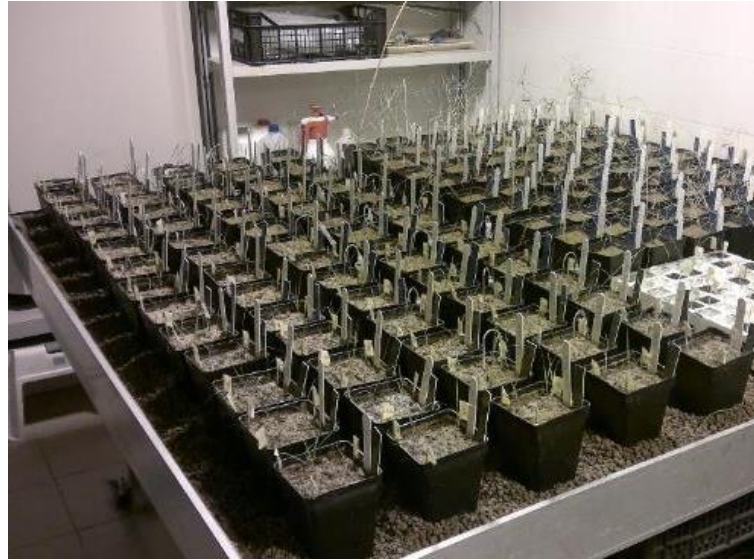
The *in situ* experiments

- ***In situ* experiments** are fundamental tools to check the potential of a species in real environments (two-year study or more).
- Application of soil amendments (i.e., compost, zeolite and their combinations).
- Suitability of *Pistacia lentiscus* for phytostabilization and environmental restoration (Bacchetta et al. 2012).
- Amendments increased the survival of the species.



The *ex situ* experiments

- *Ex situ* experiments help to optimize phytoremediation actions, taking advantages of controlled conditions.
- Implementation of compost or other soil amendments.
- Bioaugmentation and administration of selected Plant Growth Promoting Bacteria (PGPB).
- Compost and bacterial strains decreased the metal uptake and improved the survival of plants (Bacchetta et al. 2015; Boi et al. 2021; Tamburini et al. 2017).



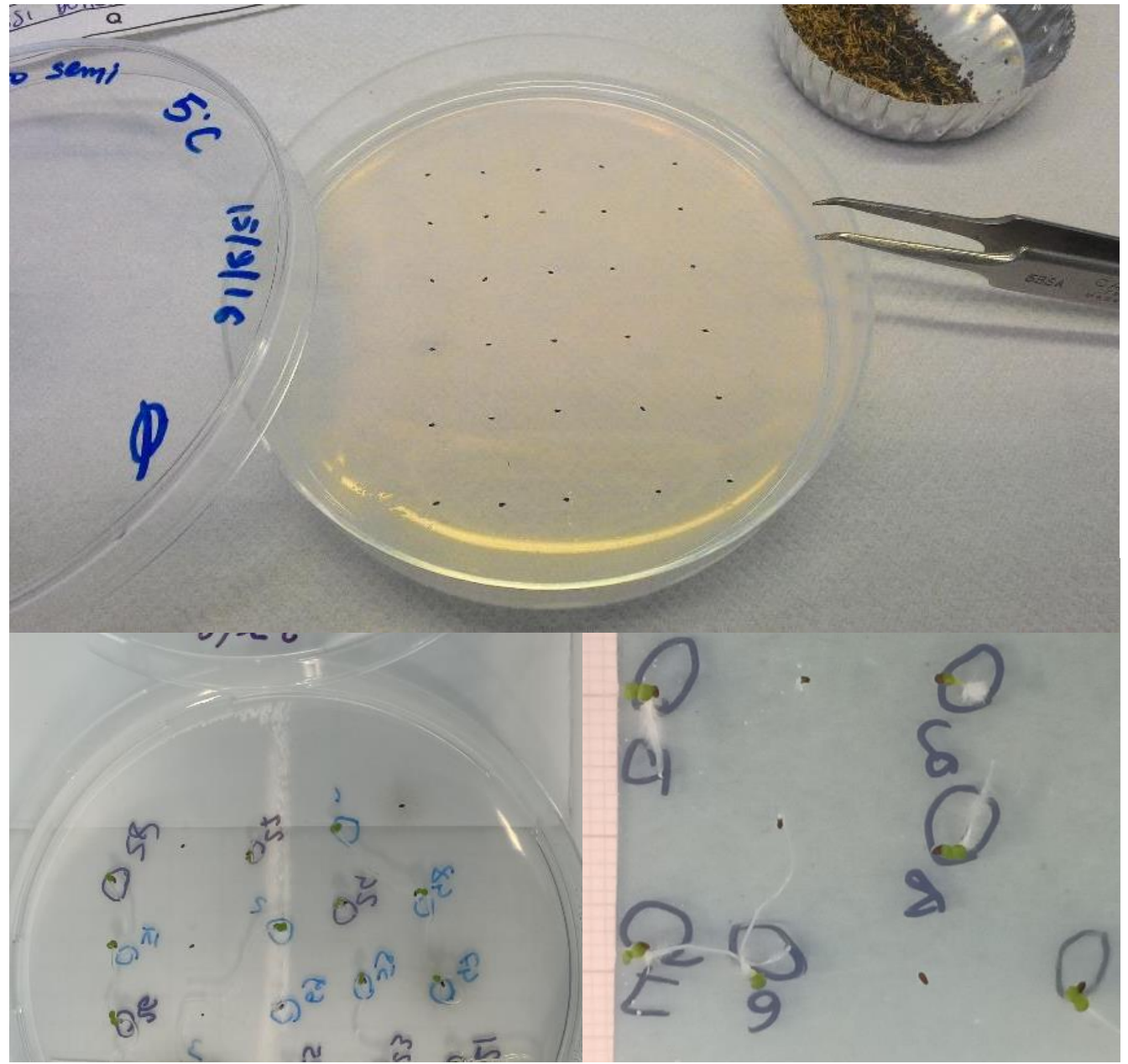
Pistacia lentiscus

Helichrysum microphyllum subsp. *tyrrhenicum*



Germination tests

- Germination tests under metal(loid)s stress help to develop remediation action starting from seeds.
- Seeds of *Helichrysum microphyllum* subsp. *tyrrhenicum* were subjected to Zn, Pb and As stress.
- Seeds germinated under high concentrations of Zn and Pb, without the inhibition of the process (Boi et al. 2020).
- Speciation effect on germination and seedling development when arsenicals are used (Boi et al. 2022).



Conclusion

The application of a multidisciplinary approach can reveal many details:

- the behavior of a species (tolerant, accumulator, hyperaccumulator);
- the mechanism of plant survival, i.e., biominerals;
- interaction with microorganisms at root-substrate interface;
- the ability to resist to metal(loid)s stress during germination and seedlings development;
- the effect of metal(loid)s speciation during these step.

This same approach can also be applied:

- in other Mediterranean mining contexts;
- with different plant species.



Ptilostemon casabonae (L.) Greuter



Linum mulleri Moris.



Iberis integerrima Moris



Thank you for your attention



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