Metal phyto-extraction technology as a remediation step in the redevelopment of an Italian industrial site

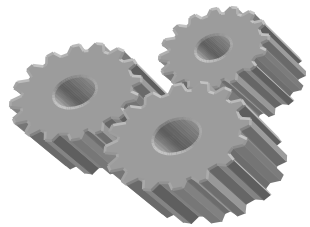
Ambrosini P., Patata L.
Saipem/RISAMB – Fano - Italy

Pedron F., Petruzzelli G., Barbafieri M.
CNR - Institute for Ecosystem Studies – Pisa - Italy
Meri.Barbafieri@ise.cnr.it

The Brindisi area

The industrial site is an oil refinery located in Brindisi (southern Italy) and belongs to a multi-company.

Solving the problem



In the redevelopment process it was necessary to proceed with the remediation of soil moderately contaminated mainly by hydrocarbons and metals (Hg, Pb, Cu, Zn)

Following applicability tests, on-site phytoextraction was selected as a viable technology approved by the Italian Ministry of the Environment.

Italian legislation supports remediation technologies such as in-situ and matrix recovery

Remediation

The site remediation was planned in different steps and in sub-areas.

Reclamation comprehends two phases:

Phase 1 (2003 – 2008): excavation, selection, transport and sieving of the materials and subsequent deposit in the phytoremediation area

Phase 2: (2007- present) phyto-treatment of the selected materials (soil)

The remediation: phase 1

Phytoremediation plant

Areas of intervention

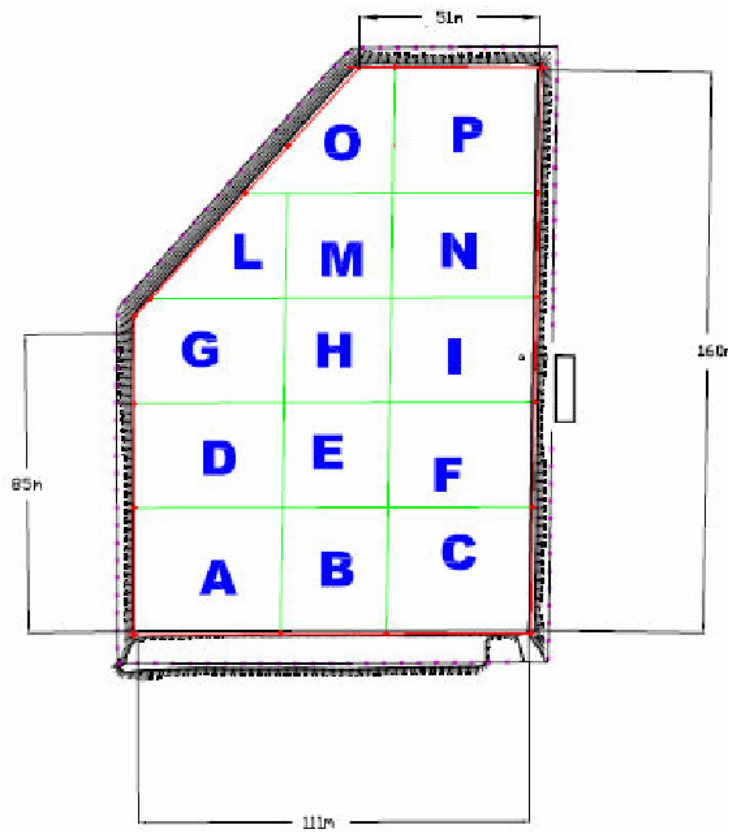
Excavation, selection, transport and sieving of the materials and subsequent deposit in the phytoremediation area

The remediation: phase 2

Started in 2007 and still running: with the phyto-treatment of the selected materials (soil)

The phytoremediation plant is located inside the industrial area

It covers 15,000 m^2 and is about 0.7m high



Some pictures

Anti-bird intrusion net at 5m high

Irrigation system to assure the spread of water and of metals mobilizing additives

Waterproof basin to contain contaminated soils

Some pictures

Water drainage system to collect leachates into a controlled tank.

Tank for chemical additives

Cooperation

The process is assisted by ongoing experimental research to implement the technology

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Site Specific Feasability test

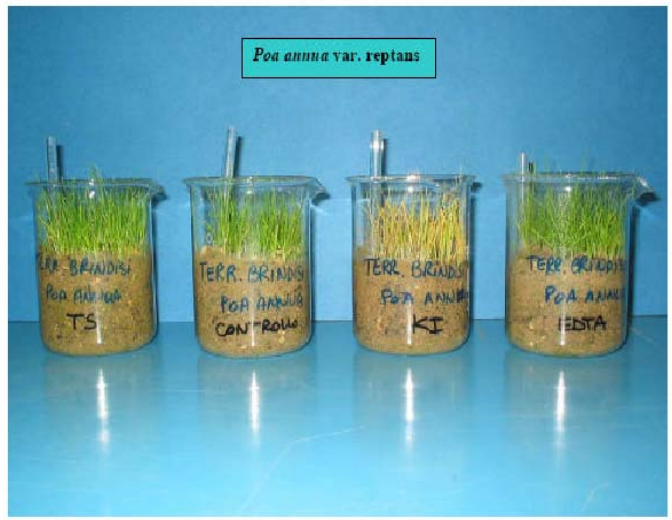
❖ Increased bio-accessibility of metals following addition of mobilizing agents

Hg contamination is of major concern with a content of about 15 $mgkg^{-1}$

We screened different additives for increasing Hg mobilization; the most effective were ammonium thiosulfate (TS) and potassium iodide (KI)

❖ Increased metal concentration in the crop plants used

Ammonium thiosulfate was tested in microcosm to verify its effectiveness in increasing Hg uptake by plants



(a)

It was effective!

eg. in *Poa annua* Hg uptake increased 400-fold in the aerial part (140 mg kg^{-1}) and in *Brassica* increased 70-fold (100 mgkg-1)

Test microcosm – some observations

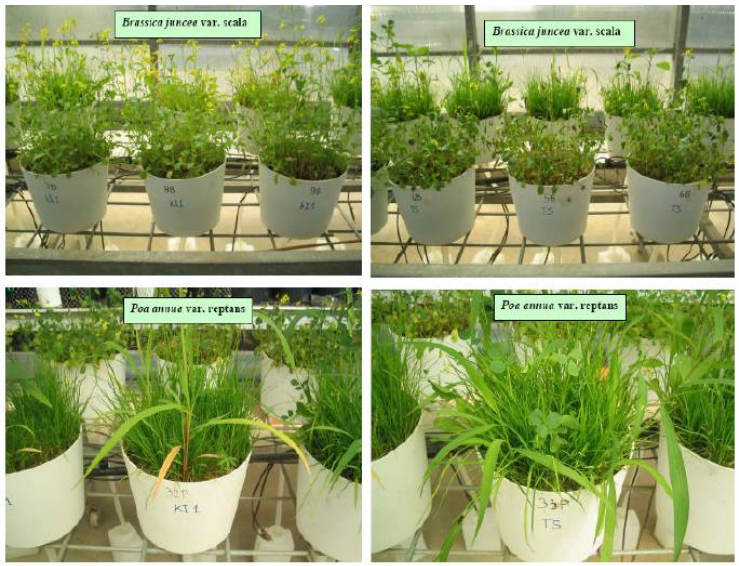
Biomass– Hg uptake – Translocation - Phytoextraction

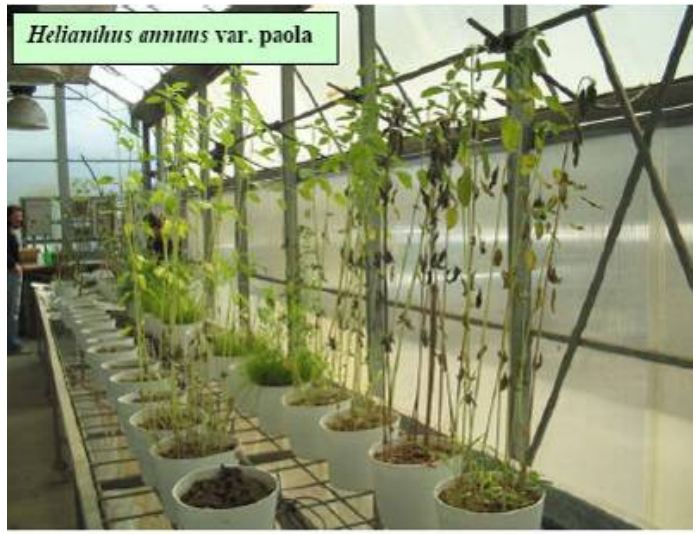
TS treated plants show toxic symptoms

TS treatment showed good effectiveness in increasing Hg uptake and translocation

TS increased Hg phytoextraction

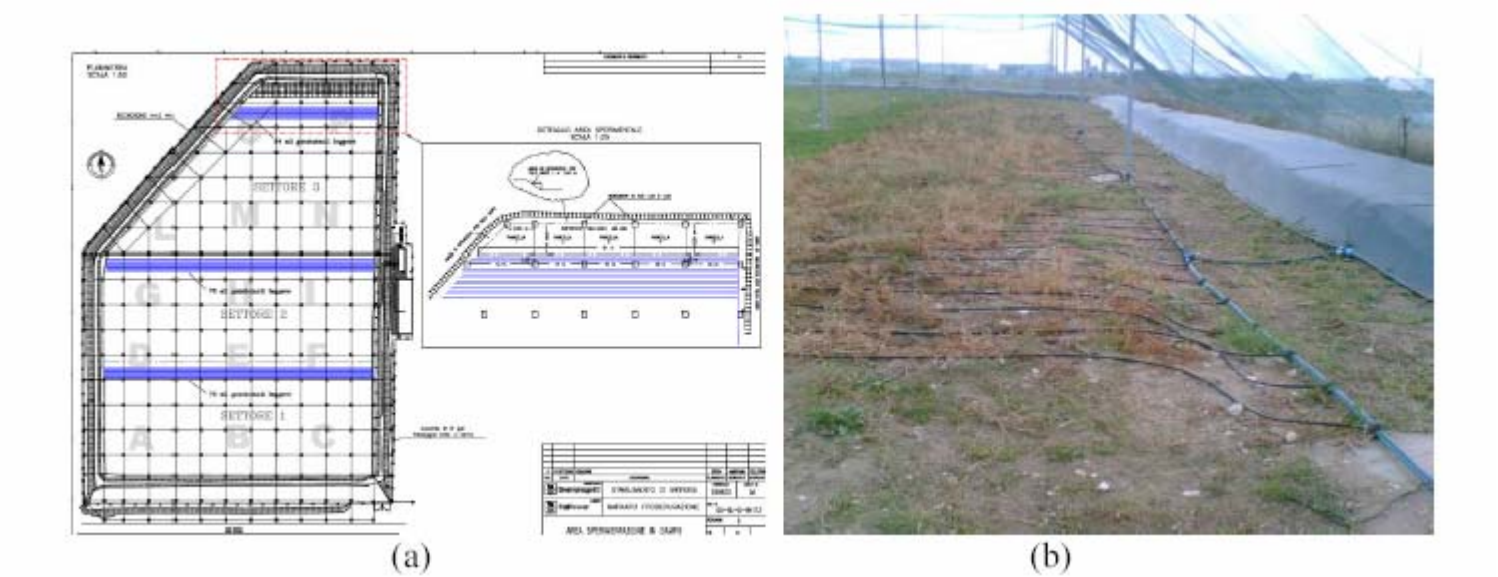
Test in scale-up - Mesocosm





Most successful protocols: plants + additive are tested on mesocosm scale

Test in scale-up – field test



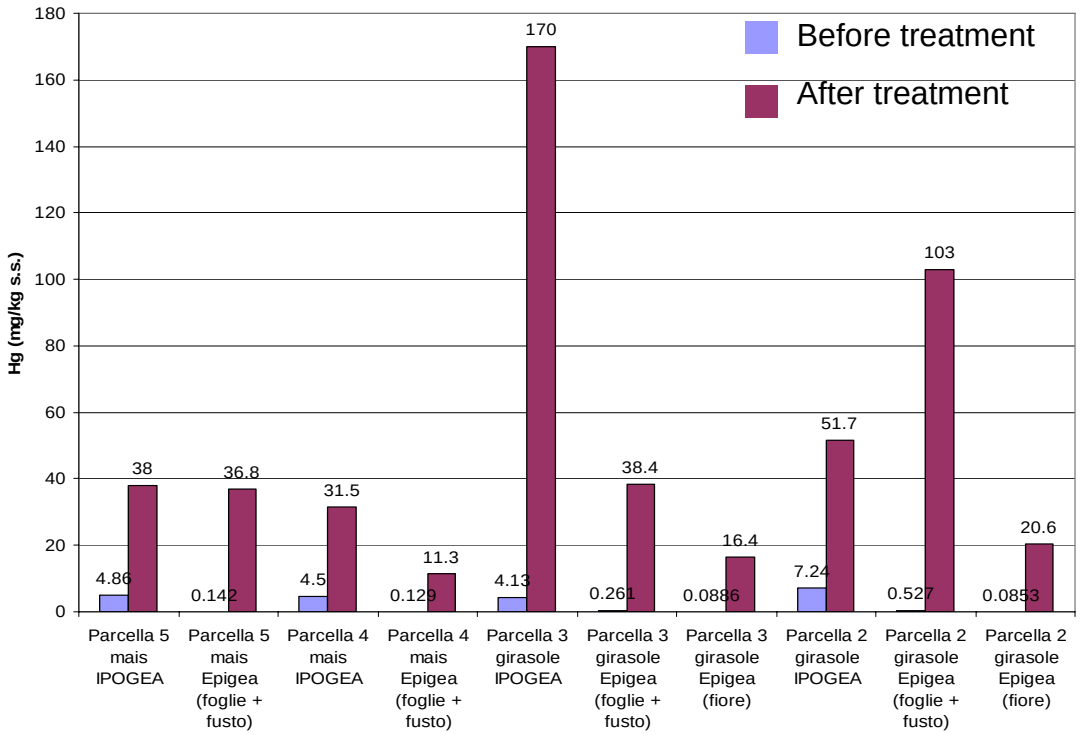
Moreover, field tests are carried out in a portion of the field subdivided into 5 plots

How things are going!

In the first period, the on-site phytoremediation plant showed very good results, in particular regarding:

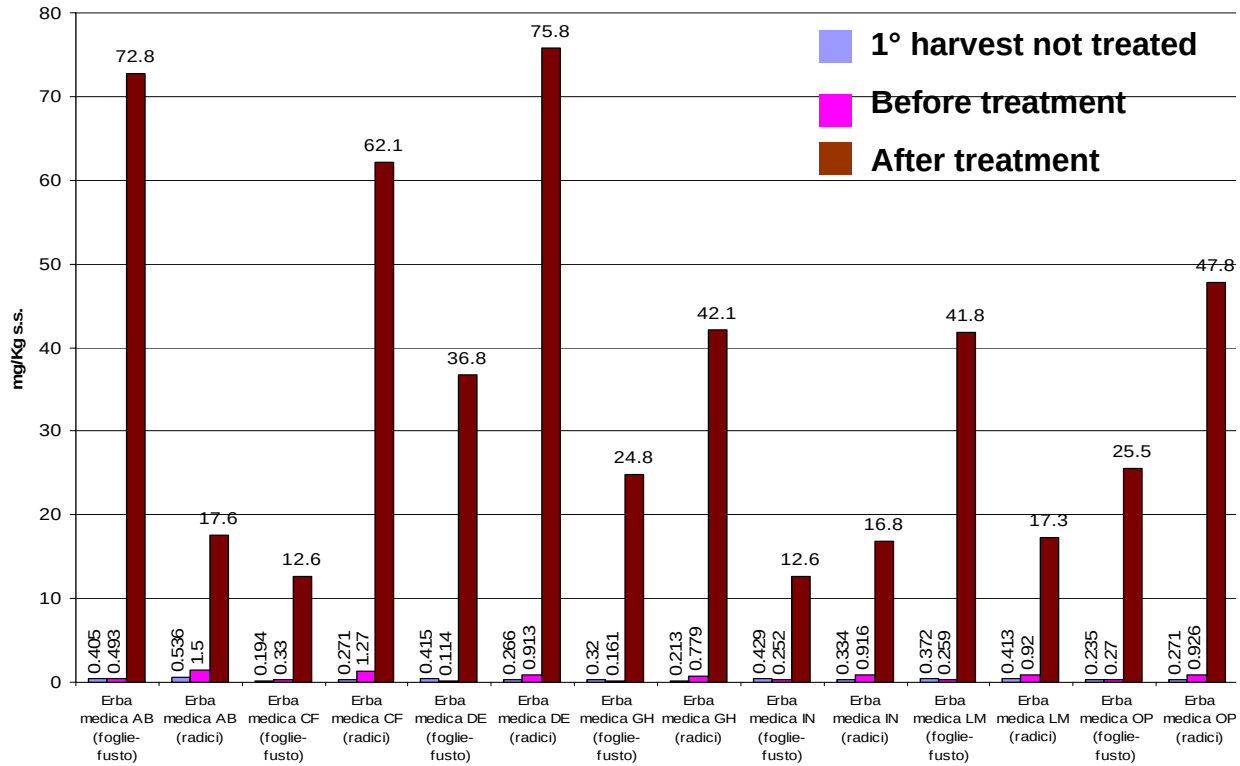
- Increased bio-accessibility of metals following addition of mobilizing agents
  - Increased metal concentration in the crop plants used (alfalfa, corn, sunflower, mustard plants)
- Trend in decreased metal concentration in the soil under phyto-treatment.

One result from field-test



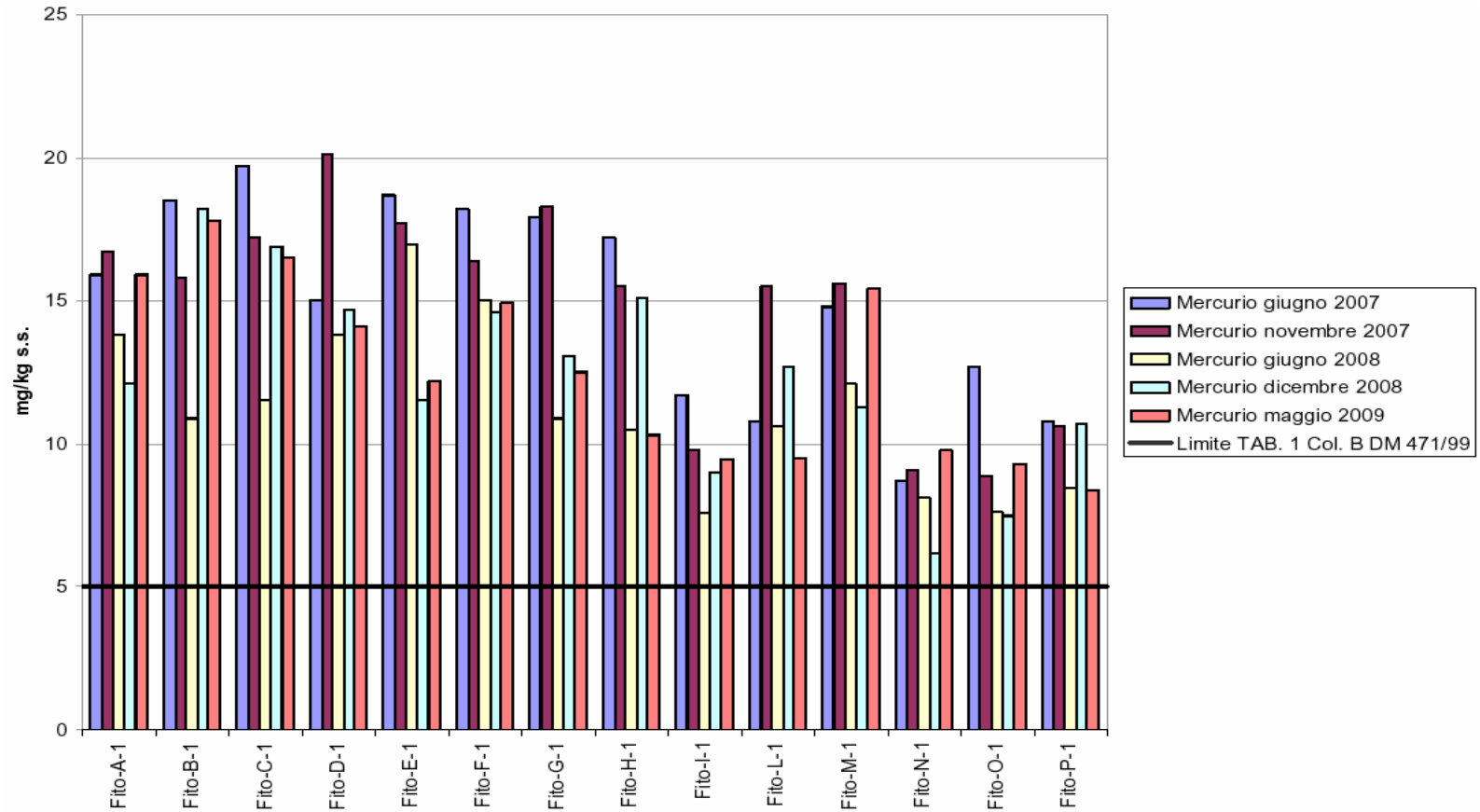
Hg content in Corn and Sunflower plants before and after TS treatment.

A Field result: alfalfa



Hg content in alfalfa plants before and after TS treatment.

Trend in decreased of mercury concentration in the soil under phyto-treatment



Phytoremediation

- The reclamation of contaminated site with low environmental impact and cost is the main objective of phyto-technologies.
- Phytoremediation study implies different levels of scale test: microcosm, mesocosm and field test.
- The efficiency of phytoremediation is complex and depends on the nature of contaminants, the additive if used, plant characteristics and local environmental conditions.

Difficulties in field operation

- ✓ Heterogeneous physical soil characteristics and contaminant concentration
- ✓ Heterogeneous plant growth
- ✓ Heterogeneous treatment application
- ✓ Uncertain weather conditions ?????????

So data from field operations are sometimes non-predictive

Future implementation of the Hg - phytoextraction

- Test crop plant (eg. corn, sunflower) at high biomass production selected for bio-energy goal
- Implement additive addition in dose and timing to increase metal uptake and translocation
- Study of other additives to increase metal mobilization and consequently metal phytoextraction
- Study the use of PGR to increase metal translocation by foliar application. Products currently used in flori- and horticulture could be of benefit for phytotechnology

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Thanks to everybody!!!

as I am very busy……