



# **INDTECH2018**

## **Innovative industries for smart growth**

29-31 October, 2018  
Vienna, Austria

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**PILLAR 1**

**Session 1.3**

**New bioremediation approach for soils and sediments**

**Grazia Masciandaro**

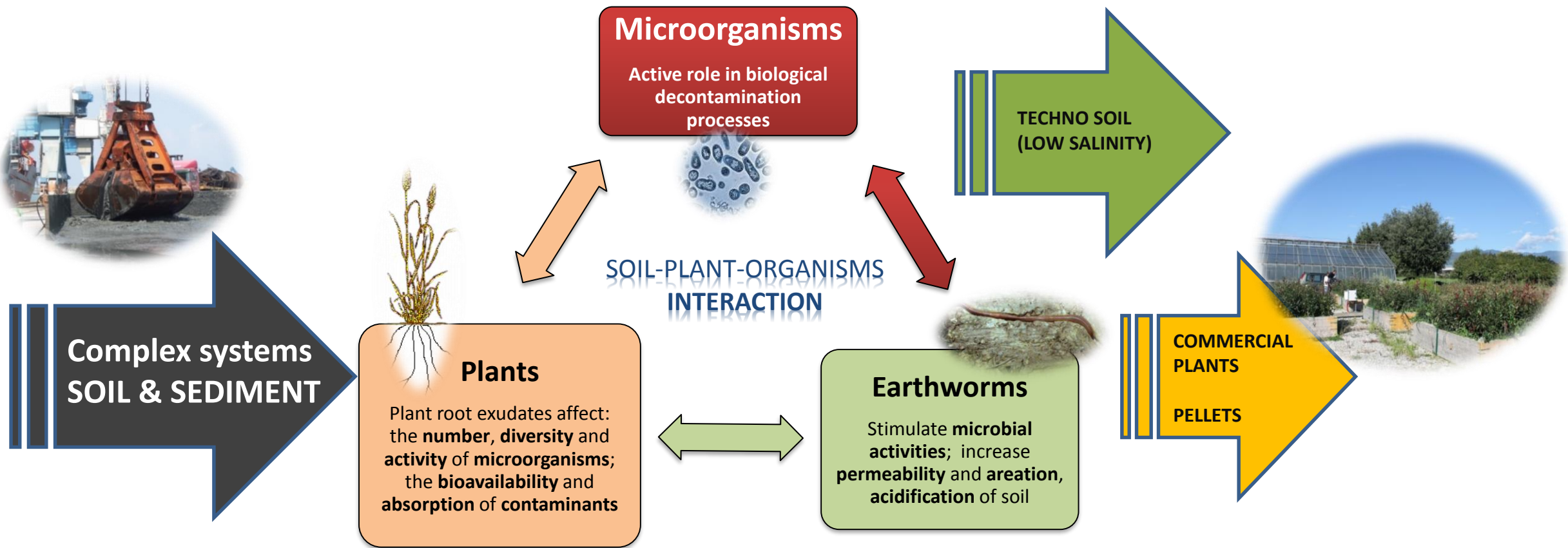
**CNR-IRET**

**31 October 2018**



## Biological treatments

Range of clean up methodologies using natural organisms to degrade organic contaminants or to convert inorganic contaminants to environmentally less toxic or non-toxic compounds





# NATIONAL PROJECT

## 2006-2012 "ECOLOGICAL APPROACH TO REMEDIATE POLLUTED SOIL THROUGH NATURAL TECHNOLOGIES"

**Funded by:** Tuscany Region and Municipality of San Giuliano Terme (Pisa).  
**Site location:** Madonna dell'Acqua (Pisa)



*Cytisus scoparius*



*Populus nigra*




*Paulownia tomentosa*



### Treatments:

1. Untreated soil
2. Organic matter + plants+earthworms

  
**BIOREMEDIATION  
AT FULL SCALE**

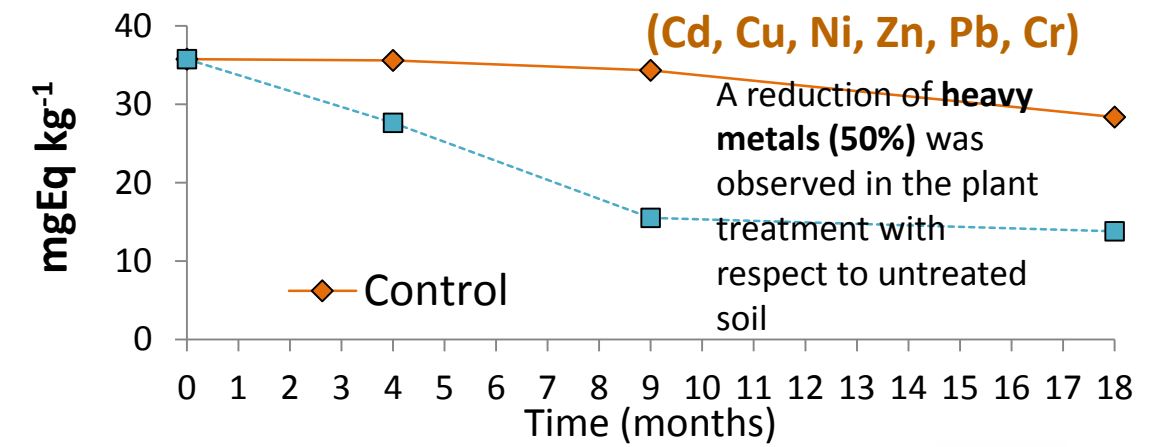
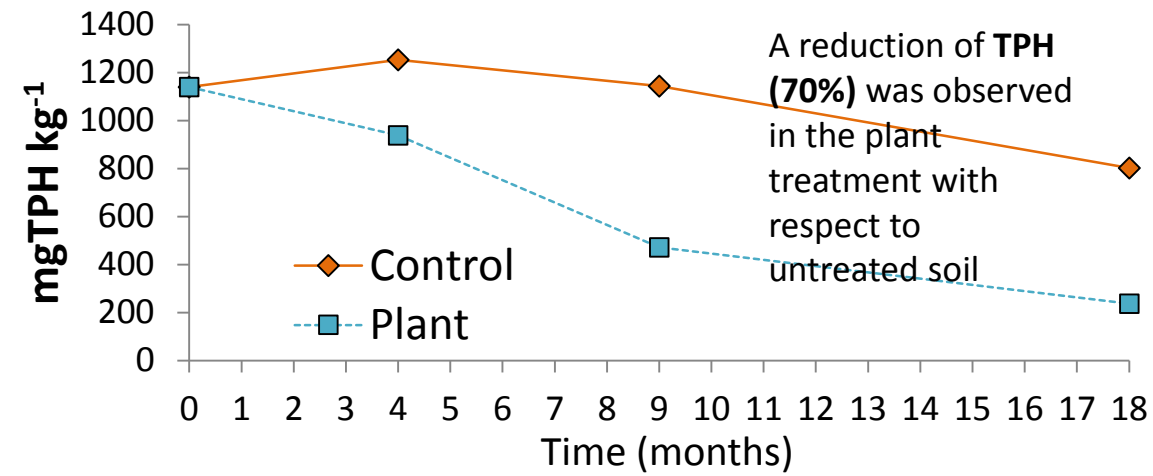
**Treated surface: 1.5 ha**





## Main results at the project end

### Total Petroleum Hydrocarbons



- 29.5 t/ha increase in soil organic carbon;
- +93% soil carbon content;
- +120% increase in microbial functionality
- + 96% increase in microbial biodiversity
- +100 % plant cover;
- 100% reduction of loss of organic matter;
- 50% reduction of soil erosion;
- 50% increment in soil fertility;
- yearly sequestration of 12 mg/cm<sup>2</sup> of carbon (as humic carbon).





## DREDGED SEDIMENTS

...in quantitative terms:

the continuous stream of sediments, dredged from harbors and waterways for **maintaining shipping traffic efficiency** determines the production of **several million cubic meters** of dredged material every year.

**in Europe about 100-200 million m<sup>3</sup> need to be disposed of in specific and expensive ways**

... in qualitative terms:

the sediments are often characterized by a **high level of contaminants** (heavy metals and hydrocarbons)



## PEAT: NURSERY GROWTH SUBSTRATE

- Substrates most used for its physico-chemical properties
- Non-renewable resource
- Imported countries North-East Europe
- High costs
- Need to identify alternative materials

**Peat yearly used in Italy in nursery 5•10<sup>6</sup> m<sup>3</sup>**





Brackish sediments  
Canale dei Navicelli



gravel-sand drainage



plastic network



soil-sediment 30%



# 2009-2012 AGRICULTURAL REUSE OF POLLUTED DREDGED SEDIMENTS NO. ECO/08/239065/S12.532262



## Selected plants



*Nerium oleander*



*Paspalum vaginatum*



*Tamarix Gallica*



*Phragmites australis*



*Spartium Junceum*



Marine sediments  
Livorno harbour



### Decontamination

➤ Decrease in **heavy metals (20%)** and total petroleum **hydrocarbons (50-60%)** concentration.

### Agronomical recovery

➤ Improvement of the chemical-nutritional properties (**25% increase in N and P**) of the treated sediments indicating the recovery of agronomical fertility.

### Ecological-Functional Recovery

➤ Stimulation of the biological parameters contributed to create a functional "soil ecosystem" (**50% increase in number and activity of microorganisms**), called

## "technosoil"

**National patent:** Iannelli R, Masciandaro G, Ceccanti B, Bianchi V, Doni S (2012). Metodo per il trattamento di residui di dragaggio mediante fitorimediazione e impianto che realizza tale metodo. PI2012A000013. Il Brevetto italiano è stato rilasciato il 05/09/2014 con No. 0001410263





## EUROPEAN PROJECTS



### 2013-2016 «INNOVATIVE INTEGRATED METHODOLOGY FOR THE USE OF DECONTAMINATED RIVER SEDIMENTS IN PLANT NURSERY AND ROAD BUILDING» LIFE12 ENV/IT/000652



Coordinator: **CNR**

Demonstration of the use of decontaminated sediments as growing substrate for the cultivation of **ornamental plants** in the nursery sector.



*Eleagnus macrophylla* L.



*Viburnum tinus* L.



*Photinia x fraseri*

### 2015-2017 «DEMONSTRATION OF THE SUITABILITY OF DREDGED REMEDIATED SEDIMENTS FOR SAFE AND SUSTAINABLE HORTICULTURE PRODUCTION» LIFE14 ENV/IT/000113

Coordinator: **University of Florence**

Demonstrate the suitability of dredged remediated sediments as an alternative for the preparation of growing media in **horticulture (pomegranate and strawberry)**.



**The sediment is suitable for chemical and biochemical fertility, for plant growth and development, and for food quality**



**Impact on greenhouse gas emissions**

Sediments disposed in landfills

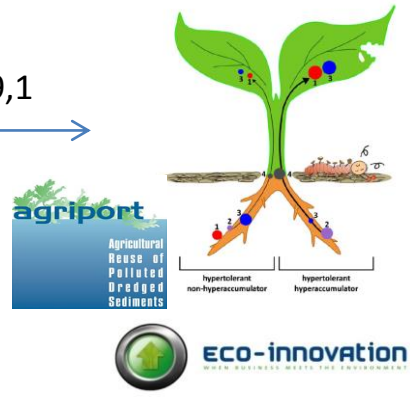


Dredged sediment

+99,1

-99,1

+22,7  
 Phytoremediation



-76,4



peat-free growing media

+12,5



-63,9

Two cultivation cycles and disposal

+45,6  
**-18,3 Kg CO<sub>2</sub> eq.**

Peat



+11,6

+17,8



Peat growing media

+29,4

One cultivation cycle and disposal  
 +24,3

**+53,7 Kg CO<sub>2</sub> eq.**





## POLICY IMPLICATIONS

EU legislation is still unclear on the possibilities of dredged sediments as by-products usable in agriculture (Oslo 1972, London Protocol 96, Paris 1974, OSPAR 1992 and Barcelona 1995 Conventions, EU waste and water directives (1999/31/CE, 2000/60/CE) and EU Parliament Decisions 2000/532/CE, 2001/118/CE, 2001/119/CE, 2001/573/CE (European Waste Inventory).

European Countries has only individual national legislations

The results of European Projects may lead to a single European legislation in order to allow the EU use of transformed sediments in horticulture for cultivation of vegetable and fruit plants, after proper testing of human and environmental safety.



## New European Projects



2018 -2021 European project **AGRISED LIFE17 ENV/IT/269** “Use of dredged sediments for creating innovative growing media and technosols for plant nursery and rehabilitation”



2018 -2021 European project **SUBSED LIFE17 ENV/IT/000347** “Sustainable substrates for agriculture from dredged remediated marine sediments: from ports to pots”



## New National Project

2017-2019 Funded by Cassa di Risparmio Pistoia e Pescia “Posidonia oceanica and sediments for the production of an agronomic substrate to be used in nursery activity and horticulture”



## Conclusions

- The bioremediation strategies resulted successful at removing pollutants and improving the agronomical properties (biodiversity, functionality and carbon sequestration) in contaminated soils and sediments thanks to the mutually interaction between plants, microbes and earthworms;
- The sediment re-cycling as ingredient of growing media for plant nursery reduced the C footprint of plant production as compared to the use of the traditional peat based growing media.
- The decontamination and recycling of dredging sediments in agriculture significantly contribute to the sustainable management of wastes by implementing the concept of circular economy.





# INDustrial TECHNOLOGIES 2018

Innovative Industries for Smart Growth

## Thanks for your attention

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