GNGTS - GRUPPO NAZIONALE DI GEOFISICA DELLA TERRA SOLIDA

Monitoraggio geofisico del dominio non saturo in un sito contaminato soggetto a bonifica

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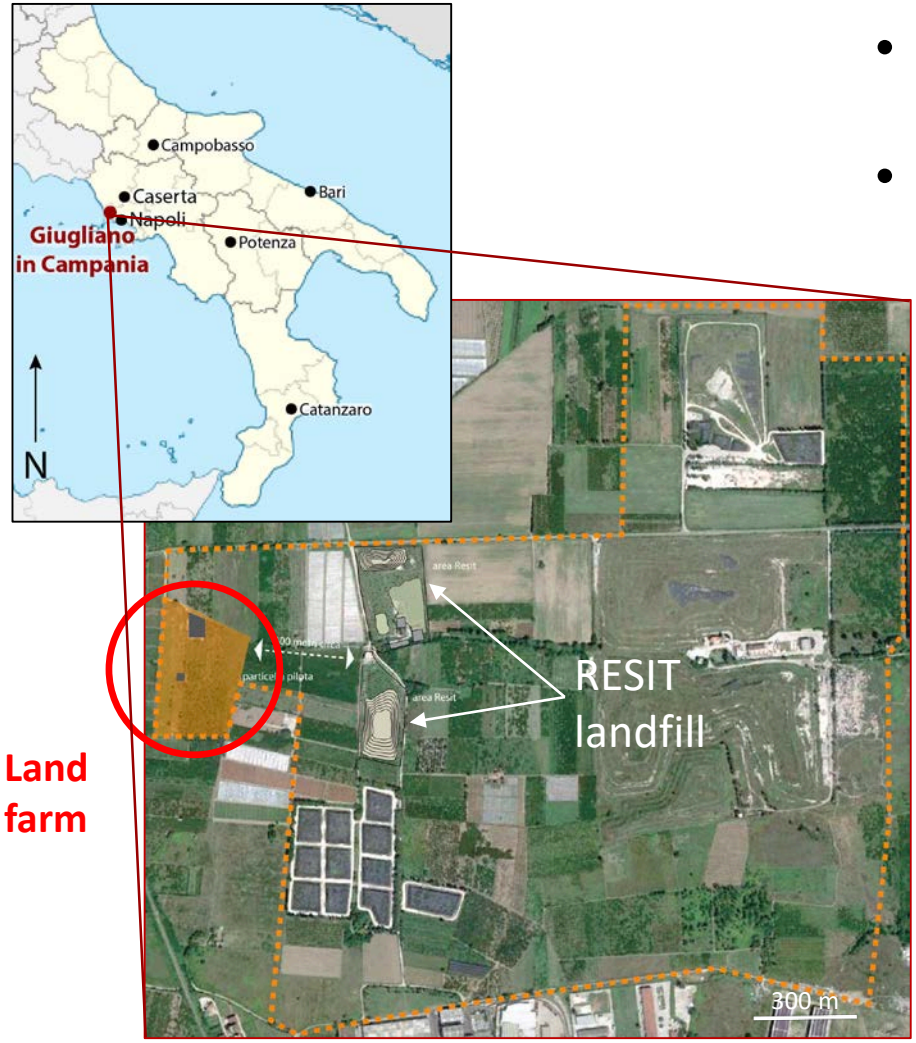
PROGETTO LIFE11 ENV/IT/275 ECOREMED

DIPARTIMENTO DI GEOSCIENZE

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DIPARTIMENTO DI AGRARIA

Site: San Giuseppiello land farm



- San Giuseppiello land farm (Giugliano in Campania – NA);
- Located in the so-called "**TERRA DEI FUOCHI**", close to the RESIT landfill.

Geology and hydrology:
Volcanic soil (pozzolana) with sandy-loam grain size and with the presence of antropic material.

Pumice layer around 2 m depth.

Water table depth: 40 m b.g.l.

Site: San Giuseppiello land farm

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- Between 1998 and 2003: **illegal discharge** of industrial and tannery sludge and 22 tons of leather waste
  (sequestro giudiziario Procedimento Penale n° 15968/08 rg.nr.mod.21).

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Chromium and heavy hydrocarbon pollution in the first meter of soil and Volatile Organic Compounds (VOCs) in the aquifer.

The LIFE-ECOREMED protocol

The **LIFE-ECOREMED protocol** is based on the ***mycorrhiza-assisted phytoremediation:***
the phytoextraction process is facilitated by **organic matter input**
(to improve the metal availability) and by **mycorrhization**.

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Poplar grove (*Populus nigra*)
(spacing: 3m x 1m)

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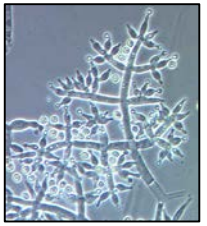
Grassing with **gramigna rossa** (*Cynodon dactylon*) and **festuca rossa** (*Festuca rubra*)
Application of a **microbial mixture**



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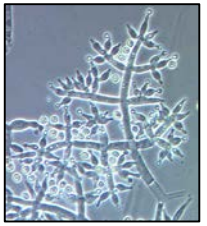


The aquifer water is treated by means of **air stripping**
(irrigazione con micro spruzzatori spaziati 2m lungo ciascun filare)
Aim: **VOCs decontamination**

The LIFE-ECOREMED protocol

Why should we choose this protocol?

- This protocol is based on agriculture: the securing of the site takes place by means of **bio- and phytoremediation techniques**;
- The presence of a poplar grove guarantees an active defence and **prevents further inappropriate activities** in the site;
- Unlike traditional methods, this protocol leads to the original agroforestry condition of the site;
- **The costs are dramatically reduced**:
  18 million € (traditional techinques) vs **950 000 €** (LIFE-ECOREMED)

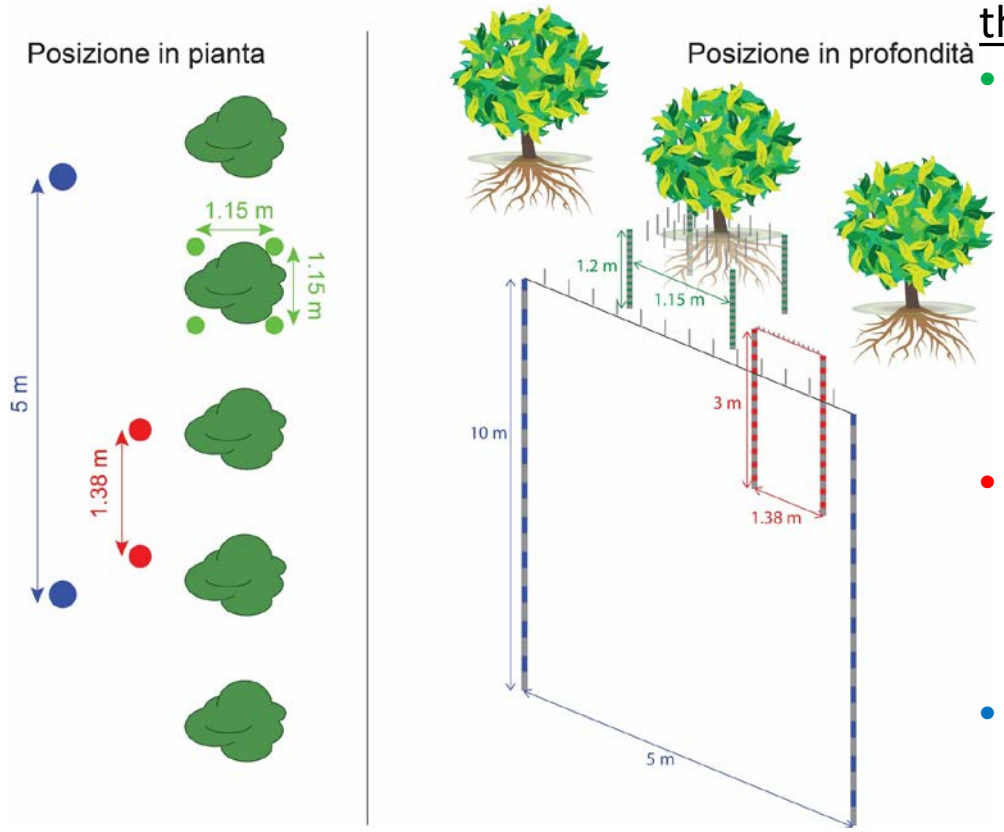
Electrical resistivity tomography (ERT)

Some auxiliary activities are associated to the LIFE-ECOREMED protocol, such as the hot spot SOIL WASHING and the HYDRAULIC CHARACTERIZATION.

Among these activities:
SOIL WATER REGIME MONITORING
by means of

ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT)

Electrical resistivity tomography (ERT)

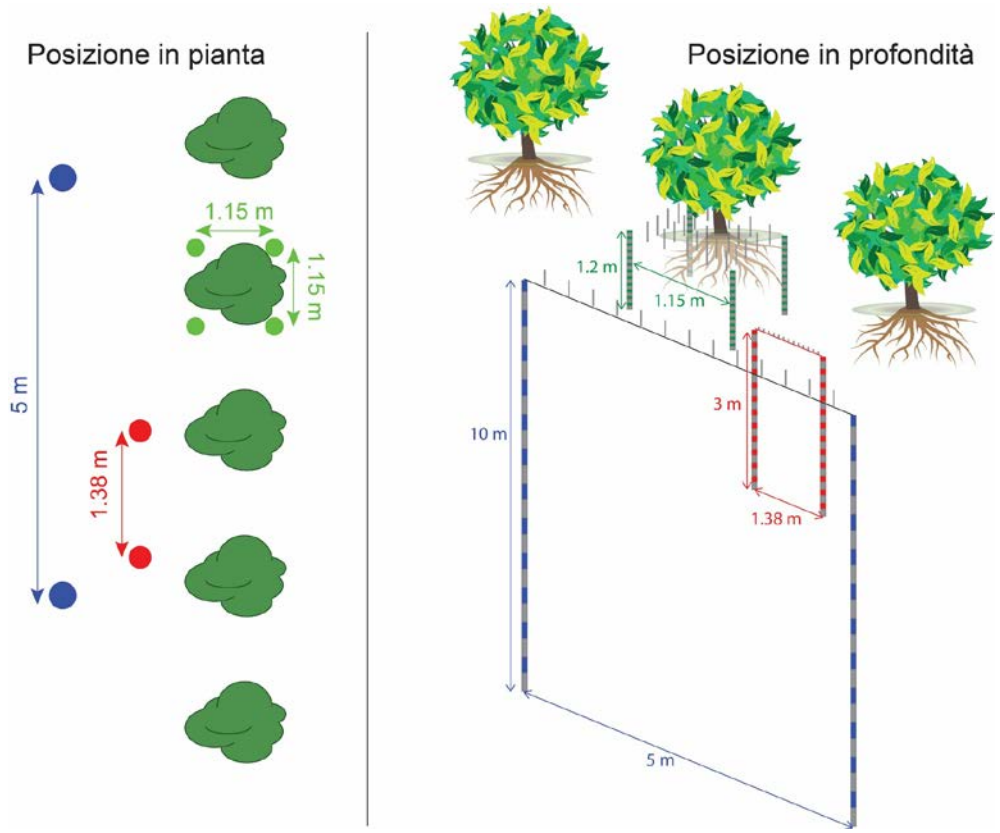


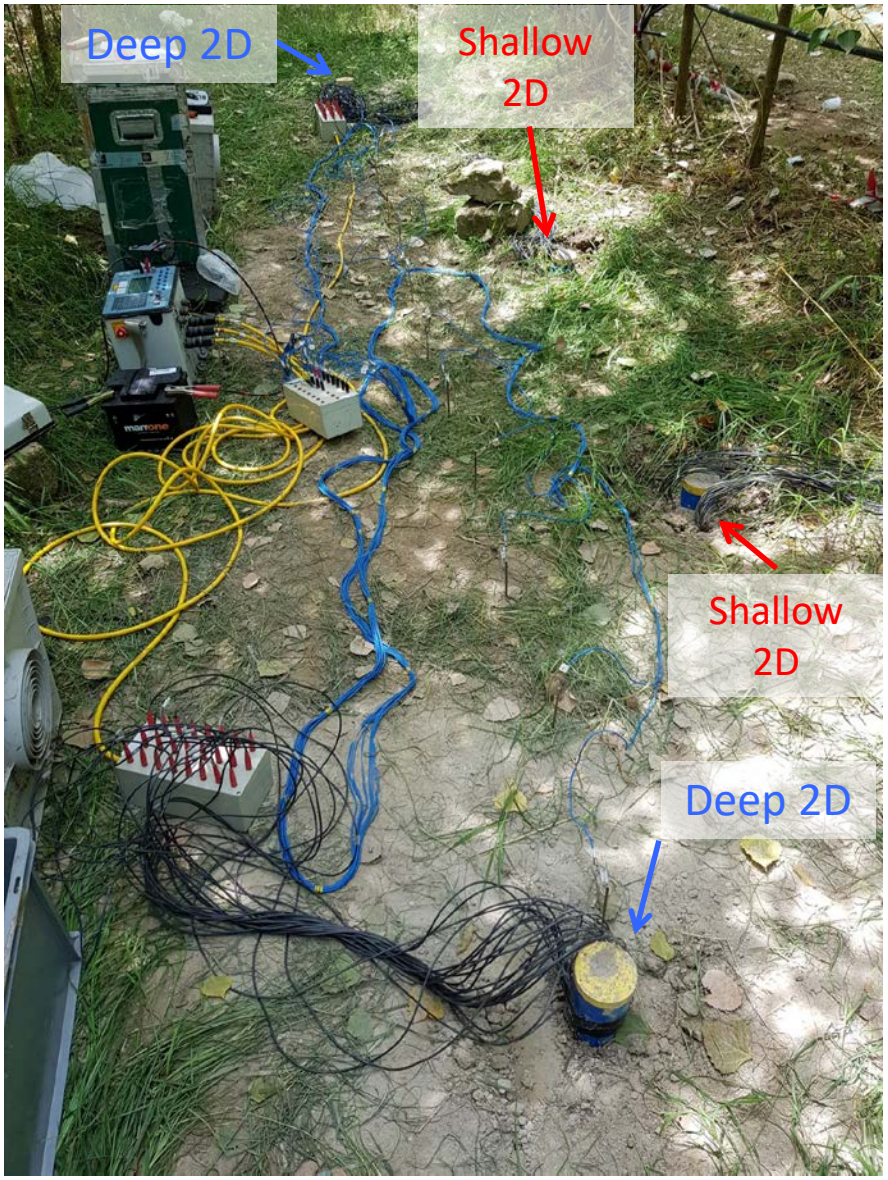
The **monitoring system** is made up of three cross-borehole subsystems:

- **3D subsystem**:
  4 boreholes 1.2 m deep (*each with 12 eletrodes* spaced 0.1 m) located at the vertexes of a square (side equal to 1.15 m) centred on a poplar and *24 superficial electrodes* forming a grid centered on the trunk;
- **Shallow 2D subsystem**:
  2 boreholes 3 m deep, 1.38 m distant, *each with 24 electrodes* spaced 0.24 m, and *13 superficial electrodes* evenly spaced;
- **Deep 2D subsystem**:
  2 boreholes 10 m deep, 5 m distant, *each with 24 electrodes* spaced 0.40 m, and *13 superficial electrodes* evenly spaced;

The geophysical monitoring consists of monthly acquisitions that started in June 2018.
The geophysical monitoring is currently on-going.

Electrical resistivity tomography (ERT)





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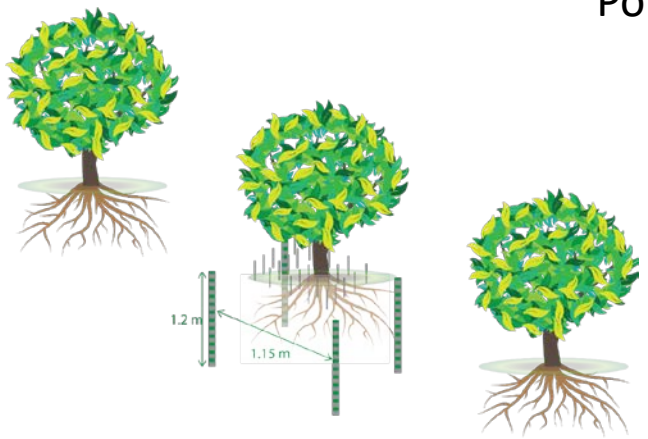
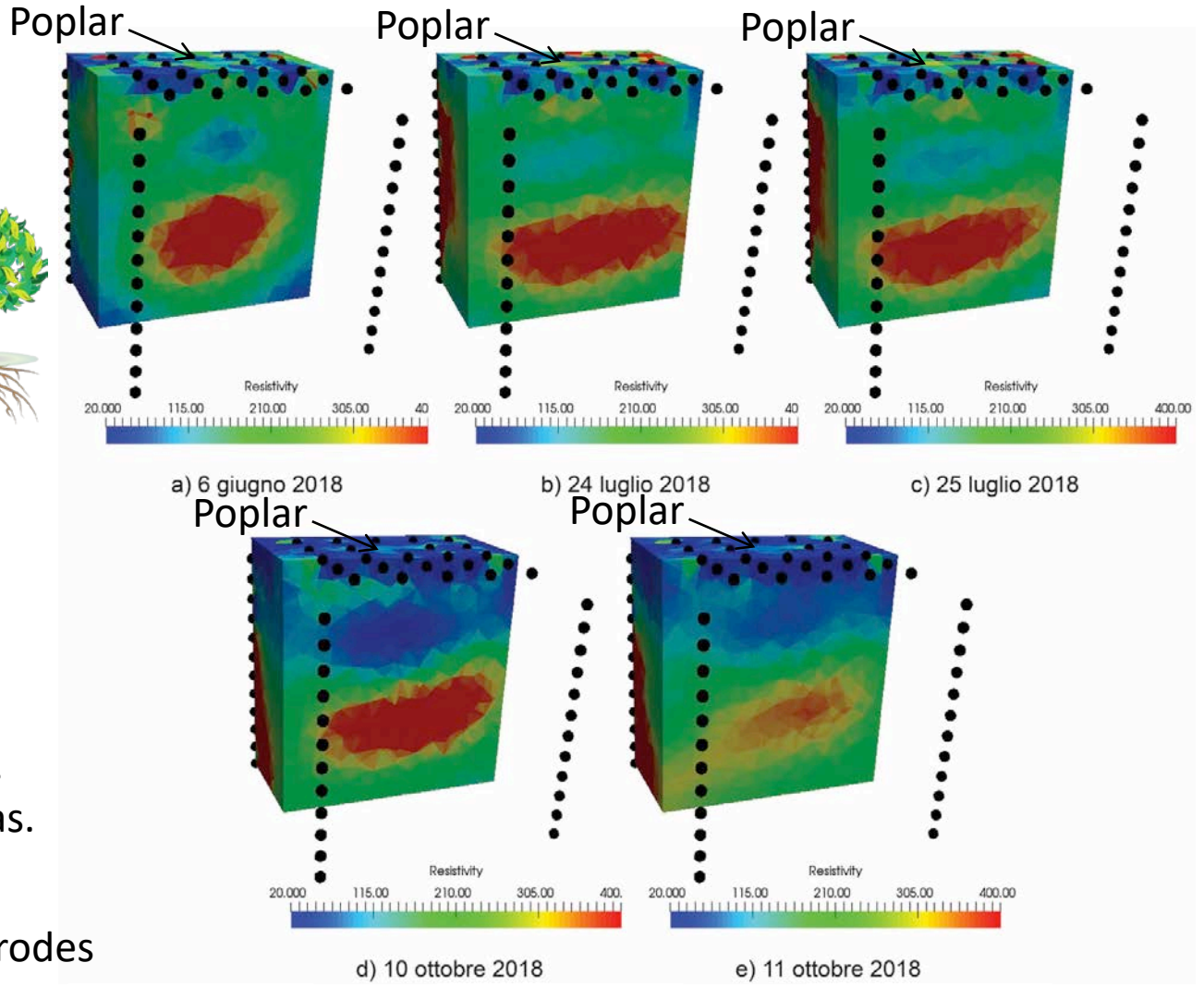
Electrical resistivity tomography (ERT)

Preliminary results: 3D SUBSYSTEM – ABSOLUTE INVERSION





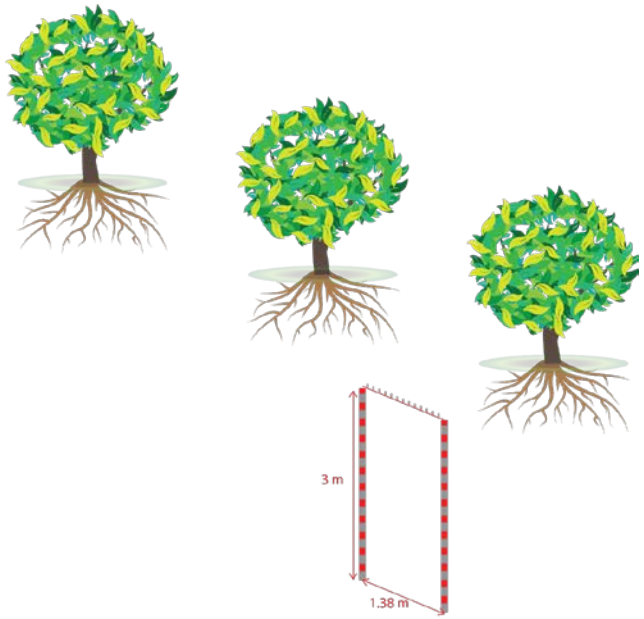
Irrigation:

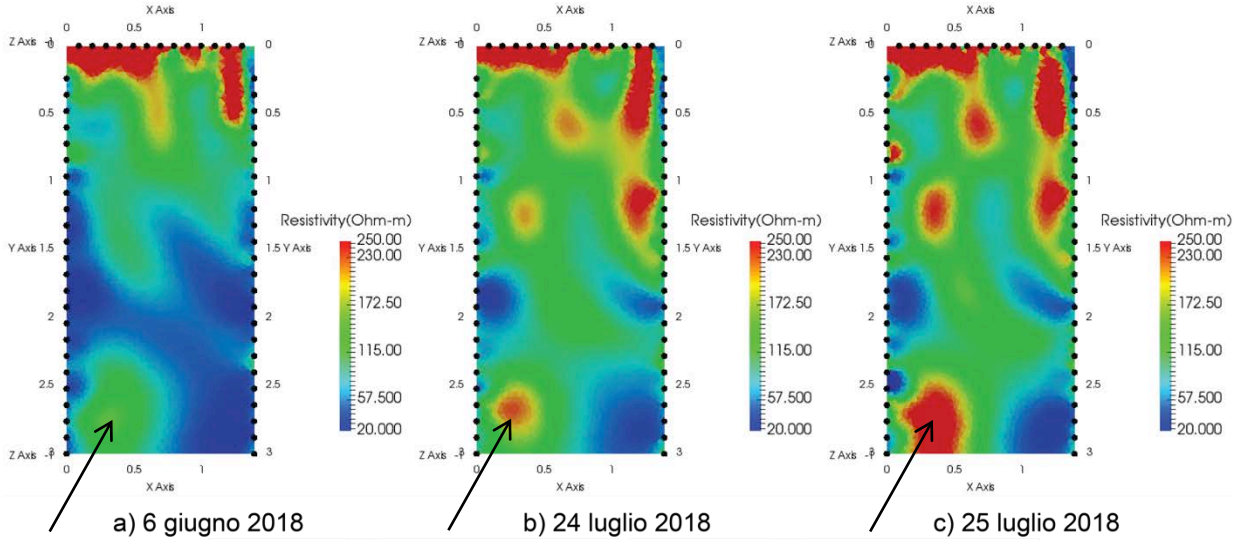
- Rain on 23rd July
- 24th October after meas.
- 11th October before meas.

Dipole-dipole skip4 – 72 electrodes
Error = 10%, R3t (Binley A.)

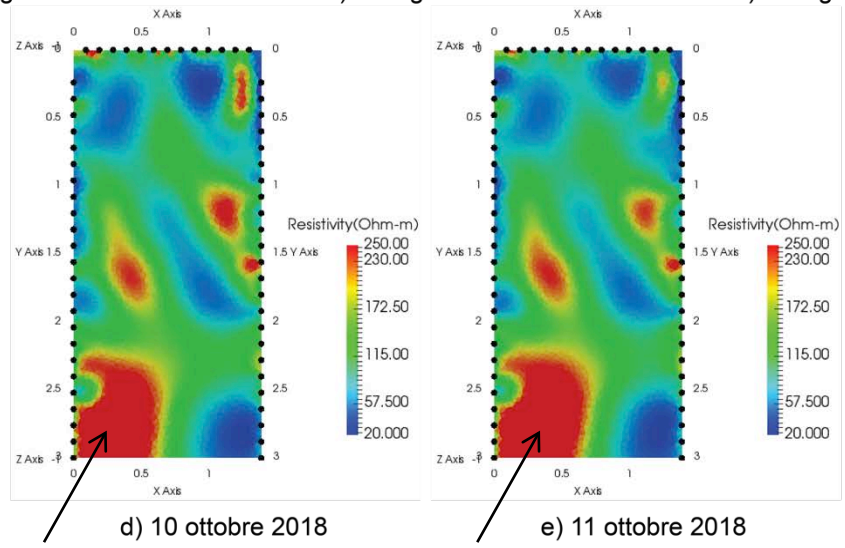
Electrical resistivity tomography (ERT)

Preliminary results: SHALLOW 2D SUBSYSTEM – ABSOLUTE INVERSION





a) 6 giugno 2018 b) 24 luglio 2018 c) 25 luglio 2018



d) 10 ottobre 2018 e) 11 ottobre 2018

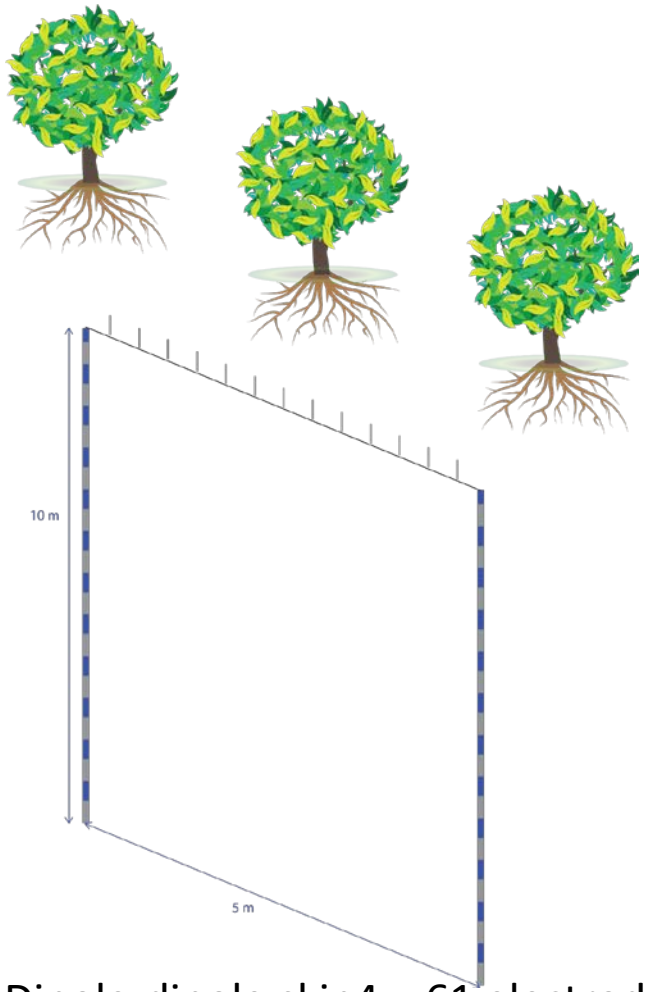
Irrigation:

- Rain on 23rd July
- 24th October after meas.
- 11th October before meas.

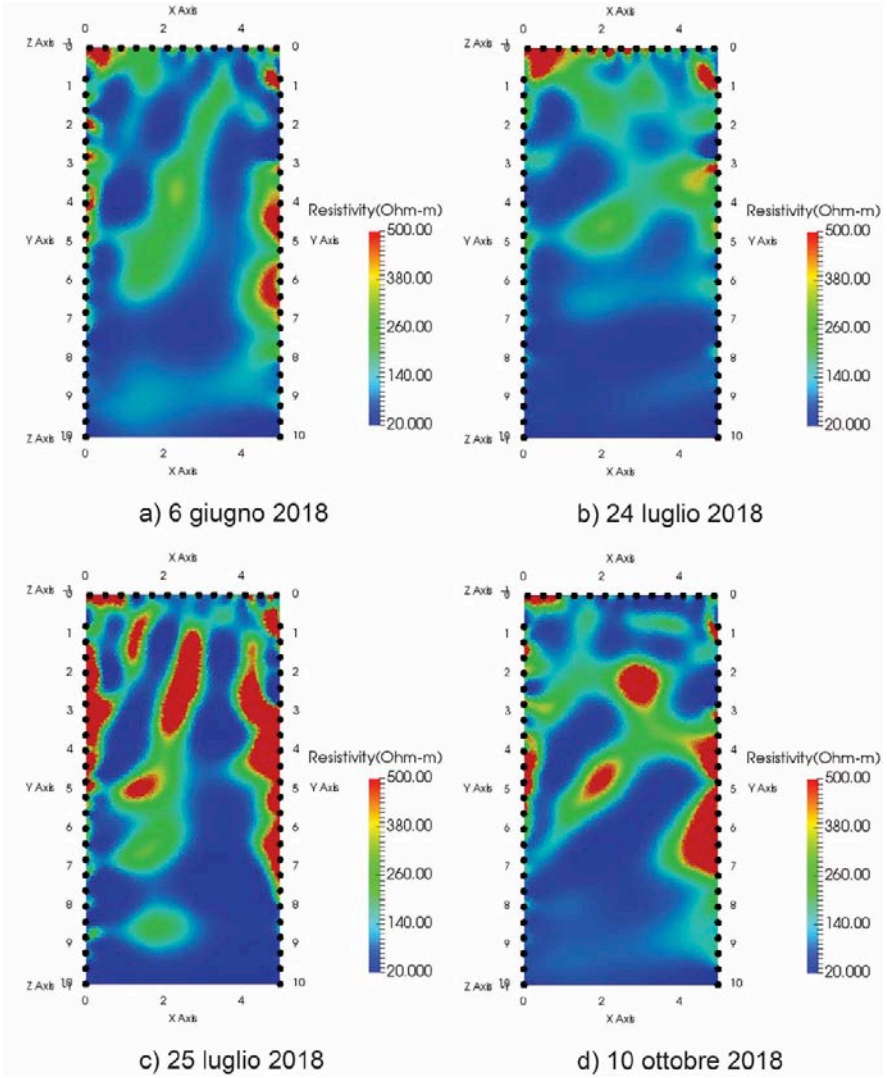
Dipole-dipole skip4 – 61 electrodes
Error = 10%, R2 (Binley A.)

Electrical resistivity tomography (ERT)

Preliminary results: DEEP 2D SUBSYSTEM – ABSOLUTE INVERSION

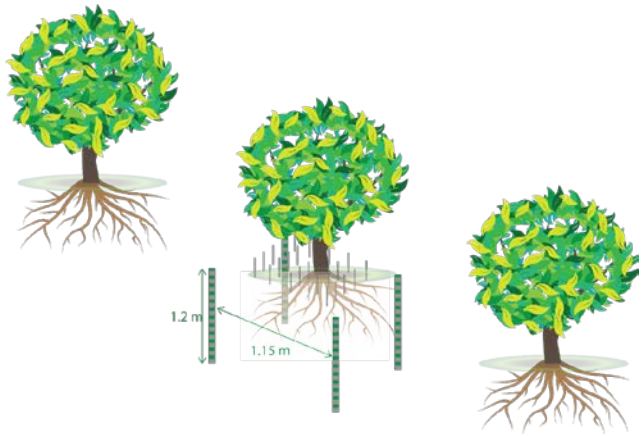


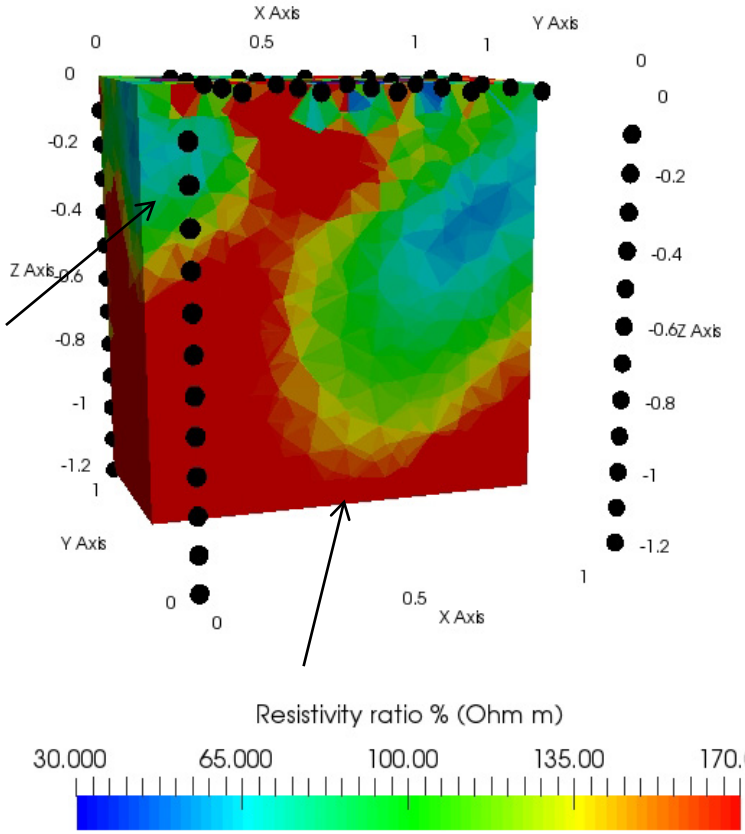
Dipole-dipole skip4 – 61 electrodes
Error = 10%, R2 (Binley A.)



Electrical resistivity tomography (ERT)

Preliminary results: 3D SUBSYSTEM – RATIO





Irrigation:

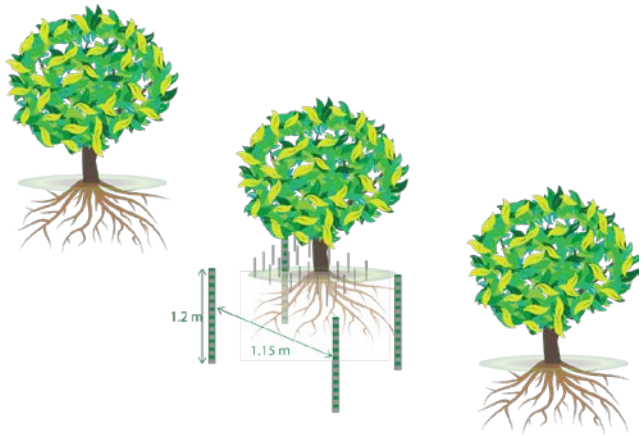
- Rain on 23rd July
- 24th October after meas.

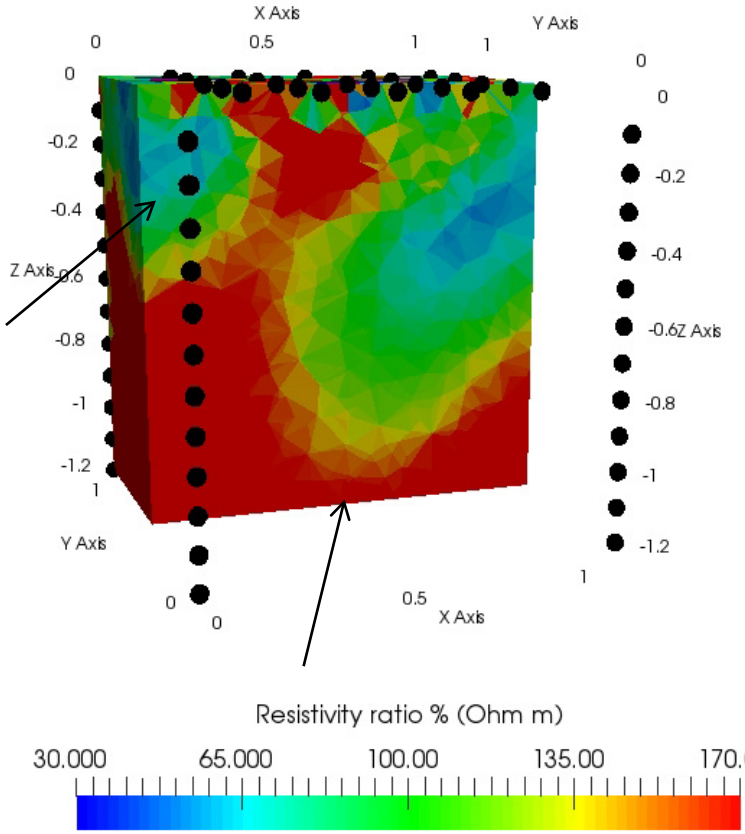
Dipole-dipole skip4 – 72 electrodes
Error = 5%, R3t (Binley A.)

Background: 6th June 2018 at 13:00
Measurement: 24th June 2018 at 13:45

Electrical resistivity tomography (ERT)

Preliminary results: 3D SUBSYSTEM – RATIO





Irrigation:

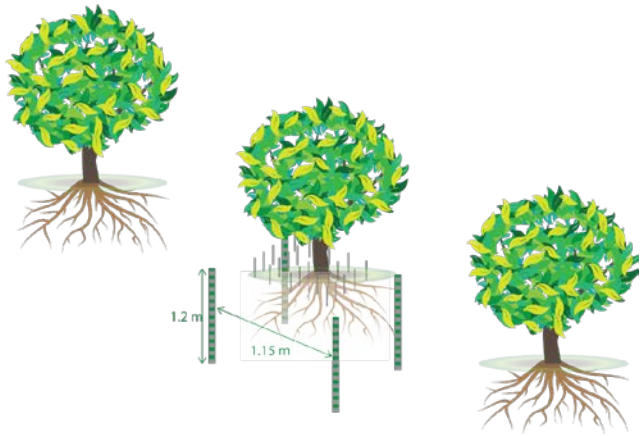
- Rain on 23rd July
- 24th October after meas.

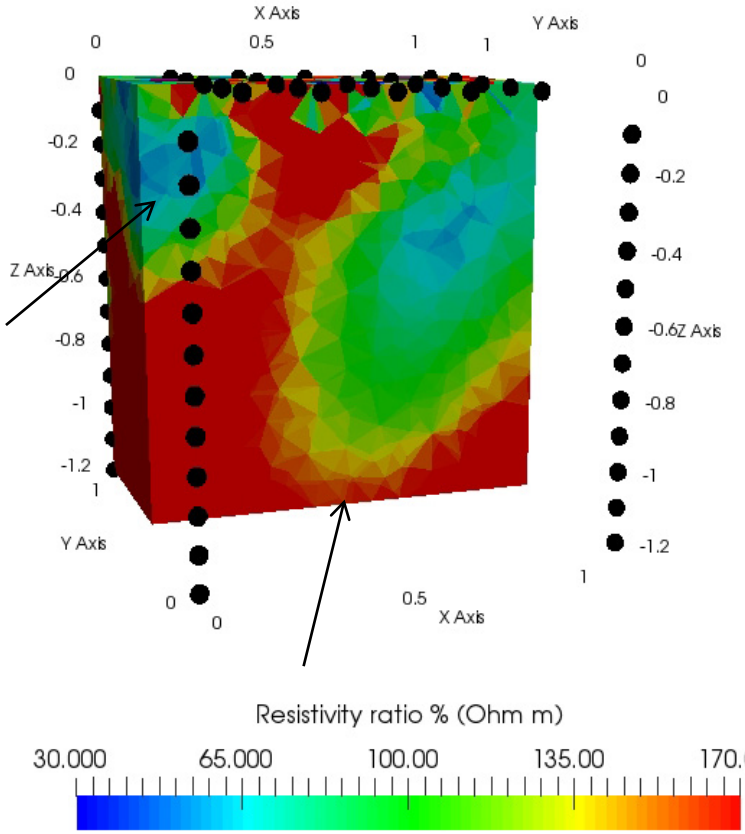
Background: 6th June 2018 at 13:00
Measurement: 25th June 2018 at 09:40

Dipole-dipole skip4 – 72 electrodes
Error = 5%, R3t (Binley A.)

Electrical resistivity tomography (ERT)

Preliminary results: 3D SUBSYSTEM – RATIO





Irrigation:

- Rain on 23rd July
- 24th October after meas.

Dipole-dipole skip4 – 72 electrodes
Error = 5%, R3t (Binley A.)

Background: 6th June 2018 at 13:00
Measurement: 25th June 2018 at 12:25

Future work

- Perform **new acquisitions** during late autumn/beginning of winter (poplars less active);

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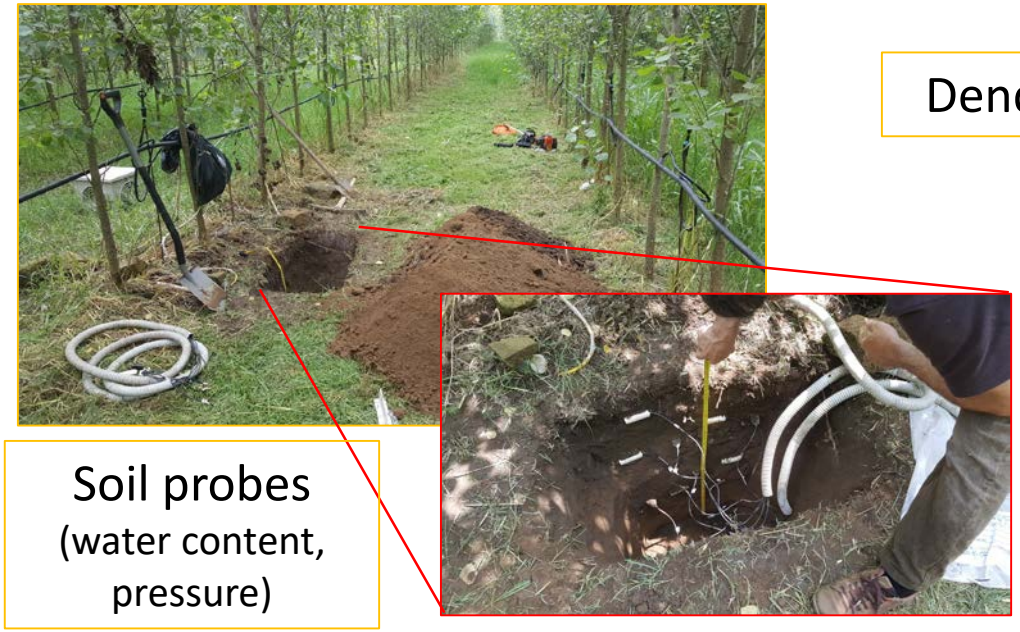
- Perform an **infiltration test**;
- Combine the geophysical data with auxiliary information:



Soil probes
(water content, pressure)

Dendrometry

Conclusions

- The LIFE-ECOREMED is an **effective protocol** to treat contaminated sites in the Terra dei Fuochi area;
- This protocol presents several advantages: costs, does not modify the designated use, etc.;
- Auxiliary information are necessary to monitor the site during the application of the protocol: ERT provides information on the soil structures and on the processes **at different scales**;
- These information would not be obtained with other techniques (e.g. **spatial extent**);
- To fully understand the ERT results, the data need to be merged with other information (soil water content, pressure, etc.).

Grazie per l'attenzione

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LIFE-ECOREMED

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