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

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Site: San Giuseppiello land farm

- San Giuseppiello land farm (Giugliano in Campania – NA);
- Located in the so-called “TERRA DEI FUOCCHI”, 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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- Located in the so-called ”**TERRA DEI FUOCHI**”, close to the RESIT landfill.
- 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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**Poplar grove** (*Populus nigra*)
(spacing: 3m x 1m)

Grassing with **gramigna rossa** (*Cynodon dactylon*)
and **festuca rossa** (*Festuca rubra*)
Application of a **microbial mixture**
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Poplar grove (*Populus nigra*)
(spacing: 3m x 1m)

Grassing with *gramigna rossa* (*Cynodon dactylon*) and *festa rossa* (*Festuca rubra*)

Application of a microbial mixture

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 techniques) vs 950 000 € (LIFE-ECOREMED)
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)
The monitoring system is made up of three cross-borehole subsystems:

- **3D subsystem:**
  4 boreholes 1.2 m deep (each with 12 electrodes 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.
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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**

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 23\textsuperscript{rd} July
- 24\textsuperscript{th} 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 23\textsuperscript{rd} July
- 24\textsuperscript{th} 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 09:40
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**;
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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

Si ringraziano il dott. Benedetto Sica e l’ENEA di Napoli.
References

LIFE-ECOREMED

Balestri G.; 2010: Consulenza Tecnica nei luoghi di cui al decreto di sequestro probatorio del 17/07/08 e segg. nelle Località: Masseria del Pozzo, Schiavi e San Giuseppiello in Giugliano in Campania; terreni in SP Trentola-Ischitella in Trentola e in Torre di Pacifico in Lusciano e siti non sequestrati in Castel Volturno o oggetto di precedenti sequestri in loc. Scafarea (Giugliano).
http://corrieredelmezzogiorno.corriere.it/campania/media/fissi/pdf/

http://www.ecoremed.it/

OTHER


