CONTAMINAZIONE DA EPT NEI SISTEMI ACQUA – SUOLO – PIANTA: PROCESSI DI RISANAMENTO

Le terre ricostituite: tecnologia e possibili applicazioni nella bonifica dei suoli contaminati

The reconstituited soils: the technology and its possible implementation in the remediation of contaminated soils

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Life

NEW LIFE

Workshop 8-9 June/giugno 2016 - Palazzo Sersanti – Imola

La ricostituzione dei suoli

The technology of soil reconstitution has been conceived for restoring degraded land and acts on unproductive and desertification affected soil by modifying its structure through a treatment of soil loosening and subsequent reconstitution

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Reconstitution is based on the incorporation of organic matter into the soil mineral fraction: the process takes place along with the simultaneous destructuring of aggregates.

In the final stage a compression of the loosened soil mass referred to as reconstitution takes place.

The treatment is both mechanical and chemical and generates a (final) product which has properties and characteristics different from those of the matrices it originally derived from.

Structure

Organic carbon

Organic matter structural ratio in the mineral component of the soil

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The treatment begins by blending waste materials from different industrial and agro-industrial activities into the soil, then the actual reconstitution process takes place.

Such matrices referred to as non-hazardous waste must meet specific suitability standards in compliance with the law.

Test cessione UNI EN 10802

Analisi sul tal quale D. Lgs. 152/06

Reconstituted soils are produced with waste matrices of special agronomic and environmental interest generated by various industrial activities which don't use environmentally hazardous substances and compounds in their production process. Such activities are:

- Paper and wood pulp production
- Production of drinking and industrial water
- Electicity production
- Natural aggregates washing plants
- Hydroelectic dams
- Production of titanium dioxide/gypsum

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Reconstituted soil production

The production process of reconstituted soil is illustrated in the following flow-chart:

Raw materials
- Natural soil
- Silt from washing of aggregates

Soil collector

Recyclable waste

Reserve storage

Pre-blending compartment
Dosage adjustment of pre-blends

Module 1

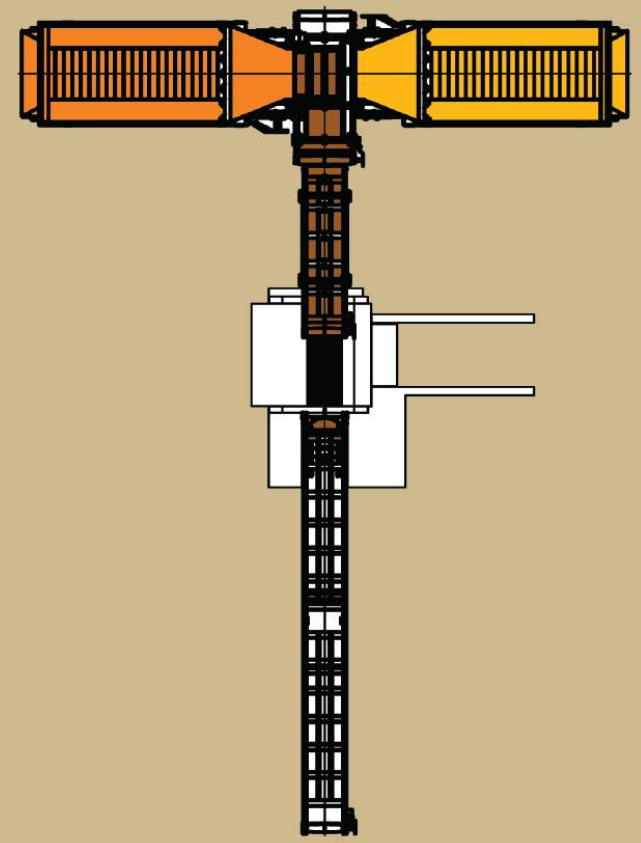
Module 2

Grinding and pre-blending are performed inside a reactor
together with potential addition of any material needed

Disgregation of pre-blended soil

Reconstitution

Reconstituted soil



Reconstitution can be performed either inside a mobile or stationary plant and has been used so far for the treatment and production of fertile soil from degraded and unproductive soil.

The first implementation was started in 2006 on an unproductive plot ranked between Class IV and V in the Land Capability Classification System(LCC). The already unfavourable soil conditions were aggravated by mining activities which had been conducted on site and followed by an inappropriate remedial action.

The reconstitution process lasted 4 years and significantly boosted productivity.

High crop yield

«As expected, the restoration project on this site has had a positive impact on soil fertility thus allowing demanding crops such as maize to be grown without using large quantities of fertilizers »

«Crops grown on reconstituted soil increased ear weight by 21% as opposed to those g
natural soil » **PILOT FARM "VITTORIO TADINI" REGIONE EMILI**

Reduction in fertilization requirements

«Results have evidenced the effectiveness of the treatment and shown that reconstituted soils can increase production while reducing nitrogen fertilization by 50%. »

INSTITUTE OF AGRICULTURAL AND ENVIRONMENTAL CHEMISTRY, UNIVERSITÀ CATTOLICA DEL SACRO CUORE, PIACENZA

Improvement in soil workability

«…. this soil has a better workability than natural soil therefore machinery such as tractors and smaller tools will run on reduced power and irrigation requirements will be cut down »

PILOT FARM "VITTORIO TADINI" REGIONE EMILIA ROMAGNA

Saving on irrigation costs

«….reconstituted soil which has preserved high productive levels while reducing water requirements by 45% »

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Listed below are the improvements in soil conditions resulting from changes generated by reconstitution:

Increase in soil thickness – root depth (from shallow to deep)

Reduction of the soil skeleton and surface stoniness (from exceedingly stony to slightly stony)

Improvement in aggregate structure – porosity increase

Increase in water retention

Decrease in soil reaction (from 8,3 to 7,9 pH)

Decrease in active lime and total lime

Increase of organic matter and C/N ratio

Increase of humic fraction

Increase in P Olsen phosphorus availability

Marked increase of heterotrophic aerobic bacteria and fungal population

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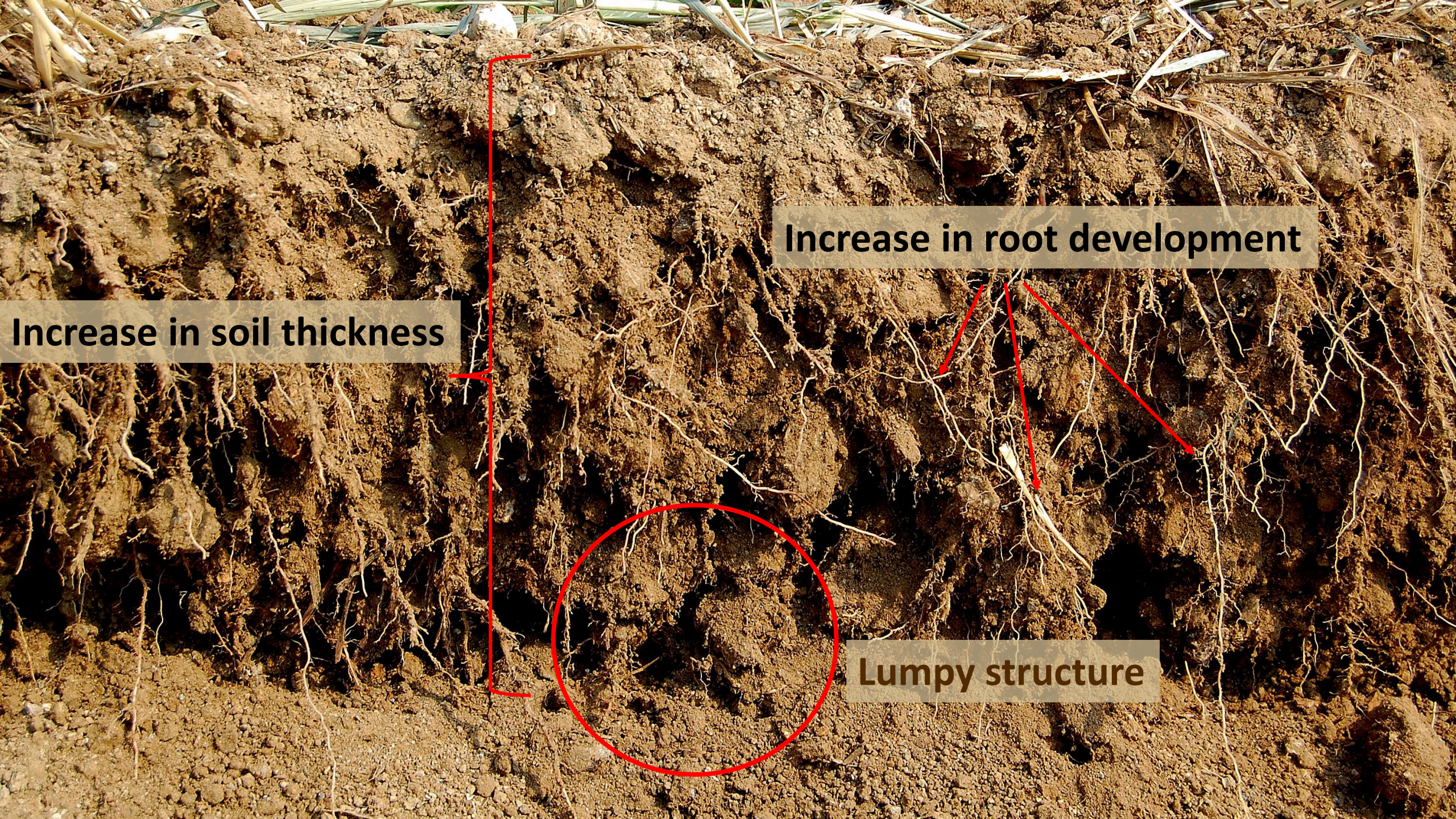
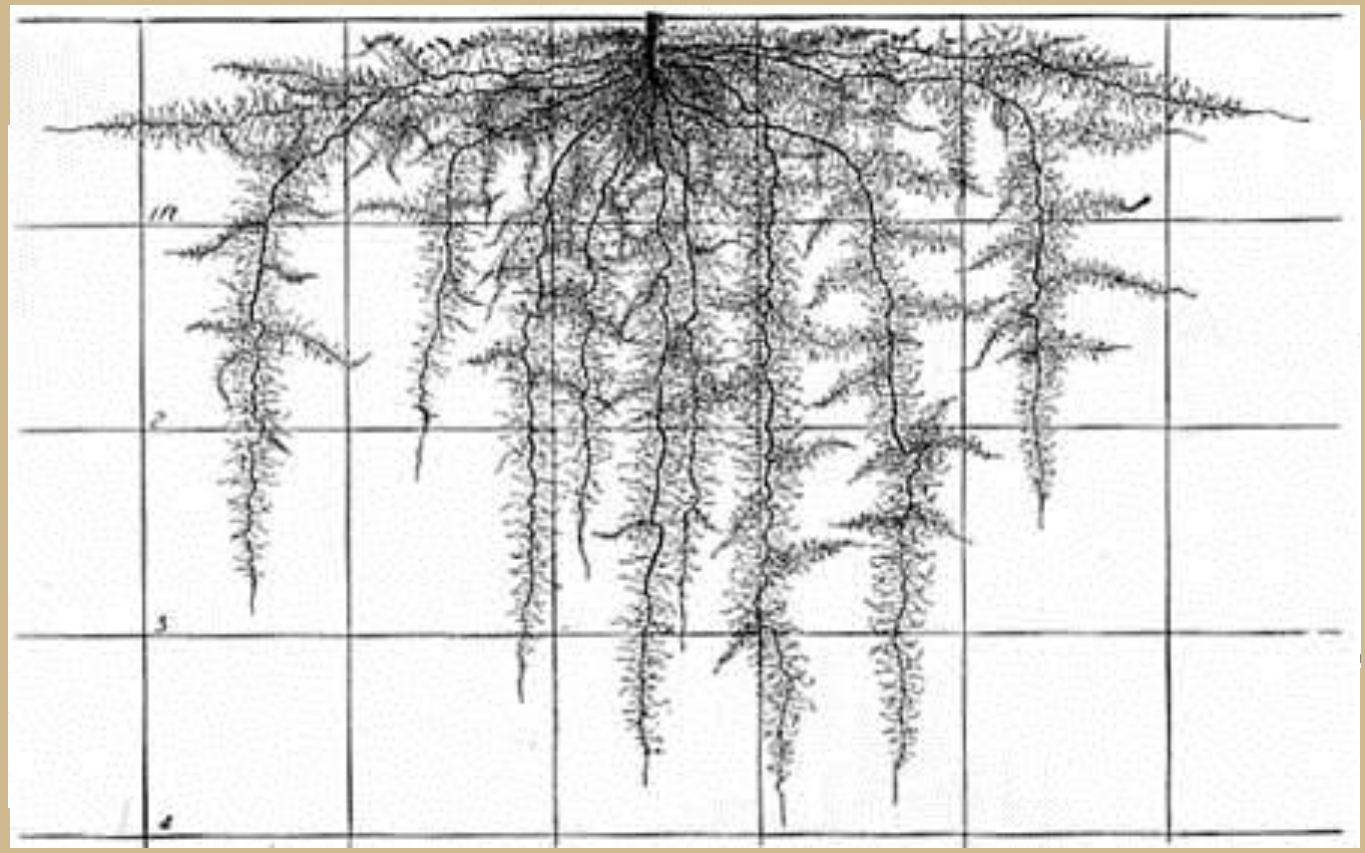

Increase in root development
Increase in soil thickness
Lumpy structure

The fact that the effectiveness of the treatment has succeeded in improving some of the soil properties suggests that further expansion into the field of contaminated soil remediation is to be expected

- Biopile
- Landfarming
- Phytoremediation
  - Phytostabilization
  - Phytoaccumulation
  - Phytodegradation
  - Phytovolatilization
  - Rhizodegradation



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Properties of reconstituted soil in relation to different remediation techniques

Biopile

Soil characteristics for assessing the effectiveness of biopile are

- *Microbial population density*
- *Soil pH*
- *Moisture*
- *Soil temperature*
- *Nutrients concentrations*
- *Type of soil at the site and surrounding area (sandy, silt and clayey) and its structure*

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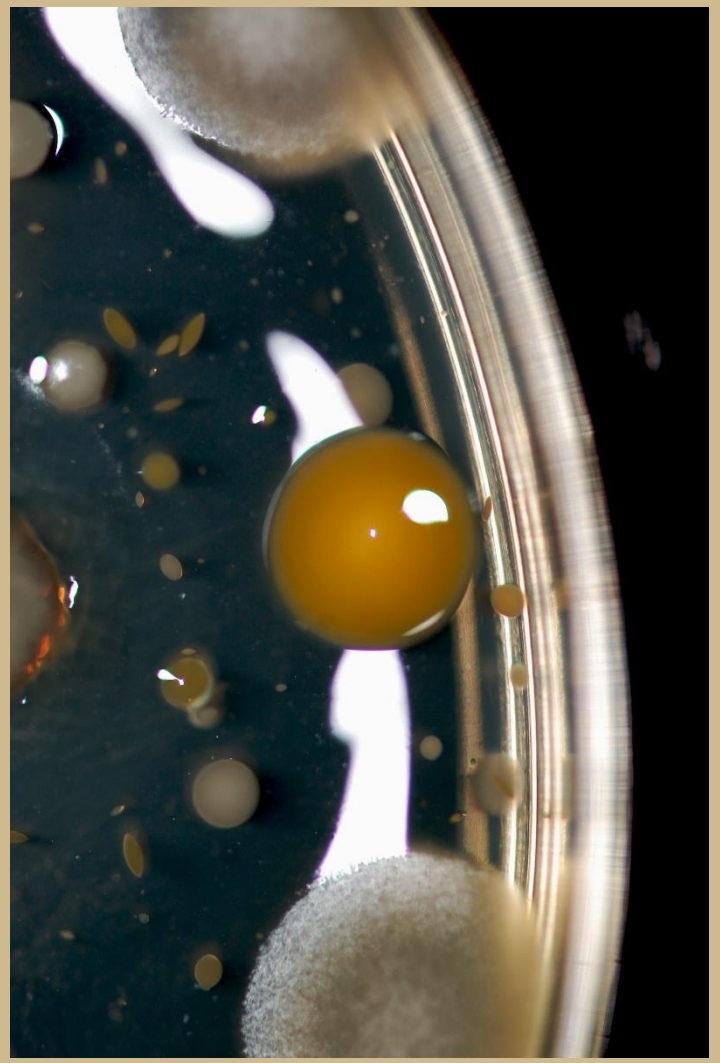
Microbial population density

Total heterotrophic bacteria in relation to biopile effectiveness	
Total heterotrophic bacteria	Biopile effectiveness
> 1.000 CFU/g ss	Effective treatment
< 1.000 CFU/g ss	May be effective only if either organic matter or bacterial cultures are added



Reaction

Soil reaction in relation to biopile effectiveness	
Soil pH	**Biopile effectiveness**
[6 – 8]	Optimal range for bio-remediation
[<6 - >8]	Unsuitable range; will require amendments

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Reaction

Soil pH
6 – 8

Dosage adjustment between matrices

Treatments

$CaCO_3$ - $FeSO_4$ – S
amendments

SC.	Matrice	pH	I Livello	II Livello	III Livello	IV Livello	V Livello
S.12B	Villa Lagarina Bio	6,76	x	x	x	x	x
S.36	Burgo Verzuolo	7,49	x	x	x	x	x
S.18	Delicarta	7,72	x	x	x	x	x
S.2	Cartiera Galliera	7,80	x	x	x	x	x
S.8	Med. Isoverde	7,88	x	x	x	x	x
S.12A	Villa Lagarina	7,89	x	x	x	x	x
S.4	Cartiera Garda	8,03		x	x	x	x
S.14	Europaper	8,04		x	x	x	x
S.20	Pub. Anconella	8,07		x	x	x	x
S.9	Med. Mignanego	8,12		x	x	x	x
S.19	Giorgione	8,14		x	x	x	x
S.5	Carbonera	8,16		x	x	x	x
S.11	Cartitalia	8,18		x	x	x	x
S.3	DSSmih	8,19		x	x	x	x
S.31	Mosaico srl	8,20		x	x	x	x
S. 29A	Cartiera Giacosa	8,21		x	x	x	x
S.30	Burgo Sarego	8,27			x	x	x
S.32	Tolentino	8,27			x	x	x
8,42	Toscolano	8,42			x	x	x
8,47	Cartiera Favini	8,47			x	x	x
8,52	Favini	8,52					x

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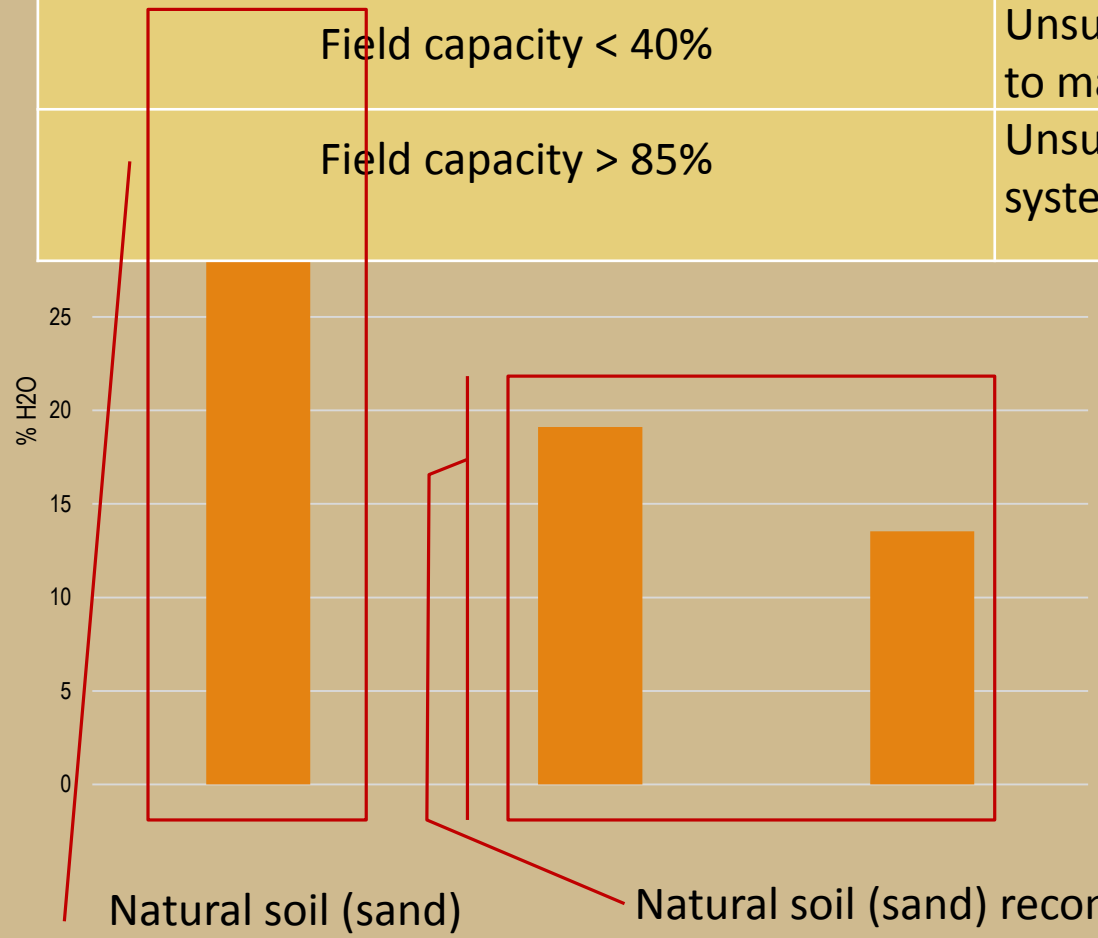
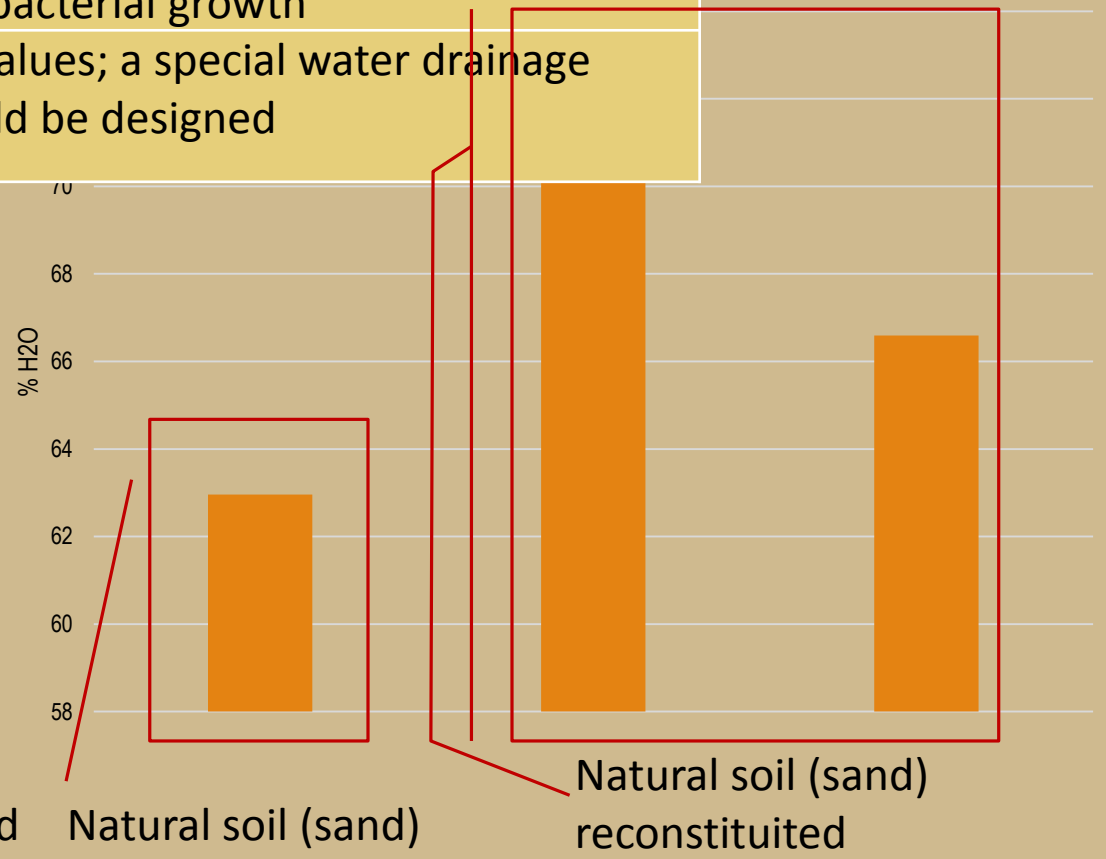
Soil moisture in relation to biopile effectiveness

Soil moisture	Biopile effectiveness
40% ≤ Field capacity ≤ 85%	Optimal range for bioremediation
Field capacity < 40%	Unsuitable values; moisture addition is needed to maintain bacterial growth
Field capacity > 85%	Unsuitable values; a special water drainage system should be designed

water

biosi naturali -

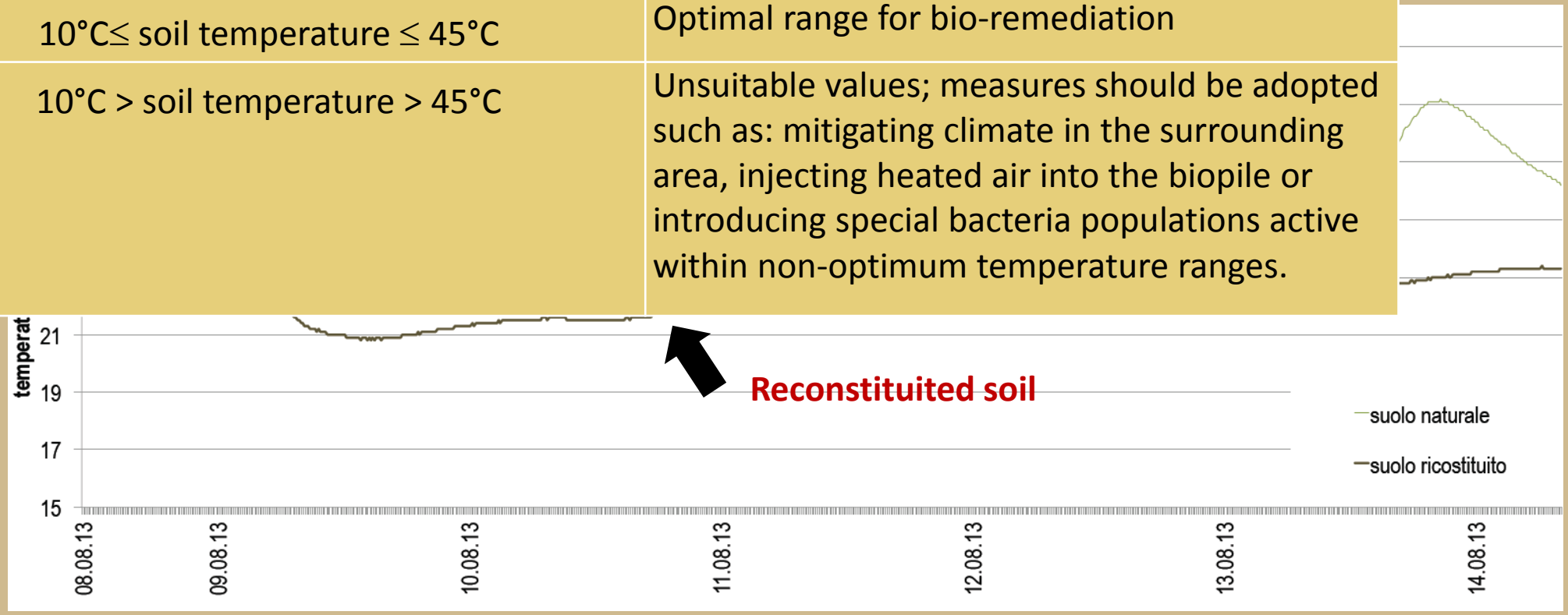




Soil temperature

nd enzymatic

Soil temperature in relaction to biopile effectiveness	
Soil temperature	Biopile effectiveness
10°C≤ soil temperature ≤ 45°C	Optimal range for bio-remediation
10°C > soil temperature > 45°C	Unsuitable values; measures should be adopted such as: mitigating climate in the surrounding area, injecting heated air into the biopile or introducing special bacteria populations active within non-optimum temperature ranges.



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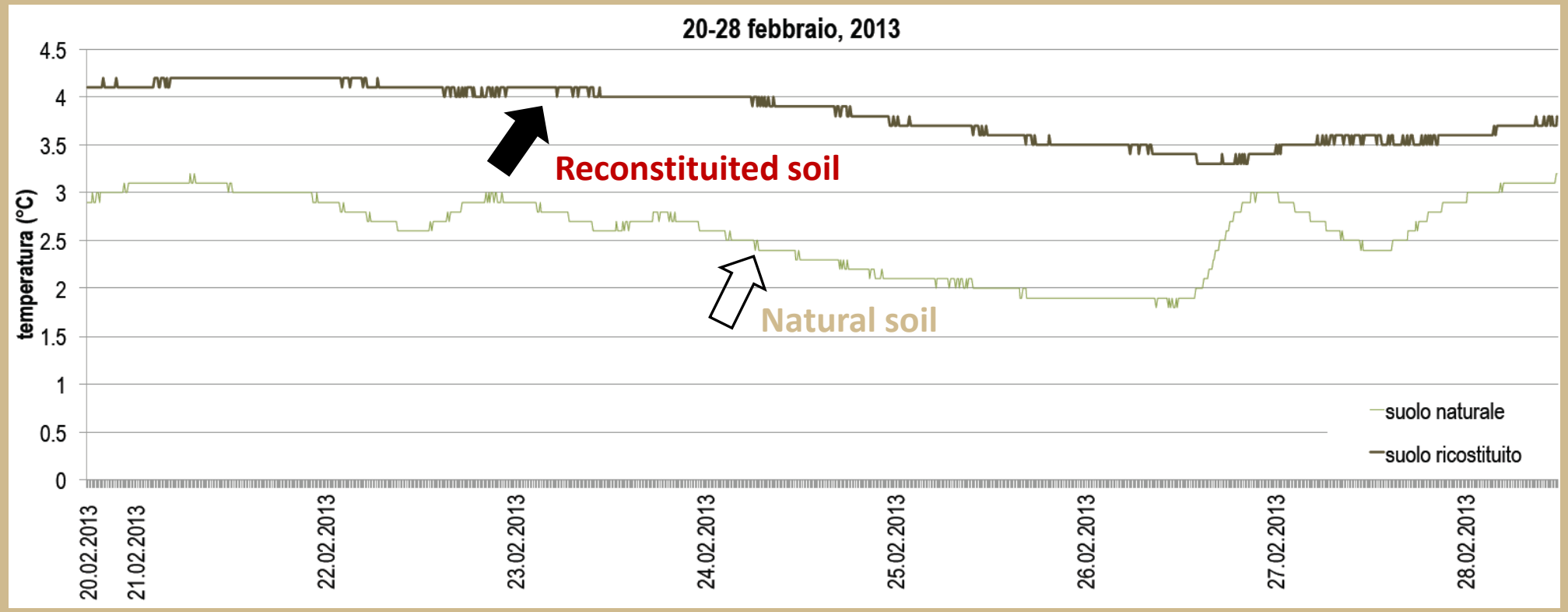
Soil temperature



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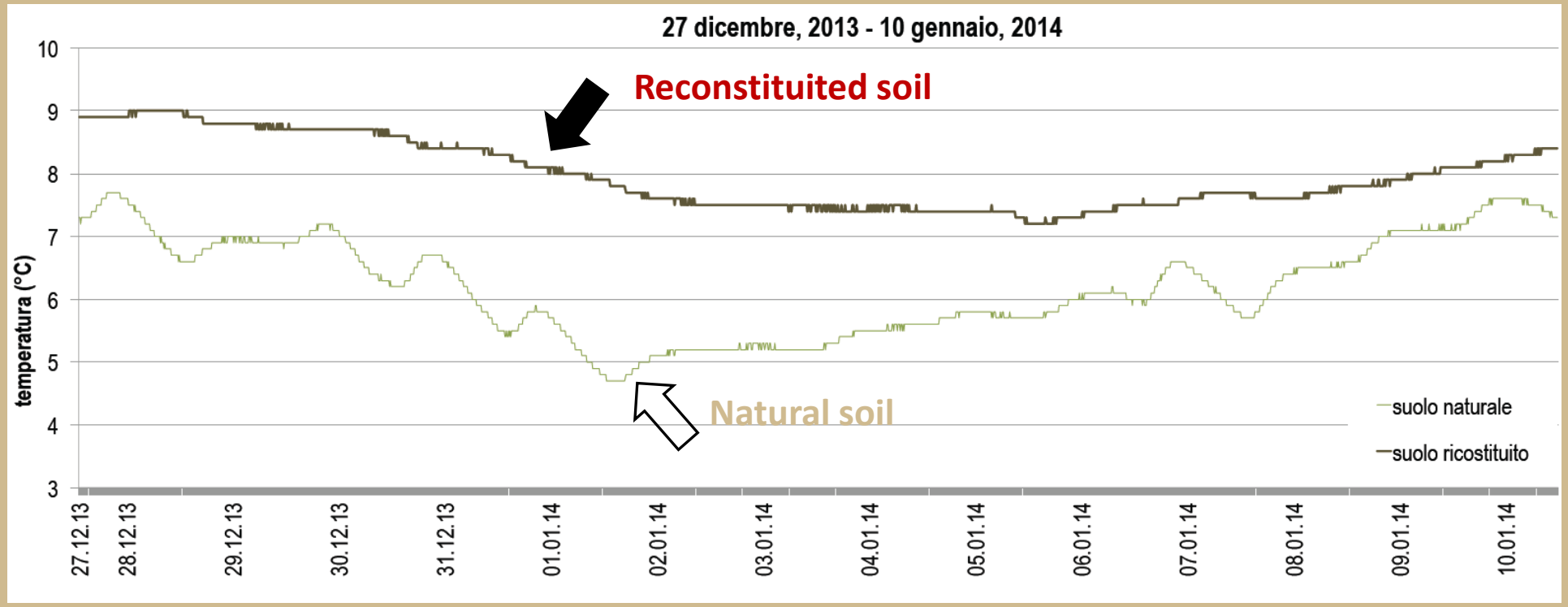
Temperatura del suolo



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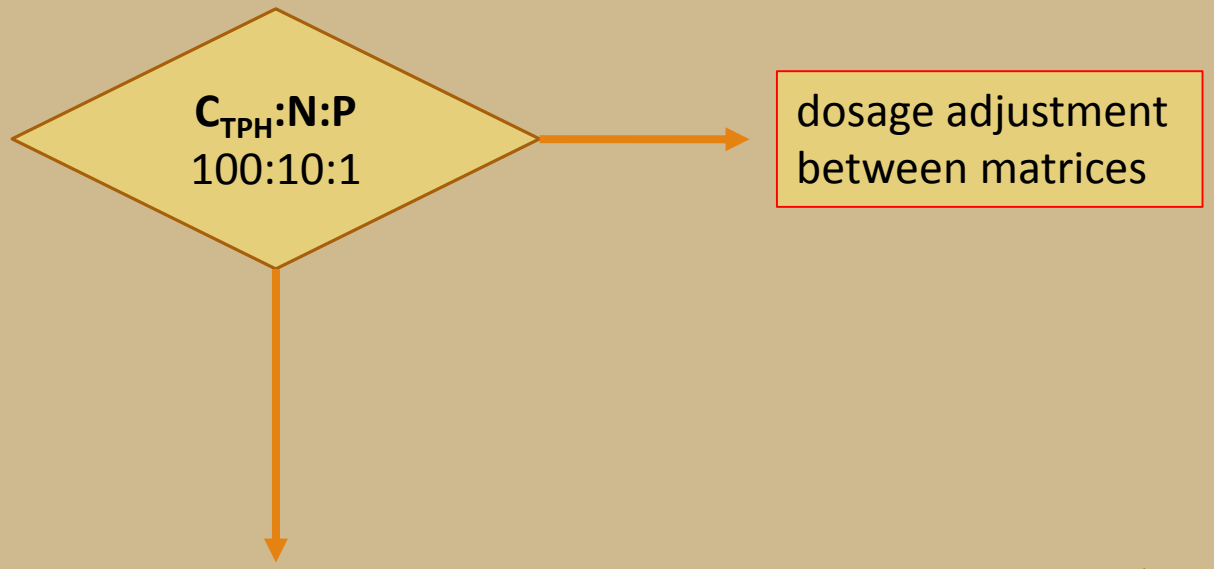
Nutrient concentrations

Nutrient concentrations are adjusted to suit the conditions of the soil that needs bioremediation treatment

C:N:P
100:10:1

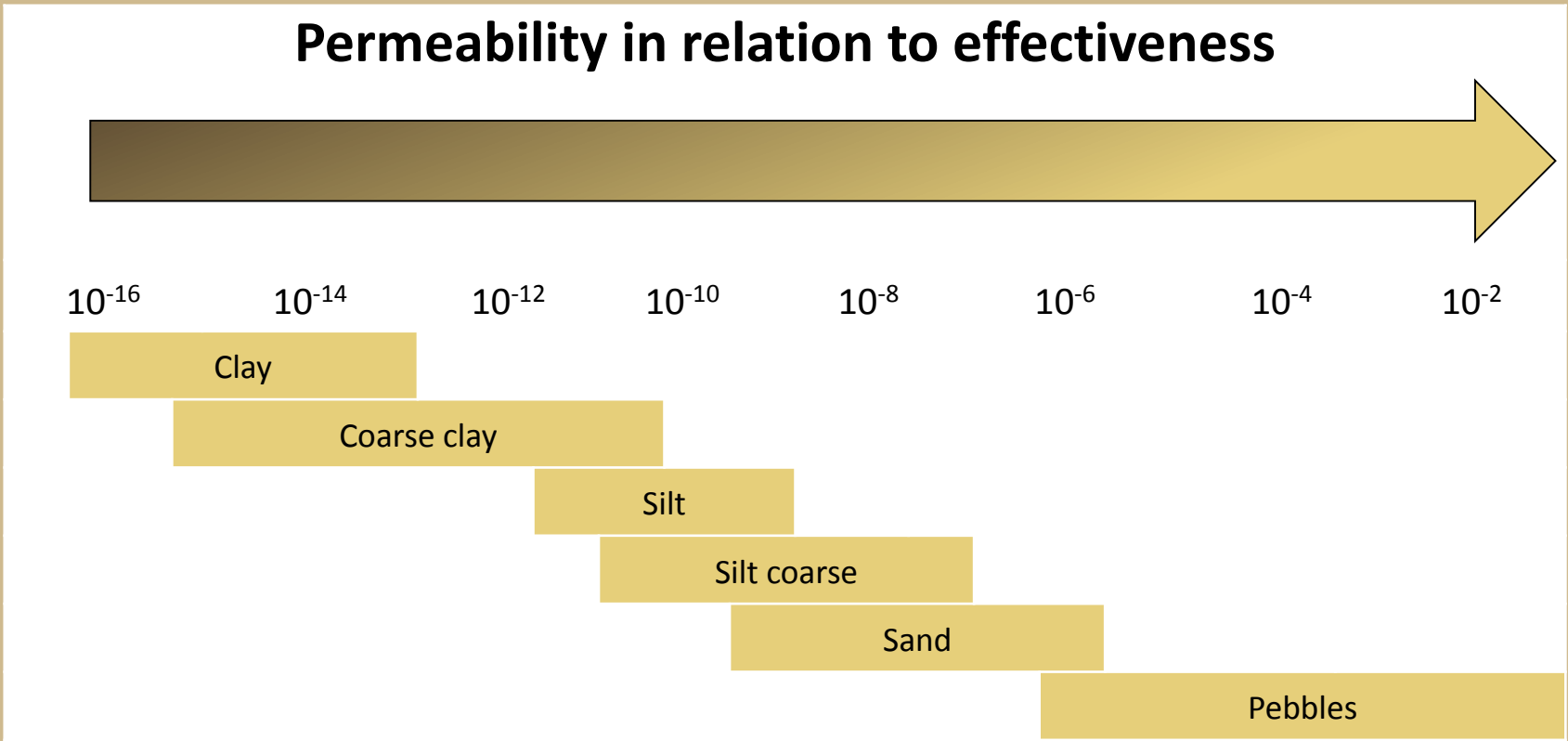


SC.	Matrice	C org g/kg

SC.	Matrice	Ntot g/kg (%)

SC	Matrice	P Olsen mg/kg	< 0,1
S. 33	Cartiera Favini	11,0	1,50 (0,15%)
S. 12A	Villa Lagarina	4,59	2,30 (0,23%)
S.22	Lucart	5,05	2,40. (0,24%)
S.1	Pescia	18,5	2,80 (0.28%)
S.11	Cartitalia	28,7	2,85 (0,28%)
S.3	DSSmih	18,2	2,90 (0,29%)
S.4	Cartiera Garda	14,1	3,10 (0,31%)
S.	Mosaico srl	0,08	3,30 (0,33%)
S.5	Carbonera	74,8	3,90 (0,39%)
S.6	Champaper Carmignano	7,21	4,50 (0,45%)
S.13	Cordenons	14,5	4,50 (0,45%)
S.7A	Fedrigoni (Arco)	6,23	4,55 (0,45%)
S.29B	Cartiera Giacosa	0,00	4,60 (0,46%)
S.33	Favini s.r.l.	7,40	4,90 (0,49%)
S.29°	Cartiera Giorgione	5,67	4,90 (0,49%)
S.14	Europaper	29,9	5,15 (0,51%)
S.18	Delicarta	78,1	5,40 (0,54%)
S.30	Borgo group Sarego	21,0	5,40 (0,54%)
S.34	Toscolano	11,3	6,20 (0,62%)
S.7C	Fedrigoni Verona	10,1	6,80 (0,68%)
S.9	Mediterranea Mign.	2,24	8,10 (0,81%)
S.2	Cartiera Galliera	38,0	8,40 (0,84%)
S.32	Cartiera di Tolentino Srl	18,9	10,4 (1,04%)
S.8	Mediterranea - Isoverde	0,73	10,7 (1,07%)
S.12B	Cartiere Villa Lagarina	408	11,4 (1,14%)
S.20	Publiacqua Anconella	15,3	14,8 (1,48%)
S.36	Burgo Gruop Verzuolo	117	43,4 (4,34%)
			55,1 (5,51%)

Texture - Structure



Texture - Structure

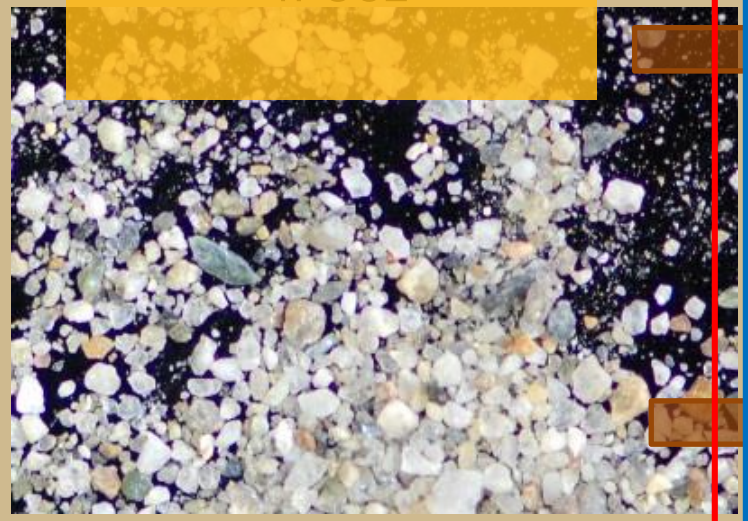
1PSC2

2PSC2

6PSC2

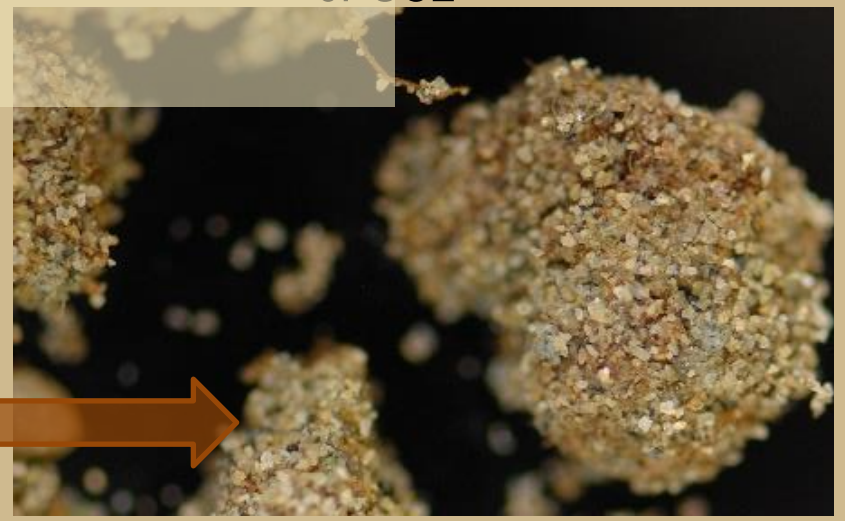
NATURAL SAND

RECONSTITUITE SAND



1PSC2

2PSC2



6PSC2

Texture - Structure

8PSC2

9PSC2

NATURAL CLAY

RECONSTITUITE CLAY

7PSC2

8PSC2

9PSC2

Fitorimediazione - Landfarming

Soil characteristics for evaluating the efficiency of phytoremediation and landfarming treatments are

- *microbial population density*
- *soil pH*
- *moisture content*
- *soil temperature*
- *nutrient concentrations*
- *type of soil at the site and surrounding area (texture) and its structure*
- *development of root system*

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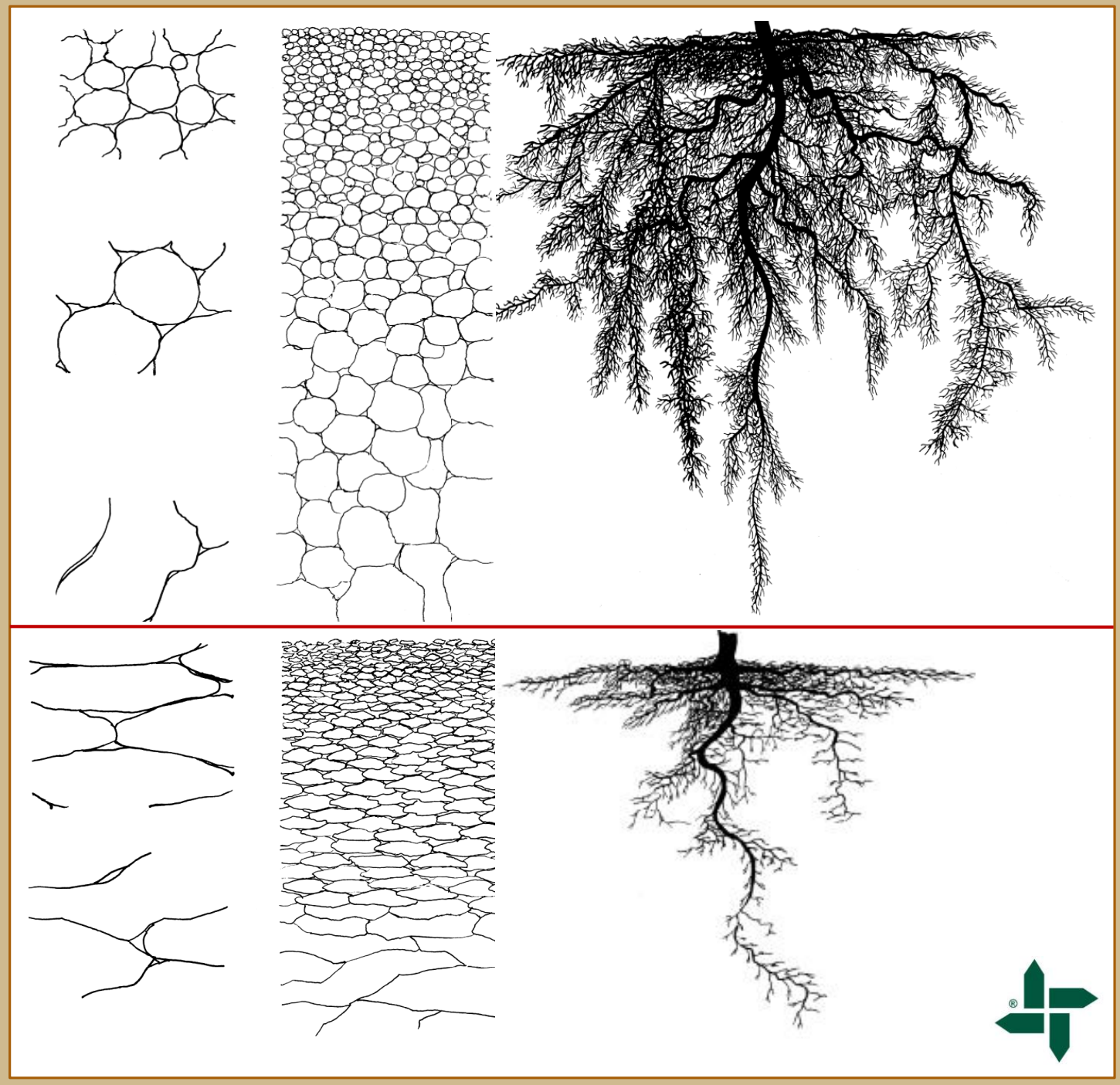
Root system architecture

Reconstituite soil

Natural soil deg.



Root system architecture

The wider the root system the greater the effectiveness of phytoremediation treatments

Mechanism Process	Typical Contaminants	Plant Types
Phytostabilization	As, Cd, Cr, Cu, Pb, Zn	Herbaceous species, grasses, trees, wetland species
Rhizodegradation	Organic compounds (TPH, PAHs, BTEX, pesticides, chlorinated solvents, PCBs)	Herbaceous species, grasses, trees, wetland species
Phytoaccumulation	Ag, Au, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn; Radionuclides: 90Sr, 137Cs, 239Pu, 234, 238U	Herbaceous species, grasses, trees, wetland species
Phytodegradation	Organics compounds, chlorinated solvents, phenols, pesticides, munitions	Algae, herbaceous species, trees, wetland species

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The technology of reconstitution used for the remediation of contaminated soil may represent a valuable innovation worth considering when conducting feasibility studies in the field of bioremediation, and for enhancing natural attenuation processes in polluted soil.

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Grazie per l’attenzione