UNIVERSITÀ DEGLI STUDI FIRENZE
DISPAA
DIPARTIMENTO DI SCIENZE DELLE PRODUZIONI AGROALIMENTARI E DELL'AMBIENTE

Demonstration of the suitability of dredged remediated sediments for safe and sustainable horticulture production

CNR Consiglio Nazionale delle Ricerche
ISE Istituto per lo Studio degli Ecosistemi
Universitas Miguel Hernández
ZELARI COMPANY
CaliPlant

Hortised

Life

Remediated marine dredged sediments as growing media for agricultural activities: first results from the Hortised project (LIFE14 ENV/IT/000113)

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Using sediments as a resource - Sediments in a circular economy
10th International SedNet Conference
Genova 14-17 June 2017

Marine port sediment as a substrate

Dredging → Remediation - Landfarming → Remediated sediment

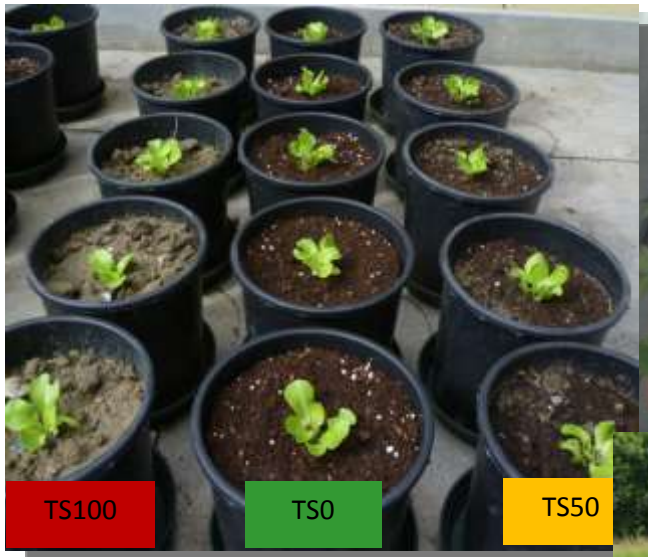
Chemical, physical, biochemical and toxicological analysis and characterization of remediated sediment

Substrate (v/v): Treated Sediment (TS) and Peat (or Coconut fiber) Based Commercial Substrate (PBCS)

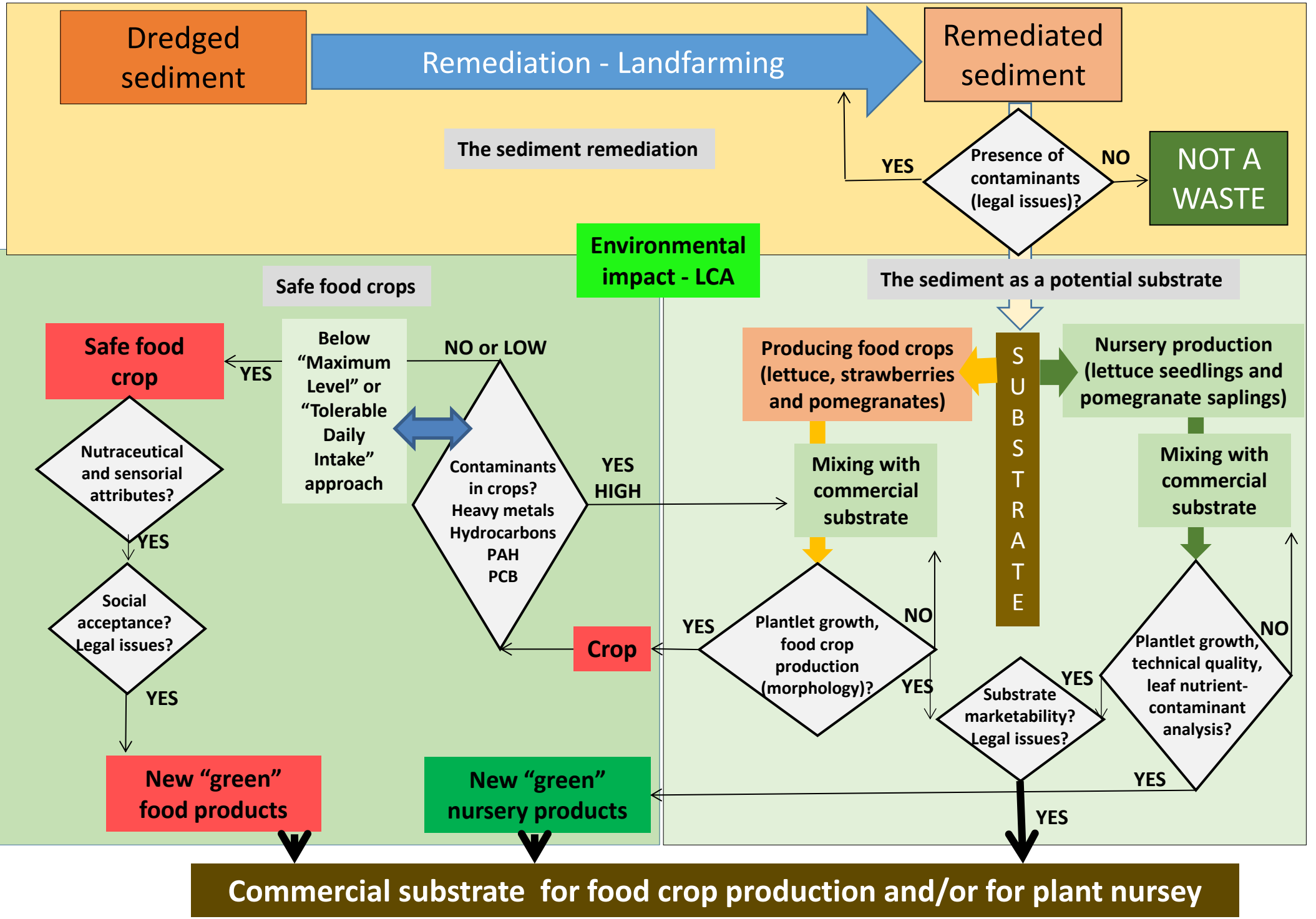
- TS0 — 100% PBCS
- TS50 — 50% PBCS + 50% TS
- TS100 — 100% TS

Plant material

Food crops: **lettuce** (cv Ballerina), **strawberry** (cv Camarosa and Monterey) and **pomegranate** (cv Mollar de Elche and Purple Queen)



Flow chart of the remediated sediment use in horticulture



Sediment after landfarming

Physical, chemical and heavy metal characterization

Parameters	Sediments at the end of landfarming	D.Lgs.75/2010 Agronomic substrates
Texture	Sand: 57,8 ±1,2 Silt: 23,3 ± 0,66 Clay: 18,9 ± 0,9	-
Bulk density (g/cm^3)	1.08 ± 0.12	0,95
pH	8,1 ± 0,01	4,5-8,5
Eletrical conductivity (ds/m)	0,3 ± 0,04	<1
TOC %	1,97 ± 0,02	>4
TN %	0,13 ± 0,01	<2,5
Total P (mg/kg)	577 ± 33	<6550
P_2O_5 %	0,11 ± 0.02	<1,5
Cd (mg/kg)	< L.Q	1,5
Cu (mg/kg)	34,3 ± 4,3	230
Hg (mg/kg)	0,075 ± 0,001	1,5
Ni (mg/kg)	34,6 ± 5,33	100
Pb (mg/kg)	35,2 ± 3,7	100
Zn (mg/kg)	248 ± 11	500

- Sandy-loam texture (USDA)
- Bulk density slightly higher
- Total organic carbon relatively low

The landfarming is successful

Physical and chemical characteristics comparable with those of an agronomic substrate (D.lgs 75/2010)

Sediment after landfarming

Organic contaminants

Parameters	Sediments at the end of landfarming	D.Lgs 152/2006 Table A civil use (mg/kg)	D.Lgs 152/2006 Table B industrial use (mg/kg)
C>12	174 ± 26	50	750
C<12	< L.Q	10	250
PAHs	49.2 ± 6.13	10	100
PCB	0.039	0.06	5

D.Lgs 152/2006 Table A and B for civil and industrial use as reference limit for organic contaminants

- C<12 and PCBs: very good
- Contamination by C>12 and PAHs (higher than the legal limit for civil use, but lower than the threshold set for industrial use)

Biochemical and toxicological analysis

Parameters	Sediments at the end of landfarming
Dehydrogenase (mg/kg*h)	2,78 ± 0,32
β-glucosidase (umol/g*h)	44,1 ± 6,7
Phosphatase (umol/g*h)	51,2 ± 6,7
Protease (umol/g*h)	192 ± 15
BIOTOX (%)	13,6 ± 1,1

- During the three months of landfarming, all the measured enzyme activities significantly increased

- Biotox test showed an inhibition value below 20% (toxic limit)

Lettuce Growth

Statistical differences in final biomass: lettuce grown on TS0 had greater biomass than TS50 and TS100.

After two weeks, lettuce grown on TS50 and TS100 reached similar development of TS0. From the agronomical point of view, lettuce cultivated on sediments has two weeks of delay.

Sediments too compact?

Lettuce contaminants **21 elements and 130 pollutants ("Terra dei Fuochi")**

The food safety assessment is based on:

1) **Maximum Level-Codex Alimentarius (EC, No 1881/2006)** (if available) →
2) **Tolerable Daily Intake (TDI)** (mg of pollutant / kg of body weight)

Cd and nitrate found in lettuce grown on sediments were below the maximum level

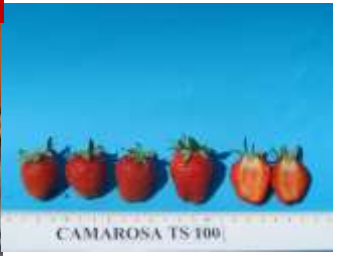
Tolerable daily amount (kg fw) of lettuce intake for a person of 60 kg

Treatment	Al	Ni	Sr	Cr	Cu	Zn	Dioxin + dioxin-like PCBs	Pentachlorophenol
TS0	1,46	3,5	2,8	46,6	1875,7	394,6	nd	1158,2
TS50	0,39	1,7	1,5	16,2	438,4	195,7	nd	920,2
TS100	0,26	1,5	1,3	17,2	386,2	229,2	71,0	560,9
Commercial	0,5	0,6	1,1	1,9	610,8	333,6	-	-

Strawberry growth

Both strawberry cultivars grown on sediments (TS50 and TS100) showed a lower vigour.

Variety	Treatment	Average of fruit weight (g)		Average of fruit width (cm)		Fruit weight per plant		Fruit number per plant	
Camarosa	TS0	8.06	a	2.37	a	59.6	a	7.63	a
	TS50	7.68	a	2.38	a	58.2	a	7.69	a
	TS100	5.72	b	2.15	b	35.7	b	6.24	a
Monterey	TS0	12.64	a	2.79	a	62.8	a	4.96	a
	TS50	8.84	b	2.50	b	43.2	b	4.89	a
	TS100	8.64	b	2.49	b	29.5	c	3.40	a



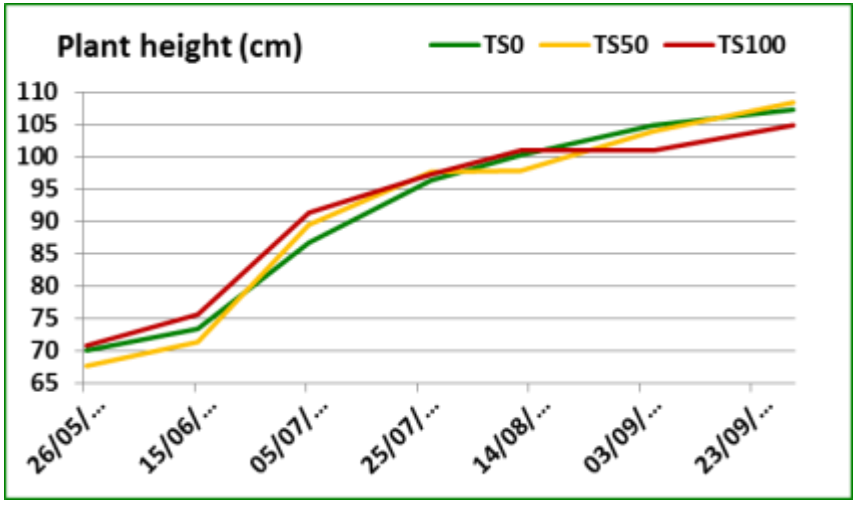
Strawberry fruit contaminants

Tolerable daily amount (kg fw) of strawberry intake for a person of 60 kg

Treatment	Ni	Sr	Al	Cr	Zn	Cu
TS0	2,2	3,7	4,9	72,4	2000,2	1093,8
TS50	2,7	3,8	17,7	82,1	1699,7	708,4
TS100	2,0	3,6	13,4	118,8	1803,9	773,0
Commercial	4,2	43,9	nd	84,0	1709,3	737,2

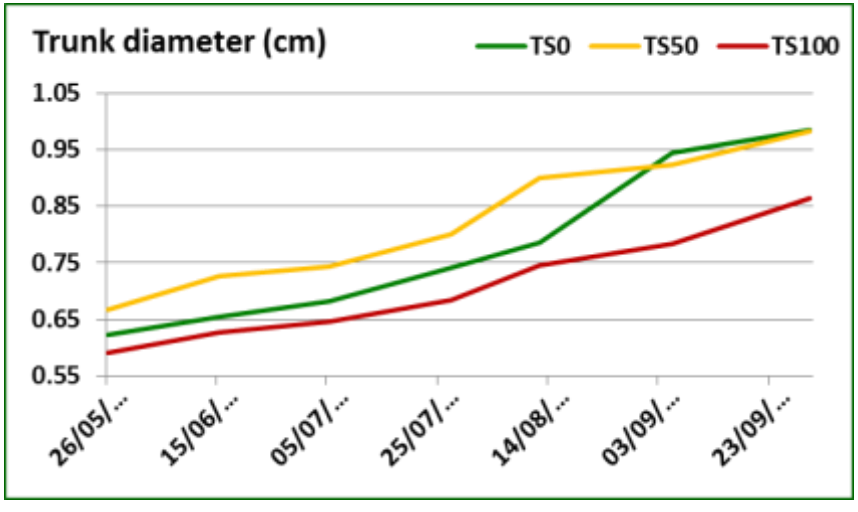
Pomegranate growth

Year 2016: no statistical differences for pomegranate height between the plants grown on the peat and sediments. Trunk diameter were found slightly higher for TS0 and TS50 plants.
Year 2017: the trial is still currently underway. At the end of the season final canopy and root biomass will be measured.



Pomegranate leaf contaminants

Al, Ni, Cu, Cr, Sr, Fe, Mn, Zn were found in pomegranate leaves for plants grown on both peat and sediments. Each cultivar has a different trend in element absorbing.
Years 2017: waiting for the contaminats analysis in fruits.



Dissemination/Legal issues and policy/Crop acceptability

Authority of Cartagena Port

Fruitlogistic - Berlin

Customers at Caliplant

S. Fratoni (Assessor of the Environment - Tuscany Region) at the HORTISED Monitoring meeting