RegioneEmilia-Romagna
servizio geologico sismico e dei suoli

8th EUREGEO
Barcelona | Catalonia | june 15th - 17th 2015

Cartographic tools to support the management of contaminated sites: the “Pedogeochemical maps at 1:250.000 scale” of Emilia-Romagna Region

Nazaria Marchi & Marina Guermandi

Regulatory framework

Italian Legislative Decree 152/06.

Art.240, comma1,point b: *"Concentration Limit Values are the screening values of environmental matrix above which the characterization and site specific risk analysis of the contaminated site, as described in the Annex 5 at part four of the present law. becomes necessary. In the event the potentially contaminated site is locat* ***geogenic*** *or* ***anthropogenic factors*** *are responsible fo* *Concentration Limit Values for some parameters, the background content of these parameters are assumed as CLV.*

How?

Annex1 Title V : setting of the risk analysis for human health, parameters to consider

"..the choice of contaminats must take in account the exceeding of Concentration Limit Values ***that is*** *natural background values.."*

Geochemical maps of Emilia-Romagna alluvial plain
1:250.000 scale

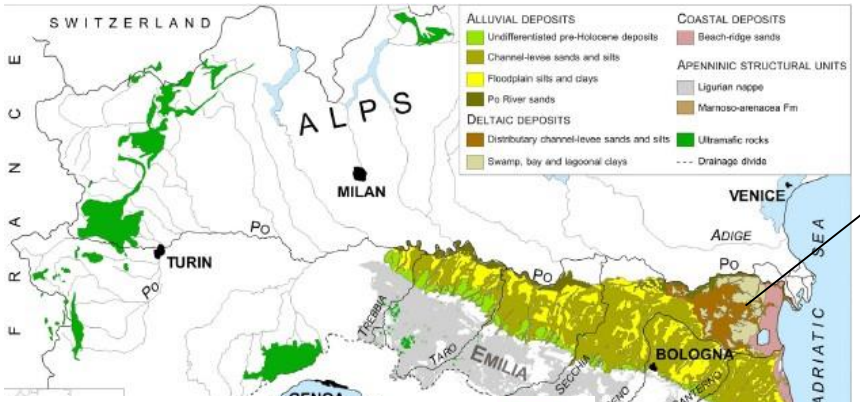
1. pedo-geochemical maps (Cr, Cu, Ni, Pb, Zn, V) - "*geogenic factors*"-

2. maps of background content (As, Cu, Cr, Ni, Pb, Sn, V, Zn) -"*geogenic" + "anthropogenic" factors* -

3. maps of Geochemical anomalies (Cr, Cu, Ni, Pb, Zn, V) Igeo = log2 Cn / (1.5*Bn) *(Müller 1979, Förstner and Müller)* where **Cn** metal concentration in topsoil samples (at 20-30 cm depth) **Bn** is the pedo-geochemical content of the same metal (calculated on the basis of subsoil geochemistry, at 90-140 cm depth) - *quantification of anthropogenic impact-*

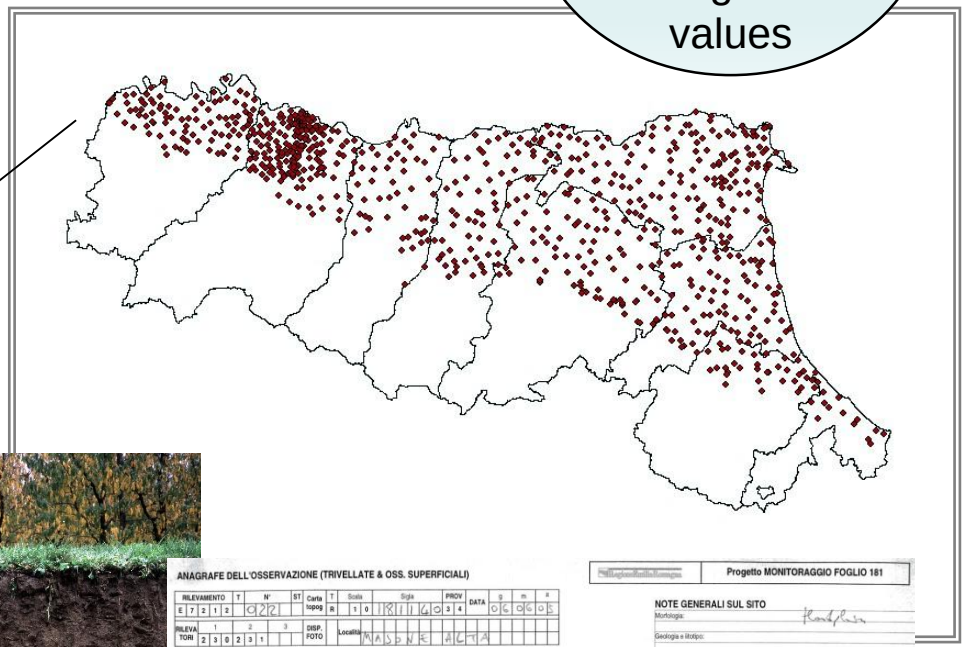
1.Sampling strategy

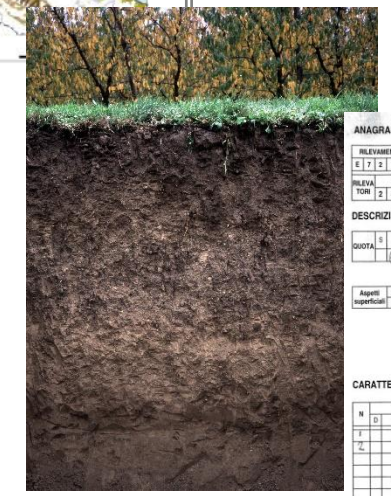
Iso 19258:2005 Soil quality-guidance on background values

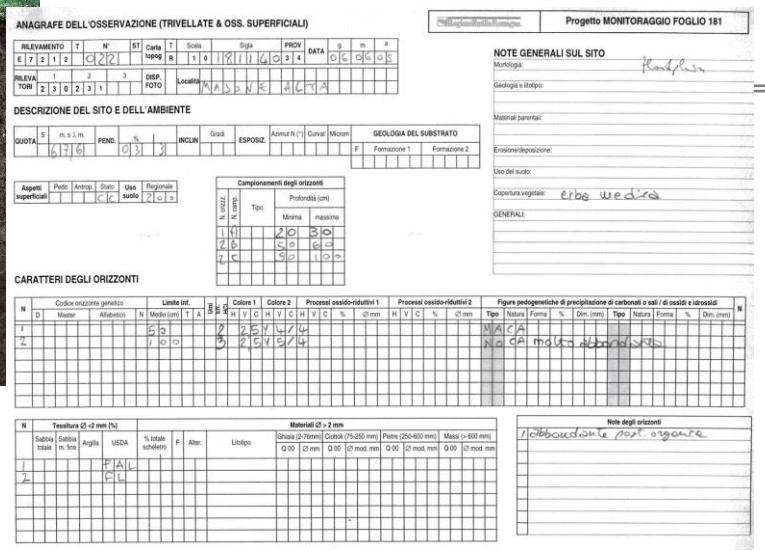


Fingerprinting sedimentary and soil units by their natural metal contents: A new approach to assess metal contamination

Alessandro Amorosi [a,*], Marina Guermandi [b], Nazaria Marchi [b], Irene Sammartino [d]

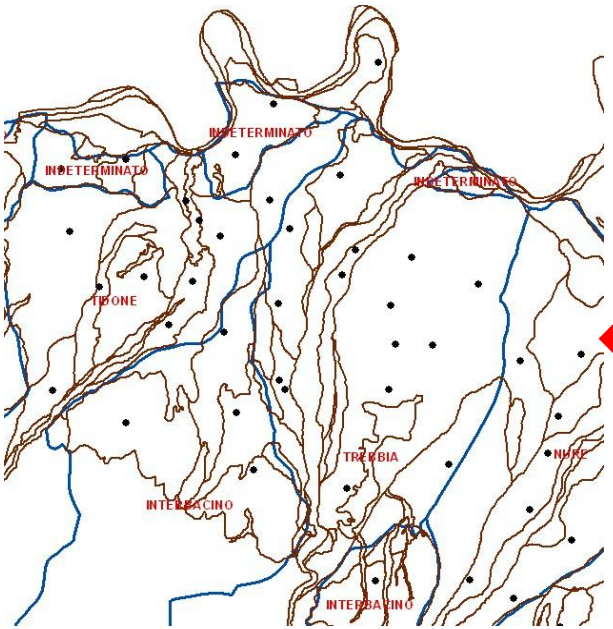


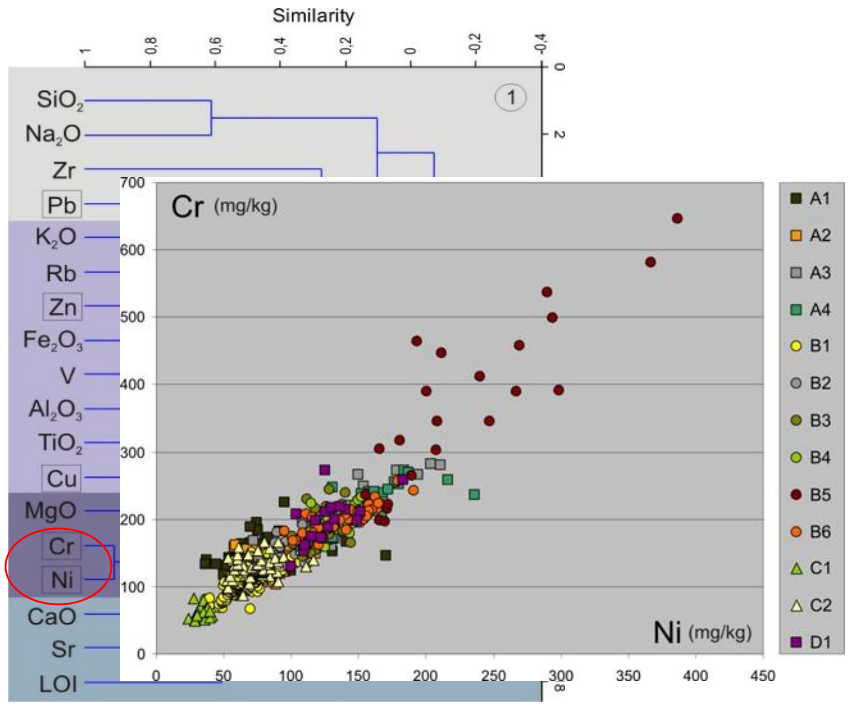




- 709 sites of sampling avg. 1/16 km2
- every site of sampling is attributed to a Soil Type Unit
- samples at 90-140 cm depth
- xrf

1.Typological approach



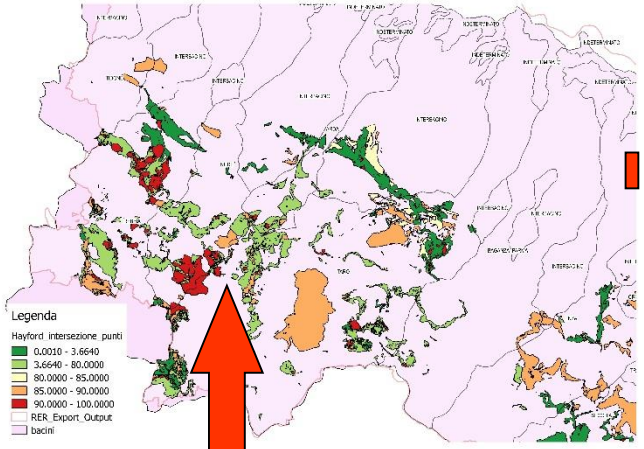


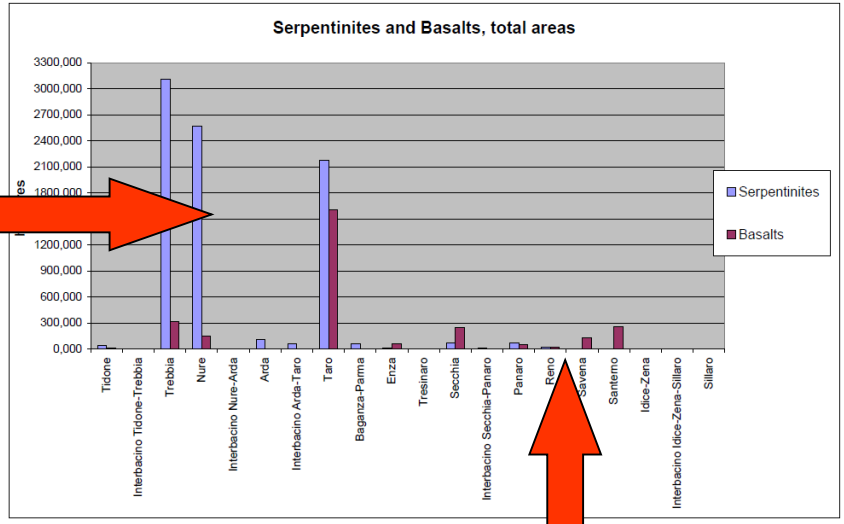
First identification of groups of soils homogeneous for texture, parent material provenance and degree of weathering

Identification of geochemical *markers* and affinities for texture, provenance and degree of weathering

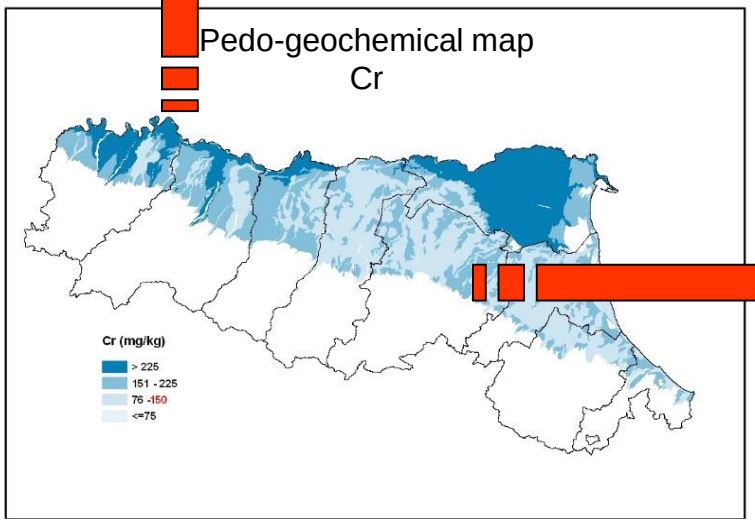
1. Parent material provenance

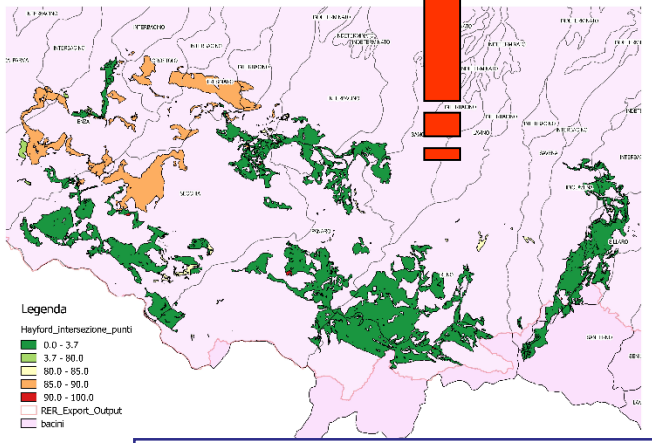
Classification of ophiolitic formations western basins





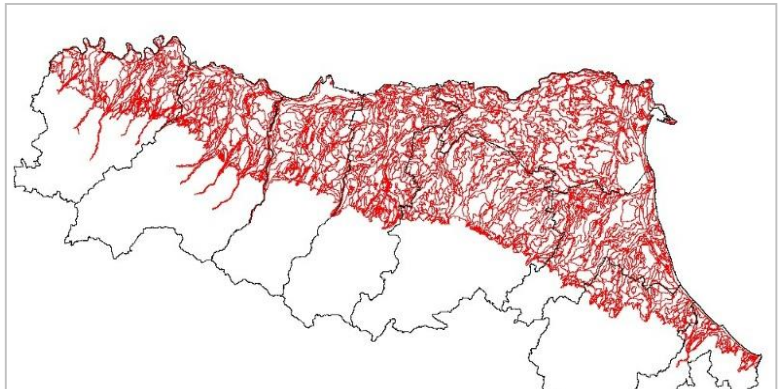
Pedo-geochemical map
Cr



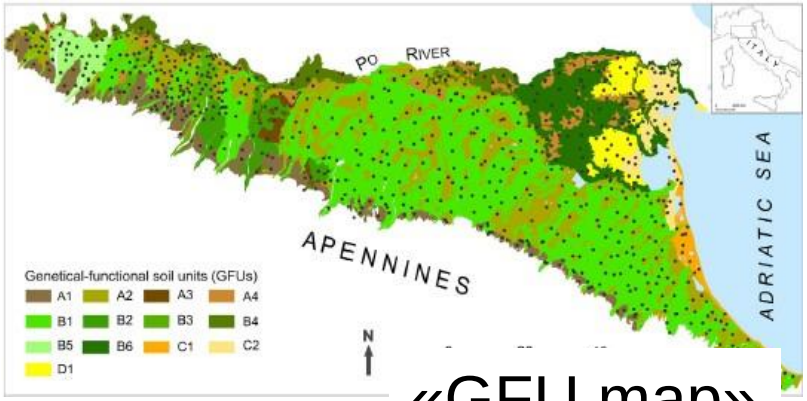


Classification of ophiolitic formations eastern basins

1.Genetical Functional Units



Soil map at 1:50.000 scale



«GFU map»

Genetical Functional Units

Medium to fine textured, high degree of weathering

A1

Ophiolitic content

Fine textured, low to moderate degree of weathering (D1 with organic horizons)

A2 A3 A4/D1

Ophiolitic content

Moderately fine grained to moderately coarse grained with rare gravels

B1 B2 B3 B4/B6 B5

Ophiolitic content

Coarse textured, low degree of weathering

C1 C2

Ophiolitic content

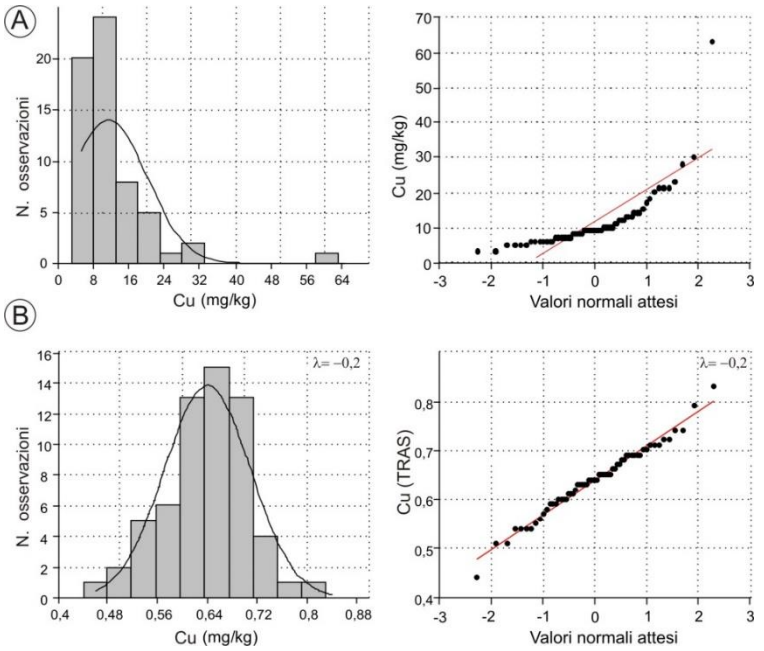
1.Statistical analysis

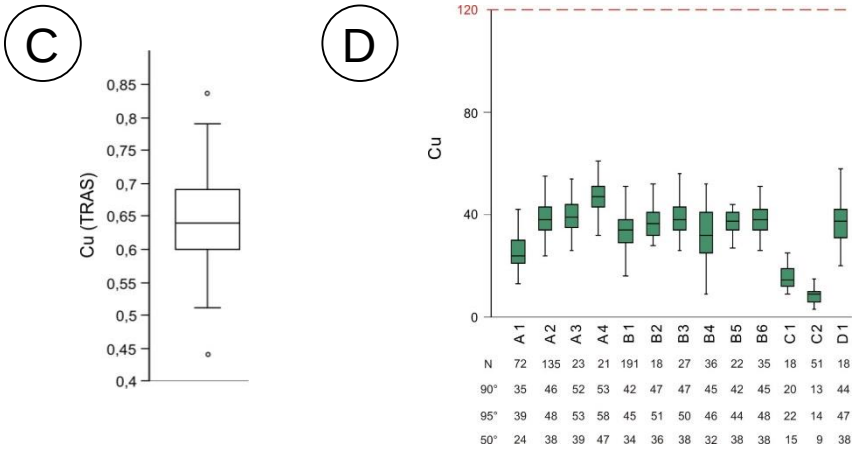
A - frequency histograms (K-S test)
outlier test (“box-plot”)

B - normalization
(Box-Cox transformation)

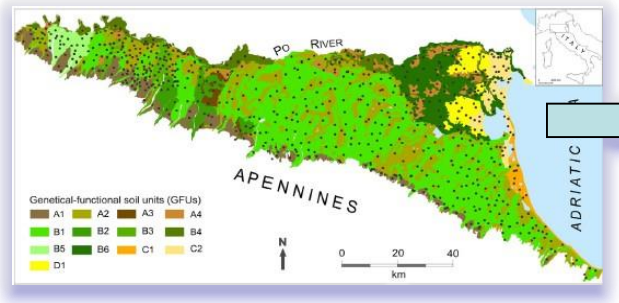
C - *outlier* test (“box-plot”)

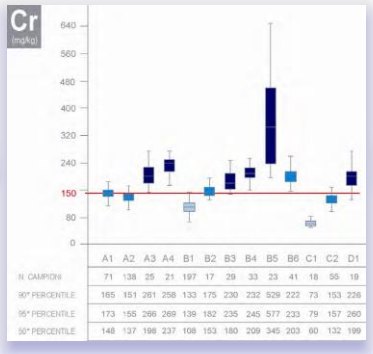
D - identification of 90° and 95°
percentile for every GFU

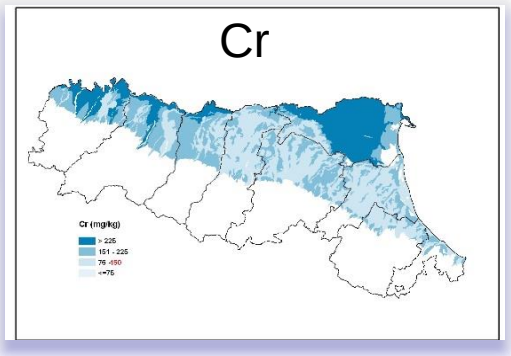


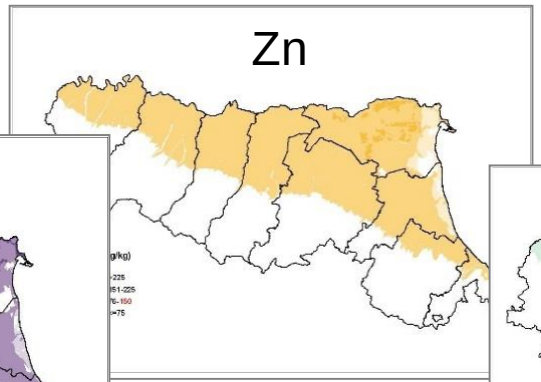


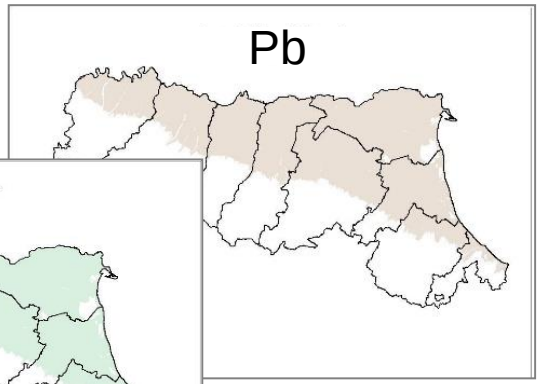
1.Map processing

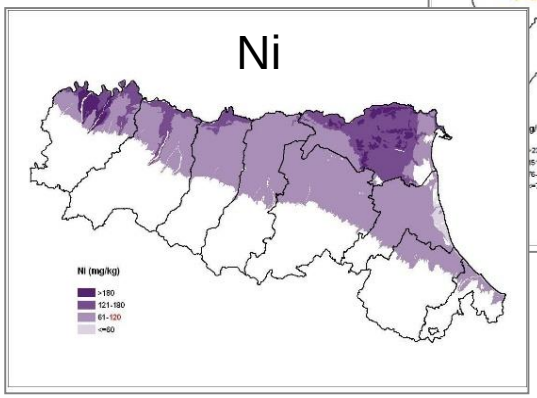


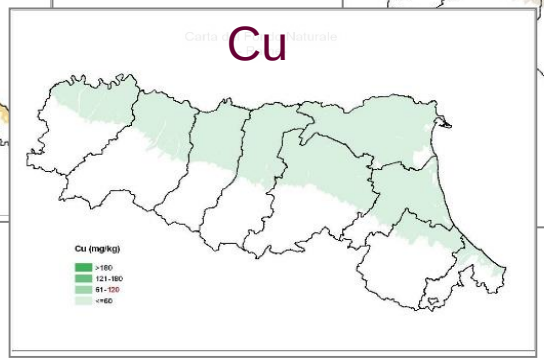










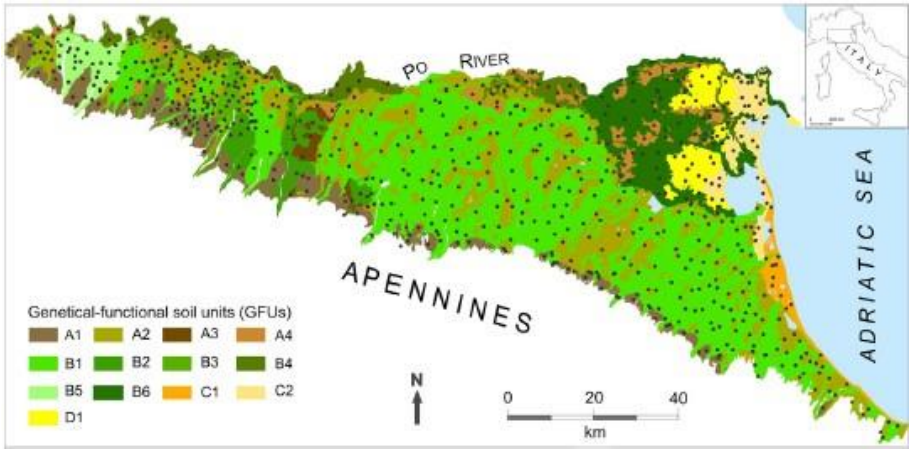


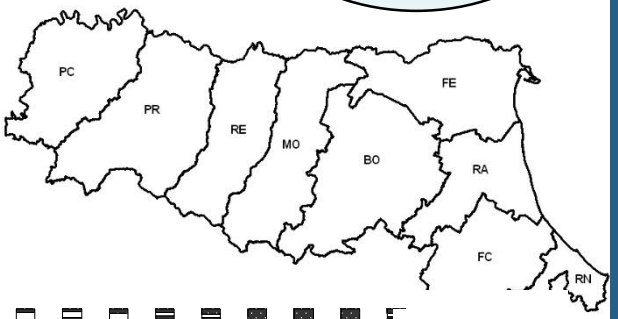
Cr (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Pb (mg/kg)
> 225	> 180	> 225	> 180	> 150
151 - 225	121 - 180	151 - 225	121 - 180	101 - 15
76 -150	61 -120	76 -150	61 -120	51 -100
= 75	= 60	= 75	= 60	= 50

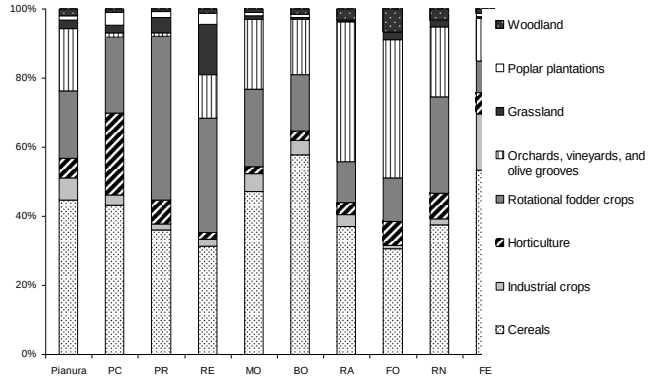
(D.lgs 152/06) TAB.A
green and residential areas

2- Map of background conte

Iso 19258:2005 Soil quality-guidance on background values







- 709 sites of sampling avg. 1/16 km2: samples at 20-30 cm depth
- typological approach based on GFUs and Land Use: *GFU - agricultural districts (ISTAT census 2000)*
- pseudo-total content - *acqua regia* extraction (UNI/EN13346) and detection by ICP Mass Spectrometry for the determination of (EPA 6020)

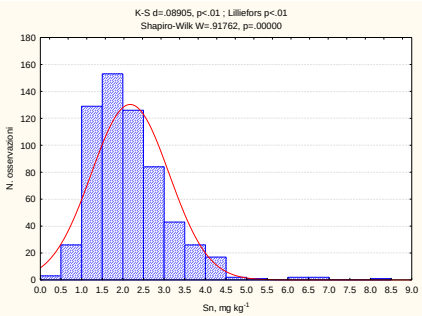
2. Statistical analysis

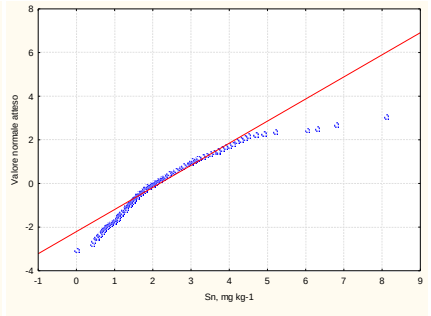
A - frequency histograms (K-S test)

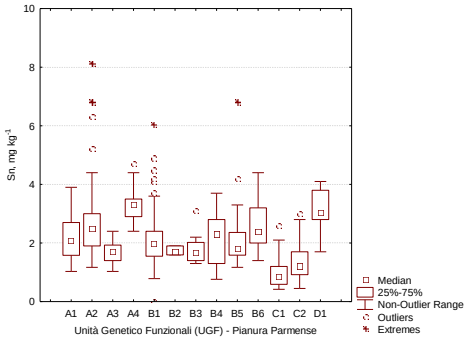
B - normalization

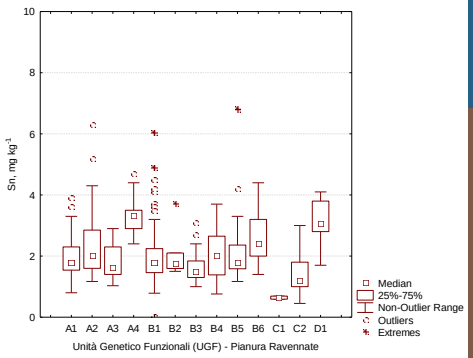
C - *outlier* test (“box-plot”)

D - identification of 90° and 95° percentile for every GFU



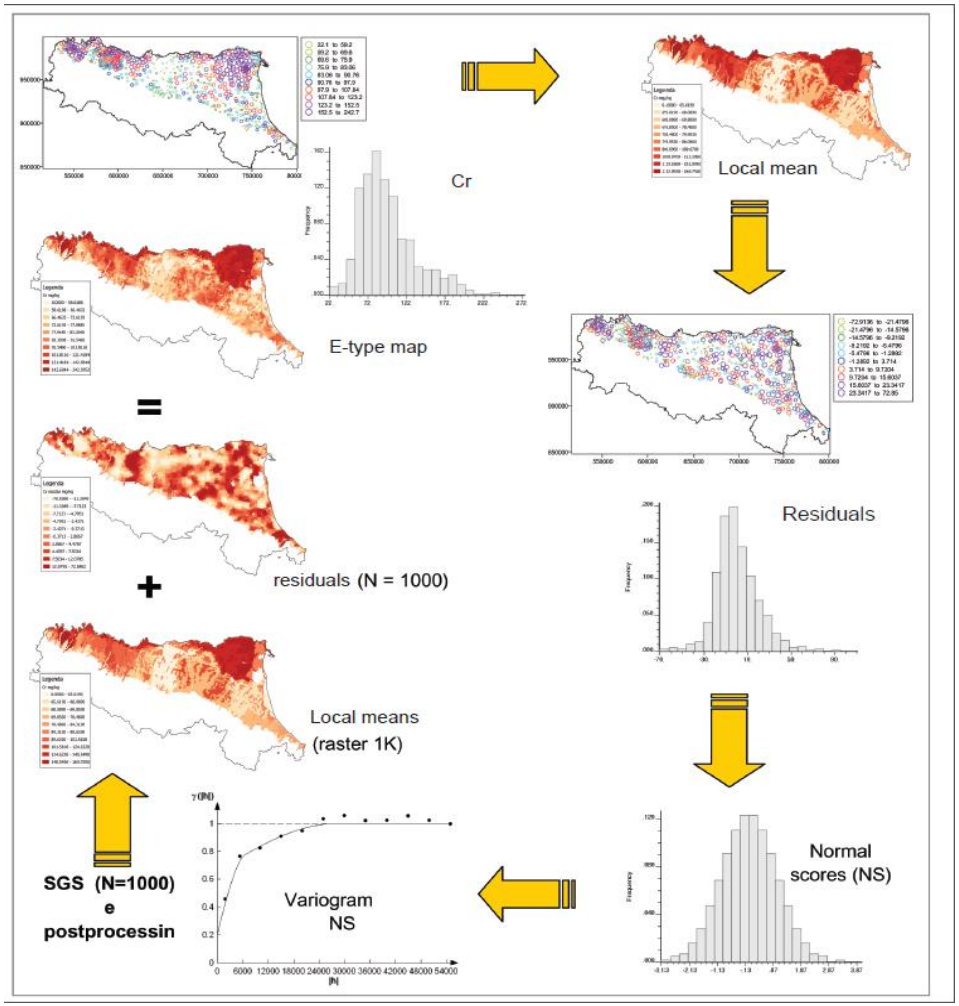






	As	Cr	Cu	Ni	Pb	Sn	Zn	V
Num. oss.	632							614
Media	7,77	97,79	47,08	71,74	19,82	2,12	83,41	62,63
Lim. inf. Interv. di confid. della media	7,53	95,08	44,97	69,37	19,38	2,06	81,40	60,71
Lim. sup. interv. di confid. della media	8,00	100,51	49,19	74,12	20,25	2,19	85,13	64,54
Num. oss.	631,00	694,00	696,00	692,00	683,00	601,00	696,00	599,00
Deviazione standard	3,03	36,44	28,37	31,35	5,78	0,81	23,06	24,19
Errore standard	0,12	1,38	1,08	1,21	0,22	0,03	0,87	0,98
Minimo	2,70	22,10	2,60	13,40	3,10	0,42	17,60	12,70
10° Percentile	5,20	59,20	23,80	40,70	13,70	1,20	54,30	35,00
25° Percentile	5,90	72,02	31,17	49,18	16,70	1,50	68,80	45,00
Mediana	7,00	90,80	40,40	63,32	19,59	2,00	83,66	58,30
75° Percentile	8,70	116,00	54,85	88,18	22,80	2,60	98,02	78,20
90° Percentile	11,30	152,50	78,40	116,50	26,00	3,30	110,00	98,80
95°Percentile	14,10	176,20	97,24	134,04	28,96	3,70	117,95	108,00
Massimo	27,96	242,60	313,40	214,60	69,40	5,20	193,76	135,50

2. Map approaching

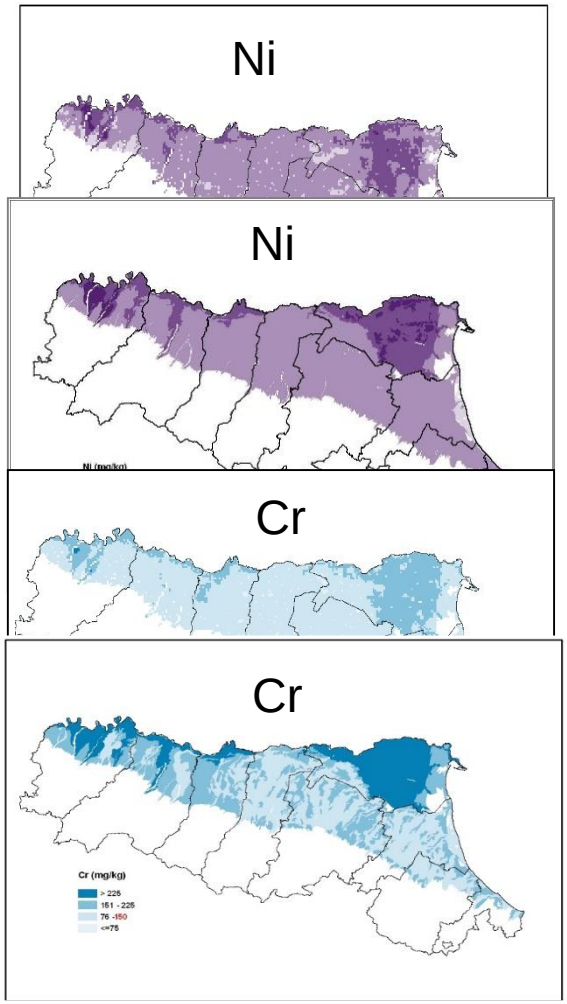


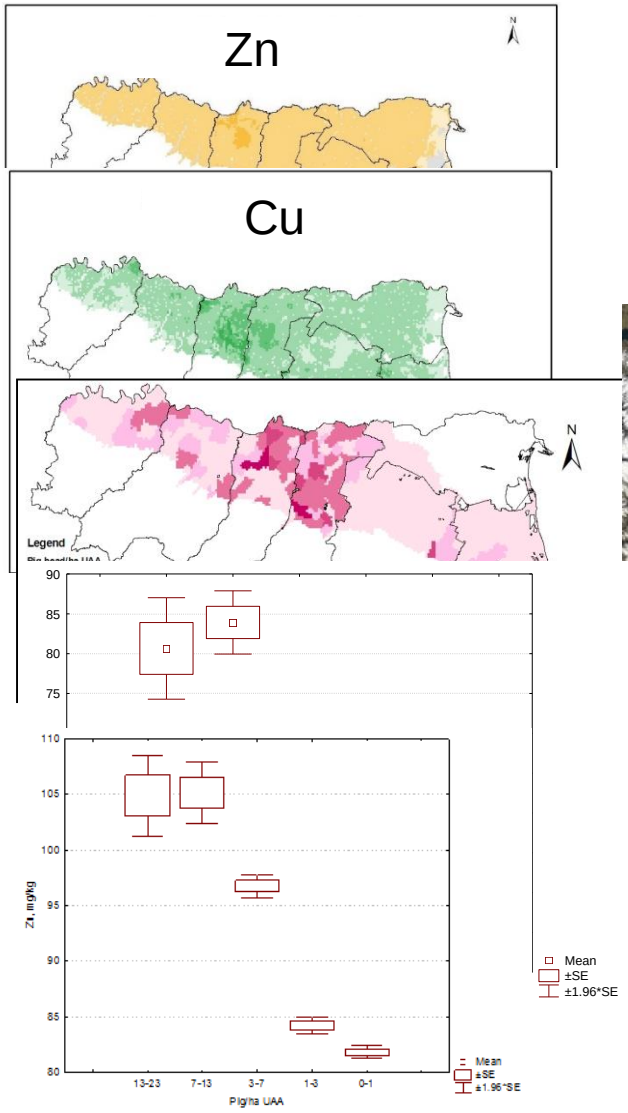
Scorpan Kriging approach in combination with Sequential Gaussian Simulation (SGS) combines the trend of metal concentration as derived from the 1:50.000 soil map with geostatistical modelling of the stochastic, locally varying but spatially correlated component.

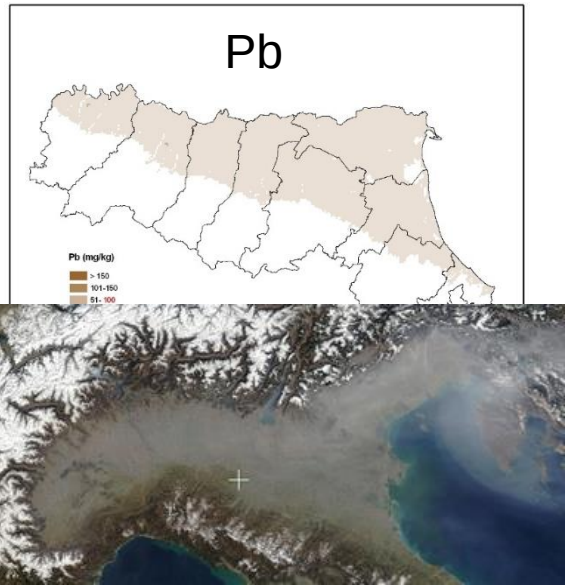
The trend component is described in terms of varying local means calculated accounting for soil pedogeochemical affinity and dominant land use. The locally varying means were calculated from the observations: these were divided into classes and mapped as categorical secondary information i.e. genetic functional group (UGF) - district combinations.

Consiglio Nazionale delle Ricerche
Istituto di Biometeorologia

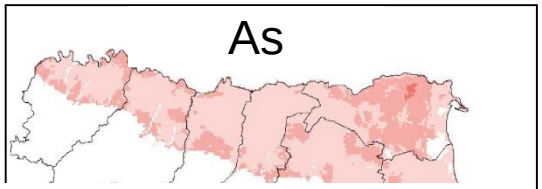
Results


Ni
Ni
Cr
Cr
Cr (mg/kg)
> 225
151 - 225
76 -150
<=75


Zn
Cu
Legend
90
85
80
75
110
105
100
95
90
85
80
Zn, mg/kg
13-23
7-13
3-7
1-3
0-1
Pig/ha UAA
Mean
±SE
±1.96*SE

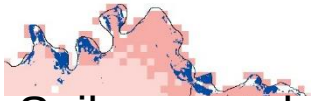

Pb
Pb (mg/kg)
> 150
101-150
51- 100

Results

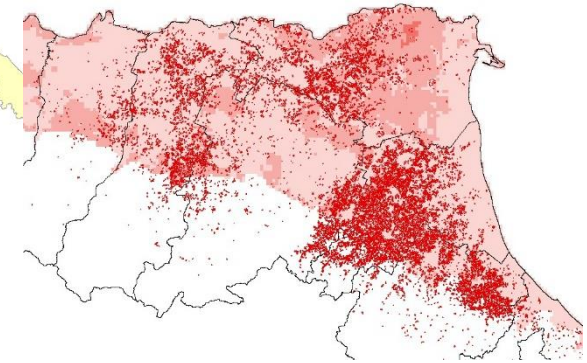


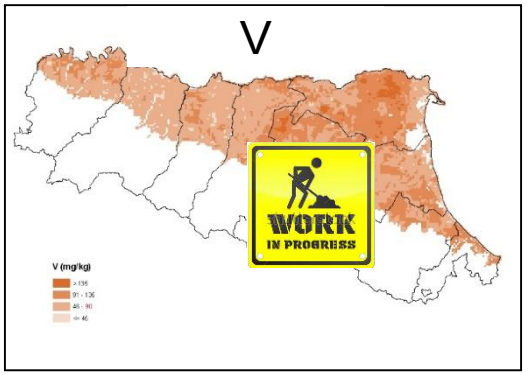
Soil use: rice

Soil use: poplar



Soil use: orchards

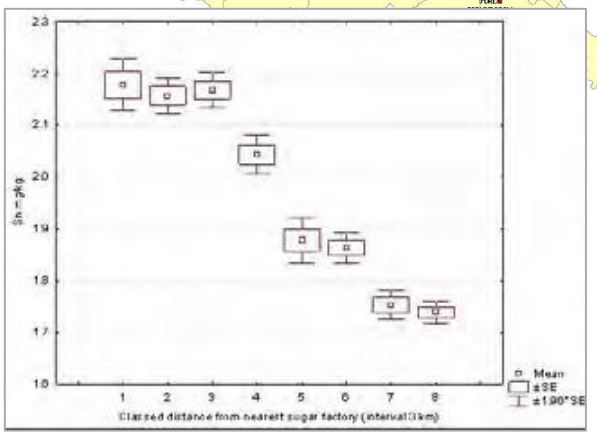




Cr (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
> 225	> 180	> 225	> 180
151 - 225	121 - 180	151 - 225	121 - 180
76 - 150	61 - 120	76 - 150	61 - 120
≤ 75	≤ 60	≤ 75	≤ 60

Pb (mg/kg)	Sn (mg/kg)	As (mg/kg)	V (mg/kg)
> 150	> 1.5	> 30	> 135
101 - 150	1.1 - 1.5	21 - 30	91 - 135
51 - 100	0.6 - 1.0	11 - 20	46 - 90
≤ 50	< 0.6	≤ 10	≤ 45

(D.lgs 152/06) TAB.A
green and residential areas



QUESTIONS

1. The site is located in an area with pedo-geochemical/background values above the Concentration Limit Value?
2. Where locate sampling points useful to the definition of the pedo-geochemical/background value around the site?
3. How evaluate previous data around and inside the site?

TOOLS

- *GEOLOGICAL/PARENT MATERIAL MAP*
- PEDO-GEOCHEMICAL MAP and MAP OF BACKGROUND CONTENT
- *SOIL USE MAP*

provide integration of informations from different maps

single tool for the pubblic body and site tenant

describe regional and local specificities

enable more realistic remedial action

Thank you !