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Using bioavailability assessment to  
better diagnose the contamination  
potential of industrial territories

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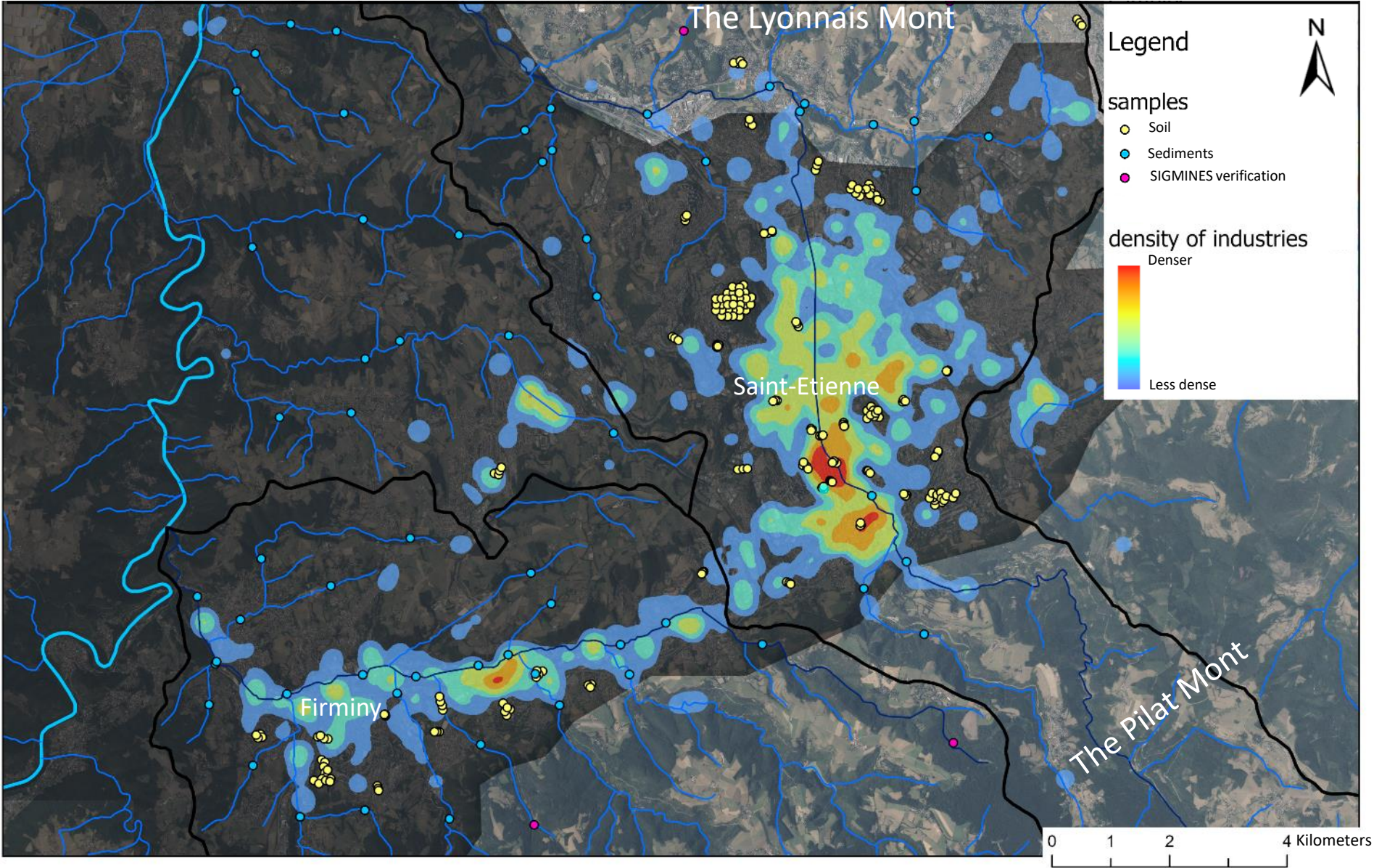
# Industrial territories : past and present



Industrial territories : past and present



Saint-Etienne  
industrial territory



# Industrial territories : past and present

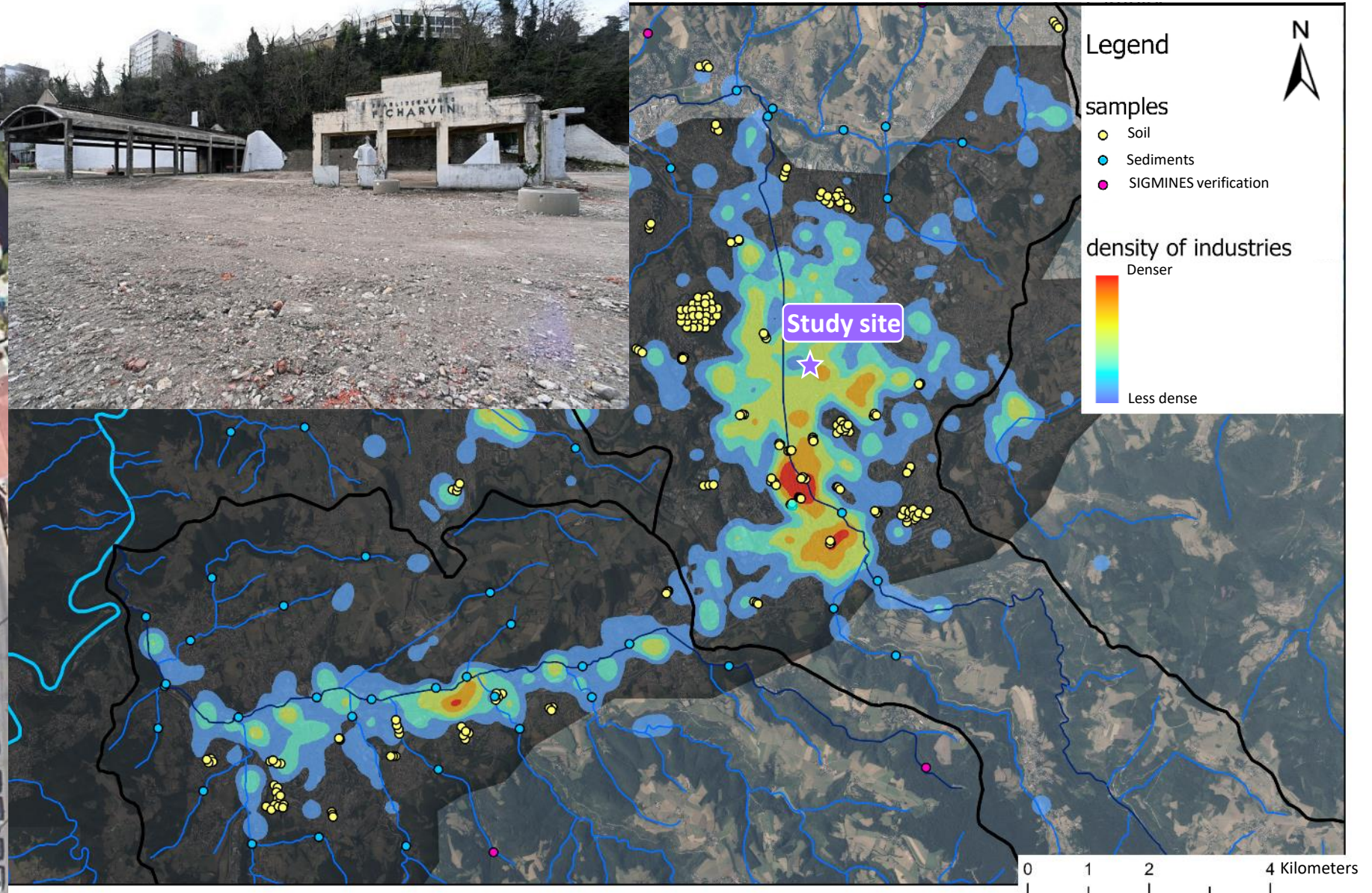
## Study site

Some metals found on site :  
Zn, Ni, Cr

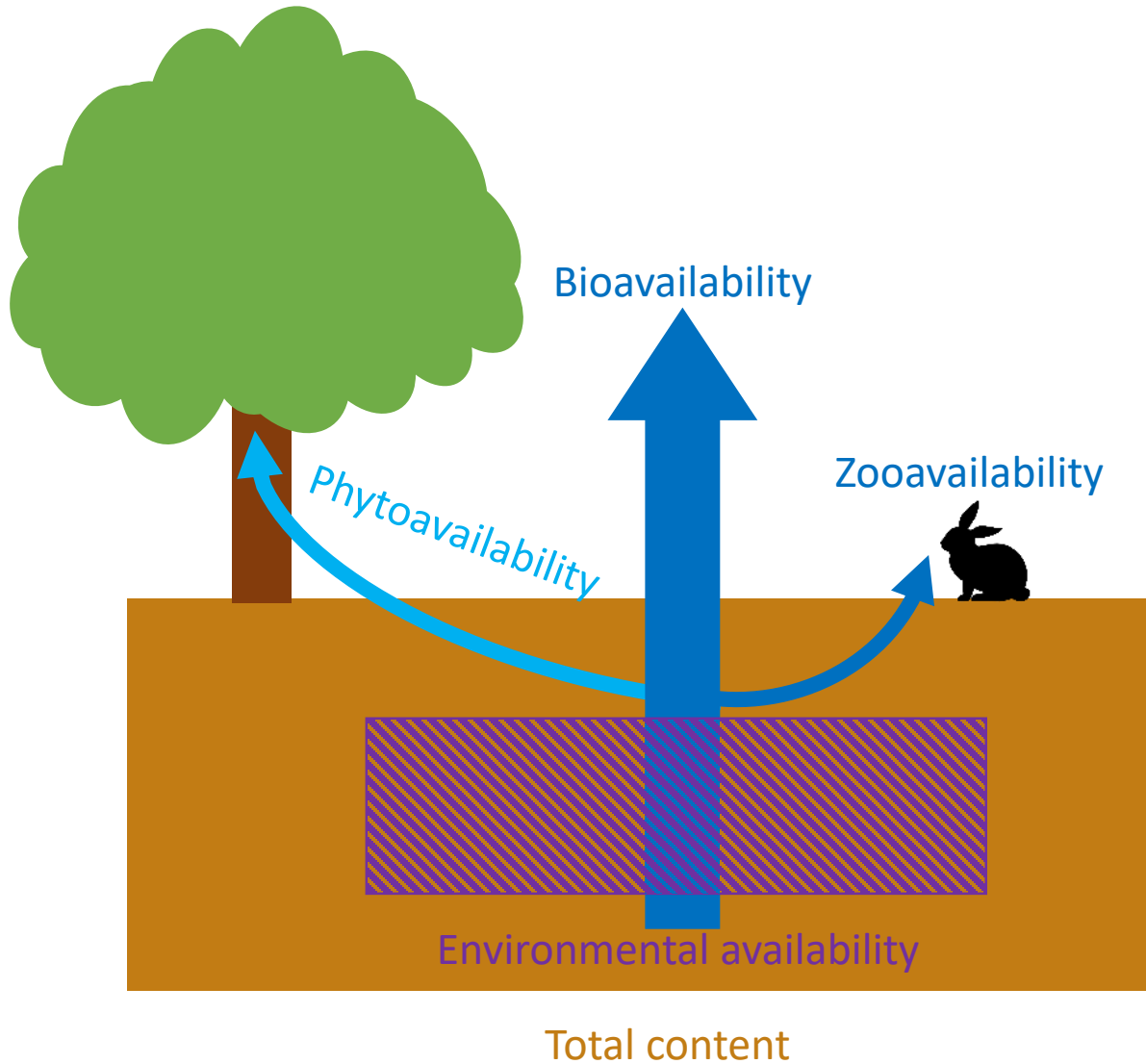
© Google Maps



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## Transfer pathways : Explanation of key terms



### Total content

Element content  
in all the fractions  
of the soil

### Environmental availability

Element content in the  
most soluble fraction of  
the soil

### Phytoavailability

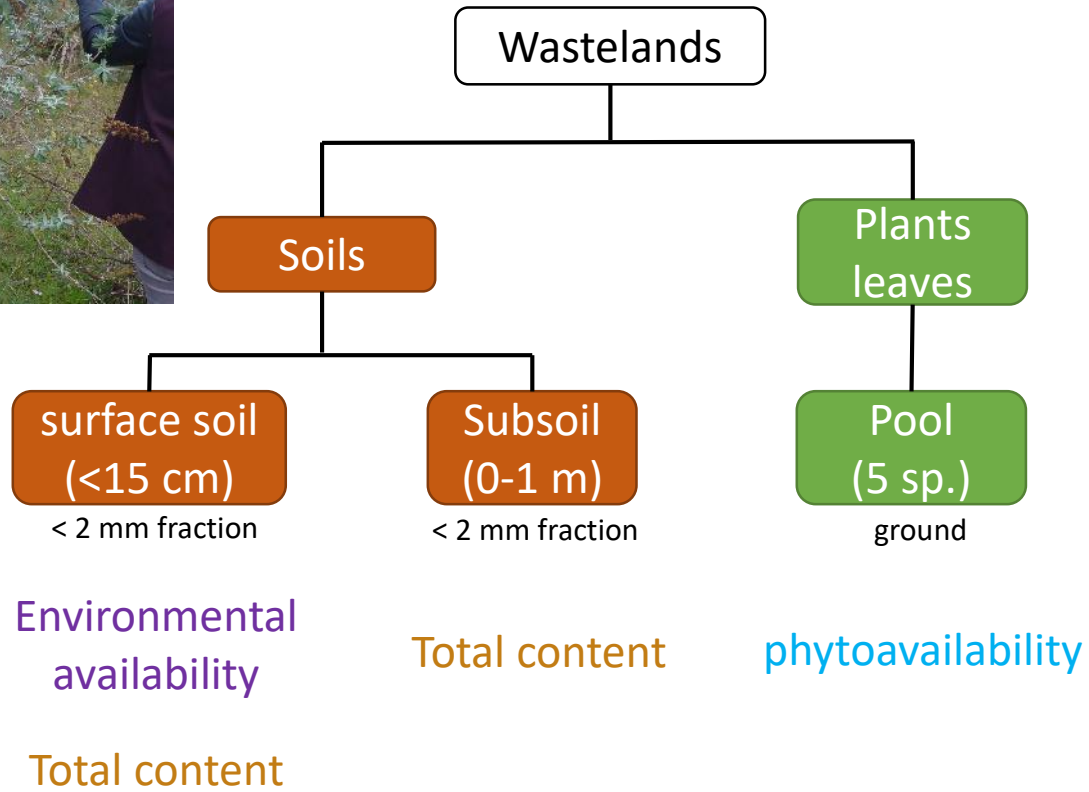
Element content  
actually accumulated in  
plants

How to integrate available fractions  
into contamination diagnosis ?

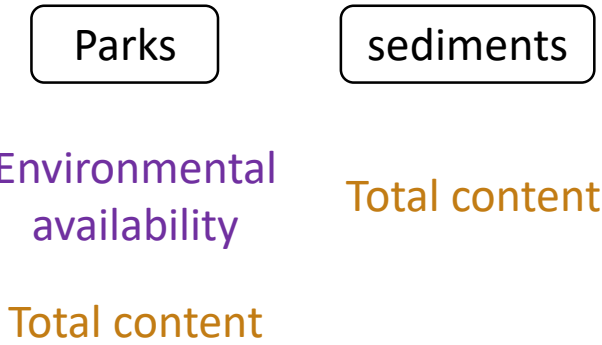
## Sampling strategy



### anthropogenic anomalies



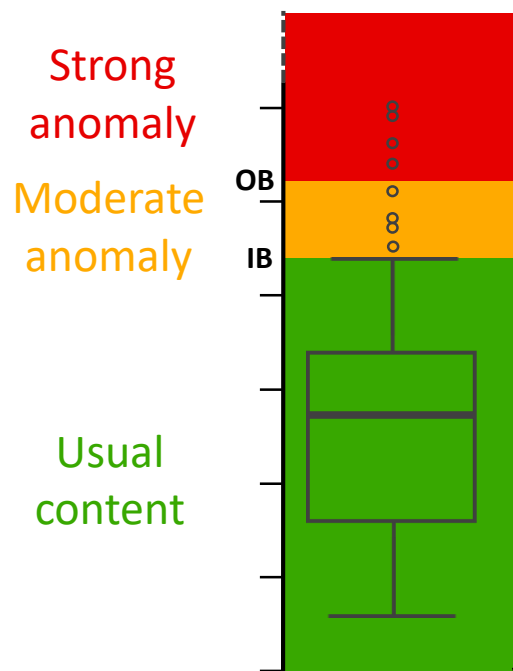
### Local geochemical background



# Geochemical background study : Determination of class limit

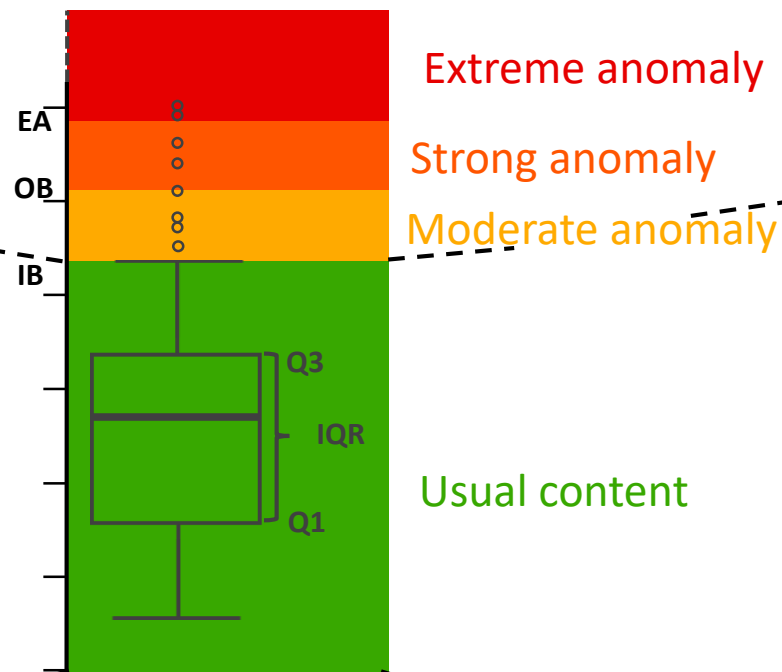
## Environmental availability

From "Bio indicator" project, ADEME



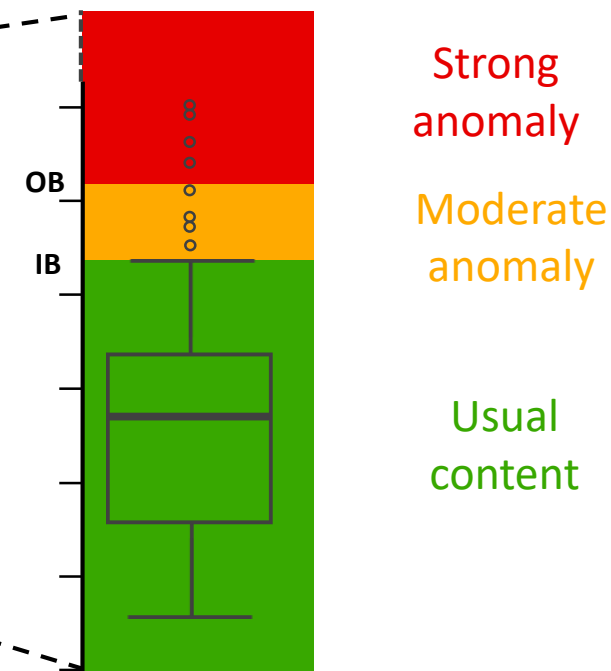
## Total content

From National methodology for the management of polluted sites and soils (ASPITET project)



## phytoavailability

From "BioII" project, ADEME



Q1 : first quartile

Q3 : third quartile

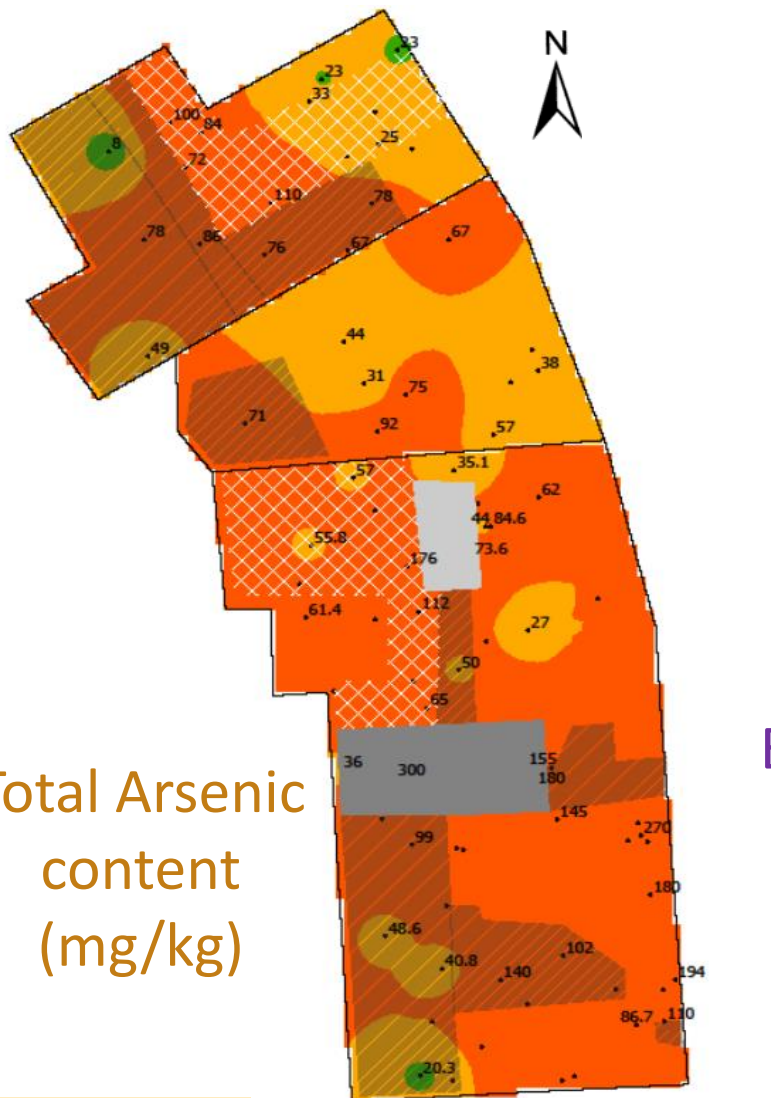
IQR : inter quartile range (Q3 - Q1)

OB : Outer Boundary ( $Q3 + 3 \times IQR$ )

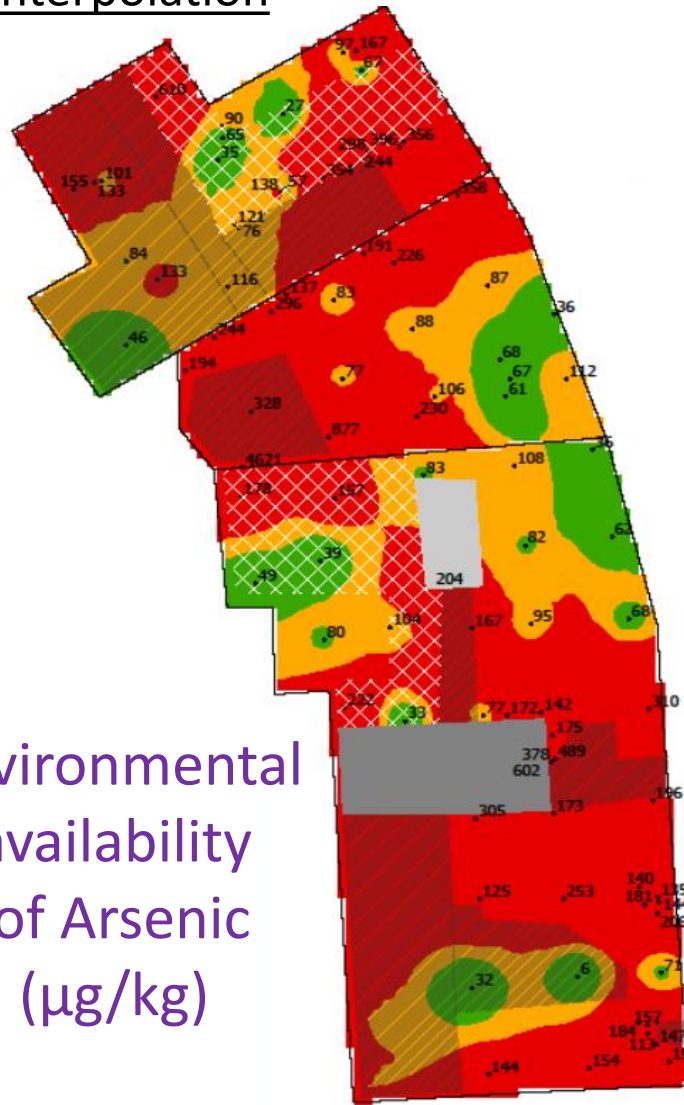
IB : Inner Boundary ( $Q3 + 1,5 \times IQR$ )

EA : Extreme value of natural soils (ASPITET)

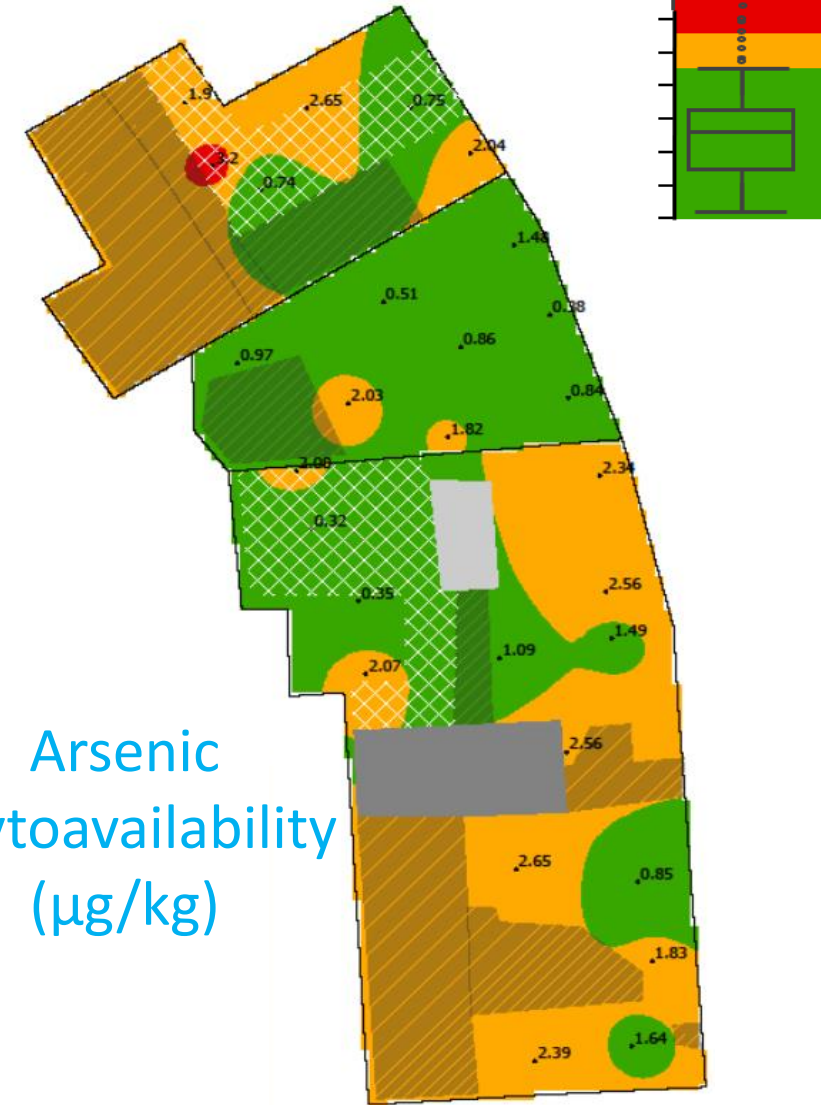
# Study of contaminant pathways : As interpolation



Environmental availability of Arsenic ( $\mu\text{g/kg}$ )



Arsenic Phytoavailability ( $\mu\text{g/kg}$ )



→ Spatial divergence of anomalies according to the metal fraction under consideration

Study of contaminant pathways : Hazard Index (HI)

$$HI = \sum \left( \frac{C_m}{C_r} \right)_i \times k_i$$

modified from Contamination factor

toxicity constant used (Based on METOX index)

$k_{As} : 10$	$k_{Cd} : 30$	$k_{Cr} : 2$
$k_{Cu} : 5$	$k_{Hg} : 40$	$k_{Ni} : 5$
$k_{Pb} : 5$	$k_{Zn} : 1$	

$i$  : chemical element

$k$  : toxicity constant

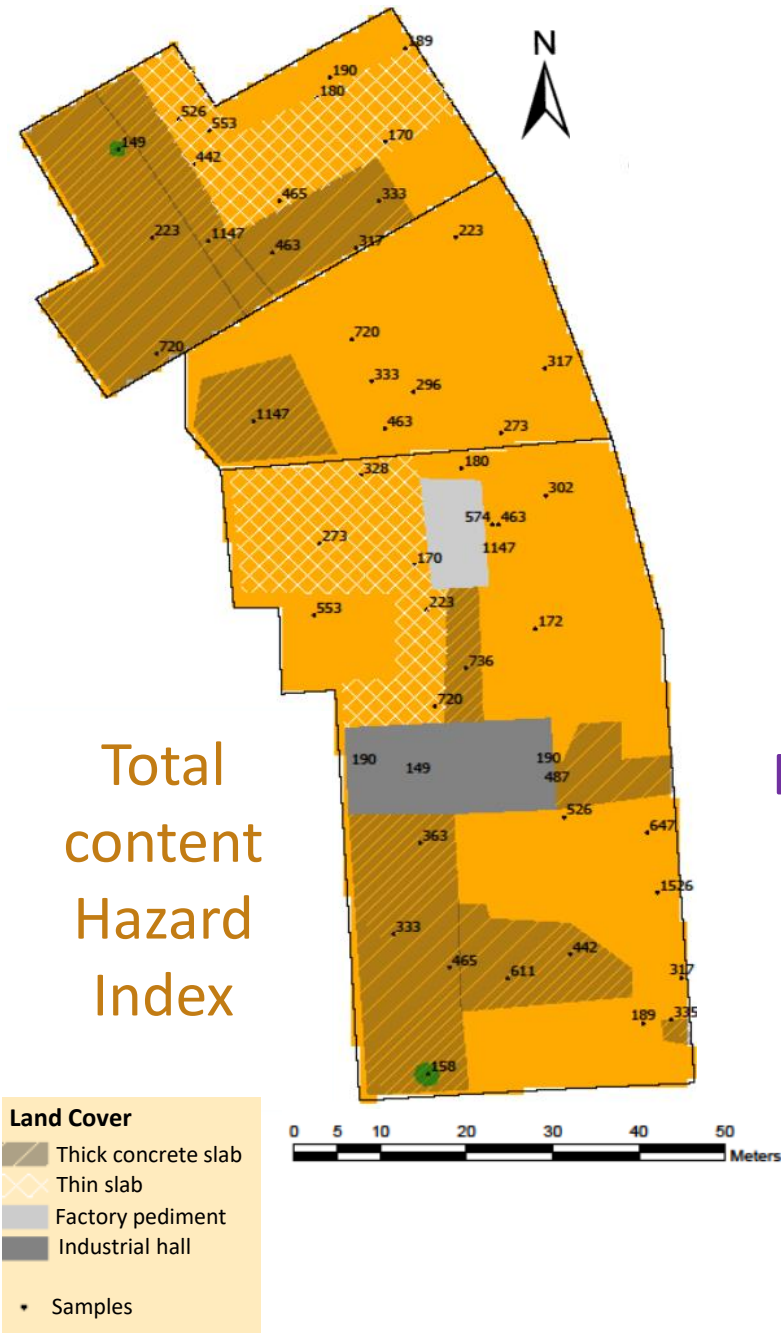
$C_m$  : Measured content

$C_r$  : Reference content Inner Boundary

Metal	Range of values commonly observed in "ordinary" soils of all grain sizes	Range of values observed for moderate natural anomaly	Range of values observed in the case of strong natural anomaly
Ni	2 to 60	60 to 130	130 to 2076

Example from the table of ASPITET project, values in mg/kg

Study of contaminant pathways : Hazard Index (HI)



Environmental availability Hazard Index



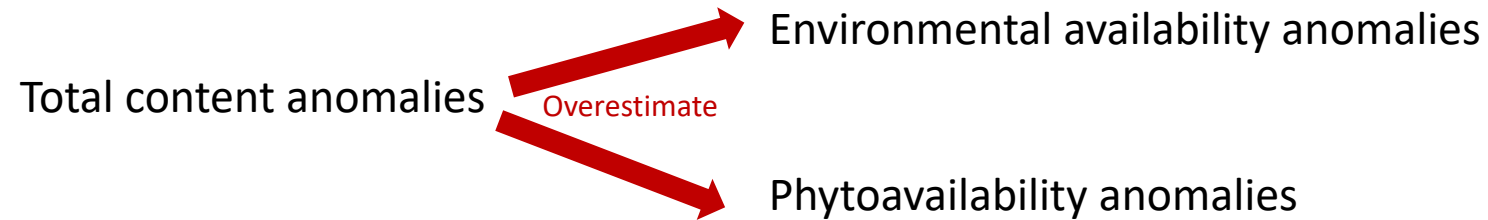
Phytoavailability Hazard Index



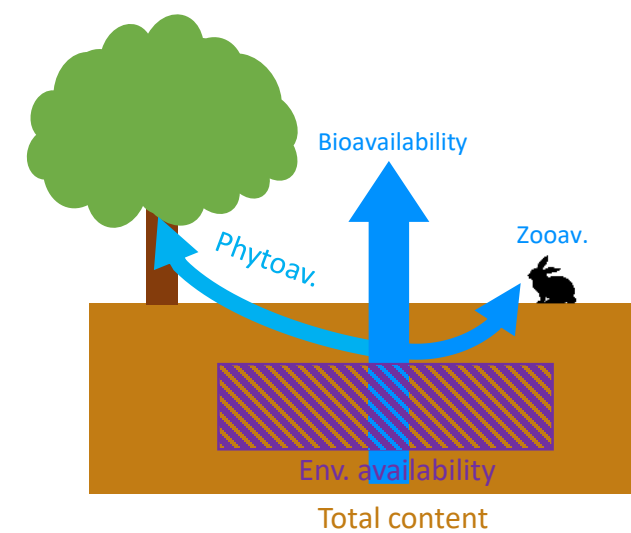
➔ Better identification of the most hazardous area

## Conclusion

Environmental availability  $\neq 0$   $\rightarrow$  mobility of metals in wasteland soil



Overestimation of risks



Using danger index helps site characterization to better rehabilitate wasteland according to its use

└─ *Using local soil-geochemical background as a reference (Anthropogenic and natural)*

└─ *Development of an index combining soil and plants metals contents*



Une école de l'IMT

# Thank you for your attention

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