Environmental bioavailability of As, Ni and Cr in soils with high background content (Wallonia, Belgium)



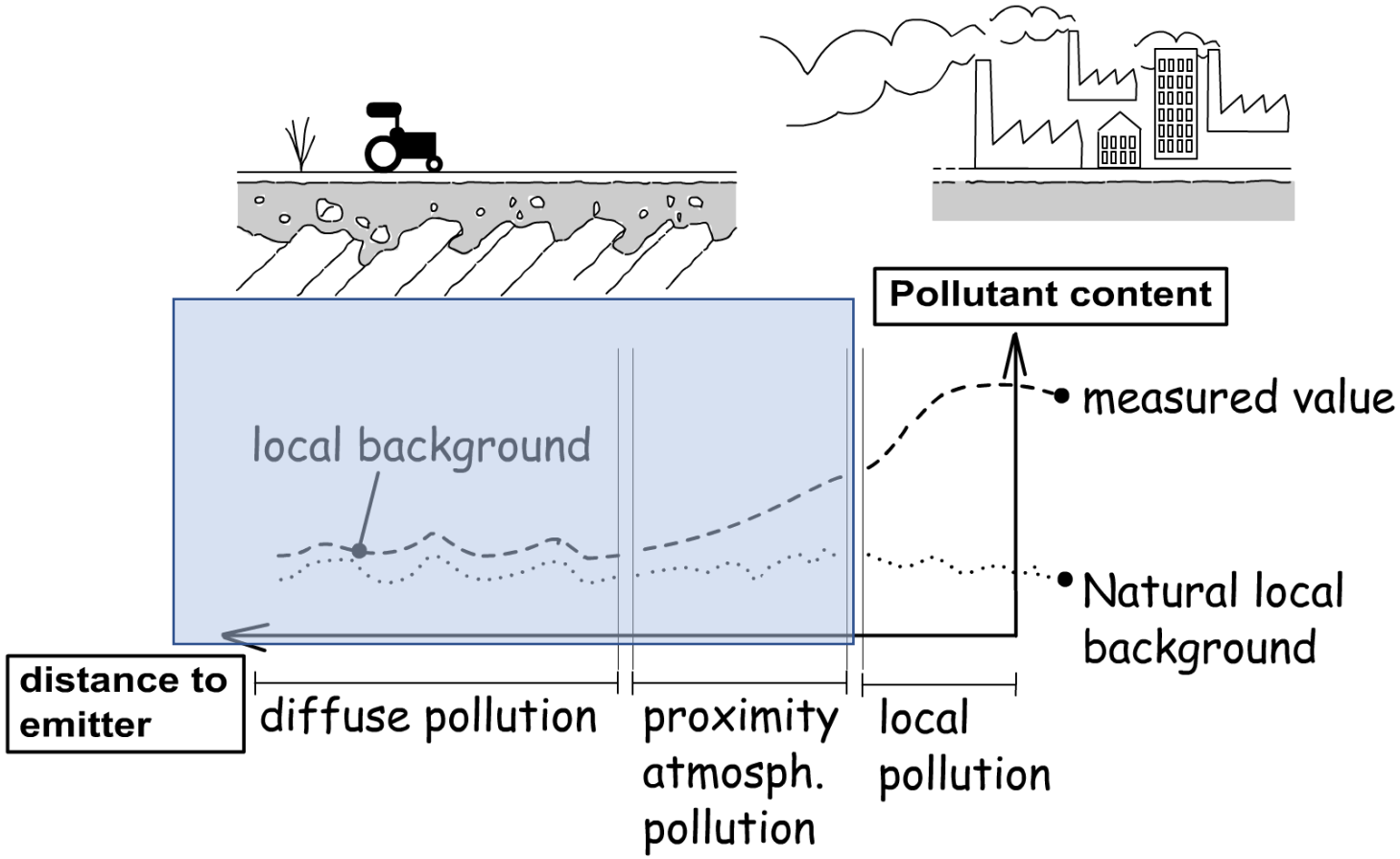


Goldschmidt 2023

Aubry Vandeuren - Benoît Pereira - Kaba Abdoulaye - Pierre Delmelle

High soil PTE background content

content characteristic of a soil type in an area or region arising from both ***natural sources*** *and* ***anthropogenic diffuse sources*** *such as atmospheric deposition (ISO 2011)*



High PTE background content in soils



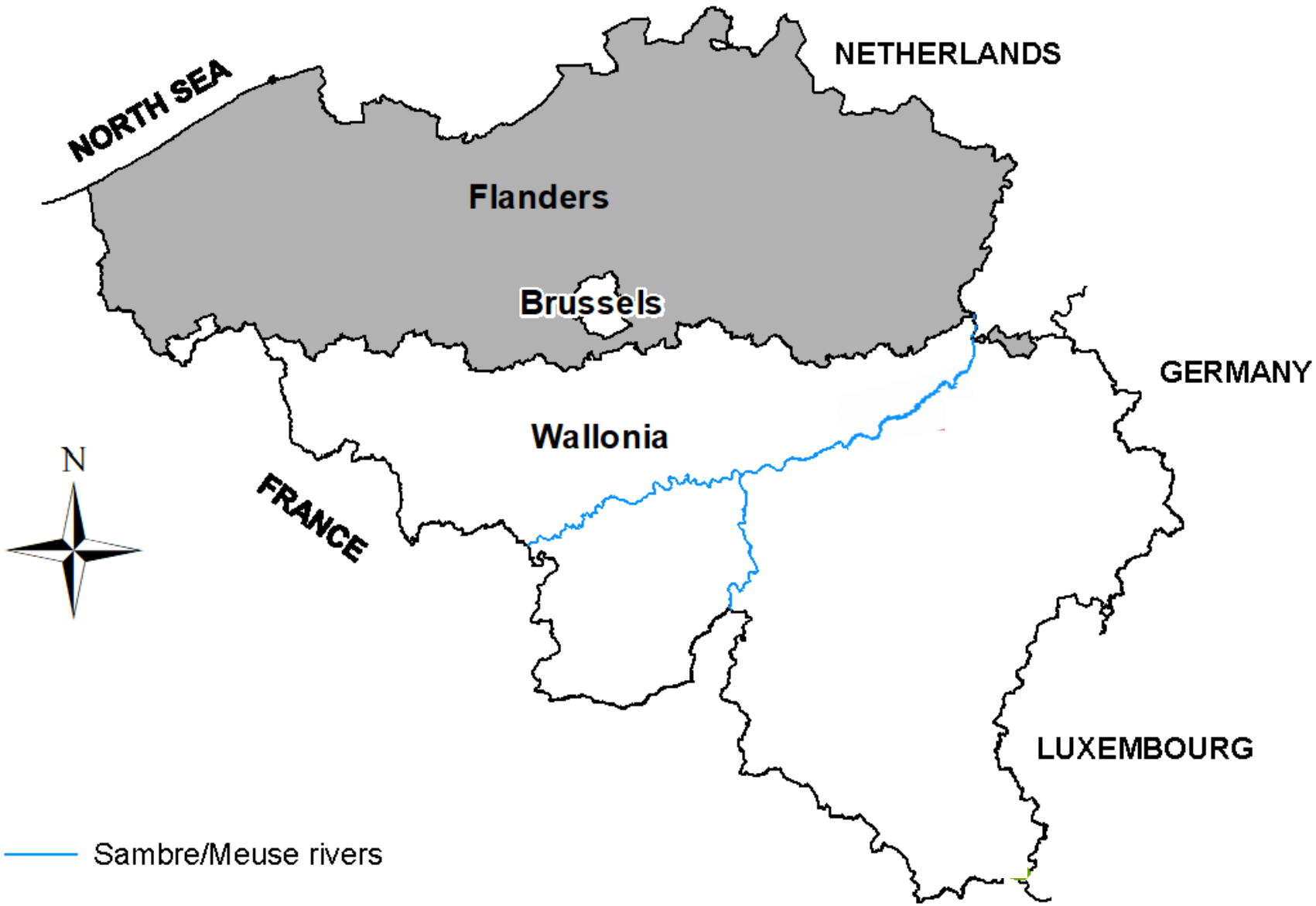




PTE Transfer to organisms/ foodchain?

Environmental bioavailability?

Belgium

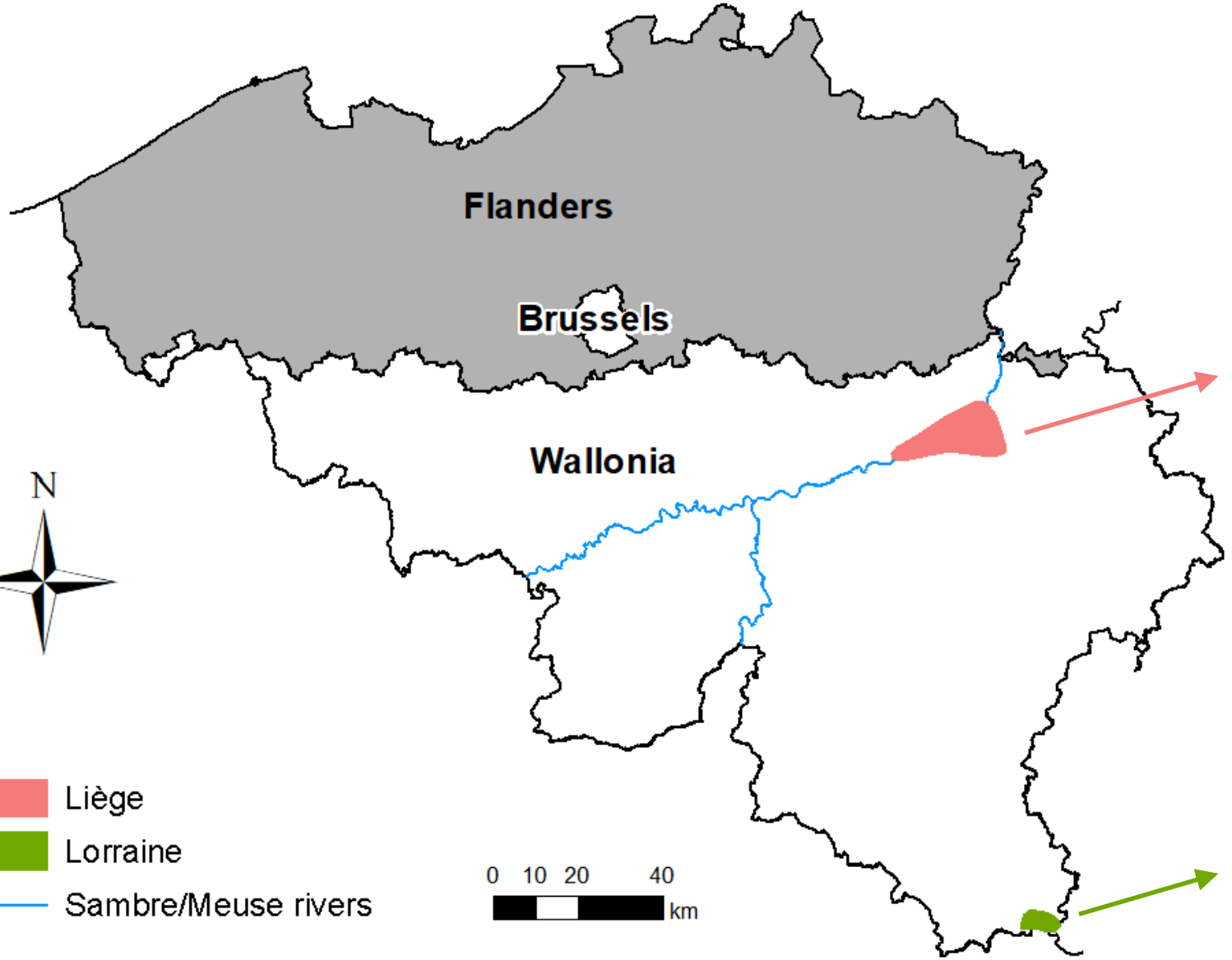

NETHERLANDS
NORTH SEA
Flanders
Brussels
GERMANY
Wallonia
N
FRANCE
LUXEMBOURG
Sambre/Meuse rivers

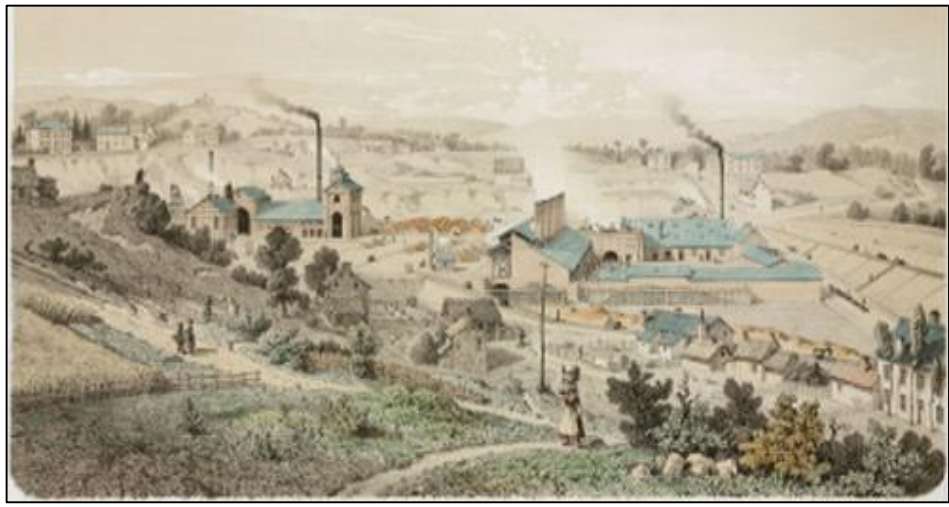
Belgium


NORTH SEA
NETHERLANDS
Flanders
Brussels
Wallonia
FRANCE
GERMANY
LUXEMBOURG
N
Sambre/Meuse rivers


Trappist
Achel
CHIMAY
PÈRES TRAPPISTES
ORVAL
TRAPPIST ALE
Trappistes
Rochefort
Westmalle
TRAPPIST
Abdij
St. Sixtus
Westvleteren

High PTE background content in Liège and Belgian Lorraine



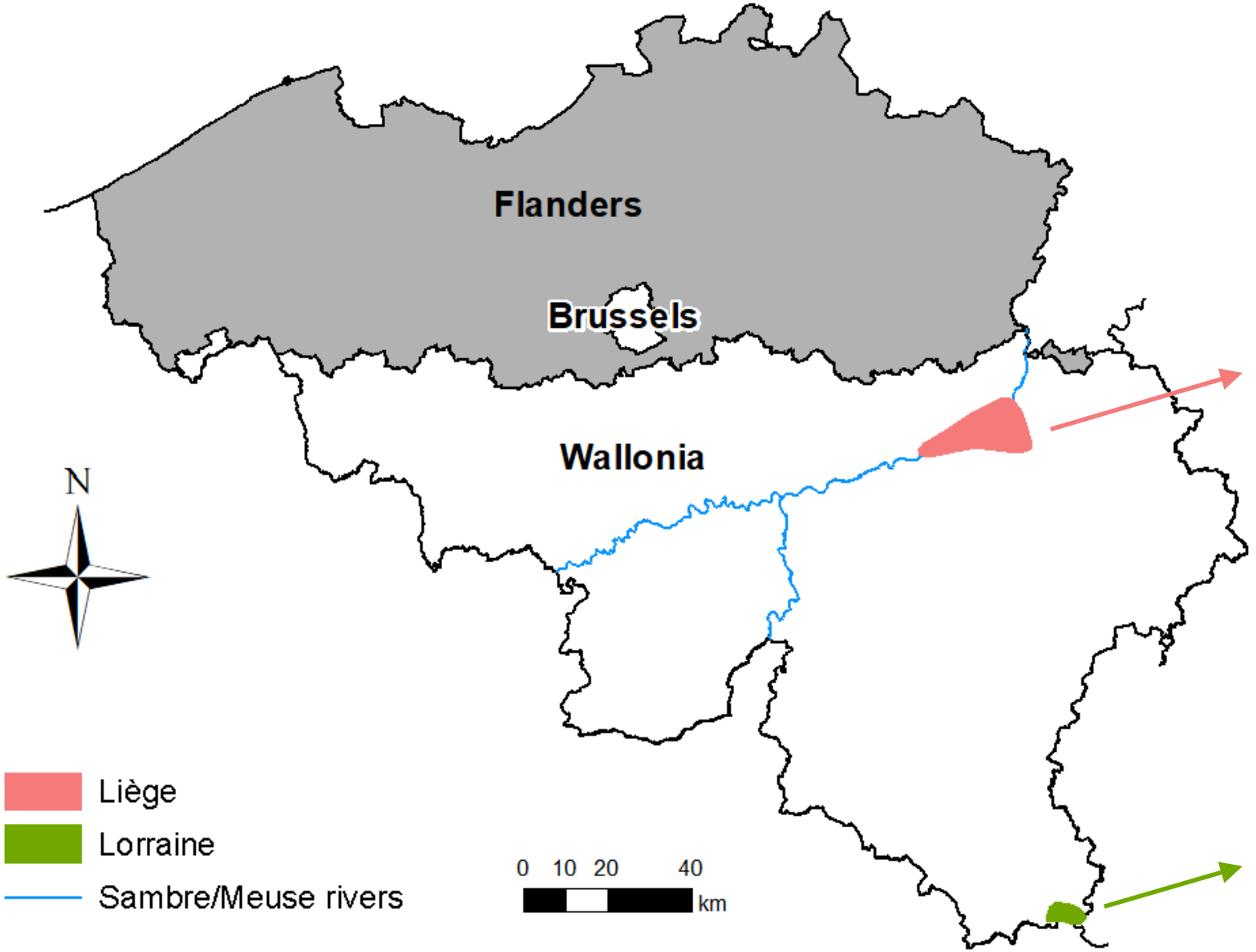


Liège : glorious industrial past



Lorraine : peaceful countryside

High PTE background content in Liège and Belgian Lorraine





Liège : anthropogenic contamination



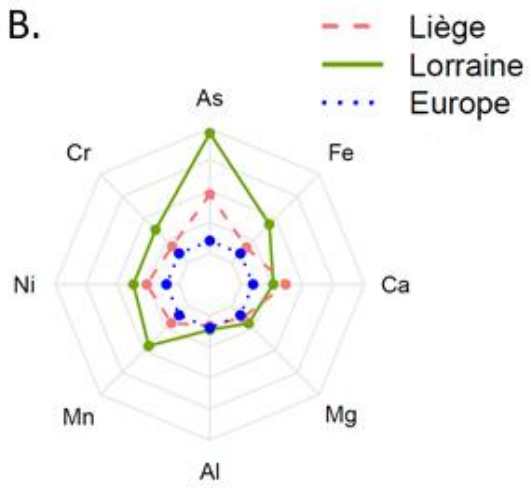
Lorraine : geogenic contamination

High As, Cr and Ni background concentrations in Liège and Belgian Lorraine

Boxplot
Ou spider?

As : 15-30
Cr : 60-80
Ni : ,,,

VS Walloon decree soil threshold



Environmental bioavailability?



Liège : anthropogenic contamination



Lorraine : geogenic contamination

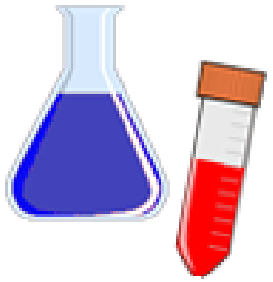
As : 15-30
Cr : 60-80
Ni : ,,,

VS Walloon decree soil threshold

Environmental bioavailability?

Liège (N = 36)
Lorraine (N = 28)

BCR 3 steps factionation
exchangeable
reducible
oxidizable



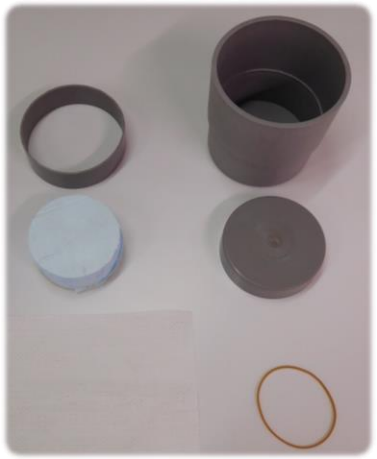
➔« Potentially mobilizable fraction/content »
upon environmental changes

Plant-based biotest
ISO 16258



➔« Phytoavailable » content

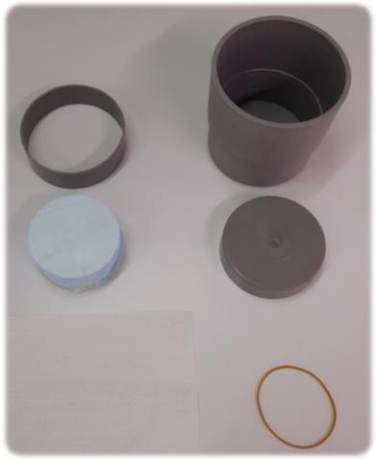
Plant-based rhizotest







Plant-based rhizotest

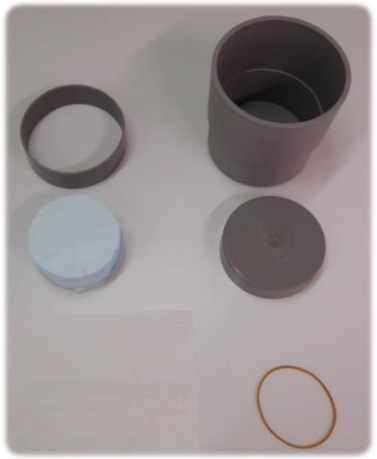








Plant-based rhizotest









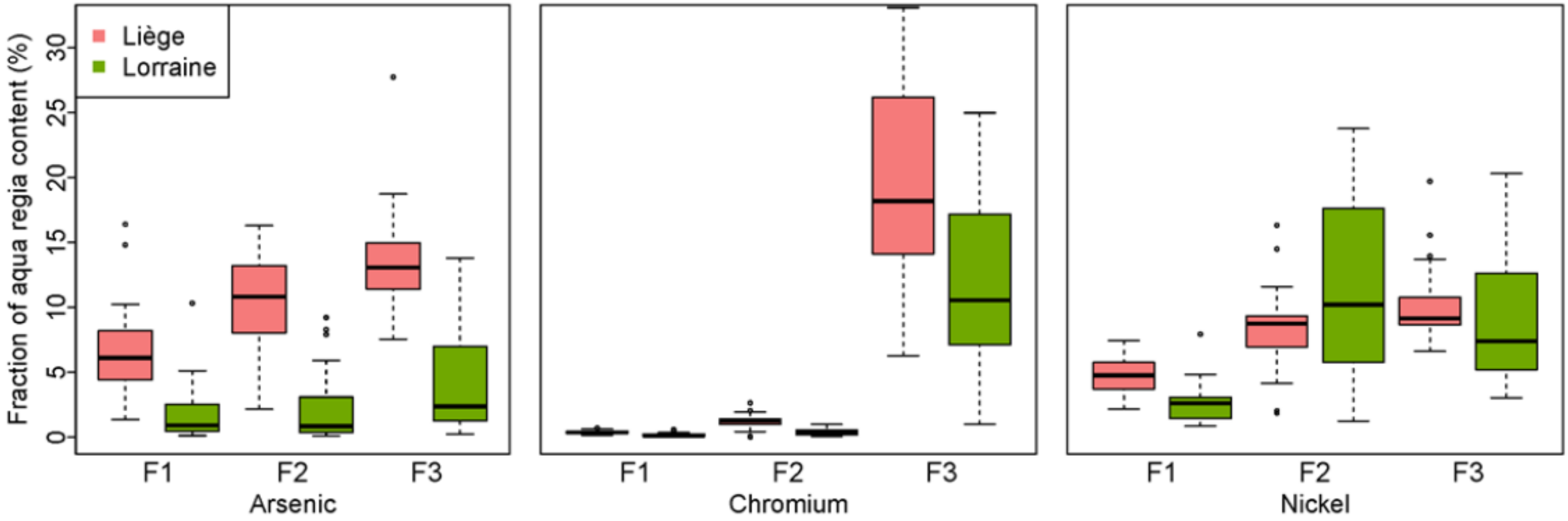




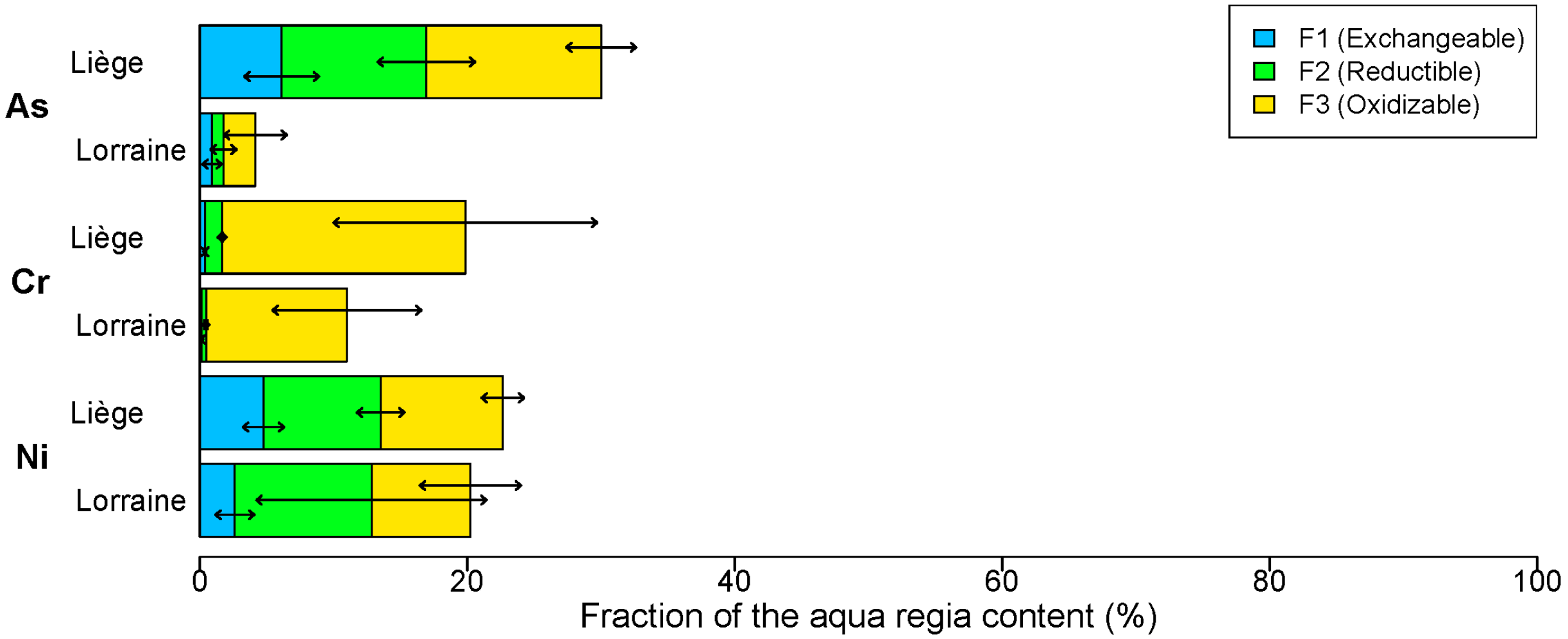


ISO 16258

As, Cr & Ni chemical fractionation

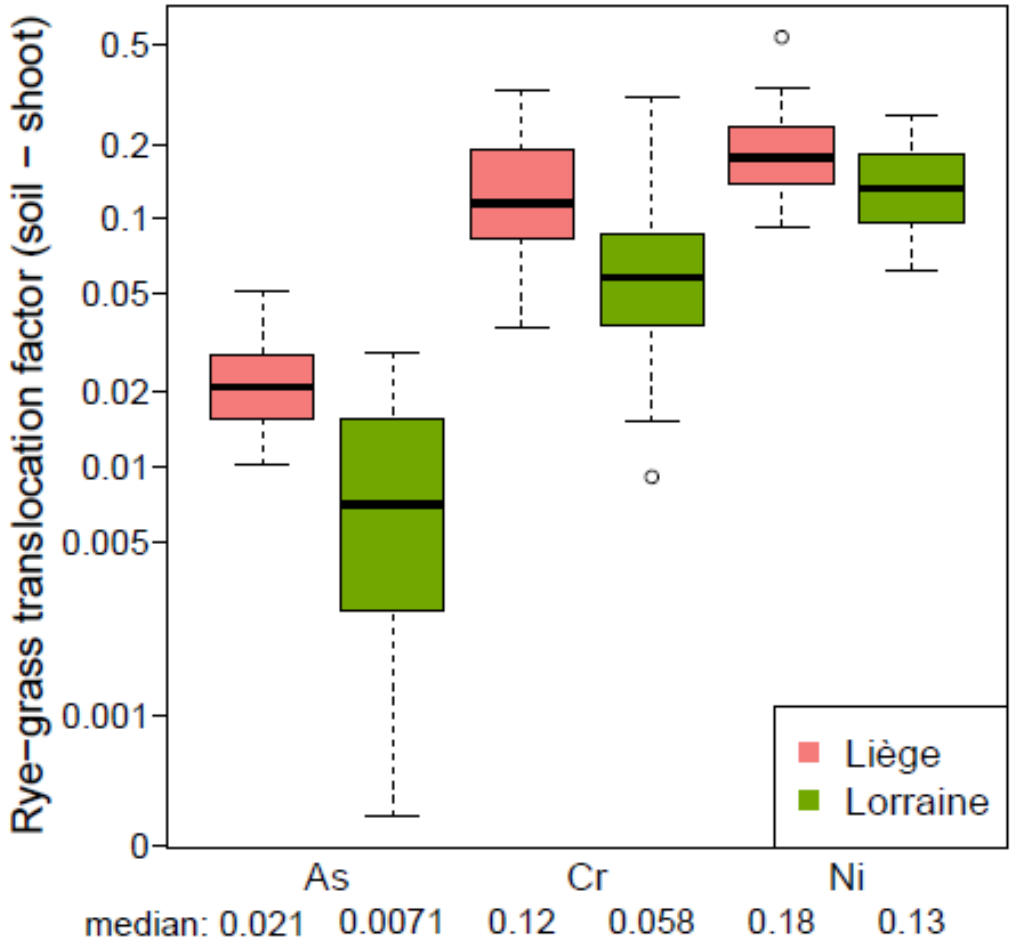


Max 30% total As, Cr & Ni potentially mobilizable

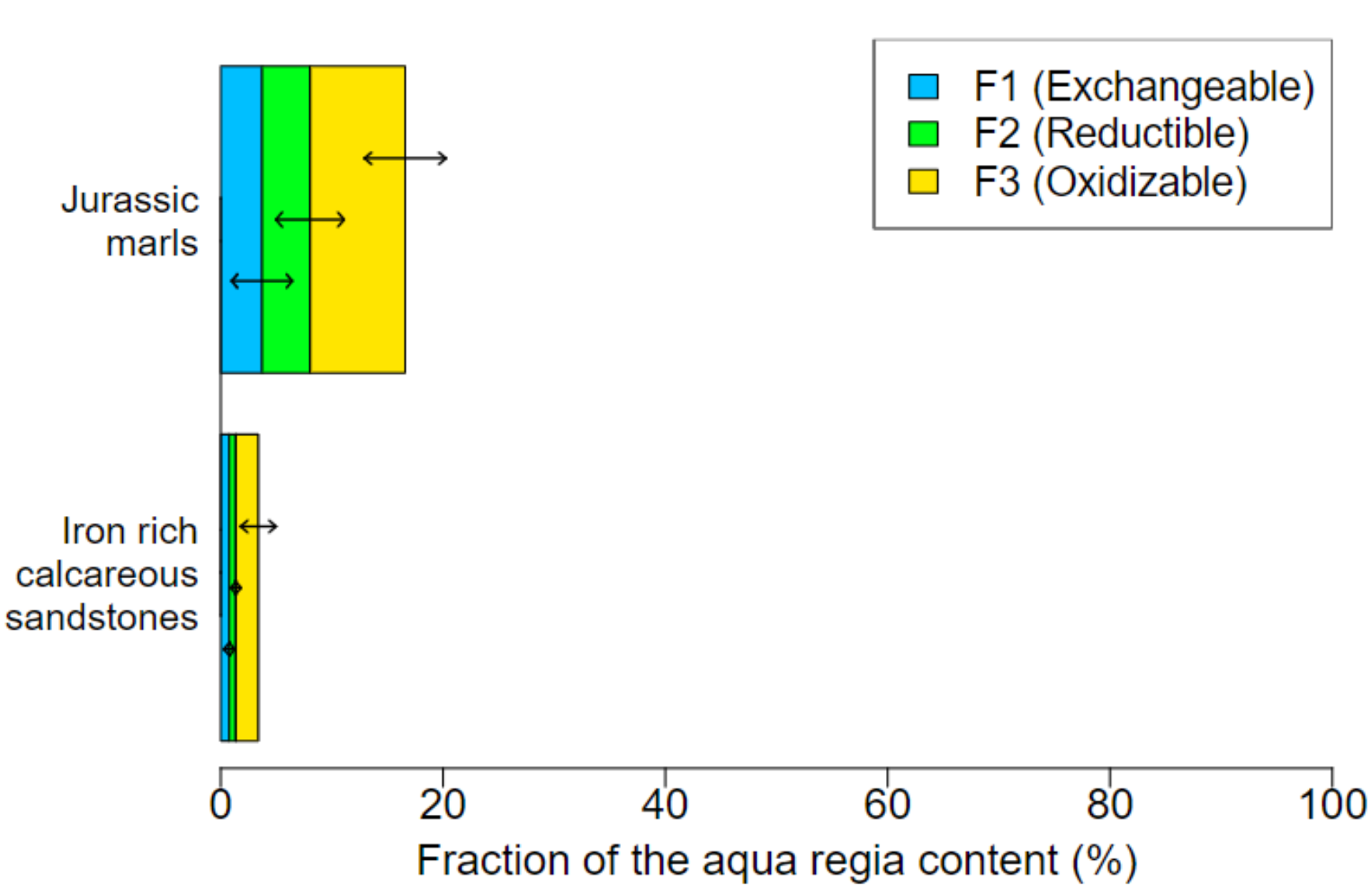


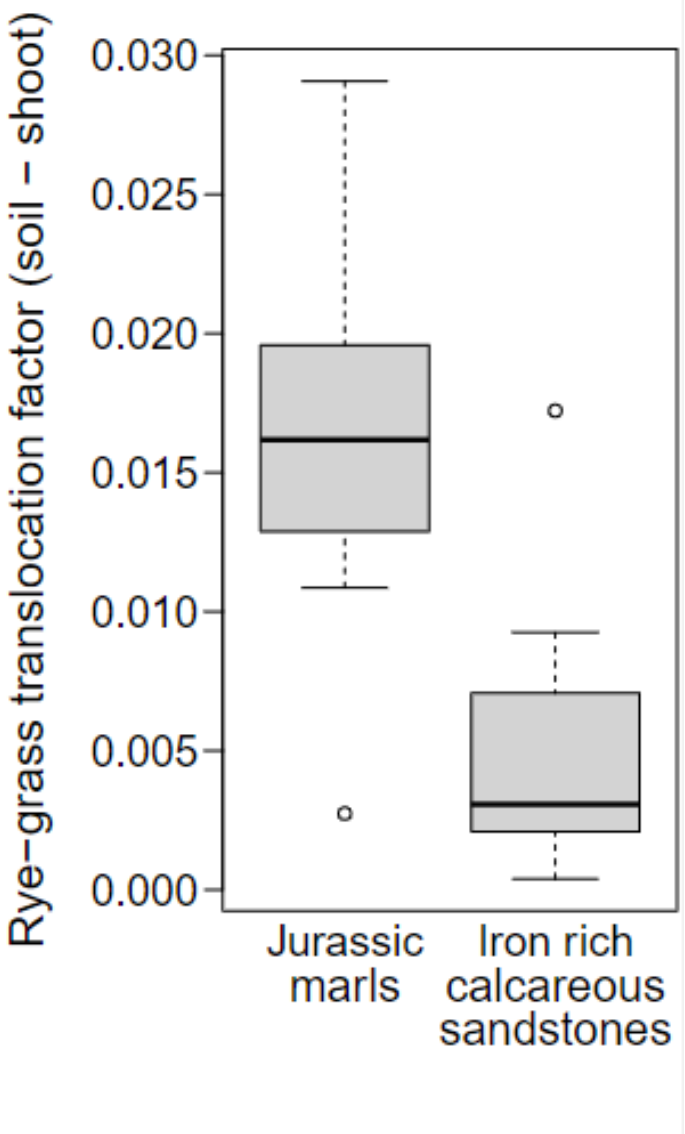
Rye-grass content vs soil-shoot TF : not the same story

	Liège	Lorraine
As	0.60	0.38
Cr	4.76	5.44
Ni	6.52	7.91

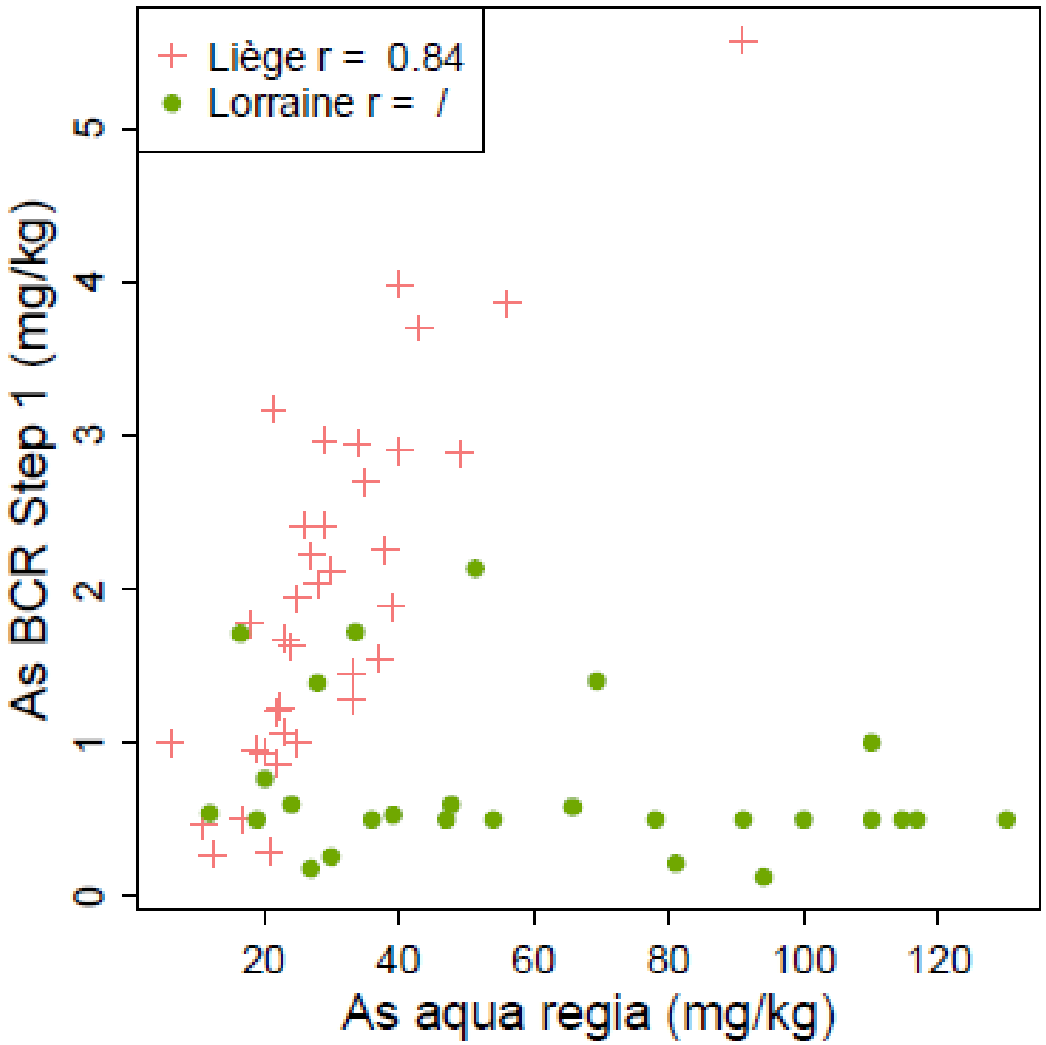


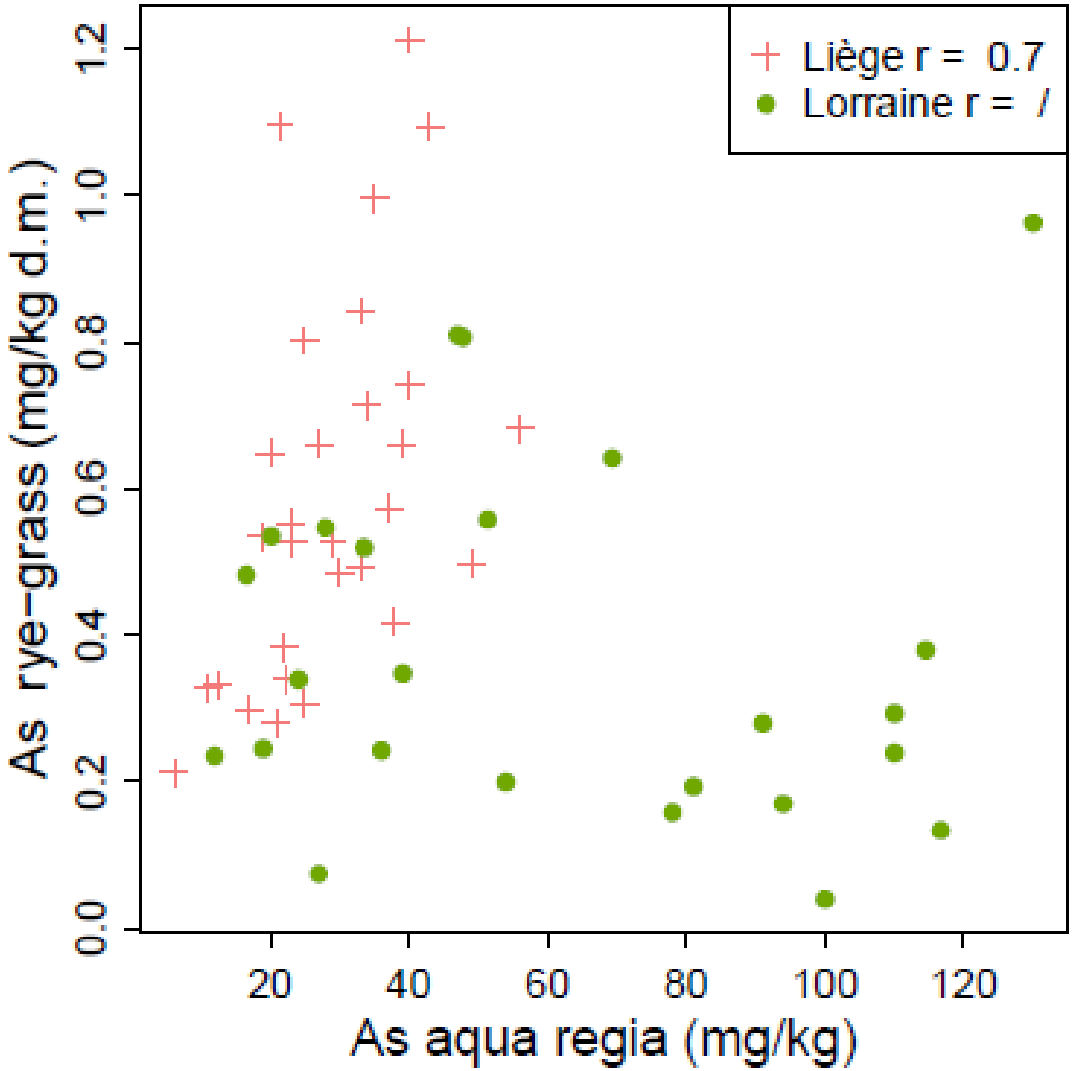
Lorraine : environmental availability Jurassic marls > Iron rich sandstones



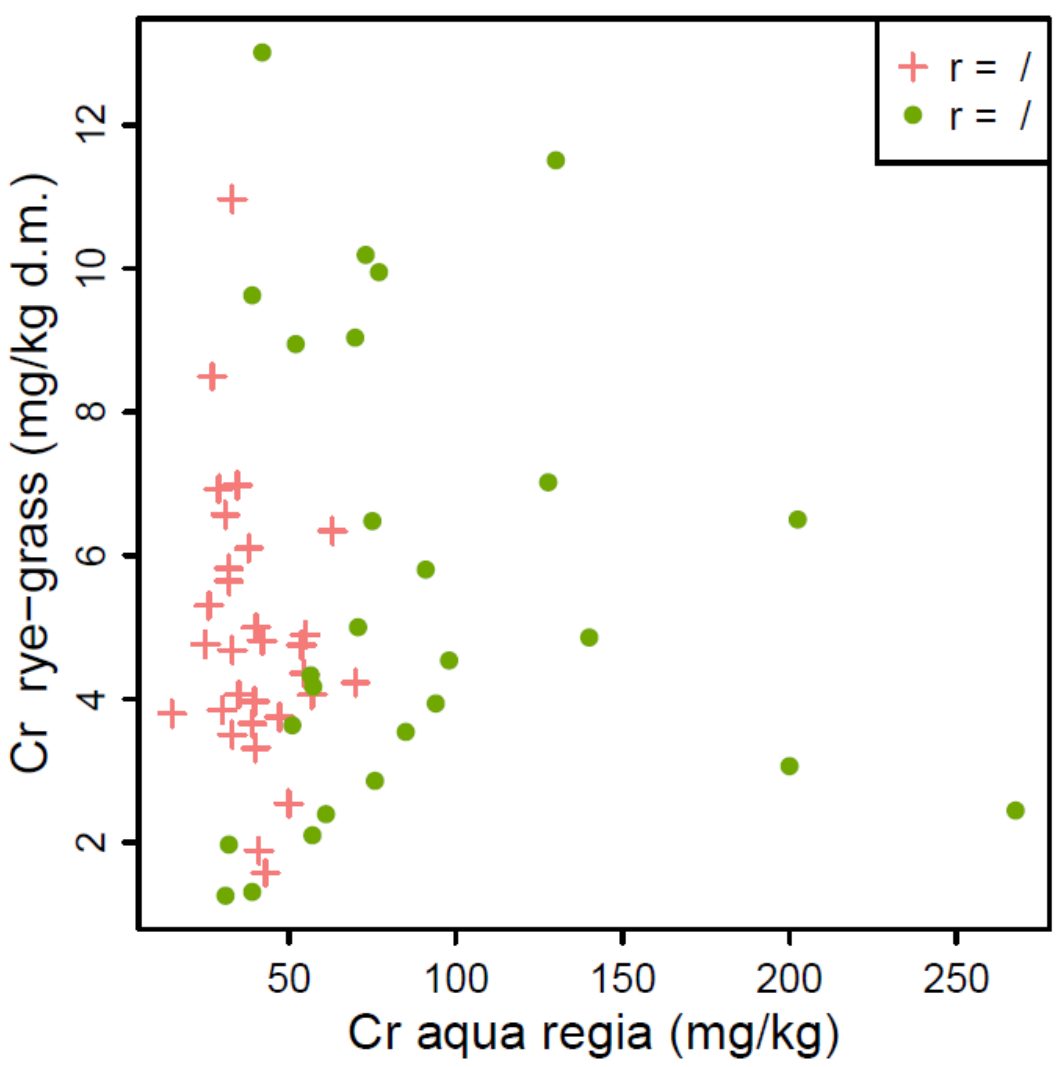


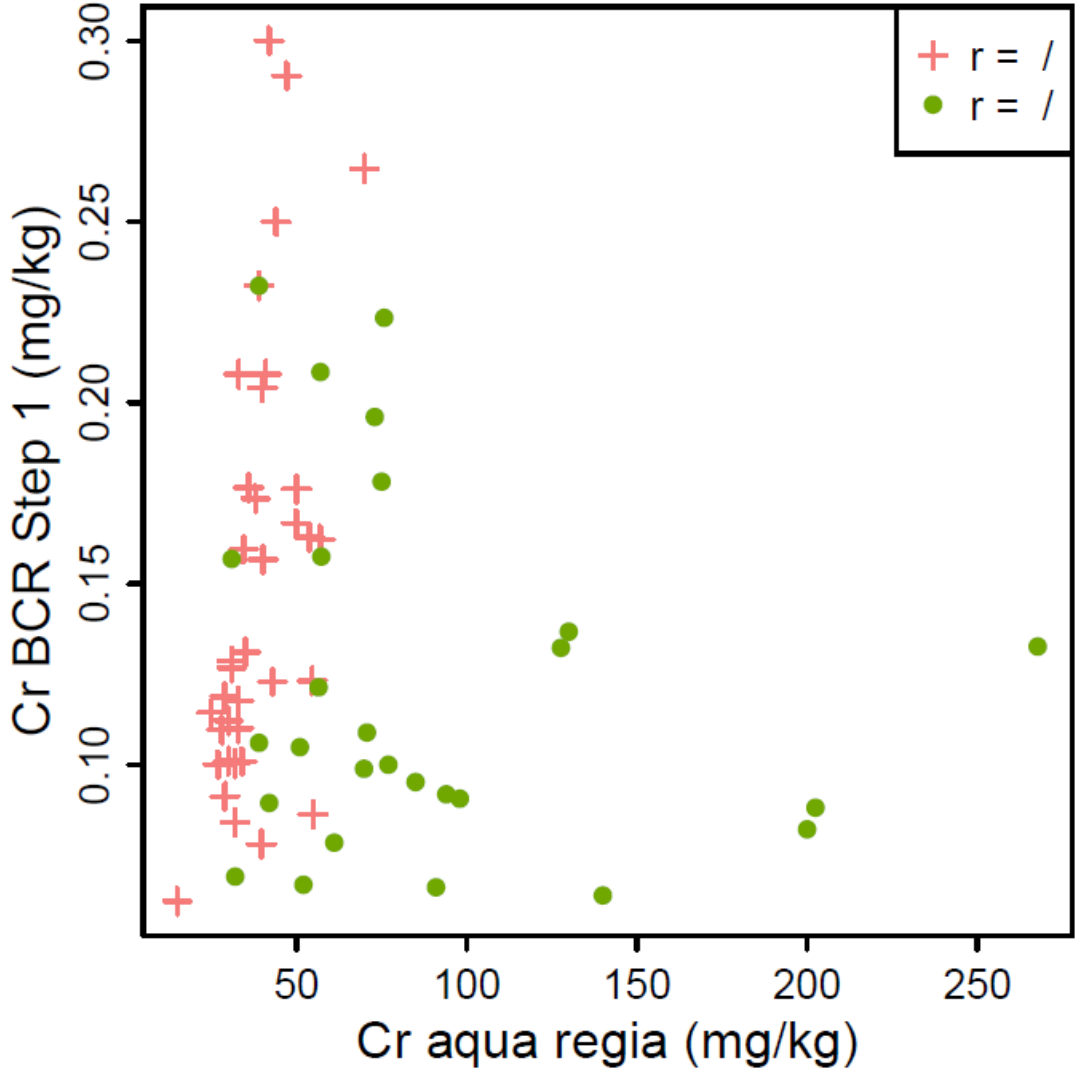
As : BCR step 1 & Rye-grass content correlated with total content in Liège



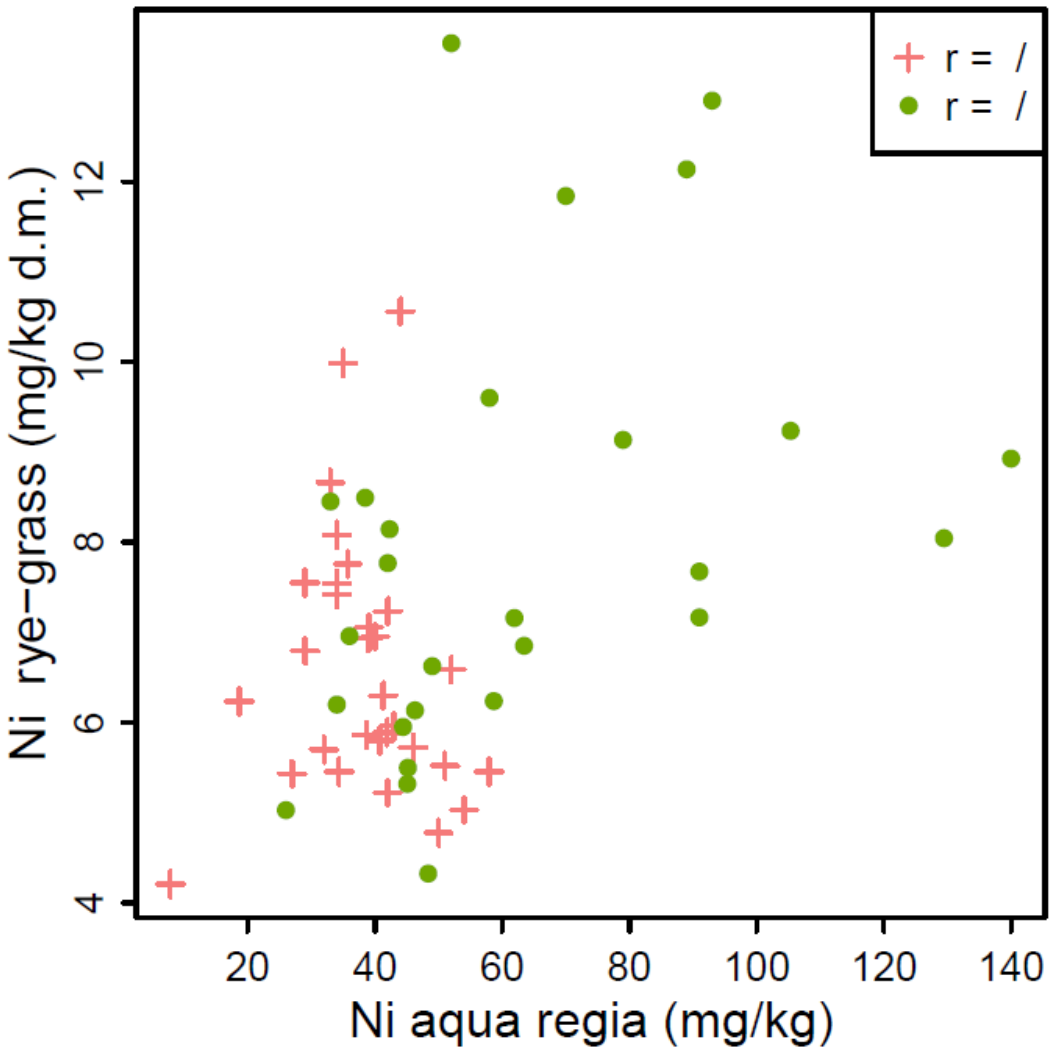


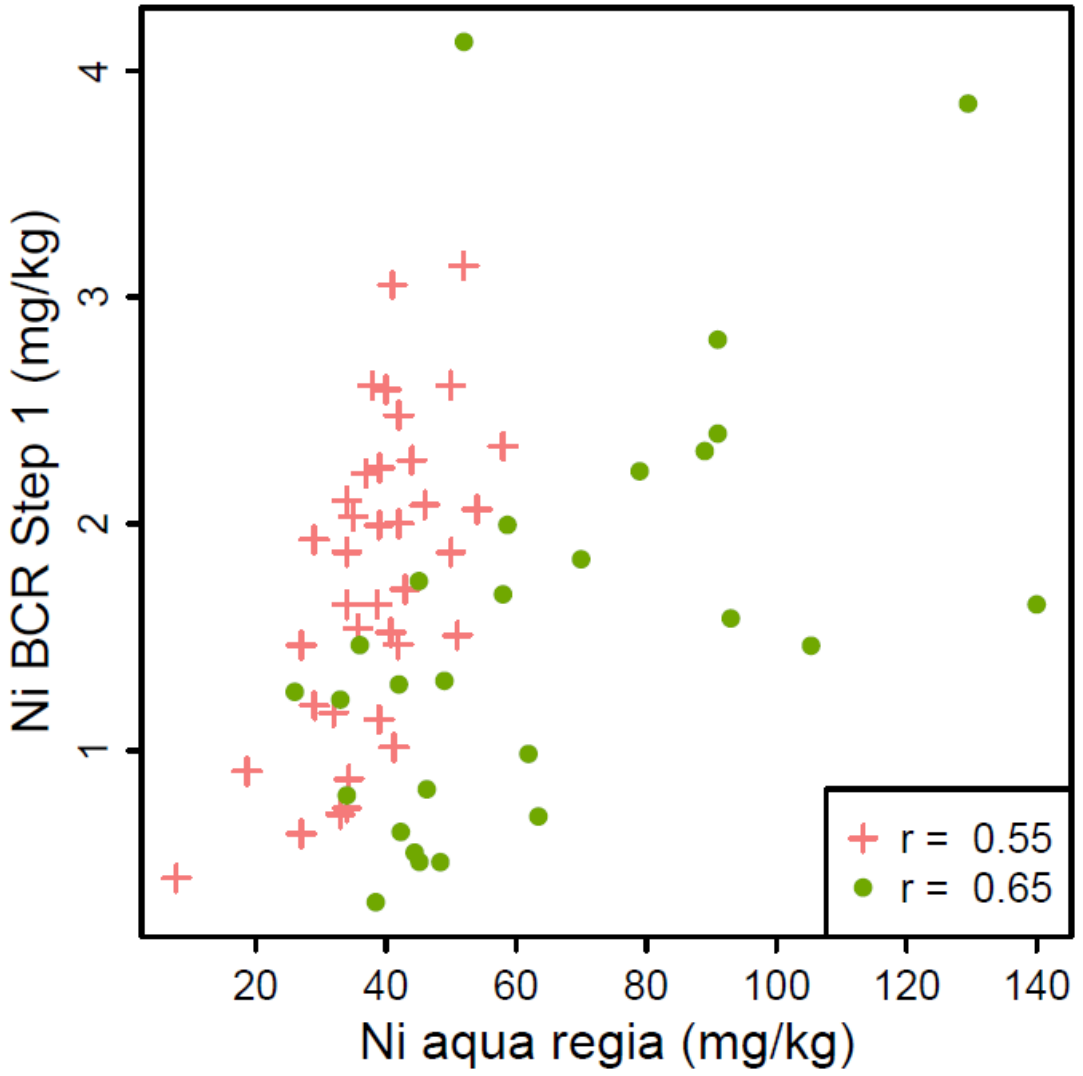
Cr : nothing


r = /
r = /
Cr rye−grass (mg/kg d.m.)
2
4
6
8
10
12
50
100
150
200
250
Cr aqua regia (mg/kg)


r = /
r = /
Cr BCR Step 1 (mg/kg)
0.10
0.15
0.20
0.25
0.30
50
100
150
200
250
Cr aqua regia (mg/kg)

Ni : BCR in step 1 slightly correlated to total content





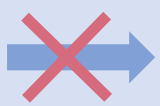
As prediction

Model	R^2
Liège	
Rye-grass = - 0.736 + 0.434 Step 1	0.65
Rye-grass = - 4.25 + 0.361 Step 1 + 0.524 Mn	0.69
Rye-grass = - 2.75 + 0.663 As	0.46
Rye-grass = - 4.00 + 0.559 As + 0.172 Ca	0.56
Lorraine	
Rye-grass = - 0.846 + 0.617 Step 2	0.66
Rye-grass = - 8.43 + 0.579 Step 2 + 0.931 Mg	0.74
Rye-grass = 0.0713 + 0.398 Ca + 0.558 As - 0.641 Fe	0.58
Lorraine and Liège combined	
Rye-grass = - 0.853 + 0.553 Step 1	0.62
Rye-grass = - 0.902 + 0.301 Step 1 + 0.239 Step 2	0.70
Rye-grass = 5.68 + 0.880 As + 0.355 Ca - 1.21 Fe	0.59

No model with $R^2 > 0.3$ for Ni/Cr

No relationship with pH, OrgC and Clay content

Take home messages

↗ Total content  ↗ environmental available content (except As in Liège)

Max 30% total content *potentially mobilizable*

➔ Total content shouldn’t be used in soil management

Take holiday messages

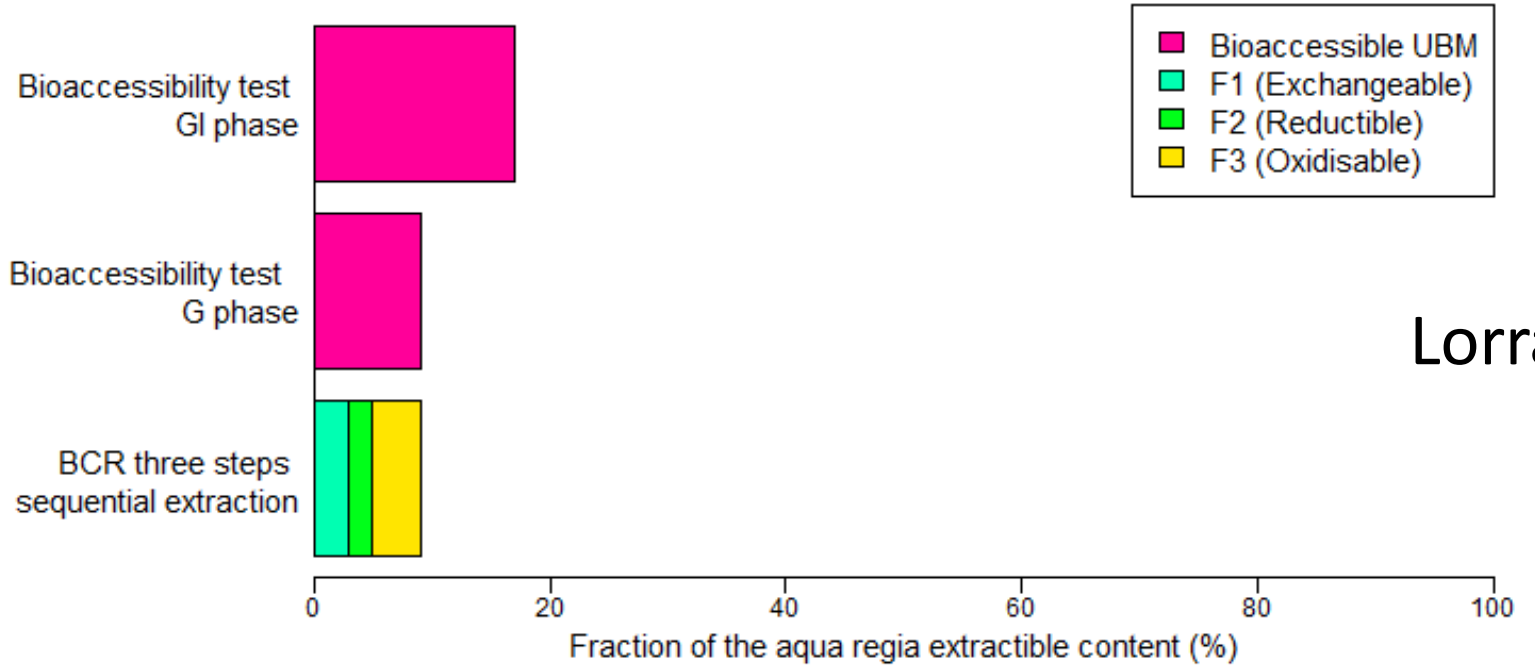
Models for As in Liège

In Lorraine (geogenic origin) : environmental availability iron-rich sandstone < < marls

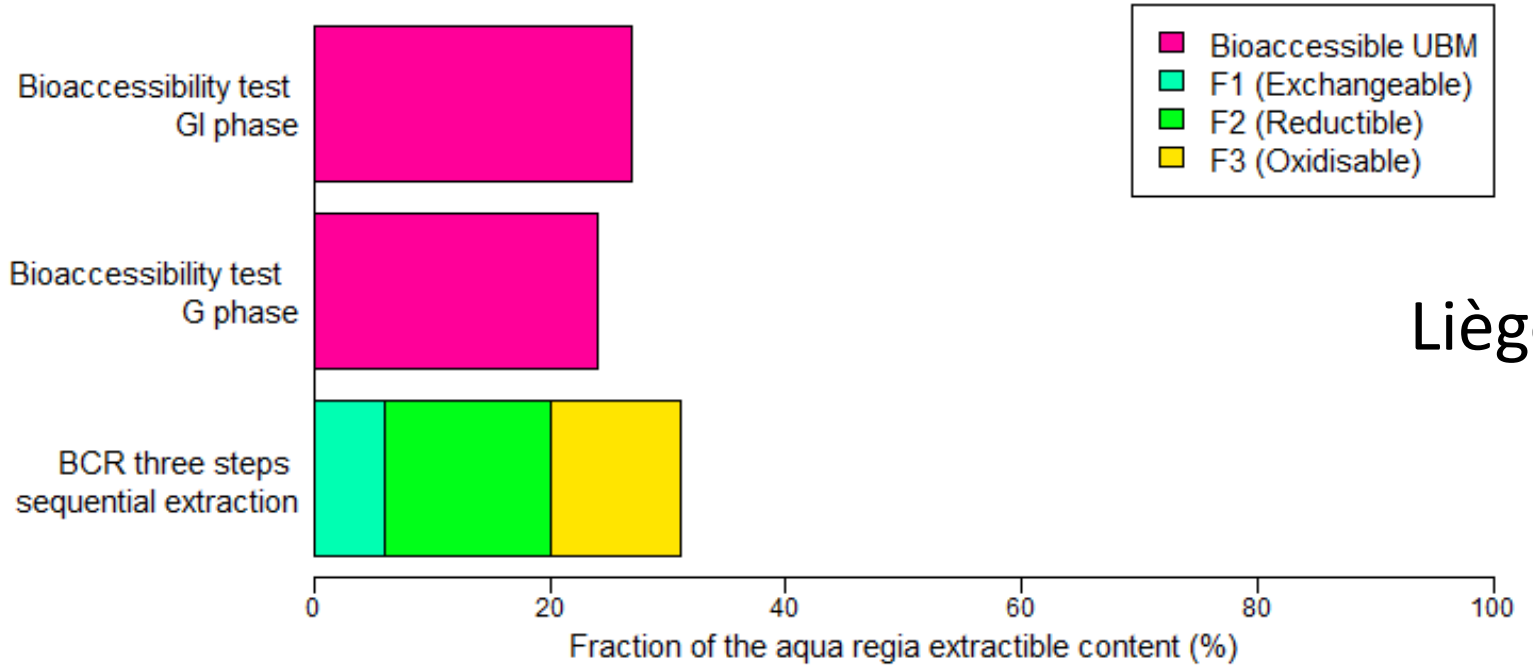
No link with soil properties

Toyota : reinventing the sampling trip



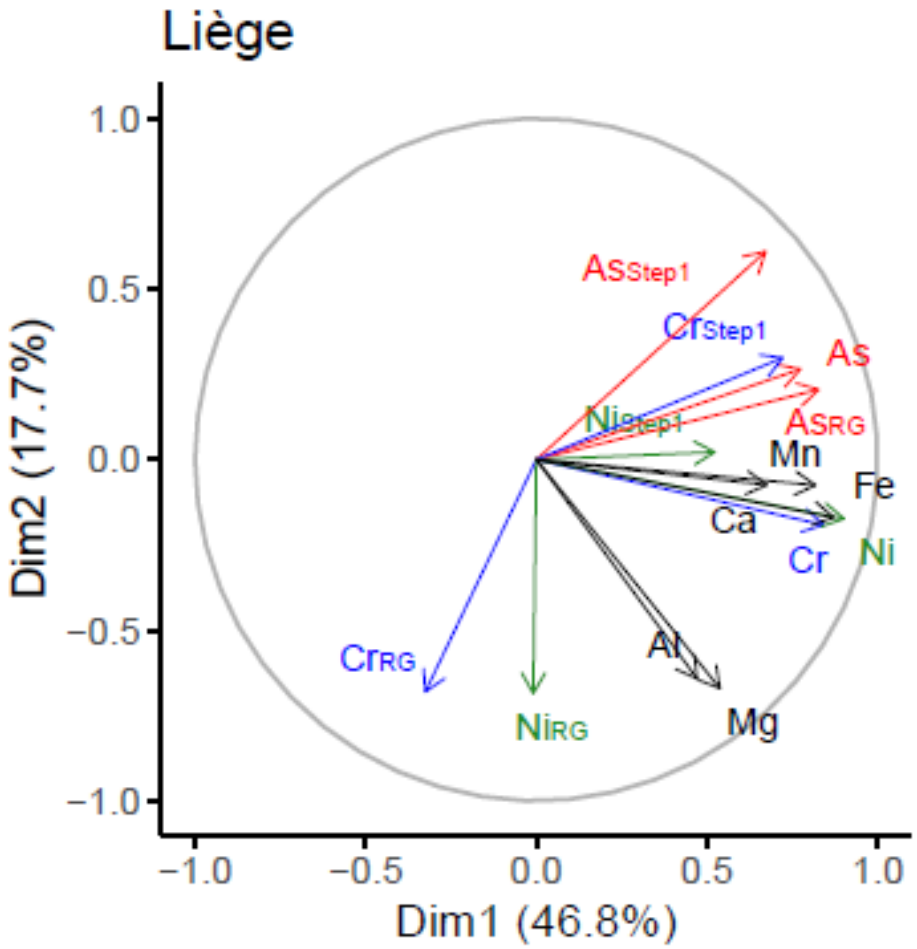


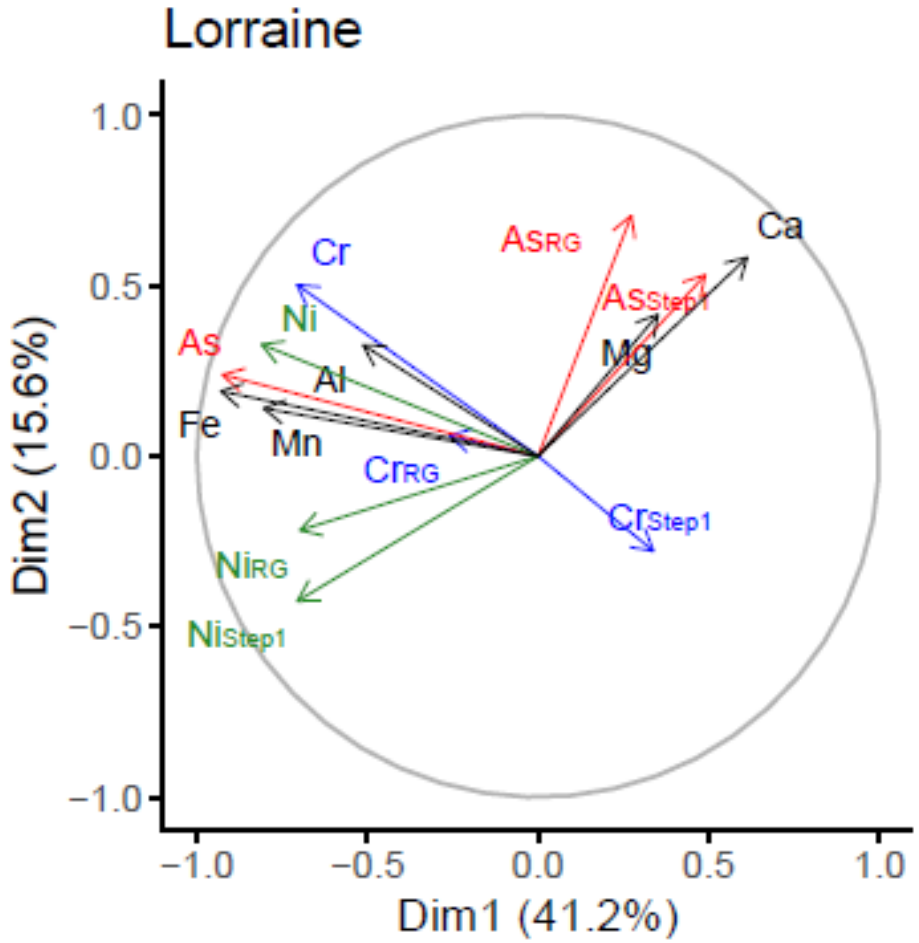
Lorraine



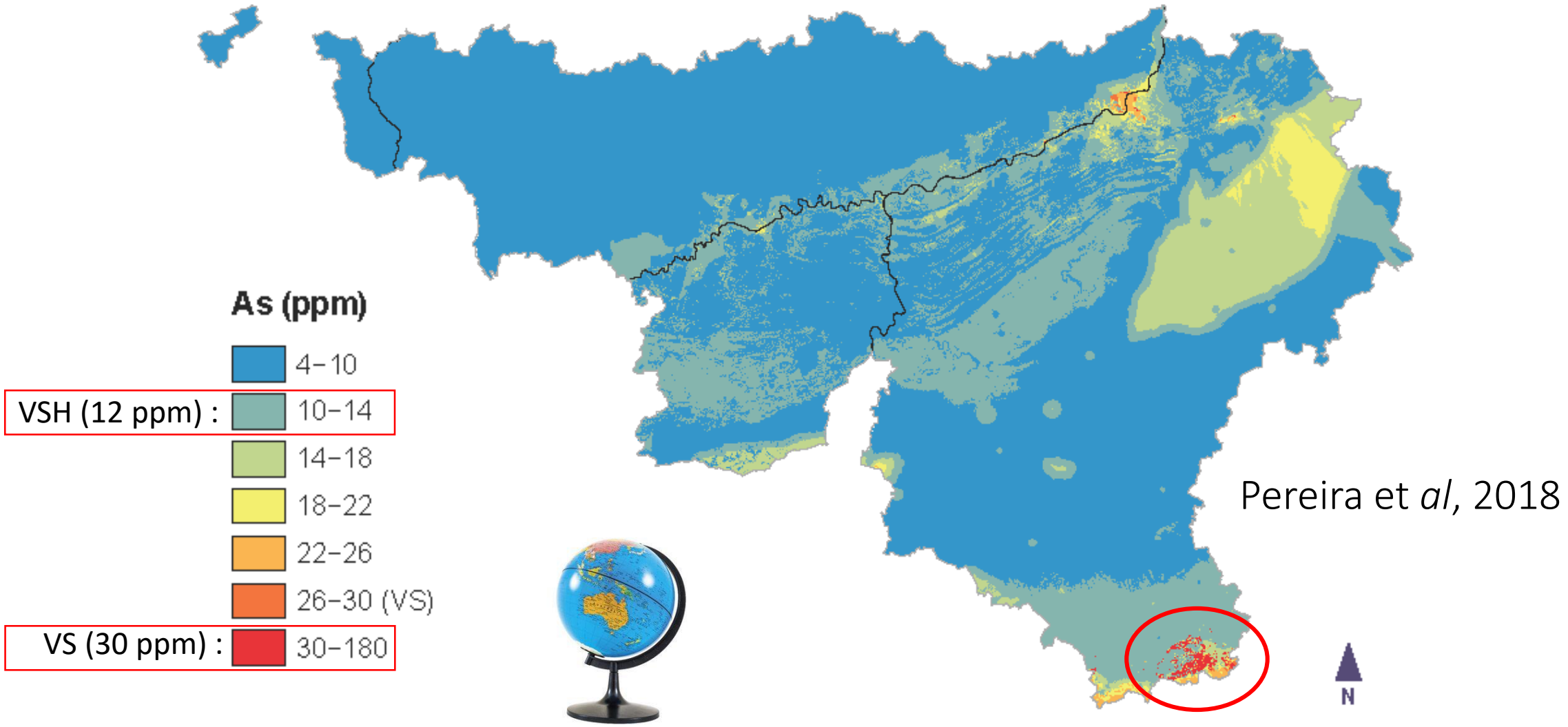
Liège

PCA


Liège
Dim2 (17.7%)
Dim1 (46.8%)
1.0
0.5
0.0
−0.5
−1.0
AsStep1
CrStep1
As
NiStep1
AsRG
Mn
Fe
Ca
Cr
Ni
CrRG
Al
NiRG
Mg


Lorraine
Dim2 (15.6%)
Dim1 (41.2%)
1.0
0.5
0.0
−0.5
−1.0
Cr
AsRG
Ca
Ni
AsStep1
As
Mg
Al
Fe
Mn
CrRG
CrStep1
NiRG
NiStep1

High arsenic content in Liège and Belgian Lorraine

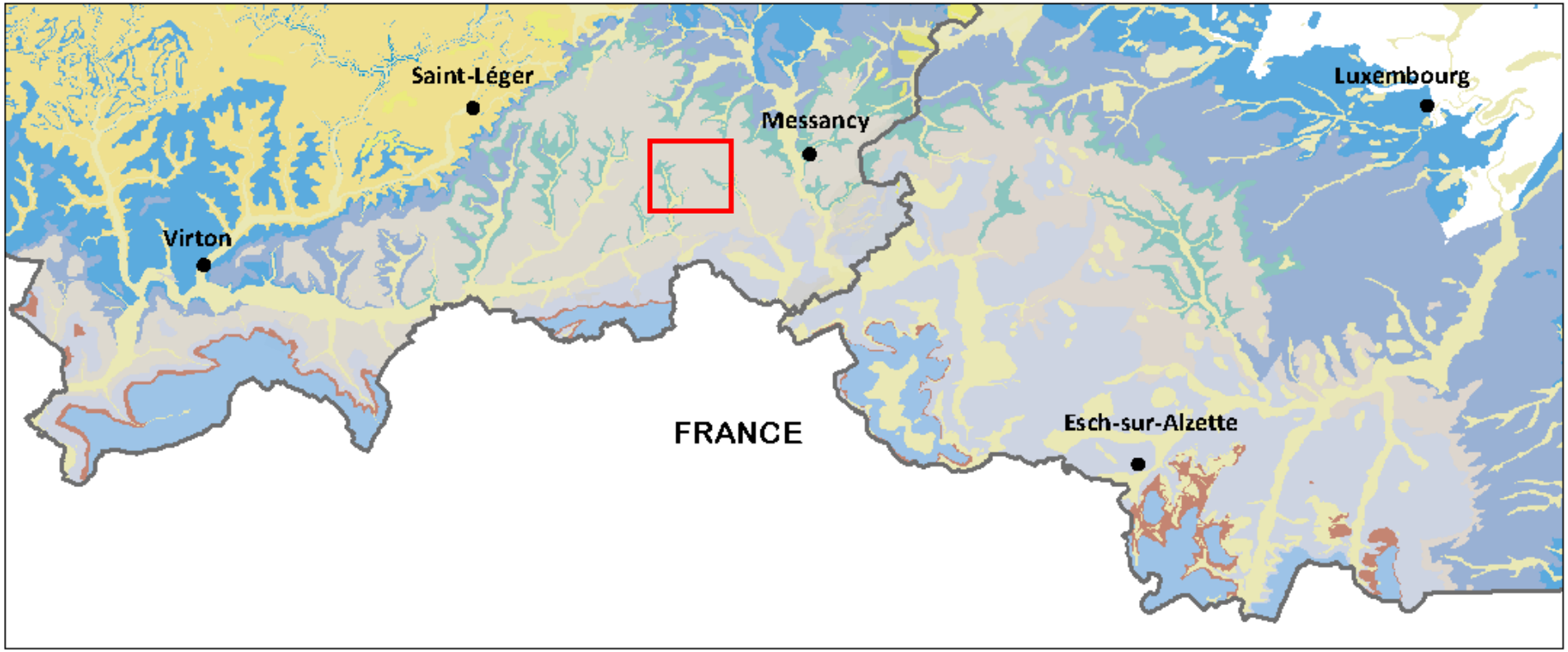


Pereira et *al*, 2018

0.1 - 40 ppm (μ = 5 - 6 ppm)

Calcareous Sandstone

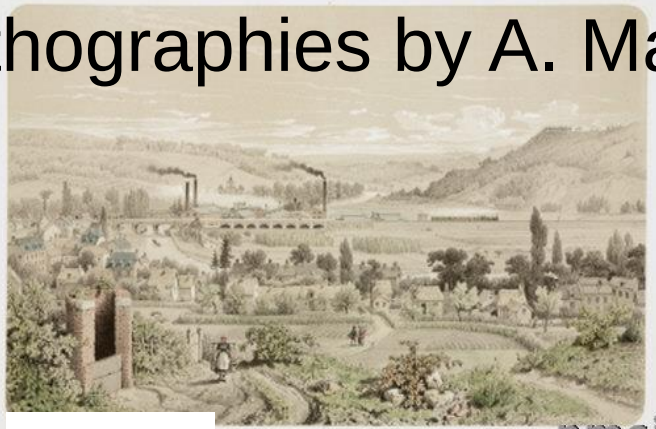
~190 Ma



Zinc smelting, lithographies by A. Maugendre, 1855



Angleur



Angleur



Tilff



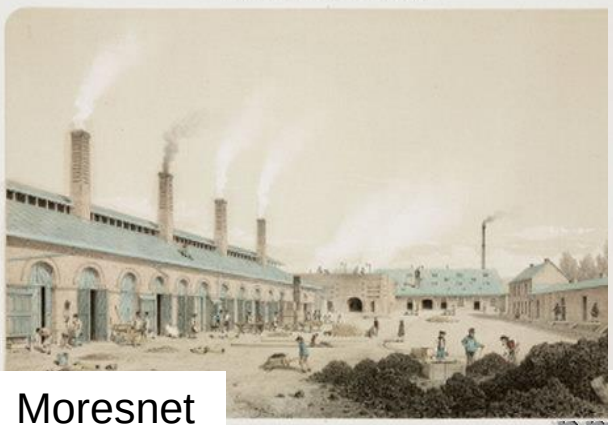
Moresnet



Angleur



St Leonard, Liège



Moresnet



Welkenraedt



Flône