



# Spatial distribution of metallic trace elements in soils contaminated by atmospheric fallouts

## Case study: Sclaigneaux (Belgium)

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Bari (Italy), 3<sup>rd</sup> July 2012

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PHD STUDENT

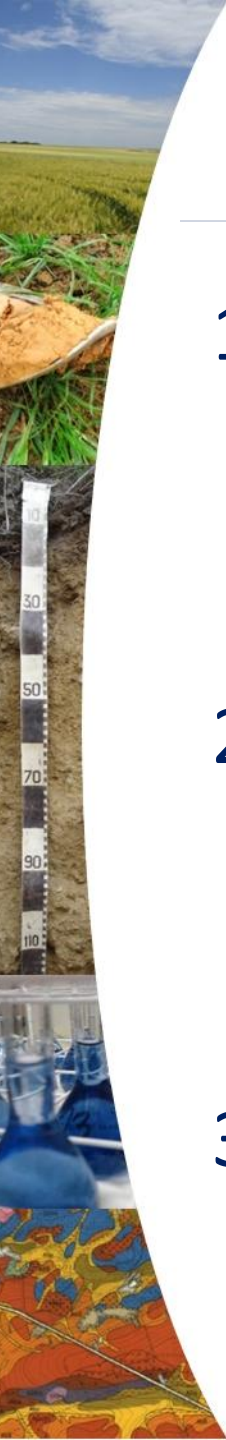
*University of Liege– Gembloux Agro-Bio Tech – Soil - Water Systems*



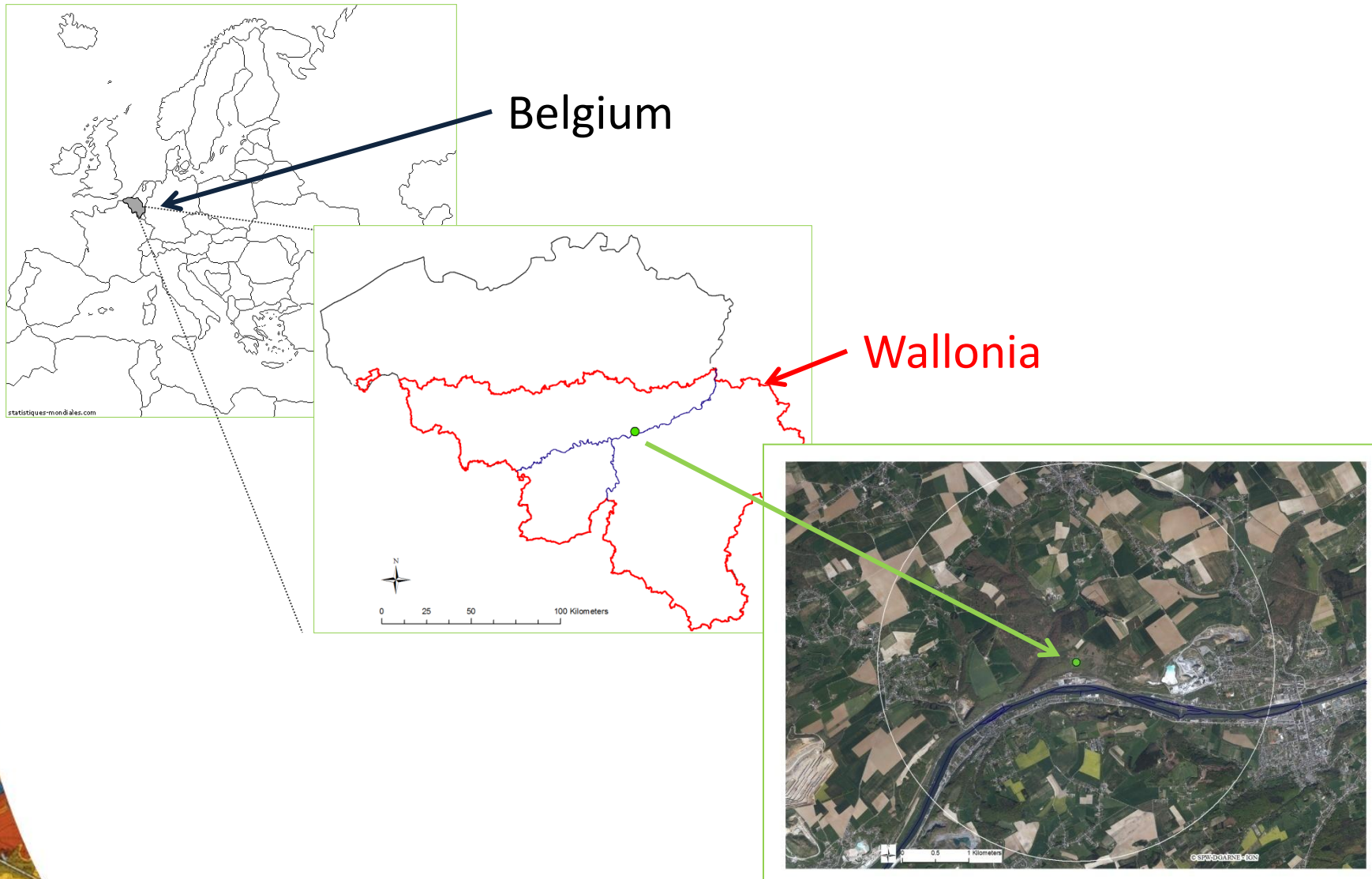
# Aims

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1. Spatial distribution of metallic trace elements (MTE) at the landscape scale in the topsoil, in the subsoil and in sediments
2. Impact of land uses, soil types, wind directions and distance from contaminants source on the MTE content
3. Risk assessment for agricultural soil utilisations

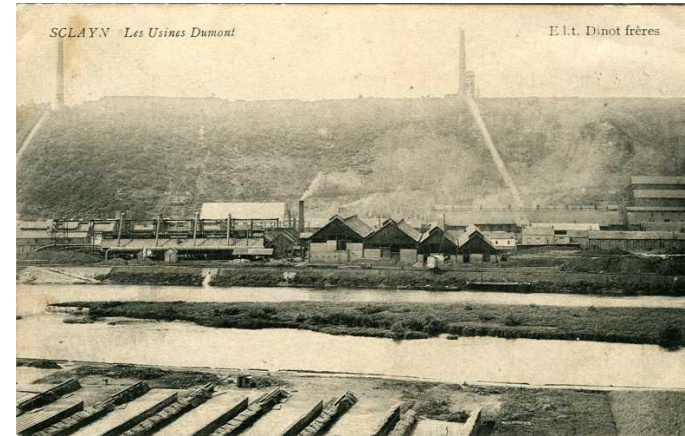


# Study area: localization





# Study area: characteristics



Loyse river

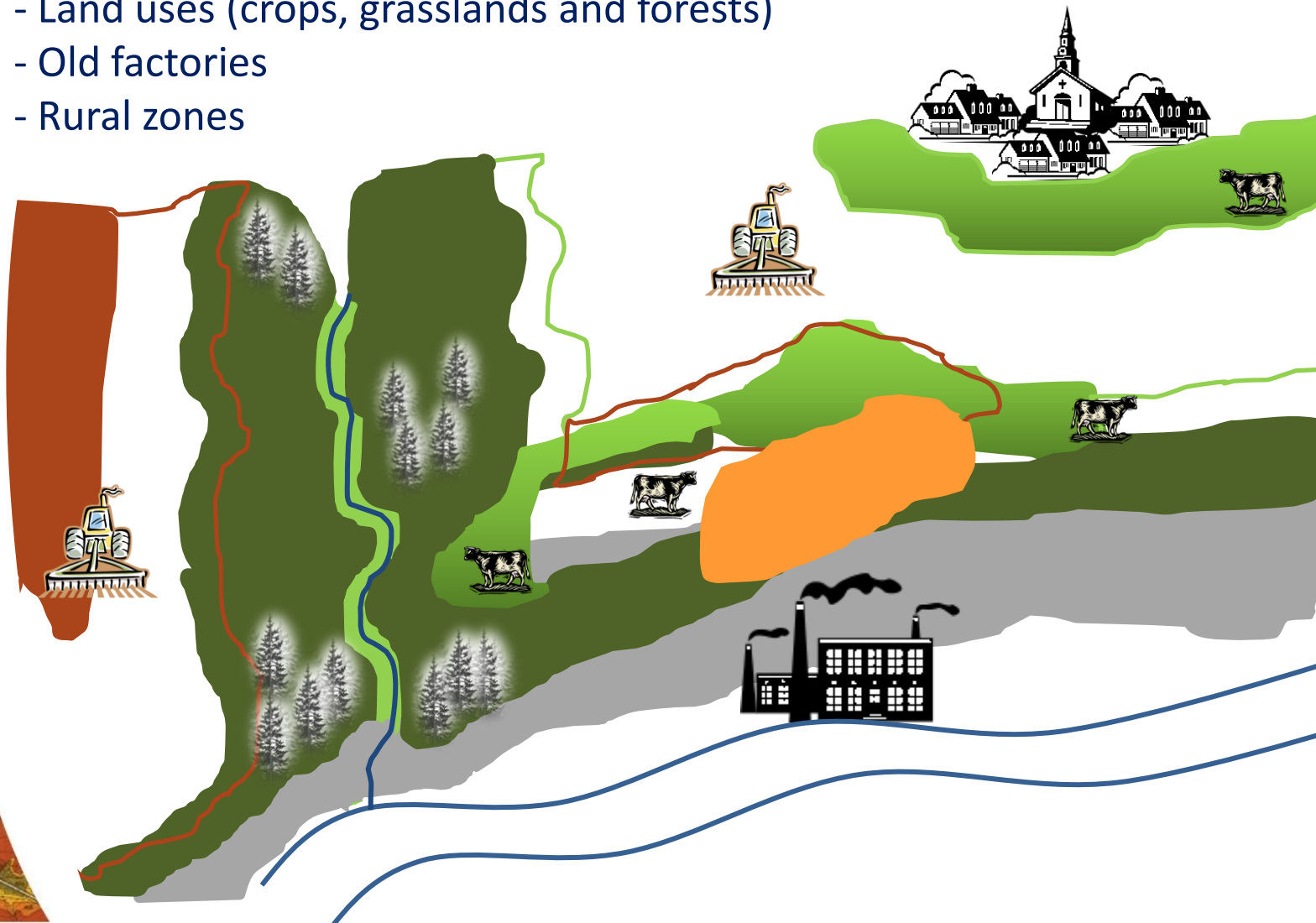
Situation of old chimney

Meuse valley



# Study area: characteristics

- Different soil types
- Land uses (crops, grasslands and forests)
- Old factories
- Rural zones





# What about spatial distribution in topsoil?

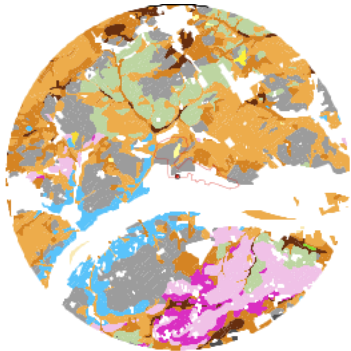
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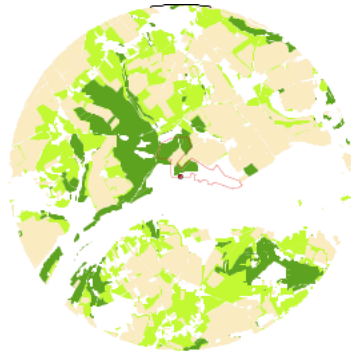
# Topsoil study

## Sampling Strategy - Map projections



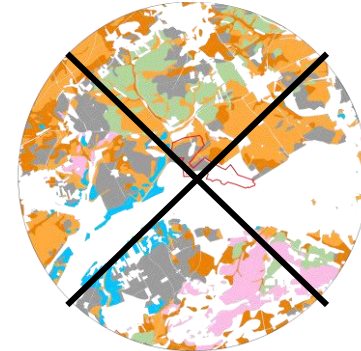
1. Main soil types

×

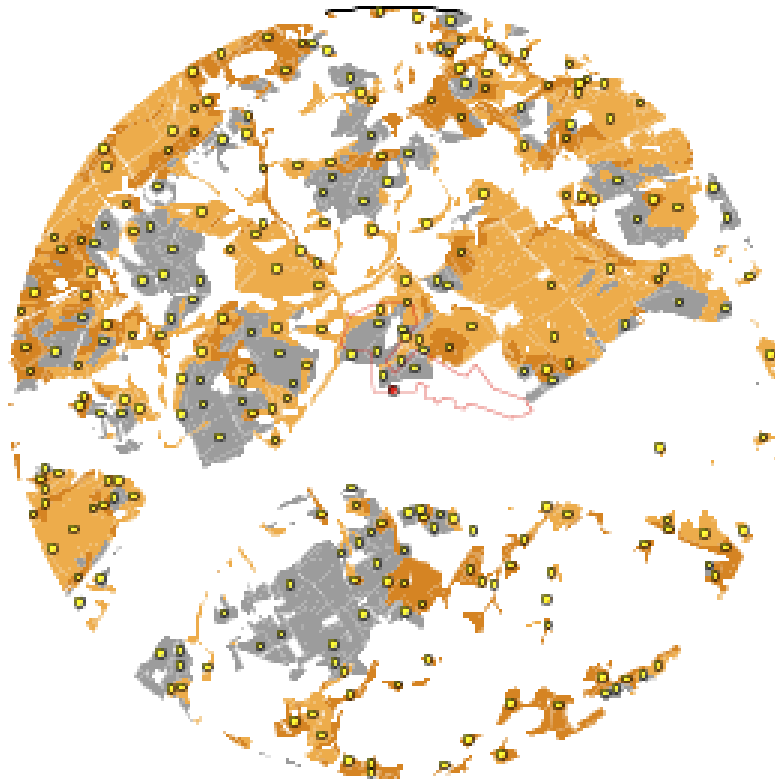


2. Land use

+



3. Wind directions



Sampling points are distributed between 3 distinct soil types, 3 land uses and 4 wind directions (36 combinations)



Loamy soil with good drainage



Loamy soil with imperfect drainage



Loamy stony soil with silexite and gravels

# Methodology

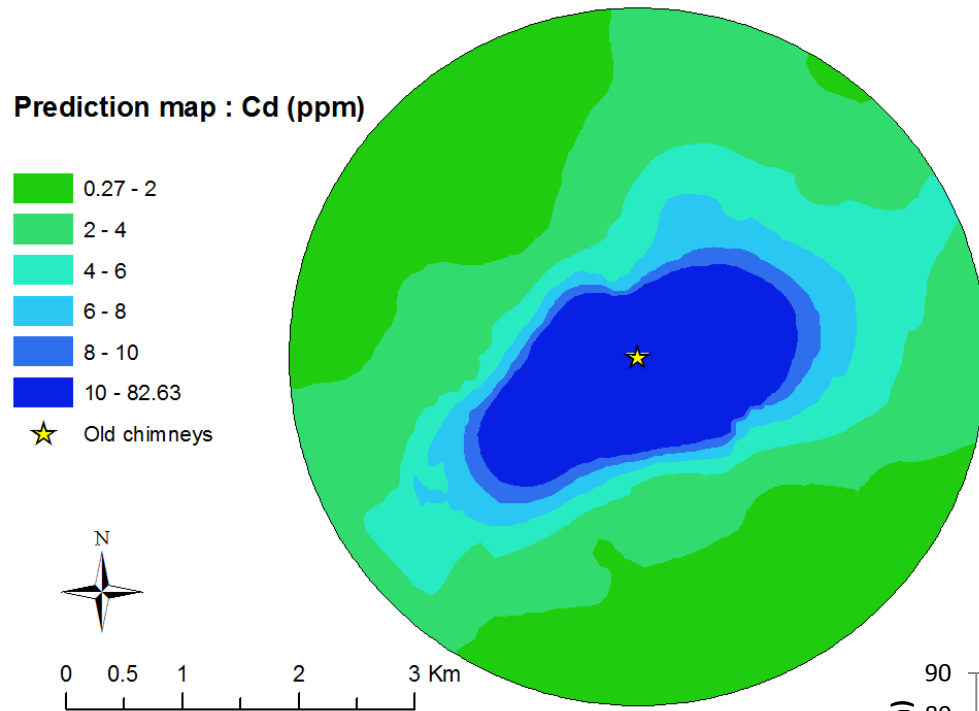
- 250 topsoil samples were collected according to this stratified design
- All samples were prepared for analyses :
  - Pseudo-total contents in inorganic elements
  - pH
  - Total Organic Carbon
  - N
- Statistical analyses :
  - Anova (AV3)
  - Ancova (AV3) with distance as covariate
  - PCA





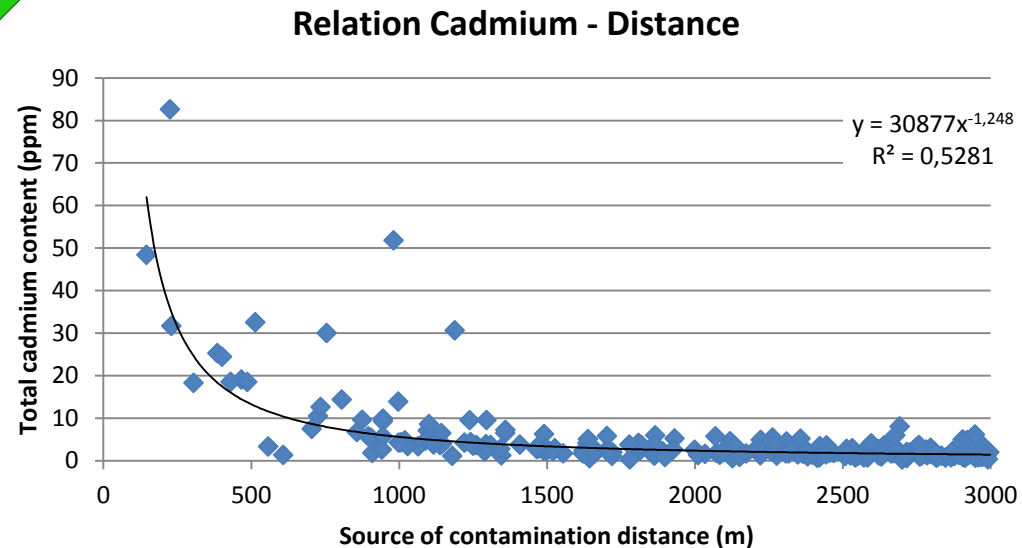


# Distance from source: The main factor influencing MTE content in topsoil



- Content in each MTE decreases with distance

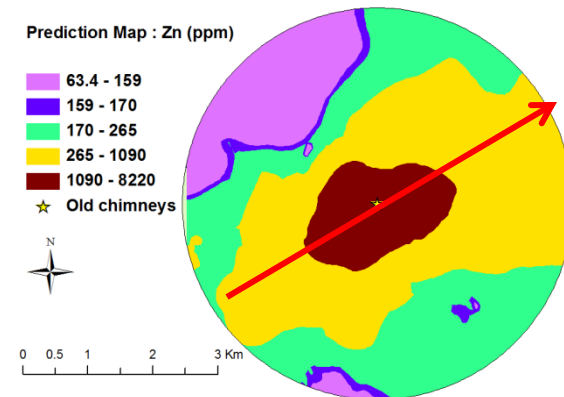
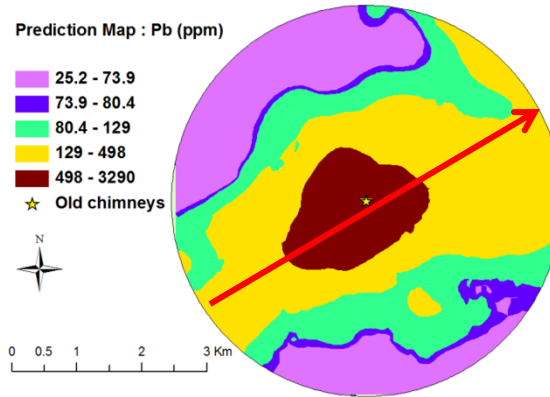
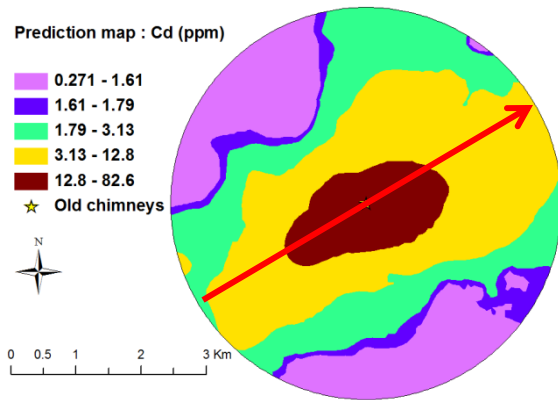
- P-value < 0.001 and  $R^2 > 0.5$



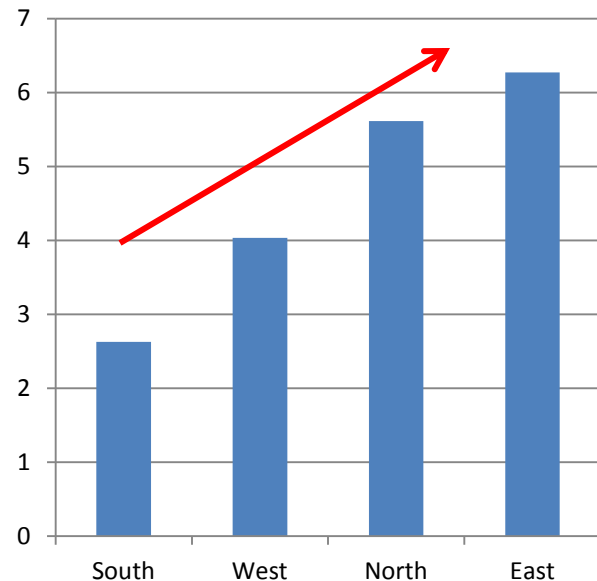


# Direction of dominant winds :

## A second factor which influences MTE content in topsoil



### Cadmium content (ppm)



- Typical wind direction in Wallonia is South-West toward North-East

- MTE dispersion is higher along this axe

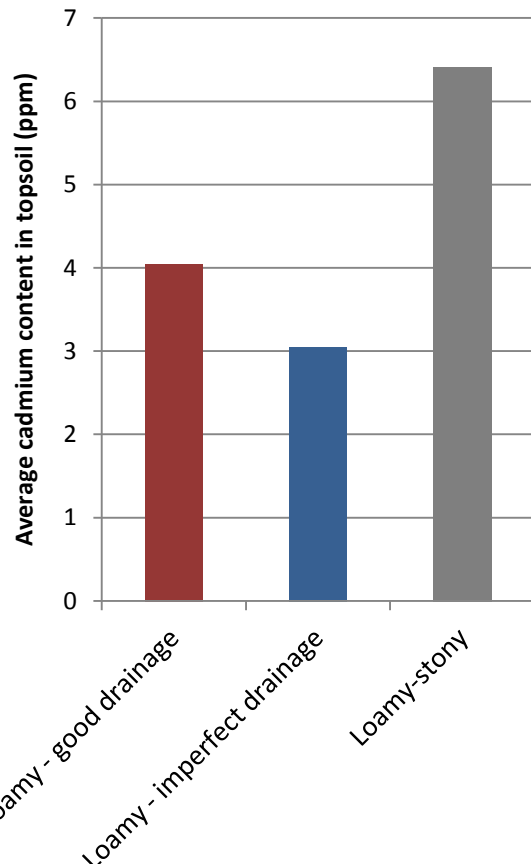


# Soil types :

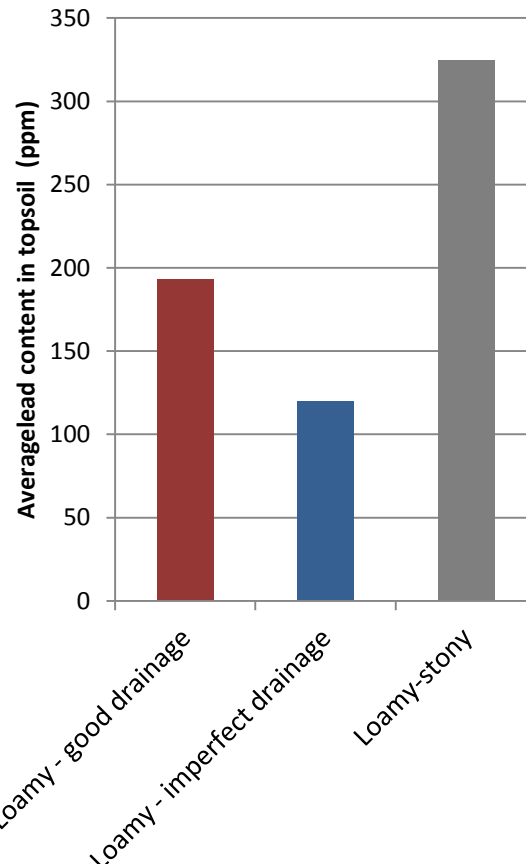
A third factor which influences the MTE content in topsoil

- Loamy stony soils with silexite and gravels contain more MTE than loamy soils
- Effect most likely due to their position in the landscape

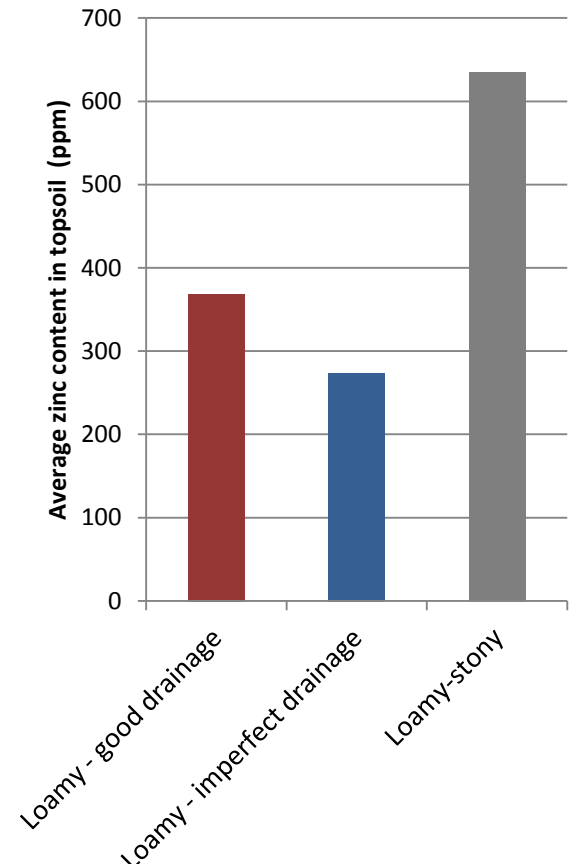
**Cadmium**



**Lead**



**Zinc**



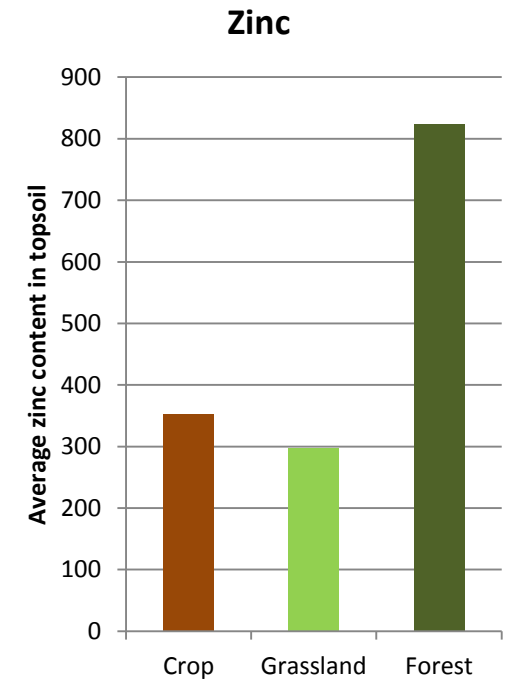
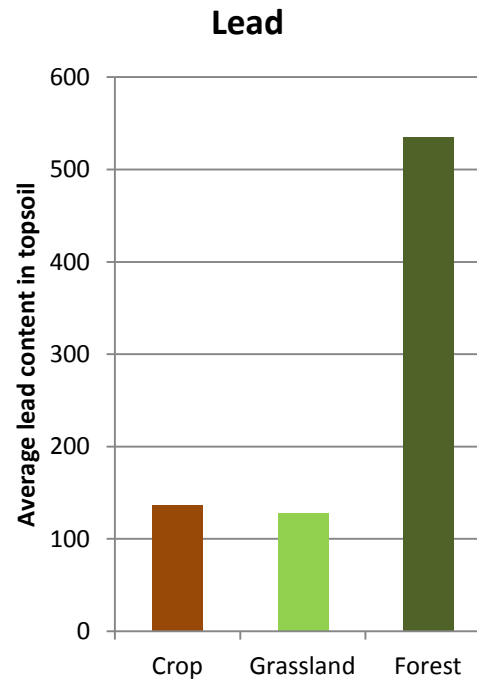
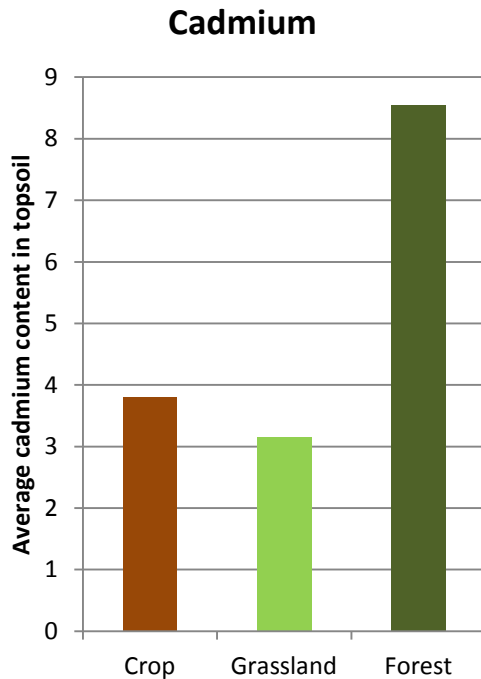




# Land use :

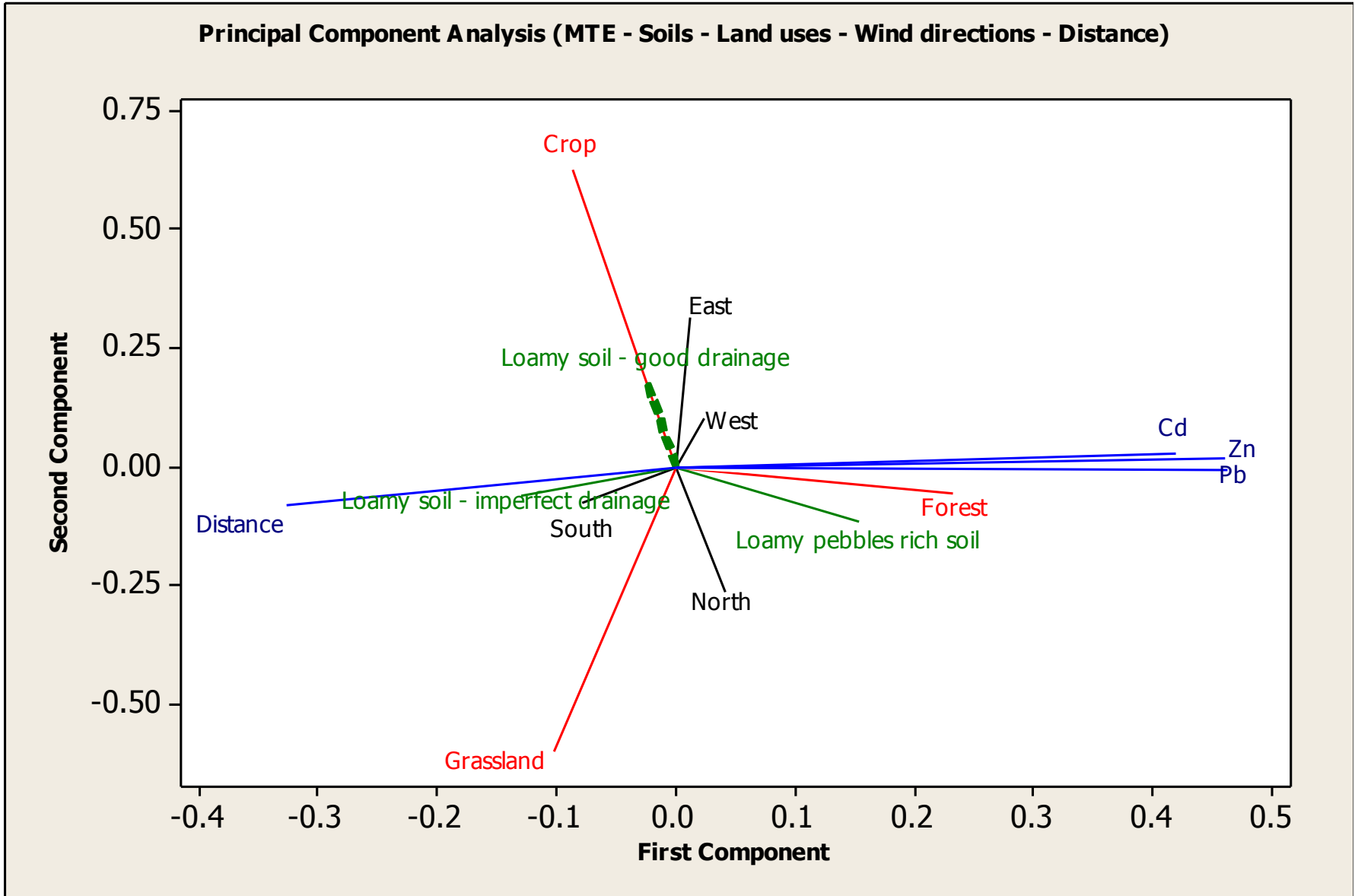
## A last factor which influences the MTE content in topsoil

- Forest content in MTE is always higher (2X) than the other land uses
- Likely due to higher content in organic matter, lower pH,...





# Confirmation by PCA analysis

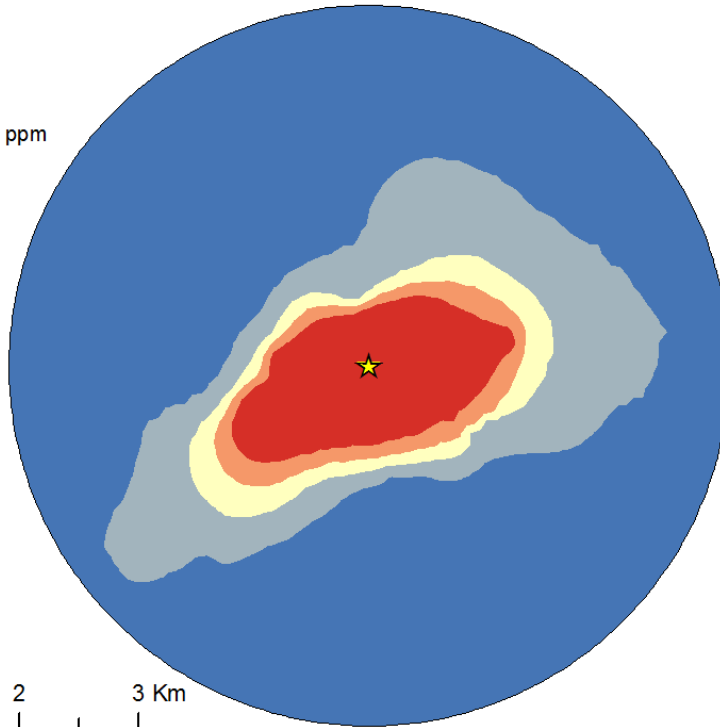
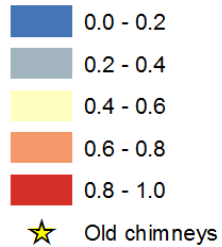




# Topsoils Risk assessment study

## Probability Map

Cadmium > 10 ppm



In a 1km radius around the source, there is 80% chance for each contaminant to be above the allowed regional intervention value

	Cadmium	Lead	Zinc
Natural reference	0.2	25	67
Critical level	1	200	155
Intervention value	10	400	300



# What about sediments ?

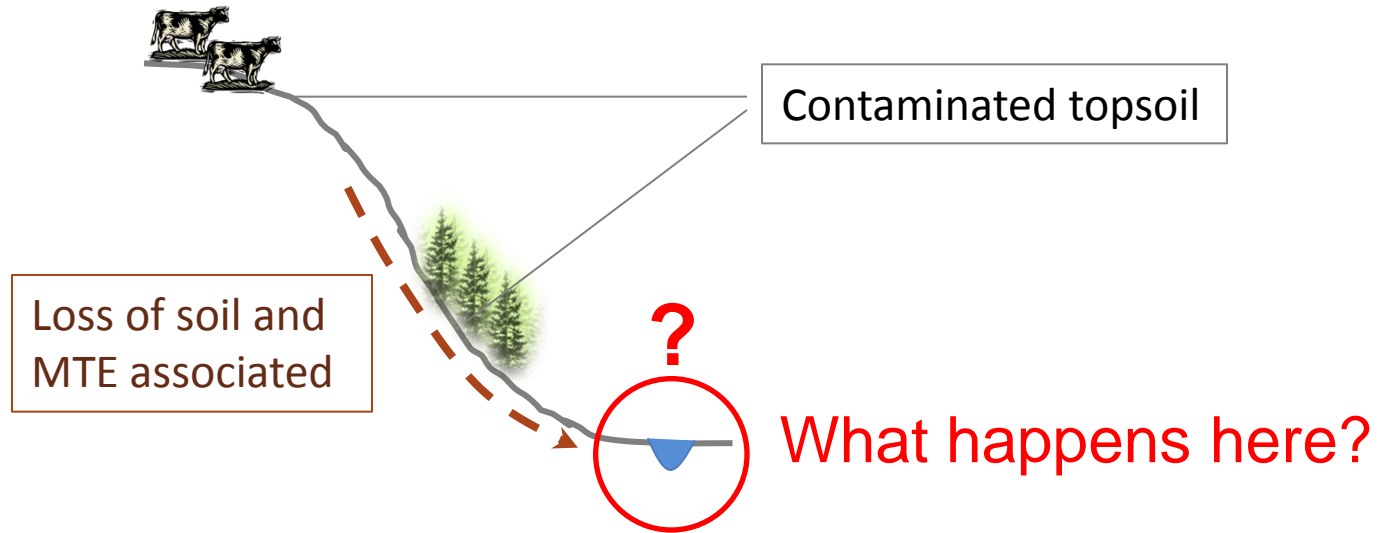
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# Sediments



→ Comparison of topsoil and sediment samples taken very close from each other (max 3m)



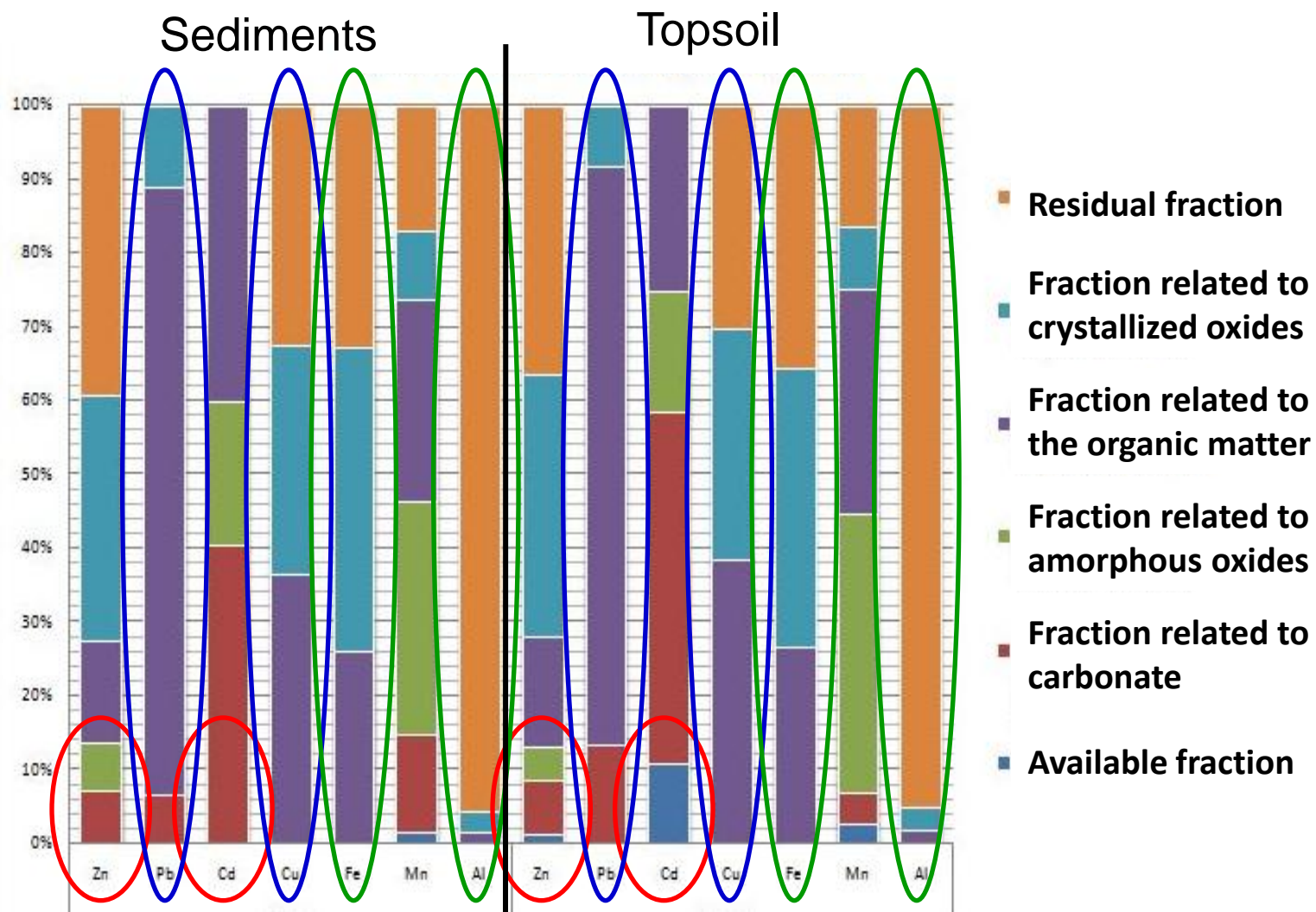
Topsoil sample



Sediments sample

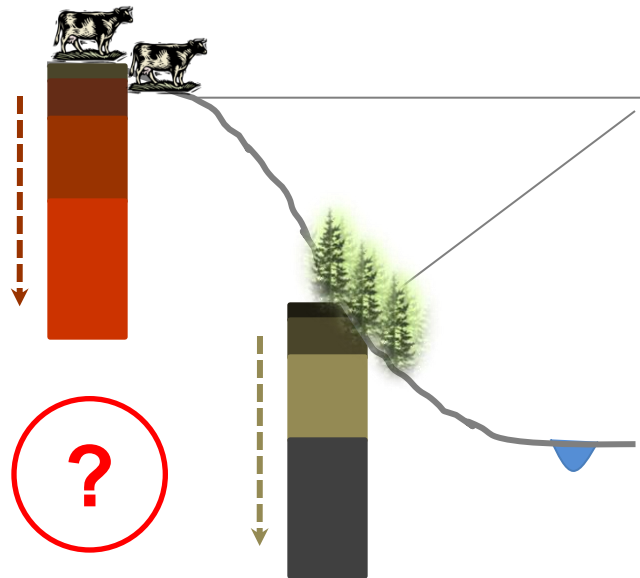


# Comparison of speciation elements from topsoil and sediments





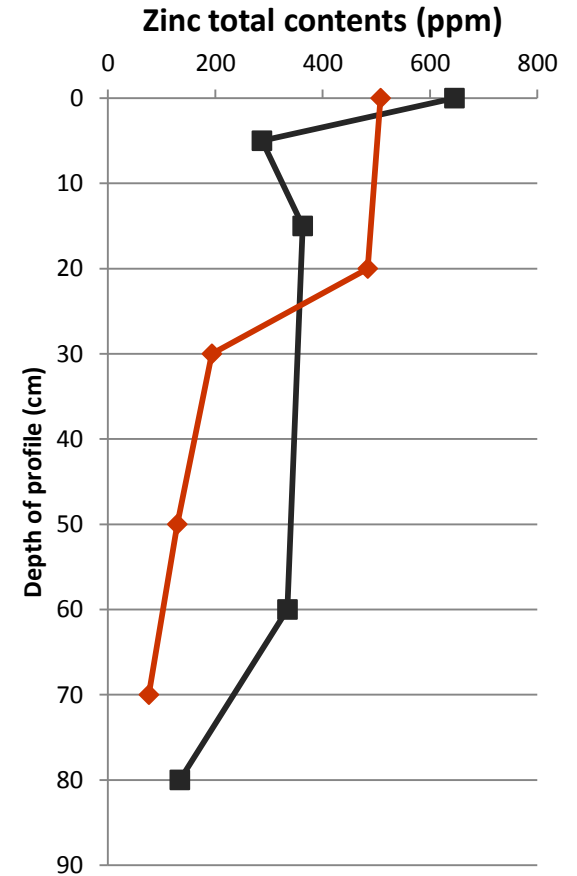
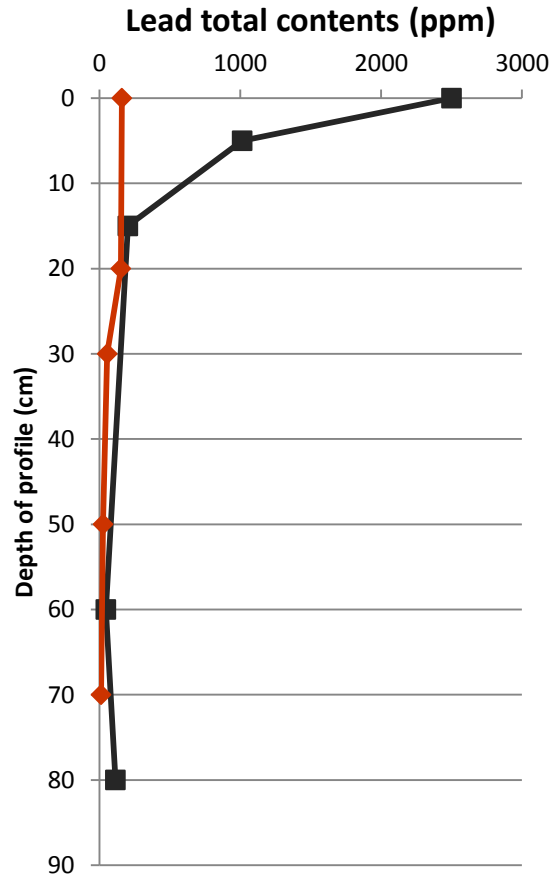
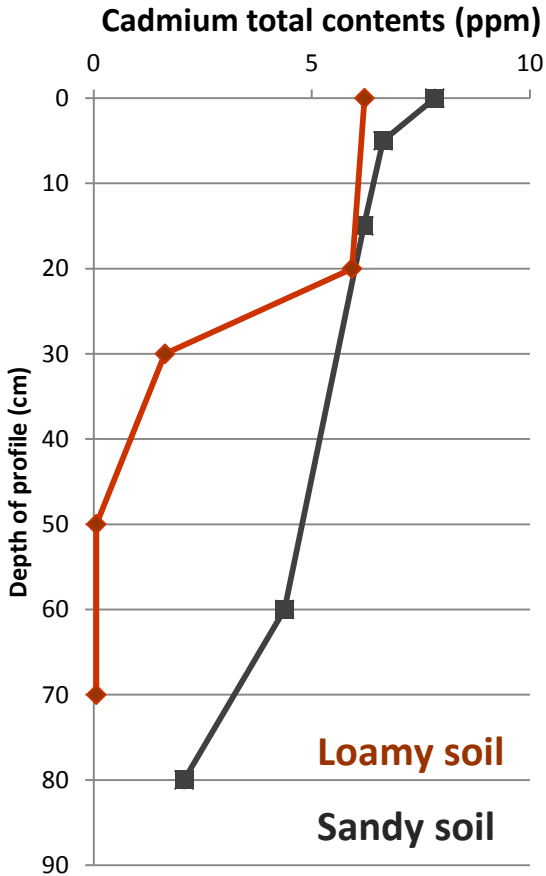
# What about MTE leaching ?



Contaminated topsoil



# MTE leaching?



- Atmospheric dusts are at the origin of the contamination
- MTE evolution is different according to the kind of soil

# Conclusions

- Factors influencing spatial distribution of MTE in the topsoil may be classified in the following order :
  - Distance  $\gg$  Wind directions  $>$  Soil type  $\approx$  Land use
  - Forests and loamy-stony soils are the most contaminated
- The greatest risk is met in an area of 1 km radius around the old chimney - should be decontaminated
- Sediments present in the river are contaminated and the available fraction is gone
- In a soil profile the contamination decreases with depth and the evolution depends on soil types and land uses







Thank you for your attention...

Thank you to my collaborators:

- Colinet Gilles
- Bock Laurent
- Members of Soil Unit of Gembloux Agro-Bio Tech (Ulg - Belgium)