Hazards of plant contamination around former Zn-Pb industries in Wallonia

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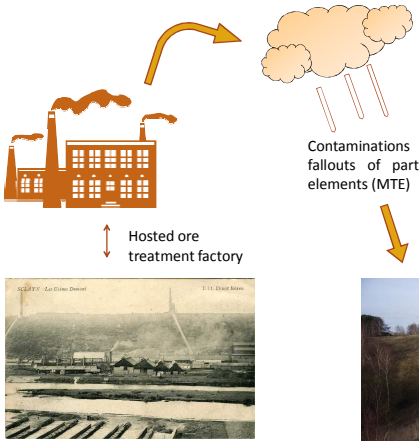
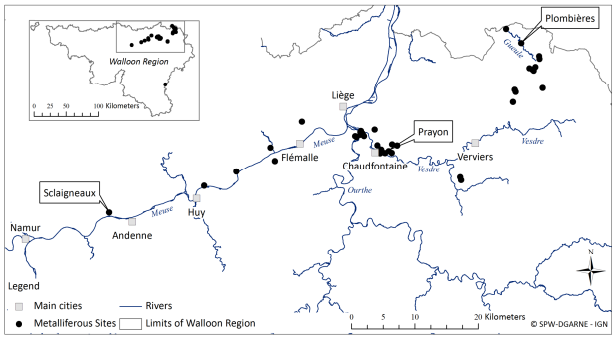
CONTEXT



Map of walloon metalliferous sites repartition



However, this fact is not reasonable argument to consider that the atmospheric fallouts were limited to these sites.

After one century of exploitation without environmental concern, it is time to study the risks regarding the quality and the sustainability of crops, grasslands and vegetable gardening.

CASE STUDY 1 – CROPS QUALITY

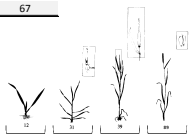
The MTE uptake of plant evolves according to phenologic stages and to MTE contents in soils. To confirm this hypothesis, we cultivated *Hordeum vulgare* L. in greenhouse conditions in soils sampled on different agricultural areas on a same main soil type (loamy-stony soil).

An experimental device was developed with a control and four different soils with a range of MTE contents (Table 2).

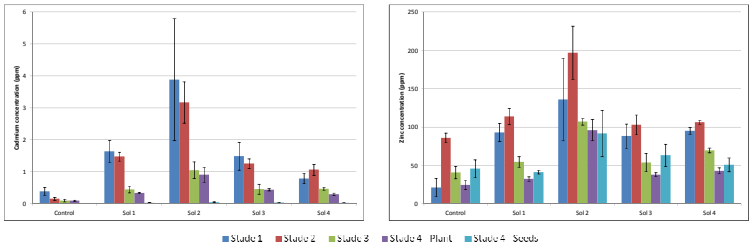
Table 1. (Unit: ppm)

	Cd total	Cd available	Zn total	Zn available
Control	0,92	0,54	284	69
Soil 1	4,70	2,90	410	243
Soil 2	10,74	8,49	980	91
Soil 3	3,78	2,79	318	51
Soil 4	1,98	1,12	200	67

We harvested plants at four phenologic stages and to compare the uptake of MTE according to the stage. We set up 4 replicates by combination (soil-stage).



Cd and Zn uptake in *Hordeum vulgare*



- The highest concentration of Cd is measured in stade 1 (three leaves) while the highest concentration of Zn is measured in stade 2 (2 nodes).
- In the end of growth, Zn is stored in the seeds while Cd remains in the plant (leaves and stem) and is found only in small quantities in seeds.
- Cd and Zn have a different behavior because the first is a contaminant and the second is an oligo-element.

CASE STUDY 2 – GRASSLAND QUALITY

Map of sampling places realized in grassland around the metalliferous site of Plombières

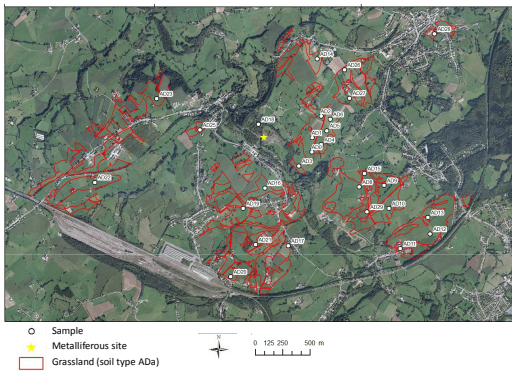


Table 2. Pearson's correlation coefficients *r* between Cd-Cu-Pb-Zn in plants and in topsoil (ER: Pseudo-total content (Aqua regia) , EDTA : Available content, $CaCl_2$: soluble content) (N=28) (*p<0.05; **p<0.01; ***p<0.001)

	Cd Plants	Cd ER	Cd EDTA	Cd $CaCl_2$	Cu Plants	Cu ER	Cu EDTA	Cu $CaCl_2$	Pb Plants	Pb ER	Pb EDTA	Pb $CaCl_2$	Zn Plants	Zn ER	Zn EDTA
Cd ER	0.263														
Cd EDTA	0.271	0.941 ***													
Cd $CaCl_2$	0.425 *	0.760 ***	0.811 ***												
Cu Plants	0.462 *	0.506 **	0.511 **	0.568 **											
Cu ER	0.298	0.236	0.198	0.048	0.471 *										
Cu EDTA	0.082	-0.194	-0.061	-0.230	0.269	0.578 **									
Cu $CaCl_2$	-0.593 **	-0.193	-0.146	-0.389 *	-0.246	0.012	0.196								
Pb Plants	0.423 *	0.320	0.244	0.205	0.214	0.416 *	-0.044	-0.406 *							
Pb ER	0.168	0.617 ***	0.576 **	0.572 **	0.520 **	0.435 *	-0.102	-0.268	0.608 **						
Pb EDTA	0.152	0.622 ***	0.612 **	0.590 **	0.525 **	0.394 *	-0.060	-0.233	0.571 **	0.991 ***					
Pb $CaCl_2$	-0.231	-0.074	-0.052	-0.136	-0.341	-0.105	-0.016	0.331	0.355	0.076	0.085				
Zn Plants	0.549 **	0.112	0.122	0.189	0.172	0.299	0.013	-0.306	0.591 **	0.323	0.291	0.045			
Zn ER	0.058	0.626 ***	0.613 **	0.376	0.342	0.482 **	0.000	0.025	0.526 **	0.799 ***	0.805 ***	0.079	0.277		
Zn EDTA	-0.184	0.432 *	0.487 **	0.226	0.168	0.280	-0.011	0.345	0.296	0.588 **	0.620 ***	0.238	0.218	0.771 ***	
Zn $CaCl_2$	0.221	0.458 *	0.562 **	0.744 ***	0.218	0.065	-0.208	-0.235	0.390 *	0.634 ***	0.655 ***	0.182	0.451 *	0.454 *	0.544 **

- The MTE uptake by plants can be estimated by some MTE contents in soils :
  - $[Cu]_{Plant}$ is correlated by $[Cd]_{soil}$ and $[Pb]_{soil}$
  - $[Pb]_{Plant}$ is correlated by $[Pb]_{soil}$ and $[Zn]_{soil\ (ER)}$
  - $[Cd]_{Plant}$ is only correlated with $[Zn]_{Plant}$
- Pseudo-total contents of Cd, Pb and Zn are strongly correlated with Cd, Pb and Zn EDTA contents.

CASE STUDY 3 – GARDEN QUALITY

Lettuce sp. and *Endive sp.* were cultivated on 10 contaminated garden soils (Meuse valley) and 2 control soils during 2 months.

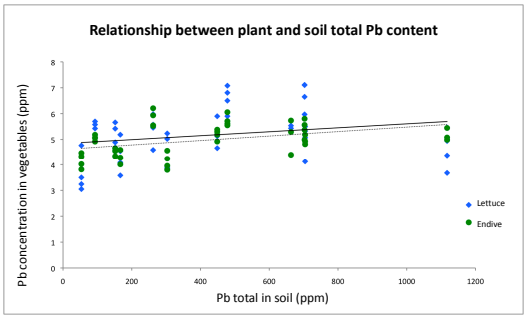
Range of MTE concentration of the 10 contaminated gardens soils:

- Cd: 0,9 – 22 ppm
- Cu: 20 – 250 ppm
- Pb: 55 – 1120 ppm
- Zn: 240 – 5840 ppm

This range is representative of levels found in Liège province.

We investigated the MTE uptake of the two vegetable species when they grow on this range of contamination.

Relationship between plant and soil total Pb content



- Statistically, both species accumulate the same concentration of cadmium, copper, lead and zinc.
- Positive significant relationships were found between plant and soil content for studied MTE.

The risks for people linked to MTE ingestion seem therefore significant and do not depend on the species studied.