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Thirteen years after: dynamics of trace metals in free-ranging small mammals related to soil aging (2006-2019)



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Equally contributed to the supervision of the study



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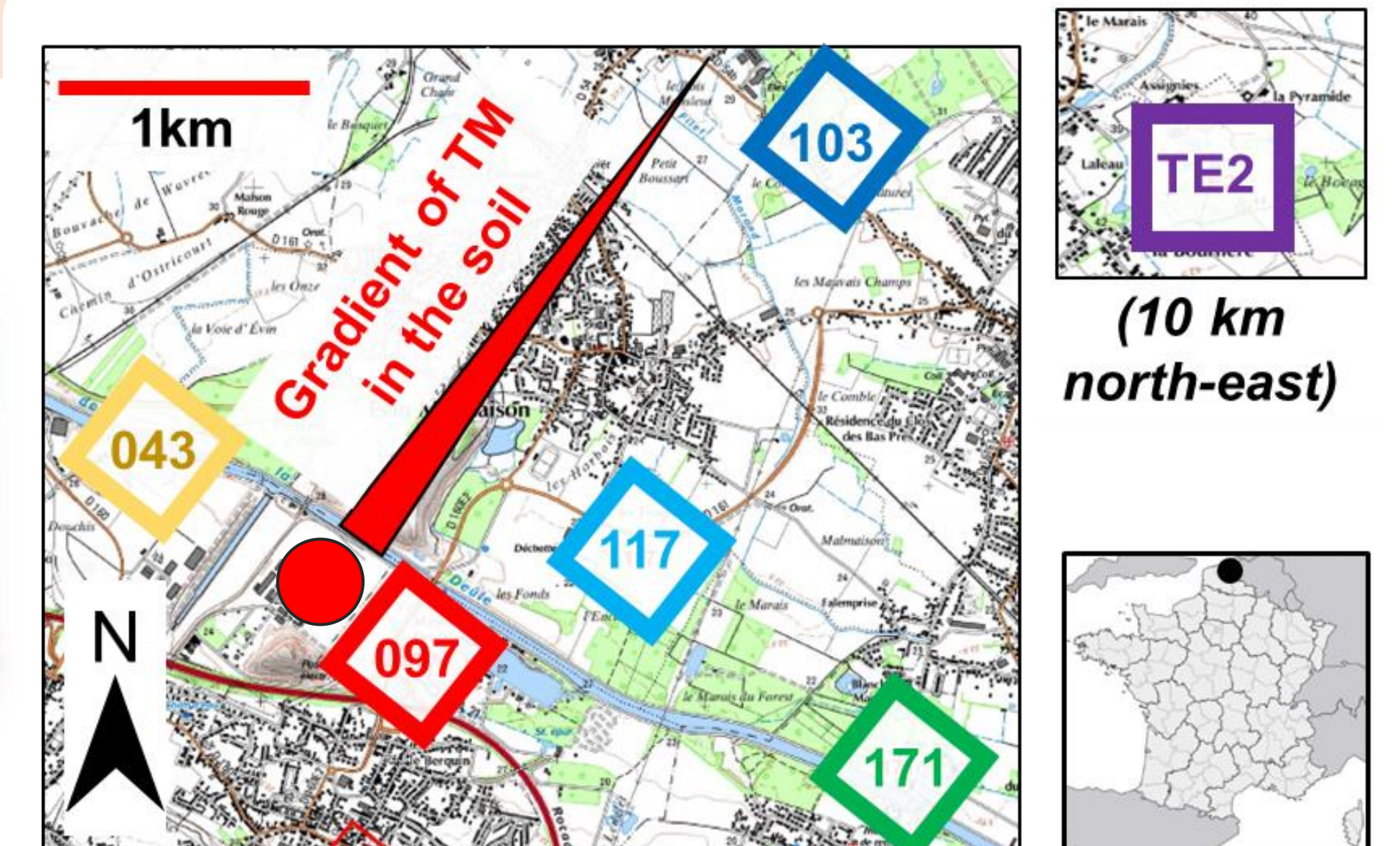
Background & Aims

The lability of **trace metals (TM)** in the soil is time-dependent, and temporal changes in metals' state are known as “**soil aging.**” However, there is no study assessing a long-term change in the environmental availability of metals and the effects of soil aging on the dynamics of bioaccumulation of TM in terrestrial wild mammals.

This study aims to estimate whether and how soil aging affects the transfers of TM in terrestrial food webs. Based on **long-term monitoring from 2006 to 2019** in metal-contaminated sites, we compared the temporal change in the availability of TM in the soil to temporal trends of TMs in small mammals' tissues.

Study sites

The study was carried out in the surroundings of the former smelter “**Metaleurop Nord**” in northern France. Samplings were undertaken at 37 woody habitats located in **six sites of 25 ha** around the smelter.



Small mammals

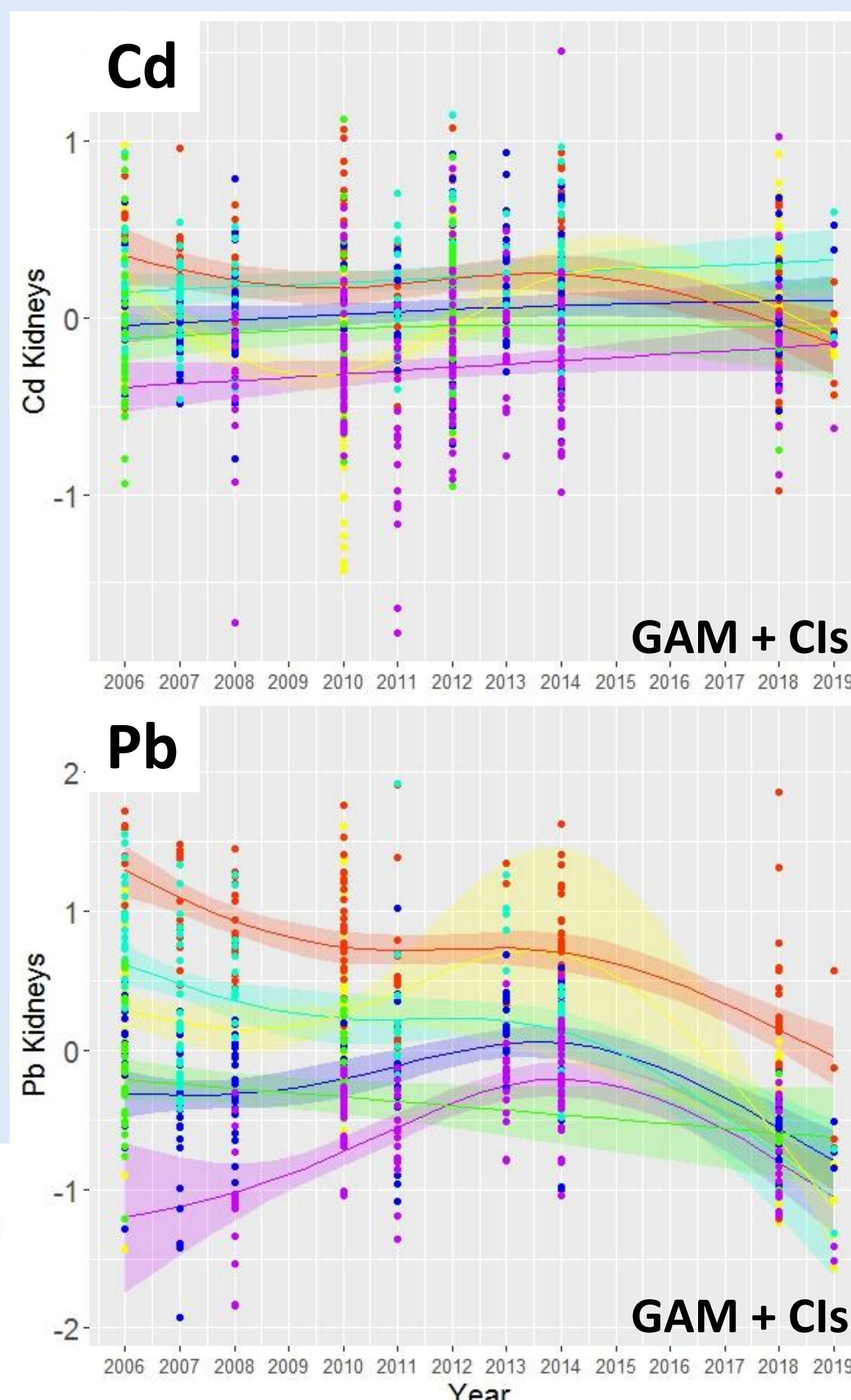
One thousand forty-five **wood mice, *Apodemus sylvaticus***, were captured from 2006 to 2019. **The total concentrations of Cd and Pb in their liver and kidneys** were measured ($\mu\text{g}\cdot\text{g}^{-1}$ dry weight) as a proxy for bioaccumulation of TM. These concentrations were normalized with age and seasons.

Cd in the tissues:

- No temporal trend was detected in the liver nor in kidneys, except for the site “097” which showed a decreasing trend.

Pb in the tissues:

- Significant decreasing trend (GAM; $p < 0.05$).
- The decreasing trend was prominent in highly contaminated sites.



Site
 097: TM level +++
 043: TM level ++
 171: TM level ++
 117: TM level ++
 103: TM level +
 TE2: Control

Bioaccumulation of Pb in tissues declined and became less contrasted among sites over time.

Soil

A composite soil sample was taken from the surface layer of the soils from the same woody patches in 2006 and 2019. **The total concentrations of Cd and Pb and their four fractions** were measured ($\text{mg}\cdot\text{kg}^{-1}$ dry weight):

F1: exchangeable fraction **F2: reducible fraction**
F3: oxidation fraction **F4: residual fraction**

Cd fractions:

- Relatively stable over time, except for the control site where F1 increased but F2 decreased.

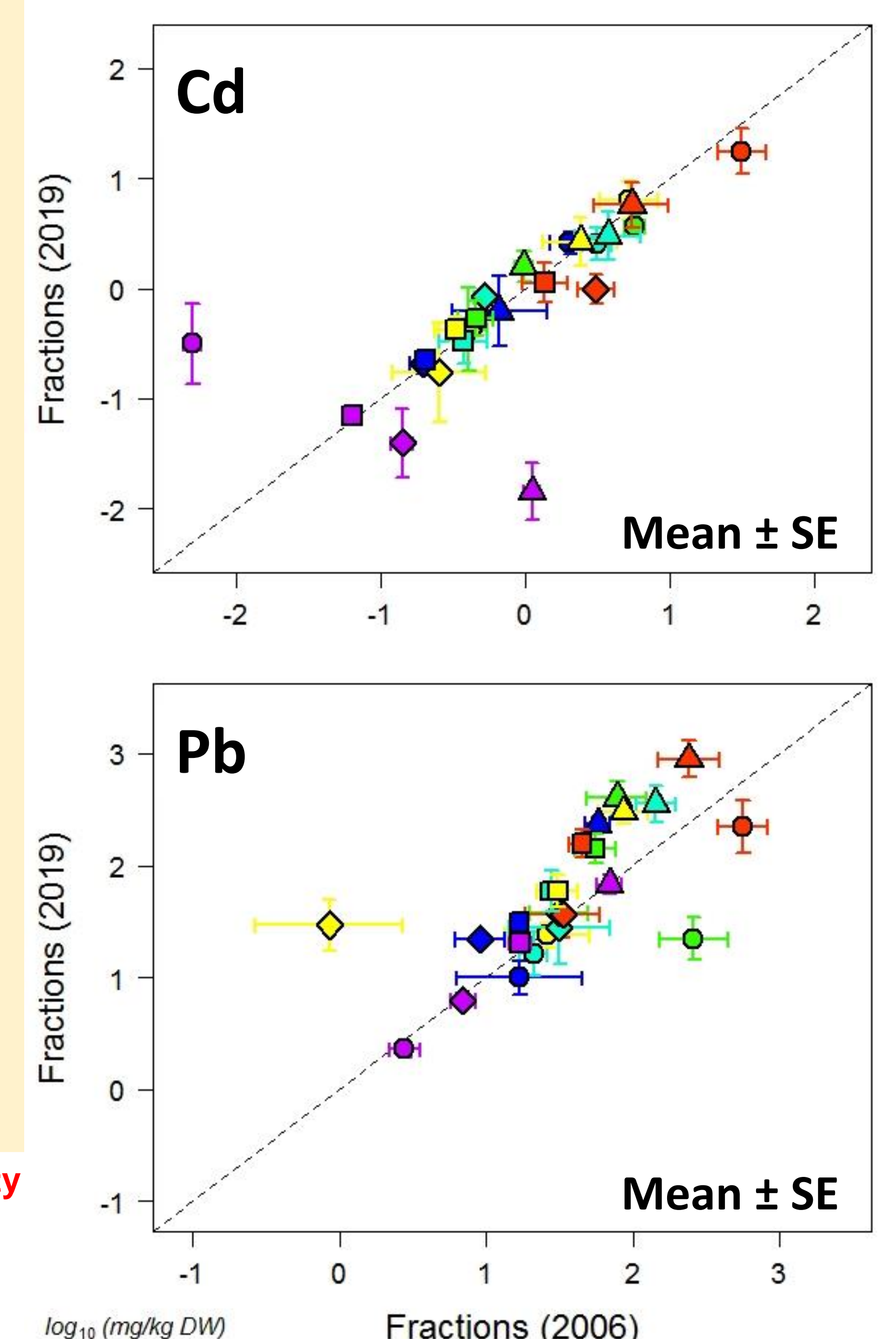
Pb fractions:

- F1 remained stable or decreased, while the less mobile fractions increased.

Total concentrations:

- No significant change (paired t-test; $p > 0.05$) in Cd and Pb.

Fraction Mobility
 ● F1
 ▲ F2
 ◆ F3
 ■ F4



In 2019, Cd became more mobile in the control site, while Pb became less mobile in contaminated sites.

Discussion & Prospects

Overall, **soil aging for 13 years could affect the availability of soil TM and the dynamics of metal transfers to biota**, which also varied between metals and study sites. Given that remediation strategies require prioritization of sites to remediate and a long-term view of their application, our findings may have important implications for risk assessment and management of polluted sites.