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DYNAMICS OF TRACE ELEMENT ACCUMULATION AT THE PLANT COMMUNITY LEVEL ALONG MEDITERRANEAN ROADSIDE SECONDARY SUCCESSION

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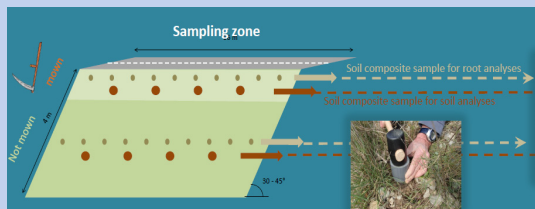


Background and aims

Material and methods

Disturbances of biogeochemical cycles as a result of human activities can lead to dramatic consequences for ecosystems. The enrichment of traffic-related trace elements (TE) in roadside environments has been a focus of concern for more than 50 years. The time is a key factor for TE accumulation in the topsoil and plants. The purpose of this study is to examine the large scale of TEs concentrations in soils and plants in close proximity to traffic to help elucidate associated elemental deposition and soil-to-root transfers along the secondary succession (the study of communities with different age). This research will mainly discuss: (1) change of TE accumulation along succession, (2) relationships between soil and plant parameters.

Study area and sampling strategy: Selected roadsides are located north from Montpellier (43°6'N; 3°8'E) in southern France. 24 road slopes (4x16 m, angle 30-45°) distributed in 5 age class groups (0-10; 11-20; 21-30; 31-40 and 41-62 years) were devised in two sampling zones (mown zone - 1.5 m, not mown zone 2.5 m large). In each zone the 5 soil samples (using cylindrical rods, 10 cm long and 5 cm diameter) and 10 root samples (cylindrical rods, 3 cm diameter) were collected in 2014 (community level). The roots were separated from soil and washed. The leaves of dominant plant species were also collected (individual level).



Soil analysis. Soil mineral composition was measured using ICP-MS method (24 elements, AETE Plate-Forme, University of Montpellier, France). The other soil characteristics were also studied: C, N, P, granulometry, CaCO₃, pH, CEC (Cesar laboratory, France)

Plant analysis. The mineral content in root and leaf digests (24 elements) was determined by ICP-MS method (AETE). Certified reference material and blank reagents were included in all series. Root trait measurements were carried out at plant community level: root dry matter content - RDMC, specific root length - SRL, mean root diameter - RD, root mass density - RMD, root length density - RLD, the percentage of fine roots - PF, the percentage of very fine roots - PVF, macronutrients (N - RN, C - RC).

Results and discussion

SOILS

□ For some of trace elements the excess of pedogeochemical level were identified at several sampling sites (in % of total site number): Cr (88), Cu (69.6), Pb (37), Cd (32.6), As (28.3), Mn (23.9), Zn (13), Co (6.5), Ni (4.3) and TI (4.3).

□ Mowing **did not induce** any significant changes in soil element content during succession, however the strong relationships between soil properties and chemical composition were identified, e.g. C organic increased with age and also by mowing, favors the mobility of ones elements (Cu), whereas pH variations, influence negatively the solubility of others (Zn, Cd).

□ PCA has identified several groups of elements according to their behavior in the soil (Fig. 1)

□ The change of element concentrations in the topsoil along secondary succession can be described by 3 models (Fig.2): (1) gradual increase over time (typical for the most of traffic-related TEs), (2) stable level (typical for most of major elements), (3) initial increase and following decline (typical for elements with high mobility and significant biological role)

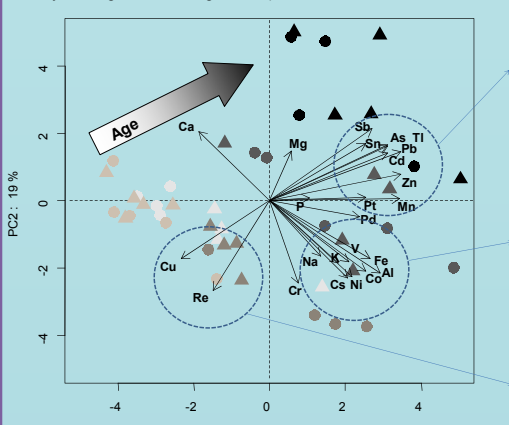


Figure 1. PCA of element content in soil (n=48)
 The points are observed traits in communities submitted to mowing (triangles) or no mowing (circles). The color intensity of the symbols increase with age

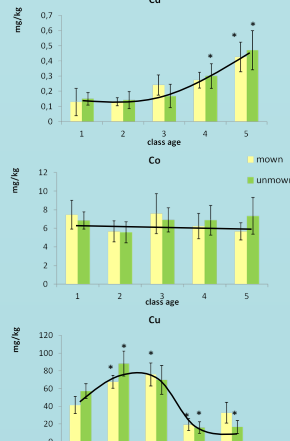


Figure 2. Dynamics of element accumulation in the soils: accumulation, stable and peak

PLANTS

□ Analysis of **BCF** (bioconcentration factor = C_{root}/C_{soil}):

<1 **excluder strategy**: V, Cr, Co, Ni, As, Re, Pt, Ti, Pb

>1 **accumulation strategy**: Na, P, K, Cu, Zn, Cd, Pd, Sn, Sb,

During the succession most of elements decreased in this index, which can be caused by (1) the inclusion of protective barrier and excluder strategies in plants (due to the change of grass fast growing communities by wood slow-growing); (2) the phytostabilisation the elements and reduce their bioavailability in the soil in consequence of increasing the organic matter content; (3) the increase of foliar path of elements uptake in late-successional stages communities - the increase of C_{leaves}/C_{root} ratio (or **TF-translocation factor**) was identified.

□ **TF** of majority of technogenic element had a strong correlation.

□ The relationship between the chemical root composition and their root morphology were revealed only for some elements (Fig. 3)

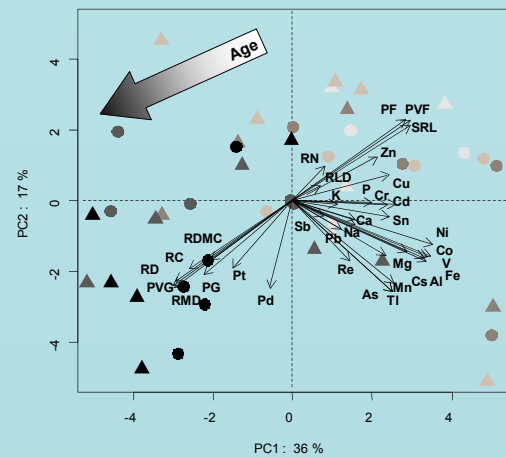


Figure 3. PCA of root chemical and morphological traits (n=46)

The points are observed traits in communities submitted to mowing (triangles) or no mowing (circles). The color intensity of the symbols increase with age.
 Root dry matter content - RDMC, specific root length - SRL, mean root diameter - RD, root mass density - RMD, root length density - RLD, the percentage of fine roots - PF, the percentage of very fine roots - PVF, macronutrients: N - RN, C - RC

CONCLUSIONS:

- > Changes in the topsoil and plant element concentrations indicate the existence of pollution sources, originating from traffic (10-12 elements)
- > The change of element concentrations in the topsoil along secondary succession can be described by 3 models in relation of origin and role of elements for plant: stable, increase or initial increase and following decline
- > The root elements uptake can be described by two strategies: accumulation or exclusion
- > The metal stabilization in the soil increased due to the organic matter accumulation, changing in soil pH and in plant uptake strategies as a result of community change during succession. The excluder strategies for plants were developed due to the change of grass fast growing communities by wood slow-growing. The increase of foliar path of elements uptake in late-successional stages communities was described for Cu, Zn, As, Cd, Pb
- > Some relationships between the chemical and morphological parameters of plant were investigated for use the obtained data in the subsequent biomonitoring

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