Concentration of toxic metals in black poplar leaves in urban environment

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INTRODUCTION

Metal pollution is one of the most critical environmental issues worldwide. The high temporal and spatial variability of metal pollution in urban environments makes it difficult to be monitored at high spatial resolution using instrumental analysis. Biomonitoring using tree leaves provides information on the metal concentration in the urban environment, at a relatively low cost. Black poplar (*Populus nigra*) is one of the most effective biomonitor tree species due to the high sensitivity of its leaves to metal pollution.

The objective of the study was to assess the toxic metal content in poplar leaves in Cluj-Napoca city.

SAMPLING AND ANALYSIS

Black poplar (*Populus nigra* L.) leaves were collected from 12 sites situated in Cluj-Napoca city, Romania. Sites P1, P4, P6, P7 were characterized by intense traffic, sites P2, P3, P9, P12 and sites P5, P8, P10, P11 by low traffic. In each site, 10–20 mature leaves from 3 branches from different sides of the outer canopy of a single tree were collected from a height of approximately 2 m. The sampled trees were of similar age and height and did not show any signs of chlorosis or necrosis.

The leaves were washed in ultrapure water, freeze-dried and powdered. Leaf powder (1 g) was digested with 5 mL of 65 % HNO_3 and 2 mL of 30 % H_2O_2 in a closed PTFE vessel MWS-3+ microwave digestion system (Berghof, Eningen).

Toxic metal contents (Cd, Co, Ni and Pb) were determined by inductively coupled plasma mass spectrometry using an Elan DRC II (Perkin Elmer) spectrometer.

CONCLUSIONS

Black poplar leaves were found to be a moderate accumulator of toxic metals (Ni, Co, Cd, Pb) in urban environments, being a suitable candidate for the metal pollution biomonitoring in urban environments.

RESULTS AND DISCUSSIONS

The Pb, Ni, Cd, and Co do not have a known role in the physiology of plants and are toxic. In the studied sites, the metal concentrations in poplar leaves varied widely, however, the phytotoxic level was not reached for any of the analyzed metals.
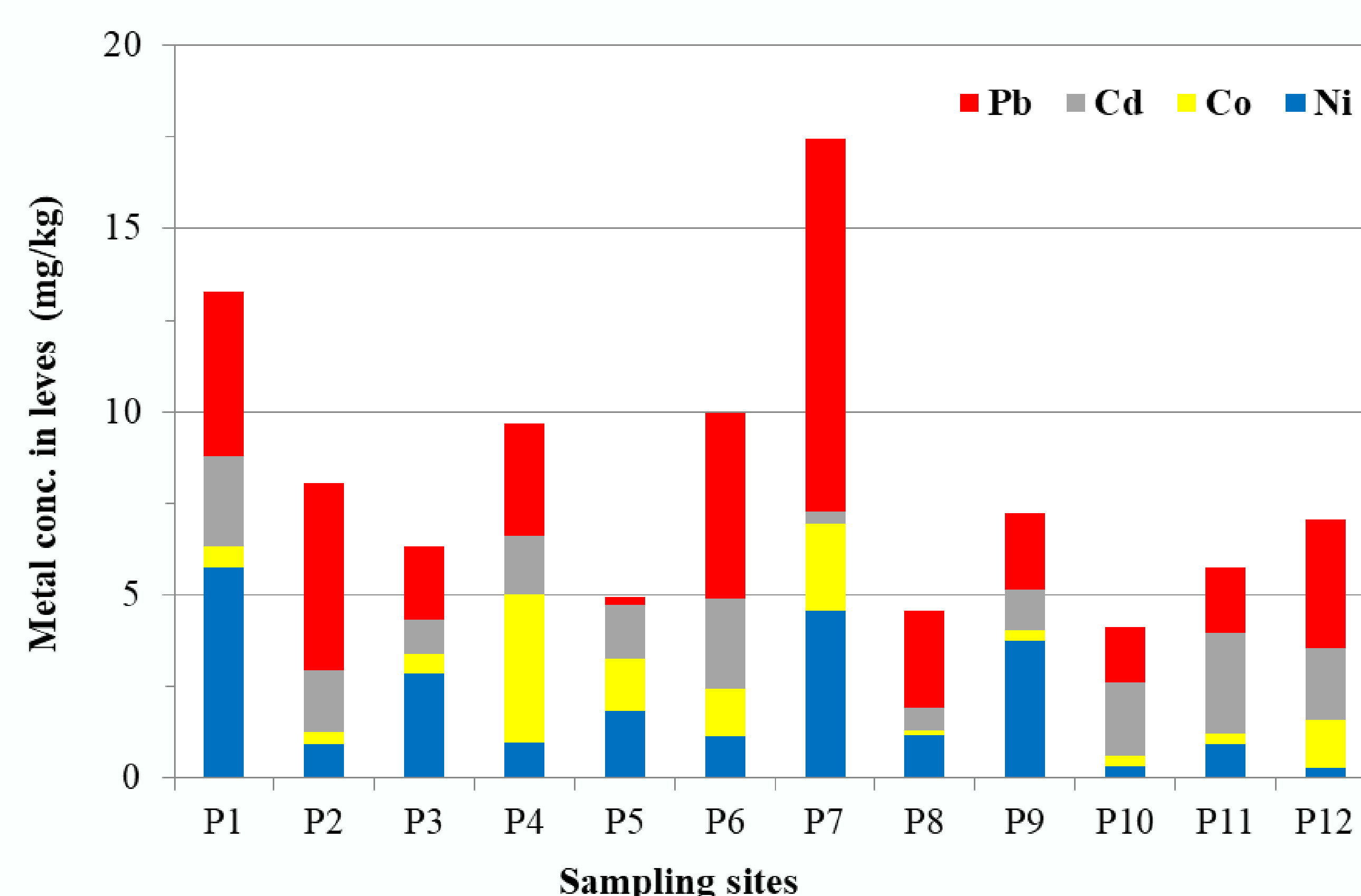

Figure 1. Concentration of toxic metals in poplar

The average concentration of toxic metals in poplar leaves decreased in the order Pb>Ni>Cd>Co, and as expected, the highest toxic metal concentrations were found in sites characterized by intense traffic.

The concentration of Cd in poplar leaves had the lowest variability (0.3-2.7 mg/kg) and was well below the usual Cd concentration in plants (<10 mg/kg). The concentration of Pb in poplar leaves varied largely (0.2-10 mg/kg), but was below the toxic threshold for plants (>20 mg/kg). The low concentration of Pb (<3 mg/kg) in half of the samples could be a consequence of the fact that the Pb uptake occurs through the root system and not by particulates deposition, whereas the Pb translocation to the aerial parts is usually low. The Ni content in poplar leaves ranged between 0.3-5.8 mg/kg but it was <3 mg/kg, in most of the samples, whereas the Co content was <2.5 mg/kg except for site P4 where it was 4.1 mg/kg.
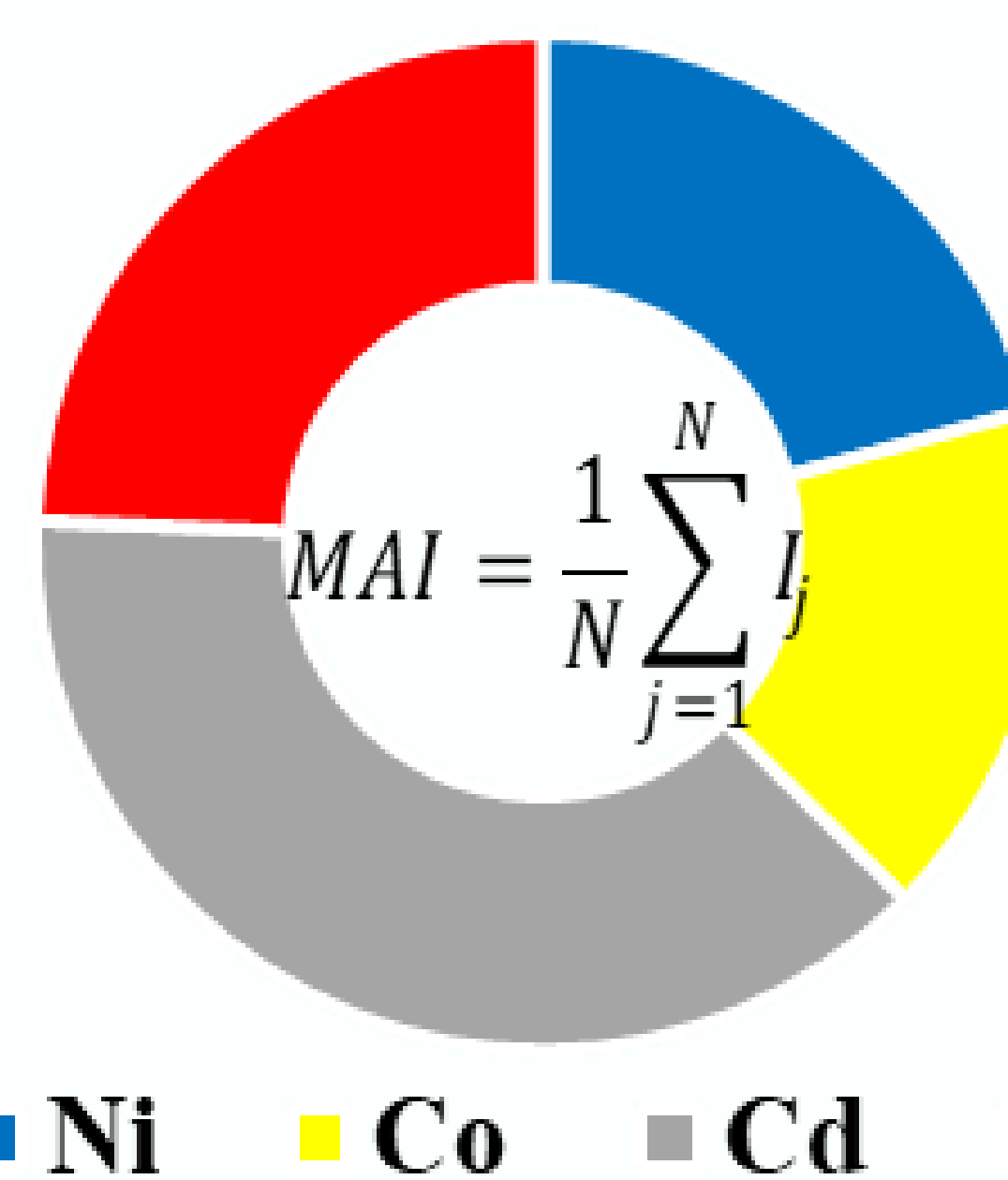

$$MAI = \frac{1}{N} \sum_{j=1}^{N} I_j$$

Figure 2. Metal accumulation index of toxic metals in poplar leaves

The metal accumulation index (MAI) for poplar species from Cluj-Napoca was 1.4, showing that poplar is a moderate metal accumulator.