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The impact of soil metal(loid) and physicochemical properties on soil microbial community structure in urban areas

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The rapid development of industry and agriculture has resulted in increased heavy metal(loid) pollution that threatens the ecosystem. Numerous environmental studies indicted high metal(loid) accumulation (e.g., As, Cd, Cu, Pb, Zn, etc.) around the urban areas alter physicochemical and biological properties of the soils. As a result, heavy metals damage the cell wall, disrupt metabolism, denatures proteins, DNA, and other functional groups by increasing oxidative stress in cells. Therefore, they are considered toxic to all living organisms, however, among them, the microorganisms are the most resistant ones.

The current study was conducted in two former industrial cities of Hungary (Salgótarján and Ózd), where both were significant brown coal, iron, and steel suppliers of the region. The main goal was to define the differences in the soil microbial communities (bacteria) across the sampling sites and cities to understand and identify the influence of the environmental factors (including metal/loid/s, soil texture, Eh, pH, organic content) on community structure and diversity.

Analysis indicated that in all the sampling sites (n=11) bacterial community was dominated by Proteobacteria, constituted of 20-28 % of the total soil bacterial community. The abundance followed by Acidobacteria (7.7-14.4 %), Planctomycetes (9-13.8 %), Actinobacteria (7.6-12.6 %), and Bacteroidetes (7-12.3 %). The Simper test analysis indicated a significant ($p<0.05$) difference (55%) in the metal content (Pb, Cd, Hg, Zn, Cr, Sn, etc.) of Salgótarján and Ózd soils, and those metal contents were significantly correlating with soil microbial community in both cities.

The results were justified by canonical correlation analysis (CCA) which explains the 15.3 % (CCA1) and 12.2 % (CCA2) variations, respectively. Observed operational taxonomic unit (OTU) differences especially exist in two sampling sites, both contaminated by various industrial contaminants, however, the rest of the samples (9 samples) indicated comparable OTU values. The similarity in the core community members between metal(loid) polluted urban and unpolluted soil samples is assumed to be the cause of long-term gained resistance against metal(loid)s. Changes in the diversity of the contaminated areas suggest that among the soil parameters, especially metals (Zn, Fe, Hg, Pb, Cd) have a significant regulatory effect on community structure.