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REVIEW PAPER

# Urban areas as emitters of potentially toxic elements to urban and suburban forest ecosystems in Poland: A review\*

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## Abstract

Heavy metals, metalloids, and many trace elements are harmful to living organisms when they accumulate above a certain level of concentration. These potentially toxic elements (PTEs) are released in large quantities in urban areas due to domestic heating, heavy traffic, industrial emissions, and municipal and industrial waste disposal. A portion of PTEs is transported to neighboring ecosystems, including urban and suburban forests, which serve as important barriers and sinks for pollutants. The impact of PTEs extends to both abiotic and biotic ecosystem components, as well as to human populations that benefit from forest ecosystems. This paper aims to characterize Polish urban areas as sources of PTEs and the channels through which PTEs flow from urban areas to urban and suburban forest ecosystems, with a focus on the existing national literature. The potential consequences of pollution of urban and suburban forests by PTEs are also discussed. Published Polish studies do not allow for a full qualitative and quantitative assessment of PTEs entering forest ecosystems from urban areas via different channels (air, water, human-related channels). National monitoring and scientific investigations have focused primarily on Al, As, Cd, Cu, Fe, Hg, Mn, Ni, Pb and Zn. Many other PTEs have been surveyed less frequently and irregularly. The transfer of PTEs via water and human-related channels is not extensively addressed in the national literature. A more comprehensive approach to this topic is needed in future studies.

**Keywords:** heavy metals, trace elements, urban ecosystems, forest ecosystems, element flow, pollution

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