



Environmental risk assessment of heavy metal air pollution in Serbian spruce (*Picea omorika*) ecosystems

Jelena Beloica · Snežana Obradović ·
Milan Medarević · Nevena Čule ·
Stefan Miletić · Predrag Miljković

Received: 26 March 2025 / Accepted: 28 June 2025 / Published online: 10 July 2025
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2025, corrected publication 2025

Abstract This paper aims to analyze the patterns and dynamics of long-term atmospheric pollution (deposition of Pb, Cd, and Hg) and its impact on *Picea omorika* (Pančić) Purk (Serbian spruce) forests in Tara National Park. Due to changing ecological conditions, these relict-endemic forests have experienced significant habitat loss and fragmentation of their last remaining refugia. In this study, we analyze heavy metal deposition patterns and dynamics and the content of these metals in the Serbian spruce forest (soil and biomass). The heavy metal content was analyzed and compared with ICPF (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) data across Serbia, revealing the level of environmental risk these ecosystems face from air pollution in comparison to other forest ecosystems in the country. Four Serbian spruce forest clusters stand out compared to others,

with the highest long-term heavy metal deposition and elevated levels of lead, cadmium, and mercury detected in both soil and biomass at these sites. These findings may serve as a guide for identifying priority locations for future monitoring, facilitating the implementation of the Critical Loads concept. It also highlights the need for revision of forest management practices in protected areas and the implementation of buffer zones.

Keywords *Picea omorika* · Heavy metals · Air pollution · Tara National Park · CLRTAP · Environmental monitoring

Introduction

Air pollution in the past decades has been one of the most significant factors affecting the health of the forest ecosystem (Johansson et al., 2001; Hernandez

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10661-025-14355-1>.

J. Beloica (✉) · S. Miletić · P. Miljković
Faculty of Forestry, Department of Ecological Engineering for Soil and Water Resources Protection, University of Belgrade, Belgrade, Serbia
e-mail: jelena.beloica@sfb.bg.ac.rs

S. Miletić
e-mail: stefan.miletic@sfb.bg.ac.rs

P. Miljković
e-mail: predrag.miljkovic@sfb.bg.ac.rs

S. Obradović · M. Medarević
Faculty of Forestry, Forestry and Nature Protection, University of Belgrade, Belgrade, Serbia
e-mail: snezana.obradovic@sfb.bg.ac.rs

M. Medarević
e-mail: milan.medarevic@sfb.bg.ac.rs

N. Čule
Department of Environmental Protection and Improvement, Institute of Forestry, Belgrade, Serbia
e-mail: nevena.cule@forest.org.rs