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# Trees' response to anthropogenic environmental changes: bio-monitoring of industrial area nearby nitrogen plant in the most industrialized part of Poland

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## Abstract

Trees can provide annual records of ecosystem changes connected with human activity over several decades. The main objectives of this study were: to analyse (1) record of historical contamination and (2) biological adaptation of pine to environmental contamination in the area nearby chemical and nitrogen factories in Kędzierzyn-Koźle during the period of industrial development and implementation of pro-ecological policy in Poland. The conifers investigated in this study covered the time span from 1920s to 2010 AD.

The stable carbon and oxygen isotope compositions of the samples were determined using an IsoPrime elemental analyzer/ Continuous flow isotope ratio mass spectrometer (GV Instruments, Manchester, UK) at the Mass Spectrometry Laboratory of the Silesian University of Technology, whereas radiocarbon were determined using Accelerator mass *spectrometry* at the DirectAMS, Seattle, USA. Radial trace-element profiles were determined by the Laser-Ablation Inductively Coupled with Plasma-Mass Spectrometer (Laser ablation: New Wave Research UP-193 FX Fast Excimer, ICP-MS: Thermo Scientific X-Series2 with CCT -Collision Cell Technology) at Royal Museum for Central Africa (Belgium). LA-ICP-MS provides a repeatable, minimally destructive, sensitive method for determining many elements in wood tissue, with relatively high spatial resolution.

The study reveals significant changes in tree ring width, carbon and oxygen stable isotopes, radiocarbon and chemical composition (Na, Mg, Fe, Ni, Cu, Zn, Pb) of living pines (*Pinus sylvestris* L.). Data of pine tree cores collected from the area nearby chemical and nitrogen factories in Kędzierzyn-Koźle show increasing levels of pollution, linked to the increasing of industrial activities in Poland and subsequent dust fallout around the site. The combined usage of tree ring width and dendrochemical composition data provides historical records of anthropogenic impact on the environment and allows to identify the behaviour adaptation to the contamination. This study evidences that tree rings can be used as complementary archive of past environmental contamination.

**Keywords:** Trees; pollution; stable isotopes; radiocarbon; dendrochemical analysis