Oecologia Montana 2016, **25,** 33-38

Heavy metals and other elements in the *Pinus sylvestris* needles – Ružomberok

P. VÁCLAVÍK, M. KMEŤOVÁ and M. JANIGA[1]

Institute of High Mountain Biology, University of Žilina, SK-059 56 Tatranská Javorina 7, Slovak Republic, [1]corresponding author: janiga@uniza.sk

Abstract. In our work we examined the use of needles *Pinus sylvestris* as the bioindicator of pollution in Ružomberok. One-year, two-year and three-year needles were collected during the years 2011 and 2012 during autumn, spring and summer months in two sampling locations (Mních and Hrboltová). The samples were dried, ground and X-rated in the XRF spectrometer Delta. The resulting data matrix was evaluated by the program STATISTICA 10. From the analysis made, we tried to determine the level of concentration of pollution and to examine the consequences and causes of contamination and the impact of Mondi SCP on this pollution. Probably, the pollution of needles is unrelated with the impact of local paper factory, but with the global pollution of the area. The concentration of Cr, Pb, Mo, S, K, Zn does not depend on the sample locality. The concentration of K, Cl and S in relation to Mn is influenced by the presence of the paper plant in the Liptov Basin. The accumulation of K, Cl, S is raising when the growing season begins.

Key words: bioindicators, *Pinus sylvestris*, heavy metals, Ružomberok, Mondi SCP

Introduction

During the last decades we have seen an increase of paper production, which can have no other effect than an only adverse impact on air, soil and water (Vall 2006). The location of the factory Mondi SCP, a. s. in the Liptov Basin is very hazardous; due to the lack of winds in the atmosphere, emissions are concentrated in the area and the air pollutants contained in precipitation have an adverse impact on the environment.

In the industrial production, pollutants are getting into the environment. Pollutants such as heavy metals, e.g. Pb, Cu, Cr, Ti, Cd as well as S and Cl have an adverse impact on the environment and biota and their accumulation in plant tissues and animal tissues, diseases of parts (Giertych *et al.* 1999).

Plants which accumulate heavy metals can explore our advanced technology when they are used as bio-indicators (Kuang *et al.* 2006). Pine is an excellent bioindicator because of its wide distribution and easy identification, inter alia, these are evergreen trees, whose needles do not fall off under normal conditions. Most studies have focused on the chemical composition of needles, where most of the elements reached their highest concentrations. The element content in the needles was often studied as part of wider studies concerning various issues, e.g. air and soil pollution (Dmochowski and Bytnerowicz 1995; Rautio *et al.* 1998). It is known that Scots Pine (*Pinus sylvestris*) is a good bioindicator, so this kind of plant is used in the case of research surrounding Mondi SCP, a. s. namely from the top of the Mních Hill and the neighbouring Hrboltová village.

Industrialization and urbanization result in the release of gaseous and particulate pollutants such as sulphur and heavy metals. These have been reported to cause abnormalities in the nutrient status of conifers (Rautio *et al.* 1998) and also to reduce plant growth and development at high concentrations, causing the death of plants in extreme cases (Yilmaz 2004). Changes in calcium concentrations have been found to be a general physiological response of plants to metal toxicity (Nieminen and Helmisaari 1996). Pine is an excellent bioindicator because of its wide distribution and easy identification, inter alia, these are evergreen trees whose needles do not fall off in normal conditions. Most studies have focused on the chemical composition of needles where most of the elements reached their highest concentrations. The element content in the needles was often studied as part of wider studies concerning various issues, e.g. air and soil pollution (Dmochowski and Bytnerowicz 1995; Kurczyńska *et al.* 1997; Rautio *et al.* 1998). It is known that pollutants are in a tree receiving the land, but many times the aerial parts of the plant contain a much larger value of pollutants than the actual soil solution (Ma *et al.* 2001), therefore the plants accumulate heavy metals and the air. To determine the exact source of the contamination is very difficult, practically impossible (Oliva and Espinosa 2007). Changing the concentration of pollutants in needles is directly proportional to the change in concentration in the atmosphere (Pacyna *et al.* 2009). It is known that trees are not the best indicators for monitoring the air pollution when compared to lower plants (fungi, algae, lichens or mosses), but they are widely distributed in many countries as the major plant type of polluted urban areas (Wittig 1993). A huge advantage of trees as bio-indicators is that they live a long time, so they can observe the changes, but these changes can be examined only after a certain time from the beginning of pollution. From leaves