

# Heavy metals and other elements in the different types of precipitation - Ružomberok experimental area, Liptov, Slovakia

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**Abstract.** From the acquired results of environmental monitoring and analyses of 117 samples of air water, 50 samples of rain water and 29 samples of solid water sampled from the sample plot Lisková, situated almost 2 km from the company Mondi SCP, a.s. (Ružomberok), we may assume the following concluding points: From the chosen elements of S, P, Cl, Ca, K, Ti, Mn, Cr, Fe, Ni, Co, Cu, As, Zn, Rb, Zr, Sr, Mo, Cd, Ag, Sn, Ba, Sb, Pb and Hg the acquired concentrations (ppm) were higher than the detection limits of the used X-ray fluorescence spectrometry only in cases of Cl, Ca, K, Ti, Mo, Rb, Sb, S and Sn. One factor ANOVA also showed that the concentration of K in samples of snow decreased with the increasing age of snow or temperature at sampling. This relationship remains unconfirmed from a statistic point of view for the other elements. Higher levels of chlorine were present in a liquid form - rain water, air water. In solid water (ice, snow) the levels were lower. Chlorine occurred more in places where sulphur was not detected, which was in contrast with the places, where sulphur was detected. Chlorine cumulated in an increased manner in an environment where CO<sub>2</sub> levels were higher, temperature was higher and there were higher levels of O<sub>3</sub> in the air. Less chlorine occurred in an environment at times when the air was very humid and partly accompanied with increased dustiness. The variance of potassium amount did not correlate with this phenomenon. Sulphur correlated almost absolutely with an increasing or decreasing amount of PM<sub>10</sub> particles.

*Key words:* solid water, air humidity, rain, inorganic pollutants, alloys, pollution, deposition, Ružomberok, X-ray fluorescence spectrometry

## Introduction

This work is focused on retaining inorganic pollutants in snow, fog, frost cover, air humidity and rain. The main objective was to evaluate the impact of Mondi SCP, a.s. within the distribution of inorganic substances, especially metals from snowfall, fog, rain, frost cover and air humidity at places lying close to the Ružomberok - Lisková area.

Mondi SCP, a.s. in the town of Ružomberok is one of the biggest Slovak plants. It is the largest

manufacturer of paper and pulp in Slovakia and its production capacity is 560,000 metric tons of uncoated paper, 66,000 metric tons of wrapping paper and 100,000 metric tons of market pulp (www.mondigroup.com 2016).

The processing industry of paper and pulp demands a lot of water and energy, which causes releasing of different inorganic substances or organic compounds into atmosphere and water sources. In regard to the fact that fog, air humidity, snow and rain are active mediums, which can bring over gases and particulates from atmosphere in the land, rain, snow, air humidity and fog can also be an appropriate indicator of different particulates and compounds, accumulations and deposits. In this respect accumulations reflect the chemistry of atmosphere.

Heavy metals, which originate in human activities, become various environmental components and they are considered as a serious problem because they are not biologically decomposed, they are toxic and get in food chains. The agency for toxic substances and the register of diseases recorded arsenic (As) on the first position, plumbum (Pb) on second place and mercury (Hg) on third place in the register of the most dangerous substances on the basis of frequencies, toxicity and occurrence in environment, which can consequently affect human health (ATSDR 2016). Thanks to that monitoring is growing because of the adverse effects from heavy metals on the mentioned human health and ecosystems as such.

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The aim of this study is to find out the anthropogenic impact on environment and to improve the quality and impact of the company Mondi SCP. This work coincides with the scientific research of the Institute of High Mountain Biology, University of Žilina, Slovakia.

## Material and Methods

### *Description of sampling sites and samples obtained snow samples*

The samples of solid water, rain water and air humidity (Table 1) were collected from the selected locality of the Lisková village (N49° 05' 26'' and E19° 20' 56''), next to the company Mondi SCP, Inc. (altitude above sea-level: 480 m; coordinates: N49° 04'43'' and E19° 18'30''V). The location is marked on the satellite image by the yellow star. The company Mondi SCP, Inc. is marked by the









