

THE APPLICATION OF *TARAXACUM OFFICINALE* FOR MONITORING OF SOIL POLLUTION IN MOUNTAIN AREAS – PRELIMINARY REPORT

Alicja Kicińska

AGH – University of Science and Technology, Faculty of Geology, Geophysics and
Environment Protection, A. Mickiewicza 30 Ave., 30-059 Kraków, Poland,
e-mail: kicinska@geol.agh.edu.pl

Abstract: *In the Beskid Sądecki Mountains samples of dandelion *Taraxacum officinale* and soils were collected and analyzed for Cd, Cr, Pb and Zn contents. These elements originate from combustion of fuels and from other pollution-generating operations and activities. In soil samples contents of analyzed elements exceed considerably the natural background. Moreover, in a few samples the contents of analyzed metals are higher than permissible values for agricultural soils. In plant samples the contents of analyzed elements corresponds to natural background values quoted in the literature except for Pb, which exceeds the upper limit in over 50 % of analyzed samples. The analytical results were processed with the factor analysis tools and correlation coefficients were calculated, as well. The results allow the author to conclude that *Taraxacum officinale* can be used as bioindicator of the quality of environment, particularly for Zn and Pb.*

Keywords: *Taraxacum officinale*, soil, trace metals, Beskid Sądecki Mts.

INTRODUCTION

Biomarkers or bioindicators are plant species which common occurrence and rate of reaction on environmental stress caused by pollution are used for the monitoring of the quality of environment (Bell, Treshow 2002; Lin, Yu 2008; Maciak 2003). In the Beskid Sądecki Mts. samples of dandelion *Taraxacum officinale* and soil samples were collected and analyzed for Cd, Cr, Pb and Zn contents. These elements originate from combustion of fuels and from other pollution-generating operations and activities (Dueck 1986; Haiyan, Stuanes 2003; Kicińska-Świdorska et al. 2005). The research aimed to check the hypothesis that *Taraxacum officinale* can be use as a good bioindicator of traffic pollution.

The Beskid Sądecki Mts. belong to the Western Carpathians. The mountain range occupies an area of 670 km² and has population approximately 200,000 from which 18.5 % lives in urban areas and the remaining 81.5 % occupies rural areas. It is built of flysch sediments of the Magura Unit representing two subunits: Krynica and Bystrica. Five SPA-resorts are located

in the mountains. Due to outstanding values: mineral waters resources, high forestation rate (about 70 %) along with animate and inanimate nature resources, the Beskid Sądecki Mts. is protected as the Poprad Landscape Park (since 1989). Moreover, there exists the Poprad Habitat area protected as a part of the NATURE 2000 project.

METHODOLOGY AND SAMPLING PROCEDURE

The sampling procedure followed the principles of representativeness and repeatability. Hence, samples of dandelion and soil were collected from the same sites, every 5 km along the main roads of the Beskid Sądecki Mts. (for sample location see fig. 1).

The soil samples (n = 92, weight of each sample ca 0.5 kg) were collected from the topsoil layer (0 – 20 cm depth interval), from the grooves cut at each of side of a triangle (length 0.5 m). The soil samples were air-dried, homogenized, grounded < 1 mm fraction and separated with 1 mm nylon sieve. Weighted amounts of 0.5 g were digested with 10 ml of 65 % HNO₃ and 2 ml of 30 % H₂O₂. Samples were mineralized in the NDS–2000 microwave stove under 3-steps pressure of 90, 100, 110 psi, then filtered and diluted with distilled water to a volume of 50 mL. The total Cd, Cr, Pb and Zn contents were analyzed with the Elan 6100 PerkinElmer ICP-MS instrument.

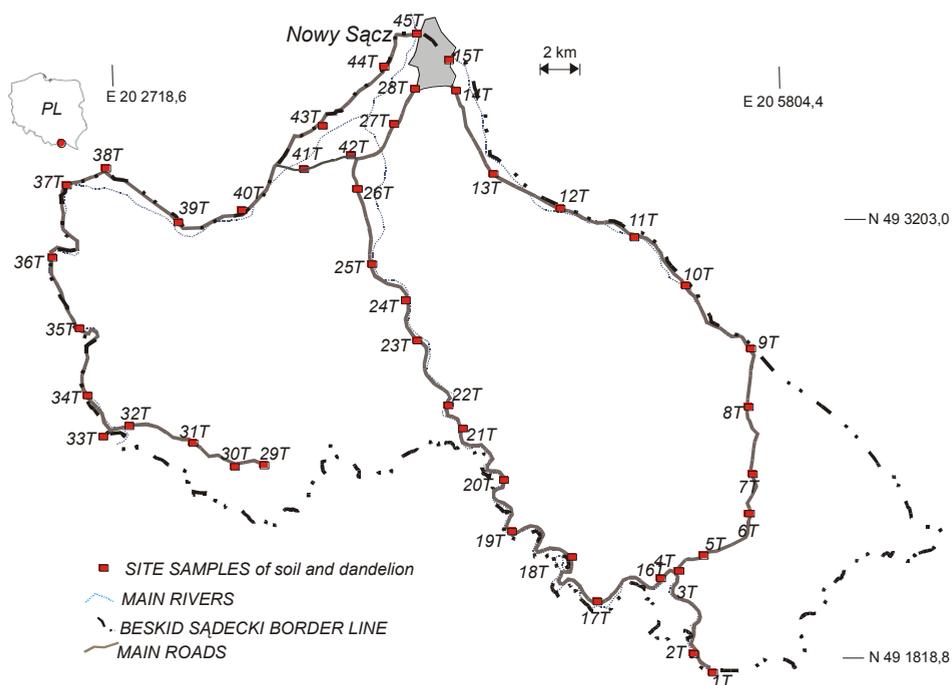


Fig. 1: Localization of soil and plant samples collected from the Beskid Sądecki Mts.

Plants were sampled in September. Dandelion *Taraxacum officinale* samples (n = 92) were taken as the whole plants (excluding root system), then mixed and cut into small pieces. Plant samples were washed with the same volume of distilled water, drained and then mixed. The plant material was digested due to the 3050B-EPA procedure. After air-drying the weighed samples were cut into small pieces, mixed evenly and dried at 105 °C for 2 hours until constant weights were reached. About 1 g of each sample was dissolved with 2 mL H₂O and 10 mL concentrated HNO₃, mineralized under 95 °C for 2 hours, then added with 10 mL 30 % H₂O₂, diluted to a volume of 50 mL with distilled water and analyzed for the total content of Cd, Cr, Pb and Zn with the Elan 6100 PerkinElmer ICP-MS instrument.

RESULTS

The concentrations of measured elements in topsoil samples varied from (in mgkg⁻¹): 76 to 541 for Zn, 13 to 119 for Pb, 0.1 – 5.3 for Cd and 18 to 49 for Cr (see tab. 1). The higher concentrations of Zn, Pb and Cd were measured in samples located near parking lots and next to bus-stations. Measured concentration of Zn, Pb and Cd in analyzed soils samples were higher than natural background values recommended by Kabata-Pendias and Pendias (1999). Chromium concentrations in soils generally related to natural factors, mainly the geological structure of the Beskid Sądecki Mts.

The concentrations of Zn, Pb and Cr in plants material were significantly lower than in corresponding soils samples. The zinc content varied (in mgkg⁻¹) from 2 to 83, lead – from 0.5 to 27 and Cr – from 0.7 to 12. The arithmetic means calculated for measured elements are 3 – 10 times lower than those found in soils samples. In over 50 % of plant samples measured Pb concentration were higher than the natural background recommended by Kabata-Pendias and Pendias (1999). The alarming results were obtained for chromium. Concentrations higher than 5 ppm are considered as toxic for plants (Adriano et al. 1997). In the following research Cr concentrations exceeding 5 ppm were indicated in 11 % of analyzed dandelion samples. At two sampling sites (both in Nowy Sącz – the largest town in the Beskid Sądecki Mts.) Cr concentration reached even 11.8 to 12.4 mgkg⁻¹.

DISCUSSION

Concentrations of trace metals in soils and plants were processed statistically with the Ward's method (accepting the Euclidean distance) using the Statistica software (Noori et al. 2010; Yay et al. 2008). For each sample population two groups of samples (group I and group II) were allocated in dendrograms (see fig. 2).

Tab. 1: Trace metals contents in soils and plants from the Beskid Sądecki Mts. (in mgkg^{-1})

Statistical parameters	Content in dandelion				Content in soils			
	Zn	Pb	Cd	Cr	Zn	Pb	Cd	Cr
minimum	2.0	0.5	0.1	0.7	76.4	13.1	0.1	18.2
maximum	82.8	26.8	0.8	12.4	540.7	118.6	5.3	48.8
arithmetic mean	41.5	5.2	0.3	3.1	207.3	54.5	1.0	29.2
median	39.7	3.6	0.3	2.2	186.6	48.1	0.7	27.7

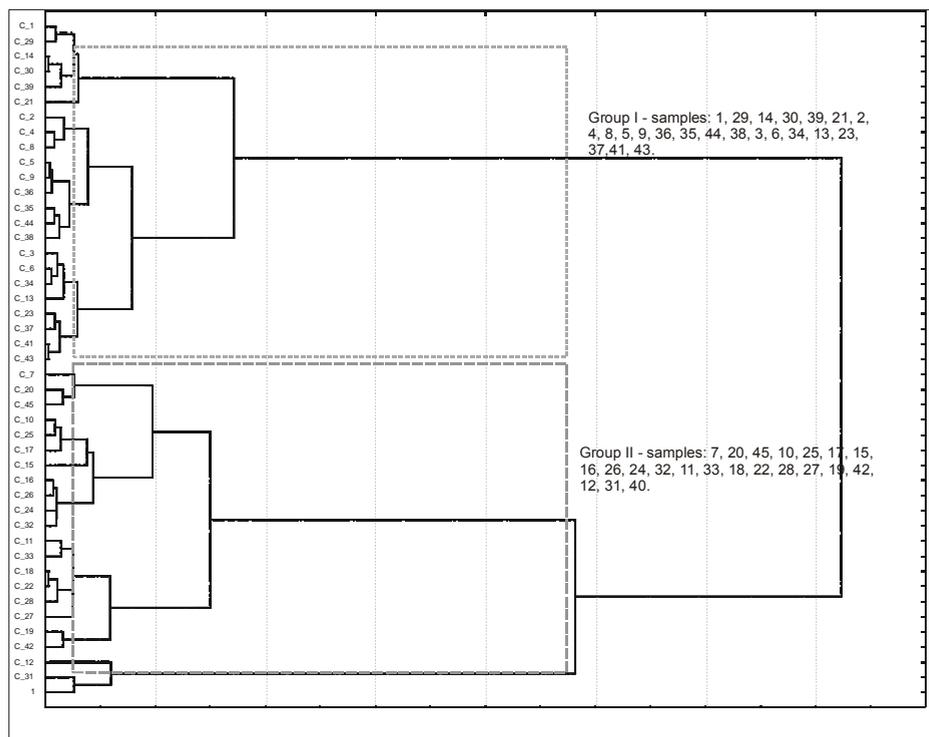


Fig. 2: Dendrogram of Zn, Pb Cd and Cr concentrations in soil and dandelion samples

For both groups of samples arithmetics average and means were calculated and statistically important differences in contents of measured trace metal were sought (tab. 2). The results demonstrate significant differences in concentrations of Zn, Pb, Cd and Cr. In samples which belong to the group I, contents of Zn and Cd are approximately 20 % less than in samples form group II whereas Cr content is lower by 35 %. Highest differences were measured for Pb contents – in soil and plants samples of group I concentrations of that metal were lower by about 55 %.

A wide range of concentrations of measured elements (particularly Zn, Pb and Cr, tab. 1) in samples of dandelion *Taraxacum officinale* deserves particular attention because of possible migration of metals into the food chain. Most of study area is a farmland or pasture (Kabata-Pendias, Mukherjee 2007; Sawicka-Kapusta 2007) and local residents produce and sell honey, fruit liqueurs or jam.

Tab. 2: Statistical parameters of Zn, Pb, Cd and Cr concentrations in assigned sample groups (I, II, see fig. 2) (in mgkg⁻¹)

		Dandelion samples				Soils samples			
		Zn	Pb	Cd	Cr	Zn	Pb	Cd	Cr
group I	average	37.9	3.14	0.30	2.52	147.2	33.59	1.01	31.07
	median	37.0	3.00	0.24	2.36	153.4	34.75	0.69	31.29
group II	average	46.2	7.08	0.37	3.81	272.4	72.96	1.17	28.60
	median	47.2	4.74	0.29	2.48	240.9	62.92	1.09	27.57

CONCLUSION

Preliminary analysis of obtained data allows for the ambiguous statement that dandelion species *Taraxacum officinale* demonstrates the following properties:

- it is a dominant species,
- it enables the evaluation of pollution in short time intervals,
- it shows the quick, explicit reaction against stress factors.

Final conclusion is that dandelion *Taraxacum officinale* should be used as a bioindicator for monitoring the changes in quality of environment in areas used for recreation and agriculture.

CLOSING REMARK

The paper is a preliminary presentation of the results of research project conformed to rather limited space of publication. Profound discussion, based on analysis of all factors and conditions affecting the contents of analyzed elements will be given in a separate, extended publication.

ACKNOWLEDGEMENT

This study is a part of the AGH – University of Science and Technology research project No. 11.11.140.447.

REFERENCES

- Adriano D. C., Chen Z. S., Yang S. S., Iskandar I. K. 1997. Biogeochemistry of Trace Metals. Northwood, Science Reviews.
- Bell J. N. B., Treshow M. 2002. Zanieczyszczenie powietrza a życie roślin. Wydawnictwo Naukowo-Techniczne, Warszawa, pp. 1-521. [In Polish]
- Dueck T. 1986. Impact of heavy metals and air pollutants on plants. Free university Press, Amsterdam, pp. 1-159.
- Guha M. M., Mitchell R. L. 1966. The trace and major element composition of the leaves of some deciduous trees. *Plant and Soil* 24 (1), pp. 90-112.
- Haiyan W., Stuanes A. O. 2003. Heavy metal pollution in air-water-soil-plant system of Zhuzhou city, Hunan province, China. *Water, Air, and Soil Pollution* 147, pp. 79-107.
- Kabata-Pendias A., Mukherjee A. B. 2007. Trace elements from soil to human. Berlin, Springer.
- Kabata-Pendias A., Pendias H. 1999. Biogeochemia pierwiastków śladowych. Warszawa PWN. [In Polish]
- Kicińska-Świdorska A., Bazarnik K., Kowalska J. 2005. The structure of road traffic and lead concentrations in Krynica soils In: GEOTOURism – new dimensions in XXI century tourism and chances for future development: 2nd international conference, Kraków, Poland, pp. 68-69.
- Lin J., Yu D. 2008. Traffic-related air quality assessment for open road tolling highway facility. *Journal of Environmental Management* 88, pp. 962-969.
- Maciak F. 2003. Ochrona i rekultywacja środowiska, Wyd. SSGW, Warszawa, pp. 59-83. [In Polish]
- Noori R., Karbassi A., Sabahi M. S. 2010. Evaluation of PCA and Gamma test techniques on ANN operation for weekly solid waste prediction. *Journal of Environmental Management* 91, pp. 767-771.
- Sawicka-Kapusta K. 2007. Zanieczyszczenie środowiska przyrodniczego w Polsce. In: Integralna Ochrona Przyrody, IOP, Kraków, pp. 143-146. [In Polish]
- Yay O. D., Alahga O., Tuncel G. 2008. Multivariate statistic to investigate metal contamination in surface soil. *Journal of Environmental Management* 18, pp. 581-594.