

## **Deposition of Air Pollutants to Forest Ecosystems Along Pollution and Climatic Gradients in Poland**

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### **Abstract**

Measurements of bulk deposition, throughfall and soil solution were taken at six permanent plots located in spruce and/or pine stands along pollution and climatic gradients. The investigation was accompanied by continuous measurements of SO<sub>2</sub> and NO<sub>2</sub> concentration in the air. Concentrations of sulphur and nitrogen in pine and spruce needles were determined. Health quality of forests stands was assessed. Annual loads of sulphur and nitrogen compounds reaching the forest ecosystems were calculated.

### **1. AIM OF THE STUDY AND METHODS APPLIED**

The aim of this study is to determine the direct and indirect effects of air pollutants to forest ecosystems. Concentration of sulphur dioxide and nitrogen dioxide are measured. Bulk deposition, throughfall and soil solution are collected at six permanent forest plots.

Both annual mean concentration and load of pollutants: sulphur and nitrogen were calculated. Permanent plots were established in spruce (Brenna - the Beskidy Mountains and Smóldzino - the Baltic Sea shore) and pine stands (Katowice, Woźniki - Upper Silesia, Puszczykowo - Central-West Poland, and Smóldzino). Pollution and climatic gradients are represented by the South - North locations.

Methods recommended for Integrated Monitoring for Northern Countries and ICP Forests (under the Convention on Long Range Transboundary Air Pollution) have been used.

### **2. RESULTS AND CONCLUSIONS**

The highest concentration of sulphur dioxide and nitrogen dioxide was found at the Katowice site, followed by Puszczykowo and Brenna. The lowest concentration of air pollutants was found at the Smóldzino site (Tab.1). The Polish standard for SO<sub>2</sub> (annual mean - 32 µg m<sup>3</sup>), has been violated in Katowice only.

Bulk deposition, throughfall and soil solution from all locations are acidic, ranging from 3.32 in soil solution in Smóldzino (spruce stand) to 4.79 in soil solution in Smóldzino (pine stand). In spruce stands, a decrease in the throughfall pH when compared to bulk precipitation was

Table 1

Concentration of SO<sub>2</sub>, NO<sub>2</sub> in the air and sulphates, nitrates and ammonium in rainfall and soil solution from different locations along a pollution and climatic gradients in Poland.

	Air [ $\mu\text{g}/\text{m}^3$ ]		Bulk [ppm]			Throughfall [ppm]			Soil solution [ppm]		
	SO <sub>2</sub>	NO <sub>2</sub>	SO <sub>4</sub>	NO <sub>3</sub>	NH <sub>4</sub>	SO <sub>4</sub>	NO <sub>3</sub>	NH <sub>4</sub>	SO <sub>4</sub>	NO <sub>3</sub>	NH <sub>4</sub>
Brenna	25.59	7.23	4.45	2.38	1.68	14.80	6.89	2.59	17.90	8.50	1.50
Katowice	55.73	23.10	8.25	6.72	2.95	20.05	5.60	2.93	58.00	3.20	2.50
Woźniki	-	-	6.17	3.20	1.75	14.88	5.26	1.53	142.00	0.50	1.70
Puszczykowo	34.34	9.00	13.70	5.00	2.80	25.20	6.50	3.70	90.00	1.00	1.80
Smóldzino	4.60	4.60	4.85	5.88	2.68	7.77	4.67	1.27	27.70	1.80	2.50

found (Brenna, Smóldzino). The pH of throughfall from pine stands is increasing slightly (Puszczykowo, Katowice). A small decrease is observed for the Smóldzino site. No differences in pH of throughfall in Smóldzino spruce and pine stands have been found. It can be concluded, that differences between locations with spruce and pine are caused by the chemical character of deposited air pollutants.

The concentrations of sulphates and nitrogen compounds in Brenna and Smóldzino do not differ markedly. They differ for soil solution (Tab. 1). No differences in load of sulphates, but large differences for nitrogen compounds have been found for these two location (Tab. 1). One possible explanation are differences in the amount of rainfall. The data for the pine stands seem to favour this explanation.

The concentration of sulphur in spruce needles at Brenna is 0.18%, and in the Smóldzino needles 0.11% [1]. The highest concentration of sulphur in pine needles has been found in Katowice (0.16%) followed by Puszczykowo (0.14%), and Smóldzino (0.11%) These concentrations are higher than accepted as "normal".

The concentration of nitrogen are in the range described as normal ( 1.3 - 1.7% for spruce and 1.4 - 1.8% for pine)[2-3].

Trees injury (crown transparency) for spruce stands at Brenna and the Smóldzino does not differ. For pine stands the most severe injury has been found for the Katowice stand, followed by Puszczykowo and Smóldzino [1]. This reflects the gradient in air pollution.

In the authors opinion, lack or poor correlations between some parameters investigated may be caused, at least in part, by the short measurement time.

### 3. REFERENCES

- 1 S. Godzik, W. Łukasik, P. Poborski, T. Staszewski, J. Szdzuj, B. Andrzejczek, Oddziaływanie i obieg związków siarki i azotu zawartych w powietrzu i opadach w ekosystemach leśnych - badania w gradiencie stężeń i klimatu. Annual Report of Institute for Ecology of Industrial Areas.(1994)
- 2 Anonymus, Commission Advice Forest Fertilization (1990)
- 3 J.N. Cape, P.H. Freer-Smith, I.S. Paterson, J.A. Parkinson, J. Wolfenden. Trees, 4 (1990) 211 - 224.