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## **Average winter gas pollution of air in the area of the Pieniny National Park in 1996–1999**

The results of four year investigations on winter gas pollution of air in the region of the Pieniny National Park were presented in the work. Concentrations of SO<sub>2</sub> and NO<sub>2</sub> were measured using passive method. The results showing high differentiations of measured pollutants were presented as the spatial distributions. The highest pollution was stated in the places located in mountain basins.

### **1. Introduction**

The rocky range of the Pieniny Mountains, part of which is protected as the Pieniny National Park, is one of the most precious places for the nature and offers one of the most beautiful landscapes in Poland. Clean air is a factor which decides on the attractiveness of the place so widely visited by tourists, holiday-makers and visitors to health resorts.

The later development of the tourist infrastructure, the complex topoclimate, and inversion phenomena caused the conditions producing periodical higher concentrations of pollutants in the region. [Miczyński et al. 1995]. The end of the 20th century was characterised with generally low concentrations, only in winter higher local concentrations were noted, which was related to the local emissions [Miczyński et al. 1998]. The poverty of provincial centres caused the return to domestic heating with the cheapest fuel (mainly coal), as a result of which in many health resorts a dangerous increase in the concentrations of sulphur dioxide and dust has been observed recently [Miczyński 1996]. Some sources of low emission situated in the immediate vicinity of the Park have become hazardous [Miczyński, Stolarczyk 2001].

## 2. Research, methods and objective

The research objective was to generally assess the level of the average winter concentrations of the gas air indicator pollutants within the Pieniny National Park and its surroundings, i.e. towns and villages in its immediate vicinity, as well as showing the spatial differentiation of the pollutants, especially in winter.

The research used a modified Japanese measurement method of Amaya – Sugiura, according to Polish Standard No. 89 Z-04092/08, in relation to the marking of nitrogen dioxide in the air (imission) by spectrophotometric method with passive sampling. A similar procedure was applied to sulphur dioxide, however presently the method of marking these pollutants is not standardised. The absorbent in the samples consisted of the 10% solution of trietanolomin, contained in the fabric of the absorber ring. Marking of absorption products NO<sub>2</sub> and SO<sub>2</sub> was performed on the ion chromatograph [Polska Norma... 1989].

Measurements were conducted as monthly averages in February in the following years of the period 1996–1998, as well as in November in the years 1998 and 1999. From these years, the average long-term concentration was calculated for SO<sub>2</sub> and NO<sub>2</sub>.

For spatial differentiation of the measured pollutants, their interpolation was performed using the screening method and the Surfer software.

## 3. Results

The general course of the average distribution of concentrations within the area studied shows that their highest concentrations occur in the compact settlement areas, near large traffic routes and areas with unfavourable topoclimatic conditions that facilitate pollutant concentrations (Fig. 1, 2). Such situations occur in villages located near Krościenko and Szczawnica and along the Krośnica Valley. The highest levels of sulphur dioxide concentration in the air up to 60 µg·m<sup>-3</sup> are observed in these areas, while in the dispersed settlement rural areas the concentrations remain at the level of 10 µg·m<sup>-3</sup>. The highest concentration levels of NO<sub>2</sub> reaching the values up to 40 µg·m<sup>-3</sup> and related mainly to traffic pollution were noted in Krościenko and Szczawnica, while in the rural areas the concentration level falls below 10 µg·m<sup>-3</sup>.

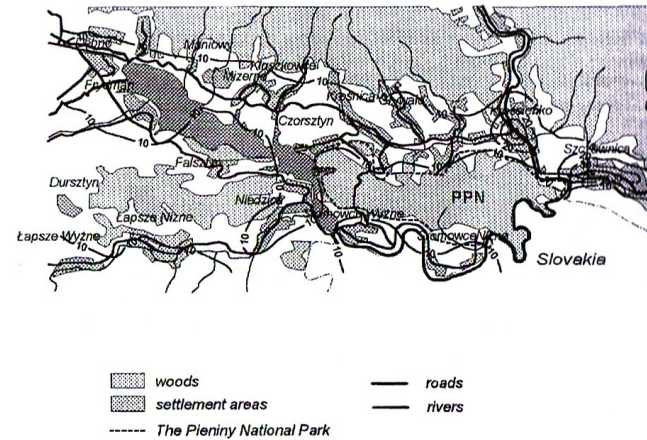


Fig. 1. Spatial distribution of SO<sub>2</sub> in the heating season, based on the average values (February 1996–1998 and November 1998–1999)

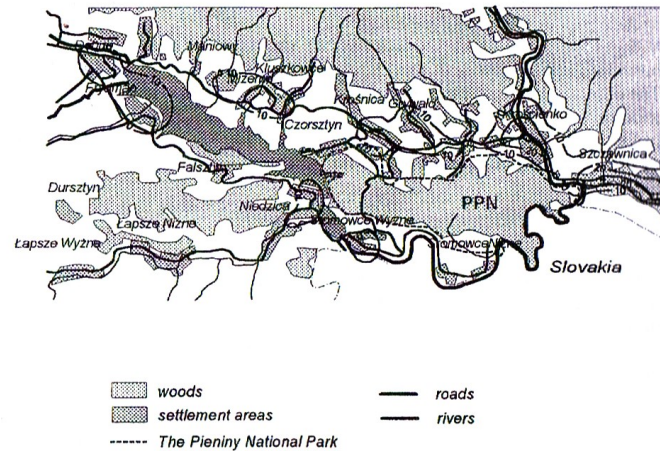


Fig. 2. Spatial distribution of NO<sub>2</sub> in the heating season, based on the average values (February 1996–1998 and November 1998–1999)



The analysis of the trend of the pollutants studied is generally accordant to the overall national tendency, and shows a decrease in sulphur dioxide, while in the recent years an increase in the nitrogen dioxide in the air was noted (Fig 3).

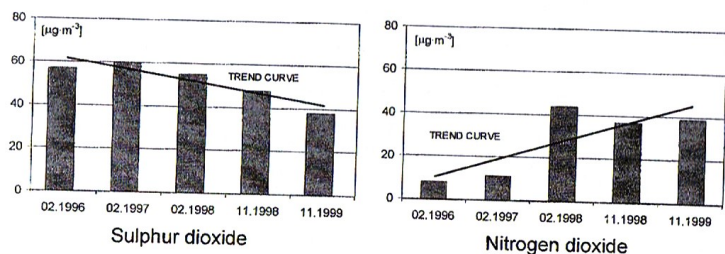


Fig. 3. Monthly average concentration of SO<sub>2</sub> and NO<sub>2</sub> in Krościenko

#### 4. Conclusions

1. Spatial distribution of the studied winter gas pollutants of air (SO<sub>2</sub> and NO<sub>2</sub>) points to their local origin.
2. The highest winter concentrations of gas air pollutants were observed in the compact settlement areas and around main traffic routes surrounding the Pieniny National Park, reaching their peak in Krościenko and Szczawnica.
3. Villages situated in the depressions have an especially unfavourable location facilitating inversions and occurrence of concentrations higher than in the surroundings.
4. The observed pollutant concentrations are low as monthly average, yet one may expect periodical high daily concentrations.
5. In the years 1996–1999, winter concentrations of sulphur dioxide showed a falling tendency, while nitrogen dioxide concentrations marked an increase.

#### References

- Miczyński J. 1996. Analiza zmian zanieczyszczenia powietrza w Rabce w aspekcie prowadzonej gazyfikacji. I Forum Inżynierii Ekologicznej „Technika i Technologia w Ochronie Środowiska”, Lublin – Nałęczów, 251–254.
- Miczyński J., Stolarczyk M. 2001. Inwentaryzacja źródeł emisji i szacunkowe określenie wielkości emisji zanieczyszczeń w granicach przyległych do PPN. *Problemy Ekologii*, 4, 157–166.
- Miczyński J., Kozak J., Jurkiewicz T. 1998. Przestrzenny rozkład dwutlenku siarki i azotu w rejonie Pienińskiego Parku Narodowego. *Pieniny – Przyroda i Człowiek*, Krościenko, 6, 143–153.

Miczyński J., Zawora T., Kozak J. 1995. Przestrzenny rozkład stężeń zanieczyszczeń powietrza w Szczawnicy i okolicy. *Zesz. Nauk. AR w Krakowie, ser. Sesja Naukowa*, 45, 391–396.

Polska Norma PN-89 Z-04092/08. Oznaczanie dwutlenku azotu w powietrzu atmosferycznym (emisja) metoda spektrofotometryczną z pasywnym pobieraniem próbek. 1989. Wydaw. Normal., Alfa, Warszawa.

## Średnie zimowe gazowe zanieczyszczenia powietrza w rejonie Pienińskiego Parku Narodowego w latach 1996–1999

### Streszczenie

W pracy przedstawiono uśrednione wyniki z 4-letnich badań średnich zimowych gazowych zanieczyszczeń powietrza w rejonie Pienińskiego Parku Narodowego. Przy zastosowaniu metody pasywnej wykonano pomiary SO<sub>2</sub> i NO<sub>2</sub>. Wyniki przedstawiono jako rozkłady przestrzenne ukazujące duże zróżnicowanie mierzonych zanieczyszczeń, najwyższe stwierdzono w miejscowościach zlokalizowanych w dolinach.

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