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EFFECTS OF THE AIR POLLUTION WITHIN THE PIATRA-NEAMȚ – SĂVINEŞTI AREA

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Resumé. Ont ete analysées les principales caracteristiques de la pollution dans le cadre de Piatra Neamt et Savinesti dans l`intervale 1985-1999 . Il est evidencié le role purificateur des precipitations. La distribution spatio-temporelle des polluants est fortement conditionée par le specifique du climat et par les facteurs géographiques.

1. Introduction

The field of air pollution is very complex and inter-disciplinary due to its multiple effects on the precipitations, surface waters, soil, vegetation, fauna and human habitats.

Based upon distance toward impact area, air pollution sources can be conventionally divided in two main categories, namely distant sources and local sources. The distant sources are watched by regulatory ambient monitoring stations, the most important of which is located on Rarau Mount, where the nitrogen oxides and sulfur are analyzed. The main local source for Piatra Neamț city is the Săvineşti Roznov chemical platform, specialized in manufacture of synthetic fires and fibres ("Fibrex", "Comes","Melana", "Rifil") and synthetic fertilizers ("Azochim"). Its emissions include the main polluting agents: nitrogen oxides, ammonia, acrylonitrile, sulfur dioxide, sulphate ions, chlorine, urea and carbon monoxide.

The climatic (weather related) factors exert a major influence on the propagation and dispersion of the air pollutants. They are also deeply involved in the chemical reaction kinetics related to atmospheric (environmental) pollution. Among these major climatic factors directing pollution processes we mention temperature, humidity, and wind.

The chemical reactions produced in the atmosphere strongly depend on both type of gaseous pollutant and climatic factors. So, the sulfur dioxide is very soluble and reactive in the air, easily dissolving within fog and clouds, producing sulphurous acid that is rapidly oxidized resulting sulphuric acid. The nitrogen compounds in the presence of some forms of the oxygen determine rapid reactions forming nitrogen dioxide. They react with ammonia giving nitrites. The ammonia easily reacts with sulphuric acid and nitric acid producing ammonium, which is present as aerosols within the rain drops.

The air temperature is an important factor acting on air polluting agents, higher values resulting in a significant increase in the reaction rate of pollutants.

Plume rising and dispersion in the atmosphere are slowed down and even blocked owing to the presence of the thermic inversions, higher pollution levels resulting at the ground. If the inversion is total, then it can even stop vertical extension of the pollution plume.

The wind (the pollution vector) is the main climatic factor involved in the pollutant dispersion; generally, lower speeds (under 3m/s) are seen to favour pollution effects, while higher values (above 3 m/s) facilitate plume dispersion.

Rainfall represents an efficient de-pollution factor as it "washes" the atmosphere (rain washes away gaseous pollutants, while snowfall-only solid particles). The water content of precipitations (rainfalls) determines the washing away of acid gases (SO_2, NO_2), their changing into acids, sulphates, nitrates, thus producing atmospheric self-purification. Yet, these pollutants have negative effects on the soil, surface and underground water, vegetation and human communities.

In the impact areas of the pollutants (nitrogen oxides, ammonia, sulfur dioxide, chlorine) released between 1985 and 1996 within the Piatra-Neamț-Săvineşti area, the effect of rainfall was as follows:

- for no-rainfall periods: the highest (gaseous) pollutant concentration was located in the areas neighboring major pollution sources, while moderate levels were registered in the rest of area;
- for rainfall periods: a decrease in the concentration of gaseous noxes (33%) was registered.

The purifying role of rainfall was proved by 40% drop in the pollution levels during the rains.

A variation in rainfall acidity, e.g. a raise was registered in low rainfall years and those with diminished numbers of rainy days; this aspect was related to the electrical conductivity of rainfall water which was higher in years with higher air pollution levels.

The following atmospheric pollutants have been registered inside the city area: sulfur dioxide, nitrogen dioxide, sulphuratted hydrogen, carbon dioxide, chlorine cyanogens, mercaptaine, as well as air acidity.

Consequently, five areas of pollution have been established:

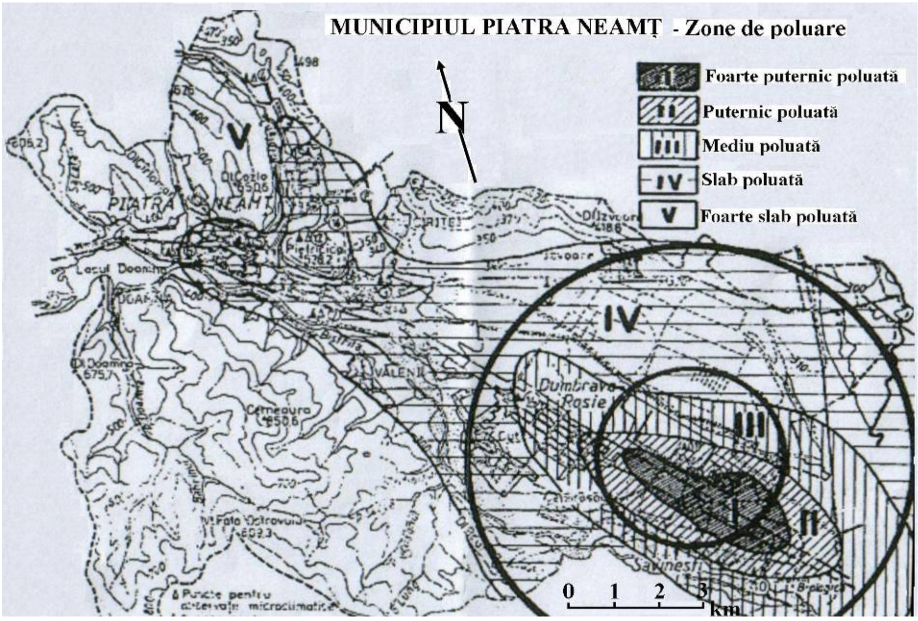


Fig. 1. Characteristic pollution areas:

I. Very high pollution (1-3 km) Savinesti –Roznov (the map)
II. High pollution, around Savinesti platform
III. Average pollution: Dumbrava Rosie-Roznov (1-8 km)
IV. Low pollution: along Bistriţa and Cuejdi rivers
V. Very low pollution: along Bistriţa and Cuejdi rivers

2. Experimental Method

All raw water samples were collected every 12 hours from rainfalls and blended into a larger receptacle to weekly analyze their acidity/alkalinity. During winter snow samples were weekly collected, when available.

For the period June 1986-March 1991 the data were delivered by the Environmental Protection Agency, from different locations by Piatra-Neamţ city (the weather station) and Frunzeni (near Buhusi), close to the Bistriţa exit from depression.

Taking in consideration both features of the air pollution sources in the inferior valley of Bistriţa and climatic characteristics that influence pollutant dispersion, as well as the chemical loading of rainfall water and of snow layer, starting in April 1990, the “Stejarul” Station, in close collaboration with the weather station Piatra Neamţ and ASPM Neamţ, initiated the investigation of the "acid rains" in the Bistrița valley. Thus, new sampling locations have been added to the existing ambient monitoring network, e.g. CFS Săvineşti (a maximum pollution area), the "Stejarul" Station Piatra-Neamț (situated in the downtown Piatra Neamț) and Pagarati (located in the Bistrița mountain corridor, half way Piatra Neamț-Bicaz), in an area of the corridor narrowing and deviation, where sometimes the influence of downstream air pollution is felt.

In order to discriminate between registered and real values for chemical loading of rainfalls in 12-hour sampling interval, since by weekly accumulation of eventual acid and alkaline rains an almost neutral pH can be obtained (so, weekly analyses being irrelevant), in two distinctive months (July and February) at the "Stejarul" Research Station separate analyses for rainfall intensity every 12 hours have been done. In this way analyses for 12-hour interval of the solid precipitations became possible, because the way of pollutant incorporation by these precipitations is different from that of liquid precipitations (rainfalls) and according to existing methodology, during winter in ASFM network solid precipitations are not directly collected. These are weekly (every Monday) collected from the snow layer, if available; so, the possibility exists that for many weeks, analyses could not to be done (due to the melting of the snow layer). Also, one must take into consideration the fact that, besides pollutants incorporated by precipitation water (vapors during condensation or sublimation, as well as during precipitation falls), the snow layer is exposed, in time, to surrounding air pollution.

3. Results and Discussions

The purification of the atmosphere in the cold season by the rainfalls depending on rainfall amounts is illustrated in Fig. 2 (though a weak degree of correlation).

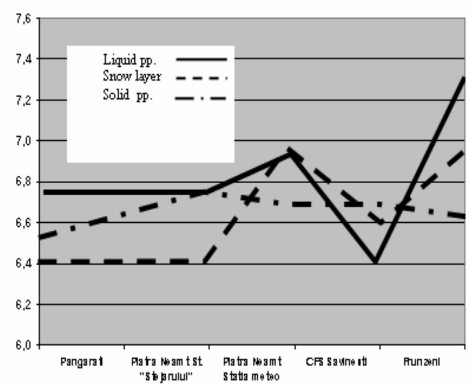


Fig. 2. pH medium variation in Bistrita valley, on Pagarati-Frunzeni

Figure 3 ponts out the presence of polluted, acid type air, especially, in the urban area of Piatra Neamţ.

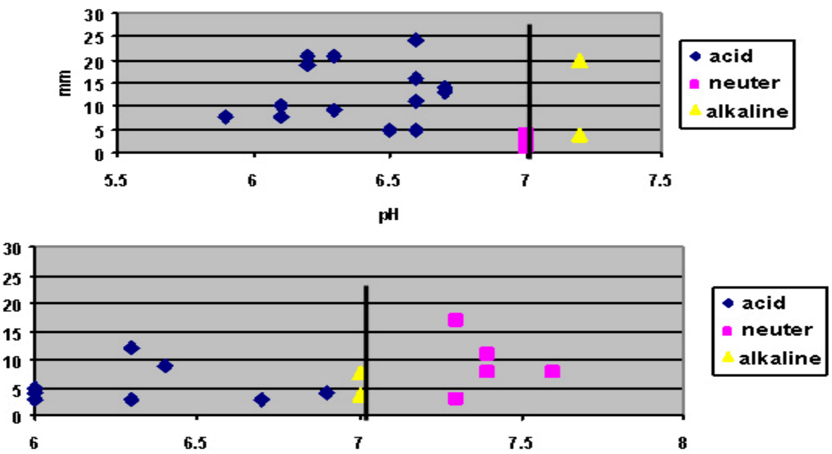
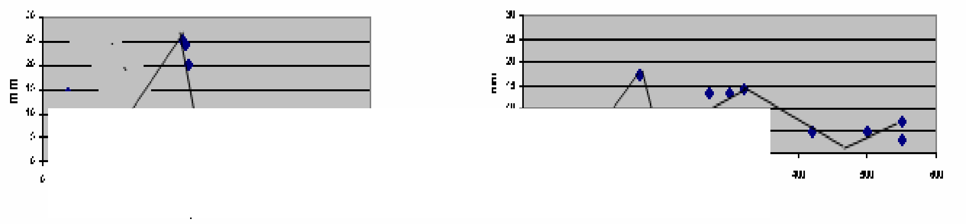


Fig. 3. The variation of pH depending on the rainfall Pângăraţi (up), Săvineşti (down) (November, 1990 – March, 1999)



Conductivity $(\mu S/cm) = 477,6 - 36,58y + 0,9703y^2$ Conductivity $(\mu S/cm) = 360,3 - 7,81 + 0,1895y^2$

Fig.4. The variation of conductivity depending on the rainfall amount for Pângăraţi collection area. Cold season (left), hot season (right).

The stable correlation between rainfall amount and electrical conductivity was rather good, especially for the solid rainfall (Fig. 4).

The correlation between two parameters was fitted as a second-order polynomial (parabolic) regression. In the cold season, the average pH (6.6) was lower compared to the hot season (6.8). The extreme concentration limits were lower in the hot season, when the extreme pH (acid) index was 4.4, compared to 5.5 in the cold season.

In Table 1 are shown the synthetic results of atmospheric pollutants dissolved in precipitation and snow, concerning some chemical characteristics of the rainfall (sulfur dioxide, sulfate ions, nitrogen oxides, ammonia).

All samples were collected each Monday in 12-hour sampling interval, from rainfalls and snow, on condition that the layer would be thicker than 1 cm.

Table 1. The medium and extreme characteristics of atmospheric rainfall and snow layer in the mentioned months.

DISSOLVED NOXIOUS GASES(mg/l)												
	SO_2 (from SO_3^-)			SO_4^{2-}			NO_2 (as NO_2^-+NO_3^-)			NH_3 (as NH_4)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
JULY												
P	0.00	3.09	7.44	6.67	12.53	33.33	0.94	1.96	4.23			
PN	0.00	4.45	12.40	13.33	19.65	46.66	2.12	9.17	70.50			
S	0.00	3.60	9.92	6.67	29.54	60.00	1.64	13.50	19.27			
FEBRUARY-rainfall												
P	0.00	0.091	0.31	10.00	18.27	46.66	0.94	1.24	2.94	3.94	15.40	69.02
PN	0.00	0.250	0.62	6.67	16.78	21.66	2.82	3.98	6.35	6.41	10.48	25.88
S	0.00	0.233	1.24	6.67	25.71	61.66	1.18	4.86	8.35	43.88	65.34	92.68
FEBRUARY – the snow layer												
P	0.31	0.85	1.86	3.33	4.16	6.67	0.35	2.09	4.00	6.41	11.46	18.73
PN	0.31	0.70	1.24	1.67	3.33	5.00	0.59	0.82	1.29	6.41	8.14	11.34
S	0.00	0.31	0.63	3.33	24.16	83.32	1.41	8.29	22.94	13.31	53.61	156.77

P=Pângărați; PN=P. Neamț („Stejarul"); S=Săvinești

Source: Three Meteo Stations from Savineşti Area

As can be seen in the above table, the highest concentration comes from ammonia dissolution.

4. Conclusion

The polluting levels show space-time variability; the plume dispersion is strongly conditioned by the particularities of the climate factors.

The action of polluting factors is cumulative; their effects induce chain reactions that affect several environment components (soil, air, water, constructions, human health).

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