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THE DISTRIBUTION OVER TIME AND SPACE OF SULFUR DIOXIDE AND INFLUENCE ON ORGANIC FARMING. CASE STUDY: THE AREA OF SLATINA CITY

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Abstract

The article discusses issues of air quality in the area of Slatina city regarding the pollution index – sulfur dioxide, describing the main characteristics of the polluter, emission sources, and especially its evolution in time and space of the concentrations and the annual trend, correlated with causes that may increase or diminish the monthly and annually concentrator's values. Data was collected and provided by The Environmental Agency of Olt County and The Analysis Laboratory for Evaluation of Emissions of ALRO S.A. Company. During the analyzed period, 1996-2006, there were no average monthly levels in the time and space distribution higher than the maximum allowed concentration, which is of 0,125 mg/m^3 in 24 hours; also, the annual average values of the index follow a decreasing trend. However, when put together with other urban polluters, the vegetation along with the population of Slatina city is put under discomfort. Towards the end of the article, there are presented conclusions mentioning the main effects over the environment.

Key words**:** *agriculture, air pollution, organic, Slatina, sulfur dioxide*

INTRODUCTION

Pollution has become a characteristic phenomenon of contemporary world, having the most striking effects in the urban area. Usually, the polluted air contains a mixture of different gases and dust, gases absorbed by dust, condensed gases or gases dissolved in water drops in the atmosphere. Gas and steam pollution is much more diverse and powerful, and generates more unfavorable effects that dust pollution. Thereby, complex pollution phenomena result from simultaneous presence of various polluters.

In the urban atmosphere, among various evacuated polluters, the most important regarding the unfavorable effects for the environment are: sulfur dioxide, carbon oxide or monoxide, oxidant substances, nitrous oxides, suspension particles, and lead. These polluters are specific to the urban area, and the percentage of each substance is increasing in the industrial or highly traffic areas.

In the atmosphere of Slatina city, the sulfur oxide (SO_2) is present due to the industrial platform of the city, thermal factories, and road traffic. The polluter is a great danger not only through its presence, but also because of the compounds which are generated in reaction with water.

MATERIALS AND METHODS

The *sulfur compounds* reach urban atmosphere following the process of coal, wood, petrol burn and other fuels based on sulfur dioxide (SO_2), sulfur trioxide (SO_3), sulfur hydrogen (H_2S), sulfur acid (H_2SO_3) and other sulfates. Among all the sulfur compounds, we will pay attention to sulfur dioxide.

The sulfur dioxide (SO_2) is a colorless, suffocating gas present in the urban atmosphere. The physical properties of SO_2 rationed to air are: a density of 225, a viscosity of 70, thermal conductibility, 39, and magnetic susceptibility of -0.05. It is generated by the reaction of sulfur with oxygen ($S + O_2 = SO_2$) and under ultraviolet radiation it becomes fluorescent.

The reference values of the main atmospheric polluters are determined in Romania by STAS 12574, which became effective on 01.09.1987, thus for sulfur dioxide, the maximum admitted concentrations (MAC) expressed in mg/m^3 are: 0.75 for 30 minutes,

0.25 for 24 hours, and 0.06 for the annual average. By the order of MAPM no. 592/2002 the MACs have been modified to: for MAC 1 hour – 0.35 mg/m^3, MAC 24 hours – 0.125 mg/m^3.

The European Union's reference values for sulfur dioxide are: 125 µg/m^3 for average daily concentration, or an annual of 50 µg/m^3; as for an interval of 10 minutes, the sulfur dioxide concentration should not exceed 500 µg/m^3 (0.175ppm) [1].

The SO_2 distribution is conditioned by the weather, landform, water surface percentage, lithological composition interface, type of vegetation amiability, the quantity and type of emission/immission. There has been previously concluded that almost half of the sulfur dioxide present in particles is deposited, on average, in 4 days on the land surface after it penetrated the atmosphere, and the remaining reacts with the water in the air, generating acid rain, deposited later on soil: 8.5% by washing, and around 40% under dry form, becoming the most dangerous immission [3].

RESULTS AND DISCUSSIONS

a. Concentrations and the annual regime of sulfur dioxide as monitored by APM OLT

In Slatina, until 2006 there was no monitoring station for background pollution, nor was there any data about this type of pollution. The process of tracking the quality of environment factors is made by chemical analysis of specific indexes evacuated in the urban atmosphere from the industrial platform.

In Slatina, the network for pollution monitoring (EPA Olt) occurs in three fixed sample station points over 24 hours for the following indexes: sulfur dioxide, nitrous dioxide, ammonia, Fluor, suspension dust.

The interpretation of both the physical and chemical analysis is made according to STAS 12574/97 and the Order of MAPM no. 592/2002 on air quality conditions in protected areas [6]. The units from the industrial platform of the city are evacuating emissions in the atmosphere as follows: nitrous dioxide, *sulfur dioxide*, carbon monoxide, Fluor, coke dusts, tar, etc. The most representative sources are: S.C. ALRO S.A., S.C. ELECTROCARBON S.A., S.C. ALPROM S.A. and S.C. ARTROM S.A [2].

The fixed sample points for 24 hours of the main atmospheric pollutants measured in the area of Slatina City are: *EPA*, situated on Ionaşcu Street, *Oltina* on Piteşti Street, and *ACR* situated at the crossing of Nicolae Titulescu Boulevard with Libertăţii Street (fig. 1) [7].

Besides these measurements could be mentioned those made during the collaboration with The Public Health Authority of Olt County, as episodic measurements in the area of The Hospital of Olt County, situated on Nicolae Titulescu Boulevard.

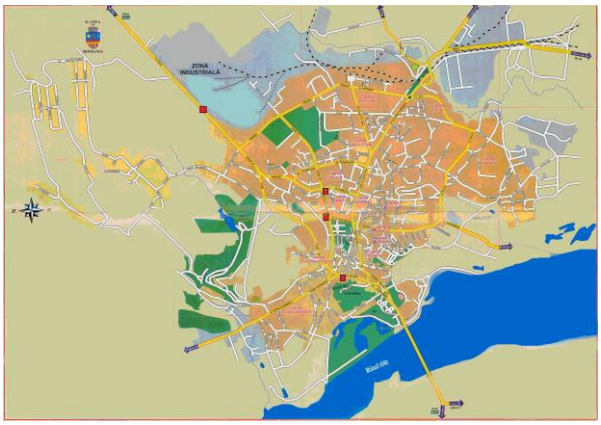

Fig.1. Location of the fixed sample points in the area of Slatina city

The highest values of the polluter concentrations are those located near the sources, but they can also reach a peak point over a certain distance from the industrial furnace, under environmental conditions such as wind direction and velocity.

The sulfur dioxide immissions for the period 1995-2006 concerning monthly average values are situated under the MAC level of 0.125 mg/m^3, having the peak values in May, which is 0.033689 mg/m^3. Beginning with July, the monthly average values are under 0.03 mg/m^3, the monthly minimum being recorded in October, which is 0.018115 mg/m^3. The evolution of monthly average values of SO_2 is depicted in Fig. 2. The maximum admitted value was not exceeded.

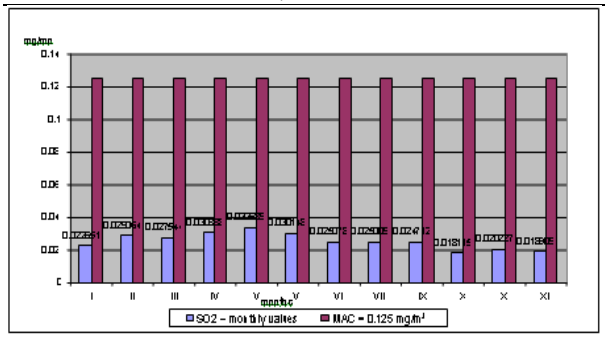

Fig. 2. The evolution of monthly average values of SO_2 in the area of Slatina city, 1995-2006 (Data processed from APM Olt, 2007)

In the evolution of the annual average values of SO_2, depicted in Fig. 3, can be observed a considerable drop of SO_2 emissions in the years following 2001, when the maximum annual of 0.07447 mg/m^3 was reached, due to the technology changes made at the thermal urban installations by replacement of fuels rich in sulfur, but also due to endowment with superior burning installations. The graph shows that over 1995-2006, the annual values oscillate around 0.02 mg/m^3; the lowest value was 0.01776 mg/m^3, recorded in 1999. All the average values are below the MAC level for the SO_2 index, and the multiannual average value of the period is 0.030098 mg/m^3, which is only 24% of the MAC.

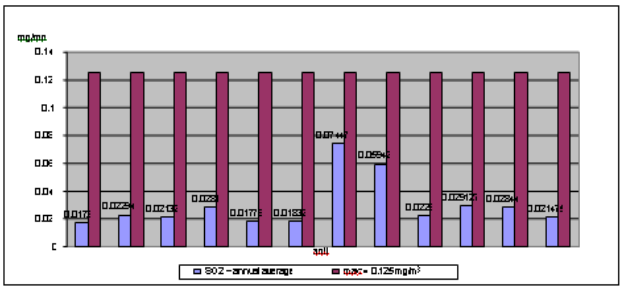

Fig. 3. The evolution of the annual average values of the SO_2 index in the area of Slatina city, 1995-2006 (Data processed from APM Olt, 2007)

The vertical distribution of air polluters depends on their falling speed, the latter depending on the ratio between the gravitational force and their resistance to air friction; under circumstances of ascendant movements of air masses, the distribution of air polluters depends on the ratio between air current speed and their falling speed.

In the area of Slatina city there are three highlighted high concentrated layers of sulfur dioxide, separated by weakly unpurified intervals, being localized as follows:

- *the first layer* is situated above the active surface, being caused especially by road traffic;
- *the second layer* is situated above the average level of buildings, as a consequence of household emissions;
- *the third layer* is situated at heights between 40-60 m, being the striking result of high industrial furnaces and a certain air stratification, especially during thermal inversions.

Any pollutant, and, as a consequence, *sulfur dioxide*, has a daily, weekly, and annually regime.

During the daily regime of sulfur dioxide, there are two points of minimum and two points of maximum, with a main minimum during the night and a second one around noon and over the afternoon, at various hours. The daily point of maximum occurs around 8, due to the beginning of activity and the intensification if road traffic (main maximum) and around 18-22, due to travel intensification (secondary maximum).

During the weekly regime of sulfur dioxide, there is noticed a continuous increase beginning with Monday until the middle of the week, when the maximum is recorded; afterwards, the data show a decrease from Friday until Sunday, due to either economic activity and traffic stop, or, especially, decrease.

During the annual regime of sulfur dioxide, under constant pollution, in winter a maximum is recorded due to decrease of thermal convection along with elicitation of an important supplementary entropic source, which is artificial thermal heating. During the cold season, the degree of pollution is increased because of thermal inversions, mist and nebulosity. The warm season comes with a decrease in pollution, mainly due to both favorable meteorological condition for polluter dispersion, and an intense photosynthesis process.

b.The dynamics of sulfur dioxide immission evolution as monitored by S.C. ALRO S.A.

S.C. ALRO S.A. is the main representative of the aluminum industry in Romania, the only producer of primary aluminum in the country and the biggest one in Eastern Europe. The main activity of the company is aluminum production and trade, in Romania and abroad. The company also provides know-how, consulting, expertise, technical assistance, projections, production and trade of primary and refined aluminum blocs, bars, wires made of aluminum and mixes, installations for aluminum production with the help of electro-chemical procedures (capacity: 470 t/day, in 2006), installations for melting non-ferrous metals (capacity:470 t/day, in 2006), packing activities, transport and services, collecting, processing and delivery of reusable waste [8]. The economic and social development of the city is linked to this important company beginning with 1960; thus, the analysis of data on *sulfur dioxide immissions* due to this economic agent is not a coincidence.

From S.C. ALRO S.A. Slatina the following gases are released into air: burning gases from the thermal heating, sections Anodes and Foundry; gases containing compound of chlorine and fluor due to fluxes in the Foundry section; *sulfur dioxide (SO_2)*, dust, petrol coke from the section Anodes and aerosols, carbon monoxide (CO), *sulfur dioxide (SO_2)*, dusts containing fluor from the section Electrolytes.

The dynamic of the immissions evolution in Slatina for the *sulfur dioxide* index as monitored by The Analysis and Evaluation of Emissions Laboratory of ALRO S.A. for the period 2000-2006 is presented below.

Regarding the monthly average values, during 2000-2006, the MAC value of 0.25 mg/m^3 is not surpassed, the monthly maximum being recorded in November, which is 0.054718 mg/m^3, and the monthly minimum being recorded in April, which is 0.009209 mg/m^3.

In ten months, the monthly average values are situated below the value of 0.0258 mg/m^3. The evolution of the monthly average values is summarized in Fig. 4.

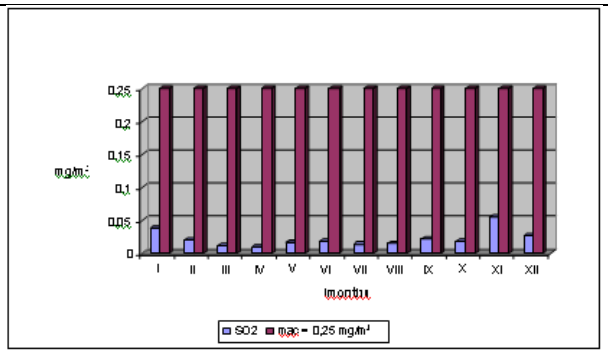

Fig. 4. The evolution of monthly average immissions values of SO_2 index in Slatina city, 2000 – 2006 (Data processed after ALRO – The Bureau of Analysis and Evaluation of Emissions, 2007)

For the SO_2 index, a descending trend is recorded with an annual maximum of 0.038162 mg/m^3 in 2000, and an annual minimum of 0.004423 mg/m^3 in 2006. All he recorded values are situated under the MAC value, as depicted in Fig. 5.

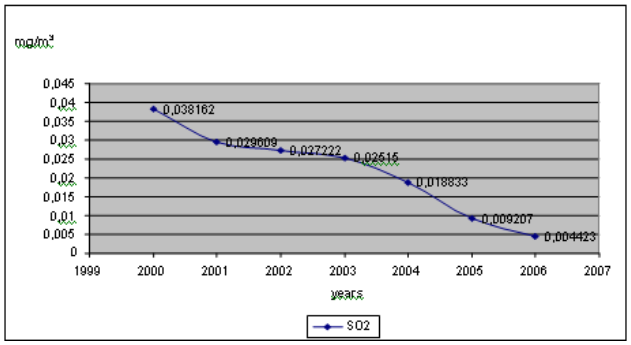

Fig. 5. The evolution of annual average values of immissions of SO_2 in Slatina city, 2000 – 2006 (Data processed after ALRO – The Bureau of Analysis and Evaluation of Emissions, 2007)

c. Development of organic farming in the area of Slatina city

Air pollution and in particular by oxidizing pollutants affect both soil that is essential for plant growth and development, and human existence, including the work and welfare of people who depend on the land, in a considerable degree.

Reduced fertility of agricultural soils, plants with any direct cause damage to crops. There are many policies and programs that have the effect of environmental sustainability and improved quality of which can be mentioned [5]:

-National program for renewal of tractors and agricultural machines autopropelled;

-The project "Irrigation Rehabilitation and Reform";
-Research projects funded by the World Bank;
-Implementation of law package "energy-climate". National Action Plan on Renewable Energy (PNAER);
-National Strategy for reducing the drough effects , prevention and combating land degradation and desertification for the short, medium and long term;
-Strategic elements and fertilizers in agriculture regime;
-Programs on exploitation and soil conservation;
-Programs to promote and support organic farming systems;
-National strategy for drought mitigation, prevention and combating land degradation and desertification in the short, medium and long term;
-Soil and crop management;
-Promotion of energy crops to produce biofuels in non- alimentary, bioliquids and biomass for fuel and electricity.

Due to excessive pollution Slatina is difficult to put into practice such policies and programs. However, there are both small producers who practice organic farming in greenhouses and solariums, conducted in small areas, as well as companies specialized in agricultural production, and using clean production technologies. The thousands of acres for which producers in Slatina were recorded at the Department of Agriculture and have pledged that they will maintain and cultivate ecological means very little in a predominantly agricultural county, but following the trend, it is certain that the example they will be followed by other farmers, even more because organic farming is subsidized with European money.

In Slatina city, the marketing of organic products is performed by traders registered with Ministry of Agriculture and Rural Development, using various channels to market: sales of the company gate, wholesale sales in stores, sales in shops, online sales through stock organic products, sales by market seasonal [5].

CONCLUSIONS

Lately, the *emissions and immissions of sulfur dioxide* have started to diminish quantitatively by the usage of lighter sulfur combustibles, by introducing the process of de-sulfuration of burning gases and by implementing modern production technologies, as depicted in the temporal and spatial analysis of the area of Slatina city during 1996-2006.

However, the effects of sulfur dioxide emissions are still visible both on a local level and regional level, over distances of hundreds of km from the pollution sources, because of polluter fixation on dust particles or aerosols, easily moved by the wind.

By combining the pollutant with the water particles, these emissions generate sulfur acid, which has a great contribution to acid rain formation and the phenomenon of acidification. The damaging potential of sulfur dioxide is amplified by its synergism with nitrous dioxide [4].

In general, sulfur oxides and their hydrating compounds determine corrosion phenomena, material discoloration and reduced resistance of construction materials or installations (e.g. electrical cables).

The presence of sulfur dioxide in the atmosphere may generate highly salivation, expectorant cough, spasm and breathing difficulties to the human body, as well as loss of olfactory and taste senses. It may also produce metabolic and enzymes process disorders.

It is compulsory practical application of all measures that reduce air pollution by certain compounds (sulfur dioxide, particulate matter) or capping their growth trend. Fortunately, in recent years there have been considerable efforts in this regard, so the impact of air pollution on soils decreased significantly, showing a slight recovery of degraded soils under the impact of acid rain.

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