

## MONITORING THE CONTENT OF TOXICANTS IN THE AIR

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### Abstract

*The article presents data on environmental monitoring of heavy metals in the air of the metropolis. Studied the dynamics of accumulation of ten heavy metals » (iron, chromium, copper, mercury, lead, cadmium, nickel, zinc, cobalt, strontium) in the atmosphere on the streets of Krasnodar with different vehicular traffic. The results of the six-year monitoring of the environmental situation of the city of Krasnodar are presented. It is shown that the content of heavy metals is well correlated with population size and the intensity of traffic.*

**Keywords:** heavy metals, atomic absorption chromatography, experiment, analysis, biomass, atmosphere, ecology, metropolis

### 1. INTRODUCTION

Information of an environmental nature are contained in the works scientists since the time of Aristotle. But only since the mid-20th century anthropogenic impact on the environment begin to track on a systematic basis.

Negative human impact on nature is a global problem. During the development of civilization, humanity comes to the awareness of global environmental problems. In 1972 ,the programme environment was adopted by the UN (UNEP, United Nations Environment Programme) to promote the coordination of environmental protection at the system-wide level. The international community has created more than two hundred international organizations in charge of ecology and environmental protection. Important documents where adopted on this issue - such as the Kyoto agreement [1997], Declaration on environment and development [1992] and others. Similar programs operate in Russia [1996, Ursul A.D., 1998]. However, we have to admit that significant progress towards ending the degradation of the biosphere has not been while reached. Currently almost all ecosystems on our planet suffer degradation under the influence of anthropogenic factors [Global Environment Outlook, 2002].

Krasnodar is a city with almost a million people, the capital of the Kuban, the administrative center of Krasnodar region. Like other big cities, Krasnodar experiencing serious strain on the environment by industrial enterprises, boiler rooms and transport. Clean air in the foothills of the Caucasus currently contains heavy metals, oxides of carbon, nitrogen, sulfur, methane and other toxic substances,

### 2. MATERIALS AND METHODS

The preparation of samples for instrumental analysis was performed on microwave mineralizator "Minotaur-1." Further quantitative measurements were made on optical emission spectrometry with inductively coupled plasma «Optima-2100-DV» (iron, chromium, copper, mercury, lead, cadmium) and by atomic absorption chromatography ("Capel-104T") including computer processing of the results by Multichrom program (nickel, zinc, cobalt, strontium).

Contention of heavy metals was determined by their accumulation in the biomass of trees growing in the streets of Krasnodar with different traffic. Trees are very accurate and sensitive indicators of environmental conditions. Our research showed that the dynamics of metal accumulation by leaves of the trees reliably shows the degree of air pollution [Tkachenko A.V.. 2011-2013].

The problem of the XXI century is the increase of anthropogenic impact on ecosystems, especially in big cities, where the natural cleaning mechanisms can't manage their task. Industrial enterprises, municipal waste, and in particular, road transport is a major source of pollution.

The proportion of vehicles in urban air pollution reaches 70-90%. In 2009 in Krasnodar registered more than 260000 vehicles; In addition, the city is visited by about 150000 non-resident cars. At present, 2015, the number of cars in Krasnodar exceeded 370000.

Among the toxins there are quite dangerous heavy metals. They make a lot of harm for both natural ecosystems and human health. Adverse environmental impacts arising exacerbate the demographic situation due to increased morbidity and mortality of the population. This is due to the fact that metals are quickly accumulate in the soil and the wood, but very long and

hardly are removed.

The most dangerous to public health are compounds of lead, cadmium and mercury related to first class of danger [Resolution of the Government of the Russian Federation, 2003 ].

The plants are the primary element in the chain of biosphere changes occurring under the influence of environmental pollution with heavy metals. The environmental consequences of pollution phytocenosis can lead to a shift in the ecological balance of landscape systems. In

urban areas experiencing high human impacts, an important role in protecting the environment play green areas that are needed to convert and to save with regard to their functional role. Number of green space of the city of Krasnodar is almost 2 times less than the established norm.

There are a variety of ways of heavy metals to transferring into plants suggests the existence of two major factors in the formation of elemental chemical composition of plants: genetic and environmental.

Fractional part of each factor varies depending on changes in environmental conditions. In woody plants during ontogenesis and phyto genesis develop mechanisms, which are capable of controlling the entry and removal of some elements by physiological reactions. Heavy metals in leaves through the cuticle, which is closely linked to the cuticles transpiration, and depends on the water content of the tissue lamina. Heavy metals in plants have an active role in metabolic processes, but they can also be stored in form of inactive compounds to the cells and cellular membranes.

We have studied the dynamics of accumulation of heavy metals in the atmosphere on the streets of Krasnodar with different vehicular traffic.

By sampling steel posts with a certain intensity vehicular traffic, which is calculated based on the number of lanes and the number of vehicles during the day. Preliminary analysis has allowed to generate 4 posts, where is extracted biomaterial.

1 post - bi moderate movement;

2 post - medium-intensive two-lane traffic;

3 post - a four heavy traffic;

4 post - six-lane high-intensity movement.

Control - forest 30 km from Krasnodar.

The leaf selection was performed using the average of the sample. From each tree were collected at least 500 grams of mixed samples of the leaves. The metal content in the leaves was studied in 68 the trees above breeds, different days of the week. In 2014 analyzed 136 samples of biomass.

Determined the content of heavy metals (cadmium, lead, zinc, copper, nickel, cobalt, chromium, mercury, iron) in the ash leaves, i.e. number of toxicants absorbed by tissues. The results of these studies are processed by methods of mathematical statistics: we calculated the median values for the sampling location, the average values of the confidence interval t standard deviations.

### 3. RESULTS AND DISCUSSION

The results of determination of metals in the biomass are shown in Table 1.

Table 1 Contents of heavy metals in the biomass, mg / kg

| Metal | Number of post |           |           |           | Control   |
|-------|----------------|-----------|-----------|-----------|-----------|
|       | 1              | 2         | 3         | 4         |           |
| Pb    | 8,9±0,18       | 9,8±0,29  | 10,7±0,31 | 12,1±0,40 | 0,9±0,05  |
| Fe    | 87,1±2,03      | 95,1±2,86 | 63,4±1,94 | 72,6±2,20 | 56,8±1,38 |
| Cr    | 0,2±0,01       | 0,3±0,01  | 0,2±0,01  | 0,4±0,02  | 0,2±0,01  |
| Cu    | 0,7±0,03       | 0,8±0,04  | 0,6±0,04  | 0,8±0,05  | 0,2±0,01  |
| Hg    | 0,03±0,01      | – *       | 0,02±0,01 | 0,02±0,01 | –*        |
| Cd    | 0,4±0,02       | 0,4±0,02  | 0,5±0,02  | 0,7±0,03  | 0,2±0,02  |
| Ni    | 0,04±0,01      | 0,04±0,01 | 0,05±0,02 | 0,05±0,02 | 0,04±0,01 |
| Sr    | 20,5±0,71      | 19,3±0,62 | 24,7±0,68 | 26,8±0,75 | 48,5±0,54 |
| Zn    | 1,2±0,05       | 1,5±0,04  | 1,6±0,06  | 0,7±0,04  | 1,2±0,05  |
| Co    | 1,3±0,06       | 1,2±0,05  | 1,4±0,04  | 0,5±0,03  | 1,3±0,04  |

\* traces or below the detection limit

The accumulation of elements in plants depends on its composition in air, water and soil. In this case, the biochemical structure of the region of the city (soil, water) is practically unchanged within the city.

The differences of metals content in the leaves is caused mainly of various contents of pollutions in the air. Background values can be regarded as the metal content in the control sample, excluding the impact of anthropogenic factors.

Auer results are about a significant excess compared to the control of the content of metals such as lead, iron, cadmium, copper in all samples; chromium and zinc in three of four posts. Noteworthy increase of cadmium content in comparison previous years. Obviously, this is due to the exposure of cadmium to the atmosphere from cadmium rubbing of cars [Radko V.D., 1995].

The mercury traces were found at three posts; formerly mercury in biomass was not detected. We are comparing the results obtained with the intensity of traffic. Accumulation of iron, lead, zinc increase with increasing of traffic intensity. For other metals the differences are not unidirectional in nature. The lowest metal content marked on the street with moderate traffic (1 post), but even in this case, iron, lead and cadmium were significantly higher than the control.

All the performance increases on the streets with intensive and high-intensity movement (3,4 post). In the dynamic accumulating properties of biomass was investigated at the end of the growing season.

We conducted a comparative study of the absorptive capacity of different species of trees in relation to heavy metals (Table 2). These varieties of trees represented on the streets in the greatest number.

Table 2 Metal content in biomass, mg / kg

| Tree species                     | Metal     |           |          |
|----------------------------------|-----------|-----------|----------|
|                                  | lead      | iron      | zinc     |
| Linden                           | 10,1±0,31 | 98,2±2,68 | 1,6±0,06 |
| Birch                            | 9,7±0,28  | 97,4±3,02 | 1,5±0,05 |
| Maple                            | 9,4±0,30  | 89,6±2,56 | 1,4±0,04 |
| Sycamore                         | 9,9±0,28  | 95,3±3,17 | 1,5±0,05 |
| Canadian maple                   | 9,8±0,29  | 95,1±2,86 | 1,5±0,05 |
| The average value                | 6,9±0,25  | 81,0±2,75 | 1,3±0,04 |
| Average values according to 2012 | 9,5       | 97,5      | 1,5      |

We have previously conducted a similar study [Tkachenko A.V., 2012], the final results of which are shown in the bottom row of Table 2. Some of the positive trend observed in iron content (down 2.5%), but the lead content increased by 3.2%. Characteristically, the zinc content remained almost unchanged.

Table 3 Comparison of lead content and statistics data

| Date                                                         | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  |
|--------------------------------------------------------------|-------|-------|-------|-------|-------|-------|
| The lead content, mg/kg                                      | 8,9   | 9,3   | 9,4   | 9,5   | 9,7   | 9,8   |
| The average number resident population, thousand inhabitants | 713,1 | 734,9 | 745,0 | 759,8 | 784,0 | 807,2 |
| The number of vehicles thousand units                        | 268,5 | -*    | 305,9 | 326,4 | -*    | 373,8 |

\* data not found

Table 3 summarizes the results of six years monitoring of lead accumulation in the atmosphere of Krasnodar in comparison with the statistics. The lead content during this period increased by 10.1%, the population of 13.1%, the number of vehicles - 39.2%. As the table shows, the accumulation of harmful impurities in the atmosphere of the city is well correlated with the number of its inhabitants and the number of vehicles. This data confirms the fact of anthropogenic impact on environmental degradation. Almost linear dynamics lead accumulation allows to extrapolate the data obtained up to 2020. The disappointing results were obtained: with the current dynamics of the lead content in biomass (and thus in the air) will increase to 11 mg/kg or 23.6%.

The role of green spaces is invaluable in the preservation of ecological health of cities. Trees not only enrich the air with oxygen cities, but also actively accumulate harmful substances from it.

We conducted monitoring of the environmental situation in the metropolis confirmed the trend of transformation of the environment as the environment of survival. Progress cannot be stopped, so the number of cars on the streets of our cities in the foreseeable future will increase. To maintain the

purity of the air and the health of citizens is necessary to improve the design of cars, fuel, transport, and most importantly - to be used for the protection of the environment the forces of nature itself, i.e. green spaces.

The severity of the problem requires new efficient solutions with investment attraction, creation of Park and ride facilities at the entrance to the city, development of public transport routes for the transportation of the population in the Central part of the city [Parmuhin I.P., 2014]. Increasing the number of routes environmentally friendly electric transport.

## CONCLUSIONS

The results of the six-year monitoring of the environmental situation of the city of Krasnodar are presented. The dynamics of accumulation of heavy metals in the atmosphere of the city is well correlated with population, intensity of road transport and has a steady tendency to increase levels of these toxic substances

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