Mosses as Biomonitors of Air Pollution

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Abstract: - Content of heavy metals and radionuclides in mosses provide valuable information for the monitoring of the air pollution.Mosses, soil and water in the Dashkesen, Mingechaur and Sumgait cities of the Azerbaijan Republic were studied to identify the bioindicator properties of mosses. The concentrations of heavy metals and activity of radionuclides in samples of mosses, soil and water samples were determined. It was defined, that the content of Cr, Mn and Fe in samples of mosses and soil, collected from Dashkesen were more than in Mingechaur and Sumgait. Content of Cu, Zn,Cd, Ba, Pb, Hg, Ni in samples of mosses and soil, collected from Mingechaur and Sumgait were more than in Dashkesen. It was revealed, that the activity of ^{40}K was more than other isotopes. On the other hand it was found out that ^{7}Be, ^{214}Pb, ^{214}Bi, ^{137}Cs, ^{134}Cs, ^{60}Co were more in Mingechaur region than in Sumgait and Dashkesen.

Key-Words: - Environment, Pollution, Environmental Protection, Environmental Science

1 Introduction

Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole. Most air pollution comes from energy use and production.

Burning fossil fuels releases gases and chemicals into the air. And in an especially destructive feedback loop, air pollution not only contributes to climate change but is also exacerbated by it. Air pollution in the form of carbon dioxide and methane raises the earth's temperature. Another type of air pollution is then worsened by that increased heat: Smog forms when the weather is warmer and there's more ultraviolet radiation. Climate change also increases the production of allergenic air pollutants including mold (thanks to damp conditions caused by extreme weather and increased flooding) and pollen (due to a longer pollen season and more pollen production).

These two are the most prevalent types of air pollution. Smog, or ground-level ozone, as it is more wonkily called, occurs when emissions from combusting fossil fuels react with sunlight. Soot, or particulate matter, is made up of tiny particles of chemicals, soil, smoke, dust, or allergens, in the form of gas or solid are carried in the air. The sources of smog and soot are similar. "Both come from cars and trucks, factories, power plants, incinerators, engines—anything that combusts fossil fuels such as coal, gas, or natural gas. The tiniest airborne particles in soot—whether they're in the form of gas or solids—are especially dangerous because they can penetrate the lungs and bloodstream and worsen bronchitis, lead to heart attacks, and even hasten death.

Smog can irritate the eyes and throat and also damage the lungs—especially of people who work or exercise outside, children, and senior citizens. It's even worse for people who have asthma or allergies—these extra pollutants only intensify their symptoms and can trigger asthma attacks.

These are either deadly or have severe health risks even in small amounts. Some of the most common are mercury, lead, dioxins, and benzene. These are also most often emitted during gas or coal combustion, incinerating, or in the case of benzene, found in gasoline. Benzene, classified as a carcinogen by the EPA, can cause eye, skin, and lung irritation in the short term and blood disorders in the long term. Dioxins, more typically found in food but also present in small amounts in the air, can affect the liver in the short term and harm the immune, nervous, and endocrine systems, as well as reproductive functions. Lead in large amounts can damage children's brains and kidneys, and even in small amounts it can affect children's IQ and ability to learn. Mercury affects the central nervous system.

Polycyclic aromatic hydrocarbons are toxic components of traffic exhaust and wildfire smoke. In large amounts, they have been linked to eye and lung irritation, blood and liver issues, and even cancer. In one recent study, the children of mothers who'd had higher PAH exposure during pregnancy had slower brain processing speeds.

By trapping the earth's heat in the atmosphere, greenhouse gases lead to warmer temperatures and all the hallmarks of climate

change: rising sea levels, more extreme weather, heat-related deaths, and increasing transmission of infectious diseases. Carbon dioxide comes from combusting fossil fuels, and methane comes from natural and industrial sources, including the large amounts that are released during oil and gas drilling. We emit far larger amounts of carbon dioxide, but methane is significantly more potent, so it's also very destructive." Another class of greenhouse gases, hydrofluorocarbons are thousands of times more powerful than carbon dioxide in their ability to trap heat.

Mold and allergens from trees, weeds, and grass are also carried in the air, are exacerbated by climate change, and can be hazardous to health. They are not regulated by the government and are less directly connected to human actions, but they can be considered air pollution. When homes, schools, or businesses get water damage, mold can grow and can produce allergenic airborne pollutants. Mold exposure can precipitate asthma attacks or an allergic response, and some molds can even produce toxins that would be dangerous for anyone to inhale.

Pollen allergies are worsening because of climate change. Lab and field studies are showing that the more carbon dioxide pollen-producing plants are grown in, the bigger they grow and the more pollen they produce. Climate change also extends the pollen production season, and some studies are beginning to suggest that ragweed pollen itself might be becoming a more potent allergen. That means more people will suffer runny noses, fevers, itchy eyes, and other symptoms. The less gasoline we burn, the better we're doing to reduce air pollution and harmful effects of climate change. Make good choices about transportation. When you can, walk, ride a bike, or take public transportation.

Texnogens emissions of the industrial enterprises: oil refining, oilextracting, metallurgical, chemical, power branches of Azerbaijan Republic promotes saturation of it by toxic substances, heavy metals, radionucleotids and pollution of air and biosphere, including air, soil, vegetation and water resources.

Rapid industrialization in cities and the contributory relationships with the original pollution sources can cause serious environmental problems within cities.

Currently, methods based on the use of natural recources, which include mosses, are actively developing to assess the degree of air pollution by radionuclides and other toxic elements.

Mosses has been used for the monitoring of atmospheric deposition of radionuclides and heavy metals since the late 50es of the last century, mostly for tracing deposition patterns of radionuclides due to technological accidents [1-3]. However, until recent time this aspect of investigations was absent in the UNECE ICP Vegetation in spite of the great importance of knowledge on global mixing of long-lived radionuclides and heavy metals in the atmosphere and their deposition after the Chernobyl and Fukushima disasters. In the moss survey 2015/2016, an optional assessment of long-lived radionuclides such as ^{137}Cs and ^{210}Pb was suggested [4]. The feasibility of moss sampling to assess the atmospheric deposition of radionuclides and heavy metals is discussed and examples from the literature are reviewed [5].

Mosses are effective accumulators of pollutants contained in the atmosphere. Biomonitoring of atmospheric pollution with of heavy metals and other chemical elements using moss is one of the simplest, most promising and effective methods for monitoring, detecting and evaluating changes in air quality [6,7].

In our previous works we investigated air pollution problems in some regions of Azerbaijan Republic [8, 9]. The purpose of the work was to identify the degree of air pollution with ions of heavy metals and activity of radio nuclides using moss bioindicators. For the studied samples of moss and soil near Dashkesen and Mingechaur region, Azerbaijan to identify the bioindicator properties of moss and for bioindication of air and soil.

2 Materials and Methods

It was studied samples of moss, soil and water in various cities of Azerbaijan Republic. Concentrations of heavy metals were determined on an Agilent Technologies 7500 Series ICP-MS (7500cx) instrument using inductively coupled plasma mass spectrometry (ICP-MS, USA).

The activity of radionuclides were determined on Gamma spectrometer. Determination of content and activity of the radionuclides in the tests of moss, soil and water was carried out at "Canberra" (USA) γ-spectrometer with germanium detector (HP Ge).

3 Results and Discussion

Experimental measurements of the definition of content and quantity of heavy metals and activity of radionuclides in samples of mosses, soil, water collected near the Dashkesen, Mingechaur, Sumgait cities of Azerbaijan Republic have been conducted. Samples of mosses, soil and water have been taken from these cities.

The analyzed tests allowed us to define content of Cr, Fe, Mn, Cu, Zn, Cd, Ba, Pb, Ni, Hg in the composition of investigated samples.

Our results on the content of heavy metals and radionuclides are presented in the table 1, fig.1, fig.2.

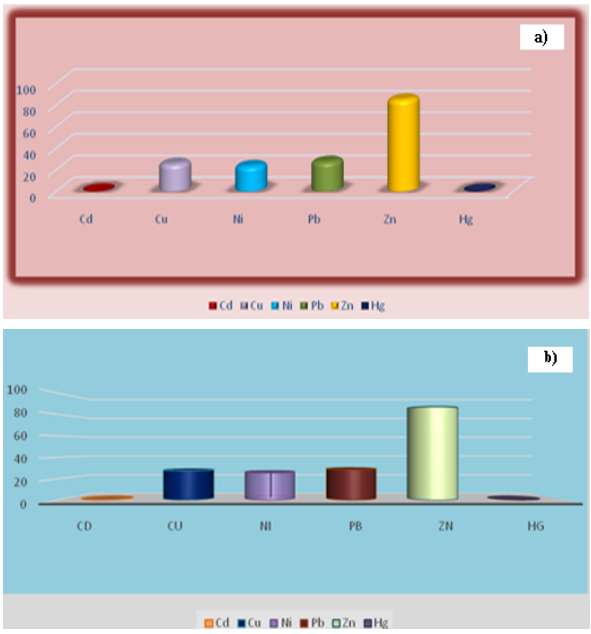

Fig.1. Comparative data on the content of metal ions in the studied samples of mosses collected from the most polluted area near the a) Mingechaur b) Sumgait

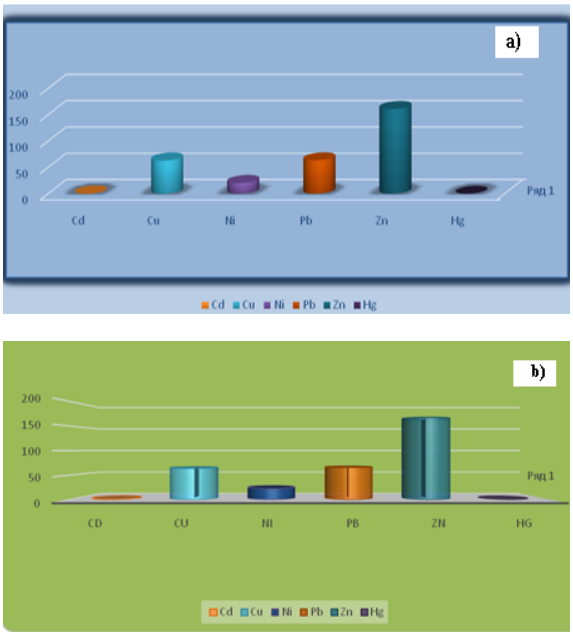

Fig.2. Data on the content of metal ions in the studied soil samples collected from the most polluted area near the a) Mingechaur b) Sumgait

As can be seen from the results, the content of Cr, Mn and Fe in samples of mosses and soil, collected from Dashkesen were more than in Mingechaur and Sumgait. Besides, content of Cu, Zn,Cd, Ba, Pb, Hg, Ni in samples of mosses and soil, collected from Mingechaur, Sumgait were more than in Dashkesen.

It was determined the activity of radionuclides: ^{7}Be, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{214}Bi, ^{212}Bi, ^{212}Pb in the samples of of mosses and soil samples taken from the Mingechaur region and in Sumgait region of the Azerbaijan Republic. The results are presented in table.2

As a result of the research it was revealed, that the activity of ^{40}K was more than other isotopes (648,1 Bq/kg). It was found out ^{7}Be of activity 79.08 Bq/kg, ^{214}Pb of activity 62.62Bq/kg, ^{214}Bi of activity 28.74 Bq/kg, ^{137}Cs of activity 14.01 Bq/kg, ^{134}Cs of activity 12.15 Bq/kg, ^{60}Co of activity 11.34 Bq/kg, which were more in Mingechaur region than in Sumgait and Dashkesen.

4 Conclusion

To investigate elemental atmospheric deposition patterns, 75 samples of moss biomonitors were collected. Mass- and γ-spectrometry analysis were used to maximize the number of elements determined, including trace elements, radionuclides. The content of 17 elements was measured.

The content of Cr, Mn, Fe in samples of moss and soil, collected from Dashkesen city were more than in Mingechaur and Sumgait cities. Content of Cu, Zn,Cd, Ba, Pb, Hg, Ni in samples of moss and soil, collected from Mingechaur, Sumgait cities were more than in Dashkesen city.

It was revealed, that the activity of ^{40}K was more than other isotopes. On the other hand it was found out that ^{7}Be, ^{214}Pb, ^{214}Bi, ^{137}Cs, ^{134}Cs, ^{60}Co were more in Mingechaur region than in Sumgait and Dashkesen.

Thus, the method of moss biomonitoring was used to define heavy metals and radionuclides in atmospheric depositions. The most polluted sites were defined on the basis of the analysis.The activity values of the detection of heavy metals and radionuclides in moss, soil and water samples provide valuable information for the monitoring of the air pollution in the

Dashkesen, Mingechaur and Sumgait cities of the Azerbaijan Republic. The increasing content of heavy metals and radionuclides in the soil and atmospheric air can lead to serious consequences and even affect a person. The used method proved to be a cheap and efficient tool to assess heavy metal and radionuclides pollution in urban area.

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Table 1. The content of heavy metals in the studied samples collected from the most polluted area near the city of Dashkesen, Mingechaur, Sumgait

Elements, mg/kg / Medium	Cr	Mn	Fe	Cu	Zn	Cd	Ba	Pb	Hg	Ni
Dashkesen										
moss	28.6	510.2	16488.8	14.9	27.0	0.1	164.9	5.1	0	0
soil	15.2	476.2	12692.7	12.2	20.8	0.1	87.3	4.3	0	0
water	0.1	1.6	1.6	1.5	0	0	19.2	0	0	0
Mingechaur										
moss	0	0	0	59.2	50.1	0.2	0	62.4	0.1	18.7
soil	0	0	0	23.2	12.1	1.1	0	27.5	0.1	20.3
Sumgait										
moss	0	0	0	64.3	167.5	0.6	0	65.7	0.1	22.8
soil	0	0	0	27.6	87.1	0.3	0	28.6	0.1	25.7

Table 2. Activity of radionuclides in the studied samples collected from the most polluted area near the city of Dashkesen, Mingechaur, Sumgait

Elements, Bq/kg / Mosses	^{7}Be	^{40}K	^{60}Co	^{134}Cs	^{137}Cs	^{214}Bi	^{212}Pb
Dashkesen	78.4	512.1	11.4	16.3	11.5	15.2	50.2
Mingechaur	89.6	673.2	15.4	19.1	12.6	18.2	52.6
Sumgait	81.7	562,3	13.6	18.2	12.1	17.8	51.4