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Assessment of the ecological state of green spaces of Almaty city on the example of Bostandyk district

The article provides an assessment of the ecological state of green spaces on the example of the Bostandyk district of Almaty. The total area of boulevards, squares and green areas of the Bostandyk district of Almaty today is 147.4 hectares. Bostandyk district of Almaty is one of the three greenest districts of Almaty after Medeu and Turksib districts. As our studies have shown, 95 % of green plantations of tree species in the Bostandyk district of Almaty are represented by introducers and a small part of local species — natives. The landscaping of the territory of the city of Almaty is represented by plantings of different types. These include groves, alleys, gardens, parks, boulevards, squares, green areas, intra-district gardening, street gardening. At the same time, a wide variety of species is observed in gardens, parks, boulevards, groves and a very small use of three or four species in landscaping streets. Among the tree plantations, 35 species are massive, which grow along all the streets, boulevards, squares of the Bostandyk district. From hardwoods: *Populus nigra*, *Populus italica*, *Populus alba*, *Fraxinus excelsior* and others. From the local natural flora grow — *Armeniaca vulgaris*, *Prunus sogdiana*, *Fraxinus sogdiana*, *Rhamnus cathartica*, *Picea schrenkiana*.

Keywords: Almaty city, Bostandyk district, green spaces, urban environment, air pollution.

Introduction

In recent years, the city of Almaty, as the largest metropolis of our country, has been growing rapidly, while the annual population growth leads to a decrease not only in the number of green spaces, but also in the quality of the habitat. In conditions of weak natural ventilation and a large number of mobile and stationary sources, atmospheric air pollution is the most urgent environmental problem of the city of Almaty. Expansion of roads, construction of transport interchanges, entertainment centers, parking lots, advertising, etc. led to the destruction and cutting down of a large number of trees and shrubs. Due to the lack of information, it became necessary to analyze the state of urban green spaces in the city of Almaty. Green spaces, especially in large cities, megacities serve as a means of decoration, health improvement, climate improvement and a place of rest for citizens. The normal life of a person, his state of health and life expectancy depends on the sustainable functioning of the urban ecosystem.

Over the past decade, the growth of new buildings in Almaty has led to an increase in anthropogenic pressure on the city's ecosystem. In this regard, the monitoring of green spaces in the city, including the inventory and assessment of the current state of the flora, seems to be very relevant.

The city of Almaty is located in the center of the Eurasian continent, in the southeast of the Republic of Kazakhstan. Almaty is unique in its physical-geographical and natural-climatic characteristics, which form the ecological features of its territory. The city of Almaty is located in the foothills of the Zailiy Alatau, the total area of which is more than 683.51 square kilometers. The city is located in the valley of the Bolshaya and Malaya Almatinka rivers and their tributaries flowing from the glaciers of the Zailiy Alatau and mountain gorges in a zone of increased seismicity and mudflow hazard [1-3].

It should be noted an interesting formation of the structure of green spaces in the city of Almaty. The creation of Almaty parks and gardens has more than 150 years of history. The first State Garden (now the Central Park of Culture and Leisure) was established in 1868 by the Governor-General I.A. Kolpakovsky. On his own initiative, the Vernenskaya Grove (Baum Grove), Pushkin Garden (Park of 28 Panfilov Guardsmen) was created. In the Treasury Garden and the Vernenskaya Grove there were nurseries of ornamental trees, shrubs, fruit trees, from which many seedlings were distributed free of charge to the population for landscaping the territory. At that time, in Almaty, an active change began not only in the landscape of the area, which included the active construction of both the city of Verny itself and the massive introduction of planting material that was supplied to Verny from different countries. Seeds and seedlings were sent from different regions of Russia and Central Asia for the Vernensky State Garden, so seedlings of *Morus alba* L.,

Morus nigra L., different varieties of grapes, cherries, plums, walnuts, plane trees, etc. were sent from Tashkent. From the Nikitsky Botanical Garden, and the Moscow Zoological Garden, seeds of *Gleditsia triacanthos* L., *Aesculus hippocastanum* L., *Ailanthus altissima* (Mill.) Swingle, *Robinia pseudoacacia* L., *Syringa vulgaris* L., *Cydonia oblonga* Mill., apple trees, pears, plums were sent. Coniferous plants were sent from Penza. Seeds of flower, vegetable and ornamental coniferous and deciduous plants of open and protected ground were sent from the St. Petersburg Botanical Garden. In the Treasury Garden, fruit and ornamental trees and shrubs were also grown, which were brought from Siberia and Europe; oak, linden, birch, alder, and poplar grew here. A gardening school was also opened here. The landscaping of the city of Verny was carried out mainly by *Populus alba* L, and *Ulmus parvifolia* Jacq. In the middle of the twentieth century, Almaty turned into a flourishing garden city [4].

At the present stage, the landscaping of the territory of the city of Almaty is represented by plantings of various types. These include groves, alleys, gardens, parks, boulevards, squares, green areas, intra-district gardening, street gardening. At the same time, a wide variety of species is observed in gardens, parks, boulevards, groves and a very small use of three or four species in landscaping streets. Currently, the city of Almaty suffers from severe air pollution, where more than 90 % of the emission of harmful substances into the atmosphere is vehicle emissions, which leads to a change in the chemical composition of the soil and its salinity. As well as a large influx of the rural population into the city, the increasing overcrowding of certain urban areas, the desire of the population to live closer to the city center, and not on its outskirts. To date, more than 8000 hectares of urban territory are occupied by gardens and parks, squares and boulevards (Fig. 1) [5].



Figure 1. Boulevards and squares of the Bostandyk district of Almaty

As an object of study, we took species of coniferous and deciduous tree and shrub species found in the Bostandyk district of Almaty. The Bostandyk district of the city of Almaty with an area of 99.4 km² was formed in 1966 (Fig. 2, Table 1).



Figure 2. Schematic map of the Bostandyk district of Almaty

Table 1

General characteristics of the Bostandyk district of Almaty

District	Foundation date	Area, km ²	Population (thousand people)	Natural area
Bostandyk	1966	99,4	343 54	steppe

The structure of the soil cover of Almaty, including the Bostandyk district, is completely determined by the vertical zonality of the Zailiy Alatau, where both natural and climatic zones and belts, respectively, and the soil and vegetation cover change with altitude. In the steppe foothill zone there are belts (subzones): a belt of high foothills (counters) with chernozems (from 1000 to 1200-1400 m) and a belt of foothill dark chestnut soils (from 750 to 1000 m). Chernozems occupy approximately the lower border along Al-Farabi Avenue to the Tausamaly microdistrict, have an extended profile and are fertile soils (8-13 % of humus and other nutrients). From Al-Farabi Avenue, and in some places much lower (approximately to Raiymbek Avenue), there are chestnut soils, which are the area of alluvial fans, mostly dark chestnut soils, which are the main soils of the city [6]. The Malaya Almatinka river flows through the Bostandyk District, as well as their tributaries — Esentai (Vesnovka), Remizovka. The average long-term air temperature is 9 °C, the coldest month (January) — 7 °C, the warmest month (July) 23 °C [7].

There are 195 streets in the Bostandyk district today, of which the largest streets are: Al-Farabi, Saina, Timiryazev, Gagarin, Satpaev, Baitursynov, Furmanov, Abai and others. There are 3 parks on the territory of the Bostandyk district: the park of the First President with an area of 70.0 ha, the Yuzhny park with an area of 16.2 ha, and the Friendship Park with an area of 0.6 ha. There are: 5 boulevards, 10 squares and 2 green areas (Table 2).

Table 2

The total number of parks, squares, boulevards, green areas in Bostandyk district

District	Name					
	Parks	Groves	Alleys	Boulevards	Squares	Green areas
Bostandyk	3	-	-	5	10	2
Total:	3	-	-	5	10	2

The total area of boulevards, squares and green areas of the Bostandyk district of Almaty today is 147.4 hectares. Bostandyk district of Almaty is one of the three greenest districts of Almaty after Medeu and Turksib districts. There are 380,000 thousand trees in the Bostandyk region [8].

Experimental

We have been monitoring the state of tree and shrub green spaces in the Bostandyk district of Almaty since 2019-2021. The survey included objects of green spaces of various types: landscaping of streets (taking into account the intensity of car traffic), parks, boulevards, squares. The reconnaissance method was used to survey the study area, a detailed survey of trial plots. The sanitary condition of plantations was taken into account (mechanical damage, frost cracks, damage by diseases and pests). In the studied areas along the main streets, a detailed survey of tree and shrub plantations was carried out with the definition of the condition category using the generally accepted scale:

1. Healthy coefficient of the state of the object (KSO) — without signs of weakening with normal development and without damage (normal leafing of the crown and high decorative effect, intensive growth of shoots, pests and diseases are absent). According to the age characteristics, these are mainly young and middle-aged plantations.

2. Weakened (KSO-2) — trees and shrubs with minor damage or with one-sided development of the crown, medium decorative, up to 10 % dry branches, weak oppression (less leaf blade), damaged by 25 % by pests and diseases. It is typical mainly for ripening plantations.

3. Oppressed (KSO-3) — often dry-topped trees, with a significant depression in development and mechanical damage (hollows, dry branches up to 50 %), weak leafing, non-decorative, and damaged by pests and diseases up to 50 %. Most often found in mature stands.

4. Drying (KSO-4) — the process of dying off is very developed, there is a massive (more than 50 %) damage to the tree by pests and diseases, dry tops. As a rule, ripe and over mature stands.

5. Dead wood (KSO-5) — a completely withered (dead) tree or shrub that is subject to priority felling [9].

To measure the MPC of harmful substances in the atmosphere by the method of continuous observation, we monitored the quality of the state of the atmospheric air in Almaty using a measuring device — gas analyzer GANK — 4 [10, 11]. Pilot studies were carried out in Almaty every month during 2021. For this purpose, 10 main measurement points were selected: Seifullin-Raiymbek, Seifullin-Ryskulov, Momyshuly-Tole bi, Al-Farabi-Navoi, Rozybakiev-Raiymbek, Raiymbek-Bayzakov, Tole bi-Otegen Batyr, Abai-Rozybakiev, Al-Farabi -Zheltoksan, Al — Farabi-Nazarbayev.

Results and discussion

We monitored the state of green spaces in the Bostandyk district of Almaty. Monitoring was carried out, paying special attention to the condition of trees and shrubs on the main streets of the Bostandyk district. Large and main highways were surveyed, which are characterized by high congestion and saturation with vehicles and high air pollution, where the level of MPC of harmful impurities exceeds the norm several times (Table 3).

Table 3

Conditions of trees planted along the carriageway of Timiryazev Street

Species name	Number of trees	Condition (points)	Barrel damage, %		
			Mechanical	Rotten, diseased	Total
<i>Ulmus parvifolia</i>	660	4	8.0	1.2	9.2
<i>Fraxinus excelsior</i>	120	3	6.0	1.0	7.0
<i>Fraxinus sogdiana</i>	56	4	5.0	1.1	6.1
<i>Populus pyramidalis</i>	45	4	11.0	1.6	12.6
<i>Betula pendula</i>	43	4	6.0	1.1	7.1
<i>Populus alba</i>	40	3	13.0	1.3	14.3
<i>Pinus sylvestris</i>	121	3	4.0	2.1	6.1

These include streets such as Al-Farabi Avenue, st. Auezov, st. Satpaev, st. Rozybakiev, st. Gagarin, st. Baitursynov, st. Aimanov, st. Radostovtseva, st. Shashkina, st. Tlendieva and others. We also examined sections of streets where recreation areas for citizens are located (parks, boulevards, squares). An analysis of green spaces in the Bostandyk district of Almaty showed that more than 101 tree and shrub species belonging to 146 genera and 47 families grow along the main streets, in parks, boulevards and squares. The vast

majority of green plantations of trees and shrubs are represented by alien species and a small part of trees and shrubs by local species. Among the trees — 35 species are massive, which grow along all the streets, boulevards, squares of the Bostandyk district — mostly introduced species. These include: *Populus nigra*, *Populus italica*, *Populus alba*, *Populus balsamifera*, *Fraxinus excelsior*, *Fraxinus pennsylvanica*, *Fraxinus americana*, *Betula pendula*, *Acer negundo*, *Acer platanoides*, *Acer pseudoplatanus*, *Tilia cordata*, *Tilia mandshurica*, *Aesculus hippocastanum*, *Ulmus parvifolia*, *Ulmus laevis*, *Ulmus glabra*, *Gleditsia triacanthos*, *Acacia alba*, *Quercus robur*, *Crataegus submollis*, *Picea pungens*, *Picea abies*, *Pinus sylvestris*, *Pinus pallasiana*, *Larix gmelinii*, *Berberis vulgaris*, *Syringa vulgaris*, *Ligustrum vulgare*, *Viburnum opulus*, *Philadelphus coronarius*, *Thuja occidentalis* *ұдызue*. From the local natural flora grow — *Armeniaca vulgaris*, *Prunus sogdiana*, *Fraxinus sogdiana*, *Rhamnus cathartica*, *Picea schrenkiana*, *Crataegus chlorocarpa*, *Spiraea hypericifolia*, *Juniperus sabina*, *Juniperus turkestanica* and others. Many interesting ornamental species have been introduced singly, but they all grow mainly in the parks of the Bostandyk district of Almaty. Boulevards and some squares of the studied area of Almaty are distinguished by a variety of species. If in the Soviet years more fruit trees were planted, now many ornamental tree and shrub species are preferred. I would like to especially note the group of evergreen conifers, which are the most valuable and ornamental plants in landscaping. All species of coniferous tree and shrub species growing in the Bostandyk region are stable in local conditions, winter-hardy and do not suffer from heat and dry air. Of the conifers in the landings of the streets, the following types are most often found: *Picea schrenkiana*, *Picea abies*, *Picea pungens*, *Thuja occidentalis*, *Biota orientalis*, *Juniperus virginiana*, *Juniperus sabina*, *Pinus sylvestris*, *Pinus pallasiana*, *Buxus sempervirens* and others.

An analysis of the life forms of tree and shrub species growing in the Bostandyk district of Almaty showed the leading positions of the tree form — 75 species or 38.2 %, including 8 species (10.6 %) and 67 species from the local natural flora of Kazakhstan. (89.3 %) are introduced species (Fig. 3).

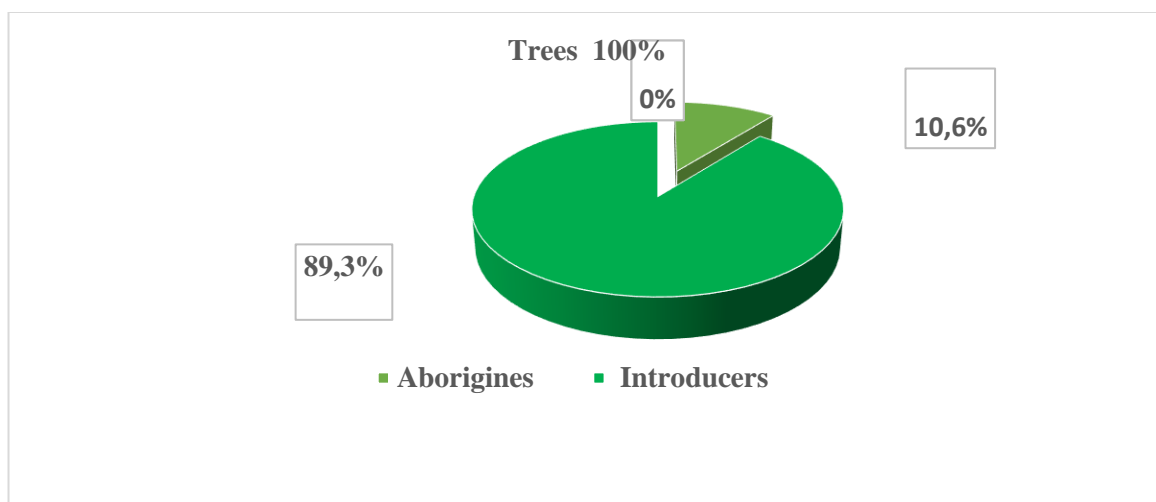


Figure 3. Distribution of introduced species and native species among tree species

Shrub species are represented by 26 species or 13.2 %, of which 6 species (23.0 %) are from the local natural flora and 20 species (77.0 %) are introduced species (Fig. 4).

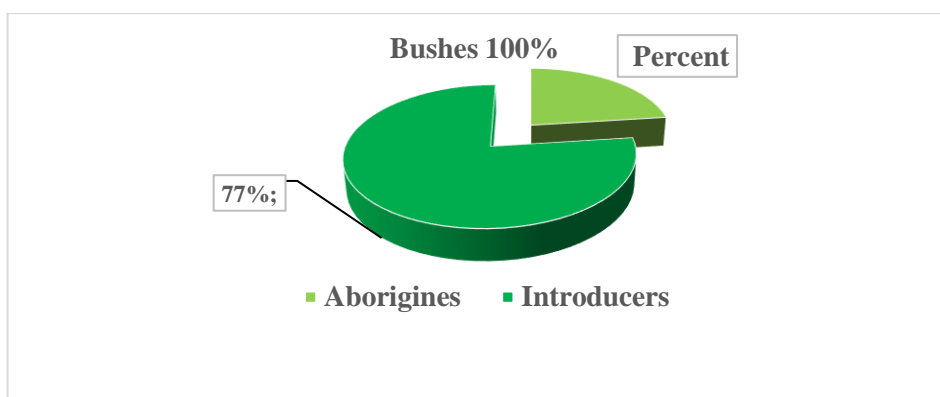


Figure 4. Distribution of introduced species and native species among shrub species

As noted above, the state of tree plantations was determined by us visually by biomorphological features, which include: crown density, its foliage, correspondence of leaf size, shoot growth to normal for these species and a given age of trees, the presence or absence of deviations in the structure of the trunk, crown of branches and shoots, dry top or the presence and proportion of dry branches in the crown. As a result of a survey of green spaces in the main streets of the Bostandyk district, it was found that many trees and shrubs have drying out of the crown and early yellowing of the leaves, which in turn is associated with the bad ecology of the city, accompanied by high air pollution. Trees planted in the median are particularly affected. They often get sick, turn yellow and quickly dry out. Thus, 15 coniferous trees of the species *Pinus sylvestris* and *Aesculus hippocastanum* 70 trees planted in the dividing strip along Zharokova Street are in a severely oppressed and drying out state, and most of them have practically dried up due to the high concentration of car exhaust gases. They are often changed to young ones; however, young trees quickly dry out and die. Trees planted and growing along the sidewalk on both sides of the main streets of Timiryazev, Abay, Gagarin, Baitursynov, Satpaev, Rozybakiev were assessed by us as relatively healthy with some signs of weakening and normal development. 27 % of the examined trees had damage. Almost all trees showed normal leafing of the crown, high decorativeness and intensive growth of shoots. In most of 89 % of the examined trees, pests and diseases are absent (Tables 3-5). According to the age characteristics, these are mainly young and middle-aged tree plantations.

Table 4

Conditions of trees planted along the carriageway of Gagarin Street

Species name	Number of trees	Condition (points)	Barrel damage, %		
			Mechanical	Rotten, diseased	Total
<i>Ulmus parvifolia</i>	460	4,5	9,0	1,2	10,2
<i>Fraxinus excelsior</i>	96	4	4,0	1,3	5,0
<i>Fraxinus sogdiana</i>	36	4,7	3,0	0,9	3,9
<i>Populus pyramidalis</i>	28	4	10,0	1,9	11,9
<i>Populus alba</i>	5	4	14,0	2,6	16,6
<i>Pinus sylvestris</i>	12	3,5	7,0	2,1	9,1

Table 5

Conditions of trees planted along the carriageway of Rozybakiev Street

Species name	Number of trees	Condition (points)	Barrel damage, %		
			Mechanical	Rotten, diseased	Total
<i>Ulmus parvifolia</i>	346	4	11,0	2,5	13,5
<i>Fraxinus excelsior</i>	67	4	7,0	1,0	8,0
<i>Fraxinus sogdiana</i>	27	4	4,0	1,1	5,1
<i>Populus pyramidalis</i>	26	3	14,0	2,2	16,2
<i>Populus alba</i>	10	2	9,0	1,8	10,8
<i>Pinus sylvestris</i>	15	3	6,0	2,7	8,7

As our studies have shown, urban tree plantations have disrupted photosynthesis processes, so they have a rarer crown, small leaves, and short shoots. In heavily polluted urban conditions, the leaves begin to dry out at the edges, brown spots appear on them, these are areas of dead tissue and they quickly curl. The crowns of coniferous and deciduous trees dry out, their annual growth is lower than in unpolluted areas, and the productivity of phyto mass decreases. It should be noted that active visits by city residents to parks, gardens, squares and other green spaces also lead to direct and indirect impacts on green spaces. Direct impacts include breakage and damage to trees and shrubs, excessive collection of flowering ornamental trees and shrubs, littering, and fires. A high level of air and soil pollution has a huge impact on the vital activity of urban green spaces, which in turn leads to a decrease in their life expectancy. So, if in the mountain forests of the Trans-Ili Alatau, spruce lives up to 300-600 years, then in Almaty parks — up to 125-150 years, and on the streets — only up to 60-70 years. In an urbanized environment, tree plantations are a kind of certain indicators of the ecological situation in cities. As studies have shown, in general, the state of tree plantations in the Bostandyk district of Almaty, we assess it as satisfactory. As you know, the city of Almaty belongs to the polluted cities of Kazakhstan. Due to the location of Almaty in a foothill basin, the city is characterized by a very difficult environmental situation associated with strong gas contamination and the accumulation of harmful impurities in the air under the influence of weak circulation of air masses. According to long-term statistical data of Kazhydromet for the last 11 years, the air pollution index of the city of Almaty was equal to 8-12 units [12].

As can be seen from Figure 5, the city of Almaty, which is the largest metropolis in Kazakhstan, is characterized by a high level of air pollution. The level of air pollution is estimated by the value of the air pollution index and is calculated for five substances with maximum values normalized for MPC, taking into account their hazard class, where — 0-4 is low, 5-7 is medium, 7-14 is high, over 14 very high, etc. The level of atmospheric air pollution has somewhat stabilized in recent years, but still remains at a high level. The air pollution index of the city of Almaty in 2015-2020 decreased from 8.0 to 7.0 (Fig. 5).

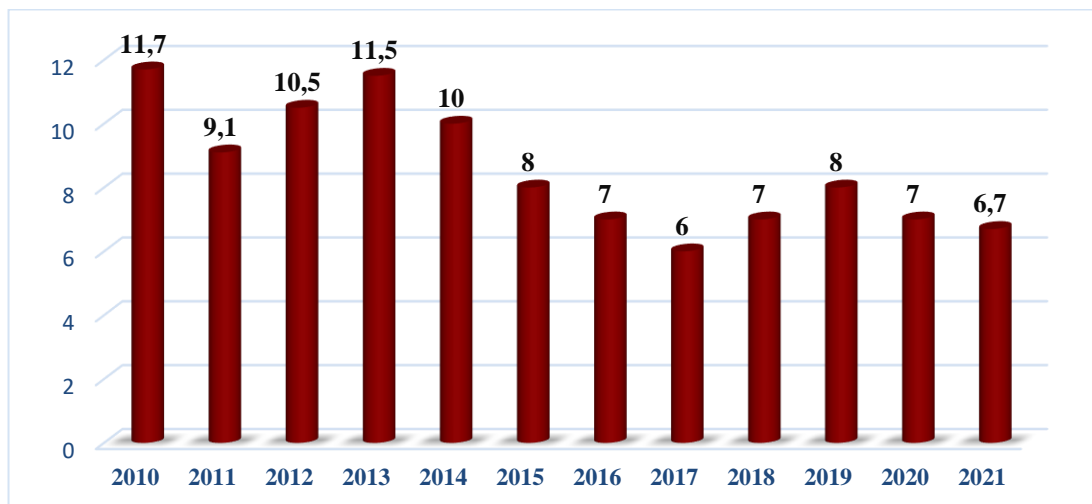


Figure 5. Air pollution index

As already noted, the main environmental problem of the city of Almaty is air pollution. Special natural and climatic features, low level of natural blowing of the territory contribute to the accumulation of pollutants in the surface layer of the atmosphere, which leads to the formation of smoke (smog).

In order to study air pollution in Almaty, we applied a method for determining the mass concentration of harmful substances in the atmospheric air with a gas analyzer. This approach allows obtaining data on the amount of harmful and greenhouse gases in the atmospheric air emitted into the atmosphere. The method of the study was to control the amount of pollutants NO, NO₂, CO, SO₂, PM 2.5 at 10 measurement points using a gas analyzer GANK-4. The tests were carried out once a month (Table 6).

Seasonal contaminant data obtained using a gas analyzer for 2021

Measuring points	Name of compounds	MPC	Summer	Autumn	Winter	Spring
Seifullin-Raiymbek	NO	0,4	0,227	0,3	0,046	0,276
	NO ₂	0,2	0,191	0,18	0,045	0,172
	CO	5	5,5	7	2,13	4,2
	SO ₂	0,5	0,0311	0,35	0,022	0,028
	PM 2.5	0,16	0,169	0,351	0,214	0,209
Seifullin-Ryskulov	NO	0,4	0,29	0,33	0,045	0,30
	NO ₂	0,2	0,21	0,2	0,036	0,18
	CO	5	6,8	5,5	2,67	4,7
	SO ₂	0,5	0,35	0,26	0,024	0,48
	PM 2.5	0,16	0,145	0,215	0,214	0,139
Momyshuly-Tolebi	NO	0,4	0,25	0,15	0,044	0,11
	NO ₂	0,2	0,18	0,16	0,036	0,17
	CO	5	5,6	3,5	2,53	4,3
	SO ₂	0,5	0,35	0,42	0,018	0,31
	PM 2.5	0,16	0,12	0,155	0,165	0,132
Al-Farabi-Navoi	NO	0,4	0,46	0,42	0,042	0,39
	NO ₂	0,2	0,2	0,19	0,034	0,17
	CO	5	4,5	5,9	2,79	3,8
	SO ₂	0,5	0,48	0,19	0,022	0,20
	PM 2.5	0,16	0,144	0,254	0,254	0,198
Rozybakiev — Raiymbek	NO	0,4	0,35	0,35	0,051	0,275
	NO ₂	0,2	0,15	0,14	0,041	0,11
	CO	5	4,5	4,1	2,36	3,6
	SO ₂	0,5	0,39	0,314	0,017	0,274
	PM 2.5	0,16	0,096	0,115	0,146	0,149
Raiymbek — Baizakova	NO	0,4	0,35	0,354	0,044	0,337
	NO ₂	0,2	0,13	0,13	0,032	0,16
	CO	5	2,5	5,3	2,45	2,6
	SO ₂	0,5	0,36	0,46	0,021	0,41
	PM 2.5	0,16	0,136	0,214	0,151	0,175
Tolebi — Otegen batyr	NO	0,4	0,15	0,245	0,042	0,115
	NO ₂	0,2	0,12	0,0159	0,037	0,095
	CO	5	1,9	2,156	2,41	1,14
	SO ₂	0,5	0,15	0,415	0,016	0,12
	PM 2.5	0,16	0,078	0,243	0,145	0,0825
Abai — Rozybakiev	NO	0,4	0,25	0,125	0,039	0,20
	NO ₂	0,2	0,13	0,14	0,031	0,11
	CO	5	3,36	3,9	2,34	3,16
	SO ₂	0,5	0,49	0,351	0,017	0,28
	PM 2.5	0,16	0,12	0,198	0,245	0,13
Al-Farabi-Zheltoksan	NO	0,4	0,31	0,39	0,042	0,29
	NO ₂	0,2	0,04	0,16	0,035	0,065
	CO	5	4,2	5,2	2,15	3,7
	SO ₂	0,5	0,19	0,354	0,021	0,14
	PM 2.5	0,16	0,076	0,216	0,145	0,097
Al — Farabi-Nazarbayeva	NO	0,4	0,22	0,312	0,047	0,20
	NO ₂	0,2	0,14	0,214	0,039	0,13
	CO	5	2,6	3,25	2,41	2,92
	SO ₂	0,5	0,12	0,33	0,022	0,26
	PM 2.5	0,16	0,065	0,316	0,195	0,094

As can be seen from Table 6, the highest concentration of harmful impurities: NO is observed at the intersection of streets — Al — Farabi-Navoi, especially in summer; NO₂ — Seifullin — Ryskulov and Al-

Farabi-Nazarbaev in autumn and summer; CO — Seifullin-Raiymbek, Seifullin — Ryskulov, Momyshuly-Tole bi, Al-Farabi-Navoi, Raiymbek-Baizakov, Al-Farabi-Zheltoksan in summer and autumn; PM 2.5 — in almost all collection points (except for Rozybakiev — Raiymbek streets), the MPC is exceeded, especially in autumn and winter, which is associated with the highest concentration of vehicles on these above-mentioned streets. Of all the given harmful impurities, only sulfur dioxide (SO₂) did not exceed the maximum permissible concentration at all measurement points.

According to our research results for 2021, the highest level of atmospheric air pollution with harmful impurities in the city of Almaty was observed in the autumn period, compared with the rest of the spring, summer, and winter seasons. In general, the ecological state of the air in the Bostandyk district of Almaty can be assessed as satisfactory.

Conclusions

Today, urban plants are influenced by the peculiar a biotic conditions of the urbanized environment, being exposed to urban stress. In large cities — megacities, a special thermal regime of air is created, which is accompanied by elevated air and soil temperatures, a light regime, characterized by a reduced intake of solar radiation due to gas contamination and dustiness of the air basin. It has its own specifics and provision of woody-shrub plants with moisture. From waterproof asphalt, rainwater flows into the sewer network, while increasing the possibility of green spaces to be in soil drought conditions. The influence of urban conditions on the plant can be seen in various indicators of life processes, appearance, structural features of its organs, and the longevity of the plant under these conditions. As our studies have shown, due to strong gas contamination and air and soil pollution, tree and shrub plantations of the Bostandyk district of Almaty are exposed to the adverse effects of the urban environment, which manifests it in the weakening of plants, a decrease in the productivity of phyto mass, and a reduction in their longevity. Deterioration of decorative properties, where crowns, especially conifers, quickly grow bald. Long-term exposure to the above factors leads to a decrease in the resistance of plants to anthropogenic impact and, in the end, the death of plants.

As a result of monitoring the quality of the state of the atmospheric air in Almaty, by the method of continuous observation, which was carried out by us using a measuring device — a gas analyzer GANK — 4 to measure the Maximum Permissible Concentration of harmful substances in the atmosphere every month during 2021, it was found that the territory of the city of Almaty is heterogeneous in terms of level air pollution, where carbon monoxide and suspended particles exceed the MPC at many measurement points. It should also be noted that the dynamics of changes in MPC levels over the past 10 years has not been stable. It is possible to single out the period of MPC decrease from 2015 to 2021 and the period of rise from 2010 to 2014. To improve the environmental situation in the city of Almaty, it is necessary to act in three main areas: the greening of vehicles, the reduction of air pollution from constant sources, including the gasification of the private sector, the preservation and development of the green fund. As for the concept of car greening, studies have shown an increase in the content of atmospheric pollutants in the exhaust gases of old vehicles compared to the year of production of new vehicles. Based on this, it is possible to significantly reduce the share of vehicles and the number of vehicles for pollution by introducing a 10-year period for the production of vehicles, as in Germany. In addition, it is necessary to take such measures as the creation of cars with low fuel consumption, the conversion of gasoline to liquefied gas, the use of vegetable oils instead of gasoline fodder (beetroot, corn).

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Жасыл желектердің экологиялық жағдайын бағалау Алматы қаласының Бостандық ауданы мысалында

Мақалада Алматы қаласының Бостандық ауданының мысалында жасыл желектердің экологиялық жай-күйін бағалау берілген. Бүгінгі күні Алматы қаласының Бостандық ауданының бульварларының, скверлерінің және жасыл аймақтарының жалпы ауданы 147,4 га құрайды. Аталған аудан Медеу және Түркісіб аудандарынан кейінгі Алматы қаласының ең жасыл аудандарының үштігіне кіреді. Зерттеу нәтижесі көрсеткендей, қаланың Бостандық ауданындағы ағаш түрлерінің жасыл екпелерінің 95 % — интродуценттер және аз бөлігін жергілікті абorigендік түрлер құрайды. Алматы қаласының аумағын көгалдандыру әртүрлі типтегі екпелермен ұсынылған. Оларға тоғайлар, аллеялар, бактар, саябақтар, бульварлар, скверлер, жасыл аймақтар, ауданишілік көгалдандыру, көшелерді көгалдандыру жатады. Сонымен қатар, бактарда, саябақтарда, бульварларда, тоғайларда түрлердің алуан түрлілігі байқалады және көшелерді көгалдандыруда үш-төрт түрді өте аз пайдаланады. Ағаш екпелерінің ішінде Бостандық ауданының барлық көшелерінде, бульварларында, гүлзарларында өсетін 35 түрі жаппай түрден тұрады. Атап айтсақ, қатты ағаштардан: *Populus nigra*, *populus italica*, *populus alba*, *Fraxinus excelsior* және басқалары. Ал жергілікті табиғи флорадан — *Armeniaca vulgaris*, *Prunus sogdiana*, *Fraxinus sogdiana*, *Rhamnus cathartica*, *Picea schrenkiana* өседі.

Кілт сөздер: Алматы қаласы, Бостандық ауданы, жасыл желектер, қалалық орта, ауаның ластануы.

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Оценка экологического состояния зеленых насаждений города Алматы на примере Бостандыкского района

В статье приведена оценка экологического состояния зеленых насаждений на примере Бостандыкского района города Алматы. Общая площадь бульваров, скверов и зеленых зон Бостандыкского района г. Алматы на сегодняшний день составляет 147,4 га. Бостандыкский район г. Алматы входит в тройку самых зеленых районов города Алматы после Медеуского и Турксибского районов. Как показали наши исследования, 95 % зеленых насаждений древесных пород в Бостандыкском районе Алматы представлены интродуцентами, и небольшая часть — местными видами-аборигенами. Озеленение территории города Алматы состоит из насаждений разных типов. К ним относятся рощи, аллеи, сады, парки, бульвары, скверы, зеленые зоны, внутрирайонное озеленение, озеленение улиц. При этом большое разнообразие видов наблюдается в садах, парках, бульварах, рощах и очень небольшое использование трех-четырёх видов при озеленении улиц. Среди древесных насаждений 35 видов составляют массовые, которые произрастают по всем улицам, бульварам, скверам Бостандыкского района. Из лиственных пород широко распространены: *Populus nigra*, *Populus italica*, *Populus alba*, *Fraxinus excelsior* и другие. Из местной природной флоры произрастают *Armeniaca vulgaris*, *Prunus sogdiana*, *Fraxinus sogdiana*, *Rhamnus cathartica*, *Picea schrenkiana*.

Ключевые слова: город Алматы, Бостандыкский район, зеленые насаждения, городская среда, загрязнение воздуха.

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