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January - February 2020
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Integrated Landscape-Ecological Evaluation of Recreational Zones of Nur-Sultan

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Abstract:
A comprehensive landscape-ecological assessment of the recreational areas of the city of Nur-Sultan has been carried out: squares “Kerey and Zhanibek Khandary”, “Islamic Cultural Center”, “Chess Players”. The landscape-ecological assessment of the trees and shrubs of the square “Kerey and Zhanibek Khandary” has showed that 653 trees and shrubs grow in the square. The assortment is represented by 28 breeds. The proportion of hardwoods is 75%, conifers - 25%. The area of flower beds is 186.5 sq.m., the area of lawns is 13466 sq.m. 2446 trees and shrubs growin the square “Islamic Cultural Center”. The assortment is represented by 29 breeds. The share of deciduous trees and shrubs is 93.2%, conifers - 6.8%. The area of lawns is 397728 sq.m., the area of flower beds is 385 sq.m. 295 trees and shrubsgrow in the square "Chess Players". The assortment of green spaces is represented by 19 species. The share of hardwoods is 65.7%, conifers - 34.2%. The area of lawns is 2749 square meters, flower beds - 49 square meters, the length of hedges is 75.5 linear meters. According to the inventory, electronic maps of green spaces in the ArcGIS Desktop program have been compiled. Instrumental measurements of atmospheric air has showed excesses of maximum occasional permissible concentration for settlementsof formaldehyde in the squares “Kerey and Zhanibek Khandary”, “Islamic Cultural Center”. The agrochemical characteristics of squares urbanozem indicate a low supply of soils with nitrogen, phosphorus and a high supply of potassium.

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I. Introduction

Nur-Sultan is the political, business and cultural center of the Republic of Kazakhstan, one of the fastest-growing megacities in the entire Eurasian space. Nur-Sultan was planned as a city in which nature and buildings, people and transport, new and old, traditions and innovation should coexist in harmony. The rapid pace of development of the capital creates complex problems associated with increased pollution as well as lack of recreational areas.

The main strategic goal of sustainable development of the city of Nur-Sultan is a balanced stable socio-economic and environmental development, based on the rational use of urban resource potential. According to the "Master Plan for the Development of the City of Astana until 2030" and the "Concept of Greening the City of Astana for 2007-2030", the authorities planned the greening of the city territory, access roads, suburban and residential areas. To improve the city’s ecosystem, it is planned to create large green areas and a system of green corridors along the Yesil, Akbulak, Sarybulak, Maybulak lakes, which will serve as a link between parks and suburban natural areas. To date, the landscaping area of urban areas makes up 15 thousand hectares. During the implementation of these measures, it is planned to increase the area of the city’s greenery to 52%. The current intracity landscaping system of Nur-Sultan, both in the area and in terms of environmental and sanitary-hygienic functions, does not meet the needs of the metropolis.

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

The city of Nur Sultan is located in an arid zone, which is characterized by limited water resources. The only waterway of the city is the Esil River with two small tributaries Sarybulak and Akbulak, replenished by melting snow during the flood period. The climate is sharply continental, with hot, dry summers and long frosty winters. Due to the adverse climatic conditions of the region associated with gusty winds, dust storms, and dry winds, since 1998 a large-scale campaign has been carried out to create a protective "Green Belt" around Nur Sultan. Today, its total area makes up about 80 thousand hectares, with an actual area of forest stands of about 12 thousand hectares, where more than 10 million trees and about 2 million shrubs grow. The share of hardwoods makes up 98.2% and conifers 1.8%. By 2020, it is planned to increase the area of forest planting to 100 thousand ha. As part of the implementation of this project, it is planned to connect the Green Belt of Nur-Sultan with the Shchuchinsk-Borovoe resort area and Alakol State Nature Reserve. However, the climatic conditions of the Akmola region do not allow implementing this project in full, due to the limited natural factors associated with soil salinity, low levels of precipitation in the summer. In this connection, a comprehensive landscape and environmental assessment of green urban areas and suburban areas is an urgent task.

The territory of the city of Nur-Sultan makes up 801.54 sq.km. The administrative-territorial structure of the city is divided into four districts: "Saryarka, Almaty, Esil, and Baikonur". Currently, the city has 10 parks with a total area of 401.29 hectares; 10 boulevards with an area of 30 hectares; more than 100 squares with an area of over 150 hectares. Parks and boulevards are located only in the new part of the city - Almaty and Esil districts. The green frame of these parks is not sufficiently formed. In the old part of the city - in the area of "Saryarka" there are only squares and their number is not enough. The green public areas of the city include the following parks and squares: the Central Park of Culture and Recreation "Stolichny", "Arai", Triathlon Park Astana, "Presidential", B. Momyshuly Park, "Zheruiyk", Zh. Zhabayev Park, Kemal Atatürk Park, "Lovers' Park", "Student Park", "Fatherland Defender's Park", "Pushkin Park", Afghan War Park, "Chess Players" squares, "Islamic Cultural Centre", "Kerey and Janibek Khandary" and others. In 2018, about 10 new squares were opened for the 20thanniversary of the capital: "Illusion Square", "Suitcase Park", "Japanese Garden of Stones" and Selfie Square of musical instruments.

As part of the research work on the budget program 217 Development of Science "Grant Financing of Scientific Research for 2018-2020" within "Landscape-ecological assessment of the state of green spaces of the city of Astana and suburban areas, ways of optimizing the landscaping system" project, a landscape-ecological assessment of "Kerey and Zhanibek Khandary", Chess Players, "Islamic Cultural Center" squares was carried out.

Kerey and Zhanibek Khandary Square is located in the Saryarka district of the city of Nur Sultan at the intersection of Zheltoksan, Bigeldinova streets and Abay Avenue, near the Museum of the First President. The total area of the square makes up 1.97 ha. In the central part of the square, there is a sculptural and artistic composition, established in 2010, and dedicated to the founders of the Kazakh Khanate, Kerey and Zhanibek.

An inventory of tree-shrubbery vegetation was carried out according to D.N.Sarsekova's method of using map schemes on a scale of M 1: 500. According to this technique, the species, age, and quantitative composition of woody-shrubby vegetation, their condition, height, trunk diameter, openwork of the crown of trees, the area of flower beds and lawns, the presence of pests, and recommendations on economic activities were determined. The height of trees and shrubs was determined using a Suunto PM-5/1520 altimeter. The area of lawns and flowerbeds was determined using a Leica Distro D5 laser range finder. The diameter of the tree trunk was determined using a measuring fork. Inventory data was entered in taxation logs and assortment lists. According to the inventory, electronic maps of green spaces in the ArcGIS Desktop program were compiled. Monitoring of atmospheric air in the surface layers of road networks for the content of NO2, SO2, formaldehyde, inorganic dust was carried out using a universal gas analyzer GANK-4 according to the methods of ST RK 2.302-2014,

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

MPT No. 02-37-2007. The determination of lead was carried out according to the method M 02-09-2005 / KZ.07.00.01339-2016. To determine the environmental factors of the soil, soil samples were selected using a drill according to GOST 17.4.4.02-84. Sampling was carried out by the "envelope" method at sites 10x10 m in size from a surface horizon of 0-40 cm. In the selected soil samples using a flame photometer, mobile forms of exchange potassium and phosphorus were determined. The content of easily hydrolyzable nitrogen and humus were determined by the method of Tyurin.

To conduct a landscape-ecological assessment of the Kerey and Zhanibek Handary square, the territory was conditionally divided into 18 sections along the lines of pavement paths. Based on taxation data, electronic maps were compiled in the ArcGIS Desktop program (Figure 1).

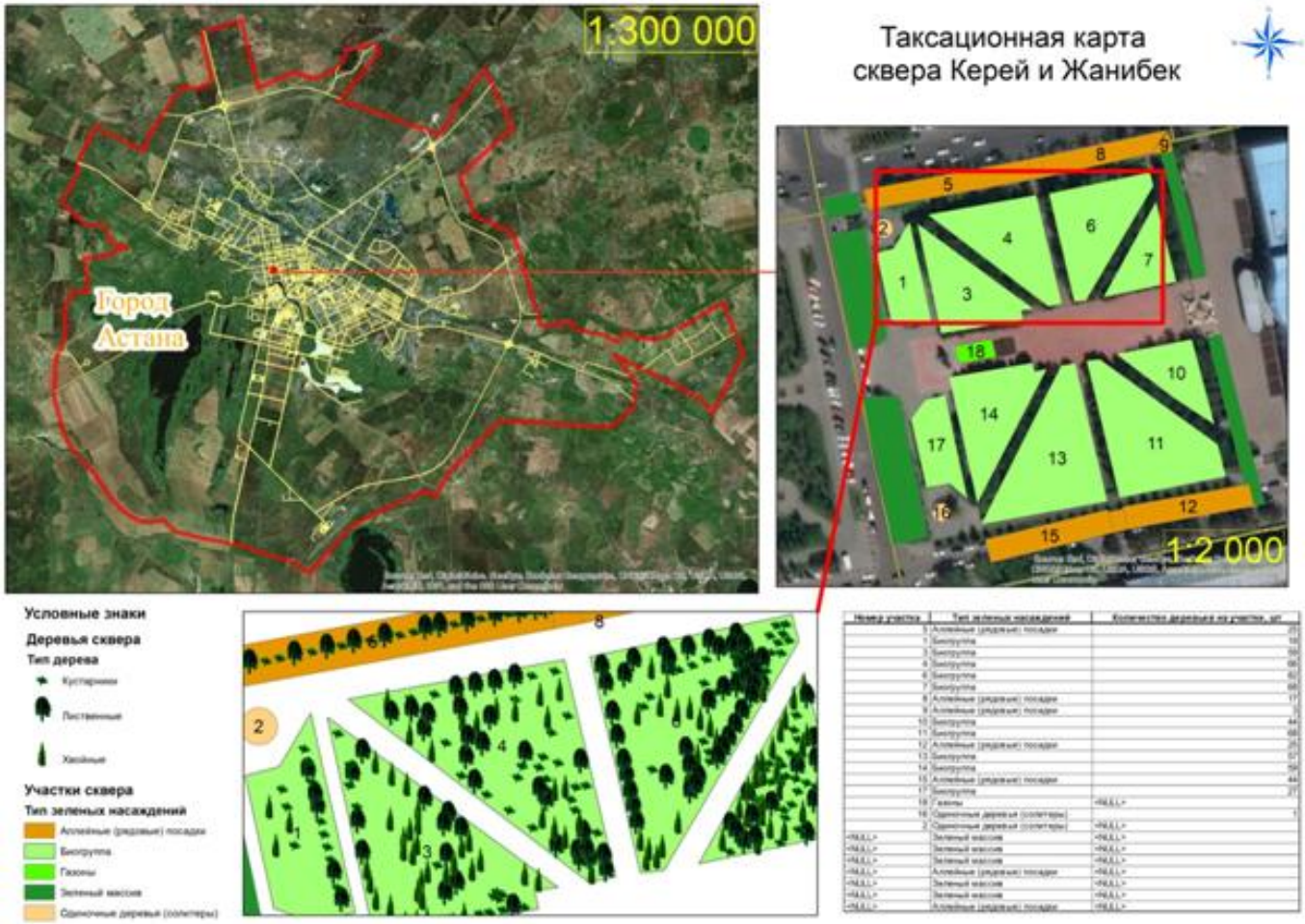

Figure 1 - Electronic map of “Kerey and Zhanibek Khandary” square in ArcGIS Desktop

The landscape-ecological assessment of the trees and shrubs of “Kerey and Zhanibek Khandary” square showed that 653 trees and shrubs grow in the square. The assortment composition of trees and shrubs is represented by 28 species: ash-leaved maple (Acer negundo), Tatar maple (Acer tataricum), drooping birch (Betula pendula), small-leaved elm (Ulmus parvifolia), rough elm (Ulmus glabra), oak oak (Quercus rob), small-leaved linden (Tilia cordata), European spruce (Picea abies), spruce (Picea pungens), Siberian fir (Abies sibrica), ordinary pine (Pinus sylvestris), silver poplar (Populus alba), Siberian apple tree (Malus baccata) white willow (Salix alba), mountain ash (Sorbus aucuparia) common barberry (Berberis vulgaris), Hungarian lilac (Syringa josikaea), common lilac (Siring a vulgaris), wild rose (Rosa), tree-like caragana (Caragana arborescens), common cherry (Prunus padus), common cherubillus (Physocarpus opulifolius) and common mock (Philadelphus coronariussheherfinus sylveriferidae).

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

The main share of woody-shrubby vegetation is dangling birch (32%), Hungarian lilac (18%), ordinary pine (10%) and European spruce (10%). The proportion of hardwoods is 75%, conifers - 25%. The garden is fenced on three sides by a hedge consisting of small-leaved elm with a total length of 275 m. The length of a hedge up to 2 m high on Bigeldinov Street is 100 m, on Zheltoksan Street - 54 m and their condition is good. The hedge on Abay Avenue is in an unsatisfactory condition, height up to 1 m and the length is 121 m. The area of flower gardens makes up 186.5 sq.m.and the area of lawns is 13466 sq.m.

In general, the condition of woody-shrubby vegetation is good, the crown openwork is high, harmful insects have not been identified. In the square there are three white willows, the age of them is more than 50 years. European spruce trees growing in the park are mostly over 30 years old and are in poor condition. There are 15 dead trees recommended for removal in the square. There is an irrigation system in the square, systematic watering of vegetation is carried out. In general, the square "Kerey and Zhanibek" performs natural-protective, decorative and planning functions. However, timely maintenance and improvement of the square are required.

The Islamic Cultural Center Square was established in 2005 around the Nur-Astana mosque, located in the Yesil district. The area of the square makes up 4.12 hectares. Noteworthy is the radial location of the square and terracing of the plots. Along Kabanbay Batyr Avenue and Syganak Street, along the perimeter of the square, there are ravines, which are reservoirs for meltwater and precipitation. To carry out a landscape-ecological assessment of the Islamic Cultural Center square, the territory was conditionally divided into 43 sections along the sidewalk lines and an electronic map was compiled (Figure 2).

EFigure 2 - Digital map of "Islamic Cultural Center" square in ArcGIS Desktop

An examination of the green spaces of the Islamic Cultural Center square it was revealed that the assortment composition of trees and shrubs is represented by 29 species. In total 2446 pieces of

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

wood and shrubby vegetation grow. The area of lawnsmakes up 397728 sq.m. and the area of flower beds makes up 385 sq.m..

The assortment of trees and shrubs is represented by the following species: ash-leaved maple (Acer negundo), Tatar maple (Acer tataricum), green ash (Fraxinus excelsior), birch birch (Betula pendula), small-leaved elm (Ulmus parvifolia), Ulus rufus), English oak (Quercus robur), small-leaved linden (Tilia cordata), European spruce (Picea abies), spruce (Picea pungens), common pine (Pinus sylvestris), Siberian cedar (Pinus sibirica), silver poplar (Populus alba) , pyramidal poplar (Populus nigraf. pyramidalis), balsam poplar (Populus balsamifera), Siberian apple tree (Malus baccata), Ussuriys pear kaya (Pyrusus suriensis), steppe cherry (Prunus fruticosa), bitter almonds (Prunus dulcis), white willow (Salix alba), chokeberry (Aronia melanocarpa), red elderberry (Sambucus racemosa), common lilac (Siringa vulgaris, g) (Lonicera tatarica), bird cherry (Prunus virginiana), goose narrow-leaved (Elaeàgnus angustifólia), Kuril tea (Potentilla alba), Cossack juniper (Juniperus sabina), golden currant (Ribes aureum).

Deciduous tree and shrub species prevail in the park, the share of which is 93.2%, including pyramidal poplar - 14.2%, small-leaved elm - 13.4%, white willow - 11.2%, ash-leaved maple - 9.2%, Siberian apple tree - 6.1%, rough elm - 3.1%, etc. Thickets of narrow-leaved sucker amounted to 14.0%, bitter almond - 6.8%, Kuril tea - 1.9%. The share of conifers is 6.8%, including the share of European spruce - 4.7%, prickly spruce - 1.5%, Cossack juniper - 0.3%, ordinary pine - 0.2%, Siberian cedar - 0.1%.

In the square, woody and shrubby vegetation is represented at different ages. The proportion of trees under the age of 10 years is 11.5%; 11-20 years - 20.4%; 21-30 years old - 35.2%;over 30 years - 30.7%. The proportion of shrubs under the age of 5 years is 2.1%; over 5 years old 97.9%. The main share of woody plants aged 21-30 years and older is made up of old-age planting of willow, poplar and squat elm. In general, trees and shrubs are in good condition; 49 dead trees need to be removed. The area of landscaping the garden makes up 57%.

In general, the Islamic Cultural Center is characterized by a meager species assortment of tree and shrub species, a low proportion of conifers and hedges, the uniformity of flowerbeds and the absence of multi-tier plantings. In the park, it is recommended to improve phytosanitary surveillance, increase the assortment in flowerbeds with perennial plants, conduct timely cutting of hedges, treat frost holes, cracks in the trunks, and apply fertilizers. In general, the square performs its sanitary-hygienic, aesthetic, decorative and planning functions.

The Chess Players Square is located near Saryarka at the intersection of Kenesary Street and Republic Avenue. The square was opened in 2005 and covers an area of 0.48 hectares. The square owes its name to chess figures, game tables and original chess benches installed in the open air. This square is a favorite place for the townspeople. To carry out the landscape and ecological assessment of "Chessplayers" park, the territory was conditionally divided into 24 sections along the sidewalk paths (Figure 3).

The landscape and ecological assessment of the Chess Players Square showed that 295 trees and shrubs are growing in the park. The assortment of green spaces is represented by 19 species: ash maple (Acer negundo), green ash (Fraxinus excelsior), birch bent (Betula pendula), small elm (Ulmus parvifolia), European aspen (Populus tremula), European spruce (Pice abies), Pice European larch (Larix decidua), prickly spruce (Picea pungens), Scots pine (Pinus sylvestris), silver poplar (Populus alba), Siberian apple tree (Malus baccata), Ussuri pear (Pyrus ussuriensis), white willow (Salix alba) common (Syringa vulgaris), bird cherry (Prunus virginiana), wild rose (Rosa), bitter almond (Prunus dulcis), juniper Cossack (Juniperus sabina)and chokeberry (Aronia melanocarpa).

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

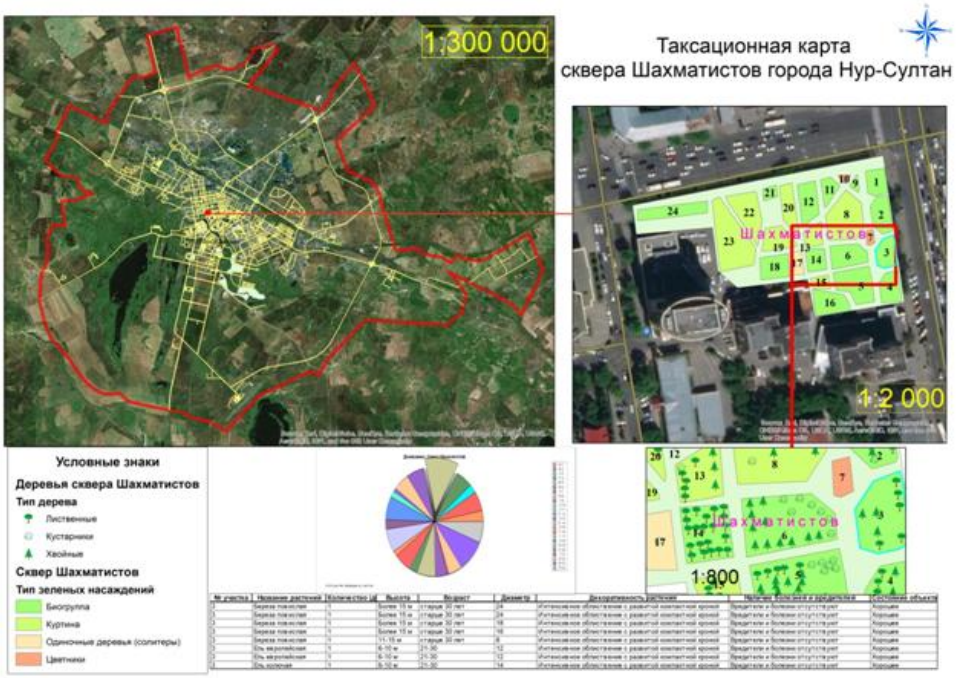

Figure 3 - Digital map of "Chess Players" square in ArcGIS Desktop

The share of hardwoods makes up 65.7% and conifers - 34.2%. Among deciduous species there are saggy birch (13.2%), bitter almonds (10.8%), common lilac (10.1%), green ash (6.4%), ash-leaved maple (5.4%), bird cherry Virginia (3.4%), small-leaved elm (3.4%), wild rose (3.4%), Ussuri pear (3.0%), Siberian apple tree (2.0%), white willow (2.0 %), white poplar (2.0%) and common aspen (0.3%). Among conifers, European spruce (22.7%), prickly spruce (7.8%), ordinary pine (2.0%) and European larch (1.7%) are the main part.

In the square, woody and shrubby vegetation is represented at different ages and amounts to up to 10 years - 12.3%; 11-20 years old - 17.3%; 21-30 years old - 24.2% and older than 30 years - 46.2%. The age of 77 shrubs is over 5 years old. The majority of woody plants are older than 30 years.

The area of lawns is 2749 square meters, flowerbeds - 49 square meters and the length of hedges - 75.5 linear meters. Most of the trees in the park are in good condition with a developed crown. The area of landscaping the park as a whole is about 70%. As economic measures, forestry operations are recommended, which include trimming dry branches and trunks, cutting hedges, fertilizing, feeding epin fir trees, improving phytosanitary surveillance, increasing the assortment in flowerbeds. About 30 trees and shrubs need to be planted additionally. In general, the square is in good condition.

To determine the quality of atmospheric air in “Kerey and Zhanibek Khandary”, “Islamic Cultural Center”and “Chess Players” squares, instrumental measurements of atmospheric air were carried out for the content of nitrogen (IV) oxides, sulfur, formaldehyde, lead and inorganic dust. The results are presented in Table 1. During instrumental measurements of pollutants, the weather was clear, pressure was 736 mm Hg; t = + 20-21 ° C; wind direction - southwest; wind speed - 2.96-2.99 m / s; air humidity - 35-36%.

Table 1 - The results of instrumental measurements of atmospheric air in the squares of Nur Sultan city in 2018

Sampling Place	Name of the defined indicator				
	inorganic dust	NO_2	SO_2	HCOH	Pb^{2+}
	concentration of pollutants, mg / m3				
The “Kerey and Zhanibek Khandary” Square					
Point 1	0,04	0,008	0,004	> 0,05	0,000032
Point 2	0,04	0,009	0,003	-	0,000031
Point 3	0,04	0,01	0,01	-	0,000031
The Chess Players Square					
Point 1	0,04	0,001	0,007	0,0423	0,000030

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

Point 2	0,05	0,010	0,009	0,008	0,000031
The "Islamic Cultural Centre"Squer					
Point 1	0,04	0,06	-	> 0,05	0,000032
Point 2	0,04	0,05	-	-	0,000030
Point 3	0,04	0,04	0,1	-	0,000030
Point 4	0,04	0,08	> 0,5	-	0,000030
Point 5	0,04	0,01	0,01	-	0,000032
Point 6	0,040	0,01	0,009	-	0,000031
Point 7	-	0,01	0,007	1,87	0,000032
MAC for populated areas, mg / m3	0,5	0,2	0,5	0,05	0,003

As can be seen from table 1 one-time excess Pdcm.R. formaldehyde observed at three points of measurement: in "Kerey and Zhanibek Khandary" and "Islamic cultural center" squares. In the "Chess players" square, the concentration of formaldehyde was close to the MPC. Excessive concentrations of sulfur oxide (IV) were revealed in the "Islamic cultural center" square. The concentration of nitrogen oxide (IV) is in the range of 0.001-0.08 mg/m3 and does not exceed the MPC. The content of mineral dust is relatively stable and is in the range of 0.04-0.05 mg/m3, which does not exceed the MPC. The lead content is in the range of 0,000030-0,000032 mg/cm3, which also exceeds the MCL (0.003 mg mg/cm3).

Therefore, instrumental measurements of atmospheric air of squares of city of Nur-Sultan ("Kerey and Zhanibek Khandary","Players" and "Islamic cultural center" squares) for the maintenance of oxides of nitrogen, sulfur, formaldehyde, lead and inorganic dust with a gas analyzer GANK-4 showed exceeding the maximum one-time maximum permissible concentration of formaldehyde in the three points of measurement. Formaldehyde, formic aldehyde officially recognized carcinogen, as the International Agency for research on cancer, a member of the world health organization proved that the use of formaldehyde is associated with an increased risk of developing cancer, particularly tumors of the nasopharynx. In addition, formaldehyde can lead to leukemia. It is also noted occasional excessive concentrations of sulfur oxide (IV) were revealed in the "Islamic cultural center" square. According to the obtained results, it follows that the quality of atmospheric air in parks and squares of the city does not meet established standards. Today in the city, there are seven posts of observations of the state of atmospheric air. However, according to the established norms in the larger cities with a population of over 1 million people to monitor the condition of atmospheric air must be installed at least 12 fixed monitoring stations. In this connection, within the city should increase the number of fixed monitoring stations to the set standards. It is also necessary to expand the list of designated pollutants on automatic posts.

Man because of mixing, burial, delivery of soil and natural soil, mainly creates urban soils of cities. Man-made layer of soil-like body will be transformed in the future under the influence of soil formation factors and man into urban soils with different composition and property. Therefore, our research aimed to study the ecological state of the soil cover of recreational areas and assess the availability of woody-shrubby vegetation with basic macroelements and humus.

The agrochemical characteristics of urban squares (Table 2) indicate that the humus content in the upper 0–20 cm layer ranges from 2.3–4.45%; at a depth of 20-40 cm - 1.52-3.54%, which indicates a low humus content. The same situation persists in the content of total forms of nitrogen and phosphorus. Easily hydrolyzed nitrogen in the upper horizons (0-20 cm) varies between 0.126-0.26 mg per 100 g of soil, in the lower horizons (20-40 cm) - 0.098-0.184 mg per 100 g of soil, which indicates a low nitrogen supply in the spring. According to the content of mobile phosphorus, urban urbanozems of the squares are poorly provided, because its content at a depth of 0-40 cm was 0.03-0.045 mg per 100 g of soil. The content of exchange potassium at a depth of 0-20 cm is 45.8-77.6 mg / 100 g of soil; at a depth of 20-40 cm - 25.8-53.0 mg/100 g of soil, which indicates a high availability of soil with exchange potassium.

Table 2 - Agrochemical characteristics of the soil cover of the squares of the city of Nur Sultan

	Depth cm	%	Gross, %	Movable mg / 100 g

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 10245 - 10252

Square Name		humus	CO_2 carb.	N	P_2O_5	$N_{l.g}$	P_2O_5	K_2O
The "Kerey and Zhanibek Khandary" Square	0 - 20	2,3	0,52	0,126	0,045	2,80	1,49	45,8
	20 - 40	1,52	1,04	0,098	0,030	2,24	1,15	25,8
The Chess Players Square	0 - 20	4,45	0,69	0,230	0,030	4,76	8,06	77,6
	20 - 40	2,63	0,69	0,136	0,030	2,80	2,73	48,6
The "Islamic Cultural Centre" Squer	0 - 20	2,66	0,52	0,135	0,030	-	0,50	57,8
	20 - 40	3,54	0,52	0,184	0,030	2,80	2,12	53,0

Thus, the landscape-ecological assessment of the Kerey and Zhanibek Khandary, Chess players, the Islamic Cultural Center squares of the city of Nur Sultan, showed the poor species composition of woody-shrub plants, a low proportion of conifers, the presence of dead trees, the absence of landscape planning planting of woody-shrubby vegetation, medium gardening of squares, low content of humus, nitrogen and phosphorus in soils. At the same time, in the surface layers of the atmospheric air of road networks, excesses of pollutants are recorded, which indicates a low proportion of gas-collecting and dust-collecting trees and shrubs, multi-row planting along roads.

The capital of each state is a kind of "business card" of its own. The special status of Nur-Sultan requires the solution of many tasks related to its establishment as the capital of the state in the Central Asian region. Nur-Sultan's mission is to become an exemplary capital in the Eurasian space, to be the basis for sustainable development of the Republic of Kazakhstan. According to the Strategic plan of development of the capital city, the sustainable development of the city should ensure the creation of a beautiful, healthy and beloved by the residents of the city, providing the satisfaction of their needs.

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