

Artículo de investigación

Analysis of the range of trees and shrubs used in the landscaping of Saratov

Анализ ассортимента древесно-кустарниковых растений, используемых в озеленении г. Саратова

Análisis de la variedad de plantas de árboles y arbustos utilizados en el paisajismo de la ciudad de Saratov

Recibido: 12 de julio del 2019 Aceptado: 24 de agosto del 2019

Written by:

Anna Leonidovna Kalmykova²²³

https://elibrary.ru/author_items.asp?authorid=672076

ORCID ID: 0000-0002-7476-5060

Alexander Valerievich Tereshkin²²⁴

https://elibrary.ru/author_items.asp?authorid=670681

ORCID ID: 0000-0002-2125-0290

Galina Nikolaevna Zaigralova²²⁵

https://elibrary.ru/author_items.asp?authorid=324019

ORCID ID: 0000-0003-2708-8287

Dmitry Vladimirovich Eskov²²⁶

https://elibrary.ru/author_items.asp?authorid=320006

ORCID ID: 0000-0002-5240-9364

Mikhail Yuryevich Kornienko²²⁷

https://elibrary.ru/author_items.asp?authorid=351352

ORCID ID: 0000-0003-4448-090X

Abstract

The article deals with the history of green space expansion in the city of Saratov based on comparative analysis of the range of green spaces for 1966, 1998, and 2017. The authors note the expansion tendency of the wood species range applied in city landscaping due to the inclusion of invasive plants and decorative forms of trees and bushes. The results of a comprehensive assessment of the current state of the range of plants at the sites of urban landscaping and long-term observations of them allowed determining the types and varieties of trees, shrubs, and lianas, which had successfully adapted to the urban environment states. The authors have developed a broad range of plants, which includes 138 names of tree and bush species recommended for application on landscaping sites of various categories in Saratov.

Аннотация

В статье рассмотрена история зеленого строительства в г. Саратове, выполнен сравнительный анализ ассортимента зеленых насаждений за 1966, 1998 и 2017 годы. Отмечена тенденция расширения ассортимента применяемых в озеленении города пород за счет включения в него интродуцентов и декоративных форм деревьев и кустарников. Результаты комплексной оценки современного состояния ассортимента растений на объектах озеленения города и многолетние наблюдения за ними позволили определить виды и сорта древесных, кустарниковых пород и лиан, которые успешно адаптировались к условиям городской среды. На основании полученных данных разработан ассортимент из 138 наименований древесно-кустарниковых видов, рекомендованных к применению на объектах

²²³ Saratov State Agrarian University named after N.I. Vavilov, 1 Teatralnaya Sq., Saratov, 410012, Russian Federation, nwuta80@mail.ru

²²⁴ Saratov State Agrarian University named after N.I. Vavilov, 1 Teatralnaya Sq., Saratov, 410012, Russian Federation

²²⁵ Saratov State Agrarian University named after N.I. Vavilov, 1 Teatralnaya Sq., Saratov, 410012, Russian Federation

²²⁶ Saratov State Agrarian University named after N.I. Vavilov, 1 Teatralnaya Sq., Saratov, 410012, Russian Federation

²²⁷ Saratov State Agrarian University named after N.I. Vavilov, 1 Teatralnaya Sq., Saratov, 410012, Russian Federation

Keywords: Assortment, landscaping, inventory, trees, shrubs, lianas, Saratov.

различных категорий зеленых насаждений г. Саратова.

Ключевые слова: ассортимент, озеленение, инвентаризация, деревья, кустарники, лианы, Саратов.

Resumen

El artículo considera la historia de la construcción verde en la ciudad de Saratov, se realiza un análisis comparativo de la variedad de espacios verdes para 1966, 1998 y 2017. Existe una tendencia a expandir la variedad de especies utilizadas en el paisajismo de la ciudad debido a la inclusión de introductores y formas decorativas de árboles y arbustos en ella. Los resultados de una evaluación exhaustiva del estado actual del surtido de plantas en las instalaciones de paisajismo de la ciudad y las observaciones a largo plazo de ellos permitieron determinar los tipos y variedades de especies de árboles, arbustos y enredaderas que se adaptaron con éxito a las condiciones del entorno urbano. Sobre la base de los datos obtenidos, se desarrolló una variedad de 138 nombres de especies de arbustos arbóreos recomendados para su uso en objetos de varias categorías de espacios verdes de la ciudad de Saratov.

Palabras clave: Surtido, jardinería, inventario, árboles, arbustos, vides, Saratov.

Introduction

The challenging ecological situation in the large cities of Russia imposes strict requirements for the range of wood and shrub plants. For effective performance of ecological and esthetic functions in populated areas, the range of wood species used when creating green plantings should be multifarious and include the plants possessing the ability to absorb harmful substances from all environments (atmosphere, hydrosphere, and lithosphere). These plant species must have high resistance to adverse factors, to pests and diseases, have sufficient winter hardiness, and possess decorative effect during the long period. At that, an important factor is a simple and relatively cheap reproduction, cultivation, and maintenance technology (Zhukova, 2013; Tkhorikov et al, 2018).

The research purpose is to assess the current status of the used range of woody and shrub plants at the landscaping sites of Saratov and to substantiate the prospects for its expansion.

Tasks of the research are as follows:

- To conduct a comparative analysis of the range according to the stock of materials and inventory of green plantings in the city of Saratov in 1966, 1998 and 2017;
- To determine the age characteristics and assess the sanitary state, as well as the decorative level of the used range of

- wood and shrub plants at the landscaping sites;
- To substantiate the possibility of expanding the range of these plants.

Materials and methods

When defining a range of trees and shrubs recommended for application in the urban territory of Saratov, the authors used zoning materials for landscaping, obtained by A.I. Kolesnikov (1974). The species composition was studied based on the inventory carried out by the Saratov Branch of the Rosgidroles Institute in 1998-1999, as well as inventory materials (1965 – 1966), and own studies (2015-2017) of landscaping sites (Zaigralova, Kabanov, 2016; Cherepanov, 1995).

Evaluation of the sanitary state of the plants was carried out based on a range of biomorphological features, namely, leaves color, crown density, the presence and proportion of dead branches in the crown, bark state, and signs of the settling by stem pests. All plants were assessed by the following categories:

1. No signs of weakening;
2. Weakened;
3. Strongly weakened;
4. Shrunken;
5. Fresh dead-wood;
6. Old dead-wood.

The tree state index of various species is defined as the weighted average value of estimates of the distribution of the number of tree stems of different categories of the state.

The weighted average for each tree species (Kav) is calculated by the formula:

$$K_{cp} = \frac{\sum_i^6 = 1K_i \times W_i}{\sum_i^6 = 1W_i}$$

where i is the numbers of the tree state categories; K_i is the index of the i -th tree state category;

W_i is the weight of the trees (their number) of the i -th state category.

The weighted average for tree stand is as follows:

$$K_{\text{Hac}} = \frac{\sum_j^n = 1K_{cpj} * W_j}{\sum_j^n = W_j}$$

where j is the number of wood species involved in the composition of the tree stand; K_{av} is the state index of the j wood species; W_j is the weight of j -th wood species (number of trees).

According to the values of K_{av} and K_{sat} , the tree stand can be attributed to a certain state category according to the following parameters (Table 1) (Pravila sanitarnoj bezopasnosti v leash, 2017)

Table 1. Compliance of state category of the tree stand based on its state index

State index	State category of the tree stand
1.0 – 1.5	Healthy tree stand
1.51 – 2.5	Weakened tree stand
2.51 – 3.5	Strongly weakened tree stand
3.51 – 4.5	Dying tree stand
Over 4.51	Deadwood

The age characteristic was carried out based on the Ontogenetic Atlas of plants (Zhukova, 2013). Only five age categories were taken into account when determining the age status of different tree species. Age states of seedlings, juvenile, and immature plants were not taken into account, while in the postgenerative period, subsenile species were not considered due to their absence in the plantings. Thus, the following age categories of woody plants have been identified for the urban environment:

- Virgin (v) - young trees that have not entered the fruiting phase;
- Young generative plants (g1) - plants with an acute apex that have entered the fruiting period;
- Middle-aged generative plants (g2) - well-formed plants with a blunt apex, abundantly fruiting;
- Old generative plants (g3) - plants having a wide rounded crown with a small increment in height, whose large branches of the apical crown begin to dry off;
- Senile plants (s) with a dry or broken apex.

Results

The development of landscaping in the city of Saratov and the region has a long history dating back to the founding of urban settlements. However, the improvement of the city and its sanitary situation was very slow. In pre-revolutionary Saratov, artificial plantings existed in the form of gardens in private holdings. There were almost no public gardens, where residents of the city could relax.

At the beginning of the 19th century in the picturesque surroundings of Saratov, a foundation of the manor of Saratov Governor Alexei Panchulidzev was laid. After 1812, the natural oak grove in the territory of the estate was supplemented with young oaks. Memories of Saratov official Konstantin Popov indicate that the Governor's estate became the first public garden in Saratov: "Exit to the terrace into the flower garden was from the living room of the summer cottage. Three alleys laid from the flower garden were separated by different kinds of trees, such as cherries, bergamot, plums, a variety of pear, etc. On both sides of these alleys, there was a garden with the best varieties of apple trees..., well-constructed gazebos were scattered in the garden... These three alleys were adjacent to the pond, perfectly designed bridges were stretched across the pond, benches and tables

were situated around the pond and in the grove, laid paths were everywhere, which flanked the grove of diverse shrubs creating the picturesque view... In spring and summer time, on holidays and solemn days, citizens of Saratov of all social stratum used to walk here free of any charge. There was no prohibition for anyone, provided that people were decently dressed and kept themselves decent" (Shishkina, 2011).

After the death of Panchulidzev in 1834, the owners of the estate changed, while the estate itself was split up. In 1855-1857, in the place of the farmstead buildings, the building of the Mariinsky Institute for Noble Maidens was built, while the land, which was not needed by the institution, was sold to merchants D.M. Vakurov, V.M. Parusinov, and others. After the revolution, Vakurov's and Parusinov's lands were given to city authorities.

In 1824, on the initiative of the Saratov city Duma, commoner Mikhail Smirnov, and peasant Nikifor Fedorov planted 1080 linden trees around the newly built Alexander Nevsky Cathedral. At first, the boulevard was called Alexandrovsky, while later it was renamed to "Lipki" (Lindens).

Over the years passed, the state of "Lipki" was improving than worsening again. The plants were periodically supplemented by the planting of "new trees from floodplains and urban forest cottages". The Boulevard which later became a garden was a place of rest for citizens of different social stratum and ages, for whom individual areas and time for visiting the Boulevard were scheduled (Shishkina, 2011).

In 1891, on an area of 65 hectares, Frenchman Verdier laid the first garden of mulberry trees, which existed for two decades.

In the late 18th - early 19th centuries, Saratov began to copy the image of the capital cities and acquire the image of the city, where the rich and the nobility people lived. At the same time, merchants were against creating garden squares and boulevards in the city. City development was carried out by ordinary citizens. Gradually, the trees started to appear near the houses and along the city streets, though the range of wood species was poor and monotonous.

In 1927, the question was raised about how to cut down Vakulovsky Park at all, or to make it a place of public festivals. The Commission, composed of the City Council members, and representatives of other official urban

organizations, as well as professor and urban forester, inspected the Park, Parusinovsky and Institutsky groves, and concluded that plants died out. Forest area, with a predominance of century-old oak trees, was abandoned. The leaves were devoured by silkworms, the shoots were destroyed by goats. The number of dry trees was growing.

A decision was made about the improvement of the groves for public recreation, as well as attributing Parusinovsky and Institutsky groves to the revolutionary monuments. Work began in 1928. The railroad workers cleaned two ponds, alleys, paved new paths, while the Park was fenced with barbed wire protecting plants from goats, pigs, and cows.

In 1929 in Saratov it was decided to organize the city Park of culture and rest, for which the Vakurovsky Park was chosen. Reconstruction of the Park ended only in 1935 by the workers of the factories of Oktyabrsky district, and students. The park was symbolically planted with 1917 trees and 21 thousand units of ornamental shrubs. About 300 thousand summer flowers were planted on the flower beds.

The first greening trust appeared in 1935. In 1970 it was reorganized into Zelenstroy RSU repair and construction department, which began to carry out works on the landscaping of Saratov. The state farm of ornamental crops, where planting material of trees, shrubs, and flower seedlings for the needs of the city was grown, was under the jurisdiction of the established repair and construction department.

Dry summers, snowy winters, strong winds, often turning into dust storms and other factors stipulated the complexity of the climatic condition of Saratov for the growth of vegetation, with the exception of unpretentious local tree species, whose range was quite insignificant. In 1949, in the zone of arid South-East of the European part of Russia, the first tree nursery was laid, where the staff was engaged in the study of acclimatization and implementation of new woody species. The range of wood species used in landscaping began to expand. In 1957, *Picea pungens* Engelm., as well as various garden forms of *Lonicera* L., *Salix babylonica* L. of rare beauty, were planted in parks, gardens, boulevards, and garden squares. In 1962, the Botanical garden was founded in Saratov, where not only the transference of woody species was carried out, but also the collections of flower cultures were formed. During this period, urban landscaping included two gardens, four parks,

seven boulevards, and fifty garden squares. However, despite active rates of greening and improvement of the city, the area of green plantings of the general use in the city still lagged behind the standard, substantially conceding on this indicator to the neighbors – regional centers of the Volga Region (Luzina, 1987).

The results of the first surveys conducted in 1965-1966 had shown that in the green spaces of the city on the public landscaping sites, 104 species and seven cultivars of trees and shrubs were growing (Milovidova, Tarenkov, 1968).

The distribution of species of trees and shrubs by life forms is shown in the diagram (Figure 1).

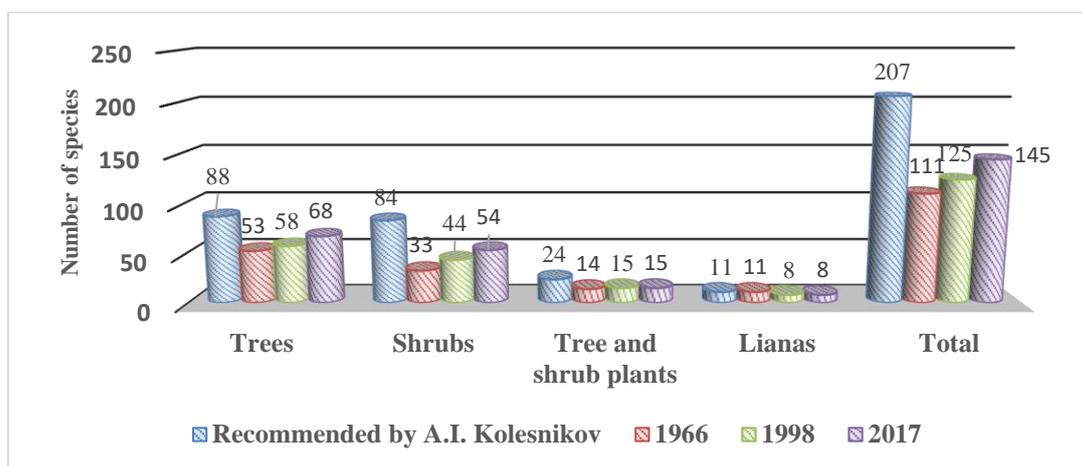


Figure 1. Distribution dynamics of tree and shrub plants of different life forms in the green spaces of Saratov.

The increase in the number of industrial enterprises and their development, as well as the increase in the number of vehicles in the 1970s, led to a deterioration of the environmental situation in the city. Ongoing work on landscaping was insufficient, and the level of landscaping still lagged behind the normative.

In 1979, a branch of the Giproles Institute drew up a long-range plan for the comprehensive greening of a regional city. This plan was aimed at bringing the number of green spaces to statutory indicators, as well as the expansion of the range of species composition. The list of species recommended for use in the greening of the city was based on the list of tree and shrub species suggested by A.I. Kolesnikov, which included 207 names of tree and shrub plants. The proposed range was quite broad and diverse. However, the development of technologies for growing their planting material within a short period was not possible. Therefore, first of all, it was planned to establish the cultivation of plant species intended for the creation of street plantings, as well as for vertical landscaping in addition to the already existing range of plants. In addition, it was recommended to increase the growing volumes and the range of deciduous species (*Phellodendron amurense* Rupr.),

conifers (*Juniperus virginiana* L. and *Juniperus sabina* L., *Abies concolor* Lindl., *Thuja occidentalis* L.), as well as shrubs (various species of *Crataegus* L., *Spiraea* L., *Viburnum opulus* L., *Ligustrum vulgare* L., *Berberis* L.).

In 1998, the Rosgidroles Institute carried out large-scale works on the inventory of green plantings in the city objects of public use. According to the results of surveys, it was found that for 32 years, the range of trees and shrubs increased by 36 species (11.5%). According to the results of the inventory, 120 species of trees and shrubs used in landscaping were identified. However, despite the rather wide floristic composition, the background for all plantings of Saratov were species with low aesthetic value, but featuring by rapid growth and resistance to severe growing conditions, to environmental pollution, and lack of care for green spaces. These were *Ulmus pumila* L. (22.9%), *Fraxinus lanceolata* Borkh. (9.7%), *Acer platanoides* L. (9.2%), *Acer negunda* L. (9.9%), *Populus pyramidalis* Borkh. (8.5%), and *Populus berolinensis* Dippel (6.3%).

Since 2000, on many landscaping sites of Saratov, work was held aimed at the reconstruction of green plantings. In the course

of this work, dry and damaged trees were removed, as well as ramshackle and old specimens of *Ulmus pumila* L., *Acer negunda* L., and *Populus* L. Planting were supplemented by more decorative and durable species of woody plants and shrubs.

In 2015-2017, sample monitoring surveys of green spaces were conducted, during which it was revealed that the range of trees and shrubs has changed towards increasing the species composition by 11.7% compared to the results of the inventory in 1998. Over 140 species of trees and shrubs were identified at the landscaping objects. The landscaping of Saratov was dominated mainly by trees (69.7%), while the proportion of shrubs was just 30.3%, i.e. the statutory indicator was not met.

The list and ratio of species that make up the overall background of plantings had partly changed: *Fraxinus lanceolata* Borkh. (11.0%), *Aesculus hippocastanum* L. (8.3%), *Ulmus parvifolia* Jacq. (7.4%), *Populus pyramidalis* Borkh. (5.9%), *Acer platanoides* L. (3.3%) and *Tilia platyphyllos* Scop. (3.1%). The proportion of *Acer negunda* L. in green spaces had decreased to 2.1%, while the proportion of *Aesculus hippocastanum* L. had increased.

The results of the plant surveys have shown a tendency towards increasing the species and varietal diversity of coniferous woody plants in landscaping. *Juniperus virginiana* L. and its decorative varieties, such as *Juniperus sabina* L., *Juniperus squamata* Lamb, *Abies concolor* Lindl., and *Larix sibirica* Ldb. were planted at the landscaping sites. However, in general, the number of coniferous species in the landscaping sites remained insignificant. Their proportion amounted to an average of 11.7%, which was lower than the statutory indicator (13%). Two wood species were dominating on the landscaping objects, namely, *Picea abies* (L.) Karst., and *Picea pungens* Engelm. (5.1%).

Analysis of the range of decorative trees and shrubs in the landscaping of the city has shown that in its streets, parks and garden squares, along with local plants, grow a large number of invasive plants. Wood and shrub invasive plants are often characterized by special decorative nature and expressiveness of the external appearance in comparison with native species.

Some of the invasive plants show greater resistance to a complex of unfavorable factors of the urban environment (Ozelenenie naseleennyh

punktov Habarovskogo kraja, n.d.; Yakushina, 1982).

The species and shape diversity of shrubs at landscaping sites of Saratov is quite broad, though many species are represented by a small number of samples, on average from one to ten pieces, and at the landscaping, sites are represented by solitary or group plantings. As before, the most common species at the landscaping sites are *Syringa vulgaris* L., *Philadelphia coronarius* L. and *Rosa majalis* Herrm (6.5%), present at all landscaping sites in the form of groups and single plantings. These types of shrubs have a maximum age and require replacement by young specimens. Green fence at all landscaping sites is formed by *Cotoneaster lucidus* Schlecht.

Since 2017, the work on the improvement of the city carried out within the framework of the municipal program "Formation of the modern urban environment of the municipality of Saratov city for 2018-2022" has allowed increasing the range of decorative shrubs. The list of species that were used for planting in the green space includes *Spiraea bumolda* Burv. (Anthony Water, Shirobana), *Spiraea×cinerea* Zabel. (Grefsheim), *Spiraea vanhouttei* (Briot) Zab., *Spiraea japonica* L. (Little Princess), *Ribes alpinum* L., *Berberis vulgaris* L., and *Berberis thunbergii* DC., *Cornus alba* L. and *Cornus sanguinea* L. (including variegated varieties), *Physocarpus opulifolius* (L.) Maxim. (Diabolo, Luteus), *Sorbaria sorbifolia* (L.) A. Br., *Hydrangea paniculata* Sieb. (Grandiflora, Vanille Fraise, Pinky Winky).

It should be noted that vertical landscaping is poorly developed in the city. Among all plantings in Saratov, 18 species of perennial lianas belonging to 10 genera were revealed, as well as six species of annual climbing plants belonging to five genera. *Parthenocissus quinquefolia* (L.) Planch is the most common species in all categories of urban plantings. Its habitats occupy 67.5% of the total number of habitats of lianas in Saratov. Occasionally one can encounter with *Vitis amurensis* Rupr. и *Lonicera caprifolium* L., *Clematis virginiana* L. in plantings of restricted use (Kalmykova, 2008; Tereshkin, Kalmykova, Ishutina, 2014).

The analysis of the age structure of trees according to the results of conducted inventories has shown that for the period since 1998, the proportion of middle-aged trees has increased from 29.2 to 37.8% (Figure 2). The number of old-aged and senile specimens has also

increased. The tendency of plantings aging has been observed despite the implementation of measures for reconstruction of landscaping, where from plantings has been partly removed

not only dead and dry trees but the age trees (ripe trees), which pose a danger to city residents. The increase in the proportion of middle, old, and very old trees indicates the need to replace them.

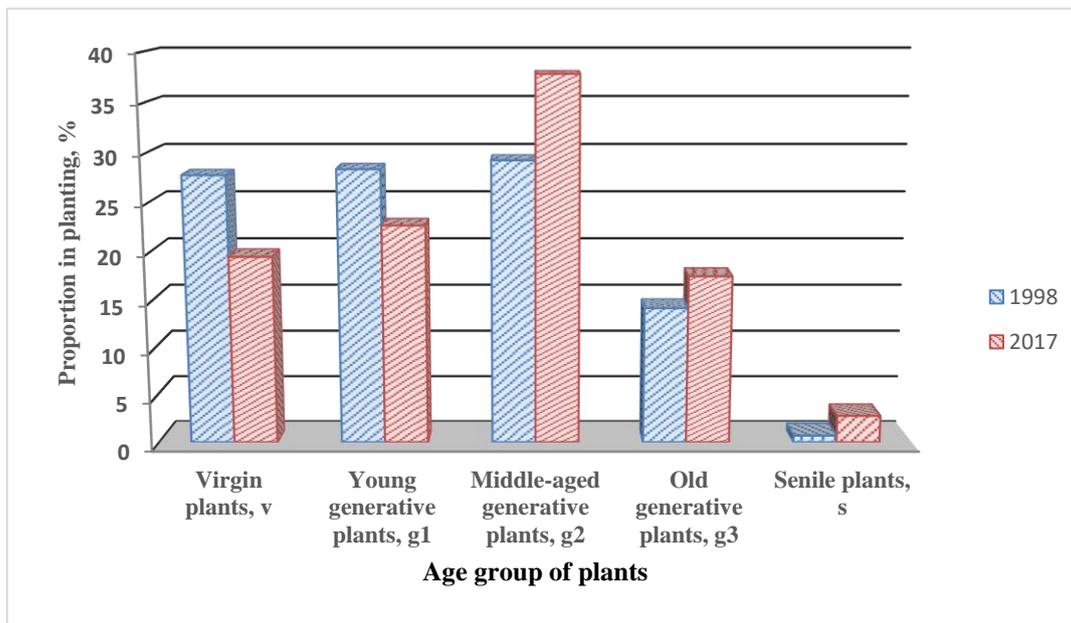


Figure 2. The proportion of age distribution of trees in the green areas of Saratov.

The results of the sanitary assessment of the woody plants' state have shown that the largest number of surveyed trees (59%) belonged to the category of healthy trees, 4% of trees were weakened, 36% of trees were strongly weakened, while 1% of trees were dry or dead.

The physiological state of the identified lianas can be assessed, in most cases, as good, due to the stability of species or good care. However, plant pests and diseases of varying severity have been reported. No sick or depressed specimen of *Parthenocissus quinquefolia* (L.) Planch was identified that, undoubtedly, testifies to its high stability, including that with respect to the increased anthropogenic loadings (Kalmykova, 2008).

Taking into account the age and sanitary state of wood and shrub plants in 2016, when developing the project "Strategy of greening populated localities of the Saratov Region up to 2040", a range of 138 names of tree and shrub species was developed (Table 2).

In this list, conifers amount to 13.8%, while shrubs – to 2.2%. The low proportion of

coniferous species is due to the unfavorable state of the urban environment, which has pronounced negative impact on the growth and development of most species. They are included in the list exceptionally due to their high decorative and sanitary qualities.

In the recommended list of plant species, preference is given to deciduous tree shrubs (49.2%), while the proportion of trees accounts for 29% of the total range.

To improve the microclimate of parks, garden squares, and boulevards, the recommended range provides 10 species of lianas (6%).

The recommended list of plants aims at increasing the proportion of trees and shrubs with high decorative qualities, resistant to adverse factors of the urban environment.

Table 2. Recommended range of wood and shrub plants for the use in greening common public sites in Saratov

Plant name	Planting category			
	Highways and streets	Parks, garden squares, boulevards	Inner-block plantings	Forest-parks
TREES (coniferous)				
<i>Picea abies</i> (L.) Karst.		+	+	+
- «Nidiformis»		+	+	
<i>Picea pungens</i> Engelm.		+	+	
including species of <i>Glauca Globosa</i> , Koster, Fat Albert, Hoto, Hoopsii, Spek		+	+	
<i>Picea glauca</i> (Moench.) Voss.		+	+	
<i>Pseudotsuga menziesii</i> (Mirb.) Franco		+	+	+
<i>Larix sibirica</i> Ldb.		+		+
<i>Larix sukaczewii</i> Dyl.		+		+
<i>Larix decidua</i> Mill.		+		+
<i>Larix gmelinii</i> (Rupr.) Rupr.		+		+
<i>Juniperus virginiana</i> L.		+	+	+
<i>Abies concolor</i> Lindl.		+	+	
<i>Platycladus orientalis</i> (L.) Franco		+	+	
<i>Pinus sylvestris</i> L.		*		+
<i>Pinus sibirica</i> Du Tour.		+		+
<i>Pinus koraiensis</i> Sieb.et Zucc		+		+
<i>Pinus pallasiana</i> D. Don.		+		+
<i>Pinus nigra</i> Dougl.		+		+
<i>Pinus mugo</i> Turra.		+	+	
<i>Pinus strobus</i> L.		+		+
<i>Thuja occidentalis</i> L.				
including species of <i>Aureospicata</i> , Brabant, <i>Globosa</i> , <i>Columna</i> , <i>Rheingold</i> , <i>Sunkist</i> , <i>Smaragd</i> , <i>Spiralis</i> , <i>Holmstrup</i>		+	+	
TREES (foliaceous)				
<i>Armeniaca vulgaris</i> Lam.		+	+	
<i>Phellodendron amurense</i> Rupr.		+		+
<i>Betula pendula</i> Roth.				
including species of <i>Youngii</i> , <i>Gracilis</i> , <i>Laciniata</i> , <i>Purpurea</i>		+	+	+
<i>Ulmus laevis</i> Pall.	+	+		+
<i>Ulmus glabra</i> Hunds.				+
<i>Ulmus carpinifolia</i> Rupr.exSuckow.		+		+
<i>Ulmus pumila</i> L.	+	+		
<i>Carpinus betulus</i> L.		+		+
<i>Pyrus communis</i> L.		+		+
<i>Quercus robur</i> L.		+		+
<i>Quercus rubra</i> L.		+	+	+
<i>Salix alba</i> L.		+	+	+
<i>Salix fragilis</i> L.		+	+	+
<i>Salix babilonica</i> L.		+	+	
<i>Catalpa bignonioides</i> Walt.		+	+	
<i>Aesculus hippocastanum</i> L.	*	+	+	
<i>Acer platanoides</i> L.				
including species of <i>Globosum</i> , <i>Golden</i> <i>Globe</i> , <i>Crimson King</i> , <i>Crimson Sentry</i> , <i>Princeton Gold</i> , <i>Faassen's Black</i>	*	+	+	+
<i>Acer platanoides</i> L. <i>Schwedlerii</i>		+	+	+

<i>Acer campestre</i> L. including species of Elegant, Nanum		+	+	+
<i>Acer saccharinum</i> L.		+		
<i>Tilia cordata</i> Mill. including species of Greenspire	*	+	+	+
<i>Tilia platyphyllos</i> Scop.	*	+		
<i>Juglans regia</i> L.	*	+		+
<i>Juglans nigra</i> L.	*	+		+
<i>Robinia pseudoacacia</i> L.	*	+	+	
<i>Sorbus aucuparia</i> L. including species of Pendula, Fastigiata	*	+	+	+
<i>Sorbus intermedia</i> (Ehrh)Pers.	*	+	+	+
<i>Populus pyramidalis</i> Borkh.	+	+		
<i>Populus balsamifera</i> L.	+	+		
<i>Populus deltoides</i> Marsh.	+	+		
<i>Populus nigra</i> L.	+	+		
<i>Populus alba</i> L.	+	+		
<i>Padus avium</i> Mill.		+	+	+
<i>Padus virginiana</i> (L.) Mill		+	+	
<i>Padus maaeckii</i> (Rupr) Mill		+	+	
<i>Morus nigra</i> L.		+	+	
<i>Malus baccata</i> (L.) Borkh.	+	+	+	+
<i>Malus nedzwetzkyana</i> Diek.		+	+	
<i>Fraxinus lanceolata</i> Borkh.	+	+	+	
<i>Fraxinus excelsior</i> L.	+	+		
SHRUBS				
<i>Juniperus communis</i> L. including species of Repanda, Depressa Aurea etc.		+	+	+
<i>Juniperus sabina</i> L. including species of Variegata, Glauca, Mas, Tamariscifolia etc.		+	+	
<i>Juniperus scopulorum</i> L. including species of Blue Arrow, Skyrocket etc.	+	+	+	+
<i>Juniperus xmedia</i> including species of Gold Star, Mint Julep, Blue and Gold, Old Gold, Pfitzeriana Aurea, Pfitzeriana Compacta	+	+	+	+
<i>Juniperus horizontalis</i> L. including species of Agnieszka, Icee Blue, Andorra Variegata, Andorra Compact, Blue Chip, Villa Marie, Wiltonii, Golden Carpet, Jade River, Lime Glow, Leningrad, Prince of Wales, Hughes etc.		+	+	+
<i>Juniperus squamata</i> Lamb. Including species of Blue Swede, Blue Carpet, Blue Star, Floriant, Holgeri etc.		+	+	+
<i>Juniperus procumbens</i> (Siebold ex Endl.) Siebold ex Miq. including species of Nana		+	+	+
<i>Amorpha fruticosa</i> L.	+	+	+	
<i>Aronia melanocarpa</i> (Michx.) Elliot.		+	+	
<i>Berberis vulgaris</i> L.	*	+	+	+
<i>Berberis vulgaris</i> L. <i>atropurpurea</i>	*	+	+	

<i>Berberis thunbergii</i> DC. including species of Atropurpurea Nana, Aurea, Bagatelle, Golden Ring, Green Carpet, Green Ornament, Dart`s Red Lady, Red Chief, Rose Glow, Rose Rocket, Harlequin, Erecta etc.	*	+	+	
<i>Berberis</i> × <i>ottawensis</i> including species of Decora, Silver Miles, Superba	*	+	+	
<i>Eonimus europaea</i> L.		+	+	
<i>Ligustrum vulgare</i> L.	+	+	+	
<i>Crataegus sanguine</i> Pall.		+	+	
<i>Crataegus submolis</i> Sarg.		+	+	
<i>Sambucus racemosa</i> L.		+		+
<i>Sambucus nigra</i> L.		+		+
<i>Weigela florida</i> (Bge.) A.DC		+	+	
<i>Cerasus fruticosa</i> Pall.		+	+	
<i>Cerasus tomentosa</i> (Thunb.) Wall.		+	+	
<i>Hydrangea arborescens</i> L.		+	+	
<i>Hydrangea paniculata</i> Sieb. including species of Limelight, Pinky Winky, Vanille Fraise, Phantom etc.		+	+	
<i>Cornus sanguinea</i> L.	+	+	+	
<i>Cornus alba</i> L. including species of Aurea, Variegata, Gouchaultii, Kesselringii, and others	+	+	+	+
<i>Genista tinctoria</i> L.	+	+	+	+
<i>Lonicera tatarica</i> L.	*	+	+	+
<i>Salix cinerea</i> L.		+	+	+
<i>Salix acutifolia</i> Willd.		+	+	+
<i>Salix viminalis</i> L.		+	+	+
<i>Salix triandra</i> L.		+	+	+
<i>Amelanchier canadensis</i> (L.) Medik	*	+	+	
<i>Amelanchier ovalis</i> Med.	*	+	+	
<i>Viburnum opulus</i> L.		+	+	+
<i>Viburnum opulus</i> L “Rosea”		+	+	
<i>Viburnum lantana</i> L.	+	+	+	
<i>Caragana arborescens</i> Lam.	+	+		+
<i>Caragana frutex</i> (L.) K. Koch.	+	+		+
<i>Cotoneaster lucidus</i> Schlecht.	+	+	+	
<i>Acer ginnala</i> Maxim.		+	+	
<i>Acer tataricum</i> L.	+	+		+
<i>Dasiphora fruticosa</i> (L.) Rydb. including species of Abbotswood, Annette, Goldstar, Goldfinger, Daydawn, Kobold, Lovely Pink, Pink Queen, Red Ace, Tilford Cream, Hachmann`s Gigant and others		+	+	+
<i>Corylus avellana</i> L.		+		+
<i>Elaeagnus angustifolia</i> L.		+		
<i>Elaeagnus argentea</i> Purch.		+		
<i>Mahonia aquifolium</i> (pursh.) Nutt		+	+	
<i>Amygdalus nana</i> L.		+	+	+
<i>Physocarpus opulifolius</i> (L.) Maxim. including species of Luteus, Diabolo, Diable d`Or, Dart`s Gold	*	+	+	
<i>Chamaecytisus ruthenicus</i> (Fisch.ex Woloszcz.) Klaskova		+	+	+
<i>Rosa majalis</i> Herrm.		+	+	+

<i>Rosa spinosissima</i> L.		+	+	
<i>Rosa glauca</i> Pourr.		+	+	
<i>Rosa rugosa</i> Thunb.		+	+	
<i>Sorbaria sorbifolia</i> (L.) A. Br		+	+	
<i>Syringa vulgaris</i> L.				
including species of Krasavitsa Moskvy, Sensation etc.	+	+	+	
<i>Syringa josikaea</i> Jacq.	*	+	+	
<i>Cotinus coggygria</i> Scop.	+	+	+	
<i>Ribes aureum</i> Pursh.	+	+	+	+
<i>Symphoricarpos albus</i> (L.) Blake		+	+	
<i>Spiraea media</i> Fr. Schmidt.		+	+	+
<i>Spiraea crenata</i> L.		+	+	+
<i>Spiraea chamaedryfolia</i> L.		+	+	+
<i>Spiraea hypericifolia</i> L.		+	+	+
<i>Spiraea vanhouttei</i> (Briot) Zab.		+	+	
<i>Spiraea salicifolia</i> L.		+	+	
<i>Spiraea Douglasii</i> Hook.		+	+	
<i>Spiraea bumolda</i> Burv.		+	+	
<i>Spiraea japonica</i> L.				
including species of Albaflora, Anthony Waterer, Golden Princess, Goldmound, Goldflame, Dart`s Red, Little Princess, Froebeli, Shirobana, and others		+	+	
<i>Rhus tuphina</i> L.		+	+	
<i>Tamarix laxa</i> Wild.		+	+	
<i>Forsythia europaea</i> Geg. et Bald				
including species of Spectabilis and others		+	+	
<i>Chanomeles maulei</i> (Mast) C.K.Schneid		+	+	
<i>Philadelphus coronarius</i> L.		+	+	
<i>Philadelphus microphyllus</i> Gray.		+	+	
<i>Philadelphus caucasicus</i> Koehne.		+	+	
LIANAS				
<i>Actinidia kolomicta</i> (Maxim) Maxim		+	+	
<i>Ampelopsis aconitifolia</i> Bunge.		+	+	
<i>Vitis amurensis</i> Rupr.		+	+	
<i>Parthenocissus quinquefolia</i> (L.) Planch		+	+	
<i>Celastrus flagelialis</i> Rupr.		+	+	
<i>Lonicera caprifolium</i> L.		+	+	
<i>Lonicera ×brownii</i>		+	+	
<i>Schisandra chinensis</i> (Turcz.) Baill.		+	+	
<i>Clematis Jackmani</i> Th. Moore		+	+	
<i>Clematis tangutica</i> (Maxim) Korsh.		+	+	

Note:

- * - recommended for landscaping within this category of plantings with restriction;
- + - recommended for landscaping within this category of plantings with no restriction;
- - not recommended for landscaping within this category of plantings

Conclusion

- In the course of the historical development of Saratov, the range of tree and shrub species used in landscaping constantly expanded due to the inclusion of invasive and decorative forms of plants;
- Currently, the range of green plantings of Saratov consists of deciduous species

- accounting for 91.5%, and coniferous ones accounting for 8.5%. The composition of plantings is dominated by invasive trees and shrubs (68.3%), while native species account for 31.7%;
- Long-term observations of the plants in the landscaping sites allowed determining the types and varieties of tree and shrub species as well as lianas, which had successfully adapted to the

urban environment, and recommending their inclusion in the promising range for greening common public sites;

- Through the development of varieties that are more resistant to the adverse conditions of the urban environment in comparison with parent species, and changes in the microclimate of the urban environment (more mild temperature, availability of care, in particular, irrigation), it becomes possible to use for landscaping plant species previously not included in the recommended range.

References

- Cherepanov S. K., (1995). *Sosudistye rasteniya Rossii i sopredel'nyh gosudarstv* [Vascular plants of Russia and neighboring countries]. St. Petersburg.
- Kalmykova A.L. (2008). *Ispol'zovanie lian v vertikal'nom ozelenenii naseleennykh punktov stepi i lesostepi Povolzh'ya* [Use of lianas in vertical landscaping of populated localities of the steppe and forest-steppe of the Volga Region]. Ph.D. thesis. Saratov: All-Russian Scientific and Research Institute of Agricultural Afforestation.
- Kolesnikov A. I. (1974). *Dekorativnaya dendrologiya* [Decorative dendrology]. Moscow: Forest Industry.
- Luzina E. S. (1987). *Po parkam i skveram Saratova* [Parks and garden squares of Saratov]. Saratov: Volga Publishing House.
- Materialy inventarizacii zelenykh nasazhdenij g. Saratova. (1998). [Inventory materials of green plantings of Saratov]. Saratov: Russian State Design and Survey Institute Rosgiproles, Saratov Branch.
- Milovidova I. B., Tarenkov V. A. (1968). *Derev'ya i kustarniki zelenykh nasazhdenij g. Saratova* [Trees and shrubs of green plantings of Saratov]. Materials on flora and vegetation of the South-East. Saratov, 17-29.
- Ozelenenie naseleennykh punktov Habarovskogo kraya (n.d.). [Landscaping of populated localities of the Khabarovsk Territory]. Khabarovsk: Main Department of Forestry and Forest Protection under the USSR Council of Ministers. Far Eastern Scientific and Research Institute of Forestry.
- Pravila sanitarnoj bezopasnosti v lesah [Rules of sanitary safety in forests]. Approved by the Government of the Russian Federation of 29.06.2017 No. 414. Moscow, 2017.
- Shishkina Yu. (2011). *S posazheniem derev i prilichnoy ogorodkoyu* [With the planting of trees and a decent fence]. Decrepit parks spanning tangled threads of life. Newspaper of the week in Saratov, 45(178).
- Tereshkin A. V., Kalmykova A. L., Ishutina E. I. (2014). *Sravnitel'nyj analiz ispol'zovaniya mnogoletnih i odnoletnih lian dlya vertikal'nogo ozeleneniya v g. Saratove* [Comparative analysis of the use of perennial and annual lianas for vertical landscaping in Saratov]. Agricultural Scientific Journal, 6, 35-37.
- Tkhorikov, Boris; Semibratsky, Maksim; Gerasimenko, Olga; Merezhko, Anna (2018). *Análisis de los enfoques metodológicos para la gestión de proyectos*. Revista Científica del Amazonas, 1 (1), 28-34.
- Yakushina E. I. (1982). *Drevesnye rasteniya v ozelenenii Moskvy* [Woody plants in the greening of Moscow]. Moscow: Science, 13-40.
- Zaigralova G. N., Kabanov S. V. (2016). *Vidovoe raznoobrazie i sostoyanie zelenykh nasazhdenij central'noj chasti goroda Saratova* [Species diversity and state of green spaces of the central part of Saratov]. Bulletin of the Saratov University. Chemistry. Biology, 16(3), 387-349.
- Zhukova L. A. (2013). *Ontogeneticheskij atlas: nauchnoe izdanie* [Ontogenetic Atlas: scientific publication]. Yoshkar-Ola: Mari State University.