Urban Greening as a Response to Societal Challenges. Toward Biophilic Megacities (Case Studies of Saint Petersburg and Moscow, Russia)

Diana Dushkova, Maria Ignatieva, and Irina Melnichuk

Abstract The population density in megacities is continuously increasing, resulting in a reduction of green spaces and a deterioration in the urban environment quality. Urban green is often being replaced by parking places, shopping centers, and service enterprises. This chapter examines the efforts of two megacities in Russia—Moscow and Saint Petersburg—to organize sustainable greening solutions for their residential areas using new achievements in landscape design theory and practice, such as the concept of the biophilic city. The chapter analyzes the history of greening strategies and discusses the concept of urban green infrastructure and its implementation in both Russian megacities. The chapter presents an assessment of the current state of urban green spaces and the most recent master plans and how these cities are facing and responding to modern societal challenges. The results of an analytical review of the most successful urban greening projects in Moscow and Saint Petersburg are presented as well. The economic and climatic features of the urban green areas and their architectural and planning features are considered, along with strategies for further development of the urban green spaces in both cities, aiming to address the new principles of biophilic cities.

Keywords Urban green spaces · Greening strategies · Biophilic cities · Societal challenges · Saint Petersburg · Moscow

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J. Breuste et al. (eds.), *Making Green Cities*, Cities and Nature,
https://doi.org/10.1007/978-3-030-73089-5_25

1 Introduction

1.1 Urbanization and Green Infrastructure

The rapid process of urbanization in modern cities has led to a reduction in living spaces and an increase in the number of inhabitants per m^2. Depending on a city's typology and history, the urbanization process results in urban sprawl or densification. Increasing land consumption, air pollution, and water contamination from traffic and industry lead to native habitat extinction and often extreme concentration of toxic substances in urban areas (Vasenev et al. 2017). In the case of large cities and megacities, where the process is on an even bigger scale, there is a call for development of new urban strategies. One of the most crucial modern concepts in this regard is urban green infrastructure or urban greening. A variety of research addresses environmental impacts on urban greens and how urban plant communities face the current societal challenges in megacities (Aleksandrova 2013; Breuste et al. 2015; Kabisch et al. 2017; Melnichuk 2017; Ignatieva et al. 2015; Pauleit et al. 2018; Seto and Reenberg 2014; Vasenev et al. 2017). Modern urban green infrastructure provides significant ecosystem services and promotes biodiversity and social values (Haase 2017; Haase et al. 2019). Both concepts—ecosystem services and green infrastructure—are correlated with the concept of a biophilic city, which refers to bringing abundant nature into urban areas to make city dwellers happier and healthier, and their lives more meaningful (Beatley 2010; Ignatieva and Ahrné 2013).

1.2 Urbanization and Green Infrastructure in Russia

Russian cities share modern anthropogenic and technogenic pressures. Over the last two decades, Russia has experienced dramatic changes in political, economic, and social structures. These changes are reflected in urban planning approaches, including urban green space design and management (Dushkova and Krasovskaya 2018; Haase et al. 2019). It is especially visible in the two biggest Russian cities: Moscow and Saint Petersburg.

A great number of studies on conceptual and empirical approaches assessing the problems of urbanization in megacities and the response of urban green policies have been conducted worldwide (e.g., Breuste et al. 2015; Kabisch et al. 2017; Ignatieva et al. 2011b; Vasenev et al. 2017). However, the issue directly related to urban green infrastructure and its interaction with land-use patterns and its effects on human well-being have not yet received much explicit attention in regard to Russian cities. There are publications from the Soviet era on different aspects of urban green infrastructure—for example, development of green belts, typology of urban green areas, current conditions, and future planning of urban greening (Korzhev 1954; Khodakov 1986), development of Soviet city masterplans with blue and green infrastructure (Bunin et al. 1945; Bunin 1953)—and more recent research on the

history of urban greening and ecological conditions of urban landscapes in Russia (Dushkova et al. 2016; Ignatieva et al. 1997, 2011a; Kochurov and Ivashkina 2015; Melnichuk 2017; Minin 2014; Nilsson et al. 2007; Yanitsky and Usacheva 2017; Weiner 2002). But what is needed is an analysis of different aspects and elements of urban green infrastructure and its contribution to livable and healthy cities, as this could help policy makers to better understand the consequences of ecosystem changes and their impact on human life, thus helping them make better-informed decisions.

1.3 Aim

In this chapter, we focus on an analysis of the urban green infrastructure in Moscow and Saint Petersburg, particularly in different urban green areas. We have studied the main documents related to the development of these areas and related regulations and policies and examined the current environmental and social problems. We also discuss several successful, sustainable green area projects currently underway in both cities.

2 Methodology

2.1 Study Area

Moscow and Saint Petersburg are among the most populous cities in Russia and in Europe and are the fastest growing cities in Russia. Between 1991 and 2018, the population increased from 9.02 to 12.56 million people in Moscow and from 5.00 to 5.35 million in Saint Petersburg (Mosgorstat Moscow 2018; Petrostat 2018). Urban areas have been continuing to expand. It is especially relevant in the case of Moscow where the administrative reforms of 2011 expanded the city limits and almost doubled Moscow's area, which has reached 2,531 km^2. This growth took place only in one—south-western direction ("New Moscow"). The Saint Petersburg area reached 1,439 km^2 in 2018. The growth of Saint Petersburg is also quite significant, reaching 1,439 km^2 in 2018 and growing in north and south directions.

Saint Petersburg has a big historical center called the "Historic Center of Saint Petersburg and Related Groups of Monuments" (4,000 ha), which has the status of a UNESCO Heritage Site. Thus, unlike Moscow, it requires special regulations and policies for its development. Another important peculiarity of Saint Petersburg is that water bodies cover 7% of the city's surface area.

The continuous process of urbanization in both cities, combined with intense building and housing market development, has resulted in a great transformation of

their green areas (Aleksandrova 2013; Klimanova and Kolbovsky 2013; Melnichuk 2017).

2.2 A Literature Review

This chapter uses comparison analysis of Moscow and Saint Petersburg. We conduct a literature review and analysis of official reports. In addition, we use as basic data the information on urban green space (size, elements, and management) available in Moscow (Mosgorstat Moscow 2018) and Saint Petersburg (Petrostat 2018), administrative reports along with general city plans, environmental reports (Department of Natural Resources 2018; Moskomecomonitoring 2017), and material collected by authors and their doctoral and master's students during their research, and design projects on different aspects of green infrastructure over the last 10 years (Melnichuk 2017; Shumilova 2016).

3 Results

3.1 History of Urban Development in Moscow and Saint Petersburg

The development of the green city concepts as well as of different landscape architecture strategies in both cities has always been associated with the dominant political, economic, social, and ideological processes of the time (Dushkova et al. 2016; Ignatieva et al. 2011a).

Moscow

Almost five centuries older than Saint Petersburg, Moscow was founded in 1137 as a fortress city at a strategic bend in the Moskva River. Moscow tempo of development was slower when compared to Saint Petersburg. Moscow planning structure is so-called radial-concentric. Its development had several stages. Kremlin was always the compact walled center of the city. In the beginning, Moscow consisted of a combination of Kremlin and picturesque spread-out villages. There were a lot of natural groves, forests, meadows, and pasture patches within the city, as well as productive gardens inside the house complexes. After creating radial roads and a series of fortified rings, the city began to densify and change to the radial-concentric shape. However, even with the denser population, the existing structures of individual house-farmstead complexes—called *usad'ba* (consisting of main house, service buildings, and gardens)—and numerous monasteries within Moscow's boundaries allowed green areas to remain very close to the city's center (Bunin et al. 1945; Bunin 1953). Thus, until the end of the eighteenth century, there were no planned urban green

Fig. 1 Moscow yard (Moskovskii Dvorik), 1878, painting by V. D. Polenov (1844–1927), Moscow State Tretiakov Gallery. *Source* Kartinki24.ru (2019)

areas in Moscow. One of the first important planned improvements during that time was the Boulevard Ring on the site of Moscow's demolished city walls (Goretskaya and Toporina 2017).

After the fire in 1812 during Napoleonic Wars, Moscow was redesigned but kept that original picturesque and, in some places, informal rural character and image of a green city (Fig. 1).

Saint Petersburg

Saint Petersburg is quite a young city. It was founded in 1703 by the order of Peter the Great with a purely political aim—to open a "Window to Europe" and to demonstrate the prosperity and power of the "Tsar and the Russian Empire." Baroque principles such big open spaces, perfect straight and broad streets, and visual dominants were realized in the huge scale.

The city was built quickly on the inhospitable flat lower land of the Neva River delta with its numerous islands covered by bogs, lakes, wet forests, and willow thickets. This original vegetation was cleared and drained, and places were filled in with more fertile soil, and planted with mostly broadleaved trees following European formal garden fashion (Ignatieva et al. 2011a, b). The new city soon earned the name "Venice of the North" because of the numerous rivers and canals and abundance of water. Founded at great physical and financial effort, Saint Petersburg was, in short,

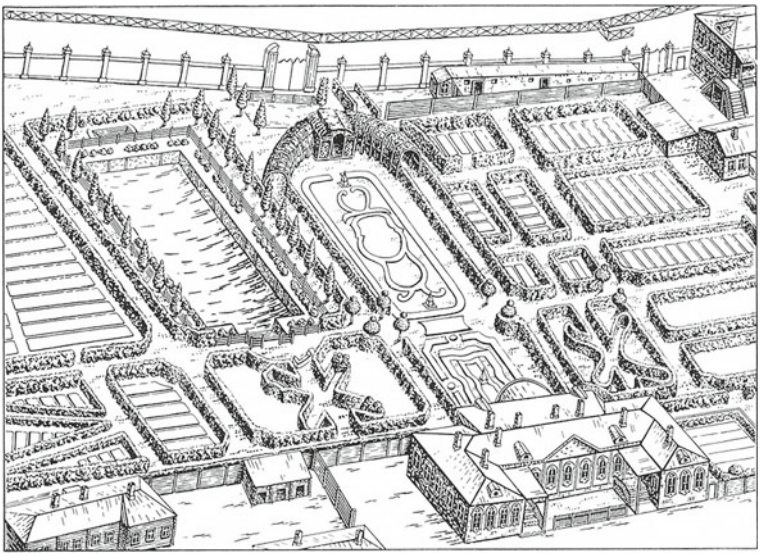

Fig. 2 Gardens and orchards of planned green rings (part of a noble palace-garden complex—usad'ba) along the Fontanka River, Perspective plan of Saint Petersburg, 1764–1773. *Source* Totalarch (2019)

one of the most ambitious and costly experiments in landscape transformation and urban development ever conducted.

From the very beginning, green areas were expected to follow the regulated design and be a part of the urban planning strategy through the whole history of St. Petersburg. In the eighteenth century, most of the city's green areas consisted of gardens belonging to the Tsar and the nobility. Two green "rings" along the rivers Fontanka and Moyka consisted of private gardens detached to palaces were the most significant urban greenery in the city's center (Fig. 2).

In Moscow and Saint Petersburg, there were still a few remnant forests and bogs, meadows, wastelands, orchards, and vegetable gardens within the city's boundaries.

Nineteenth Century

During the nineteenth century, as a result of industrialization and urbanization, both cities lost many green areas. However, new public parks were established in the city's centers and near estates or "profitable" houses of wealthy citizens (Yanitsky and Usacheva 2017). Some of these original parks survive till today. In Moscow, there are still some protected areas dating back to the sixteenth century, when the royal family and nobility kept some forests as hunting grounds and as part of their private estates. For example, Losiny Ostrov (Moose Island) and Izmaylovo Park in Moscow were strictly guarded hunting grounds for Grand Princes and Tsars.

These survived areas are particularly valuable in rapidly growing Moscow. In 1804, Emperor Alexander I issued the first Russian Forest Act "On the Improved

Protection of Forests and the Establishment of Forest Management in Moscow." Losiny Ostrov was the first officially protected area in Russia. The first nature protected area in Saint Petersburg was established much later, in 1990—namely, the Yuntolovsky Wildlife Preserve for the protection of 25 bird species and their habitats. The end of nineteenth century was characterized by the active beautification of the central areas of both cities with planted boulevards, new public gardens, and green plazas. It was a time of developing plant nurseries, lawn and flower bedding industries, botanical garden collections, and introduction of new exotic trees and shrubs. At the beginning of the twentieth century, Saint Petersburg and Moscow, despite the Russian revolution of 1917 and the Civil War (1918–1923) and related dramatic changes to political, economic, and social structures, preserved and developed historical urban structures and associated green areas.

Early Soviet Period: The 1930s

Addressing the urgency of improving living conditions in fast growing cities (as a result of industrialization and collectivization), Moscow and Saint Petersburg introduced the concept of master plans (*genplan* in Russian). In such plans, industrial, residential areas, city centers, and green areas were clearly defined. Within the General Plan of Moscow (1935), a greenbelt 10–15 km wide around the city boundaries was established. It included forests, meadows, agricultural fields, farms, orchards, and small towns with a population of less than 270,000 inhabitants. The plan also included a ring of several parks around the city center. Today, these parks are still protected by law. The plans also called for establishing wedges of greenery connected to the greenbelt, thus creating comfortable microclimates and places for public recreation. New social classes—first of all, the proletariat (the factory workers)—who lived in cities needed new types of urban green areas. Among the most distinguished types of public green spaces were the Parks of Culture and Rest (Park kulturi i otdicha in Russian) established in the late 1920s. Their multizonal structure aimed to provide diverse programs for all groups of people such as passive (reading, walking) and active (sport, entertainment) recreation, cultural events (festivals), and the political education of the urban community. The first and most influential Park of Culture and Rest (named after Maxim Gorky) appeared in Moscow in 1928. Kirov Park, named after Communist Party leader Sergei Kirov, was opened in then Leningrad (Saint Petersburg) in 1932.

Postwar Time: The 1950s

Russia experienced the most devastating loss of people as well as city destruction during the Great Patriotic War (1941–1945). St. Petersburg lost half of the population from hunger, cold, and bombing. Moscow experienced devastating bombing and related destruction. Many green areas were damaged or completely destroyed.

After the war, one of the main goals was to build new housing and create suitable green areas in residential neighborhoods. A very significant initiative was the introduction of the microdistrict *(mycrorayon* in Russian) concept in the late 1950s. It was specifically a Soviet urban planning idea, where there were residential clusters of 30–50 ha for 12,000–15,000 people, consisting of multi-story houses for families,

schools and pre-school facilities, and centers for shops, laundries, and cleaning and repair stores (Ignatieva et al. 2018). This standardized design and greening strategy aimed to plant extensive greenery within each microdistrict. Green areas and new public parks were created by special government design and planning organizations with the help of botanic gardens, which at that time, were innovative scientific research institutions.

The socialist planning system developed several standards, including the typology and the norm of urban green areas per capita. For example, there were urban green areas for common use (publicly accessible parks, gardens, boulevards, green plazas, and street greening), green areas of limited use (publicly accessible but for particular categories of people who lived, worked or occasionally visited such areas, for example the gardens of residential areas, schools, hospitals, and similar institutions), and green areas for special purposes (plant nurseries, cemeteries, protection zones next to the rivers and lakes). There was also a forest-park zone (in some classifications this zone was also called a suburban zone), which included a specialized type of green area—forest-parks based on native forests but containing planned and designed elements. Forest-parks aimed at short-term recreational use (Korzhev 1954; Khodakov 1986). Moscow and Saint Petersburg pioneered the planning of these forest-parks. For example, the Nevsky Forest Park in Saint Petersburg was opened in 1936 and became the first such project in the USSR (Ignatieva et al. 2011a).

The dynamic of urban green space based on common use standards in Moscow and Saint Petersburg from 1913 up to the present time is shown in Table 1. The standards for urban green space for both cities have increased during soviet time comparing with the pre-revolutionary period. The policy on increasing green areas in Soviet cities has a strong political foundation. The main goal was to provide an even distribution of green areas in all parts of a city, especially in the formal working-class neighborhoods. It was seen as the socialistic approach (and opposite to the old capitalistic view of the city), based on a planned economy and common property rights. The greening policy was the way to create truly green cities for everyone and not only for the privileged bourgeois class. A special meeting of the Central Communist Committee (1931) even dedicated a whole paragraph to urban greening and pointed out that "The Soviet city should harmoniously mitigate the existing remoteness of the urban citizen from the natural environment and decrease the contrast between city and nature" (Korzhev 1954). However, the vulnerable 1990s had an impact on the area of green space when both cities experienced difficult times in the post-Soviet transition: Green spaces were greatly transformed and pressured by traffic pollution and construction processes and went through a period of absolute neglect. But in case of Moscow after the city growth (with the appearance of New Moscow), the situation is getting better (mostly due to green area of annexed territories, but also due to the new green projects).

The standard of the green areas established in soviet time should provide each citizen with access (walking distance from a house) to a healthy green environment. Standardization, however, had a downside. The design of housing, planning structures, and even plant choices for green areas was very similar, which resulted in the creation of homogeneous neighborhoods all over the Soviet Union.

Table 1 Urban green space based on common use standards in square meters per capita in Moscow and Saint Petersburg from 1913 to present time

City	1913–1926	1958	1974	1980	1985	1994–2005	2017	Planned for 2025 according to city master plans	Norms for big cities in Soviet Union
Moscow	5.1	7.5	9.8	13.0	14.2	16.0	36.4	37.2	15.0
Saint Petersburg (Leningrad 1924–1991)	4.5	4.8	8.0	15.8	10.9–16.8	12.0	12.2 (2015)	12.8 for central and 16 for other districts	15.0

Sources Korzhev (1954); Mosgorstat Moscow (2018); Petrostat (2018); Research and Project Institute of Moscow City Master Plan (2018); State Research and design center of Saint Petersburg Masterplan (2018); Khodakov (1986); Shumilova (2016)

Fig. 3 Subbotniks in soviet Moscow and soviet Saint Petersburg (former Leningrad). **a** Subbotnik in Leningrad in May 1954, **b** Muscovites at the beautification and site improvement of Vernadsky prospect's green area within the All Russian communist subbotnik on 15 April 1972. *Source* a—Archive Committee of Saint Petersburg (2019), b—Archive Buro of Moscow (2018)

Also, often there were not enough maintenance care for microdistrict greenery and people had to take care of the green areas themselves. For this purpose, voluntary get-togethers of city residents known as *subbotnik* (taking place on spring Saturdays) and *voskresnik* (on Sundays) appeared in order to improve or clean up green spaces (Fig. 3). People got involved in such "social cohesion practices," at times involuntarily, because their confidence in the efficiency of governmental green management agencies was rather limited. Such measures aimed to contribute to the ecological and sanitary improvement of the surrounding residential areas while at the same time promote collectivism or "brotherhood" as the main purpose of state socialism (Dushkova et al. 2016; Haase et al. 2019; Ignatieva et al. 2015).

"Perestroika" and Post-Soviet Development (1990–2010)

The dramatic shift of Russian society to a market economy occurred during the very vulnerable period of the Yeltsin administration (1991–1999), which was associated with corruption and short-sighted business practices and deep economic crisis. The strategy of urban development and the relationship with urban nature went "wild" at this time. First, the number of private cars skyrocketed, resulting in high air and water pollution. It also led to fragmentation of urban natural remnants because of uncontrolled private housing construction (Dushkova et al. 2016). Thus, public green spaces were under incredible pressure. According to different estimations, within only ten years, from 1991 to 2001, 20–25% of the green belt within 30 km of Moscow was used for new constructions—most often in the form of private housing (Klimanova and Kolbovskiy 2013; Vasenev et al. 2017). Saint Petersburg's green belt also experienced tremendous pressure and lost many forests. From 2003 to 2006, the city lost 10% of its green areas (Ignatieva et al. 2011a).

The most unfortunate consequence of that period was illegal privatization of formal public spaces and even part of the special protected nature areas. Many of the green spaces in microrayon such as courtyards and children's playgrounds

were converted to carparks or private constructions. Green areas were completely neglected mainly because of financial difficulties.

During that difficult time, many people grew their own agricultural products in Soviet-era cooperative garden plots (*dachas*) to supplement their poor diet. In the Soviet time, however, the primary goal of these *dachas* was to give urban people an opportunity to be closer to nature and work on the land. Yes, growing vegetables and fruit trees was an important part of the *dacha* movement, but it was more about lifestyle than survival (Dushkova and Krasovskaya 2018; Ignatieva et al. 2011b).

3.2 Modern Green Infrastructure Strategy (2010–2018)

In the Soviet time, the greening strategy in both cities developed as a top-down approach. Today, we can observe a shift to the bottom-up way of dealing with urban greening with rising activities among civil society. This started in 1989 with the first mass protests to protect green areas in Moscow because of increasing threat of new constructions and deforestation.

Recently accepted Masterplan 2025 of Saint Petersburg is based on the 2005 Master Plan and the 2005 Landscape Scenario that aimed to improve the quality of the urban environment and ecological situation (Melnichuk 2017). Masterplans 2025 for both cities prioritize pedestrians over cars and the concept of greening block by block (e.g., My Street program in Moscow), redesigning inner yards in historic centers (and the outskirts of Saint Petersburg) with the local community's participation.

The goal of the Moscow Masterplan 2025 is creating an integrated system of urban green spaces, which is also linked to the greenbelt. The city plans to increase urban parklands from 30.3 to 35.1 thousand ha. It is planting 20,000 trees every year. The plan will also add about 200 ha of open spaces with flower beds, lawns, and other types of decorative urban greening.

Similarly, the Saint Petersburg Masterplan 2025 aims to create interconnected green infrastructure, which is also part of overall architectural and urban planning development. One of the proposals is to create a system of ecological axes along main urban arteries. The axes should start in the city center with a system of green streets and pedestrian zones and create relatively large clusters on the intersections of such axes. One of the strategic measures is to increase green areas in dense central historic districts by transforming formal industrial areas and relocating industries from the center and rehabilitating disengaged areas as effective green habitats (Melnichuk 2017). The planning strategy of the Masterplan is to increase green areas in central districts up to 20% and in other districts up to 70%. The plan will increase biodiversity and create environmentally friendly urban conditions, moving toward biophilic megacities.

According to the World Health Organization (WHO 2017), green space within the city boundaries has to be not less than 40% of the city area. Otherwise, the urban environment loses its quality and cannot fulfill its ecosystem functions and services.

Table 2 Areas of green space throughout the world's major cities

City	Green areas from the total city area, percentage (%)
Moscow	54
Singapore	47
Sydney	46
Vienna	45
Shenzhen	45
Saint Petersburg	40
Berlin	33
New York	27
London	26
Paris	21
San Francisco	14
Los Angeles	7
Taipei	4
Shanghai	3
Dubai	2
Istanbul	2

Moscow and Saint Petersburg have one of the best ratios of public green space to whole city area and the green of common use per inhabitant in the world (Table 2). For example, 54% of Moscow city's area is under green areas. In Saint Petersburg, green areas cover 40% of the total city area. The specifics of Saint Petersburg's historical development reflect the proportion of green-area distribution. The actual provision of green areas to residents of Saint Petersburg ranges from 7 to 158 m^2 per capita among the districts of the city. The lowest level of green areas is in the Central Administrative district, and the highest are located in the five districts that have big remnants of urban forests and historic parks (Melnichuk 2017) (Fig. 5). The provision of green space per capita in different districts of Moscow in m^2 per capita is as follows: 46—Eastern; 41—South-Western; 38—North-Eastern; 37—North-Western; 31—Northern; 30—Southern; 29—South-Eastern; and 16—Central District (Fig. 4). Thus, the situation with the green-space distribution throughout Moscow is quite similar to Saint Petersburg. Such uneven distribution of green space is connected, on the one hand, to historic development of the cities and, on the other hand, to replacement of green areas by residential housing, energy facilities, and the transport network. The loss of green areas has resulted in environmental pollution, landscape degradation, and growing social tension.

Changes in political and economic structures, and the emergence of private ownership, demanded revisiting the classifications and definitions of urban green areas, and to accompany this process with corresponding new legislation. However, the core of

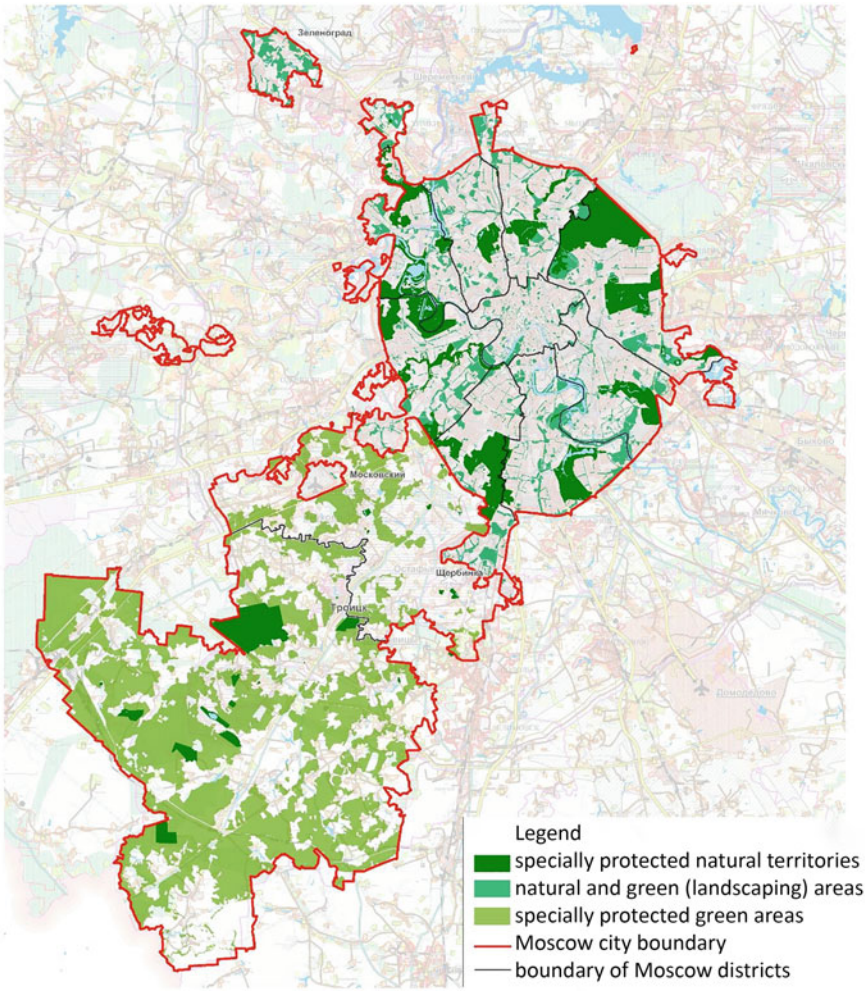

Fig. 4 Map of green areas of Moscow. *Source* Research and Project Institute of Moscow City Master plan (2018)

such new classifications is still very much Soviet, especially for the overall green-area categories. For example, according to the Law on the Protection of Green Areas (2004, with modifications of 2010), Saint Petersburg's greenery is subdivided into eight types:

- green areas of common use (greenery dedicated to recreational use which is free of charge (no fee)—for example, parks, gardens, street trees, and boulevards);
- green areas of limited use (paid or those designed for a special regime of use);
- green areas of residential areas (in their borders);

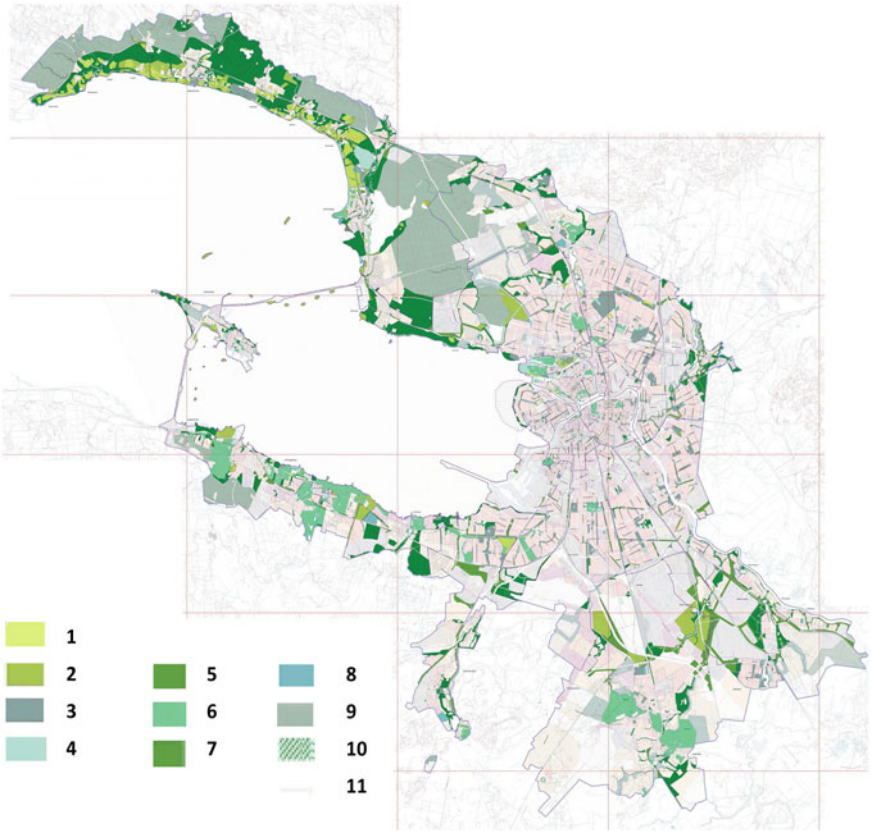

Fig. 5 Map of green areas in Saint Petersburg. *Source* Zemvopros.ru (2019). 1—green areas of leisure, sport, cultural and recreational facilities, tourism, health-resort treatments, hotels and pensions of various types, private houses and dachas, established on their existing territories; 2—green areas of leisure, sports, cultural and recreational facilities, tourism, health-resort treatments, hotels and pensions of various types, green areas of private houses and dachas established in areas that have been rehabilitated and redeveloped; 3—green areas of common use established on their existing territories; 4—green areas of common use established in areas that have been rehabilitated and redeveloped; 5—green areas of historical parks, palace-park complexes; 6—green areas of special purposes; 7—areas of sport facilities and public beaches established on their existing territories; 8—areas of sport facilities and public beaches established in areas that have been rehabilitated and redeveloped; 9—urban forests and forest parks; 10—recreational territories planned to be implemented in 2025; 11—borders of zones/areas

- green areas of special purposes (plantings for sanitary purposes and water protection, land-reclamation, fire zones, cemeteries, ground outlets and engineering structures, green roofs of residential and industrial buildings);
- urban forests;
- green areas of special protected nature areas;
- federal green areas (located on land in the Property of the Russian Federation);
- green areas of private houses and dachas.

Moscow has a quite similar modern typology of green areas (for further information see Chap. 6 of Moscow Law on the Protection of Green Areas (1999, with modifications of 2014) http://docs.cntd.ru/document/901734936).

The most significant difference in the modern Saint Petersburg classification of green areas is the articulation of residential areas into a special separate category, as well as identification of private green areas. However, most urban green areas are still publicly accessible. Another significant difference from the Soviet green-areas typology is the accentuation of the protected nature reserves into a special category, which reflects an understanding of the importance of such areas in urban ecosystems (Figs. 4 and 5).

If the master plans from the Soviet period aimed to build a model socialist city with high standards of living conditions and equality (access for everyone to green areas and public transportation), the modern Master Plan 2025 reflects the market economy pathway (pressure from private housing developers) and influence of the globalization era (invitation of international designers for urban and landscape architecture competitions, accepting new planning and design trends in green area design). The main difference in strategic approaches between Saint Petersburg and Moscow is that Saint Petersburg has stricter policies related to urban design due to the city's unique planning and architectural heritage. Over the last 20 years, Moscow's skyline has completely changed, moving toward the global city including skyscrapers, as in the "Moscow City" and following the way of many of the world's megacities.

3.3 Urban Biodiversity of Green Areas

Green areas are the core of urban biodiversity. Our understanding of urban biodiversity is based on the most recent studies in urban ecology (Müller and Werner 2010; Ignatieva 2010). In our particular cases, species diversity (number of species) and ecological diversity (diversity of communities) are the most important parameters. The Federal Law of Russia No. 33 "On specially protected natural territories" from the 14 March 1995 aims to provide legislation for an extensive system of protected areas (in Russia, known as *OOPT*). It defines the following OOPT categories according to their role and the level of protection: *Zapovedniks* (total reserves, including biosphere ones), *Zakazniks* (federal and regional reserves with different regimes of nature protection), national parks; nature parks; natural wildlife reserves and monuments of nature; wetlands under the Ramsar Convention; dendrological parks and botanical gardens; health-improving areas and health resorts (www.oopt.info).

Both cities share similar tendencies in the dynamic of urban vegetation. There are a range of natural habitats and remnants of forests and wetlands within the specially protected nature areas (which have a more restricted code for public use) or in fragments of the green belts as well as in some historic gardens. One of the most representative of the latter is a fragment of the protected oak forest (52 ha) in

Moscow's Main Botanic Garden and in the White Birch Area of Pavlovskiy Park in Saint Petersburg.

Another type is semi-natural modified indigenous vegetation (for example, forest with designed pedestrian pathways), which was transformed during the Soviet time in a special type of urban green area called a "forest-park."

However, the most representative category, the core of urban areas, is urban habitats (parks, gardens, street plantings, hedges, and flowerbeds) where plants were deliberately planted for decorative (greening) purposes. Such plant communities consisted of native and exotic species (planted or spontaneously appeared).

There are 15 specially protected nature areas, which cover 6142.7 ha or 4.3% of Saint Petersburg (Melnichuk 2017). They are represented by two categories of OOPT—state nature wildlife preserves and monuments of nature. Moscow has a higher number of such areas—119, which are represented by nature wildlife preserves, monuments of nature, natural-historical parks, national parks, etc. They cover 17,000 ha or 14% of the city's area. Wildlife in such places are refuges to squirrels, hedgehogs, small mammals, fish and amphibians, and to a variety of birds and of course to numerous rare and protected plant species. These natural areas are also recognized as unique genetic pools for urban biodiversity. According to their masterplans for 2025, both cities plan to include new areas in the category of special protected nature areas.

In Saint Petersburg, many historic parks and gardens are seen as important biodiversity hotspots. For example, the recently restored Summer Garden in the very center of the city has green groves and hedged bosquets, which were planted with understory bushes attractive to birds. Many rare plants such as native orchids appeared in such bosquets within last five years (Ignatieva 2013).

The quality of urban green biodiversity can be indirectly assessed through some indicators such as density of bird population. Figure 6 illustrates the density of nightingales throughout the city of Moscow. This density was the highest in western districts, and it correlates with the best ratio of green space distribution.

Moscow's green belt was created within the Master Plan of 1935 and covered 35,000 ha (Genplan Moscow 1935). In this regard, it followed the common approach of the late 19th—early twentieth century when land preservation was used as a tool for controlling urban sprawl. The other purpose of the green belt was the creation of recreational places (Genplan Moscow 1935). After World War II, the urban growth of Moscow was correlated with the growth of urban green areas (up to 162,500 ha).

4 Discussion

A very important milestone in the greening of both cities was the hosting of two of the world's largest and most prestigious sport events: the 2014 Sochi Winter Olympics and the 2018 FIFA World Cup. In order to appear as a sustainable and ecologically oriented country, many Russian cities organized events in a sustainable "green way." In addition, year 2013 was proclaimed as the Year of Environmental Protection and

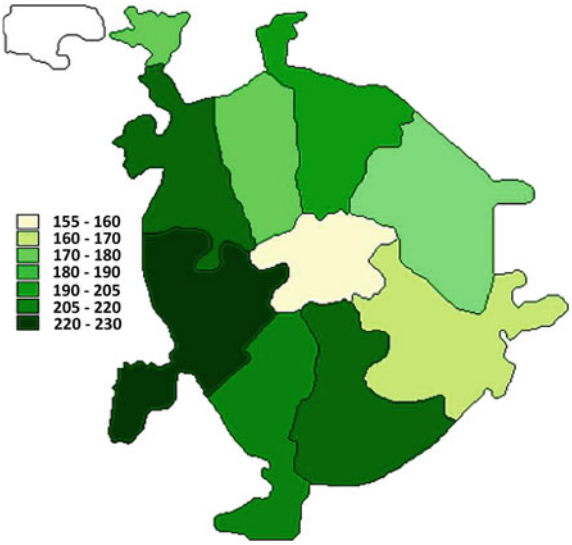

Fig. 6 Density of nightingales in districts of Moscow. *Source* BioDAT (2005)

2017 as the Year of Ecology. Urban planners, together with public activists and local political leaders, revisited existing master plans in both cities, trying to reinforce sustainability and apply the principles of biophilic cities.

In this regard, there were measures to protect and expand existing green areas, creating entirely new public transportation systems (ring roads and bypasses) with the aim of reducing private car usage and easing urban traffic congestion. New sustainable "green" buildings (with standards of high energy and water efficiency), green roofs and green walls, as well as advanced environmental solutions for waste and recycling programs, were implemented in some districts.

Moscow, however, is characterized by more rapid and sometimes radical reforms and transformation of urban landscapes, which often result in ignoring ecological needs and ruining historic integrity. Saint Petersburg, on the other hand, tries to save its historical traditions but is slower in decision-making process and improving ecological conditions in residential areas.

Last year, Saint Petersburg was quite active in the discussion of urban development. The masterplan concept including green infrastructure prioritized five target areas—mobility and transportation, education, healthcare, improvement of urban environment, and preserving cultural legacy. A similar approach exists in Moscow. Residents of both cities have voted for a more attractive, environmentally friendly, and beautiful green city with authentic character. There have been several successful examples at reconstruction of former industrial sites into new green areas—for example, Park Zaryadye in Moscow and New Holland in Saint Petersburg (Fig. 7).

In Saint Petersburg, unique new green areas have been created on reclaimed areas of the Gulf of Finland (e.g., Park of the 300th Anniversary of Saint Petersburg)—see Table 3. Both cities have a legacy from the Soviet era regarding greening the city for the common use. This good practice could be developed further by adding

Fig. 7 **a** New Holland in Saint Petersburg, **b** Park Zaryadye in Moscow. *Photo* N. Kerimova (Park Zaryadye) and M. Ignatieva (New Holland)

Table 3 Main greening projects occurring in the last 10 years in Moscow and Saint Petersburg

Name of the project/greening activity	
Moscow	Saint Petersburg
Park of arts museum	Park of the 300th anniversary of Saint Petersburg
Park Zaryadye	New Holland. Revitalization of former industrial zone
Reconstruction of Gorky Park	Restoration of the Summer Garden
Revitalization of former industrial area ZIL	Reconstruction of Neva River embankments
Park of physical education and sport "Dinamo"	Park "Kurakina Dacha"
Reconstruction of river embankments	Greening of the embankment along the South Road in Krestovsky Island
Reconstruction of Sokolniki Park	Park Stroitelei in one of the residential districts
Green area VSKhV—VDNKh—VVC. The development of recreation zones	Murinsky Park in one of the residential districts
Strogino—the lungs of the capital. The initiative of community of Strogino minipolis/City-XXI century for ecological improvement	Creation of two park zones in Frunzensky and Primorsky districts

comprehensive and socially inclusive plans. Some obstacles to implementing them are connected with the lack of financing, which is the common explanation given among city planners and decision-makers (e.g., municipal budgets in both cities have other priorities such as to replace or renovate the cities' residential building stock). The improvement of green areas seems not so vitally important. One of the most negative consequences of Moscow's and Saint Petersburg's rapid development is the risk of losing natural habitats and thus biodiversity.

Our vision of a new green infrastructure in both cities should be developed based on the following concept: It should be established not only as a random mosaic

of different green spaces, but as an entire complex of interconnected green infrastructural elements, including green corridors and ecological axes along city roads and river embankments, as well as resource-saving technologies (sustainable energy, low-impact development, water-sensitive design, and ecological design). It should adopt progressive ideas from the Soviet period, such as support from the Botanical Gardens and organized public activities (e.g., "subbotniks," etc.).

The priority should be given to the design of new parks and gardens in the newly built areas, which have a higher population in comparison with older districts. There is great potential for green space in the courtyards of the new residential multifamily areas. The increase of green areas in old city districts is surely restricted by the heritage status, but it is also possible through the introduction of new technologies, such as vertical and container gardening, greening roofs and walls, and cleaning and restoration of existing waterways.

5 Conclusions

At the present time, Moscow and Saint Petersburg can be considered as green cities thanks to their large number of parks, gardens, squares, boulevards, residential green areas, and urban forests.

The ideology of the Soviet time was deeply connected with the idea of making cities livable for all their inhabitants and having access to nature (principle of harmonious existence of people and nature). While the concept of urban green infrastructure and biophilic city was introduced and started to be implemented in cities worldwide only in the last decades, the principles of planned greening were successfully implemented already in the period of Peter the Great, then flourished in the Soviet time. Both cities experienced difficult times in the post-Soviet transition when green spaces were greatly transformed and pressured by traffic pollution and construction processes and went through a period of absolute neglect. Nowadays, there is the strategy of the 2025 master plans, based on the principles of interconnected sustainable green infrastructure and use of innovative design thinking and new technological opportunities.

Acknowledgements This work was supported by the Russian Foundation for Basic Research (RFBR) project "Mathematical-cartographic assessment of medico-ecological situation in cities of European Russia for their integrated ecological characteristics" (2018–2020) under Grant number No 18-05-406 00236/18 and by the Horizon 2020 Framework Program of the European Union project "Connecting Nature" under Grant Agreement No 730222.

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