



# Green and Resilient City: Obligatory Requirements and Voluntary Actions in Moscow

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**Abstract.** The interest to the sustainable development, resilience and smartness of cities and communities has been growing globally since 1980s. City governments have been working out strategies, forming unions and associations, and exchanging experience in facing urbanization challenges and managing city assets sustainably. Authors consider international initiatives and standards providing for the common background needed to work out and implement sustainable development and resilience strategies and management plans as well as to assess and compare results achieved. Major initiatives analyzed include the United Nations HABITAT Program, the International "Green City Index" research, the network of the world's megacities committed to addressing climate change (C40), the Charter of European Cities and Towns Towards Sustainability (Aalborg Charter) and the Working Group on Environmentally Sustainable Cities of Association of Southeast Asian Nations. A new series of the International Organization for Standardization standards ISO 37000 establishing requirements to management systems for sustainable development of communities and offering guidance in setting aims and objectives and measuring success is considered. Peculiarities of the understanding and use of these standards in Russia are described. Authors study a wide range of legal requirements set by Moscow city government in the period of 1993–2018 and demonstrate advantages and shortcoming of the legal acts passed and enforced. Consider voluntary actions undertaken by the local community, non-governmental organizations and educational establishments. The Chapter demonstrates the need for systematizing patchy policy documents and research projects. The case for the restoration of Moscow water bodies (small rivers) as backbones of the urban ecological network will be elaborated.

**Keywords:** Sustainability · Resilient city · Green City Index · International standards · Legal requirements · Voluntary actions · Moscow

# 1 Introduction

It is estimated that 50% of the world's population now live in cities. Overpopulation, irrational consumption, environmental pollution, and depletion of resources have presented challenges in major cities. The need has never been greater to find solutions and reimagine urban landscapes. This is why sustainability, resilience and smartness of cities and communities attract attention of various stakeholders around the world. Cities unite trying to work out and implement strategies, develop standards and guides on best practices, learn lessons of leaders located in Europe, Africa, America Asia, and Australia.

The wellbeing of residents is the primary concern of each city government. It includes guaranteed access to quality education, high level health care, reliable and affordable public transportation, appropriate waste management, good air and water quality, etc. The importance of management for sustainable development and resilience is universal while adaptive solutions vary a lot depending on population, economic structure and cultural traditions, geographic, climate conditions, available resources and other factors.

The renovation of public spaces is a fundamental characteristic of sustainable cities. Parks, public streets, boulevards, embankments, urban spaces as well as modern irrigation and waste management practices are vital aspects of sustainable living. They help preserve the cultural heritage and identity of a city through renovation and restoration. Urban renewal in a city has to be done using a holistic approach and thinking of both the quality of living and energy efficiency, environmental friendliness of selected solutions and climate change challenges. The reduction of Greenhouse Gases emissions becomes the most significant measure of the environmental commitment of cities.

Sustainable cities should favor ethical consumption and use of resources. Overconsumption leads to excessive depletion of natural resources, greater waste formation and environmental pollution. Managers of a sustainable city must raise awareness about the importance of recycling and responsible consumption and create infrastructure that allows for waste minimization. Ethical use of such common resources and urban water bodies, soils, green areas has also to be promoted and encouraged. This is where public participation in voluntary actions is crucial.

Moscow joined international initiatives in the field of sustainability and resilience at the end of the XX century. Facing rapid urbanization and enormous population growth, it has been trying to introduce sustainability management principles. Moscow government is concerned about the city attractiveness, conserve and improve the state of environment (enhancing environmental performance of municipal services, restoring green and blue network, biological diversity and ecosystem services). It also cares about the resilience developing and implementing climate change mitigation and adaptation measures.

The need for obligatory requirements and voluntary actions to improve the sustainability and resilience of Moscow is discussed at various national and international forums. This article is prepared by the team of experts who participated in the international conference “Green technologies and infrastructure to enhance urban ecosystem services” organized by Peoples’ Friendship University of Russia in May 2018.

## 2 Large Cities Versus Sustainable Communities

For many years, perhaps since “Walden; or, Life in the Woods” [1], the famous novel of Henry David Thoreau was published in 1854, and up to the beginning of the XXI century, two terms had been used as antonyms – city (large city) and sustainability. Thoreau was possibly the first environmentalist-philosopher and ideologist, though his numerous modern followers recall his name quite seldom. It is necessary to emphasize that Thoreau neither denied civilization (and its essence – the city) nor fully honored wilderness. Instead he sought a middle ground, the ideal terrain that integrates nature and culture [2].

So, where is this middle ground, or is there any? – Pessimists say, “No”, optimists say, “Yes”. It is typical of human beings to hope for the best, and quite many people believe that some level of the integrity of nature and culture can be reached. This is why communities around the world keep trying to find the necessary balance between nature and culture developing and implementing their sustainability and resilience programs, following common principles and finding specific solutions, in many instances – unique.

Sustainable development is understood as “the development that meets the environmental, social and economic needs of the present without compromising the ability of future generations to meet their own needs” [3]. The idea was first put forward in 1987 and since that time has been further developed by many researchers and international bodies. To translate the definition into Russian, one should specify the development of what is meant, for example, “the sustainable development of the mankind”. Interestingly, in most cases researchers tend to speak of the sustainable development of communities rather than cities though both versions can be found in the literature [4–6] and in the international standards [7, 8]. Moreover, researchers argue that cities can rather contribute towards sustainable development than become sustainable themselves [9].

The concept of resilience was originally defined in physics and psychology, and later on successively applied to ecology, environmental science and social systems. The Intergovernmental Panel on Climate Change (IPPC) [10] defines resilience as “the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions”.

In ecology, resilience addresses the ability of ecosystems to absorb change and disturbance and adapt to small-scale perturbations, both in the length of time it takes to recover from external stress and in the magnitude of stress from which a system can recover without rapidly moving to a new stable condition [11–13]. Speaking of city resilience and sustainability we turn to large-scale perturbations and consider opportunities to recover from stresses – environmental, social and economic ones.

It is evident that both concepts are very multidimensional and at the same time they are interrelated. We will consider them mostly from the environmental standpoint and to the extent needed to better understand current initiatives of Russian cities.

## 2.1 International Initiatives and Standards

There is a wide spectrum of international initiatives addressing – to various extents – challenges and opportunities of the sustainable development at the city and community levels [14–17]. More than half of the world's population now live in urban areas. By 2050, that figure will have risen to 6.5 billion people – two-thirds of all humanity. Sustainable development cannot be achieved without significantly transforming the way we build and manage our urban spaces. The challenge is so evident that back in 2015, the United Nations set the Millennium Development Goal 11: “Make cities inclusive, safe, resilient and sustainable” [18].

In 2017, the UN Report entitled “Progress towards the Sustainable Development Goals” was issued. It was stated that, “Urbanization is an unstoppable phenomenon. Rapid urbanization has brought enormous challenges, including growing numbers of slum dwellers, increased air pollution, inadequate basic services and infrastructure, and unplanned urban sprawl, which also make cities more vulnerable to disasters. Better urban planning and management are needed to make the world's urban spaces more inclusive, safe, resilient and sustainable. As of May 2017, 149 countries were developing national-level urban policies” [19]. Air pollution, waste management along with the need for the greener planning were addressed as the priority issues of the urban development.

Various international initiatives in the field of the sustainable urban development have been growing since the 90s. Some of the initiatives are more region-oriented (as the Charter of European Cities and Towns Towards Sustainability (Aalborg Charter) [14] or The Integrated Program for Better Air Quality in Asia and The ASEAN Working Group on Environmentally Sustainable Cities [20–23]; others focus on specific issues like City Prosperity Initiative [24], C40, the network of the world's megacities committed to addressing climate change [25] or Urban governance and resource efficiency project [26].

Most of the programs are now either parts of or connected to the Sustainable Cities Program (SCP). The SCP is a joint UN-HABITAT/United Nations Environment Program (UNEP) capacity-building and institutional strengthening facility, promoting good environmental governance at all levels to support local and national partners adopt environmental planning management processes and integrate good practice into national policy and legal frameworks [27].

While challenges of sustainable development are global, the strategies for achieving it at community level are to a large extent local and vary in context and content from country to country and region to region. General, region and sector-oriented guidance materials, best practice reports and practical recommendations are prepared and shared by many programs and projects. A new series of International Standards (ISO 37000) is being developed by the Technical Committee ISO/TC 268 “Sustainable cities and communities” for a holistic and integrated approach to sustainable development and resilience [28].

ISO 37101:201 establishes requirements for a management system for sustainable development in communities, including cities, using a holistic approach, with a view to ensuring consistency with the sustainable development policy of communities. The intended outcomes of a management system for sustainable development in communities include [7]:

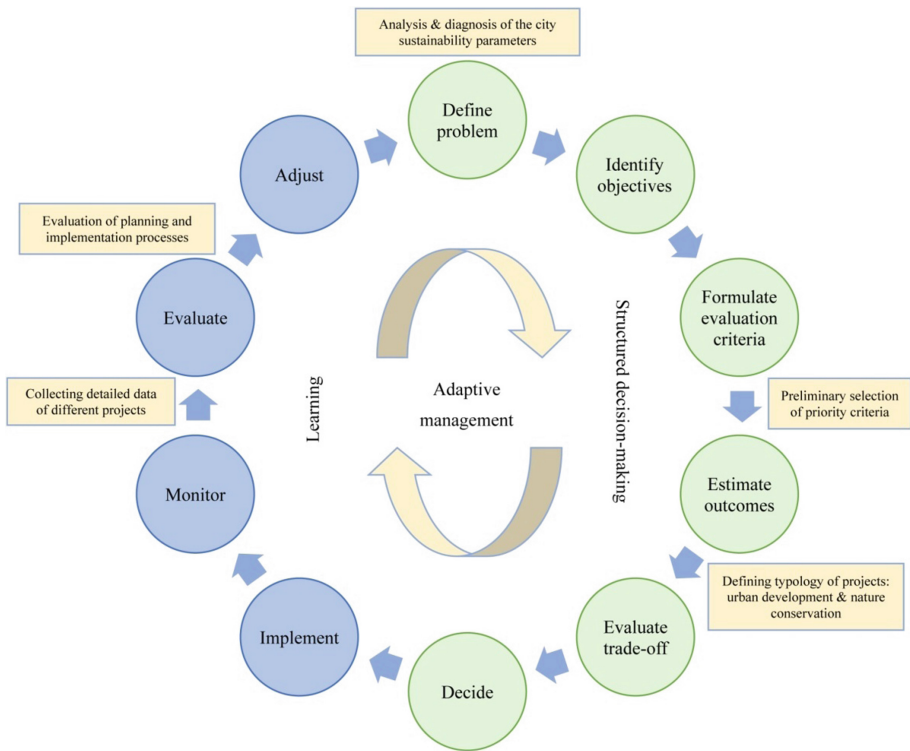
- managing sustainability and fostering smartness and resilience in communities, while taking into account the territorial boundaries to which it applies;
- improving the contribution of communities to sustainable development outcomes;
- assessing the performance of communities in progressing towards sustainable development outcomes and the level of smartness and of resilience that they have achieved;
- fulfilling compliance obligations.

Other standards of this series playing methodological roles include:

- ISO 37106:2018. Sustainable cities and communities – Guidance on establishing smart city operating models for sustainable communities [29];
- ISO 37120:2018. Sustainable cities and communities – Indicators for city services and quality of life [8];
- ISO/DIS 37122. Sustainable development in communities – Indicators for smart cities (under development) [30];
- ISO/CD 37123. Sustainable development in communities – Indicators for resilient cities (under development) [31].

Thanks to ISO 37120 (first issued in 2014), city indicators providing a uniform approach to measure sustainability have been used by cities. It enables them to communicate amongst themselves using globally standardized, comparable data, allowing them to get insights into other cities and learn from each other [28]. Another point is that there is a definite tendency to widen the scope of standards offering special indicators for smart and resilient cities (it is expected that standards will be issued in 2019).

Management systems for sustainable development need to be based on the adaptive approach following in general Plan-Do-Check-Act cycle but being focused on preventing (or solving) urban problems and involving many more stakeholders than any typical management system of an organization, being it small or big (Fig. 1).



**Fig. 1.** Adaptive management for sustainable development.

In the standards, resilience is defined as “the adaptive capacity of an organization in a complex and changing environment” [7]. Special notes are added to emphasize that resilience can be also defined as:

- “the ability of an organization to resist being affected by an event or the ability to return to an acceptable level of performance in an acceptable period of time after being affected by an event;
- the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when this is necessary”.

It is noted also that the IPCC definition is the fundamental one and it helps understanding the complexity of challenges met by communities in the rapidly changing environment.

Thus, speaking of resilience we’ll keep in mind that local governments (addressed in ISO 37000 as organizations) shall be prepared to improve their adaptive capacities and to maintain their functions in the face of internal and external change.

Another important term in smartness which is defined as “the quality of contributing to sustainable development and resilience, through soundly based decision making and the adoption of a long- and short-term perspective” [7]. It is noted also that:

- “smartness is embedded in the process of sustainable development, i.e. sustainable development is the overarching process, while smartness is a characteristic. It implies a holistic approach, including good governance and adequate organization, processes and behavior, and appropriate innovative use of techniques, technologies and natural resources;
- smartness is addressed in terms of performance, relevant to technologically implementable solutions”.

Though guidance standards of ISO 37000 are very useful for local governments, it is the management system standard ISO 37101 which plays the key role in the establishment of the management system for sustainable development. According to ISO 37101 requirements, “The organization shall establish, implement, maintain and continually improve a management system for sustainable development in communities, including the processes needed and their interactions, in accordance with the requirements of this International Standard. The organization shall secure sufficient resources to implement the management system at the appropriate level of authority” [7].

Nowadays, nearly a hundred cities have implemented, or are in the process of implementing, ISO 3700 series of standards, and lessons learned by these cities are being reflected in new systems of indicators, guidance standards and practical recommendations [28].

Two standards – ISO 37120 (the first version of 2014) and ISO 37101 – were translated into Russian and discussed in research articles [32, 33]. Neither standards themselves nor research papers attracted any interest of practitioners – partially to the reluctance of governors and mayors to discuss sustainability and resilience issues in general, partially due to the unsuccessful translation of the original standards. The first issue is very characteristic of regional level decision-makers in Russia: they tend to discuss sustainable development almost exclusively from the environmental point of view. The UN Millennium Development Goals are considered more comprehensively, and governors begin realizing that regional performance is going to be measured against National Development Goals. At least, the Federal State Statistics Service of the Russian Federation has been elaborating a system of indicators to track progress towards these goals [34].

## 2.2 Moscow Sustainability Concept

It is likely that for the first time, sustainable development was addressed at the governmental level of the Russian Federation back in 1996, when the Executive Order on the Concept of Transition of the Russian Federation to Sustainable Development was signed [35] by President Yeltsyn. The Order set the framework for incorporating sustainable development into policy making stating that Russia should:

- pursue environmentally sustainable development within a market economy;
- protect the environment;
- restore ecosystems that suffered damage in the past;
- participate in solving international environmental problems.

The ambitious plan included numerous objectives to be achieved, requirements to setting regional sustainable development strategies as well as indicators and was based on the staged approach to solving environmental, social and economic problems. A 1996 government report to the United Nations on Russia's progress towards implementing Agenda XXI dramatically asserted that "the transition to the sustainable development may be seen as a national idea which could unite all strata of society in the cause of Russia's rebirth" [36]. Though Russian Academy of Sciences published a fundamental research entitled "Main provisions of the Sustainable Development Strategy of Russia" [37], Russia never established a national strategy for sustainable development. A number of legislative acts (covering mostly environmental aspects) was passed [38–40] and several national and regional programs implemented [41–43]. A new series of programs will be implemented in 2019–2024 in accordance with the Executive Order of the Russian Federation President of May, 07, 2018 No 204 on National Goals and Strategic Objectives of the Russian Federation through to 2024 [44]. There are certain parallels between the Sustainable Development Goals and National Goal of the Russian Federation which are formulated as follows:

- "ensure sustainable natural population growth;
- increase life expectancy to 78 years (80 years by 2030);
- ensure sustainable growth of real wages, as well as the growth of pensions above inflation level;
- cut poverty in half;
- improve housing conditions for at least 5 million households annually;
- accelerate technological development and increase the number of organizations engaged in technological innovation to 50% of the total;
- speed up the introduction of digital technologies in the economy and the social sphere;
- take Russia into the top five largest economies, ensure economic growth rates exceeding international rates, while at the same time maintaining macroeconomic stability, including inflation under 4%;
- support high-productivity export-oriented businesses in the basic sectors of the economy, primarily, in manufacturing and the agro-industrial complex, based on modern technology and staffed with highly qualified employees" [44].

For the context of this article two national programs need to be mentioned, namely: "Housing and urban environment" and "Environment". These programs are rooted in the research resulted in the preparation of the National Report "On Environmentally Sound Development of the Russian Federation in Interests of Future Generations" [45, 46].

At the regional or city level, both legislative acts and targeted programs in the field of environmental protection have been developed and implemented since the 1990s; very few of them have been called sustainable development acts or programs.

In Moscow, first attempts to establish a sustainable development strategy were undertaken at the end of the 1990s. By 2004, Mayor Yuri Luzhkov had set the United Research and Expert Council of the Russian Academy of Sciences and Moscow Government on the Sustainable Development and Safety of Moscow Megapolis [47] which worked out a doctrine which was entitled "The Environmental Doctrine of



Moscow” [48] and never turned to the sustainable development doctrine as it was initially intended.

For 18 years of his governance (1992–2010), Mayor Yuri Luzhkov passed several Moscow Laws addressing environmental, special planning and protected areas issues, namely:

- Moscow City Law of May, 05, 1999 No 17 on the Protection of Green Areas [49];
- Moscow City Law of September, 26, 2001 No 48 on Protected Natural Landscapes in Moscow [50];
- Moscow City Law of October 20, 2004 No 65 on the Environmental Monitoring System in Moscow [51];
- Moscow City Law of April, 27, 2005 No 14 on the General Development Plan of Moscow [52];
- Moscow City Law of July 06, 2005 No 37 on the development of Protected Landscapes in Moscow [53];
- Moscow City Law of June, 25, 2008 No 28 on Moscow City-Planning Code [54].

Moscow had become one of the most active Federation subjects (regions and cities) passing and enforcing environmental legislation. Along with dozens of Moscow City Decrees, city laws formed a framework of requirements to environmental conservation and special planning in the capital of Russia. Special attention was paid to urban soil and water quality [55, 56]. Several Targeted Environmental Programs had been implemented in the city resulting in improving environmental conservation practices, setting modern environmental monitoring system, introducing experimental environmental training courses at Moscow secondary school establishments, etc.

A series of documents addressing environmental monitoring issues and setting requirements to continuous self-monitoring of larger industries (large combustion plants, oil refineries, tobacco factories, etc.) formed a basis for the development of the national legislation in this field [57]. While Moscow put forward the idea of the continuous self-monitoring of industrial installations in 2004, the national legislation introduced this requirement in 2014. Besides that, the overall environmental monitoring system of Moscow is much stronger and better established than that functioning within the framework of the Ministry for Natural resources and Environment.

In 2005–2009 a number of international projects aimed at working out a sustainable development concept for Moscow, preparing its climate change mitigation and adaptation plans, assessing Moscow Green Index according to the international methodology [58], setting an online calculator of greenhouse gases emissions, etc. had been implemented in Moscow. They resulted in preparing new training programs for secondary and higher school establishments, passing several Decrees of Moscow Government but no sustainable development concept was adopted for Moscow. In 2006, Moscow joined C 40, C40, the network of the world’s megacities committed to addressing climate change [25], now (in 2018) it remains the only Russian city participating in C40 activities.

Ironically, Mayor Yuri Luzhkov who considered climate change related projects least useful for the city, lost his position after horrible 2010 heat waves and fires resulted in increased mortality rate in Moscow [59, 60].

Sergei Sobyenin has been serving as Moscow Mayor since October 2010. Immediately after taking office, Mayor Sergei Sobyenin declared that the city's transport system crisis was the most visible imbalance in Moscow's development. Transport remains the favorite theme of the Moscow Mayor along with sport and public spaces.

In 2012, the draft Strategy for the Socio-Economic Development of Moscow was developed. The document stated contained a thorough analysis of social and economic challenges and suggested three development scenarios. Unfortunately, in 2018, the Strategy remains being just a draft though fragments of it are often cited and the statement that "Moscow is in the process of its sustainable development" is put online on the website of the Russian Federation "Strategy" project (<https://strategyrf.ru/moscow>).

In 2013, the Government of Moscow initiated a reform (optimization) of the city health care system, which did not lead to any positive results: the number of doctors and nurses reduced dramatically and people relying on so called "obligatory" insurances claim that health care in Moscow is not affordable.

The minimum wage in Moscow has been increasing and in 2018, reached 18,742 Rub. (just over \$270) per month. On the other hand, the growth in rental fees (increase in property tax, utility charges, paid parking) may indicate the desire of Moscow authorities to force low-income people out of the city center.

From the environmental point of view, Moscow waste management system and greening campaigns (like "Millions of trees" and "My street") are the issues discussed in mass media. With the support of Moscow Government, Moscow Urban Forum and Moscow Climate Forum have been held in the capital since several years ago. At the same time, the Environmental Council which used to act as the Advisory Board to Moscow Mayor (1999–2010) has lost its positions and functions now as a Public Council at the Department for Natural Resources and Environmental Protection of Moscow. Mayor Sergey Sobyenin never participates in Moscow Government sessions discussing City Reports on the State of Environment. Though Moscow Mayor often speaks of the sustainable development of the Russian capital and mentions economic, social and environmental aspects, no concept has been approved up to 2018.

In 2018, the Environmental Strategy of Moscow has a status of a draft document though it had to be passed back in 2017. The overall objective of this strategy is described as "maintaining the balance between the nature conservation and smart, well-controlled usage of natural resources needed for the technological development of all branches of the city's economy aimed at the sustainable development and at the formation of the comfortable environmental conditions" [61]. The draft Environmental Strategy was worked out by the employees of the Department for Natural Resources and Environmental Protection of Moscow with the support of the Public Environmental Council; UN-HABITAT/United Nations Environment Program principles were considered to some extent. Though the "sustainable development" expression is used over 30 times, the strategy remains mostly the document addressing environmental conservation issues but not economic and social aspects.

### 3 Green and Blue City: Joint Actions Needed

As it was discussed in Sect. 1, urbanization is a worldwide, multidimensional phenomenon altering the relationship between society and the environment and affecting sustainability and resilience of not just urban areas themselves but many social and economic systems around them. Sustainability, resilience, smartness and transformation have become key concepts aimed at understanding and responding to the urbanization challenges [62].

Green Cities are concerned about designing (or re-designing) the whole city in a more sustainable and resilient way. They recognize connections between different sectors and support development strategies that fulfil multiple functions and create benefits for society and urban ecosystems [63]. One of the internationally recognized approaches to measuring sustainability of urban areas is called the Green City Index. It is The Green City Index methodology was developed by the Economist Intelligence Unit in cooperation with Siemens. The Green City Index measures cities on approximately 30 indicators across eight to nine categories (depending on the region) [58]. Indicators cover greenhouse gases emissions, energy use, buildings, land use, transport, water and sanitation, waste management, air quality and environmental governance. Over 120 cities worldwide were studied. Participating in the research, city governments better understood their specific challenges and got to know more about best practices in the field of sustainable development of urban areas.

Another initiative – Blue-Green City – emphasizes the importance of water in the urban environment and calls for the holistic planning and management of water, wastewater and storm water across the whole city to ensure that populations are resilient to climate change and extreme weather events while ensuring the health of aquatic ecosystems. In a Blue-Green City, Blue-Green Infrastructure involves the use of natural or man-made systems to enhance ecosystem services in the management of water resources and increase resilience to climate change risks [64].

Both concepts are of the great interest to Moscow looking for opportunities to measure and to enhance its “blue-green color” developing and implementing respective policies and involving wider stakeholders into environmentally sound activities.

#### 3.1 Moscow City Site

Moscow is located in western Russia; it stands on the Moscow River, a tributary of the Oka and thus of the Volga, in the center of the vast plain of European Russia. The city and its surrounding area, the Moscow region (province), lie in the northwest corner of the most highly developed and densely populated part of Russia. Moscow is situated in the broad, extremely shallow valley of the Moscow River and its tributaries [65].

A map of the “old Moscow” (prior to including new areas located South-West from the center) occupying 1,070 km<sup>2</sup>, presents a pattern of concentric rings that circle the rough triangle of the Kremlin and its rectangular extension, the Kitay-gorod, with outwardly radiating spokes connecting the rings. The whole pattern is modified by the twisting, northwest–southeast-trending Moscow River. These rings and radials mark the historical stages of the city’s growth: successive epochs of development are traced by the green Boulevard Ring and the formerly green Garden Ring (both following the

line of ancient fortifications), the Moscow Little Ring Railway (built in part along the line of the former Kamer-Kollezhsky customs barrier), and the Moscow Ring Road [65]. In 2011, the area of Moscow more than doubled: it received new afforested territories lying south-west of the city (1,480 km<sup>2</sup>).

The hydrographic network of Moscow amounts about 1,200 water bodies including the Moscow river and its tributaries, the Khimki water reservoir, the Kosino lakes, etc. Though it has been seriously altered since the XVIII century, this network is still a part of the natural environment bearing important city-forming, ecological and engineering functions. Moscow water bodies play a very important role in storm water management though flood-producing storms of the past decade show the necessity to significantly improve the system [66].

Moscow is one of the greenest megacities in the world: its green areas amount up to 49% of the city area fulfilling ecological, environmental, recreational, city-forming and sanitary functions. Green lanes allow decreasing air pollution along main roads and traffic noise; they also help forming a more comfortable environment for city inhabitants. Green areas of Moscow consist of planted spots and natural landscapes; the latter ones are often protected as the National Park LosinyOstrov (the Elk Island), Natural Parks or Nature Monuments. Protected landscapes occupy about 175 km<sup>2</sup>. New protected landscapes are being designated; it is expected that The RamenkiRiver Valley Part will be established in 2019 [66].

### 3.2 Conservation Policies and Public Actions

Back in 2005–2006, Moscow City Government was invited to take part in the research project “European Green City Index”. It is difficult to say now what were the reasons for not taking part in the research, but it was not Moscow but four former Soviet Union cities who joint the project – Kiev (Ukraine), Riga (Latvia), Tallinn (Estonia) and Vilnius (Lithuania) [67].

Both the methodology and results of the research keep intriguing Moscow government which included a special Green Index session into the agenda of the Second Moscow Climate Forum (<http://climate-forum.ru/en/program/>). While trying to assess indicators used in the project, Moscow researchers found out that percentage of renewable energy used and share of waste recycled were not just weak but apparently not accounted for. Fortunately, greenhouse gases emissions had been assessed for the first time in 2008 and showed to be comparable with those measured in Amsterdam or Helsinki (about 6 tons per capita per year) [68]. Still, the importance of the sustainable development strategy and measurable objectives was undervalued back in 2005–2006 and is only becoming realized now, in 2017–2018. At the same time, the need to measure and improve energy and water consumption parameters as well as the necessity to enhance waste management and nature conservation practices are often discussed with regards to the Green Index, to the implementation of the city management system for sustainable development [7] and opportunities to run a national project similar to one implemented with the support of Siemens worldwide.

While Moscow government and especially the Department for Natural Resources and Environmental Protection develop conservation policies, wider stakeholders show their preparedness to take part in real actions. Sometimes this preparedness simply

reflects a corporate policy, sometimes greening activities are organized to support elections but such things happen everywhere, don't they?

Let us consider the interrelatedness of Moscow conservation policies and public actions using the river valley restoration example.

Urban rivers (and rivers of Moscow are not an exclusion) present particular challenges to river restoration. First of all, the urban context forms the conflicts between water resources management and river restoration. The huge number of people (over 12 mln) and a wide range of enterprises operating in the Moscow river catchment mean that most city rivers are heavily contested environments, and managing them requires addressing conflicting social, cultural, economic, and environmental factors. Second of all, in socio-economic terms, the Moscow river catchment is extremely dynamic and it is a subject to the high rate of change and uncertainty regarding future pressures.

The older Moscow has 142 rivers and streams while only 45 of them have completely open riverbeds; 16 rivers are longer than 2 km and are rather valuable from the ecological, landscape and recreation points of view. Due to decades- of not centuries-long policies, valleys of small rivers had been modified, watercourses straightened, and the hydrographic system broken. Over 40 small rivers and brooks had been lost and 55 stream flows had been significantly modified.

Modern city-planning policy has to aim at minimizing technogenic landscapes areas and restoring natural and cultural landscapes. Natural and seminatural landscapes need to be interlinked, united into the whole system that can be called an ecological network. Ecological networks consist of sites containing diverse areas of habitat that support species and have ecological connections between them that enable species to move. They provide a range of ecosystem service benefits to society and in doing so underpin sustainable economic activity, allow biodiversity assets to recover from losses and also provide resilience to climate change impacts. Maintaining and improving habitat connectivity is important in ensuring the long-term survival of biodiversity in a fragmented landscape and with a changing climate [69].

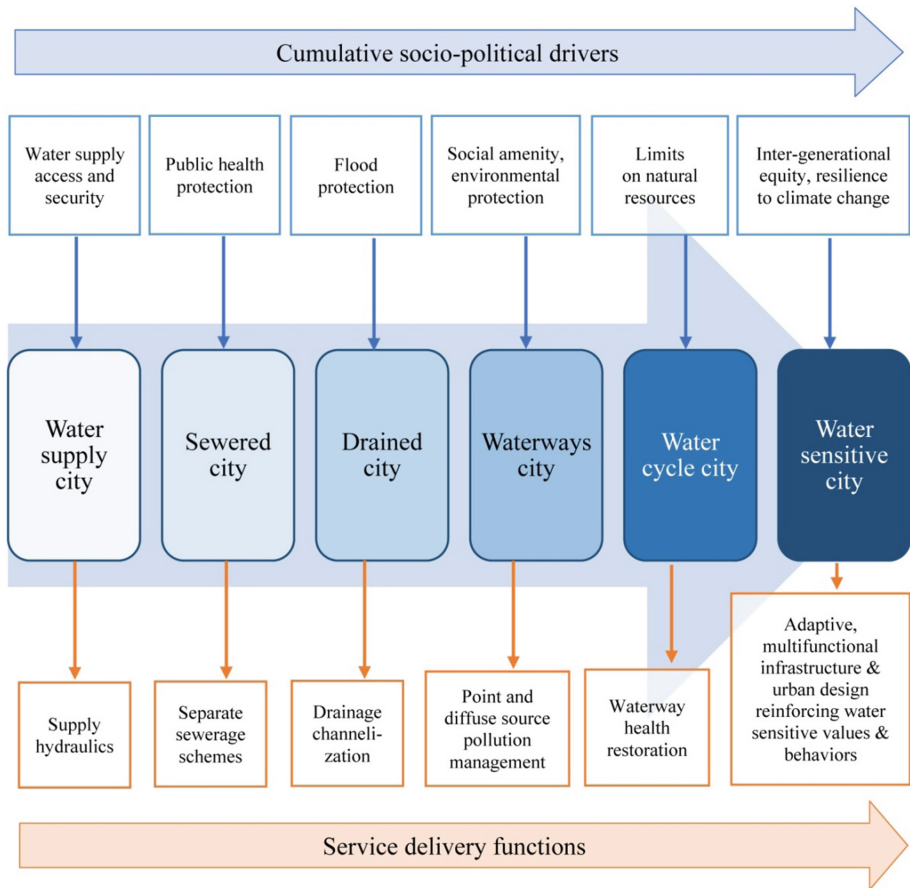
Being structured along a river, an urban ecological framework can consist of assets with various levels of protection (conservation) such as natural parks, wildlife sanctuaries, parks, gardens, etc. Thus, river restoration opens opportunities for providing better ecosystem and social services. But in most cases returning rivers to a natural state is not feasible. Traditional approaches to river restoration relied on the use of natural rivers as a benchmark. The degree of change in river catchments around the world means that nearly always returning rivers to a historical, pre-development condition is now physically or economically impractical. In contrary, river restoration aims at achieving multiple objectives, by balancing the natural functions of the river with specific human needs. There are cumulative socio-political drivers that should be considered while planning a new river restoration project (Fig. 2) [70]. In a modern city, while intending to restore a river or even a brook, planners need to consider a greater number of issues and consult a wider range of stakeholders [71].

In Moscow, procedure of stakeholder involvement into city-planning discussions (and planning of riverbank transformation is not an exclusion) are underdeveloped. Usually, local dwellers receive information on the intended changes at the final stage, when the project design is ready and construction process is just about to be started. But an integrated approach, addressing land and water issues, and involving inter-departmental

and community collaboration, has much better chances to achieve valuable results for river restoration. At the same time, the international experience proves that the grassroots nature of river restoration makes the involvement of non-governmental organizations, teachers, students, and community groups an important element of many projects. Here we return to the requirements of ISO 37101 [7] standard concerning the contribution of communities to sustainable development outcomes.

In addition to the involvement of communities in sustainability practices, restoration projects also offer the opportunity to reconnect people and rivers, which can result in benefits that go beyond project completion. The restoration process should also provide opportunities for continued learning and to ensure that stakeholders develop the capacity to respond to ongoing challenges related to river management [71].

By now, Moscow government has understood that public participation is needed at all stages of the project development because river restoration, revitalization never completes when construction works are finished. Public support is essential to maintain the restored river.



**Fig. 2.** River restoration socio-political drivers and service delivery functions (based on [70])

Public actions are often supported by the leading Moscow enterprises. Thus, such companies as Nestle, BP, Gazprom, etc. bear costs of “Millions of Trees”, “My Street” “Green Spring” programs and actions while employees of these companies participate in the above mentioned and other events. The National Council on Corporate Voluntary Actions coordinates activities of various companies and promotes best practices.

At the initial stage of a river restoration plan draft preparation, volunteers can contribute a lot. They can survey riverbanks, make pictures of damaged and survived patches of a river corridor, make notes of evidences seen (lush as illegal dams or wildlife seen). Then volunteers organize conservation actions. At the Federal level, there is an action entitled “Green Spring”, which is supported by Vladimir Vernadsky Foundation [72]. Active Muscovites clean riverbeds, remove rubbish from riverbanks, plant bushes and trees. In 2017, “The Vibrant River” action attracted volunteers (families, school children, and students) from the city and its vicinities to the Nara river. They managed to remove 12 river course blockings, 53 car tyres, 9 supermarket trolleys, collect about 200 cubic meters of garbage. Moscow Ecocenter for Children involve pupils in “Let’s Help Small Rivers” program, which also includes annual river cleaning actions.

At the second stage, field studies need to be conducted: key polluters have to be identified, water and sediment quality analyzed and interpreted. Undeniably, it is a very professional part of work, but students of environmental departments of Moscow universities often take part in these studies following standardized procedures of sample collection and analysis. Data obtained by university laboratories are considered along with the official information [73].

Only when data collected at stages one and two are analyzed, the river restoration objectives and targets can be formulated and the overall project be developed. This involves a process of prioritizing river ecosystem assets, values, functions, and services and agreeing on what levels of improvement constitute success. The question of which of these should be given priority when setting the restoration goals and objectives is primarily a strategic issue. Ideally, a restored river has to become one of the key components of the city ecological network. Forming (or conserving) linear elements connecting basic protected areas (habitats) is the crucial condition of the city and region ecological network functionality since the fragmentation of habitats is the key threat to biodiversity. Under the urbanization conditions, river valleys are possibly the only promising natural corridors that can be found almost in each city.

The overall objective of a river corridor management is the ecological space continuity. Today, only comprehensive and well-planned restoration of all Moscow blue-green system and formation of a network of ecological corridors on the basis of restored rivers can help improve the state of environment in the city, enhance its resilience to environmental and climate change stresses and bring socio-economic benefits.

## 4 Conclusion

World cities have always been centers for ideas, education, science, commerce, culture, social development and much more. Cities have enabled people to advance socially and economically. It is expected that by 2030, about 5 billion people will live in cities. This is why efficient urban planning and management practices are very important; without them it's impossible to deal with the challenges brought by urbanization. Rapid urbanization challenges, such as the effective waste management and provision for safe water and clear air, can be overcome. Cities can continue growing and flourishing, while enhancing resource efficiency and reducing pollution.

Several decades ago, sustainable living was merely a phrase used by scientists and scholars. Now, a greater focus on the environment and climate change becomes characteristic of many cities in Europe, Africa, Americas, Asia and Australia. The most important goal now is to make our hopes and dreams about cleaner and smarter living a reality. Cities around the world unite in national, regional and international actions, governments develop sustainable development strategies, the International Organization for Standardization issues series of standards for cities and communities. Well-developed methodologies, international studies, information exchange and competitions of cities act as powerful instruments used not only for setting clear goals and developing strategies, but also for mobilizing resources needed to implement ambitious programs and improve sustainability of urban areas.

Moscow joined associations of cities concerned about the environmental and climate change issues back in 1990s. It initiated a whole range research projects and assessed its resource efficiency, air, water and soil quality against characteristics of the European leading cities. Several acts setting requirements to the protection of green areas and natural water bodies, as well as to the city environmental monitoring system were passed. Attention paid to the sustainability management has been growing gradually; the city has improved its energy efficiency, started mitigating greenhouse gases emissions; air quality and water quality in rivers and streams has improved.

At the same time, public participation in environmental decision-making needs to be strengthened to make Moscow regulatory system effective and efficient. Individuals and organizations affected by development approvals, land use plans, pollution charges and other types of regulatory processes demand greater consultation, and more transparent and accountable decisions. Moscow community, university teachers, students and non-governmental organizations are ready to take part in greening and cleaning actions and quite often initiate them but they have to be involved in environmental planning and practices on the regular basis. It is likely that the sustainability strategy worked out by the city government will be passed in 2018, but to provide for its implementation, Moscow government needs to become more transparent and to gain real support of Muscovites.



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