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The green space as a driver of sustainability in Post-Socialist urban areas: the case of Almaty City (Kazakhstan)

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The green space as a driver of sustainability in Post-Socialist urban areas: the case of Almaty City (Kazakhstan)

Alla Pakina and Aiman Batkalova

Introduction

- 1 At the beginning of the 21st century cities – and above all the largest cities – became the centers of problems associated with environmental degradation and socio-economic polarization (UNCHS, 2001). The process of urbanization causes the escalation of complex problems inherent to cities and stimulates urban studies devoted to sustainability issues on the city level all over the world. There is a recognition that urban sustainability – environmental, social and economic – must be tackled through holistic and integrated approaches, and that local governments must be at the center of efforts to tackle such issues (Tsenkova, 2003). Responsibilities transfer from the state governance to the city administration can be considered as an important step towards power decentralization and social life democratization. These processes are important particularly for post-soviet cities, since they are experiencing profound transformation associated with the transition from the planned economy to the market economy. In this context, building the effective green-infrastructure in post-soviet cities characterized by common features has great importance for the environmental and social development.
- 2 The spatial aspects of urban greenspaces in post-socialist cities are an interesting point due to their specific settlement structures and historical (industrial, architectural, cultural and natural) heritage. During the Soviet era, promoting social equality was the main ideological foundation for the development of urban planning strategies and planned investments. City planning was considered not as only an integral part of

national economic development, but also as an essential part of the planning strategy (Molodikova, Makhrova, 2007). Despite this, spatial aspects of urban area transformation in post-socialist period are analyzed quite little due to the built environment of a city is much more enduring than its social structure (Stanilov, 2007). In this regard, studies on greenspace-design are quite important as a key element contributing to improving both the state of urban environment and the living standards of the people in the cities.

- 3 The large cities in the post-soviet countries accounted for about four-fifths of the national GDP in the period of 1990s (World Bank, 2000), and up to now they remain the centers of economic growth, financial operations, technological innovations and cultural diversity in these countries. At the same time all the post-soviet cities have the similar model of urban structure which was created entirely for the needs of working class and industrial economy (Urbanica, 2016). Majority of them are characterized by the typical urban-planning and architectural decisions, strict approach to functional zoning and strong bonds between living areas and industrial sites. In this article, the case of Almaty – former capital city of Republic of Kazakhstan is studied.

Almaty as a typical post-soviet city

- 4 Almaty is known since the Silk Road time; nevertheless, it received the status of city only in the middle of the 19th century. At that time it was a settlement called Verny (means “Faithful”, translated from Russian), formed by immigrants (peasants and cossacks) from the southern provinces of Russia, and merchants from Tashkent. The city was established in 1867, when its Governor G. Kolpakovsky had formed the first bodies of city government (Official web-site..., 2018). At the same time, the first plan of urban development was accepted.
- 5 Natural conditions have always played an important role in the fate of the city: in the period before the Soviet era, the city was twice (in 1887 and 1910) exposed to devastating earthquakes, which subsequently affected city’s architecture. After the earthquake of 1887, preference in architecture gave squat log buildings, however, pretentious, with elegant roofs and balconies. A great contribution to the restoration of the city and its changes for the better was made by the architect and the army engineer A. Zenkov, who put into practice the principles of seismic construction. One of the hallmarks of the city – the orthodox Cathedral “Voznesensky” (figure 1) – was also built with his participation. The Cathedral has withstood during the earthquake of 1910, which confirmed the correctness of its construction.

Figure 1. The Cathedral “Voznesensky” in the beginning of XXth century (left) and modern time (right).

Official web-site of almaty city, https://www.almaty.gov.kz/page.php?page_id=4266&lang=1

- 6 At the same time the stage of greening of the city began. The basis of future urban green space – Public Garden (later Gorky Park) – was created in 1883 with the participation of the famous scientist-forester O. Baum, who became its Director. Later such recreation areas (parks “for culture and rest”) were created in most of the Soviet republic capitals and major cities. They formed the core of cities green infrastructure and saved this function until modern time.
- 7 In 1921, the city of Verny was renamed Alma-Ata, and in 1927 it received the status of the capital of the Kazakh SSR as a part of the Russian Federation. Since that time, Almaty has been developing rapidly: it is connected with the regions of Russian Federation by rail and air, the population is growing, housing construction is developing. In 1936, a General Plan of Almaty was developed to transform it into a comfortable city and the cultural capital of the Kazakh SSR. The planning is based on the historically formed rectangular system of blocks with its simultaneous enlargement and reconstruction.
- 8 However, the greatest impetus for the development of Almaty gets after the end of the Great Patriotic War in 1945. Scale projects were being implemented: the construction of earthquake-resistant residential blocks, the system of anti-mudflow protection of the city, the high-mountainous sports complex and stadium “Medeu” (figure 2) at an altitude of 1691 meters above the sea level.
- 9 At that time, Almaty received the unwritten status of a “garden city”: great attention was paid to the development of green infrastructure, which was facilitated by the location of the city in an intermountain basin and the historically developed system of green spaces. The Central Park of culture and rest (Gorky Park) remained the core of the city green infrastructure (with an area of 125 ha, against 42 ha today). Due to a well-developed system of green spaces the Park was twice awarded the title of “Best

Park of the Soviet Union” during the Soviet time. The city was renamed Almaty, its kazakh denomination, in 1993.

- 10 In the post-soviet period the green network of the city did not receive sufficient funds from the city budget. The housing construction became the main interest of investors, where they began to concentrate fixed assets. The current situation reflects the processes in most major cities in the post-Soviet space.

Figure 2. Stadium “Medeu” in 1974 (left) and 2012 (right).

Official web-site of almaty city, https://www.almaty.gov.kz/page.php?page_id=4266&lang=1

- 11 Today, Almaty is no more the capital of Kazakhstan, but remains the largest socio-economic, cultural and political center of the country, with a population of more than 1.7 mln. It produces 20% of national GDP (Ministry of National Economy of Kazakhstan, 2016). The population has been constantly growing on 30-60 thousand people per year during the last 15 years. Population growth is accompanied by growth of human pressure on city environment, such as pollution from Thermal Power Plant (TPP), working on Ekibastuz coal, and transport emissions, degradation of vegetation cover, etc.
- 12 The spatial structure of Almaty city and its green space has been formed during the Soviet period. Until the beginning of 1990-th the city remained one of the greenest cities in the post-soviet space (Abilov, 2015). Reduction of the city’s green space area, caused by changes in social order during the post-soviet period, contributed to a deterioration of the environmental situation.
- 13 The location of Almaty city on the foothills of the Northern spur of the Tien Shan – Zailiysky Alatau – plays a decisive role in the current pollution of the urban environment. The city is located at an altitude of 600-1650 meters above the sea level, in a depression, with frequent calm weather, fogs and surface inversions, which make dispersion of pollutants quite difficult. This feature leads to an accumulation in the lower layers of the air pollution's produced by the exhaust gases of vehicles, the emissions of the power plants and industrial facilities (figure 3). The biggest part of pollutions of air, soil and surface waters is provided by emissions which contain carbon and nitrogen oxides, hydrocarbons, particulates and heavy metals compounds. Phenomenon of smog has become habitual for the city of Almaty, regardless of the moment in the year.

Figure 3. Main sources of pollution in Almaty city.

National Report, 2017

- 14 Green infrastructure plays a significant role in improving the state of urban environment and living standards of cities' populations. As far as greenspace is usually associated with natural elements, such as public gardens, parks, lawns, green walls etc., there has been a growing interest in green spaces research, due to the evidence that nature positively impact human wellbeing (Taylor, Hochuli, 2015). On the other hand, studies on green space are usually based on complex researches, including social and ecological aspects, due to their significance for prevention of urbanization risks. The case of Almaty city demonstrates strong relation between the state of green spaces and the quality of urban environment, and its study allows giving recommendations on improvement of environmental situation through regulation of the spatial structure of green space.

Methods

- 15 Methodology of the research is based on the evaluation of the urban green space contribution to the improvement of Almaty city's environment. The calculation of the green areas was carried out by using the program ArcGIS and satellite images on the study area along with the program SAS PLANET. The green spaces of Almaty city have been analyzed for the ratio of their different elements: trees, shrubs and lawns, and a ranking of the city's districts according to the total area of green spaces was undertaken. Thereafter, the total ecological potential of the green spaces was differentiated by administrative districts of the city.
- 16 We interpret the ecological potential of the green spaces of a certain territory as a set of environmentally significant properties of the plant communities, which are essential for the practice of land use as well as for any economic activity. The ecological potential of the vegetation in a certain territory is determined by the morphological, physiological, coenotic and functional features of its plant communities (Belov, Sokolova, 2014). The number and the diversity of these features, inherent to different

plant communities, form the total ecological potential. The concept of total ecological potential (TEP) is widely used in the Russian environmental researches for evaluating the role of the natural ecosystems in population's well-being, and is close to the concept of ecological services (ES). Many authors consider ES as the direct and indirect contributions of ecosystems to human well-being (de Groot *et al.*, 2010; Iniesta-Arandia *et al.*, 2014; Meerow, Newell, 2017), whose assessment aims to inform environmental management. In contrast to the concept of ecological services, the concept of ecological potential operates on the term «ecological functions» and aims not only to evaluate their contribution to the quality of life improvement, but more generally to preserve the quality of the environment.

- 17 According to numerous researches (Chang J. *et al.*, 2017; Kobak, 1988; Larondelle, Lauf, 2016), ecological functions of certain elements of the green spaces, such as different species of trees, shrubs and herbages, differ significantly due to their spatial pattern and the level of human activities' pressure. Identification of different types of green spaces was conducted on the basis of satellite images of the territory of the city, inventory materials of Almaty green spaces (2016) and their verification by authors' own observation during the summer field seasons 2016-2017. Spatial differentiation was based on evaluation of the green plants' ecological potential, with regard to such indicators as absorption capacity of different pollutants, land use type and the area of green spaces per capita in each district (Bukharina *et al.*, 2007). Data on air pollution were used to assess the impact on green spaces. Taking into account that different types of trees absorb pollutants in different proportions, we evaluated the absorption of four major pollutants (carbon, sulphur and nitrogen oxides and solids) by tree communities in each district. The rates of the pollutions absorption by various tree species are based on studies (Nikolaevsky, 1979; Zherebtsova, Pokalov, 1988), which are commonly used for urban green infrastructure's planning in CIS. Taking into account the specific composition of green spaces and the emissions in each district, conclusions on their ecological potential were made.

Green space's structure of the city

- 18 According to Almaty General Plan, the territory of the modern city consists of 8 districts (figure 4), different in their functionality, density of population (table 1), green infrastructure properties and environmental situation.

Table 1. Distribution of the population between the districts of Almaty city.

Districts	Population (1,000 people)	Density of population, people per km ²
Almaly	204,879	1,877
Alatau	195,348	11,152
Auezov	277,338	11,754
Bostandyk	316,020	3,179

Zhetysu	157,999	4,001
Medeu	188,899	746
Nauryzbai	91,172	1,308
Turksib	209,789	2,783

Source: Statistical overview (2016)

Figure 4. Administrative territorial division of Almaty city.

- 19 The city's green infrastructure consists of different categories of land use, such as industrial zones, settlement areas and protected areas, and is unequally distributed across the territory (table 2).

Table 2. Green space's share in the Almaty city's districts.

Districts	Share in the district's areas, %
Almaly	9.16
Alatau	26.01
Auezov	12.47
Bostandyk	60.16

Zhetysu	2.1
Medeu	58.09
Nauryzbai	54.03
Turksib	1.04

- 20 Such a spatial structure is typical for the majority of post-soviet cities: they are normally characterized by typical urban-planning and architectural decisions, a strict approach of functional zoning and strong bonds between living areas and industrial sites. The spatial structure of the green infrastructure is strictly related both to natural features and environmental characteristics, and also to the settlements and engineering infrastructure patterns. For example, the southern part of the city area (Bostandyk, Medeu, Nauryzbai districts), located on the foothills of the Zailiysky Alatau, is a dangerous seismic zone, and there is almost no industrial activity there, therefore natural landscapes are not experiencing strong anthropogenic pressure. In this regard all the specially protected areas like “Ile-Alatau” National Park and protective mountain forests, are preserved in good conditions and play a role as the core areas in the urban green infrastructure.
- 21 The National Park “Ile-Alatau”, the history of which begins with the self-titled reserve in 1931, is quite a large area – more than 1.7 thousand km². Minor part of this unique natural area – about 1/10 – is located within Almaty city’s borders. This area became the core of the city’s ecological framework in the soviet period. In later years, its structure has been constantly transformed under urban development pressure, but nevertheless the city bore the title of one of the greenest cities in the Soviet Union. Large part of the modern green space in Almaty is formed by the city's parks, gardens, green courtyard space, etc. (table 3). Specific feature of Almaty green space is the presence of apple orchards, confirming the name of the city, which means “apple” in the Kazakh language.

Table 3. Greenspace structure of Almaty city (2016).

Subsystems	Elements	Area, ha
Forests	Forest plots	9,184
Gardens	Botanical garden of Almaty	103
	Apple gardens	230
	Gardens of the state farm (sovkhoz) «Alatau»	247
City parks and groves	Baum grove	154
	Park «Prezidentsky»	210
	Public green areas of “Zelenstroy”	77

	Dendropark «XXI century»	73
	Central park of culture and rest	43
	Park named by Seyfulin	11
	Park named by 28 Panfilovits	18
	Children's Park	3.8
	Other city's parks	27
Intra- and inter-districts green spaces	Intra-districts green spaces	22,117
	Alleys, squares, small parks	103
Ancient cemeteries	Saka necropolis of Boralday	141
	Cemetery	108
	Ancient cemetery	11
Water reservoirs	Lake Sayran	49
	Small lakes	1,270

Source: Department of architecture ...; own research

Ecological functions of the green plants

- 22 The analysis of the spatial distribution of the elements of city's green areas was undertaken by using the ArcGIS program and satellite images (figure 5). Additionally, data on air pollution and soil contamination within city's boundaries allowed identifying areas with the highest pressure. The highest concentration of atmospheric air contaminants (dust, oxides of nitrogen and carbon, sulphur dioxide) is regularly registered in Alatau, Zhetysu and Turksib districts; the highest content of heavy metals in soils are present in the central districts, such as Almaly and Zhetysu (National Report, 2017).

Figure 5. Elements of ecological framework of Almaty city.

- 23 The ability of the tree species prevalent in the structure of city's greenspace to absorb pollutions was also analyzed. Composition of tree-species in Almaty is very diverse and varies by administrative districts: number of species ranges from 47 in Nauryzbai district to 72 in Medeu. According to the inventory data, received from the communal company "EcologStroy", there are 94 plants species, which belong to 26 families, on the territory of Almaty. The elm family (*Ulmus*), which accounts for 42% of the total number of tree and shrub plantings, is prevailing and includes such species as *Ulmus pumila* and *Ulmus glabra*. The share of conifers is only 5% of the total area of city's green spaces: they are basically located in mountain areas, and in recreational zones of the city.
- 24 The most resistant plant species to dust contamination available in the study area are: *Lombardy poplar* and *Birch ordinary* (able to absorb more than 100 kg of dust per year), while the elm tree absorbs about 20 kg of dust per year (Zherebtsova, Pokalov, 1988). With regard to other emissions, the local species are almost equally susceptible to absorb hazardous gases such as oxides of nitrogen. Providing of ecological services depends, first of all, on sufficient density and good condition of green spaces. In general, the distribution of green spaces on the territory of the city, and their diversity within each location is determined by the functional zoning of the city.

Green areas in functional zoning of Almaty city

- 25 Spatial structure of functional zoning of Almaty city (table 4) represents the distribution of land use types and the level of human pressure in the city area.

Table 4. Functional zones of Almaty and their distribution in the city area.

Functional zones	Total area, ha	City's districts	Objects types
Residential	12640.72	Alatau, Turksib, Auezov, Medeu (northern part)	Residential areas, with buildings of different heights
Public and business	3210.24	Almaly, Auezov, Bostandyk	Educational institutions, cultural and sporting centers, hospitals, shopping centers etc.
Industrial	2497.07	Zhetysu, Turksib	Industrial enterprises with their surrounding areas
Recreational	4159.18	Bostandyk, Medeu, Nauryzbai	Green spaces, natural protected areas, water reservoirs etc.
Transport and engineering infrastructure	5402.34	Evenly on the city area, excluding natural protected areas	Transport communications (highways, train and buses stations, etc.)
Agriculture and forestry	3373.16	Alatau, Turksib	Forestry plantations, greenhouses
Special use	659.50	Alatau, Zhetysu, Turksib	Waste polygons, sedimentation tanks, etc.
Unused area	479.33	Fragmented small areas	Disturbed areas requiring reclamation

Source: Department of architecture..., <http://almaty.genplan.kz>

Figure 6. Residential area in modern Almaty.

Official web-site ...

- 26 The level of pressure is quite high in Zhetysu and Turksib districts, and the lowest pressure is in Bostandyk and Medeu districts. The last ones – Bostandyk and Medeu districts – are characterised by the largest areas of green spaces, which form the basis of the urban ecological framework: the recreation zone includes a wide range of natural areas, such as forests, parks, gardens, water bodies, etc. The specially protected natural areas, as well as territories of sanatoria and health resorts, are also belonging to this zone. Thus, from North to South, the area of green spaces and protected natural areas increases significantly. The share of industrial enterprises and human pressures reduces in the same way, and inversely the ecological situation gradually improves. Taking into account the absorptive capacity of the most common tree-species to the most significant pollutants in the urban environment, as well as the square areas of the green framework in every district and per capita, the most sustainable and the most vulnerable parts of the city's green space were defined (figure 7).

Figure 7. Green spaces area per capita within Almaty city.

- 27 The highest resistance to human pressures provides green spaces in Medeu and Nauryzbai districts of Almaty city, located on the foothills of the Tien Shan. The least stable are Alatau and Zhetyysay districts, which green spaces were deeply transformed during post-soviet time and does not meet the current load level.

Conclusion

- 28 The analysis of the green space's actual structure is an important task to evaluate its effectiveness and to plan its further development. Planning structure of post-socialist cities plays an essential role in shaping the living space for the modern and future generations. Transformation of the city's greenspace during post-socialist period had often opposite consequences (both positive and negative) for its spatial integrity and ecological capacity.
- 29 The analysis of the green spaces network in a number of districts of Almaty city shows that it was deeply transformed during the post-soviet time and does not meet the current load level. At the same time, the structure of the green spaces of the city demonstrates high level of inertness: the greatest safety is noted in the part of green spaces protected by the status of especially protected natural areas at the Bostandyk, Medeu, Nauryzbai districts, and the lowest in the green spaces in the districts with highest human pressure (Zhetyysay and Turksib districts), where the green network is quite weak to perform its ecological functions.
- 30 Thus, our research has allowed to highlight the main features of the Almaty city's green space and to suggest recommendations on its further studying. In order to mitigate the risks of urbanization with attention to ecological services of natural landscapes, as well as planning aspects of the urban area development, a number of measures to improve

the environmental situation and the quality of life of the city's population can be proposed. The most resistant to anthropogenic pollution tree species, such as canadian poplar and silver maple can be recommended for the industrial zones of Zhetysu, Turksib and Alatau districts, as well as along the busiest highways of Almaty city. The expansion of areas occupied by conifers can be also considered among the priorities for optimizing the greenspace structure all over the territory of Almaty. The set of ecological functions of green spaces, such as resistance to anthropogenic pollution and ability to absorb contaminations, together with the assessment of anthropogenic pressure, create a sufficient basis for recommendations on green space structure improvement. Connecting planning decisions with ecological dimension of quality of life can create a strong basis for sustainable development of the city of Almaty.

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ABSTRACTS

Green spaces play a crucial role in improving the state of the urban environment and the living standards of cities' populations. The spatial aspects of the urban green spaces in the post-socialist cities are a point of special interest due to their specific settlement structures and historical heritage. The study of the green spaces design was undertaken for Almaty city, the former capital of the Republic of Kazakhstan. The city is divided into 8 districts, functionally and environmentally different. The optimization of the green space's structure may contribute to the improvement of the environmental situation and the quality of life for the local population. The research has allowed to highlight the main features of the Almaty city's green space, with a special attention to its ecological functions and the planning aspects.

Les espaces verts jouent un rôle crucial pour l'amélioration de l'état de l'environnement urbain et la qualité de vie des populations. Les aspects spatiaux relatifs aux espaces verts urbains dans les villes post-socialistes sont d'un intérêt particulier en raison des structures de peuplement spécifiques et du patrimoine historique de celles-ci. L'étude des espaces verts et de leur conception présentée ici a été menée dans le cas d'Almaty, ancienne capitale de la République du Kazakhstan. La ville est divisée en 8 districts, différents en termes de fonctionnalité et de situation environnementale. L'optimisation de la structure des espaces verts pourrait contribuer à améliorer la situation environnementale et la qualité de vie de la population locale. La recherche a mis en évidence les principales caractéristiques des espaces verts d'Almaty, avec une attention spéciale portée à leurs fonctions écologiques et aux aspects liés à la planification.

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Keywords: green spaces, post-soviet cities, spatial distribution, Almaty city, Kazakhstan

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