

# Urban ecological framework as an optimal mechanism for managing the development of urban areas

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**Abstract.** The urban ecological framework is the systematisation of several frameworks in the city and beyond, connected with each other by actual bonds. However, they are often torn apart and not joined in urban planning documents and rules. This especially affected the Soviet and post-Soviet school of planning, both in theory and in practice. Having a rich knowledge base in practical and scientific fields, there are systemic inconsistencies in regulatory documents. This seriously impacts on the design and implementation results. Strong negative consequences of not being connected into a single mechanism of urban-ecological frameworks are revealed during the operation of finished objects. All this leads to an increase in costs in the long run. All these factors add up to negative consequences for human health and together result in economic losses and costs. The outcomes summed up by economists and doctors only fix the actual state, but medical and economic theory does not have methods for changing the situation in cities seriously. This requires an alliance with the methods of planning and development of urban and adjacent territories, as well as making changes to the regulatory and legal documents of cities.

**Key words:** Urban ecological framework; Hygiene; City microclimate and engineering; Residents' health; Urban planning norms and rules.

## 1 Introduction

Today, the concept of an urban ecological framework has not been defined in Russian urban planning. There are definitions in the field of geography that have a peripheral meaning of this concept, as soon as natural, recreational zones that are not part of the urban system. "understood in it as a set of undeveloped and unsealed (i.e., not covered with artificial materials: concrete, asphalt, etc.) territories with vegetation providing ecosystem services." [1]. However, the author rightly states the fact of the divergence of the fields of science, which are partly the reasons for the current state of affairs in the urban science of Russia. "There are few works in the Russian scientific literature that consider the scientific foundations of mutual conjugation of protected areas that form the basis of the country's EC and a system of complex cities' EC. This may be due to the different "departmental". The

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data was collected from open sources. All methodological solutions were tested within the framework of the practical activities of the KazGrazhdanProekt Institute by the team of the creative group at the Kazan City Hall. Where the author of the article was the manager and chief architect from 2012-2016 and from 2018-2023.

While in the European theory the concept of urban-ecological frame or water-green frame is interpreted much more broadly than the criteria of permeability and development. And it includes concepts from related areas of sociology, engineering, road principles, light-evening and others. “However, previous studies have not considered the joint equilibrium of the supply of ecosystem services (ES) and the relationship with social systems [2].

The author proposes an approach at the intersection of ecology and urban planning - the principle of linking the environmental value of natural objects with urban development objectives while maintaining the social objectives of the modern urban environment. Composition and functioning. It is necessary to consider the problem of ecology in cities from the perspective of architecture, it is obvious that the main reasons for the imbalance lie in the violation of the sequence of urban planning methods, namely, in the ability to create a holistic environment, with the interaction of all its constituent elements.

In ancient times, such a ratio of parts and the whole was defined by the scientific term “harmony” (ἁρμονία – connection, harmony, harmony). This academic concept included the functional qualities of the system, its viability and balance. Today, the popular term “sustainable development” also implies a holistic, evolving environment [3, 4].

In modern conditions, the most viable and reasonable model that reduces the ecological burden and anthropogenic footprint is the model of organization of the territory “Urban-ecological framework” (UEC).

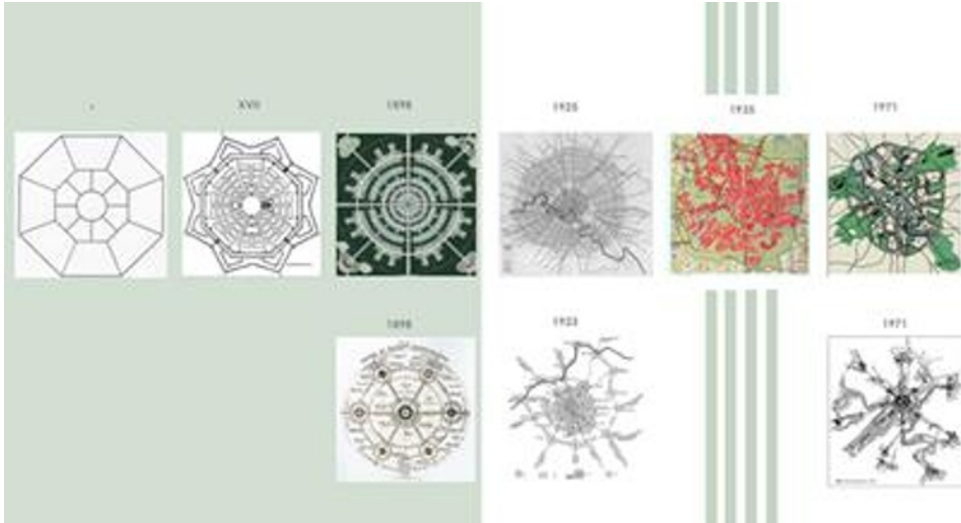
The fundamental methodology and principles of sustainability, i.e. vitality, urban environment formed Mark Vitruvius Pollio. Thanks to Vitruvius, methods of complex study of the territory appeared in the tools of designers, which determine the potential for comfort and prospects for construction, including: climatic conditions, geography, geology of the area, the position of stars and planets. In domestic architecture, Semenov made a significant contribution to the implementation of environmental principles of urban planning.

The underlying principle of the green frame was its integrity. Thanks to the work carried out by the All-Russian GIPROGor under the leadership of Semenov, the urban systems of Moscow, Ekaterinburg, Omsk, Volgograd, Novosibirsk, Nizhny Novgorod, Kazan, Yerevan developed as frames, with the ability to preserve the natural and anthropogenic balance. In each of the master plans of the cities, a development strategy was laid down, including forecasting the horizon, which, for many reasons, was not lucky enough to come true [5]. The degradation of natural and socio-cultural systems has led to detectable problems of urbanization: criminality, the destruction of families, social aggression, loss of health, etc., that is, to chaos and degradation [6].

The need for a detailed analysis of the prerequisites and primordial criteria for comfort for a person in the cross-section of epochs is an obvious fact. Having an exhaustive list of criteria for human needs, we can predict future trends in the development of cities through the environmental safety of residents. However, it is important to move away from general theoretical recommendations, and offer real steps towards the implementation of the theory of an eco-friendly city.

The main characteristics of the urban environment, which has a beneficial effect on the health of each person and the well-being of the state as a whole, have been the subject of research by architects and philosophers since ancient times. Analyzing the process of formation of urban-natural models of the urban environment, the dynamics of the development of the foundations of the urban-ecological framework is observed. The study of the elements of the city frame, which have been implemented and shown to be effective over

the centuries of the practice of urban construction, allows us to identify effective mechanisms, methods and tools of urban planning.



**Fig. 1.** Evolution of the urban ecological framework system.

Based on academic approaches to design, it is possible to optimize and digitalize methods by integrating the achievements of previous generations of architects with the latest technologies for working with information: 1. In 1 in the basic principles of organizing a balanced, healthy environment are formulated. 2. The 16th century the Renaissance brought social values to urban development. A social and cultural layer appeared in the model of the urban-natural framework. 3. The 17th century French architects created the Theory of the City, which became the prototype of a strategic approach to the development of territories. The democratic principles of town formation are formulated. 4. The 20th century. the city becomes an instrument of social development. “Garden City” is becoming a model for organizing a sustainable environment for spatial development. The urban area and residents become beneficiaries and actors in the development of the urban environment. 5. Development of the principles of a balanced, harmonious organization in the general plans of 1918-1930. 6. Formation of a frame urban-ecological system of cities in the USSR. Structuring of the water-green urban-ecological model of the organization of the urban environment [7].

The population of the United States of America is currently experiencing increased illness from dispersed and synergistic causes. Many of the acute insults of the past have receded due to centralized health care and regulatory action. However, chronic ailments including asthma and allergies, animal-transmitted diseases, obesity, diabetes, heart disease, and depression are on the rise. These diverse illnesses join with forest fragmentation, stream degradation, wetlands destruction, and the concomitant loss of native species to suggest detrimental contributions from the built environment [8].

## 2 Materials and methods

The methodology described in the article is based on practical solutions for the integration of theoretical, scientific, practical knowledge. Models were made based on practical developments in interconnecting the regulatory framework, theoretical knowledge and

conclusions from related areas involved in the development of urban areas on the example of building a balanced model of a water-green or urban-ecological urban frame of the city of Kazan. The article presents developments in the systematization and typology of natural and urban areas. The problems due to which there is a loss of ecology in the city are analyzed. Developments and mechanisms for solving these difficulties are proposed. Theoretical definitions and substantiations of the methodology are formulated.

The object of the study was the city of Kazan, the Republic of Tatarstan in the Russian Federation with a population of more than 1 million 200 thousand people. The study was based on the idea of the urban-ecological framework of the city as a set of recreational-natural and engineering-technological territories located in remote areas of the city and retaining its environmental criteria, as well as heavily urbanized areas near or inside built-up areas. Also, sections of the city were studied for the development of construction and engineering infrastructure for analysis and conclusions on the value and formulation of recommendations for the conservation of natural and ecological sites in the development zone. The most important part of the urban-ecological framework in this vein is territories with old vegetation or wetlands. Data on land ownership and intentions was obtained from open sources [8].

Data on urban area statistics, crop area, population and plantings were taken from the Rosstat database. Regional cadastres became the source of data on the quality and characteristics of urban specially protected natural areas, as well as areas [7].

The article is widely distributed and protected by data on research experience in the development of natural resources and all the problems associated with their conservation and distribution. This article uses the main practical principles and approaches formed over 10 years of practical research, analysis of urban planning documents, norms, rules, research, archival data on the territory of the city of Kazan in the Republic of Tatarstan of the Russian Federation.

As well as in the review of the research review, methods for creating a natural-recreational frame of the city. In the process of practical and theoretical developments, the concept of building an urban-ecological framework of the city was built: Such as: health, climatology, engineering sciences, sociology, culture, hydrology, geology and ecology. 2. The main criteria for building such a model in this hypothesis are: 1. Optimization and implementation of new knowledge. The introduction of new knowledge from other sciences is carried out using various methods aimed at development. 2. It will simplify the processes of task formation, and hence the design of objects. 3. Will lead to the protection and conservation of environmental objects. 4. Eliminate the proposed restoration and creation of new natural recreational facilities. 5. Create process synchronization between federations and speed up implementation processes. 6. The result will be an overall improvement in the ecological balance of the urban environment. 6. Will lead to an increase in the attractiveness of the city for tourists and expats. 7. Strengthen the attractiveness for the construction and development industry. 8. Reduces the load on the medical cluster. 9. The consequences of all actions will result in the amount of tax base receipts.

Examples of the implementation of the methodology of the urban-ecological framework is the project of reorganization of the Russian-German Switzerland in Kazan the prehistory of the project for the revitalization and organization of protected areas on the territory of the region – Russian-German Switzerland. Urban planning decisions were made without taking into account natural scientific aspects; the value of the swampy and flooded territories of Kazan was not fully explored and obvious until the last decade. During its long history, the area was a “resort” suburban area, later the land turned into agricultural use, was depleted and abandoned. And by the end of the 20th century the bio-system regenerated, representing a unique type of forest and wetland.

The urban-ecological framework model has become a technique that allows architects to respond to social demand. Creative cooperation and direct participation in international

activities allowed the architectural group of the Kazan City Hall under the leadership of Tolovenkova to test hypotheses on this site empirically and adapt them to specific conditions [7, 8].

In the complex world of the environment, climate parameters, vegetation, surfaces and structures constantly interact with each other. Because of the interdependencies that arise, these elements cannot be considered in isolation or analyzed independently of each other. To adequately model a healthy environment, it is vital to integrate all interacting elements into one system [9].

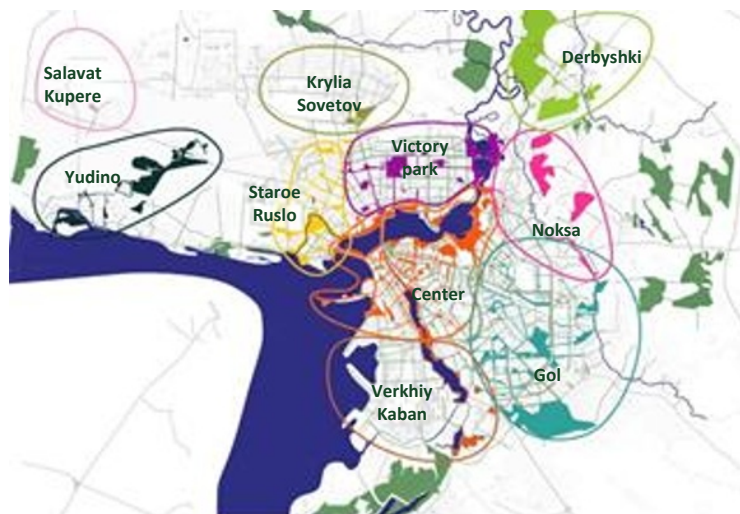
Ecophilosophy is considered as a new direction of philosophy, formed on at the intersection of such sciences as biology, genetics, sociology, ecology, etc. Modern approaches to identifying the essential characteristics of the interaction between man and nature are analyzed. Particular attention is paid to the worldview approach in the study of this issue. As the main conclusion, the thesis about the need to abandon the use of discrete approaches in the study of the interaction of society and the surrounding world, the formation of a new paradigm for the development of modern society is substantiated [10].

The problems of urban ecology, with a proper methodological approach, can become the key to solving the problem of serious theoretical issues of a general biological nature [2, 11].

It is important to take into account that the sanitary and hygienic comfort of the urban environment is the main criterion for its assessment [12]. To make urban life comfortable, it is necessary to give nature more freedom. Conservation is a connection with nature, which is characterized by the possibility of contact between man and natural space. This connection can be direct: physical, visual, psychological. Its quality is ensured, first of all, by the preservation of natural spaces, as well as the organization of the environment. Nature and even man himself are gradually being forced out of the city by technology, communications, equipment, and buildings. Physical pollution causes deterioration of the sanitary and hygienic state of the environment. Visual, acoustic and energy-informational – negatively affect the mental and social well-being of the population, cause stress. Psychological comfort is valued by a person above physical. In today's urbanized environment, the boundaries of personal space are shrinking. The study of ways of greening urban spaces is an essential aspect of improving the quality of the living environment [13, 14].

The problems of the 1st stage of the formation and implementation of the Urban Ecological Framework in cities originate in the absence of common scientific terms and definitions.

Absence: 1 The all-Russian standard and requirements for the parameters of all elements of the Urban Ecological Framework. 2. Methods of urban planning and legal mechanisms for assessing the environmental value of natural and recreational needs of urban public facilities. 3. Methodology and urban planning legal mechanisms for the conservation of valuable natural areas that do not have a protected status (SPNA and other reserves). 4. Legal mechanisms for substantiating the requirements for the creation of new elements of the SEC (parks, squares and boulevards, especially with the integrated development of the territory). Large nuclei and bonds. 5. Town-planning and legal mechanisms for the preservation of municipal landscaped areas necessary for the creation of an urban-ecological framework. Large nuclei and bonds. 6. Lack of detailed methods, standards for the design of all elements of the urban-ecological framework. A huge list of regulatory data for various industries leads to chaos in the design of urban elements (roads, parks, social infrastructure, etc.).



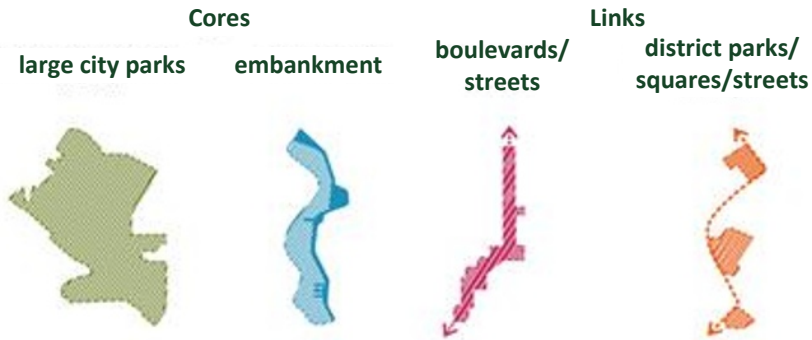
**Fig. 2.** Creation of a typology of recreational and public spaces based on ecological and recreational value. Development of a unified classification of urban spaces for the creation of the urban-ecological framework of Kazan.

A single system consists of natural and nature-like elements. They are subdivided into legal regulations in Russia. according to the author, the composition of the green frame in the structure of the urban-ecological frame should consist of: Natural elements of nuclei and connections.

The nuclei are divided into: 1st order: key natural areas. 2nd orders: environment-forming natural and green areas. 3rd order: microclimatic comfort cells  
Ecological corridors are subdivided into: Main: 1st and 2nd order. Additional corridors are divided into: urbanized and fragmented [15].

"Problems of organizing a system of green spaces in cities, issues of designing and building parks, gardens, squares, boulevards, public recreation areas, as well as landscaping residential areas and microdistricts, territories of public institutions, industrial enterprises. Much attention is paid to the analysis of the role of green spaces and the formation of an external environment The problem of green building is covered comprehensively, taking into account modern architectural, engineering, hygienic and economic" [16].

By type of use, they are divided into: Territories of objects of environmental regulation: Green areas for general use, Green areas for limited use, Green areas for special purposes. Categories are subdivided into: Specially Protected Natural Territories of Federal Importance, Specially Protected Natural Territories of Regional Importance, Specially Protected Natural Territories of Municipal Importance, Multifunctional parks, Specialized parks, Gardens, Squares, Linear parks, Embankments, Boulevards. The views are divided into: Cultural Park, Historical Park, Swamp Park, Garden, Rain Garden, Square, Mini Square, Embankment, Embankment, Boulevards, Alleys, etc. The cores of the 1st and 2nd levels in the structure of hydro power plants should have an indivisible contour, close to the ring. If there is a reasonable need for dividing the contour, ecoducts are arranged between the separable parts of the core in accordance with GOST R 58947-2020, Fig. 3 [2, 3, 8, 17].



**Fig. 3.** Typology of cores and connections of the city in the system of urban ecological framework. cores (large city parks and embankments), communications (boulevards and streets, district parks and squares and streets).

Whilst urban-dwelling individuals who seek out parks and gardens appear to intuitively understand the personal health and well-being benefits arising from 'contact with nature', public health strategies are yet to maximize the untapped resource nature provides, including the benefits of nature contact as an upstream health promotion intervention for populations. [8, 18]. When calculating the availability of green spaces, green areas of limited use, special purpose and untyped natural objects are not taken into account, however, they should be taken into account as structural elements of the Urban Ecological Framework for ecosystem services.

The cores of the 1st and 2nd levels in the structure of the Urban Ecological Framework should have an indivisible contour close to the annular. Kernels of all levels in the absence of rationing in terms of the minimum area should be taken as 1.7 ha.

In Kazan and in Russia there is a problem-differences in regulatory standards. Inaccuracy of formulations and descriptions of parameters of each type leads to differences in the design of natural zones among specialist designers. Even bigger confusion has the place to be in administrative circles of cities. Different documents determine different criteria and parameters of natural zones depending on accessories [7, 8, 19].

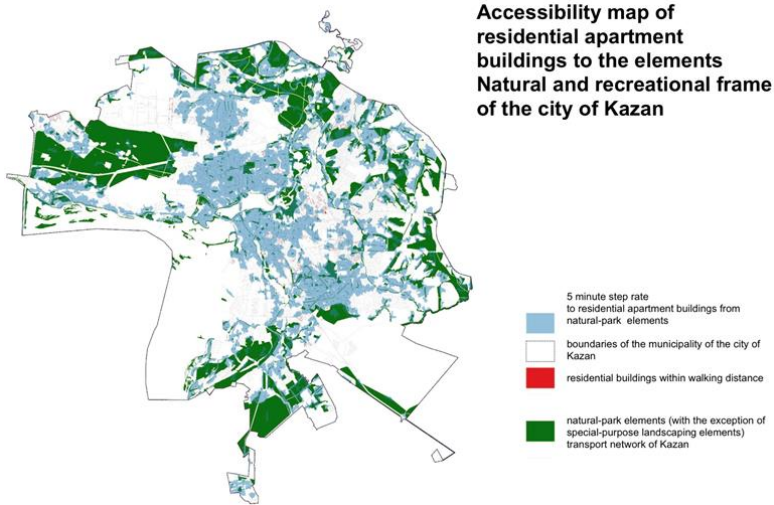
The size of the park in the city is strategic and tactically important. Therefore, it is so important to adopt unified area standards for each type of green area. This will lead urban planning technologies to understand the value of preserving natural areas. Large Chinese studies confirm this thesis.

	A rain garden is a landscaped area occupied by appropriate landscaping elements, water disposal and water purification systems (according to SP 82.13330.2016): rain gardens, infiltration reservoirs and bio-drainage ditches, which performs the function of reducing the load on the storm sewer system	Connection	Not standardized	Not standardized	Not standardized	
<b>Cemetery</b> - (according to GOST R 53107-2008) a funeral facility intended for the burial of the remains and ashes of the dead or dead.	Current cemetery	Level 2 core	Not standardized	Not standardized	Not standardized	
	historical cemetery	Level 2 core	Not standardized	Not standardized	Not standardized	
<b>Nursery</b> - a territory and a farm located on it, specializing in the cultivation and breeding of plants, as well as an experimental site on which they are studied.	Nursery of ornamental crops	Level 2 core	80	Not standardized	Not standardized	
	Flower and greenhouse farm	Level 2 core	80	Not standardized	Not standardized	
	fruit nursery	Level 2 core	80	Not standardized	Not standardized	
<b>Industrial horticulture</b>	Orchard - (according to GOST R 53044-2008) a plantation of a fruit crop cultivated in order to obtain fruits for fresh and processed consumption or for harvesting the reproductive organs of a fruit plant.	Level 2 core	Not standardized	Not standardized	Not standardized	
	Berry - (according to GOST R 53044-2008) a plantation of a berry crop cultivated in order to obtain berries for consumption in fresh and processed form or for harvesting the reproductive organs of a berry plant.	Level 2 core	Not standardized	Not standardized	Not standardized	
<b>Botanical Garden</b> - (according to GOST 28329-89) a green area for special purposes, which houses a collection of woody, shrubby and herbaceous plants for research and educational purposes	Botanical Garden	Level 2 core	Not standardized	Not standardized	Not standardized	
	Dendrological garden - (according to GOST 28329-89) part of the botanical garden or an independent object, where a collection of only woody and shrubby plants is exhibited	Level 2 core	Not standardized	Not standardized	Not standardized	
<b>Zoo</b> - (according to GOST R 57013-2016) a permanently operating and open to visitors organization containing a zoological collection on a stationary	Zoo	Level 2 core	Not standardized	Not standardized	Not standardized	
territory, including wild animals, contributing to the conservation of animal species through education, collection and dissemination of information about animals, recreation and research.						
<b>Untyped (Natural-anthropogenic)</b>	<b>Natural-anthropogenic object</b> - (According to the Federal Law of January 10, 2002 N 7-FZ (as amended on July 14, 2022) a natural object modified as a result of economic and other activities, and (or) an object created by a person, possessing the properties of a natural object and having recreational and protective value;	Natural park - (according to N 33-FZ of March 14, 1995 (as amended on June 28, 2022) specially protected natural territories of regional significance, within the boundaries of which zones are distinguished that have ecological, cultural or recreational purposes, and, accordingly, prohibitions and restrictions on economic and other activities	Level 1 Core	Not standardized	Not standardized	in accordance with the regulation on the Specially Protected Natural Territory
	<b>Untyped (Natural)</b>	<b>Natural object</b> - (According to the Federal Law of 01/10/2002 N 7-FZ (as amended on 07/14/2022) natural ecological system, natural landscape and their constituent elements that have retained their natural properties;	Wetlands (WBU) (Non-categorical PPH)	Level 1 Core	Not standardized	Not standardized
	Natural object not related to wetlands (Non-categorical PPH)	Level 1 Core	Not standardized	Not standardized	Not standardized	

**Fig. 4.** Typologies and parametric characteristics of recreational objects of the city.

Large Chinese studies confirm this thesis. “We analyzed data from 3544 Chinese men and women (aged  $\geq 65$  years at baseline) in a community-based cohort study. The initial indicators established from the death register were death from all causes, diseases of the respiratory system, diseases of the circulatory system. The amount of green space (%) within a 300 m radius buffer was calculated for each feature based on a map generated from a normalized vegetation difference index. Proportional hazard models adjusted for demographics, socioeconomic factors, lifestyle, health status, and housing type were used to estimate HR and 95% CI. The effect of green space on all-cause mortality and cardiovascular disease tended to be stronger in women than in men. Greater green space coverage has been associated with a reduced risk of all-cause mortality, cardiovascular disease mortality, and stroke mortality in older people in China living in a highly urbanized city [20, 21, 22, 42].





**Fig. 5.** 15 minutes on foot, taking into account all obstacles (fences, roads, terrain) accessibility map taking into account the terrain, fences, roads and other restrictions. For this analysis, all elements of the natural and recreational complex, displayed in the master plan of the city of Kazan in 2020, were used. A centroid was selected from each of these elements and 5-minute isochrones were calculated from it. The relief and obstacles within the existing building of the city are taken into account. With the help of the program Q-gis. Calculation of 5-minute availability through the Valhalla plugin.

This study investigates whether the presence of green space can attenuate negative health impacts of stressful life events. Individual-level data on health and socio-demographic characteristics were drawn from a representative two-stage sample of 4,529 Dutch respondents to the second Dutch National Survey of General Practice (DNSGP-2), conducted in 2000-2002. Health measures included: (1) the number of health complaints in the last 14 days; (2) perceived mental health (measured by the GHQ-12); and (3) a single item measure of perceived general health ranging from 'excellent' to 'poor'. Percentages of green space in a 1-km and 3-km radius around the home were derived from the 2001 National Land cover Classification database (LGN4). Data were analysed using multilevel regression analysis, with GP practices as the group-level units. All analyses were controlled for age, gender, income, education level, and level of urbanity. The results show that the relationships of stressful life events with number of health complaints and perceived general health were significantly moderated by amount of green space in a 3-km radius. Respondents with a high amount of green space in a 3-km radius were less affected by experiencing a stressful life event than respondents with a low amount of green space in this radius. The same pattern was observed for perceived mental health, although it was marginally significant. The moderating effects of green space were found only for green space within 3 km, and not for green space within 1 km of residents' homes, presumably because the 3-km indicator is more affected by the presence of larger areas of green space, that are supposed to sustain deeper forms of restoration. These results support the notion that green space can provide a buffer against the negative health impact of stressful life events [21, 22, 23, 24].

The Covid-19 pandemic has had a negative impact on the mental health and well-being of citizens [25, 26]. Accessibility expressed in minutes is the most important factor in the fight against any respiratory and infectious diseases, no more important what a beautiful park there is in the city, if it is more than minutes walk would from home. In other words, an expensive and fashionable park with many functions and services in the city center is much less important for a particular resident than the trees in front of the window. Therefore, it is so important not only to organize and preserve the nuclei and connections of recreational and

natural spaces. But also to organize urban normative means of protecting these territories from infill development. This decision was applied in Kazan. Intra-block pedestrian-recreation zones were identified and fixed with the status of "zero development".

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**Fig. 6.** Map of intra-block pedestrian zones with zero building percentage. Prohibit building on the natural type of recreational spaces.

The proximity of natural recreational facilities to housing is confirmed by analytics on the health of children and adolescents. In Denmark, patterns of children's psychological illnesses and ecological zones were revealed. The risk of subsequent mental illness in those who lived with the lowest levels of green space as children was 55% higher for various disorders compared to those who lived with the highest level of green space. The relationship remained even after adjusting for urbanization, socioeconomic factors, parental mental illness history, and parental age. The stronger association of cumulative green space presence in childhood compared to single year green space presence suggests that presence throughout childhood is important. Our results show that green space in childhood is associated with improved mental health, supporting efforts to better integrate the natural environment into urban planning and children's lives [28-30].

Economic calculations also testify in favor of the preservation and expansion of natural recreational zones with new development. Economic benefits generated by green urban infrastructure across different sources. Creation of green zones in projects is a new trend in elite and mass construction. Where there are no parks and green areas, developers create them themselves. In Saint Petersburg, the cost of landscaping a yard can be 3-5 thousand rubles per 1 m<sup>2</sup> in the mass segment and 7-15 thousand rubles in the business class. On average, 3-5% of the total cost of construction is allocated for the improvement and landscaping of the territory of a residential complex. These costs are built into the financial model of the project and reviewed by the banks. The cost of housing in objects located near parks and squares is 25-35% higher than the prices for analogues without green areas. The price of an apartment overlooking the greenery of the parks is 10-15% higher compared to other apartments. In the city center, Pushkin, Pavlovsk or Sestroretsk, walking distance to the park can increase the cost of housing by 20-30%. Moscow has a +20% rule for popular parks. The article shows the algorithm of the valuation of ecosystem services of city parks, which allows substantiating urban planning decisions and determining the damage from their destruction; the value of the main types of urban ecosystems in Moscow is given as an example [31-38].

Here are some examples: In the Netherlands, a study was conducted that found an association between proximity to green areas and the incidence of disease. The lowest rates in terms of the number of reported cases of diseases, and especially the syndrome of anxiety and depression, were in those areas that are located within 1 km from green spaces [26,27].

American researchers have proven that physical and visual contact with green spaces is a living key to health. Greenery elements must necessarily be introduced into relatively dense urban areas, including public buildings and open areas, since urban design has a strong impact on the health and well-being of the population [34, 40].

Today, three-quarters of Russia's inhabitants live in cities. At the same time, the life of 85% of them does not meet elementary environmental standards. Hence, the average life expectancy in the Russian Federation is only 70.5 years, which is 13 years less than in Singapore, one of the leading countries in the field of urban environmental infrastructure.

For many years, the attention of hygienists has been drawn to the rationing of the total area of green spaces per inhabitant. The opinions of scientists regarding the establishment of the norm differ significantly and range from 18 to 67 m<sup>2</sup> of green spaces per 1 inhabitant. In general, the average total value of plantations of common use per person varies depending on the category of the settlement. For the largest, large and large cities, it should be 16 m<sup>2</sup>, for medium-sized cities – 13 m<sup>2</sup>, for small towns – 8-10 m<sup>2</sup>, for rural settlements – 12 m<sup>2</sup>. In the present, the norms of landscaping have decreased qualitatively and quantitatively, the load of the anthropogenic factor on the Green Fund of Cities has increased many times over. Greening norms for the residential area have been reduced, amounting to only 7 m<sup>2</sup> per person. At the same time, WHO recommends from 50 m<sup>2</sup>, and values less than 10 m<sup>2</sup> are critical for the health of citizens and in no way contribute to increasing the resilience of cities to climate change, rather, on the contrary, they increase negative effects [19, 29, 30-37, 41].

Materials of international organizations (WHO, WMO, EU, etc.) on the problems of assessing the impact of climate risks on the health of the urban population and action plans for adapting the system and other health authorities. The results of Russian studies on assessing the impact of heat and cold waves on the size of the population of megacities (Moscow, St. Petersburg) and other large cities are systematized, based on various climatic zones - in the Arctic, subarctic and southern territories, in conditions of a sharp continental and monsoonal climate. It is shown that heat waves in cities with a temperate continental climate lead to a significant increase in the increase in mortality from all causes than cold waves, compared with cities in other climatic zones [34].

At the same time, the need to change existing building norms to take into account ecosystem services became apparent. The key parameters here are compaction and expansion of the functionality in the emerging development, so that within the same area it is possible to receive the largest amount. The parameter of the greening norm per person is still important, moreover, taking into account the qualitative component [33, 34].

Greening norms – a certain amount of green space, “green islands” per one city resident, necessary to meet the needs in the field of recreation, as well as to improve the conditions of the residential area. Favorable conditions for living or staying of the population in the designated functional areas of the city are regulated by the Federal Law “On the sanitary and epidemiological well-being of the population” by combining them with a certain type of vegetation.

The Paris Agreement provides some motivational and cognitive roots for the denial of the crisis. The document ends with: a) a list of principles of ecological economics consistent with the analysis and; b) the minimum set of political actions required by the world community to achieve a more equitable sustainable economy and a stable population within the biocapacity.

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cost of housing in objects located near parks and squares is 25-35% higher than the prices for analogues without green areas. The price of an apartment overlooking the greenery of the parks is 10-15% higher compared to other apartments. In the city center, Pushkin, Pavlovsk or Sestroretsk, walking distance to the park can increase the cost of housing by 20-30%. In the city center, the cost of apartments overlooking green areas is at least 10% higher than the average price in a residential complex. On average, 3-5% of the total cost of construction is allocated for the improvement and landscaping of the territory of a residential complex. Moscow has a +20% rule for popular parks.

Here are some examples: In the Netherlands, a study was conducted that found an association between proximity to green areas and the incidence of disease. The lowest rates in terms of the number of reported cases of diseases, and especially the syndrome of anxiety and depression, were in those areas that are located within 1 km from green spaces [19, 35, 36].

American researchers have proven that physical and visual contact with green spaces is a living key to health. Greenery elements must necessarily be introduced into relatively dense urban areas, including public buildings and open areas, since urban design has a strong impact on the health and well-being of the population [37].

Today, three-quarters of Russia’s inhabitants live in cities. At the same time, the life of 85% of them does not meet elementary environmental standards. Hence, the average life expectancy in the Russian Federation is only 70.5 years, which is 13 years less than in Singapore, one of the leading countries in the field of urban environmental infrastructure.

At the same time, the need to change existing building norms to take into account ecosystem services became apparent. The key parameters here are compaction and expansion of the functionality in the emerging development, so that within the same area it is possible to receive the largest amount. The parameter of the greening norm per person is still important, moreover, taking into account the qualitative component [37-39].

Greening norms – a certain amount of green space, “green islands” per one city resident, necessary to meet the needs in the field of recreation, as well as to improve the conditions of the residential area. Favorable conditions for living or staying of the population in the designated functional areas of the city are regulated by the Federal Law “On the sanitary and epidemiological well-being of the population” by combining them with a certain type of vegetation.



**Fig. 7.** Calculation of the anthropogenic load on the territory with reference to the budget for implementation and operation (node of the city center, calculation of the cost of implementation for 2020).

It can be assumed that the cost of arranging and preserving natural recreational areas is much cheaper than the cost of the health of residents. The scheme shows the calculations of funds for implementation, taking into account the typology of the spaces themselves, according to the typologies given above in the text (Fig. 4).

Embankments 15 rubles sq.m., cores 13-15 rubles sq.m., historical squares, streets, squares 13 rubles per square meter, boulevards, streets 10 rubles per square meter, large yards 7-8 rubles sq.m., small yards 5 rubles sq.m.

### **3 Results**

Identification of historical and cultural prerequisites for the formation of urban-ecological framework in cities is the basis in the methodology for constructing modern urban development areas. It is the understanding of historical background that provides the key to solving contemporary environmental problems in cities, while cultural codes are guiding vectors for different cities and towns while maintaining uniqueness and identity.

The theoretical principles of urban-ecological frameworks proposed by the author reflect the most complete list of modern decision-making criteria in the development of urban areas. The text describes the causes and existing problems that arise when these principles are not taken into account.

A methodology for the typology of urban areas is proposed, taking into account theoretical knowledge and concepts from the field of ecology, geography, economics, health care, climatology, and transport and engineering planning. A research methodology has been developed and a mechanism for regulating pedestrian accessibility through recreational areas in the city has been proposed. The scientific novelty of the methodology lies in linking scientific knowledge that contradicts each other in practice with implemented examples. Also, for the first time, the cost of implementation was calculated depending on the typology. The criteria and parameters of the typology are formulated, with reference to the recommendations for the design and content of each of the types. The data of the impact on the economy and health of residents, the creation of an urban-ecological framework in cities, are presented.

Such a symbiosis of theoretical knowledge is not reflected in existing models for building ecological or natural frameworks in cities. The understanding of historical and cultural prerequisites for the formation of urban-ecological framework in cities is the basis in the methodology for constructing modern urban development areas. It is the understanding of historical background that provides the key to solving contemporary environmental problems in cities, while cultural codes are guiding vectors for different cities and towns while maintaining uniqueness and identity.

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Such a symbiosis of theoretical knowledge is not reflected in existing models for building ecological or natural frameworks in cities.

## 4 Conclusion

The development of historical experience and the development of fundamental principles for the organization of complex systems have led modern architects to formulate and implement the “urban-ecological framework” model. It was the “natural selection” of effective methods that led to the formation of this urban planning model, which organizes a single social, engineering and biological environment.

And today it seems to be the most effective (ideal) model for organizing a modern city. Only carefully analyzed urban planning methods and analytics from doctors, economists, transport workers, developers can provide objective data on those aspects that do not work today in city government. The urban-ecological framework is the optimization and saving of efforts, money, time and the preservation of the health of the inhabitants.

Increase and uncontrolled development of cities leads to increase of heat and heat islands, so it is necessary to introduce additional criteria, indicators and assessment of resident health risk regulations and rules starting from the stage of location of development [28].

Zones at the level of city strategy, as well as should include heat island calculations when compacting buildings in existing urban area. It is necessary to introduce high indicators, norms and rules for assessing the risk to the health of residents associated with the stages of development location.

Therefore, the following studies will be devoted to narrow shifting scientific fields (climatology, engineering, transport, cultural, social, environmental) and identifying the coherence and consistent impact on the quality of the urban environment and the health of residents.

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