InterAcción y PerspectivA

Revista de Trabajo Social

ISSN 2244-808X
D.L. pp 201002Z43506

Enero-Junio 2023
Vol. 13 No. 1

Universidad del Zulia
Facultad de Ciencias Jurídicas y Políticas
Centro de Investigaciones en Trabajo Social

Interacción y Perspectiva
Revista de Trabajo Social
Vol. 13 Nº1 50-62 pp.
enero-junio

Dep. Legal pp 201002Z43506
ISSN 2244-808X

ARTÍCULO DE INVESTIGACIÓN

Enfoque ecológico urbano para la fundamentación de la ubicación de las instituciones educativas preescolares /DOI: 10.5281/zenodo.7382771

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Resumen

La evaluación ecológica urbana es una de las áreas prometedoras para la aplicación de soluciones de planificación urbana sólidas. El estudio se llevó a cabo con el fin de elaborar recomendaciones metodológicas para la ubicación óptima de los centros de enseñanza preescolar basadas en la evaluación ecológica urbana. Se ha establecido que el uso de la evaluación ecológica urbana en la ubicación de instituciones educativas preescolares permitirá identificar los territorios desfavorables y proporcionar un conjunto de medidas para eliminar los factores negativos. Se realizó una evaluación ecológica del estado del medio ambiente de Tiumén (Rusia) cuyo resultado demostró que el territorio de la parte central y sudoriental de la ciudad está sometido a efectos negativos. A partir de los datos obtenidos, se ha elaborado un mapa del concepto de emplazamiento ecológico urbano de los centros de enseñanza preescolar en el territorio de Tiumén. Como resultado del estudio, se propone prever la construcción de nuevos jardines de infancia basándose en los enfoques metodológicos de la fundamentación ecológica urbana de la ubicación de las instituciones educativas preescolares en una zona urbanizada. Se proponen directrices metodológicas para la justificación ecológica urbana de la ubicación de los centros de educación preescolar en una zona urbanizada y un mapa de apoyo informativo para el sistema de justificación ecológica urbana de la ubicación de los centros de educación preescolar. En conclusión, se puede decir que la evaluación ecológica urbana permitirá un enfoque más detallado y sistemático del diseño de las instituciones educativas preescolares.

Palabras clave: evaluación ecológica urbana, nivel de contaminación ambiental, índice de contaminación atmosférica, índice de contaminación total del suelo.

Abstract

Urban ecological approach in the substantiation of the placement of preschool educational institutions

Urban environmental assessment is one of the promising areas for the application of sound urban planning solutions. The study was conducted to develop methodological recommendations for the optimal placement of preschool educational institutions based on urban ecological assessment. It has been established that the use of urban ecological assessment in the placement of preschool educational institutions will allow for the identification of unfavorable territories and provide a set of measures to eliminate negative factors. An ecological assessment of the state of the environment of Tyumen (Russia) has been carried out. The assessment has demonstrated that the territory in

the central and southeastern parts of the city is subject to negative effects. Based on the data obtained, a map of the concept of the urban ecological placement of preschool educational institutions in the territory of Tyumen has been developed. According to the results of the urban ecological substantiation, an improvement project is provided for preschool institutions located in an unfavorable zone to eliminate the negative impact. As a result of the conducted study, it is proposed to provide for the construction of new kindergartens based on methodological approaches of the urban ecological substantiation of the placement of preschool educational institutions in a built-up area. Methodological guidelines for the urban ecological substantiation of the placement of preschool educational institutions in a built-up area and a map of information support for the system of urban ecological substantiation of the placement of preschool educational institutions have been developed. In conclusion, one can say that the urban environmental assessment will allow for a more detailed and systematic approach to the design of preschool educational institutions.

Keywords: urban ecological assessment, environmental pollution level, atmospheric pollution index, total soil pollution index.

Recibido: 01/10/2022 Aceptado: 25/11/2022

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1.- Introduction

At the present stage of urbanization, environmental pollution has a huge impact on the health of the population. Preschool children are the most vulnerable group in this respect. According to the results of many studies, it has been demonstrated that the pollution of the kindergarten territory has a strong impact on the health of children. In this regard, it is necessary to conduct an urban ecological assessment of territories when planning the placement of preschool educational institutions (PEI) to improve the socio-economic development of urban settlements.

The study object: PEIs of the city of Tyumen (Russia).

The study subject: methodological approaches to the urban ecological substantiation of the placement of educational institutions in built-up urban areas.

The purpose of the study was to develop methodological recommendations for the optimal placement of PEIs based on urban environmental assessment.

To date, the rapid development of urban areas is due to an increase in the population, in connection with which several problems arise affecting the socio-economic, environmental, and urban planning spheres of activity.

Modern challenges in the urban planning policy of large cities are closely related to the problem of optimizing public spaces, improving their quality, and providing

comfortable living conditions for the population (State Duma of the Federal Assembly of the Russian Federation, 2004; Mezhyan, 2021).

The assessment of the comfort and convenience of an urban or rural territory is made by its residents. Today, most rural residents move from the village to the district, and then to the city, and this proves that there are more amenities and prospects for life in the urban district (Bochkarev, 2019; Bespalov and Taran, 2020).

As a result of the increase in the urban population, specialists face an increasing need for urban development and planning, including the theory and practice of planning urban, rural, and other settlements, the formation, and development of social, transport, engineering, and technical infrastructure (Bochkarev, 2019; Danilina et al., 2019).

Under Article 1 of the Urban Planning Code (UPC) of the Russian Federation, urban development is understood as the development of territories, including cities and other settlements, carried out in the form of territorial development, urban zoning, territory planning, architectural and construction design, construction, capital repairs, reconstruction, demolition of capital construction facilities, operation of buildings and structures, and complex development of territories and their improvement (State Duma of the Federal Assembly of the Russian Federation, 2004).

When creating a sustainable urban environment, it is important not just to fill the territory with the necessary elements of landscaping, but to create a high-quality urban space equipped with social functions, comfortable to stay in, accessible to all population groups, and including a natural and recreational environment for residents (Danilina et al., 2019; Bespalov and Taran, 2020).

The formation of the social sphere in the urban environment has its characteristics, including the effectiveness and completeness of the implementation of social assistance, such as the possibility of consolidation of nomenclature units, their cooperation with other branches of the service sector, good transport accessibility of institutions, but at the same time, it comes with some problems with the environment and free territories for the placement of new institutions, etc. (Bochkarev, 2019; Ofitsialnyi sait administratsii, 2021).

Due to the growth of cities, as well as an increase in the population, the main goal of the socio-economic development of urban areas is to provide preschool children with places in PEIs that must meet urban planning-related and environmental requirements.

The design of newly constructed and reconstructed buildings for PEIs is carried out under the code of rules 252.1325800.2016 "Buildings of preschool educational organizations (PEO). Design rules". One of the main requirements for the placement of buildings is the radius of accessibility of services from the place of residence to the general type of PEO (Ministry of Construction, 2016a).

To date, the current problem of shortage of places in kindergartens, the introduction of a new regulatory framework and changed standards of education attract changes in the architecture of kindergartens (Bochkarev, 2019; Rekun, 2019).

The projects of kindergartens of the new generation meet the strictest requirements of safety, comfort, energy, and heat conservation and are harmoniously combined with the surrounding space (Rekun, 2019).

In modern conditions, when planning preschool institutions, the main attention should be paid to ensuring a high level of environmental safety (Bespalov and Taran, 2020).

In the course of modern scientific and technological progress taking place in the conditions of urbanization of regions, the pressure of anthropogenic factors on nature increases and leads to disruption of the ecological structures of the biosphere, which leads to degradation of the environment as a whole, depletion of resources, and as a consequence, damage to human health (Bochkarev, 2019).

In the conditions of unfavorable environmental conditions in cities, it is necessary to carry out appropriate measures. The main measure to reduce the negative impact on the environment is the green space expansion in urban areas.

To reduce the negative impact on PEIs, it is necessary to carry out outdoor landscaping of these territories.

One of the elements of outdoor landscaping is landscape gardening in the territory of preschool institutions. Plants can have a direct effect on physiological processes due to phytoncide secretion, i. e. their ability to secrete ethers and other volatile substances (Danilina et al., 2019; Mezhyan, 2021).

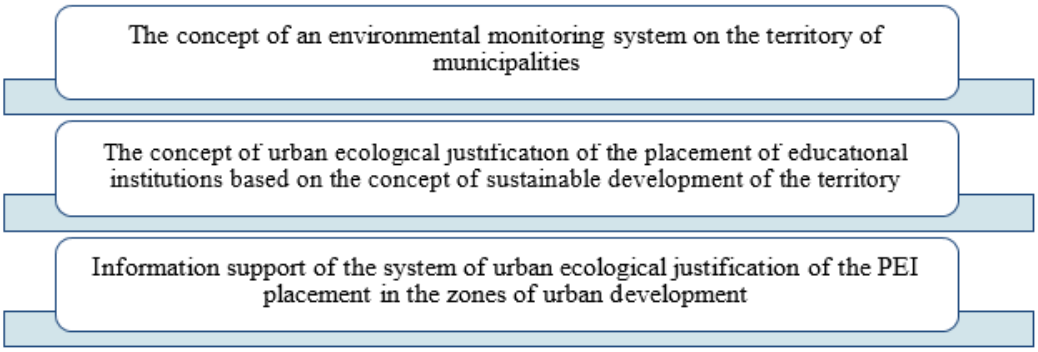
Following the sanitary and epidemiological requirements for organizations of education and training, recreation, and health improvement of children and youth, the territory of the PEI should be landscaped at the rate of at least 50% of the area of the territory free from buildings and sports grounds, including along the perimeter of this territory (Chief State Sanitary Doctor of the Russian Federation, 2020).

2. Materials and methods

The study was conducted from 2018-2021, on the territory of the city of Tyumen. According to environmental monitoring data, maps have been developed and basic approaches have been proposed for the formation of the concept of urban ecological substantiation for the placement of educational institutions based on the sustainable development of the territory.

Figure 1

The main components of the urban environmental assessment system



Source: Authors development

The urban ecological approach to the substantiation of the placement of educational institutions is carried out based on an environmental assessment of the state of the environment, which in turn is carried out according to a complex of natural and anthropogenic factors.

Depending on the degree of environmental pollution, each of the assessment factors is assigned a certain number of points. When they are added together, a quantitative assessment of the environmental condition of the settlement is obtained. The components of environmental factors obtained as a result of a comprehensive assessment must comply with the normative quality indicators of environmental components (Table 1).

Table 1

State of environmental components

The level of environmental pollution	The state of the most important components of the natural environment				
	Noise load during the day, dBA	Atmospheric Pollution Index (API)	The total indicator of soil pollution Zs = sum of C/Sf-(n-1)	Radiation pollution, equivalent radiation dose, mSv/year	Scores
Insignificant	<55	<2	<16	<5	1-6
Low	55-70	2-5	16-32	5-10	7-12
Average	70-80	5-6	32-64	10-20	13-18
Severe	80	7-13	64-128	20-50	19-24
Very severe	90	>14	>128	>50	25-30

Source: Authors development

At the same time, the atmospheric API is determined following the guidelines for the control of atmospheric pollution RD 52.04.186-89, according to formula 1.

$$Ii = (qsr./PDKm.ri)Ci \quad (1)$$

where i is an impurity;

qsr is the average annual concentration of the i-th pollutant;

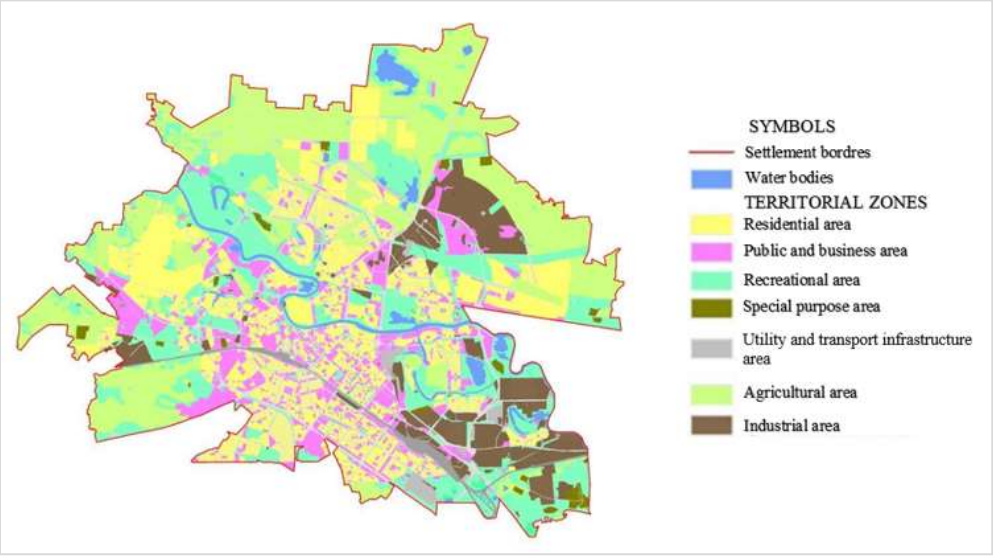
PDKM.pi is the maximum single concentration of the i-th pollutant;

Ci is a dimensionless coefficient that makes it possible to bring the degree of harmfulness of the i-th pollutant to the degree of harmfulness of sulfur dioxide. The Ci values are 1.5; 1.3; 1.0 and 0.85, respectively, for the 1st, 2nd, 3rd, and 4th hazard classes of the pollutant.

Following the point system of Professor V.V. Privalenko, we conducted the ecological zoning of the territory (Table 2) (Ofitsialnyi sait administratsii, 2021).

Figure 2

Index map of the territory of Tyumen



Source: Authors development

Table 2

Classification of ecological zones

Ecological zones		
By degree of liveability	*By degree of pollution*	*By degree of safety*
High	Insignificant, low	Non-dangerous
Average	Average	Slightly dangerous
Low	Severe	Dangerous
	Very severe	Extremely dangerous

Source: Authors development

The results of the environmental assessment of the state of the urban environment make it possible to identify problems and provide the necessary measures to eliminate adverse factors.

3. Results and discussion

The city of Tyumen is part of the Ural Federal District and the administrative, financial, business, cultural, and sports center of the Tyumen region, a major economic and cultural center of Siberia, and also an important industrial and transport hub (Ofitsialnyi sait Departamenta obrazovaniya, 2021).

The city is located in the south of western Siberia, on the bank of the Tura River, the left tributary of the Tobol, in the southwestern part of the West Siberian Lowland. The geographical position of Tyumen is 57°09' N, 65°32' E (Ofitsialnyi sait administratsii, 2021).

The city is administratively divided into four territorial districts: Central, Leninsky, Kalininsky, and Vostochny.

The city of Tyumen is part of the city district and its administrative center. According to the Department of the Federal Service for State Registration, Cadastre, and Cartography in the Tyumen Region, the land fund of the territory within the boundaries of the municipal formation of the Tyumen city district as of 01.01.2021 amounted to 69,848.0 ha (Ofitsialnyi sait administratsii, 2021).

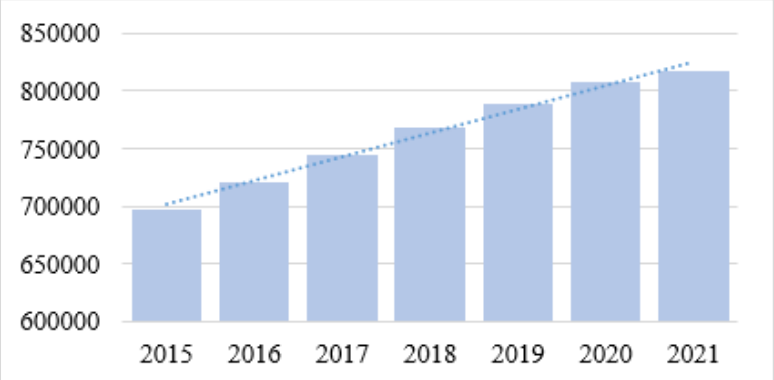
According to the rules of land use and development, most of the territory is occupied by a recreational zone (12,734.9 ha, which is 28.2% of the territory). The smallest area of the city's territory is occupied by a special and other-purpose zone (466.1 ha). At the same time, residential development occupies 21.4% of the territory, which indicates the constant territory development and the need for constant monitoring of compliance with environmental and urban planning requirements (Tyumen City Duma, 2014; Simakova et al., 2019).

One of the main elements of the formation of the urban component is the dynamics of the population. Thus, according to the website "Tyumenstat", the population of Tyumen on 01.01.2021 equaled 816,800 people. According to the results of socio-economic development, the increase in the urban population is due to migration (Ofitsialnyi sait upravleniya, 2021).

The dynamics of the city's population for 2015-2021 are shown in Figure 3.

Figure 3

Population dynamics of Tyumen

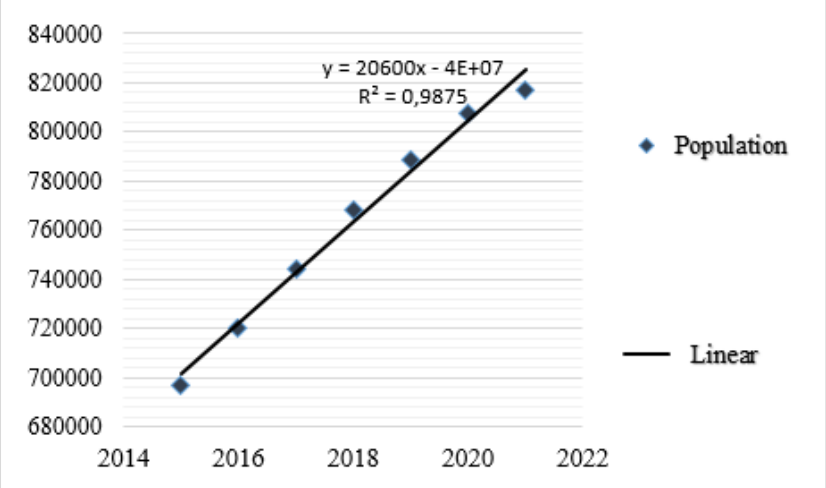


Source: Authors development

Based on the results obtained, there is a positive dynamic in the population on the territory of Tyumen, on average, the population increases by 14.3% annually.

Figure 4

Linear correlation of population size



Source: Authors development

When analyzing the linear correlation dependence of the dynamics of the urban population, we saw that the correlation coefficient was close to one (R^2 = 0.98), which indicates a positive linear correlation.

According to the analysis of the provision of the population of the city of Tyumen with institutions of cultural, household, and social services, it was observed that 7,378 places were not enough for the full provision of children with places in PEIs.

According to the data of the Tyumen Department of Education, 56 organizations operating on the territory of the city carry out educational activities as PEIs. The design capacity of preschool organizations is 41,066 places (Ofitsialnyi sait Departamenta obrazovaniya, 2021).

Most of the buildings of the Tyumen PEI were built in the 1960s to 1980s and require technical re-equipment.

The construction of PEIs on the territory of Tyumen developed rapidly from the 1960s to the 1990s. The maximum number of preschool institutions' buildings was erected from 1980-1989 (49 PEIs). From the beginning of the 2000s to 2010, the construction of PEIs stopped and resumed only in 2011.

To date, new PEIs are being built on the city's territory, planned to be put into operation in 2021.

Urban ecological design is a reasonable placement of real estate objects considering urban planning and environmental factors.

Kindergartens have special requirements for placement in a built-up area.

The construction and reconstruction of buildings of PEOs must comply with the standards specified in the Code of Rules 252.1325800.2016 "Buildings of preschool educational organizations. Design rules" (Ministry of Construction, 2016a, 2016b).

The main urban planning requirements for the placement of PEIs in built-up areas are presented in Table 3.

Table 3

Urban planning requirements for the placement of PEIs

The construction of PEI buildings should be carried out, protecting sources of dangerous natural and harmful man-made impacts	It is not allowed to place the plots of the PEOs within the sanitary protection zones of enterprises and other objects	The arrangement and equipment of the PEI site should provide for protection from negative natural and meteorological factors and harmful man-made environmental influences, taking into account the climatic and landscape conditions of the PEIs	The radius of service available from the place of residence to the general type of preschool: **300 m** in the largest, large, big, and medium-sized cities; **500 m** in small towns and rural settlements, with low-rise buildings.

Source: Authors development

According to the decision of the Tyumen City Duma of December 25, 2014 No. 243 "On local standards for urban planning in the city of Tyumen", the standard for the PEI capacity in the territories of new construction with crowded multi-story buildings equals 60 available places per 1 thousand people (Tyumen City Duma, 2014).

Following the "Local standards of urban planning in the city of Tyumen", the calculation of the regulatory need for additional places in the PEIs of Tyumen was made. Thus, the regulatory requirement for 816.8 thousand people is 49,008 places. As a result, there is a shortage of places in preschool organizations in the territory of Tyumen. The provision of the population with places in preschool institutions is 84%.

An analysis of urban planning assessment was carried out on the territory of Tyumen, based on the identification of modern functional (territorial), urban planning, and landscape use of urban territory, as well as compliance with urban planning regulations.

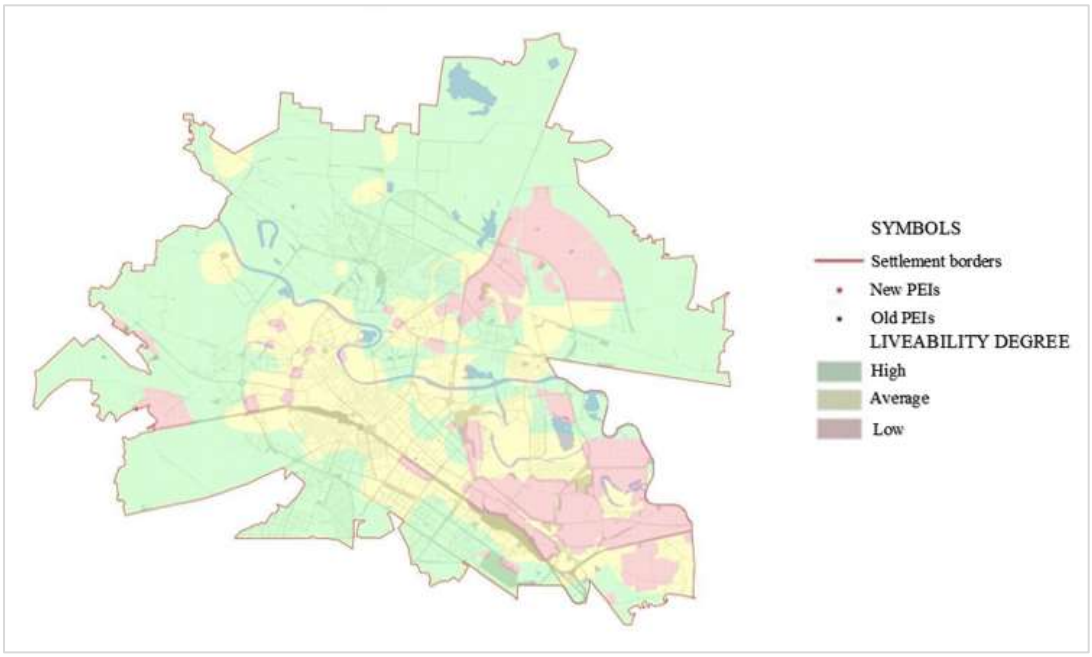
According to the results of the urban planning assessment, a map of the PEI placement was developed and violations of urban planning requirements were identified.

Being a large industrial center, as well as a powerful transport hub, Tyumen is in the stage of economic and territorial growth, as a result of which the ecological condition of the city is deteriorating annually.

According to the results of a comprehensive environmental assessment, it was observed that the central and south-eastern parts of Tyumen were subject to greater negative impacts (Figure 5).

Figure 5

Map of the liveability of the territory of Tyumen

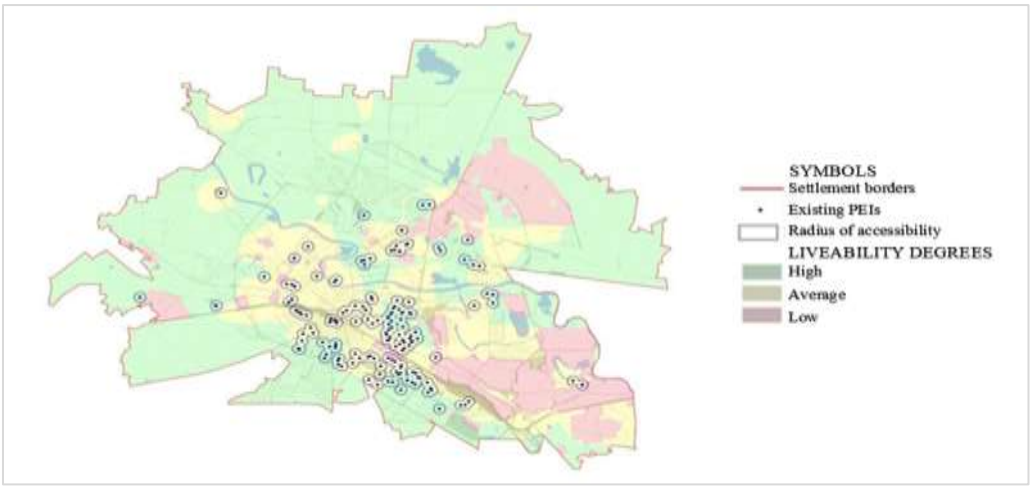


Source: Authors development

Based on the results of the analysis of a comprehensive environmental assessment of the state of the urban environment, a map of the PEI placement on the territory of Tyumen has been developed (Figure 6).

Figure 6

Placement of PEIs in the territory of Tyumen



Source: Authors development

Analyzing the results obtained on the PEI placement, it can be seen that 25% were assigned to the zone with a low degree of liveability, 73% to the average one, and 2.0% to the one with high liveability. This suggests that most PEIs are concentrated in the central part of the city, so it is necessary to provide a set of measures to improve the environmental situation in the city (Figure 6).

Following the methodology of the urban ecological substantiation of the PEI placement, for each of the preschool institutions located near the objects of negative impact, an analysis of the main components of the state of the environment was carried out and a set of measures to reduce the negative impact was developed.

Despite the proximity of PEIs with the objects of negative impact, the level of environmental pollution of most objects is characterized as insignificant or low. In some cases, there is an average level of environmental pollution.

To date, active construction and reconstruction of preschool institutions are underway on the territory of Tyumen. Thus, following the resolution of the city administration dated April 11, 2016 No. 86-pk "On approval of the program for the Integrated development of the social infrastructure of the city of Tyumen", eight preschool institutions are planned to be commissioned in 2021.

To identify the ecological situation in the territories of new construction, an analysis of the urban ecological substantiation of the PEI placement was carried out.

The construction of new PEIs is carried out in compliance with all sanitary and epidemiological norms and rules. The level of environmental pollution is characterized as low or insignificant.

Based on the obtained data on the assessment of the state of environmental components for preschool institutions located near the objects of a negative impact and new preschool institutions, as well as based on a comprehensive environmental assessment, a map of the urban ecological substantiation for the PEI placement in the territory of Tyumen has been developed.

Thus, the urban ecological assessment will allow analyzing the environmental situation in advance and will allow proper planning of the PEIs considering all the norms and rules of urban planning.

4. Conclusion

According to the results of a comprehensive urban environmental assessment, the number of pollutant emissions had increased on the territory of Tyumen. Therefore, it is necessary to carry out appropriate measures to protect the environment of PEIs in the city (Ofitsialnyi sait upravleniya, 2021).

The dynamics of population growth in Tyumen is increasing every year by 14.3%, in this regard, there is a need to provide preschool children with additional places in PEIs.

An ecological assessment of the state of the environment of Tyumen has been carried out. The assessment has demonstrated that the territory in the central and southeastern parts of the city is subject to negative effects.

Based on the data obtained, we developed a map of the concept of urban ecological placement of PEIs in the territory of Tyumen, which showed that the majority of kindergartens (73%) were located in the average liveability zone.

According to the results of the urban ecological substantiation, an improvement project is provided for preschool institutions located in an unfavorable zone to eliminate the negative impact.

As a result of the conducted study, it is proposed to provide for the construction of new kindergartens based on methodological approaches of the urban ecological substantiation of the PEI placement in a built-up area.

Methodological guidelines have been developed for the urban ecological substantiation of the PIE placement in a built-up area.

A map of information support for the system of urban ecological substantiation of the PEI placement has been developed.

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