Landscape Analysis via Modeling of the City Map

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Abstract

Landscape-architectural analysis as a method of urban environment quality assessment applied for historical part of Yekaterinburg. The essence of the method and its results are in the paper. A scheme of the environment quality on the city map developed based on the research. Streets and intersections, which have a great importance for the transportation system of the city, have on average higher quality of the urban environment. Improving of landscaping quality is preferred way of environment development, because of its efficiency, which confirmed by statistical processing of the results.

1. Introduction

The urban environment is a complex multifunctional system designed to provide comfort and safety for people. In 2010, in Yekaterinburg, passed a strategic development plan, which provides a SWOT analysis of convenience and environmentally prosperous of urban environment. Currently there are two strategic project of the city development, aimed at improving the comfort of the urban environment for residents: "the City for pedestrians" and "Clean and comfortable city" [1], but the problem of the quality local urban landscapes solved unilaterally in each of them.

World experience in assessing the quality of the urban environment, and development of ways of improving the environment quality by each of its indicators, expressed in several documents – guidelines for the design and maintenance of elements of the urban structure, usually called Design Manuals. These guidelines apply in many countries, States, cities [2-5].

In many countries, there are organizations, which implement control and quality improvement of the urban environment, for example, the Department of visual-landscape research in Moscow. In other countries, these functions performed by organizations such as the departments of transportation, urban planning councils, and other similar institutions.

The method of landscape-architectural analysis of intersections and segments of streets between them will allow us to provide activities that enhance the environmental, aesthetic qualities, and will reveal the potential comfort of the urban environment.

The purpose of the research was to determine the qualitative state of improvement of the urban environment on the streets of the Central part of Yekaterinburg by the method of landscape-architectural analysis, and to offer directions for elimination of the revealed shortcomings.

2. The method of landscape-architectural analysis

2.1. The essence of the method of landscape-architectural analysis

The potentially possible level of comfort of the urban environment is usually not achieved due to various reasons [6-12]. Comfortable urban environment is whole urban natural spaces, and the combination of elements of the city structure, that allows to fully satisfy individual and social needs of the population, which ultimately should lead to improving the quality of life of citizens [13]. Proposed method of landscape-architectural analysis

combines the methods of several research fields of the urban environment to ensure its comprehensive consideration. The results of the analysis allow to decide on the need of reconstruction of the territory, because it takes into account the mutual influence of natural and human-induced elements of the environment and provides ways of finding optimal design solutions.

The landscape-architectural analysis synthesizes all of the developments in the field of the urban environment comfort, and focuses on its comprehensive review and assessment.

2.2. Parameters of objects of the research

Objects of the analysis defined by reviewing of cartographic materials. The main categories of local urban landscapes include intersections, streets and complexes - areas, spatial structure and the functioning of which is due to the proximity of any center of attraction. Area of research – the historical part of the city has an area of 16.7 km2, and contains 101 streets, including 26 streets adjacent to the area from outside and not continuing directly in the historical part of the city of Yekaterinburg. Streets create 233 intersections. As a common characteristic for the distribution of research objects used amount of indicated or calculated in accordance with the Traffic regulations of the Russian Federation traffic lanes – indicator characterizing the importance of the street in the transportation system of the city. Thus, the intersections and segments of streets distributed by the following groups: small, medium, large, extra-large.

2.3. Determination of environmental indicators at intersections

The analysis requires the collection and processing of information on a large number of objects with the requirement of providing selective consideration of individual objects and comparing the results. In this regard, the forms of the Passport of local urban landscape and the summary table form for assessing the quality of urban conditions at intersections are considered. The passport and the summary table contains considerable part of numeric data: number of streets adjoining to a crossroads, including, walking streets; the number of traffic lanes; the radius of the analyzed area - the visibility range was taken 50m from the center of the intersection, and for especially for extra-large intersections - from the middle of the carriageways of each segment of adjacent streets (Fig. 1); the average radius of remoteness of buildings from the center of the intersection; the ratio of the areas of different types of objects of the city structure; degree of compliance with the standard of the amount of landscaping [13].
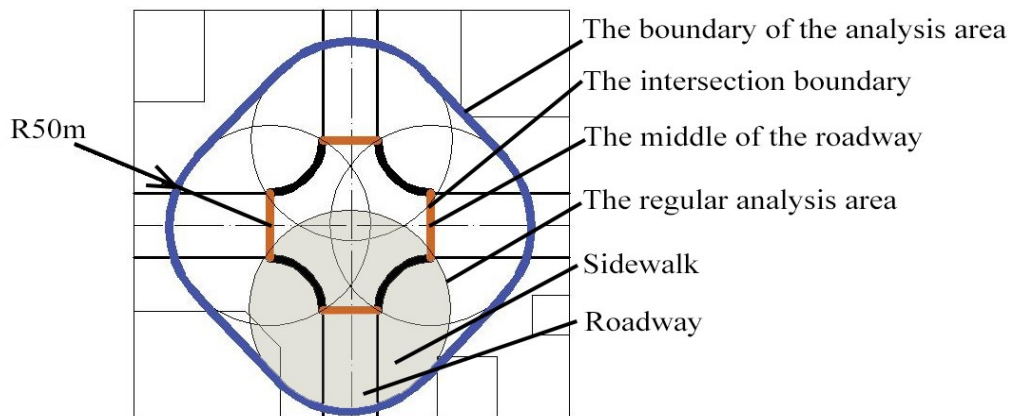

Figure 1: Determining of the analysis area on extra-large intersection

The distribution of elements on street segments adjacent to the intersection determined by presence of elements of each type on sides of streets. Introduction of the structure elements distribution coefficient for this research allows applying statistical methods to determine relationships between the structure of the intersection and other indicators of landscape-architectural analysis. The structure elements distribution coefficient determined by calculation of values of each type. If any object of considered type presented on the side of street, then the value increases by 0.5 (Fig. 2). Thus, the contribution of one segment of the street may be max 1. The maximum value depends on the structure of the intersection, i.e. the number of segments of streets.
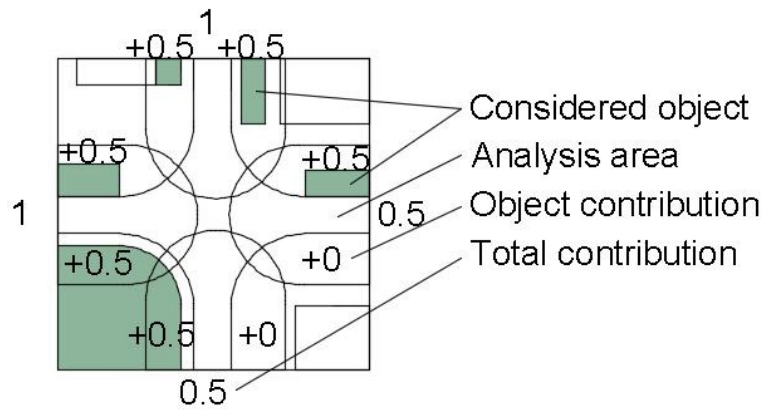
+0.5 1 +0.5

Considered object
Analysis area
Object contribution
Total contribution

+0.5   +0.5

1   0.5

+0.5   +0

+0.5   +0

0.5

Figure 2: Determining of the structure elements distribution coefficient

2.4. Determination of environmental indicators ofstreets and complexes

Assessment of the spatial structure of the streets performed by graphical methods. For that purpose, was draw longitudinal and transverse sections of streets and analyzed the arrangement of elements and compositional unity.

Analysis of the street landscaping performed using the appropriate data analysis of intersections belonging to the streets. Used average values of the assessments.

Landscape-architectural analysis applicable for assessment of the urban environment, within complexes that localized by its relation to any center of attraction. Methods and techniques of analysis in this case coincide with the assessment of streets and intersections. Complexes analysis includes development of explanatory note with detailing the characteristics of the quality of the urban environment. For enhance the information content of the explanatory notes used photographs and satellite images.

The result of the landscape-architectural analysis is a total estimation of quality of local urban landscapes. The interval of possible ratings (-16 to +16) is divided into 3 parts, representing the General expression of the evaluation of the quality of the urban environment as unsatisfactory, neutral and satisfactory (table. 1).

Table 1: Comparison of total estimation of quality of local urban landscapes and assessment of city structure objects quality

-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Unsatisfactory											Neutral											Satisfactory										
Extremelylow			Low																			Good						Excellent				

3. Results

3.1. Landscape-architectural analysis of intersections

About 40% of intersections in the historical part of Yekaterinburg belong to the small intersections group, which includes 59 objects. The number of traffic lanes is in range of from 0 to 8. The total estimation has on average a positive value, although statistics mode for this indicator is 0. In the group was identified 36 intersections (61%) with negative value of total estimation; satisfactory value has 44 intersections - 48,9%.

Analysis results indicate that for intersections in the group of small, the most important factor determining the quality of the urban environment, is landscaping. The coefficient of determination between the total estimation of local urban landscapes quality and landscaping overall assessment (R^2) is 0.6 (Fig. 3).
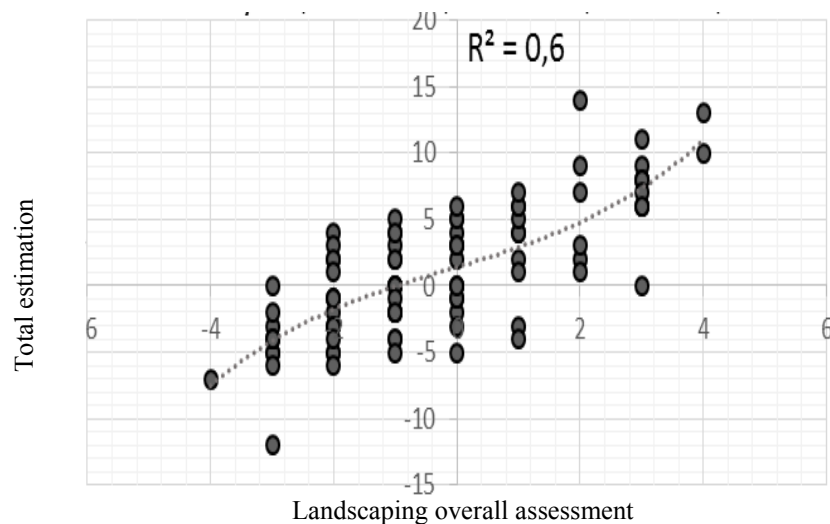
Figure 3: The correlation of the assessments of landscaping assessment and total estimation of the urban environment quality

The group of medium intersections includes about 45% of the total number of intersections in the considered area. Medium intersections contain from 9 to 16 traffic lanes.

Dispersion of final assessment of the quality of the urban environment is 26 points (from -11 to 15), which indicates significant dissimilarity of intersections environment quality. By different criteria, 583 negative assessments assigned. Thus, many intersections in this group is in need for deficiencies, which is especially important for the largest group of intersections in historical part of Yekaterinburg.

Based on the amounts of unsatisfactory assessments by the various factors, identified the most common troubles. The highest increase of the total estimation of the urban environment at medium intersections can be obtain by lawns recovering, removing of stumps and overgrown; equipping of recreation areas; placing decorative architectural landscape elements and dismantling of unused power line supports; eliminating of excessive amounts of advertising structures; restoration of the drainage systems and repair of building facades.

The group of large intersections includes 34 objects with total number of traffic lanes from 17 to 24. Extra-large intersections group with a number of traffic lanes more than 25 contains 5 objects. Because of great importance, these intersections must meet high requirements on the quality of the urban environment.

The average rating of the urban environment within these groups is positive and is in range from 2.4 to 6.6.

Statistical analysis of the results allows concluding that the main disadvantages are violation the ratio of the areas of different types of objects of the city structure, lack of or non-compliance for standards of elements of the landscaping.

The most developed transport nodes in historical part of Yekaterinburg have a relatively high environment quality. Three intersection of group of large, has not received negative assessment on any of the criteria. In sum, the negative assessments for this group are -159 out of possible 1024. A large part of the studied objects is in good condition and has a positive overall assessment of the qualities of the environment. However, only nine intersections (22% of large and 40% of very large) have scores above 75% of maximum.

The results of the analysis of intersections of different groups shown in table 2. Dispersion of the total estimation of the urban environment quality assessment inversely proportional to the size of intersections, and is reduced from 26 for small to 8 for large intersections.

Table 2: The total estimation of the urban environment quality assessment of various size intersections

Group of intersections	The total estimation						
	Average	Max	Min	Positive		More than 75% out of maximal possible	
Small	1,1	14	-12	44	(44,4%)	9	(9,1%)
Medium	1,2	15	-11	60	(57,7%)	14	(13,5%)
Large	2,4	13	-1	22	(68,8%)	7	(21,9%)
Extra-large	6,6	11	3	5	(100%)	2	(40%)

A comparison of the performance of different groups allows us to conclude that the level of content and well thought-out plan is directly proportional to the size of the intersection (groups). The reason for this phenomenon is the relationship between the levels of development of the transport hub and its environment, arising due to

various, in particular, economic reasons. The obtained values also show that the frequency of defects according to certain criteria is not constant for different groups – at small and medium intersections, the poor condition of lawns, the absence of recreation areas and flower decoration are more often observed; for large and very large – lack of landscaping, poor quality lawns, improper organization of drainage, the presence of seedlings or stumps.

3.2. Landscape-architectural analysis of streets

For distribution of streets by groups used the average number of traffic lanes on intersections belonging to the street. The streets of the group of small characterized by a large spread of estimates of the quality of the environment, due to planning decisions of streets, and also, unsatisfactory condition of plants. High scores on various criteria observed mainly near intersections with large and medium streets.

Medium streets form the basis of the transport network of the historical part of Yekaterinburg. The quality of the urban environment on their territory satisfactory and on average estimated at 1.8. Features of distribution of the found violations and their combinations on certain sites testify to mistakes of design, non-observance of technologies of landscape construction, insufficient level of the maintenance of the territory, violations of frequency and technology of care of plants, and insufficient understanding of the population of own responsibility in the address with elements of gardening and improvement, and other objects. At the moment, improvement of various qualities of the environment is necessary.

Large streets have on average higher than on the streets belonging to other groups total estimation of environment quality. On large streets, due to insufficient amount of landscaping, high level of technogenic and anthropogenic influences and a large area of artificial surfaces identified adverse conditions. As a result, the most important city streets are not quite comfortable, visually unattractive and unsafe.

3.3. Landscape-architectural analysis of complexes

Centers of attraction in the urban environment presented by transportation hubs, public squares, shopping centers, etc., are the unifying element for the space of adjacent streets and intersections [14-17]. The urban environment inside the complexes perceived by people as part of these complexes and different from his environment. The analysis of Yekaterinburg railway station, 1905 Revolution Square and Grinvich shopping center, made the following conclusions: firstly the quality of the urban environment of the complexes is not high enough; secondly, the complexes not optimized to perform its basic functions; third, the urban environment of complexes does not support optional social activities. The last problem is common for many cities.

Thus, to increase the efficiency of complexes, as a part of city structure, by increasing their comfort and safety requires, it is necessary to develop and implement of a system of actions, including reconstruction of some landscapes with a minimal total estimation of the quality of the urban environment.

3.4. Overall results

Based on the landscape-architectural analysis, the scheme was made. It reflects the quality of the urban environment in the historical part of Yekaterinburg (Fig. 4). The most comfortable environment is considered close to Lenina prospect, Karla Liebknekhta St., Sverdlova St., 8 Marta St.; the least comfortable area fragmented, but it is close to the Moscovskaya St., Vostochnaya St., Rosy Luxemburg St. and others. This is due to the different importance of streets in the city transportation system, as well as cultural and economic reasons.
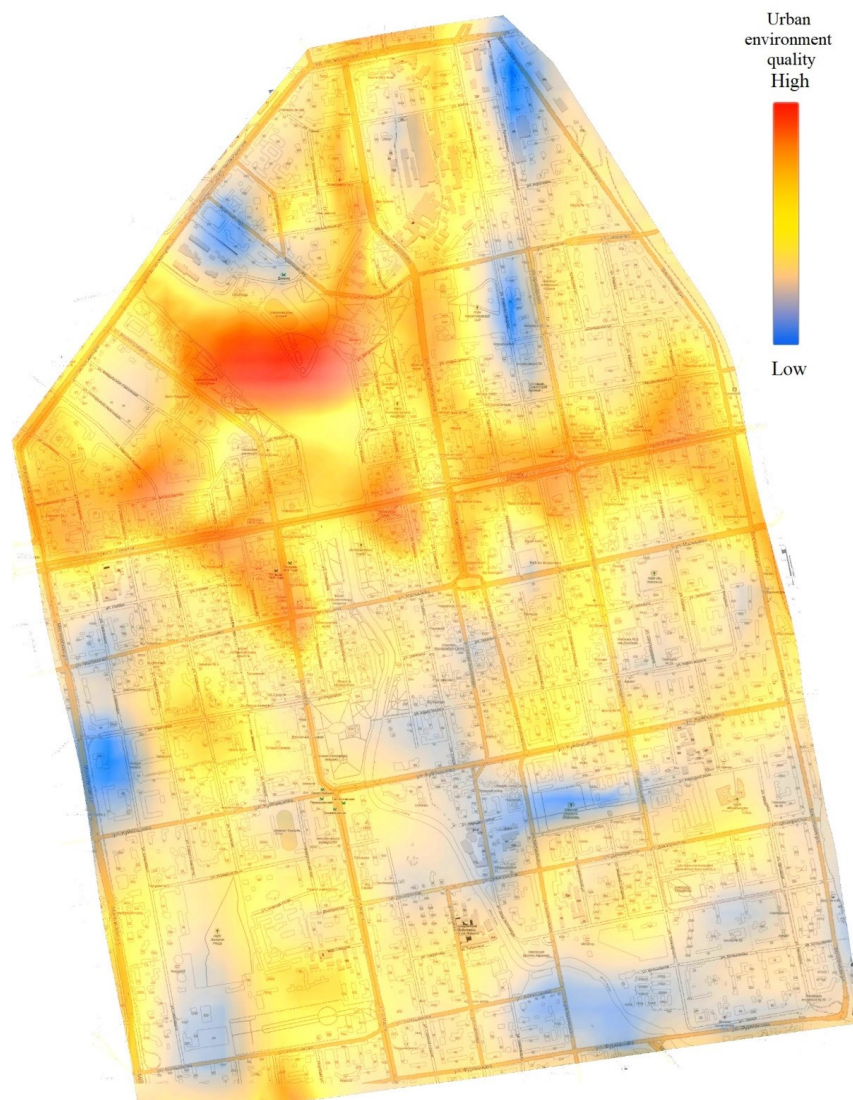
Figure 4: The scheme of urban environment quality of historical part of Yekaterinburg

The analysis of the territory of the Central part of Yekaterinburg revealed the following:

1. The area of greening of local urban landscapes is insufficient and is less than 34% of the norm. To ensure the maximum quality of the urban environment, in addition to eliminating other shortcomings, it is necessary to increase the area of plantations by almost 3 times by increasing the size of landscaped areas and their Association, as well as the use of container landings, landscaping roofs and vertical surfaces.

2. The landscaping is unevenly distributed: the density of street landscaping on various parts of the historical part of the city is much different.

3. The most common disadvantage is the presence of dangerous trees, thickets, stumps. The range of tree species is not optimal, some species are distributed spontaneously.

Figure 5 shows the main groups of problems in the formation of a comfortable urban environment.
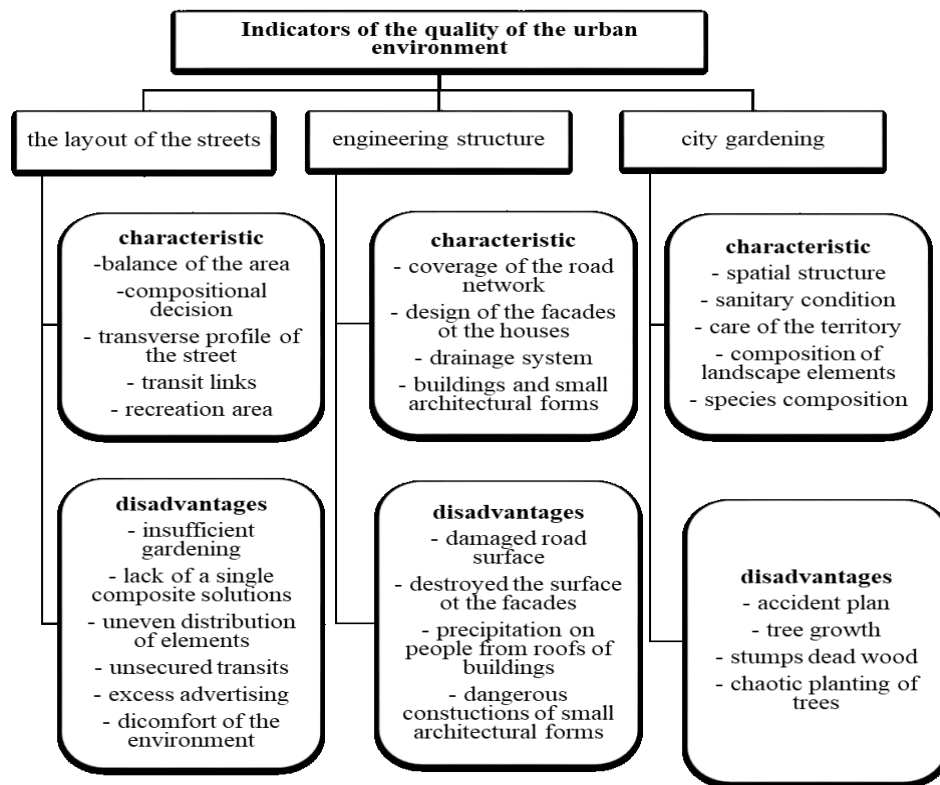
Figure 5: compliance of identified problems with categories of assessment factors
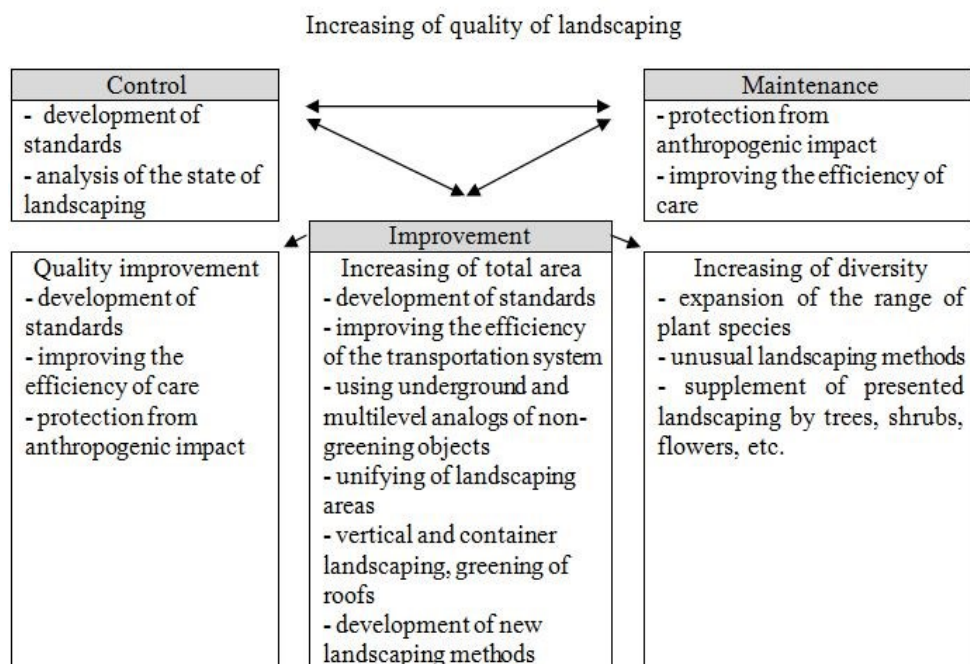

Figure 6: The scheme of landscaping quality increasing developed

4. Conclusions

Landscape architectural analysis identified the most significant factors of creation of comfortable conditions to stay of people and factors that decrease the level of comfort, security and functionality of urban landscapes and of the road system as a whole.

A trend of increasing of quality of the urban environment with the increasing role of intersections in the transport system of the city discovered by statistical analysis.

Streets, intersections and complexes of the historical part of Yekaterinburg have significant dispersion of the final estimates of the quality of the urban environment. The highest estimation assigned to large streets. The considered systems are not adapted to provide favourable conditions for the stay and transfer of a large number of people.

In descending order of expected effectiveness of the impact to the overall environment quality, parameters grouped in the following way: site design, the condition of the landscaping elements, the degree of development of engineering structures and other elements.

Landscape-architectural analysis allows making the following conclusions:

- design solutions of streets and intersections do not take into account the specificities of local urban landscapes;

- streets has dissimilar planning concepts, and intersections are not combining it;

- greened area of streets is not insufficient, and it is advisable to increase the area about three times;

- the range of plant species used in landscaping of streets of Yekaterinburg and technics of care for trees allow the formation of windfall inclined plants with a low visual characteristics;

- using of modern methods of landscaping is not wide enough.

It is necessary to research the existing condition of the urban environment and improve the quality of landscaping, because it is less expensive and very effective way of formation of comfortable conditions for the city population.

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