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## THE ASSESSMENT OF VISUAL ENVIRONMENT QUALITY AT SOLOMYANSKY DISTRICT, KYIV CITY

**Abstract.** *The visual pollution is among the environmental problems of modern urban ecosystems. Thus, visual environment quality is considered an important element of the quality of life for residents of cities. The formation of the visual pollution concept has been showed, indicating the lack of uniform formulation. The differentiation of elements of visual pollution as well as the properties of visual fields has been performed. The analysis of methods for visual pollution assessment has demonstrated mostly descriptive character of corresponding research works. Some works have been performed using complicated instruments, but their results are eventually interpreted in descriptive forms as well. The special method of visual environment quality evaluation has been developed, accounting such parameters as degree of aggressiveness and homogeneity, pollution with advertisements and retail outlets, transport and population loading, area and location of green zones, shading level and presence of landfills. Each parameter included in the assessment is provided with rating scale and weighting index, which reflects its contribution to the scenery formed. The method has been applied to the assessment of the visual environment at the Solomyansky district of the Kyiv City has been performed. The results demonstrate the high level of visual pollution along the major highways and streets, namely Borschagivska Street, Vadyma Getmana Street, Kosmonavta Komarova Avenue, Chokolivsky Boulevard and Povitroflotsky Avenue. The minor streets, in particular Levanovskogo Street, Nizhynska Street and Valeria Lobanovskogo Avenue, with predominantly residential buildings demonstrate predictably lower intensity of pollution, but increased area of low quality visual fields. The most common element of visual pollution is garbage accumulations, traffic jams, unregulated retailing and lack of green plantations. The recommendations on the improvement of visual environment quality have been formulated, including the need for development of the city's visual environment standard.*

**Keywords:** *visual pollution; grading assessment; human health effects; quality of life*

### Problem formulation

The current state of the environment has undergone a significant transformation and changes due to large and diverse number of factors that have an impact on all components of nature. The visual environment, its colour gamma, structure, dimensions and shapes of the surrounding space have also changed. Still it is obvious

that people living in urban environment are equally affected by chemical, physical and aesthetic (visual) factors [1]. The potential effects of visual environment pollution has started to be a research area since the publication of classic works by Lynch and followed by a range of research works in modern times [2-5]. Considering the potential growth of urban areas, making cities safe, resilient and sustainable is a major challenge.

The urban environment is basically formed of natural abiotic and biotic components and introduced artificial structures. The combination of all these elements, perceived by human eye is a visual environment. In other words, it is the all its diversity and manifestations of material objects around humans – forests, seafloor, mountains, buildings, structures, interior of residential and industrial premises, transport infrastructure, skies, etc. [6].

Consequently, human visual environment can be divided into natural and artificial types. It is quite understandable and obvious that the natural visual environment fully corresponds to the physiological standards of human vision, since a person is an integral component of nature and for the dominant time share of our existence we have lived under natural conditions [7]. With time passing the artificial environment created by people according to peculiarities and specifics of their living activity under urban conditions becomes more and more different from the natural. Such manmade environment includes various visual elements, which damage the aesthetic quality of the scenery, are called clutter, eyesore or visual pollution objects. Sightings of garbage at open dumping, curbside wastes, beach trash, badly maintained or abandon buildings, graffiti, billboards, street banners, advertisement signs, electronic signs and public LED screens, cables and wires, damaged vehicles and buildings, smog/ haze and smoke are all considered an eyesore to the viewer in cities, raising the topic of visual pollution to the level of individual research field, which is seen in the fundamental works by V. V. Filin and S. Sivaramanan [10, 11].

The new visual elements are not typical for the nature and lead to a range of adverse effects on humans, including short-sightedness, psychological disorders (prolonged depression, stress), aggressiveness and fatigue, which have been proved by a range of research [7, 8, 9]. Furthermore, living in the surroundings filled with visual pollution objects hinders normal perception of nature, as they stay in such condition since their childhood [9, 17]. Given this it is very hard to develop frugal and protective attitude to nature among city dwellers, which worsens this and other environmental problems.

An important issue of visual pollution is increased accident probability due to distraction [12] and vice versa – lost ability to grasp information and detect objects within the visually polluted environment. The latter issue is widely discussed by scientists, in terms of health effects and provision of information comprehension under strong visual pressure, as it is seen in the works by Asher et al., Henderson J. M. et al., Neider M. B. and Zelinsky G. J., Bravo M. J. and Farid H. [13-16].

The intensity of this problem is different from city to city, but in order to give objective comparative analysis of the pollution level it is necessary to develop strict evaluation procedure and choose representative criteria.

The aim of the given research is to formulate the visual pollution assessment approach and apply it for the analysis of visual environment quality in one of the Kyiv city districts.

## Methods and materials

The presence of one such object may be a sign of a time or undergo some more kind of management, but when these objects are concentrated on a constant basis and overwhelm citizens – this is a question of visual pollution. In other words the number of visual pollution elements determines the intensity of visual pollution [18, 20].

The diversity of visual pollution objects and their properties, the subjectivity of observers, the scale of urban space and lack of measurable parameters are the key challenges for visual pollution assessment [19]. In most research works there are two directions of the analysis – some of them concentrate on the methods of visual clutter detection and characterizing, while the others search for approaches to measure the reaction of people to this environmental problem. Consequently the methods of visual pollution assessment could be differentiated into subjective, objective and intermediate or transitional. The first group is based on some specific equipment usage for detection of visual pollution objects or human reaction to them. It is mostly based on the measuring the work of human visual system: the pattern of saccade formation [10], or the rate of the target objects detection by human eye within the intensive cluttering of visual field [7, 14, 15].

The intermediate methods involve technical analysis of landscape components and their numerical representation. They may be based on application of GIS methods and other geospatial tools [19, 20], photometry instruments [21], and architectural methods with further numerical evaluation [22].

The subjective methods are based on questioning residents and specialists and statistical processing of their feedbacks [19, 23]. These methods are easiest to perform, but in order to reach acceptable level of reliability they have to be based on vast statistical sample.

Thus, it can be argued that depending on the specific task of the study, any of the above methods can be applied. However, the assessment of visual pollution will always include some subjectivity of the approach, since the evaluation is finally based on people's opinions.

Despite the method applied it is possible to find a range of research works related to visual pollution of various cities around the world since the publication of the first assessment of that kind in relation to the city of Jacksonville in 1985 [9, 11, 12, 17, 19-22]. As for city of Kyiv and other Ukrainian cities the range of research works are quite narrow. One can find mostly the analysis of landscape attributes of such cities as Kharkiv, Dnipro, Vinnytsya, Ivano-Frankivsk and Kyiv, while the component of visual pollution is covered in the mentioned works only partially [24-29]. So, there is a need for detailed analysis of Kyiv city with application of uniform approach.

Since the object of our research is the territory of the urban ecosystem, the factors to be accounted in the evaluation of visual environment pollution should include the elements of eyesore and the quality of visual fields. Eyesore elements included into the further analysis are transport, crowding, solid domestic wastes accumulation, and advertising and information materials. There are several factors that worsen the visual quality of the city: homogeneous and aggressive fields, excess of straight lines, sharp edges, large planes, reduced area of green plantations and open spaces. Thus, the quality of visual fields should be evaluated based on the ratio and repentance of uniform and monotonous elements, presence of attractive elements suitable for efficient saccade formation.

For the purpose of the given research the special procedure of visual pollution level assessment was developed (Table 1). The method involves the rating of the above mentioned parameters in points, each of which is provided with the weighting index, according to its relative importance in the formation of visual environment.

The parameters analyzed could be roughly divided into two groups the first group describes visual fields character, including:

- degree of the visual environment aggressiveness (W1);
- degree of the visual environment homogeneity (W2);
- availability of green zones (W8);
- green belts in front of residential buildings and along the roads (W9).

The second group characterizes of visual pollutants:

- degree of pollution with advertisements (W3);
- degree of transport loading (W4);
- degree of population loading (W5);
- degree of bus stops loading by public transport (W6);
- retail outlets density (W7);
- presence of spontaneous and controlled landfills (W10);
- shading level (W11).

Table 1 – Rating of visual environment quality parameters

Parameter	Meaning	Rating value	Weighting index
1	2	3	4
W1 (the degree of the visual environment aggressiveness)	The area of aggressive field visible from one point	< 100 m <sup>2</sup> ; 100-500 m <sup>2</sup> ; 500-1000 m <sup>2</sup> ; > 1000 m <sup>2</sup>	0,2
W2 (the degree of the visual environment homogeneity)	The area of homogeneous field visible from one point	< 100 m <sup>2</sup> ; 100-500 m <sup>2</sup> ; 500-1000 m <sup>2</sup> ; > 1000 m <sup>2</sup>	0,2
W3 (the degree of pollution with advertisements)	The number of advertisements elements visible from one point	1-5; 6-10; 11-20; > 20	0,1
W4 (the degree of transport loading)	The level of transport intensity	the intensity is < 100 cars/h; 100-300 cars/h; 300-500 cars/h; > 500 cars/h;	0,05
W5 (the degree of population loading)	The number of people visible from one point	< 100; 100-500; 500-100; >1000;	0,05
W6 (the degree of station loading with public transport)	The number of public transport vehicles simultaneously arriving at the station	< 1; 2-5; 6-10; > 10	0,025
W7 (the retail outlets density)	The number of retail outlets visible from one point	1-5; 6-10; 11-20; > 20	0,05

Continuation Table 1

1	2	3	4
W8 (the availability of green zones)	The number of green zones visible from one point	> 3; 2; 1; 0;	0,1
W9 (the presence or absence of green areas)	The number of green areas in front of residential buildings and along roads	green zones are in front of residential buildings and roads; only in front of buildings and roads; green zones are absent;	0,15
W10 (the presence of spontaneous and controlled landfills)	The number of spontaneous and controlled landfills visible from one point	0; one controlled; two and more controlled; spontaneous landfills	0,05
W11 (the shading level)	The duration of shading	All areas are uniformly lit; periodically shaded for several hours; area is lit up only during half of day	0,025

### Study object description

The Kyiv city general plan clearly implies further expansion of residential areas, which will lead to gradual reduction of suburban natural green zones by turning into metropolitan area. Moreover, the new residential blocks are densely built up with no regard to shading effect, and provided with poor green infrastructure. All these issues are well displayed in the quality of visual environment, which lacks natural elements of greenery, while homogenous and aggressive fields are overwhelming.

The Solomyansky district of Kyiv is located at the right bank of the Dnieper. Total area of the district is 40 km<sup>2</sup> with the total number of about 370 thousands. The district has a diversified industrial complex, 54 research and design institutes, 6 higher educational establishments and numerous residential areas. According to the statistical data published at Solomyansky district passport dated by 01.01.2019 the total number of streets at district is 365.

In the frame of experimental work performance it was decided to analyze the visual quality of the main streets of Solomyansky district and some minor streets with dense residential districts. The list of streets investigated include: Borschagivska street, Vadyma Hetmana street, Levanovsky street, Mykoly Golego street, Nizhynska street, Garmatna street, Kosmonavta Komarova avenue, Povitroflotsky avenue, Valeriya Lobanovskogo avenue, Chokolivsky boulevard.

### Results and discussions

The general overview of the visual environment Solomyansky district shows that it is not comfortable and imposes risks to the residents.

Borshchagivska Street is located in Shevchenkivskiy and Solomyansky districts of the Kyiv and its visual environment is predominantly formed of multistory residential buildings, built with aggressive interior and coloristic style. The biggest visual problems of the Borschagivska street is concentration of aggressive visual

fields, number of vehicles, the level of ads pollution (total number of advertisements reached by human sight from one point of view equals up to 15 elements).

The visual environment at the Vadyma Getmana Street is also significantly polluted with huge amount of people moving and significant concentration of public and private vehicles. High concentration of retail facilities, aggressive and homogeneous fields (due to new residential buildings construction), among all other studied pollution parameters are typical for this street. Ads are generally located along the street and very often get into human eyes 25-50 objects, visible from 1 point.

The Levanovsky Street belongs to small streets: its total length is 550 meters. The most degrading parameters in visual aspect are absence of green zones in front of the buildings and considerable amount of waste accumulation points. Beneficial to visual environment at Levanovskogo street is rare points of advertising elements (not more than 8).

Currently the territory of the Mykoly Golego Street is actively being built up, which in turn leads to the increasing of aggressive and homogeneous fields, appearance of shaded areas and garbage storing places formation. Moreover, the visual environment of the investigated street is also deteriorated by the presence of retail and ads objects. As for the number of ads elements, advertizing objects are of medium size and their highest density is observed at the crossroad with the major streets (19-20 on average). Generally, the state of the street visual environment is satisfactory, but it is expected to be less comfortable, due to tendency of new facilities construction along the street.

The Nizhynska Street visual environment quality is moderate. The modern feature is numerous aggressive and homogeneous fields in the visual field, but here they are mitigated by green plantations. The tall multistoried bindings are not dominant, thus in most cases the street territory is uniformly lighted. Intensity of ads elements along the street is also not very high – not more than 9.

Analysis of visual environment quality of the Garmatna street shows significant contribution of numerous degrading factors: high density of retail objects and other small architectural form; significant level of shading and number of vehicles and people circulating. Aggressive fields dominate over homogeneous. Ads elements are located at streets cross-section as in previous cases, very often on the houses in the quantity of 12-15 objects.

The Kosmonavta Komarova Avenue is equally affected by aggressive and homogeneous fields. Significant impact at visual environment quality is formed by the transport system functioning and people accumulation. The advertising impact is moderate – less than 10 objects. Due to the presence of tall residential buildings, which facades are done in aggressive style, some areas are continuously shaded.

The Povitroflotsky Avenue has plenty of aggressive fields, transport and people accumulation. Components of visual pollution also include lots of small retail objects. The impact of advertising objects is also significant: there are ads of different size from small to big at the investigated territory. The density of ads element is from 13 to 35 objects.

The Lobanovsky Avenue study reveals that the most damaging parameters are the impact of aggressive fields and intensive transport loading. However, the pollution caused by ads at the Lobanovsky Avenue is considerable (up to 20).

The Chokolivsky Boulevard most significant visual environment pollution elements are aggressive fields, transportation system pressure, retail objects distribution and significant number of advertising – up to 22.

Generally, all the studied streets are characterized with poor green infrastructure, when there are only narrow green belts along the highways. Significant environmental problem lies in the absence of green parks in the view, which also contribute to visual disturbances in the street environment, because vegetation is very efficient visual and aesthetic pollution mitigation factor.

Another typical problem is accumulation of solid domestic waste. During investigation several controlled garbage bins, which in most cases are overfilled, and zones, where garbage was spontaneously accumulated, were also found. The aggressive and homogenous visual fields are also a common problem of all areas.

The grading of the visual environment quality based on the offered method shows that the Levanovsko Street, Nizhynska Street and Valeria Lobanovskogo Avenue are the less polluted among all the rest investigated areas. The highest level of visual pollution is set for the Borschagivska Street, Vadyma Getmana Street, Kosmonavta Komarova Avenue, Chokolivsky Boulevard and Povitroflotsky Avenue (Fig. 1).

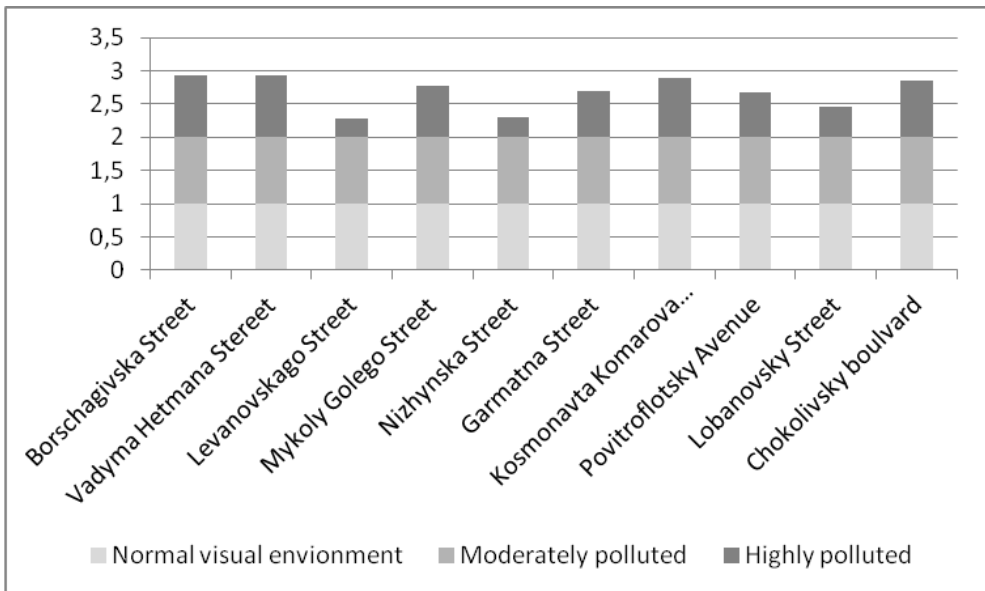


Fig. 1 – Comparative analysis of the total visual pollution levels defined at the investigated are

### Conclusions and Recommendations

In order to reduce the negative impact of visual pollution at Solomyansky district of Kyiv it is possible to implement specific projects of urban settlements planning meeting the requirements of comfortable visual environment. There are many such types of projects along the Globe. The most efficient project in term of ads problem solving is Sao Paulo Clean City law.

A range of applied solutions has been developed for the study area:

- Optimization of design solutions for residential buildings and facilities;
- Implementation of streets greening program;
- Optimization of the transport system;
- Improvement of domestic waste management system;
- Reconstruction of aggressive and homogeneous fields in Environmentally acceptable way;
- Limitation of advertising intensity.

The primary concern for the Solomyansky district, as well as for all other modern urban districts, is the facades of building, which are the first to be perceived by human eye. Most of the investigated sites have a problem of aggressive elements concentration sourced by residential buildings and industrial facilities. Thus, the organization of the visual environment in terms of the design decisions should use a variety of forms and sizes of visible elements and primarily it is applicable to windows, balconies and loggias. Appropriate implementation of coloristic solutions at the Solomyansky district is very important too as it will reduce the area of homogeneous fields. Especially it is true for the Vadym Getman and Borshchagivska streets. Large planes in architecture of the district are the dominant problem. Such situation can be managed by separation of such huge areas of facades at more single elements as a portico, columns, bay windows, decoration.

As for the problem with SDW accumulation, in particular, unauthorized points, this is the question of ecological culture and education, which should be managed in appropriate way by the state programs. The authorities may have the positive impact on the situation by improving the system of waste management in terms of collection and removal.

In relation to pollution with advertisements it is also the question of legal regulation. The “visual standard of the city of Kyiv” should be developed, specifying acceptable location, area, quantity, color and style of ads.

Among the top solutions for the problem the improvement of green infrastructure is one of the best. Vegetation helps to link the diverse elements stylistically into a single urban planning ensemble as well as mitigate the impact of aggressive and homogenous fields, traffic and crowding – as they are inevitable elements of a big city. Buildings greening procedure by vertical and horizontal greening, decoration of roof by plants and other similar procedures are necessary to be implemented. Landscaping of roofs at the Solomyansky district is very important: district includes buildings of different height and for many people roof is a dominant element of visual environment; in this regard roofs’ greening is very efficient tool for negative impact reduction.

All these measures for visual pollution decreasing should be supported by appropriate legislative documents [30-33]. It is necessary to create specific legislation dealing with the visual pollution; especially it is important for the development of standard methods of assessment and acceptable levels of the visual pollution. Thus, there is a need for detailed analysis of visual pollution components and intensity in order to develop efficient regulations in this field of environmental safety.



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## **ОЦІНКА ВІЗУАЛЬНОЇ ЯКОСТІ ДОВКІЛЛЯ СОЛОМ'ЯНСЬКОГО РАЙОНУ МІСТА КИЄВА**

**Анотація.** Візуальне забруднення входить до числа екологічних проблем сучасних міських екосистем. Так, якість візуального середовища вважається важливим елементом якості життя жителів міст. У роботі показано процес формулювання концепції візуального забруднення, що свідчить про відсутність однозначного визначення. Проведено диференціацію елементів візуального забруднення, а також властивостей візуальних полів. Аналіз методів оцінки візуального забруднення продемонстрував здебільшого описовий характер відповідних дослідницьких робіт. У ряді випадків для оцінки застосовуються складні інструментальні методи, результати яких інтерпретують знову в описовій формі. Розроблено спеціальний метод оцінювання якості візуального середовища, який враховує такі параметри, як ступінь агресивності та однорідності, забруднення рекламою та торговими точками, транспорт та навантаження населення, площа та розташування зелених зон, рівень затінення та наявність скупчень сміття. Кожен параметр, що входить до оцінки, забезпечений рейтинговою шкалою та ваговим індексом, що відображає його внесок у формування візуального ландшафту. Для апробації методу проведено оцінку візуального середовища у Солом'янському районі міста Києва. Результати демонструють високий рівень візуального забруднення вздовж основних автомобільних доріг та вулиць, а саме вулиці Борщагівська, вулиці Вадима Гетьмана, проспекту Космонавта Комарова, Чоколівського бульвару та Повітрофлотського проспекту. Малі вулиці, зокрема вулиця Левановського, вулиця Ніжинська та проспект Валерія Лобановського, з переважно житловою забудовою, демонструють передбачувано нижчу інтенсивність забруднення, але збільшують площу низьких якісних полів зору. Найпоширеніший елемент візуального забруднення – це скупчення сміття, транспортні затори, нерегульована роздрібна торгівля та відсутність зелених насаджень. Розроблено рекомендації щодо покращення якості візуального середовища, включаючи необхідність розробки міського стандарту візуального середовища.

**Ключові слова:** візуальне забруднення; бальна оцінка; наслідки для здоров'я людини; якість життя

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