

## Urban Planning Aspects of Ecological and Urban Planning Regulation Fundamentals for Main Street and Road Network Functioning and Forward Development

*Oleksiy Priymachenko*

Kyiv National University of Construction and Architecture  
31 Povitroflotskyi Ave., Kyiv, Ukraine, 03680  
[priymachenko\\_a@ukr.net](mailto:priymachenko_a@ukr.net), [orcid.org/0000-0001-5125-8472](https://orcid.org/0000-0001-5125-8472)

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**Abstract.** The greatest influence of motor vehicles is manifested in the urbanized environment. The city is an indicator of sustainable development or an unfavourable relationship between motor vehicles and the urban environment. The study is based on an assessment of the impact of the vehicles current state on the street and road network and trunk road adjacent areas to substantiate the adopted planning protective measures and to determine the functional purpose of the trunk road adjacent areas proceeding from environmental impact on street and road networks. Anthropogenic air pollution sources are primarily represented by industrial enterprises and vehicles emissions.

The main task in determining the assessment of the effectiveness of the protective solutions of trunk road adjacent areas is the correct choice of assessment criteria, according to which the efficiency of solutions will differ. Since the street and road network with all its traffic flows is an integral structural element of the city, its impact on the environmental performance of the urban environment can undoubtedly be called the prevailing one.

It is necessary to highlight noise, airborne emissions and air (atmosphere) pollution among the main environmental impacts, the source of which is the functioning of the street and road network. Since the street and road system is the main tool in wastewater collection and disposal, it also has a direct impact on the ecological condition of hydrosphere objects, i.e. groundwater, springs, water bodies. Its environmental impacts on the urban setting's lithosphere are also evident: road surface contamination, lubricant residues and gasoline pollute the soil during the removal of rain and melt wastewater. It is impossible to rule out the harmful



Oleksiy Priymachenko  
Assistant Professor of the  
City Urban Planning and  
Development  
PhD, Ass. Prof.

effects of electromagnetic loads from rail vehicle operation. According to the State Statistics Service of Ukraine, the quality of atmospheric air in a modern developed city is primarily dependent on the volume of pollutant emissions, the two main sources of pollution being stationary 15...30% and mobile 70...85% (using Kyiv's example).

**Key words:** ecological state of urban environment, trunk road adjacent area, environmental impact.

### PROBLEM STATEMENT

The purpose of this work is to explore the issues relating to the coordination of area development regulation and management processes that require research and unity of urban planning and ecological systems based on fundamental laws that are invariable and the violation of which leads to negative effects.

The development of methodological bases for regulating the functioning and development processes of the main street and road network in environmental and urban planning should be based on a comprehensive, problem-

oriented approach and interdisciplinary approaches used in research to solve many of our time's problems. The basics of the formation of the ecological and urban planning regulation need to be searched through the development of the metropolitan setting for the scientific substantiation of the functioning and development of regulatory urban planning codes and standards.

The following research tasks are identified in accordance with the objective:

- to analyse the existing ecological and city planning models of the urban environment;
- to develop a modern model of the ecological and urban planning setting;
- to investigate the main factors of impacts and potential of pollution of the urban setting ecological system;
- to explore the impact of vehicles on the ecological state of the urban setting;
- to identify methods for reducing environmental impacts on a trunk road adjacent area;
- a model of the effectiveness of the ecological and urban planning regulation of the functioning and development of trunk road adjacent areas has been proposed to assess and predict the environmental impacts on a trunk road adjacent area.

To achieve this goal, appropriate methods were used: a systematic approach, modelling methods, analytical methods, field studies, experimental design methods, mathematical methods, graphical-analytical methods of material systematization and presentation, as well as the principles and provisions of the general system theory, system and comparative analysis.

#### RECENT RESEARCH AND PUBLICATIONS ANALYSIS

The relevance of this research topic is indicated by the analysis of scientific works and urban development codes and standards in effect. This research topic is the subject of research by renowned scientists such as:

- V.I. Nudelman, M.M. Domin, Ye.Ye. Kliushnichenko, H.I. Lavryk, M.M. Habrel, Yu.M. Bilokon, I.O. Fomin, M.M. Kushnirenko, A.P. Ositnianko, O.I. Synhaivska, A.M.

Pleshkanovska, H.Y. Filvarov in urban and territorial planning issues;

- B.V. Solukha, M.M. Osietrin, Ye.O. Rejtsin, D.S. Samoiloova, V.I. Huk, T.O. Shilova, M.S. Fishelson, M.S. Murza, A.Ya. Tulaieva, H.L. Karaban, Z.I. Aleksandrovska, Yu.L. Shevchenko, V.S. Weinberg, I.B. Solukha, O.S. Furmanenko, I.I. Ustinova etc. in theoretical and scientific-methodical system studies in the aspect of transport and ecological problems.

#### STATEMENT OF BASIC MATERIAL

Environmental pollution is a complex process with different structural features and action parameters to generate different environmental impacts. The information model has been plotted with the classification of the pollution structure in the urban setting for the study of ecological and urban planning processes (Fig.1). According to this model, pollution impacts in the urban environment are classified by the following features:

- pollution sources;
- impact assessment;
- occurrence rate;
- exposure duration;
- pollution components;
- the parameters of effect on the urban environment;
- labour-intensive measures taken to eliminate pollution effects;
- complexity of such events' organization;
- external factors' effects.

In turn, two types of origin were proposed to distinguish pollution sources in the urban environment: communication and area-specific (Fig.2).

Communication pollution sources which are the facilities of the city's street and road network, should include all traffic flows, vehicles and mechanisms. Area-specific pollution sources are separate functional areas of the city (industrial, municipal, commercial). According to the impact assessment, pollution is divided into ultimately hazardous, highly hazardous, moderately hazardous, acceptable and safe.

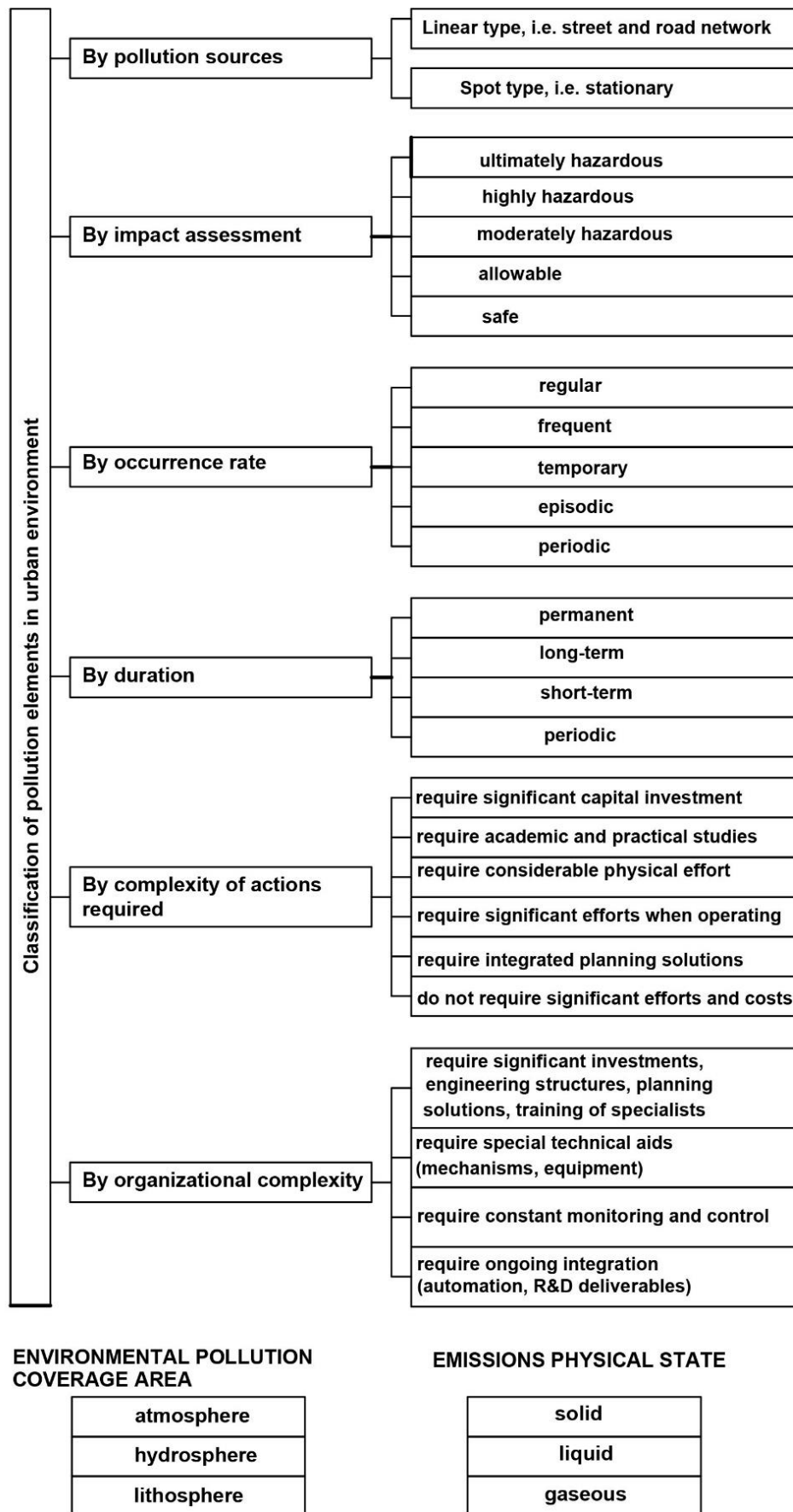
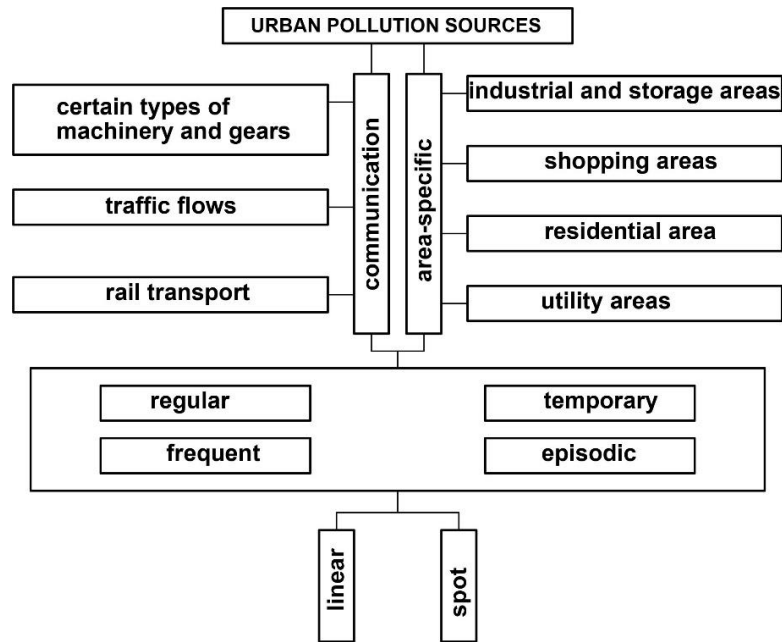


Fig. 1. Classification of pollution elements in the urban environment



**Fig. 2.** Block diagram of the classification of urban pollution sources

The results of the completed study allow us to formulate the consequences of pollution impacts on the urban environment:

- environmental pollution is a process of undesirable material costs, energy, labour, means and funds that people invest in the construction and planning of the area, which in turn become the irrecoverable waste that pollutes the urban environment;
- pollution results in irreversible damage to both individual ecological systems and the biosphere as a whole, including the impact on global physical and chemical parameters of the environment;
- fertile land is lost, ecological system the entire biosphere productivity are decreased as a result of pollution;
- pollution directly or indirectly leads to deterioration of physical and moral state of a person as the main production link of a society.

The developed information models indicate the complexity of the processes occurring in the planning structure of the city.

Formalized multistage representation of the object of study of the main street and road network allows to understand clearly the process of formation of certain environmental loads, their physical and chemical condition,

and indicates the management methods to reduce environmental impacts on an area in question.

In general, it is possible to work out a matrix of factors influencing the environmental impact on the street and road network based on the completed studies and the system-structural analysis (Fig.3).

It is necessary to distinguish noise and gas air pollution in the atmosphere among the main

the functioning of a street and road network. Since the street and road system is the main tool in wastewater collection and disposal, it also directly affects the ecological state of hydrosphere objects, i.e. groundwater, water sources, and water bodies. Its environmental impact on the urban lithosphere is also evident: contaminated road surface, remains of lubricants and gasoline pollute the soil during the removal of rain and melt wastewater.

The need to develop a set of methods for managing and developing the ecological condition of urban environment is proven by analysing modern data on emissions from motor vehicles. It is also evident that as a result of the city's main concentration of traffic flows, the main street and road network areas are under the major influence. The degree of at-

mospheric

City ecosystem	Atmosphere								Hydrosphere								Lithosphere								
Impact factors																									
Traffic intensity, vehicle/hour																									
Speed, km/h																									
Density, vehicle/ km																									
Vehicle interval																									
Composition of flow																									
Mode of motion																									
Daily intensity																									
Vehicle purpose																									
Vehicle engine type																									
Traffic management																									
Maintenance management																									
Additional background pollution																									
Energy resource quality																									
Air humidity																									
Wind speed																									
Wind direction																									
Season																									
Air temperature																									
Roadway surface type																									
Build-up of area between trunk roads																									
Landscaping of area between trunk roads																									
Relief																									
	noise	thermal	light	gas	radiation	electromagnetic	solid	liquid	noise	thermal	light	gas	radiation	electromagnetic	solid	liquid	noise	thermal	light	gas	radiation	electromagnetic	solid	liquid	
	Environmental impacts from the street and road network																								

Fig. 3. The matrix of factors influencing the environmental impacts on a street and road network



air pollution caused by vehicle emissions in local areas depends on the possibility of transferring pollutants, their level of chemical activity, meteorological distribution conditions in the area, and underlying surface characteristics. Numerous chemical reactions with different reaction rates, time of existence of all the substances involved, different dependencies of turbulent diffusion coefficients on the properties of the underlying surfaces, and certain hydrometeorological processes may occur in a limited space. The complexity of reliable modelling of automotive emission processes spread in the atmosphere therefore arises.

The approach that has been researched and proposed before for determining the EPI (ecological planning indicator) with its multifactorial content (value), on the determination of the elements and factors of influence on its action potential, will lead to the possible use of this EPI indicator by experts as an indicator of compliance of existing planning and design solutions with the regulatory planning support of the area, identifying environmental damage cases due to their direct effect, the investment volume to reduce the extent of environmental impacts, which in turn will affect the value of land and its functional efficient use. To evaluate the planning solutions enacted and the measures to reduce the EPI indicator, a model was proposed to streamline the use of trunk road adjacent areas, streamline the engineering solutions enacted, appropriately take into account a deterrent factor in countering the potential environmental impact, and determine the optimum protective measures for the area in the form of an optimum efficiency indicator formula:

$$E_{opt} = EPI(Rm; Nn) \quad (1)$$

provided that  $Rm \rightarrow \max; Nn \rightarrow \min$

where  $E_{opt}$  is the optimum quality of protective measures;  $EPI$  is the ecological planning indicator;  $Rm$  is the coverage of civil construction protective measures;  $Nn$  is the set of types of civil construction protective measures.

The calculation of the minimum impact on the area, which allows the use of  $Nn$ -type protective measures, is given by the method of

inverse action potential of the selected optimum protective measure to counteract the spread of environmental impact.

The studies that have been completed for the spatial arrangement of trunk road adjacent areas allow us to highlight a number of features:

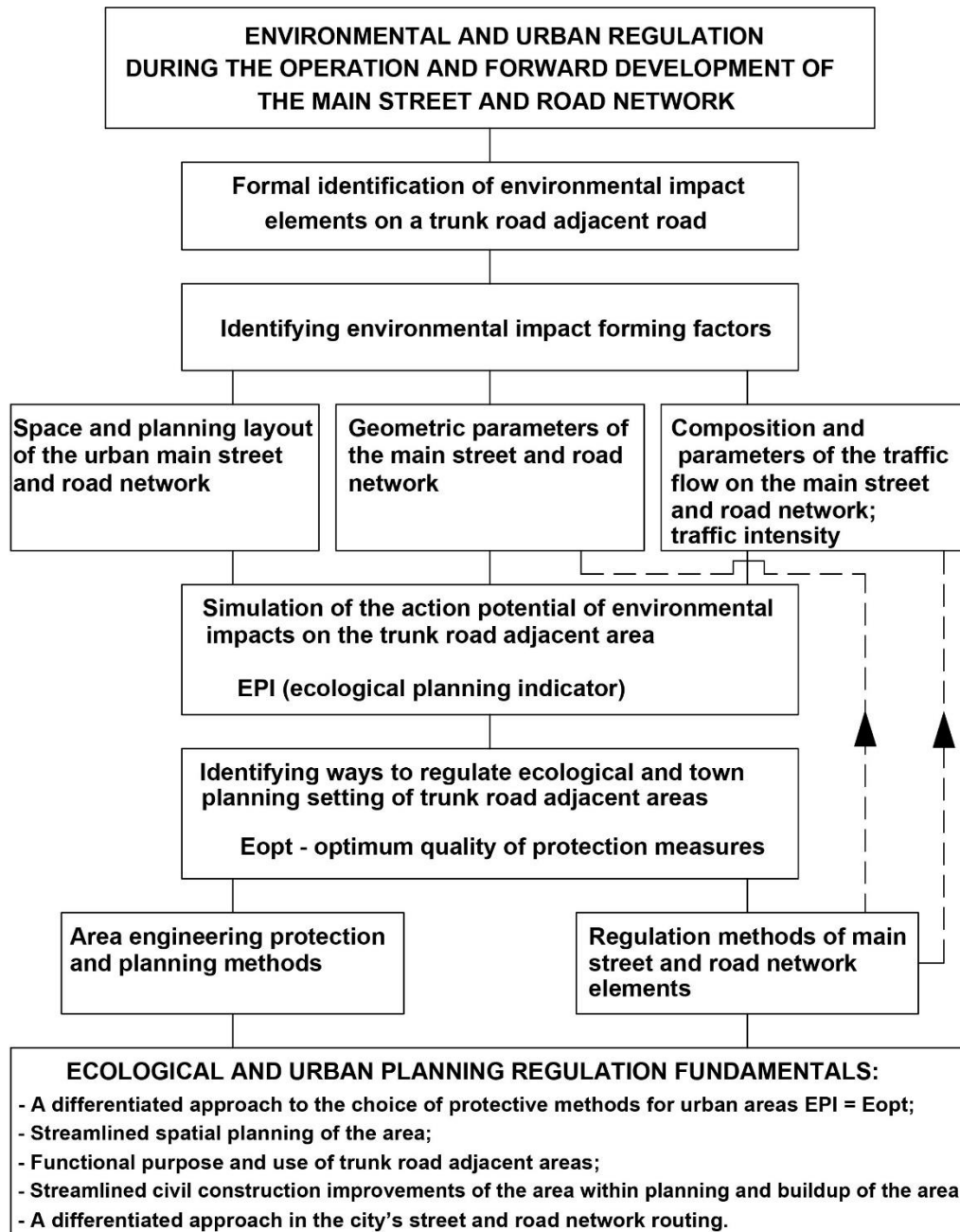
- a differential approach to urban areas protection methods;
- area spatial planning optimization;
- functional and applying the trunk road adjacent areas;
- optimization of site preparation during planning and construction;
- a differential approach in the city's street and road network routing.

As a result of the research conducted and the developed scientifically based models, a system of interrelated criteria and factors influencing the formation of the urban area has been created as a set of methods for plotting the Ecological and Urban Planning Regulation Fundamentals for the functioning and forward development processes of the main street and road network (Fig.4).

The creation of the city's ecological framework should therefore take into consideration all the components of planning solutions, reflecting an effective scientific and technical justification for implementing and resolving the relevant challenges within the urban planning sector, one of which is creating a population-friendly (proper quality) environment and maintaining its continued effective upgrades.

## CONCLUSIONS

Using the experience of theoretical and practical advances in urban and spatial planning the models have been developed in the study to ensure the effectiveness of regulating the ecological and urban planning status of adjacent areas of trunk road adjacent areas. A model of providing the Ecological and Urban Planning Regulation Fundamentals for the functioning and forward development processes of the main street and road network, taking into consideration the environmental impacts and forecasts, has been de-



**Fig.4.** A model of providing the Ecological and Urban Planning Regulation Fundamentals for the functioning and forward development processes of the main street and road network

veloped based on the planning solutions enacted, with the functional purpose of the area and the choice of civil construction protective measures for the area pointed out.

Studies of the trunk road adjacent areas, taking into account the ecological and urban planning aspect, will ensure the viability of their further functional use, the formation of the city's main motor transport corridors in the context of the development of new infrastruc-

ture and the reconstruction of the city's main road and road network, and identifying the economic efficiency of urban planning design solutions.

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**Градостроительные аспекты обеспечения оснований эколого-градостроительного регулирования процессов функционирования и развития магистральной улично-дорожной сети**

*Алексей Приймаченко*

**Аннотация.** Рассмотрены основные проблемы, связанные с исследованием и разработкой методологических основ эколого-градостроительного регулирования процессов функционирования и развития магистральной улично-дорожной сети под влиянием экологических нагрузок.

В наибольшей степени влияние автотранспорта имеет проявление в урбанизированной среде. Город является индикатором устойчиво-

го развития или неблагоприятной взаимосвязи автотранспорта и урбанизированной среды. В основу исследования положена оценка влияния современного состояния автотранспорта на улично-дорожную сеть и на прилегающую территорию для обоснования принятых планировочных мер защиты, определения функционального назначения прилегающих территорий в соответствии с экологическими нагрузками, которые возникают на улично-дорожной сети. Техногенные источники загрязнения атмосферного воздуха представлены, главным образом, выбросами промышленных предприятий и автотранспорта.

Главной задачей в определении оценки эффективности планировочных решений защиты прилегающих территорий является правильный выбор критериев оценки, согласно которым эффективность решений будет отличаться. Поскольку улично-дорожная сеть со всеми ее транспортными потоками является неотъемлемым структурным элементом города, ее влияние на экологические показатели городской среды бесспорно можно считать доминирующим.

**Ключевые слова:** экологическое состояние городской среды, магистральные территории, экологические нагрузки.