CHEMICAL AND PHYSICAL POLLUTION OF URBAN ECOSYSTEMS BY MOTOR TRANSPORT

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Abstract. *This article examines the issues of chemical and physical pollution of urban ecosystems caused by motor vehicles. The main sources of pollution are analyzed, including emissions of harmful substances into the atmosphere, noise impact, vibration, and thermal pollution. The influence of road transport on environmental conditions and public health in urbanized areas is assessed. Special attention is paid to modern approaches aimed at reducing the negative impact of transport, including the greening of transport systems and the implementation of innovative technologies. The results of the study can be used in the development of environmental protection measures and ensuring ecological safety in cities.*

Keywords: *motor vehicles, urban ecosystem, chemical pollution, physical pollution, atmospheric air, noise impact, vibration, pollutant emissions, environmental safety, urbanization.*

ХИМИЧЕСКОЕ И ФИЗИЧЕСКОЕ ЗАГРЯЗНЕНИЕ ГОРОДСКИХ ЭКОСИСТЕМ АВТОТРАНСПОРТОМ

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Аннотация. *В данной статье рассматриваются вопросы химического и физического загрязнения городских экосистем, обусловленного воздействием автотранспортных средств. Проведен анализ основных источников загрязнения, включая выбросы вредных веществ в атмосферный воздух, шумовое воздействие, вибрации и тепловое загрязнение. Оценено влияние автотранспорта на состояние окружающей среды и здоровье населения в условиях урбанизированных территорий. Особое внимание уделено современным подходам к снижению негативного воздействия транспорта, включая экологизацию транспортной системы и внедрение инновационных технологий. Результаты исследования могут быть использованы при разработке мероприятий по охране окружающей среды и обеспечению экологической безопасности городов.*

Ключевые слова: *автотранспорт, городская экосистема, химическое загрязнение, физическое загрязнение, атмосферный воздух, шумовое воздействие, вибрация, выбросы загрязняющих веществ, экологическая безопасность, урбанизация.*

SHAHAR EKOTIZIMLARINING AVTOTRANSPORT TA’SIRIDA KIMYOVIY VA FIZIK IFLOSLANISHI

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Annotatsiya.*Mazkur maqolada shahar ekotizimlarining avtotransport vositalari ta’sirida yuzaga keladigan kimyoviy va fizik ifloslanish muammolari ko‘rib chiqilgan. Atmosfera havosiga zararli moddalar chiqindilari, shovqin ta’siri, vibratsiya va issiqlik ifloslanishi kabi asosiy ifloslanish manbalari tahlil qilingan. Urbanizatsiyalashgan hududlarda avtotransportning atrof-muhit holati hamda aholi salomatligiga ta’siri baholangan. Shuningdek, transportning salbiy ta’sirini kamaytirishga qaratilgan zamonaviy yondashuvlar, jumladan transport tizimini ekologiyalashtirish va innovatsion texnologiyalarni joriy etish masalalariga alohida e’tibor qaratilgan. Tadqiqot natijalari shaharlar ekologik xavfsizligini ta’minlash va atrof-muhitni muhofaza qilish bo‘yicha chora-tadbirlarni ishlab chiqishda qo‘llanishi mumkin.*

Kalit so‘zlar: *avtotransport, shahar ekotizimi, kimyoviy ifloslanish, fizik ifloslanish, atmosfera havosi, shovqin ta’siri, vibratsiya, ifloslantiruvchi moddalarning chiqindilari, ekologik xavfsizlik, urbanizatsiya.*

In recent years, an increase in the flow of motor transport and the lifting of restrictions on its movement have led to a significant increase in physical and chemical pollution of resort towns. Today, in many Russian cities, there is a steady trend towards multiple, dozens or more times, excess of sanitary and hygienic standards for the content of carbon oxides, nitrogen, dust, toxic metal compounds and other harmful substances in the urban atmosphere [1-4]. There are serious problems with land reclamation, uncontrolled use of mineral fertilizers in agriculture, and excessive use of pesticides and herbicides. Wastewater from industrial and municipal enterprises pollutes large and small rivers, lakes, and coastal marine waters. Due to the constant pollution of atmospheric air, surface and groundwater, soils, vegetation, ecosystems are deteriorating, and the productive capacity of the biosphere is decreasing.

The main part of toxic impurities from motor transport enters the atmosphere with the exhaust gases of the internal combustion engine. Approximately 45% of hydrocarbons from their total emissions enter the atmosphere with crankcase gases and fuel vapors. The amount of harmful substances entering the atmosphere as part of the exhaust gases depends on the general technical condition of the vehicles, especially from the engine, which is the source of the greatest pollution. The relative proportion (of the total mass of emissions) of hydrocarbons and carbon monoxide is highest during braking and idling, while the proportion of nitrogen oxides is highest during acceleration. Cars pollute the air environment especially strongly during frequent stops and when driving at low speed [5].

Yangiyul City is a city with a population of 100,000 people and it is located 20 km from the capital. translated from Uzbek, it means new road, new way) is a city in the Tashkent region of Uzbekistan, located 20 kilometers southwest of Tashkent. It emerged as a major railway junction and industrial settlement. Its geographical coordinates are approximately 41°06'45" north latitude and 60002'48'' east longitude. There are practically no unchanged natural landscapes on its territory, various modifications of anthropogenic landscapes have been formed, in which elements created as a result of human activity prevail over natural ones to varying degrees. There are 3 main types and 8 subtypes of anthropogenic landscapes in the city according to socio-economic functions. The number of mobile and stationary sources of air pollution is increasing every year, which affects not only the state of the environment, but also the health of the population [6,7].

The purpose of the study. The purpose of this study is a comprehensive hygienic assessment of the chemical and physical pollution of urban ecosystems caused by the impact of traffic flows, identifying the main risk factors, levels of excess of sanitary and hygienic standards and spatial patterns of the spread of pollutants and noise.

The research materials were data from field observations of the intensity of traffic flows on the main highways of the city of Yangiyul, as well as the results of instrumental measurements of the levels of chemical and physical pollution of the environment. Statistical data processing was carried out using generally accepted methods of variation statistics with the determination of averages, relative indicators and the degree of deviation from the standard values.

Methodology for determining vehicle emissions. For environmental research, a field experiment is a source data provider for modeling the processes of pollution creation and distribution. The concentrations of pollutants entering the atmosphere from vehicles are calculated for streets with the highest traffic load. The streets of Yangiyul are not straight and narrow everywhere. Houses adjacent to highways mostly consist of 1-2-5-storey buildings, less often 7-storey buildings. Field studies of the traffic flow were conducted in 2025 (spring – summer) during the working week during peak hours – from 8 a.m. to 11 a.m. and from 4 p.m. to 7 p.m. For the calculation, the maximum number of vehicles passing through the motorway in a 20-minute period of time was used [8]. Motor transport was divided into the following groups: 1) passenger cars, separately domestic (Pc) and foreign (Pf); 2) minibuses (MB) and vans (V) of domestic and foreign production; 3) gasoline buses (GB); 4) diesel buses (DB); 5) gasoline trucks over 3.5 tons (including those running on liquefied petroleum gas petroleum gas) (T> 3.5); 6) diesel trucks up to 12 tons (DT < 12); 7) diesel trucks over 12 tons (DT > 12).

The results and their discussion. The calculation of the automobile transport is given in the table. 1. Emissions calculations are performed for the following harmful substances entering the atmosphere from the running gases of cars: carbon monoxide (CO); nitrogen oxides NOx (in terms of nitrogen dioxide); hydrocarbons (CH); soot; sulfur dioxide (SO2); formaldehyde; benz (a)pyrene.

Table 1.

The intensity of traffic flows along the streets of Yangiyul

Street name	Passenger cars (units)	Trucks (units)	Buses (units)	Special transport (units)	Всего, ед.	Speed, km/h (passenger/truck/auto.)
A. Temur	326 (171+88+67)	12	1	–	339	60 / 40 / 40
Navbahor	436 (270+115+51)	3	1	–	440	60 / 40 / 40
Tinchlik	766 (428+148+190)	26 (11+15)	12	–	804	60 / 40 / 40
Matonatli	1540 (779+531+230)	22 (10+12)	–	–	1562	60 / 40 / 40
Farovon	1023 (625+284+114)	18 (7+11)	–	–	1041	60 / 40 / 40
Furqat	317 (190+61+66)	–	10	–	327	60 / 40 / 40
ziyolilar	181 (104+28+49)	7	3	–	191	60 / 40 / 40

Note: The column "Passenger cars" summarizes the categories (Pc, Pf, MB, V). In the "Truck" column, vehicles over 3.5 tons are combined. "–" means no or insignificant quantity.

An analysis of the intensity of traffic flows on the Yangiyul city road network has shown a significant unevenness in the distribution of traffic load. The highest traffic intensity was registered on Matonatli Street (1,562 units), which allows it to be attributed to the main thoroughfares of the city with the maximum anthropogenic load. Significant traffic flows are also observed on the streets of Farovon (1,041 units) and Tinchlik (804 units), forming zones of increased environmental impact.

The average level of traffic load is noted on Navbahor and A. Temur streets, while the lowest traffic intensity is typical for Ziyolilar and Furqat streets.

A structural analysis of the traffic flow showed the predominance of light vehicles, which account for the majority of traffic in all the studied sections. At the same time, the availability of freight and public transport (especially on Matonatli and Tinchlik streets) significantly increases the level of environmental stress, including air pollution and noise pollution.

The established speed indicators (60 km/h for passenger cars and 40 km/h for trucks and public transport) contribute to the formation of stable pollution zones, especially near main streets.

Thus, the data obtained indicate the need to develop a set of measures to optimize traffic flows, reduce environmental stress and improve the sanitary and hygienic condition of the urban environment.

The concentrations of pollutants calculated by the method showed that the concentration of carbon monoxide entering the city Nalchik air pool from vehicles varies from 2.2512 to 13.031 g/s, nitrogen dioxide – from 0.4899 to 2.1417 g/s, hydrocarbons – from 0.59436 to 2.69865 g/s, soot – from 0.01443 to 0.09033, sulfur dioxide – from 0.01005 to 0.05677 g/s, formaldehyde – corresponds to the maximum permissible concentration. The concentration of other pollutants entering the atmospheric air of Yangiyul from vehicles does not exceed the maximum permissible concentration. The paper also investigated the physical (noise) pollution of Yangiyul due to the fact that noise has become one of the dangerous factors harming the environment these days. Prolonged exposure to noise harms not only hearing, it makes a person nervous and worsens his well-being. All the calculated points with concentrations of pollutants were mapped in Yangiyul. It was found that on Matonatli Street, closer to the intersection of Matonatli – Furqat streets, the concentration of nitrogen dioxide exceeds the MPC by 1.12 times, polluting residential landscapes.

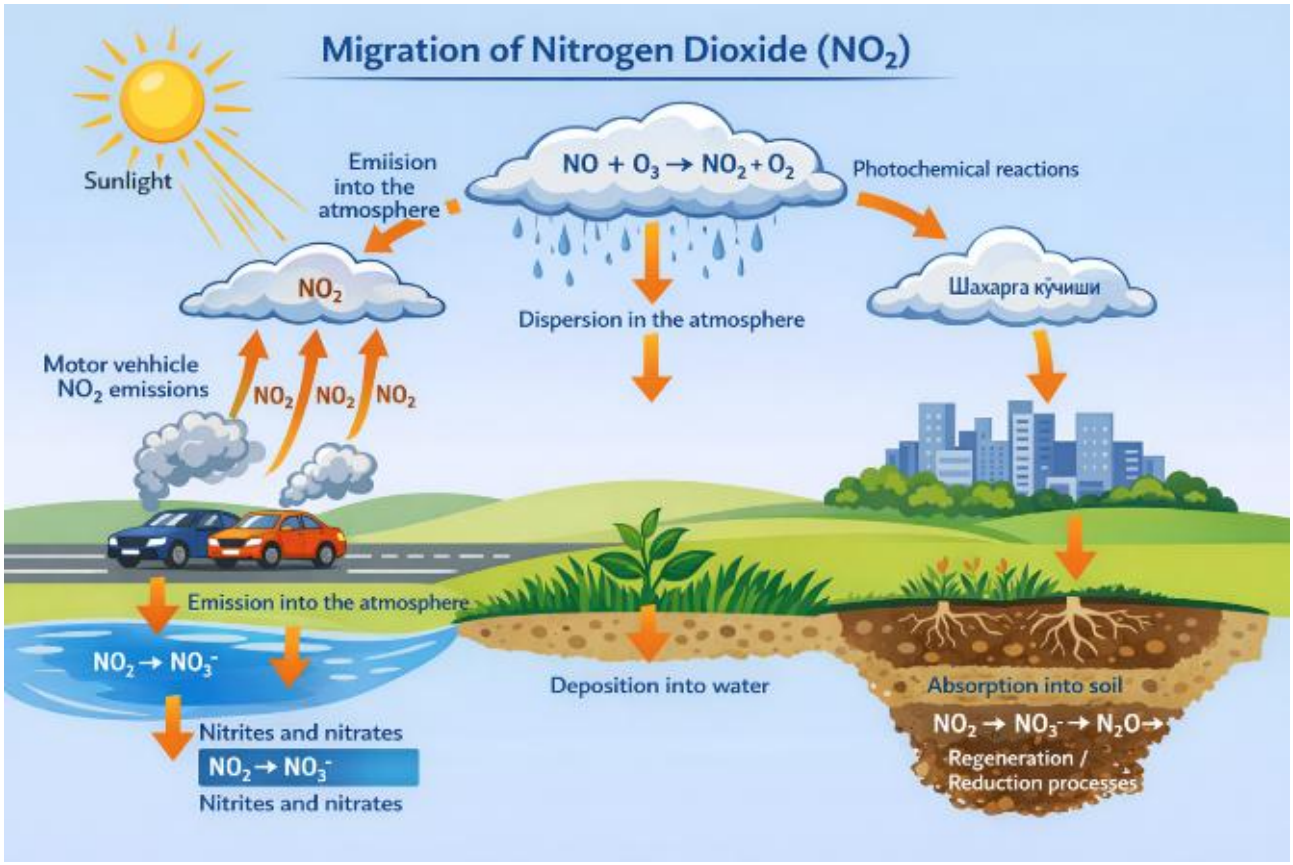

Fig. 1. **Migration map of nitrogen dioxide entering the landscapes of the city of Nalchik from motor vehicles (scale 1: 60,000)**

At the intersection of Matonatli and A.Temura streets, the concentration of nitrogen dioxide meets hygienic requirements. The main sources of noise in everyday life include the movement of vehicles, including street traffic in the city center and on major urban highways, where cars have to slow down and accelerate again. The noise level depends on the number of vehicles, their technical condition, and the distance of houses from the roadway. Method for calculating expected traffic noise levels Equivalent sound levels (dB) generated by traffic flow at the facade of a building can be obtained by measurement or calculated based on the noise characteristics of the traffic flow determined by the method based on the characteristics of traffic and the composition of the traffic flow. The highest levels of traffic noise in the building's garden are observed at the height of the third and fifth floors. At the height of the first and second floors, noise levels may be lower due to sound absorption by the ground and greenery. The initial parameter for calculating the equivalent sound level created at the facade of a building by the flow of motor vehicles (including buses and trolleybuses) is the noise characteristic of the flow rate of equivalent (L Acv) sound level. (dB), determined by rules of the norm of urban planning standard 2.08.01-19 – at a distance of 7.5 m from the axis of the near lane of traffic. The expected equivalent sound level generated by the flow of motor transport vehicles at the design point at the exterior fence of the building is determined by the method. A.Temur, Navbahor and Faravon, Tinchlik and Matonatli streets have 4 lanes of traffic. Furqat and Ziyolilar streets – 2 lanes. The number of vehicles passing through the main streets of Yangiyul (units/hour) is only increasing every year. The share of freight and public transport vehicles in the flow on A.Temur Ave. is 19%, on Navbahor - 16, Tinchlik Street – 28, Matonatli Street – 16, Farovon Street – 13, Furqat Street – 26, Ziyolilar Street – 29%. Table 2 shows calculations of equivalent sound levels generated by vehicles at a distance of 7 m from the roadbed.

Table 2.

The equivalent sound levels L Acv. and L Acv.ter.2

Street names	Lacv. DB	Increase in permissible levels (times)
A. Temur	73	1,2
Navbahor	74,1	1,22
Tinchlik	77,2	1,26
Matonatli	79,2	1,27
Farovon	77,2	1,27
Furqat	73,8	1,2
Ziyolilar	72,3	1,2

The acceptable values of the equivalent sound level in residential areas are 60 dB during the day and 50 dB at night. As can be seen from the data in Table 2, an increase in the permissible sound level at a distance of 7.5 m is observed on all streets, the maximum is on Matonatli and Farovon (1.27 times), and the minimum is on A.Temura Ave. and Ziyolilar St. (1.2 times). Table 2 shows calculations of equivalent sound levels generated by vehicles at a distance of 7 m from the roadbed.

Table 3.

Equivalent sound levels

№	Street names	Lacv. DB	Lacv. Ter.2, DB	Exceeding the permissible level (times)
1	A.Temur	73,0	71,5	1,20
2	Navbahor	74,1	73,5	1,22
3	Tinchlik	77,2	75,7	1,26
4	Matonatli	79,2	76,2	1,32
5	Farovon	77,2	76,2	1,29
6	Furqat	73,8	72,8	1,23
7	Ziyolilar	72,3	71,8	1,20

Note: The permissible values of the equivalent noise level in residential areas are: 60 dB during the day, 50 dB at night.

As can be seen from the data in Table 2, the excess of the permissible sound level at a distance of 7.5 m is observed on all streets, the maximum is the calculations of the sound level distribution in the city were carried out using the above data (Table. 2) using the program "Ecocenter Noise".

The analysis of equivalent noise levels (LAcv and LAcv.ter.2) in the streets under study showed

that at all observation points there was an excess of permissible hygienic standards for residential areas. It was found that the actual values of the noise level vary between 72.3 and 79.2 dB, which significantly exceeds the standard value of 60 dB in the daytime.

The highest noise levels were recorded on the streets of Matonatli (79.2 dB), Farovon and Tinchlik (77.2 dB), which indicates a high intensity of traffic flow and a significant acoustic burden on the population. The minimum values were recorded on Ziyolilar Street (72.3 dB), however, they also exceed the permissible values.

The coefficient of exceeding the permissible noise level is, which indicates the systematic impact of increased background noise on residents. It should be noted that even a slight but constant excess of standards can have an adverse effect on public health, including increased stress levels, sleep disorders and the development of cardiovascular diseases.

Thus, the data obtained indicate the need to develop and implement a set of sanitary and hygienic and organizational measures aimed at reducing traffic noise in residential areas. Such measures include the optimization of traffic flows, the use of noise barriers, increased landscaping, as well as the improvement of urban planning solutions.

In general, the problem of noise pollution in the studied territories is relevant and requires an integrated approach to its solution in order to ensure favorable living conditions for the population.

The analysis of the distribution of the equivalent noise level showed that there are three sites in the city that exceed the permissible sanitary standards. The most significant area is the second section, located along Ziyolilar Street, which is characterized not only by its largest area (more than 2 km2), but also by its long linear character, which indicates the influence of heavy traffic flows.

The first and third sections have a relatively smaller area (about 1 km2 each) and are characterized by a local increase in noise levels, probably due to the peculiarities of the road network, building density and traffic load. The identified areas of excess of acoustic standards indicate the need to develop and implement a set of sanitary and hygienic measures aimed at reducing the noise load. Such measures include: optimization of traffic flows, installation of noise barriers, landscaping, as well as rational urban planning. Thus, the results of the study confirm the relevance of the problem of traffic noise in the urban environment and the need for a systematic approach to its solution.

To assess the accuracy of the calculations, measurements of the equivalent sound level were carried out using the SVAN 949 noise analyzer. A comparison of the equivalent sound level obtained by the calculated method and the measured one showed a difference from 3.8 to 8.2%. Calculations of the conducted studies show that in Yangiyul, protective measures must be carried out to protect the population from the effects of noise. Moreover, in recent years there has been a tendency to increase the number of vehicles in the city. Protection of residential and public buildings from traffic noise can be carried out using urban planning (rational design of the street and road network, zoning of urban areas), architectural planning (special noise-proof buildings with the orientation of living rooms mainly towards the inner-city area), organizational (restriction of freight transport in residential areas, speed limits of vehicles, prohibition transit transport) and constructive measures. To plant green spaces. Dense planting of green spaces and screening structures located along highways have the property of enhancing vertical air currents. This leads to a decrease in the concentrations of toxic substances emitted from the exhaust gases of cars in the surface air layer behind these structures. In addition, green spaces have the properties of precipitation and biological processing of toxic compounds, which enhances their protective effect.

Conclusions

1.An analysis of the intensity of traffic flows in the territory of Yangiyul showed that the greatest load of vehicles is observed on Matonatli, Farovon, Tinchlik streets, as well as at the intersection of Matonatli and Furqat streets, which causes the formation of zones of increased anthropogenic impact.

2.It was found that in the Strelka area, the concentration of nitrogen dioxide, taking into account the migration of pollutants in the atmospheric air, exceeds the maximum permissible concentration (MPC) by 1.12 times, spreading to residential areas. At the same time, the concentrations of other pollutants do not exceed the regulatory values and amount to: soot — 0.23 MPC; carbon monoxide — 0.51 MPC; benz(a)pyrene — 0.24 MPC; formaldehyde — 0.42 MPC; - hydrocarbons — 0.44 MPC; sulfur dioxide — 0.04 MPC. The combined effects of nitrogen dioxide and sulfur dioxide in this area reach 1.16 MPC, which indicates that hygiene standards have been exceeded in residential areas.

3.It has been established that the share of freight and public transport in the total structure of the city's traffic flow ranges from 13 to 29%, which has a significant impact on the formation of chemical and physical pollution of atmospheric air.

4.The assessment of physical (noise) pollution showed that in the territories adjacent to the main highways, excess of sanitary standards for noise levels by 15-20 dB is recorded, which creates unfavorable living conditions for the population.

5.A comparative analysis of the calculated and instrumentally measured noise levels revealed their satisfactory correspondence.: The discrepancies ranged from 3.8 to 8.2%, which confirms the reliability of the applied calculation methods.

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