MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF ENVIRONMENTAL SAFETY,
ENGINEERING AND TECHNOLOGIES
DEPARTMENT OF ENVIRONMENTAL SCIENCE

APPROVED TO DEFENCE
Head of the Graduate Department
_____ Tamara DUDAR
«_____» _____ 2024

BACHELOR THESIS
(EXPLANATORY NOTE)

Theme: « Assessment of the state of environment for the main functional zones of small towns»

Done by: seeker of EK-402a group, Yaroshenko Dmytro Ruslanovych
(student, group, surname, name, patronymic)

Supervisor: PhD, Ass.Prof. Radomska Marharyta Myroslavivna
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Standards Inspector: _____ Andrian IAVNIUK
(signature) (name, surname)

KYIV 2024

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ ЕКОЛОГІЧНОЇ БЕЗПЕКИ,
ІНЖЕНЕРІЇ ТА ТЕХНОЛОГІЙ
КАФЕДРА ЕКОЛОГІЇ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
_____ Тамара ДУДАР
«_____» _____ 2024 р.

КВАЛІФІКАЦІЙНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «БАКАЛАВР»

Тема: « Оцінка стану довкілля основних функціональних зон малих міст»

Виконавець: здобувач групи ЕК-402 Ярошенко Дмитро Русланович

Керівник: : к.т.н., доц. Радомська Маргарита Мирославівна

Нормоконтролер: _____ Андріан ЯВНЮК

КИЇВ 2024

NATIONAL AVIATION UNIVERSITY
Faculty of Environmental Safety, Engineering and Technologies
Department of Environmental Science
Specialty, Educational and Professional Program: specialty 101 “Ecology”, Educational and Professional Program: “Ecology and Environment Protection”
(code, name)

APPROVED
Head of the Department
_____ Tamara DUDAR
«____» _____ 2024

BACHELOR THESIS ASSIGNMENT
Yaroshenko Dmytro Ruslanovych

1. Theme: « Assessment of the state of environment for the main functional zones of small towns» approved by the Rector on 03.04.2024 №504/ан.

2. Duration of work: from 11.03.2024 to 12.06.2024.

3. Output data of work: The data was collected from July to August 2023.

4. Content of explanatory note: Analytical review of the literature on the topic of the diploma. Assessment of the state of the environment in the town of Boyarka. Recommendations for improving the situation in the town.

5. The list of mandatory graphic (illustrated) materials: maps, diagrams, photos.

6. Schedule of thesis performance

№ з/п	Task	Term	Advisor’s signature
1	Formation of the thesis topic	11.03.2024	
2	Discussion and approval of the thesis topic	16.03.2024	
3	Formation of the thesis plan	16.03.2024-01.04.2024	
4	Literature review and writing chapter 1	01.04.2024-10.04.2024	
5	Compilation and description of the research	10.04.2024-	

	methods. Writing chapter 2	20.04.2024	
6	Conduction of survey, results analysis.	20.04.2024- 01.05.2024	
7	Writing chapter 3	01.05.2024- 10.05.2024	
8	Finalization of the thesis, formulation of conclusions	10.05.2024- 20.05.2024	
9	Formatting and preparing the thesis for presentation	20.05.2024- 01.06.2024	
10	Preliminary defense of the thesis	03.06.2024	
11	Revision of the thesis according to the comments and recommendations from the department	04.06-06.06.2024	
12	Submitting thesis to the Department	07.06.2024	
13	Defense of Bachelor's theses	12.06.2024	

7. Date of task issue: «__11__» ____March____ 2024

Thesis supervisor: _____ Marharyta RADOMSKA
(advisor's signature) (name, surname)

Task is taken to perform: _____ Dmytro YAROSHENKO
(graduate's signature) (name, surname)

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет екологічної безпеки, інженерії та технологій

Кафедра екології

Спеціальність, освітньо-професійна програма: спеціальність 101 «Екологія», ОПП «Екологія та охорона навколишнього середовища»

(шифр, найменування)

ЗАТВЕРДЖУЮ
Завідувач кафедри
_____Тамара ДУДАР
«____» _____ 2024 р.

ЗАВДАННЯ
на виконання кваліфікаційної роботи
Ярошенко Дмитро Русланович

1. Тема кваліфікаційної роботи «Оцінка стану довкілля основних функціональних зон малих міст»
затверджена наказом ректора від 03.04.2024 №504/ан.

2. Термін виконання роботи: з з 11.03.2024 по 12.06.2024.

3. Вихідні дані роботи: Дані були зібрані з липня по серпень 2023 року..

4. Зміст пояснювальної записки: Аналітичний огляд літератури за темою диплома. Оцінка стану довкілля в м. Боярка. Рекомендації щодо покращення ситуації в м..

5. Перелік обов’язкового графічного (ілюстративного) матеріалу: таблиці, карти, діаграми.

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1	Формування теми дипломної роботи	11.03.2024	
2	Обговорення та затвердження теми дипломної роботи	16.03.2024	
3	Формування плану дипломної роботи	16.03.2024-01.04.2024	
4	Огляд літератури та написання розділу 1	01.04.2024-10.04.2024	
5	Складання та опис методики дослідження. Написання розділу 2	10.04.2024-20.04.2024	
6	Проведення опитування, аналіз результатів.	20.04.2024-01.05.2024	
7	Написання розділу 3	01.05.2024-10.05.2024	
8	Доопрацювання дипломної роботи, формулювання висновків	10.05.2024-20.05.2024	
9	Оформлення та підготовка дипломної роботи до виступу	20.05.2024-01.06.2024	
10	Попередній захист дипломної роботи	03.06.2024	
11	Доопрацювання дипломної роботи згідно із зауваженнями та рекомендаціями кафедри	04.06-06.06.2024р.	
12	Здача дипломних робіт на кафедру	07.06.2024	
13	Захист бакалаврських робіт	12.06.2024	

7. Дата видачі завдання: «__11__» ____Березня_____ 2024 р.

Керівник кваліфікаційної роботи: _____ Маргарита РАДОМСЬКА
(підпис керівника) (П.І.Б.)

Завдання прийняв до виконання: _____ Дмитро ЯРОШЕНКО
(підпис випускника) (П.І.Б.)

ABSTRACT

Explanatory note to thesis « Assessment of the state of environment for the main functional zones of small towns»: _53_ pages, _3_ figures, _6_ tables, _19_ references.

The object of research is the change of living parameters of plant under the impact of anthropogenic load of different intensity.

The subject of research is the quality of environment in the town of Boyarka.

Research methods - information search, analysis and generalization of information, comparative analysis, visual observations, bioindication, statistical data analysis.

The aim of the bachelor's thesis is to assess the environmental state of the town of Boyarka in the areas with varied level of anthropogenic load using bioindication methods.

The essence of the work is the assessment of the ecological state of the city of Boyarka as it was carried out using bioindication methods, in particular the analysis of the state of the leaf cover of trees. The study included territories with different levels of anthropogenic load to identify the impact of various factors on the state of the environment.

BIOINDICATION, ANTHROBOGENIC IMPACT, BIOINDICATION, URBAN ECOSYSTEM.

CONTENT

INTRODUCTION

Relevance of the topic. The town of Boyarka developed over many years, thereby changing the environment. In order to determine the environmental state of the town, studies using bioindication methods were carried out.

Aim and tasks of the work

The ***aim*** of the bachelor's thesis is to assess the environmental state of the town of Boyarka in the areas with varied level of anthropogenic load using bioindication methods.

The main ***objectives*** of the work are:

1. Studying the literature about the town and its functional structure and determining the factors, defining environmental status of urban areas;

2. To form the procedure of bioindication study, suitable for the urban area;

3. Identify the study areas for the research with different level of anthropogenic load on the environment and evaluate the condition of indicator organisms there;

4. To analyze the condition of the leafy cover of trees in the zone of influence of anthropogenic factors and to determine the condition of the atmospheric air of the town of Boyarka;

5. Develop recommendations for reducing the anthropogenic load on the town and improving the overall ecological condition of the town.

The object of research is the change of living parameters of plant under the impact of anthropogenic load of different intensity.

The subject of the study is the quality of the environment in Boyarka.

Research methods - information search, analysis and generalization of information, comparative analysis, visual observations, bioindication, statistical data analysis.

Personal contribution of the graduate - is the study and analysis of the literature, the identification of areas with a different anthropogenic burden, performance of bioindicative study, and development of recommendations for improving the

environmental condition of the town.

Practical value . The results of the thesis can be used for planning further research on the environmental condition in the town, as well as for planning actions and developing plans for the improvement of environment quality. The information of the thesis can serve to develop the environmental awareness of the town 's residents.

The author's personal contribution is the study and analysis of the literature, the identification of areas with a different anthropogenic burden, performance of bioindicative study, and development of recommendations for improving the environmental condition of the town.

Approbation of results:

тези доп. Міжнар. наук.-техн. конф. за участю молодих науковців «Галузеві проблеми екологічної безпеки – 2023», (26 жовтня 2023 р.). – Харків: ХНАДУ, 2023. – С. 9-10.

зб. доп. VII Міжнар. студ. наук.-техн. конф. «Природничі та гуманітарні науки. актуальні питання». Тернопіль: Тернопільський національний технічний університет ім. І. Пулюя (м. Тернопіль, 25-26 квітня 2024 р.), 2024. С. 174.

зб. матер. IX Міжнар. молодіж. конгресу «Сталий розвиток: захист навколишнього середовища. Енергоощадність. Збалансоване природокористування», 28-29 березня 2024, Україна, Львів. Київ : Ярочéнко Я. В., 2024. С. 216.

Participation in climate change adaptation , EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024.

Conferences:

Radomska M.M., Yaroshenko D.R. The issues of achieving the sustainable development goals by peri-urban communities – environmental aspect on the example of the town Boyarka : тези доп. Міжнар. наук.-техн. конф. за участю молодих науковців «Галузеві проблеми екологічної безпеки – 2023», (26 жовтня 2023 р.). – Харків: ХНАДУ, 2023. – С. 9-10.

Yaroshenko D.R. Peculiarities of performing bioindication studies at urban areas: зб. доп. VII Міжнар. студ. наук.-техн. конф. «Природничі та гуманітарні науки.

актуальні питання». Тернопіль: Тернопільський національний технічний університет ім. І. Пулюя (м. Тернопіль, 25-26 квітня 2024 р.), 2024. С. 174.

3. Huz V.V., Yarokhmedova I.V., Yaroshenko D.R., Radomska M.M. Features of the formation of environmental quality in the main functional zones of large and small cities : зб. матер. IX Міжнар. молодіж. конгресу «Сталий розвиток: захист навколишнього середовища. Енергоощадність. Збалансоване природокористування», 28-29 березня 2024, Україна, Львів. Київ : Ярочéнко Я. В., 2024. С. 216.

Publications:

1. Radomska, Marharyta & Ratushnyuk, Lesya & Yaroshenko, Dmytro & Yarokhmedova, Ivanna & Guz, Valeriy & Melnychenko, Vitaly. (2023). Comparative analysis of strategies for adaptation of urban areas to climate changes. Construction Engineering. 50-58.

CHAPTER 1
FACTORS OF THE FORMATION OF THE ENVIRONMENTAL SITUATION IN CITIES

1.1. Functional structure of the town

A town is a large settlement whose population is usually employed outside the sphere of agriculture; usually the administrative, industrial, commercial or cultural center of a certain region. A type of human settlement, usually large in number and population density, most of whose inhabitants work in industry and the service sector. In many countries, the status of a town is determined and fixed by law, taking into account the indicators of the number and employment of citizens.

Modern cities are divided into small (up to 50,000 inhabitants), medium (50,000-250,000), large (250,000-500,000), state-important (500,000-1,000,000), and millionaire cities - more than 1,000,000 people, as well as megacities – large agglomerations of cities that merge into one urban system. In 2021, there were 1,170 largest cities in the world, of which 557 were millionaire cities.

Satellite cities are emerging near many large cities with millions of people. Often, cities and satellite cities merge, forming agglomerations, which can be combined into megalopolises.

The functional structure of the town is determined by various functional zones that correspond to certain needs and activities of residents and enterprises. The main functional areas include:

1) Residential areas are areas dominated by residential buildings, as opposed to industrial and commercial areas.

Housing can vary greatly between and across residential areas. These include single-family homes, apartment buildings, or mobile homes. Zoning for residential use may allow some services or may exclude business and industry entirely. It can allow high-density land use or only low-density land use. Residential zoning typically

includes a lower FAR (area ratio) than business, commercial, or industrial/manufacturing zoning. The area can be large or small.

2) Industrial zones include industrial facilities, warehouses and similar objects. These areas are intended for activities related to the production, processing, cleaning, repair, storage and distribution of goods and materials. Each town adapts its industrial zoning laws to suit its economic needs and community goals, ensuring that the industrial sector can thrive without negatively impacting the quality of life of its residents.

3) Commercial areas in a town are areas, districts or blocks that are primarily made up of commercial buildings, such as a shopping mall, office parks, downtown, central business district, financial district, "High Street" or shopping malls. Commercial activity in cities includes the buying and selling of goods and services in retail businesses, wholesale buying and selling, financial institutions and a wide range of uses broadly classified as "business". Although commercial activities usually occupy a relatively small amount of land, they are extremely important to a community's economy. They provide jobs, facilitate the circulation of money, and often perform many other important roles in society, such as public gatherings and cultural events.

Commercial space is real property intended for use by commercial enterprises, such as office complexes, shopping centers, service stations, bars and restaurants. It can be purchased by a developer for future projects or rented through a real estate broker. This type of property is somewhere between residential and industrial property. Practically every new arrival must provide a permit for the construction of a new office complex or other profitable business, the town authorities must determine that the selected plot is indeed commercial. If the areas that separate the commercial, industrial and residential areas are clearly zoned for commercial use, the town will allow the sale to continue for that use. However, if any part of the property is zoned residential or industrial, then the buyer must obtain a "variance," a special permit to cross the zone boundary.

4) Educational and cultural districts are an important component of the functional structure of the town . They include schools, colleges, universities and other educational

institutions. These areas can be centered around large universities or include several educational complexes of different levels. Educational and cultural districts usually have a large number of libraries, cultural centers, exhibition halls and other institutions that contribute to the development of a cultural and intellectual environment. These districts may have distinctive architecture and design that reflect their educational and cultural focus.

An important characteristic of educational and cultural districts is their accessibility and developed infrastructure, which ensures a comfortable stay for residents and visitors.

Cultural districts of the town contain theatres, museums, cinemas, galleries, concert halls and other places of cultural recreation and entertainment. These areas can be the centre of the town 's cultural life, where various events and festivals are held.

Educational and cultural districts are of great importance for the development of the intellectual and cultural potential of the town, at the same time they produce minimal pressure on the environment.

5) Green spaces: In land-use planning, urban green spaces are open areas set aside for parks and other "green spaces", including plant life, water bodies, also called blue spaces, and other types of natural environments. Most urban open spaces are green spaces, but sometimes include other types of open areas. The landscape of urban open spaces can range from playing fields to well-maintained environments to relatively natural landscapes.

Urban green spaces are generally considered open to the public are sometimes privately owned, such as higher education campuses, neighborhood/community parks/gardens, and institutional or corporate grounds. Areas outside town limits, such as state and national parks, as well as open spaces in rural areas, are not considered urban open spaces. Streets, squares, plazas and town squares are not always defined as urban open space in land use planning. Urban green spaces have a large-scale positive impact on the health of people and communities near green spaces.

6) A transport hub is a place where passengers and goods are exchanged between vehicles and/or between modes of transport. Public transport hubs include railway

stations, rapid transit stations, bus and tram stops, airports and ferry stations. Freight hubs include sorting stations, airports, seaports and truck terminals, or combinations thereof. For private car transport, the parking lot functions as a unimodal node.

1.2. The main factors influencing the environmental situation in cities (by different functional zones)

Environmental situation is a spatial and temporal combination of various conditions and factors, both positive and negative, defining safety and comfort of living in cities. The environmental situation is a product of interacting natural and man-made impacts.

Let's consider the main factors influencing the environmental situation in cities by different functional zones in more details.

Industrial zones are formed in the functional structure of the town in order to effectively ensure interaction between enterprises, provide joint resource flows, and solve logistical problems. Along with this, the industrial sector creates a complex mixture of pollutants that enter the air and can interact with each other to form secondary pollutants. Under the conditions of the joint use of water bodies for the discharge of wastewater, the problem of their more intense pollution also arises. Such planning decisions also lead to deep and complex contamination of soils, the rational use of which is impossible under these conditions.

A serious threat to the state of the environment is also a significant accumulation of waste on the territories of enterprises. These wastes contain significant amounts of pollutants, which, when stored incorrectly, easily enter the tangential components of the environment.

Road transport is also one of the main sources of environmental pollution in cities due to toxic emissions and noise, and in the case of electric transport, it also creates electromagnetic pollution. Thus, transport hubs release into the atmosphere such pollutants as nitrogen oxides, hydrocarbons, solid particles and others. Noise from vehicles can also have a negative impact on town dwellers, causing stress and affecting

health.

Residential areas of the town are not only receptors of the negative effects of industry and transport, but also contribute to their formation. Pollution from heating and infrastructure facilities negatively affects air quality in residential areas and forms physical pollution.

Accumulation of domestic waste and other waste can contaminate soil and water resources in residential areas, which can have negative health and environmental consequences.

Green areas and parks are normally perceived as means of mitigating pollution of the environment, but they are exposed to the whole spectrum of effects from anthropogenic pressure. In particular, green areas can be exposed to air pollution from motor vehicles and waste, as well as be affected by the pollution of ground waters, typical for urban areas. Mass events and tourist traffic can have a negative impact on the ecosystems due to physical degradation of soils and vegetation.

These factors interact with each other and can have complex effects on environmental change in cities. Identification of these factors will help to develop effective measures to protect the environment and improve the ecological situation in cities.

1.3. Methods of providing environmental safety in various functional zones of the town

Environmental safety is the maintenance of such a state of the surrounding nature and social relations, which ensures the human right to safe environment: fresh and clean air, unpolluted land, good water and quality food products.

Environmental safety of urban population is built on interaction of components, related to the actions of population and control of the sources of environment, which takes the form of:

- awareness of urban population about their dependence on the quality of environment and factors of urban ecosystem, which threatens their balance and safety;

- control of the use of natural resource, which are limited on the territory of cities and must be transported from other territories;
- limitation of urban development expansion at the cost of green and blue infrastructure;
- determining the permissible levels of anthropogenic impacts on urban ecosystems through the setting of limitation on emissions, discharges and waste generation;
- prevention of growing physical pollution of urban environment – noise, electro-magnetic, visual and light;
- creation of a socio-economic mechanism of homeostasis in the system "nature — goods — money — nature";
- integrate the processes of environment control and nature conservation at local, regional and global levels;
- implementation of the best available resource-saving technologies in all branches of urban economy;
- recognition of the law of optimality and the principle of reasonable sufficiency in the use of methods of obtaining life's benefits within urban systems;
- limitations on environmental, social and economic risk factors for urban residents;

Specific actions, aimed at improving the level of environmental safety in cities are different depending on the urban functional zones.

Industrial areas are in need for application of strict regulations on emissions, water pollution and waste generation, as well as use of clean technologies. This should be supported by regular environmental monitoring. Replacement of outdated technologies with environmentally friendly analogues is another approach, expected to reduce the negative impact of industry on the environment.

Transport impacts could be mitigated by the promotion and development of public and green modes of transport. Traditional transport should be regulated via emission standards and monitoring of their maintenance.

Impacts on the environment form residential areas could be reduced through the

application of energy-efficient technologies and materials for construction and reconstruction of residential buildings.

Improvement of waste management and development of green areas will contribute to the improvement of environment quality in residential areas. As for the green infrastructure itself, its systematic maintenance and protection is a key for the well being of any town .

However, all this actions will have limited effect unless high level of environmental educational town residents is provided. Organizing and supporting environmental activities, festivals and events in these areas contributes to awareness and interest in environmental issues.

These methods are aimed at improving the ecological situation in cities and reducing the negative impact on the environment in various functional zones.

1.4. Sustainable development of cities: drivers and drawbacks

Urbanization is a global phenomenon that is transforming our world; this brings both potential positive and negative impacts to communities. Making sustainable urban development a reality is critical for cities to support growing populations and address environmental challenges.

Sustainable urban development is defined as development that meets the needs of the community without compromising the ability of future generations to meet their own needs. It is built on economic, environmental and social sustainability. Sustainable development aims to make cities livable and promote economic, social and environmental resilience in the face of a changing climate.

Sustainable development focuses on creating cities that offer high living standards, but also balance between the social and environmental needs of communities. Sustainable development combines strategies to reduce pollution and conserve natural resources with improvements in transportation and housing, public safety and health, and social services. It includes integrated approaches to urban planning that respond to the needs of local stakeholders, communities and the natural environment.

Sustainable urban development is important for many reasons, from long-term economic benefits to improved quality of life and reduced environmental impact. By investing in green initiatives, cities can create jobs and grow while reducing energy consumption, waste and pollution. In addition, sustainable development can improve living conditions and create opportunities for social integration among different sectors of society.

As cities become more populated and congested, the demand for urban infrastructure increases. When cities invest in innovative and effective sustainable practices, these same infrastructures can become greener and more efficient over time. This can have a significant impact on the environment, reducing both waste generation and energy consumption. For example, by implementing practices that reduce reliance on non-renewable energy sources, cities can work to reduce carbon dioxide emissions and help reduce global warming. In addition, by improving public transport networks, cities can improve air quality, reduce congestion and noise pollution, and lower the cost of living for citizens.

A second important reason why sustainable urban development is so important is the economic benefits it can bring. By investing in sustainable initiatives and practices, cities can make themselves more attractive to businesses, attracting new businesses and creating jobs. Adopting energy efficiency strategies can reduce operating costs and make businesses more profitable, allowing them to offer better wages, which in turn boosts the local economy. In addition, reducing the amount of waste generated by cities can reduce the cost of municipal services, freeing up funds for other essential services such as health, education and housing.

Finally, sustainable urban development is essential for all citizens to enjoy economic employment and a better quality of life.

Nevertheless, there are multiple challenges that cities and developers face when creating and implementing sustainable urban development projects. These challenges can range from financial constraints to a lack of understanding of how to create sustainable solutions. Understanding the challenges of sustainable urban development is key to creating successful projects that will have a lasting impact on the community and

its environment.

1.5. Strategic approaches to urban development within the sustainability framework

To achieve sustainability, cities must focus on three key aspects: economic, social and environmental. By applying strategic approaches to sustainable urban development, cities can not only improve their infrastructure and services, but also reduce their environmental impact and meet the needs of their residents. This creates multiple tasks in the field of urban planning, transport and energy supply (Fig. 1.1).

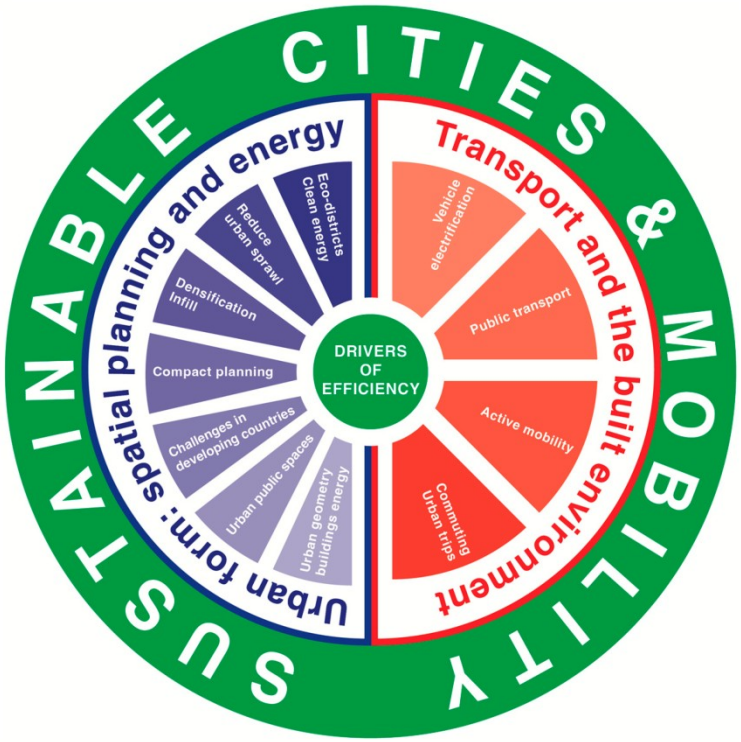

Fig. 1.1. Components of sustainable cities development

One of the most effective strategic approaches to sustainable urban planning and development is the use of green infrastructure. Green infrastructure such as green roofs, green walls, permeable pavement, urban gardens and rain gardens incorporate plants, soils and natural elements into the built environment. These features are designed to reduce stormwater runoff, improve air and water quality, reduce the urban heat island

effect, and create green spaces for recreation and leisure. In addition, green infrastructure can help reduce energy consumption, limit urban sprawl and improve the overall sustainability of a town .

Another important approach to the sustainable development of cities is the implementation of circular economy strategies. Circular economy strategies are aimed at reducing waste and increasing the efficiency of resource use by moving from a linear model of production "take-make-dispose" to a circular model of "reuse-repurpose-recycle". By implementing strategies such as reuse and re-use, retrofitting, product life extension, recycling and waste reduction, cities can reduce their overall environmental impact and better meet the needs of their residents.

In addition, it is important to promote compact construction and transport solutions as part of the strategy of sustainable urban development. Compact development is the practice of creating compact, connected and convenient neighborhoods that can provide easy access to goods, services and amenities while promoting a less car-dependent lifestyle. Similarly, transportation solutions such as improved public transit, bike lanes, and improved pedestrian infrastructure can help reduce car dependency in urban areas, improve air quality, and reduce greenhouse gas emissions.

Finally, cities should strive to create vibrant, livable neighborhoods with access to open space, green space, healthy food, and recreational activities. These zones should promote physical activity, improve social connections and provide access to nature, which can help reduce stress and improve well-being.

The underlying strategy of sustainability is education. As cities become denser and more densely populated, equipping both individuals and communities with the knowledge and skills to make informed decisions that can lead to more sustainable cities is decisive. Therefore it is important that educational institutions play an active role in this process.

Financing sustainable urban development projects is a unique challenge for both governments and private corporations due to the financial costs associated with addressing issues such as pollution, overpopulation and climate change. As a result,

innovative financing mechanisms and models need to be explored to ensure adequate funding.

One of the possible solutions for securing financial capital for sustainable urban development projects is public-private partnership. This model works by combining resources and expertise of both the public and private sectors to create and implement solutions. Thus, private sector finances initiatives under the permission of public authorities and gains benefits and incomes from the implemented projects. This approach is also instrumental for bringing together different stakeholders with their experience and getting access to financial sources, such as green loans. Green finance is an attractive financing model for sustainable urban development projects because it uses environmental, social and governance (ESG) criteria instead of traditional financial performance indicators to secure financing. With green finance, investors can identify the projects with the highest returns, comparing them to the overall impact they will have on society in the long term.

Thus, there are already strategic approaches to sustainable urban development are essential to making cities more sustainable, equitable and sustainable.

1.6 Environmental component of sustainable urban development

Provision of sustainable development of cities includes a wide variety of actions, but in terms of its environmental component the following steps are necessary:

1. Create the most complete list of sources of pollution by all components of the environment.

2. To assess the impact of each source on the components of the environment in terms of components and their quantity

3. Create and implement plans for the gradual reduction of environmental impacts of each enterprise

4. Formed a general strategy for the sustainable development of the town 's production sector

5. Develop and implement systems of permanent environmental control and

monitoring in all vulnerable territories. In this part of the work, you should use both traditional instrumental and chemical-analytical methods, as well as biological means - bioindication.

The purpose of this work is the first two stages – formation of the list of the main sources of environmental pollution in the town of Boyarka and assessment of their impact by bioindication methods.

Conclusions to Chapter 1

The functional zoning of cities is shown to play a decisive role in the formation of the environmental situation within the urban area. Sustainable development of settlements includes many components, which are interdependent andstill bound to the location of functional objects within the town . Accounting the specialization of certain districts of settlements it is possibl;e to plan efficient monitoring programs using bioindicators to control integrally such functional areas of a town .

CHAPTER 2
METHODOLOGY OF BIOINDICATION RESEARCH

2.1 Advantages and disadvantages of bioindication

Bioindication is a method of assessing the degree of environmental pollution based on the reaction of living organisms directly in their place of existence.

Bioindication is widely used as a method of detecting human pressure on biological communities during ecological studies. This method is based on the study of the influence of environmental factors on various characteristics of biological objects and systems. Thus, the state of the environment can be assessed using living organisms and their reactions to certain changes.

In general, there are two methods of bioindication - passive monitoring and active monitoring. In the first case, the study of visible or invisible damage or deviations from norms in a free-living organism is a sign of stress. Active monitoring reveals the same effects on test organisms under standard conditions in the study area.

Various specific and non-specific signs can be used as biological indicator signs. Non-specific indication of contamination of aircraft equipment can be carried out with the help of various biochemical and physiological reactions.

The main indicators reflecting stress in the indicator organism are:

• change in enzyme activity;

• destruction of pigments in plant leaves under the influence of air pollution. Chlorophyll regeneration has been well studied. Under the influence of carbon dioxide, the content of lutein increases, and the amount of carotene decreases;

• aging hormones - ethylene and abscisic acid appear prematurely;

• changes in mineral metabolism. Approximate signs are changes in the content of fatty acids, an increase in the content of sucrose and glucose.

One of the most typical indicative signs of a specific nature is a change in the chemical composition of biomass and the accumulation of pollutants. The content of

pollutants depends on the age of the leaves.

Non-specific signs of indication are indications of various morphological, anatomical and behavioral parameters. This includes: changes in the size of tissue cells, resin courses, changes in the size of leaves, stems and organisms.

Live indicators have a number of advantages:

- in conditions of chronic anthropogenic loads, they can respond even to relatively weak impacts due to the cumulative effect;
- sum up the impact of all, without exception, biologically important impacts and reflect the state of the environment as a whole, including its pollution and other anthropogenic changes.
- eliminate the need to register chemical and physical parameters characterizing the state of the environment.
- record the rate of changes occurring under the influence of external factors.
- indicate the ways and places of accumulation in ecological systems of various types of pollution and poisons.
- make it possible to draw conclusions about the degree of harmfulness of any man-synthesized substances for living nature and for himself, and make it possible to control their actions.
- provide an idea of the trends in the development of the natural environment.
- the response is manifested as the accumulation of certain critical values of the total dose of the effect;
- they are able to sum up without exception the impact of all biologically important influences reflecting general environmental conditions, including pollution and other man-made changes;
- eliminate the need to register chemical and physical parameters characterizing the state of the environment;
- able to record the speed of changes occurring in the nps;
- show the places of accumulation of various pollutants and toxic substances, as well as their possible ways of entering human food;

- make it possible to draw conclusions about the degree of harm of any substance synthesized by humans for wild animals and themselves.

Disadvantages of bioindication:

1. Subjectivity: the results of bioindication can be subjective and depend on individual characteristics of organisms, their health status, age and other factors.

2. Sensitivity to external influences: Bioindicators can respond to a wide range of factors unrelated to environmental pollution, which can cause inaccuracies in the assessment of the state of the environment.

3. Complexity of interpretation: Bioindication results require experience and qualification for their correct interpretation. It is not always clear whether the changes in the body are caused by pollution or are the result of other factors.

4. Limitation of the impact function: All changes in the ecosystem may be beyond the ability of bioindicators to detect them, especially if these changes involve chemicals that do not affect living organisms in a direction.

2.2. Choosing bioindicators

Representatives of all "kingdoms" of living nature can be used as bioindicators. Organisms affected by diseases, pests and parasites are not suitable for bioindication. A biological indicator must meet a number of requirements:

1. To be typical for the given conditions;

2. Have a high number in the studied ecotope;

3. To live in this place for a number of years, which makes it possible to follow the dynamics of pollution;

4. To be in conditions convenient for sampling;

5. Be characterized by a positive correlation between the concentration of pollutants in the body of the indicator and the object of research

6. Use the natural conditions of its existence;

7. To have a short period of ontogenesis, so that it is possible to monitor the influence of the factor on subsequent generations.

The reaction of the bioindicator to certain physical or chemical influences should be clearly expressed, that is, specific, easily recorded visually or with the help of devices.

Bioindication methods can also include detection of rare and endangered species in the studied area. They are essentially those indicator species that are most sensitive to anthropogenic influence.

Sensitive indicators indicate the presence of pollutants in the air or soil through early morphological reactions - a change in leaf color (yellow, brown or bronze), various forms of necrosis, premature wilting and leaf fall. In perennial plants, pollutants can cause changes in the size, shape and number of organs, the direction of branch growth or fertility. This reaction is usually non-specific.

Indicators can be chosen so that they reflect environmental problems at certain levels:

- Level 1: biochemical and physiological reactions;
- Level 2: abnormal anatomy, morphology, biological rhythm and behavior;
- Level 3: changes in flora and fauna;
- Level 4: genetic changes;
- Level 5: biogeocenotic changes;
- Level 6: landscape changes.

Most often bioindicator studies use plants, in particular, trees as signal organisms. They provide a number of benefits.

Trees are fundamental components of ecosystems, since they create living environment for all other species. With the use of plant organisms, it is possible to carry out bioindication of any natural environments. Thus, the composition of arboreal community and the condition of its representatives reflect the general condition of the environment and indicate the potential productivity of the soil and its moisture content. Indicator plants can also display the mechanical and acidic composition of the soil, fertility, humidity and salinity, the degree of mineralization of groundwater and the degree of air pollution by gaseous compounds, as well as determining the degree of pollution by pollutants in water bodies.

For trees, the best method of bioindication is to use leaves of the plant. Under the influence of pollutants, vital processes are violated and this leads to the changes in the structure of tissue, individual organs and general forms of plant growth. Thus, it is possible to observe changed shape of the leaves (asymmetry appears, and the area of the leaves decreases), deformations of the leaves, swelling or bending of leaves, colour changes, areas of damaged tissues and in extreme cases – formation of teratoma.

2.3. Peculiarities of performing bioindicative studies in cities

Performing bioindicative research in cities may have its own characteristics due to the specifics of the urban environment, such as:

1. Limited Biodiversity: cities may have a limited number of species that can be used as bioindicators due to the high level of anthropogenic impact and the presence of natural habitats. This can complicate the selection of bioindicators and disrupt the accuracy of the assessment of the ecological environment.

2. Small number of free territories: cities have a limited number of free territories for holding. This can lead to studies being conducted in limited areas, which can make it difficult to obtain representative data.

3. Presence of background pollution: cities often have different background pollution in air, water, and soil, which can prevent determination of the effects of specific pollutants on organisms. It can work establishing a connection between pollution and its consequences for living organisms.

4. The possibility of accumulation of toxic substances: in urban conditions, the accumulation of toxic substances in bioindicators can occur due to constant contact with polluted environments. This can lead to distortion of research results and underestimation of the pollution level.

5. Peculiarities of urban flora and fauna: urban environment has its own unique flora and fauna that can be adapted to life in the town .

When performing bioindicative studies, it is important to take into account these features and choose bioindicators that best reflect the ecological situation in the town . It

is also important to differentiate between gas resistance and gas sensitivity of plants.

Gas resistance is the ability to preserve the processes characteristic of the organism, the processes of vital activity and reproduction of seeds in conditions of pollution by atmospheric gases and vapors. The level of air resistance of a species or individual is estimated as the maximum concentration of toxic substances that will not cause disturbances in the work and structure of the organism during the period of maximum physiological activity and sensitivity to active atmospheric impurities.

Gas sensitivity is the body's reaction to the action of pollutants during a certain period of its development. When studying biological indicators, it is necessary to take into account the systematic affiliation of species and changes in their gas resistance.

In general, conducting bioindicative research in cities requires important consideration of the features of the urban environment and the selection of appropriate research methods to obtain reliable results.

2.4. The bioindicative study procedure

Bioindicative research by visible observation is a method that has been used to assess the state of the environment and pollution by analyzing the state of plant leaves. The basic idea is that plants respond to changes in environmental quality, such as pollution or stress.

The procedure for conducting such a study included the following steps:

1. Selection of trees or plants for observation in the functional zones of the town of Boyarka. Other types of plants are chosen that grow in different places of the town or on the territory under the influence of different sources of pollution.
2. Observation of the condition of the leaves. For this, color, shape, size, texture and the presence of any defects such as spots, yellowing or high leaf edges are produced.
3. Record the results of observations. The information is recorded in the information, which indicates the types of plants, their location, as well as detected signs or changes in the state of the leaf.

4. Analysis of the received data. The obtained results act on the presence of possible effects of pollution or other factors that can affect the condition of plants.

The method is quite simple and effective for the first assessment of the ecological situation in urban regions. It allows you to quickly identify signs of contamination and use of an area that requires further investigation.

Objects from different functional zones of the town were selected for the study:

- Victory Park – an object that is not technologically loaded, which also serves as a reference object in this study;

- The lakeside area is a recreational facility that has an intensive anthropogenic load, but insignificant technogenic pressure;

- A construction site and a woodworking workshop as examples of sources of intensive impact on the environment, which have a small area;

- The plant of polymer products is a full-fledged production facility with a wide range of influences.

The condition of trees was rated using the following scale:

1 – Healthy trees without external signs of damage, young branches are visible in the crown in all directions (if missing in any direction - indicate this in the notes)

2 – Weakened trees. The crown is lacy, that is, it is not continuous and light passes through it, individual branches have dried up. Leaves and needles have a less saturated color or with a yellow tint. In conifers, peeling of the bark can be seen on the trunk

3 – Strongly weakened trees. The crown is thinned, with significant drying of the branches, the top is dry. The leaves are light green, the needles have a brown tint and last 1-2 years. The leaves are small, but sometimes they are enlarged, but nervous-dark (in some places). Growth is reduced or absent, that is, new branches are either very few or only on one side. Significant areas of bark are exfoliated or dead

4 – Trees drying. Drying of branches throughout the crown. The leaves are small, underdeveloped, pale green with a yellow tint; early November is celebrated. Needles are damaged by 60% of the total number. There is no increase. There are signs of colonization by bark beetles and other pests on the trunks

5 – Dry trees. The crown is dry, there are no leaves, the needles are yellow or brown (falling off or falling off). The bark on the trunks peels off or has completely fallen off. The trunks are inhabited by xylophages (wood consumers).

Conclusions to Chapter 2

The chapter presents the analysis of advantages and disadvantages of bioindication methods. Cities are ecosystems with specific combination of man0-made and natural elements which affects the parameters of possible biomonitoring studies. Therefore the choice of bioindicators for the given research was substantiated to suit the conditions of urban environment and the procedure of the experimental part of the work was set.

CHAPTER 3
ASSESSMENT OF THE ENVIRONMENTAL SITUATION IN THE FUNCTIONAL ZONES OF THE TOWN OF BOYARKA

3.1. The functional structure of Boyarka and its environmental problems

Boyarka is a town in Ukraine, the center of the Boyarka urban community in the Fastiv district of the Kyiv region. Population is 53,161. The territory is 1,320 hectares (550 hectares are under development).

The town of Boyarka has a good geographical location. The capital can be reached by train in 25 minutes and by road in 40 minutes. In the direction of Kyiv and back every 5-10 minutes there are 7 routes that can be used to reach any suburb of the right bank of the capital. The town borders the Odesa highway, which is the the most important transport route of the area.

The town is divided by the railway into two parts: the southeastern (historical part of the town) – the residential sector of individual cottages (about 7,000 residential buildings), and the northwestern (Nova Boyarka) – more than 30 apartment buildings and the individual cottages.

The industrial area of the town is not formed, instead production sites are dispersed over the town and include a variety of industries. The main production enterprises of the town are:

- Branch "Ukrgazenergoservice Production Repair and Technical Enterprise" PJSC "Ukrtransgaz",
- Branch "Ukrgaztehzvyazok" PJSC "Ukrtransgaz",
- Boyarske linear management of main gas pipelines,
- Plant "Vents"; OJSC "Arxy",
- CJSC Boyarskaya sewing factory "Malva",
- Boyar Forest Research Station,
- LATO Furniture Factory LLC, Silhouette LLC, and others.

Environmental problems of the settlement are quire diverse:

- insufficient provision of water supply, the need to modernize sewerage networks and sewage treatment facilities and the fire extinguishing system;
- contamination of the main aquifer with nitrates is observed;
- less than 70% of the town 's population is provided with a centralized drainage system;
- lack of disinfection of wastewater for hospitals and anti-tuberculosis dispensary;
- there is no single system of storm sewers, treatment facilities at the outlets of storm sewers have not been built;
- the need to clear riverbeds, streams and ensure the improvement of reservoirs;
- the problem of road congestion in the connection "Boyarka - Kyiv" and the transit of heavy vehicles through the town of Boyarka;
- lack of an effective system for monitoring the state of the natural environment;
- low level of greening;
- low level of local production;
- lack of a system for sorting and processing household and other types of waste.

3.2. Description of studied objects

Victory Park is a place for recreation and entertainment in the town of Boyarka. Located at 86 Khreshchatyk Street, this park attracts tourists with its beauty and comfort. Here you can enjoy walks among the greenery, visit the playground or simply enjoy the beauty of nature. Victory Park is an ideal place to relax with family or friends.

Industrial production facilities are located on Sobornosti Street No. 36, No. 47 in the northern part of the town .

The factory of polymer products Elite Décor Industry is a manufacturer of molded decorative polymer jewelry with many years of experience. A few years ago, the investment group BLAUBERG GROUP, having studied all the economic components of the market, decided to open a modern high-tech plant in Ukraine, specializing in the

production of polymer products. The opening of a new factory in Ukraine, which is located in the geographical center of Europe, was due to the growing demand for stucco decoration made of polyurethane foam in the markets of Western and Eastern Europe.

Elite Décor Industry is a powerful production and trading enterprise that owns a large modern production base, which produces collections of polyurethane stucco decor and facade decor under the world-famous brands Grand Décor, Harmony, Prestige Décor, Deco Wood, Home Décor, Tesori, Fabello Décor, etc.

Metal Furniture LLC is a recognized institution specializing in the manufacture and sale of high-quality metal furniture.

Vents is a company with many years of experience that offers a wide range of modern ventilation equipment to solve any tasks in the field of ventilation. Our products are distinguished by high quality, balanced technical characteristics and meet European and international requirements for energy efficiency, reliability and safety, which is confirmed by relevant certificates and realized objects all over the world.

Construction of a multi-apartment 10-story sectional residential building with built-in and attached public premises is also a source of potential environment pollution.

"Sawmill" is a store that sells a large selection of wood of various species and sizes, as well as materials for construction and repair.

All these objects were studied in terms of their effect of the surrounding plant communities and the results are presented below.

3.3. Results of bioindicative research and their analysis

A bioindicative study was conducted during June-September 2023. In total, the condition of 99 trees in five locations will be assessed (Table 3.1). According to the main scale of the state of trees (presented in chapter 2.4), the vast majority was rated at 2 points.

Trees of the best quality are not dominant in all association, and generally 2-3 such trees are found in each plot. Among the extreme cases, several trees of the 3rd and one 4th quality class can be singled out in the zone of influence of the plant and the

woodworking workshop. The largest number of trees of a lower quality class (five trees of class 3-4) was found near the lake, which, according to personal observations, is associated with a rather high level of disease damage. Along with this, it is near the lake that the largest number of trees of the highest quality grows.

Table 3.1

Information about inspected trees

Tree number	Species	Location	Area of influence of the object	Rating on a scale
1	2	3	4	5
1.1	Oak	2 m southwest of the main entrance	Victory Park	2
1.2	linden	10 m southwest of the main entrance	Victory Park	2
1.3	chestnut	12 m southwest of the main entrance	Victory Park	2
1.4	chestnut	15 m southwest of the main entrance	Victory Park	2
1.5	chestnut	14 m southwest of the main entrance	Victory Park	2
1.6	Cherry	16 m southwest of the main entrance	Victory Park	2
1.7	Oak	25 m southwest of the main entrance	Victory Park	2
1.8	Linden	30 m southwest of the main entrance	Victory Park	1
1.9	Linden	8 m southwest of the main entrance	Victory Park	2
1.10	Linden	10 m southwest of the main entrance	Victory Park	3
1.11	Linden	14 m southwest of the main entrance	Victory Park	1
1.12	Mulberry	30 m southwest of the main entrance	Victory Park	2
1.13	Linden	14 m southwest of the main entrance	Victory Park	2
1.14	Rowan	15 m southwest of the main entrance	Victory Park	2
1.15	Chestnut	17 m southwest of the main entrance	Victory Park	2
1.16	Oak	19 m southwest of the main entrance	Victory Park	2
1.17	Linden	19 m southwest of the main entrance	Victory Park	2
1.18	Oak	20 m south-west from the main entrance	Victory Park	2
1.19	Oak	32 m southwest of the main entrance	Victory Park	2
1.20	Maple	32 m southwest of the main entrance	Victory Park	2
1.21	Linden	32 m southwest of the main entrance	Victory Park	2
1.22	Oak	35 m southwest of the main entrance	Victory Park	2
1.23	Oak	35 m southwest of the main entrance	Victory Park	2
2.1	Linden	South from the main building 25 m	Construction	2
2.2	Linden	South from the main building 25 m	Construction	2

Table 3.1 continued

1	2	3	4	5
2.3	Linden	South from the main building 25 m	Construction	2
2.4	Maple	South from the main building 25 m	Construction	2
2.5	Nut	South-east of the main building 25 m	Construction	2
2.6	Maple	South-east of the main building 25 m	Construction	2
2.7	Linden	South-east of the main building 25 m	Construction	2
2.8	Apple	South-east of the main building 25 m	Construction	1
2.9	Nut	South-east of the main building 25 m	Construction	2
2.10	Nut	South-east of the main building 25 m	Construction	2
2.11	Apple	East of the main building 25 m	Construction	2
2.12	Nut	East of the main building 25 m	Construction	2
2.13	Apple	East of the main building 25 m	Construction	1
2.14	Bush	East of the main building 25 m	Construction	2
2.15	Bush	North of the main building 25 m	Construction	1

2.16	Nut	North of the main building 25 m	Construction	2
3.1	Chestnut	In front of the main gate, 35 m from the plant	Plant	2
3.2	Chestnut	In front of the main gate, 35 m from the plant	Plant	2
3.3	Chestnut	In front of the main gate, 35 m from the plant	Plant	2
3.4	Chestnut	In front of the main gate, 35 m from the plant	Plant	2
3.5	Chestnut	In front of the main gate, 35 m from the plant	Plant	2
3.6	Oak	In front of the main gate, 35 m from the plant	Plant	4
3.7	Linden	In front of the main gate, 35 m from the plant	Plant	3
3.8	Oak	In front of the main gate, 35 m from the plant	Plant	3
3.9	Chestnut	In front of the main gate, 35 m from the plant	Plant	2
3.10	Chestnut	North 35 m from the plant	Plant	2
3.11	Chestnut	North 36 m from the plant	Plant	2
3.12	Chestnut	North 37 m from the plant	Plant	2
3.13	Chestnut	North 38 m from the plant	Plant	2
3.14	Chestnut	North 39 m from the plant	Plant	2
3.15	Chestnut	North 40 m from the plant	Plant	2
3.16	Chestnut	North 41 m from the plant	Plant	2
3.17	Chestnut	North 42 m from the plant	Plant	2
3.18	Birch	Northwest 44 m from the plant	Plant	2
3.19	Birch	Northwest 44 m from the plant	Plant	2
3.20	Poplar	Northwest 45 m from the plant	Plant	2
3.21	Poplar	Northwest 46 m from the plant	Plant	2
3.22	Poplar	Northwest 47 m from the plant	Plant	2
3.23	Poplar	Northwest 48 m from the plant	Plant	2
3.24	Poplar	Northwest 49 m from the plant	Plant	2
3.25	Poplar	Northwest 50 m from the plant	Plant	2
4.1	Nut	East 70 meters from the cutting blade	Sawmills	1

Table 3.1 end

1	2	3	4	5
4.2	Nut	East 68 meters from the cutting blade	Sawmills	1
4.3	Cherry	East 65 meters from the cutting blade	Sawmills	2
4.4	Willow	East 60 meters from the cutting blade	Sawmills	2
4.5	Nut	East 60 meters from the cutting blade	Sawmills	1
4.6	Cherry	East 55 meters from the cutting blade	Sawmills	1
4.7	Willow	East 50 meters from the cutting blade	Sawmills	1
4.8	Nut	East 50 meters from the cutting blade	Sawmills	1
4.9	Mulberry	East 50 meters from the cutting blade	Sawmills	1
410	Willow	East 50 meters from the cutting blade	Sawmills	1
4.11	Nut	East 50 meters from the cutting blade	Sawmills	2
4.12	Cherry	East 50 meters from the cutting blade	Sawmills	2
4.13	Cherry	East 50 meters from the cutting blade	Sawmill	2
4.14	Cherry	East 50 meters from the cutting blade	Sawmill	3
4.15	Cherry	East 50 meters from the cutting blade	Sawmill	3
4.16	Apple	South 50 meters from the cutting blade	Sawmill	2
4.17	Plum	South 52 meters from the cutting blade	Sawmill	2
4.18	Grape	South 56 meters from the cutting blade	Sawmill	2
4.19	Hop	South 60 meters from the cutting blade	Sawmill	2
4.20	Linden	South 62 meters from the cutting blade	Sawmill	2
4.21	Cherry	South 62 meters from the cutting blade	Sawmill	2
4.22	Apple	South 64 meters from the cutting blade	Sawmill	2
4.23	linden	South 66 meters from the cutting blade	Sawmill	2
5.1	Alycha	South 5 meters from the water	Lake	1
5.2	Willow	South 5 meters from the water	Lake	1
5.3	Apple	South 5 meters from the water	Lake	4
5.4	Willow	South 5 meters from the water	Lake	2
5.5	Willow	South 5 meters from the water	Lake	2
5.6	Willow	South-west 5 meters from the water	Lake	3
5.7	Alycha	South-west 5 meters from the water	Lake	2
5.8	Maple	South-west 5 meters from the water	Lake	3

5.9	Robinia	South-west 5 meters from the water	Lake	2
5.10	Robinia	South-east 5 meters from the water	Lake	2
5.11	Robinia	South-east 5 meters from the water	Lake	3
5.12	Willow	South-east 5 meters from the water	Lake	2
5.13	Apple	East 5 meters from the water	Lake	2
5.14	Robinia	East 5 meters from the water	Lake	3
5.15	Willow	South-east 5 meters from the water	Lake	1
5.16	Linden	South-east 5 meters from the water	Lake	2
5.17	Apple	East 5 meters from the water	Lake	2
5.18	Willow	South-east 5 meters from the water	Lake	1
5.19	Willow	South-east 5 meters from the water	Lake	2
5.20	Willow	South-west 5 meters from the water	Lake	2
5.21	Willow	West 5 meters from the water	Lake	2
5.22	Apple	West 5 meters from the water	Lake	2

A detailed visual inspection of the leaves (tables 3.2-3.6) revealed that the greatest number of leaf injuries is characteristic of the areas around the woodworking shop and the polymer products factory. A fairly high level of disease damage was also found there. Around the lake, there is also a rather intense damage by diseases, which may be related to the high level of humidity and the stagnant mode of air circulation in this area, which, in particular, increases the persistence of pollution in a specific part of the environment.

Fig. 3.1

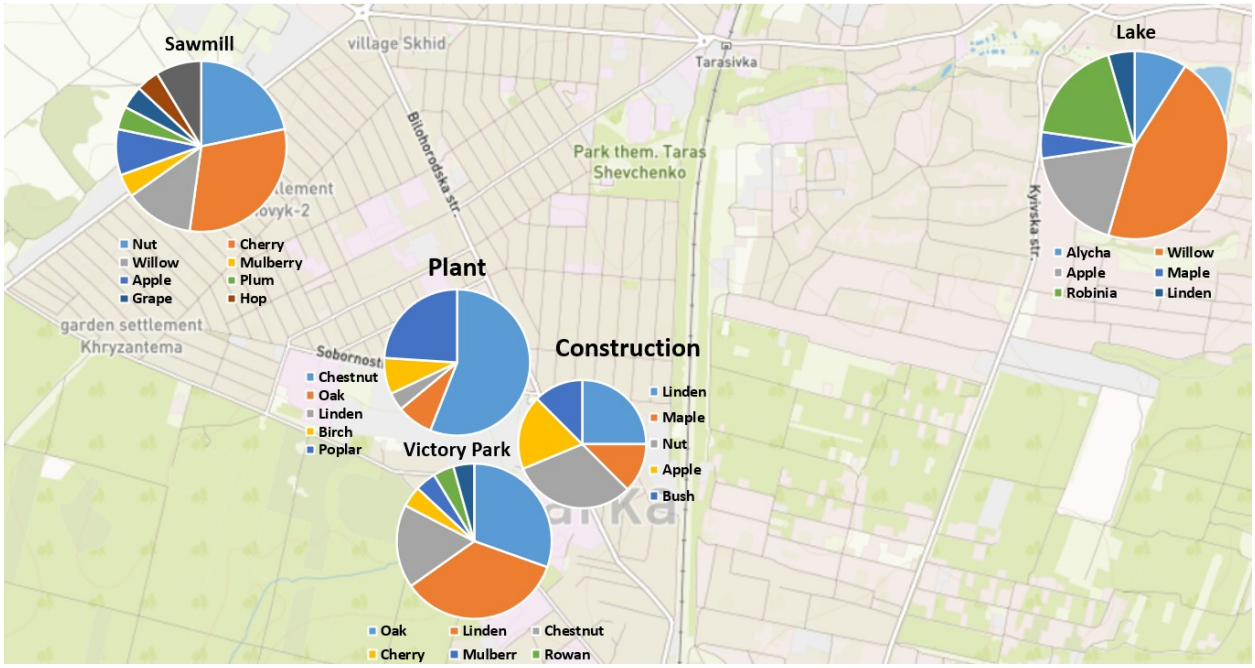

Fig. 3.1 Structure of plant association at the studied sites in the town of Boyarka

Table 3.2

Phytopathology assessment information for a group of trees around Victory Park

Pathology names	Percentage of affected crown												
Number and type of tree	1	2	3	4	5	6	7	8	9	10	11	12	13
Damage to leaves of trees and shrubs by insects*:													
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	0	0	0
4. regional dining	0	0	0	0	0	15	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	0	0	0	15	0	0	5	10	5	0	5
7. adhesive flow	0	0	0	0	0	0	0	0	0	0	0	0	0
Damage to the leaves of trees and shrubs by diseases:													
8. spotting	0	0	0	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	0	0	0	0	0	0	0	0	0	0	0	0	0
11. rot	0	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	0	0	0	0	0	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	0	0	50	50	50	0	10	0	0	0	0	0	0

Table 3.2 (continued)

Pathology names	Percentage of affected crown									
Number and type of tree	14	15	16	17	18	19	20	21	22	23
Damage to leaves of trees and shrubs by insects*:										
1. skeletonization	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0
4. regional dining	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0
6. perforation	0	15	0	10	0	0	0	0	0	0
7. adhesive flow	0	0	0	0	0	0	0	0	0	0
Damage to the leaves of trees and shrubs by diseases:										
8. spotting	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0
10. burn	5	0	0	0	0	0	0	0	2	0
11. rot	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	0	0	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0
14. rust	0	0	0	0	0	0	0	0	0	0

Table 3.3

Phytopathology assessment information for a group of trees around the construction site

Pathology names	Percentage of affected crown															
Number and type of	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

tree																
Damage to leaves of trees and shrubs by insects*:																
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0
4. regional dining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	70	5	70	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	10
7. adhesive flow	0	0	0	0	0	0	0	0	15	15	0	0	0	0	0	15
Damage to the leaves of trees and shrubs by diseases:																
8. spotting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	0	0	0	0	0	0	5	0	0	5	0	0	0	5	0	0
11. rot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0
14. rust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.4

Phytopathology assessment information for a group of trees around the Polymer Products Plant

Pathology names	Percentage of affected crown												
Number and type of tree	1	2	3	4	5	6	7	8	9	10	11	12	13
Damage to leaves of trees and shrubs by insects*:													
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	0	0	0
4. regional dining	0	0	0	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	0	0	0	0	0	0	0	0	0	0	0
7. adhesive flow	0	0	0	0	0	0	0	0	0	0	0	0	0
Damage to the leaves of trees and shrubs by diseases:													
8. spotting	0	0	0	0	0	0	0	0	15	15	15	15	15
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	0	0	0	0	0	0	0	0	0	0	0	0	0
11. rot	0	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	0	0	0	25	25	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	80	80	80	80	80	0	0	0	80	80	80	80	80

Table 3.4 (continued)

Pathology names	Percentage of affected crown											
Number and type of tree	14	15	16	17	18	19	20	21	22	23	24	25
Damage to leaves of trees and shrubs by insects*:												

1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	15	0
4. regional dining	0	0	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	70	5	70	0
6. perforation	0	0	0	0	0	0	0	0	0	0	0	0
7. adhesive flow	0	0	0	0	0	0	0	0	0	0	0	0
Damage to the leaves of trees and shrubs by diseases:												
8. spotting	15	15	15	15	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	5	0	0	0	0	0	0	0	0	0	0	5
11. rot	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	0	0	0	0	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	80	80	80	80	0	0	5	5	5	5	5	5

Table 3.5

Phytopathology assessment information for a group of trees around the Polymer Products Plant

Pathology names	Percentage of affected crown												
Number and type of tree	1	2	3	4	5	6	7	8	9	10	11	12	13
Damage to leaves of trees and shrubs by insects*:													
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	0	0	0
4. regional dining	5	0	0	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	0	0	5	10	5	10	10	0	10	20	20
7. adhesive flow	10	0	0	0	5	0	0	0	0	0	5	0	0
Damage to the leaves of trees and shrubs by diseases:													
8. spotting	0	0	0	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	5	20	5	0	5	0	0	5	10	5	0	0	0
11. rot	0	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	15	5	5	2	0	0	5	0	10	16	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	5	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.5 (continued)

Pathology names	Percentage of affected crown											
Number and type of tree	14	15	16	17	18	19	20	21	22	23	24	25
Damage to leaves of trees and shrubs by insects*:												
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	0	0
4. regional dining	0	0	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	10	0	10	0	10	10	15	0	0	0
7. adhesive flow	20	0	10	60	0	0	0	0	0	0	0	0
Damage to the leaves of trees and shrubs by diseases:												
8. spotting	0	0	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	0	0	15	5	0	0	0	0	0	0	0	5
11. rot	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	5	0	5	0	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	0	10	0	0	0	0	0	0	0	0	0	0

Table 3.6

Phytopathology assessment information for a group of trees around the Lake

Pathology names	Percentage of affected crown											
Number and type of tree	1	2	3	4	5	6	7	8	9	10	11	12
Damage to leaves of trees and shrubs by insects*:												
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	0	0
4. regional dining	10	5	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	0	0	0	0	15	0	10	0	0	0
7. adhesive flow	0	0	0	0	0	0	0	10	0	0	0	10
Damage to the leaves of trees and shrubs by diseases:												
8. spotting	0	0	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	0	5	0	5	15	10	0	10	10	10	10	5
11. rot	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	0	0	0	10	5	10	0	10	10	5	15	5
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	0	0	0	0	0	0	0	5	0	0	0	0

Table 3.6 (continued)

Pathology names	Percentage of affected crown												
Number and type of tree	13	14	15	16	17	18	19	20	21	22	23	24	25
Damage to leaves of trees and shrubs by insects*:													
1. skeletonization	0	0	0	0	0	0	0	0	0	0	0	0	0
2. single galls	0	0	0	0	0	0	0	0	0	0	0	0	0
3. deformation of the sheet plate	0	0	0	0	0	0	0	0	0	0	0	0	0
4. regional dining	0	0	0	0	0	0	0	0	0	0	0	0	0
5. mining	0	0	0	0	0	0	0	0	0	0	0	0	0
6. perforation	0	0	0	20	0	0	10	10	0	0	0	0	0
7. adhesive flow	0	5	0	20	0	0	10	0	0	10	0	0	0
Damage to the leaves of trees and shrubs by diseases:													
8. spotting	0	0	0	0	0	0	0	0	0	0	0	0	0
9. necrosis	0	0	0	0	0	0	0	0	0	0	0	0	0
10. burn	0	20	0	0	10	5	20	0	5	0	0	0	5
11. rot	0	0	0	0	0	0	0	0	0	0	0	0	0
12. wilting	5	10	0	30	0	0	0	5	0	0	0	0	0
13. mosaic	0	0	0	0	0	0	0	0	0	0	0	0	0
14. rust	0	0	0	10	0	0	0	0	0	0	0	0	0

In general, it can be concluded that the state of vegetation in the studied areas is from good to satisfactory. Nevertheless, a certain stable level of technogenic and anthropogenic load is present in the territory of the town of Boyarka, since the number of trees of high quality is uniformly low throughout the territory of the town (Fig. 3.2).

The town of Boyarka is a typical small town of Ukraine, which is also a satellite of a larger town . Such settlements are characterized by a high level of industrialization and a combination of typical urban and rural land use structures and structures. As can be seen from the example of the town of Boyarka, even in the absence of a formed industrial zone, the level of environmental load is quite significant and can be considered the cause of health risks, and therefore requires the implementation of measures to increase the level of environmental safety in the town . In particular, there is a need for planning and implementation of measures aimed at rational use of nature in the town . Cities with such a deep attachment to the industrial sector and the metropolis tend to neglect environmental protection rules, as the priority for municipality and its residents is to provide jobs and fill the town budget, which is often a serious problem for small cities.

Nevertheless, adherence to the principles of sustainable development in the planning of the town 's economic and social activities usually provides all the basic

needs of the town 's residents and, at the same time, creates additional opportunities for the development of entrepreneurship and improves the ecological situation in the town .

Fig. 3.2

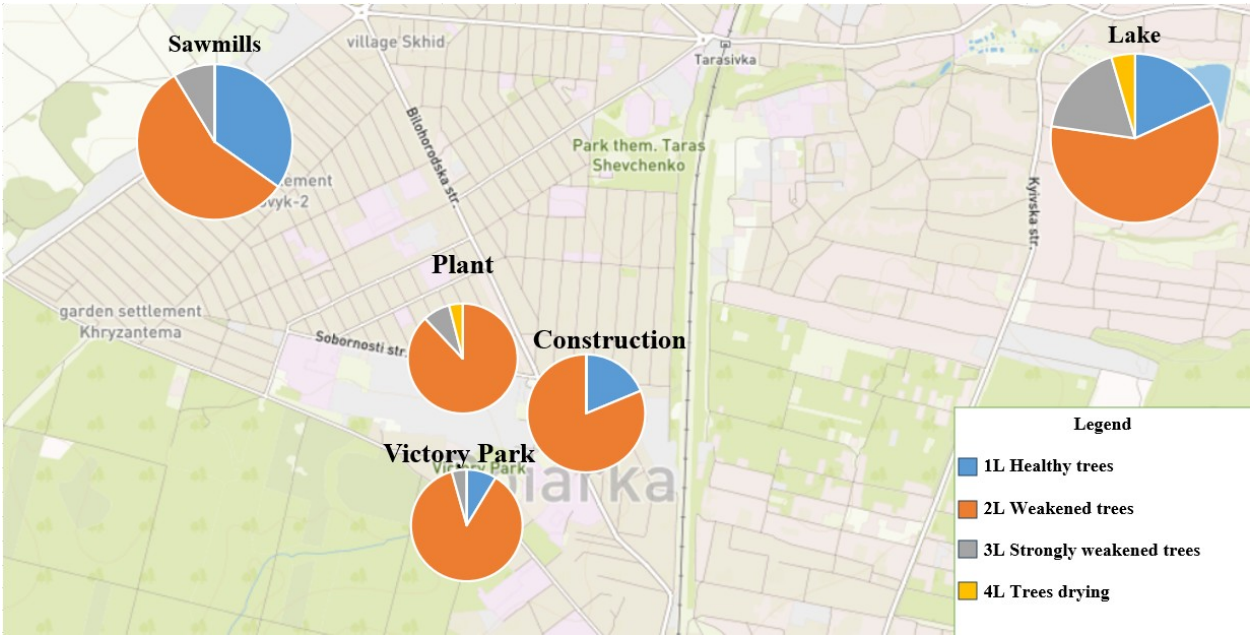

Fig. 3.2 Tree quality level at data collection sites

3.4. Recommendations for increasing the level of environmental safety and organizing rational nature management

Industrial facilities, especially in the case of towns with a predominantly rural settlement structure, are significant sources of environmental pollution. Despite their central role in filling the town budget and providing jobs, the activities of these facilities should be organized in strict compliance with environmental regulations and principles of rational nature management, taking into account the limited resource potential of such territories and the generally unaltered state of the environment, which is worth preserving. Thus, for the industrial facilities of the town , it is necessary:

- Plan the implementation of stricter environmental standards regarding emissions, water pollution and waste management;

- Direct efforts to find investments to replace outdated technologies with environmentally friendly counterparts to reduce the negative impact of industry on the environment.

- Regular monitoring of the level of atmospheric, water and soil pollution for timely identification of problems and adoption of the latest measures.

Satellite cities, including Boyarka, have a transport network integrated with the metropolis, which also ensures the transit of a large amount of transport. At the same time, cities are often located along the main transit highway. This makes residents particularly vulnerable to the effects of transport pollution. Undoubtedly, there are no opportunities for radical changes in such town planning, but there remains a whole range of solutions, including nature-oriented ones to reduce the level of the negative impact of transport:

1) Public transport is often underdeveloped in small cities, while the intensity of private car use is constantly increasing. Therefore, an important direction of the town government's work should be the promotion of the use of public transport, bicycles and pedestrian routes to reduce the additional burden on the environment. For this, it is also necessary to create conditions - bicycle paths and lines of mixed use, to set restrictions on the access of motor vehicles to sensitive areas of the town .

2) Implementation of current European environmental standards for motor vehicles and monitoring of compliance with these standards.

3) Allocation of areas for transit transport outside the town limits and appropriate development of service infrastructure in such areas.

4) Development of infrastructure for electric vehicles: creation of charging stations for electric vehicles and stimulation of the use of electric vehicles.

The residential sector of the town also needs improvement, especially from the point of view of rational nature management:

1) Increasing the energy efficiency of buildings – the use of energy-efficient technologies and materials in the construction and reconstruction of residential buildings.

2) Separate collection and processing of waste is a problem of the town of Boyarka and contributes to both visual and chemical pollution of the environment.

3) The semi-rural structure of the town 's landscapes is under constant pressure and shrinking due to the activity of developers who seek to use land in the immediate

vicinity of the metropolis. In such conditions, the town 's green infrastructure and recreational opportunities for the population are constantly decreasing. Therefore, it is an important task to preserve and care for natural communities in the town . After all, in conditions of stable anthropogenic load, degradation processes can be actively manifested in natural, unprotected areas.

In general, the development of green infrastructure should be among the priorities of the town management and active public. The creation of parks, squares and other green areas contributes to the improvement of air quality and encourages a healthy lifestyle. Green zones and parks, if properly perceived, serve as means of controlling the development of the planning structure of the town and prevent the accumulation of ecologically dangerous objects in limited areas. Even residential development needs rational planning to avoid uneven access to the infrastructure and excessive load on it. In this direction, it is necessary to direct efforts to:

1) Clear delineation of the boundaries of green zones in the plan and on the area and consolidation of their status, including the granting of a certain nature protection status to valuable and typical groups.

2) Carrying out systematic care and protection of natural resources in green areas and parks of the town .

3) Organization of informational knowledge and educational events on environmental education for town residents and park visitors to form an active position of town residents in the field of preservation and protection of green areas.

4) Preservation and development of biodiversity in parks and green areas.

The development of sustainable and conscious consumption is also a necessary part of the rationalization of nature use in the town , as it contributes to the formation of residents' attention to the state of the environment and stimulates them to actively support and participate in environmental protection measures. Organization of environmental activities, festivals and events in these areas to raise awareness and interest in environmental protection issues is one of the effective means of improving the environmental situation in the town .

3.5. Challenges for the sustainable development of the town

Sustainable urban development is becoming an increasingly important topic in cities around the world as communities strive to create greener and healthier areas. Despite the increasing attention to sustainable development, there are various problems that cities face during the creation and implementation of relevant projects.

One of the main challenges of sustainable urban development is resources. Cities like Boyarka have limited resources to implement large-scale projects. This may mean that they cannot afford to implement certain initiatives or do not have the tools or materials needed to implement these project ideas. However, this does not mean that a set of smaller-scale measures will not have positive results.

In addition to limited resources, cities and developers may also lack the necessary knowledge and experience to effectively implement sustainable development. Often, architects and designers do not have adequate training in green architecture, which can lead to them not being able to correctly follow concepts such as green building and energy efficiency. In some cases, there may be a lack of education and communication about sustainability, meaning that citizens may not be aware of the impact of consumption on the environment or the positive changes they can make by participating in sustainability projects.

It is necessary to study the experience of similar cities in the world and implement successful strategies. For this, informational resources from many international organizations, which also provide micro-grants for their implementation, are sufficient.

Political and cultural barriers are also a challenge for sustainable urban development due to conflicting interests in different parts of the town , creating challenges for cooperation. In part, these problems can be solved by involving in the design and development of plans and strategies for the sustainable development of the organization from other settlements and even the region, relying on their experience, because ignorance of the local context in this case can be an advantage, not a disadvantage.

By understanding the challenges, having a careful plan and working with local communities and political partners, sustainable urban development initiatives can have a positive impact on the environment and the quality of life in cities.

Conclusions to chapter 3

Using the technique of bioindication research the assessment of the environment condition in the town of Boyarka was conducted. The results demonstrated that the increased level of anthropogenic pressure is typical for the whole urban territory, since the full majority of indicator organisms were not of the best condition. It was also defined that even natural objects are under pressure of and quality of potential recreation infrastructure is reduced.

The necessary steps towards the improvement of the situation were formulated, as well as possible complications on the way towards the improvement of environment quality and promotion of sustainable use of resources. The development of ecological awareness is named a necessary condition for the successful organization of rational nature management, since it is the insufficient level of ecological culture that often stands in the way of the successful implementation of even the best plans.

CONCLUSIONS

The thesis contains the assessment of the state of the environment in the town of Boyarka using bioindication methods to identify factors of influence and contribute to optimization of environmental policy of the town.

Based on the literature analysis, it was established that Boyarka is a typical satellite town, which is characterized by a high level of industrialization and a combination of urban and rural land use structures. Such urban areas face problems of environmental pollution due to intensive traffic and the activities of industrial enterprises, which undergo limited control due to budget-forming role.

The assessment of the state of environment in Boyarka was conducted with the help of bioindication, namely the leaf cover of trees. Areas with different functional purposes were included in the study.

As a result of the study, it was established that the condition of the green areas of the town of Boyarka is from good to satisfactory. However, the level of technogenic and anthropogenic load remains consistently significant, which causes environmental risks for the health of the population.

Recommendations were developed to improve the level of environmental safety, including the introduction of stricter environmental standards for industrial enterprises, the development of infrastructure for electric vehicles and the creation of conditions for the use of public transport and bicycles.

Taking into account the features of the planning structure of the town, it is proposed to invest efforts in improving the environmental situation in all functional zones of the town, even those which are relatively distant from direct sources of pollution. In particular, it is suggested to pay attention to the development of environmental awareness of residents as a guarantee of their active participation in environmental protection.

Organization of rational nature management for towns often faces difficulties. These challenges can range from financial constraints to a lack of understanding of how

to create sustainable solutions. Understanding the challenges of sustainable urban development is a key to creating successful projects that will have a lasting impact on the community and its environment.

LIST OF REFERENCES

1. Bryo-indication method of researching atmospheric pollution as one of the directions of bio-indication monitoring. Gapon Yu.V. Special secondary school No. 39, Poltava.

2. Bioindication of the environment. Methodical instructions for the performance of work on the topic: "Express assessment of the quality of the environment based on the fluctuating asymmetry of the leaf plate (on the example of the hanging birch (Betula pendula))" for students of the second (master's) level of higher education in full-time and correspondence forms of education with majors 101 Ecology.

3. Indication of the state of the environment by the degree of damage to the leaf blade of Betula pendula Roth Authors: Obruch, Krystyna Igorivna Date of publication: 2021

4. Bio-indication of the level of pollution by the reaction of the assimilation apparatus of picea avies in the inguletsk district of Kryvy Rih m. Qualification work of a student of ECO-19 group, degree of higher education, bachelor's degree, specialty 101 Ecology Bondarenko Olga Vladyslavivna

5. Bryo-indicative method of atmospheric pollution research as one of the directions of bio-indicative monitoring Authors: Gapon, Yu.V. Publication date: 2011

6. Assessment of the environmental state of the town of Rivne by bioindication studies Klymenko M. O., Pryshchepa A. M., Khomych N. R. - National University of Water Management and Nature Management, Rivne, Ukraine 3rd International Ecological Forum Clean TOWN │ Clean RIVER │ Clean PLANET Kherson November 17-18, 2011

7. Environmental assessment of the level of pollution within transport routes using bioindicative methods Authors: Arzantseva, I. S. Publication date: 2022 Publisher: Polisky National University

8. Arzantseva Iryna Serhiyivna UDC 574:58.632:59.636 QUALIFICATION WORK Environmental assessment of the level of pollution within transport routes using bioindicative methods 101 – ecology

9. Bioindication of the pollution level based on the reaction of the Picea abies

assimilation apparatus in the Ingulets district of Kryvyi Rih Authors: Bondarenko, Olga Vladyslavivna Publication date: May 29, 2023

10. Bio-indication of the level of pollution by the reaction of the assimilation apparatus of picea avies in the inguletsk district of Kryvy Rih m. Qualification work of a student of ECO-19 group, degree of higher education, bachelor's degree, specialty 101 Ecology Bondarenko Olga Vladyslavivna

11. Topos Urban development – a sustainable future 28.02.23 Tobias Hager

12. Decision No. 43/21 On the granting of town planning conditions and restrictions, at the address: Boyarka, str. Sobornosti, 36, gr. Alimova O.A.

13. About the VENTS company

14. Information about "Metal Furniture" LLC

15. Elite Décor Industry about the company

16. Information about Victory Park

17. M. Boyarka of the Kyiv-Svitoshynsky district of the Kyiv region report on the strategic environmental assessment of the project of the general plan of the town of Boyarka of the Kyiv-Svitoshynsky district of the Kyiv region Director Sur M.G. Deputy director - chief architect Vasyltsova T.O. Kyiv - 2019

18. Information about Sawmill

19. Monteiro, J.; Sousa, N.; Coutinho-Rodrigues, J.; Natividade-Jesus, E. Challenges Ahead for Sustainable Cities: An Urban Form and Transport System Review. *Energies* **2024**, *17*, 409. https://doi.org/10.3390/en17020409