**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:** «Environmental state of limnic systems of the Darnytsky district of Kyiv city»

**Done by:** seeker of EK-402 group**,** Ivanna Yarokhmedova
(student, group, surname, name, patronymic)

**Supervisor:** Ph. D. in Biol. Sc., Associate Professor of the Ecology Department, Marharyta M. Radomska
(academic degree, academic rank, surname, name, patronymic)

**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:** «Екологічний стан лімнологічних систем Дарницького району міста Києва»

**Виконавець:** здобувач(ка) групи ЕК-402а Ярохмедова Іванна Віталіївна

**Керівник:** д. біол. н., доцент кафедри екології 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

1. Theme: «Environmental state of limnic systems of the Darnytsky district of Kyiv city» approved by the Rector on September 3, 2024 № 504/ст
2. Duration of work: from 20.05.2024 to 16.06.2024.
3. Output work (project): maps of the study area, description of industrial objects at the study area reference data on the origin and evolution of lakes, survey of local population in the Darnytskyi district of Kyiv.
4. Content of explanatory note (list of issues): includes an introduction to the environmental importance of urban lakes, a detailed description of the lakes in the Darnytskyi district, methods used for assessing their environmental state, and an analysis of the findings. It also provides recommendations for reducing anthropogenic pressure and improving the overall environmental condition of these lakes.
5. The list of mandatory graphic (illustrated materials): tables, figures, graphs.

6. Schedule of thesis fulfillment

| № з/п | Task | Term | Advisor's signature |
|---|---|---|---|
| 1 | Setting up the experiment | 20.05.2024 - 04.06.2024 | |
| 2 | Collection and analysis of the experiment | 06.06.2023 – 25.07.2023 | |
| 3 | Justification of the goal, object and subject of research | 29.11.2023 – 04.01.2024 | |
| 4 | Review of the literary sources | 20.03.2024 – 04.05.2024 | |
| 5 | Collection and analysis of materials | 06.03.2024 – 04.05.2024 | |
| 6 | Writing chapters I of the thesis | 10.03.2024 – 18.03.2024 | |
| 7 | Writing chapters II of the thesis | 20.04.2024 – 25.04.2024 | |
| 8 | Writing chapters III of the thesis | 29.05.2024 – 14.05.2024 | |
| 9 | Issuance of an explanatory note | | |
| 10 | Defense of the thesis | 12.06.2024 | |

7. Date of task issue: «_20_» May 2024

Diploma (project) advisor: _____ Radomska M.M.
(advisor's signature) (S.N.P.)

Task is taken to perform: _____ Yarokhmedova I.V.
(graduate's signature) (S.N.P.)

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**
Ярохмедова Іванна Віталіївна

1. Тема кваліфікаційної роботи: «Екологічний стан лімнологічних систем Дарницького району міста Києва» затверджена наказом ректора від Вересень 3, 2024 № 504/ст

2. Термін виконання роботи: з 20.05.2024 по 16.06.2024.

3. Вихідні дані роботи: карти досліджуваної території, опис промислових об'єктів на досліджуваній території, довідкові дані про походження та розвиток озер, опитування місцевого населення Дарницького району м. Києва.

4. Зміст пояснювальної записки: містить ознайомлення з екологічним значенням міських озер, детальний опис озер Дарницького району, методи оцінки їх екологічного стану та аналіз отриманих даних. Він також містить рекомендації щодо зменшення антропогенного тиску та покращення загального екологічного стану цих озер. До екологічної ролі ґрунту, до методології дослідження, до впливу забруднення ґрунту на мікроорганізми.

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

6. Календарний план-графік

| № з/п | Завдання | Термін виконання | Підпис керівника |
|---|---|---|---|
| 1 | Постановка експерименту | 20.05.2024 - 04.06.2024 | |
| 2 | Збір і аналіз досліду | 06.06.2023 – 25.07.2023 | |
| 3 | Обґрунтування мети, об’єкта та предмета дослідження | 29.11.2023 – 04.01.2024 | |
| 4 | Огляд літературних джерел | 20.03.2024 – 04.05.2024 | |
| 5 | Збір та аналіз матеріалів | 06.03.2024 – 04.05.2024 | |
| 6 | Написання І розділу дипломної роботи | 10.03.2024 – 18.03.2024 | |
| 7 | Написання ІІ розділу дипломної роботи | 20.04.2024 – 25.04.2024 | |
| 8 | Написання ІІІ розділу дипломної роботи | 29.05.2024 – 14.05.2024 | |
| 9 | Видача пояснювальної записки | | |
| 10 | Захист дипломної роботи | 12.06.2024 | |

7. Дата видачі завдання: «20» Травня 2024 р.

Керівник кваліфікаційної роботи: _____ Радомська М.М.

(підпискерівника) (П.І.Б.)

Завдання прийняв до виконання: _____ Ярохмедова І. В.

(підпис випускника) (П.І.Б.)

# ABSTRACT

Explanatory note to thesis «Environmental state of limnic systems of the Darnytsky district of Kyiv city»: 59 pages, 17 figures, 3 tables. .

***Object of research*** – transformation of urban lakes under the anthropogenic pressure.

***Subject of research*** – environmental status of Darnytskyi Lakes.

Aim of research: To determine the environmental status of the lakes of the Darnytsky District of Kyiv city and determine the level of the anthropogenic pressure on them.

Methods of research – information search, analysis and synthesis of information, comparative analysis, visual observations, organoleptic analysis.

Practical value – the obtained results, including a description of the characteristics of the lakes, data on water quality and pollution levels, can be used to plan measures for the protection of public health and restoration of environment quality. The determined locations of lakes on the map will contribute to more accurate monitoring of the environmental state of water bodies. The results of the research can be useful for local residents and environmental specialists. Information from the work will contribute to increasing the environmental awareness of the residents of the district.

LAKE, EUTROPHICATION, WATER POLLUTION, ANTHROPOGENIC LOAD, URBAN ECOSYSTEMS.

## CONTENT

# INTRODUCTION

***Relevance of the topic.*** The Darnytsky district of Kyiv is characterized by intensive urbanization and industrial activity, posing pressure on all environmental components of ecosystem. However, such small elements of urban ecosystems, such as lakes are often omitted in the studies of environment quality in cities. At the same time, urban lakes are important elements of recreational infrastructure, support local biodiversity, and thus have direct effect of wellbeing and health of local residents.

***The aim*** of the Bachelor's thesis is to determine the environmental state of the lakes of the Darnytsky district of Kyiv by assessing water quality, identifying level of anthropogenic pressure and sources of pollution and their impact on local ecosystems.

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

1. Study the literature about the Darnytskyi district and determine the background state of the lakes;
2. Master the methods of visual observation of ecosystems and organoleptic assessment of water quality;
3. Identify zones with a large anthropogenic load on the lakes of the district;
4. Analyze the quality of water, level of Lake Ecosystem degradation;
5. Develop recommendations for reducing the anthropogenic load and improving the general environmental condition of the lakes.

***Object of research*** – transformation of urban lakes under the anthropogenic pressure.

***Subject of research*** – environmental status of Darnytskyi Lakes.

***Methods of research*** – Information search, analysis and synthesis of information, comparative analysis, visual observations.

**Practical value.** The obtained results, including a description of the characteristics of the lakes, data on water quality and pollution levels, can be used to plan measures for the protection of public health and restoration of environment

quality. The determined locations of lakes on the map will contribute to more accurate monitoring of the environmental state of water bodies. The results of the research can be useful for local residents and environmental specialists. Information from the work will contribute to increasing the environmental awareness of the residents of the district.

***Personal contribution of the author*** – Study and analysis of literature, identification of areas with high anthropogenic load, water sampling, description of lake characteristics (color, width, length, temperature, etc.), fixation of eutrophication and pollution level in photos, analysis of collected data on water quality and pollution level, development of recommendations regarding the improvement of the environmental status of the lakes of the Darnytskyi district.

***Approbation:***

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.

***Publications:***

1. Radomska M., Huz V., Yarokhmedova I. ECOSYSTEM SERVICES OF GREEN AND BLUE INFRASTRUCTURE AT URBAN AREAS: тези доп. IV міжнародного наукового симпозіуму «Сталий розвиток – стан та перспективи», 13–16 лютого 2024, Україна, Львів – Славське. С. 232-234.

2. Yarokhmedova I., Radomska M. Assessment of the environmental status of the Vyrlytsia lake : тези доп. VI Міжнародна науково-практична конференція «Екологічний стан навколишнього середовища та раціонального природокористування в контексті сталого розвитку» до дня пам’яті професора Ю.В.Пилипенка (26-27 жовтня 2023). – Херсон: Херсонський державний аграрно-економічний університет. - С. 112-113.

3. Radomska M.M., Yarokhmedova I. V. Analysis of lacustrine water quality by organoleptic parameters: case study of Darnytsya lakes: тези доп. XXVI Міжнародної науково-практичної конференції «Екологія, охорона

навколишнього середовища та збалансоване природокористування: освіта – наука – виробництво – 2024», (м. Харків, 17-18 квітня 2024 року). Харків: ХНУ імені В. Н. Каразіна, 2024. С. 54-55.

4. 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.

# CHAPTER 1
# WATER BODIES IN THE STRUCTURE OF URBANIZED TERRITORIES

## 1.1. Water bodies in the structure of urbanized territories

Water bodies, such as natural and artificial reservoirs, play an important role in the structure of urban areas. Water bodies are not only an important natural resource, but also an important component of urban social and environmental systems. Historically, water bodies were one of the main factors influencing the development of cities and towns. However, with increasing urbanization, water resources are negatively affected by pollution and changes. Therefore, the study of water bodies in urbanized areas has become an important issue that requires attention and research.

### 1.1.1. Types of urban reservoirs. Natural and artificial

In urban regions, reservoirs can be conditionally divided into natural and artificial objects. Natural bodies of water are formed as a result of natural processes without direct human intervention and can include rivers, lakes and reservoirs. On the other hand, man-made bodies of water are formed by human activity and may include ponds, canals, fountains, and other features that have been specially created or modified for specific purposes, such as irrigation, recreation, or decorative design. The distinction between these two categories of bodies of water is important for analyzing their environmental impact and for determining their management strategies.

#### 1.1.1.1. Natural water bodies

Rivers. Rivers are natural water forms that arise as a result of natural processes and phenomena. Their origin is connected with atmospheric precipitation, at the same time partly with the phenomena of evaporation and condensation. When rain

or snow water collects on the ground surface or seeps into the soil, it gradually flows down to the lowest places, forming a stream. This stream, calling it a brook or stream, gradually merges with other streams, creating larger and more powerful bodies of water - rivers.

The main process of river formation is called drainage, when water flows down sloping surfaces, forming streams that eventually merge into a river system. Rivers are classified according to different characteristics. According to the length of the basin, the rivers are divided into small, medium and large. According to the nature of the flow, there can be mountain or plain rivers. Rivers are also divided according to the type of feeding: snow (due to the waist of snow and glaciers), rain (due to rainfall), glacial (due to glaciers) and underground (due to underground water sources).

Lakes. A lake is a natural body of water located deep inland and not connected to seas and oceans. They are important as components of the hydrosphere, but are not part of the World Ocean. The characteristic of lakes is that they have a slow exchange of water, do not receive mainly fresh water from rivers, and their currents do not determine the regime of the reservoir. Large lakes have the effect of softening the climate and temperature of the surrounding areas due to the significant thermal inertia of the water mass. The shape, size and relief of the bottom of lakes can change due to the accumulation of bottom sediments. As a result, lakes can create groundwater backup, which causes waterlogging of land. In the process of sediment accumulation, thick bottom sediments are formed, which can change and turn into swamps or dry land. Lakes are also a place of distribution of various flora and fauna.

They are classified by origin into tectonic, glacial, moraine, river, coastal, fault, floodplain, backfill-dam, mountain, crater. According to the water balance, they are divided into sewage and non-sewage, and according to water mineralization - into fresh, brackish, and mineral. Depending on the chemical composition of the water and the predominant ions, carbonate, sulfate, and chloride lakes are distinguished. Lakes are also classified by surface area and average depth. Regarding

trophicity, they are divided into oligotrophic, mesotrophic, eutrophic and dystrophic, depending on the content of nutrients and productivity of biological life.

Stream. A stream is a natural outlet of groundwater to the surface of the Earth or in water bodies such as rivers, lakes, or at their bottom, also known as an underwater spring. It is an important element of the water cycle and is of great importance for nature and people. According to hydrodynamic features, two types of rapids are distinguished: ascending, which are fed by pressurized waters, and descending, which are fed by non-pressured waters. They are divided into different types depending on the feeding stream: headwater, soil, artesian and karst. Each type has its own unique characteristics and modes. For people, water streams are of great importance, they are used for drinking water, electricity generation, irrigation, balneology and recreation. It is important to preserve and efficiently use these resources to meet the needs of modern society.

Marshes. Marshes are natural bodies of water formed as a result of the accumulation of water on a given piece of land. This reservoir is characterized by stagnant water flow and the growth of moisture-loving vegetation. Marshes are an important component of ecosystems and play an important role in maintaining biodiversity and the balanced functioning of hydrological processes.

Marshes are classified according to several criteria, such as vegetation type, degree of water mineralization, peat thickness and location. Depending on the type of vegetation and the characteristics of peat formation, the following main wetland zones can be distinguished: cold mineral reed bog, hill bog and convex oligotrophic bog. In addition, there are transitional swamps with moderate vegetation character and water mineralization, located between lowland and upland swamps.

In wetlands, special vegetation adapted to the wet environment develops. Depending on the environmental conditions, different plant species such as sedges, reeds, birches and mosses can be found in the marshes. Each type of marsh has its own characteristics and certain types of vegetation can be found. An important feature of marshes is their importance for the protection of water resources and biodiversity, and for the regulation of hydrological processes. Marshes play an

important role in filtering and purifying water, retaining moisture and preventing soil erosion. They are also important habitats and migration areas for many animals.

#### 1.1.1.2. Artificial water bodies

Pond. A pond is an artificial body of water created by the construction of a dam in the valleys of small rivers, streams or on the territory of gullies and ravines, as well as by the collapse of the territory outside the channel, in the lowering of the relief, on flat areas of the terrain and in artificial recesses. Its main function is to accumulate a supply of water for further economic use. Usually, the pond has steep banks, a gentle slope of the bottom and is resistant to erosion. The pond is filled due to the flow of river or groundwater, especially during spring thaw periods. Waterfalls are often used to control the water level.

In rural areas, ponds are used for irrigation, watering, breeding of fish and waterfowl, as well as for storing water for economic, cultural, and household needs. In cities and recreation areas, ponds are often places for fishing, swimming and sports events, and in parks, they perform a landscape and decorative function. Technical ponds or technical reservoirs are created at industrial facilities for the purpose of storing water for backup supply in case of fire, for wastewater treatment or discharge of spent water mixtures. According to the power source, they are divided into: snow, ground or artificial water. By functional purpose: irrigation, recreational, fire-fighting and others.

Water channel. A water channel is an artificial waterway created to provide water supply or drainage for people, crops and domestic animals, as well as to shorten waterways or divert water flows. The main purposes of canals can be divided into reclamation and transport. Reclamation canals are used to supply or drain water for agriculture, providing irrigation or water supply for plants. Transport canals are intended for the transportation of goods or passengers, in particular for the provision of shipping and the connection of waterways.

There are several types of channels that differ in purpose and functionality. These include reclamation canals, which are divided into irrigation and drainage

canals, water supply canals for supplying water to arid or arid regions, energy canals for powering hydroelectric power plants, as well as shipping canals that provide transport links between reservoirs and basins. Each type of channel performs its functions depending on the needs of users and local conditions.

Reservoir. A reservoir is an artificial reservoir built to store water for economic use and flow regulation. They are an important element of water management, allowing efficient management of water resources. Most of the reservoirs are formed in the valleys of watercourses during the construction of hydroelectric facilities. Their design includes dams and various sluices to help regulate water levels and flow.

There are many more types of urban water bodies (Fig. 1.1), since cities and towns are always build at the vicinity of a water body. Regarding classification, reservoirs can be divided by geographical location into mountain, foothill, plain and coastal. This classification takes into account the location of the reservoir and its relation to the landforms. They can be hydropower, irrigation, transport, recreation, etc. Each type meets specific economic or social needs and is used for specific purposes at the territory of urban areas


Fig 1.1. Type of water bodies

## 1.2. The importance of urban reservoirs

Reservoirs have always been not only natural beauty, but also an important part of the urban environment, which plays a significant role in the formation and maintenance of the life of cities. From the beginning of the formation of urban settlements to the present day, reservoirs act as natural oases that provide city residents not only with the opportunity to relax, but also contribute to the preservation of environmental balance and provide urban areas with various services.

Among the most important values, the following should be highlighted:

Water supply. Water resources can serve as a source of fresh water for the urban population, industrial enterprises, as well as for agriculture and other industries. Lakes, rivers, springs, canals, swamps, ponds and reservoirs can be used as sources of water for drinking and domestic use, as well as for industrial purposes. Providing the city with clean and uninterrupted water supply is an important condition for ensuring the health and well-being of residents. Moreover, urban reservoirs can serve as reservoirs for water in emergency situations such as fires or other emergencies. Ensuring access to a reliable source of water is an important aspect of public safety and protection of the city from possible crisis situations.

Environmental. Reservoirs perform key functions in preserving the natural environment and maintaining the diversity of life. First, urban reservoirs contribute to the purification of water from pollutants, helping to maintain water quality at an acceptable level for plant and animal nutrition and for human use. In addition, they create unique ecosystems that serve as a habitat for a variety of plant and animal species, contributing to the preservation of biodiversity. Also, urban reservoirs help to reduce the effect of heat islands, making the urban environment more comfortable for people to live in. Thus, urban water bodies are an integral part of the urban environmental landscape, and their conservation and proper management are essential to ensure sustainable urban development.

Recreational. They form natural oases for relaxation, rest and physical activity in the context of urban life. They offer opportunities for a variety of recreational activities such as water sports, fishing, picnicking on the water, coastal walks and wildlife watching. Recreational activities on city embankments contribute to the physical and mental health of city residents. Recreation creates opportunities for positive recreation and regeneration in the natural environment, which is important for the overall well-being of urban residents. In addition, the recreational use of city waters contributes to the development of tourism and the economic development of the city. Water features attract tourists and investors looking for places for recreation and entertainment, which contributes to the creation of jobs and infrastructure development.

Aesthetic. Urban ponds are of great aesthetic value to cities, as they add charm and beauty to the urban landscape. They form natural elements of the landscape and make urban areas more attractive and harmonious for city residents and guests. Reflections on the water surface, reflections of sunlight and shading of water bodies at different times of the day and year create a picturesque landscape that is a source of inspiration and relaxation for people. The attractiveness of the promenade can be further enhanced by decorating it with elements of landscape design, such as green spaces, flower beds and gazebos. In addition, various cultural events such as festivals, concerts and art exhibitions can be held on the city's embankments. This contributes to the development of the cultural life of the city and the preservation of its cultural and historical heritage.

Economic. The economic value is closely related to the recreational one. Can contribute to the development of the tourism and recreation industry, attracting tourists and investors. Recreational activities such as water sports and fishing available in urban water bodies create opportunities for business development and job creation in the tourism sector. In addition, urban water bodies can have a significant economic impact on the property and real estate market. Especially in coastal areas, the presence of water bodies can increase the attractiveness and value

of local real estate. Water bodies also function as a source of fresh water for cities, which is important for urban infrastructure and industry.

Hydrological. They serve to regulate the water balance, control the level of groundwater and reduce the risk of flooding of cities. Reservoirs can absorb excess water during rain and snowmelt, reduce pressure on sewers, and provide water exchange with groundwater. In addition, urban reservoirs can affect the urban microclimate by reducing temperature fluctuations due to evaporation and absorption of heat by water. This can have a positive effect on the comfort of city dwellers, especially in the summer months when the air temperature is higher.

### 1.3. Environmental problems of urban reservoirs

Environmental issues of urban water bodies represent a significant aspect of contemporary environmental concerns. Urban water resources are subjected to substantial anthropogenic influence, leading to a range of serious problems.

The first problem is the contamination of water resources with organic and inorganic substances due to insufficient or absent wastewater treatment. This poses a threat not only to water quality but also to the entire aquatic ecosystem. Organic substances contribute to excessive algae growth, endangering aquatic life by reducing dissolved oxygen levels in water. Inorganic substances, such as heavy metals, may accumulate in water and biota, affecting their health and viability. This issue is particularly acute in urban areas with numerous industrial facilities and high population densities, resulting in significant wastewater discharges. Improper treatment of these wastewater streams exacerbates the situation, increasing the adverse impact on the environment. Some of these substances are toxic to humans and other organisms that use water bodies as sources of drinking water and food.

The second problem is the contamination of water bodies with biogenic elements such as nitrogen and phosphorus. This is caused by insufficient treatment of wastewater and runoff from agricultural lands. Since nitrogen and phosphorus are components of common fertilizers, they can enter water bodies in excess through

runoff from fields during rain events and irrigation. This contributes to algae blooms, including harmful algal blooms, which proliferate due to high concentrations of biogenic elements in the water. Such algal blooms can cause serious environmental problems, such as water toxicity, decreased oxygen levels in water, and the formation of "dead zones" where life for many fish and other aquatic organisms becomes unsustainable. Additionally, extensive algal blooms can lead to light attenuation and reduced oxygen influx into the water, affecting the entire aquatic ecosystem.

The third problem is the contamination of urban waters with hazardous substances that enter water bodies due to accidental pollution. Emergency situations, such as accidental releases of hazardous substances at industrial facilities, transportation accidents, or other incidents, can lead to emergencies with water pollution. For example, accidents at chemical plants or accidental spills of hazardous substances during transportation can result in hazardous substances entering water bodies directly. This can have serious consequences for water quality and the health of people who use the water body. Such emergency situations require immediate action and measures to mitigate the consequences of pollution and prevent further spread of hazardous substances. However, even if measures are taken, the accumulation of hazardous substances in water and biota can have long-term consequences for ecosystems and human health.

In addition, hydrological changes caused by various hydraulic structures and construction activities can alter the natural aquatic environment and alter its environmental characteristics. For example, the construction of dams, canals and reservoirs can change the water supply regime, water level and characteristics of river and lake beds. Such changes can affect biological processes such as fish migration, reproduction of aquatic organisms, and formation of aquatic ecosystems.

The fourth problem is pollution of city waters with household waste, especially plastic. After entering the aquatic environment, plastic waste accumulates over time and poses a threat to aquatic organisms and ecosystems. In water, plastic breaks down into small particles, and these particles can enter the body of fish and

other aquatic organisms, causing poisoning and even death. Plastic can also be a source of pollution, releasing harmful chemicals into the aquatic environment that have significant impacts on biodiversity and aquatic ecosystems.

It is also important to consider the potential impacts of climate change on urban water bodies, such as increasing the frequency and intensity of natural events such as floods and droughts. Such phenomena can lead to a change in the hydrological regime of water bodies and a significant increase in water pollution. For example, rising water levels during floods can lead to increased runoff of pollutants into water bodies from urban areas such as roads, landfills, and industrial facilities. Droughts, on the other hand, can reduce the volume of water in reservoirs, concentrating pollutants and increasing their toxicity to aquatic organisms. In addition, climate change can cause changes in the distribution of precipitation and the temperature regime, which can affect the chemical composition of water and the speed of biodegradation processes. For example, higher temperatures can increase the number of algae and other organisms.

### 1.4. Natural and artificial lakes in cities and their features

There are many lakes in the world that play an important role in the life of different cities, providing them with unique natural features and creating opportunities for various types of activities. Lakes can be both natural and artificial, each of which has its own characteristics and significance. Natural lakes often become an integral part of a city's ecosystem, providing resources for water transportation, recreation, and leisure. At the same time, artificial lakes are created to add aesthetic appeal, support local infrastructure and develop tourism. Let's look at some examples of cities that have natural and artificial lakes and their impact on the urban environment:

In urban landscapes, artificial and natural lakes are important elements that affect the quality of life of the urban population and the environmental sustainability

of cities. Their characteristics and role require attention because they affect many aspects of the urban environment, from ecosystems to recreational opportunities.

### 1.4.1. Artificial lakes of urban areas.

Artificial lakes in cities are created for various reasons, such as providing water to urban consumers, regulating water levels, reducing flood risks, and improving the aesthetic appearance of urban areas. The most common types of man-made lakes in cities are reservoirs used as sources of drinking water and for industrial purposes, as well as ponds and lakes created for recreation and entertainment.

Such lakes are usually located in public places, such as city parks and squares, creating a natural oasis in the middle of the noise and bustle of city life. They are also used for recreational activities such as fishing, water sports and swimming. Such lakes often become the central element of the landscape design of the city and the main attraction for local residents and tourists.

In addition, artificial lakes in cities can perform important environmental functions, such as protecting water resources, maintaining biodiversity, purifying water, and creating favorable conditions for the development of aquatic plants and animals. Therefore, urban artificial lakes play an important role in improving the quality of life of city residents and maintaining the environmental balance of the urban environment.

Notable examples of lakes, created in cities around the world (Fig. 1.2) include:

1) Las Vegas, USA – In the middle of the desert landscape of Las Vegas is Lake Bellagio, which was created as part of the landscaping and architecture of the Bellagio Hotel and Casino. This lake is a central attraction known for its musical fountains.

2) Singapore – Singapore has an artificial lake, Marina Reservoir, created as part of the Marina Bay Sands integrated complex project. This large lake serves not only for decorative purposes, but also for holding various water shows and sports competitions.

3) Milan, Italy - In Milan, the artificial lake Idroskalo was created, which is used for various water sports and recreation. Built in the 1920s, this lake has become a popular spot for water skiing, rowing and swimming. It also serves as a venue for cultural events and concerts.

a) Lake Bellagio, USA

b) Marina Reservoir, Singapore

c) Idroskalo, Italy

Fig. 1.2. Artificial lakes in cities around the world

1.4.2. Natural urban lake.

Natural urban lakes are an important component of the natural environment and differ from artificial lakes. These lakes are usually the result of natural phenomena such as geological changes, the movement of glaciers and the formation of river systems. They vary in size and shape: from small lakes in city parks to large lakes in nature reserves.

Natural lakes in urban areas are characterized by a greater diversity of ecosystems compared to artificial lakes. Their ecosystems are often rich in plant and animal diversity and perform important environmental functions such as water purification, climate regulation and biodiversity conservation.

Natural lakes in cities can serve a variety of functions, such as providing habitat for aquatic animals, regulating water resources, and providing recreational opportunities for local communities. They can also serve as important sites for scientific research and study and help conserve natural resources and biodiversity in urban ecosystems.

Unfortunately, both artificial and natural lakes in cities are often in a problematic state and require attention and action to restore and protect them. Lakes can become polluted due to the discharge of pollutants from industrial facilities and urban infrastructure, which threatens water quality and the ecosystem as a whole. In addition, inappropriate use and recreation near lakes can lead to shoreline degradation and loss of biodiversity. In such cases, it is necessary to carry out systematic monitoring of water quality, implement measures for nature protection and rational nature management, as well as actively involve local communities in the protection and restoration of lake ecosystems. Such measures are important for ensuring the sustainable functioning of lakes in the urban environment and the well-being of the urban population.

Examples of urban ecosystems built on natural lakes (Fig. 1.3) include:

1) Stockholm, Sweden – The Swedish capital is located on 14 islands in the Mälaren reservoir. It is one of the largest natural lakes in Sweden, which influences the atmosphere and geography of the city. Lake Malaren provides opportunities for water transport, water recreation and recreation.

2) Zurich, Switzerland - The city of Zurich is located on the shores of Lake Zurich. This large natural lake serves not only as a source of drinking water for the city, but also a popular place for water sports, jet skiing and beautiful walks along the shore.

3) Vancouver, Canada - The city of Vancouver is located near the Fraser River Delta, which includes a large lake, Birding Lake. Birding Lake is an important water source and natural habitat for numerous species of fish and birds in an urban environment.



a) Mälaren reservoir, Sweden

b) Zurich Lake, Switzerland

c) Fraser River Delta, Canada

Fig. 1.3. Natural lakes in cities around the world

Many Ukrainian cities also include lakes as elements of urban ecosystem (Table 1.1). Most of them have recreational and aesthetic purpose, and very limited number are maintained in natural form to support natural biodiversity in cities. This is possible only in big cities with multiple lakes, as Kyiv.

Table 1.1

Examples of Ukrainian cities with lakes

| City | Lake | Area (ha) | Origin | Usage |
|---|---|---|---|---|
| Kyiv | Telbin Lake | 22 | Natural | Recreation, fishing |
| Lviv | Navariya Lake | 75 | Artificial | Water sports, fishing |
| Kharkiv | Zhuravlivske Lake | 1,9 | Natural | Recreation, swimming |
| Ternopil | Ternopil Lake-reservoir | 300 | Artificial | Recreation, promenades |
| Ivano-Frankivsk | City Lake | 36 | Artificial | Recreation, cultural events |

**Conclusions to Chapter 1**

This chapter examines the importance of water bodies in urban environments and their impact on ecosystems and the lives of residents. They have been found to contribute to climate regulation, create recreational areas and provide important resources for urban life. Emphasis is placed on the importance of their preservation and protection in the context of sustainable urban development. This understanding

will determine approaches to further studies of the environmental state of water bodies, which will be considered further.

# CHAPTER 2
# METHODOLOGY OF ASSESSMENT OF ENVIRONMENTAL STATE OF WATER BODIES

The study of the environmental state of water bodies is a key component of natural resource management and environmental protection. They make it possible to assess the state of aquatic ecosystems, identify the impact of anthropogenic factors, and take timely measures to preserve and restore them. The use of modern research methods helps to ensure a comprehensive approach to monitoring and management of water resources, which is necessary for sustainable development and maintenance of environmental balance.

## 2.1. The concept of the environmental state of a water body and its components

The health of aquatic ecosystems is a significant part of the whole process of the sustainable functioning of natural environments and the well-being of people. The environmental assessment of the water body is a study that is highly complex and includes an analysis of various factors impacting the relationship of a particular ecosystem with natural processes and human activities. Primarily, a good measure would be the water quality, which is dependent on the level of pollution and the dissolved substance that are critical to the ecosystem. The second element, – biodiversity, – shows the variability of life, which is the evidence of the sustainability and environmental value of a water body.

This will cover the third point on the hydro-morphological characteristics of the water body and its surrounding natural landscape and the stability of the banks of the water body. Land and water are also two elements that affect the health of the water, both in terms of quality and quantity, and the lives of people and ecosystems. Finally yet importantly, the hydrological regime is the reflection of the dynamics of

the water resources, their quantity and availability in different periods of time, which is the key for the sustainable development.

By including these elements, we can create complex solutions of the protection and revival of aquatic ecosystems, what is leading to equilibrium development and conservation of nature.

### 2.2. Negative factors affecting urban water bodies

Urban reservoirs, carrying an important environmental and recreational function for local communities, face a number of serious problems that threaten their condition and environmental value. First of all, recreational loads on bodies of water, especially in areas where swimming is prohibited for medical or safety reasons, can put significant pressure on the ecosystem through intensive use of the water and surrounding areas. Excessive visitation can lead to reduced water quality, bank erosion and destruction of vegetation, which in turn affects biodiversity and environmental balance

Household waste also poses a serious threat to urban water bodies. Illegal dumping of garbage directly into a reservoir leads to water pollution with toxic substances and plastic, which can lead to poisoning and death of various species of fish and other aquatic organisms. In addition, the negative impact on water ecosystems is caused by the destruction of natural landscapes of lakes due to the construction of residential structures and infrastructure, which leads to the loss of important areas for the preservation of biodiversity and the natural environment.

In addition, the location of urban reservoirs next to highways increases the risk of water pollution by toxic substances emitted by motor vehicles. Emissions from exhaust gases and other waste can negatively affect water quality and ecosystem health, leading to threats to local biodiversity and the health of residents. Urban reservoirs face numerous threats. A comprehensive assessment of all factors affecting urban reservoirs, as shown at Fig.2.1, is important for understanding all possible ways of influencing a water body.

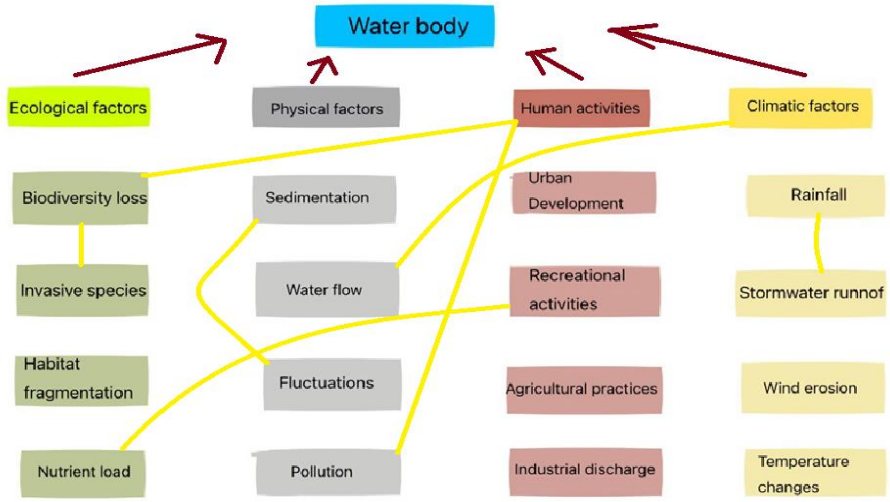


Fig. 2.1. Factors effecting on water body

## 2.3. The procedure for performing an assessment of the environmental status of water bodies

By means of a descriptive-analytical approach without the use of specialized equipment, it is possible to obtain valuable information about the quality of water, its hydrological characteristics, landscape patterns of the coastal zone, influence of anthropogenic factors and the biodiversity of plant communities. These data help identify problematic aspects of the reservoir ecosystem and develop measures for their protection and sustainable management.

The process of this assessment included descriptive and analytical approach to thoroughly evaluate the characteristics of the water body.

*General characteristics:*

I started by doing visual surveys and using satellite imagery to determine the location, size and area of the reservoir. Historical data and geological maps were used to understand its origin. In addition, I interviewed local residents to gain insight into its various uses, including recreation, aesthetics, and water management.

*Hydrological characteristics:*

Through direct observation, I estimated the depth of the reservoir and recorded water level fluctuations over a certain period. Based on the coastline study, I made conclusions about the nature of the bottom sediments and the patterns of their deposition.

*Characteristics of the landscape:*

I conducted field research to classify landscape and vegetation types in the coastal zone. Using visual observation and documentation, I quantified the percentage of different landscape elements. By personal inspection, I assessed the naturalness or alteration of the landscape.

*Water quality:*

On-site assessment of water quality parameters was carried out by visual inspection and descriptive analysis. Water samples were taken from each lake for qualitative analysis and assessment of organoleptic properties. I recorded the color, smell, transparency and temperature directly in the field. After visually inspecting the water, I made a conclusion about the concentration of nutrients and the level of eutrophication. The intensity of algal blooms and the surface vegetation cover were documented by photo.

*Anthropogenic pressure:*

I assessed the degree of anthropogenic influence by visual survey and interviewing local residents. I have personally documented the accumulation of trash and recreational activities along the shoreline. Using visual cues, I identified intake points and outlets. The level of urbanization was assessed based on proximity to residential areas and industrial sites.

*Biodiversity of coastal vegetation:*

Systematic surveys of coastal vegetation were conducted by direct observations along transects perpendicular to the shoreline. I identified and recorded plant species, quantifying their abundance using descriptive methods. The diversity and distribution of coastal vegetation species was documented using personal photographs.

This descriptive and analytical approach ensured thorough data collection and analysis, provided valuable information on the environmental status and conservation needs of the reservoir.

### 2.4. Methods of visual assessment of water quality in natural and artificial reservoirs

In the process of water sampling from the reservoir, the method of descriptive and analytical approach was used. Prior to sampling, a visual assessment of the water was performed, including analysis of color, odor, and clarity. Water temperature was measured by immersing the hand. A water sample was taken in a clean glass jar and left for two weeks in the light for further analysis. After this period, the jar was inspected: the presence of gas bubbles was detected, the area and height of the sediment were measured, and any hydrobionts were studied.

This approach made it possible to obtain information about the state of aquatic ecosystems without using complex devices or specialized equipment. A visual assessment revealed obvious changes in the quality of water and its environment. Temperature measurement and sampling provided reliable data for further analysis. This approach is an effective and affordable way to assess the state of water resources and identify possible problems.

### Conclusions to Chapter 2

In this section, I applied the descriptive-analytical approach to the study of aquatic ecosystems. Having chosen this methodology, I was able to analyze in detail the hydrological, landscape and quality characteristics of water bodies. The obtained results are a key to understanding the environmental state of water bodies and determining the necessary measures for their preservation and restoration. This analysis made it possible to draw objective conclusions about the state of aquatic ecosystems, which will be further discussed in the following sections.

# CHAPTER 3
# ASSESSMENT OF THE ENVIRONMENTAL STATE OF THE LAKES OF THE DARNYTSKYI DISTRICT

The study of the environmental state of the lakes in the Darnytskyi district included a holistic study aimed at understanding the state of water resources, and their influence on the environment. The main purpose of this study was to find out the quality of water, to assess the level of pollution and to identify the factors that affect the environmental balance of lakes. The obtained data is a big asset in further shaping strategies for continuous efforts on protecting and preserving water resources and natural environment in this area.

## 3.1. Description of research objects

The following lakes were selected for the evaluation of the environment status of water bodies in the Darnytsia district: Zaryvaha, Tyagle, Martysh, Nebrezh, and Vyrlytsia (Fig. 3.1). Each of these lakes has its own unique characteristics and features that affect their biological diversity. In the course of research the water quality, hydrological and landscape characteristics, anthropogenic load and pollution level of each of these reservoirs were assessed.


Fi. 3.1 Location of studied water bodies

All the lakes are located in close proximity, but are characterized by different landscape structure (Table 3.1) and consequently structure of communities and level of biodiversity. The types of landscapes, in particular, share of transformed landscapes, also affect the resistance of lacustrine ecosystems to anthropogenic pressure and climate changes.

Table 3.1

Landscape Structure of lake floodplain

| **Lake** | **Percentage of area covered with specific landscape** | | | | |
|---|---|---|---|---|---|
| | forest, shrubs | meadows (hayfields, pastures | swamps | arable land | urbanized areas |
| Zaryvaha | there are some small areas of forest, up to 10% | less than 20% of natural meadows or steppes | the floodplain was drained or there were no swamps | 40-60% | 15-30% |
| Tyagle | Small patches of forest, up to 10% | Natural meadows or steppes less than 20% | Floodplain drained or no swamps present | 40-60% | 15-30% |
| Lebedyne | No areas with natural forests, meadows, or steppes | - | Drained, "cultivated" | More than 30% | More than 70% |
| Nebrezh | Small patches of forest, up to 10% | Natural meadows or steppes less than 20% | Floodplain drained or no swamps present | 40-60% | 15-30% |

| | | | | | |
|---|---|---|---|---|---|
| Vyrlytsia | Small patches of forest, up to 10% | Natural meadows or steppes less than 20% | Floodplain drained or no swamps present | 40-60% | 15-30% |
| Martysh | 15-20% forest or forest plantations | Meadow or steppe areas about 30% | No natural swamps present | 20-40% | 10-15% |

Analyzing the data in the (table 1) about the percentage of coverage by different types of landscape for each lake, several conclusions can be drawn.

Lake Zaryvaha has been noted to have some small patches of forest, accounting for up to 10% of the total area, as well as small patches of natural meadows or steppes of less than 20%. However, most of the floodplain has been drained or swamps are absent, and more than 40-60% of the area is urbanized, indicating a significant impact of human activity.

In the case of Lake Tyagle, Nebrezh and Vyrlytsia, there is also a small number of forest areas, up to 10%, and small fragments of natural meadows or steppes less than 20%. Similar to Zaryvaha, most of the floodplain has been drained or swamps are absent, and much of the area between 40% and 60% is urbanized.

It is noted that Lake Lebedyne does not have any areas of natural forest, grassland or steppe, and the area has been drained and "cultivated" by more than 30%. More than 70% of the territory is urbanized, which indicates the great impact of human activity on this lake.

Finally, Martysh Lake has the most diverse landscape feature. It has some areas of forest or forest plantations between 15% and 20%, and areas of meadows or steppes, about 30% of the area. There are no natural wetlands on this lake, and 20% to 40% of the area is built-up or urbanized.

If count the data about the area occupied by urban area and arable land given in Table 3.1, the level of lakes anthropization ranges from 50 (Lake Martysh) to

almost 100% (Lake Lebedyne). This means that the Martysh is the most stable ecosystem, possessing potential for climate change resilience.

### 3.2. Hydrological characteristics of lakes

Each lake has its own unique features of the landscape and the level of influence of human activity, which is important for further understanding of its environmental state and adoption of protection measures.

Table 3.2

**Hydrological profile of lakes**

| Lake | Depth | Nutrition source | Nature of the bottom | Torturity of the bottom | Regulation |
|---|---|---|---|---|---|
| Zaryvaha | approximately 17-20 meters | rainwater | natural with unevenness, like islands, according to local residents, it has large pits. | a layer of silt of about 1.5-2 meters, significant, dense. | the floodplain and banks have not been changed, natural tributaries have not been diverted |
| Tyagla | Approximately 37m | rainwater | artificial - flat without features | layer of silt 15-40 cm, mostly dense | the possibility of changes in the floodplain, regulation of the water level, as well as reconstruction of the coastline through construction or engineering measures. |

| | | | | | |
|---|---|---|---|---|---|
| Lebedyne | 17m | rainwater | flat without features | layer of silt 15-40 cm, mostly dense | it is a completely designed park around the lake, part of the shoreline has been converted into a park |
| Nebrezh | 32 m | rainwater | natural with irregularities | a layer of silt up to 15 cm, mostly soft | Large-scale urban construction led to the fact that a small fragment remained from the huge floodplain, |
| Vyrlytsia | 28 m | mainly from rainwater, as well as from underground sources and tributaries. | natural with irregularities, embankment, pits, protrusions, etc | a layer of silt up to 10 cm, mostly soft | was not subjected to significant engineering or anthropogenic changes. However, the possibility of changes in the hydrological regime or in the coastline due to construction and engineering |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | measures cannot be excluded |
| Martysh | 20 m | rainwater that flows from the surrounding areas during rainfall. | natural with irregularities | a layer of silt from 15 to 1 m in different parts of the lake | construction and shifting of the coastline are observed |

### 3.3. The results of visual evaluation of the lakes status

3.3.1. Zarivakha reservoir

*General characteristics.* Lake "Zarivakha" is located on the territory of garden and country plots in Nizhny Sady. It is a medium-sized reservoir with an area of approximately 3.5 hectares. The lake has a natural origin, it arose without human intervention. It is mainly used for recreational purposes, such as recreation by the water, fishing, etc.

However, it should be taken into account that the lake can be used quite intensively, especially in the warm season, when many people relax at summer cottages and in garden associations. This can lead to increased pressure on the lake ecosystem and deterioration of its condition.

*Water quality evaluation:*

- Color: greenish-brown.
- Odor: grassy-swampy.
- Transparency: low.
- Water temperature: 11 degrees Celsius.

The development of eutrophication: the presence of a silt layer, a large number of algae and reeds indicate eutrophication 50% (Fig. 3.2)

Fig. 3.2 Lake Zarivakha view

Anthropogenic load on the lake is not high and can be characterized as follows:

- Littering: Both the coast and the water are polluted with domestic waste.
- Level of recreational load: low level.
- Water intake: absent.
- Waste water discharge: none.
- Urbanization of the coast: the presence of nearby residential buildings, a shopping complex.

### 3.3.2. Lake Tyagle

*General characteristics.* Lake Tyagle (Fig.3.3) is located in the meadows south to the Kolektorny Lane. It has large dimensions, the area of the lake is 137 hectares. It is an anthropogenic lake by origin. It is mainly used for recreational purposes.

*Water quality:*

- Water color: Muddy or earthy.
- Odor: Grassy-earthy.

- Transparency: High, difficult to determine transparency only 50 cm from the surface of the water.
- Water temperature: 14°C.

The presence of an excessive garbage load, a disturbed shoreline and the smell of water indicate the initial stage of eutrophication. However, surface fouling is not : 10% to the area of the water mirror.

Fig. 3.3 Lake Tyagle view

*Anthropogenic load is moderate with the biggest share falling to the category of recreational use.*

- Littering: There are separate accumulations of objects of unnatural origin and organic remains.
- Level of recreational load: Average, 4-2 people.
- Water intake: Unknown.
- Discharge of sewage, storm water or sewage: None.
- Urbanization of the coast: There are few buildings nearby.

3.3.3. Lebedyne reservoir

*General characteristics.* Lake Lebedyne (Fig. 3.4) is located between Poznyaki and Kharkivska metro stations in the urbanized area of the city. It is small

in size, with an area of 6.5 hectares. The lake has an anthropogenic origin, as it was created artificially for specific needs. The main use of the lake is recreational and decorative, which makes it an important element of the local environmental and social infrastructure. Thanks to its location and characteristics, Lake Lebedyne contributes to the improvement of the quality of life of residents and provides an attractive place for recreation and leisure.

Water quality of the Lake Lebedyne is poor:

- Water color: Grayish-green.
- Odor: Pungent, grassy, marshy.
- Transparency: It is difficult to see the bottom at a depth of 10 cm, at 20 - there is no transparency.
- Water temperature: 16°C.
- High intensity of eutrophication, covering 50% of water surface.
- Surface overgrowth: 20%.

Fig. 3.4. Lake Lebedyne

Due to artificial origin and mostly recreational use anthropogenic load is significant, but hasn’t changed the area much:

- Littering: There are separate accumulations of objects of unnatural origin and organic remains.
- Level of recreational load: Up to 10 people per 10 m².
- Water intake: None.

- Discharge of sewage, storm water or sewage: None.

Plant biodiversity of the coastal zone is quite typical for natural lakes of such parameters and includes algae, aquatic plants (water lily, frog cabbage, sage, watercress) and coastal plants (sedge, sedge, lilac, willow, various types of herbaceous plants, etc.

3.3.4. Lake Martysh

*General characteristics.* Lake Martysh (Fig 3.5) is a natural reservoir at certain distance from residential and other urban developments. In terms of water volume, it belongs to the category of large lakes, covering an area of 26 hectares. The reservoir was formed naturally and has significant environmental and hydrological importance for the local biota and hydrological processes of the region. One of the significant functions of the lake is its recreational use, making it a valuable recreational and rejuvenating resource for the city's residents and visitors.

Fig. 3.5. Lake Martysh

Water quality is satisfactory:

- Water color: Bluish-greenish.
- Odor: Earthy in the southern part, grassy and putrid in the northern.
- Transparency: Medium-transparent, slightly cloudy in some areas.

- Water temperature: 13-15°C.
- Development of eutrophication: Insignificant, 15-20%.

Relatively good quality of water is probably due to natural self-purification potential and limited anthropogenic pressure on the ecosystem:

- Littering: There are separate accumulations of objects of unnatural origin and organic remains.
- Level of recreational load: 3-4 people per 10 m².
- Water intake: None.
- Wastewater, rainwater or sewage discharge: None.
- Urbanization of the coast: Presence near residential construction complexes, roads, shops.

3.3.5. Nebrezh lake

*General characteristics.* Lake Nebrezh is located (Fig 3.6) between lakes Martysh and Tyagle. This is a large reservoir with an area of 44.1 hectares. It has a natural origin and is used for recreational purposes, providing an opportunity for recreation and entertainment for the local population and visitors to the city.

Water quality changes depending on the period of the year and at the moment of description was poor:

- Water color: Greenish.
- Odor: Grassy.
- Transparency: Low level, cloudy water, difficult to see at a depth of 10 cm.
- Water temperature: From 13 to 16°C.
- Development of eutrophication: Difficult to determine.
- Surface overgrowth: 10% in some areas.

Anthropogenic load was hard to determine, but the recreational type of use is definitely present:

- Littering: Littered coastline and water.
- Level of recreational load: 2-3 people per 10 m².

- Water intake: Unknown.
- Wastewater discharge: Unknown.
- Urbanization of the coast: The presence of a small number of residential buildings on the one hand, and on the other - the beginning of the construction of new complexes, roads and new buildings.

Fig. 3.6. Lake Nebrezh

3.3.6. Vyrlytsia reservoir

*General characteristics.* Vyrlytsia Lake (Fig. 3.7) is located in the south-eastern part of the Darnytsky district of Kyiv, is a large natural reservoir with an area of 99 hectares. This lake is of natural origin and is used mainly for recreational purposes, while other forms of anthropogenic load were not clear seen:

- Littering: There are some objects of unnatural origin.
- Level of recreational load: Sufficient level, 5-6 per 10 m².
- Water intake: Unknown.
- Wastewater discharge: Unknown.
- Urbanization of the coast: Presence near residential buildings, complexes, shopping centers, industries, highways.

Water quality is satisfactory:

- Water color: Bluish.
- Smell: Earthy, sometimes grassy.

- Transparency: High level of transparency even at a depth of 40-45 cm from the water surface.
- Water temperature: 13-14°C.
- Development of eutrophication: In some individual zones there is a sufficient level, but in relation to the total size of the lake - 10-15%.
- Overgrowth of the surface: The same situation - 10-15%.

Fig. 3.7. Lake Vyrlytsya

3.3.7. Aggregation of the visual assessment results

Combining the results obtained through visual tours to the territory a range of common features was defined:

1. *Recreational use.* All lakes are used for rest and recreation. They serve as a place for recreation by the water and fishing.

2. *Nutrition source.* Most lakes are fed by precipitation, although some also have an additional source of water from underground springs or tributaries.

3. *Silt layer*. All lakes have a layer of silt at the bottom, but its thickness can vary. This can potentially mean that there is pollution accumulated.

Being located close to each other, each lake still represents a separate ecosystem and thus there are certain differences in their characteristics:

1. *Origin.* "Zaryvaha", "Nebrezh" and "Vyrlytsia" are of natural origin, while "Tyagle", "Lebedyne" and "Martysh" are man-made lakes.

2. *Anthropogenic influence.* The level of anthropogenic impact is different for each lake: some have a small footprint, while others have undergone significant changes due to urban development and engineering.

3. *Level of eutrophication*. Lakes differ in the level of eutrophication and water pollution. For example, "Lebedyne" and "Zaryvaha" show a high intensity of eutrophication, while "Martysh" has a negligible level of eutrophication.

4. *State of the environment*. The lakes differ in environmental status: "Tyagle" shows signs of initial eutrophication and pollution, while "Vyrlytsia" remains practically untouched by the unchanged environment.

Although all lakes have their own unique characteristics, their preservation and condition require constant monitoring and attention in order to ensure their environmental stability and future use.

### 3.4. Environmental issues of the Darnytsya lakes

Each of studied lakes has its own unique features and faces its own environmental challenges. Let's take a closer look at each of them to understand the current state and possible ways to solve the problems.

**Lake Zaryvaha** faces the following environmental problems:

1. Littering of the shores: The shoreline of the lake is littered, which affects the aesthetics and environmental condition of the reservoir. The presence of garbage disrupts the natural balance and threatens local ecosystems.

2. High level of waterlogging: The lake is characterized by a high level of waterlogging, which indicates a significant amount of plant material and other organic matter growing on the bottom. This can lead to a decrease in the oxygen regime and a threat to aquatic organisms.

3. Low water clarity: The water in the lake has low clarity due to the abundance of algae and other plant material in the water. This makes it difficult for light to penetrate and can lead to an imbalance in the ecosystem.

4. Excessive amount of algae: A large amount of algae is observed on the surface of the water, which indicates an excessive concentration of nutrients in the reservoir. This can lead to eutrophication and a decrease in oxygen levels in the water, which threatens aquatic life.

5. Presence of reeds: A large number of reeds on the shores of the lake indicates environmental degradation of the coastal zone. This can affect the biodiversity and natural beauty of the water body.

**Tyagle Lake** is under considerable anthropogenic pressure due to excessive recreational use. Numerous visitors bring litter and pollute the shoreline, which deteriorates water quality and the state of the natural environment. Additional wastes are brought from construction site. The lake was formed as a result of the erosion of the territory for the construction of residential areas. As a result, there is an excessive load of garbage from developers and ordinary household waste. This leads to water pollution and disturbance of the environmental balance.

As a result of these negative factors water quality has declined considerably: water transparency is rated as cloudy. This may be the result of emissions of garbage, construction materials and other pollutants into the reservoir, which complicates the life of aquatic organisms and threatens the lake's ecosystem.

The beginning of eutrophication is observed, which indicates a high level of nutrients in the water, which stimulates the rapid growth of algae and can affect the environmental balance of the lake.

The odor of the water can be characterized as grassy-earthy, which may be a consequence of the decomposition of organic substances in the water and the presence of waste in the lake.

**Lebedyne Lake** faces a number of serious environmental problems: it has been converted into a fitness park, and our survey showed that it has the worst water

quality of all studied. The water in it has a characteristic acrid smell, gray color, and high turbidity. This indicates serious pollution.

The bottom of the lake is muddy, and when pressed, it squeezes. This can be a consequence of the deposition of a large amount of sediments and organic substances on the bottom; these contribute to the deterioration of water quality and environmental pollution.

So, Lake Lebedine may not comply with environmental standards and insufficient measures for its cleaning and protection are applied.

**Lake Martysh** faces not as many environmental problems? However, they are still present. The primary concern is irregularity of water quality. Although Lake Martysh is of natural origin and is located in the floodplains of the Dnieper, its northern part has worse water quality. There is a grassy smell, low transparency of the water and pollution of the bottom, which may be the result of insufficient purification of water from pollution and the negative impact of human activity.

The water quality in the southern part of Lake Martysh is better compared to the northern part. There are less pronounced problems, a slight earthy smell and high transparency of the water. However, even in this part, pollution problems can arise due to human activities and emissions of pollutants.

**Lake Nebrezh** is obviously affected by pollution. Thus, the water of Lake Nebrezh has a high level of turbidity and low transparency. This may be the result of the deposition of solid particles on the bottom of the lake and the influence of anthropogenic factors, such as uncontrolled discharge of sewage or emissions from the surrounding areas.

Coastal pollution: The coast of Lake Nebrezh is partially littered with garbage and waste. This may be the result of an inadequate attitude of visitors to nature and an insufficient garbage collection and disposal system.

Algae growth: On the surface of the water and at the bottom of Lake Nebrezh, a large amount of algae can be observed. This can be the result of oversaturation of the water with nutrients such as phosphates and nitrates, which promote active growth of algae.

Smell of water: The smell of the water of Lake Nebrezh can be defined as grassy and delirious. This may indicate the presence of organic matter in the water, such as plant residues or sewage, which are subject to the processes of decay and putrefaction.

**Lake Vyrlytsia**, of natural origin, has significantly increased due to hydroerosion of nearby settlements. This led to changes in the ecosystem and an additional burden on the surrounding areas.

The shores of the lake, in particular from enterprises, are in an extremely polluted state, which makes it impossible to restore recreational services. Careless use of the territory has led to the accumulation of garbage and waste, which negatively affects the quality of water and the environment.

The part of the lake located on the side of the track, although prohibited for recreational purposes, has better conditions. The water in it is quite transparent, does not have a pronounced unpleasant smell and is not cloudy. However, growing pollution may threaten this part of the lake in the future.

### 3.5. Integrated environmental assessment of Darnytsia Lakes

Summarizing the environmental problems of the lakes in the Darnytskyi district reveals a pressing need for immediate intervention due to a multitude of serious challenges. One prominent issue is the proliferation of algae, disrupting the aquatic ecosystem and endangering biodiversity. This surge in algal growth stems from heightened nutrient concentrations, often resulting from uncontrolled discharge of fertilizers and organic substances into the lakes. Such overgrowth can lead to adverse effects on other aquatic organisms and degrade water quality.

Furthermore, the pervasive odour of the water, often reminiscent of grassy or marshy scents, poses another significant challenge, impacting the environmental quality and deterring tourism potential in the region. This could diminish the appeal of local water bodies to visitors and raise concerns among the community.

All lakes - Zaryvaga, Tyagle, Lebedyne, Nebrezh, Vyrlytsia, and Martysh - encounter *similar* environmental issues necessitating urgent remedial action:

- Organoleptic properties of water in the lakes are of poor quality: water have low transparency, high turbidity and often unpleasant smell, which indicates general problems of water pollution.
- Eutrophication is observed in all lakes – this is an increase in the amount of nutrients in the water, which contributes to the rapid growth of algae and disrupts the environmental balance.
- Coastal pollution with solid waste is a problem typical to all lakes to certain extent, which negatively affects the aesthetics and quality of water bodies.
- Lakes are overexploited for recreational purposes; especially this is the issue of Tyagle, Lebedine and Vyrlytsia.

In addition to common problems, each lake has its own *unique* aspects that should be considered:

- Zaryvaga and Nebrezh lakes suffer from high levels of algae and deep coastal pollution.
- Tyagle has turbid water and large amount of garbage and construction materials inside.
- Lebedine’s water has a characteristic sour smell, which can be an indicator of the presence of harmful substances in the water.
- Vyrlytsia suffers from a particularly large amount of litter and waste on the coast, which negatively affects recreational opportunities.
- Martysh also faces problems with algae and shoreline debris, although these problems may be less pronounced compared to other lakes.

### 3.5.1 Assessment of the condition of the lakes in points.

To facilitate the assessment of the environmental state of each lake, a scoring system was used, which allows for a visual comparison of their state. Lakes were evaluated according to five criteria: water transparency, pollution level, presence of

eutrophication, shoreline condition and general environmental condition. Each criterion was evaluated on a scale from 1 (very bad) to 5 (very good). The average scores for the lakes are as follows:

***Lake Lebedyne:*** 1.5 – The worst environmental condition, with the highest level of pollution and eutrophication.

***Lake Tyagle:*** 2.0 – High level of anthropogenic load, pollution of shores and water.

***Lake Zarivaha:*** 2.5 – A significant amount of algae, low water transparency and pollution of the shores.

***Lake Nebrezh:*** 2.8 – A significant amount of algae, low water transparency and pollution of the shores.

***Lake Vyrlytsia:*** 3.0 – Better compared to others, but still has problems with pollution and eutrophication.

***Lake Martysh:*** 3.2 – Best condition among the lakes surveyed, but still needs improvement.

### 3.4. Recommendations for the improvement of the lakes' environmental status

To address the environmental challenges facing **Lake Zaryvaha**, immediate action is required to clean up the shoreline and reduce waterlogging. A comprehensive waste management program should be implemented, focusing on regular clean-ups and the installation of waste disposal facilities around the lake. To combat waterlogging and low water clarity, the introduction of aeration systems can help improve oxygen levels, while controlled harvesting of excess algae and plant material will help restore balance. Additionally, managing nutrient inflows by monitoring and reducing agricultural runoff can prevent further eutrophication. Rehabilitating the reed-dominated shorelines with native plants can enhance biodiversity and stabilize the ecosystem.

The environmental health of the Tyagle Lake can be improved through stringent waste management practices, especially targeting construction debris and household garbage. Establishing a monitoring system to track pollution sources and implementing stricter regulations on waste disposal by nearby residential areas are crucial. Enhancing water clarity and reducing turbidity can be achieved by introducing filtration systems and promoting natural filtration through wetland plants. To address excessive recreational use, designated picnic areas and clearly marked waste bins can help control littering, while educational campaigns can raise awareness about preserving the lake's natural environment. Early intervention to manage eutrophication through the use of phosphate-reducing agents and regular monitoring will help maintain environmental balance.

Improving **Lake Lebedyne's** severely polluted waters necessitates a multifaceted approach. Initiating a thorough clean-up operation to remove the accumulated sediments and pollutants is the first step. Upgrading the lake's water treatment infrastructure is essential to ensure compliance with environmental standards. Introducing bio-remediation techniques, such as the use of specific plants and microorganisms to break down harmful substances, can improve water quality over time. Establishing buffer zones with vegetation around the lake will help filter runoff and reduce further pollution. Regular water quality assessments should be conducted to monitor improvements and adjust strategies as needed. Community engagement and awareness programs can foster a sense of responsibility among visitors and locals, reducing the human impact on the lake.

For the **Lake Martysh**, targeted efforts to improve water quality, particularly in the northern part, are needed. Enhancing water purification methods to address the grassy smell and low transparency involves the use of natural filtration systems, such as floating wetlands, which can help clean the water. Promoting the use of eco-friendly agricultural practices in the surrounding areas can reduce the inflow of pollutants. Regular dredging of the bottom sediments will help in maintaining water clarity. Establishing conservation zones around the lake can protect sensitive areas from human interference and allow natural recovery processes to take place.

Educating the community about the environmental importance of the lake can lead to better cooperation in conservation efforts.

To tackle the pollution issues in **Lake Nebrezh**, a strategic plan focusing on both water and shoreline clean-up is essential. Regular removal of solid waste and the establishment of waste collection points around the lake will mitigate coastal pollution. Implementing a nutrient management plan to control the input of phosphates and nitrates can help curb algae growth. Enhancing the lake's natural filtration capacity by planting aquatic vegetation that absorbs excess nutrients will improve water quality. Regular monitoring and maintenance of these plants are necessary to ensure their effectiveness. Addressing the source of the grassy and delirious smell involves reducing organic matter decomposition through aeration and bioremediation techniques. Community involvement in clean-up activities and educational programs can foster a culture of environmental stewardship.

**Lake Vyrlytsia's** environmental improvement requires addressing both the increase in volume and shore pollution. Initiating reforestation and planting buffer strips around the lake can help stabilize the shores and prevent further erosion. Conducting regular clean-ups and enforcing stricter waste disposal regulations for nearby enterprises will reduce shoreline pollution. Implementing erosion control measures and creating retention basins can manage the increased water volume and protect the ecosystem. Promoting the use of eco-friendly materials and practices among local industries will further safeguard the lake's health. Ensuring that the clear water conditions in the less polluted parts are maintained requires ongoing monitoring and rapid response to emerging pollution threats. Establishing recreational guidelines and facilities that minimize environmental impact can balance human use and conservation efforts.

### Conclusions to Chapter 3

The analysis of the environmental status of the Darnytsia Lakes was conducted based on the results of visual observations. It was defined that such problems as poor water quality, eutrophication, coastal pollution with solid waste

and overexploited for recreational purposes are common for all lakes. However, the reasons and sources of water pollution are defined to be specific for each lake. The recommendations on the improvement of the environmental status were developed for each lake.

# CONCLUSIONS

1. The conducted analysis showed that the environmental state of the lakes of the Darnytsky District of Kyiv varies depending on the anthropogenic load and the natural features of each object. Lakes Zaryvaha, Tyagle, Martysh, Nebrezh, and Vyrlytsia differ in the level of pollution, water quality, and the presence of biological diversity. The most polluted lakes have a high level of anthropogenic load, which leads to a decrease in water quality and a loss of biological diversity.

2. City reservoirs play an important role in the environmental and recreational infrastructure of the city. They support local biodiversity, create favorable conditions for residents to relax, and also perform an important ecosystem function, in particular, in microclimate regulation and water purification. Despite this, they often do not receive enough attention in studies of the quality of the urban environment.

3. The method of visual assessment of water quality and organoleptic assessment was used in the work, which made it possible to obtain detailed information about the environmental state of the lakes. The assessment was carried out on the basis of hydrological and landscape characteristics, as well as the level of anthropogenic influence. These methods are effective and affordable ways to assess the state of water resources and identify possible problems.

4. It has been established that the main sources of lake pollution are domestic and industrial wastewater, improper handling of solid waste, and intensive urbanization. This leads to the accumulation of toxic substances in the water and at the bottom of lakes, which negatively affects ecosystems and the health of local residents. Lakes with a high level of anthropogenic influence require urgent measures for their preservation and restoration.

5. The main environmental problems of the lakes of the Darnytskyi district are water pollution, reduction of biological diversity, eutrophication and siltation. To improve their environmental condition, it is recommended:

- Development and implementation of complex programs for monitoring and cleaning water bodies.
- Involvement of the public in the protection of water bodies by conducting information campaigns and eco-educational events.
- Strengthening control over compliance with environmental legislation and the introduction of modern wastewater treatment technologies.

6. Further research should be aimed at developing new methods for assessing the state of water bodies, taking into account climate changes and urbanization processes. It is also important to develop international cooperation for the exchange of experience and implementation of best practices in the field of water resources protection.

7. The work highlighted the importance of a comprehensive approach to the assessment of the environmental state of urban water bodies. The results of the research can be used to develop strategies for the conservation and restoration of water resources, which will contribute to the improvement of the quality of life of city residents and the preservation of biodiversity in urban areas.

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