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**Тема: «Оцінка якості повітря в межах житлового масиву «Позняки»
міста Києва»**

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BACHELOR THESIS

(EXPLANATORY NOTE)

SPECIALTY 101 «ECOLOGY»,
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**Theme: «Assessment of air quality within the residential area “Poznyaki”
of Kyiv city»**

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BACHELOR THESIS ASSIGNMENT

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1. Theme: «Assessment of air quality within the residential area “Poznyaki” of Kyiv city» approved by the Rector on April 27, 2020, № 527/ст.
2. Duration of work: from 25.05.2020 to 21.06.2020.
3. Output work: The statistical data from Pozniaky district and major polluting roads.
4. Content of explanatory note: To analyse the main sources of air pollution and the impact of polluting sources on human health, to investigate the main anthropogenic industries that have a negative impact on the environment, to study the level of air pollution by the CO chemical substance in the Poznyaky area, to propose methods for improving the quality of atmospheric air in the Poznyaky area, to compare the methods of improving the quality of atmospheric air in Ukraine and European countries.
5. The list of mandatory graphic (illustrated materials): tables, figures, graphs.

6. Schedule of thesis fulfillment

№ з/П	Task	Term	Advisor's signature
1	Receive themes task, search the literature and legislation	27.04.2020	
2	Preparing the main part (Chapter I)	29.04.2020	
3	Preparing the main part (Chapter II)	13.05.2020	
4	Preparing the main part (Chapter III)	14.05.2020	
5	Formulating conclusions and recommendations of the thesis	14.05.2020	
6	Making an explanatory note to the previous presentation of the department, consultation with the norms controller	02.06.2020	
7	Presentation of the work at the department	05.06.2020	
8	Taking into account the comments and recommendations and training to protect	05.06.2020	
9	Thesis defense at the department	17.06.2020	

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ЗАТВЕРДЖУЮ
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ЗАВДАННЯ
на виконання дипломної роботи
Цисар Ганни Олегівни

1. Тема роботи «Оцінка якості повітря в межах житлового масиву «Позняки» міста Києва» затверджена наказом ректора від «27» квітня 2020 р. №527/ст.
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3. Вихідні дані роботи: статистичні дані з району Позняки (м. Київ) та головних доріг-забруднювачів.
4. Зміст пояснювальної записки: проаналізувати головні джерела забруднення атмосферного повітря та вплив забруднюючих джерел на здоров'я людини, дослідити головні антропогенні галузі, які негативно впливають на навколишнє середовище; вивчити рівень забруднення повітряного басейну хімічною речовиною СО у районі Позняки, запропонувати методи для покращення якості атмосферного повітря у районі Позняки, порівняти методи покращення якості атмосферного повітря в Україні та Європейських державах.
5. Перелік обов'язкового графічного (ілюстративного) матеріалу: таблиці, рисунки, діаграми.

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1	Отримання теми завдання, пошук літературних джерел та законодавчої бази	27.04.2020	
2	Підготовка основної частини (Розділ I)	29.04.2020	
3	Підготовка основної частини (Розділ II)	13.05.2020	
4	Підготовка основної частини (Розділ III)	14.05.2020	
5	Формулювання висновків та рекомендацій дипломної роботи	14.05.2020	
6	Оформлення пояснювальної записки до попереднього представлення на кафедрі, консультація з нормоконтролером	02.06.2020	
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ABSTRACT

Explanatory note to thesis « Assessment of air quality within the residential area “Poznyaki” of Kyiv city»: 65 pages, 12 figures, 22 tables, 39 references.

Object of research – formation of air quality.

Subject – air pollution of Kyiv city.

Aim of work – to assess the atmospheric pollution level in Pozniaky district.

Methods of research: analysis, data comparison, statistical data processing.

**AIR CONTAMINATION, TOXIC GASES, TRANSPORT, POZNIAKY
DISTRICT**

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LIST OF SYMBOLIC NOTATIONS AND ABBREVIATIONS

WHO — World Health Organization.

TPP — Thermal Power Plant.

USSR — The Union of Soviet Socialist Republics.

INTRODUCTION

Relevance. Nowadays in Ukraine, the air pollution is one of the main environmental problems. The Air pollution by various natural and anthropogenic sources leads to poor health and the development of dangerous diseases in humans, as well as to climate change and the development of the greenhouse effect, and global warming. Kyiv is millionaire city and one of the most polluted air basins among the cities of Ukraine and the world. The 84% of air pollution caused by transport, because the transport emits tons of toxic exhaust gases. CO, CO₂, SO₂, NO_x, Pb, and others have a devastating effect on the ozone layer, air quality and ecology, climate, and on human health. In Kyiv, many peoples have more than 2-3 cars in the family, therefore, to assess the quality of the level of air pollution, the densely populated Pozniaky district was chosen.

Aim and tasks of graduate work. The aim of the work is assessing the atmospheric pollution level in Pozniaky district.

Tasks of work:

1. To analyze the sources of air pollution;
2. To estimate the air quality in Pozniaky district;
3. To suggest methods to improve air quality in Pozniaky district.

Object – formation of air quality.

Subject – air pollution of Kyiv city.

Methods of research. Analysis, data comparison, statistical data processing.

Personal contribution of the graduate. The analysis of sources of atmospheric pollution was carried out, the air quality in a densely populated area of Kyiv was analyzed, methods for reducing CO concentration near high-traffic roads were proposed, and methods for atmospheric purification in Ukraine and European countries were compared.

Publications.

1. Comparison of water quality indicators in Ukraine and European Union/ Tsysar H.O. – Technogenic and Ecological Security of Ukraine: State and Prospects for Development / TEB-2019. — Irpin, Ukraine, 2019. — p.150.
2. Transport influence on the environmental state of water reservoirs/ Tsysar H.O — 22th Conference for Lithuanian Junior Researchers “Science – Future of Lithuania. Transport Engineering and Management”. — Vilnius, Lithuania, 2019. — p. 126-129.
3. The influence of Thermal Power plants on the air pollution in Kyiv/ Tsysar H.O. — All-Ukrainian Scientific and Practical Conference of Young Scientists and Students “Ecological Security of the State”. — Kyiv, Ukraine, 2020. — p.26-27.
4. Investigation of Air pollution by Oil sources in Kyiv/ Tsysar H.O. — X International Scientific-Technical Conference “Advance in Petroleum and Gas Industry and Petrochemistry”. — Lviv, Ukraine, 2020. — p. 339-341.

CHAPTER 1

ANALYSIS OF ATMOSPHERICAL POLLUTION FACTORS

Air pollution is the ingress of a huge amount of harmful chemicals, gases and various solid particles, biological molecules, into the earth's atmosphere. Pollution of the Earth's atmosphere is one of the global environmental problems that negatively effects on human health, causing dangerous respiratory diseases, problems with the cardiovascular system, oncology, and often leads to death. Air pollution also negatively affects the entire biota: animals, plants, food crops, natural ecosystems and artificially created ones.

1.1 Types of air pollution

Natural pollution is air pollution from natural sources such as volcanoes, forest and steppe fires, dust, plant pollen, animal waste. Natural pollution comes from natural sources of pollution, which are at a considerable distance from each other and, as a rule, cannot be regulated by humans.

Anthropogenic pollution, or artificial, is pollution created with the help of man. The main sources of anthropogenic pollution are transport, industry, agriculture, household waste.

Physical pollution is the pollution of the atmosphere by dust, particulate matter, and radioactive radiation, various types of electromagnetic waves, noise pollution, thermal pollution, and light pollution.

Chemical pollution is the pollution of the atmosphere with the help of gaseous substances and aerosols. Major gaseous pollutants CO, CO₂, SO₂, NO_x, O₃, Pb, hydrocarbons, dust, smog [1].

Carbon monoxide (or CO) is a dangerous poisonous and colorless gas that is formed because of incomplete combustion of fuel (coal, oil, etc.) in the engines of machines or appliances for heating. The anxiety of this gas lies in the fact that it has

no smell; therefore, poisoning of the body occurs imperceptibly. Even a small amount of carbon monoxide (about 0.3%) is enough for death: as soon as the gas enters the blood, it forms a stable compound — carbohemoglobin, which destroys the possibility of oxygen saturation of the blood.

Carbon dioxide (CO₂) is a colorless, odorless gas that is released during the breathing of animals and people. It can exist in three aggregate states: at high pressure (about 6000 kPa) it tends to turn into a liquid, and when it is strongly cooled (-80 °C) it crystallizes. Carbon dioxide is a natural gas that is released from several sources: when all living things are exhaled, volcanoes erupt, and when organic substances decompose (rotting and burning of organics). In addition, CO₂ is formed because of the operation of automobile transport and the process of burning fuel in industry.

The danger of CO₂ to human health and life is multifaceted from hypoxia (excess oxygen in the blood and suffocation) to the destruction of our home. The waste hazard level is high. This type of waste violates the ecosystem structure; the period of environmental restoration is more than 30 years in the Earth.

A small amount of carbon dioxide is in the atmosphere of our planet; however, its increase worsens the state of our environment. Literally, over the past 100 years, the level of carbon dioxide has almost doubled.

Carbon dioxide is one of the greenhouse gases that pose a huge danger to all living things. It holds and absorbs infrared radiation coming from the Earth's surface, thereby raising the temperature on the planet and create the Global warming. Carbon dioxide is directly related to the maintenance of the photosynthesis process that plants generate. One of the main problems of our time is the active deforestation — the "key" to solve the problem of global warming. As a result, with the help of CO₂ we change the climate, get weather anomalies, and lose the uniqueness of the natural habitats, as well as ecosystems, plant and animal species. With the help of this gas, we destroy our world and ourselves.

Sulfur gas (SO₂) is a transparent gas with an unpleasant odor that poses a threat to human health: damage to the liver and circulatory system. The Sulfur dioxide reacts with water vapor and forms sulfuric acid when once in the atmosphere. This liquid is

a "mirror" for the sun's rays: sulfuric acid refracts the rays and does not transmit light to the earth's surface, which affects a sharp change in temperature and climate, the environment as a whole.

Nitrogen oxides (NO + NO₂) are designated by the general formula NO_x — oxides resulting from combustion. Combining in the atmosphere with water vapor, the oxides form acid rain and smog when mixed with other harmful chemicals. NO_x are included in the group of hazardous emissions, therefore, they are subject to certain restrictions that are controlled by international Laws. Unfortunately, the abandonment of conventional vehicles will not lead to a decrease in nitrogen oxides, since they are an important component in the operation of the engine itself.

Ozone (O₃) is a modification of oxygen, consisting of three atoms of O molecules, has a bluish color and a pungent odor; ozone can be in several states of aggregation such as a dark blue liquid, or crystalline mass. Ozone protects our planet from ultraviolet sunlight, in the atmosphere, it is in a ratio of 0.1 billion -1, while closer to the earth it reaches almost 29-30 billion in some cities. The main anthropogenic source of ozone emissions into the atmosphere is air transport [2].

The main source of aerosol pollution is thermal power plants, which use combustible minerals such as coal, oil products for work.

Dust depending on their formation divided into 4 classes (Table 1.1).

Table 1.1

The types of the dust

Dust	Mechanical	It is dust generated by grinding a product in industrial processes.
	Sublimation	It is dust generated during large volumes of vapor condensation during gas cooling, which filtered using a processing unit.
	Fly ash	It is a non-combustible fuel residue that is contained in flue gas and is formed because of burning of mineral impurities
	Soot	It is solid carbon that forms part of industrial emissions

Smog is a dangerous excess of air pollution by various particles that transform air into black and dense veil. The sources of pollution are industrial enterprises,

transport, forest fires and so on (Fig.1.1). Smog is very dangerous for human and animal health, as it has the property of suffocation or airway pollution.

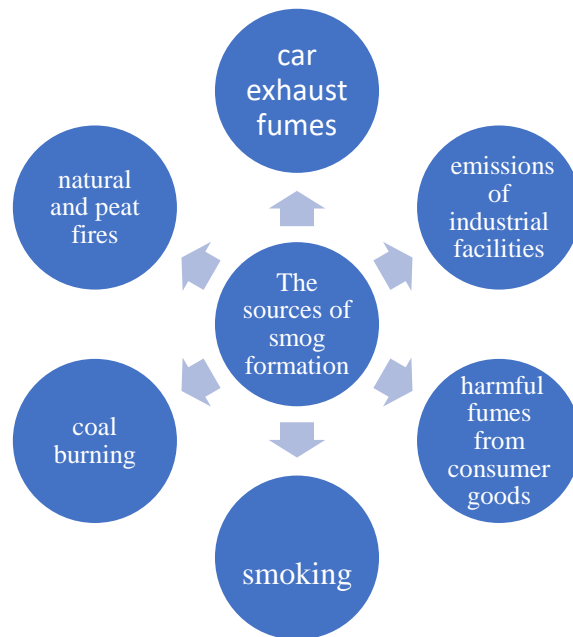


Fig. 1.1. The sources of smog formation

The main factors causing the appearance of smog are calm weather, direct sunlight, a large amount of car exhaust and abundant toxic emissions from industry in combination with high air temperature. In addition, the phenomenon of "temperature inversion" contributes to the formation of smog — different air temperatures near the surface of the earth (warm) and above the ground (cold), in which heavy and harmful particles remain under the "dome".

The main element of smog is carbon monoxide, which has no visible and tangible signs for recognition by human receptors, but in large quantities has a choking effect, often leading to death. There are several types of smog (Table 1.2).

Smog is a high risk to human health because it contains highly dispersed particles PM2.5 and PM10 [3].

These particles are the smallest dust invisible to the human eye (10 microns to 2.5 microns, compared with the diameter of a human hair (80 - 100 microns), which easily enter the human circulatory system. The ranges of these particles are the entire planet; however, in megacities and densely populated cities, the concentration of these particles is maximum.

The types of smog

Smog	Sulfuric	It formed because of a large amount of sulfur dioxide in the atmosphere, resulting from a high content of sulfur-containing exhaust gases (coal is the fuel) and high humidity in the atmosphere
	Photochemical	This is the most common type of smog in our time, is formed as a result of compounds of nitrogen oxides, ozone, volatile organic compounds and hazardous particles such as PM2 (dust, soot, ash). This smog is very dangerous for human health, since the substances contained in it are not palpable to the human sensory system, taken together they lead to cardiovascular diseases, the development of oncological and respiratory diseases, and sometimes they are fatal. Sources of smog are industrial combustion products and car exhaust.
	Volcanic	This type of smog formed because of volcanic activity. When a volcano erupts, large amounts of toxic gases enters the atmosphere and react with oxygen and sunlight. Volcanic smog has a high density, with direct contact with the lungs it causes respiratory diseases and in some cases leads to death. In addition, this type of smog causes serious damage to all types of living beings.
	Ice	This type of smog is the rarest and formed taken together of the following factors: low air temperature, high air humidity, and calm weather. As a result, small crystalline particles form in the atmosphere and interact with harmful particles, and form a thick ice fog. This phenomenon leads to diseases of the respiratory tract and negatively affects the human circulatory system.

These particles are small pieces of soot, mineral salts, plant pollen, allergens, and residues of heavy metal compounds. The greatest danger is PM_{2.5}, which are light in weight and long kept in the air in a volatile state, and freely enter the human body. While PM₁₀, the human body can be delayed by using the smallest hairs on the mucosa. The amount of fine particles is controlled at the level of the World Health Organization.

According to the World Health Organization, more than 92% of the world's population breathes air that exceeds the pollution rate. These are Asia, Arab countries, as well as states in central and northwestern Africa (data based on a map presented on the official website of the World Health Organization), where incomes and quality of life are low. Excess PM_{2.5} and PM₁₀ ultrafine particles result in diseases such as lung cancer, cardiovascular disease, stroke, and chronic lung disease. According to

WHO estimates, more than 3 million deaths associated with air pollution recorded annually. Children, women, and people of retirement age fall into the risk category.

To control harmful particles in the air, the state establishes monitoring posts for atmospheric air, which take measurements every day and calculate deviations from the maximum permissible norm. Especially monitoring posts are common in the USA and Europe. In Asia, the most polluted air basin is in China. On the Internet, there are a large number of smog photos and information on air pollution, so residents of megacities are forced to use masks and respirators to reduce their health risks. More than 60% of the time, the roofs of skyscrapers and the blue sky are not visible in a year. Interesting fact: when forecasting the weather, the amount of PM2.5 index in the atmosphere is always taken into account [4].

Permissible contamination with fine particles should not exceed $10 \mu\text{g} / \text{m}^3$. To improve the environmental situation of the atmosphere, the WHO has developed a program to increase understanding of the air situation called "BreatheLife". This program created to improve the climate and clean the air basin, reduce harmful toxic substances that affect the biosphere.

We can improve the situation of air pollution on our own. The methods show for preventing and solving the smog problem.

Methods to prevent the appearance and development of smog:

1. Minimize the use of personal vehicles as a means of transportation. The cultural development of the public and the development of habits in the use of "green transport", the use of public transport or walking.
2. To prevent the evaporation of high concentrations of gasoline and the formation of ozone, personal transport (car) is recommended to refuel early in the morning or at night.
3. When walking, avoid close contact with the main sources of pollution by smog: busy roads, highways, industrial areas.
4. To ensure a safe and fresh air for your personal living area, you can use special cleaning technologies: air purifiers and disinfectants, breathers.

5. It is recommended to buy products without a high content of harmful volatile organic compounds, for example, such as paint or solvents.
6. For domestic purposes recommended replacing the use of gas appliances with electric ones [5].

1.2 Investigation of Air pollution impact on the health of humankind

The peculiarity of this pollution is that the environment copes with the number of incoming pollutants and has the property of purification and restoration.

Volcanic pollution is natural pollution that occurs because of volcanic eruptions and the release of large amounts of dust and gas into the atmosphere. Volcanoes pose a great danger to the environment, including human life. The substances that make up volcanic gases are radioactive gas radon, sulfur dioxide, chlorine, and other poisons. Scientists established that sulfur dioxide in the atmosphere reacts and turns into sulfuric acid. The consequences of this reaction, a layer of smog may form, which will close the sunlight with dense clouds.

According to scientists, the number of volcanoes on Earth exceeds several tens of thousands (including submarine volcanoes) that release more than 250 tons of carbon dioxide into the planet's atmosphere per year. For comparison, with the help of anthropogenic pollution (automobiles and industry), more than 25 billion tons of CO₂ enter the Earth's atmosphere.

Chlorine, which is in a volcanic eruption, enters the atmosphere, mainly with hydrogen. Forming hydrogen chloride, gas in large quantities enters the upper air basins - the stratosphere and destroys the ozone layer, which protects the entire environment from destructive solar ultraviolet rays. However, the release of chlorine and other gases is a natural local process, anthropogenic air pollution destroys the quality of air masses and worsens the quality of the environment in which people, animals, and plants live [6].

Forest fires are the ignition and burning out of certain sections of the earth's surface, namely, wooded areas, which often leads to the destruction of various types

of ecosystems and the reconstruction of reliefs. When igniting and destroying biota, a significant amount of soot particles and dangerous greenhouse gases, such as carbon monoxide, nitrogen oxides, sulfur dioxide, organic compounds (formaldehyde, ammonia, etc.), which cause severe damage to the environment, enter the atmosphere [7].

Forest fires lead to the transformation of soil composition, the destruction of a source of clean air, the alteration, and reduction of the habitat of animals, the extermination of rare species of vegetation, and the deterioration of the environment. Forest restoration takes a large amount of time, as the forest is not always able to recover naturally (Fig.1.2).

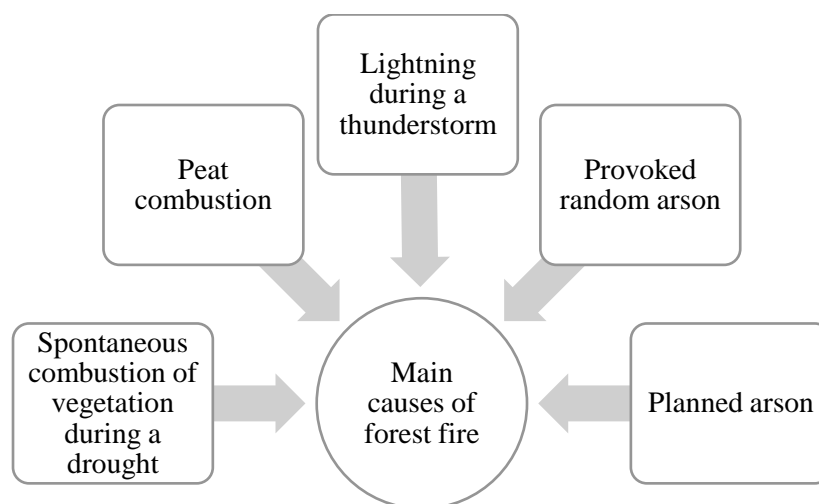


Fig. 1.2. Main causes of forest fire

To prevent forest fires, a controlled burning technique is used. With controlled burning of forests, it is possible to control fire, as well as reduce the amount of combustible and flammable materials.

Forest fires are classified into six types, depending on the area of ignition, duration, type of fire, the number of equipment and people used to eliminate the disaster (Table 1.3) [8].

Due to global warming and climate change, 2019 was one of the hottest years in the history of humankind, because of which we could observe fires around the planet. The forests of the Amazon (Brazil), the forests of Siberia (Russia), the terrible fire in Australia were affected particularly.

The types of forest fire levels

Level	Parameters
A	The defeat of the area is not more than 0.2 ha, which can be extinguished by one person
B	A small fire does not exceed 2 hectares, is stopped by a group of 2–4 people
C	The small fire with an area of 2.1 to 20 ha. 10 people are involved in braising
D	The average fire covers an area of forest from 21 to 200 hectares. It can be stopped by specialized groups formed of 30-40 people
E	A large forest fire, the area of the outbreak reaches 2000 ha, fire extinguishing by a group of up to 100 people
F	This category determined by the coverage of the forest burning area of more than 2000 hectares. Catastrophic combustion localizations are stopped by a shock group of people, numbering 400 people or more

Amazonian forests, as noted in all geographic sources, are the «lungs of the Earth», more than 20% of the forest potential falls on it. In August 2019, one of the natural tragedies occurred - the burning out of large areas of the forest. Between July and October, the "dry season" begins in Amazonia. According to researchers, fires appear here every year, however, only in 2019 more than 75 thousand sources of ignition were record. Smoke from the Amazon fire spread over more than 3,000 km, blocking the entry of sunlight. This season the vegetation is drier, so farmers burn out the area to expand their agricultural land. Unfortunately, in 2019, this procedure went out of control. According to Brazilian ecologists, after the change of political power, deforestation has intensified in the country, which has led to a change in the local climate, the disappearance and reduction of the unique flora and fauna [9].

Siberia is a geographical part of Asia, separated by the Ural Mountains from the west and the Pacific Ocean from the east. This territory is more than 13 million meters square, located on the territory of the Russian Federation. In this area, there are unique species of animals and plants, some of which listed in the Red Book of Russia: the Amur tiger, snow leopard, black crane, peregrine falcon, and others.

In the summer of 2019, a global environmental disaster occurred in Siberia, which caused great damage to the Earth. According to media reports, the first fires occurred in the spring of this year in remote areas of the Krasnoyarsk Territory, but

in July, their number exceeded. According to Russian ecologists, dry thunderstorms, which repeatedly caused a fire in this area, are common at this time of year in Siberia. Therefore, the Ministry of Natural Resources did not pay attention to the first fires. Within a few days, the area of ignition increased, and the state did not take any action since it did not consider it a disaster (Table 1.4). Due to the indifferent attitude of politicians, literally in a matter of days, the nearby cities were smog and led to a deterioration of the environmental situation. According to Russian media, the authorities refused to participate in the cessation of the fire, as in their opinion "it is economically inexpedient." Therefore, according to the results of Greenpeace Russia, the fire affected 5.4 million hectares. In areas located in the ignition area (Krasnoyarsk Territory, Buryatia, Irkutsk Region and Yakutia), an emergency regime was introduced. When the fires became abnormal and no longer controlled, when social networks filled out the extinguish Siberia calls, the Russian government attracted soldiers to eliminate the disaster [10].

Table 1.4

The types of fires

Fires	Lower	It is a type of fire when dry trees light up, sometimes deadwood lichens. This type of fire does not cause enormous damage to the biota, and nature can recover in a few years.
	Upper	It is a type of fire when trees and their entire structure light up, and animal and plant worlds in large quantities also burn out. After this type of fire, nature recovers very slowly often it takes decades. Fires in Siberia are upper fires.

Assessing the whole situation from an environmental point of view, we can safely conclude that this is one of the global disasters of 2019, which will irreversibly affect the climate of the planet, as well as affect the development of the greenhouse effect and global warming. More than tens of tons of CO₂ were emitted into the atmosphere. In addition, the flora and fauna were affected. According to scientists, it will take more than 100 years to restore the forest. However, humanity does not have so much time, since anomalies will occur now and now we cannot assume what awaits us.

Australia is the mainland in the southeast of the planet, surrounded by the Pacific Ocean in the east and the Indian Ocean in the west. Fires in Australia became one of the worst disasters of 2019-2020. Fires began in the month of August when abnormal heat and dry weather were observed on the mainland. Then in southeastern Australia, there were thunderstorms with lightning and a fire broke out. The whole world spoke about this situation and this has become an inalienable pain of everyone. Fires across the territory spread abnormally quickly, and the state could not cope with them. Fires in Australia stopped in February 2020 due to weather conditions when heavy rainfall with rainfall of 300 mm swept over the territories and extinguished all sources of ignition. Fires burned over 20 million hectares of land and, according to scientists, claimed more than 1.25 billion animals, such as koalas, kangaroos, birds, and reptiles, not including amphibians, insects and other invertebrates. In addition, more than 180 residential buildings burned down and about 30 people died. At the same time, during an extinguishing fire, a plane crashed with American rescuers. No one survived [11].

There are several reasons for the fires: abnormal dry and hot weather, lack of precipitation, and not entirely correct restrictions on the protection of the area. Given the weather conditions, this has become one of the causes of fire and forest fires. In addition, the sources indicate that the cause of the fire was arson and global warming.

The fires of 2019-2020 became the most destructive in the world in the history of humankind. In 2019, the main sources of oxygen on our planet were burning: the Amazonian forests and Siberia, and the fires in Australia contributed to the development of global warming. Tons of carbon dioxide were released into the atmosphere. The consequences of the fires were not long in coming: all over the world, abnormal weather was observed in different parts of the planet: in Ukraine, which is in the temperate zone, there was not enough snow (in Kyiv it was not), the temperature ranged from minus 5 to plus 5 degrees Celsius. The floods and heavy rains observed in Asia; Australia was covered with heavy torrential rains, as was Israel. In the United States, a large number of tornadoes were registered, and Egypt experienced precipitation in the form of snow. Over the course of six months,

abnormal weather conditions were recorded all over the world: an abnormal temperature was recorded in Antarctica: +18, because of which the melting of glaciers, the main source of fresh water on the planet, intensified, unique flora and fauna were destroyed rapidly, and the sea level was rising. A new type of incurable virus has been discovered in China that takes a huge amount of human life.

Observing all the events from the outside, we can confidently say that global warming and the "end of the world" are already close, and the solution to our problem can be a speedy change in our usual lives, reducing the use of personal transport, switching to alternative energy sources and restructuring the economy and culture of humankind.

1.3 Physical pollution of the atmosphere

A dust is one of the main sources of environmental pollution, namely the atmosphere. The dust is a product of grinding materials into fine particles at industrial enterprises that have their own physical and chemical properties: a degree of grinding, chemical composition, density, structure, density, etc. Natural dust is in the air with a concentration of not more than $0.2 \text{ mg} / \text{m}^3$, but in industrial enterprises, it can reach $0.5 \text{ mg} / \text{m}^3$, which affects human health.

The dust classified according to the following criteria (Table 1.5). Regular contact of a person with industrial dust leads to poor health and sometimes death. The danger of dust lies in its shape, composition, and in size. The most dangerous dust is up to 0.015 microns in size because the particles on the mucous membrane of the human body cannot hold and filter the particles, so they freely enter the respiratory tract and circulatory system, causing a number of diseases. The most dangerous forms of dust: spherical and jagged. Also, if the composition of dust includes poisons, such as arsenic, lead, manganese, and others, when it enters the human body cause a number of negative changes in internal organs and various systems, often lead to poisoning and death.

Table 1.5

The classification of the industrial dust

By origin	Organic	A Plant, animal, artificial dust
	Inorganic	A mineral, metal dust
	Mixed	The presence of particles of organic and inorganic origin
By the method of formation	Disintegration	Grinding, cutting, grinding, etc.
	Smoke	The soot and particles of the substance that burns
	Condensation	Condensation in the air of the vapor of molten metals
For the toxic effect on the human body	Neutral	The dust non-toxic to humans
	Toxic	Poisoning the human body

Diseases caused by industrial dust: changes in the bronchi, lungs, suppuration of the mucous membranes, peptic ulcer of the nasopharynx and nasal septum, pneumonia, bronchitis, conjunctivitis, silicosis, and others.

Dust is the result of outdated technological equipment in production, which is very dangerous for human health. Dust also causes damage to the environment: settling on the surface of green plants, it clogs the leaves, causes damage and prevents photosynthesis. In agriculture, dust affects the quality of soils and lowers the quality of products, affects the growth and development of land. According to researchers from the United States, in the atmosphere of the earth, there are more than 5 million tons of dust particles. The danger of dust also lies in its chemical properties: dust, which is a product of the processing of combustible substances (peat, coal, magnesium, etc.), poses a threat to the role of explosive substances. US statistics annually totals more than 1000 explosions due to dust and several thousand injured [12].

Radioactive pollution is the environmental pollution of radioactive components, such as isotopes of strontium, thorium, uranium, barium, cesium, etc.,

which leads to a change and disruption of natural processes, climate change and deformation of the plant and animal worlds, produces a negative impact on human health (Table.1.6) .

Table 1.6

The radiation sources

Natural	Cosmic radiation
	Radiation of Natural Isotopes
Anthropogenic	Extraction of radioactive minerals (radioactive ores)
	Nuclear power plants
	Peaceful Nuclear Explosions
	Nuclear weapon test
	Nuclear explosions

Now 190 nuclear power plants with 443 power units are recorded in the world. The largest and global problem of humankind was the accident at the Chernobyl nuclear power plant in 1986 (Ukraine) when 4 power units exploded due to improper maintenance and use of reactors. As a result, hundreds of thousands of people suffered, more than one ecosystem was destroyed. This disaster also affected the fate of other countries. Ukraine and Belarus were especially affected, where after a huge amount of radiation emission into the atmosphere; air masses went to the territory of the states and shed radioactive rains. The series “Chernobyl” from the company “Netflix” dedicated to this disaster, and this day was marked on the calendar (April 26), since what is happening is still fixed in the memory of humanity.

The main and dangerous source of radioactive contamination is nuclear testing, which pollutes most of the Earth’s space. They held in different parts of the world, especially on islands in the Pacific Ocean (Table 1.7). According to scientists, more than 2,5 thousand tests of nuclear weapons have been carried out in the world, which pollute the atmosphere and affects the natural processes of the formation of the biosphere, accumulating in all living and non-living organisms [13].

World Nuclear Tests by Country

Country	Amount of tests	A place of nuclear tests
The USA	1054 tests according to official data (at least 1151 devices, 331 ground tests)	Tests conducted at the Nevada training ground and at the Pacific Proving Grounds in the Marshall Islands; another 10 tests were conducted at various locations throughout the United States, including Alaska, Colorado, Mississippi, and New Mexico.
The USSR	715 tests (969 devices)	The tests carried out mainly at the Semipalatinsk test site and on Novaya Zemlya, as well as several in various places in Russia, Kazakhstan, Ukraine, Uzbekistan, and Turkmenistan.
The United Kingdom	45 tests	21 in Australia, including 9 in South Australia at Maralinga and Emu Field, the rest in the United States when conducting joint trials
France	210 tests	4 in Reagan in the Tanesruft desert, 12 in Tan Afella (French) and In Ecker (fr.) Russian. on the Aghaggar Highlands in Algeria. The rest are on the islands of Fangatauf and Mururoa in French Polynesia.
China	45 tests	23 land and 22 underground, at the Lob Nor base in Xinjiang
India	5 to 6 underground tests	Pokhran
Pakistan	3 to 6 tests	Chagai Hills
The Democratic People's Republic of Korea	6 tests	Hwadae-ri

Our planet is on the verge of an abnormal increase in radiation (more than 3%), which will lead to the destruction of life on Earth. The most susceptible to radiation are soils with a low calcium content since the radioactive isotope strontium replaces this element, and the decay period of strontium lasts for 30 years. Accordingly, radiation accumulates in animals and plants that people eat. This isotope is dangerous because it accumulates in the human body and affects the next generation, often-developing leukemia disease in the offspring. The carbon-14 isotope, which has a half-life of thousands of years, is dangerous. Accumulating in living organisms, it causes a mutation of subsequent generations. Another of the main and dangerous

isotopes is cesium-137: entering the body causes hereditary defects in generations of the species.

The earth was originally adapted to radioactive cosmic rays — they became the engine in the development of the biosphere. In addition, radiation on the planet distributed evenly from the equator to the poles. However, the use of radiation-related vehicles: submarines, aircraft carrying nuclear warheads, increases the level of radiation. In the event of an explosion, radioactive contamination enters the stratosphere, where the ionization of molecules occurs and new chemical compounds formed. The decay of radiation in the stratosphere takes more than 12 years. The accumulation of radioactive substances in the atmosphere is not the same: the most favorable conditions for reaching the earth's surface are the temperate zone, whose climatic features suggest a large amount of precipitation. This phenomenon is minimized to the equator, since precipitation is much lower here.

Due to tests on islands in the oceans, radioactive contamination affects not only the atmosphere but also water masses up to 300 meters deep, where the habitat of marine creatures is located. Therefore, the liver of fish accumulates radiation 300 thousand times. The formation of air masses over the oceans is much higher than on land, but radiation also affects freshwater [14].

The increase in radiation also affects the formation of weather and abnormal natural phenomena, such as seismic activity, affects the direction and speed of the wind, the level of precipitation, floods. In nuclear explosions, the damage caused to the ozone layer of the Earth, which protects the biota from harmful ultraviolet rays, which will inevitably lead to the extinction of many species of living things.

Electromagnetic pollution is a pollution of the environment by magnetic fields, the sources of which are technologies related to electricity: computers, electric wires, radio, and others. The danger of electromagnetic waves lies in the effect on human physical health and the full development of flora and fauna, the appearance of electromagnetic smog. Electromagnetic pollution affects the structure and purity of water, the development of plant structures (mutations, resizing parts of the body),

pollutes the atmosphere; it causes severe headache in people, affects the central nervous system, affects fatigue, and upsets the metabolism of living organisms [15].

Noise pollution is a type of environmental pollution caused by urbanization and is an integral part of living within the city. Noise pollution is one of the main and serious pollutions that affects human health.

Thermal pollution is pollution at an elevated and unusual temperature for the environment, which leads to a change in the geosphere as a whole.

With the development of civilization, this type of pollution and its sources appeared thermal power plants and nuclear power plants use combustible minerals and complex plants for processing raw materials, and cooling the equipment of the enterprise. Thus, these types of power plants pollute the environment. The hydrosphere is also most at risk: the water that cools the heating system or reactors purified and poured into water bodies at elevated temperatures. So, in many rivers, the water temperature increased by 6-7 degrees. Abnormal temperature provokes the development of phytoplankton and protozoa, changes the temperature of the water and destroys unique species of fish; the dead remains of algae and other organisms fill the water, thereby lowering the level of oxygen [16].

Thermal power plants and nuclear power plants also pollute the atmosphere with fuel combustion products, emitting tons of chemical and toxic substances along with carbon dioxide. As you know, carbon dioxide is the main element in the problem of global warming and the greenhouse effect. With its help, a dense shell is formed, which delays the sun's rays on the surface of the earth by heating it and changing the climate and nature as a whole. Thermal pollution is one of the reasons for the high temperature in cities; it softens the winter and prevents the freezing temperature; in the summer season provokes the appearance of abnormal heat.

Thermal pollution is local in nature, however, forming a system in every city, thermal pollution negatively affects the environment and participates in climate change, destroys species of animals and plants, negatively affects human health.

Light pollution is a type of environmental pollution using excessive amounts of lighting and reflection of light radiation in the atmosphere using aerosols and other

chemicals; pollution forms a light dome, thereby influencing and changing the habitual life rhythm of all ecosystems.

Light pollution arose most recently with a period of urbanization and the supply of cities with excessive amounts of lighting. Sources of pollution are residential buildings, business centers, street lighting, roads, stadiums, billboards and so on. The effect of light pollution on the environment can be direct and indirect.

Direct pollution is a change in the usual biorhythms of various animal species, from insects and reptiles to mammals. Researchers of light pollution have found that the creation of an artificial sun negatively affects nocturnal species of animals, which are replaced by daytime species. In addition, light pollution affects migratory birds, blinding and knocking them off the usual route. More than 5 million birds are victims of light pollution each year. The illumination of oil-producing installations leads to the fact that birds circulate above the "artificial sun" and, exhausted, fall dead into the ocean. Light at night knocks down some types of insects that participate in the pollination of plants and help them multiply. Thus, this can lead to the destruction of certain plant species and a change in the ecosystem as a whole.

Light pollution negatively affects the human psyche, leading to such diseases: insomnia, headache, increased anxiety, etc.

Indirect pollution is associated with mining for processing and use. Coal, oil, and gas are actively used in the system of thermal power plants, nuclear power plants, transforming, lighting and polluting the environment.

Light pollution also affects the atmosphere: according to researchers from the United States of America, light destroys the radicals of the nitric acid salt, which are involved in preventing and reducing smog. Thus, light pollution affects the entire geosphere, changing and destroying the usual life cycle of insects, plants, and animals, negatively affect the mental health of a person. To solve this problem, you can use a temporary restriction of lighting to prevent changes and environmental pollution by converting minerals into electricity [17].

1.4 Anthropogenic pollution of the atmosphere

Agriculture is a type of anthropogenic human activity, consisting in the use of land resources for growing usable plant crops; use of land for raising cattle, poultry and other animal species that are used for the physiological needs of humans. Agriculture is an integral part of the economic component of the state, which depends on many factors, such as land, water supply, type of soil, and energy.

Table 1.8

Environmental Impact of Agriculture

Soil erosion	Degradation of the upper layers of the soil by wind and water currents. The cause of soil erosion is the destruction of vegetation: trees, shrubs, and grasses.
Desertification	This is a process of soil degradation and the transformation of territories into deserts that occurs due to the overuse of land, grazing, deforestation.
Salinization	Degradation of different types of soils using readily soluble minerals of salts, which make the soil unsuitable for use. This occurs due to the irrigation and drainage of soils.
Toxification	Pollution and an excess of toxic substances in the soil (pesticides, hormones, antibiotics, nitrates, and others), which make the land unsuitable and dangerous to use.
Eutrophication	The process of pollution of water bodies with phosphates and phosphorus, which leads to increased development of biological productivity. The result of eutrophication is green water and the development of bacteria, which reduce the amount of oxygen in the water and destroy the local flora and fauna.
Loss of land due to infrastructure development	The rapid development of infrastructure leads to the destruction of land, the destruction of the natural habitats of many species of living organisms and, as a result, the extinction and extinction of rare and other species.
Drainage	Change in soil moisture by changing the level of groundwater and its structure, which ultimately leads to soil degradation and a violation of the water regime in large areas.
Irrigation	The use of water resources to moisten dry soils for fertility and growing crops. It leads to a violation of the water regime in large areas.

To maintain and grow the crop, artificial growth stimulants such as pesticides, nitrates, hormones, antibiotics and other chemicals that negatively affect the atmosphere, lithosphere, hydrosphere, and biosphere began to be use. Chemicals

violate the natural structure of soils, lead to salinization, soil erosion, water pollution and the destruction of local unique flora and fauna, and lead to exhaustion of natural resources (Table 1.8).

The negative impact of agriculture on the atmosphere is the use of chemicals and deforestation.

Excessive use of land resources led to the fact that the amount of vitamins and minerals sharply decreased in the soil and chemicals were used to compensate for them. In today's world, soil productivity is directly dependent on the use of fertilizers. Research scientists have shown that the mass of fertilizers in the soil today is more than 70%. An excess of organic and mineral fertilizers leads to soil intoxication.

The main fertilizer is nitrogen. More than 30% of nitrogen is not absorbed by plants and enters the atmosphere. As you know, nitrogen compounds are often toxic and in large quantities lead to suffocation. Nitrogen is also one of the chemical elements that destroy the ozone layer in the atmosphere, thereby contributing to the destruction of all biota on the planet. To destroy insect pests, the chemical methyl bromide is used, which also enters the atmosphere and contributes to the destruction of the ozone layer.

The danger of pesticides is that 50% of these substances enter the atmosphere. Pesticides are not in the atmosphere for a long time — they enter into compounds, circulate with air masses and pollute the environment through precipitation, worsening the quality of water and soil.

Serving agriculture requires energy. Energy requires fossil fuels, the production and use of which pollutes the atmosphere with particulate matter, carbon dioxide, nitrogen oxides, sulfur oxides, and other hazardous compounds. All these compounds lead to the greenhouse effect and global warming. Forests cut down to use the territories for agricultural land, which also leads to a change for oxygen in the atmosphere, the accumulation of carbon dioxide and the deterioration of air quality.

Agriculture requires the transportation of products. For transportation use, paving roads, heavy equipment, transport. For the operation of the transport, oil products and combustible minerals (gasoline, diesel, natural gas, and coal) are used.

As you know, 84% of atmospheric pollution occurs through transport and the ingress of exhaust gases into the air. The cultivation and livelihoods of livestock also lead to atmospheric pollution by digestion products — methane. Methane (CH₄) is involved in creating the greenhouse effect on Earth; from an environmental point of view, it is 84 times more dangerous than CO₂ [18].

Agriculture directly affects the quality of air, soil, water and the health of biota, especially humans. Growing various crops using fertilizers leads to the accumulation of chemicals in plants, soil, and water, which are necessary factors for human existence on the planet. Many chemicals enter the human body through food intake and settle in the body, provoking the development of various diseases: oncology, cardiovascular diseases, kidney problems, and gastrointestinal tract.

The development and maintenance of agriculture directly affect climate change, the proper functioning of natural processes, the destruction of unique biodiversity, the reduction or increase in rainfall, temperature, and soil destruction. All the consequences of agriculture in the opposite way affect the development of agricultural land. The opposite effect is formed.

Excessive development of the territory for agriculture, deforestation, changes in water balance and other natural factors we can observe today. Landslides, floods, abnormal rainfall, tornadoes, and other natural disasters not controlled by humans have become more frequent in many countries.

To solve this problem, states should take laws and measures to protect the environment and take into account the costs of managing resources.

With the development of urbanization and an increase in population, humanity needs a greater amount of all the natural resources of our planet: water, air, land, minerals, and the use of land for raising livestock, the use of marine biota and others. However, with an increase in environmental consumption, a new problem has arisen - waste that litters our planet.

Waste is a type of waste product of all living things that have a classification and negatively affect the environment (Table 1.9). The danger of waste lies in its quantity and insufficient means and technologies for its disposal.

Table 1.9

Types of waste

Name	The types of waste	Dangerous for the environment
Food waste enterprises	Foods that have expired; waste from the food industry, food leftovers in cafes and restaurants, waste from educational institutions and other places of public and individual nutrition.	Food waste is dangerous, as it is excellent breeding and habitat for carriers of various infections: flies, cockroaches, bacteria, rodents, etc.
Waste from meat processing enterprises	In the process of processing raw materials, the following products are formed: meat and meat products; bones, fat, horns, hooves that are waste.	The danger of these wastes is not great since all wastes are secondary and various parts are processed into semi-finished products, aerosol-drying plasma (used in the dairy, confectionery, baking industries), feed additive (contains keratin).
Motor Vehicle Waste	Petroleum products, greases, ethylene glycol, brake fluid and other chemicals that are used to service vehicles.	For servicing the machine, the material used whose waste exceeds the machine volume by more than 10 times. All waste enters the environment. For example, washing the car with chemicals is a danger to the hydrosphere - used and dirty water gets into the soil, and later into underground water, thereby poisoning it.
Coal Waste	Since coal contains organic and mineral substances, ash is formed after coal processing. Ash and slag are used for the preparation of building materials and is also used in agriculture. In construction, ash and slag are used to replace sand and can be used in the production of concrete, bricks, ceramic tiles, drainage pipes.	The threat of ash and slag (ash and slag) is that these materials are stored in dumps. Today, the area of ash dumps is many tens of thousands of hectares. The mass of these materials creates dust and harms human health while damaging the environment.
Chemical Waste	Development of laboratories and chemical enterprises, alkali, acid, poisons, substances containing oil and mercury, halogens.	The danger of chemical waste lies in pesticides, fertilizers, pharmaceutical waste that enter the environment and pollute it.
Waste from metallurgical enterprises	Scale, ceramic scrap and slag, lining fight, dust. Wastes of heavy metals including mercury, lead and cadmium, chromium, molybdenum, cobalt and nickel, manganese and vanadium. Analyzing industrial waste, we can confidently say that they include at least half of the periodic table.	Waste from metallurgical enterprises is dangerous in toxins that pollute the environment. According to scientists, the environment is polluted within a radius of 200 kilometers from the waste storage site. Within a radius of 100 kilometers, the complete destruction of the plant world was record.

Name	The types of waste	Dangerous for the environment
Waste from transport enterprises	Metal parts, tires and rubber products, batteries, heavy oil sludge, wooden sleepers, ferrous scrap, non-ferrous scrap.	The danger of these wastes is that their amount is regulated by the state, but there are no ways to dispose of materials. Accordingly, harmful and radioactive substances in the battery, rubber tires and residues of petroleum products enter the environment, pollute it and destroy all life.
Industrial waste	Waste from industrial enterprises depends on the type of activity of the enterprise.	The danger of these wastes also lies in the ingress of harmful substances into the atmosphere, hydrosphere, and lithosphere, which is associated with the destruction of the natural cycle.
Solid household waste	Waste paper, glass fighting, things that are not suitable for further use of household appliances, food wastes, apartment, and street estimates, building wastes left from the current apartment repair; broken household appliances, etc.	The largest amount of waste falls into the category of household waste that a person produces every day. Every day, tons of plastic, machinery, glass and other materials fall into the environment, the processing of which takes centuries by nature. Unfortunately, the rate of pollution is much higher than the processing of garbage in enterprises or its natural destruction by nature.
Space debris	Broken satellites, debris, debris from being in space, debris and fragmentation	The danger of space debris lies in the fact that it can be measured in thousands in the Earth's orbit and this type of waste cannot be disposed of in a simple way. All rubbish moves with great speed, already hindering the normal functioning of functioning celestial devices. At the moment, only technologies are being developed to reduce the amount of space debris, but it is still unknown what to do with it to the end.

The most common pollution is household waste, as it is the remnants of daily use and human activity. New technologies are being developed around the world to increase waste recycling. Waste is classified according to the level of danger in the field of human health and environmental pollution. Hazard levels are presented in the Table 1.10.

Classification of waste by hazard level and environmental impact

The level	Impact on the environment
1 — Extremely Dangerous	Extremely hazardous waste that irreparably destroys the structure of the ecosystem and negatively affects the environment. The degree of negative impact is high. There is no recovery period for the environment.
2 — Highly Dangerous	The waste hazard level is high. This type of waste violates the ecosystem structure; the period of environmental restoration is more than 30 years.
3 — Moderately dangerous	This type of waste is less dangerous, but also has a negative impact on the environment, pollutes it and destroys the structure of ecosystems. Recovery period about 10 years. The degree of negative impact is medium.
4 — Low hazard	The degree of negative impact is low. This type of waste also disrupts ecosystems, but the recovery period of nature is much shorter than at previous levels — up to 3 years
5 — Practically harmless	The degree of negative impact is very low. This type of waste practically does not violate the structure of the ecosystem. Hazardous waste contains chemicals such as beryllium, cadmium, vanadium, cobalt, nickel, chromium, lead, mercury, and metal-organic compounds.

The main contaminant is plastic. Plastic (plastic) is a material consisting of natural compounds of high molecular level; however, it often consists of synthetic substances. The danger of plastic lies in the fact that it takes more than 150 years to process by nature, and with some compounds, according to environmentalists, it can go up to a thousand years [19]. There is already so much plastic on our planet that more than one ecosystem suffers from this. On the Internet, there is not one news about the death of marine inhabitants who died due to plastic. Regularly, turtles, stingrays, fish, mammals and other organisms that are injured in the form of cuts and deprivation of eyes, other parts of the body get into plastic products; often falling into a plastic product leads to strangulation or inability to escape from predators. For example, in March 2019, a female whale jumped ashore, which poisoned with plastic and starved to death. Such cases of animal death are not isolated [20]. Waste has a

negative effect on the atmosphere. The following methods are used to eliminate waste and process it: garbage removal to landfills, waste incineration plants, waste processing plants.

The landfill is a specially prepared area for the removal and storage of non-recycling garbage for no more than 20 years, which is developed according to certain criteria. All landfills must comply with regulatory standards. In Ukraine, operation and landfill standards are determined and controlled by the State Building Norms of Ukraine (DBN V.2.4-2-2005), the Law of Ukraine “On the Approval of the Rules for the Operation of Landfills for Domestic Waste” and the Law of Ukraine “On Waste” (Fig.1.3) [21].

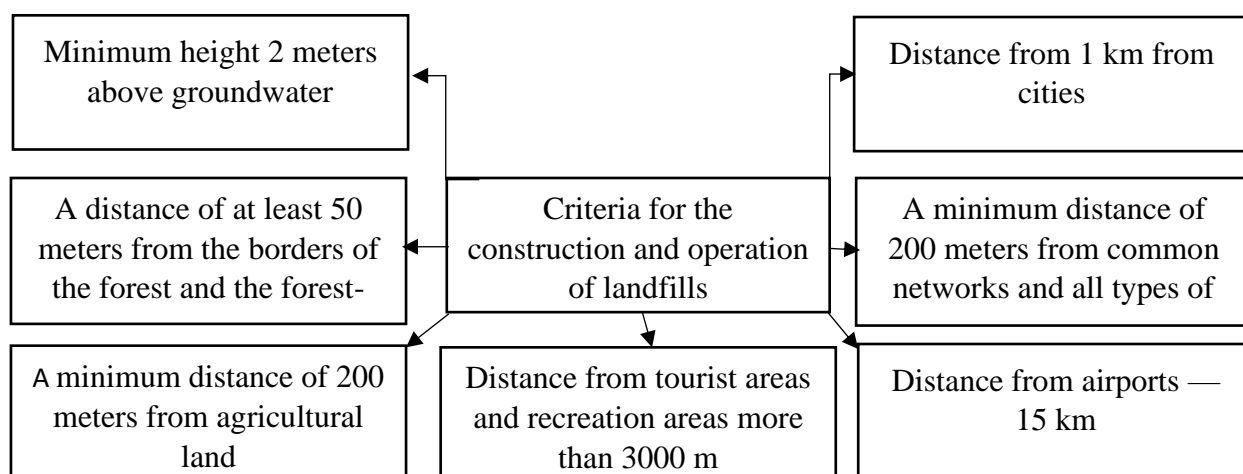


Fig. 1.3. Criteria for the construction and operation of landfills

Monitoring sites must be established at the landfills, which are obliged to collect and transmit the analysis of water, soil, and air to chemical laboratories in order to control pollutants at the legislative level and prevent an environmental disaster.

Unfortunately, in Ukraine, the ecology is not valid, as a result of which we can observe an overabundance of garbage at landfills, the appearance of garbage in forest zones, on the banks of rivers and reservoirs, and at other natural sites. The problem of waste in Ukraine is very relevant since most of the facilities for recycling do not meet the standards in general. According to estimates to date, the state has about 7 thousand landfills and about 40 thousand illegal landfills that are not equipped to store

all waste. Because of this, a huge amount of toxic substances that poison all living things fall into the geosphere of the Earth. In addition to water and soil pollution, landfills pollute the atmosphere. Several tons of garbage have direct access to the air basin, into which toxic gases, methane and hydrogen, carbon dioxide, and sulfur oxides get as a result of fermentation and decay. All these compounds not only poison the biota but also contribute to the development of the greenhouse effect, the destruction of the ozone layer, climate change and the destruction of all life on the planet. In Ukraine alone, about 17 million tons of garbage were produced per year, 30-35% were processed and less than 1% was burnt. All other waste was disposed of as landfill, as it was not sorted correctly. An average Ukrainian produces about 300 kg of garbage per year, of which approximately 15% can be recycled. Only in four cities of Ukraine (Kyiv, Dnieper, Kharkiv, and Lviv) are waste bins adapted for sorting garbage. According to media reports, only in Kyiv, due to improper distribution of garbage, about 10% of waste was recycled.

The problem with landfills is that they are full. Regularly there is news about landfills that distribute their garbage in Ukraine. Landfills and illegal dumps are poison for our planet and poison for the health of all living things. To solve this environmental catastrophe, it is necessary to popularize the correct sorting of garbage and build the appropriate infrastructure (waste recycling plants) for the rational use and stable disposal of human waste [22].

An incinerator is the production of energy and heat through the disposal of garbage not subject to reuse. The main principle of waste recycling is the burning of garbage in furnaces and boilers. Incinerators are widespread all over the world, especially they are used in Europe, there are also several in Ukraine.

Incinerators are one of the most cost-effective and basic methods for the processing and disposal of garbage. When burning garbage, heat and energy are released, which are used for different needs, most often to provide the city with heating, hot water. Various garbage processing technologies are implemented at the plant, depending on the combustion temperature and the materials in the waste (Table 1.11).

Garbage processing technologies at incinerators

Names of processing technology	Principle of operation
Layered burning	Combustion takes place using the grate grids on which the trash is located. Air flows at a temperature of 850-1500°C. The temperature is determined depending on the chemical composition of the materials. Residues after garbage combustion - ash and slag, are disposed of from the combustion chamber into a tank filled with chilled water.
Pyrolysis and gasification	This type of technology is used in the disposal of hazardous chemical wastes such as plastic, rubber products (for example, car tires), industrial wastes, and so on. The garbage is sent to a chamber with a rotary kiln, wherein a vacuum environment is destroyed at a temperature of 400-600 degrees Celsius. The residual gases from combustion are discharged into the final afterburner and burn out, reacting with oxygen. Residues from waste disposal (liquids, gases, and sludge) are used as fuel or sent for reuse in the chemical industry.
Plasma technology	This recycling technology is used to destroy highly toxic chemicals and is the most effective (destroys 99% of the waste mass) and is expensive. Disposal of waste takes place in an electric arc furnace at temperatures up to 4000 °C. Plasma technology is not actually used, as it is not economically viable.

Incinerators are more effective at destroying garbage, in comparison with landfills. Factories less pollute the lithosphere and hydrosphere, but they also affect air quality. Incinerators require investments and economic support for the rational use of plants, in the regular updating of equipment (especially filters through which tons of toxic substances are emitted into the atmosphere) and in highly qualified employees. Air pollution standards, according to European standards, should not exceed 10 milligrams per m³. However, Ukraine has its own standards — 50 mg per m³.

Incinerators are less toxic, but still atmospheric pollutants. When garbage is burned, various compounds, such as carbon dioxide, hydrogen chloride, sulfur oxides, nitrogen oxides, heavy metal compounds, and others, enter the atmosphere. All substances are poisons to the environment, they enter the atmosphere affecting air quality and the health of plants, animals and of course people. Moreover, these gases

are involved in the creation of the greenhouse effect and the destruction of the ozone layer [23].

During the burning of garbage, toxic substances such as dioxides and furans also enter the environment. These substances contribute to the development of cancer in humans, respiratory diseases, problems with the nervous system and the occurrence of hereditary diseases. According to environmentalists from Germany, incinerators are "absolutely safe", but this statement can easily be challenged. Excluding all chemicals, tons of smoke are also emitted into the atmosphere. Smoke is a dense dark cloud of compounds, consisting of solid small particles. Particle hazard 2.5 PM and 10 PM have been described previously [24].

The Ukrainian government cannot cope with the amount of garbage produced by the population, while doing nothing to improve the environmental situation and solve such global problems. There is a lot of data on the Internet about foreign investors who want to invest their capital for the construction or reconstruction of the incineration industry. From my personal experience, I know a person who wanted to build an incineration plant, but received an unjustified rejection of governments. The incineration industry is economically viable, as it has uncontrolled stocks of material and processed products, which are income. Based on all of the above, it is safe to say that for the Ukrainian government, ecology and public health is not a priority.

Industry is industrial enterprises of various fields of activity that specialize in the development of certain goods or final products consumed by man. The word "industry" usually means factories, plants, power plants, combines and so on, which in turn are engaged in the extraction and processing of minerals and other materials; the production of heat or electricity, the production of agricultural products, etc. The following industries are available in the Table 1.12 [25]. The industry is one of the global environmental problems, as it like transport, occupies the first place of honor in environmental pollution. Industry pollutes the geosphere from the moment of mining to the final human consumption.

Types of industry

Type	The products of the industry
Power industry	A type of industry that specializes in energy generation, transmission, and marketing. Electricity is very important for humanity, as it provides the work of each industry with electricity, and also participates in all spheres of vital activity of human life. This industry includes thermal power plants, nuclear and hydroelectric power stations, wind generators, solar panels, and others.
Fuel industry	A type of industry that specializes in the extraction, transportation, processing and consumption of fuel minerals: oil, coal, gas, peat. The fuel industry is closely connected with the electric power industry, as it supplies minerals for further energy production.
Ferrous metallurgy	A type of heavy industry that specializes in the extraction of ore and non-metallic raw materials, specializes in the processing of metals into cast iron, steel, various types of dark metals, and rolled metal. The main raw materials are iron ore, alloying metals, and coking coal.
Non-ferrous metallurgy	A type of industry that specializes in the extraction of non-ferrous metals and their transportation, processing, and smelting. The sources of development of the non-ferrous industry are heavy and light metals: copper, lead, zinc, nickel, titanium, magnesium, aluminum, etc.
Chemical and petrochemical industry	A type of industry that specializes in the production of mineral and other raw materials by chemical processing. The petrochemical industry specializes in refining petroleum into petroleum products such as gasoline, diesel, kerosene, lubricating solutions, solvents, etc.
Engineering and metalworking	A type of industry that specializes in manufacturing, complex development and providing all areas of services with machines and technological plants for various purposes. Metalworking is a technological process of changing the shape and size of metal products and their transformation into metal structures, parts, and individual parts. It specializes in shipbuilding to the jewelry industry.
Timber, woodworking and pulp and paper industry	A type of industry that specializes in the extraction, processing, harvesting, and sale of forest products. The forest industry is regulated by law, as the main material is wood. Products of the forest industry are building materials, furniture, paper, cardboard, and others.
Building Materials Industry	A type of industry that specializes in the use of natural and synthetic materials for the construction of buildings and structures. The construction industry uses wood, bricks, stones, plastic, rubber, glass and steel, metals, organic and inorganic binders.
Light industry	A type of industry that specializes in the production of consumer goods, ranging from special purposes for the aviation and automotive industries to finished products. Types of the light industry: fabric, leather, sewing, shoe, fur, haberdashery.
Food industry	A type of industry that specializes in the production of consumer goods such as soaps, tobacco products, food products, and convenience foods. Closely linked to agriculture.

Medical industry	A type of industry that specializes in the manufacture of medicines and medical equipment for therapeutic purposes. It includes such types of industry: medical-instrumental, chemical-pharmaceutical, production of medical products from glass, porcelain, and plastics.
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Electricity, metallurgy, oil products, mining and the forest industry particularly affect the quality of atmospheric air. The following Table 1.13 shows the types of environmental pollution [26].

Table 1.13

The types of industrial pollution

Chemical	Chemicals hazardous to the environment and biota, such as formaldehyde and chlorine, sulfur dioxide and phenols, hydrogen sulfide and carbon monoxide.
Pollution of the hydrosphere and lithosphere	Enterprises discharge drains, oil and fuel oil spills, garbage, toxic and toxic liquids occur.
Biological	In the biosphere live, various types of viruses and infections that are in the atmosphere, biosphere, and hydrosphere. Viruses and infections are the causative agents of many life-threatening diseases for humans and animals, such as tetanus, cholera, coronavirus, dysentery and fungal diseases.
Noisy	Sources of noise pollution are roads, enterprises, repairs, etc. Noises and vibrations lead to diseases of the auditory apparatus and diseases of the nervous system.
Thermal	Thermal pollution is pollution by exhaust gas waste or heated wastewater, which leads to an unnatural increase in ambient temperature.
Radiation	Radiation pollution occurs in the event of accidents at nuclear power plants, during the release of radioactive substances by plants or when using nuclear weapons.
Electromagnetic pollution	This pollution occurs with the help of electrical installations: the operation of power lines, radars, television stations, and other objects that form radio fields

Thermal power plants and nuclear power plants make a particularly significant contribution to air pollution. The thermal power plant is an industrial facility specializing in the production of energy by processing combustible minerals, most often coal, oil, and natural gas. Today, the consumption of these minerals is in the following proportions: coal production — 40%, oil — 27%, natural gas — 21%.

These minerals are not recoverable and their supply is limited. Many sources of mining have already exhausted their reserves, so the world is in control of the extraction and processing of coal, oil, and gas. When these fossils are processed, tons of heavy particles and hazardous gases (CO_2 , hydrocarbons, CO , NO_x , sulfur oxides) are emitted into the atmosphere, which pollutes air pools and negatively affects the environment (Fig.1.4). As a result, atmospheric pollution in all cases leads to a greenhouse effect and an increase in temperature on the planet, the formation of an “ice effect” in which aerosol particles that reflect sunlight are accumulated in the upper layers of the atmosphere, and climate change. Air pollution leads to the development of many diseases in humans: oncology, coronary heart diseases, respiratory diseases and affects almost all body systems necessary for proper functioning and maintenance of life.

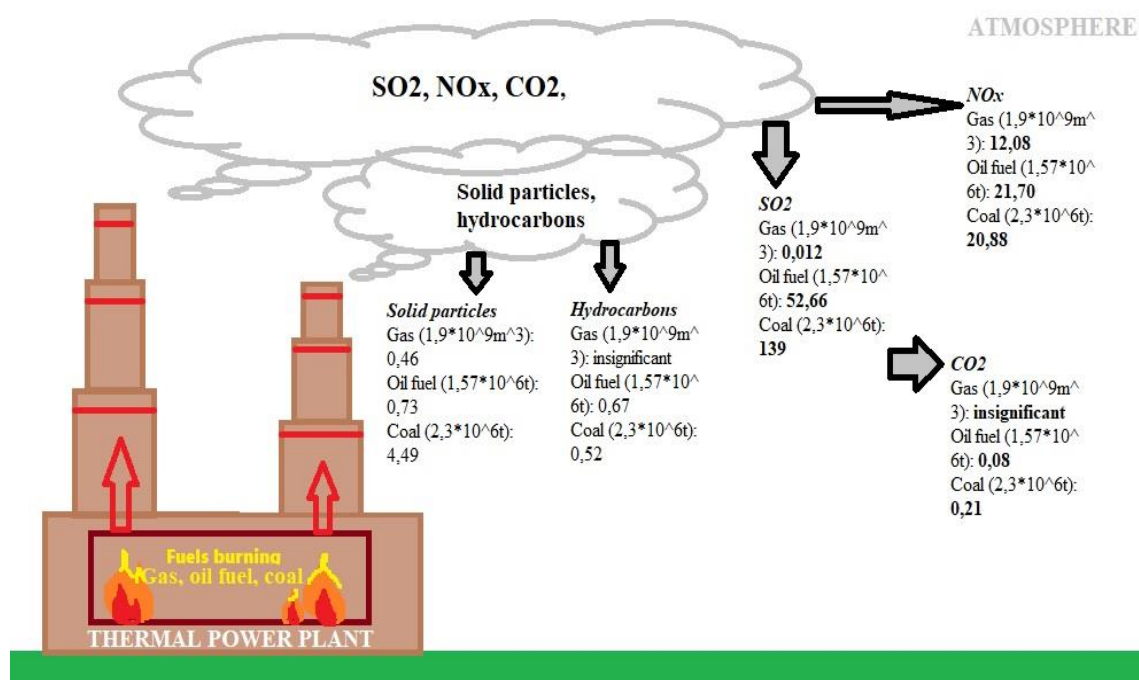


Fig 1.4. Air contamination by thermal power plant

A nuclear power plant is an industrial facility that produces and provides energy to all spheres of human activity through the processing of radioactive minerals, mainly uranium (99%). It is believed that a nuclear power plant is more environmentally friendly, but this is not entirely true. At a nuclear power plant, complex technological processes occur for the release of uranium isotopes in the process of nuclear fission,

and after the deceleration of uranium-235 with the help of water or graphite. Further, the reactor is controlled using specific rods of boron or cadmium, which are introduced into the reactor. To extract the desired energy level and start the reactor with these rods, the reactor itself is controlled. All processes around the clock require proper maintenance and regular maintenance of stable power and temperature. Incorrect technology can lead to an explosion of the reactor and environmental pollution by radiation, which will lead to the irradiation of all living things. This topic was described earlier in the section “Radiation Pollution”.

To compare environmental pollution by thermal and nuclear power plants, a table was analyzed. At the same time, the plants produce the same amount of billions of kilowatts, but in all respects, the supply and consumption of a thermal power plant have exceeded the nuclear power plant many times over. A TPP uses about 12 million tons of coal, 6 million tons of fuel oil (in this category, a nuclear plant consumes 286 tons), and 26 million tons of oxygen. Instead, tons of carbon oxides, nitrogen oxides, ash, and even radioactive nuclides fall into the atmosphere. A thermal power plant is a dangerous threat to the environment and the atmosphere as a whole [27].

Specifically in Ukraine, the electric power industry is equal in terms of air pollution (and other parts of the geosphere) to the emissions of heavy metallurgy; therefore, the state limits the development of energy in order to protect the environment. The energy in Ukraine produces more than 60% of sulfur oxides and nitrogen oxides, which are the result of acid rain [28]. Heavy industry also affects air pollution, as tons of particulate matter and toxic gases are released into the atmosphere during mining and processing. All types of industry in Ukraine are in technological decline, as many plants and factories have not been reconstructed since the time of construction in the USSR. Each production has its own operating time and in most cases requires reconstruction for further use. Improving the environment depends entirely on investing and replacing old parts, filters and new technologies in production. Now, the situation remains the same deplorable.

In this section, not all spheres of the industry analyzed from an environmental point of view, but the whole industry definitely pollutes both air, water, soil, and all

biota. The solution to this problem can only be the development and use of technologies and the economical use of the Earth and its resources. The transition of the electric power industry to alternative "green" sources of electricity production, improvement of parts at all enterprises and their modern reconstruction, reduction of production, since most of it is not used rationally and turns into highly toxic waste. In Ukraine, there are no regulatory laws on industrial emissions, so the level of pollution is not fixed at the legislative level. In February 2020, the law "On Prevention, Reduction, and Control of Industrial Pollution" was adopted, which did not enter into force due to a change in the government. The law indicates the creation of calculations of the maximum amount of industrial emissions for each industrial process, but it is currently not valid. Therefore, tons of uncontrolled toxic and dangerous substances get into the environment even now.

Transport is a technological device designed for quickly move a person, and used to move cargo (Table 1.14).

Table 1.14

Types of the transport

Type	Subtype	Description
Land transport	Railway	The type of transport that carries out using rail tracks: trains, trams, subways, trains, and others.
	Car	The type of transport that travels via roads: cars, KAMAZ trucks, trucks, buses, trolleybuses, etc.
	Pipeline	A type of transport that is used for the extraction and transportation of oil and gas over long distances using pipes of different diameters.
Water transport	Nautical	The type of transport that is used to move cargo and passenger traffic over long distances through marine water bodies (seas and oceans). Ships are used for transportation.
	River	The type of transport that is used to move cargo and passenger traffic over long distances along with river water bodies (rivers). Ships are used for transportation.
Air Transport	Aviation	The type of transport that is used to move cargo and passenger traffic over long distances by air (airplanes and helicopters).
	Space	The type of transport that is used to study space and space objects, for transporting people to the orbit of the earth and other planets.

In connection with the development of the population and the development of other parts of the world by man over long distances, there has been a development in the field of transportation. This development in the modern world has become a global environmental problem. Today, the most used transport are automobile and aviation. Road transport is the most dangerous for the environment, as it is a source of noise, mechanical and the most dangerous — chemical pollution. More than 60% of air pollution is caused by road transport, in densely populated cities this indicator is greater — almost 90%. The most dangerous aggressive pollution from motor vehicles are exhaust fumes. All transport operates using fuel - oil products: gasoline, diesel, and gas. During the combustion of fuel, toxic chemicals such as carbon dioxide, sulfur oxides, nitric oxide, hydrocarbons, lead, aldehydes, soot, phenols, metal oxides, sulfates and nitrates and others enter the atmosphere. Carbon dioxide is not dangerous in small quantities, but due to the large amount of transport, CO₂ is higher than normal. Carbon dioxide is one of the main chemical compounds that create a greenhouse effect and contribute to the development of global warming. In fact, he is actively involved in the destruction of all life on Earth, and we contribute to this. The following hazardous compounds for the atmosphere are NO_x: N₂O, NO, N₂O₄ and N₂O₅, N₂O₃, NO₂. The emission of nitrogen oxides is controlled at the legislative level, as they are very dangerous both for the environment and for humans. A high concentration of NO_x kills a person. Transport is dangerous for the atmosphere, because unlike industrial plants, it pollutes the environment in vast territories and in the lower atmosphere (where we are). CO is a colorless poisonous gas that affects a person's central nervous system in large quantities and leads to suffocation and death [29].

Automobile transport passes 4 tons of oxygen through it and forms more than 3 tons of CO₂, 800 kg of CO, 200 kg of hydrocarbon and 40 kg of NO_x at the outlet. Only in Ukraine, according to the Ministry of Health, more than 60,000 people die due to air pollution. According to WHO, air pollution as of 2016 led to more than 4,000,000 premature deaths. To solve the problem of air pollution, it is necessary to reduce the amount of transport used. Families often operate more than 2-3 cars that

worsen our planet, so it is necessary to introduce fines for the additional use of transport and taxes on emissions of harmful substances by transport (Pic. 1.5). A reasonable solution is the development of green energy and the transition from gasoline and diesel vehicles to electric cars that are less polluting. Campaigning on the use of public transport, cycling or walking, which will improve the functioning of the musculoskeletal system and overall health [30].

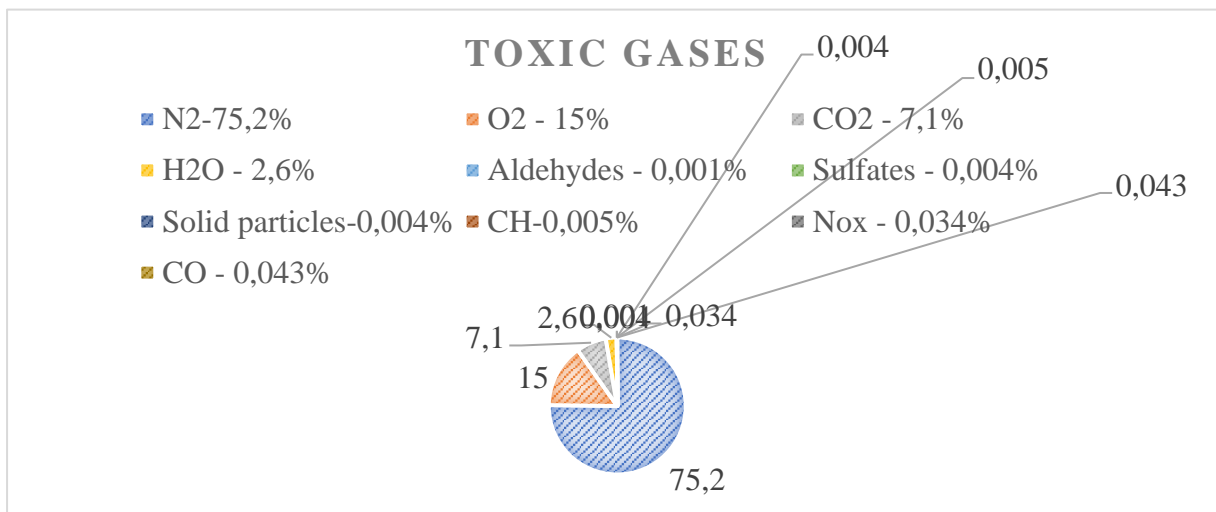


Fig 1.5. Composition of exhaust gases from cars in the process of gasoline combustion

The next powerful source of pollution is aviation. For flights and the operation of tons of metal, aircraft require a huge amount of fuel, which pollutes all layers of the atmosphere during combustion. During the combustion process, the familiar carbon dioxide, soot, water vapor, nitrogen and sulfur oxides, and other greenhouse gases enter the troposphere (the atmosphere layer in which the planes fly). The troposphere is the atmospheric layer in which the weather is formed, therefore aircraft technology directly affects acid rain and other precipitation, climate formation and other anomalies on our planet.

For ecology, all transport is a threat. Ensuring the functionality of transport and its first pollution factor begins with the extraction of minerals - oil, the following are: providing the car with fuel, spare parts (rubber tires, batteries, carburetors, and others), service at service stations, car washes. Transport affects everything: water,

soil, and flora, and fauna, humans, atmosphere. Without a vehicle, not a single person can imagine their existence, but tons of toxins and chemicals are thrown into the environment. A dangerous and pressing problem is global warming. All factors of anthropogenic human activity have now led to an increase in temperature on the planet. Global warming will lead to a change in the familiar climate, and this will be felt not only by flora and fauna but also by humans. In addition to the extinction of many species of marine and terrestrial animals, soils will not be suitable for growing crops consumed by humans. Climate change will lead to natural disasters, droughts, environmental toxicity and the extinction of freshwater. In 2019, the maximum temperature plus 16 degrees Celsius was recorded at the South Pole, which is anomalous for this region. At some points in the Antarctic, a temperature of minus 60 degrees considered normal. The South and North Poles are glaciers, which are the main reserve of freshwater in the world. Their melting changes the level of the world's oceans and their salt concentration, which will lead to flooding of many regions of the planet and the destruction of complex life forms. All pollution of our planet affects a person's life expectancy, health, resources, and needs. Therefore, it is necessary to improve the ecological state by all means, since life on other planets is not possible, and on Earth, it becomes more dangerous.

1.5. Conclusion the Chapter 1

In this chapter, we studied all types of atmospheric and environmental pollution: physical, natural, anthropogenic, physical and biological. Each pollution described and analyzed in detail, taking into account any changes in the environment as of 2019 and 2020. Atmospheric pollution most affected by man and his activities, respectively; the most dangerous for the atmosphere is anthropogenic pollution. According to the analysis of sources, air and industry pollute especially strongly. Transport accounts for about 84% of air pollution, and in cities, this figure reaches 95%. Powerful pollution targets are Thermal Power Plants and Nuclear Power Plants, Heavy Metallurgy and the Oil Industry, Agriculture, Landfills and Incinerators. In

total, each type of these objects daily releases tons of toxic and chemical substances into the atmosphere that negatively affect air quality, as well as other environmental components. Anthropogenic pollution affects the livelihoods and health of each species, especially humans. Many diseases are associated with air pollution: mainly oncology, cardiovascular disorders, respiratory illness, and even DNA cell mutation. The ways of solving the global problems of humankind that need investment and the initiative of states are presented.

CHAPTER 2

ASSESSMENT OF AIR POLLUTION SOURCES IN KYIV

2.1. Pollutants of the atmosphere in Kyiv

With development of cities and infrastructure, increase of population, quality of atmospheric air gradually gets worse and comes to the critical point. The capital of our country — Kyiv became one of the muddiest cities of Ukraine and world (according to rating of company IQ Air, 2020 year).

The main air pollutant, according to the Department of Environmental Control of the Ministry of Environmental Protection of Ukraine, are cars. In Kyiv, road transport accounts for 83.4% of all harmful emissions into the atmosphere. Most vehicles with exhaust emissions meet only Euro-2 standards. A large number of cars run on low-octane gasoline, which is added to the most powerful carcinogen — tetraethyl lead. In certain weather conditions, the level of air pollution can increase by 5-6 times. Automobile exhaust gases are especially dangerous for health, as they are emitted directly into the breathing zone of people - in the immediate vicinity of sidewalks in the area of active walking. The maximum indicators of air pollution in Kyiv are recorded from March to August, peak indicators occur in May-June

Kyiv is the densely populated city of Ukraine, many types of industry are developed in that and on the amount of cars, and it yields to not a single other city. As is generally known, a transport is the most dangerous and basic source contamination of atmospheric air that influences on quality of biota and on the health of man. Thermal power plant and other plants that every day throw out in air of ton of toxic gases are also located in city boundaries (Fig.2.1). These connections assist development the greenhouse effect and appearance of smog. The greenhouse effect is an increase in the temperature of the earth's surface due to the heating of the lower atmosphere by the accumulation of greenhouse gases. As a result, the air temperature

is higher than it should be, and this leads to irreversible consequences such as climate change and global warming.

In the fall of 2019, a serious problem arose with the atmosphere of the city is a high level of smog was registered for several days. Thanks to the Windy online service, residents of the capital were able to monitor air pollution levels in different areas and use precautionary measures. The same service showed a high concentration of carbon monoxide (CO). The main source of its origin is emissions from cars, the former head of the Ministry of Health notes on her blog [31].

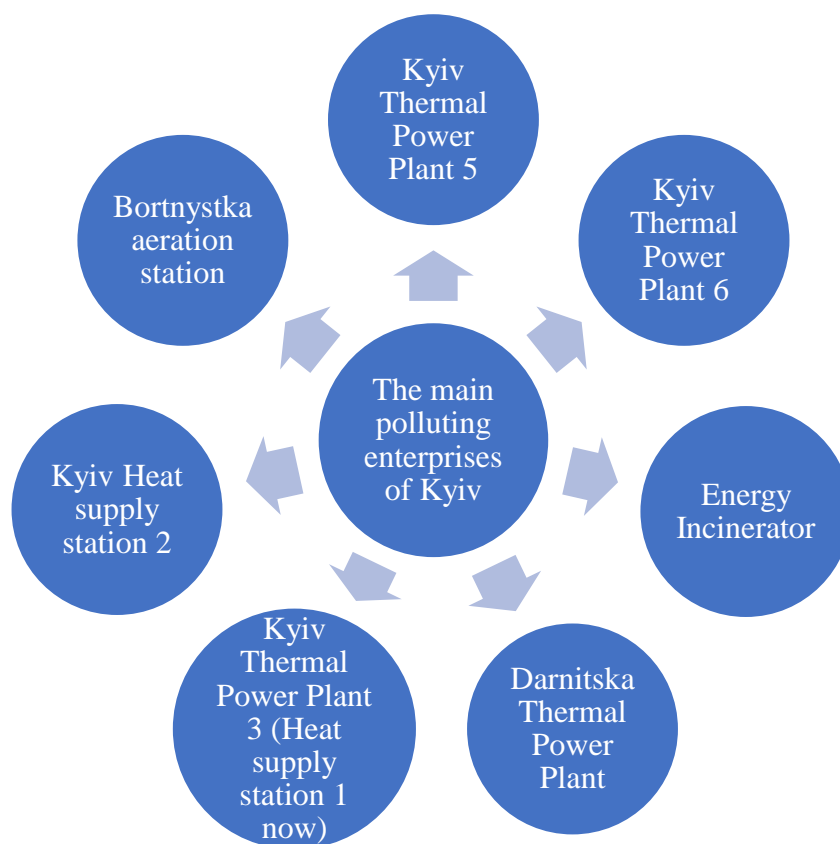


Fig 2.1. Basic enterprises contaminating the atmosphere of air in Kyiv

One of the main sources of atmospheric pollution is thermal power plants, because in this industry, they use the processing of fossil fuels (mainly coal, but other types of solid minerals, fuel oil, and natural gas can also be used). Thermal power plants use coal since Ukraine has a large reserve of this mineral (more than 95%); the potential of coal reserves is more than 50 billion tons.

The cogeneration plant 1 (formerly Cogeneration Plant No. 3) belongs to “Kyivenergo”. It was built before the Second World War. Initially, one sector built

and launched in 1937; later the second sector was completed and launched in 1940. Now the thermal power plant is only engaged in heating the Kyiv infrastructure and acts as a boiler room. Information about the fossil used not known, however, analyzing with our own eyes the color and density of the smoke coming out of the pipes into the atmosphere, and we can assume that the station uses natural gas [32].

Thermal Power Station 5 is one of the most powerful energy enterprises in Kyiv. This construction provides heat and energy to about 1 million residents of Kyiv, the transmission of electric energy occurs through 20 wind power lines with different capacities: 330 kV, 110 kV, and 35 kV. Thermal energy is carried out using six heat mains. Thermal Power Station 5 consists of four power units, which were commissioned in 1971 and the building was completed in 1995. During this period, another five water heating boilers were rebuilt. According to media reports, in 2018, the station switched from using coal to natural gas, which was purchased from a "private supplier". When using natural gas for industrial purposes, enterprises emit about 98% of toxic substances. The product of natural gas combustion is nitrogen oxides. According to a professor at the Gas Institute, the height of the pipes of the Thermal Power Station 5 reaches 175 m. When nitrogen enters the atmosphere, it combines with sulfur oxides, which leads to the formation of acid rain, which negatively affects the environment and damages the healthy state of the biota [33].

Thermal Power Station 6 is one of the largest thermal power plants in Ukraine about the times of the USSR and as of today, it is one of the most powerful thermal power plants in the state and Kyiv. Thermal Power Station 6, like five, belongs to the branch of "Kyivteploenergo" specializes in providing energy and heat, due to the completed stakes. The station was commissioned in 1981. The last reconstruction was carried out in 2001, and already in 2004, a new boiler was put into operation, which is considered 95% more economical and efficient. Thermal Power Station 6 is located in the Kyiv region of Troyeshchina, which is one of the largest sleeping areas of the city. Like the fifth Thermal Power Station, the 6th station releases an incredible amount of toxic substances into the atmosphere. Official sources do not indicate tons of pollution [34].

The oldest and most harmful to the environment is considered Darnitska thermal power plant. No reconstruction has been found in the sources since 1954. The station provides with heat about 10% of the living space of Kyiv, however, city residents complain about the smell and quality of atmospheric air. To confirm the information in the sources, I personally decided to analyze the state of the environment in the nearby area to the station. The distance from the boilers and the station to the housing estates is unacceptably small. The cogeneration plant is a 10-minute walk from Chernigovska metro station. Under the station, there are offices and a road, which pedestrians walk. The air is as polluted as possible, exhaust from a black pipe. To reduce health risks, I used a mask and a scarf, but this did not eliminate the burning sensation in the nose and mouth, and there was also a sharp burning sensation on the mucous membrane of the eye.

"According to the public man, in winter the peak of evaporation occurs at night, when the temperature usually drops, at the same time the load of the entire heat generation increases. When the products of the TPP processing get into Goryachka, the temperature rises and, accordingly, the evaporation becomes more intense. With steam, it enters the air. Almost everything in that water, including some metals. The evaporation is so intense that the water mixture hangs in the air, forming a poisoned artificial fog. There may be heavy metals - mercury, arsenic, stibium (previously significant excesses of their norms were recorded)" — the environmental activist said [35].

The main air pollutant, according to the Department of Environmental Control of the Ministry of Environmental Protection of Ukraine, are cars. In Kyiv, road transport accounts for 83.4% of all harmful emissions into the atmosphere. Most vehicles with exhaust emissions meet only Euro-2 standards. A large number of cars run on low-octane gasoline, which added to the most powerful carcinogen — tetraethyl lead. In certain weather conditions, the level of air pollution can increase by 5-6 times. Automobile exhaust gases are especially dangerous for health, as they are emitted directly into the breathing zone of people in the immediate vicinity of

sidewalks in the area of active walking. The maximum indicators of air pollution in Kyiv are recorded from March to August, peak indicators occur in May-June.

In the folded situation, even to date with limitation of movement of public transport, enterprises and private cars contaminate air also. Contamination of air in districts it is possible to know by means of the special web sites that fix contamination of atmosphere in real time. However, in Kyiv posts not enough of monitoring for a correct and more exact analysis and registration of toxic substances in midair. In the Darnitskyi district, namely on the stations of Pozniaky, Kharkivska, Virlitsa, information about quality of air pool cannot be absolutely reliable, because near-by these stations there are not posts of monitoring of air.

2.2 Conclusion the Chapter 2

In this chapter, the main sources of pollution in Kyiv were analyzed. Kyiv is a densely populated city-capital, which there is air polluting thermal power plants, treatment plants, and a waste recycling plant, as well as a huge amount of transport. Transport is the main source of air quality deterioration (almost 85%) and human health. The methods of identification of air pollution were analyzed.

CHAPTER 3

AIR QUALITY ASSESSMENT IN POZNIAKY DISTRICT

3.1 Air quality assessment in Pozniaky District

One of the most densely populated districts of Kyiv is sleeping quarters Pozniaky district. Pozniaky is located on the Left bank in the Darnitskyi district. The Pozniaky district was named after rich villagers by the name of Pozniaky, which were mentioned in the 17th century. At the end of the 20th century, there were a large number of lakes and sandstones in this area, but by 1980, active development began with multi-story residential areas, infrastructure development, and active settlement. Today, Pozniaky is one of the youngest and fastest-growing areas with expensive living space, as well as a large percentage of the young population. About 350 thousand people live in Darnitskyi district, 25% of which live on Pozniaky [36]. The basic sources of contamination of air in this district are a motor and public transport, “Energy” Incinerator and Bortnystka aeration station.

Drinking water in Kyiv is taken from the main source of urban freshwater - from the Dnieper River. It cleaned and fed through taps to apartments and houses. After use, water flows into the sewers, and from there they fall into a special sewage treatment plant.

Bortnystka aeration station is a treatment plant that cleans sewage waste from almost all of Kyiv and some cities that are located close to the capital. To the sewage treatment plant, 20 minutes’ walk from the metro station Borispilska. Reservoirs with drains and treated water are in the open. Wastewater treatment is carried out using bacteria: secondary sedimentation tanks and aeration tanks are used. The maximum capacity of the station is about 2 million m³ of water per day, but in fact, less sewage is handled [37]. All steam from the hot mass of water and other volatile compounds enter the atmosphere and pollute it. The purified water from the Bortnystka aeration station flows back to the Dnieper River. Municipal solid waste that was filtered out

because of water treatment is transferred to the “Energy” waste incinerator (Vyrlitsa metro station). The minus of Pozniaky is that, depending on the direction of the wind, a pungent and pungent smell of treatment facilities and plant emissions are felt, which prevent a comfortable stay on the street.

For the practical part of this work, I decided to establish the quality of the atmospheric pool in the Pozniaky region and the level of pollution in this territory. The main source of air pollution is motor vehicles, as this area is densely populated and apartment owners have a large number of vehicles. For research, I took the 4 "main" roads of the Pozniaky district (Fig.3.1).

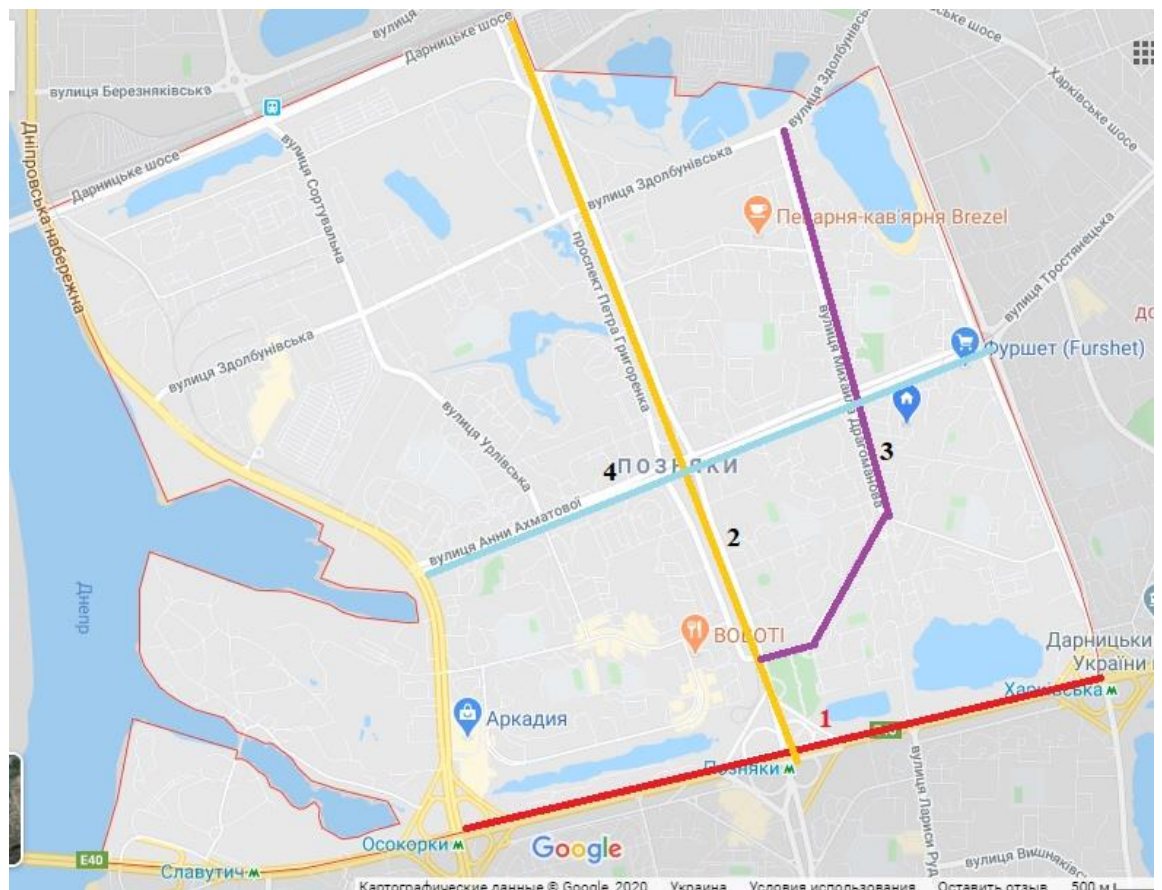


Fig. 3.1. The main streets in the Pozniaky district — 1 is Mykoly Bazhana Avenue; 2 is Petra Grigorenko Street; 3 is Mikhaïla Dragomanova Street; 4 is Anna Akhmatova Street

The most dangerous chemical product of combustion, which emits vehicles, is carbon dioxide. CO studied previously, but this gas has no taste, color, or smell, and is also very toxic to the environment and dangerous to human life. Interaction with

the human body leads to the displacement of O₂ and oxygen starvation, in large doses, carbon monoxide leads to suffocation. The carbon monoxide hazard level depends on the amount of this compound. The amount of CO is regulated at the legislative level and has a limit that does not entail a negative and dangerous effect on human health.

The allowable concentration limit (ACL) is a certain exact concentration of a permissible substance that does not affect the environment and does not harm human health. Measured in mg / m³. The daily average ACL_{CO} equals 3 mg/m³, one maximal (duration 20 min) ACL_{CO} = 5 mg/m³, a concentration in 20 mg/m³ is dangerous for human life.

The statistical method was used to analyze the quality of atmospheric air.

On each road for research, the following actions were taken:

1. A specific section of the road 1 km long was selected;
2. The number of vehicles of various types was recorded within 1 hour;
3. All observations were made on the same day (March 9, 2020) at different time intervals;
4. The amount of toxic carbon monoxide in the atmosphere for a certain type of transport investigated and calculated;
5. Using the coefficients C_{Ti}, C_A, C_S, C_W, C_H, C_I, we calculated the atmospheric air pollution CO by the Begm's formula (1984), modified by Shapovalov in 1990;
6. The sanitary zone for a comfortable and safe stay and residence was calculated.

The main formula for CO calculating is the Begm's formula (1984), modified by Shapovalov in 1990 according to formula 3.1:

$$C_{CO} = (A + 0,01N \cdot C_T) \cdot C_A \cdot C_S \cdot C_W \cdot C_H \cdot C_I \text{ mg/m}^3, \quad (3.1)$$

where A is a background contamination of the atmospheric air (for Ukraine – A=0,5 mg/m³),

N is a total intensity of the transport movement on the part of the road –
 $N=(n_1+n_2+n_3+n_4+n_5)$, numbers/hour; in the rush hour —
 $N=1,5 \cdot (n_1+n_2+n_3+n_4+n_5)$, numbers/hour;

C_T is a toxicity coefficient due to the CO emissions into the atmospheric air (Tab.3.1) according to formula 3.2:

$$C_T = \sum P_i \cdot C_{Ti}, \quad (3.2)$$

where P_i is the part of the individual type of the transport in the traffic flow, according to formula 3.3:

$$P_i = \frac{n_i}{(n_1 + n_2 + n_3 + n_4 + n_5)}, \quad (3.3)$$

C_A is the coefficient includes the territory aeration (Table 3.2),

C_S is the coefficient includes the longitudinal slope of the road (Table 3.3),

C_W is the coefficient that includes the wind speed on the territory (Table 3.4),

C_H is the coefficient that includes the relative air humidity (Table 3.5),

C_I is the coefficient includes the increasing of air contamination on the crossings of highways with other roads (Table 3.6).

The radius of sanitary-hygienic zone calculate according to formula 3.4:

$$R_{SHZ} = (0,5 \cdot C_{CO} - ACL_{CO})/0,1, \quad (3.4)$$

where $ACL_{CO} = 5 \text{ mg/m}^3$.

Table 3.1

The toxicity coefficient due to the CO emissions into the atmospheric air

Vehicle type	Intensity of the transport movement N_i , autos/hour	C_{Ti}
Cars	n_1	1,0
Light trucks (minibus)	n_2	2,3
Average tracks	n_3	2,9
Heavy trucks (diesel)	n_4	0,2
Buses	n_5	3,7

Table 3.2

The coefficient includes the territory aeration

Type of the territory by the aeration	C_A
Transport tunnels	2,7
Transport galleries	1,5
The main streets of multi-story buildings on both sides	1,0
Streets and roads with one-story buildings	0,6
City streets and roads with one-sided buildings, with embankments	0,4
Under crossings	0,3

Table 3.3

The coefficient includes the longitudinal slope of the road

Longitudinal slope, degrees	C_S	Vertical height of the road (the interval of road 100 m)
0	1,00	-
2	1,06	1
4	1,07	2
6	1,18	3
8	1,55	5

Table 3.4

The coefficient that includes the wind speed on the territory

Wind speed, m/sec	C_w
1	2,70
2	2,00
3	1,50
4	1,20
5	1,05
6	1,00

Table 3.5

The coefficient that includes the relative air humidity

Relative air humidity, %	C_H
100	1,45
90	1,30
80	1,15
70	1,00
60	0,85
50	0,75

Table 3.6

The coefficient includes the increasing of air contamination on the crossings of highways with other roads

Type of street crossings	C_I
Signaled crossing	2,0
Non-signalized crossing	2,2
Non-signalized crossing with the obligatory stop	3,0
No crossing	1,0

Traffic characteristics at Mykoly Bazhana Avenue

Measurement time: 14:00-15:00, Monday, March 9

Table 3.7

Table of observations of the amount of transport, traffic intensity and allocation of the amount of CO in the atmospheric basin of Mykoly Bazhana Avenue

Type of the vehicle	Intensity of the vehicle movement n_i , numbers/hours	Part in traffic flow P_i	Emission toxicity C_T
Cars	5134	0,937	0,997

End of Table 3.7

Light trucks (minibus)	87	0,015	2,293
Average trucks	116	0,021	2,891
Trucks (diesel)	41	0,007	0,199
Buses	98	0,017	3,688
Σ	<i>N = 5476</i>	<i>P = 0,997</i>	<i>C_T = 10,068</i>

$$C_{CO} = (0,5 + 0,01 * 5476 * 10,068) * 1,0 * 1,06 * 1,20 * 1,45 * 1,0 = 1017,7 \text{ mg/m}^3$$

$$R_{SHZ} = (0,5 * 1017,7 \text{ mg/m}^3 - 5 \text{ mg/m}^3) / 0,1 = 5038,5 \text{ m}$$

Traffic characteristics at Petra Hrihorenko Street

Measurement time: 12:00-13:00, Monday, March 9

Table 3.8

Table of observations of the amount of transport, traffic intensity and allocation of the amount of CO in the atmospheric basin of Petra Hrihorenko Street

Type of the vehicle	Intensity of the vehicle movement n_i , numbers/hours	Part in traffic flow P_i	Emission toxicity C_T
Cars	2457	0,936	0,997
Light trucks (minibus)	52	0,019	2,293
Average trucks	26	0,009	2,891
Trucks (diesel)	11	0,004	0,199
Buses	78	0,029	3,688
Σ	<i>N = 2624</i>	<i>P = 0,997</i>	<i>C_T = 10,068</i>

$$C_{CO} = (0,5 + 0,01 * 2624 * 10,068) * 0,4 * 1,0 * 2,00 * 1,15 * 2,0 = 487 \text{ mg/m}^3$$

$$R_{SHZ} = (0,5 * 487 \text{ mg/m}^3 - 5 \text{ mg/m}^3) / 0,1 = 2385 \text{ m}$$

Traffic characteristics at Mikhaila Drahomanova Street

Measurement time: 17:00-18:00, Monday, March 9

Table 3.9

Table of observations of the amount of transport, traffic intensity and allocation of the amount of CO in the atmospheric basin of Mikhaila Drahomanova Street

Type of the vehicle	Intensity of the vehicle movement n_i , numbers/hours	Part in traffic flow P_i	Emission toxicity C_T
Cars	3312	0,642	0,664
Light trucks (minibus)	4	0	0,996
Average trucks	6	0,001	1,925
Trucks (diesel)	0	0	0,13
Buses	112	0,021	2,456
Σ	$N * 1,5 = 5151$	$P = 0,664$	$C_T = 6,171$

$$C_{CO} = (0,5 + 0,01 * 5151 * 6,171) * 1,0 * 1,06 * 2,00 * 1,30 * 2,0 = 1754,84 \text{ mg/m}^3$$

$$R_{SHZ} = (0,5 * 1754,84 \text{ mg/m}^3 - 5 \text{ mg/m}^3) / 0,1 = 8724 \text{ m}$$

Traffic characteristics at Anna Akhmatova Street

Measurement time: 20:00-21:00, Monday, March 9

Table 3.10

Table of observations of the amount of transport, traffic intensity and allocation of the amount of CO in the atmospheric basin of Anna Akhmatova Street

Type of the vehicle	Intensity of the vehicle movement n_i , numbers/hours	Part in traffic flow P_i	Emission toxicity C_T
Cars	4783	0,646	0,664
Light trucks (minibus)	18	0,002	0,996
Average trucks	7	0	1,925
Trucks (diesel)	1	0	0,13
Buses	120	0,016	2,456

Σ	$N * 1,5 = 7393$	$P = 0,664$	$C_T = 6,171$
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$$C_{CO} = (0,5 + 0,01 * 7393 * 6,171) * 1,0 * 1,06 * 2,00 * 1,30 * 2,0 = 2517,45 \text{ mg/m}^3$$

$$R_{SHZ} = (0,5 * 2517,45 \text{ mg/m}^3 - 5 \text{ mg/m}^3) / 0,1 = 12537,25 \text{ m}$$

After analyzing the calculations of environmental pollution by the amount of CO that enters the atmosphere (see the Table 3.7, Table 3.8, Table 3.9, Table 3.10), we can conclude that the highest concentration of gas during the rush hour. The level of air pollution exceeds the permissible limits by dozens of times. However, under standard conditions M. Bazhana Avenue is the most saturated with vehicles and pollution of carbon monoxide (Fig.3.2).

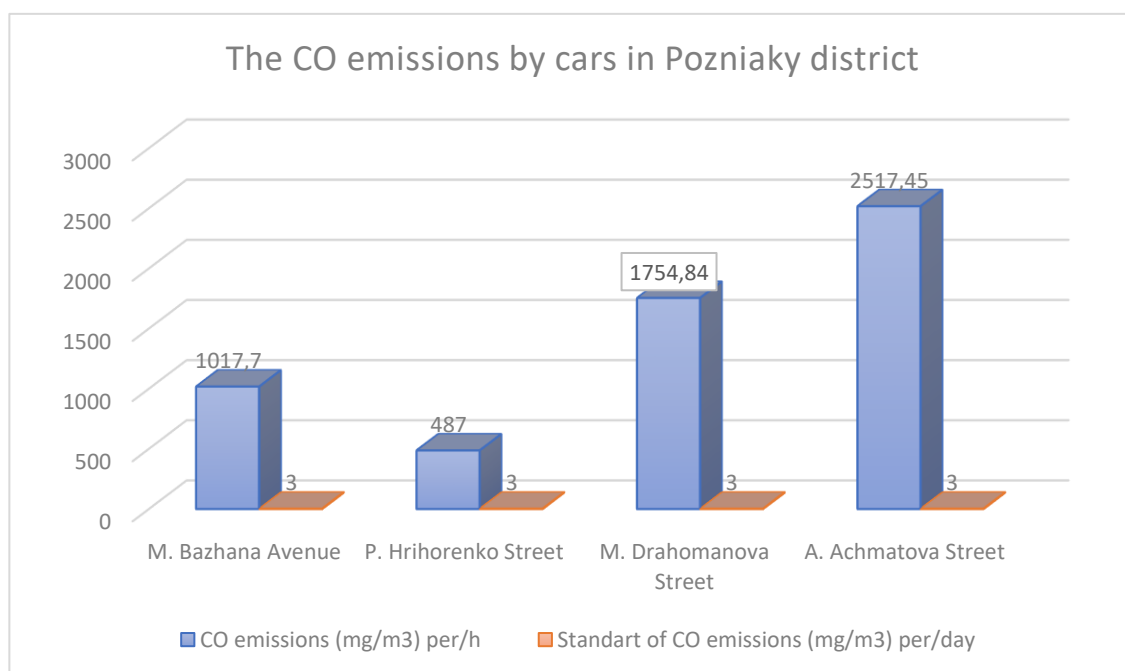


Fig. 3.2. Comparison of standard CO emissions per day with CO emissions in Pozniaky district per hour

3.2. Methods for reducing automotive emissions in European countries. Methods to Reduce Air Pollution in Pozniaky

Air pollution by exhaust gases is not a national but an international problem. All states on Earth fight harmful substances, but the greatest attention paid to this problem in the countries of the European Union (Table 3.11).

Table 3.11

Measures to reduce air pollution by road in the European Union

Countries	The methods
France	<ul style="list-style-type: none"> • Tax benefits for heat, gas, hybrid and electric vehicles; • Tax benefits for giving up an old car; • Paris pollution stickers (determines the number of carbon emissions and is subject to penalties if exceeded).
Germany	<ul style="list-style-type: none"> • Car tax (Kraftfahrzeugsteuer); • Ecological green areas; • Ecological icon (determines the class of pollution and is subject to penalties for violation).
Poland	<ul style="list-style-type: none"> • Ecological public transport is being purchased and electric transport is being promoted; • The taxes on air pollution by cars.
The United Kingdom	<ul style="list-style-type: none"> • Regulations on-road vehicles (regulating standards for the production of new cars, including standards for exhaust emissions); • Penalties for engine operation (more time) without car movement; • Ban on the sale of ethyl gasoline.
Switzerland	<ul style="list-style-type: none"> • Upgrading public transport to reduce emissions; • Vehicles running on gasoline and diesel are subject to regulatory emissions at the legislative level; • Tax incentives.

Pozniaky is a new area, where there is not enough green vegetation. The green vegetation could absorb air, improve the quality of the air basin and reduce risks to human health. Analyzing the map, we see that there are very few green areas in the Pozniaky area, and traffic and emissions are hazardous to health. The only "green" site is "Pozniaky Park", which is located near Petra Hrihorenko Street and Mykoly Bazhana Avenue.

To improve the state of air quality, it is necessary to develop the most effective methods of air purification with a wide range of actions. Therefore, in this work, different types of purification analyzed and optimal ones were selected. For example,

in enterprises, carbon monoxide pollution with a gaseous substance is neutralized using the thermocatalytic method, but this species is local. For gas purification, reactors with catalysts (most often minerals) used, which have high resistance, neutralization, the activity of the substance, and resistance to toxins. For large scales, this view cannot be applied [38].

The most optimal and effective method is to create a dense green band (Fig.3.4, Fig.3.5, Fig.3.6, Fig.3.7). The green bar has a number of functions, but the main ones are the retention of pollutants and air purification. The green lane is set at a certain distance depending on the number of lanes and traffic intensity: if the road with one lane is up to 3 meters, more than 2 lanes - from 5 meters [39]. After analyzing the vegetation of the district, it was found that there is not enough green space. They cannot cope with the roadside load (high concentration of exhaust gases, high temperature and low rainfall in the summer, strong and cold wind in the winter, lack of fertilizer): the distance between the trees about 15-25 meters, the predominant plant species are linden and chestnuts. It has been studied that plants are a natural sorbent for various chemicals. Therefore, to improve the quality of the air basin, it is necessary to select "persistent" plants of temperate latitudes.

In early ecology courses, we studied the resistance of Kyiv plants to various irritants: acid rain, dust, heat treatment, concentrated brine. The most severe plant species to pollution were maple, acacia, and poplar. The weakest plants are lilac, linden and chestnuts. Therefore, the trees that are planted off the roads in Pozniaky are not suitable and do not fulfill their function. The number of phytoncide shrubs should be increased: *Juniperus*, *Spiraea*, *Ligustrum vulgare* and others. These shrubs trap harmful substances and improve the visual component of the range.

Visually analyzing the structure of persistent plant species, we can conclude that maple and acacia have a lush crown and the optimal distance between them should be up to 10 meters, and for poplar with a more elongated crown 7-8 meters.

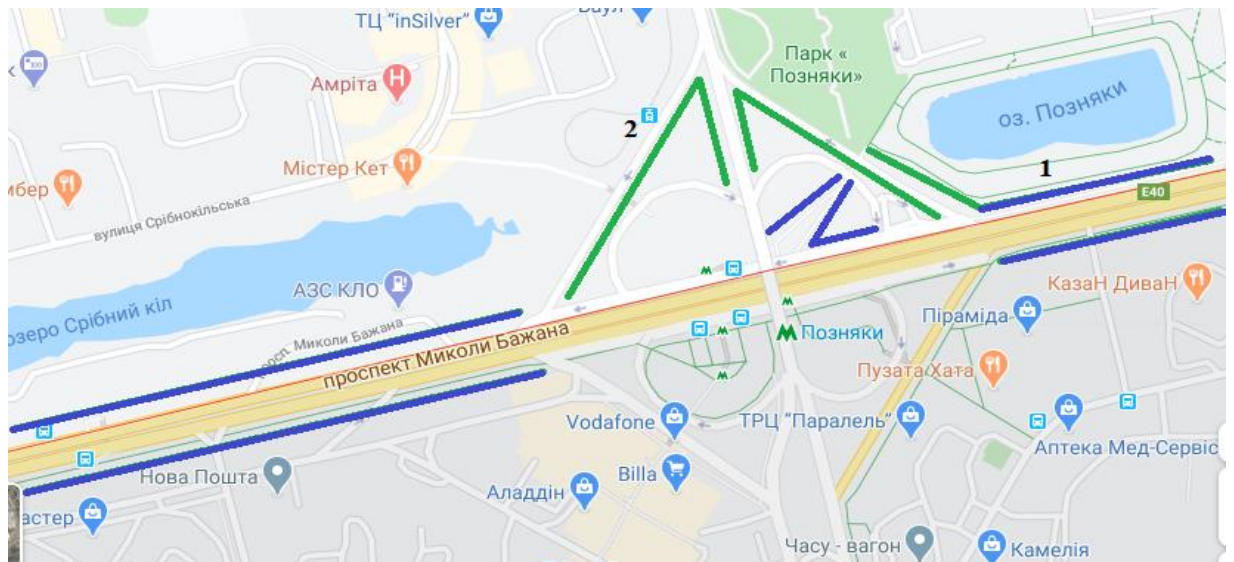


Fig. 3.4. The design of green band along M. Bazhana Avenue — 1 is species of trees resistant to atmospheric pollution; 2 is shrubs resistant to atmospheric pollution (to prevent the creation of road accidents)

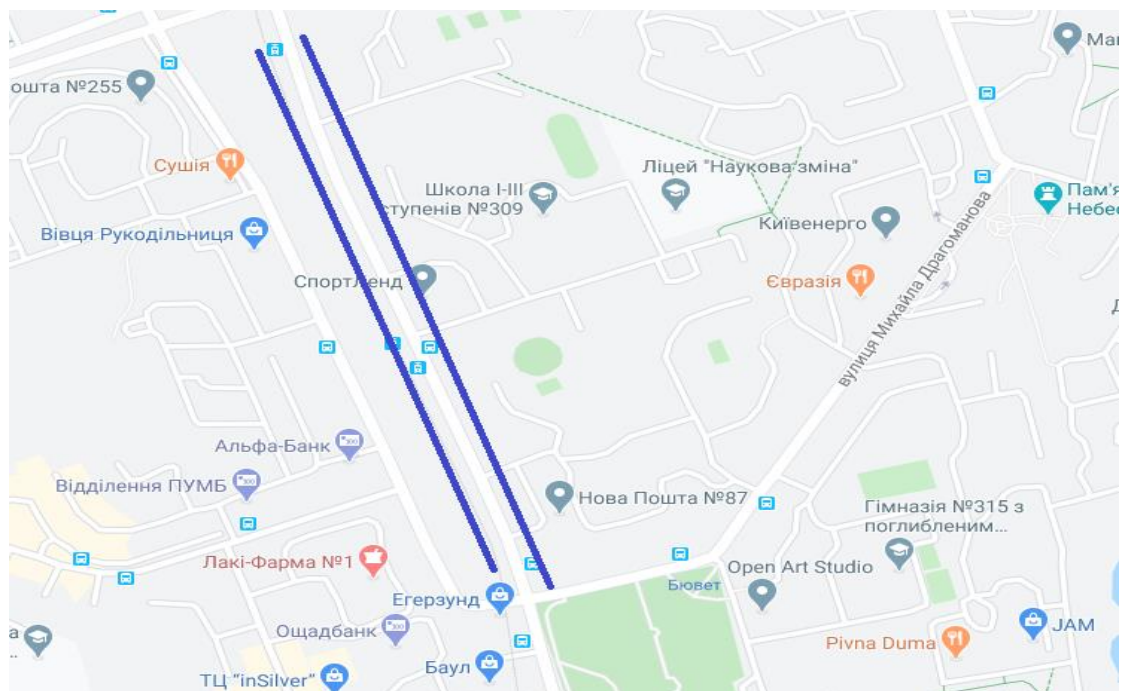


Fig. 3.5. The design of green band along P. Hrihorenko Street— blue line is species of trees resistant to atmospheric pollution

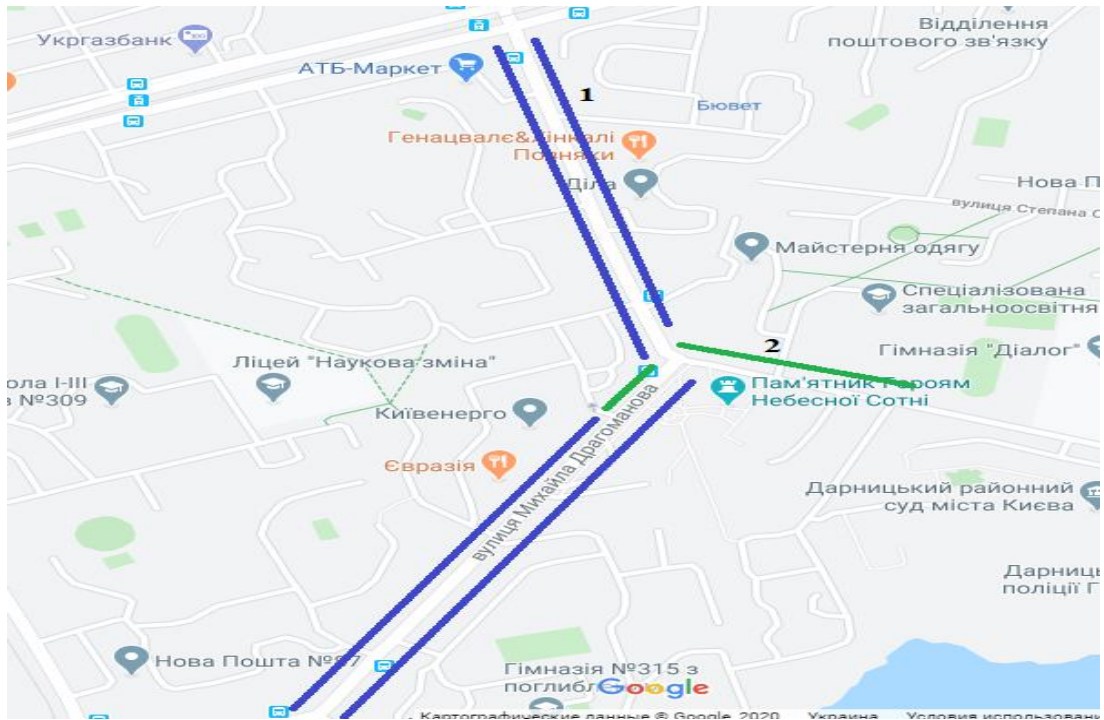


Fig. 3.6. The design of green band along M. Drahomanova Street —1 is species of trees resistant to atmospheric pollution; 2 is shrubs resistant to atmospheric pollution (to prevent the creation of road accidents)

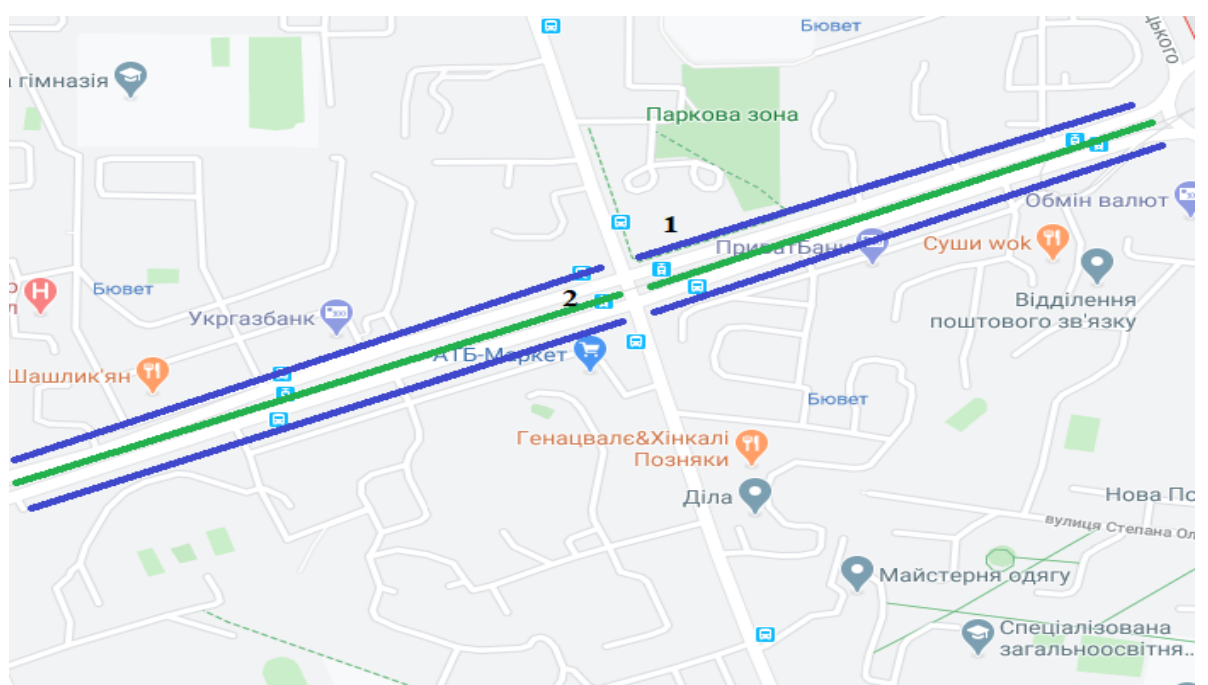


Fig. 3.7. The design of green band along A. Akhmatova Street —1 is species of trees resistant to atmospheric pollution; 2 is shrubs resistant to atmospheric pollution (to prevent the creation of road accidents)

3.3 Conclusion the Chapter 3

In this chapter calculations were carried out on the air pollution of CO in the Pozniaky area. Four main streets with high traffic activity were selected. To use of the statistical method and observations, it was possible to calculate the amount of CO emitted into the air basin per hour. Thanks to the indicators, it was possible to conclude that air pollution exceeds the norm by more than 100 times and is very dangerous for human health. In this section, methods for reducing exhaust emissions in the European Union were analyzed and optimal options for reducing air pollution in the Pozniaky region were proposed. The most acceptable option was planting green spaces along the roads. Some species that were resistant to pollution were selected for greater productivity.

CONCLUSIONS

As a result of research scientific and applied task was solved to minimize negative impact on the environment.

Air pollution is an important issue for the modern and healthy living of people. Deterioration in air quality occurs through human activities.

The main sources of air pollution are transport, thermal power plants and nuclear power plants (most of the energy complex), agriculture, mining, many industries (heavy, oil refining, and forestry), deforestation, uncontrolled fires due to arson of grass and more.

Major gaseous pollutants CO, CO₂, SO₂, NO_x, O₃, Pb, hydrocarbons, dust, smog.

The 84% of air pollution caused by transport, because the transport emits tons of toxic exhaust gases. CO, CO₂, SO₂, NO_x, Pb, and others have a devastating effect on the ozone layer, air quality and ecology, climate, and on human health.

We analyzed the main sources of air pollution. As a result, CO emissions into the atmosphere in the Pozniaky region were calculated and indicators analyzed. Air pollution in the area by this gas exceeds the norm by hundreds of times. Methods were analyzed to improve air quality due to automobile pollution in European countries such as France, Germany, Poland, The United Kingdom, and Switzerland. To reduce the negative impact on the air pool, air-cleaning methods have been proposed. The best option for reducing CO emissions into the atmosphere is to plant green spaces (resistant to exhaust and climate conditions) and create a green strip. Using the Google map, the territory was proposed for planting green spaces.

LIST OF REFERENCES

1. Air pollution [Internet resource]: Mode of access - https://en.wikipedia.org/wiki/Air_pollution . Retrieved 13.02.2020.
2. Ambient (outdoor) air pollution [Internet resource]: Mode of access - [https://www.who.int/ru/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/ru/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health) . Retrieved 13.02.2020.
3. ВОЗ публикует оценочные данные (с разбивкой по странам) по воздействию загрязнения воздуха на здоровье человека [Internet resource]: Mode of access - <https://www.who.int/ru/news-room/detail/27-09-2016-who-releases-country-estimates-on-air-pollution-exposure-and-health-impact> . Retrieved 15.02.2020.
4. Что такое индекс PM 2.5 [Internet resource]: Mode of access - <https://www.atmostech.ru/potrebitelyam/stati/chto-takoe-indeks-rm-2-5.php> . Retrieved 15.02.2020.
5. Рекомендации ВОЗ по качеству атмосферного воздуха. Компания по борьбе против загрязнения воздуха BretheLife [Internet resource]: Mode of access - <https://www.who.int/ru/news-room/detail/27-09-2016-who-releases-country-estimates-on-air-pollution-exposure-and-health-impact> . Retrieved 17.02.2020.
6. Вулканы — загрязнители воздуха [Internet resource]: Mode of access - <http://mirekologii.ru/vozdux/vulkany-zagryazniteli-vozduxa/> . Retrieved 17.02.2020.
7. Матвеева Т.А., Матвеев А.М. Экология и рациональное природопользование. *Успехи современного естествознания*. 2012. №10. С. 107-109.
8. Виды лесных пожаров и их классификация [Internet resource]: Mode of access - <https://protivpozhara.com/tipologija/prirodnye/vidy-lesnyx-pozharov> . Retrieved 18.02.2020.
9. «Легкие планеты» превращаются в пепелище. Кто виноват в невиданных пожарах амазонских лесов [Internet resource]: Mode of access -

<https://tsn.ua/ru/svit/legkie-planety-prevrashchayutsya-v-pepelsche-kto-vinovat-v-nevidannyh-pozharah-amazonskih-lesov-1399164.html> . Retrieved 20.02.2020.

10. В Сибири горят леса, города в дыму, а власти говорят, что пожары можно не тушить. Это правда? [Internet resource]: Mode of access - <https://meduza.io/cards/govoryat-lesnye-pozhary-ne-nuzhno-tushit-eto-pravda> . Retrieved 18.02.2020.

11. 2019-20 Australian bushfire season [Internet resource]: Mode of access - https://en.wikipedia.org/wiki/2019%E2%80%9320_Australian_bushfire_season . Retrieved 18.02.2020.

12. Пылевое загрязнение воздуха [Internet resource]: Mode of access - <http://econbooks.ru/books/part/17096> . Retrieved 20.02.2020.

13. Nuclear weapons testing [Internet resource]: Mode of access - https://en.wikipedia.org/wiki/Nuclear_weapons_testing . Retrieved 21.02.2020.

14. Родзевич Н.Н. Геоэкология и природопользование: учебник для вузов. 2003. 256 с.

15. Электромагнитное загрязнение [Internet resource]: Mode of access - <https://ecoportal.info/elektromagnitnoe-zagryaznenie/> . Retrieved 02.03.2020.

16. Маслеева О.В., Воеводин А.Г., Пачурин Г.В. Технические науки. *Международный журнал прикладных и фундаментальных исследований*. 2014. №5 (часть 1). С. 26-30.

17. Frank, Kenneth D. Impact of outdoor lightning on moths. *Journal of the Lepidopterists' Society. International Dark-Sky Association*. 1988. №. 42. P. 63-93.

18. Сельское хозяйство и окружающая среда [Internet resource]: Mode of access https://www.unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.33/2013/mtg1/rus_FDES_Chapter_5_extract.pdf . Retrieved 02.03.2020.

19. Химическая энциклопедия: в 5 т./ Большая Российская энциклопедия, 1992. Т. 3: Пластические массы/ Тростянская Е.Б., Бабаевский А.Г.

20. Кит с 40 килограммами пластика в желудке выбросился на берег [Internet resource]: Mode of access - <https://www.currenttime.tv/a/29842929.html> . Retrieved 02.03.2020.
21. ДБН В.2.4-2-2005. Полігони твердих побутових відходів. Основні положення проектування. [Чинний від 1983-05-16]. Вид. офіц. Київ, 2005. (Інформація і документація).
22. Трагедия украинских свалок [Internet resource]: Mode of access - <https://www.vtorma.ua/ru/utilizatsiya-musora-na-poligonah-tbo/> . Retrieved 06.04.2020.
23. Алексашина В. В. Экология города. Мусоросжигательные заводы/ *Academia. Архитектура и строительство*. — 2014.
24. В Германии засомневались в экологичности сжигания мусора [Internet resource]: Mode of access - <https://p.dw.com/p/3SHSP> . Retrieved 07.04.2020.
25. Industry [Internet resource]: Mode of access - <https://en.wikipedia.org/wiki/Industry> . Retrieved 08.04.2020.
26. Промышленное загрязнение окружающей среды [Internet resource]: Mode of access - <https://ecoportal.info/promyshlennoe-zagryaznenie-okruzhayushhej-sredy/> . Retrieved 08.04.2020.
27. Электроэнергетика и экология [Internet resource]: Mode of access - <http://www.eco.nw.ru/lib/data/09/1/080109.htm> . Retrieved 08.04.2020.
28. Energy in Ukraine [Internet resource]: Mode of access - https://en.wikipedia.org/wiki/Energy_in_Ukraine . Retrieved 08.04.2020.
29. Загрязнение автотранспортом окружающей среды [Internet resource]: Mode of access - <https://ustroistvo-avtomobilya.ru/sistemy-snizheniya-toksichnosti/zagryaznenie-avtotransportom-okruzhayushhej-sredy/> . Retrieved 09.04.2020.
30. Качество атмосферного воздуха и здоровье [Internet resource]: Mode of access - [https://www.who.int/ru/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/ru/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health) . Retrieved 09.04.2020.

31. Загрязнение воздуха в Киеве. Что происходит и надо ли покупать маску-карточки. [Internet resource]: Mode of access - <https://nv.ua/ukraine/events/zagryaznenie-vozduha-v-kieve-50049426.html> . Retrieved 04.02.2020.

32. Станция теплоснабжения №1 (Киев) [Internet resource]: Mode of access <http://wikimapia.org/1408926/ru/%D0%A1%D1%82%D0%B0%D0%BD%D1%86%D0%B8%D1%8F%D1%82%D0%B5%D0%BF%D0%BB%D0%BE%D1%81%D0%BD%D0%B0%D0%B1%D0%B6%D0%B5%D0%BD%D0%B8%D1%8F-%E2%84%96-1> . Retrieved 04.02.2020.

33. Київська теплоелектроцентраль №5 [Internet resource]: Mode of access https://uk.wikipedia.org/wiki/%D0%9A%D0%B8%D1%97%D0%B2%D1%81%D1%8C%D0%BA%D0%B0_%D1%82%D0%B5%D0%BF%D0%BB%D0%BE%D0%B5%D0%BB%D0%B5%D0%BA%D1%82%D1%80%D0%BE%D1%86%D0%B5%D0%BD%D1%82%D1%80%D0%B0%D0%BB%D1%8C_%E2%84%96_5 . Retrieved 04.02.2020.

34. Київська теплоелектроцентраль №6 [Internet resource]: Mode of access https://uk.wikipedia.org/wiki/%D0%9A%D0%B8%D1%97%D0%B2%D1%81%D1%8C%D0%BA%D0%B0_%D1%82%D0%B5%D0%BF%D0%BB%D0%BE%D0%B5%D0%BB%D0%B5%D0%BA%D1%82%D1%80%D0%BE%D1%86%D0%B5%D0%BD%D1%82%D1%80%D0%B0%D0%BB%D1%8C_%E2%84%96_6 . Retrieved 04.02.2020.

35. Где в Киеве самый грязный воздух? [Internet resource]: Mode of access - <https://fakty.ua/330901-gde-v-kieve-samyj-gryaznyj-vozduh> . Retrieved 04.02.2020.

36. Названы самые населенные районы Киева: население столицы растет за счет миграции [Internet resource]: Mode of access - <https://100realty.ua/news/nazvany-samyje-naselennye-raiony-kieva-naselenie-stolicy-rastet-za-schet-migracii> . Retrieved 05.05.2020.

37. Дарницкий. Позняки. [Internet resource]: Mode of access - <https://flatfy.lun.ua/%D0%BC%D0%B8%D0%BA%D1%80%D0%BE%D1%80>

[D0%B0%D0%B9%D0%BE%D0%BD%D1%8B%D0%BA%D0%B8%D0%B5%D0%B2%D0%B0/%D0%BF%D0%BE%D0%B7%D0%BD%D1%8F%D0%BA%D0%B8](#) . Retrieved 05.05.2020.

38. Описание существующих методов очистки воздуха от вредных газообразных примесей [Internet resource]: Mode of access - http://www.air-cleaning.ru/d_method_rev.php . Retrieved 14.05.2020.

39. Насаждения на городских улицах [Internet resource]: Mode of access - <http://landscape.totalarch.com/node/33> . Retrieved 14.05.2020.