THEME 13
INDUSTRIAL AND URBAN ECOSYSTEMS

Motivational statement

As a result of human activity, significant changes occur in the environment. In order to meet their increasing needs, man changes natural ecosystems and even destroys them, and builds artificial anthropogenic ecosystems. One of the variants of anthropogenic systems are industrial-urban ecosystems (urban systems).

The urban system is characterized by the presence of a number of new significant factors (physical, chemical, biological and social).

A significant part of ecosystems is under the constant influence of these factors in cities and in the territories adjacent to cities, as well as in places inaccessible to humans, but inhabited by representatives of flora and fauna. Knowledge of the main harmful factors of the urban system and ways to protect organisms from their harmful effects is necessary for the development of industrial and urban ecosystems, because it allows you to predict the environmental consequences of anthropogenic impacts.

The objective: to form an idea of the quality of the urban environment as a factor that can have a negative impact on human and animal health, the state of plants and ecosystems; to get acquainted with the methods of assessing anthropogenic environmental impact on models of broadband electromagnetic radiation and aeroion composition of air.

Questions for discussion

1. Industrial and urban ecosystems. Ecosystem characteristics of the city.
2. Differentiation of urban areas into functional zones.
3. Factors of the urban environment: classification, influence on biological systems and humans.
4. Socio-environmental factors, the impact on human health from a biomedical perspective.
5. Consequences of the urbanization process
6. The main measures to improve the environment of urbanized territories.

Independent work of students

1. Work with tests on the topic of the lesson.

Test task

(select one /several/all variants of correct answers and put a "+" sign

1. Ecosystem characteristics of the city:
1) polymorphism
2) complexity;
3) addiction;
2. The most important component of the ecosystem of a modern city are:
1) well-maintained dwellings
2) roads and transport
3) services and entertainment
4) green spaces
5) the totality of industrial enterprises
3. Anthropogenic sources of pollution of the urban environment do not include:
1) transport
2) agriculture
3) volcanoes and geysers
4) industrial enterprises
5) urban economy
4. The severity of the impact of pollutants on the human body is determined by 3 main factors:
1) chemical nature of the pollutant, its concentration and stability in the external environment
2) the nature of the source of pollution, the concentration of the contaminant and the duration of its effect on organisms
3) the aggregate state of the pollutant, its stability in the external environment and the area of contamination
4) the nature of the source of pollution, the chemical nature of the pollutant and its ability to self-destruct
5. An indicator of the quality of the urban environment is:
1) public health
2) overuse
3) the level of production development
4) demographic explosion
6. The role of green spaces is as follows:
1) regulate the gas composition of the atmosphere
2) release oxygen
3) absorb carbon dioxide
4) increase the humidity of the air
5) reduce the air temperature in the warm season
6) reduce the speed of air movement

7. Socio-ecological factors of the urban environment affecting the health of the population:
1) physical inactivity
2) overeating
3) information abundance
4) psychoemotional stress
8. Violation of human biological rhythms in an urban environment can be caused by:
1) electric lighting
2) intense rhythm of life
3) atmospheric air pollution

9. Which of the listed enterprises cannot be located in the sanitary protection zone:
1) pharmaceutical industry enterprises
2) food industry enterprises
3) procurement enterprises, as well as wholesale warehouses of food raw materials and food products,
4) warehouses for the storage of agricultural products,
5) complexes of water supply facilities for the preparation and storage of drinking water
10. Consequences of absorption of light rays (visible and ultraviolet spectrum) by polluted atmospheric air of cities:
1) ambient light illumination decreases
2) the level of UV radiation is reduced
3) the temperature and humidity of the air changes
4) anthropogenic foci of rickets are formed.
11. On the territory of recreational zones and zones, specially protected areas, it is not allowed to place:
1) new and expansion of existing industrial enterprises
2) communal and warehouse
3) objects that are not directly related to the operation of recreational, recreational and environmental facilities.
12. Transport problems of urbanized territories:
1) increasing the duration of a citizen's stay in transport
2) transport fatigue, transport neuroses
3) air pollution
4) epidemiological risk
5) increased noise and vibration levels
6) traffic injuries

2. Hearing and discussion of abstracts prepared by students on the individual assignment of the teacher.

3. Practical work

Measurement and assessment of anthropogenic environmental pollution by factors of physical nature on the model of broadband electromagnetic radiation and aeroion composition of air.

3.1. Assessment of parameters of electric and magnetic fields at workplaces equipped with a PC using the device BE-meter-AT-002.

3.1.1. Get acquainted with the instructions for organizing work with the meter of electric and magnetic fields BE-meter-AT-002.

3.1.2. Under the supervision of the teacher, evaluate the parameters of electric and magnetic fields at workplaces equipped with a PC using the VE-meter-AT-002 device.

3.1.3. Record the total measurement results in the protocol (Table 1) and compare with the normative data, formulate a conclusion.

Table 1

The actual value of the measured parameter

№ p / n	The measured parameter	Permissible values (remote control)	The measurement value in front of the screen (at levels (from the floor, m):			Background values	The value above the remote control
			1.0	1.5 m	0.5 m		
1	2	3	4a	4b	4c	5	6
1	Monitor _____ The intensity of the electro-magnetic field by the electrical component, V / m in the frequency range 5 Hz-2 kHz at a distance of 50 cm around the VDT	25 V / m					

2	The intensity of the electro-magnetic field by the electrical component, V / m in the frequency range 2-400 kHz at a distance of 50 cm around the VDT						
3	Magnetic flux density, (nT) in the frequency range 5Hz-2 kHz	250 nT					
4	Magnetic flux density, (nT) in the frequency range 2-400 kHz	25 nT					

3.2. Control when measuring the aeroion composition of indoor air using the device "Small-sized aeroion meter MAS-01.

3.2.1.Get acquainted with the instructions for organizing work with device "Small-sized aeroion meter MAS-01.

3.2.2. Under the supervision of the teacher, evaluate the parameters of electric and magnetic fields at workplaces equipped with a PC using the VE-meter-AT-002 device.

3.2.3. Record the total measurement results in the protocol (Table 2) and compare with the normative data, formulate a conclusion.

Table 2

The actual value of the measured parameter

Research stage	Negative aeroions	Positive aeroions	Ratio
1st stage (at the beginning of the first hour)			
Stage 2 (at the end of the first hour)			
Stage 3 (at the beginning of the second hour, after			

conducting through ventilation of the room)			

Reference material

The emergence of industrial –urban ecosystems was caused mainly by the processes of urbanization.

Urbanization is the growth and development of cities, an increase in the share of urban population at the expense of rural areas, the process of increasing the role of cities in the development of society.

The process of urbanization is due to: the natural growth of the urban population, the transformation of rural settlements into urban ones, migration from rural to urban areas, the pendulum movement of the population from the rural environment and the nearest small towns to large cities (for work, for cultural and household needs)

Population growth and its density are a characteristic feature of cities.

A person creates these complex urban systems himself, pursuing the goal of improving living conditions, and not only by simply "protecting himself" from limiting factors, but also by creating for himself a new artificial environment that increases the comfort of life. This leads to the separation of a person from the natural environment and to the disruption of natural ecosystems.

In some approximation, the city can be compared with a single complex organism that actively exchanges matter, energy and information with the surrounding natural and agricultural territorial complexes and other cities.

The urban system is an unstable natural and anthropogenic system, with the development of the city, they are increasingly differentiated into functional zones - industrial, residential, forest park.

Industrial zones are areas of concentration of industrial facilities of various industries (metallurgical, chemical, machine—building, electronic, etc.). They are the main sources of environmental pollution.

Residential zones are areas of concentration of residential buildings, administrative buildings, cultural, educational facilities, etc.

Forest park zone is a green area around the city, cultivated by man, i.e. adapted for mass recreation, sports, entertainment. Its sections are also possible inside cities, but usually there are urban parks — tree plantations in the city, occupying quite extensive territories and also serving citizens for recreation. Unlike natural forests, urban parks and in the city (squares, boulevards) are not self-sustaining and self-regulated systems.

The forest park zone, city parks and other areas of the territory designated and specially adapted for people's recreation are called *recreational zones.*

The deepening of urbanization processes leads to the complication of the city's infrastructure. A significant place occupied by *transport* and *transport facilities* (automobile terminals, gas stations, garages, service stations, railways with their complex infrastructure, including underground - metro; airfields with a service complex, etc.). *Transport systems* cross all functional zones of the city and have an impact on the entire urban environment.

The environment surrounding a person - is a combination of abiotic and social environments that jointly and directly affect people and their economy. According to N. F. Reimers, it can be divided into the *natural environment* itself and the *natural environment transformed by man* (anthropogenic landscapes up to the artificial environment of people - buildings, asphalt roads, artificial lighting, etc., i.e. to the artificial environment).

Urban ecosystems (territories of cities and their populations) are heterotrophic anthropogenic ecosystems in which there is no element of self–regulation.

Urban ecosystems are characterized by the following features:

Polymorphism – a combination of natural (hydrosphere, atmosphere, etc.) and anthropogenic (buildings, infrastructure elements, etc.) subsystems.

Therefore, it is difficult to optimize cities, because it is impossible to solve the problem by reconstructing only one kind of structure

The complexity of the urban system – any entity functions as part of a larger/smaller subsystem, so it is impossible to take into account all internal and external relations.

Urban ecosystems require input from outside and export outside, i.e. they are not capable of self–regulation, they are dependent on external influence - they are regulated by a person. The existence of urban systems depends on the energy of fossil fuels and atomic energy raw materials, is artificially regulated and maintained by man.

The urban environment and urban—type settlements are part of the *technosphere,* i.e. the biosphere, radically transformed by man into technical and man-made objects.

In urban areas, in urban ecosystems, it is possible to distinguish a group of systems that reflect the complexity of the interaction of buildings and structures with

the environment, which are called *natural-technical systems.* They are closely connected with anthropogenic landscapes, with their geological structure and relief

Consequences of the urbanization process:

1. Destruction of the natural landscape
2. Atmospheric air pollution (road transport is the main source of urban air pollution. Motor transport is the leader in terms of environmental damage, in all types of negative impacts: air pollution – 95%, noise – 49.5%, climate impact – 68%).
3. Increased noise and vibration
4. Pollution of the coastal water area
5. Changes in climatic characteristics in urbanized territories (parameters of change compared to rural areas):

The average annual temperature in winter is 0.5-1 degrees higher, in summer - 1-2 degrees;

The wind speed is 20-30 less%;

Fogs are 100% more in winter; 30% more in summer%;

Absorption of light rays (visible and ultraviolet spectrum) by polluted atmospheric air of cities. As a result, ambient light illumination decreases by 40-50%, the level of UV radiation decreases by 30% in winter, by 5% in summer (light (solar) starvation develops, anthropogenic foci of rickets).

Transport problems of urbanized territories:

- increase in the duration of a citizen's stay in transport;
- transport fatigue;
- transport neuroses;
- air pollution;
- epidemiological risk;
- increased noise and vibration levels;
- traffic injuries;

Epidemiological consequences of urbanization

Factors supporting epidemics: crowding in cities, congestion of city centers by people, increased daily contacts, reduced body resistance.

The main directions of solving urban problems

1. Architectural and planning direction: zoning of the city territory, sanitary protection zones, rational placement of television antennas, relay stations.

Example: "Industrial relocation" - removal of industrial enterprises polluting the environment outside the city. Fixing the boundaries of cities (stopping their spread)

Using the achievements of ecological architecture for the construction of new cities and the reconstruction of old ones: the growth of cities up and down (development of underground and infrastructure)

2. Sanitary and technical direction: modernization of vehicles, improvement of sound-proofing qualities of building structures, noise-protective screens, sewage treatment plants.

Example: Greening of urban transport by increasing the share of public transport (primarily electric traction), the use of cars with low fuel consumption and the gradual transfer of transport to environmentally friendly fuel. . Recycling of solid household waste: separate collection, sorting, processing. Resource conservation (water) and energy supply in all areas of public utilities.

3. Legislative direction. The legislation in the field of urban development , Law on the Protection of Atmospheric Air.

4. Administrative direction: rational organization of traffic flows ("green wave", intersection of streets at different levels, reduction of the number of trucks in areas with dense residential buildings); restriction of sound signals of street transport; control of atmospheric air quality, noise levels, EMF intensity and others public utilities. Economic mechanisms of influence.

5. The attractiveness of the city for residents: cleanliness, landscaping, small architectural forms. Example of "Ecopolis".

6. Formation of a healthy lifestyle of a citizen.

Purpose: to expand the range of adaptive protective mechanisms of the body of city residents.

Ecopolis = Ecocity

Ecopolis is an ecological settlement of a new type - an ecologically clean social multidisciplinary center of ecovillage on a regional scale, located in the suburbs of a large city, away from large industrial enterprises and close to agricultural enterprises.

Principles of ecopolis construction:

1. Proportionality of architectural forms to human growth.

2. The unity of water and green areas ("the illusion of being inscribed").

3. Elements of apartment landscaping (balconies, roofs of houses, vertical landscaping of streets).

A set of rules. Urban planning. Planning and development of urban and rural settlements extraction. The urban area should be zoned - zones are divided depending on the type of functional use.

The list of functional zones includes zones of residential, public-business and mixed development, industrial development, engineering and transport

infrastructure, recreational zones, agricultural use zones, special purpose zones, including zones of military and other regime facilities, cemeteries, and other special purpose zones.

4.4. Urban and rural settlements, depending on the population size are divided into groups in accordance with table 3.

Table 3

Urban and rural settlements depending on the projected population

Groups	Population, thousand people.	
	Cities	Rural settlements
The largest	> 1000	-
Sized cities, 	500 - 1000 250 - 500	> 5 3 - 5
Large	100 - 250	1 - 3
Medium-sized cities	50 - 100	0.2 -1
Small* 	20- 50 10-20 10	0.05 0,2 0,05
* Urban-type settlements are included in the group of small towns.		

4.18. The planning structure of urban and rural settlements should have: compact placement and interconnection of functional zones; rational zoning of the territory in conjunction with the system of public centers, engineering and transport infrastructure; effective use of the territory depending on its urban value; comprehensive consideration of architectural and urban traditions, natural-climatic, landscape, national and other local features; environmental protection, historical and cultural monuments.

5. Residential areas

5.1 Residential areas should be provided for in order to create a comfortable, healthy and safe living environment for the population. Residential areas are occupied by: residential buildings of various types (multi-storey multi-storey, medium and small

storeys); manor houses with apartment and household plots; detached, built-in or attached objects of social and cultural services to the population; garages and parking lots for cars; religious objects.

6. Public and business zones

6.1 Public and business zones are designed to accommodate healthcare facilities, culture, trade, catering, social and communal services, entrepreneurship, secondary vocational and higher professional education facilities, administrative, research institutions, religious buildings, parking lots of motor transport, business and financial facilities

7.1 Distances between residential buildings, residential and public, as well as industrial buildings should be taken on the basis of calculations of insolation and illumination in accordance with the requirements, illumination standards given in SP 52.13330-2016, as well as in accordance with fire protection requirements.

Distances should be taken between the long sides of residential buildings: for residential buildings with a height of two or three floors - at least 15 m; four floors - at least 20 m; between the long sides and the ends of the same buildings with windows from living rooms - at least 10 m.

7.4 The area of the landscaped territory of the microdistrict (block) of multi-apartment residential development (excluding the sites of general education and preschool educational organizations) must be at least 25% of the area of the block.

8. Production zones, transport and engineering infrastructure zones

8.1 *Industrial zones,* engineering and transport infrastructure zones include: communal zones, zones for housing and communal facilities, housing and communal services, transport facilities, wholesale trade facilities; industrial zones - zones for industrial enterprises that require sanitary protection zones with a width of more than 50 m, as well as railway access roads.

8.2 Within the industrial and sanitary protection zones of enterprises, it is not allowed to place: residential houses, landscape and recreational zones, recreation areas, territories of resorts, sanatoriums and rest homes, territories of cottage development, as well as other territories with normalized indicators of habitat quality; sports facilities, playgrounds, general education and preschool educational organizations, medical and preventive and health-improving institutions of general use.

8.3. As part of the industrial zones of cities, industrial zones may be formed, intended for the placement of industrial enterprises, depending on the sanitary classification of production, scientific and industrial, communal and warehouse. Enterprises of food, medical, pharmaceutical and other industries with a sanitary protection zone up to 100 m should not be located on the territory of industrial zones

with enterprises of metallurgical, chemical, petrochemical and other industries with harmful industries.

Sanitary protection zones are established in relation to existing, planned for construction, reconstructed construction facilities that are sources of chemical, physical, biological effects on the human environment, in case of formation of chemical, physical and (or) biological effects beyond their contours exceeding sanitary and epidemiological requirements.

Depending on the amount and degree of harmfulness of the substances emitted into the atmosphere, all enterprises are divided into 5 classes. In accordance with this, there are 5 sanitary protection zones:

1-1000 m; 2-500 m; 3- 300m; 4-100m; 5-50m.

It is not allowed to place within the boundaries of the sanitary protection zone:

a) residential buildings, buildings of educational and medical organizations, recreation organizations for children and their health improvement, open-type sports facilities, recreational areas and gardening;

b)* pharmaceutical industry enterprises, food industry enterprises, procurement enterprises, as well as wholesale warehouses of food raw materials and food products, warehouses for the storage of agricultural products, complexes of water supply facilities for the preparation and storage of drinking water.

8.6. The sufficiency of the width of the sanitary protection zone should be confirmed by calculations of the dispersion in the atmospheric air of harmful substances contained in the emissions of industrial enterprises.

The minimum landscaping area of sanitary protection zones should be taken in accordance with (table 4).

Table 4

Minimum landscaping area of sanitary protection zones, %

Zone width	%
Up to 300 m	60
300-1000m	50
1000-3000 m	40
More than 3000	20

8.9 In the territories of communal storage zones, enterprises of the food (food-tasting, meat and dairy) industry, general (food and non-food), specialized warehouses (refrigerators, potato, vegetable, fruit storage), municipal, transport and consumer services enterprises of the city population should be located.

8.16 Zones of transport and engineering infrastructure should be provided for the placement of structures and communications of railway, road transport, communications, engineering equipment.

8.17 In order to prevent adverse impacts during the operation of transport, communications, engineering communications facilities, sanitary protection zones are established from these facilities to the borders of residential, public-business and recreational areas.

8.21 Motorways of the general network of categories I - III should be designed to bypass settlements.

8.22 Airfields and heliports should be located at a distance from the borders of residential, public-business and recreational zones, ensuring flight safety and the permissible levels of aviation noise and the permissible concentration of pollutants in the atmospheric air and the permissible level of electromagnetic radiation established for these territorial zones from transmitting radio equipment installed at the aerodrome.

9. Recreational areas.

Zones of specially protected territories

9.1. Recreational zones include territories occupied by urban forests, squares, parks, urban gardens, ponds, lakes, reservoirs, beaches, as well as other territories used and intended for recreation, tourism, physical culture and sports.

Within the boundaries of urban and rural settlements, zones of specially protected territories are allocated, which include land plots of special environmental, scientific, historical and cultural, recreational and health-improving significance.

9.2. On the territory of recreational zones and zones of specially protected territories, it is not allowed to build new and expand existing industrial, utility, warehouse and other facilities that are not directly related to the operation of recreational, recreational and environmental facilities.

9.3 In urban and rural settlements, it is necessary to provide for a continuous system of green areas of common use and other open spaces. The time of accessibility of city and district parks by public transport should be no more than: 30min. - for urban and 20min. - for district parks.

9.7 The placement of objects of mass short-term recreation of the population located in recreational areas should be provided, taking into account the availability of these zones for no more than 1.5 hours by public transport. The size of the territory of recreation areas should be taken at the rate of at least 500 m2 per visitor.

9.8. The area of green areas of common use - parks, gardens, squares, boulevards located on the territory of urban and rural settlements should be taken according to table 5.

Table 5

Green areas of common use	The area of green areas of common use, m2 per person			
	The largest cities, sized cities, and large cities	Medium-sized cities	Small towns	Rural settlements
Citywide	10	7	8(10)*	12
Residential areas	6	6	-	-

9.23. The resort area should be located in areas with natural healing factors, the most favorable microclimatic, landscape and sanitary conditions. Within its limits, sanatorium-resort and health-improving institutions, recreation and tourism institutions, institutions and service enterprises for patients and vacationers should be located.

9.24. When designing resort areas, it should be provided for: the placement of sanatorium-resort institutions for long-term recreation in areas with permissible noise levels, children's sanatorium-resort and health-improving institutions isolated from adult institutions with their separation by a strip of green spaces with a width of at least 100 m; the removal of industrial and communal storage facilities, residential buildings and public buildings, not related to the service of patients and vacationers; restriction of traffic and complete exclusion of transit traffic flows.

10.1. Institutions, organizations and service enterprises should be located on the territory of urban and rural settlements, bringing them closer to their places of residence and work, providing for the formation of public centers in conjunction with the public passenger transport network, with ensuring their accessibility for MGN.

11.4 The road network of settlements should be designed as a continuous system taking into account the functional purpose of streets and roads, the intensity of transport, cycling and pedestrian traffic.