THE DEVELOPMENT OF ECOLOGICAL THINKING IN PRACTICAL ACTIVITIES AND ENSURING THE FUNCTIONING OF THE ECONOMY IN ACCORDANCE WITH THE REQUIREMENTS OF ENVIRONMENTAL PROTECTION

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Citation:
Honcharuk, V. (2023). The development of ecological thinking in practical activities and ensuring the functioning of the economy in accordance with the requirements of environmental protection. *Public Administration and Law Review*, (4), 26–45. https://doi.org/10.36690/2674-5216-2023-4-26-45

Received: November 24, 2023
Approved: December 29, 2023
Published: December 30, 2023

Abstract. *The deterioration of the majority of ecosystems in the biosphere, significant reduction in bioproductivity and biodiversity, catastrophic depletion of soils and mineral resources due to unprecedented pollution of the Earth's surface, hydrosphere, and atmosphere, are all linked to the intensive growth of the global population and the development of scientific and technological progress over the past 50 years. The necessity to meet the ever-increasing needs of human society has led to a tremendous expansion of economic activities, changes in the proportions of the world economy, production capacities, techniques, and technologies, as well as the variety of products and consumption patterns. The production and consumption models that have emerged in the world no longer correspond to the conditions of sustainable coexistence between humans and nature. The analysis of the state of the natural environment indicates that in recent years, there have been no significant positive shifts in the ecological situation, and in some areas, it has even worsened. The high concentration of industry and agriculture, along with ecologically unjustified economic activities, have made Ukraine one of the most environmentally troubled countries in Europe. The situation was significantly exacerbated by the Chernobyl nuclear power plant accident and the armed conflict in Ukraine. The aim of the article is to develop of ecological thinking involves aligning human practical activities with the laws of nature and ensuring that the economy operates in accordance with the requirements of environmental preservation. The study of human ecology is an interdisciplinary science that focuses on a clearly defined and specific set of issues. In its research, it utilizes both general scientific methods (grounded in philosophical and general scientific principles) and specific methods (characteristic of certain fields of scientific activity). General scientific methods include empirical research methods (observation, measurement, comparison) and empirical-theoretical methods (abstraction, analysis, synthesis, induction, deduction, analogy, modeling) as well as theoretical methods (ascending from abstract to concrete, forecasting, systematic approach). The most specific method used in the study of human ecology is anthropoecological monitoring, a system of observations of changes in human life processes in connection with environmental factors' impact on them. It also involves monitoring and evaluating environmental conditions that negatively affect population health and contribute to the spread of diseases. The article systematizes the main threats to economic security in Ukraine and describes their main consequences. In further research, the author's efforts will be focused on the development of measures to neutralize the impact of these threats on the ecological security of Ukraine.*

Keywords: *deterioration of biosphere ecosystems, production and consumption models, analysis of the natural environment, accidental releases from chemical plants, wastewater pollution, pesticides, environmental situation.*

JEL Classification: H75, I12
Formulas: 0; fig.: 0; table: 1; bibl.: 20

Introduction. The deterioration of the majority of ecosystems in the biosphere, significant reduction in bioproductivity and biodiversity, catastrophic depletion of soils and mineral resources due to unprecedented pollution of the Earth's surface, hydrosphere, and atmosphere, are all linked to the intensive growth of the global population and the development of scientific and technological progress over the past 50 years. The necessity to meet the ever-increasing needs of human society has led to a tremendous expansion of economic activities, changes in the proportions of the world economy, production capacities, techniques, and technologies, as well as the variety of products and consumption patterns. The production and consumption models that have emerged in the world no longer correspond to the conditions of sustainable coexistence between humans and nature.

The analysis of the state of the natural environment indicates that in recent years, there have been no significant positive shifts in the ecological situation, and in some areas, it has even worsened. The high concentration of industry and agriculture, along with ecologically unjustified economic activities, have made Ukraine one of the most environmentally troubled countries in Europe. The situation was significantly exacerbated by the Chernobyl nuclear power plant accident and the armed conflict in the ATO zone. Accidental releases from chemical plants, nuclear power plant accidents, and the testing and use of chemical weapons have led to a situation where, despite the human body's mobilization of defensive functions, it is no longer capable of withstanding the technogenic processes. Many pollutants transform into carcinogenic compounds within the human body, leading to malignant tumors. Some of these substances accumulate in the body and cause poisoning. One particularly dangerous group of substances that disrupt the body's defense mechanisms is dioxins. They are formed in various industries and also during the boiling of chlorinated tap water. According to statistical data, the discharge of polluted wastewater into open water bodies increases year by year and amounts to billions of cubic meters.

The environmental analysis indicates that in recent years, there has been a certain tendency towards reducing emissions into the atmosphere, primarily due to the closure of some productions for economic reasons. However, there are still significant environmental issues, particularly in certain regions of Ukraine. For example, in Krivyi Rih, an industrial city, stationary sources release 1.2 million tons of pollutants into the air annually, accounting for one-tenth of all emissions in the country. Additionally, harmful atmospheric emissions in Donetsk and Dnipropetrovsk regions constitute over half of the total volume.

In recent years, the closure of beaches due to high bacteriological contamination of water has become a common occurrence in resort areas such as Odessa, Crimea, and the Azov Sea. The average pesticide load on agricultural land is three kilograms per hectare, which is six times higher than the global average. In some regions like Zakarpattia, the pesticide load reaches 8.7 kilograms per hectare, and in Crimea, it is as high as 12.7 kilograms per hectare. About 14 million hectares of farmland are polluted with remnants of chemical plant protection substances, making up one-third of all agricultural lands. Approximately 17 million people, or 34% of the country's total population, are exposed to the adverse effects of atmospheric pollution. Over the past

20 years, negative health trends have been observed in the population, many of which are closely related to the unsatisfactory environmental situation. For instance, the incidence of blood and circulatory system diseases has increased by 51.3%, while malignant tumors have risen by 27.8%.

Medical professionals attribute these trends to the toxic effects of certain substances and blue-green bacteria present in water supplies. According to the Ukrainian Scientific and Research Institute of Pediatrics, Obstetrics, and Gynecology, over a ten-year period, the number of newborns experiencing health issues on their first day of life has increased by 20%.

Literature review. In the history of human production activities, four main stages are usually distinguished:

1) Gathering and hunting, which lasted for about 4,000 years. Primitive human communities at this stage existed in harmony with natural ecosystems.

2) Agriculture and animal husbandry, when the development of civilization became mainly dependent on the use of living matter produced in artificial or semi-artificial ecosystems. This transition to productive forms of economy was called the "Neolithic Revolution" and required solving significant problems such as domestication of animals and cultivation of plants.

3) Industrial production, focused on widespread consumption of non-renewable resources and energy. During this stage, the pressure that human society exerted on the natural environment continuously increased.

4) Modern era, characterized by advanced industrialization, technological advancements, and globalization. It includes the present time and continues to shape the relationship between human activities and the environment.

Throughout these stages, the way human society interacted with nature evolved, leading to various impacts on the environment. The transition to industrial production significantly accelerated human activities' impact on the natural world.

Only from the mid-20th century, the world's gross national product increased fivefold, and humanity mastered nuclear energy and methods of synthesizing many substances. The use of oil and the production of various goods experienced a rapid leap (see Table 1). However, parallel to these developments, there was degradation of the biosphere. Approximately 20% of fertile soils were lost, the concentration of carbon dioxide in the atmosphere increased, and "holes" appeared in the planet's ozone layer. Acid rain became common, and the resource base diminished. All geospheres of the planet became catastrophically polluted with various waste and emissions [2].

The reference to "Table 1" is mentioned in the text, but the actual table content is not provided. The specific data from the table are missing in this response.

4) The information society, unified by computer technologies, and attempting to transition to noospheric activity.

K. Ritter, in the 1930s, was one of the first to call the Earth the "common home of humanity." However, the prosperity in this "home" has a rather long history. It is a history of warnings that went unheard, a history of scientific and technological progress at any cost, and a history of humanity's self-blinding to the imaginary power of its ability to "transform" nature.

Table 1. Volumes of goods in the world market in million tons or million pieces

Years	Fossil	Cars	Dutch oven	Wheat	Fertilizers
1900	0,025	–	70,0	69,0	–
1920	5,6	–	80,0	105,0	1
1940	20,0	5,0	95,0	140,0	31,0
I960	125,0	16,4	336,0	250,0	62,0
1980	260,0	30,0	716,0	445,0	210,0

Sources: according to M. Allen

Unfortunately, the actual content of Table 1 is not provided, so specific data from the table are not available in this response.

The development of degradative processes on the planet has been foreseen for a long time. The great thinker Avicenna understood ten centuries ago that the course of social development and economic activities is harmful to nature and dangerous for humanity. In particular, numerous warnings about the degradation of the planet's environment emerged in the second half of the 20th century. About a quarter of a century ago, in 1972, the Club of Rome published an alarming forecast of human civilization's development called "The Limits to Growth," prepared by a group of experts at the Massachusetts Institute of Technology (USA) under the guidance of D. Meadows, which predicted environmental degradation. Later, D. Meadows prepared and published a new book called "Beyond the Limits," in which he analyzed the "humanity - natural environment" system based on data from the 1970s to the 1990s, also indicating a global ecological crisis. However, all these warnings were hardly followed by appropriate actions. Peter Emerson, a member of the Irish Green Party in 1991, believed that all socio-economic systems tested by humanity throughout its existence were based on the priority of "consumption" and, therefore, proved hostile to nature [3].

Humanity has various channels of influence on the environment (see Figure 1). This includes the direct impact of humans as biological beings on the environment (such as oxygen consumption for breathing and the use of biomass from plants and animals for food), as well as numerous direct and indirect changes resulting from human economic activities.

The degradation of the natural environment occurs under the negative influence of two types:

1) Comparatively minor but long-lasting impacts.

2) Phrasal catastrophic events that occur during accidents, which are not only powerful but also sudden and sharp in their effects.

Throughout the second half of the 20th century, numerous examples of anthropogenic impacts on the biosphere have accumulated. However, for the general population, significant indicators of environmental problems and economic activities are ecological catastrophes, where the state of the environment rapidly and drastically changes for the worse.

One such alarming event was the Chernivtsi situation in Ukraine. In the city of Chernivtsi in 1988-1989, a rapidly developing mass serious illness in children occurred, accompanied by hair loss, nervous system disorders, and respiratory tract issues. The cause of the illness was attributed to contamination of the environment with

thallium and partially boron, resulting from a one-time industrial emission. The moral and material losses incurred by the city were incalculable.

The "Kirish Syndrome" has a similarly infamous reputation. In the city of Kirish, located in the northeastern part of Russia, a mass outbreak of illness among residents occurred. It was caused by emissions from a biotechnology plant that produced microbial protein called paprine, or BVK (protein-vitamin concentrate). The production of BVK has a long history. The microbial synthesis of protein from fungi of the Saparia genus was first carried out in Germany during the First World War. Later, this technology gained some popularity in the USA and the UK.

In the former Soviet Union, BVK production began in the 1980s using liquid petroleum paraffins, methanol, and natural gas, reaching over 1 million tons of BVK (paprine) per year. However, this production was environmentally dirty, with severe violations of technology and safety measures, leading to unavoidable emissions of fine paprine dust into the atmosphere. Its impact on human respiratory organs is highly unfavorable and can lead to the development of severe asthma-like allergic diseases, which sometimes result in death.

All biotechnological productions have an increased level of danger because they involve the use of genetically engineered microorganisms. If these microorganisms escape into the environment, they can become much more hazardous than chemical or radioactive pollutants [4].

The models of the largest environmental disasters include the Chernobyl accident, the Aral Sea ecological crisis, and the war in Iran. Unfortunately, the number and frequency of major environmental catastrophes in the world are increasing: there were 14 in the decade from 1960 to 1970, and 70 in the decade from 1980 to 1990. In just one year, 1989, there were 1773 major accidents with oil spills and various toxic substances released into the environment worldwide. Technogenic earthquakes (in Germany, Belarus, and elsewhere) have also started to be recorded, resulting from mining of rocks, oil or gas extraction, reservoir filling, or the injection of industrial wastewater into rock formations. The environment surrounding us is becoming increasingly unreliable.

However, the main danger to humanity lies not in individual environmental disasters, no matter how tragic they may be, but in the gradual degradation of the natural environment under the seemingly inconspicuous influence of industrial activities.

Aims. The aim of the article is to develop of ecological thinking involves aligning human practical activities with the laws of nature and ensuring that the economy operates in accordance with the requirements of environmental preservation.

The study of human ecology is a system called "human-environment" or anthropoecosystem. It is a territorial system within which a homogeneous human population (e.g., rural, urban, etc.) interacts with a relatively uniform surrounding environment. The effectiveness of its functioning is determined by the high level of population health. In this context, humans are considered at the level of individual organisms and as populations, while the environment includes natural, cultural, and technological components.

Methodology. The study of human ecology is an interdisciplinary science that focuses on a clearly defined and specific set of issues. In its research, it utilizes both general scientific methods (grounded in philosophical and general scientific principles) and specific methods (characteristic of certain fields of scientific activity). General scientific methods include empirical research methods (observation, measurement, comparison) and empirical-theoretical methods (abstraction, analysis, synthesis, induction, deduction, analogy, modeling) as well as theoretical methods (ascending from abstract to concrete, forecasting, systematic approach). The most specific method used in the study of human ecology is anthropoecological monitoring, a system of observations of changes in human life processes in connection with environmental factors' impact on them. It also involves monitoring and evaluating environmental conditions that negatively affect population health and contribute to the spread of diseases.

Several well-known methods are used to investigate the impact of environmental pollution on human health, such as:

- Environmental assessment using computer systems (Electronic Computing Machines);
- Epidemiological risk assessment of chemical substances;
- Epidemiological diagnosis;
- Quantitative assessment of the impact of environmental factors on population health;
- Mathematical modeling of daily disease rates and elevated levels of harmful substances using scoring;
- Dispersion method (sampling);
- Method of "control" areas;
- Method of medical-ecological zoning, etc.

The choice of research method depends on the geoclimatic conditions, the tasks to be addressed, and the characteristics of the research problem. To obtain objective data, researchers combine various methods and techniques and verify their results through multiple means. Human ecology, being a young science, is in the process of forming its subject matter, research framework, methodology, and theoretical foundations. In recent decades, it has been developing particularly dynamically due to the emergence of new challenges and threats to humanity. The observations and conclusions of this science urge humans to contemplate how their irrational and imprudent actions in nature harm not only specific objects (reservoirs, trees, air, etc.) but also pose a threat to their health, life, and safety of humanity. The consequences of such activities can haunt future generations for centuries, disrupting the genetic code and causing disastrous mutations.

Understanding this, humanity has found the strength to rise above its own instincts, to transcend selfish desires, and to expand its perception of the world and itself to a planetary, universal scale. Such feelings and reflections form the foundation and primary resource of humanity's post-industrial era culture, which is beginning to comprehend the advantages and risks of a globalized world. As a result, human ecology as a science not only accumulates ecological and technological knowledge but also incorporates ideas and principles from various spheres of human cognitive and research

activities, concentrating the concerns of humanity for its existence and future [5].

Results. *Deep disruptions of natural ecological balance and strained relations between humans and nature, resulting from the mismatch between the productive forces and production relations in human society with the resource capabilities of the biosphere, are referred to as an ecological crisis.*

Crises, by their nature, are reversible, whereas the transition of crisis phenomena into an ecological catastrophe signifies irreversible changes that have occurred.

In Ukraine, two categories of adverse regional ecological situations are distinguished:

- *Ecological catastrophe, which results in the death of a large number of living organisms and leads to economic losses.*
- *Ecological hazard, characterized by the emergence of signs of adverse changes that endanger human health, the state of natural objects, and economic activities.*

The technogenic type of civilization development, in conditions of rapid population growth, demands the utilization of an increasing amount of natural resources in production processes. For example, from 1958 to 1986, a total of 117 billion tons of fossil fuels, a non-renewable resource, were used worldwide. The extraction of fossil fuels and ores involves large-scale interventions in the geosphere of the planet. In the former Soviet Union alone, over 1 billion tons of rock were extracted annually, with less than 20% being useful. Similar processes occur in other countries worldwide. As a result, geological structures of rock masses are disturbed, leading to the creation of mining and waste disposal sites, tailings and sludge ponds, and trenches. The landscape of vast territories is altered due to these activities.

The world has registered more than 9 million artificially synthesized chemical substances, with approximately 300,000 of them available for sale. The artificial synthesis of organic compounds has reached massive scales: in 1950, the global industry produced 7 million tons of these compounds, while by 1985, the production had increased to 250 million tons. The assortment of artificial organic compounds exceeds 2 million names. Many of these substances are toxic to living organisms, but maximum permissible concentrations (MPC) have been established for only 4,500 of them. For substances toxic to plants and animals, MPCs are not developed at all. Furthermore, there are no methods for registering the presence of the majority of polluting substances in the natural environment.

Wide-scale consumption of resources and materials leads to an increase in waste generation. On average, in the industry, only 1-1.5% of consumed resources are included in the final useful product. The rest becomes waste, polluting the natural environment. The total volume of waste worldwide is estimated at 600 million tons per year. Agriculture and industry are considered high waste-generating sectors.

According to D. Tirpak (1991), there are two likely models for resolving the ecological crisis. The first one corresponds to a slowly changing world with a gradual increase in the degradation of the natural environment and dangerous exacerbations of social contradictions on this basis. The second model represents a rapidly changing world with accelerated conversion of all industries and regulation of population growth. Nature allows no delay in decision-making. In our time, humanity is facing

urgent ecological problems that demand immediate action. Among them are:

- *The contamination of the natural environment by industrial and agricultural waste;*
- *Climate warming and the consequent rise in sea levels;*
- *Acid rain;*
- *Desertification of vast territories;*
- *Rapid decline in biodiversity, deforestation, and loss of entire ecosystems.*

Understanding the nature of the ecological crisis as a whole and its specific manifestations, drawing conclusions from past development projections, and adjusting economic, political, and cultural development are the main tasks that people all over the planet must address. Otherwise, the ecological crisis will escalate into an irreversible environmental catastrophe, resulting in the complete destruction of the biosphere [6].

The main directions of state policy towards ensuring technogenic and ecological security in Ukraine are based on the principles outlined in the "Basic Directions of State Policy of Ukraine in the Field of Environmental Protection, Natural Resource Utilization, and Ecological Security" (further referred to as the "Basic Directions"). These principles were established by the resolution of the Verkhovna Rada of Ukraine on March 5, 1998, under No. 188/98-VR, in accordance with Article 16 of the Constitution of Ukraine, which designates the responsibility of the state to ensure ecological security and maintain ecological balance within the territory of Ukraine, as well as to preserve its gene pool.

The current environmental situation in Ukraine, as described in the "Basic Directions," is characterized as a crisis that has emerged due to neglecting the objective laws of development and reproduction of the country's natural-resource complex, leading to structural deformations in various sectors of the economy. The preference was given to the development of raw material and extractive industries, which are among the most environmentally hazardous sectors of the industry. Additionally, the Ukrainian economy has been characterized by a high specific weight of resource- and energy-intensive technologies, resulting in the generation of significant amounts of waste, which often remained untreated and unutilized, being accumulated in landfills, tailing ponds, and other facilities. This situation was possible due to the lack of effectively functioning legal, administrative, and economic mechanisms for natural resource management, and a failure to consider the requirements for environmental protection.

Indeed, modern production is primarily a massive consumer. However, material production inevitably leads to the generation of substances that are by-products of various technologies. Waste is also produced during the consumption of manufactured goods.

The consumerist concept of production has led to a situation where waste and by-products, regardless of their harmfulness, were simply discarded into the environment for many decades. Only starting from the second half of the 20th century, various means have been applied to contain and neutralize industrial, agricultural, and household waste. In the countries of the European Union, waste is categorized into three types:

1. **"Green"** - non-hazardous waste.
2. **"Yellow"** - hazardous waste that requires special permits for disposal.
3. **"Red"** - highly dangerous waste that is strictly controlled.

However, not all modern industrial and agricultural technologies include waste management, and even if they do, the efficiency of this process is often low[7].

Anthropogenic pollution of the environment can be categorized into several types:

1. Chemical pollution: *Involves the release of various xenobiotics and synthetic chemicals into the environment.*

2. Physical pollution: *Includes the destruction of territories, noise barriers, and electromagnetic radiation.*

3. Thermal pollution: *Occurs when heated water is discharged into water bodies from industrial plants, especially thermal power plants (TECs).*

4. Radioactive pollution: *Relates to the release of artificial isotopes into the natural environment.*

5. Littering: *Manifests as the accumulation of various solid wastes in the environment.*

6. Biological pollution: *Involves the introduction of non-native organisms into natural and anthropogenic ecosystems, disrupting their natural balance. A particular case of this pollution is microbiological pollution, caused by the proliferation of parasitic microorganisms in the environment.*

All these types of pollution have significant impacts on the environment and require proper management and prevention to protect the ecological balance and human health.

In general, **environmental pollution** refers to any introduction of living or non-living components or structural changes into it, causing disruptions in biogeochemical cycles and energy flow in the biosphere and ultimately having adverse effects on living organisms and humans.

Anthropogenic pollution has led to the incorporation of a significant amount of foreign substances into global biogeochemical cycles. This primarily includes metals. In biogeochemical cycles, approximately 4x10^9 tons of iron, 10^10 tons of aluminum, 3x10^5 tons of lead, and 2x10^3 tons of cadmium are annually introduced.

Industrial and agricultural production have caused the emergence of a specific, anthropogenic, type of substance migration on the planet. Anthropogenic migration involves the transportation of raw materials, production goods, and waste over large distances. This type of migration leads to particularly sharp disruptions in the biogeochemical carbon cycle, as an increasing amount of carbon that was previously stored as coal, oil, and natural gas is now being released into circulation. Biogeochemical cycles of nitrogen are significantly disturbed due to its annual excess input to the biosphere, amounting to approximately 9 million tons, as well as phosphorus cycles due to increased runoff into water bodies.

There are numerous types of disturbances that humans introduce into the biosphere, leading to its degradation. Surprisingly, even tourism, which some people consider as a form of *"contact with nature"*, contributes to these disruptions. Due to

demographic explosions and urbanization, tourism has become mass-scale. There are very few places left in the world that remain inaccessible to modern tourism. While animals may tolerate occasional individuals, they are significantly disturbed by tourist groups that often try to establish prolonged contact with the animals, *"observing"* their behavior. In such conditions, most animal species interrupt their reproductive cycle, resulting in a decline in their population and potential extinction of some species without offspring.

Indeed, sports activities can have significant negative impacts on natural ecosystems. For example, the popularity of golf in Japan over the last few decades has led to a considerable loss of land. The golf courses cover an area of 37,483 square kilometers, which is quite substantial for the relatively small country. However, the damage goes beyond just land loss; golf courses also experience rapid erosion and require large amounts of fertilizers.

Similarly, mass amateur and professional skiing has caused significant damage to mountainous regions like the Alps, the Carpathians, the Caucasus, and others around the world. In the Alps alone, there are 13,000 ski lifts and 45,000 ski slopes. Each year, more than 100 million tourists visit this mountainous area. Such intense tourism and skiing activities can lead to environmental degradation and disruption of natural ecosystems.

In response to these issues, countries like Germany have been compelled to promote *"gentle"* tourism, emphasizing practices that conserve and protect the natural environment. The focus is on sustainable tourism that minimizes the negative impacts on the fragile mountain ecosystems.

Under the influence of anthropogenic pressure, ecosystems have rapidly begun to change. Entire blocks of organisms have started to disappear, structures have simplified, and functioning has become less efficient. As a result of direct destruction of living organisms by human activities such as hunting, fishing, and harvesting medicinal plants, there is a depletion of the living matter in the planet's biosphere. Indirect destruction occurs when plants and animals perish due to the destruction of their habitats and breeding grounds. In addition to this, anthropogenic catastrophes such as fires, accidental releases of harmful substances, accidents in transportation, and power lines impact all living beings.

The extraction of bioproducts from the biosphere has reached 70%, while living matter functions optimally when only 1% of biosphere production is extracted. Ecosystems and the biosphere as a whole are losing their ability for self-regulation and self-sustenance. As a result, the circulation of substances on Earth is taking on a qualitatively new and unpredictable nature. The stability of the biosphere's functioning is now under threat. Pollution and degradation have affected all of Earth's geospheres. Air, water, and soil are losing their essential natural properties.

Earthquakes. Seismically active regions include the Crimean Mountains and the Carpathians (areas of young Alpine folding). Earthquakes of up to 6-7 magnitude (on the Richter scale) are possible in these regions. They occur rarely, on average every 33 years. Smaller earthquakes occur more frequently, about once every 4-2 years. The seismically hazardous zone also includes a part of the Black Sea region, including the

Odessa region, where earthquakes of up to 7 magnitudes can occur. Depending on the depth of the focus, earthquakes can cover different areas with the same magnitude[9].

For Ukraine, the most dangerous earthquakes in terms of area coverage are those with epicenters located in the Romanian Carpathians, particularly in the Vrancea Mountains, where the depth of earthquake foci is 100-170 km. During earthquakes with epicenters in these areas, the area of the zone with 5 or more magnitude extends to 290,000 square kilometers within Ukraine. This covers almost 48% of the country's territory with a population of 23 million people. The zone with an intensity of 7 and higher magnitudes covers 27,000 square kilometers with a population of over 2 million people, while the zone with 8 or higher magnitudes covers 1,500 square kilometers with a population of over 1 million people (including the Odessa region, Crimea, and the city of Sevastopol). The overall level of danger in seismically hazardous regions is further increased due to the presence of nearly 300 chemical and fire-hazardous objects, as well as gas and oil pipelines. In areas where landslides, flooding, and karst formations are possible, the seismicity level is increased by 1-3 magnitudes.

Karst processes affect up to 60% of Ukraine's territory. Open karst, which poses particular danger, is developed in the Volyn, Rivne, Lviv, and Khmelnytskyi regions. Open karst covers 27% of Ukraine's total area.

Landslide processes are widespread in areas of tectonic disturbances, high terraces on the slopes of ravines, rivers, and reservoirs. In built-up areas, the rise in groundwater levels (due to water supply pipelines, sewage systems, reduced evaporation due to construction, road construction, etc.) intensifies these processes. In the regions of Prykarpattia, Crimea, Donbas, Odessa, Dnipropetrovsk, Khmelnytskyi, and in industrial urban agglomerations, approximately 140,000 landslides have been recorded.

Settlements or ground subsidence occur where forest soils become excessively moistened, which usually happens during the development of a territory. In areas where forest soils lie in thick layers, the surface appears as a series of gently sloping depressions (hollows, "saucers"). This phenomenon represents the subsidence of forest soils that naturally occurs due to increased moisture in the forest soils.

Large floods and inundations cause significant damage to various economic sectors, particularly in the Carpathians and Polissia regions of Ukraine. The threat of catastrophic floods in the Carpathians is related to severe violations in forest and water management systems, as well as uncontrolled construction in hazardous areas and excessive grazing of livestock on mountain meadows (polonynas).

In Polissia, flooding of agricultural lands mostly has a natural character. In the past, the areas that are now submerged after drainage works were originally swamps, and there were no agricultural lands except for hayfields. After extensive land reclamation in Polissia, these areas were drained along with floodplains, which are meant to be flooded naturally.

Overall, the mismanagement of natural resources and unplanned development exacerbate the impacts of these natural disasters in both regions, causing significant economic and environmental consequences.

Over 15% of the territory in Ukraine is affected by flooding and inundation

(approximately 900,000 hectares, including 200,000 hectares in irrigation zones). This negative phenomenon is entirely of anthropogenic origin. It has resulted from hydroengineering and road construction activities, as well as water losses from water supply and sewage networks in urban areas and reduced evaporation on developed lands. As a consequence of this situation, 240 towns and urban-type settlements, along with nearly 140,000 private houses, have been flooded. The artificial expansion of marshlands in the floodplains of small rivers often leads to intensified erosion, slope washouts, and sedimentation of groundwater outlets at the foot of slopes.[10].

Landslides and debris flows are common in Crimea and the Carpathian Mountains (Zakarpattia, Ivano-Frankivsk, Chernivtsi, and Lviv regions), particularly in the basins of the Cheremosh, Dniester, Tisza, and Prut rivers. Areas prone to landslides typically arise where forest management practices deviate significantly from scientifically established and proven rules that are characteristic for a specific region. The Carpathian forests, known as the jewel of Ukraine, have a distinct nature. Beneath a thin layer of loose rocks lie dense mountainous formations that do not allow water to penetrate deep into the ground. Disturbing the established equilibrium in this region, such as through deforestation, can lead to landslides with the first rain, and it may take centuries for vegetation to re-establish on the affected slope, particularly in the valleys (depressions). To prevent landslides and debris flows, it is crucial to adhere to sustainable forest management practices and consider the geological and hydrological features of the region. Effective measures should be implemented to maintain the stability of these delicate ecosystems, protecting both the environment and the communities residing in these areas.

Snow avalanches are observed in the Carpathian Mountains, particularly in the mountainous regions of Gorgany, Poloninsky, and Chornohora. In the Zakarpattia region, there are six settlements located in avalanche-prone areas.

Forest fires are a significant concern in Ukraine. As of January 1, 1996, the forested area covered 9,400.2 thousand hectares, while the total forest land area was 10,782.2 thousand hectares. On average, about 3,500 fires occur each year, destroying more than 5,000 hectares of forest. For example, in 1998 alone, there were 3,906 forest fires, resulting in the destruction of 4,408 hectares of forest (with damages estimated at 4.56 million hryvnias). Only 10% of forest fires are of natural origin, while the remaining 90% are human-caused. The majority of these fires (up to 90%) occur in suburban areas.

The most probable occurrence of large-scale forest fires and significant damages is characteristic of forests classified as fire hazard classes III-V. The regions with the highest areas of such forests are Zhytomyr (920 thousand hectares), Rivne (718 thousand hectares), Zakarpattia (629 thousand hectares), Volyn (592 thousand hectares), Chernihiv (575 thousand hectares), Lviv (572 thousand hectares), Ivano-Frankivsk (555 thousand hectares), and Kyiv (548 thousand hectares) oblasts.

Fires on agricultural lands. The probable occurrence of such fires and the potential areas of mass field fires in July - August (fire-prone season) are as follows:

In the Steppe region - covering an area of over 6800 thousand hectares (which is 36% of the total agricultural lands in the Steppe and over 47% of the fire-prone

agricultural lands in the country);

In the Forest-Steppe region - respectively, 5400 thousand hectares, 37% of the agricultural lands in the Forest-Steppe and 37% of the fire-prone agricultural lands in the country; in the Polissia region - respectively, 2020 thousand hectares, 28% of the agricultural lands in the Polissia and 14% of the fire-prone agricultural lands in the country; in the Carpathians - respectively, 200 thousand hectares, 18% of the agricultural lands in the Carpathians and 1.4% of the fire-prone agricultural lands in the country.

In terms of regions, the most probable areas of field fires are distributed as follows: Odessa region - 919 thousand hectares, Dnipropetrovsk region - 909 thousand hectares, Poltava region - 837 thousand hectares, Vinnytsia region - 827 thousand hectares, Kirovohrad region - 823 thousand hectares, Zaporizhzhia region - 813 thousand hectares, Kherson region - 811 thousand hectares.

Epidemics and epizootics. In Ukraine, there are natural foci of dangerous infections such as ascariasis, leptospirosis, Q fever, Siberian ulcer, tularemia, and tuberculosis. These infections can remain in the natural environment for decades without showing any signs. They are transmitted to humans through animals, water, and soil.

Currently, there is a sharp increase in the likelihood of mass infectious diseases due to a decrease in the protective functions of the immune system in the population, significant deterioration of socio-economic conditions, and a decrease in the level of sanitary and preventive work. People are susceptible to infection, and the diseases often have severe outcomes and very frequently result in death [11].

Natural foci (hotspots) of ascariasis exist within 16 regions in Ukraine, covering a total area of 265.1 thousand square kilometers with a population of over 22.3 million people. These foci are present on 80% to 100% of the territory in the Vinnytsia, Volyn, Zhytomyr, Zakarpattia, Ivano-Frankivsk, Kyiv, Poltava, Rivne, Sumy, Ternopil, Khmelnytskyi, Cherkasy, and Chernivtsi regions.

The area of high-risk for contracting trichinellosis (trichinosis) covers over 28 thousand square kilometers of territory with a population of up to 16.6 million people. This zone includes 17 regions, namely Khmelnytskyi, Cherkasy, Chernihiv, Ternopil (covering up to 100% of the region's territory); Vinnytsia, Kyiv, Poltava (covering from 70% to 90%); Dnipropetrovsk, Kirovohrad, Lviv, Sumy, Chernihiv regions (covering from 40% to 50%).

Natural foci of leptospirosis and an increased risk of contracting the disease are observed in the country on an area of over 115 thousand square kilometers with a population of approximately 9.8 million people. These foci are widespread in all regions, with the highest concentration in Kyiv region (up to 50% of the territory). Chernihiv region (up to 35%), Volyn region, Kirovohrad region, Ternopil region (up to 30%), and Mykolaiv region (up to 25%) also have significant numbers of these foci.

Siberian ulcer (tularemia) has natural foci in all regions. The total area of parts of the regions where possible outbreaks of tularemia may occur is 63 thousand square kilometers with a population of approximately 4.5 million people. The regions most saturated with natural foci of possible tularemia outbreaks are Chernivtsi region (about

60% of the territory), Chernihiv region (40%), Cherkasy region, and Khmelnytskyi region (25% each), as well as Vinnytsia region, Poltava region, and Sumy region (20% of the territory each) [12].

Tularemia. Areas with an increased risk of the disease are observed on a combined area of approximately 80 thousand square kilometers with a population of over 5.6 million people, including in Rivne region (50% of the territory), Volyn region, Lviv region (up to 40%), Sumy region (35%), Cherkasy region (25%), Kyiv region (20%), and Ternopil region (15%) [12].

Viral hepatitis. The number of reported cases of the disease has increased by 2 to 4 times in the last 5 years. This increase is primarily attributed to violations of sanitary and hygienic norms in the use of drinking water sources. The highest number of cases was reported in Kherson, Mykolaiv, Odesa, Donetsk, Kirovohrad, Ivano-Frankivsk, Zhytomyr, and Chernihiv regions.

Tuberculosis. The epidemic status of tuberculosis has been declared since 1995. In recent years, the number of tuberculosis cases has increased by tens of times. Each year, the number of affected individuals in the country grows by almost 20%, with over 8,000 deaths reported. The main cause of this surge is the weakening of human body functions and immune systems due to chemical, toxicological, bacterial, and radiation pollution of water, air, soil, and consequently, the food chain, along with worsening socio-economic living conditions in the country. As of the beginning of 2003, there were officially registered over 650,000 tuberculosis patients, out of which 130,000 had an active form of the disease. However, according to phthisiologists (tuberculosis specialists), the actual number of affected individuals is 2 to 2.5 times higher. A significant proportion of the patients are infected with drug-resistant forms of tuberculosis.

Tuberculosis is most commonly reported in the Donetsk, Kherson, Mykolaiv, Kirovohrad, Cherkasy, Zhytomyr, Rivne, and Chernihiv regions.

HIV infection is showing a tendency to spread rapidly.

Infectious diseases among animals in Ukraine are most prevalent among cattle, including tuberculosis, leukemia, leptospirosis, salmonellosis, siberia, and rinderpest. Additionally, classical swine fever, Gumboro disease, and Marek's disease have also been detected.

Grain crops in Ukraine suffer from epidemics of powdery mildew, brown leaf rust, fusarium, sooty molds, and other diseases. In the Steppe region, there has been an outbreak of the most dangerous pest of winter wheat, the tortoise beetle [13].

Discussion. *Radiation danger.* Ukraine has 5 nuclear power plants with 16 nuclear reactors, 2 research nuclear reactors, and over 3,000 enterprises and organizations that use various radioactive substances in production, scientific research, and medical practice. Radioactive waste is present practically everywhere.

In the event of an accident and destruction of one reactor with a release of 10% of radioactive products beyond the sanitary protection zones of nuclear power plants, contamination of various levels occurs over an area of 431,200 square kilometers with 5,249 settlements and a population of over 22,722,700 people. For Ukraine, the nuclear power plants in Russia's Kursk and Smolensk regions, the Ignalina Nuclear Power

Plant in Lithuania, and to some extent, the nuclear power plants in Bulgaria, Slovakia, and Hungary also pose potential danger.

As a result of the Chernobyl nuclear power plant accident in 1986, thousands of square kilometers of land were contaminated. The total area of contamination in Ukraine with cesium-137 (with a half-life of about 30 years) and cesium-134 in the contamination density range of 1-5 Ci/km2 exceeds 10,000 square kilometers. Strontium-90 contamination (with a half-life of about 29 years) is much lower. Outside the 30-kilometer zone, strontium is found only in the northern part of the Kyiv region. The population in other regions of Ukraine receives strontium from drinking water from the Dnieper river.

Indeed, contamination with plutonium isotopes is particularly hazardous as plutonium is highly toxic in all forms and compounds. After the explosion at the Chernobyl reactor, up to 200 kg of plutonium was released, spreading in the surrounding areas. Currently, the highest probability of its exposure to humans is through inhalation of plutonium-contaminated dust.

Chemical hazard is a significant concern in Ukraine. There are approximately 2,000 chemical hazardous facilities in the country, where up to 300,000 tons of highly toxic substances are stored or used in production processes. This includes nearly 10,000 tons of chlorine and around 180,000 tons of ammonia. The areas at risk of chemical contamination are inhabited by up to 20 million people, accounting for 38.5% of the country's population.

Ukraine has over 1,200 explosive and fire hazardous facilities where more than 13.6 million tons of solid and *liquid explosive and fire hazardous substances* are concentrated. These facilities are primarily located in the central, eastern, and southern regions of the country. They include chemical, oil and gas processing, coke-chemical, and other manufacturing plants, as well as a network of oil, gas, ammonia, and product pipelines. The total length of main gas pipelines is over 35,000 km, and main oil pipelines amount to approximately 4,000 km. There are 31 compressor oil pumping stations and 89 gas pumping stations within these pipelines. The length of product pipelines is 3,300 km, and the length of the main ammonia pipeline is 1,022 km. These facilities pose significant potential threats in terms of explosions and fire hazards.

Practically the entire network of pipeline transportation has already exhausted its projected service life, and the likelihood of accidents and emergencies is increasing [15].

The danger from the destruction of hydraulic structures. As a result of the collapse of dams, embankments, and water control structures on 16 reservoirs of the Dnieper, Dniester, Southern Bug, and Siverskyi Donets rivers, catastrophic flooding is possible over an area of 8294 km2, affecting 356 settlements and 470 industrial facilities. This could lead to disruptions in the operation of power systems, gas and oil pipelines, water supply and sanitation systems, and transportation connections.

However, the threat from the destruction of dams in the Dnieper Cascade reservoirs is not the only concern. There is a significant amount of radioactive substances in the sediment at the bottom of the reservoirs, particularly in the Kyiv Reservoir. If the reservoirs were to dry up, the bottom sediments could be dispersed by

the wind, leading to the spread of radioactive materials over long distances.

There is a significant threat from potential destruction of protective dams or failure of high-capacity pumping stations that were constructed to safeguard the lands from flooding by the waters of the Dnieper Cascade reservoirs. These protective complexes consist of 35 pumping stations, 400 km of water defense dams with a head up to 15 m, 340 km of collector-drainage networks, and over 100 complex hydraulic structures. This complex protects 22 areas covering an approximate area of 400,000 hectares, where 190 settlements with a population of up to 400,000 people and over 700 enterprises are located.

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The energy sector poses a significant danger. In Ukraine, there are 17 large thermal power plants with 122 power units. Among them, three units have a capacity of 100,000 kW, four units have a capacity of 127, 32 units have a capacity of 200, six units have a capacity of 210, six units have a capacity of 280, 57 units have a capacity of 300, and eight units have a capacity of 800,000 kW. Over 80% of these power units have already exceeded their estimated operational lifespan, and 48% have reached their maximum operational limit. Additionally, 40-50 thousand kilometers of power grids were constructed before 1970 and have also surpassed their operational lifespan.

It is evident that potential accidents at these facilities not only pose a localized threat at the accident site but can also lead to emergency situations in power consumption facilities.

Transport poses a significant danger in Ukraine. The country has a dense network of various transportation systems, including railways with a total length of 22.6 thousand kilometers, roads with a length of 172.3 thousand kilometers, of which 16.3 thousand kilometers are paved, and pipeline systems (mainly gas, oil, and product pipelines) with a total length of 42.4 thousand kilometers. Additionally, there is a well-developed network of river, maritime, and air transport.

Every year, transportation accidents rank first among man-made emergencies in terms of the number of casualties and fatalities. Ukraine has over 17,000 bridges on its transportation routes, with approximately 5,800 of them built before 1961, even though the design lifespan of bridges is typically no more than 30-40 years. The probability of accidents increases at the same rate as these bridges surpass their operational limits.

The danger from the deterioration of metal and reinforced concrete structures is significant. In the major industrial sectors alone, there are over 35 million tons of load-bearing metal structures and more than 259 million cubic meters of reinforced concrete structures in operation. A considerable portion of these structures is already worn out, which poses a serious risk. The industries with the highest number of such structures

are the energy, chemical, oil, machinery, metallurgical, and coal mining sectors [17].

In Ukraine, there are more than 115,600 construction objects. Among them, 1,800 objects and approximately 700 km of engineering networks are unfit for further use. Over 600 objects and 600 km of engineering networks are in a critical condition.

Wastes. The issue of waste is the most pressing and significant problem of modern times. *Wastes are pollution of water, atmosphere, and soil; it poses a threat to human health and all living beings; it is a threat to the biosphere.*

In Ukraine, the main sources of waste generation are the enterprises of the mining, chemical-metallurgical, machinery, fuel and energy, construction, pulp and paper, and agro-industrial complexes, as well as municipal services.

The crisis in the ecological situation has raised particular concern about the formation and accumulation of various types of waste in the country, including a significant amount of toxic waste containing heavy metals, petroleum products, and hazardous chemicals, such as pesticides. Approximately 13,500 tons of expired pesticides have accumulated, some of which are stored in unsuitable facilities for long-term storage. There are 109 centralized storage facilities for hazardous pesticides and agrochemicals, along with about 5,000 storage facilities on agricultural enterprises.

As of January 1, 1999, the total mass of accumulated toxic waste in Ukraine's organized storage facilities alone amounted to 4,210.6 million tons, which was 52 million tons more than on January 1, 1997. This situation poses a serious threat to the environment, human health, and the overall biosphere.

Therefore, an average of 1.0 - 1.5 tons of toxic waste is generated per person per year, and a total of over 82.6 tons of such waste has already been accumulated per person in Ukraine. The main bulk of these wastes is formed in the Donetsk and Dnipropetrovsk regions.

Underneath the toxic waste repositories, there are almost 20 thousand hectares of land. In cities and urban-type settlements, approximately 40 million cubic meters of waste are generated annually, which is about 0.8 cubic meters per person. This waste is taken to 700 landfills, the majority of which are a significant source of water and air pollution [18].

The waste problem is a problem of pollution of the surrounding natural environment, which ultimately affects people's health and leads to depopulation.

This problem in Ukraine is exacerbated by radioactive contamination.

Food safety is also a significant concern. It has emerged as a logical continuation and consequence of the crisis of pollution in the surrounding natural environment, its components, and the reduction of self-purification functions in natural ecosystems.

Chemical factors such as fertilizers, pesticides, heavy metals, nitrates, hormones, antibiotics, anabolics, phenols, dioxins, microbial toxins, radionuclides, parasitic, fungal, and viral infections, substandard packaging of products, counterfeit food additives, the production of products and beverages using genetically modified plants and animals pose a great danger to human health.

Reasons for rising groundwater levels are always the same - an excess of water inflow into the aquifer compared to its outflow (and, of course, losses due to evaporation). Groundwater levels constantly fluctuate because the components of the

local water balance and the aquifer are continually changing. These levels are high during seasons with rainfall and snowmelt and low during dry periods. Fluctuations in groundwater levels vary in different areas but remain within certain limits. Only in extreme years, characterized by very heavy rainfall or severe drought, do these fluctuations exceed the usual boundaries. In such cases, flooding may occur in the first scenario, and small rivers may dry up, leading to water loss in wells during the second scenario. These are entirely natural phenomena.

However, human activities have introduced abrupt changes to this natural process. Significant impacts on groundwater levels include the construction of artificial reservoirs (ponds, water reservoirs), canals, water losses from sewage and water supply networks, riverbed siltation, and road construction. Irrigated agriculture plays a significant role in flooding. Building reservoirs and water reservoirs creates a support for water levels in rivers, which can extend (sometimes over considerable distances) to affect groundwater levels, causing them to rise and flood surrounding lands. The same effect occurs due to water filtration from canals and leakage from sewage and water supply networks. Riverbed siltation raises the water level in rivers and, consequently, the level of groundwater.

When irrigating land, a large amount of water, sometimes up to 40% of what is applied to the fields, seeps into the soil and replenishes the aquifer, causing its level to gradually rise toward the land surface. Due to technological losses, groundwater can approach the surface at a rate of 0.3-0.5 meters per year and even 1.5-2 meters per year within hydroengineering structures such as canals and reservoirs.

Therefore, over ten years, technological water losses can cause groundwater levels to rise from 3-5 to 15-20 meters, which is already observable in the southern regions of Ukraine in areas with irrigated agriculture.

Issues of flooding, degradation of irrigated lands, and loss of fertility are not new on a global scale. According to the United Nations, the total area of land that has lost fertility due to human activity, including flooding, has reached 2 billion hectares worldwide, which is 1.5 times the total area of arable land in Europe. Each year, 200-300 thousand hectares of irrigated land are removed from agricultural use due to waterlogging and salinization. Sooner or later, the majority of irrigated land will become barren, either through waterlogging, salinization, or complete exhaustion. This can be prevented, but at a very high cost.

It's essential to remember, as farmers well know, that each kilogram of harvest "costs" more over time. More energy needs to be expended continually. Soon, the price of energy will intensively rise because fossil fuels (energy sources) are non-renewable resources that will be depleted within 50-60 years. Therefore, it might be more sensible to invest in genetics to develop drought-resistant, high-yielding crops instead of irrigation.

To achieve this, irrigation should be stopped where there is no reliable self-flowing drainage (vertical drainage requiring electricity) and where groundwater levels have risen. This is also true for fields located in coastal areas. To improve natural drainage, the land's plowing needs to be reduced by 30% through afforestation of sloping land. The forest coverage in the Ukrainian Steppe should be increased to 10-

12%, and the country's overall territory should be covered by forests at 28-32%.

State policies concerning agriculture should focus on increasing the productivity of crops. Doubling the yield on half the area is more ecologically and economically advantageous.

Creating a scientific center to develop a comprehensive program for agricultural development based on ecological principles is currently relevant. Such a center could address the issues the country will face in the near future, such as crises related to fuel, water, and other natural resources.

The implementation of biotechnology methods to obtain genetically modified plants and animals poses a potential threat of global significance. There are no guarantees that genetically modified foods and additives are safe for humans (and living beings in general). Worldwide testing cannot be considered valid because genetically modified products have only recently appeared (the first gene transfer from one organism to another was carried out in 1973, and the first food product modified by biotechnology was allowed in 1990 (cheese production); in 1994, a tomato variety obtained through biotechnological methods was introduced), and their impact on human health may only become evident in subsequent generations. Another concern about the use of biotechnological methods arises from one of the laws of ecology, stating that "nature knows best." This law suggests that until we have entirely reliable information about the mechanisms and functions of nature, attempting to improve it may cause harm. Thus, the potential threat is only probable, but if it materializes, it can be highly severe and come with unpredictable consequences.

Conclusions. The most critical problems of modern times, which were once localized and have now transformed into national and global issues, are related to *ecological safety*. Humanity has created a technical civilization that is accompanied by ever-increasing energy consumption, water usage, and exploitation of other natural resources. In this process, nature is often seen merely as a means or a resource. People have placed themselves above nature, forgetting that they are a part of it and subject to its laws.

This, in essence, is the root cause of the ecological crisis, which manifests as environmental degradation, hazardous pollution, and simplification of ecosystems. The utilization of natural resources and environmental pollution have reached scales comparable to natural self-regulation processes. This disruption leads to an imbalance in the environment, which has evolved over an extended period, resulting in ecological crises in specific regions.

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