

SCIENCE DURING THE WAR: REALITIES, CHALLENGES AND WAYS OF OVERCOMING

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Abstract. Human has always interacted with nature. Such interaction was not always in favor of the surrounding natural environment. The influence of people on nature, conscious, purposeful, orderly, Unfortunately, turns such interaction into an environmental problem.

One of the most pressing problems today is the full-scale war unleashed by russia against Ukraine. The deliberate destructive impact on the Ukrainian environment and ecosystems is causing an ecological crisis. Such damage to the environment can become part of the world's environmental problems [1, P. 225]. That is why it is so important to develop a sufficient level of environmental culture in every person, to form environmental awareness starting from early childhood and continuing throughout life.

Key words: environment, natural resources, environmental education, interaction, environmental crisis.

Formulation of the problem. Environmental education and youth education is an important aspect in solving the problem of preserving natural resources, especially in today's changing environment. The rapid development of science and technology, innovative technologies in human development, this is the modern age in which young people are living [2, P. 738]. This era provides new technologies, new opportunities and benefits for human development. But there are also negative consequences of the scientific and technological revolution and the demographic explosion. The interaction is not one-sided, unfortunately it has another side and grows into a problem of spontaneous human influence on nature.

Let's note, human activity increasingly pollutes the atmosphere, hydrosphere, and lithosphere, accumulates huge volumes of human waste, depletes almost all types of natural resources. There are signs of the development of an ecological crisis. In such circumstances, humanity needs a new philosophy of life - high environmental culture and consciousness, especially young people. Today, in all developed countries of the world, ecological culture is becoming an integral part of the functional literacy of the population.

Analysis of recent research and publications. Of all human activities, war has the worst impact on the environment. Military operations have a negative impact on the environment, therefore, domestic scientists are actively studying resource-efficient technologies to preserve the environment.

The following scientists study the impact of military operations on the environment in Eastern Ukraine, as S. Stepanenko, O. Kravchenko, O. Vasylyuk, A. Voytsikhovska, K. Norenko, N. Lisova.

The following Ukrainian scientists draw attention to and scientifically substantiate in their scientific works the ecological dangers of military operations in Ukraine, as S. Butnik, O. Brion, V. Serebryakov, M. Nazaruk, V. Torkatyuk and others. Scientific works on the issues and problems of assessing the impact of military actions on the environment, which need to be solved in the context of damages are published by scientists Yakiv Didukh, Halyna Minicheva, Yuriy Kvach, Mykhailo Son, Pavlo Goldin, Viktor Demchenko, Yevhen Sokolov, Serhii Bushuyev.

Understanding the current crisis and shaping the future of the world should be done through education. For the sake of saving our planet and interacting with nature, to draw the attention of all people to the awareness of planet Earth as a common home scientists Vasyl Ivantsiv, Olena Lyutak, Mykola Fedonyuk, Olga Vishnevskaya, Vira Balandina, Borys Babelyas publish their works on the inclusion of environmental education in the interests of sustainable development in all educational programs.

Research goals. To outline the strategy as well as the main tasks regarding the formation of the environmental culture of the society as a whole, particularly young people; skills formation, general environmental knowledge, ecological thinking and consciousness based on the attitude towards nature as a universal, unique value. To consider the methodological foundations of the formation of education for balanced development and its relationship with environmental education.

Presentation of the main research material. The guarantee of a safe future for all mankind, in particular, Ukraine is in the process of forming the ecological culture of the population (youth), careful attitude to the natural environment. Such activity in today's changing conditions (martial law) is a priority area of training and education. With the deterioration of the ecological situation in Ukraine, the importance of environmental education is no longer in doubt.

For the sake of one's own survival and for the sake of future life on Earth, transformations are needed in Ukrainian education. The government of the country has set itself the goal of making environmental education the main component of educational programs in all educational institutions, in particular, institutions of higher education. However, such a process is delayed. Curriculum reforms and progress in spreading the knowledge, skills, values and attitudes needed to make positive changes and protect the future of the planet are not yet fully realized..

Modern environmental education should be a systemic component of the national education system in Ukraine. One of the conditions for the development of environmental education in Ukraine is the harmonization of Ukrainian environmental legislation with EU standards [3, P. 38]. Environmental reforms in Ukraine are taking place in accordance with the Association Agreement

between the EU and Ukraine and have the goal of forming a new type of worldview regarding the rational relationship between man and the environment in the "nature-human-society" system.

Defense of the Motherland with weapons in hand is on the agenda today. But there is another important issue - the sphere of environmental protection and the development of environmental education. This is decades ahead. Sustainable development and war are not compatible, so scientists are studying and telling young people about the consequences of the Russian invasion for the environment. Only the spread of knowledge about the environment can help humanity prevent wars in the future [4, P. 9]. Ukraine is trying to do this today.

Another problem that is being solved by Ukrainian scientists is the assessment of environmental damage from military conflicts. Of course, there is an American method of damage assessment, and there is a European, which emphasizes the evaluation of what is expressed in value equivalent (example: value of wood stocks in the forest, forest care, secondary use of forest resources).

Ukrainian scientists have found another way to assess environmental damage. It is complex and requires considerable time and high qualification of performers, but does not state the facts of decline and losses. It takes into account losses taking into account various environmental functions such as: regulation of gas balance; impact of ecosystems on climate; ensuring trophic relationships; preservation of biodiversity of fauna and flora, etc. In the methods of Ukrainian ecologists-scientists, the time aspect is taken into account, that is, the time required to restore ecosystems of a certain type.

Regional ecosystems have their own specifics, Ukrainian ones are no exception. Without an analysis of the specifics, structural components of the ecosystem, development, recovery possibilities, it is very difficult to assess the damage. Adapted to Ukrainian realities, the method of assessing ecological damage should be based on the analysis of the following components: sustainability and vulnerability of ecosystems, the degree of its damage.

The methodology assumes participation in damage calculations by ecologists, economists, lawyers, representatives of united territorial communities, relevant departments. Complexity is necessary in solving today's complex tasks [5, P. 21].

There is a problem – whether the damage assessment methods of Ukrainian scientists comply with legal norms, whether they can be recognized in the world. Compliance with the requirements at the level of our state - yes. Another thing is the international level and international courts.

Certificates of copyright registration for the work or other document that will prove their significance are required. Government initiative is necessary (Committee of the Verkhovna Rada of Ukraine on Environmental Policy and Nature Management) regarding the organization of work on the creation of teams of scientists with the involvement of relevant international experts. If this is not done, you will have to independently prepare legal documents for international courts and various

expert groups for the assessment of environmental damage and compensation for damage caused to the environment. It will take tens of years.

There is another aspect - duration of research. The indirect impact of war on the environment triggers cascading processes, which may appear in a few years and give a very large negative result. An example is fires that destroy forest ecosystems [6, P. 327]. At the same time, after the liberation of the territory of the Chernobyl nuclear power plant, scientists studied the losses from the fires.

Preliminary studies indicate the emergence of adventitious species in such places. Among them, according to historical research, there will be dangerous ones for human health (experience of World War II). Synergistic effect of climate change and human anthropogenic activity, in particular, military actions only intensify and accelerate negative processes.

Ukrainian scientists have studied the trends of climate change and the impact of such processes on ecology and nature management [7, P. 47]. Calculations show, due to an increase in average annual temperatures by 2⁰C and military actions on the lands of Ukraine will destroy about 25% of the populations of rare plants and more than 30% of the habitats of biotopes of Ukraine. These are almost catastrophic consequences.

You should not expect compensation from the aggressor state. Scientists must continue to work: predict, warn, propose measures to minimize this negative impact.

Currently, an urgent problem is the impact of military operations on the marine ecosystems of Ukraine and the ways of their recovery. Scientists of the Department of Ecological Integration of Biocycles of the Institute of Marine Biology of the National Academy of Sciences of Ukraine have been trying to monitor since the beginning of the Russian aggression and research on the problems of scientifically objective assessment of the state of the Black and Azov Seas today.

The problem of a scientifically objective assessment of the state of the sea lies in active hostilities in the region. State marine monitoring is limited to the occupation of part of the territory and the coastal sea water area, mining and littering of used military equipment. Academic scientists had/have access only to some estuaries of the northwestern Black Sea.

In the pre-war period (Association Agreement between Ukraine and the EU) Ukraine switched to European standards for assessing the ecological state of the sea. Implementation of six EU water directives, two of which – The Water Framework Directive and the Marine Strategy helped to develop a methodological tool for the assessment of marine ecosystems at the national level.

The situation changed with the beginning of Russian aggression - marine ecosystems began to suffer from the dangers of war [8, P. 99]. Just one example: the cruiser of the Russian fleet "Moscow" struck directly within the botanical reserve of national importance "Filophorne Pole Zernov" is a threat to the destruction of the unique biocenosis of the red alga phyllophora and the complex of red book inhabitants associated with it.

Environmental monitoring, which was carried out by Ukrainian scientists in such difficult conditions, revealed spills of oil products (consequences of military incidents). The oil film covered tens of thousands of square kilometers of marine protected areas of Ukraine. Contaminated water areas of the zoological reserve of national importance "Snake Island", the National Nature Park "Biloberezhya Svyatoslav", the Black Sea Biosphere Reserve of the National Academy of Sciences of Ukraine, etc..

The main goal of environmental monitoring – to achieve an honest assessment of the ecological state during military operations and during post-war reconstruction, compensation for damage to the environment. Many materials about their condition are causing concern among marine mammal scientists. The internet is full of information about the effects of war on marine mammals. But, unfortunately, there is a lot of speculation. Scientists have not abandoned scientific research since the beginning of hostilities. With limited access to material, they documented every instance of discards of dead, alive, and emaciated animals. Biological material for analysis was sent to European countries in a timely manner.

Scientists and researchers of the National Nature Park "Biloberezhya Svyatoslav", the Black Sea Biosphere Reserve of the National Academy of Sciences of Ukraine are investigating another risk of martial law. During hostilities, the structure of shipping changes, there is practically no control over ballast water, the pressure on invasive species disappears due to the cessation of industrial fishing, in our case pilengas and rapan. This leads to an increase in biological pollution.

Being in difficult conditions, scientists are investigating the factors against which the ecological state of the Black Sea is formed (2022-2023). For example: a decrease in the volume of river flow, low sea water temperatures. Prohibition of using the coastal strip due to mining (a kind of modern experiment), confirmed the effectiveness of the principles of intermittent zoning of untouched and anthropogenic zones. Zoning emphasizes the European approach «Marine Spatial Planning». After scientific research, the research scientists claim that the experiment with zoning will need to be implemented in the future during the post-war reconstruction of the Black Sea-Azov coast of Ukraine.

Studies of biological indicators have confirmed the assumptions of scientists - the ecological condition of the marine environment, at least in the Odesa coastal region, is improving. Of course, research should be continued [9, P. 235], post-war recovery will not take place under such favorable circumstances, and climatic conditions may change.

Scientists of the department of ecological integration of biocycles of the Institute of Marine Biology of the National Academy of Sciences of Ukraine, based on the results of research and data analysis, outlined ways to restore marine ecosystems of Ukraine. It is, in particular, about:

- access of specialized specialists and the organization of their work in safe areas of the sea for the selection of empirical material, without which it is impossible to substantiate the losses, under the control of the Armed Forces of Ukraine;

- development of a methodology for assessing the impact of military actions on marine ecosystems and the integration of the 12th Descriptor «Military Impact» to the State Monitoring Program of Coastal and Marine Waters of the Black and Azov Seas until 2026;

- wide implementation of such European ecological and economic instruments as «Ecosystem Based Management», «Blue Growth» etc.;

- expansion of the national maritime network of Ukraine at the expense of areas of the coastal zone and wetlands (wetlands) that were not damaged by military actions;

- development of a program for the post-war restoration of marine ecosystems of Ukraine to combine financial, institutional and intellectual resources at the national level.

Many research institutions and institutions of higher education draw public attention to the needs of science during the war. Today, one can hear too often the opinion about the survival of Ukrainian science in the conditions of martial law. But there is another - we need to think about reforms today [10, P. 24]. The problems of the scientific sphere are only partially related to the war, as evidenced by the indicators on the number of researchers and their scientific discoveries.

The root problem of domestic science is its weak connection with the economy. In recent years, research expenditures have been constantly decreasing. Among the problems - limited demand for scientific research, low incentives for private investment.

A serious problem is the lack of a strategy for the development/modernization of the scientific material base. Such questions should not be overlooked [11, P. 105]. Low academic mobility, detachment from world science, separation of education and research that exist in almost parallel worlds of universities and academies of sciences, low level of English language proficiency are problems of international cooperation.

Accumulated problems will not solve themselves. The war only intensified such negative phenomena as imitation of science, academic dishonesty. There are also reductions in funding, damage to the research infrastructure, the outflow of many scientists abroad, the difficulty of conducting research by those who remained in Ukraine (low level of concentration).

But Ukrainian science has preserved the main part of human capital, they need to develop. It is not in our interest to remain weak [12, P. 240]. With weak science, our allies and international donors do not need us. We must be strong and become long-term partners of EU countries. The support contributes/will contribute to the strengthening and development of organizational structures and tools of scientific research. One of the elements of integration is the organization of centers of excellence and innovation in education and science.

Human capital in science should not only be saved, but also its development should be taken care of [13, P. 261]. Helping researchers overcome the shock of war and return to scientific life is a difficult task. We cannot wait for the end of the war. We are not a weak country, we are ready for fundamental reforms in the scientific field and post-war restoration of human capital, because science is scientists, young scientists.

One of the biggest problems today is cooperation between science and business. It is still insufficient. There is a problem of weak communication mechanisms. There is a problem of weak communication mechanisms.

Let's note, business meets science, there is an understanding that scientists need support. It is a pity that business does not understand - it needs not just to help science, it needs to support itself with science. Only in such conditions will he receive a positive result from these investments.

But in the conditions of martial law, business is not ready to help anyone except the Armed Forces of Ukraine, it only invests in science [14, P. 148]. If scientific development and research does not increase the profits of the business, it will not contribute to it. What is the business sense of investing. Cooperation of the Ministry of Education and Science with business institutions takes place through information events, hackathons, innovation festivals, pitching, etc..

Conclusions and prospects for further scientific research. Are there "educational gaps" in national education and science? Yes, we recognize them. We see what we have come to a moment of crisis, which has deepened, which is critical. We understand the long-term nature of problems, without solving which it is impossible to compensate for new challenges.

The previous history of domestic science hindered its integration into the world research space, time after time increased scientific gaps. With the beginning of hostilities, new problems were added: complications in scientific research, a break in ties within scientific teams, partial loss of research infrastructure, problems at the level of institutions. Even before the war, the state's capabilities did not have sufficient capacity (underfunding, insufficient management culture, lack of understanding, etc.), during martial law, it is even more difficult to build up this capability.

To preserve the scientific potential of Ukraine, more flexible tools are needed. Perhaps it is necessary to focus on the scientific achievements of scientists, and not on what they promise to do. We need a well-thought-out strategy for the development of science, the elimination of scientific gaps that we have lost and need to be made up for. However, despite all the tragedy of the moment, the country is emerging from the crisis. Scientists (teams of scientists) act effectively even when they do not have response protocols. War is a time when all sides understand the importance of cooperation and are open to dialogue.

Ukrainians, after the victory, strive to rebuild a strong, intelligent, high-tech country. Of course, this can only be done on the basis of science. This is an ambitious vision that requires a lot of

work and research. But do we understand what other problems will need to be solved, what threats and obstacles to overcome? If we do not know this, then our dream is in great question. This is the perspective of further scientific research and research.

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