

*Olena Zhytova, Professor of the Department of Ecology,
Doctor of Biological Sciences, Professor
Polissia National University
Zhytomyr, Ukraine
elmi1969@meta.ua*

*Daniel Klich, Dr.habil., Professor
Department of Animal Genetics and Conservation,
Institute of Animal Sciences, Warsaw University of Life Sciences,
Warsaw, Poland*

OVERALL ASSESSMENT OF THE IMPACT OF MILITARY ACTION ON THE ENVIRONMENT IN UKRAINE

Military action in Ukraine is causing significant damage to the country's ecological systems and natural resources. The deliberate destruction of industrial and agricultural facilities, as well as life-support infrastructure, leads to the release of harmful and hazardous substances into the environment, causing air, water and soil pollution, and destroying *fertile land*. The destruction of dams and treatment facilities, as well as the disabling of service stations that provided water supply and wastewater treatment, has created an extremely difficult situation with regard to drinking water quality for the population, as all untreated wastewater is entering water bodies. Water shortages and deteriorating sanitary conditions have been observed in many regions, leading to various water- and food-borne diseases [1, 2]. Therefore, in the current context, one of the most pressing issues is to assess the pollution levels in aquatic ecosystems.

Hostilities have resulted in a significant deterioration in air quality. The destruction of industrial infrastructure and military facilities has caused large-scale fires and explosions, releasing significant amounts of toxic gases and other pollutants into the atmosphere. Currently, Ukraine has some of the worst air quality in Europe. According to estimates by the Kyiv School of Economics (KSE), around 5.5 million tonnes of pollutants have been released into the atmosphere due to military operations. Another dangerous consequence is the formation of acid rain, which causes significant damage to natural ecosystems and agricultural crops.

In addition, the explosions caused by rockets, artillery shells, aerial bombs, drones and various types of shells are destroying the top fertile layer of soil that has formed over centuries. This is despite Ukrainian soils already having lost around 30% of their humus over the last 100 years. It is the war that is accelerating this process. Soils are losing their fertility due to changes in their physical, agrochemical, and physicochemical properties. Currently, scientists are recording excess levels of mercury, zinc and cadmium in the soil at sites where rockets and artillery shells have detonated, as well as high levels of copper, nickel, lead, phosphorus and barium. After shelling, the land becomes unusable. Clearly, agricultural activities will not be possible on such soils for a long time to come. The prolonged presence of explosive devices and other military waste in the soil requires changes to land use approaches. According to KSE data, approximately 188,000 km² of soil is at risk of contamination [1, 2]. In order to continue using land damaged by hostilities, a set of measures must be implemented, including demining, ammunition disposal, phytoremediation and recultivation.

Over 59 hectares of forests and other plantations have been destroyed as a result of military operations. Not only have forests in the east and north of the country been damaged, but regions that are regularly subjected to shelling and bombing have also been affected. Under martial law, Ukraine's forestry sector requires an in-depth analysis and the development of effective mechanisms to address the issues that have become particularly acute during this period. Currently, approximately 2.9 million hectares of forest have been damaged to varying degrees, with around 1 million hectares located in territories temporarily occupied or affected by ongoing hostilities. Forest fires, which are one of the most significant contributors to the degradation of forest ecosystems due to climate change and increased recreational use, have worsened since 2022 due to shelling, explosions, the mining of forest areas, and other military activities. The large number of such areas and explosive objects makes it difficult to detect and respond quickly to ignition points, which complicates the organisation of firefighting measures in forest areas and contributes to environmental losses associated with biodiversity degradation, soil cover destruction and reduced forest ecosystem stability. Compared to 2021, the total area affected by forest fires has increased 45-fold, with more than 1,500 cases of ecosystem destruction recorded [1, 2]. Currently, firefighting and forestry activities in frontline areas are extremely dangerous and virtually impossible until hostilities cease completely and the areas are cleared of mines. Under these conditions, reducing Ukraine's forest cover is emerging as one of the key environmental problems.

Since 24 February 2022, more than 22,171 hectares of land in the Chernobyl exclusion zone have been burned in fires, including around 14,000 hectares during the occupation. Hundreds of thousands of hectares of forests and swamps need to be completely cleared of mines, a process which is significantly complicated by radioactive contamination. The fires have destroyed forests, meadows, and swamps, devastating the habitats of numerous species of fauna in the Chernobyl Radiation and Ecological Biosphere Reserve and causing significant damage to Ukraine's natural environment.

A total of 44% of Ukraine's nature reserves and national parks are located in combat zones or temporarily occupied territories. A total of 900 sites, covering over 12,000 km², have been affected, resulting in the destruction of rare species of flora and fauna. According to Ukraine's Ministry of Environmental Protection and Natural Resources [3], Russia's military aggression has affected 812 nature reserve sites covering 0.9 million hectares. Additionally, 2.9 million hectares of the Emerald Network – territories that form part of the pan-European nature conservation network and are protected under EU and Council of Europe legislation – are under threat of destruction.

Seventeen wetlands of international importance, which are protected by the Ramsar Convention due to their unique biodiversity, are currently at risk. A total of 514 nature reserve sites, covering an area of 0.8 million hectares, remain occupied. Two such wetlands, the 'Archipelago Velyki and Mali Kuchuhury' and 'Zaplava Sim Mayakiv', have almost been destroyed. Additionally, 1,558 hectares of the most valuable steppe section of the Dzharylgach National Nature Park have been destroyed. The habitats of species of flora and fauna listed in the Red Books of Ukraine and Europe, which are threatened with extinction on a global scale, have been damaged. The ongoing war is causing serious damage to biodiversity and increasing the risk of extinction of unique plant and animal species, which currently require urgent protection and conservation of their habitats [5]. War is an extremely powerful anthropogenic factor impacting wildlife, as it causes radical changes in living conditions to which animals are unable to adapt. They either die or are forced to leave combat zones. Therefore, after martial law ends, a conservation regime will need to be introduced in areas adjacent to the locality, at a distance of at least 50–70 km [3, 4]. In conditions of hostilities, it becomes almost impossible to implement nature conservation measures in key areas.

Despite martial law, it should be noted that Ukraine has defined its own strategic objectives in the field of biodiversity conservation, taking into account European experience. These include reducing the loss of biological and landscape diversity, restoring populations of natural flora and fauna, tackling the illegal trade in wild animals and plants, and increasing the size of nature reserves. Once the war is over, it is clear that the restoration of the environment will be an extremely important task. To achieve this efficiently, an effective environmental monitoring system must be established to provide an objective assessment of the damage caused and prioritise areas for restoration. This system must also implement environmental protection solutions during the post-war reconstruction period. Biodiversity restoration measures must be incorporated into the country's comprehensive plan and aligned with international and European environmental strategies. Consolidating international and national efforts and integrating environmental considerations into all areas of public life are prerequisites for sustainable development in the post-war period.

Therefore, there is an urgent need to study the main aspects of Russia's military aggression's impact on Ukraine's environment today. These can pose serious environmental and social threats, causing long-term negative consequences not only locally, but globally too.

List of references

1. Bondar O. I., Gandzyura V. P., Matvienko M. G. The impact of military actions and their ecological consequences on the environment of Ukraine. *Ecological Sciences*. 2024. No. 1 (52). Vol. 1. Pp. 7–15 [in Ukrainian].
2. Bondar O. I., Melnyk Y. Y., Pogorelova O. M., Bitsyura L. O., Golovatyuk L. M. Analysis of the results of the impact of military actions on the environment and infrastructure of Ukraine. *Scientific bulletin of UNFU*. 2025. Vol. 35. No. 1. Pp. 60–67 [in Ukrainian].
3. Zagorodniuk I. V., Vyshnevskiy D. O. Losses and changes in biodiversity in areas of prolonged hostilities in Ukraine: teriological component (2014–2022). *Visnyk of the National Academy of Sciences of Ukraine*, 2022, No. 11. Pp. 60–78 [in Ukrainian].
4. Vasyliuk O.V., Nekrasova O.D., Shyriaieva D.V., Kolomytsev G.O. A Review of Major Impact Factors of Hostilities Influencing Biodiversity in Eastern Ukraine (Modelled on Selected Animal Species). *Vestnik Zoologii*. 2015. 49(2). P. 451–456.
5. The war in Ukraine is recognised as a threat to rare species on the international Red List. URL. : <https://uncg.org.ua/vijna-v-ukrayini-vyznana-zagrozoyu-dlya-ridkisnyh-vydiv-u-mizhnarodnomu-chervonomu-spysku> [in Ukrainian].
6. The impact of war on nature conservation areas in Ukraine. URL. : <https://www.wwf.mg/?12163316/The-impact-of-war-on-protected-areas-in-Ukraine> [in Ukrainian].