

## **THE IMPACT OF MILITARY OPERATIONS ON THE DISTURBANCE OF NATURAL COMPONENTS IN THE KHARKIV REGION**

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The Kharkiv region has been significantly affected by military actions related to the full-scale war that has been ongoing in Ukraine since 2022. Military conflicts have a devastating effect on the natural environment, and Kharkiv region was no exception. Natural components such as forests, water resources, soils and biodiversity have been severely damaged by the fighting, leading to severe ecological degradation in the region.

### **The main factors of military influence on natural components:**

1. *Physical destruction of natural landscapes:* the hostilities in the Kharkiv region have led to the destruction of large areas of forests, fields, steppes and other natural ecosystems. Shelling and bombing destroy vegetation, which disrupts ecosystem chains. Explosions of shells and rockets damage the soil structure, cause erosion and impede the natural regeneration of vegetation. Forests, which serve as air purifiers and provide habitat for many species of animals and plants, have fallen victim to fires caused by shelling [1]. The fire destroys not only trees but also living organisms living in these forests, upsetting the balance of the ecosystem.

2. *Soil contamination:* the soil of Kharkiv region has been seriously contaminated by the use of heavy artillery, tanks, missile systems and other weapons. The explosions release chemicals, heavy metals, and ammunition remnants into the soil, which seriously impairs its fertility. Some munitions contain toxic components, such as lead, mercury, and cadmium, which accumulate in the soil and can get into plants, affecting agricultural production and, consequently, public health [2]. Soil contamination also disrupts ecosystem processes, such as the decomposition of organic matter and the restoration of soil biota.

3. *Water pollution:* the water resources of the Kharkiv region, in particular the Siverskyi Donets, Udy and Lopan rivers, have suffered from pollution from military equipment, the destruction of industrial facilities and contamination with fuel and other chemicals. Infrastructure facilities, such as sewage treatment plants and water supply systems, are damaged during the hostilities, leading to pollutants entering the rivers and groundwater. Pollutants such as oil, heavy metals, and other chemicals enter water bodies, reducing water quality and threatening the health of the population using these resources [3]. The hostilities have also damaged natural aquatic ecosystems, leading to a decline in the number of aquatic organisms and fish.

4. *Destruction of biodiversity*: the hostilities have caused a serious decline in biodiversity in the Kharkiv region. The destruction of natural habitats, including forests, steppes and wetlands, leads to the death of many species of animals and plants, including rare and endangered ones. Shelling and mining of natural areas make it impossible for wild animals to live in their habitats. Many animals are forced to migrate because of the hostilities, but new places are often unsuitable for their survival. Some species cannot adapt to new conditions or simply die as a result of explosions and fires [4]. The loss of wildlife disrupts natural ecosystems and can have long-term consequences for the region's biodiversity.

5. *Emissions of harmful substances into the air*: military operations in the Kharkiv region are accompanied by large-scale fires, destruction of infrastructure and the use of large quantities of explosives. This leads to significant emissions of harmful substances into the air, such as nitrogen oxides, sulfur oxides, carbon dioxide, and hazardous particles from explosions and fires [2]. Air pollution with hazardous substances not only affects human health, but also damages natural ecosystems. In regions where hostilities have been going on for a long time, the concentration of harmful substances in the air is increasing, which can affect changes in climate conditions and microclimate.

The disruption of the natural components of the Kharkiv region as a result of the hostilities has both short- and long-term consequences [5]. **The main environmental problems include:**

- *degradation of ecosystems*: war destroys natural habitats, leading to loss of biodiversity, disruption of natural processes and difficulties in restoring ecosystems;

- *long-term environmental pollution*: soil, water, and air pollution leaves dangerous consequences for a long time, making these areas unsafe to use and live in;

- *climate change*: large emissions of carbon dioxide and other pollutants cause localized climate change, which can intensify extreme weather events.

After the end of the war, restoring the ecological state of the Kharkiv region will require significant resources and time [6]. **Some of the key areas:**

- *demining and land reclamation*: clearing territories of mines and explosive devices is a priority for returning land to agricultural and natural use.

- *cleanup of water and soil resources*: work to clean contaminated soil and water from toxic substances and restore their quality.

- *biodiversity restoration*: implementation of programs to restore forests, steppe ecosystems and protected areas, which will help restore the natural balance.

- *environmental monitoring and research*: it is necessary to implement systems for monitoring the state of natural components and conduct research on effective methods of environmental restoration.

**Conclusion.** The hostilities in the Kharkiv region have dealt a serious blow to the natural components of the region, which has had profound environmental and social consequences. As a result of large-scale hostilities, the natural environment has been significantly damaged, with large areas of forests,

steppes and other natural landscapes destroyed. Soil contamination has become a particularly serious problem due to the remnants of military equipment, ammunition, and heavy metals that penetrate the ground and groundwater. This poses a threat to agriculture, local health, and flora and fauna.

The region's water resources have also been heavily contaminated by toxic releases into rivers, lakes, and underground aquifers. The consequences of pollution can be catastrophic for the water supply of local residents and the ecosystem as a whole. Air pollution from explosions, fires, and industrial facilities damaged during the hostilities affects the quality of life and the region's ability to recover.

One of the most tragic consequences is the loss of biodiversity. The destruction of natural habitats leads to the death or displacement of many species of animals and plants. Rare species are disappearing, and those that remain are often at risk of extinction due to deteriorating living conditions.

After the end of hostilities, it will be crucial to develop comprehensive strategies to restore the region's ecosystem. This should include the cleanup of contaminated areas, land reclamation, restoration of forests, steppes and other natural landscapes, and the implementation of measures to protect and restore biodiversity. The joint efforts of environmentalists, scientists, local communities and international organizations will be necessary to effectively restore and maintain ecological balance in the Kharkiv region.

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