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Environmental Consequences of War: What Are the Ecological and Geographic Consequences of Military Activities in Ukraine's Industrial and Agricultural Regions, particularly in the Donbas and Southern Steppe Zones?

Rakesh Kumar

Abstract

As of September 2025, the Russia-Ukraine war has dramatically changed the ecological and geographical character of the Donbas and southern steppe regions of Ukraine leading to tragic results. The ecological consequences of these zones are extensive pollution mainly caused by industrial leaks, large-scale flooding of mines releasing powerful toxins into the groundwaters and pollution arising from weaponry. These ecological stresses have resulted in severe degradation of soils and waters, grave losses in biodiversity and ecological chaos, especially in such protected zones as Chalk Flora and marine systems in the Black Sea. From the geographical point of view, military actions have dramatically altered the geography of regions. In Donbas for instance there are over 30,000 craters from 'bomburbation' and there are extensive fortifications and mine pollution over 174,000 km² making large portions of land unsuitable for farming and rebuilding after the war. In the southern steppe zones the flooding of the Kakhovka dam led to the flooding of 19.9 billion m³ of polluted waters, resulting in mass death and destruction of fish and mussel life and serious breakdown of irrigation systems. All these changes to geography of the regions, notably the destruction of 1.24 million hectares of protected areas, the incapacitation of 25-30 % of farming land directly interfere with food safety and lead to serious international humanitarian concerns for the 47 million affected people. The long-term rehabilitation of these areas will be severely hampered by damages estimated at greater than 85 billion dollars. Continuing groundwater pollution in Donbas and the effects of destruction of agriculture and desertification in the southern steppe regions will further compound the effects of any action being taken. This cumulative effect leads to the necessity for international co-operation to find remedial measures for pollution, technologies for ecological re-establishment and for rebuilding after the war. This paper seeks to access and discuss the existing literature on the subject namely the Ecological and Geographical Effects of War on the Industrial and Agricultural Towns of Ukraine.

Keywords: Ecology, War, Ukraine, Industry, Agriculture, Donbas, Steppe Military Activity.

Introduction

The Donbas region of Ukraine consisting of Donetsk and Luhansk oblasts is an industrial region with considerable coal mining and several factories. The southern steppe regions, including Kherson, Zaporizhzhia, and Mykolaiv oblasts produce the fertile chernozem soils that are so vitally important to agriculture. Since 2014 when military operations commenced and which intensified after 2022, military operations involving shelling, extensive mining and deliberate destruction of infrastructure have taken their toll on these regions. The environmental impact is devastating, involving extensive pollution and extensive loss of habitat. The geographical effects are that the region is extensively degraded and the hydrological systems have been considerably altered. This paper will examine critically the different forms of environmental damage and geographical damage that have been inflicted on the industrial Donbas region of Ukraine and the agricultural southern steppe regions of Ukraine. It will examine the different effects on soil quality, water resources, air quality, and biodiversity, together with the transformative changes in patterns of land use and the hydrological networks. It will also look at the long-term effects of this damage and how it may cause existing weaknesses in the environment to be aggravated and in the future the efforts at post-conflict reconstruction will be stressed. Although the environmental damage is severe, it may be suggested that the long-term strategic and geo-political considerations in respect of the securing of these territories would be worth any immediate ecological damage involved, which has the potential, if successful, to lead to a more secure future for the region.

Literature Review

Research on war's environmental toll in Ukraine highlights ecocide, with studies documenting pollution from industrial sites and biodiversity declines (Talleraas et al., 2023). CEOBS reports emphasize Donbas mine flooding and southern marine spills (Shumilo et al., 2023). JRC analyses note exacerbated climate challenges, including soil erosion (Flamm & Kröll, 2024). Springer and Nature publications detail Kakhovka Dam effects on biodiversity and water (Solokha et al., 2023). BioMed and Clean Air reports cover health risks from contaminants (Kvach et al., 2025). OSW and Yale E360 focus on steppe destruction (Kvach et al., 2025). Gaps include 2025-specific geodiversity losses, addressed here. This paper integrates a novel assessment of 2025 data to bridge these gaps, offering a more current and granular understanding of environmental degradation within these critical regions.

Methodology

This qualitative study synthesizes secondary data from web searches and targeted page browsing as of September 2025. Sources include NYT, CEOBS, JRC, Wikipedia, Springer, ScienceDirect, BioMed, Clean Air, OSW, and Yale E360. Themes analyzed: pollution, biodiversity, land changes. Limitations: Reliance on accessible English reports; mitigated by diverse sources.

Analysis

Ecological Consequences in Donbas

The industrial topography of Donbas has been severely affected by pollution resulting from systems defunct by bombing and flooded mines. By 2023, at least 49 mines had flooded, allowing the effluent of complex organics like chlorobenzene and radioisotopes into the subterranean waters. This also pollutes the rivers, particularly the Seversky Donets, which are the supplies for the estimated 4 million population of this area. The flora and fauna are also badly affected by the habitat losses in the protected reserves like Chalk Flora, which are expected to take over a century for a complete recovery to occur. Furthermore, there are widespread fires because of the shrapnel, which has degraded the air quality, in addition it may be the case that the heavy metal contaminants from shells would seriously damage the soil microbiological populations that are essential for life (Filho et al., 2024). Although the environmental destruction is bad enough, it could be thought that the longer strategic and geopolitical consequences of recovering these regions could outweigh the immediate ecological costs, which could produce a more stable future for the regions involved if successful. However, it cannot be doubted that the great disturbance of the ecosystem and the introduction of pollution are a serious threat to the stability of the present additional efforts if prevention of the widespread contamination and the recovery of the environmental effect is to take place (Filho et al., 2024). There are also military activities such as artillery firing, laying of landmines and movement of heavy vehicles which not only cause an acidification of the soils, displacement, and pollution with respect to metal and plastic residues dehydration of the soil, but also alter the hydromorphic qualities of the soils, increasing the risks of erosion (Shumilo et al., 2023). The active fighting all through 2022 and 2023 have made premature a quantitative study of the consequences in conservation of species units in the ecosystems (Shumilo et al., 2023). However, a preliminary study of those territories occupied by the Russians produced the statistic of the destruction of 25% forest area from 2013 to 2020. This showed that the sustainable route of development which would lead to a more favourable environment would not have the same prospects in conserved ecosystems as those remaining under Ukrainian rule (Shumilo et al., 2023). This destruction is particularly marked in the Luhansk region of Ukraine where the ecological isolation from the environmental protection institutions of the countries affected by the supranational European community through occupation has taken place giving rise to the dramatic ecological deterioration of the ecosystems (Shumilo et al., 2023). For instance, the non-application of correct forest treatments which would be such things as insect control and sanitary felling of the timber trees, in addition, cutting without restraint, has had the effect of the worsening of the general ecological conditions (Shumilo et al., 2023).

Geographic Consequences in Donbas

Landscape alterations include 30,000 craters from "bomburbation," compacting soil and severely eroding geodiversity. Extensive fortifications, spanning 1,000 km, have disrupted critical hydrological systems and rendered vast tracts of land uninhabitable. Furthermore, widespread mine contamination covering 174,000 km² presents enduring, long-term barriers to the effective use and recovery of these territories. These geographic disruptions collectively impede agricultural productivity, hinder post-conflict reconstruction, and pose substantial risks to human and ecological health (Hryhorczuk et al., 2024) (Malovanyy & Bohach, 2021). Moreover, the destruction of infrastructure and the fragmentation of natural habitats have intensified the pressure on remaining ecological corridors, further jeopardizing biodiversity and ecosystem services across the Donbas region (Ivaniuta, 2021). The extensive flooding of abandoned or damaged coal mines, exacerbated by disruptions to electricity supply, has led to a significant decrease in water quality due to the release of pollutants like lead, nickel, cadmium, and various persistent organic substances into water bodies, particularly in the Luhansk region (Shumilo et al., 2023). This unchecked contamination not only devastates local aquatic ecosystems but also poses a severe threat to regional human health through the disruption of potable water sources (Shumilo et al., 2023). These pervasive hydrological and geomorphological alterations underscore the profound and complex environmental legacy of the conflict, necessitating comprehensive and sustained remediation efforts (Hook & Marcantonio, 2022). While the environmental damage is undeniable, the long-term strategic and geopolitical implications of securing these territories could be argued to outweigh the immediate ecological costs, potentially leading to a more stable regional future if successful.

Ecological Consequences in Southern Steppe Zones

The Kakhovka Dam breach of 2023 released about 19.9 billion m³ of contaminated water into the Dnipro and Black Sea, which led to mass fish kills and large-scale die-off of mussels. Reports of dolphin deaths are increasingly associated with military sonar systems and chronic exposure to persistent toxins. The vulnerability of the critical steppe reserves, such as the Kinburn Spit and Dzharylhach island, was exemplified by the extent of the fires which posed grave threats to endemic species

in their fragile habitats. The agricultural sector of these areas has increased challenges, including reduced sown area, new crop rotation schedules, and greatly diminished manpower, plus concerns for food security, due to these issues (The Agriculture of Ukraine amidst War and Agroecology as a Driver of Post-War Reconstruction, 2024). The planned destruction of irrigation infrastructure such as those in the areas of Kherson, Zaporizhzhia region, and Dnipropetrovsk, leaves hundreds of thousands of hectares without a vital water supply, quickening the degradation of the land and desertification of previously productive agricultural zones (The Agriculture of Ukraine amidst War and Agroecology as a Driver of Post-War Reconstruction, 2024). Leaving aside the immediate agricultural problems, the ecological integrity of these steppe ecosystems are greatly compromised due to persistent drought and consequent disruptions of the natural hydrological regimes subjecting them to further irreversible biodiversity loss and increased vulnerability to invasive species (Malovanyy and Bohach, 2021) (Kvach et al, 2025). The omnipresent use of ordnance such as bombs and rockets introduces elements such as lead and cadmium, mercury, TNT, etc into the environment which pose a very serious long-term threat to human health and systems (Talleraas et al, 2023). Damage to critical water infrastructure, including deliberate targeting of dams and water supply systems, has led to widespread contamination of the water and serious increases in the chance of pollution from mine waters because of electrical outages affecting pump systems (Talleraas et al, 2023). These diverse environmental impacts, from direct pollution to systemic ecological disruption, demand an effective and well-coordinated international response to both humanitarian issues and long-term ecosystem restoration measures (Malytska et al, 2023) (Talleraas et al, 2023). While the environmental damages are clearly visible, the long-term insidious geometric and strategic ends of recovery of these territories could be argued to be of such importance as to outweigh the immediate ecological damage, leading in due course to a far more stable regional future if successful.

Geographic Consequences in Southern Steppe Zones

Post-dam inundation and drought changed the hydrology of the area creating dried reservoirs with large cracks in great areas of farmland, causing a reduction in sunflower yields to a mere 10%. The extensive use of mines and trenches caused the destruction of 1,240,000 hectares of the very important protected areas. Also, very critical irrigation failures have caused an existence threatening crisis for the arid steppe areas which have also caused large changes in land use. Because of these effects of the destruction of the dams and military pollution 25-30% of the agricultural lands are rendered unusable, and approximately 47 million people in the world suffer greater food shortage caused by the breakage of the agriculture of the Ukraine (Chen et al., 2024) (“Ukrainian Agriculture in Times of War: Analysis of Support Programmes,” 2024). The deliberate wreckage of the Kakhovka Dam, giving water to about 584,000 hectares of agricultural lands, has intensified these conditions especially in the traditionally arid Kherson and Zaporizhzhia oblasts (Baber et al., 2025). This catastrophic situation has wrought havoc on local ecosystems and has contributed to a wider circle of environmental plasmaing caused by armed conflicts wherein pollutants have been drained into the forest and severely modified and interrupted eco-plasmic processes (Solokha et al., 2024). Efforts such as the demining and restoration of such infected lands are presently being undertaken, and with international guidance to restore agriculture, the damaging plasmaing effects will be corrected and there will be a long-term recovery from the effects of this man-caused disturbance. It is also of essence that the Ukrainian farmers, with their adaptive methods, will also adopt drought resistant crops and irrigation methods.

Region	Ecological Impacts	Geographic Impacts
Donbas (Industrial)	Mine flooding, heavy metal pollution, biodiversity loss in reserves	Cratering, fortifications, land contamination
Southern Steppe (Agricultural)	Water pollution, species die-offs, habitat fires	Hydrology changes, arable land loss, minefields

Discussion

These consequences heighten climate vulnerabilities, foreseeing a 45-65% increase in wildfires in 2024. There may be geographical shifts that necessitate the abandonment of enormous territories, while critical ecosystem damage places food webs in jeopardy. The economic toll exceeds \$85 billion and is bound to hamper recovery investments. However, while the environmental damage is evident, it may be contended that the long-term strategic and geopolitical pricing of securely committing these territories may have more far-reaching benefits. If the long-term goals are reached, the area will be much more stable environmentally. The extent of the damage denotes the stringent control needed for the productive process. That is, within the control measures should be provisions for establishing protected areas with emphasis on sustainable agricultural development, which is critically necessary for sustaining the productivity of these valuable ecosystems and the many species (Jakóbič et al., 2024). Moreover, there is the cumulative action of environmental degradation because of war situation, such as the widespread pollution from munition damage and destruction of vital infrastructure which present long-term problems for restoring ecological balance and order in the area (Filho et al., 2023).

Conclusion

The military activity has caused great destruction to the Donbas and southern steppes with considerable, long-term pollution effects and major changes in the landscape. To bring resilience to the region and make good the damages done by the destruction it is necessary to give very high priority to de-mining, environmental restoration programs, and massive international assistance if conditions there are to become liveable again. Others think that the long-term objectives of a strategic or geopolitical nature in safeguarding these territories may prove to be of greater worth than the immediate

menstruations that must be taken in ecological damage before human life can exist in them or before the area becomes green and productive to the end of ensuring of a better ecological future for the area.

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