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THE ECOLOGY OF WAR: MONITORING WILDFIRES AND TOXIC EMISSIONS IN UKRAINE

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Ongoing military operations in Ukraine have caused severe damage not only to human livelihoods but also to ecosystems. Hostilities have increased the risk of catastrophic failures at industrial sites and critical infrastructure [1]. Beyond the tragic civilian toll, the conflict has triggered transboundary environmental and biomedical consequences [2]. A major result of the hostilities is widespread chemical contamination of air, soil, and water [3]. About 30% of Ukraine's territory is now contaminated by landmines and unexploded ordnance [1]. Warfare has fragmented landscapes, caused extensive wildfires—including in radioactively contaminated zones—and degraded protected areas, affecting nearly a third of Ukraine's designated ecosystems [1–2]. The seizure of the Zaporizhzhia Nuclear Power Plant and the destruction of the Kakhovka Dam further elevate the risk of a prolonged ecological crisis [1].

This study emphasizes an integrated monitoring framework that combines commercial satellite data from OroraTech with open-access Earth observation resources from the EU Copernicus program (Sentinel-2) and NASA systems (FIRMS). This multi-source approach enables rapid wildfire detection, continuous tracking of fire spread, and precise mapping of thermal anomalies and pollution patterns [4–6]. OroraTech's real-time data from over 20 commercial satellites significantly enhances the temporal resolution and operational response capacity compared to using only public satellite resources. Of particular concern are fires occurring in areas with radioactive contamination, where combustion processes can remobilize radioactive particles deposited in soil and vegetation since the Chernobyl disaster. The migration of these particles during wildfires creates a unique transboundary threat, as radioactive aerosols can travel far beyond national borders, complicating air quality management and emergency response. The synergy of multiple pollutants—including radionuclides, carbon oxides, and nitrogen oxides—further amplifies ecological and health risks.

Using the Ozone Mapping and Profiler Suite (OMPS) on the Suomi-NPP satellite, aerosol indices were analyzed to detect smoke plumes and trace pollutant dispersion over large distances. The combination of OroraTech's near real-time alerts with Copernicus and NASA datasets demonstrates the effectiveness of multi-service remote sensing for crisis monitoring. Such synergy provides timely data for local authorities to plan protective measures and supports scientific assessments of long-term environmental damage. Remote sensing thus serves as a vital tool for early warning, ecosystem risk assessment, and evidence-based post-conflict recovery planning. Given the continuing threats of soil contamination, biodiversity loss, and large-scale forest fires, strengthening Earth observation capabilities through innovative public–private partnerships is crucial. International collaboration will play a decisive role in mitigating environmental impacts and supporting ecosystem restoration.

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