Natural Resources for Human Health
eISSN: 2583-1194

Original Research
Received 10 March 2026
Revised 18 April 2026
Accepted 20 May 2026

Natural Resources for Human Health 2026, Vol. 6 (1s): 169–182

KEYWORDS:
War ecology; strategic energy infrastructure; Capitalocene; slow violence; environmental justice; sustainable energy transitions

War, Energy Systems and Ecological Degradation: Rethinking Environmental Sustainability in Contemporary Conflicts

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ABSTRACT: Contemporary warfare increasingly disrupts global energy systems, producing environmental consequences that extend far beyond active conflict zones. This article examines how strategic energy infrastructure—defined here as high-dependency energy assets such as pipelines, refineries, power stations, and fuel transport networks essential to civilian and industrial continuity—becomes both a target and instrument of modern conflict. Drawing on case studies of the Russia–Ukraine War, the Gaza conflict, and the Iraq War, the study adopts an interdisciplinary framework combining Capitalocene theory, Rob Nixon's concept of slow violence, and environmental justice perspectives to analyse the war–energy–environment nexus. The findings demonstrate that warfare intensifies fossil fuel dependency, generates significant atmospheric emissions, contaminates soil and water systems, disrupts biodiversity, and exacerbates energy insecurity among vulnerable populations. By situating warfare within Jason W. Moore's critique of capitalist resource extraction and "cheap nature," the paper argues that environmental degradation in conflict is not merely collateral damage but structurally embedded within geopolitical energy economies. The analysis also examines the temporal and spatial diffusion of ecological harm, highlighting how pollution and infrastructure damage persist long after direct hostilities cease. Rather than proposing idealized transitions, the study critically evaluates the feasibility of resilient post-conflict energy reconstruction, including decentralized renewable systems where contextually viable. The article concludes by advocating stronger environmental accountability in international humanitarian governance and more conflict-sensitive sustainable energy planning.

1. INTRODUCTION

War in the twenty-first century must be understood not only as a geopolitical or military event, but also as a process that reshapes ecological systems, energy infrastructures, and sustainability trajectories. Traditional conflict studies have largely examined warfare through questions of territorial sovereignty, political power, and economic control, while the environmental consequences of armed conflict have often remained secondary. However, in an era marked by accelerating climate instability, biodiversity decline, and energy insecurity, warfare demands renewed examination as a critical driver of ecological disruption.

Contemporary armed conflicts are deeply entangled with global energy systems. Fossil-fuel infrastructures—including oil pipelines, gas transit corridors, refineries, electricity generation facilities, fuel storage depots, and transmission networks—frequently occupy strategic positions within conflict geographies. In this study, *strategic energy infrastructure* refers to energy assets whose disruption produces significant military, economic, or civilian consequences due to their scale, network

centrality, or dependence relationships within regional energy systems. Such infrastructures function not merely as collateral sites of destruction but as deliberate instruments of coercion, territorial control, and geopolitical leverage.

Recent conflicts illustrate the measurable environmental implications of these disruptions. The Russia–Ukraine war, for instance, destabilized European gas markets, altered fuel procurement strategies, and temporarily increased dependence on coal in several energy systems. Likewise, the destruction of fuel depots, industrial facilities, and electricity infrastructure in conflict zones has generated atmospheric emissions, contamination risks, and ecosystem stress. At the same time, military institutions themselves remain highly energy-intensive, relying heavily on fossil fuels for logistics, transportation, weapons deployment, and operational maintenance. Warfare therefore contributes to environmental degradation not only through destruction, but also through its embedded dependence on carbon-intensive systems.

To analytically frame these dynamics, this study draws on two complementary theoretical perspectives: Jason W. Moore's concept of the *Capitalocene* and Rob Nixon's framework of *slow violence*. The Capitalocene provides a structural lens through which warfare can be interpreted not simply as isolated geopolitical rupture, but as embedded within capitalist systems of extraction, resource accumulation, and infrastructural control. Energy conflicts often emerge where strategic resources intersect with economic interests, revealing how ecological degradation is mediated through political-economic structures rather than generic human activity alone. In this sense, war becomes both a consequence and reinforcement of fossil-capital dependency.

Nixon's concept of slow violence helps illuminate the temporal and spatial dimensions of war-induced environmental harm. While explosions, fires, and infrastructure collapse constitute immediate and visible destruction, many ecological consequences unfold gradually across extended timeframes and beyond battlefield boundaries. Toxic soil contamination, groundwater pollution, methane leakage, biodiversity loss, and degraded agricultural productivity frequently persist long after formal hostilities end. These delayed consequences are often unevenly distributed, disproportionately affecting vulnerable populations with limited access to environmental recovery mechanisms, clean energy alternatives, or institutional protection.

This inequitable distribution raises important environmental justice concerns. Following Schlosberg's multidimensional framework, environmental justice in conflict contexts involves not only unequal exposure to ecological harm, but also questions of recognition, participation, and access to environmental resources. Populations in conflict-affected regions frequently face energy poverty, infrastructure collapse, and exclusion from reconstruction decision-making, making environmental degradation simultaneously an ecological and social justice issue.

Despite increasing scholarship on war ecology and environmental security, significant gaps remain. Existing studies often examine military emissions, resource geopolitics, or environmental destruction in isolation, while limited attention has been given to the interconnected relationship between warfare, strategic energy infrastructure, ecological degradation, and sustainable energy planning. Similarly, while environmental humanities offer critical interpretive tools for understanding ecological violence, these insights have rarely been translated into practical energy resilience or infrastructure governance frameworks.

This study addresses that gap through an interdisciplinary analysis of the Russia–Ukraine war, the Gaza conflict, and the Iraq War. These cases were selected because they represent distinct modes of conflict-related energy disruption: transnational energy weaponization, urban infrastructural collapse, and fossil-fuel-driven military intervention. Rather than treating war as a singular political event, the study conceptualizes conflict as an ecological-energy process with measurable environmental consequences.

The paper argues that sustainable energy planning cannot remain insulated from geopolitical conflict analysis. Energy resilience must include not only technological transition but also conflict vulnerability, environmental justice, infrastructural protection, and post-conflict ecological reconstruction. While decentralized renewable systems may improve resilience under certain conditions, their implementation in conflict zones remains contingent upon governance capacity, security conditions, and infrastructural feasibility. Therefore, sustainability discourse must move beyond idealized technological solutions toward context-sensitive frameworks grounded in ecological and political realities.

Finally, this study also engages with international governance limitations. Although international humanitarian law provides partial protection for civilian infrastructure, the classification, enforcement, and political implementation of such protections

remain contested in practice, particularly where energy assets possess dual civilian-military significance. Recognizing these limitations is essential if environmental sustainability is to be meaningfully integrated into conflict governance.

By positioning war at the intersection of ecology, energy, and political economy, this study contributes to broader sustainability scholarship by reframing armed conflict as a structural environmental problem rather than solely a military or humanitarian crisis.

2. LITERATURE REVIEW

Scholarly engagement with the environmental consequences of warfare has expanded across environmental humanities, political ecology, security studies, and sustainability research. Yet the specific relationship between warfare, strategic energy infrastructure, and ecological degradation remains insufficiently theorized. Existing studies often examine armed conflict either as a geopolitical event or as an environmental crisis, but rarely as a process where energy systems function simultaneously as strategic assets, ecological risk zones, and instruments of political control. This review identifies the conceptual and empirical foundations relevant to this study while locating the gaps it addresses.

A useful starting point is Rob Nixon's concept of *slow violence*, which explains forms of environmental harm that unfold gradually, remain dispersed across time and space, and often escape immediate public attention. Unlike direct wartime destruction—bombings, fires, or visible infrastructural collapse—slow violence captures delayed ecological consequences such as groundwater contamination, toxic soil accumulation, methane leakage, and biodiversity decline. In conflict settings, these effects may persist for decades after formal hostilities end. However, for this framework to move beyond metaphor, scholars must also consider temporal lag and spatial diffusion. Environmental damage from war is rarely confined to the immediate battlefield; atmospheric pollutants, contaminated waterways, and disrupted ecological chains frequently extend across borders. This makes slow violence particularly relevant for understanding warfare as a prolonged ecological process rather than a discrete military event.

While Nixon helps explain the temporal character of environmental destruction, his framework offers limited insight into the economic structures that produce such destruction. Jason W. Moore's concept of the *Capitalocene* addresses this limitation by locating ecological crisis within historical systems of capitalist accumulation rather than abstract "human activity." Moore's argument concerning capitalism's dependence on "cheap nature" is especially relevant to war-energy relations. Energy infrastructures—oil pipelines, gas terminals, refineries, storage facilities, transmission grids, and export corridors—are not merely technical systems; they are embedded within global circuits of capital, extraction, and geopolitical competition. In this context, warfare cannot be understood simply as territorial conflict, but as part of broader struggles over resource control, market stability, and strategic energy dominance. The destruction or capture of energy systems often produces economic opportunities for state and corporate actors, revealing how conflict may reinforce extractive capitalist logics rather than merely disrupt them.

To avoid conceptual ambiguity, this study defines *strategic energy infrastructure* as energy systems whose disruption produces consequences beyond localized service interruption. These include infrastructures characterized by high network connectivity, regional supply dependence, economic centrality, or civilian dependency. Such infrastructures include cross-border pipelines, refineries, electricity generation facilities, LNG terminals, and transmission hubs. Their strategic significance lies not merely in physical scale, but in their systemic role within energy security and civilian life. This operational framing improves comparability across conflict cases and helps distinguish incidental infrastructure damage from deliberate strategic targeting.

Environmental security scholarship has also contributed significantly to understanding the environment-conflict nexus. Homer-Dixon's work on environmental scarcity and conflict, along with Barnett and Adger's climate-conflict analyses, demonstrates how ecological stress may intensify political instability. These studies are important in explaining how environmental pressures can contribute to conflict emergence. However, they are less attentive to the reverse relationship: how conflict itself produces enduring environmental harm through infrastructural destruction, resource contamination, and ecological destabilization. This imbalance creates a significant research gap, particularly when examining energy-intensive warfare.

Recent research has begun addressing this omission through empirical assessments of military environmental impact. Belcher et al. (2019) highlight the substantial carbon footprint of military logistics, while Dalby (2013) situates warfare within broader environmental geopolitics shaped by global resource systems. Such studies establish that military institutions are not

environmentally neutral actors. However, quantitative environmental war studies often remain disconnected from critical theoretical interpretation, while humanities-oriented analyses frequently lack empirical specificity. This disciplinary separation limits comprehensive understanding.

The question of environmental justice further deepens this discussion. Schlosberg's framework, emphasizing distribution, recognition, and participation, offers a valuable lens for examining the unequal burdens of war-related environmental degradation. Environmental harm in conflict is rarely experienced equally. Marginalized populations often face the greatest exposure to polluted water, damaged energy access, degraded housing conditions, and ecological health risks, while possessing the fewest resources for adaptation or recovery. In regions such as Gaza, energy insecurity is inseparable from broader environmental injustice, where limited access to electricity, sanitation, and clean infrastructure intensifies humanitarian vulnerability. Integrating environmental justice into war-energy analysis shifts the discussion from ecological damage alone to questions of equity, access, and structural exclusion.

At the policy level, sustainable energy scholarship generally prioritizes technological innovation, market transitions, and decarbonization pathways, but rarely incorporates conflict vulnerability into energy planning. Recommendations for decentralized renewable systems frequently appear attractive in theory, yet evidence regarding their deployment in conflict settings remains uneven. Questions of infrastructure security, financing constraints, governance instability, and maintenance capacity complicate simplistic assumptions regarding renewable resilience. Therefore, rather than treating decentralized renewables as universally applicable solutions, this study approaches them critically as context-dependent possibilities requiring empirical validation.

Legal scholarship similarly presents limitations. International humanitarian law provides partial protection for civilian infrastructure, yet energy systems occupy ambiguous legal and strategic positions. Under Additional Protocol I, infrastructure may lose civilian protection if deemed to provide effective military advantage. Enforcement remains politically constrained, particularly where jurisdictional limitations or state interests obstruct accountability. Calls for stronger legal protection of energy infrastructure must therefore acknowledge practical constraints rather than assume straightforward implementation.

Ecocritical scholarship offers an additional interpretive contribution through its attention to environmental ethics, cultural imagination, and human-nature relations. Lawrence Buell's work emphasizes ecological consciousness and environmental representation, but contemporary conflict analysis requires moving beyond symbolic interpretation toward material infrastructures and policy consequences. Here, environmental humanities can enrich sustainable energy research by foregrounding ethical questions, vulnerability narratives, and justice-oriented stakeholder perspectives often absent from technical planning frameworks.

Taken together, the literature reveals an important fragmentation. Security studies explain conflict dynamics; sustainable energy research addresses technological transitions; environmental humanities interrogate ecological ethics; political ecology critiques extractive systems. Yet few studies bring these strands together to examine warfare as an ecological-energy phenomenon operating across material, structural, temporal, and ethical dimensions.

This study addresses that gap through an interdisciplinary framework integrating slow violence, the Capitalocene, environmental justice, and sustainable energy analysis. By examining warfare not simply as military confrontation but as a process that destabilizes energy systems, produces delayed ecological harm, and reinforces structural inequalities, the study offers a more comprehensive understanding of the war-energy-environment nexus.

3. MODERN WARFARE

Modern warfare is inseparable from energy systems, both in operational dependence and in its wider ecological consequences. For analytical clarity, this study defines **strategic energy infrastructure** as energy assets whose disruption produces significant military, economic, or civilian consequences because of their scale, network centrality, or dependence of surrounding populations. This includes oil and gas pipelines, refineries, electricity grids, fuel depots, power generation facilities, and transmission networks. Such infrastructures become strategic not merely because they supply energy, but because they shape the capacity of states and societies to sustain military operations, industrial activity, and civilian life.

Military institutions remain among the most energy-intensive public actors globally. Contemporary warfare relies heavily on fossil-fuel-based logistics, including aircraft deployment, naval mobility, armored transport, surveillance systems, and supply-

chain operations. The environmental consequences of this dependence extend beyond the battlefield, as fuel combustion and infrastructure destruction generate substantial greenhouse gas emissions. According to the Watson Institute's *Costs of War Project* (2023), military operations contribute significantly to institutional fossil fuel consumption, although precise estimates vary because many states do not publicly disclose military emissions. This lack of transparency itself represents a methodological challenge in assessing the environmental cost of warfare.

From a Capitalocene perspective, war cannot be understood merely as geopolitical confrontation; it must also be interpreted within the logic of resource-intensive capitalist expansion. Jason W. Moore's concept of "cheap nature" helps explain how energy systems are embedded within extractive economic structures that treat ecological resources as expendable inputs for military and industrial power. In this framework, conflict is not simply a disruption of energy systems but also a mechanism through which struggles over resource control, market access, and infrastructural dominance are intensified. The targeting of energy infrastructure therefore reflects not only military strategy but also deeper political-economic structures linked to fossil capital.

Recent conflicts demonstrate how warfare destabilizes energy transitions. The Russia–Ukraine conflict, for instance, disrupted gas flows across Europe, creating supply insecurity that compelled several countries to temporarily reactivate coal-fired power generation to stabilize electricity demand. This illustrates how conflict can reverse decarbonization efforts and reinforce short-term dependence on carbon-intensive energy systems.

War also produces unequal energy consequences. Civilian populations in conflict zones frequently experience acute energy insecurity, including disrupted electricity access, fuel shortages, and collapse of essential public services such as water treatment and healthcare systems. These effects align with environmental justice concerns, particularly Schlosberg's framework of distributive inequality, recognition, and procedural exclusion, as marginalized communities bear disproportionate ecological and energy burdens without meaningful participation in recovery planning.

Thus, war should be understood not only as an immediate military event but as an energy-system shock with long-term environmental implications. Its effects are material, infrastructural, and socio-ecological, disrupting both present energy access and future sustainability transitions.

4. ENVIRONMENTAL IMPACTS OF WAR

The environmental consequences of armed conflict extend far beyond the battlefield and often persist long after military hostilities cease. While the visible destruction of war—collapsed infrastructure, casualties, and immediate humanitarian crises—receives significant attention, ecological damage frequently unfolds more gradually across time and space. This aligns with Rob Nixon's concept of *slow violence*, where environmental harm accumulates incrementally and becomes difficult to quantify in conventional war narratives.

In contemporary conflicts, environmental degradation is closely tied to attacks on **strategic energy infrastructure**, defined here as energy assets whose disruption affects regional energy security, civilian livelihoods, industrial continuity, or transnational supply networks. These include pipelines, refineries, thermal power plants, fuel depots, transmission grids, and industrial processing facilities. Damage to such infrastructure produces not only immediate operational disruptions but also cascading ecological consequences.

From a Capitalocene perspective, these environmental disruptions are not merely accidental by-products of warfare; they are embedded within political-economic systems that treat energy landscapes, natural resources, and ecosystems as expendable instruments of strategic control. War therefore becomes both a symptom and accelerator of extractive ecological relations.

4.1 Atmospheric Pollution and Conflict-Related Emissions

Armed conflict contributes significantly to atmospheric degradation through direct military activity, destruction of industrial assets, and emergency energy substitutions. Air pollution emerges immediately during bombardment, infrastructure fires, fuel combustion, and military logistics operations.

The Russia–Ukraine conflict illustrates the measurable environmental burden of warfare. Carbon accounting studies have estimated substantial emissions associated with military fuel use, reconstruction demands, infrastructure destruction, and

landscape fires, though exact figures remain sensitive to methodology, temporal scope, and data availability. Such uncertainty highlights the importance of transparency in conflict-related environmental accounting.

Military machinery itself is highly carbon-intensive. Fighter aircraft, armored vehicles, naval fleets, and supply convoys consume significant quantities of fossil fuel, generating carbon dioxide alongside pollutants such as nitrogen oxides, sulfur compounds, and particulate matter. These emissions worsen both local air quality and global climate pressures.

Historical precedents further demonstrate this pattern. The Gulf War oil well fires generated large-scale atmospheric contamination, with smoke plumes extending across regional boundaries. Such incidents reveal the spatial diffusion of war-related pollution, where ecological damage frequently exceeds national borders. Airborne pollutants may persist for weeks or months, producing delayed health consequences including respiratory illness, cardiovascular stress, and toxic exposure.

Thus, atmospheric degradation during war should be understood not only as immediate destruction but also as a temporally extended environmental process.

4.2 Water and Soil Contamination

Conflict creates enduring contamination pathways through damage to industrial sites, fuel infrastructure, sewage systems, and hazardous storage facilities. Water and soil pollution often represent some of the most persistent ecological legacies of warfare because contaminants can remain embedded in environmental systems for decades.

Attacks on pipelines, refineries, and fuel depots frequently release petroleum hydrocarbons into surrounding ecosystems. Oil contamination disrupts aquatic biodiversity, reduces oxygen availability in water bodies, and compromises agricultural irrigation systems. Similarly, damage to chemical facilities may release toxic compounds, heavy metals, or industrial residues into groundwater systems.

The temporal dimension of contamination is especially significant. Unlike explosive destruction, which is immediate and visible, toxic seepage often unfolds gradually. Pollutants may migrate through soil layers over extended periods before becoming detectable in groundwater or agricultural land. This delayed manifestation makes remediation difficult and obscures causal accountability.

The Iraq conflict provides a clear example of such prolonged ecological harm, where hydrocarbon contamination and war-related toxic residues persisted long after military operations ended. Similar concerns have emerged in contemporary conflict zones where monitoring institutions are weakened or inaccessible.

Soil contamination also directly affects food systems. Agricultural land exposed to explosive residue, petroleum contamination, or industrial toxins often becomes unsuitable for cultivation, intensifying food insecurity and economic instability. Vulnerable populations dependent on local agriculture bear disproportionate consequences, linking ecological damage with environmental injustice.

4.3 Biodiversity Loss and Ecosystem Disruption

War significantly destabilizes ecosystems through habitat destruction, land fragmentation, pollution, and forced changes in land use. Forests, wetlands, grasslands, and coastal systems frequently become militarized spaces, resulting in direct ecological disturbance.

Habitat fragmentation is particularly damaging because ecological resilience depends on connectivity. When military infrastructure, bombardment zones, or land clearing divide habitats into isolated patches, species movement becomes restricted, breeding patterns are disrupted, and genetic diversity declines. These pressures increase extinction risks, especially for already vulnerable species.

Pollution further compounds biodiversity loss. Oil spills can devastate aquatic ecosystems, while chemical toxins accumulate in food chains, affecting reproductive health and species survival. In urban conflict zones, debris accumulation and sewage collapse create additional ecological stress.

These disruptions weaken ecosystem services essential to both human and environmental survival, including water purification, pollination, climate regulation, and soil regeneration. The destruction of biodiversity therefore represents not merely species loss, but the erosion of ecological systems that sustain communities.

From a Capitalocene perspective, biodiversity destruction reflects broader extractive logics in which ecological systems are subordinated to military and geopolitical priorities.

4.4 Long-Term Ecological Consequences and Sustainability Challenges

The ecological aftermath of war creates serious barriers to sustainability transitions. Damaged environments, weakened governance structures, disrupted infrastructure, and urgent reconstruction pressures often push post-conflict societies toward carbon-intensive recovery pathways.

One recurring pattern is renewed dependence on fossil fuels. When centralized energy systems are destroyed, governments frequently prioritize rapid restoration of conventional infrastructure over sustainable alternatives. Although this may address short-term energy insecurity, it can entrench environmentally harmful systems for decades.

This creates a strategic contradiction: reconstruction intended to restore stability may simultaneously deepen ecological vulnerability.

The concept of slow violence is particularly useful here because it explains how war's environmental consequences continue unfolding after formal conflict ends. Pollution migrates, ecosystems recover unevenly, public health burdens accumulate, and degraded environments reduce future development options.

These impacts also raise environmental justice concerns. Communities with limited access to clean energy, healthcare, or institutional protection face greater exposure to environmental harm and fewer opportunities for recovery. In places such as Gaza, damage to electricity, sanitation, and water infrastructure demonstrates how ecological destruction intersects with energy poverty and social inequality.

Consequently, war-related environmental degradation should not be treated as incidental collateral damage. It must be understood as a structural sustainability challenge that affects climate governance, energy transitions, ecological resilience, and social justice simultaneously.

5. CASE STUDIES: STRATEGIC ENERGY INFRASTRUCTURE, CONFLICT, AND ECOLOGICAL HARM

To examine the relationship between warfare, energy systems, and ecological degradation, this section analyses three conflict settings: the Russia–Ukraine War, the Gaza conflict, and the Iraq War. These cases were selected because each demonstrates a distinct mode through which **strategic energy infrastructure** becomes implicated in warfare.

For the purpose of this study, *strategic energy infrastructure* refers to energy assets whose disruption generates consequences beyond immediate military operations due to their systemic role in energy production, transmission, civilian dependence, or geopolitical supply chains. This includes pipelines, refineries, thermal power plants, fuel depots, electricity grids, and water-energy linked infrastructure. Such systems are not merely collateral casualties; their operational centrality makes them politically and militarily significant targets.

The selected conflicts also permit comparative analysis across temporal and spatial scales. While the Iraq War illustrates long-duration ecological contamination associated with fossil-fuel militarism, the Russia–Ukraine conflict reveals how attacks on interconnected energy systems generate transboundary environmental consequences. Gaza, by contrast, demonstrates how destruction of energy-dependent urban infrastructure intensifies ecological and humanitarian crises in densely populated regions. Together, these cases show that warfare produces both immediate environmental disruption and forms of ecological harm that persist across time.

5.1 Russia–Ukraine War: Energy Infrastructure as Strategic Target and Transboundary Ecological Risk

The Russia–Ukraine war provides a contemporary example of how strategic energy systems become embedded within military conflict. Ukraine occupies a critical position within European energy geography due to its gas transit infrastructure, storage systems, thermal power generation, and industrial energy networks. Because of this interconnectedness, attacks on energy infrastructure have consequences extending beyond national borders.

Conflict-related environmental assessments estimate that emissions associated with military fuel consumption, infrastructure destruction, fires, and reconstruction burdens have exceeded 170 million tonnes of carbon dioxide equivalent during the first two years of war. Although such figures vary depending on methodology, they indicate the measurable environmental

footprint of modern warfare. Methane leakage from damaged gas infrastructure presents an additional concern, given methane's significantly higher short-term warming potential relative to carbon dioxide.

The ecological implications extend beyond atmospheric emissions. Damage to fuel depots, industrial facilities, chemical plants, and electricity infrastructure creates risks of toxic contamination in soil and groundwater. Wartime disruption of environmental monitoring institutions further complicates assessment, delaying remediation and increasing uncertainty regarding cumulative harm.

This case also illustrates the temporal dimension of **slow violence**. Immediate explosions attract media attention, yet the environmental consequences unfold gradually through contaminated landscapes, damaged ecosystems, and prolonged reconstruction dependency on carbon-intensive energy systems.

From a **Capitalocene perspective**, the conflict demonstrates how fossil-fuel infrastructures function not merely as technical assets but as nodes within larger political-economic systems shaped by extraction, dependency, and geopolitical control. The disruption of Russian gas supplies and subsequent short-term return to coal use in parts of Europe reflects how war can reinforce carbon-intensive energy structures rather than accelerate sustainable transition.

The Russia–Ukraine case therefore demonstrates that strategic energy infrastructure is both a military target and an ecological vulnerability whose destruction generates regional and transboundary environmental consequences.

5.2 Gaza Conflict: Energy Insecurity, Environmental Justice, and Urban Ecological Collapse

The Gaza conflict presents a different but equally significant pattern of war-induced ecological degradation. Unlike resource-centered geopolitical conflicts, Gaza demonstrates how attacks on fragile urban energy systems can trigger severe environmental collapse in highly populated and infrastructure-constrained territories.

Energy infrastructure in Gaza is closely interconnected with water supply, wastewater treatment, healthcare operations, and civilian survival. Damage to electricity generation facilities, fuel delivery systems, and sanitation infrastructure has significantly reduced operational capacity across these sectors. As electricity shortages intensify, wastewater treatment systems fail, resulting in untreated sewage discharge, water contamination, and serious public health risks.

This case highlights the environmental justice dimensions of conflict. Ecological harm is not distributed equally; communities already facing structural vulnerability experience disproportionate consequences due to restricted access to clean water, energy, waste management, and healthcare infrastructure. Applying Schlosberg's environmental justice framework, the conflict reflects inequities in distribution (unequal exposure to ecological harm), recognition (marginalized civilian suffering), and participation (absence of agency in environmental decision-making).

The environmental consequences are immediate and cumulative. Air pollution from explosions, construction debris, hazardous material exposure, and unmanaged waste accumulation creates layered ecological stress. In dense urban environments, these effects rapidly intensify because ecological carrying capacity is already limited.

This conflict also illustrates **slow violence** through temporal extension. While infrastructure destruction appears immediate, contamination, health deterioration, ecosystem stress, and resource depletion continue long after visible military action subsides.

From an energy planning perspective, Gaza exposes the dangers of centralized and fragile energy dependence. The case suggests that resilience requires decentralized systems capable of sustaining critical civilian services under disruption. However, such transitions remain constrained by political instability, infrastructure damage, territorial restrictions, and governance limitations.

Thus, Gaza demonstrates how war transforms energy insecurity into ecological crisis, particularly where pre-existing structural vulnerabilities intensify environmental harm.

5.3 Iraq War: Fossil Fuel Militarism and Long-Term Ecological Damage

The Iraq War represents a historically significant case in understanding the environmental consequences of fossil-fuel-centered conflict. Unlike Gaza, where infrastructural fragility shapes ecological collapse, Iraq illustrates how resource geopolitics and fossil-fuel militarism generate long-term environmental degradation.

Oil infrastructure occupied a central strategic position throughout the conflict. Control over extraction sites, refineries, transport routes, and export systems formed an important dimension of military and geopolitical decision-making. This reflects the structural relationship between warfare and energy capitalism.

One of the most visible ecological consequences was large-scale atmospheric pollution associated with burning oil infrastructure. Smoke emissions, particulate matter, and toxic combustion residues contributed to regional air quality deterioration. Simultaneously, damaged petroleum infrastructure caused extensive soil and water contamination, affecting ecosystems, agriculture, and public health.

The most analytically significant feature of this case lies in its long-term ecological persistence. Contaminated land, degraded water systems, toxic residues, and unresolved environmental exposure remain concerns decades after active conflict. This temporal endurance aligns strongly with Nixon's concept of **slow violence**, where environmental destruction persists beyond immediate warfare and becomes normalized through delayed visibility.

The case also reinforces the **Capitalocene framework**. Iraq demonstrates how warfare may operate within broader systems of resource extraction, geopolitical control, and fossil-fuel dependency. Energy infrastructure here is not merely collateral damage but structurally tied to political-economic power.

Post-conflict reconstruction further deepens this contradiction. Recovery efforts frequently prioritize rapid economic stabilization through restoration of conventional fossil-fuel systems rather than ecologically sustainable alternatives. In this sense, reconstruction itself may reproduce the environmental logic that contributed to degradation.

The Iraq case therefore shows how war produces enduring ecological harm through fossil-fuel militarism and structurally embedded extractive economies.

5.4 Comparative Analysis

Taken together, these three cases reveal recurring patterns in the war–energy–environment nexus.

First, energy infrastructure emerges consistently as strategically significant due to its systemic civilian, economic, and geopolitical importance. Whether through gas transit networks in Ukraine, urban electricity dependence in Gaza, or oil extraction systems in Iraq, energy assets become central to conflict dynamics.

Second, environmental harm operates across multiple temporal scales. Immediate impacts include emissions, explosions, toxic releases, and infrastructure destruction. Longer-term effects include contaminated ecosystems, public health deterioration, carbon lock-in, and ecological recovery barriers.

Third, the environmental consequences vary according to infrastructural form and political context. Russia–Ukraine demonstrates transboundary energy disruption; Gaza reveals environmental injustice under infrastructural fragility; Iraq exemplifies fossil-fuel militarism and enduring contamination.

Finally, all cases suggest that warfare reinforces unsustainable energy trajectories. Destruction of infrastructure often increases short-term reliance on fossil fuels, while reconstruction prioritizes rapid restoration over ecological transformation.

Collectively, these cases support the argument that war should be understood not only as military conflict but also as a process of ecological destabilization embedded within global energy systems.

6. WAR AS SLOW VIOLENCE

The environmental consequences of warfare cannot be adequately understood through frameworks that focus only on immediate destruction, visible casualties, or damaged infrastructure. While explosions, burning fuel depots, and collapsed power systems represent the most visible dimensions of armed conflict, they capture only the immediate phase of ecological harm. A more comprehensive understanding requires attention to the gradual, dispersed, and often politically neglected forms of damage that continue long after active hostilities decline. Rob Nixon's concept of *slow violence* provides an appropriate analytical framework for interpreting these delayed environmental consequences.

Nixon conceptualizes slow violence as a form of destruction that unfolds incrementally across time and space, often escaping immediate public recognition because it lacks the dramatic visibility associated with conventional warfare. Applied to conflict ecology, this framework helps explain how war produces environmental harms that are temporally delayed, spatially diffused,

and socially uneven. Unlike direct battlefield violence, ecological damage often emerges through cumulative contamination, degraded infrastructure, interrupted ecological recovery, and weakened environmental governance.

The temporal dimension of slow violence is particularly significant in war-related environmental degradation. Environmental harm does not always become immediately measurable at the moment of military attack. The destruction of oil facilities, chemical plants, pipelines, and electricity infrastructure may trigger contamination whose effects appear months or even years later. Soil toxicity from petroleum hydrocarbons, groundwater contamination from damaged industrial systems, and respiratory illness caused by persistent particulate pollution frequently outlast the formal duration of conflict. This delayed manifestation complicates environmental accountability because cause and effect are separated over time, making remediation politically and institutionally more difficult.

The spatial dimension is equally important. Ecological harm generated in conflict zones rarely remains geographically contained. Methane leakage from damaged gas infrastructure, atmospheric emissions from fuel combustion, and water contamination from destroyed sanitation systems can extend far beyond the battlefield itself. The Russia–Ukraine conflict demonstrates this transboundary dynamic, where energy infrastructure disruption contributed not only to localized contamination but also to broader atmospheric emissions and global energy instability. Similarly, pollution generated in one region may enter hydrological systems, migrate through ecosystems, or intensify climate pressures elsewhere. Slow violence therefore operates not only temporally but geographically, crossing political borders and complicating conventional notions of territorial responsibility.

The case studies examined in this research illustrate these dynamics clearly. In Iraq, the destruction of oil infrastructure generated long-term atmospheric pollution, contaminated soils, and persistent ecosystem degradation whose effects remained visible decades later. In Ukraine, attacks on industrial and energy infrastructure created ecological risks extending beyond immediate military objectives, including contamination concerns linked to industrial leakage and fuel-related emissions. In Gaza, the destruction of sanitation systems, electricity supply, and waste management infrastructure has produced a prolonged ecological crisis characterized by water contamination, unmanaged waste accumulation, and declining public health conditions. These examples demonstrate that ecological harm in wartime is not merely collateral damage but an enduring environmental process.

A defining characteristic of slow violence is invisibility. Environmental destruction rarely receives the same level of media attention as battlefield casualties or geopolitical developments because its effects are cumulative rather than spectacular. Polluted groundwater, degraded soil fertility, toxic debris, and ecosystem disruption do not produce immediate visual drama, despite their profound long-term consequences. This invisibility contributes to policy neglect, as international responses often prioritize humanitarian emergency management while overlooking ecological rehabilitation.

Slow violence is also inseparable from environmental justice. Ecological harm produced by war is not distributed equally across populations. Communities already facing infrastructural fragility, poverty, displacement, or restricted access to public resources experience disproportionately severe consequences. Schlosberg's environmental justice framework helps explain this inequality through its emphasis on distribution, recognition, and participation. In conflict zones, vulnerable communities often bear the greatest environmental burdens while possessing the least institutional capacity to influence recovery decisions. In Gaza, for example, destruction of energy infrastructure intensifies energy poverty by limiting access to electricity, clean water treatment, and sanitation services. Environmental degradation therefore intersects directly with energy injustice, transforming ecological harm into a broader question of human survival and equity.

From an energy perspective, slow violence reveals how warfare destabilizes not only current supply systems but also future sustainability transitions. Damaged energy infrastructure often forces short-term dependence on carbon-intensive alternatives, while contaminated or militarized landscapes may delay renewable energy deployment. Reconstruction processes frequently prioritize rapid restoration over sustainable redesign, reinforcing fossil-fuel dependency rather than enabling resilient transformation. In this sense, ecological violence extends into energy governance itself.

This perspective also challenges conventional environmental governance frameworks, which are generally designed to address immediate disasters rather than cumulative wartime degradation. Existing policy mechanisms are better equipped to respond to identifiable accidents than to slow, conflict-generated ecological deterioration that unfolds over extended periods.

Recognizing war as a generator of slow violence therefore requires broader environmental monitoring, long-term ecological accountability, and post-conflict sustainability planning.

By interpreting warfare through the lens of slow violence, this study shifts attention from immediate destruction to enduring ecological transformation. Such an approach strengthens understanding of war's environmental consequences not as isolated episodes of damage, but as prolonged ecological processes that reshape landscapes, public health, energy systems, and environmental justice outcomes across generations.

7. DISCUSSION: IMPLICATIONS FOR SUSTAINABLE ENERGY PLANNING

The findings of this study suggest that warfare must be treated as a significant variable in sustainable energy planning rather than as an external geopolitical disturbance. Contemporary conflicts demonstrate that energy systems are not merely collateral victims of war; they frequently become deliberate strategic targets because of their scale, network centrality and their role in sustaining civilian life and state operations. Damage to pipelines, refineries, transmission systems and fuel storage facilities creates immediate supply shocks, but the consequences extend far beyond temporary disruption. Such attacks trigger emergency energy responses, increase dependence on carbon-intensive fuels and generate ecological harms that complicate long-term sustainability planning.

One important implication is the fragility of energy transitions during periods of geopolitical instability. The case studies examined in this paper indicate that conflict often compels states to prioritize short-term energy security over climate commitments. The return to coal and other fossil fuels during recent supply disruptions demonstrates how quickly sustainability goals can be deferred when energy access becomes uncertain. This pattern reflects a deeper structural contradiction identified by Capitalocene thinking. War does not simply interrupt energy systems; it exposes how global energy governance remains embedded within extractive economic structures that privilege immediate market stability, resource control and strategic advantage over ecological responsibility. In this sense, conflict intensifies already existing dependencies rather than creating entirely new vulnerabilities.

The discussion also highlights the need to reconsider infrastructure resilience. Centralized energy systems, while efficient under stable conditions, are particularly exposed during armed conflict because a limited number of critical nodes can be targeted with widespread consequences. However, the promotion of decentralized renewable systems should not be treated as a universal solution without contextual evaluation. Small-scale solar installations, hybrid microgrids and localized energy systems may offer resilience in some conflict-affected settings, but their effectiveness depends on factors such as maintenance capacity, security conditions, technological access and political governance. Sustainable energy planning must therefore adopt context-sensitive resilience models instead of assuming technological neutrality.

Another critical implication concerns the temporal and spatial dimensions of environmental harm. The ecological effects of warfare rarely conclude with the cessation of armed violence. Methane leakage from damaged gas infrastructure, contamination of groundwater, toxic soil accumulation and ecosystem fragmentation often emerge gradually and may persist for decades. These patterns align with the concept of slow violence, but the present analysis suggests that such violence should be understood in measurable material terms rather than only as a theoretical metaphor. Environmental monitoring in post-conflict zones should therefore become an integral part of energy recovery planning, particularly where delayed contamination may undermine future renewable deployment or public health.

The issue of environmental justice is equally central. Conflict-generated energy disruptions do not affect all populations equally. Vulnerable communities, displaced populations and economically marginalized groups often face prolonged energy poverty, limited access to clean infrastructure and greater exposure to environmental contamination. Sustainable energy planning in conflict and post-conflict regions must therefore move beyond technological reconstruction to questions of distributive and procedural justice. Access to energy should be treated not only as an infrastructure issue but as a matter of social equity and human security.

Post-conflict reconstruction presents both risk and opportunity. Historically, reconstruction efforts have prioritized rapid restoration of conventional infrastructure, often reinforcing fossil fuel dependence because such systems are already institutionally embedded and politically expedient. Yet reconstruction can also serve as a moment for structural transformation if sustainability principles are integrated from the outset. This requires long-term planning frameworks that link ecological restoration with energy redevelopment rather than treating them as separate policy domains.

The legal and policy dimensions also demand realistic consideration. Although stronger international protection for civilian energy infrastructure appears desirable, implementation remains constrained by existing interpretations of international humanitarian law, particularly where infrastructure may be classified as dual-use. Enforcement mechanisms are similarly uneven, especially in prolonged or politically contested conflicts. For this reason, sustainable energy governance cannot rely solely on legal protections; it must also include preventive resilience planning, international monitoring and institutional accountability mechanisms.

Finally, this study underscores the necessity of deeper interdisciplinary engagement. Environmental humanities contribute interpretive frameworks that illuminate how conflict reshapes ecological relationships, public memory and ethical understandings of environmental harm, while energy studies provide technical tools for infrastructure assessment and transition planning. Bringing these perspectives together allows for a more comprehensive understanding of warfare as both a material and ecological process. Sustainable energy planning in the twenty-first century requires precisely this kind of interdisciplinary thinking, particularly in a world where environmental crises and geopolitical instability increasingly intersect.

Overall, the evidence suggests that sustainable energy planning cannot remain insulated from conflict analysis. War destabilizes infrastructure, reinforces fossil fuel dependency, deepens environmental injustice and produces ecological damage that persists long after formal hostilities end. Any credible sustainability framework must therefore incorporate geopolitical risk, environmental accountability and equitable energy access as central planning concerns rather than peripheral considerations.

8. CONCLUSION

This study argues that contemporary warfare must be understood not merely as a geopolitical or military phenomenon, but as a multidimensional environmental and energy crisis with consequences that extend far beyond the battlefield. Across the examined conflicts, the destruction or disruption of **strategic energy infrastructure**—including pipelines, refineries, electricity grids, fuel storage facilities, and distribution networks essential for civilian and industrial functioning—demonstrates how energy systems become both instruments and casualties of war. Their damage produces immediate supply shocks while also generating wider ecological consequences through emissions, toxic contamination, and ecosystem destabilization.

The case studies of the Russia–Ukraine war, the Gaza conflict, and the Iraq war reveal that warfare intensifies environmental degradation through both visible destruction and delayed ecological harm. Air pollution from explosions and fuel combustion, contamination of water and soil through damaged industrial systems, and biodiversity loss through habitat disruption indicate that the environmental cost of conflict is neither temporary nor geographically confined. These effects often spread across borders and persist long after active combat has ended, making war an ecological process rather than a singular political event.

Rob Nixon's concept of *slow violence* provides an important framework for understanding these extended consequences. Environmental destruction caused by war frequently unfolds gradually, becoming visible only after significant temporal delay. Polluted groundwater, degraded agricultural land, toxic residues, and weakened ecosystems may continue to affect human and non-human communities for decades. Such delayed harm disproportionately affects vulnerable populations, especially those already experiencing fragile infrastructure, energy insecurity, or limited institutional support. In this sense, environmental justice becomes central to any discussion of conflict ecology, particularly where unequal access to clean energy and environmental recovery deepens post-war social inequalities.

The study also strengthens the relevance of the *Capitalocene* framework by demonstrating that warfare is not simply an accidental source of ecological damage, but is often embedded within larger systems of resource competition, fossil-fuel dependency, and geopolitical economic interests. Strategic control over energy resources has repeatedly shaped the logic of modern conflict, while post-war reconstruction frequently reproduces carbon-intensive development pathways rather than enabling sustainable transformation. This reflects the persistence of extractive economic structures in which ecological degradation becomes normalized within political and military decision-making.

From the perspective of sustainable energy planning, the findings suggest that resilience must be redefined beyond conventional supply security. Energy planning in conflict-prone regions should incorporate decentralized and adaptable systems where feasible, particularly those capable of reducing dependence on centralized vulnerable infrastructure. However,

the implementation of such alternatives remains constrained by political instability, governance breakdown, financial limitations, and security risks. Therefore, sustainable reconstruction requires context-sensitive planning rather than universal technological prescriptions.

The paper further highlights the limitations of current international governance mechanisms in addressing environmental harm during warfare. Although international humanitarian law offers partial protection for civilian infrastructure, enforcement remains inconsistent, particularly when energy systems occupy ambiguous strategic positions. Stronger international accountability frameworks are therefore necessary, though their implementation remains politically challenging.

Finally, this research contributes to interdisciplinary scholarship by bringing environmental humanities into dialogue with sustainable energy studies and conflict analysis. Ecocritical frameworks such as slow violence and the Capitalocene do not merely offer metaphorical interpretation; they provide analytical tools for understanding how environmental harm unfolds structurally, unevenly, and over time. Recognizing warfare as an energy-environment nexus is essential if sustainability discourse is to engage seriously with the realities of contemporary conflict.

Future research should focus on more systematic comparative data regarding conflict-related environmental emissions, transboundary ecological damage, energy poverty in war-affected regions, and post-conflict sustainable reconstruction models. A sustainable future cannot be imagined without accounting for the environmental afterlives of war.

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