

**MISSILES, DRONES AND THE CLIMATE CRISIS: ASSESSING THE
ENVIRONMENTAL IMPACT OF MODERN WARFARE UNDER INTERNATIONAL
LAW**

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Abstract

This article interrogates the environmental and climate consequences of modern warfare technologies, with particular focus on the deployment of missiles and drones in contemporary armed conflicts. While international humanitarian law (IHL) recognizes the need to protect the natural environment during hostilities, its existing framework remains limited and ill-equipped to address the cumulative and long-term environmental harm associated with technologically advanced warfare. The article identifies a critical doctrinal gap: the environmental effects of missile strikes and drone operations, including greenhouse gas emissions, toxic contamination, and ecological disruption, are rarely incorporated into legal assessments of military necessity or proportionality. Drawing on reports from recent conflicts involving large-scale attacks on industrial and energy infrastructure, it demonstrates how contemporary warfare contributes to environmental degradation and intensifies the global climate crisis. Adopting a doctrinal methodology, supplemented by empirical evidence, the article evaluates the adequacy of IHL, international environmental law, and climate law in regulating wartime environmental harm. It argues that existing legal thresholds, particularly the requirement of “widespread, long-term and severe” damage, set an unrealistically high bar, effectively shielding most environmentally harmful military conduct from legal scrutiny. The article concludes that, although international law contains relevant principles, it lacks coherence and effective integration across regimes. It advocates a recalibration of existing frameworks through a more flexible interpretation of proportionality, the systematic inclusion of environmental considerations in military decision-making, and greater transparency in reporting military emissions. Such reforms are necessary to ensure that international law remains responsive to the environmental realities of modern warfare.

Key words: International Humanitarian Law, Armed Conflict, Military Emissions, Environmental Protection, Climate Change.

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Introduction

Missiles and drones are typically discussed in terms of precision, deterrence, or strategic reach. Far less attention is paid to the environmental consequences that follow in their wake. These consequences are not always immediate or easily contained. Emissions released into the atmosphere, toxic contamination, and ecological disruption often unfold over time, extending beyond the site of attack and, in some cases, beyond the temporal boundaries of the conflict itself. Contemporary hostilities, including those involving Iran, Israel and the United States, illustrate how technologically advanced warfare operates at a scale capable of producing both immediate destruction and longer-term environmental harm.¹

International humanitarian law does recognise the need to protect the natural environment during armed conflict. Its existing framework, however, remains largely oriented towards direct and observable damage. The prohibition of widespread, long-term and severe environmental harm, alongside the incorporation of environmental considerations within proportionality and military necessity, reflects an attempt to regulate environmental effects within the broader structure of the law of armed conflict. Yet these rules were developed in a context where environmental harm was conceived primarily in visible and spatially bounded terms. They sit less comfortably with forms of harm that are cumulative, indirect, and scientifically diffuse. Emissions generated by missile launches, drone operations and large-scale military mobilisation, for instance, rarely feature in legal assessments, despite their measurable environmental impact.²

This points to a deeper structural misalignment. International environmental law, particularly in the context of climate change, has developed increasingly sophisticated mechanisms for addressing anthropogenic emissions and long-term ecological degradation.³ By contrast, the legal regulation of armed conflict has not integrated these developments in any systematic way. The result is a fragmented landscape in which environmentally harmful military activities,

¹N Crawford, *Pentagon Fuel Use, Climate Change and the Costs of War* (Watson Institute Brown University 2019); D Weir and W Zwijsenburg, *Environmental and Health Impacts of Explosive Weapons* (PAX and Conflict and Environment Observatory).

² P Sands, J Peel, A Fabra and R MacKenzie, *Principles of International Environmental Law* (4th edn Cambridge University Press 2018); United Nations Framework Convention on Climate Change 1992; Paris Agreement 2015.

³ D Bodansky, J Brunnee and L Rajamani, *International Climate Change Law* (Oxford University Press 2017) 209-313.

especially those contributing to climate change, fall between regulatory regimes rather than within them.⁰⁴

The concept of weaponised emissions offers one way of bringing this gap into sharper focus. It captures forms of environmental harm that arise as a routine consequence of technologically advanced military operations, rather than as isolated or unintended by-products. Such harm does not fit easily within the thresholds established by international humanitarian law, nor does it fall squarely within the scope of international climate governance. A significant dimension of wartime environmental impact therefore remains insufficiently regulated and, at times, effectively invisible within legal analysis.⁵

This article examines how international law responds to the environmental consequences of modern warfare technologies, with particular attention to missile systems and drone operations. It argues that existing legal frameworks are structurally ill-equipped to address climate-related harm because they privilege immediacy over accumulation and visibility over systemic impact. By situating technological developments within the broader legal architecture, the article seeks to expose the limitations of current approaches and to open space for a more integrated understanding of environmental harm in armed conflict.

Literature Review

Scholarly engagement with environmental protection in armed conflict has developed along two main trajectories, though their interaction remains limited. One strand focuses on the capacity of international humanitarian law to regulate environmental harm during hostilities. Another examines environmental degradation through the lens of international environmental law and climate governance. While both bodies of scholarship offer important insights, they often proceed in parallel rather than in dialogue, leaving significant gaps in the analysis of contemporary warfare technologies.

⁴ P Sands, J Peel, A Fabra and R MacKenzie, *Principles of International Environmental Law* (4th edn Cambridge University Press 2018); United Nations Framework Convention on Climate Change 1992; Paris Agreement 2015.

⁵ International Law Commission, *Draft Principles on Protection of the Environment in Relation to Armed Conflicts with Commentaries* (UN 2022); International Committee of the Red Cross, *Guidelines on the Protection of the Natural Environment in Armed Conflict* (ICRC 2020).

Within international humanitarian law, there is broad agreement that environmental protection occupies a relatively marginal position. Dinstein and Sassòli, for instance, emphasise that environmental considerations are embedded within general rules on the conduct of hostilities rather than articulated as an independent legal objective. This structural positioning has been widely criticised. Hulme and Henckaerts argue that the threshold of widespread, long-term and severe damage sets an exceptionally high bar, one that is rarely met in practice and therefore limits the practical effectiveness of environmental protections. Fleck similarly observes that environmental concerns are often subordinated to military necessity, reinforcing their secondary status within the legal framework.⁶

At the same time, scholars⁷ differ in their assessment of how these rules operate in practice. Some suggest that the flexibility of IHL allows for environmental considerations to be incorporated through interpretation, particularly within proportionality assessments. Others are more sceptical, pointing to the indeterminate nature of key terms and the absence of clear enforcement mechanisms. The work of the International Law Commission has sought to clarify these issues by articulating principles on the protection of the environment in relation to armed conflicts. However, the non-binding nature of these principles has led some commentators to question their practical impact.⁸

In contrast, international environmental law has developed more detailed mechanisms for addressing environmental degradation and climate change. Scholars such as Sands, Peel and Birnie highlight the evolution of treaty regimes aimed at regulating anthropogenic emissions and promoting sustainable environmental governance. These frameworks reflect a growing recognition of the cumulative and long-term nature of environmental harm. However, they are largely designed for peacetime application and do not directly engage with the realities of armed

⁶ D Fleck (ed), *The Handbook of International Humanitarian Law* (4th edn Oxford University Press 2021).

⁷ P Sands, J Peel, A Fabra and R MacKenzie, *Principles of International Environmental Law* (4th edn Cambridge University Press 2018); United Nations Framework Convention on Climate Change 1992; Paris Agreement 2015. N Crawford, *Pentagon Fuel Use, Climate Change and the Costs of War* (Watson Institute Brown University 2019); D Weir and W Zwijnenburg, *Environmental and Health Impacts of Explosive Weapons* (PAX and Conflict and Environment Observatory).

⁸ International Law Commission, *Draft Principles on Protection of the Environment in Relation to Armed Conflicts with Commentaries* (UN 2022).

conflict. As a result, military activities, particularly those generating significant emissions, remain insufficiently regulated within this domain.⁹

More recent scholarship has attempted to bridge this division by examining the relationship between armed conflict and climate change. Empirical studies, particularly those by Crawford, draw attention to the substantial carbon footprint of military operations, including fuel consumption, infrastructure destruction and the use of explosive weapons. These findings challenge the assumption that environmental harm in warfare is primarily localised or immediate. However, the legal implications of such evidence remain underdeveloped, and the integration of these insights into doctrinal analysis has been limited.¹⁰

A further gap concerns the environmental consequences of specific technologies such as drones and missile systems. While studies by Weir and Zwijnenburg document the environmental and health impacts of explosive weapons, including contamination and atmospheric pollution, these analyses are rarely situated within broader discussions of climate change or legal accountability. Given the centrality of these technologies in contemporary conflicts, this omission is significant.¹¹

Taken together, the literature reveals a fragmented and, at times, internally inconsistent approach to wartime environmental harm. International humanitarian law provides a framework that is both limited and difficult to operationalise, while international environmental law offers more developed tools that do not extend effectively into conflict situations. Although emerging work on military emissions introduces an important empirical angle, it has yet to be fully integrated into legal analysis.

This article engages with these strands by positioning the concept of weaponised emissions as a point of intersection between them. In doing so, it moves beyond descriptive accounts of environmental harm to interrogate the underlying assumptions that shape its legal regulation, and

⁹ P Sands, J Peel, A Fabra and R MacKenzie, *Principles of International Environmental Law* (4th edn Cambridge University Press 2018); P Birnie, A Boyle and C Redgwell, *International Law and the Environment* (4th edn Oxford University Press 2021).

¹⁰ N Crawford, *The Pentagon, Climate Change and War: Charting the Rise and Fall of US Military Emissions* (MIT Press 2022); N Crawford, *Pentagon Fuel Use, Climate Change and the Costs of War* (Watson Institute Brown University 2019).

¹¹ D Weir and W Zwijnenburg, *Environmental and Health Impacts of Explosive Weapons* (PAX and Conflict and Environment Observatory).

to question whether existing frameworks are capable of addressing the climate implications of modern warfare technologies.

3. The Environmental and Emissions Footprint of Modern Warfare Technologies

3.1 Missile Strikes and the Destruction of Industrial and Energy Infrastructure

It is often easier to describe what a missile strike destroys than what it leaves behind. The former is immediate and visible, the latter tends to disperse. When industrial and energy infrastructure is targeted, the effects do not stop at structural damage. Fires take hold, chemicals are released, and something less contained begins to circulate through air, soil and water. In some cases, the damage continues long after the strike itself has receded from attention.¹²

These sites are usually approached through the language of military advantage. Refineries, power plants and storage depots are framed as strategic targets, and often with good reason. Still, the consequences of their destruction do not sit neatly within that frame. Explosions generate particulate matter, greenhouse gases and hazardous substances, and where petrochemical infrastructure is involved, the scale of emissions can be considerable. Over time, these processes can lead to groundwater contamination and broader ecological disruption. The effects are cumulative, though they do not always present themselves as such.¹³

Attacks on energy infrastructure have produced fires and pollution that extend beyond the immediate area of impact. Recent conflicts bring this into sharper focus. In Ukraine, attacks on oil depots, fuel storage facilities, electricity infrastructure, and industrial installations have generated significant air, soil, and water pollution, prompting concerns regarding long-term environmental degradation. Similar concerns have arisen in relation to recent hostilities involving Israel and Iran, where strikes targeting energy and military infrastructure raised fears of pollution, toxic releases and wider ecological consequences.

Reports tend to capture these effects in fragments, while the legal analysis that follows them often narrows again. Proportionality continues to turn on civilian harm in its more immediate forms, and environmental consequences, especially those that travel or accumulate, remain less

¹² Ibid.

¹³ United Nations Environment Programme, *Protecting the Environment During Armed Conflict: An Inventory and Analysis of International Law* (UNEP 2009).

clearly situated. It is not entirely clear how they are weighed, or whether they are weighed at all.¹⁴

And yet, repetition changes the picture. A single strike may be treated as an isolated event, but a series of strikes, over time, begins to look different. Emissions persist, damage settles unevenly, and what initially appears episodic starts to resemble something more continuous. This is where the difficulty sharpens, legal thresholds are calibrated to moments, while the harm, increasingly, is not.¹⁵

3.2 Drone Warfare and Cumulative Ecological Disruption

If missile strikes are defined by intensity, drone warfare is defined by duration, or something close to it. The distinction is not absolute, but it matters. Drones do not always produce the same scale of immediate destruction. What they enable instead is presence. They remain, they return, and in doing so generate a different kind of environmental effect, one that builds gradually rather than arriving all at once.

This is not always easy to register. A single strike may leave little trace when compared to large-scale bombardment, but repetition alters the terrain. Surveillance, targeting, and the infrastructure that sustains them introduce ongoing disturbances. Habitats shift, wildlife moves or disappears, and agricultural land may degrade, though often slowly enough to evade immediate attribution. The damage is not absent; it is just less concentrated.¹⁶

There is also the question of what supports these operations. Drone warfare depends on networks, fuel, maintenance systems and data infrastructures that extend well beyond the site of conflict. These elements rarely appear in legal discussions of environmental harm, perhaps because they are too diffuse, or because they fall outside the conventional frame of the battlefield. Yet they form part of the same system.¹⁷

¹⁴ United Nations Environment Programme, *The Environmental Impact of the Conflict in Ukraine: A Preliminary Review* (UNEP 2022); Britta Sjostedt, 'Protecting War's Unseen Environmental Damage' *NJIL* 94(1):24-44. UNEP 2025.

¹⁵ International Committee of the Red Cross, *Guidelines on the Protection of the Natural Environment in Armed Conflict* (ICRC 2020).

¹⁶ D Weir and W Zwijnenburg, *Environmental and Health Impacts of Explosive Weapons* (PAX and Conflict and Environment Observatory)

¹⁷ N Crawford, *Pentagon Fuel Use, Climate Change and the Costs of War* (Watson Institute Brown University 2019).

What complicates matters further is the way drone operations are distributed across space. They do not remain in one place; their footprint stretches, sometimes across regions that are only intermittently associated with active hostilities. This dispersal makes harm harder to see as a single event, and it appears instead as a pattern, though not always one that law is equipped to recognise.

The literature has not entirely kept pace with this shift. Much of it remains focused on targeting, accountability and civilian protection. These are important concerns, but the environmental dimension sits somewhat to the side, not absent, but not fully integrated either. The question, then, is not simply what drones do, but how their effects are framed, or left unframed in legal terms.¹⁸

3.3 Military Emissions, Atmospheric Pollution and Climate Impact

When military activity is being carried out, the distinction between battlefield environmental effects and broader environmental outcomes becomes increasingly difficult to separate, because military activities generate emissions and environmental harm at every stage of an operation; from the moment of preparation, deployment, logistical support, and post-conflict recovery. The environmental impacts of these extend beyond the immediate context of hostilities in both time and space.

Armed forces consume fuel on a scale that is difficult to ignore. Transportation, infrastructure and combat operations all contribute to greenhouse gas emissions, though not always in ways that are systematically recorded.¹⁹ Missile launches, aerial operations and armoured movement generate direct emissions, while the destruction of infrastructure releases additional carbon and hazardous substances into the atmosphere.²⁰ None of this is especially controversial. What is less clear is how these contributions are treated within existing legal frameworks.

The effects do not end when hostilities cease. Reconstruction introduces another layer. Rebuilding damaged infrastructure, clearing debris and restoring affected environments generate

¹⁸ M N Schmitt and S Watts (eds), *The Law of Armed Conflict: Contemporary Challenges* (Cambridge University Press 2020).

¹⁹ United Nations Environment Programme (UNEP), **Environmental Impacts of Armed Conflict: Inventory and Analysis** (2022); International Committee of the Red Cross (ICRC), **Guidelines on the Protection of the Natural Environment in Armed Conflict** (2020).

²⁰ Conflict and Environment Observatory (CEOBS), **Environmental Impacts of Explosive Weapons and Infrastructure Destruction** (2022); UNEP, **Environmental Consequences of the War in Ukraine** (2023).

further emissions, often over extended periods.²¹ In that sense, the climate footprint of conflict does not have a clear endpoint, and it stretches forward even as legal analysis tends to remain tied to the period of active hostilities.

Empirical work has begun to map this more carefully. Military emissions, particularly from technologically advanced states, account for a measurable share of global greenhouse gases, although reporting remains uneven and, in some cases, deliberately limited²². Military activity therefore occupies an uncertain position within climate governance frameworks, present, but not fully accounted for within national emissions reporting obligations.²³

This is where the idea of weaponised emissions becomes more analytically useful. It is less a fixed legal category than a way of drawing attention to connections that might otherwise be overlooked. Emissions are not only a by-product of warfare; they are, in many cases, embedded within its operation, arising predictably from energy-intensive technologies and the targeting of emissions-intensive infrastructure. The difficulty is that they do not align neatly with existing legal categories, being too dispersed, too extended, and sometimes too indirect.

The problem, then, is not only regulatory but also perceptual. Missile strikes, drone operations and broader military activity produce environmental harm that is cumulative, transboundary and unevenly recognised. While international law does not ignore these effects entirely, it does not consistently hold them within view.

4. Environmental Protection under International Law

4.1 Environmental Limits on the Means and Methods of Warfare

International humanitarian law is usually taken as the primary framework governing the conduct of hostilities, including, in a qualified sense, the protection of the natural environment.

²¹ UNEP, **Post-Conflict Environmental Assessment and Recovery** (various reports).

²² Neta C Crawford, **Pentagon Fuel Use, Climate Change, and the Costs of War** (Brown University, 2019); Stockholm International Peace Research Institute (SIPRI), **Military Emissions and Climate Security** (2022).

²³ United Nations Framework Convention on Climate Change (UNFCCC), **Reporting Guidelines on National Greenhouse Gas Inventories**; see also discussions on the treatment of military emissions within national reporting obligations.

That protection, however, is neither autonomous nor especially stable. It tends to surface within broader rules regulating the means and methods of warfare, particularly distinction, proportionality and military necessity, and in doing so it often recedes into the background rather than standing on its own.

The principle of distinction requires parties to differentiate between civilian objects and military objectives. In some cases, this offers a measure of indirect protection to elements of the natural environment, at least where they can plausibly be characterised as civilian. Yet that protection is fragile. Once environmental features acquire military relevance, or become entangled with infrastructure that does, they are drawn into the logic of targeting. In practice, this has allowed attacks on energy facilities and industrial installations to proceed, even where the environmental consequences are likely to be extensive.²⁴

Proportionality, at least in theory, operates as a further constraint. It prohibits attacks expected to cause excessive incidental harm relative to the anticipated military advantage. Still, environmental harm does not sit comfortably within this calculus. The focus remains anchored in immediate civilian casualties and physical damage, while longer-term effects, including emissions and ecological degradation, tend to fall at the edges of the analysis. It is not entirely clear how such harm is weighed, particularly where its effects unfold gradually rather than at the moment of attack.²⁵

Military necessity introduces a further layer of uncertainty. It permits the use of force required to achieve legitimate objectives, subject to legal limits, but those limits are not always articulated with environmental harm in view. In the absence of clearer standards, the doctrine can accommodate actions with significant ecological consequences. The result is a framework in which environmental protection appears contingent, acknowledged in principle, yet often subordinated in practice.²⁶

²⁴ Protocol Additional to the Geneva Conventions of 12 August 1949 (Additional Protocol I) 1977 art 48.

²⁵ Protocol Additional to the Geneva Conventions of 12 August 1949 (Additional Protocol I) 1977 art 51(5)(b).

²⁶ Y Dinstein, *The Conduct of Hostilities under the Law of International Armed Conflict* (4th edn Cambridge University Press 2022).

4.2 The “Widespread, Long-Term and Severe” Damage Threshold

More explicit protection for the environment is found in the prohibition of methods or means of warfare expected to cause widespread, long-term and severe damage. This standard, reflected in Additional Protocol I, is often treated as the central environmental safeguard within international humanitarian law. Yet its reach, on closer inspection, is narrower than it first appears.²⁷

The threshold is cumulative. Damage must be widespread, long-term and severe, not merely one or two of these. In practice, this sets a bar that is difficult to meet. Many forms of environmental harm, including those associated with contemporary warfare technologies, fall below it, even where their effects are far from trivial. As the earlier discussion of missile strikes and drone operations suggests, harm may accumulate across time and space without ever crystallising into a form that satisfies the threshold at a single point.²⁸

Interpretation adds another layer of difficulty. The terms themselves remain open-textured. What counts as “widespread” or “long-term” is not fixed, and interpretations vary across states and commentators. This does not render the provision meaningless, but it does leave its contours uncertain. In some cases, that uncertainty may function less as flexibility and more as a source of indeterminacy.²⁹

More fundamentally, the threshold seems misaligned with the character of environmental harm in contemporary conflicts. Damage is often incremental, dispersed and temporally extended. It does not always present itself in ways that are easily captured at the moment of attack. The law, however, continues to look for precisely that kind of moment. The result is a gap, not simply between rules and practice, but between legal categories and the forms of harm they are asked to address.

4.3 The Interface between International Humanitarian Law and Environmental Law

If international humanitarian law offers one set of tools, international environmental law offers another, though the two do not always fit together easily. Environmental law has developed more

²⁷Protocol Additional to the Geneva Conventions of 12 August 1949 (Additional Protocol I) 1977 arts 35(3), 55

²⁸ K Hulme, *War Torn Environment: Interpreting the Legal Threshold* (Martinus Nijhoff 2004)

²⁹ The travaux préparatoires and commentary to Articles 35(3) and 55 of Additional Protocol I.

M Henckaerts and L Doswald-Beck, *Customary International Humanitarian Law Volume I: Rules* (Cambridge University Press 2005).

detailed principles for preventing harm and managing resources, but these are largely oriented towards peacetime conditions. Their application during armed conflict remains, in many respects, unsettled.³⁰

Some obligations appear to persist across both contexts. The duty to prevent transboundary harm, for example, has been recognised beyond peacetime alone. Still, its practical force during hostilities is uncertain. Many environmental treaties are silent on armed conflict, and where they are not, their provisions do not always translate smoothly into situations shaped by military necessity.³¹

The relationship between these regimes is often framed through the idea of *lex specialis*, with international humanitarian law taking precedence during armed conflict. That framing has a certain coherence, but it is not without cost. It risks narrowing the scope of environmental protection by filtering it through a framework primarily concerned with military conduct. Whether this amounts to coordination or, in effect, displacement is not always clear.³²

Efforts to bridge this divide have emerged, particularly in the work of the International Law Commission. These developments gesture towards a more integrated approach, though their practical influence remains limited. They suggest a direction of travel, but do not yet fully resolve the tension between humanitarian and environmental norms.³³

4.4 Climate Governance and the Regulation Gap in Military Emissions

Climate law introduces a further layer of complexity. The United Nations Framework Convention on Climate Change and the Paris Agreement establish a global framework for regulating emissions and addressing climate change. At first glance, these regimes appear comprehensive. Yet military activity occupies a more ambiguous position within them, present, but not always fully accounted for.³⁴

³⁰ P Sands, J Peel, A Fabra and R MacKenzie, *Principles of International Environmental Law* (4th edn Cambridge University Press 2018); P Birnie, A Boyle and C Redgwell, *International Law and the Environment* (4th edn Oxford University Press 2021).

³¹ *Pulp Mills on the River Uruguay (Argentina v Uruguay)* [2010] ICJ Rep 14.

³² International Law Commission, *Draft Principles on Protection of the Environment in Relation to Armed Conflicts with Commentaries* (United Nations 2022).

³³ *Ibid.*

³⁴ United Nations Framework Convention on Climate Change 1992; Paris Agreement 2015

Historically, military emissions have been treated differently, sometimes excluded, sometimes only partially included in national commitments. The reasons are not difficult to identify. National security concerns, combined with political sensitivities, have made states reluctant to subject military operations to sustained scrutiny. The result is a regulatory space that remains, to a significant extent, underdeveloped.³⁵

This becomes harder to ignore when viewed alongside the environmental footprint of contemporary warfare. Missile strikes, drone operations and infrastructure destruction generate emissions that contribute to climate change, even if they are not always recorded in those terms. As discussed earlier, these effects may be dispersed, delayed and difficult to attribute, but they are not insignificant.

The temporal dimension complicates matters further. Emissions do not end with hostilities. Reconstruction, remediation and rebuilding extend the climate impact of conflict beyond its formal conclusion. Existing frameworks, designed largely with peacetime regulation in mind, struggle to account for this extension. They are not easily able to follow the harm as it unfolds.³⁶

The absence of clear obligations in this area points to a broader limitation. International law has made considerable progress in regulating environmental harm and climate change in general. Yet when these issues intersect with armed conflict, the framework becomes less certain, less settled. The gap is not absolute, but it is difficult to overlook.

The legal landscape that emerges is uneven, though perhaps not unexpectedly so. International humanitarian law offers partial protection, shaped by thresholds and competing military considerations. Environmental law and climate governance provide more developed structures, but do not consistently extend into the realities of armed conflict. The result is not a complete absence of regulation, but something more fragmented.

What remains unresolved is whether this fragmentation can hold. The environmental and climate impacts of modern warfare technologies are cumulative, transboundary and long-term, while the law continues, for the most part, to approach them in more immediate and compartmentalised

³⁵ N Crawford, *The Pentagon, Climate Change and War: Charting the Rise and Fall of US Military Emissions* (MIT Press 2022).

³⁶ United Nations Environment Programme, *Environmental Rule of Law: Tracking Progress and Charting Future Directions* (UNEP 2023).

ways. Whether that approach is sustainable, as these impacts become harder to ignore, is perhaps still an open question.

5. Environmental and Emissions Harm in Contemporary Conflicts

5.1 Industrial Contamination and Emissions in the Russia–Ukraine Conflict

The Russia–Ukraine conflict is often cited as one of the clearest contemporary illustrations of how modern warfare technologies translate into environmental harm, not only in the sense of visible destruction, but in what follows from it, sometimes immediately, sometimes less visibly. The widespread use of missile systems and aerial bombardment against industrial and energy infrastructure has produced effects that do not remain confined to the battlefield, even if they are often described that way.³⁷

Attacks on oil depots, refineries and power generation facilities have triggered fires and explosions that release substantial quantities of greenhouse gases and toxic pollutants into the atmosphere.³⁸ These incidents degrade local air quality and, in some cases, contribute to broader climate effects through the emission of carbon dioxide and other climate-forcing substances. The destruction of industrial installations has also led to the release of hazardous chemicals, contaminating soil and water systems in ways that are likely to persist, though not always in ways that can be easily tracked.³⁹ The damage does not settle neatly.

Some of the more consequential effects are indirect, and perhaps less immediately legible. Damage to energy systems has, in some instances, required a shift towards alternative, often less efficient, fuel sources, thereby increasing overall emissions.⁴⁰ At the same time, disruptions to environmental monitoring systems have reduced the capacity to assess these impacts with any

³⁷ United Nations Environment Programme (UNEP), *Environmental Consequences of the War in Ukraine: A Preliminary Assessment* (2022);

Conflict and Environment Observatory (CEOBS), *Ukraine Environmental Damage Monitoring* (ongoing reports).

³⁸ UNEP, *Ukraine Conflict Environmental Impact Assessments* (2022–2023);

CEOBS, *documentation of fires at oil depots and industrial facilities*.

³⁹ UNEP, *assessments of industrial contamination and chemical release in Ukraine conflict zones*;

ICRC, *Urban Services During Protracted Armed Conflict* (environmental implications).

⁴⁰ International Energy Agency (IEA), *Energy Implications of the Ukraine Conflict* (2022); related analyses on fuel substitution and emissions.

precision.⁴¹ What emerges is a form of harm that is partially visible, partially obscured, and not always easy to attribute.

Still, what becomes difficult to ignore is its cumulative character. Repeated strikes on infrastructure generate sustained pollution and ecological disruption, suggesting that environmental harm in this context unfolds rather than occurs. Yet much of this harm, particularly in its atmospheric and incremental form, sits uneasily within existing legal categories, which remain oriented towards immediacy and what can be observed and measured at a given moment, rather than what accumulates across time.

5.2 Environmental Degradation and Atmospheric Pollution in the Gaza Conflict

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A different configuration appears in Gaza, though the underlying dynamics are not entirely distinct. Here, the intensity and spatial concentration of hostilities produce environmental effects that are at once immediate and layered. Destruction is visible, but it is also particulate, airborne and absorbed into the environment in ways that are harder to contain.⁴²

One of the more immediate consequences is the generation of debris and fine particulate matter. The collapse of buildings releases dust, asbestos and other hazardous materials into the atmosphere, creating conditions that affect both human health and surrounding ecosystems.⁴³ These effects are acute, though they do not end there. The destruction of sewage systems, waste infrastructure and water networks introduces further contamination, extending into land and marine environments in ways that may persist well beyond the period of active hostilities.⁴⁴

⁴¹ CEOBS, reporting on damage to environmental monitoring infrastructure in Ukraine; UNEP, environmental data gaps in conflict conditions.

⁴² United Nations Environment Programme (UNEP), *Environmental Impacts of Armed Conflict*; United Nations Office for the Coordination of Humanitarian Affairs (OCHA), situation reports on Gaza.

⁴³ World Health Organization (WHO), *Health Risks of Dust, Debris and Asbestos Exposure in Conflict Zones*; UNEP, urban environmental damage assessments.

⁴⁴ UNEP, *Environmental Assessment of the Gaza Strip*; OCHA, reporting on damage to water and sanitation infrastructure in Gaza.

Fires add another dimension, though perhaps a more familiar one. The burning of buildings, fuel storage facilities and other materials releases greenhouse gases and toxic substances, contributing to atmospheric pollution.⁴⁵ Conflict and Environment Observatory (CEOBS), Environmental

The precise scale of these emissions is not always clear, particularly in conditions of ongoing conflict, but their presence is difficult to dispute. What distinguishes this context is not only the scale of destruction, but its repetition within a confined space. Strikes occur in close proximity, sometimes in rapid succession, producing cycles of damage and pollution that reinforce one another. The harm becomes layered, not simply additive, but cumulative in ways that are not always immediately apparent.

As with the Ukraine conflict, environmental considerations tend to remain peripheral in legal and political discourse. Attention centres, understandably, on humanitarian consequences. Still, this leaves open a quieter question: how environmental harm, particularly when dispersed through air, debris and water systems, is accounted for within existing legal frameworks. At present, it is not entirely clear that it is.

5.3 Missile and Drone Attacks on Energy Infrastructure in Middle Eastern Conflicts

In the Middle East, a somewhat different pattern emerges, though it carries familiar elements. Conflicts involving Iran, Israel and other regional actors have increasingly involved missile and drone attacks on energy infrastructure, oil facilities, pipelines, storage installations. These are not incidental targets. They are selected, often precisely, for their strategic value.

The environmental consequences, however, are not easily contained within that logic. Such attacks often produce large-scale fires and, in some cases, oil spills. The combustion of fossil fuels releases carbon dioxide, methane and other pollutants into the atmosphere, while spills contaminate terrestrial and marine ecosystems. These effects may extend beyond national borders, raising questions about transboundary harm that are, in practice, difficult to resolve.⁴⁶

Drone technology complicates the picture further. Its precision is frequently emphasised, and with reason. Yet precision does not eliminate environmental consequence, particularly where the

⁴⁵ Conflict and Environment Observatory (CEOBS), Environmental Impacts of Explosive Weapons in Urban Areas; UNEP, reports on air pollution and conflict-related fires.

⁴⁶ Ibid.

targets themselves contain volatile or hazardous materials. In some cases, it may simply concentrate the impact. The relative ease of deployment also increases the likelihood of repeated strikes, introducing a cumulative dimension that is not always fully captured in legal analysis.⁴⁷

There are also effects that unfold more slowly, and perhaps less visibly. Damage to energy infrastructure disrupts production and supply chains, sometimes leading to the use of alternative energy sources or reconstruction processes that generate additional emissions. These are not always framed as environmental harms, but they extend the environmental footprint of conflict nonetheless.⁴⁸

Across these cases, a pattern begins to take shape, though not always in a straightforward way. The targeting of infrastructure with high environmental and emissions potential is not merely incidental. It appears, in some instances, to be part of the strategic logic of contemporary warfare. The law does not prohibit such targeting outright, but it does not fully engage with the environmental consequences that follow either.

Across these conflicts, the pattern is difficult to overlook, even if it resists easy categorisation. Missiles and drones are not only instruments of immediate destruction. They are also, in effect, carriers of environmental and climate harm, though that harm does not always register in the same way.

What these examples suggest is not simply that environmental damage occurs in armed conflict. That is already well established. Rather, they point to a form of harm that accumulates, travels and persists, sometimes beyond the frame within which it is legally assessed. While international law offers certain points of engagement, its application remains uneven, particularly in relation to emissions and long-term climate effects.

The gap that emerges is not abstract. It is grounded in the empirical realities of contemporary conflicts. And it raises a question that is not easily resolved, whether existing legal frameworks

⁴⁷ M N Schmitt and S Watts (eds), *The Law of Armed Conflict: Contemporary Challenges* (Cambridge University Press 2020).

⁴⁸ D Weir and W Zwijnenburg, *Environmental and Health Impacts of Explosive Weapons* (PAX and Conflict and Environment Observatory).

are capable of recognising, and responding to, forms of environmental harm that do not present themselves all at once, but instead unfold over time

7. Legal Gaps in

8. Regulating Climate and Emissions Harm in Armed Conflict

6.1 The Marginal Status of Environmental Harm in Proportionality Assessments

One of the more persistent limitations in the existing legal framework lies in the way environmental harm is handled within proportionality assessments. International humanitarian law, at least formally, prohibits attacks expected to cause excessive incidental damage. Still, the way this rule is applied suggests a quieter hierarchy of interests, one in which environmental considerations are, more often than not, pushed to the margins.

In practice, proportionality tends to centre on what can be counted. Civilian casualties, damage to identifiable objects, forms of harm that present themselves clearly and immediately. Environmental damage does not always behave in this way. Where it unfolds over time, or through less direct pathways such as emissions, it becomes harder to integrate into the balancing exercise. In some cases, it seems to fall away from it altogether.⁴⁹ This is not only a matter of emphasis, but also of method. There is no settled approach for evaluating environmental harm within proportionality analysis. Unlike civilian harm, which can often be approximated, environmental impacts are diffuse, layered, and sometimes only partially observable. That difference matters. It introduces a kind of structural asymmetry, one that makes certain harms easier to recognise, and others easier to set aside.⁵⁰

As the earlier discussion of missile strikes and drone operations suggests, much of the resulting damage is cumulative rather than immediate. Emissions build, contamination spreads, ecosystems shift gradually. Still, proportionality remains tied to the moment of decision. It is not entirely clear how forms of harm that unfold beyond that moment are meant to be accounted for. The result is not so much an explicit exclusion as a quiet form of omission.

⁴⁹ Protocol Additional to the Geneva Conventions of 12 August 1949 (Additional Protocol I) 1977 art 51(5)(b); Y Dinstein, *The Conduct of Hostilities under the Law of International Armed Conflict* (4th edn Cambridge University Press 2022).

⁵⁰ International Committee of the Red Cross, *Guidelines on the Protection of the Natural Environment in Armed Conflict* (ICRC 2020).

6.2 The Silence of International Climate Law on Military Emissions

If proportionality reveals one kind of gap, climate law reveals another. The United Nations Framework Convention on Climate Change and the Paris Agreement establish broad systems for regulating greenhouse gas emissions. On paper, they appear comprehensive. Yet military activity occupies a more uncertain position within these frameworks, acknowledged in some respects, but not fully brought within their scope.⁵¹

Historically, military emissions have been treated as exceptional. The reasons are familiar. Concerns about national security, the sensitivity of military data, the reluctance of states to subject defence activities to external scrutiny. In practice, this has translated into limited reporting and, in some instances, partial exclusion from national emissions inventories. The effect is that a potentially significant source of emissions remains only partially visible within the system designed to regulate them.⁵²

This position becomes more difficult to sustain when set alongside the patterns discussed earlier. Modern conflicts generate emissions through missile strikes, drone operations and the destruction of infrastructure. These emissions may be dispersed, delayed, or difficult to quantify with precision, but they accumulate nonetheless.

The difficulty, then, is not simply one of omission, but of alignment. Climate law seeks to regulate emissions on a global scale, yet it does not fully engage with a sector in which emissions are, arguably, both substantial and increasing. The silence is not absolute, but it is noticeable. And it creates a gap between what climate law aims to address and what it is, in practice, able to reach.

6.3 Attribution and Accountability Challenges under International Law

Even where environmental harm is recognised, questions of attribution and accountability remain unsettled. This is particularly so in relation to emissions and long-term ecological damage, where cause and effect do not always align neatly.

⁵¹ 51United Nations Framework Convention on Climate Change 1992; Paris Agreement 2015

⁵² N Crawford, *The Pentagon, Climate Change and War: Charting the Rise and Fall of US Military Emissions* (MIT Press 2022)

International law typically requires a reasonably clear link between conduct and harm. In contemporary conflicts, that link is often difficult to establish. Environmental damage may result from repeated strikes, infrastructure collapse, and secondary effects such as fires or contamination, all interacting over time. Responsibility, in these cases, is not always easy to isolate.⁵³

The temporal dimension complicates matters further. Some effects emerge only gradually, sometimes well after hostilities have ceased. This makes it harder to draw a direct line between a particular act and a particular harm, especially within legal frameworks that remain oriented towards immediacy. It is not that attribution is impossible, but that it becomes less certain.

International criminal law offers only a partial response. The Rome Statute recognises environmental damage as a war crime, but it adopts the familiar threshold of widespread, long-term and severe damage. As discussed earlier, that threshold is demanding, and in many cases, it excludes forms of harm that are cumulative or indirect.⁵⁴

Beyond this, enforcement mechanisms remain limited. There are few specialised processes for addressing environmental harm in armed conflict, and existing institutions are not always equipped to deal with the complexity of climate-related damage. The gap is not total, but it is difficult to ignore.

Taken together, these gaps do not suggest that environmental harm is entirely absent from international law. It is present, but unevenly so, recognised in some contexts and less clearly in others. Proportionality tends to privilege what is immediate, climate law leaves certain emissions insufficiently addressed, and attribution becomes uncertain where harm is dispersed across time and space.

What follows from this is not entirely settled. The environmental and climate impacts of modern warfare technologies continue to accumulate, often in ways that exceed the categories through which they are assessed. The question, then, may not simply be whether the law applies, but

⁵³ United Nations Environment Programme, *The Environmental Impact of the Conflict in Ukraine: A Preliminary Review* (UNEP 2022).

⁵⁴ Rome Statute of the International Criminal Court 1998 art 8(2)(b)(iv).

whether it is capable, in its current form, of keeping pace with the kinds of harm it now encounters

7. Towards Stronger Legal Responses to Climate Harm in Armed Conflict

Addressing the environmental and climate impacts of modern warfare does not necessarily require a wholly new legal regime. The existing frameworks already contain more than is sometimes acknowledged. The difficulty, perhaps, lies less in absence than in application, in how these rules are interpreted, and at times quietly set aside. Progress, if it comes, is likely to be incremental, and not always consistent.

What follows is not a blueprint, but a set of possible directions, shaped as much by constraint as by ambition.

7.1 Integrating Environmental Considerations into Proportionality Assessments

A first step lies in how environmental harm is treated within proportionality. International humanitarian law does not exclude it, but neither does it clearly centre it. In practice, its role remains uneven. Part of the difficulty may lie in the structure of proportionality itself, which tends to favour harms that are immediate and measurable. Environmental damage, particularly when cumulative or indirect, does not always present itself in those terms. It can be acknowledged, but not always in ways that alter the balance.

It is not entirely clear how far this can be addressed through doctrine alone. Still, states and military operators could develop clearer guidance recognising environmental harm, including longer-term effects, as part of incidental damage. Such adjustments would not transform the law, but they might begin to shift how it is applied in practice.⁵⁵

There are, in some cases, signs of movement through soft law and interpretive guidance. Whether these translate into consistent practice remains uncertain.⁵⁶

Yet doctrinal adjustment alone is unlikely to be sufficient.

⁵⁵ Y Dinstein, *The Conduct of Hostilities under the Law of International Armed Conflict* (4th edn Cambridge University Press 2022).

⁵⁶ International Committee of the Red Cross, *Guidelines on the Protection of the Natural Environment in Armed Conflict* (ICRC 2020).

7.2 Enhancing Transparency and Reporting of Military Emissions

If environmental harm is difficult to weigh, military emissions are, in many ways, difficult even to see. International climate law regulates emissions across sectors, but military activity continues to sit somewhat uneasily within these frameworks.⁵⁷

This reflects longstanding sensitivities around national security, which have resulted in partial reporting and, at times, omission. The outcome is not complete invisibility, but something close to it.⁵⁸

A more realistic approach may lie in gradual integration. Voluntary disclosure, particularly for non-sensitive activities, could offer a starting point. Over time, this might evolve into more structured reporting, though that is far from certain.

Still, visibility has its own effects. Even partial transparency may begin to shift how military emissions are understood, not only as operational by-products, but as part of a broader emissions landscape.

7.3 Strengthening the Role of Soft Law and Institutional Guidance

Where treaty reform appears unlikely, soft law offers a more flexible, if less direct, route. The work of the International Law Commission and the International Committee of the Red Cross provides a foundation. These instruments are not binding, but they can shape expectations and, over time, influence practice.

Their impact, however, is uneven. In some instances, they are taken up. In others, they remain largely aspirational. It is not always clear why. Further development could focus on the environmental implications of specific technologies, missiles, drones, infrastructure targeting. More detailed guidance may not resolve underlying tensions, but it could narrow the space within which environmental harm is treated as incidental. Even so, guidance without enforcement has its limits.

⁵⁷United Nations Framework Convention on Climate Change 1992; Paris Agreement 2015.

⁵⁸N Crawford, *The Pentagon, Climate Change and War: Charting the Rise and Fall of US Military Emissions* (MIT Press 2022).

7.4 Improving Accountability through Existing Legal Mechanisms

Accountability remains one of the more difficult questions. Not because mechanisms are entirely absent, but because they do not always align with the nature of the harm.

Existing frameworks, including international criminal law and state responsibility, provide avenues in principle. In practice, thresholds remain high and causation difficult to establish, particularly where harm is cumulative or delayed.⁵⁹

There may be some room for interpretive development, though whether institutions will move in that direction is uncertain.

Post-conflict processes, including reparations and environmental restoration, offer a more practical avenue. These processes are uneven and often under-resourced, but they remain one of the few spaces where environmental harm is addressed directly.⁶⁰ Still, accountability exists in partial and uneven forms.

Taken together, these pathways suggest that strengthening environmental protection in armed conflict is less about creating new structures than about reworking those already in place. The tools exist, though they are not always used in ways that reflect contemporary forms of harm.

Incremental reform may not be sufficient. It may not even be coherent. Still, it offers a starting point. The environmental consequences of modern warfare are becoming harder to ignore, even if they remain only partially recognised in law.

Conclusion

It is increasingly difficult to treat the environmental consequences of modern warfare as peripheral. They do not end with the strike. They linger, in emissions, in damaged systems, in forms of harm that unfold slowly and unevenly. Missiles, drones and the infrastructures they target produce effects that are not always visible at the moment they occur, but they accumulate nonetheless.

⁵⁹ 59Rome Statute of the International Criminal Court 1998 art 8(2)(b)(iv).

⁶⁰ United Nations Environment Programme, *From Conflict to Peacebuilding: The Role of Natural Resources and the Environment* (UNEP 2009).

International law does not entirely ignore this, yet it does not always meet it. Proportionality, for instance, still tends to focus on what can be seen and measured, while environmental harm, especially when delayed or diffuse, sits somewhat outside that frame. The result is a partial recognition. The harm is there, but its legal expression remains limited.

It might seem that what is needed is an entirely new framework. Still, it is not entirely clear that absence of rules is the central issue. In some cases, the difficulty lies in how existing principles are applied. Environmental considerations could be more fully integrated into proportionality assessments. Military emissions could be made more visible within climate governance. These are not sweeping changes, but they are not insignificant either.

Whether such adjustments will be enough remains uncertain. What seems clearer is that these harms no longer sit comfortably at the margins. They persist, even when the law does not fully register them.