Environmental Warfare Tactics in Irregular Conflicts

Anna Feuer

This article considers how, and under what conditions, actors in irregular conflicts weaponize nature. When do insurgents and counterinsurgents pursue environmental degradation—ranging from limited and short-term damage to ecocidal violence—as a tactic of war? To what extent do we see variation in the frequency and form of environmental warfare? And when do conflict actors exercise restraint in their use of violence against the natural environment? Often, the intentional destruction of the natural landscape is difficult to explain by reference to operational strategy or tactical logic alone. Deliberate attacks on the natural landscape, the frequency with which these tactics are deployed, and the diverse forms they take are conditioned by context-specific incentives, constraints, and intervening variables. I identify six categories of incentives and constraints that influence the decision to engage in environmental destruction: strategic, tactical, political, ideological, cultural, and technological. Using suggestive evidence from multiple case studies, I theorize some possible interactions between incentives and constraints that help to explain variation in the form and frequency of environmental warfare tactics.

> … And you shall attack every fortified city and every choice city, and shall fell every good tree and stop up all springs of water and ruin every good piece of land with stones. 2 Kings 3:19

> When you besiege a city for a long time, making war against it in order to take it, you shall not destroy its trees by wielding an axe against them. You may eat from them, but you shall not cut them down. Are the trees in the field human, that they should be besieged by you? Deuteronomy 20:19

1. Introduction

Of the tactics employed by the Islamic State to resist counterinsurgent forces and subjugate civilians, few produced such far-reaching damage as its deliberate annihilation of the natural environment in Syria and Iraq. In 2016, Islamic State fighters set fire to sulfur plants and oil fields in Qayyarah, near Mosul, releasing dense clouds of pollutant smoke to obscure their positions from American drones and warplanes (Zwijnenburg and Postma 2017). The fires resulted in humanitarian, environmental, and health crises: toxins seeped into the surrounding soil and water sources, contaminating croplands and causing serious respiratory and other medical conditions among the civilian population (El-Ghobashy and Warrick 2018).

In wielding environmental degradation as a weapon, the Islamic State drew on a wartime tactic with a long and devastating history—one that stretches from Cyrus' diversion of the Euphrates to overtake Babylon, to Sherman's scorched-earth campaign across Georgia and Virginia, to Saddam Hussein's destruction of Kuwaiti oil wells during the Gulf War. All wars entail environmental damage, often significant and sometimes irreversible (McNeill 2004). Yet there has been little effort by social scientists to identify the conditions under which conflict actors make use of environmental warfare tactics in either conventional or irregular warfare; the limited social science scholarship on this topic typically makes use of single case studies rather than cross-case analysis (e.g., Ahram 2015; Álvarez 2003; Braverman 2009; Grech-Madin 2021; Martin 2016).

This article considers how, and under what conditions, actors in irregular conflicts weaponize nature. When do insurgents and counterinsurgents pursue environmental degradation—ranging from limited and short-term damage to ecocidal violence—as a tactic of war? To what extent do we see variation in the frequency and form of environmental warfare? And when do conflict actors exercise restraint in their use of violence against the natural environment?

In some cases, there is a clear strategic or tactical logic that governs the treatment of nature in war. While counterinsurgents in Vietnam, Indonesia, Colombia, and Turkey carried out extensive defoliation in pursuit of guerrilla targets, their Marxist opponents adopted conservationist practices to conceal strategic bases in densely forested terrain (e.g., Álvarez 2003, 58). Often, however, the intentional destruction of the natural landscape is difficult to explain by reference to operational strategy alone. Consider the following examples:

- Conflict actors sometimes engage in widespread environmental destruction far beyond the threshold of

Anna Feuer is the Julian Steward Chair of the Social Sciences at Deep Springs College in Big Pine, California.

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military necessity. After the 1991 Gulf War, Saddam Hussein's government retaliated against Shi'a rebels by draining the marshes of southern Iraq (Hough 2016, 12). Cynically described as an agricultural development project, Saddam's actions obliterated the largest wetland ecosystem in the region and devastated the Ma'dan population that had inhabited the marshlands for over five thousand years (Human Rights Watch 2003).

- In other cases, conflict actors show restraint in their treatment of the natural environment even when military strategy might dictate otherwise. Despite extensive research into the development of cloud seeding during the Vietnam War, the United States agreed to prohibit the use of weather modification techniques in war as part of the 1977 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) treaty. More recently, the US military declined to bomb Islamic State-controlled oil wells, citing concerns about local environmental damage (Richardson 2015).
- The intentional and widespread destruction of the natural landscape often conflicts with the efforts of insurgents and counterinsurgents alike to secure the support of civilian populations. During the Vietnam War, the US military persisted in its use of Agent Orange even as the strategy alienated South Vietnamese farmers, whose hearts and minds it hoped to win, by inadvertently spraying their crops. The toxic chemicals proved a valuable propaganda tool for North Vietnamese forces competing with the United States for civilian loyalties (Martini 2012, 66).

The relative lack of scholarship on environmental warfare tactics represents a significant gap in the literature on political violence, counterinsurgency, and civil wars (King 2015; King and Burnell 2017; Sowers, Weinthal, and Zawahri 2017; and Van Etten et al. 2008 are important exceptions). While researchers frequently subsume attacks on the environment under the broad category of "scorched earth" (e.g., Stanton 2016), these attacks constitute distinct and often highly damaging operational tactics and means of exacting punishment on noncombatants. Moreover, the extensive literature on the effects of geography and terrain on conflict onset and outcomes is limited by its neglect of the (often dramatic) transformations that terrain features undergo during war.

The study of environmental warfare also has critical policy implications—made all the more urgent by the efforts of the Islamic State and al-Shabaab, among other groups, to weaponize water and other natural resources (King 2015). Environmental sabotage is a weapon unique in its potential to inflict long-term and devastating effects on civilian populations: herbicides and air pollution have spurred major public health crises from Vietnam to Iraq, while deforestation and other environmental warfare techniques can lead to soil degradation, water pollution, and resource depletion (Machlis and Hansen 2008). The disruption to local economies and civilian livelihoods that results from wartime environmental damage constitutes a form of "slow violence," marginalizing affected populations while also contributing to internal displacement, resource competition, and other drivers of violent conflict (Nixon 2011). While there has been more policy-maker attention to this topic than scholarly interest, international action to curtail environmental warfare remains limited in light of the weakness of the existing legal regime.

Deliberate attacks on the natural landscape, the frequency with which these tactics are deployed, and the diverse forms they take are conditioned by context-specific incentives, constraints, and intervening variables. This paper presents a new analytical framework to organize the distinguishable factors that influence the decision to adopt or discard environmental warfare tactics. I begin by defining environmental warfare and reviewing legal definitions of environmental war crimes. I then delimit the scope of my analysis and suggest how existing theoretical models from other literatures might apply to the study of environmental warfare. Describing the use of environmental warfare tactics over a broad range of irregular conflicts, I identify six categories of incentives and constraints that shape the weaponization of the natural environment: strategic, tactical, political, ideological, cultural, and technological. I then develop hypotheses that emerge from this conceptual framework to describe possible interactions between factors that make the use of environmental warfare tactics more or less likely. Finally, I conclude with additional observations to guide a broader research agenda on this subject.

2. Definitions and Scope Conditions

Defining Environmental Warfare Tactics

My definition of environmental warfare includes tactics that target the natural landscape directly (such as the use of herbicides and defoliants, river diversion, and the burning of croplands) or use elements of the natural landscape, including nonhuman animals, as a means of harming enemy combatants or civilians (such as efforts to contaminate water and livestock); for a similar approach, see Chalecki (2002). I consider environmental infrastructure, including oil and mineral installations, to be part of the natural environment (see Sowers, Weinthal, and Zawahri 2017).

Following Jensen (2005, 153), I distinguish between wartime tactics that entail the "intentional 'use' of the

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environment as a weapon of waging armed conflict" and those "not specifically designed to 'use' the environment for a particular military purpose but rather that have a degrading effect on the environment." I exclude from my definition the latter category—that is, ancillary, incidental, or collateral environmental damage in cases where the general destruction of war results in environmental degradation, but the landscape itself is not targeted directly (see Westing 2008, 69). For example, high-explosive munitions are likely to produce incidental (and perhaps significant) environmental damage, but I exclude them from my definition because they neither target the landscape directly nor "use" the environment to target the enemy (Westing 2008, 69). Likewise, the detonation of a nuclear weapon would produce environmental catastrophe, but I do not consider nuclear war to be a form of environmental warfare. I aim to distinguish the destruction of ecological conditions over and against those of human life; in aiming to destroy the conditions of *all* life, nuclear weapons obliterate that distinction. My definition *does* include the use of chemical and biological weapons designed to transmit toxins using soil, water, and other nonhuman organisms as a medium, or are directly intended to produce atmospheric pollution.

Demonstrating intentionality of action (such that we may distinguish between direct targeting and collateral damage) is intrinsically challenging, especially as any action in wartime may have more than one intent. That said, as Jensen (2005, 154) argues, empirical efforts to determine intent are essential to the long-term protection of the environment from wartime damage: even though "it is unlikely that warfare can ever be cleansed of its passive effects on the environment," we must work to "eliminate the intentional use of the environment as a weapon" in order to safeguard against some forms of severe degradation. My exclusions also aim to establish an analytical foothold by narrowing what would otherwise be an unmanageable universe of cases (see Kreike 2021). Accordingly, I exclude from my definition environmentally destructive activities undertaken in preparation for wartime operations or to provide war materiel. For example, while the use of Agent Orange to strategically clear Vietnamese jungle *does* fall under my definition, timber cutting and mineral extraction to support the production of weapons and fortifications *does not* (McNeill 2004). Nor does environmental damage incurred in the course of weapons testing or training and the movement of forces and materiel. Their exclusion is, again, intended for conceptual clarity and does not minimize the extent of environmental damage caused by war preparations (Machlis and Hansen 2008, 729).

Given that all wars produce environmental damage, pinning down a clear definition of environmental warfare is a particularly tricky task. Some weapons and tactics are difficult to classify. For instance, landmines, underwater mines, cluster bombs, and other area denial devices target enemy combatants, rather than the terrain itself; but we might think of landmines as an example of a weapon that uses mined terrain as a medium through which to inflict harm (see International Committee of the Red Cross 2020). I also include incendiary and explosive munitions in cases in which they are used to target natural cover, as in the use of napalm during the Greek Civil War and the Vietnam War (McNeill 2004, 402).

Legal Definitions

Legal definitions of environmental war crimes require that environmentally destructive actions meet certain threshold criteria: generally, the damage must be widespread, long-term, and severe. I aim to provide a thicker and broader definition of environmental warfare than is offered by existing legal instruments addressing ecocidal crimes; I include in this analysis activities that may be considered legal under *jus in bello.* Given the imprecision of the conditions required to prove criminal damage (discussed below), my definition does not impose specific threshold criteria regarding the geographical and temporal scope and severity of the damage. This is particularly important given that some wartime attacks on the natural environment may be purposefully designed to fall just short of these parameters (Brown 2001).

The legal regime governing environmental war crimes includes the 1977 ENMOD Convention, the 1977 Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of International Armed Conflicts (Protocol I), and the 1998 Rome Statute of the International Criminal Court (see Hough 2016, 15, for a timeline of international legal developments governing military ecocide). The United States is a state party to ENMOD but not to Protocol I or the Rome Statute. ENMOD, initiated by the United States and the Soviet Union in the wake of the Vietnam War, prohibits "environmental modification techniques" defined as "changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere, and atmosphere, or of outer space" (Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques 1977, para. 5). Its scope is narrower than the definition I provide above, as it is intended to prevent the modification of "synoptic systems," or large-scale ecosystems (Hamblin 2013, 211). The bombing of dams, for example, falls outside the convention (Hamblin 2013, 207). Moreover, ENMOD's provisions apply only to interstate war (Hough 2016; Leebaw 2014).

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The relevant articles of Protocol I are broader but less precise. Article 35 prohibits "methods or means of warfare which are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment," while Article 55 prohibits "the use of methods or means of warfare which are intended or may be expected to cause such damage to the natural environment and thereby to prejudice the health or survival of the population," as well as reprisals (Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of International Armed Conflicts 1977). Both ENMOD and Protocol I are widely viewed as ineffective, not only because of the difficulty of enforcing their provisions but also "due to the stringent and imprecise threshold required to demonstrate damage" (UN Environment Programme 2009). In both cases, all three conditions—"widespread, long-term, and severe" damage—must be proven in order to bring a charge of a violation. But "in practice," the United Nations Environment Programme notes, "this triple cumulative standard is nearly impossible to achieve, particularly given the imprecise definitions" of these terms (UN Environment Programme 2009, 51). The Rome Statute introduces a proportionality test but otherwise uses identical language, forbidding "widespread, long-term and severe damage to the natural environment which would be clearly excessive in relation to the concrete and direct overall military advantage anticipated" (Rome Statute of the International Criminal Court 1998, Article 8(b)(iv)).

Scope: Irregular Conflict

While environmental warfare tactics are deployed in all forms of conflict, including conventional warfare and even cyberwar (cyberattacks on environmental infrastructure would fall under my definition), I focus my discussion on irregular conflicts involving both state and nonstate actors. I do so for two reasons. First, even though irregular conflicts may not produce greater environmental damage (in terms of frequency and severity) than conventional wars, the natural environment arguably plays an outsized role in the strategic and tactical logic of civil wars and insurgencies (Galula 1964; Glaser and Kaufmann 1998). Nagl (2002, 16) highlights "the clever use of terrain to conceal guerrilla forces from the enemy's main body" as an "essential featur[e] of guerrilla warfare" that has "barely changed since the days of the Romans and Persians." To the extent that we conceptualize (counter)insurgency as a hide-and-seek contest in which both sides aim to manipulate the physical environment to their own advantage, we may understand environmental warfare as a *distinguishing imperative* of irregular conflicts. Certainly, some of the same incentives and constraints governing the use of environmental warfare tactics discussed in this paper (such as the destruction of enemy assets, or legal inhibitions on the weaponization of nature) are also present in conventional wars; but insurgents' reliance on natural cover and concealment as a means of hiding from their opponents' overwhelming firepower makes environmental manipulation a central feature of asymmetric conflict. Additionally, competition between insurgents and counterinsurgents for civilians' hearts and minds introduces particular political considerations that may condition the decision to adopt or discard certain environmental warfare tactics.

Second, attention to irregular warfare also allows me to consider incentives and constraints as they operate differently for conventional militaries and lower-tech rebel groups. Given the hide-and-seek logic of irregular wars, the unequal pressures imposed by international law, and other factors described in this paper, it is essential to distinguish between state and nonstate actors in any study of the conditions that make environmental warfare more or less likely. Again, it may be the case that certain incentives and constraints are present for state militaries regardless of conflict type (conventional or irregular); but for the purposes of this analysis, I conceptualize these incentives and constraints in the context of irregular warfare.

3. Explaining Variation in Environmental Warfare Tactics: Theoretical Models

As noted above, previous scholarship on environmental warfare tends to make use of single cases rather than cross-case or large-N studies. (Important exceptions include King and Burnell 2017; McNeill 2004; Peluso and Vandergeest 2011; Sowers, Weinthal, and Zawahri 2017.) Existing case studies underscore the causal value of three categories of incentives and constraints: strategic and tactical motivations to weaponize the landscape (e.g., Álvarez 2003; King 2015; Stanton 2016); legal and normative inhibitions that limit environmentally destructive techniques by state actors (e.g., Grech-Madin 2021; Martin 2016; Zierler 2011); and cultural and ideological orientations that encourage or restrain wartime environmental destruction (e.g., Ahram 2015; Brady 2012; Braverman 2009; Martini 2012). I review the existing evidence in support of each of these categories, as well as additional factors that may influence the decision to pursue environmental warfare tactics, in section 4 below. However, the focus on single-case analysis means that little work has been done to incorporate distinct cases into a broader theoretical framework to help us determine which of these categories might have greatest explanatory value under particular conditions.

The existing literature on (1) the accumulation and use of certain weapons by state actors and (2) the production of anticivilian violence during wartime provides us with two possible theoretical models for an investigation of conflict actors' treatment of the environment. Realist and rationalist perspectives account for the use or nonuse

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of nonconventional and other prohibited weapons—such as chemical, biological, radiological, and nuclear (CBRN) weapons, as well as cluster munitions and antipersonnel mines—in terms of the relative costs and benefits of material considerations, including the military utility of such weapons, their practicability and cost as compared to other available weapons, and the risks of escalation and retaliation. Any sustained pattern of nonuse may be explained as protecting the material interests of dominant states (see Tannenwald 1999 on materialist explanations of decision making about nuclear use). Normative or constructivist explanations, by contrast, point to the entrenchment of shared beliefs among state actors that militate against the use of certain weapons or techniques, regardless of utility (Price 1995; Tannenwald 1999).

Scholars of environmental warfare have also turned to materialist and normative explanations to account for state decision making on the use or nonuse of environmental warfare tactics (see, e.g., Grech-Madin 2021; Martin 2016). However, the field still lacks a theoretically guided research agenda that would help us to determine the relative utility of materialist and normative accounts across cases. For example, while Grech-Madin (2021) has argued for the existence of a long-standing taboo against the weaponization of water (akin to the nuclear taboo), this normative inhibition has not been extended to other environmental warfare tactics such as the deliberate setting of fires to deny use of terrain to the enemy, a technique practiced by US forces in Afghanistan (Montazzoli 2021). The water taboo's exceptionality suggests the need for further theoretical analysis as to why certain means of weaponizing nature may be subject to normative constraints while other highly destructive techniques are practiced freely. I return to the question of how scholars might weigh materialist against normative factors in section 6 below.

Existing studies of the production of violence against civilians in irregular conflicts cite a wide range of competing motivations and inhibitions. In addition to strategic and tactical incentives for attacking civilians, on the one hand, and legal and normative constraints that temper wartime violence, on the other, scholars have explored (1) armed groups' relationships with domestic constituencies, (2) territorial contestation, (3) belligerents' relative military capacities, (4) the extent to which group leaders are able to exert disciplinary control over their subordinates, (5) group ideology, and (6) individual psychological factors as possible determinants of violence against civilians. (For a review of research on violence against civilians in armed conflict, see Balcells and Stanton 2021.) These differing theoretical approaches reflect distinct levels of analysis: scholars who take a macro- or international-level approach may emphasize legal and normative efforts to protect the humanitarian treatment of civilians, while those who theorize the motivations for violence at the micro- or subnational level may focus instead on the ideological identity or organizational structure of armed groups.

The framework I develop in this paper makes use of theoretical insights from both of these existing research programs. Scholarship on the use and nonuse of certain weapons offers a model for assessing the use of weapons and tactics seen as exceptional and subject to international scrutiny, institutionalized prohibitions, or both; these include antiplant agents, napalm and landmines, attacks on oil installations, and water warfare. Likewise, research on variation in civilian targeting provides a useful array of possible explanations to the extent that we understand certain environmental warfare techniques as specifically designed to inflict violence or hardship upon civilian populations (for an example of a study that treats scorched-earth tactics as a form of violence against civilians, see Stanton 2016). Even in cases in which purposeful environmental destruction aims only at military (rather than civilian) targets, I find that this literature's multilevel analysis of the behavior of state militaries and rebel groups overlaps considerably (though not entirely) with existing explanations for conflict actors' engagement in environmental warfare. This overlap suggests that some of the same determinants may shape differing repertoires of violence in irregular wars, whether this violence aims at civilians, the natural landscape, or both.

4. Incentives and Constraints Shaping the Practice of Environmental Warfare

Geographically inaccessible spaces have long been the safe havens of rebel groups. State militaries, accordingly, develop ever-more effective "distance-demolishing technologies"—wartime forest felling and defoliation tactics among them—to further their control over these remote regions (Scott 2009). Yet the use of environmentally destructive tactics in war, whether employed by state militaries or nonstate armed groups, are conditioned by context-specific incentives, constraints, and intervening variables.

The following framework aims to organize potential explanations for why environmental warfare tactics are adopted or discarded by state and nonstate actors. I explore six categories of incentives and constraints—strategic, tactical, political, ideological, cultural, and technological—that influence the decision to weaponize the natural environment. The processes by which actors come to engage in or refrain from environmental warfare are more likely to be influenced by complex, interacting factors than they are to be straightforwardly linear or additive. My aim in this section is to identify some of these complex factors; in section 6, I attempt to theorize some possible interactions between causal mechanisms that make the use of environmental warfare tactics more or less likely. In doing so, I intend to provide a model by

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which future researchers may assess the plausibility of the relationships between, and the relative strengths of, the variables identified below in particular cases.

While my framework identifies distinct conceptual categories, in practice there is likely to be significant overlap between the factors described below. For example, in the case of Operation Ranch Hand—the United States' effort to defoliate forest cover using chemical herbicides during the Vietnam War—it may be difficult to distinguish explanations that cite high-modernist ideology on the one hand, and cultural perceptions of the South Vietnamese rainforest as wild and unproductive on the other (both ideological and cultural explanations are discussed in detail below). Indeed, these explanations are fundamentally intertwined: high modernist ideology implies an aversion to local and traditional techniques of cultivation, exemplified by the colonial administrator's orientalist attitude toward "native" environmental practices (Scott 1998). My conceptual framework does not imply that researchers should treat ideology and culture as disjunctive and monocausal variables, but rather as inseparable but nonetheless distinguishable factors. Whether they operate independently or in tandem is a question for empirical study of any given case. Following Balcells and Stanton's (2021) review of the literature on the production of violence against civilians, I recognize that these factors operate on different levels of analysis; accordingly, I identify each determinant as corresponding to an international, domestic/subnational, or organizational approach. While domestic/subnational approaches focus on interactions among state militaries, nonstate conflict actors, and civilian populations, organizational approaches highlight characteristics of individual militaries and armed groups.

Strategic

Strategic Cover and Base Areas (Domestic/Subnational). Environmental degradation may serve a number of operational aims for conflict actors in irregular wars. Most clearly, the hide-and-seek nature of counterinsurgency campaigns compels counterinsurgents to deny insurgents strategic base areas in remote geographical regions and remove natural cover that shields them from surveillance and aerial attack. This was the logic behind the use of Agent Orange and other chemical herbicides, first by the British during the Malayan Emergency in the early 1950s and subsequently by the United States in Southeast Asia in the 1960s and early 1970s. Other examples of widespread deforestation as a counterinsurgency strategy include the Indonesian state operating in Sarawak and West Kalimantan (Peluso and Vandergeest 2011), the Salvadoran government against the Farabundo Martí National Liberation Front (FMLN) (Hough 2016, 12), and the Turkish military against the Kurdistan Workers' Party (PKK) (Van Etten et al. 2008). While herbicides are perhaps the most well-known tool used to deprive insurgents of strategic cover, this technique can take a number of forms depending on the type of terrain in question. The use of Rome ploughs and the weaponization of forest fire complemented herbicidal warfare in Vietnam (Martini 2012, 44–49). More recently, in April 2017, the United States dropped the 22,000 pound "Mother of All Bombs" on Islamic State locations in Afghanistan in order to destroy a complex of underground caves and tunnels (Cooper and Mashal 2017).

Yet operational considerations may also serve as a constraint on the use of environmental warfare tactics. For rebel forces, asymmetric warfare may dictate conservationist policies, sometimes maintained with the use of force. While counterinsurgents carry out extensive defoliation in pursuit of guerrilla targets, their opponents adopt conservationist practices to conceal strategic bases in densely forested terrain. The Revolutionary Armed Forces of Colombia (FARC), for example, enforced "gunpoint conservation" in the forests of southern Serranía de la Macarena to preserve cover from air raids (Álvarez 2003, 58). Similarly, Biggs (2005, 459–60) has shown how the Viet Minh attempted to restore the natural wetlands ecology of the U Minh Forest as a means of preventing French forces from infiltrating their base areas.

Destruction of Enemy Assets (Domestic/Subnational). Counterinsurgents frequently adopt environmentally destructive practices in order to deny insurgents natural resources that serve as sources of sustenance and funding. The demolition of natural or agricultural resources may take the form of systematic attacks or scorched-earth tactics adopted during advance or withdrawal. Agent Orange, for example, was intended to destroy crops that sustained North Vietnamese forces as well as eliminate forest cover. Under "Plan Colombia," the Colombian government and American contractors sprayed suspected coca plantations with glyphosate herbicides, despite possible health hazards (Hsu 2017). The US-led coalition in Syria bombed oil installations controlled by the Islamic State with the aim of eliminating revenue sources (Sowers, Weinthal, and Zawahri 2017, 419).

Broadly, scorched-earth campaigns aim to destroy anything that might be of use to the enemy during troop advances or withdrawals. While they may be used to destroy nonenvironmental targets—such as railroads, communication lines, factories, and civilian homes—these tactics are often directed against farms, croplands, livestock, and water and enemy infrastructure. In the context of irregular warfare, notable instances include the destruction wrought by Union Forces during the American Civil War, the "Sea of Fire" that destroyed Bandung by retreating Indonesian state forces during the national revolution of 1946 (the Indonesian military reprised this strategy in Timor-Leste in 1999), the Guatemalan military campaign

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against the Guatemalan National Revolutionary Unity (URNG) rebellion in the early 1980s, and the Sri Lankan state's efforts to wipe out the Tamil Tigers in the early 2000s.

While the most well-known examples of scorched-earth campaigns have been carried out by government forces, the strategy is used by rebel groups as well: Stanton's (2016, 4–5) study of 115 post-Cold War conflicts finds that 27% of rebel groups and 47% of state militaries carried out scorched-earth campaigns (defined as burning civilian homes and crops). Consistent with Stanton's explanation of combatant restraint in civil wars, the deployment of scorched-earth strategies is differentially constrained by political factors for governments and rebel groups (discussed below).

Territorial Control (Domestic/Subnational). Deliberate attacks on the environment may also aim toward the seizure and control of enemy territory. Attempts to wield environmental damage as a weapon to capture territory and provoke enemy forces was clearly illustrated in 2015, when the Islamic State captured Iraq's Mosul dam. As King (2015) notes, the dam seizure's potential to threaten large numbers of civilians (along with the US Embassy in Baghdad) and reduce the Iraqi state's ability to provide water to its citizens was critical to the US decision to launch the air campaign against the Islamic State (King 2015, 160). King's study of 21 instances of the weaponization of water by the Islamic State between 2012 and 2015 demonstrates the strategic effectiveness of its environmental warfare tactics: "IS seizure and resulting ability to destroy dams created the threat of floods that could wipe out enemy forces distributed over a wide area as well as civilian population centers. Combatants opposing IS are forced to take this reality into account in deciding whether to occupy physically vulnerable territory" (King 2015, 160; see also Sowers, Weinthal, and Zawahri 2017 on environmental infrastructure targeting to force capitulation of cities in the Middle East).

Long-Term Strategic Objectives (Domestic/Subnational; Organizational). For state militaries and expeditionary counterinsurgent forces (i.e., foreign militaries who intervene in a civil conflict in support of the state), long-term considerations about postconflict environmental sustainability could, in theory, influence choices of environmental targets. In 2015, for example, former CIA director Michael Morell indicated that the United States had initially refrained from striking Islamic State-controlled oil fields and wells—opting instead to target oil transport trucks and mobile refineries—due to concerns about environmental damage and the importance of preserving Iraq's energy infrastructure (Odierno 2015; Richardson 2015). Beginning in late 2015, however, as part of Operation Tidal Wave II, the United States bombed oil fields after calculating that attacks on mobile refineries inflicted only minor and temporary harm on Islamic State operations. The Islamic State's frequent use of scorched-earth tactics—with which they destroyed energy infrastructure sites they were forced to abandon—may have encouraged the United States to disregard environmental concerns (Reed 2016).

Instances in which counterinsurgents have declined to hit environmental targets based purely and explicitly on operational aims appear to be few and far between; political factors, discussed below, seem to impose more powerful constraints on counterinsurgent action. Environmental concerns, however, may directly influence operational planning and objectives. Ahead of Operation Iraqi Freedom, for instance, special operations forces secured oil fields and a dam in order to avoid ecological damage like that committed by Saddam Hussein during the 1991 Gulf War (Mosher et al. 2008, 84).

Tactical

Inhibiting Enemy Advances (Domestic/Subnational). Following King (2015, 157), I characterize as tactical the targeting or weaponization of environmental features "on the battlefield in direct or immediate support of military operations or against targets of strictly military value." One of the clearest and most common uses of environmental warfare as a battlefield tactic involves inhibiting enemy advances by means of deliberate flooding. River diversion has been a constant of warfare for centuries: the seventh-century queen of Assyria, Semiramis, famously took Babylon by diverting the Euphrates, enabling her troops to march into the city on a dry riverbed (Mayor 2009). Over the past decade, river diversion and manipulation has emerged as an effective tactic for insurgents in the Middle East and Africa. For example, in June 2018, the Somali insurgent group al-Shabaab diverted the Jubba River to flood areas in which US Green Berets were stationed, forcing them to retreat to higher ground (Goldbaum 2018). Likewise, in September 2014, Islamic State forces diverted river water from Iraq's Shirwain Basin area to block the movements of Iraqi security forces (King 2015, 157).

Tactical Cover (Domestic/Subnational). While some insurgents have pursued long-term conservationist programs to maintain strategic cover at base camps, other actors have deliberately released pollutant smoke into the air to literally cloud their opponents' vision. In the conventional context, Saddam Hussein's Iraqi Army famously used this tactic during its 1991 retreat from Kuwait; smoke from burning oil installations interfered with US air operations, including the use of optical-guided weapons (Arkin 1996, 129). As discussed above, the Islamic State has employed similar tactics to interrupt aerial surveillance in Iraq.

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Political

Controlling and Punishing Civilian Populations (Domestic/Subnational). While scorched-earth campaigns serve the strategic purpose of reducing enemy assets, the destruction of crops and environmental infrastructure may aim at morale and civilian loyalty as much as the enemy's material strength. In South Africa at the turn of the nineteenth century, the British military burned Boer farms and croplands to deter civilians from supporting guerrillas and foster an atmosphere of desperation. According to Downes (2007, 431–35), the strategy landed a psychological blow that apparently hastened the defeat of the Boer republics.

State militaries have committed some of history's most notable campaigns of environmental ruin with the aim of terrorizing civilians into submission. Sowers, Weinthal, and Zawahri (2017, 415) cite Israeli aerial bombing of Palestinian environmental infrastructure as a form of collective punishment. Yet rebel and nonstate groups also weaponize environmental resources as a means of terrorizing local populations and deterring civilian cooperation with the state. Antigovernment militias in Syria, for example, have been reported to cut off water supplies to punish residents of government-controlled Aleppo (Sowers, Weinthal, and Zawahri 2017, 418).

Civilian Support (Domestic/Subnational). Crop destruction, the manipulation of water supplies, and other environmental warfare techniques can undermine the political project of capturing civilian loyalties, a concern that may moderate combatants' tactics. As Martin (2016) has shown in her analysis of the United States' decision to use chemical herbicides in Vietnam, worries about the political costs of antiplant agents divided President Kennedy's advisors. In 1962, the State Department indicated that the "primary consideration of any crop destruction program is to ensure that it will not result in US and GVN [Government of Vietnam] absorbing adverse propaganda criticism and adverse local reaction without achieving any commensurate military advantage" (quoted in Martin 2016, 341). Ultimately, however, US decision makers concluded that tactical utility would outweigh the potential propaganda advantage conferred to the North Vietnamese. More recently, in 2015, the government of Colombia halted the spraying of glyphosate to eradicate illegal coca crops that finance rebel groups like the FARC. The decision, opposed by the United States, was based in part on concerns about alienating peasant farmers whose incomes come from coca cultivation (Neuman 2015).

Counterinsurgency-Development Nexus (Domestic/Subnational). A recent research agenda has examined the counterinsurgency (COIN)-development nexus, noting that the language of modernization, scientific forestry, and rational land management has been used to transform landscapes to suit security needs while forcibly—and often violently—expelling minority populations from their homes (e.g., Ahram 2015; Scott 1998). Peluso and Vandergeest (2011, 595) show how counterinsurgency and development projects worked together in Cold War-era Indonesia, Malaysia, and Thailand; counterinsurgent states sought to "take the jungle out of the forest" by creating rigid boundaries between forested and agricultural areas (thereby criminalizing indigenous subsistence practices in forests) and forcing population resettlement into state-controlled, geographically-accessible areas. "The intention was to divide forests and agriculture into separate territorial-institutional domains of state authority … to isolate insurgents from the cover and sustenance provided by the jungle" (Peluso and Vandergeest 2011, 596). As in the case of Saddam Hussein's draining of the Mesopotamian marshes in southern Iraq (Ahram 2015), development language may provide cover for the punitive demolition of an entire ecosystem.

In a different vein, environmental stewardship may constitute an important element of rebel governance in wartime: the Zapatista Army of National Liberation (EZLN) in Chiapas, Mexico, and the Naxalites in northeastern India, among others, have made forest conservation and the protection of indigenous forest rights central to their alternative state-building projects (Sarkar and Sarkar 2017).

International Laws and Norms (International). International and domestic public opinion have rendered certain environmentally destructive weapons and targets highly controversial, regardless of their legality; these include napalm, water sources, dams, and oil facilities, among others (Arkin 1996, 118). In each of these cases, concern for civilian suffering—galvanized, in the case of napalm, by the famous Vietnam War photograph of nine-year-old Phan Thi Kim Phúc—may have been more powerful in generating taboos than worry about the natural environment (see section 6 below). Still, napalm's pariah status reflects, at least in part, international efforts to protect the environment from the effects of incendiary weapons. In 1974, the United Nations General Assembly passed Resolution 3255 (XXIX) condemning "the use of napalm and other incendiary weapons in armed conflicts in circumstances where it may affect human beings or may cause damage to the environment and/or natural resources" (quoted in Neer 2013, 183). It is not clear, however, that the normative delegitimization of napalm has proven as durable as, say, the nuclear taboo. While the US military destroyed all of its remaining Vietnam-era napalm in a "last canister ceremony" in 2001, it used Mark 77 incendiary bombs—which have similarly destructive effects—during the 2003 invasion of Iraq (Neer 2013, 208–12).

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Given the perceived limitations of the international legal regime surrounding environmental warfare, legal and normative factors would seem relatively weak sources of restraint. Still, legal and normative constraints may function instrumentally—as well as or instead of morally—in that they impose potential political costs on conflict actors, discouraging their use of weapons and tactics seen as taboo. An instrumentalist explanation of the legal and normative limits on environmental warfare is in line with Stanton's (2016, 62) account of why militaries and rebel groups exercise restraint in their use of violence against civilians: because they are concerned with securing the support of domestic and international constituencies. Legal and normative factors are likely to exert more pressure on state militaries than on rebel groups and other nonstate actors, who do not fit clearly into international legal frameworks.

Domestic Opinion (Domestic/Subnational). As in the case of weapons that inflict severe harm on civilians, domestic opposition to environmentally destructive tactics can constrain their use, particularly in democracies. Hamblin (2013) argues that domestic public opinion in the wake of the Pentagon Papers' release and the rise of the environmental movement motivated Nixon to participate in negotiations with the Soviet Union to sign the ENMOD convention: "Agreeing to ban these kinds of weapons would make Nixon appear responsive to public outcry, environmentally conscientious, willing to talk with the Soviets, and capable of coming away with a real international treaty" (Hamblin 2013, 204).

Ideological

Environmentalist Agendas (Organizational). Some conflict actors may advance a conservationist agenda as part of their particular ideological program. Maoist revolutionary theory, for instance, prescribes the maintenance of strategic "base areas" in mountainous, wooded, and otherwise inaccessible terrain (Peluso and Vandergeest 2011). The Marxist groups FARC and the National Liberation Army (ELN), in Colombia, enforced conservation in the Serranía de la Macarena and the Serranía de San Lucas; perhaps a strategic explanation (discussed above) is sufficient, but these and other Colombian Marxist rebel groups have long championed biodiversity and environmental protection as part of their nationalist projects (Álvarez 2003, 57–58). Al-Shabaab's announcement in July 2018 that it would ban plastic bags in the areas it controls in Somalia generated extensive media attention; reports focused on the contrast between the group's claims to environmental awareness with its violence and brutality (Callimachi 2018). Yet, as Karagiannis (2015) has pointed out, Islamist armed groups including al-Qaeda and Hizb'allah have developed environmental agendas. Whether their environmentalist commitments represent religious duty, an ideological critique of American-led capitalism, or instrumental efforts to mobilize supporters and demonstrate governance capacity in rebel-controlled territory is difficult to disentangle (Karagiannis 2015, 193–95; on ideology as an explanation for the behavior of armed groups, see Gutiérrez-Sanín and Wood 2014).

High-Modernist Ideology (Organizational). Ideological orientations toward the natural world may express subtler, but perhaps further-reaching, values and objectives. If we understand mid-century America's faith in scientific and technical progress as reflecting a high-modernist ideology (Scott 1998), we might explain American technophilic efforts to transform the Southeast Asian landscape to suit its security needs as an explicitly ideological project. Alternatively, we could classify the United States' environmental destruction in the region as motivated by a specific cultural understanding of the Vietnamese jungle, as discussed below. Martini (2012, 19), for example, has argued that the US Defense Department's insistence on the utility of chemical defoliants, cloud seeding, and other innovative environmental modification techniques reflected the unshakeable conviction "that a technologically advanced society like the United States could manage and control an environment like southern Vietnam and could, through the analysis and manipulation of data and the proper application of modern tools, including herbicides, impose its will on that environment and its inhabitants."

Cultural/Psychological

Understandings of Enemy Landscapes (Organizational). The reductive and often racist tendency to conflate the characteristics of physical terrain environments and the people and societies who inhabit them is a historical constant, even making its way into social science scholarship (Pickering 2012; Russell 2001). In a particularly infamous example, the extent and brutality of German scorched-earth policies on the Eastern Front during World War II have been attributed to Nazi ideas of eastern Europe as an area of *Unkultur* (McConnell 2014). Similarly, in her study of Union troops' scorched-earth campaigns across the American South during the Civil War, Brady (2012, 18–19) argues that Northerners imagined the Southern landscape as a wilderness and local agricultural practices (based on shifting cultivation and free ranging) as uncivilized. This perception of Southern landscapes as wild, unproductive spaces made it all the easier for Union soldiers to turn Southern farms and forests into true wastelands.

Nature is frequently understood by conflict actors, from generals to ground soldiers, as an enemy in itself (Tucker and Russell 2004). While biases toward foreign landscapes

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shape combatants' experiences of the natural environments in which they fight, the daily challenges of fighting in inhospitable terrain can contribute to an understanding of nature as a hostile adversary. Meier (2013, 45), studying the letters and diaries of Civil War soldiers during the 1862 campaign in Virginia, argues that they "spent the majority of their time concerned with the other enemy that had dictated movement and, to their thinking, caused staggering sickness and despondency in the ranks. That enemy was the environment—the weather, climate, seasons, terrain features, flora, and fauna they could not avoid."

Symbolic Warfare (Organizational). Attacks on the environment may serve symbolic as well as, or instead of, operational purposes. During the First Intifada, the Israel Defense Forces uprooted thousands of olive and other fruit trees to secure roads, improve visibility, and clear space for the construction of checkpoints (Braverman 2009, 246–47). However, the razing of olive groves has proven particularly damaging because the olive tree is a long-standing emblem of Palestinian national identity—so much so that Jewish settlers in the West Bank have destroyed Palestinian-planted olive trees in a symbolic claim to Israeli control over the land (Braverman 2009, 250).

Technological

Military-Industrial Complex (Organizational). Finally, the influence of the defense technology sector is likely to shape military treatments of the natural environment. Russell (2001, 104) has chronicled the relationship between the domestic pesticide industry and the military use of chemical weapons—including chemical defoliants and DDT, used to address malaria in the World War II Pacific theater and South Vietnam—in the twentieth century. By World War II, the chemical and defense industries were intertwined financially, operationally, and ideologically. Russell attributes intensive US investments in incendiary weapons during the war, including napalm, to the advocacy and influence of civilian chemists.

Today, the United States' increasing reliance on remote surveillance and sensing platforms may reduce incentives to utilize environmental warfare tactics. Foliage-penetrating sensors, for example, may obviate the need for forest clearing operations.

5. Mediating Factors

The incentives and constraints outlined above are mediated by a number of intervening variables. Most obviously, some exogenous terrain features—forests and marshes, as opposed to mountains—are more likely to be damaged by environmental warfare tactics than others. While no terrain environment, including desert, is immune from wartime damage, forests and jungles seem particularly vulnerable to manipulation and demolition on the part of counterinsurgents due to the strategic cover they supply to rebel groups and the relative ease with which they can be demolished.

A military or armed group's technological capacity may shape its orientation toward the natural environment. That counterinsurgents seek to eliminate forest cover while rebels attempt to preserve it not only reflects the hide-and-seek dynamic of counterinsurgency campaigns but also the actors' relative technological capabilities: state militaries are more likely than nonstate actors to have access to chemical herbicides and other rapid and efficient defoliation techniques. When a state military lacks the domestic capacity to deploy such technologies, it may depend on an ally to provide them—as in the case of the US-backed crop-spraying program in Colombia—which in turn may influence its engagement in environmental warfare tactics.

Regime type is also likely to influence the strength of the political incentives and constraints described above. Democracies are more likely to be sensitive to public opinion, more subject to the pressures of international norms, and less willing to collectively punish civilians (Stanton 2016).

A military or armed group's internal discipline and command structure may mediate the extent to which members follow norms or injunctions against environmentally destructive acts. Just as military discipline may determine the effectiveness of sanctions against sexual violence in conflict (Wood 2006, 330), norms surrounding the use of scorched-earth and other environmental warfare tactics are only as strong as the disciplinary structure in place to enforce them.

Finally, strategic interactions between parties to the conflict may incentivize or restrain the use of environmental warfare tactics, as we would expect in the context of other tactical weapons and cyberattacks.

6. Theorizing Interactive Processes

Table 1 summarizes the framework presented in section 4. As an illustration of how the mediating factors described in section 5 might operate to vary the strength of incentives and constraints, I have indicated how regime type is likely to modulate domestic and international political influences on state actors.

In the remainder of this article, I develop two hypotheses that emerge from this conceptual framework with the aim of investigating the relative utility of materialist, normative, and ideological explanations in accounting for conflict actors' engagement or nonengagement in environmental warfare. Following Wood (2006), I theorize possible interactions between factors that make the use of environmental warfare tactics more or less likely. My aim here is not to offer a comprehensive account of all

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Table 1
Explanatory Categories and Theorized Direction of Effect

Motivating objective	Direction of effect: state actor	Direction of effect: nonstate actor
Strategic		
Strategic cover and base areas	Incentive	Constraint
Destruction of enemy assets	Incentive	Incentive
Territorial control	Incentive	Incentive
Long-term strategic objectives	Constraint	Constraint
Tactical		
Inhibiting enemy advances	Incentive	Incentive
Tactical cover	Incentive	Constraint
Political		
Punishing civilians	Incentive (strength varies by regime type)	Incentive
Achieving civilian support	Constraint	Constraint
International laws and norms	Constraint (strength varies by regime type)	Weak constraint
Domestic opinion	Constraint (strength varies by regime type)	Weak constraint
COIN-development nexus	Incentive	Constraint
Ideological		
Environmentalist agendas	Constraint	Constraint
High-modernist ideology	Incentive	N/A
Cultural		
Understanding of enemy landscapes	Incentive or constraint	Incentive or constraint
Symbolic warfare	Incentive	Incentive
Technological		
Military-industrial complex	Incentive	N/A

possible combinations, but rather to demonstrate how researchers can use the framework presented above to (1) describe how these incentives, constraints, and mediating variables might combine to help explain variation in the form and frequency of environmental warfare, and (2) determine the strength of any particular factor within the combination.

Hypothesis 1: Established international norms against environmental warfare techniques will constrain democratic states, even when those techniques have tactical or strategic value—but the strength of the norm depends on the degree of perceived harm to civilians.

Suggestive evidence: the United States' decision to use herbicides—but to refrain from bombing dikes—during the Vietnam War. In her account of the Kennedy administration's internal debate over the use of antiplant agents for purposes of defoliation and crop destruction, Martin (2016) argues that policymakers adopted a consequentialist logic that ultimately weighed the military utility of Agent Orange and other herbicides above normative opposition to employing chemical weapons. Normative considerations were by no means absent from the administration's decision-making process: anxiety about international opinion "made the use of these weapons more difficult, with potential political costs raising the bar that had to be met in order for them to be used" (Martin 2016, 356). Yet they did not prove decisive when confronted with public pressure to win the war using all available tools.

By contrast, emerging international consciousness surrounding the weaponization of water functioned as a stronger deterrent (Grech-Madin 2021). While Richard Nixon and Henry Kissinger considered the strategic advantages of targeting water storage facilities and bombing dikes during the monsoon season, they ultimately calculated that the costs imposed by domestic and international opinion would be too high: "With apparent regret," Nixon rejected dike bombing, "saying '[I] could not allow my heart to rule my head'—his heart seeking to firmly knock out the adversary, his head alert to the expected public outcry" (Grech-Madin 2021, 103). In both cases, it appears that the Kennedy and Nixon administrations understood international norms as imposing instrumental, rather than moral, costs. In the case of the dikes, these instrumental costs outweighed the potential strategic benefits.

One might argue that the emerging norm against water weaponization was (at least understood to be) stronger than any public opposition to antiplant agents because the breaching of dikes posed a more direct threat to civilians. Kissinger estimated that an attack on the dikes would drown two thousand people (Grech-Madin 2021, 102); by contrast, the Nixon administration insisted that herbicides did not violate the existing international norm against chemical weapons because they killed plants, not

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people (Martin 2016, 347; Zierler 2011, 3). Indeed, "the case for the use of antiplant agents rested perhaps to a unique degree on the argument that they did not harm humans, for both Kennedy's initial decision to authorize use and the public case for use rested upon their safety" (Martin 2016, 355); once a study showing that Agent Orange caused birth defects and stillbirths in mice was published in 1969, the Department of Defense came to understand Agent Orange as a prohibited tool of chemical warfare and suspended its use (Martin 2016, 354–55). While normative inhibitions against antiplant agents are still weaker than the "water taboo"—the United States has used or supported the use of glyphosate and other chemical agents to destroy coca and poppies in Colombia and Afghanistan—concern for the effects of antiplant agents on the health of civilians continues to limit the practice of mass defoliation to deny natural cover to insurgents.

Hypothesis 2: Insurgent groups constrain their use of environmental warfare tactics only to the extent that conservationist policies serve strategic and tactical interests.

Suggestive evidence: uneven enforcement of conservation policies by insurgent groups in Colombia. Since the historic peace agreement between the Colombian government and the FARC was signed in 2016, Colombia has seen unprecedented rates of reduction in forest cover (International Crisis Group 2021). Using automated satellite image disturbance detection methods, researchers have documented a 50% increase in the area of forest disturbance across the Andes–Amazon Transition Belt, reflecting a dramatic surge in deforestation attributable to the end of the FARC's "gunpoint conservation" policy (Álvarez 2003, 57–58). During the war, FARC commanders forbade logging in certain forested areas to shield base areas and other sites of rebel activities from aerial surveillance. At the same time, interviews with local FARC commanders conducted by the International Crisis Group suggest a moral or ideological (and not purely instrumental) commitment to conservation: these leaders "felt they had an obligation to protect the environment for the benefit of small-hold farmers, and imposed fines for cutting down more than a certain number of trees or hunting particular species" (International Crisis Group 2021, s. III). Some commanders planted a hectare of food crops for each hectare of coca in what they understood to be an environmentally restorative effort.

Despite the strategic value of maintaining forest cover and the environmentalist agendas of individual commanders, the FARC's general approach to conservation was inconsistent. The group "knowingly contributed to environmental damage" by engaging in illegal mining, clearing forested land for coca cultivation, and attacking oil pipelines (International Crisis Group 2021). As a consequence, Álvarez (2003, 57) concludes that an environmentalist commitment to sustaining biodiversity "may partly explain the zeal with which the guerrillas preserve some forest fragments, but their practical and strategic considerations provide a more parsimonious explanation for their conservation initiatives."

Like the FARC, Hizb'allah has made reforestation a key component of its military strategy, planting more than seven million trees throughout Lebanon to revive forests destroyed during the civil war and military clashes with Israel. Hizb'allah officials have justified tree planting campaigns in explicitly military terms, citing the need for strategic cover. Likewise, as an armed-group-turned-political-party, Hizb'allah may calculate that "the adoption of an environmentally friendly agenda could improve the image of Hizb'allah against Amal, its main Shi'a competitor in Lebanon" (Karagiannis 2015, 194). That said, Karagiannis also suggests that protection of the Lebanese environment from the threat of Israeli attack has symbolic content for Hizb'allah and its supporters (Karagiannis 2015, 185–86). Researchers should not assume away insurgents' commitments to conservation as mere cover for strategic and tactical concerns without doing the empirical work to determine that a strategic or political explanation is indeed more persuasive than an account that takes normative or ideological commitments seriously. To do so, however, one would need to demonstrate that these commitments do not simply complement strategic aims (as they do in the case of Hizb'allah) but deter insurgents from environmentally destructive practices in the face of countervailing military imperatives (as they failed to do in the case of the FARC).

An adequate accounting of the relative strength of materialist, normative, and ideological explanations is beyond the scope of this paper. Together, however, these hypotheses generate two provisional insights. First, constructivist explanations for restraint in the use of environmental warfare tactics may be limited to the extent that a paramount concern for civilian safety supersedes any commitment to the conservation of the natural world per se, such that tactics seen as posing immediate or severe danger to civilians are more likely to face normative prohibitions than other forms of environmental damage. Second, normative and ideological factors influence conflict actors' decisions regarding the use of environmental warfare tactics, but they may function only as a weak constraint when military utility conflicts with existing commitments to environmental protection.

7. Conclusion and Directions for Future Research

This article develops a distinctive conceptual framework by which to assess the conditions under which state militaries and insurgents are more or less likely to engage

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in environmental warfare in irregular conflicts. By identifying six categories of incentives and constraints—strategic, tactical, political, ideological, cultural, and technological—that influence the decision to weaponize the natural environment, I offer a means of organizing potential explanations for variation in the form and frequency of environmental warfare tactics. The conceptual framework furthered in this paper suggests how some of these factors operate differently for state militaries and their lower-tech, irregular opponents due to the hide-and-seek dynamic that characterizes counterinsurgency conflicts. I seek to demonstrate how explanations for engagement or restraint in environmental warfare is best described as the product of additive or interactive—rather than monocausal—processes.

My review of the potential factors influencing combatants' decisions to deploy environmental warfare tactics in irregular conflicts suggests three new directions for future research. First, analysis of variation in the use of environmental warfare tactics—the frequency with which they are used across conflicts and by state and nonstate actors, as well as the types of tactics deployed—requires additional data collection. To my knowledge, the most extensive data collection in this area focuses on the weaponization of water resources (e.g., Oregon State University n.d.; Pacific Institute 2022). The Pacific Institute dataset in particular provides a useful model to guide data collection on other types of environmental warfare. Recent scholarship (King 2015) has used social media as a source of data on water manipulation by nonstate actors. As with all data collection efforts, identifying "the dogs that didn't bark" is a particular challenge. However, small-N research on "negative" cases in which actors do not, for example, target environmental infrastructure can help to clarify the conditions under which we are likely to see "positive" cases.

Second, the analytical approach developed in this paper promotes a conception of the natural environment as neither static nor exogenous to conflict processes. Recent political science scholarship has relied on an overly narrow understanding of environmental conditions—typically subsumed under the category of "rough terrain"—as a fixed independent variable that is taken for granted in conflict research. Cross-national studies suggest that rough terrain can make insurgencies more likely because (1) the absence of government control in inaccessible regions affords rebels the opportunity to organize and (2) rugged topography facilitates guerrilla tactics by offering natural cover and concealment (see, e.g., Collier and Hoeffler 2004; Fearon and Laitin 2003; Hendrix 2011; Tollefsen and Buhaug 2015). However, efforts to disaggregate geographic data to the subnational level have undermined these conclusions (see, e.g., Buhaug and Lujala 2005; O'Loughlin, Witmer, and Linke 2010). Among the shortcomings of these efforts to measure the effects of rough terrain is the tendency to conceptualize the natural environment as exerting a blunt-force impact on (counter)insurgent strategies and successes: rugged topography is assumed to enhance insurgent capabilities by hindering counterinsurgent visibility and mobility (Shaver, Carter, and Shawa 2019, 8; see also Linke et al. 2017).

While the assumption that rough terrain favors the insurgent is a useful baseline from which to begin analysis, it neglects military efforts to deprive insurgents of natural cover by manipulating terrain features. (Important exceptions include Carter and Veale 2013; Siroky and Dzutsati 2015; on interstate war, Sutton and Battaglia 2019.) The use of Agent Orange and other chemical defoliants to clear 23% of Vietnam's total forest area offers a striking example of how militaries can utterly transform the battlespace (McNeill 2004, 402). This rather banal point is overlooked in quantitative studies of terrain and conflict, which consistently treat terrain as a static variable.

This limitation reflects, I think, a more fundamental problem: political scientists have made little effort to critically theorize terrain and its relationships to human actors. The existing political science literature on the role that the natural environment plays in conflict does not sufficiently consider how cultural and ideological understandings may shape conflict actors' treatment of the natural environment. Quantitative studies in particular conceptualize terrain as exogenous, time-invariant, and set apart from human activity, while sociocultural constructions of or dispositions toward particular natural environments are neglected. As Woodward (2014, 48) affirms, "there is scant literature on how, exactly, military readings of the landscape inform military practice … sustained analysis of how military personnel actually look at and interact with landscapes of operations is notable by its absence."

Finally, future research needs to reflect on whether we should understand deliberate environmental destruction as a distinct means of punishing civilians and deterring resistance. Some forms of environmental warfare follow the same logic as other uses of violence against civilians: Nixon's decision against bombing dikes during monsoon season in Vietnam reflects the same strategic calculation of costs and benefits that other means of waging war demand (see Stanton 2016). But efforts to destroy features of the natural environment or use the environment as a medium through which to attack civilians are still conceptually distinct from the activity of directly targeting civilians with gunfire or explosives. Environmental warfare tactics produce especially far-reaching and long-term effects on civilian wellbeing. It also seems that conflict actors understand the decimation of the natural environment on which enemy combatants and civilians rely as a particularly devastating psychological and symbolic weapon. Saddam Hussein's destruction of the Mesopotamian marshes, for instance, suggests that environmental damage aims at terrorizing civilians—by decimating their homelands and

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producing a symbolic display of power—in addition to its strategic and tactical purposes. Counterinsurgent efforts to manipulate the natural environment may also escape international scrutiny by using the language of modernization and development as political cover.

The Islamic State's weaponization of water and attacks on oil fields in the Middle East should remind us that the deliberate destruction of the natural environment is a pervasive and highly damaging feature of irregular warfare. Identifying the incentives and constraints that determine its prevalence in counterinsurgency conflicts is essential to prevent severe environmental harm.

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