Hidden Carbon Costs of the 'Everywhere War': Logistics, Geopolitical Ecology, and the Carbon Boot-Print of the US Military

1. Introduction

'We exist to provide war fighters with what they need, where they need it, when they do it.'

Defense Logistics Agency, n.d.

'Fuel is the "blood of the military"… and is critical to the life of the theater of operation.'

U.S. Army Petroleum and Water Department, Fort Lee[1]

As climate change gathers pace, it is critical to assess how the world's largest institutions contribute to global environmental change. In this article, we analyse the United States military's impact on the climate by exploring the hidden carbon costs of the 'everywhere war' (Gregory 2011). Despite the Trump Administration's announcement to withdraw from the 2015 Paris Agreement,[2] the United States military has long understood that it is not immune from the potential consequences of climate change (see US Department of Defense 2014), nor has it completely ignored its own contribution to the problem. The US military sees climate change as a 'threat multiplier,' or a condition that will exacerbate other threats, and is fast becoming one of the leading federal agencies in the United States to invest in research and adoption of renewable energy (Gilbert 2012). These investments include solar and biofuels,[3] as well as reinforcing base infrastructure to mitigate the effects of sea-level rise (Bigger and Neimark 2017).

Nevertheless, the US military's climate policy remains fundamentally contradictory. While the military confronts the effects of climate change, it remains the largest single institutional consumer of hydrocarbons in the world (Nuttall et al. 2017). In the near future, this dependence on fossil fuels is unlikely to change as the US continues to pursue open-ended operations around the globe.[4] The extraordinary energy requirements for these conflicts has engendered new investments in fossil fuel delivery infrastructures. These energy demands are coupled with the life-cycles of existing military aircraft and warships, locking the US military into hydrocarbons for years to come (Unruh 1999). Even the military's own ambition to support development and scale-up production of less carbon intensive kit, from backpack borne solar panels to advanced biofuels, is driven by the need for ever more energy. For example, new biofuels are meant to be used in extant planes and ground vehicles without modification, which means that even if those fuels become available at scale, economic and political conditions can always force a return to fossil fuelling (cf. Urry 2014). Besides internal governmental audits, mainly from the US Department of Defense (DoD), there are with few independent, public-derived studies of the US military's fuel consumption, not to mention greenhouse gas emissions (see Liska and Perrin 2010). This article addresses this gap on the institutional practices and configurations that make US military fuel consumption possible, focusing on how a large institution like the US military contributes to the climate emergency. We show how these practices are more-or-less hidden in plain sight and develop a methodology and interpretive framework to explain them.

We argue that to account for the US military as a major climate actor, one must understand the logistical supply chain that makes its acquisition and consumption of hydrocarbon-based fuels possible. In our view, one cannot understand the importance of the US military's supply chains without understanding its *geopolitical ecology*, and vice versa. Geopolitical ecology is a theoretical framework that combines political ecology with critical geopolitics to gain deeper insight into the impact of large geopolitical institutions on environmental change (Bigger and Neimark 2017). For us, focusing on the geopolitical ecology of military fuel consumption means paying particular attention to the material-ecological metabolic flows (e.g., hydrocarbon-based fuels) enacted through US military supply chains.

Building on this framework, we draw novel links between critical logistics and supply studies (Cowen 2014; Tsing 2009; Chua et al. 2018), geopolitics, and political ecology (Benjaminsen et al. 2017) with the purpose of setting a new geopolitical ecology research agenda. Moreover, in doing so, we bring together the insights of civilian energy geographies (Lyall and Valdivia 2019; Mulvaney 2019; Bouzarovski and Haarstad 2018; Bridge et al. 2018) and recent cutting-edge geographical work on the infrastructure-nature-finance nexus (Usher 2018; Cantor and Knuth 2019) with the massive hidden carbon costs of the US military.

Our examination of the US military's 'carbon boot-print' begins with the US Defense Logistics Agency – Energy (DLA-E), a powerful yet virtually unresearched sub-agency within the larger Defense Logistics Agency.[5] The Defense Logistics Agency oversees the massive global supply chains of the US military – from energy, services, munitions, parts and maintenance distribution for military operations. The sub-agency DLA-E specifically works to deliver the energy needs of all US federal agencies, as well as multinational corporations, private contractors, and countries allied with the United States. The DLA-E has a worldwide distribution infrastructure for hydrocarbon fuels delivery and provides logistical and planning support to the military's geographic combat commands and warzones around the world. The DLA-E is also the primary purchase-point for hydrocarbon-based fuels for the US military, both domestically and internationally.

The DLA-E maintains records of bulk fuel purchases by US military personnel, both domestically and internationally. Through multiple Freedom of Information Act (FOIA) requests, we compiled a database of DLA-E records for all known land, sea, and aircraft fuel purchases, as well as fuel contracts made with US operators in military posts, camps, stations, and ship bunkers abroad from FY 2013-2017.[6] We draw on this database to examine the DLA-E and its bureaucratic and infrastructural capacity to meet carbon-intensive fuel requirements for US military operations.

This paper aims to answer two overarching questions. First, how is carbon-intensive American imperialism made possible through the DLA-E supply chains? Second, what are the physical and organizational path dependencies[7] of that sprawling apparatus that make it likely that the 'everywhere war' will become *more*, rather than less, carbon intensive? In the 'great acceleration' of economic growth after the Second World War (McNeill and Engelke 2016), there has been a correspondence between environmental degradation and the dramatic increase in rich-world consumption made possible through modern logistics and supply chains, even if the explicit link between supply chains and the environment has been undertheorized. By critically examining the DLA-E's logistical practices—based on 'just-in-time' supply chain technologies and delivery capacities developed in tandem with powerful multinational corporations—we show how the material infrastructure of the DLA-E makes possible the 'carbon costs' we demonstrate here.

In the next section, we present geopolitical ecology as a framework for understanding the hidden carbon costs of the US military's supply chain. In the subsequent section, we examine the DLA-E's supply-chain infrastructure, how the agency functions, and the scope of its operations. Based on our DLA-E records database, we explore how it becomes possible to procure, distribute, store, and consume the massive volume of fuels required for contemporary military operations. It is important to note that this is a partial picture of the US military's 'carbon boot-print'. What our critical analysis of the DLA-E allows is an understanding of the bureaucratic practices and physical infrastructure required to facilitate the US military's consumption of hydrocarbon-based fuels on a global scale, which, we argue, *can only be appreciated by examining the scope of its supply chains*. We outline several 'path dependencies'—war-fighting paradigms (e.g., counterinsurgency), weapon systems, bureaucratic requirements—that sustain a heavy reliance upon carbon-based fuels into the interminable future barring a radical rupture in US foreign policy. Our focus on the DLA-E's international flows illustrates its central role in making the 'everywhere war' possible, from Special Forces shadow engagements to major conventional operations, and allows us to highlight how the hidden carbon costs of war are produced.

2 The Geopolitical Ecology of Military Supply-Chains

2.1 Geopolitical Ecology and Institutional Bureaucracy

We begin from the premise that material-ecological metabolic flows shape geopolitical and geoeconomic power relations. In what follows, we make visible the scale of logistical practices required by the US military to burn vast quantities hydrocarbons. A geopolitical ecology framework exposes the larger institutional processes at work in the material production of global natures (Labban 2010; Mitchell 2011; Usher 2018; Valdivia 2008), and in our case, the contribution of militaries to environmental change at a variety of scales (cf. Ojeda 2012; Ybarra 2012). By mobilizing geopolitical ecology, we develop synergies between the careful attention to multi-scale environmental politics in political ecology, and the 'discursive-material co-constitution of global institutional politics' (Bigger and Neimark 2017, 14).

This explicit encounter between critical geopolitics and political ecology is not necessarily new (Benjaminsen et al 2017; Dalby 2015; Harris 2017; Parenti 2015), but remains timely, as the effects of climate change and some of the massive institutions who are most responsible, such as the US military, are left generally unchecked, both within the critical literature and outside the academy. Here, we emphasize that the military's 'self-styled relationship to the environment justifies the self-provisioning of infrastructure and material resources needed to carry out the protection of scarce nature, both home and abroad' (Bigger and Neimark 2017, 16). Our geopolitical ecological framework moves scholarship on 'global natures' into new analytical territory by incorporating the material elements of hydrocarbons and its supply lines that actually shape geopolitical relations. For example, by focusing on the material infrastructure of the U.S. military that actually exists outside of its 'greening' policy papers, our approach calls into question the veracity of the US military's attempt to rebrand itself as an ecologically friendly actor.

Critical geographic research on the hydrocarbon infrastructures for US military provision hardly exists. The conditions under which the US military operates are constantly shifting in light of rapidly changing geopolitical and ecological dynamics. There have been three significant shifts in US warfighting over the past twenty years. First, in the late-1990s 'revolution in military affairs' (RMA), there was an emphasis on 'network-centric' military capabilities coupled with conventional air bombing ('shock and awe'). A more ground-troop intensive approach followed in the mid- to late-2000s embrace of counterinsurgency (see 4.2 below). Lastly, in our current period, there has been a hybrid special operations-centric mode of warfighting buttressed by digital information-based technologies, such as drones and high-tech computing (Niva 2013). The US military's current climate change security strategy evolves along with these changes in combat paradigms, orienting its institutional approach to an unpredictable geopolitical order that is slowly being upended by the climate crisis (Dalby 2014; Gilbert 2012).

Every mode of warfighting requires its own unique hydrocarbon delivery system. The DLA-E is the bureaucratic apparatus mainly responsible for procurement and arranging delivery of hydrocarbons in this shifting geopolitical environment, and therefore controls the size and shape of the US military's carbon boot-print. Without the highly developed, professionalized logistics and military supply-chains, the US military's reach, as well as its capacity to burn so much fuel, would be substantially impeded. Yet we know very little about the DLA-E's sprawling operations or its own role as a climate actor.

How can we use a geopolitical ecology to understand the processes and procedures behind the US military as a climate actor? What is the infrastructure and day-to-day bureaucratic process that makes this massive fuel provisioning operation possible? Scott (2008, 48) defines bureaucracy as 'the existence of a specialized administrative staff' or as the 'increasing subdivision' of organizational functions – all components that can be applied for understanding the DLA-E. It is an institution that 'hides in plain sight,' as it were, behind the US military. A study of the bureaucracy of the DLA-E is important to expose the oft-overlooked aspects of the military's ability to wage the everywhere war. As Weber discusses, bureaucracy is a 'rational-legal form of domination and control' (Weber 2013, 300) that systematically organizes human activity and complex processes for purposes of efficiency and order. Kuus (2018, 1) has noted that modern-day institutions are too often 'dismissed as lumbering iron-cage bureaucracies.' The US military and DLA-E are not lumbering at all, as they 'lock-in' a future of highly mobile fossil-fuelled warfare, in spite of, and likely because of, widespread environment change (Gilbert 2012). However, as we show below, geopolitical ecology is more than a focus on institutions as ecological actors. To appreciate the DLA-E's dynamic carbon-inflected (indeed, constituted) bureaucracy, we must examine their flexible supply chain infrastructure that, paradoxically, is a primary component of fossil fuel look in. Thus, the emerging field of critical logistics and supply studies can help understand the infrastructural basis that makes such material-ecological flows possible.

2.2 Critical Logistics and Supply Studies

Global supply chains and institutional logistics, as well as the organized spaces produced by corporate managerial logics and techniques, have lately come under critical scrutiny in a move to interrogate the material infrastructure of global capitalism (Bonacich & Wilson 2008; LeCavalier 2016; Nielson 2012; Toscano & Kinkle 2015). However, with few notable exceptions (Cowen 2014; Crampton, Roberts & Poorthuis 2014; Gregory 2012; Khalili 2017), there has been relatively little written on the role of supply chains in contemporary US military practices, not to mention the role of supply chains in contributing to climate change more generally (Bergmann 2013; Bergmann & Holmberg 2016; Carse & Lewis 2017). This is surprising given that, from a historical perspective, logistics and supply chains, as a way of organizing the movement of goods and services, are fundamentally a military technology.

As Deborah Cowen (2014) has emphasized, the entanglement between logistics and military operations has only grown more pronounced as corporate management practices have assumed a privileged position within the US military since at least the Vietnam War (Gibson 1986). Ucko (2009) has shown how US counterinsurgency doctrine, adopted by the US Army in the mid-2000s as the wars in Afghanistan and Iraq were chaotically deteriorating, incorporated a small business-model approach to provisions, technology development, and tactical operations. This enacted a 'bottom-up' command structure that enabled on-the-ground officers to challenge the provision assumptions of US commanders running the wars from Central Command in Tampa, FL and the Pentagon.[8] For Cowen, what is important is not so much the US military adopting management techniques and practices fashioned by multinational corporations. Rather, it is that US corporations are also reliant on the US military to secure their own logistical supply chains; or, more precisely, that there is a symbiotic relationship between the military and corporate sector. In terms of liquid fuel logistics, one might think of the role the US military plays in securing oil shipping routes, some portion of which the military is likely to go on to burn. 'This is a matter,' Cowen writes (2014, 4), 'not only [of] military forces clearing the way for corporate trade but corporations actively supporting militaries as well… The entanglement of military and corporate logics may be deepening and changing form, but logistics was never a stranger to the world of warfare.' For this reason, Khalili (2017, 2) stresses the role of the US military as '*a wielder of capitalist infrastructural power*' (original emphasis):

> This role includes not only the US military's provision of large contracts to private businesses, but also especially the construction of the physical and virtual infrastructures that underlie the emergence of liberal capitalism overseas. Nor is this activity limited to wartime. In fact, it is in moments of global economic and political transition, and in ostensible peacetime, that the US military's infrastructural power has been a *dispositif* central to the task of disseminating liberal capitalism (Khalili 2017, 2).

What is at stake for the US military in logistics, and the DLA-managed supply-chain infrastructure for its current wars? It is the movement of lethal *matériel* to a host of conflict zones and dirty wars across the globe, interconnected through thin channels of mobile supply, rather than to a handful of battlefields relatively localized in a specific region or place. As Derek Gregory (2012, n.p) notes, 'it is, above all, the mobility of military violence that is central to the conduct of late-modern war.' The DLA is the institution which ensures that mobility across the globe. However, there is an important *materiality* to the logistical movement of lethal *matériel*. As Chua et al. (2018, 618) have argued, logistics must be understood both as a 'calculative rationality' and a 'suite of spatial practices' that ensure the circulation of capital, commodities, bodies, services, and information, to overcome the 'friction of distance,' Gregory (2012). Logistics is a calculative rationality insofar as it seems to abstract the movement of people, goods, and services from their operational context; subject these movements to logics of precision and streamlining efficiency; and finally (re)orient the movements along predetermined pathways (i.e., the supply-*chain*). 'Logistical thinking,' Chua et al (2018, 621) write, 'prioritizes quantity over quality, reducing the diverse relations of production and distribution to delivery times, stock-keeping units and other values amenable to measurement and calculation.' Logistical thinking is coupled with a sprawling physically networked infrastructure—whose management can often be messy, improvised, and thus flexible—from containers to container handling equipment, container ships and GPS tracking systems, to IT networks and new software.

We share Cowen's and Khalili's interest in the role of these calculative rationalities and spatial practices in fostering a 'new logistical imperialism' (Cowen 2014, 195), which better highlights the geoeconomic role of the US military in fostering global supply chains. However, our purpose is to shift the focus somewhat by underscoring the relationship between the material reality of military supply chains, as managed by the Defense Logistics Agency, and the distribution of carbon-based fuels *and* emission of greenhouse gasses (GHGs) along its supply chains – that is, we wish to examine its *geopolitical ecology*.

3. The Defense Logistics Agency: The Invisible Hand of Imperialism

3.1 Aims and Background of DLA-E

In this section, we detail how the DLA-E came to assume a powerful role in global fuel markets, as well as the physical infrastructure and logistical practices it engages to carry out its mission. The Defense Logistics Agency, the umbrella administration housing the DLA-E, was established in 1961 as the Defense Supply Agency under President Kennedy and Defense Secretary McNamara. Since that time, the broad mission of the Defense Logistics Agency has been to provide a 'full-spectrum supply chain' for its warfighting and other missions; e.g., humanitarian operations (McGuire 2009.) The Defense

Logistics Agency has a worldwide distribution infrastructure that provides logistics and staff-planning support to the military's geographic combat commands and war zones around the world.

The DLA-E has its roots in the Second World War as part of the Department of Interior's Army-Navy Petroleum Board, which later became the Joint Army-Navy Purchasing Agency. The DLA-E specifically manages the energy requirements military and federal agencies and departments, as well as various foreign militaries. The DLA-E is *the* one-stop shop for fuelling purchases and contracts within the US military both domestically and internationally, and acts as the US military's internal market for all consumables, including fuel. DLA serves as the entry point for energy companies to US military operations, as the DLA-E conducts regular competitive bidding for lucrative, predictable contracts to supply military-grade liquid fuels for warfighting.

The question of fuel and fuelling, and the geographies of each, has been central to US military operations for nearly its entire history. The US military's reliance upon hydrocarbons began with the US Navy's 1814 commissioning of *Demologos*, a coal-fired paddle-steamer warship sunk by an explosive gunpowder accident on the Brooklyn Naval Yards in June 1829, killing 48 men. Throughout the nineteenth and twentieth-centuries, hydrocarbon fuels were increasingly critical as warfare became increasingly mechanized. Liquid fuels, both their use and their procurement, were a central concern for military planners beginning with the US Navy's transition from coal to diesel-powered combustion with the launch of the 'Great White Fleet' in 1906 (Yergin 1990). The switch from coal to diesel was highly controversial in its time, opposed by a majority in the US Congress primarily on logistical grounds, namely as questions of access to fuel outside of well-established coaling stations were thought to pose a grave national security risk. President Theodore Roosevelt addressed these concerns in 1907 by ordering the US Navy to construct the first global hydrocarbon supply system

(Mauer 1981). The significance of this moment cannot be overstated, as it was the genesis for the US military's modern supply chain for hydrocarbon fuels.

Prior to the 1961 creation of the Defense Supply Agency (renamed the Defense Logistics Agency in 1977), procurement and distribution of *matérial* and fuel was the responsibility of individual branches of the US armed forces; meaning that each branch had its own acquisition practices, distribution networks, and fuel standards used for various vehicles. This meant, in effect, that the military was maintaining separate, and potentially overlapping, supply chains. As the Cold War heated up in the 1950s and 60s, the modes of conveyance required for military operations – from larger naval vessels, including aircraft carriers, to ground and air transport (e.g., the introduction of helicopters as mechanized 'cavalry' in Vietnam) – required unprecedented energy demands by the US Department of Defense (Gibson 1986). The increasing demand for fuel, as well as access and interoperability between military branches, was a primary driver behind the creation of a single bureaucratic entity for managing the global supply infrastructure of military operations.

The consolidation of supply and logistics services was a relatively slow-moving process, which is unsurprising given the sheer scale of purchasing and distribution conducted by the US military and points to the 'momentum' that socio-technical institutions produce and to which they are beholden (Hughes 1969). However, the reorganized fuel infrastructure was largely in place as the American presence in Vietnam grew in 1965. During World War II, each US soldier consumed, on average, one gallon of fuel per day. By the end of the Vietnam War, that number jumped to nine gallons per day per soldier (Karbuz 2006). That nine-fold increase demonstrates some of the many differences between World War II and Vietnam, reflecting (in part) the increased use of airpower; e.g., the use of F-105s and F-4 Phantoms in Vietnam bombing missions, and combat helicopters (cf. Clodfelter 1989). However, it also reflects how the Defense Supply Agency was successful in creating both infrastructure and logistical practices to deliver massive volumes of fuel in war. US military fuel consumption is even higher today. According to the Swiss security think-tank Deloitte LLP, since the Vietnam War, there has been a '175% increase in gallons of fuel consumed per US soldier per day… In today's conflicts [in Afghanistan and Iraq], fuel consumption is 22 gallons used, per soldier, per day, for an average annual increase of 2.6% in the last 40 years (Deloitte 2009, 1).'

The refinement in managing energy supply chains reflected a broader organizational shift within the Department of Defense in the 1960s. Defense Secretary McNamara, the former CEO of Ford Motor Company and trained in statistics and economics at Harvard, was especially enamoured by systems analysis and computers capable of vast number-crunching (Barnes 2015). The RAND Corporation, closely aligned with the US military, was responsible for developing 'systems analysis' for managing military budgets and the distribution of resources (McCann 2017). As Cowen (2014) shows, systems analysis developed by military intellectuals and statisticians fed directly into the contemporary management and logistics economy.

Since Vietnam, the Defense Logistics Agency has undergone a number of name changes and organizational realignments, but its service mission of supplying petroleum, and all other consumables, to the US military has essentially remained the same. As one government official put it, 'America's military infrastructure is a large part of what makes it dominant… During and before World War II, every military branch had its own way of dealing with logistics, and now its's been consolidated and turned into one overarching middleman (Koebler 2015).' Over the past twenty years, there has been a widening of the scope of DLA-E services delivery. In 1998, the object of DLA-E management transitioned from the management of energy *infrastructure* to the management of energy *products* (DLA 2010). This subtle shift entailed the expansion of logistical competencies for the subagency, leading to a comprehensive suite of logistical fuel-based supply chain practices deployed by the DLA-

E to every corner of the globe. These developments have strengthened the DLA-E's current and unique position in present-day global fuel markets; for it is not just a provider of infrastructure for fuel distribution, but actively manages a dense web of relationships, contracts, and material facilities.

3.2 DLA-E Logistics and Operations

Now that we have a picture of the emergence of the bureaucratic apparatus that facilitates the acquisition and distribution of staggering volumes of fuel, we can turn to the DLA-E's logistics operations. The institutional path dependencies that made consolidation difficult are still in place in many ways, and these path dependencies play a critical role in reproducing the US military's spatialities of energy, as access to refined hydrocarbons is fundamentally important to every aspect of its operations. Even as branches continued their own procurement of weapons systems, the Pentagon moved to consolidate fuel acquisition and distribution throughout the 1960s. The early move to consolidate energy logistics for the US military, before food or other necessities of war, demonstrates the centrality of fuels within the supply-chain infrastructure.

Given the spread of US operations across the globe, the DLA-E's material infrastructure for fuel is correspondingly sprawling. The DLA-E's global supply chains are inextricably tethered to other, non-military logistics systems, such as private contractors who traffic between military and non-military clients (Cowen 2014). The DLA's task is to coordinate all aspects of contracting, procurement, storage, and distribution with both internal and external entities to ensure that fuel (and all other materials) arrives when needed. The DLA-E uses an US Government internal ecommerce platform called FEDMALL to manage this supply chain. Essentially the 'Amazon.com' of federal agency commerce, FEDMALL is an online shopping catalogue maintained by the Defense Logistics Agency that allows federal agencies to purchase government complaint goods from external vendors. FEDMALL grew of the Department of Defense's DOD eMALL, the Defense Logistics Agency's first web-ordering interface unveiled in 1993, and was one of the first examples of ecommerce, again demonstrating the tight linkages between military and commercial logistical practices (Johnson and Lucyshyn 2003; Cowen 2014).

To give a picture of the DLA-E's daily energy operations, the agency handles 14 million gallons of fuel worth $53 million *per day* (DLA 2015). Operating from a non-descript building in Fort Belvoir, Virginia, the DLA-E has an extensive chain of sites for distribution and delivery, with 258 terminal operations worldwide (DLA Fact Book 2017). Moreover, the DLA-E has delivery capacity to 2,023 military posts, camps, and stations in 38 countries; 230 bunker contract locations in 51 countries; and 506 into-plane contract locations in 97 countries. On a daily basis, the DLA-E makes $1.1 million in foreign military sales of fuel (Ahern 2015). At DLA-E headquarters, there are 23 office heads (such as 'Business Process Support,' 'Bulk Petroleum Supply Chain Service,' 'Manpower and Workforce Analysis', and 'Procurement Process Support,' etc.) that provide implementation support for the DLA-E's regional offices across the US, Germany, Japan, South Korea, and Bahrain. In turn, these offices coordinate the purchase and movement of fuels around the world, as well as manage contracts with utilities, negotiating access to fuel infrastructure in foreign countries, down to the management of individual fuel purchase cards, along with every other step in managing the massive task of fuelling interminable global wars. It is worth examining, as part of the DLA-E's structure and practices, the scale of US interventions currently underway. After all, the goal of the US military is not the consumption of fossil fuels, but its goals require that consumption. Stephanie Saville (2018) has recently mapped the breath-taking swath of the globe over which US military activities are situated. Between 2015-2017, the US military was active in 76 countries, including seven countries on the receiving end of air/drone strikes, 15 countries with 'boots on the ground,' 44 overseas military bases, and 56 countries receiving counter-terrorism training (Saville 2018). Each of these missions requires energy—often considerable amounts of it—and the DLA-E is the institution that supplies it.

In the development of its fuel supply chains, the DLA-E and the US military commit to particular hydrocarbon-based path dependencies, or, 'situation[s] where the present policy choice is constrained or shaped by institutional paths that result from choices made in the past (Torfing 2009: 71).' In the case of US military reliance on fossil fuels, these institutional paths include decisions about procurement of infrastructure like pipelines and fuel tankers, but also organizational and specialist knowledge, computer hardware and software to manage daily operations. The kinds of knowledge practices required to keep the furnace burning range from the personal relationships that local fuel distribution companies cultivate with DLA-E's small business liaison who supplies fuel to domestic installations, to the expertise required at DLA-E's laboratories to test and certify fuels for military specification. These laboratories, located in Germany, Alaska, South Korea, and Japan, are tasked with testing samples for quality control of fuels, as well as training soldiers in on-site testing methods (DLA 2016).

The fuels delivered by the DLA-E power everything from routine base operations in the US to forward operating bases (FOBs) in Afghanistan. In FY2017, the DLA-E managed $8 billion in contracts, and was staffed by around 1,200 employees, both military and civilian, on an annual budget of 14.6 billion (DLA Fact Sheet 2017).[9] However, this budget takes into account only the direct costs of fuel acquisition and distribution, of which some of the cost must be borne both by the wider Defense Logistics Agency, and by the military branches themselves. The full cost of liquid fuel delivery is significantly higher when accounting for the dangerous conditions when it is delivered in 'non-conventional battle spaces,' such as Afghanistan (Gregory 2012). Indeed, a primary reason the US military has worked to 'green' its operations is precisely to cut-back on the extraordinary costs of fuelling wars in remote areas (Deloitte

2009), as well as the rigidity that high fuel costs impose on overall military spending. Every dollar spent on fuel is a dollar not spent on military kit or operations (Vidal 2010). However, the acute interest in alternative fuels has recently dropped out of many military documents.

The de-emphasis of non-fossil fuels has not occurred because military contributions to climate change have fallen in any meaningful way. Rather, the drift away from renewables seems to be driven by a combination of factors that include the availability of domestically produced fuels as a result of the fracking boom, persistently low and relatively stable oil prices, and a reduction in long-term deployments in Afghanistan and Iraq where oil delivery accounted for significant costs. The most active period of renewables development and discourse was between 2008, when global oil prices peaked at nearly $150/barrel, and 2011, when the average oil prices was $111/barrel, the first time oil prices averaged more than $100 for a year (EIA 2012, Read 2008). The need to curtail fuel usage seems to have rhetorically subsided as the way the US conducts war has shifted from energy-hungry FOBs, and the DLA-E focuses on 'wartime effectiveness and peacetime efficiency' (DLA 2017: 22). Given the open-endedness of the everywhere war, the DLA-E's logistical practices of fuelling seem increasingly tailored to the *effectiveness* side of the equation – indefinitely.

The results of coordinated action of the US military's logistics operations, particularly given its extraordinary and flexible budget, is the capacity to acquire and send fuel anywhere in the world. The larger DLA's expertise in developing supply lines over the course of the last two decades also allows the agency to build logistics networks where they are not yet consolidated as the everywhere war continues to expand. While the headline numbers are staggering, as is their environmental cost, the bureaucratic processes that make it a reality are extremely mundane and look very much like any institutional purchasing program, but on a global scale.[10] The acquisition of bulk fuels, which comprise by far the largest proportion of the fuels the military consumes, follows a regular, predictable process.

Each fuel-purchasing region will assess projected needs for the upcoming year based on modelling done in dialogue between military branches and DLA staff. The acquisition process is planned, and then the request for bids is offered on the US government's public solicitation webpage, FedBizzOpps. Offers received are evaluated and ranked, the winning bid is chosen, final terms are agreed, and the contract moves from solicitation to management.

Once contracts are agreed, fuels of various types are delivered to agreed supply hubs, where they can be dispatched to any number of fuel depots. These shipments can either be arranged in-house, or through a number of logistics contractors. In 2017, the DLA-E made over 25,000 fuel shipments, or about 68 shipments per day. Of these, more than 80% took place within the continental United States, representing 61% of the total gallons of fuel distributed by the DLA-E (DLA-E 2018). This flags up a critical point: namely, that fuel consumption, while conditioned to some extent by the modalities of warfighting, is still primarily located domestically. The US military would be the largest institutional consumer of oil in the world even without foreign oil-fueled operations. Thus, even a less interventionist US military would remain an important economic and climate actor.

4. The US military as Climate Actor

4.1 GHG emissions and the global military logistics network

Based on the preceding discussion, what does the US military look like as a climate actor when one accounts for its massive logistical supply chain? What is the geopolitical ecology of the movement and usage of military fuels? Here, we draw on our DLA-E records database of US foreign and domestic military fuel purchases between FY2013-17, including military posts, camps, stations, and ship bunkers. The database contains near comprehensive domestic and international contract information on fuel type purchases. Based on these FOIA requests, we use fuel purchasing and GHG emissions from 2017, and country GHG emissions data from 2014, as they are the most up-to-date and comprehensive dataset of all the years collected.

Figure 1 about here

Given its extensive institutional infrastructure and operations, both domestically and overseas, the US military consumes more liquid fuels and emits more CO_2e (carbon-dioxide equivalent[11]) than many medium-sized countries.[12] In 2017, the US military purchased about 269,230 barrels of oil a day and emitted 25,375.8 kt- CO_2e by burning those fuels (see Figure 1). If the US military were a country, it would nestle between Peru and Portugal in the global league table of fuel purchasing, when comparing 2014 World Bank country liquid fuel consumption with 2015 US military liquid fuel consumption. For 2014, the scale of emissions is roughly equivalent to total – not just fuel - emissions from Romania (Figure 2). According to our DLA-E data, covering GHG emissions in Scope 1-3[13], which includes direct or stationary sources, indirect or mobile sources and electricity use, and other indirect, including upstream and downstream emissions, the US military is the 47th largest emitter of GHG in the world, if only taking into account the emission from fuel usage. This calculation excludes emissions from the electricity and food the military consumes, land use changes from military operations, or any other source of emissions. Critically, these emissions are *not* counted as a part of aggregate US emissions following an exemption granted in negotiating the Kyoto Protocol (which the Bush Administration refused to sign in 2001). This gap was to be rectified by the Paris Accord, from which the US, famously, has withdrawn.

All country emissions data was sourced from the World Bank (World Bank 2017) and the Environmental Protection Agency (EPA 2015). The World Bank data was used to contextualize the emissions data from US military sources in terms of US total emissions and global emissions. Different levels of emissions data, from individual fuels and departments of the US military to total emissions, Scope 1-3 inclusive, were calculated as percentages of US and global emissions to gain more perspective. Raw data of the tonnes of CO_2 emissions was compared to World Bank data, scaled up from kg CO_2 to tonnes CO_2 to find the relative position of US military emissions by country.

Figure 2 about here

The DLA-E supplies a number of fuels and lubricants to all military branches, but the most common are jet fuel (e.g., JP-8, Jet A), terrestrial and marine diesel. Each of these has its own emissions profile and co-pollutants. For example, military jet fuel (JP-8) is, like all jet fuel, molecularly similar to kerosene, and it emits CO_2 water, SO_x, and NO_x (known in aggregate as carbon dioxide equivalent, CO_2e). These pollutants are more potent than terrestrial equivalents because burning at higher altitude produces different kinds of chemical reactions, resulting in warming 2-4 times greater than on the ground (IPCC 2015). This difference in GHG output is one of the reasons why impact is significant, as the bulk of fuel consumed by the US military is jet fuel used for the Air Force or Navy. The two biggest contributors in ktCO_2e is 18,348.9 and 3,633.8 for Jet Fuel and Navy Special (heavy fuel oil), respectively (see Table 1).

Table 1 about here

Greenhouse gas (GHG) inventory methods for the country data were used by adopting conversion factors sourced from the US Environmental Protection Agency (EPA). This method allowed the conversion from volumetric measurements of fuel consumption to kg CO_2 (EPA, 2015). Further factors were available in each dataset to convert the kg CO_2 values to kg CO_2e (kilograms of carbon dioxide equivalent, including carbon dioxide, methane and nitrogen dioxide emissions).

Table 2 about here

The Air Force is by far the largest emitter of GHG at 13,202.4 kt CO_2e, almost double that of the US Navy's 7,847.8 kt CO_2e. In addition to using the most polluting types of fuel, the Air Force and Navy are also the largest purchasers of fuel. In 2017 alone, the Air Force purchased $4.9 billion worth of fuel and the Navy $2.8 billion, followed by the Army at $947 million and Marines at $36 million (DLA 2017).

4.2 Hidden Carbon Costs and energy path dependencies

Another dimension of the 'hidden carbon costs' in the operations of the US military are the path dependencies built-in to major strategic commitments such as weapons systems — from the assault weapons used by soldiers, to the convoys, air, and sea carriers that deliver troops to particular sites — and the bureaucratic requirements that facilitate the operations of those commitments. Every step is dependent on a hydrocarbon fuel commitment; that is, hydrocarbon path dependencies are intertwined with the modes of warfighting chosen by the US military in operational contexts.

Consider the hydrocarbon path dependencies of counterinsurgencies, such as President Obama's 'surge' of US ground troops in southern and eastern Afghanistan in 2009-2010 when counterinsurgency was guiding military doctrine (Belcher 2014). In contrast to 'kinetic' operations that aim to bring an enemy into submission through a conventional troop presence and weapons saturation (e.g., air bombings, tank convoys, attack helicopters), counterinsurgency doctrine stresses 'winning' an occupied population's loyalty to the 'host state' and US military by turning the people against the insurgency. In US counterinsurgencies, the military assumes a posture more akin to police (Belcher 2015), and the arts of persuasion, effective governance, and economic development become paramount for gaining population support. Therefore, a pronounced ground troop presence 'amongst the people' becomes an important dimension for the military in the towns or areas where they are based. Unlike air raids, which can be commanded 'at a distance' from a secure military base in the capital (e.g., the Green Zone in Baghdad) or US Central Command in Tampa, Florida, counterinsurgency operations in environments like Afghanistan required establishing Forward Operating Bases in rural and remote areas where the majority of the Afghan population reside (Belcher 2018).

The scale of FOB-based operations in counterinsurgencies is immense. At the height of the war in Afghanistan, there were over 100 FOBs located throughout the country, mostly in the east and south where the Taliban and other insurgent groups were strongest. A typical FOB in Afghanistan required a *minimum* of 300 gallons of diesel a day to operate (Deloitte 2009). One appreciates the scale of hydrocarbon use when considering that a single US Marine Corp brigade operating across of a network of FOBs requires over 500,000 gallons of fuel per day (Deloitte 2009: 15).

As many FOBs are remote relative to major US bases in Bagram and Kandahar, guaranteeing reliable fuel and *matériel* supply is a significant logistical difficulty over a wide terrain with little by way of reliable infrastructure. High fuel requirements in forward deployed locations present the military with a significant logistical burden. More important, the transport of this fuel via truck convoy represents casualty risks, not only from IEDs and enemy attacks, but also from rough weather, traffic accidents, and pilferage. DOD officials reported that in June 2008 alone, a combination of these factors caused the loss of some 44 trucks and 220,000 gallons of fuel (Deloitte 2009: 15).

As per Gregory (2012: n.p.), '[b]y the start of 2010 around 30-40 percent of bases were being supplied by air because the Taliban controlled much of Highway 1, the ring road that loops between Afghanistan's major cities, and its IED attacks on NATO and Afghan forces were increasingly effective.' Air drops of fuel and other kit to FOBs had *their own fuel delivery cost* at an estimated $400 per gallon by air (Hodge 2011). For this reason, the US military and USAID invested heavily in paved road construction in Afghanistan to ease the conveyance of Humvee convoys around the IED-pocked Ring Road, as well as new roads connecting remote FOBs to main transport arteries. Indeed, from the military's perspective in Afghanistan, 'roads ain't roads.' As Kilcullen (2009: 109) writes, 'people [use] the process of road construction… as a framework around which to organize a full-spectrum strategy to separate insurgents from the people,' in two ways: (1) by creating greater security as it is more difficult to place IEDs on paved roads than dirt roads, and (2) by depriving the insurgency of recruits as local men make-up the road construction work force. What Kilcullen and the US commanders overlook is the civilian, and indeed the insurgency's, lock-in to carbon path-dependencies by their use of the new infrastructure. Our point is to say that a commitment to a military doctrine, like counterinsurgency, is a commitment to multidimensional hydrocarbon path dependencies—from the supply of fuel to troops, bases and vehicles; to securing the logistical supply chain in place to guarantee delivery, including across borders; to building new roads ('public works') for military and civilian use.

5. Conclusion: Turning off the Furnace by Cranking up the Heat on the US Military

In this paper, we argue that to recognize the U.S. military as a climate actor, geographers must understand how they organize and operate their supply chains. This is particularly true of oil, but also of other material acquisitions like food, machinery, and other apparently mundane materials (e.g., sand, concrete and water). As the US military continues to carry out the everywhere war in some of the least accessible corners of the globe, its supply chains require logistical sophistication like never before. In this article, we have given the first picture of the international organization of global supply chains that make the everywhere war possible. Moreover, we have stressed that this supply chain is precisely what allows the US military to be one of the largest institutional climate actors in the world. Just how is the US able to burn so much oil? Up to now, we have known very little about its infrastructural capacity to do so. This article is an attempt to take a first step toward disclosing the material infrastructure of possibility for US military carbon emissions, and the magnitude of those emissions.

How do we account for one of the most far-reaching, sophisticated supply chains, and one of the largest climate polluters in history? This is by no means an easy task. First, we need to look beyond the surface of discourse of the recent 'green' turn by the US military towards climate adaptation and mitigation, including the adoption of energy efficient technologies and alternative fuel sourcing. Instead, we emphasize the institutional bureaucracy and the material-discursive infrastructures that make massive hydrocarbon use possible. Based on our DLA-E records database, we presented a rough picture US military's current carbon boot-print, and explored how it becomes possible to procure, distribute, store, and consume the massive volume of fuels required for contemporary military operations. Our emphasis on path dependencies – war-fighting paradigms, weapons systems, etc. – also highlight another dimension that 'hides' carbon costs.

It is important to reflect on the border contributions of this study. Up to this point, few geographers have taken US military energy regimes as a focal point of US imperialism, coupled with the lack of any public reports of carbon accounting. We address this gap by bringing to the fore the hydrocarbon logistical infrastructure that make US imperialism possible. Geopolitical ecology provides a framework to pull together vital work around energy geographies and civilian path dependencies (Lyall, and Valdivia 2019; Mulvaney 2019; Bouzarovski and Haarstad 2018; Huber 2013; Watts 2003) critical logistics (Cowen 2014; Khalili 2017) and political ecology (Benjaminsen et al 2017); in particular, how infrastructure, institutions, nature, and path dependencies intersect for the service of US imperialism. We can now begin to focus on turning down the furnace, by cranking up the heat on the US military's war machine.

Disrupting these sundry path dependencies, and their constituent pieces, turns on a variety of social, political, and economic moments and movements. However, the headline summary is that social movements concerned with climate change must be every bit as vociferous in contesting US military interventionism. Whatever is left of the anti-war movement must keep environmental impacts at the front of the critique. What this means in practice is that, amongst other things, using the potential of climate-change induced conflict to argue for swifter adoption of renewables to conduct warfare is fundamentally contradictory and self-defeating. The logics, logistics, and bureaucratic structures embedded in the overarching modalities of the US war apparatus are inextricably tethered to hydrocarbons.

In this climate emergency, need something rather more radical than a repair-and-maintenance (Graham and Thrift 2007) approach that amounts to tinkering at the margins of the military's vast furnace. While incremental changes can indeed amount to radical reconfigurations, there is no shortage of evidence that the climate is on the brink of irreversible tipping points (Steffen et al. 2018).

Once past those tipping points, the impacts of climate change will continue to be more intense, prolonged, and widespread, giving cover to *even more extensive* US military interventions. We have argued elsewhere (Bigger and Neimark 2017) that it is probably good that the military has invested in the development of advanced biofuels technology and markets. But the entire point of these fuels is that they are 'drop-in'—they can be used in existing military kit—which means that, whenever convenient or cheaper, the infrastructure is already in place to undo whatever marginal gains have been made in decarbonisation. The only way to cool off the furnace is *to turn it off*, shuttering vast sections of the machine. This will have not only the immediate effect of reducing emissions in the here-and-now, but disincentivize the development of new hydrocarbon infrastructure that would be financed (in whatever unrecognized part) on the presumption of the US military as an always-willing buyer and consumer. Opposing US military adventurism now is a critical strategy for disrupting the further construction of locked-in hydrocarbons for the future.

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[1] http://www.quartermaster.army.mil/pwd/pwd_lab.html (Last accessed September 9, 2018)

[2] In November 2018, a major US federal report assessing was released forecasting effects of climate change on the US economy and natural resources in the 21st century. Despite the report's assessment of debilitating effects resulting from unmitigated climate change, the Trump Administration downplayed its significance.

[3] Four of the five branches of the US Military are part of the DOD, while The US Coast Guard sits under the Department of Homeland Security. Officially, the Marine Corps is under the Administrative jurisdiction of the US Navy.

[4] As of this writing (February 2019), the Trump Administration has vowed to withdraw US soldiers all soldiers from Syria, and more than half of US troop presence in Afghanistan as it brokers a peace deal with the Taliban. Trump's withdrawal plans were met with resistance by the Pentagon, Democrats and Republicans, including a formal rebuke of troop withdrawal by the US Senate. Whether or not the US completely withdraws from Syria and Afghanistan, US military and special operations still operate in dirty wars across Africa, and naval operations continue to expand in the South Pacific to 'counter-balance' a growing Chinese presence.

[5] To avoid confusion, we will spell out Defense Logistics Agency, while only referring to the Defense Logistics Agency – *Energy* sub-agency by its acronym, DLA-E.

[6] Through our extensive literature search on carbon footprint data for the US military, we noticed patterns around how other studies were compiling US military fuel purchasing data (Liska and Perrin 2010). During this time, we paid closer attention to the Defense Logistics Agency, specifically the DLA-E. We filed two separate FOIA requests. The first request was for data relating to all US military fuel purchases broken up by branch. The second request was for refined data on fuel type and regional location of purchases, distribution, and consumption. The FOIA process was unexpectedly quick and the DLA-E returned with data in .xls format displaying all fuel in gallons as we requested. For an account on how we obtained data from the DLA-E, and the politics of FOIA requests more generally, see Belcher and Martin (2019).

[7] We follow Urry (2004, 32) definition of path dependency illustrating that institutional decision making emanates, 'from contingent events to general processes, from small causes to large system effects, from

historically or geographically remote locations to the general…and therefore, 'systems develop irreversibly through a 'lock-in' but with only certain small causes being necessary to prompt their initiation…'

[8] An important turning point occurred in 2004 when US troops confronted Secretary of Defense Donald Rumsfeld over inadequate armour for Humvees, as soldiers were encountered roadside improvised explosive devices (IEDs) for the first time in Iraq.

[9] At the time of writing, it has been reported that the DLA could not account for $800m (£572m) in an auditing of its military construction projects and computer systems. According to the BBC (2018), 'Of the unaccounted money, $465m was found to be used for construction projects for the Army Corps of Engineers and other agencies, [and] failed to produce documentation for $100m of computer systems.'

[10] Like other institutional purchasing programs, is subject to graft, waste, and inefficiencies. While the DLA is undoubtedly adept at acquiring and distribution massive volumes of fuel and *materiel*, it is also the agency most culpable for astonishing levels of wastefulness. This is perhaps unsurprising given the military's soaring budget and the extensiveness of its supply chains, yet military leaders have been quick to disavow numerous reports of waste on a grand scale. For example, a 2016 internal investigation that found logistics practices to be the primary area where $25 billion could be saved *per year* was almost immediately removed from the Department of Defense website (Whitworth and Woodward 2016).

[11] The potential warming caused by any molecule of greenhouse gases indexed to the potential warming caused by a molecule of CO_2. See MacKenzie 2009.

[12] A standard unit for measuring carbon footprints, carbon dioxide equivalent or CO2e demonstrates the impact of each greenhouse gas in relation to the total of CO2 that would have an equivalent effect on climate change.

[13] On Scope 3 emissions, see https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf