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Treadmills of Production and Destruction in the Anthropocene

Coca Production and Gold Mining in Colombia and Peru

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Abstract

Human activities in Latin American countries have resulted in past and ongoing deforestation located in the Amazon and the Andes. Demonstrative of this new Anthropocene Epoch, the illegal production of cocaine stands as a major driver of these environmental outcomes in these countries; however, in recent years the extraction of illegal gold has yielded larger export values than that of cocaine. The consequences of these practices have far-reaching environmental, economic, and social consequences. Using a critical realist perspective, we investigate and analyze how, when, and under what conditions the treadmills of production and destruction are absent, present, and thriving in Colombia and Peru. The implications of these relationships are grave as both the Amazon and the Andes are undergoing extensive transformations – damage that represents the Anthropocene Epoch in which human activities are driving ecological systems toward "tipping points". We find that the two treadmills operate differently within each country and that treadmills are not ubiquitous but are, instead, contingent. We underscore the fact that when present, both types of treadmills have the ability to engage in social and environmental destructions, sometimes violently so.

Keywords: Treadmill of Production, Treadmill of Destruction, Anthropocene, coca production, gold mining

Logging, (legal) agricultural development, mining and illicit drug production motivate the destruction of forests in and near Amazonia. For example, one estimate places the amount of land razed by fire for mining purposes in Peru at 64,000 acres in 2012 (Webster 2012). In the context of the Colombian conflict (prior to 2016), a number of studies found deforestation positively associated with armed conflict (Negret et al. 2019), the density of coca plantations (Armenteras et al. 2013), and the proximity of a municipality to coca plantations (Davalos et al. 2009). Since the 2016 ceasefire reduced open conflict in Colombia, deforestation has *increased*, with cattle ranches and palm oil plantations replacing old-growth forests. The total amount of land deforested for agricultural use easily surpasses mining and drug production, but coca production and gold mining have disproportionately detrimental effects on the environment.

In this article, our examination of the multi-faceted assaults on the environment in the Andean region is guided by our recasting of treadmill theory (Hooks, Lengefeld, and Smith Forthcoming). In this recasting, we integrate the treadmill framework with critical realism (Bhaskar 2008; 2010; Carolan 2005a; 2005b). We define a "treadmill" as an anthropocentric process wherein (1) powerful organizations appropriate and transform nature to amass power and capital, (2) competition among these organizations propels accelerating degradation of the environment, and (3) these organizations obscure, distort, and suppress information about the environmental damage. Fleshing out this definition, we specify the distinction between a treadmill of production and a treadmill of destruction and the interplay between them. Thus, the "treadmill of production" and "treadmill of destruction" do not refer to separate and competing theories. Instead, they refer to distinct—but related—mechanisms. A treadmill of production is derived from and propels economic competition; a treadmill of destruction is fueled by geopolitical and military rivalries. It is possible that no treadmill exists in a given time and place. A treadmill of production may exist without a treadmill of destruction,and vice versa. Each treadmill, operating independently, generates unsustainable withdrawals from and deposits in ecosystems. The relationship between treadmills is contingent: they may operate simultaneously, reinforcing and amplifying one another (Jorgenson and Clark 2009; Bonds 2016); it is also possible that the operation of a treadmill of production can impede the operation of a treadmill of destruction,and vice versa.

The environmental effects of treadmills are clearly human-driven endeavors. That is, these practices should be viewed through the lens of the Anthropocene Epoch in which humans are the dominant force in environmental change. Both treadmills have played a large role in the ways that human societies have interacted with and harmed the environment in the 20th century and in the first twenty years in the new century. Although activities embedded in these treadmills, such as the drug trade and gold mining, make only a modest contribution to global environmental outcomes such as climate change, their overall environmental consequences are severe and far-reaching, particularly at the local level. With gold mining, for example, the forest is not only cleared, but the topsoil is stripped up to 50 feet in depth and the use of mercury contaminates both the site itself and nearby rivers, streams, and groundwater (Webster 2012). We consider the effects of the illegal drug trade and gold mining by assessing their relationship to treadmills operating in Colombia and Peru. Our recasting of treadmill theory guides our examination of the dynamics

and the effects of coca/cocaine production and gold mining. These case studies also advance the recasting of treadmill theory in important respects by highlighting absences and presences, and by shedding light on the transformation of treadmills over time and space and highlight the sheer human dominance over the environment.

Recasting Treadmills of Production and Destruction: Absences, Emergences, and Transformations

Building upon the three-point definition of treadmills above, treadmills are understood as generative mechanisms that produce the events that we observe. Together, the materiality and the schema make a treadmill formidable. Nonetheless, treadmills are neither immutable nor are they permanent. Because treadmills span the biophysical and the social, and because there is an ontological asymmetry between the biophysical and the social (Bhaskar 2008, 2010; Carolan 2005a, 2005b), contingency and change are inevitable.

Adopting Mann's (1986) conception of the sources and networks of power, the macrosocial context gives rise to two treadmills. The treadmill of production emerges from and is reproduced by economic networks, power, and resources. In the pursuit of market shares and profits, powerful economic actors make irresponsible and unsustainable withdrawals and additions to the environment (Schnaiberg 1980; Schnaiberg and Gould 1994). As economic networks are global, a treadmill of production can be shaped by powerful and distant actors and processes: global commodity chains (Hopkins and Wallerstein 1982). Global commodity chains disrupt and distort local economic and social relationships, and often impose steep environmental costs on vulnerable people and places (Rice 2007). These conceptual frameworks complement one another. Together, they shed light on how and why coca cultivation, cocaine manufacture, and gold mining are destructive to ecosystems.

By contrast, a treadmill of destruction is rooted in a different network of power – military power. Here, environmental use and misuse are driven by military and geopolitical motives — motives that cannot be reduced to profits and market shares (Hooks and Smith 2004, 2005). For military organizations, the use-value of weapons (not their exchange value) is paramount. The environmental damage caused by a treadmill of destruction can take many forms. The fabrication, transportation, and storage of weapons generate a stream of highly toxic by-products and waste products (often justified and obscured behind a veil of national security). When these weapons are used, battlefields are toxified. Worse still, in recent decades, civilians–not soldiers–are at the greatest risk of dying from war with the increase in risk-transfer militarism (Smith and Lengefeld 2020).

The relationship between a treadmill of production and a treadmill of destruction–in a given time in place–is contingent. Tilly's (1990) discussion of capital and coercion highlights the possibility that the concentration of capital can be such that it becomes difficult to amass and concentrate the means of coercion. Conversely, where the means of coercion are formidable and capital is modest, a militaristic social order can undermine economic growth and development. Extending this reasoning, a robust treadmill of production (and the powerful economic forces and powers sustaining it) may limit the concentration of military power, thereby limiting the

emergence and impact of a treadmill of destruction. Conversely, where military power is extensive, especially when this power takes the form of kleptocratic plundering, the infrastructure for economic growth is stunted and the space for capital accumulation will be constrained. Under these circumstances, a treadmill of production will likely be curtailed (or absent). But it is also possible that a treadmill of production and treadmill of destruction not only co-exist but are synergistic; one another and their attendant environmental damage. In fact, as discussed below, Colombia's civil war spawned a treadmill of production and a treadmill of destruction. These treadmills reinforced one another and prolonged this bloody war (Smith, Hooks, and Lengefeld 2014). This article examines the fate of these treadmills as the ceasefire brought an end to this violent conflict.

For critical realism, the existence of generative mechanisms–in this case treadmills–is neither necessary nor inevitable. Rather, the emergence, reproduction, and impact of treadmills are contingent and path-dependent. This is not to deny the existence of "external laws" that delimit what is possible and likely (Bhaskar, cited in Cooper 2013:580). Cooper (2013) uses the example of an aircraft to illustrate this point. Gravity exists and operates in a law-like fashion whether or not humans attempt to fly. In similar fashion, aerodynamics operates in predictable ways–independent of human activities. When designing and fabricating aircraft, the central challenge is to manipulate aerodynamics to keep the aircraft aloft despite the pull of gravity. In this example, the existence and operation of an aircraft is contingent. It need not come into existence; airplane flight only occurs when humans have sufficient knowledge of gravity and aerodynamics and if this knowledge is reflected in the design and fabrication of the aircraft. Routinized flight is a notable accomplishment for the human species. At the dawn of the 20th century, the inventors and investors in powered flight could not have imagined the consequences of their successes: shrinkage of travel time, global economic integration, saturation bombing to terrorize cities and entire societies, delivery of nuclear weapons, and extension to space travel. These larger outcomes and transformations were path-dependent and shaped by the contingencies of human history.

Like airplanes, treadmills exist at the interface between the biophysical and sociocultural. When a treadmill is operating, powerful organizations and the elites commanding them extract, transform, and deploy biophysical resources to amass capital and/or power. Just as airplanes are shaped and delimited by gravity and aerodynamics, treadmills are molded by the properties of specific biophysical resources. For example, for the case studies we are pursuing, the Andean climate and topography and the biological characteristics of the coca plant shaped the emergence and reproduction of treadmills fueled by cocaine. Conversely, the Andean topography and geology determined where gold is deposited, and the laws of metallurgy create a limited set of options for extracting it–including options that are spectacularly destructive for people, flora, fauna, and ecosystems. Contingency is not limited to the sociocultural realm. Even as the biophysical characteristics of the coca plant and the molecular structure of gold are unchanged, the larger context can be transformed. An earthquake or flood could destroy coca plants in one region, or these events could create new opportunities to mine gold. A prolonged drought would stunt coca production across the Andes, as could the effects of global warming. On a still larger scale, a large

asteroid could cause a mass extinction – resulting in the disappearance of the coca plant and homo sapiens. Case studies of Colombia and Peru will highlight contingency flowing from the actions of human agents, social organizations, social structures and the arc of human history: "necessities are not absolute, but relative: different combinations of law-governed phenomena produce unique, concrete outcomes" (Cooper 2013: 580).

In the Anthropocene Epoch and with our focus on treadmills, aircraft not only offer a useful example for highlighting contingency, this example also highlights the growing danger posed by treadmills. Infrastructural power (Mann 1986) refers to the capacity to do something (as opposed to despotic power which emphasizes power over others). Just as the human capacity to fly has been routinized, the human capacity to extract and degrade natural systems and ecosystems has expanded and been routinized on a much larger scale and scope. Treadmills are powerful in the sociocultural realm because they allow social actors to amass capital and power by controlling access to biophysical resources. Because the frenzied pace of a treadmill is driven by competition with rival social organizations (e.g., corporate rivalries or armies locked in war or an arms race) and indifferent to the degradation of the environment, this growth in infrastructural powers has given rise to increasingly destructive treadmills.

We are not claiming that treadmills are ubiquitous. In fact, studying the absence, emergence, and disappearance of a treadmill is of central importance. Critical realism emphasizes that "absence is not only necessary for being, but change, properly understood, presupposes absence, i.e. the coming into being of new properties or entities and the passing away from being of previously existing ones" (Bhaskar 2010: 15). The emergence of an idea, mechanism, institution, or structure implies it is not empirically present at one point in time, but subsequently is. Conversely, a social structure that currently exists and exerts effects that are empirically visible may subsequently cease to do so (see Fleetwood 2011; Martins 2011).

In Sewell's (1992) framework, social structures are defined by the interplay of resources and schemas. Resources are material; schemas are not. The existence and causal importance of schemas are implied by the resources and power that they mobilize. Because the interplay of schemas and resources are foundational in Sewell's conception of social structure, absence, and emergence are inherent. A schema can exist without mobilizing resources. Returning to the example of an airplane, the idea of an airplane that successfully capitalizes on aerodynamics to overcome gravity can be impactful. In fact, a viable aircraft design sets in motion the planning and building of aircraft. In this sense, a treadmill's schema can be impactful even when few resources are currently mobilized by it. Social actors can enact and transpose this schema in different times and places and for different biophysical resources. Conversely, material resources can exist without a schema that makes strategic use of these resources to generate social power. In another historical and spatial context, the combination of this schema and resources might generate formidable power.

Even as Sewell's framework helps us understand why treadmills are at the same time potent and destructive, it also provides tools to analyze their malleability, transformation and, ultimately, their vulnerability. First, schemas are transposable. A given schema might be applied to address

similar challenges. The treadmill schema focused on one resource might be adapted to others. But this is a possibility, not a certainty. We selected cases studies to highlight these possibilities and their contradictions. Specifically, in Colombia, cocaine production declined once a ceasefire was signed in 2016. But there has been a consolidation of agroindustrial development of legal crops (palm and ranching) and the growth of legal and illegal gold mining. In pursuing a case study of Colombia, we highlight the degree to which treadmills of production and destruction were transposed as the geopolitical context changed. Second, resource accumulation is variable and unpredictable: "the very fact that schemas are by definition capable of being transposed or extended means that the resource consequences of the enactment of cultural schemas is never entirely predictable" (Sewell 1992: 18). In one context, a treadmill of production generates spectacular profits; in another, the resource flow is anemic. The comparison between Colombia and Peru on coca production is instructive on this point: in Colombia the treadmill of production is vigorous, while in Peru, cocaine production is not characterized by the freneticism associated with a treadmill.

A treadmill of production and a treadmill of destruction can co-exist. In fact, we begin with Colombia's internal conflict. This war spawned synergistic treadmills of production and destruction (Smith, Hooks, and Lengefeld 2014). Our research examines developments after a ceasefire brought an end (or at least a dramatic reduction) in the scale and scope of violence in Colombia. The central question that motivates this research is: What became of the treadmills spawned by this conflict? Without this brutal war to sustain them, did one or both of these treadmills disappear (from presence to absence)? Did these treadmills transform and persist? On this score, we examine the possibility that these treadmills shifted to neighboring countries and new economic activities. If treadmills are now operating in nearby locations, such as Peru, does this represent the emergence of treadmills (from absence to presence)? If a treadmill of production and/or treadmill of destruction are operating in Andean gold mining (alluvial and large-scale mining in the formal sector) and in agro-industrial development more broadly, does this provide an example of emergence?

Treadmills in the Andes: Transformation, Emergence and Decline

Our case studies focus on coca production and gold mining. While some coca cultivation is legal in Peru, most is illegal, and the fabrication and sale of cocaine is illegal in both countries. Coca cultivators reap a very small portion of the profits generated through the sale of cocaine. Still, in a region with widespread poverty and few income-generating alternatives, coca cultivation is exceptionally lucrative. In 2007, using United Nations Office on Drugs and Crime estimates for coca leaf production and the farm gate price, the sale of coca generated $270 million in Peru, and $385 million in Colombia—a total of approximately $655 million (2008: 66-68). As such, the total revenue flowing to the farmers likely exceeds $1 billion per year—a valued source of income for farmers. It comes as little surprise, then, that farmers in the region find coca cultivation appealing.

Mining gold can be and is frequently legal, and actively supported by the state. However, in recent decades, illegal alluvial gold mining has swept across Colombia and Peru as well as other

Andean nations, causing vast deforestation and startling environmental degradation. Mercury is widely used in gold mining, and mercury "contamination is considered one of the worst hazards among the anthropogenic impacts upon the environment" (Bonotto and da Silveira 2009: 1). Because we are examining activities that are often illegal, the size and impact of the treadmills of production and destruction we are examining are not easily captured in official statistics. Gootenberg offers the following estimate of the "drug economies" of Andean nations relative to the gross national product:

> [C]ocaine's economic contributions from the 1990s mostly suggest exaggerated public perceptions of drug economies…. Peru's…highpoint lay in the range of 1.5-3.7% of GNP; Colombia, defying representations, was less than 3% during its war with the Medellín and Cali cartels. Two decades later,…[Peru and Colombia] are diverse export economies with sharply lower drug shares. It is the political combustibility of conflict goods that ignites their visibility (2017: 33).

Although Colombia and Peru are undergoing something of a gold boom, the total revenues generated by illegal mines would not dramatically alter the picture relative to total output. That is, cocaine and illegal gold mining combined do not make a large contribution to total economic output in the region.

Even if cocaine and gold make modest contributions to overall gross domestic product, where treadmills are present they can have wildly disproportionate environmental impacts. These deleterious impacts are amplified because this is taking place in and near the western Amazon basin. The Amazon basin is nearing a tipping point; it "generates approximately half of its rainfall by recycling moisture as masses move from the Atlantic across the basin to the west. At some point, deforestation will likely reduce this moisture cycle to a point where it will no longer support rainforest ecosystems" (Piotrowski 2019: 4).

In the course of Colombia's long and bloody internal conflict,[1] the economic logic of a treadmill of production was reinforced and amplified by a treadmill of destruction. In a variety of ways and on a variety of scales, militarism and violence have become interwoven with cocaine and gold production in and near the Andes Mountains. In Colombia, coca is being grown and gold is being mined in regions distant from the capital, Bogota. With central state control weak and logistics difficult, non-market, often coercive, means have long been used for protection and to exert control. Cocaine and gold production have been deeply intertwined with the long and bloody conflict that ravaged Colombia. As anticipated by the treadmill of destruction framework (Hooks and Smith 2005; 2012; Hooks, Lengefeld, and Smith Forthcoming), the militarization of the Andean region introduces additional—and distinct—pressure on the environment. Each treadmill, operating independently, generates unsustainable withdrawals from and deposits in local

[1] While the prolonged and bloody internal conflict in Colombia meets the definition of a civil war, we will refer to it as the Colombian internal armed conflict (Colombian conflict for short) as this is closer to the terminology used in Colombia: *conflicto armado interno colombiano* (see, for example, Salazar 2019; Thomson 2011).

ecosystems. When combined, as they have been in Colombia, the environmental damage is dramatically heightened.

Using the 2016 Colombian ceasefire as the point of departure is warranted given the history of coca/cocaine production over the course of the 20th Century. Eradication efforts of the late 20th Century were frustrated by the "balloon effect": squeezing a balloon does not change the volume of air in the balloon, it only relocates air that remains inside the balloon. Even when eradication proved successful in one region, overall cocaine production continued to grow; eradication merely shifted where cocaine production occurred and who profited from it (Gootenberg 2012; Smith, Hooks, and Lengefeld 2014). We begin with the Colombian case (where both treadmills emerged during the conflict), and we explore the possibility that the sharp diminution of violence since 2016 has eroded the foundations of these treadmills. If this war made treadmills possible/likely, do treadmills decline and disappear (from presence to absence) when the war ends? Or, did treadmills of production and destruction take new forms and shift to new places and focus on different crops and other natural resources?

Colombia: What Has Become of Treadmills Emerging from a Violent Internal Conflict?

Assigning a precise date to Colombia's violent internal conflict is no easy task. The past century has been peppered with violent interludes, ongoing contestations, and enduring challenges to political and social institutions (see for example, British Broadcasting Corporation 2018; Peace Insight 2020). Land distribution and the agrarian question have been at the center of these multi-faceted conflicts. Throughout the 20th Century, much of Colombia's agricultural output was devoted to lucrative export crops, often focused on the U.S. market (coffee, sugar, bananas, cattle, and most recently, palm oil). Seen in this light, the emergence of the highly lucrative cocaine industry followed Colombia's emphasis on export-oriented agriculture; it was not an aberration.

To increase their output and profits, large landowners relied on violence and intimidation to displace peasants and suppress union organizing (Hristov 2009; 2014). This violent path of capitalist development was condoned and often facilitated by the state, and it gave rise to sustained resistance (Thomson 2011). In the 1940s and 1950s in a violent interlude referred to as *La Violencia*, several hundred thousand people died, with land redistribution a prominent point of contention. In the mid-1960s, two left-leaning guerrilla organizations emerged: FARC (*Fuerzas Armadas Revolucionarias de Colombia*) and ELN (*Ejército de Liberación Nacional*). FARC, the largest guerrilla force, challenged state power and the economic and political power of large landowners for more than 50 years (albeit at varying levels of intensity) until the 2016 ceasefire. In part due to necessity, as FARC and ELN were driven underground in urban centers, and in part due to political commitments, these guerrilla armies wielded power in the name of and in defense of displaced peasants (Hristov 2009; 2014; Thomson 2011; López-Uribe, Pilar, and Torres 2018).

While landowners had long relied on physical intimidation and violence, the threat posed by guerrilla armies led to the emergence and growth of paramilitary forces. In the 1980s and thereafter, paramilitary forces—funded and often led by large landowners—became prominent in the Colombian countryside (Hristov 2009; 2014). The Colombian military and police forces condoned paramilitary activities, and in some instances worked closely with them to attack

guerrilla armies. With the cocaine boom—beginning in the 1980s and continuing through the 2010s—heavily armed criminal organizations added to the levels of violence in the Colombian countryside. The lucrativeness of cocaine production spawned a treadmill of destruction that sustained a merciless internal conflict and ravaged Colombian ecosystems (Smith, Hooks, and Lengefeld 2014). While the coca plant is indigenous to the Andean region, it was not a prominent crop in Colombia prior to the 1980s. As coca production was suppressed in Peru and Bolivia in the 1980s, criminal organization shifted coca growing and cocaine exports to Colombia. Guerrilla forces, with FARC the most prominent, protected farmers from criminal predation and assisted efforts to increase returns for coca production. FARC became increasingly active in managing and profiting from cocaine production in the areas that it controlled. The cocaine sector proved to be exceptionally lucrative and made it possible for FARC to maintain a larger force, to better equip this force, and to invest in governance and infrastructure in the regions it controlled. Paramilitary forces also profited from cocaine, developing close ties with organized crime networks. Like FARC, paramilitary forces used the returns from cocaine to expand and support its troops. The Colombian Government, with the encouragement and support of the United States, took aggressive steps to eradicate coca plants, especially in areas controlled by FARC. Eradication became ecocide. Beginning in 2000, Colombia increasingly militarized the drug war, with the U.S. providing support for and insisting on aerial spraying of wide-spectrum defoliants (Messina and Delameter 2006) that killed virtually all vegetation and polluted waterways.

To facilitate transport, coca leaves were typically processed into coca paste near to where they were grown, using chemicals that are toxic for humans and damaging to ecosystems, including organic solvents (e.g., kerosene and diesel fuel), sulfuric acid, and potassium carbonate (Inter-American Drug Abuse Control Commission 2005). The fabrication process consumes and contaminates a great deal of water, resulting in pollution of nearby streams (Mejía and Posada 2008). As most coca production is illegal, producers are driven to maximize harvests as soon as possible, incentivizing the use of fertilizers and insecticides. The runoff from these agricultural chemicals further degrades water resources and compounds the environmental harm attributed to coca production for the global cocaine market. In the early 1990s, Armstead (1992) estimates that around 20 million liters of dangerous chemicals are released into nearby waters feeding the Amazon and Orinoco rivers, yielding waterways that "are almost entirely devoid of many species of aquatic, plant and animal life."

Government eradication efforts and the multi-faceted conflict in the countryside motivated growers to seek out evermore remote areas. This propelled a shift to still more remote locations, clearcutting of old-growth forest, and disruption of unique ecosystems. The cocaine industry also gave rise to an extremely destructive cycle of boomtowns and ghost towns (Davalos, Bejarano, and Corea 2009). For example, Llorente, Colombia was transformed from a sleepy, quiet town to one dominated by the drug trade. Llorente is located within the province of Nariño which accounted for less than 3% of the nation's coca production in 1999, but by 2004 it accounted for 20% of that production. Drug and alcohol abuse, guns, violence, and prostitution became pervasive (Muse 2005). Where Colombian armed forces—often with U.S. support—cracked

down on a boomtown, it would shrink dramatically. But this nominal success in one boomtown led to a shift of coca production and cocaine manufacture to another locale, giving rise to another round of boomtown growth and collapse; and this cycle was repeated many times over. These environmental impacts were visible—and the warring sides were quick to blame antagonists for their irresponsible environmental actions—and widely condemned. However, in the context of a conflict waged without mercy, the warring parties were locked in deadly competition that only accelerated the environmental calamity (Smith, Hooks, and Lengefeld 2014).

The preceding paragraphs highlight similarities among combatants in this treadmill of destruction. But there were and are important differences between the FARC, paramilitaries, and government forces (Hristov 2009; 2014; Sanin 2004; 2008), and these differences shed light on the transformation of treadmills since the Colombian ceasefire took effect in 2016. For the present purposes, the most important differences between FARC and paramilitaries are in who they fought against and what they were fighting for. FARC forces experienced significantly greater casualties: they fought against the Colombian Army, and organized paramilitary units. While FARC forces did commit human rights abuses, even massacres, they were far less likely to attack civilian populations. FARC soldiers were disciplined severely if they were found guilty of looting or abusing civilians (Sanin 2004). As noted above, in the 1980s landowners and Colombian military forces forged even closer ties with paramilitary forces (Human Rights Watch 1998; 2001). Not only did paramilitary forces become larger and more lethal (with widespread human rights abuses attributed to them), but they routinely coordinated with the Colombian military (Human Rights Watch 2001). That paramilitaries were implicated in far more massacres, looting, and general abuse of peasants comes as no surprise (Sanin 2004) given their alliance with landowners. Colombia's police and military forces were allied with them, and were indifferent to or complicit in their many atrocities (Grajalas 2011; Human Rights Watch 1996; 1998; Lopez 2011). Paramilitary forces frequently attacked unarmed civilians to suppress labor unrest or to drive peasants off the land. Landowners took possession of the lands that were abandoned. "One day they (the paramilitaries) came to my place; they said—either you sell us your farm, or we'll buy it from your widow. We took all our stuff and we left. They never paid for the land" (Grajales 2011: 771). As paramilitary forces were closely allied to the political and judicial authorities locally and nationally, this type of extraconstitutional land seizure was readily legitimized (Internal Displacement Monitoring Centre 2006).

FARC used its growing coca revenues to exert direct and indirect control over much of rural Colombia: it controlled 173 municipalities in 1985, less than 20% of all municipalities; ten years later FARC controlled 622 municipalities, roughly 61% of municipalities:

> [The] FARC acts as a state would. It defends the peasants working in their territory, and exercises control and influence. In some cases, the FARC has built schools and hospitals. It also provides a rudimentary legal system to the territories that they occupy…In exchange for these services, the FARC collects taxes. A small portion of its tax revenue comes from peasants, and landholders, but the majority of tax revenue comes from coca growers and drug traffickers [based on the market value of a kilo of coca paste] (McDougall 2009: 336).

By contrast, paramilitaries were less likely to create alternative governance institutions. After all, landowners and business elites supported paramilitary forces in reaction to the waxing of guerilla power and fighting prowess. Instead of challenging the social order, paramilitaries came into existence to protect Colombia's highly unequal social order and path of economic development.

Both FARC and paramilitaries worked with drug cartels (directly and indirectly) on a regular basis. Criminal cartels controlled the export of cocaine and both FARC and paramilitary units leveraged this relationship, albeit in very different ways. FARC imposed higher "taxes" on drug production, protected farmers from predation and displacement by criminal organizations, and retained a clear distinction between those working for the cartel and the FARC soldiers. Paramilitary forces, by contrast, worked closely with criminal cartels and, at times, the boundary became quite blurred (McDougall 2009). The close ties between paramilitaries and criminal cartels became starkly evident when Colombia negotiated a demobilization of paramilitary forces in the early 2000s. This flawed agreement did lead to the disbanding of paramilitary units, and it provided a path for individual soldiers to return to civilian life. However, many paramilitary soldiers remained armed and active. Entire paramilitary units, including commanding officers, and a large number of individual soldiers became active in criminal cartels (Human Rights Watch 2010; McDermott 2014)

In one sense, the recent conflict continued a violent path of capitalist development in Colombia; on the other hand, this conflict witnessed the creation and institutionalization of a virulent and violent treadmill of production—a treadmill that worked synergistically with a treadmill of destruction while the conflict raged. Large landowners and corporations both domestic and multinational took advantage of and directly supported violence to displace peasants and disrupt labor organizing in the countryside (Internal Displacement Monitoring Centre 2006; Richani 2005). This violent land acquisition set the stage for extensive clearcutting, establishment of ecologically disastrous monoculture or cattle ranching, and the pursuit of unsustainable mining. This is not to suggest that earlier generations of large landowners and corporations held a more benign environmental ethos. Rather, in the Anthropocene Epoch, elites and corporations have much greater capacity to clear-cut forests after forcing peasants to flee and laws protect "productive" uses of land where ownership is contested.

Although mining activities in Latin America stretch back to colonial times, the modern gold mining boom began in the early 2000s (Rettberg and Ortiz-Riomalo 2016). Following the 2008 global financial crisis, the price of gold rose dramatically (Alvarez-Berríos and Aide 2014) coinciding with mounting pressure on Colombian drug producers. In this context, illegal gold mining grew rapidly, the value of gold was estimated to exceed cocaine for several years. Just as cocaine production and export provided revenues used to support FARC and paramilitary forces, gold became increasingly important in the years preceding the ceasefire (Rettberg and Ortiz-Riomalo 2016). By the time of the ceasefire, Wagner (2016) estimated that 80% of gold exported by Colombia was extracted illegally and smuggled out of the country. Instead of panning, this illegal surface mining involved clearcutting vast tracts of land, dredging the soil along waterways,

and using toxic chemicals—most notably mercury—to extract gold from the ore (Fragoso 2016; Guiza and Aristizabal 2013; Webster 2012). The problem, of course, is that mercury is known to be a highly toxic compound that can not only cause health problems to humans when ingested directly, but can bioaccumulate in the food chain via fish and then be spread among those species who eat the fish. These mining operations leave the land denuded and scarred, the waterways and ecosystems toxified, and local residents are often displaced or forced to abandon their homes to escape violence. Furthermore, because it leads to stagnant waterways and increased mosquito populations, gold mining has been linked to a rise in malaria transmissions (Sanchez et al. 2017).

The wartime dynamics of displacement and land grabbing set the stage for an environmental calamity in the wake of the ceasefire—a calamity driven by a virulent and violent treadmill of production. In the aggregate, levels of violence in Colombia have declined dramatically since 2016. FARC has been disarmed and no longer leads coordinated attacks on Colombian troops and agro-industrial elites. But violence and coercion remain quite high in Colombia—especially in rural Colombia. Peasants continue to face extortion and coercion from a criminal cadre working for large landowners and corporations (Ballvé 2013; Wesche 2018); land grabbing and ecological degradation has accelerated since the ceasefire. FARC forbade coercive land grabbing in its controlled areas, mostly distant from urban centers and in difficult to access areas (McDougall 2009). The Colombian government had great difficulty transporting and supplying troops in these remote locations; FARC's guerrilla forces were able to avoid detection when outnumbered and to defeat smaller numbers of government troops. Thus, the areas controlled, both indirectly and directly, by FARC tended to be more forested, ecologically diverse, and home to (or adjacent to) parks and other protected areas.

FARC's demobilization created a vacuum—a vacuum that has been filled by landowners, corporations, and criminal organizations allied to them (Human Rights Watch 2010). While the Colombian government has increased access to the remote regions that FARC controlled, these improvements were modest. Furthermore, rural elites and corporate leaders exert significant influence over political leaders, state institutions and courts. Colombia has long been a dangerous place to promote reform. Union leaders, community organizers, environmental activists, and other reformers have long faced violence and intimidation. This violence has continued and in some respects intensified since the ceasefire (Tomassoni 2020; Wesche 2018). In this context, landowners and corporations gave the state a *fait accompli*—relying on violence and intimidation, they quickly grabbed land, took steps to establish its title, and clear-cut the forest to establish agricultural uses (cattle ranching and palm oil plantations prominent among them). Even when and if it has the will to recognize and protect the rights of peasants, the Colombian state faced the challenge of reversing land grabbing undertaken by politically influential elites and in regions it has difficulty administering (Internal Displacement Monitoring Centre 2006).

The treadmill of production (Schnaiberg 1980; Gould, Pellow, and Schnaiberg 2008) placed a great deal of emphasis on agriculture, especially on "efficiencies" linked to the introduction of chemical and energy-intensive technologies to displace labor. The treadmill of production that has emerged in Colombia is far less concerned with labor-saving efficiencies. Instead, this treadmill

is far closer to the violent and coercive enclosures that Marx described (Foster 2005). That is, the violent treadmill of production is focused on consolidating and exploiting lands owned (if informally) by peasants and lands that have never been cultivated.

When comparing the final years of the conflict (2013-15) to the post-ceasefire years (2016-19), Clerici et al. (2020) examined deforestation in parks and protected areas. The results were "striking." Among Colombia's parks and nature reserves

> seventy-nine percent (79%) experienced increased deforestation in the post-conflict years…. This translated into a dramatic and highly significant 177% increase in the deforestation rate between the two 3-year periods…. In the biogeographical Amazon, of which FARC controlled vast areas, several parks suffered notably severe upswings in deforestation following the peace agreement (Clerici et al. 2020).

While illegal activities contribute to deforestation and other forms of environmental degradation, legal and state-sanctioned agricultural development plays a much larger role: "Cattle ranching ranks as a top driver behind both legal and illegal deforestation in the Colombian Amazon" (Piotrowski 2019: 15; see also Prem, Saavedra, and Vargas 2019). The institutionalized and violent treadmill of production is focused on legal crops and mining (especially gold) and controlled by Colombia's agro-industrial elites, powerful criminal organizations and allies in the state. Due to the strength and frenzied operations of this violent treadmill of production, "70% of Amazonian deforestation [in Colombia] is related to land grabbing driven by mafias linked to illicit activities like drug trafficking and money laundering. Illegal gold mining in rivers and floodplains is a driver of deforestation, even threatening protected areas, particularly in Peru" (Piotrowski 2019: 4).

We close this case study of Colombia by returning to the theoretical questions that we have posed: What became of the treadmills of production and destruction after the ceasefire? Recall that our definition of a treadmill includes three characteristics: (1) powerful organizations appropriate and transform nature to amass power and capital, (2) competition among these organizations propels accelerating degradation of the environment, and (3) these organization obscure, distort, and suppress information about the environmental damage. The context (network of power in Mann's [1986] framework) distinguishes a treadmill of production anchored in economic networks and focused on capital accumulation, from a treadmill of destruction based in military/geopolitical power and competition. This case study provides evidence that the treadmill of destruction has receded, while the treadmill of production has become more violent and impactful. With the demobilization of paramilitary forces in the early 2000s and the 2016 demobilization of FARC, there is no longer a military conflict fueling environmental degradation (United States Institute of Peace 2018). The peace accord promised many things, including universal education, improvements in basic services such as access to drinking water, and investments in rebel communities to improve their lives—the stated goal of the FARC (Casey 2019). The human tragedy and anemic institutions left in the wake of this long and bloody internal

conflict are staggering. With more than 6 million people displaced, only Syria surpasses Colombia in the number of displaced people (Global IDP Project 2016: 29). Although guerrilla and paramilitary armies are no longer extracting revenues from agriculture and mining to sustain military forces, it appears that the schema associated with a treadmill of destruction has been transposed and has survived. That is, during the several decades of intense conflict (circa 1980 - 2016), armed forces expropriated land, encroached on protected nature reserves and old-growth forests, and organized unsustainable cultivation and mining activities. Whereas these activities were undertaken with military objectives in mind at least in part prior to the ceasefire, these military imperatives have receded. After the ceasefire, these violent tactics have persisted: they are being deployed to achieve economic goals—expand land holdings, increase output, and expand profits.

In addition to highlighting recent and disturbing developments in Colombia, this case study serves two additional purposes. First, it clarifies the distinction between a treadmill of production and treadmill of destruction. Because they are linked to war and military competition, violence is foregrounded in a treadmill of destruction. But this does not imply that a treadmill of production is peaceful. On the contrary, as the case of post-ceasefire Colombia reveals, a treadmill of production can rest on coercion and result in structural violence. In the absence of coercive land grabbing and intimidation, environmental degradation in Colombia would be dramatically reduced. Violence and intimidation are necessary for the widespread pollution of waterways due to alluvial and formal gold mining and the clearcutting of forests. To restate; the distinction between a treadmill of production and destruction rests on the network of power in which it operates, and as the case of Colombia highlights, not the prevalence of violence. Second, documenting the emergence and consolidation of a violent treadmill of production in Colombia sets the stage for an additional case study of Peru. The questions are: Were treadmills present (or emerging) in neighboring countries prior to the ceasefire? Did the Colombian ceasefire contribute to the emergence of this schema in a new setting?

Peru: Two Commodity Chains with Two Divergent Treadmill Paths

This case study of Peru will focus on cocaine and gold production since 2016. The question is if treadmills of production or destruction were already present in Peru and/or if treadmills originating in Colombia sparked the emergence of treadmills in Peru after the ceasefire. Peru has a long history of peasant resistance and internal conflict linked with land invasions and agrarian issues. In the early 2010s, Peru displaced Colombia as the world's largest producer of coca and cocaine (Bajak 2013). Although Colombia has regained the top spot, Peru has increased as the Colombian conflict receded. Similarly, Peru is second to Colombia in illicit gold production and export—and it has been hard hit by environmental degradation as a result.

Cocaine. If we were presenting a history of cocaine production, the story would begin with Peru—not Colombia. Coca had been cultivated and consumed for centuries in Peru. In the 19th and 20th Centuries, to create demand for its sizable coca sector, the Peruvian government promoted the use of products derived from coca (including cocaine) in medicinal and consumer goods (including Coca-Cola). In the middle decades of the 20th Century, the Peruvian Government

fought a losing battle against the criminalization of cocaine in the United States, Canada, and Europe. Until the 1980s, Peru was the world's leading producer of coca and cocaine by a wide margin.[2]

In the 1980s, several contingencies aligned to create a boom for cocaine and an opportunity for the Shining Path to expand (Kay 1999). First, the demand for cocaine in the global North (especially the United States) surged—resulting in higher demand and higher prices. Second, in the wake of government programs to promote "settlement" in the region, there was an influx of peasants to the Upper Huallaga Valley—a sparsely populated and remote region. Coca had long been cultivated in Peru, but the center of production was in the VRAEM region (named after three rivers: the Apurimac, Ene and Mantaro) and this region continues to be the center of production. However, the Upper Huallaga Valley rapidly increased coca production in the 1970s and 1980s. The expansion of coca cultivation in the region degraded the environment in tangible ways. First, forests were clear-cut to make way for coca planting. The Upper Huallaga Valley is at the western edge of Amazonia, where it receives substantial rainfall, is quite warm and is mountainous, i.e., upper jungle (Dourojeanni 1992). Once the forest was degraded, the steep hillsides and high rainfall guaranteed high rates of erosion and in some cases lethal landslides, soon leaving the plot unsuitable for further farming—motivating still another round of deforestation. Second, the recently arrived farmers were unfamiliar with the topography, climate, and growing conditions. This unfamiliarity exacerbated soil erosion in the region. Finally, the processing of coca leaves to make coca paste and/or cocaine generated toxic byproducts and waste products that were dumped in rivers and streams (Dourojeanni 1992).

The Shining Path (a Maoist insurgency originating in the university sector) committed itself to armed struggle and relocated to remote areas of Peru—including the Upper Huallaga Valley. In the context of the coca boom in this remote region the Shining Path thrived. The Shining Path protected farmers from predation by drug cartels and corrupt police, and it tapped the flow of drug revenues to support and expand its military operations. For example, because planes were used to smuggle coca paste to Colombia, the Shining Path imposed a landing fee. Over the course of the 1980s, the revenues flowing to the Shining Path surged and the insurgency increased in intensity and lethality.

Just as the expansion of coca production and growth of the Shining Path were the result of contingencies, so were the factors that contributed to decline in the 1990s and early 2000s. The price paid to coca growers fell sharply in the early 1990s—due in large measure to a sharp uptick in cocaine output while demand stagnated. As a consequence, the revenues flowing to the Shining Path declined. Moreover, drug cartels and farmers found avenues to export cocaine without paying fees to the Shining Path—further reducing cash flow to support the insurgency. In the 1990s, during Alberto Fujimora's tenure as president, the Peruvian Government pursued an aggressive

[2] It is beyond the scope of this article to examine and document the first treadmill of destruction in the region. However, if we were doing so, the Shining Path insurgency offers a compelling example. And, it would be of interest to examine the ties (in terms of schema and personnel) between the Shining Path and FARC.

offensive against the Shining Path—and an aggressive eradication of coca. Peruvian troops systematically and indiscriminately violated human rights and caused the death of tens of thousands of civilians.[3] A large number of Shining Path leaders were killed and/or captured; by 2000, the Shining Path no longer posed a credible threat to the Peruvian state.

In the 2010s, as the Colombian conflict scaled back and coca demand increased, Peruvian producers were able and willing to increase output, surpassing Colombia's output in 2012 and 2013. But this increased output was taking place in a different institutional space. In the 1980s and 1990s, Colombian cartels exerted influence in Peru and, as noted, and the Shining Path played a prominent role. But neither has been prominent in recent decades. Instead coca cultivation and the fabrication of coca paste and cocaine powder is controlled by Peruvian crime syndicates:

> The business is supposedly straight-forward. Hundreds of *campesinos* (farmers) grow the crop, mainly in central and northern Peru. The *cocaleros* sell the coca leaf or coca base to *clanes* (small criminal groups often based around families), who ship either coca base or processed cocaine, to a handful of *firmas* (Peruvian organized crime syndicates), which shift the drugs to departure points (airports, seaports, and border areas) ready to move to Colombia, Ecuador, Bolivia, and Brazil (Muggah and McDermott 2013)

Drug cartels, predominately Mexican, take responsibility for smuggling the product to the United States, Europe and elsewhere in South America, predominately Brazil. Politicians and law enforcement personnel routinely accept bribes to look the other way as coca is grown, processed and smuggled out of the country. While the drug trade is routinely condemned as immoral and corrupting, efforts to suppress cocaine production are halting, uneven and ineffective. "[Unlike] in Colombia and Mexico, the drug trade involves very little violence. While popular perceptions of insecurity are rising slightly, Peru is widely considered one of the safest countries in South America" (Muggah and McDermott 2013). With the horrors of the Fujimora interlude a living memory for many, militarized coca eradication is pursued unevenly, widely condemned and met with open community resistance (Grisaffi, Ledebur, and Farthing 2020). When considering the street value of cocaine, the Peruvian share is quite modest. However, even this small share provides a reasonably reliable flow of income. Equally important, these Peruvian coca growers and the often family-based coca processors as well as larger crime syndicates are sufficiently organized to deter systematic inroads by external drug cartels. People involved in the drug trade are apprehended and go to jail. And, there are violent encounters as drugs are transported, processed and traded (see, for example, Briceno and Bajak 2015; Houghton 2017; Pressly 2015).

[3] Amnesty International concluded that: "the widespread and systematic nature of human rights violations committed during the government of former head of state Albert Fujimori (1990–2000) in Peru constitute crimes against humanity under international law" (in Strauss 2011).

Still, the scale and intensity of violence is, relatively speaking, modest (Muggah and McDermott 2013; Pressly 2015).[4]

Our case study suggests that a cocaine-focused treadmill has not emerged in Peru since the Colombian ceasefire. A treadmill of destruction has not emerged because the Shining Path has not regained the strength to challenge the Peruvian state. As such, there is no military force that depends on revenues from cocaine to sustain its fighting capacity. Conversely, without a credible threat to state sovereignty and in the shadow of the Fujimora era human rights abuses, the Peruvian state has been hesitant to pursue ecocidal eradication efforts. As such, coca growers are less motivated to seek out ever more remote areas to grow, reducing the cycle of deforestation and degradation of ecosystems. More surprisingly, it does not appear that a treadmill of production is operating. While there is no guarantee that the current balance will persist, it appears that coca cultivation and coca paste fabrication are being organized in predictable fashion, predation of coca growers is muted, and Peruvian crime syndicates have (for now) routinized relationships with foreign drug cartels in smuggling cocaine out of Peru. The pace of coca expansion is not driven by a frenzied treadmill. This optimistic assessment is tentative and guarded. It is not hard to imagine developments that would energize treadmills. A treadmill of destruction pitting insurgent forces attempting to expand production and government troops aggressively eradicating coca could emerge quickly. And the preconditions for a treadmill of production are in place. Coca leaves and coca paste are raw ingredients in a lucrative global commodity chain. Even though Peru currently fails to meet the criteria we have laid out for either of the treadmills in terms of coca production, this schema (Sewell 1992) would quickly change.

Gold. "Peru has the second-largest amount of rain forest in the world, but swaths of it are rapidly disappearing. Illegal gold mining—farmers digging up ore and selling it on the black market, so that it may eventually end up wrapped around your fiancée's finger—is one major cause" (Mullady 2014). If the case study of cocaine in Peru offers grounds for cautious optimism, a review of gold extraction and export warrants a decidedly pessimistic conclusion. On and near the slopes of the Andes, local residents have long relied on small-scale gold mining to supplement income. In recent decades, the mechanization of alluvial mining coupled with the jump in gold prices combined to dramatically increased the profitability and the destructiveness of gold mining (Bargent 2015; Fragoso 2016; Keane 2009). Through mechanization it becomes possible to dredge and process far more ore. But doing so requires widespread deforestation, despoiling land, runoff of topsoil and stagnating pools of water, and damaging waterways and ecosystems (Damonte et al. 2013; Espejo et al. 2018; Guiza and Aristizabal 2013; Swenson et al. 2011*;* Webster 2012).

[4] Coca production in the Amazonian borderlands offers a modest exception. Coca is now being cultivated on easternmost slopes of the Andes and on the adjacent forest floor. This encroachment is part of a "migratory cycle of eradication, relocation, boom, eradication, and relocation ignited by [militarized] coca elimination" (Salisbury and Fagan 2011: 57). This, in turn, fuels the boomtown/ghost town process (Camacho-Guizado and Restrepo 2000). The Peruvian government's eradication operations leave "ghost towns" in their wake, which are typically abandoned altogether, or later reused for renewed attempts at coca cultivation (Salisbury 2007).

Moreover, because mercury is used to separate gold from slag, waterways are toxified and miners experience mercury poisoning at high rates.

Depending on the gold deposits found, mining activities range from small and transitory to medium-sized operations that operate for months and sometimes even years until alluvial gold deposits are exhausted. Larger and better financed operations make use of Peruvian laws to formalize and secure official approval. Smaller operations often operate illegally or in a gray area. Regardless of their legality or formalization, the impacts of alluvial mining are violent, exploitive, and polluting. The violence and intimidation begins with the displacement of people, often Indigenous to the region, who live along waterways and depend upon them for their livelihood. This continues as forests are decimated and waterways are toxified. Where gold mining boomtowns emerge (i.e., larger deposits are found and mining continues for a longer period of time), child labor and human trafficking are common. Workers are attracted through deceptive solicitations and, upon arrival, find themselves trapped in debt and unable to leave. These coercive labor practices are not only used to recruit unfree labor to serve as mineworkers, but domestic workers and sex workers (adults and children) are forced to stay and work in mining camps by coercive means (Verité 2013).

Although there have been reports of heavily armed criminal organizations from Colombia and elsewhere playing an active role (Wagner 2016: 10), transnational criminal organizations are not emphasized when accounting for this surge in gold mining. Still, violence, intimidation, and coercion are pervasive. Even with "Plan Mercury" in which the Peruvian government deployed 1,500 military and police to shutter illegal mines, illegal gold mining operations have continued unabated. In the Department of Cusco, for example, "authorities were not able to enter into remote areas controlled by armed groups engaged in illegal mining….because they are armed to the teeth" (Verité 2013: 32). Whereas criminal syndicates play the largest role in smuggling cocaine out of the country, the available evidence suggests that laundering the illegally mined gold and exporting it is being done by legal firms. While the Peruvian government passed legislation to regulate the acquisition and export of gold, there is little evidence that the pervasively corrupt Peruvian Government has the will or the capacity to enforce this mandate (Oxfam America 2009).

The devastation of alluvial gold mining is beyond dispute. However, it contributes roughly 15% of Peru's total gold output. "In Peru, most of the gold is produced in large and medium-scale mines. In 2010, 85 percent of the total gold production was produced by these two categories and three large-scale mining companies accounted for 55 percent of Peru's gold production: Yanacocha, followed by Barrick Misquichilca and Buenaventura" (Damonte et al. 2013: 71). These mines have far-reaching impacts. Most important, they deplete and pollute water resources. As these mines are located at high elevations, this degradation of water supplies impacts downstream communities. Local residents, in many cases Indigenous communities, are openly resistant to large mines, causing disruption and prolonged closure. Peru's neoliberal approach to mining governance—and governance of big business more generally—sharply restricts the political and legal recourse available to resisters. In several instances, protest leaders have been killed. In one instance, an anti-mining regional leader, Regional President Gregorio Santos, was

imprisoned for 14 months without being charged for a crime due to his opposition to a large mining project (Eaton 2015).

That protestors face violence and intimidation should come as no surprise. Mining companies have assembled large and well-armed security forces. As of 2008, private security forces outnumber Peru's police forces. Approximately half of these private security forces are registered with the state and legal, half are unregistered and technically illegal. However, despite their dubious legality, former police and military personnel often work for and lead these forces. For these reasons, the Peruvian police and military actively collaborate with them. These security forces have been implicated in but rarely prosecuted for murdering protestors around Peru's largest mines and intimidating community and environmental activists more generally (Oxfam 2009; Kamphuis 2012).

Perhaps the most discouraging aspect of Peru's gold mining debacle is that most of it is perfectly legal. To be sure, the smallest artisanal gold mining operations have been deemed illegal, and these operations do significant damage (Swensen et al. 2011). But the Peruvian government provides mining concession to operations that are large enough and have the legal resources to apply for them. As destructive as unregulated smaller mining operations are, these larger—and formally recognized—alluvial mining operations account for significant deforestation, pollution of waterways, and degradation of ecosystems. And the Peruvian government's collaboration with the largest mining operations is closer still. In 2018, Peru announced a militarized eradication program focused on smaller illegal mining operations, but this is unlikely to succeed on its own terms (DuPée 2019; Schwartz 2019) and will not solve the larger problem. The problem is that formally recognized mining operations, financial institutions and exporters operate legally and profit from a remarkably destructive gold mining industry. According to Julio Guzmán, special prosecutor for environmental affairs: "We have dedicated our efforts on the people who extract the gold when we should be focusing on people who finance the activity" (quoted in Praeli 2019). While Peru has passed legislation that addresses causes of pollution, including the use of mercury, and forbids the export of illegally mined gold, corruption is endemic and enforcement has been inadequate (Eaton 2015; Oxfam 2009; Verité 2013).

In defining a treadmill, we emphasize three characteristics; gold mining in Peru meets each of them. First, powerful organizations appropriate and transform nature to amass power and capital. Gold is embedded in a lucrative global commodity chain. The value of gold has increased dramatically "…from around 500 USD/kg in the 1970s, to an astounding 60,000 USD/kg in 2011" (Cremers and de Thieje 2013: 6). Second, competition among people and firms involved in gold mining propels accelerating degradation of the environment. There is a finite number of alluvial deposits, the profit motive attracts producers and smugglers to exploit them at a frenzied pace. The degradation of the environment is widespread and readily evident. From the largest mines to smallest artisanal mines, gold mining causes widespread mercury and cyanide water pollution, and this pollution compromises flora and fauna in ecosystems. Deforestation is dramatic and continuing. "According to former environmental minister Antonio Brack Egg, gold mining has devastated nearly 370,000 acres of the Peruvian Amazon. That's an elevenfold increase since

2000" (Mullady 2014; see also Espejo et al. 2018; Praeli 2019; Swensen et al. 2011). Finally, where a treadmill is operating, powerful organizations and elites obscure, distort, and suppress information about the environmental damage. In the Peruvian case, a great deal of attention has focused upon smaller alluvial mines. There is good reason to do so; these mining operations have done extensive damage to the environment. At the same time, larger mines operating with formal recognition and state support, make a disproportionate contribution to pollution, deforestation and human rights abuses. Nonetheless, the state promotes these mines on the grounds that they provide a path community prosperity and sustainable economic development.

Discussion

These case studies of Colombia and Peru provide a vantagepoint for highlighting the distinctiveness and the advantages of adopting a critical realist stance to recast treadmill theory. First, we will discuss the role of violence in treadmill dynamics, and in so doing draw connections between Marxist insights into accumulation and violent treadmills of production. Second, we will revisit the importance that critical realist approaches place on absence and emergence. Finally, we will highlight the variability in the scale at which treadmill mechanisms operate, and this variability in scale provides analytic flexibility and leverage.

When discussing Colombia, we argue that a violent treadmill of production has emerged in the wake of the ceasefire. Violence also pervades the treadmill of production in Peru's gold-mining sector (Bargent 2015; Cawley 2014; Damonte et al. 2013). This is not a spillover from Colombia; these treadmill dynamics have long operated in Peru's mining sector and predates the ceasefire. The distinction between a treadmill of production and treadmill of destruction is not predicated on the prevalence of violence. Rather, this distinction is based on the network of power and the objectives pursued. Gold mining is not supporting, neither directly or indirectly, an armed challenge to the Peruvian state, nor are the armed forces active in gold mining attacking one another to gain power. Instead, this violence is projected to amass capital and follows an economic logic. This link between capital accumulation and violence was central to Foster's critique and appreciation of the treadmill of production literature:

> It is well to remember that for Marx the treadmill stood for the barbarism within civilization…. Schnaiberg, whether fully cognizant of its historical significance or not, highlighted a major contradiction of capitalism, which, for all its profession of civilization and modernization, never truly surmounts a brutal, barbaric relation to human beings and nature—robbing both human beings and the earth on an ever-increasing scale…. [By] its very nature (and its central metaphor) serves to remind us in quite deep and perceptive ways of the barbaric, unsustainable character of capitalism's relation to humanity and nature even as the system seemingly expands and prospers. This is by far the most important message that environmental sociology has to convey" (Foster 2005: 16-17).

As noted, critical realism emphasizes absence, emergence and transformation of generative mechanisms. The case studies presented in this article provide examples of each. Humans and human societies make use of biophysical resources and degrade the environment. Economic elites

and corporations compete for profits and market shares. And, armies (formal and informal) recruit troops and secure resources to wage war. While the preceding statements are true, treadmills are neither inevitable nor ubiquitous. Treadmills are distinctive in disturbing ways. Where a treadmill of production operates, economic competition is propelled by an unsustainable and ever more frenzied extraction of resources and injection of toxic byproducts into the environment; where a treadmill of destruction operates, arms races and military struggles are focused on unsustainable extraction of biophysical resources or degrading an enemy's environment, a process known as "ecocide." There are times and places in which neither a treadmill of production nor a treadmill of destruction exists (absence); there are times and places in which treadmills come into existence (from absence to presence). Our case study of Colombia documented the historical and contingent processes that gave rise to a virulent treadmill of destruction (from absence to presence). Over time, to wage war, paramilitary forces and the FARC became reliant on access to revenues generated by cocaine production and, later, gold mining. The destructiveness of these processes was amplified by the ecocidal tactics promoted by the United States and pursued by the Colombian military. The merciless conflict also transformed a treadmill of production in Colombia's agricultural sector, making it far more violent. The displacement of millions of peasants and FARC's disarmament created a vacuum. Large landowners and large agro-industrial firms, both domestic and transnational, have collaborated with former paramilitary forces and criminal gangs spawned by them to pursue aggressive, violent, and extraconstitutional land grabbing. This land grabbing accelerated deforestation and degradation of biodiversity within the context of a violent and ravenous treadmill of production. In studying Peru, we also tracked the emergence of a violent treadmill of production centered on gold. Finally, we documented the failure of a treadmill to emerge in Peru's cocaine sector. Again, we are not arguing that coca cultivation and cocaine manufacture is benign, nor are we arguing that this outcome is inevitable and guaranteed to persist. Rather, the available evidence suggests that even as Peru's cocaine output has surged over the past several decades, cocaine has not been the focal point of military struggles—which is to say that the treadmill of destruction remains absent—nor is there evidence of a spiraling economic competition focused on coca and cocaine—the treadmill of production remains absent.

Finally, at first glance, documenting the absence of a treadmill (e.g., the surprising absence of a treadmill dynamic in Peru's cocaine sector) might suggest that this theory of treadmills is of limited value. However, we believe this points to the insightfulness and adaptability of a critical realist recasting of treadmill theory. For critical realism, causal mechanisms are not propelled by functional necessity, nor is there a teleological endpoint inherent in their existence and operation. Instead, theorizing generative mechanisms is focused on describing how they operate and the impacts they have when, where, and if they exist. Earlier, we provided the example of an airplane to highlight this. A plane is able to fly on planet Earth by the interaction of aerodynamics and gravity. Finding that a propeller-powered airplane cannot fly on the Moon or on Mars due to the absence of an atmosphere does not call into question the existence of gravity or principles of aerodynamics. In fact, the plane's inability to fly provides additional evidence of aerodynamics. Conversely, finding that less energy is required to launch a spacecraft on Mars or the Moon does

not cast doubt on the existence and operation of gravity. Rather, it provides insight into the manner in which gravity works in different settings. There is neither a structural imperative nor a teleological inevitability that guarantees the existence of aircraft or spacecraft on Earth or elsewhere. However, if the attempt to fly is to succeed the causal effects of gravity and aerodynamics must be anticipated and incorporated into the design of the aircraft/spacecraft. Our claims about treadmills are similar. We are not claiming that treadmills always exist, and we have documented instances in which treadmills failed to emerge (i.e., cocaine production in Peru) and another instance in which a treadmill of destruction waned (i.e., Colombia after the ceasefire). That said, when and where treadmills exist, they generate frenzied and unsustainable degradation of the environment. And, reflecting the waxing of human infrastructural power in the Anthropocene Epoch, treadmills are becoming more frequent and more destructive.

The avoidance of functionalist and teleological explanations provides this critical realist recasting of treadmill theory a distinctive stance for engaging with political economic theories of the environment. In an important and valuable stream of contributions, Downey (2015) and collaborators (Downey, Bonds, and Clark 2010) examine environmental degradation where extraction and violence are pervasive. Downey's theory of environmental degradation and inequality centers on elite-controlled institutions and the needs of the highly inegalitarian world system. In this theoretical framework, violence is highlighted, with an emphasis on explaining ecologically unequal exchange: "those groups that successfully control, extract, and transport natural resources in specific times are able to do so because they have created a set of overlapping institutional, organizational, ideological, legal and technological mechanisms that provide them with the means to prevail over others" (Downey 2015: 174). To assess this claim, Downey examines 10 minerals that are "critical" to the economic and military power of core nations. Our research does not directly challenge Downey and associates; we ask different questions and adopt a very different approach to comparative research. First, we do not make overarching assertions about the world system and its needs. Nor are we focused on products that are essential to the functioning and reproduction of the global order. Rather, we examined cocaine and gold, products that are *not* "critical" to the reproduction of the world system: cocaine is actively suppressed by powerful states, and most gold is destined for luxury consumption. Whereas Downey (2015) and associates (Downey, Bonds, and Clark 2010) anticipate that violence and environmental degradation are intrinsic to the extraction of metals and other resources, we theorize when and where violence is linked to extraction and environmental degradation, and where it is not. Conversely, by placing emphasis on absences, we also identify instances in which market competition and militarism are *not* causally linked to accelerated environmental degradation. We emphasize the specificity and uniqueness of the Andean region in the contemporary period; we do not make claims nor do we believe that these specific dynamics are destined to play out across the globe. One might object that our goals are too modest. That said, our approach "builds on the strengths of historically grounded social science" (Tilly 1984: 88). The strength of this approach would come from studies of other times and places that probe the existence and operation of the causal mechanisms that we theorize. By understanding when, where and how treadmills come

into existence and are reproduced—across a range of times, places and contexts—we may be able to develop a richly textured understanding of environmental degradation and inequality at national, regional, and global scales.

Conclusion

The preceding analyses provide an overview, though not a comprehensive history, of each of our cases. Now, we turn our attention to their larger importance and the implications for governance in the Anthropocene Epoch.

The Andes and the Amazon basin house remarkable biodiversity, and these ecosystems are fragile (Marengo et al. 2018; Piotrowski 2019). With environmental problems, such as climate change, there is a growing sense of urgency that in order to avoid the worst effects we will have to utilize technology to resolve or alleviate the problems. However, the effects we have highlighted in Colombia and Peru provide a serious flaw with technological fixes and point to a harrowing element of the Anthropocene. If one considers the destruction of the Amazon through deforestation or the contamination of waterways, soil, and animals with mercury these kinds of problems do not yield a readily available technological solution. Treadmills are ravaging plant and animal species in the Amazon, but there is no technology for reversing the loss of biodiversity. As such, a failure to address and prevent this threat to biodiversity could generate catastrophic outcomes not only for the Amazon, but for the planet as a whole.

Dryzek (2014) presents a compelling review of governance challenges. In broad terms, core human institutions, most notably states and markets, emerged and became consolidated in human societies during the Holocene Epoch—a long period of ecological stability. In the Anthropocene, this stability is rapidly eroding, and change is all but ubiquitous. Human institutions are slow to recognize these changes and respond. Dryzek stresses reflexivity, i.e., institutional transformation that will promote "listening more effectively to an active Earth system, capacity to reconsider core values such as justice in this light, and ability to seek, receive and respond to early warnings about potential ecological state shifts" (2014: 953). The unique dynamics and context of the treadmills we examine in this article poses daunting challenges in this regard. As noted, the remoteness, apparent emptiness, and distance from national capitals contributed to the rise of coca cultivation and cocaine manufacture, and illicit gold mining in the region (Salisbury 2007). This region is home to several spectacular ecological hotspots and remarkable biodiversity (Marengo et al. 2018; Piotrowski 2019). But these hotspots are fragile, and more alarming still, the larger Amazon rainforest displays strong signs of stress. Due to human activities, the Amazon may be reaching a tipping point in which rainfall will be reduced and the rainforest ecosystem will collapse (Piotrowski 2019; see also Lenton et al. 2008; Brook et al. 2013). The distinctiveness of these treadmills and the context in which they have become activated highlight the daunting challenges of governance in the Anthropocene. The social organization at the heart of these treadmills is malleable. For example, paramilitary forces have transformed into criminal gangs, and criminal organizations have relocated in new regions. The tenuousness of state control in these regions and pervasive corruption of public officials makes rudimentary governance challenging; consolidating

reflexive governance poses daunting challenges. A first step on this path is to reflexively evaluate the treadmills currently active in the region, with an eye on identifying the resources and social organization that sustain them. These insights could inform efforts to disrupt the reproduction, spread and transformation of treadmills.

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