

# The Ecological Edges of Belligerency

## Toward a Global Environmental History of the First World War

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Even the relatively large plains that have not been cut up by trenches, which one could very well designate as fields or forests in and of themselves, are not fields or forests in the sense of the normal peacetime landscape. ... Rather, all these things have become pure things of combat.

Kurt Lewin, "Kriegslandschaft," 444.

**While convalescing from an injury** sustained in combat in 1917, German artillery officer and psychologist Kurt Lewin reflected on the phenomenology of battlefields. During his time on the western front, he had observed that soldiers experienced a peculiar perception of landscapes. Those in harm's way saw space differently from civilians living in safety. "Peace landscapes" appeared round and boundless, extending out as far as the eye could see. "War landscapes" were directed and contained, bordered by violence and destruction. Terrain within the danger zone acquired a new military signification that matched the intensity of combat. Lewin used the example of a forest, whose edge gained an exaggerated importance during battle. With the cessation of hostilities, the "direction" and meaning of the forest's edge changed; it no longer signified a fighting front.<sup>1</sup> Lewin drew a fine cerebral line between war landscapes and peace landscapes: the mental constructs soldiers placed on the material world indicated the boundaries of belligerency.

1. Kurt Lewin, "Kriegslandschaft," *Zeitschrift für angewandte Psychologie* 12 (1917): 440–47, in particular pp. 444 and 447. Translated by Jonathan Blower as "The Landscape of War," *Art in Translation* 1, no. 2 (2009): 199–209, citation at p. 205. See also Christoph Nübel, *Durchhalten und Überleben an der Westfront: Raum und Körper im Ersten Weltkrieg* (Paderborn: Ferdinand Schöningh, 2014). The literature on forests during war is extensive: see especially Andrée Corvol and Jean-Paul Amat, eds., *Forêt et guerre* (Paris: L'Harmattan, 1994); John R. McNeill, "Woods and Warfare in World History," *Environmental History* 9, no. 3 (2004): 388–410.

From a psychological standpoint, Lewin's analysis seems fitting enough, given his own experience in France and our contemporary understanding of post-traumatic stress disorder, what doctors in the First World War called "shell shock." Soldiers under fire endured horrors that those behind the lines struggled to comprehend. But many civilians also lived in danger zones, especially vulnerable populations who found themselves near the fighting fronts, and particularly minorities in the Ottoman and Russian Empires.<sup>2</sup> Where violence engulfed the home front, the distinction between war landscapes and peace landscapes became blurred.

From an ecological perspective, the distinction disappeared altogether; the borders between "war landscapes" and "peace landscapes" overlapped or vanished entirely. At first glance, this assertion may seem misleading, especially when one thinks of the familiar images of destruction on the western front. Soldiers' perceptions further reinforced the apparent differences between devastated battlegrounds and the supposedly intact nature back home. Like most of his comrades, German officer Ernst Jünger repeatedly used adjectives like "dark," "ravaged," "dreary," "savage," "eerie," "barren," and "hideously scarred" to describe the environment of the trenches. On his return to Germany, however, he observed that flowering cherry trees greeted his arrival in Heidelberg and gave him "the strong sense of having come home." Others commented on the fragrant air, fresh waters, and lush meadows they experienced while on leave, in contrast to the blasted lands of the front lines.<sup>3</sup> That many soldiers remembered nature back home as free from the stains of war, however, did not make it so. A closer examination shows that, contrary to what photographs and soldiers' impressions suggest, lands free from direct fighting also felt the environmental impact of war.

2. John Horne and Alan Kramer, *German Atrocities, 1914: A History of Denial* (New Haven: Yale University Press, 2001); Ruth Harris, "The 'Child of the Barbarian': Rape, Race and Nationalism in France during the First World War," *Past and Present* 141 (1993): 170–206. For an introduction to the Armenian Genocide and the surrounding debates, see Taner Akçam, *The Young Turks' Crime against Humanity: The Armenian Genocide and Ethnic Cleansing in the Ottoman Empire* (Princeton: Princeton University Press, 2012); Ronald Grigor Suny, Fatma Müge Göçek, and Norman M. Naimark, eds., *A Question of Genocide: Armenians and Turks at the End of the Ottoman Empire* (New York: Oxford University Press, 2011); and Ryan Gingeras, *Sorrowful Shores: Violence, Ethnicity, and the End of the Ottoman Empire, 1912–1923* (New York: Oxford University Press, 2011). On forced relocations and the status of Jews in Russia, see Peter Gatrell, *A Whole Empire Walking: Refugees in Russia during World War I* (Bloomington: Indiana University Press, 2005); Joshua A. Sanborn, "Unsettling the Empire: Violent Migrations and Social Disaster in Russia during World War I," *Journal of Modern History* 77 (2005): 290–324; and Eric Lohr, "The Russian Army and the Jews: Mass Deportation, Hostages, and Violence during World War I," *Russian Review* 60 (2001): 404–19. See also Tammy M. Proctor, *Civilians in a World at War, 1914–1918* (New York: New York University Press, 2010).

3. Ernst Jünger, *Storm of Steel* [1920], trans. Michael Hofmann (New York: Penguin, 2003). For a more detailed discussion of these points, see Tait Keller, "Destruction of the Ecosystem," *1914–1918 Online: International Encyclopedia of the First World War*, 2014, [http://encyclopedia.1914-1918-online.net/article/destruction\\_of\\_the\\_ecosystem](http://encyclopedia.1914-1918-online.net/article/destruction_of_the_ecosystem).

Combat in the industrial mode placed vast demands on raw materials and natural resources. Civilians and conscripts around the world furiously felled forests, plowed up hitherto uncultivated fields, mined more metal ore, and dug deeper for coal to supply military forces. These efforts, intensified by the war, brought their own violence that transformed the natural world and turned places far from the front lines into war landscapes. The legacies of that violence have continued long after the battlefields had recovered. Indeed, the protracted environmental transformations that occurred during the war resulted more from expanded industrial modes of production than heavy combat. Warfare accelerated environmental change that had begun in the previous century, and established patterns of military-industrial production and environmental exploitation that defined the twentieth century.

Although developments in environmental history, along with imperial and global history, lend themselves to examining the First World War from a new perspective, a global environmental history of the conflict remains to be written. Environmental historians have recently turned their attention to war and its effects on the natural world. The bulk of that work, however, centers on the Second World War and the nuclear age.<sup>4</sup> These studies often highlight the connections between the conduct of war and a society's industrial and agricultural practices. As part of our historically evolving relationship with the natural world, modern warfare thus becomes another manifestation of modern capitalism's environmental costs. A few historians have examined the Great War from an ecological perspective, but only in a limited fashion that tends to focus on the western front.<sup>5</sup>

4. For excellent introductions to studies on war and the environment, see Richard P. Tucker and Edmund Russell, eds., *Natural Enemy, Natural Ally: Toward an Environmental History of War* (Corvallis: Oregon State University Press, 2004); Charles E. Closmann, ed., *War and the Environment: Military Destruction in the Modern Age* (College Station: Texas A&M University Press, 2009); and Edmund Russell's pioneering book, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (New York: Cambridge University Press, 2001). Two notable exceptions of scholarship on earlier conflicts are John R. McNeill, *Mosquito Empires: Ecology and War in the Greater Caribbean, 1620–1914* (New York: Cambridge University Press, 2010); and Lisa M. Brady, *War upon the Land: Military Strategy and the Transformation of Southern Landscapes during the American Civil War* (Athens: University of Georgia Press, 2012).

5. Dorothee Brantz, "Environments of Death: Trench Warfare on the Western Front, 1914–1918," in Closmann, *War and the Environment*, 68–91; Joseph P. Hupy, "The Long-Term Effects of Explosive Munitions on the WWI Battlefield Surface of Verdun, France," *Scottish Geographical Journal* 122, no. 3 (2006): 167–84; Hupy, "Verdun, France: Examining the Effects of Warfare on the Natural Landscape," *Military Geography: From Peace to War*, ed. Eugene J. Palka and Francis A. Galgano (Boston: McGraw-Hill, 2005), 447–74. See also Chris Pearson, *Mobilizing Nature: The Environmental History of War and Militarization in Modern France* (Manchester: Manchester University Press, 2012); and Dennis Showalter, "Mass Warfare and the Impact of Technology," in *Great War, Total War: Combat and Mobilization on the Western Front, 1914–1918*, ed. Roger Chickering and Stig Förster (Cambridge/Washington: Cambridge University Press/German Historical Institute, 2000), 73–94. For more on current efforts to remove unexploded shells from the former battlegrounds, see Donovan Webster, *Aftermath: The Remnants of War*

Meanwhile, some First World War scholars have turned their gaze to the periphery, examining the conflict in Africa, Asia, and South America. As might be expected, this scholarship considers military, political, and economic developments but largely overlooks the attendant ecological dislocations—that is, disruptions to how organisms interact in their local habitats—and long-term environmental changes such as the social and natural relations between people and ecosystems.<sup>6</sup> A few ambitious scholars have written global histories of the First World War. Lawrence Sondhaus, for instance, framed it as a global revolution that transformed imperial maps, power relationships, and Europe's position in the world. William Storey's global history of the conflict highlights some environmental factors, but unlike Sondhaus, Storey argues that the war did not introduce a revolution: at least in environmental terms, the transformations that it caused were not radical.<sup>7</sup>

When it comes to the European theaters of the conflict, Storey makes a valid point. Hostilities did indeed disrupt ecologies on battlefields everywhere, and nowhere was the concentration of forces greater than in northern France. Trenches ran from the North Sea to the Swiss frontier, and the ensuing stalemate caused lasting ecological upheaval. Millions of soldiers and billions of shells transformed fields and forests within the relatively narrow war zone into a wasteland. Combat thus transformed the natural world—notably the makeup of forests and the composition of soil—but only within the range of artillery. Ecosystems along the western front, albeit altered, quickly regenerated. By the early 1920s, once-ravaged agricultural lands had returned to, or even exceeded, prewar productivity. Battlegrounds certainly suffered from the storms of steel, as Storey and others have illustrated, but the resulting distortions of nature were short-lived.

(New York: Pantheon Books, 1996), 11–80. For recent works on disease and the war, see Carol R. Byerly, *Fever of War: The Influenza Epidemic in the U. S. Army during World War I* (New York: New York University Press, 2005); and Hikmet Özdemir, *The Ottoman Army, 1914–1918: Disease and Death on the Battlefield* (Salt Lake City: University of Utah Press, 2008). Recent scholarship has examined battles in the Alps: Marco Armiero, *A Rugged Nation: Mountains and the Making of Modern Italy, Nineteenth and Twentieth Centuries* (Cambridge: The White Horse Press, 2011); and Tait Keller, *Apostles of the Alps: Mountaineering and Nation Building in Germany and Austria, 1860–1939* (Chapel Hill: University of North Carolina Press, 2016).

6. Hew Strachan, *The First World War in Africa* (Oxford: Oxford University Press, 2004); Edward Paice, *World War I: The African Front* (New York: Pegasus Books, 2008); Byron Farwell, *The Great War in Africa, 1914–1918* (New York: W. W. Norton, 1989); Phillip A. Dehne, *On The Far Western Front: Britain's First World War in South America* (Manchester: Manchester University Press, 2009); Bill Albert, *South America and the First World War: The Impact of the War on Brazil, Argentina, Peru and Chile* (Cambridge: Cambridge University Press, 1988); Frederick R. Dickinson, *War and National Reinvention: Japan in the Great War, 1914–1919* (Cambridge: Harvard University Press, 1999); Guoqi Xu, *China and the Great War: China's Pursuit of a New National Identity and Internationalization* (New York: Cambridge University Press, 2005); Santanu Das, "India, Empire and the First World War" (to be published).

7. Lawrence Sondhaus, *World War I: The Global Revolution* (New York: Cambridge University Press, 2011); William Kelleher Storey, *The First World War: A Concise Global History* (Lanham: Rowman and Littlefield, 2009). See also Michael S. Neiberg, *Fighting the Great War: A Global History* (Cambridge: Harvard University Press, 2006).

More often overlooked, however, are the substantial environmental transformations that occurred behind the lines, far away from the battlefields.

The armies of the First World War were both social and biological entities, which depended on a “military ecology” of energy extraction, production, and supply. To maintain the “biological welfare” of soldiers and keep engines in action, general staffs commandeered food and fuel throughout the biosphere, extending the war’s environmental reach far beyond the western front.<sup>8</sup> Civilians around the world often unexpectedly found themselves on the front lines of newly militarized landscapes. Belligerent countries exploited their colonial holdings in Africa, typically through forced labor battalions and mass migrations that upset disease ecologies. Canning perishable goods for soldiers’ meal kits provoked a massive expansion of tin mining operations on the Malay Peninsula and in the Dutch East Indies, where hydraulic sluicing choked rivers with sand and clay runoff. Armies conscripted draft horses, leaving farmers with less muscle and little manure for tilling their fields. The world’s largest sodium nitrate beds in Chile’s Atacama Desert supplied the nitrogen-based inorganic fertilizer that kept crop yields from collapsing in Western Europe. The same chemicals also constituted the basic ingredients in explosives. Huge cattle-rearing operations in Argentina provided the bulk of the Triple Entente’s protein during the conflict, transforming both the Pampas and the country’s economy. Latin American sugarcane production boomed when the European sugar beet market went bust. But expanded cultivation of cash crops reduced food production and intensified social frictions.

This article represents an initial foray into the global environmental history of the First World War and suggests new approaches that can change our understanding of the conflict. Projects of this scope typically rely on the work of other scholars during the preliminary stages of research, and this is certainly the case here. I build on previous research to show that wartime demands for energy resources strengthened and expanded networks of imperial exploitation in equatorial Africa and maritime Southeast Asia, while also upsetting and redirecting energy exchange networks between a number of Latin American countries and the European powers.<sup>9</sup> These three regions also illustrate the different ways in which the preparation and pursuit of war transformed societies and the natural world.

8. For an excellent discussion of military ecologies, see Mark Fiege, “Gettysburg and the Organic Nature of the American Civil War,” in Tucker and Russell, *Natural Enemy, Natural Ally*, 93–109. In his essay on Argentina’s economy in the early twentieth century, Ricardo Salvatore used the term “biological welfare” to measure health and nutrition: Ricardo D. Salvatore, “Stature Decline and Recovery in a Food-Rich Export Economy: Argentina, 1900–1934,” *Explorations in Economic History* 41 (2004): 233–55.

9. Several scholars have examined the connections between imperialism and environmental change: Richard H. Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600–1860* (Cambridge: Cambridge University Press, 1995); Richard P. Tucker, *Insatiable Appetite: The United States and the Ecological Degradation of the Tropical World* (New York: Rowman and Littlefield, 2007); William Beinhart and Lotte Hughes, *Environment and Empire* (New York: Oxford University Press, 2007); Tom Griffiths and Libby Robin, eds., *Ecology and Empire: Environmental History of Settler Societies* (Seattle: University of Washington Press, 1997).

Lewin defined landscapes in terms of violence, and as such these regions show that “war landscapes” were not limited to battlefields under fire. In Africa, environmental changes resulted from massive population displacement. On the Malay Peninsula, the war intensified industrialized tin mining and upset local ecosystems and livelihoods. The need for carbohydrates and protein drove agricultural expansion across several Latin American countries, especially Argentina. Examining the different ways in which war shaped the natural world—evolving disease ecologies in colonial Africa, tin extraction in Southeast Asia, and food production in Latin America—shows that the boundaries of war landscapes were in fact vast. As Lewin suggested, we must look to the ecological edges of the conflict to understand the full nature of belligerence and the Great War’s global legacy.

## Disease Ecologies in Equatorial Africa

Most histories of the First World War in Africa focus on the campaigns in German East Africa and the commander Paul von Lettow-Vorbeck. Renowned for his cunning, Lettow-Vorbeck and his Askari soldiers engaged in guerilla warfare against British, Belgian, and Portuguese forces, and remained undefeated until he surrendered three days after the official armistice in 1918. But his success came at the expense of civilians. To elude capture and to draw his adversaries farther from the coast, Lettow-Vorbeck dragged his troops through previously inaccessible parts of the Tanzanian jungle on his way to British East Africa (present-day Kenya). Hunger, more than military prowess, directed his strategy. Running low on food and determined to continue his campaign, Lettow-Vorbeck turned south and crossed the Rovuma River into Mozambique, where he attacked Portuguese supply depots. Along the way, he often seized food from nearby villages. Upon his approach, local populations frantically hid their cattle and men frequently fled into the bush to escape forced recruitment.<sup>10</sup>

Both sides carried out their campaigns on the backs of Africans. In 1914, equatorial Africa had few roads or railways. Although the war increased infrastructure, particularly throughout the Makonde region of southern Tanzania and northern Mozambique, development proceeded slowly. Since pack animals fell prey by the thousands to the tsetse fly (the biological vector for the parasite that caused animal trypanosomiasis, or sleeping sickness), European troops relied on African laborers to haul supplies. The British recruited over a million porters for the East African campaign, drawn from populations across sub-Saharan Africa. Pursuing the Germans required at least two or three carriers for every British soldier, and European officers viewed their African recruits as a tactical advantage. Major Richard Meinertzhagen, chief of British military intelligence in East Africa,

10. John P. Cann, “Mozambique, German East Africa, and the Great War,” *Small Wars and Insurgencies* 12, no. 1 (2001): 114–43, here pp. 136–37; Michael Vogel, “The Hungry War: German East Africa in World War I,” *Military Heritage* 8 (2006): 28–35.

attributed the Entente's capture of Kondoia Irangi to native-born forces: "I doubt whether any British general with British troops could have planned and carried out the move in tropical Africa during the rains," he concluded. Only those "born and bred to long distances and living on the country could have accomplished it."<sup>11</sup>

Yet death rates among African recruits during the course of the war soared to over 20 percent, higher than for British soldiers. Food shortages offer one explanation for this disparity, since by 1917 most laborers received less than a thousand calories a day. But the crucial factor was that the vast majority of African conscripts came from distant locales with different disease environments. Population displacement also meant ecological dislocation. Whatever resistance porters had developed to their local pests and pathogens proved ineffective in foreign lands where malaria and the tsetse fly were rife, while malnutrition and physical exhaustion left them even more vulnerable to disease. Attempts to evade forced conscription compelled people to enter tsetse territory that they would otherwise avoid. Cattle seizures likewise created a negative feedback loop of tsetse expansion, as cattle grazing and the clearing of pastureland had reduced the bush and lowered the incidences of sleeping sickness. The loss of cattle had the opposite effect. When people deserted rural villages for safer places, the bush recovered and tsetse numbers swelled.<sup>12</sup> The reduction of livestock, easy prey for old, lazy lions, also correlated with increased animal attacks on humans.

Massive population displacement and privation affected both soldiers and civilians. Food shortages plagued most of the African continent during the war, as hostilities disrupted international supply networks and redirected staple victuals to armies. Huge occupying forces were insatiable, and thousands of hungry soldiers outstripped local supply. Soaring food prices compounded civilian struggles to obtain limited provisions. To make matters worse, new laws restricted the sale of firearms and ammunition, leaving wild animals to ravage rice plantations and manioc fields with impunity. In any case, conscription had taken most of the hunters away. Elephants and boars ran amok, trampling and rooting up crops. Poor weather and blight in 1916 and 1917 ruined harvests, especially along Africa's Atlantic coast in Cameroon and Gabon.<sup>13</sup> Although far from the European fighting fronts, the conflict in Africa created "war landscapes" through violence, privation, and the spread of diseases.

11. Cann, "Mozambique, German East Africa," 129; Hew Strachan, *The First World War: A New Illustrated History* (London: Simon and Schuster, 2003), 82–83.

12. John Ford, *The Role of the Trypanosomiasis in African Ecology: A Study of the Tsetse Fly Problem* (Oxford: Clarendon Press, 1971), 153–57, here p. 169. See also David Killingray, "Repercussions of World War I in the Gold Coast," *Journal of African History* 19, no. 1 (1978): 39–59; Maryinez Lyons, *The Colonial Disease: A Social History of Sleeping Sickness in Northern Zaire, 1900–1940* (New York: Cambridge University Press, 2002); and James L. A. Webb, *Humanity's Burden: A Global History of Malaria* (New York: Cambridge University Press, 2009).

13. Jeremy Rich, "Hunger and Consumer Protest in Colonial Africa during the First World War: The Case of the Gabon Estuary, 1914–1920," *Food, Culture and Society* 10, no. 2 (2007): 247–48.

## Tin Extraction in Southeast Asia

Historians have done little work on Southeast Asia during the First World War.<sup>14</sup> This is hardly surprising given how the war appeared to ignore this corner of the world. Armies did not clash here, unlike in eastern China's Shandong province, where in a bid to extend their sphere of influence, the Japanese attacked and captured the German base at Tsingtao in 1914. In Malaya (now Peninsular Malaysia), the British did not enlist large numbers of their colonial subjects into military service—in contrast to India, where over a million troops joined British forces over the course of the war.<sup>15</sup> Maritime Southeast Asia did include the Strait of Malacca, one of the most important shipping lanes in the world, which connected the Indian Ocean to the Pacific. But with only a handful of major warships, the German navy's East Asia Squadron was such a meager force that it barely constituted a viable threat. In any case, its commander, vice admiral Maximilian von Spee, was busy avoiding the much larger and more powerful Japanese fleet. He was more eager to cross the Pacific and return to the North Atlantic than to battle for the Strait of Malacca. Other than the short Battle of Penang in October 1914, when a lone German cruiser snuck into the island's harbor, sank an anchored Russian ship, and torpedoed a French destroyer returning from patrol, the Strait saw no action.

The shipping lane was crucial because Malayan tin exports were essential to European industrial economies, especially that of Great Britain. In the early 1800s, the British had solidified their sphere of influence in the region after formally dividing the archipelago with the Dutch. By the mid-nineteenth century, the British Colonial Office directly administered those Malay states where the most lucrative tin mining operations were located, at a time when Europe's rapidly increasing demand for tin was outstripping its own dwindling reserves. Steel production and factory machines with moving metal parts relied heavily on tin. Its malleability made it easy to use, and since tin does not easily oxidize in air and bonds readily with iron, it was often used to coat other metals to prevent corrosion. Tin's anti-friction properties also made it ideal for the bearing material (Babbitt metal) on axles and crankshafts, while food packagers made cans with tinplate because of the metal's low toxicity. Tin was used so pervasively that most people took it for granted.

The Malay Peninsula was the world's single largest producer of tin, and 50 percent of the global supply came from the Federated Malay States and the Dutch East Indies. Tin professionals considered Southeast Asian ores high-grade,

14. According to the United Nations classification scheme, Southeast Asia comprises two geographic regions: Mainland Southeast Asia, sometimes called Indochina (Cambodia, Laos, Burma, Thailand, and Vietnam), and Maritime Southeast Asia (Brunei, Malaysia, East Timor, Indonesia, the Philippines, and Singapore). China and Japan are part of East Asia; the Indian subcontinent belongs to South Asia.

15. Budheswar Pati, *India and the First World War* (New Delhi: Atlantic Publishers, 1996).



with the highest tin content and lowest level of impurities. Between 1880 and 1905, export duties on tin alone comprised nearly half the Federated States' total revenue. Thailand's Phuket province had been the peninsula's leading tin mining center during the nineteenth century, but Malayan production soared after 1880 when mining operations expanded to the tin-rich Kinta Valley. In 1888, 8,000 acres of Malayan land were under mining leases; by 1895 that number had grown to 33,000 acres. The area under such leases in the Selangor and Klang Valleys doubled between 1895 and 1899. British firms in particular invested heavily in jungle clearing and road construction. By the turn of the century, roads and railways connected every major mining area in the Kinta Valley to the Kinta River.<sup>16</sup>

The British were eager to expand tin mining operations as they controlled so little of the market. Chinese firms dominated the industry, and even by 1900 European-owned mines still contributed only 10 percent of the total tin output. As such, most operations followed the labor-intensive Chinese model of opencast mining. Workers mined shallow alluvial deposits by removing the overburden (soil and rock above the deposits) to expose the layer of "karang," or tin-bearing earth. Miners then carried the karang in baskets to long wooden troughs and used water to separate the tin ore from the gravel. Massive digging operations sliced open ridges and left large yawning pits across the valleys. The work was exhausting and poorly paid, but that did not deter hosts of immigrants, mostly Chinese, from finding their way to Malayan mines.

Unable to compete with Chinese-owned mines in terms of the cost of labor, European firms turned to technology. In the 1890s, the British began employing motorized water pumps (monitors) for hydraulic sluicing. A powerful jet of water blasted the karang into a sludgy mixture of tin ore and mud. To achieve strong enough water pressure to break down the earth, these mines were located on hillsides where streams at higher elevations could be dammed and the water piped to pits below. A second set of pipes suctioned the karang mixture up to the surface, where workers siphoned off and processed the tin. The topographies of Perak, Selangor, and Negeri Sembilan, the leading tin-producing states in Malaya, were particularly conducive to hydraulic mining, and European tin production doubled in less than a decade. Hydraulic methods enabled European enterprises such as the Gopeng Consolidated Mines, Tekka Mines, and Kanaboi Tin Mines to gain a greater foothold in the market. In 1906, European firms in Thailand introduced dredges, large pontoons or barges that scooped up karang from the bottom of lakes or flooded basins, and similar dredging operations began in Malaya in 1912.<sup>17</sup> But the

16. Malcolm Falkus, "Labour in Thai Mining: Some Historical Considerations," *Asian Studies Review* 20, no. 2 (1996): 71–95, here pp. 86 and 91.

17. Yip Yat Hoong, *The Development of the Tin Mining Industry of Malaya* (Kuala Lumpur: University of Malaya Press, 1969), 125 and 130–32; Falkus, "Labour in Thai Mining," 92; Ernest S. Hedges, *Tin in Social and Economic History* (London: Arnold, 1964); Wong Lin Ken, *The Malayan Tin Industry to 1914: With Special Reference to the States of Perak, Selangor, Negeri Sembilan, and Pahang* (Tucson: University of Arizona Press, 1964).

outbreak of war hindered the full deployment of these floating factories because the materials used to build them were needed elsewhere, leading to an intensification of hydraulic mining.

Mining tin deposits was a messy business, and that was especially true for hydraulic sluicing. Clear-cutting forests on hillsides to access water sources and drainage from the pumps caused extensive soil erosion. Landslides smothered the lowlands, covering arable land with debris and grit and pushing farmers onto less fertile and less accessible lands. Sluicing runoff choked rivers with sand and clay, and for local populations that depended on these rivers for navigation, fishing, and clean drinking water, pollution from tin mining ruined livelihoods. Smelting operations filled the air with noxious fumes. Environmental conditions became so dire that local authorities attempted to either ban hydraulic mining in the hills or require mining companies to build a tailings dam to collect the slurry.<sup>18</sup> But the asymmetrical power relationship between European mine owners and Malayan locals meant that tin extraction continued with few restraints.

The demands of war further stymied conservation efforts and intensified mining operations. Like other strategic commodities, the value of tin rose sharply during the war. Tin prices on the London market in 1916 were 43 percent higher than in 1911, leading to a massive expansion of Malay tin mining. Not only did industrialized tin mining ruin key components of these local ecosystems, it also created an artificial bubble in the tin market. Due to the difficulty of transporting the metal to Europe, both the Federated Malay States and the Dutch East Indies accumulated large stocks that later caused a collapse of the price of tin in the 1920s.<sup>19</sup>

The war's detrimental impact on Malayan populations and their environment was largely indirect when compared to what Africans suffered, but intensified metal ore mining for industrial armies turned the peninsula's hills and valleys into "war landscapes" all the same. Since every artillery barrage on the western front potentially involved tin alloys from Southeast Asia, the raw materials of this mainly peripheral region played a central role in the war. Yet few Malaysians saw positive returns from their products. Technological innovation provided European mine operators with an advantage, which was reinforced by the war. Soon the ratio of European to Chinese tin production had been reversed, with British firms taking the lead and capital-intensive methods replacing labor-intensive operations. Yet for locals unable to compete with cheap foreign labor or expensive machinery, the war exacerbated economic dislocations. Incentives to produce tin for mechanized militaries and ever-greater industrial demands further upset environmental and social ecologies on the peninsula, leaving countless Malaysians destitute and landless. Despite the drop in tin prices after the war, firms continued to expand mining

18. Arthur W. King, "Changes in the Tin Mining Industry of Malaya," *Geography* 25, no. 3 (1940): 130–34, here p. 132. For more on the environmental effects of mining in the twentieth century, see John R. McNeill, *Something New under the Sun: An Environmental History of the Twentieth-Century World* (New York: W. W. Norton, 2000), 30–35.

19. Yat Hoong, *Development of the Tin Mining Industry of Malaya*, 153–54.

operations in the hope of recouping losses on the market. In many ways, the scars left by mining on the Malaya Peninsula have lasted longer than those left by the trenches in France.<sup>20</sup>

## Food Production in Latin America

When the United States declared war on Germany in 1917, several Latin American countries followed suit. Brazil, Cuba, Costa Rica, Guatemala, Haiti, Honduras, Nicaragua, and Panama became belligerents. Peru, Bolivia, Ecuador, Uruguay, and the Dominican Republic stayed out of the conflict but severed diplomatic relations with Germany. Argentina, Chile, Columbia, Mexico, El Salvador, Venezuela, and Paraguay remained neutral. Though often neglected in First World War scholarship, the neutral countries of Latin America, principally Argentina, Chile, and Mexico, nourished and fueled European armies throughout the duration of the war. Given their nonaligned status, their actions might well complicate our understanding of belligerency. Meanwhile, when the United States redirected the bulk of its food exports to Europe, Brazil and Cuba struggled to feed domestic populations, leading to significant changes in agrarian practices. Whether individual countries remained neutral or not, the war precipitated environmental transformations right across Latin America that frequently signaled impending economic troubles and social dislocations.<sup>21</sup>

Food security was a defining feature of the war. Both sides faced the dilemma of how to feed troops, civilians, and countless beasts of burden, and all belligerent societies attempted to increase their agricultural output. Environmental upheaval resulted. Blocked from international markets by the British, Germans plowed up churchyards, school grounds, forest glades, and even beloved soccer fields, which led to the systematic uprooting of trees, bushes, and hedges to create more farms, reducing biodiversity and increasing ecological imbalances.<sup>22</sup> To meet European demand for carbohydrates, North American wheat farmers plowed close to six million hectares across the semi-arid prairies, which were especially suited to gas-driven tractors, plows, and combines. The one-way disc plow, which could quickly break the soil and uproot weeds with its spinning blades, pulverized the dirt and left a layer of loose sediment over the ground, inviting wind erosion and the formation of dust bowls in the decades that followed.<sup>23</sup> Wheat farming was so lucrative that

20. For the best environmental analysis of tin mining in Malaya, see Corey Ross, "The Tin Frontier: Mining, Empire, and Environment in Southeast Asia, 1870s–1930s," *Environmental History* 19, no. 3 (2014): 454–79.

21. For an excellent introduction to broader issues of political and environmental change in Latin America, see Shawn William Miller, *An Environmental History of Latin America* (New York: Cambridge University Press, 2007).

22. Roger Chickering, *The Great War and Urban Life in Germany: Freiburg, 1914–1918* (New York: Cambridge University Press, 2007), 165–88.

23. Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, 2004), 89–90; Sarah T. Phillips, "Lessons from the Dust Bowl: Dryland

financial profits outweighed the environmental costs, largely because the Entente—primarily Great Britain—depended so heavily on food imports from across the Atlantic and in particular from Argentina.

British demand for Argentinian grains was not new. Since the repeal of the Corn Laws in 1846 ended agricultural protectionism, British consumers had depended on imports of foreign cereals. When Argentina became a large-scale exporter in the late nineteenth century, Great Britain purchased increasing amounts of wheat and corn, its chief staples. By the start of the First World War, food imports had become a matter of British national security. The country produced only 35 percent of the calories consumed by its citizens, and Argentina's Río de la Plata region was an essential source of carbohydrates for the United Kingdom.<sup>24</sup>

Advances in freezing technology and better livestock breeding also allowed Argentina to become a leading exporter of beef and mutton, with the bulk of its shipments likewise destined for Great Britain. This was a more recent development. During the mid-nineteenth century, in the wake of rapid urban growth and industrialization, the British Isles had reached their environmental limits of beef production. In response to consumer demands, British imperial expansion included, in part, the aim to develop new grazing lands. Colonial administrators had hoped that ranchers in Africa would provide reliable and inexpensive supplies of beef. But outbreaks of rinderpest in the 1890s destroyed nearly 90 percent of African cattle and heightened European anxieties about buying infected meat products from the colonies. Improved methods of meat sterilization in the freezing and canning process opened up new markets in South America. By the early twentieth century, imports accounted for over 40 percent of British domestic meat consumption, and 80 percent of that trade came from Argentina and Uruguay.<sup>25</sup>

Argentina's agricultural export economy drove environmental change on the vast, fertile, and sparsely populated Pampas. Soaring farming and ranching profits attracted investors, whose financial backing enabled the expansion of pastures and herds. In the three decades leading up to the First World War, cultivated acreage increased tenfold. In 1914, wheat production alone occupied seven million hectares. Most of the cereal output came from large *estancias* in the Pampas, which functioned with a combination of foreign capital and immigrant tenant farmers. Large estates

Agriculture and Soil Erosion in the United States and South Africa, 1900–1950," *Environmental History* 4, no. 2 (1999): 245–66, here pp. 255–56; McNeill, *Something New under the Sun*, 80; Avner Offer, *The First World War: An Agrarian Interpretation* (Oxford: Clarendon Press, 1989).

24. Dehne, *On the Far Western Front*, 164; Albert, *South America and the First World War*, 12; Roger Grivil, "Argentina and the First World War," *Revista de história* 54 (1976): 385–417, here p. 388.

25. Thaddeus Sunseri, "A Political Ecology of Beef in Colonial Tanzania and the Global Periphery, 1864–1961," *Journal of Historical Geography* 39 (2013): 29–42; Albert, *South America and the First World War*, 67; Daniel Gilfoyle, "Veterinary Research and the African Rinderpest Epizootic: The Cape Colony, 1896–1898," *Journal of Southern African Studies* 29, no. 1 (2003): 133–53; Richard Perren, *Taste, Trade and Technology: The Development of the International Meat Industry since 1840* (Aldershot: Ashgate, 2006).

also raised cattle and sheep, but the meat canning industry transformed ranching operations through its preference for lower-quality cattle whose leaner meat was more suitable for freezing. It also made for a cheaper product with a market niche that did not compete with the more expensive, higher-grade North American beef. Demand for carefully bred, quality fatstock diminished, meaning that wealthy Argentinian breeders who spent extravagant sums on improving their heifers received a disappointing return on their investment. Instead, poorer ranchers raising inferior cows enjoyed a financial windfall.<sup>26</sup>

The war, however, initially brought economic hardship to Argentina. Mass unemployment marked the opening months of the conflict. Severe drought and a locust infestation in 1914 caused harvest failures and a crippling drop in agricultural exports. An unusually cold winter with repeated frosts followed, leading to outbreaks of disease among the cattle. The most productive provinces of Córdoba, Entre Ríos, and Santa Fe were among the hardest hit. Moreover, Argentina lost its second most important trading partner. Prior to the war, German merchant houses controlled about 60 percent of the country's grain trade. After August 1914 this became a great concern for the British, who made every effort to stop grain shipments to Germany. When sales of maize to neutral Scandinavian countries rose suspiciously, British authorities inferred that German merchants were circumventing the naval blockade. Their warships responded with force and the Germans retaliated, Argentine ships sometimes getting caught in the crossfire. With no other trading partners, Argentinian exporters had to accept the pitifully low prices imposed by the Entente.<sup>27</sup>

Certain historians have used these developments to frame South America's relationship with the global north in a negative light, seeing it as part of Great Britain's so-called informal empire: some argue that elites in Argentina collaborated with Europeans to create "an imperialism of free trade," others that South American economies were wholly dependent on European whims.<sup>28</sup> But placing Argentina in a larger context of transatlantic energy exchange challenges both of these views. From this perspective, Great Britain was just as dependent on Argentine foodstuffs as the South American republic was on British coal. Meat and wheat gave Argentina a strategic advantage, even though it relied heavily on cheap imported coal for its nascent industrial economy. In 1914, British authorities signed a trade agreement with Argentina for monthly meat deliveries of 15,000 tons, most of which was designated for the army. The French also purchased their monthly meat shipments of 25,000 tons through the British. Perhaps some British politicians believed that their coal might serve as leverage during future trade negotiations, but instead Argentina began importing coal from the United States. By 1917, Argentina consumed twice as much US coal as British, but Great Britain dared not halve its food imports. Midway through the war, the Entente powers

26. Albert, *South America and the First World War*, 13 and 69–72.

27. Gravil, "Argentina and the First World War," 389; Albert, *South America and the First World War*, 62–64; Dehne, *On the Far Western Front*, 167.

28. For a lucid overview of these debates, see Dehne, *On the Far Western Front*, 2–4.

continued to receive the majority of their imported meat from the Río de la Plata and Patagonia. Argentina retained its title of lead exporter, even though Australia and New Zealand, both members of the British Commonwealth, were overproducing meat; the shorter route across the Atlantic made for faster deliveries and better use of the fifty-one British refrigerated steamers. Transatlantic energy exchanges created mutually dependent networks that the war directed, reinforced, and at times balanced.<sup>29</sup>

Chile also participated in this exchange. As the largest South American coal producer with an annual output of over a million tons, the country was less dependent on British imports, even though it only produced bituminous coal. More important were Chile's nitrate exports. Since the late nineteenth century, the country had gained complete control over the vast nitrate deposits in the Atacama Desert and a near monopoly over the world's natural nitrate of soda trade. During the first decade of the twentieth century, nitrate accounted for nearly 80 percent of Chile's total exports, and Great Britain, Germany, and the United States together purchased 80 percent of those exports. Germany led the pack, receiving 30 percent of Chile's total nitrate sales. Nitrogen was both an essential fertilizer and a major constituent of explosives, and thus served two of any belligerent country's most vital needs. The entire fabric of Chilean society relied on the nitrate industry and its mining operations in the Atacama Desert.<sup>30</sup>

The Atacama is one of the driest deserts in the world. Located in the belts of the southeast trade winds and the Horse Latitudes, regions of descending, dry air, its arid climate formed and preserved the great nitrate beds scattered irregularly throughout the desert between the low coastal mountains and the higher cordillera of the Andes. The nitrate deposits themselves are uneven in thickness and richness, and the mineral may lie at depths from several inches to several feet in a layer that miners called the caliche. Extracting nitrate in the early twentieth century involved digging holes to map the caliche and then shattering the layer with explosives. Workers broke up the larger fragments with sledgehammers and collected the richer pieces for processing at the treatment plants (*oficinas*). Since nitrate deposits appeared inexhaustible, miners freely discarded smaller pieces and thus generated tremendous waste.<sup>31</sup>

The war, however, accelerated the processes that would eventually exhaust Chile's nitrate reserves. In doing so, it revealed the country's systemic fiscal weaknesses and the tense relations between labor and capital. Losing Germany as a trade partner plummeted Chile into a severe depression that lasted until 1915. The nitrate-producing districts were the hardest hit, as mining was one of the few activities possible in the Atacama Desert. The government shipped thousands of unemployed nitrate workers to agricultural lands in the south, but their arrival exacerbated already dire conditions. Only the economic recovery of 1915

29. *Ibid.*, 164–66; Albert, *South America and the First World War*, 68 and 74.

30. *Ibid.*, 26 and 103; Whitbeck, "Chilean Nitrate and the Nitrogen Revolution," *Economic Geography* 7, no. 3 (1931): 273–83, here p. 273.

31. *Ibid.*, 273–75.

and the world's continued reliance on Chilean nitrates prevented social mayhem.<sup>32</sup> The country's chemicals helped maintain the shaky domestic peace and sustained European and American farmlands during the war. During the same period, however, scientists in Germany, once Chile's main trading partner, had developed the Haber-Bosch process of artificial nitrogen fixation, which doomed Chile's nitrate industry. Neutrality thus did not save the country from the misfortunes of war.

As the largest belligerent country in South America, we might speculate that Brazil played a key role in the transatlantic energy exchange. But unlike Argentine beef or Chilean nitrates, Brazil's main exports—coffee and rubber—were deemed nonessential for the war effort. The Entente governments considered coffee a luxury item, and the Brazilian rubber industry could not compete with plantation rubber production in Asia. As such, Brazil had no energy leverage to balance its need for cheap imported coal. Shortsighted policies had failed to mine domestic coal deposits in the states of Rio Grande do Sul and Santa Catarina, and the country contained no exploitable oil deposits. In response to the energy emergency, the government expanded logging operations to fuel power generating plants.<sup>33</sup>

Timber extraction did clear more arable land for increased food production. Following his government's declaration of war in October 1917, the Brazilian president Venceslau Brás issued a statement to ramp up the economy for war: "It is fitting that we exercise the greatest economy in expenditures of every nature, public or private. Let production in the fields be intensified as much as possible, so that hunger, which is already knocking at the door of Europe, may not attack us also; rather must we strive to become the granary of our Allies."<sup>34</sup> This was wishful thinking, as Argentina and the United States already served as the Entente's breadbasket. Nevertheless, Brás's call to plow resulted in an enormous expansion of cultivated land, as in the state of Minas Gerais where tilled fields increased by 500 percent. During the 1917–1918 growing season, the Ministry of Agriculture supplied over twenty-four million kilograms of seeds across fourteen states.

As in other belligerent countries, the war encouraged greater governmental intervention in the Brazilian agrarian markets. Presidential decrees created a host of new agencies, including the Commission of Public Alimentation (*Comissariado da Alimentação Publica*). Like its counterpart in the United States, the commission regulated food exports in order to satisfy Allied demands while maintaining domestic supplies. It fixed prices but did not introduce a rationing system. Though guided by good intentions, the commission's efforts produced hostility.<sup>35</sup> Entrenched business interests resisted price-fixing schemes, as did rural farmers. However, the war ended before tensions reached a breaking point, leaving bad feelings to simmer under the surface of increasing social strain.

Cuba floated on the far periphery of the First World War, but the conflict nevertheless shaped the island's landscape and social relations in significant ways.

32. Albert, *South America and the First World War*, 49–50.

33. *Ibid.*, 92.

34. Percy Alvin Martin, *Latin America and the War* (Baltimore: Johns Hopkins University Press, 1925), 69–70.

35. *Ibid.*, 92–93.

Despite its favorable climate and fertile soil, Cuba was a heavy importer of foodstuffs; it relied on growing cash crops, and sugar and tobacco exports were mainstays of the Cuban economy. The United States provided the island with most of its food imports, until it declared war on Germany in 1917 and redirected its shipments to Western Europe. The Cuban government responded with a two-pronged approach to ward off the risk of malnutrition. New state agencies were established to regulate the national market but also to encourage local gardening and conservation efforts.

April 1917 witnessed a flurry of governmental activity as authorities scrambled to solve the impending food crisis. Days after the declaration of war, President Mario García Menocal created the Junta de Subsistencias, a commission that was to fix prices for all foodstuffs. Its members traveled around the island on a campaign to educate citizens and induce them to grow more fruits and vegetables. The commission also sought to enlist support from owners of the larger sugar centrals, who in turn would persuade their tenant farmers (*colonos*) to plant food crops. Within days of receiving circulars from the secretary of agriculture requesting cooperation in addressing food scarcity, several owners promised their aid. Many, like Mr. H. W. Remy, manager of the central “Constantia” owned by the Colonial Sugar Company, provided their *colonos* with allotments of land, tools, seed, and sometimes cattle. That same month, three of the most powerful agricultural organizations on the island, the Cuba Fruit Exchange, the National Horticultural Society, and the Herradura Shipping Association, pledged President Menocal their full support to increase and conserve food supplies.<sup>36</sup> Menocal’s history of business-friendly policies had won him powerful allies.

Talk was cheap. By autumn 1917 cracks began to appear in the national façade of unity. A new government agency with greater power, the Council of National Defense (Consejo de Defensa Nacional), was created to mobilize food resources, this time under the direction of experts. The Council established a network of “war farms” and agricultural zones under its direct supervision. Like the United States Food Administration, it appealed to Cubans’ sense of patriotism and self-sacrifice, and, borrowing approaches from its northern neighbor, instituted “meatless” and “wheatless” days. Just before Christmas 1917, it issued a rather paternalistic proclamation, urging Cubans to reduce their consumption of bread, sugar, meat, lard, and olive oil, to eat more bananas and beans, and to grow vegetables or breed poultry on whatever land was available. The creation of the Council and its zealous efforts to increase food production suggest that previous approaches had proven ineffective. The establishment of the Cuban Food Administration (Dirección de Subsistencias) in May 1918 as part of the “Food Bill,” which also made it compulsory for farmers and tenants to grow food crops on 3 percent of their land, demonstrated that sugar remained more popular than vegetables.<sup>37</sup>

Sugarcane plantations meant wealth, but for many Cubans they also signified US hegemony over sugar production. Of the 130 sugar centrals on the island,

36. Ibid., 134.

37. Ibid., 135–39.



Americans owned sixty-seven while Cubans owned merely eighteen. Falling European sugar beet production during the war raised sugar prices and drove the expansion of plantations in Cuba, often at the expense of food crops. Caring little for political entanglements between Washington and Havana, impoverished peasants expressed their anti-Americanism throughout the spring of 1917 by attacking the larger sugar centrals. By the summer, fearing that German agents might recruit the insurgents, and even more concerned that valuable cash crops would be destroyed, the United States deployed Marines to calm the Cuban countryside and protect the plantations in what is now known as the “Sugar Intervention.” Their presence escalated feelings of anti-Americanism, but that year the sugar centrals brought in a record harvest. The insurgency sputtered to an end in 1918, just before the war in Europe came to a close. Yet the violence and revolts of 1917 reminded Cubans that the sweet power of sugar barely disguised the bitter taste of political rancor and festering anger.<sup>38</sup>

Having served on the western front, Kurt Lewin knew a “war landscape” when he saw one. As he suggested, these places need not be directly under fire. Even terrains free from trenches could be danger zones. Perceptions mattered, and for Lewin belligerency was in the eye of the beholder. On the war’s periphery forced labor, the threat of the tsetse fly, and violent strikes and insurgencies all transformed the natural world and constituted a belligerent environment. The social ruptures, economic turmoil, and ecological dislocations resulting from population displacement, industrialized mining, and expansive agriculture added to the sense of anxiety that came with occupying a war landscape. As we have seen, an environmental approach demonstrates how distinguishing between a peace landscape and a war landscape became increasingly difficult the farther away one moved from the fighting front. An examination of the Great War’s ecological legacy reveals that the distinction between modern war and modern industry had, in many ways, faded. Seeing the war from the outside-in forces us to consider the strengths of the periphery and exposes the different types of belligerence.

Blurring the boundaries between war landscapes and peace landscapes created unease in other, less obvious ways. The war simultaneously opened and closed frontiers. States extended their spheres of influence all along the ecological edges of the conflict, a notable feat given how inaccessible many of those environments in equatorial Africa, Southeast Asia, and Latin America were. Some of these efforts were linked to empire-building projects, while others were in part capitalistic schemes. All of them extended state control over the natural world in some way. These local developments indicated broader patterns that defined the twentieth century, in each instance the war accelerating trends that had begun with

38. For more on the role of sugar in the development of Cuba, see Gillian McGillivray, *Blazing Cane: Sugar Communities, Class, and State Formation in Cuba, 1868–1959* (Durham: Duke University Press, 2009); Sidney Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Penguin Books, 1986).

industrialization in the nineteenth century. While the war's concentrated industrial destruction obliterated battlegrounds, natural processes repaired the damaged lands. Far more detrimental to ecosystems and more pervasive than combat was the spread of industrial methods and mentalities of production that hindered natural processes, upset local ecological balances, and increased human exploitation the world over. On the ecological edges of the war, the subjugation of new environments often meant that marginalized populations were alienated from their land. This is, perhaps, the Great War's global legacy.

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