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The Global Environmental Impacts of World War I

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Abstract

Discussions of the First World War are often centered around the infamous trench fighting on the Western Front. However, in recent years, the war's environmental impact has received more exposure, though it often remains divided between European battlefields and other spheres of damage. This essay combines research from history and science to provide a more complete picture of the various and overlapping ways the war impacted environments. Aside from the damage done by artillery on the battlefields, the environmental impacts of the First World War can be further categorized into the impacts of intentional environmental manipulation, the unintentional impacts of mobilization, and the consequences of obtaining and exploiting resources abroad. Examining these different types of impacts simultaneously highlights how the war's environmental impact was compounded by active combat and the processes required to maintain it; for instance, the French Zone Rouge suffered not only from the trench warfare that occurred there but also from road creation and deforestation that will affect its environment for years to come. This essay argues that the environmental impact of the First World War was wide-ranging, often intertwined, and long-lasting. The environmental lens demonstrates how the First World War truly impacted the entire world.

Introduction

The First World War was a global conflict fought between the Allied and Central powers from 1914 to 1918. The war is most commonly associated with the Western Front and trench warfare. However, as the name suggests, the First World War was fought around the world – not just in France and Belgium – as armies fought proxy wars (e.g., Somaliland Campaign), attempted to obtain natural resources (e.g., Malayan Tin), and sought to control valuable trade routes (e.g., Taranto, Italy) on multiple continents. The First World War also marked a revolution in the usage and manufacturing of weapons as mass-produced chemical weapons (i.e., chlorine, phosgene, and mustard gas), and artillery dominated the war-torn battlefields, trenches, and No-Mans Land. Over the past century, historians have examined the First World War through military, political, economic, and even colonial lenses. Now, we are beginning to apply another lens to view the First World War: environmental impact. Taking an environmental approach – looking beyond the mechanical and human cost of WWI to its impacts on the lands and seas on which it was fought – allows us to truly see and appreciate the global scope of the war.

Though primary evidence surrounding the environmental impact of the First World War had always existed, it was not until the late twentieth century that scholars began considering the environmental history of the war and applied new technological advances from science toward this end. In particular, authors such as Joseph Hupy and Tait Keller have made numerous contributions towards understanding the global, environmental history of WWI. Hupy analyzed the environmental impact of the war on the Western Front, whereas Keller approached the war from a resource and proxy war perspective.¹ However, research that synthesizes different types of environmental impacts from WWI – on and off the battlefields – into a cohesive, worldwide narrative is rare. Works such as *Environmental Histories of the First World War* have done much to bring together off-battlefield case studies, but there still exists a separation between battle and other environmental histories of the war.²

¹ See, for instance, Joseph Hupy, “The Environmental Footprint of War,” *Environment and History* 14, No 3 (August 2008): 405-421.

<https://doi.org/10.3197/096734008X333581>; Joseph P. Hupy and Randall J. Schaeztl, “Soil development on the WWI battlefield of Verdun, France,” *Geoderma* 145, Issues 1–2 (May 2008): 37-49, <https://doi.org/10.1016/j.geoderma.2008.01.024>; Tait Keller, “The Ecological Edges of Belligerency - Toward a Global Environmental History of the First World War.” *Annales. Histoire, Sciences Sociales - English Edition* 71, no. 1 (2016): 61–78. doi:10.1017/S2398568217000036.

² Tait Keller et al. (eds.), *Environmental Histories of the First World War* (Cambridge: Cambridge University Press, 2018). doi:10.1017/9781108554237.

This risks omitting the relationship between the two and the accumulating or overlapping environmental consequences they wrought. Thus, this essay aims to bridge the gap between the existing research regarding different types of environmental impacts from the First World War – battlefield impacts, impacts of intentional environmental manipulation, unintentional impacts of mobilization, and the impacts of obtaining resources abroad. In doing so, this essay demonstrates that the environmental impacts of the war were wide-ranging beyond the main fronts, often intertwined, and long-lasting.

Battlefield Impacts

The most commonly associated form of environmental damage caused by the First World War is the immediate battle scarring from weapons, whether it be on land or at sea. The war marked a revolution in the usage of bombs, especially on the Western Front, as artillery was heavily exploited during battles and trench warfare. These trenches were carved into once-arable land; meanwhile, bombs created massive craters or tore through woods bordering the battlefields. The First World War also damaged ecosystems aside from the terrestrial Western Front: military ports faced pollution from a variety of sources, which exerted considerable pressure on local marine environments across Europe. Heavy metal from ordnance as well as chemical weapons – chlorine, phosgene, and mustard gas – also polluted the battlefields, with the resulting chemical contamination continuing to be felt today. Thus, the weapons and processes that were conceived to inflict damage on humans extended beyond their intended purpose – they had left a lasting impact on the terrestrial and marine environments in which they were deployed.

If there was a mantra that encapsulated the primary tactic for the battles on the Western Front, it would be: “Artillery conquers, infantry occupies.”³ During the infamous battle of Verdun, in an area of approximately 200 km, the Germans fired 34 million rounds and the French fired 26 million during seven months in 1916.⁴ Due to the intense, yet mostly futile, fighting on the Western Front, the deposition of bullets, shrapnel, and power casings led to the soil becoming enriched with heavy metals – namely, lead (Pb) and copper (Cu). Copper was necessary for the production of driving bands, fuzes, and shell casings, whereas lead was used for the manufacturing of shrapnel balls, primary

³ Joseph P. Hupy and Randall J. Schaetz, “Introducing “Bombturbation,” a Singular Type of Soil Disturbance and Mixing,” *Soil Science* 171, no. 11 (November 2006): 828, <http://dx.doi.org/10.1097/01.ss.0000228053.08087.19>.

⁴ *Ibid.*

explosives, and chemical warfare equipment.⁵ Both metals were and are toxic to plants and animals.

In a 2022 study on heavy metal contamination from WWI, scientists found that there was enrichment of soil Pb by 72-78 mg/kg, equivalent to more than four times the top baseline value (of soil Pb in undisturbed areas).⁶ The same soils were also enriched with 27-31 mg/kg Cu, which was 2.5 times the top baseline value (of soil Cu in undisturbed areas). The mean concentration of soil Pb was 93.34 mg/kg Pb, and the mean concentration of soil Cu was 43.37 mg/kg Cu. Copper (Cu) can be toxic to plants at concentrations as low as 20 mg/kg, and it can be detrimental to soil biota at concentrations of 10 mg/kg. Lead (Pb) can induce morphological, physiological, and biochemical changes and dysfunctions in plants and soil organisms, and its effects have been recorded at concentrations as low as 35-50 mg/kg.⁷ Given the high recordings of lead and copper from WWI deposits – far above the minimum levels at which damage to plants and animals was observed – it is apparent how the metal shrapnel and waste from the First World War left a toxic environment even after the initial destruction was cleaned up.

Aside from the heavy usage of artillery, the First World War saw another form of weapons utilized in abundance: chemical agents. Both the Allies and the Central powers experimented with chemical weapons, resulting in the creation of infamous gas weapons such as chlorine gas, phosgene gas, mustard gas, and arsenicals – just to name a few. The chemical weapons that were used (or planned to be used) in the war left behind traces in the soil and water surrounding the battlefields. In a study examining a former burning ground for arsenical munitions near Verdun, scientists found soil that was heavily contaminated with arsenic (the concentration range of arsenic was 2,019-175,907 mg/kg), a well-known poison to heavy plants.⁸ Moreover, there are sites containing mustard gas – a blister agent causing mucosal, eye, and skin irritation – originating from the First World War that continues to pose risks to

⁵ T. Bausinger, E. Bonnaire, J. Preuss, “Exposure Assessment of a Burning Ground for Chemical Ammunition on the Great War Battlefields of Verdun,” *Sci Total Environ* 382, issues 2-3 (September 2007): 260, doi: 10.1016/j.scitotenv.2007.04.029.

⁶ O. H. Williams and N. L. J. Rintoul-Hynes, “Legacy of War: Pedogenesis Divergence and Heavy Metal Contamination on the WWI Front Line a Century after Battle,” *European Journal of Soil Science* 73 (4) (2022), e13297.

<https://doi.org/10.1111/ejss.13297>; Drew Heiderscheidt, “The Impact of World War One on the Forests and Soils of Europe,” *Ursidae: The Undergraduate Research Journal at the University of North Colorado* 7, no. 3 (July 2018): 1-16.

<https://digscholarship.unco.edu/urj/vol7/iss3/3>.

⁷ Williams and Rintoul-Hynes, “Legacy of War.”

⁸ Bausinger, Bonnaire, Preuss, “Exposure assessment of a burning ground,” 270.

human health, groundwater, surface water, and the wider ecology.⁹ Finally, stockpiles of adamsite – a vomiting agent that forced soldiers to remove their gas masks – were dumped into bodies of water around Europe along with other chemical warfare agents (CWAs).¹⁰ This affected marine ecosystems, as Baltic blue mussels were found to have bioaccumulated oxidized forms of adamsite, resulting in adverse cytotoxic and immunotoxic effects.¹¹ The so-called “Chemist’s War” resulted in the creation of weaponry with pertinent environmental impacts.

Beyond the dumping of CWAs, marine ecosystems faced additional pollution and ecological damage as a direct consequence of building and sustaining the war machine at sea. An example of such damage would be the Mar Piccolo of Taranto – a strategic military port for the Italian Navy. In 1916, the dreadnought *Leonardo da Vinci* exploded, capsized, and sank in the Mar Piccolo – the explosion shock wave, the leakage of fuel oil, the production of toxic and noxious substances from burnt hydrocarbons, and the resuspension of sediments were all harmful after-effects of the explosion.¹² However, even outside of this, the body of water became a receptacle for dust (from discharged firearms), sewage water from military camps containing over 30,000 English and French soldiers (the theme of unintentional impacts of mobilization is expanded upon later in this essay), and waste from ships moored in small ports.¹³ The Tosi Shipyards (located in Taranto) built six submarines and sixteen minesweepers from 1915 to 1920, further exacerbating the pollution in the water.¹⁴ Though the Mar Piccolo of Taranto was especially harmed by the dreadnought explosion, it can be inferred that other naval ports in the First World War (such as Scapa Flow, Orkney Islands, Scotland, or the Paardenmarkt Bank in Belgium)¹⁵

⁹ Matthew Howard Ashmore and C. Paul Nathanail, “A Critical Evaluation of the Implications for Risk Based Land Management of the Environmental Chemistry of Sulphur Mustard,” *Environmental International*, 34, issue 8 (November 2008): 1193, <https://doi.org/10.1016/j.envint.2008.03.012>; Giacomo Certini, Riccardo Scalenghe, William I. Woods, “The Impact of Warfare on the Soil Environment,” *Earth-Science Reviews*, 127 (December 2013): 7, <https://doi.org/10.1016/j.earscirev.2013.08.009>.

¹⁰ Suhail Muzaffar et al., “Mechanistic Understanding of the Toxic Effects of Arsenic and Warfare Arsenicals on Human Health and Environment,” *Cell Biol Toxicol* 39, no. 1 (February 2023): 101, doi: 10.1007/s10565-022-09710-8.

¹¹ *Ibid.*

¹² Carmela Caroppo and Giuseppe Portacci, “The First World War in the Mar Piccolo of Taranto: First Case of Warfare Ecology?” *Ocean & Coastal Management* 149 (November 2017): 139, <https://doi.org/10.1016/j.ocecoaman.2017.09.020>.

¹³ *Ibid.*, 141.

¹⁴ *Ibid.*, 139.

¹⁵ Tine Missiaen, “Paardenmarkt Bank, a WWI Ammunition Dump Site Off the Belgian Coast,” *VLIJZ: De Grote Rede* 36 (2013): 53-60.

faced similar environmental impacts from the stationing of soldiers and the construction of ships. This also points to how contamination built up from several causes stemming from the war.

Damage came not only from used weapons – chemical and artillery – and accidental explosions but also from unexploded ordnances. This is especially noticeable in the “Zone Rouge” of northeastern France – a group of noncontiguous territories that the French Government deemed inhabitable due to the large number of unexploded shells, grenades, and ammunition in the soil.¹⁶ French farmers retrieve roughly 900 tons of unexploded munitions in an annual tradition commonly referred to as the “iron harvest.” Outside the Zone Rouge, in Belgium, the number is around 160 tons per year.¹⁷ Most of these unexploded ordnances are still filled with the hazardous chemicals described above – mustard gas, phosgene, and chlorine – meaning that the contamination risk continues to persist on top of burns and death. These examples perfectly demonstrate how the environmental impacts of the First World War extend into the twenty-first century and beyond.

The Zone Rouge also demonstrates how these different types of damages accumulated. The Zone Rouge included the battlefields of Verdun, the Somme, Ypres, and more, where some of the longest and most violent fights took place. The damage from the unexploded ordnances built upon that caused by those that did explode.¹⁸ Verdun has already been mentioned in connection to artillery and chemical agents on top of unexploded items, and further damages to this area and the Zone Rouge are explored below. In fact, the environmental damage done to the Zone Rouge was so severe that the Sécurité Civile (the civil defense agency of the French Government) estimated the ensuing cleanup of the area would take over 300 years.¹⁹

In summary, the usage and stationing of military resources constituted a considerable portion of the overall environmental impact of the First World War. The usage of weaponry is commonly associated

¹⁶ Stuart Thornton, “Red Zone,” *National Geographic Society*, last modified 20 May 2022, <https://education.nationalgeographic.org/resource/red-zone/>.

¹⁷ James Patton, “The ‘Iron Harvest,’” *Kansas WW1: Commemorating the First World War Centennial in Kansas*, last updated 1 August 2016, <https://ksww1.ku.edu/the-iron-harvest/>.

¹⁸ See Joseph Hupy, “The Long-Term Effects of Explosive Munitions on the WWI Battlefield Surface of Verdun, France,” *Scottish Geographical Journal* 122, issue 3 (2006): 167-184. <https://doi.org/10.1080/00369220618737264>.

¹⁹ Hugh D. Clout, *After the Ruins: Restoring the Countryside of Northern France After the Great War* (United Kingdom: University of Exeter Press, 1996): 24-34; Thornton, “Red Zone.”

with the trench fighting in the First World War; this is understandable as the substantial usage of artillery by both the Germans and the Allies induced long-lasting damage to French and Belgian soil. The heavy chemical contamination as well as the unexploded ordnance contributed to an inhospitable environment (most notably, in the Zone Rouge). Moreover, the environmental impacts of the First World War were felt beyond the trenches of the Western Front; marine ecosystems became polluted with waste from soldiers as well as shipbuilding. While these immediate environmental consequences are certainly long-lasting and significant, to achieve a greater understanding of the environmental history and legacy of the First World War, it is imperative to look beyond the battle stations.

Intentional Environmental Manipulation

Military, economic, and political histories have long acknowledged that the landscapes of the First World War were not restricted to battlefields with guns and shells. Environments from which soldiers originated and to which they traversed were purposefully manipulated with both beneficial and harmful intentions. Whether it was to sabotage or to improve living conditions, environments all over the world were purposefully altered by militaries in the name of the war.

From the Romans to Napoleon, “scorched-earth” tactics have long served as a means for armies to devastate environments beyond repair. Such tactics were also present in the First World War, most infamously during the 1917 German retreat maneuver known as Operation Alberich. During the war, the majority of the Kaiser’s troops were committed to the Eastern Front. In order to defend his stance on the Western Front, he ordered his smaller forces there to retreat 40 km to the shorter and more defensible Hindenburg line in Northern France.²⁰ However, the Kaiser wanted to ensure that the land lost due to the maneuver could not be of any use to the Allies. As a result, during the retreat, under orders from Generals Hindenburg and Ludendorff, the Germans soiled wells, excavated roads, planted tree mines, and even systematically cut down fruit trees.²¹ These actions resulted in the forced displacement of over nine thousand inhabitants of now-uninhabitable villages and hamlets between Arras, Cambrai, and Saint Quentin, an area

²⁰ Peter Schwatzstein, “The History of Poisoning the Well,” *Smithsonian Magazine*, February 13, 2019, <https://www.smithsonianmag.com/history/history-well-poisoning-180971471/>.

²¹ Michael McGuire, “‘Cultures de Guerre’ in Picardy, 1917,” *Historical Reflections / Réflexions Historiques* 42, no. 3 (2016): 29, <http://www.jstor.org/stable/44631080>; Schwatzstein, “The History of Poisoning the Well.”

that falls within the Zone Rouge mentioned above. This demonstrates how the Zone Rouge was not just created through battles alone, but also through the purposeful sabotage of land to prevent future uses.

German sabotage was also present outside of the European continent. At the outset of the war, the Germans maliciously introduced the invasive water hyacinth plant to East Bengal (modern-day Bangladesh) as a means of sabotage.²² The plant induced a multitude of negative impacts on the East Bengal ecosystem: fostering malaria (water hyacinth reduced the temperature of the water it grew inside and provided shelter against predators of mosquito larvae), destroying rice and related crops (by clogging up aquatic infrastructure), and threatening pisciculture (by thriving in the tanks and ponds of the countryside during the rainy seasons).²³ The Germans wanted to weaken the British by “killing their Indian subjects;” as such, the water hyacinth was referred to as the “German Pana” or the “German Weed.”²⁴ The German usage of an invasive species to attack India also captures the colonial aspect of the war – India was specifically targeted since it was a British imperial holding that provided key supply lines. This highlights how the environmental impact of the war was not restricted to the battlefields or the main theaters of the war – critically, it became intertwined with the colonial aspect of the war.

Invasive species were also introduced during WWI as a means to improve living conditions for soldiers. One of the most enduring environmental legacies arose from North American attempts to reduce the risk of mosquito-borne pathogens (such as malaria). These disease-bearing mosquitoes were prominent in areas such as the Middle East and the Tropics, where the Entente and the Central Powers fought a series of proxy battles.²⁵ Soldiers attempted to control mosquito populations by introducing mosquitofish to mosquito-dense areas; however, the mosquitofish’s aggressive nature resulted in a predation of local freshwater fish and amphibians. Mosquitofish are currently regarded as one of the “world’s worst” IAS (invasive alien species).²⁶ Furthermore,

²² Iftexhar Iqbal, “Fighting with a Weed: Water Hyacinth and the State in Colonial Bengal, c. 1910-1947,” *Environment and History* 15, no. 1 (2009): 38, <http://www.jstor.org/stable/20723705>.

²³ *Ibid.*, 40.

²⁴ *Ibid.*, 38.

²⁵ William E. Walton et al., “*Gambusia affinis* (Baird & Girard) and *Gambusia holbrooki* Girard (mosquitofish),” in Robert A. Francis (ed.) *A Handbook of Global Freshwater Invasive Species* (London: Routledge, 2011), Taylor & Francis eBooks, <https://doi.org/10.4324/9780203127230>.

²⁶ R. A. Francis, “The Impacts of Modern Warfare on Freshwater Ecosystems,” *Environmental Management* 48 (2011): 992, <https://doi.org/10.1007/s00267-011-9746-9>.

the lack of a tight predator-prey relationship between mosquitofish and immature mosquitoes impeded control efforts and exacerbated the issue of malaria and related diseases.²⁷ Many years after the war, countries attempted to eradicate the mosquitofish from their environments, but unfortunately ended up harming native species to a greater extent due to the mosquitofish's greater physical and chemical tolerance.²⁸ The devastating introductions of the mosquitofish and the water hyacinth plants encapsulate the “wide-ranging” aspect of the Great War's environmental impacts.

Purposeful environmental manipulation was one of the many strategies utilized by combatants during the First World War. The “scorched-earth” tactics of the Germans, the introduction of water hyacinth in East Bengal, and the introduction of mosquitofish in mosquito-rich environments all resulted in negative impacts on local ecosystems. It is also worth noting that there were instances of planned environmental manipulation that ultimately did not happen; in 1918, Italy was prepared to flood its fields to prevent an Austro-Hungarian advance.²⁹ The First World War was a global affair, as evidenced by the wide range of environments that were purposefully impacted. However, the mobilization of armies to set the stage for this global conflict also resulted in a variety of unintentional environmental impacts, on and off the European mainland.

Unintentional Impact of Mobilization

According to the United States Environmental Protection Agency, secondary impacts of a project or facility are indirect or induced changes in a physical or social environment, triggered by direct (primary) impacts.³⁰ In the case of the First World War, the war – the primary impact – led to a series of environmental changes that were not directly caused by the ecological costs of the fighting. Rather, these secondary environmental changes were the byproducts of a global upheaval that required the movement of large numbers of soldiers between

²⁷ Walton et al., “*Gambusia affinis* (Baird & Girard).”

²⁸ Ibid.

²⁹ Silvia E. Piovan and Michael E. Hodgson, “Military-Engineered Floods as Defense from the Enemy: A Brief Review and Case Study from WWI in Northern Italy,” in Dario Canzian and Elisabetta Novello (eds.), *Ecosystem Services in Floodplains* (Padova: Padova University Press, 2019): 73-97.

³⁰ Urban Systems Research and Engineering; Environmental Protection Agency (EPA), *Secondary Impact Assessment Manual* (Washington DC: Office of Federal Activities, EPA, 1981): 12. Digitized by National Service Center for Environmental Publications (NSCEP), 2014, <https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9101NC2R.txt>.

ecologically different parts of the world. Such byproducts included the accidental transportation of animals and/or plants, unintentional and long-term impacts of repurposing land and sea, and even technological advancements.

While the above section dealt with intentional manipulations of environments, ecosystems were also altered by accident, as a consequence of the mobilization efforts and movements of troops and supplies. For instance, mycologists hypothesize that *Clathrus Archeri*, or Octopus Stinkhorn, was introduced to the European continent on the wool and boots of Australian soldiers. According to scientists at the University of Basque Country in Spain, the bright red fungus with the scent of rotting flesh took such hold in Europe that it has become a “true invasive organism.”³¹ Other unintentional introductions of foreign species have had a far more disastrous impact, such as in the Mar Piccolo of Taranto – the Italian body of water mentioned above. Foreign ships (most likely British) carried the shipworm *Teredo navalis*, which rapidly damaged the chestnut wood pilings of fish farming plants.³² This affected agriculture in the Taranto region – a striking resemblance to the impacts of the water hyacinth on the production of crops in East Bengal. Moreover, the introduction of colonial troops from tropical Africa as well as India transferred malaria-inducing parasites into the European theater as they were carried by soldiers who had already developed partial immunity.³³ This issue was compounded by the nature of trench warfare, which forced soldiers to dig underground, creating favorable environments for mosquito proliferation and subsequently outbreaks of malaria.³⁴ From these examples, it can be observed that the First World War brought local species from different regions of the world to Europe; whereas some of these species were relatively benign, other species disrupted ecologies, industries, and armies.

Finally, unintentional environmental consequences also occurred from proxy war victories. German troop movements between 1914 and 1916 brought the cattle virus rinderpest into southern Tanganyika.³⁵ However, after British forces took over German East Africa in 1916,

³¹ Ángela Bernardo, “Wartime Bio-Stowaways,” *OpenMind BBVA* (March 2016), <https://www.bbvaopenmind.com/en/science/environment/wartime-bio-stowaways/>.

³² Caroppo and Portacci, “Mar Piccolo of Taranto,” 139.

³³ Bernard J Brabin, “Malaria’s Contribution to World War One – the Unexpected Adversary,” *Malaria Journal* 13, no. 1 (December 2014):1-22, at 2, <https://doi.org/10.1186/1475-2875-13-497>.

³⁴ *Ibid.*

³⁵ “Barricade Against Spread of Rinderpest in Africa,” *Nature* 152 (1943): 296–297 <https://doi.org/10.1038/152296b0>.

policies surrounding the control of rinderpest also changed. Protecting the British settlements in South Africa from the disease took priority over halting its spread in Tanganyika. As a result, the disease raged “with utmost virulence uncontrolled” in eastern Africa, reducing a herd of 4 million cattle by 20-30 percent in the span of four years.³⁶ In this case, colonial administration governance exacerbated an environmental issue introduced by war.

Aside from the introduction of invasive species, the First World War led to another form of biological impact: the repurposing of land and sea that altered the harvesting cycle of flora and fauna. Changes to the use of territory – from farming fields to battlefields, forest to flat roads, fishing lanes to military blockades – carried both short and long-term impacts on local trades and environments. The Zone Rouge was converted from an area of grazing and farming to a waste-ridden battlefield unfit for agricultural purposes. In addition to artillery damage and sabotage, nearly 17 billion board feet of lumber was harvested from French forests during World War One.³⁷ This lumber was required to build thousands of new roads and passageways for the transportation of guns, munitions, supplies, and men.³⁸ These roads, known as corduroy roads, had a base made up of tree trunks, which were overlaid with branches and earth.³⁹ The loss of these forests changed the surrounding ecosystem and increased the risk of erosion.

Other cases are more indirect. For example, during WWI, the North Sea had been converted into a theater of mine warfare, rendering fishing activity virtually impossible; trawlers (commercial fishing vessels) in the North Sea that relied on fishing gear below the surface were especially at risk of damage.⁴⁰ As a result of the lack of fishing activity, the fish stocks in the North Sea replenished during the war. Initially, this appeared to have a positive environmental impact; however, during the war, trawlers and minesweepers quickly became much larger and more sophisticated and were easily reconfigured into ordinary fishing trawlers

³⁶ Thaddeus Sunseri, “Forest Policy, Wildlife Destruction, and Disease Ecologies,” in Tucker et al. (eds.), *Environmental Histories of the First World War*, 243, <https://doi.org/10.1017/9781108554237.012>.

³⁷ Hupy, “The Environmental Footprint of War,” 420. Additional forest damage also came from the heavy artillery: Heiderscheidt, “The Impact of World War One on the Forests and Soils of Europe,” 3.

³⁸ P.S. Risdale, “Shot, Shell and Soldiers Devastate Forests,” *American Forestry* 22 (1916): 334.

³⁹ Ibid.

⁴⁰ Ingo Heidbrink, “The First World War and the Beginning of Overfishing in the North Sea,” in Tucker et al. (eds.), *Environmental Histories of the First World War*, 138.

by the end of the war.⁴¹ The modernization of the fishing fleets resulted in a heavily increased fishing capacity, leading to a massive overfishing of the fish stocks.⁴² Before the war, fishermen had a total catch of roughly 37,000 fish per year, but following the war, the total catch increased to 69,000 fish per year.⁴³ These examples demonstrate how the presence and logistics of war resulted in the creation of new ecological situations and the altering of existing landscapes – active battles were not needed to inflict lasting environmental impacts. This phenomenon will continue to be explored in further detail (and on a much more global scale) in the section below.

There is a tendency to pigeonhole the environmental impacts of the First World War to the damage caused by intentional destructive actions, particularly on the Western Front. But taking a look at the larger picture of the war suggests an alternate narrative: the global nature of the war itself acted as an agent of ecological disturbance. The introduction of invasive species to foreign environments – intentional or unintentional, benevolent or malicious – left impacts on ecosystems around the world, some of which can still be observed today. Moreover, land and seascapes that had been reshaped to accommodate armies or offensive tactics remained changed (or changed further) following the events of the war. However, it is important to look at one final aspect of the war, far from the battlefields and main theaters: the long-distance supply chains.

Obtaining and Exploiting Resources Abroad

Although research surrounding the environmental impacts of the First World War is largely associated with and concentrated on Europe, the production of food and weapons to support soldiers inflicted damage to environments all around the world – truly bringing out the “world” in “world war.” In particular, Asia, North America, and South America were abundant in natural resources that the European powers – namely, Britain – heavily exploited to acquire materials that were unavailable domestically. The war’s insatiable demand for resources quickly gave rise to barren landscapes, devoid of flora and fauna, that resembled those of the European No-Man’s lands.

One of Britain’s primary issues was food. As a small island in the Atlantic, Britain could not feed her soldiers solely with domestic produce; as such, Britain turned to the Americas to replenish two

⁴¹ Heidbrink, “Overfishing in the North Sea,” 143.

⁴² *Ibid.*, 141.

⁴³ *Ibid.*, 147.

primary resources: carbohydrates and proteins. According to historian Tait Keller, “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-drive tractors, plows, and combines.”⁴⁴ The one-way disc plow, which was utilized for the mass production of food, easily broke the soil, pulverized the dirt, and uprooted weeds – this resulted in the formation of a loose layer of sediment over the ground, inviting wind erosion. Moreover, the war fostered a spirit of overproduction and exploitation of natural resources among American farmers.⁴⁵ This outdated perspective towards agriculture, combined with the environmental repercussions of wheat farming, contributed to the 1930s Dust Bowl – a series of dust storms that wreaked havoc on the American and Canadian prairies.⁴⁶ Thus, as a result of WWI, America underwent an agricultural boom that then provided the conditions for the ecological disaster it would soon face.

While North America provided Britain with its needed carbohydrates, demands for protein were met in South America, particularly Argentina. Due to the rapid growth and industrialization in the mid-nineteenth century, the British Isles reached their environmental limits of beef and thus had to turn to grazing lands in the fertile Argentinian Pampas.⁴⁷ With the advent of improved sterilization methods in freezing and canning processes, the Pampas saw an explosive increase in farming and ranching – especially with lower-quality cattle. Because the beef from the Pampas was cheaper, it enjoyed greater popularity with the Entente compared to high-end North American beef.⁴⁸ The high beef demands, as well as for cheap wool from sheep, resulted in even more land being used for grazing. Overgrazing in many areas, especially land of weaker quality, led to severe erosion, raised the risk of devastating fires, and resulted in the infestation of aggressive small trees, *Geoffroea decorticans*.⁴⁹ This resulted in the formation of a monospecific shrubland layer with poor primary productivity.⁵⁰ Nor did Argentina have much option to say no; the country had been under the

⁴⁴ Keller, “The Ecological Edges of Belligerency,” 71.

⁴⁵ Jason L. Ruffing, “A Century of Overproduction in American Agriculture,” MA diss. (University of North Texas, 2014): 19.

⁴⁶ *Ibid.*, 48.

⁴⁷ Keller, “The Ecological Edges of Belligerency,” 72.

⁴⁸ *Ibid.*, 73.

⁴⁹ D. Agesen, “Crisis and Conservation at the End of the World: Sheep Ranching in Argentine Patagonia,” *Environmental Conservation* 27, no. 2 (2000): 211; Osvaldo A. Fernández and Carlos A. Busso, “Arid and semi-arid rangelands: two-thirds of Argentina,” *RALA Report* No. 200 (Reykjavík, Iceland: Agricultural Research Institute, 1999): 50.

⁵⁰ Fernández and Busso, “Arid and semi-arid rangelands,” 50.

financial control of British companies before and during the war.⁵¹ The huge demand for Argentinian meat had converted the once-fertile lands of Patagonia and the Rio de la Plata to unrecognizable terrain; not with shells and explosives, but instead with the collective hunger of an overseas army.

Aside from food, the European powers sought another resource in the Americas: Chilean nitrate. Chile had control of the vast nitrate deposits in the Atacama Desert and possessed a near monopoly over the world's nitrate trade.⁵² As nitrate could be utilized as both a fertilizer and a material to make explosives, it was a crucial resource for any belligerent in the First World War. From 1914 to 1918, Chile exported upwards of 25 million tons of nitrate to the Germans and the Entente.⁵³ However, the process of obtaining the nitrate destroyed the Atacama desert; workers dug holes to map the nitrate deposits and then shattered the deposits with explosives.⁵⁴ After breaking the nitrate into fragments, the miners broke the larger fragments with sledgehammers and collected the “richer” pieces for treatment – smaller pieces were freely discarded as miners believed that nitrate deposits were inexhaustible.⁵⁵ This method of obtaining nitrate harmed the desert environment; regions of desert that were flat and traversable became impassable, and littered with the extensive waste of nitrate mining.⁵⁶ Geographer John Rich, who flew over the nitrate district in 1939, puts it best: “The nitrate district was a sorry spectacle. Most of the plants were truly ‘ghost’ towns, rendered particularly unattractive by the barrenness of their surroundings.”⁵⁷

European powers sourced needed materials not just from the Americas but also from another area of the world that saw little combat: Southeast Asia. In particular, Britain relied heavily on imports of tin from Malaysia – a Crown Colony at the time. Tin was a desirable commodity due to the combination of its malleability, its ability to remain unoxidized in air, and its ability to form strong bonds with iron – these three qualities enabled tin to coat other metals to prevent corrosion.⁵⁸ As well, tin's low toxicity allowed food packagers to make

⁵¹ David Rock, *The British in Argentina Commerce, Settlers and Power, 1800–2000* (Cham, Switzerland: Palgrave Macmillan, 2019): 207, 234.

⁵² Keller, “The Ecological Edges of Belligerency,” 74.

⁵³ R. H. Whitbeck, “Chilean Nitrate and the Nitrogen Revolution,” *Economic Geography* 7, no. 3 (1931): 277. <https://doi.org/10.2307/140893>.

⁵⁴ Keller, “The Ecological Edges of Belligerency,” 74.

⁵⁵ *Ibid.*

⁵⁶ Paul Marr, “Ghosts of the Atacama: The Abandonment of Nitrate Mining in the Tarapacá Region of Chile,” *Middle States Geographer* 40 (2007): 27.

⁵⁷ *Ibid.*, 26.

⁵⁸ Keller, “The Ecological Edges of Belligerency,” 68.

cans with tinplate.⁵⁹ The Allies were then able to use this tin to package the proteins and carbohydrates drawn from the Americas. Malaysia tin was deemed so essential to British wartime operations that the empire made sure to safeguard the Strait of Malacca, which connected the Indian Ocean with the Pacific, and protect its importation routes. Although no battles took place there (Germany primarily focused on securing the North Atlantic), British military presence in the strait demonstrates that acquiring foreign materials was a wartime necessity, and it further exemplified the global reach of the war.⁶⁰

If economic trade hints at the global reach of the war, an environmental lens highlights the damage of the war felt outside the battlefield. In order to increase the speed of tin production, Britain began to employ motorized water pumps for hydraulic sluicing – such methods allowed European enterprises to gain an advantage in the tin market.⁶¹ However, this production method came with an irreparable environmental cost. The action of clear-cutting forests on hillsides to access water sources resulted in extensive soil erosion, exposing the surface to rainfall and subsequently generating large amounts of sediment.⁶² This sediment, transported by surface runoff, polluted rivers with sand clay, which ruined the lives of the locals who depended on the rivers for navigation, fishing, and clean drinking water.⁶³ Furthermore, landslides (which occurred due to soil erosion) covered the once-arable lowlands with debris and grit, pushing Malaysian farmers onto less desirable territories.⁶⁴ The state of the Malaysian environment progressively worsened to the extent that the local authorities attempted to ban and/or place restrictions on the act of hydraulic mining; however, the asymmetrical power relationship between Britain and Malaysia (Malaysia did not achieve independence from the British Empire until 1957) resulted in the extraction of tin continuing without any real opposition.⁶⁵ The intensified metal ore mining for the European wartime industrial efforts had created yet another “wartime landscape,” with some historians claiming that the mining in the Malay peninsula had left more permanent environmental scars than the trench fighting on the Western Front.⁶⁶

⁵⁹ Ibid., 72.

⁶⁰ Ibid., 68.

⁶¹ Ibid., 69.

⁶² G. Balamurugan, “Tin Mining and Sediment Supply in Peninsular Malaysia with Special Reference to the Kelang River Basin,” *Environmentalist* 11 (December 1991): 290, <https://doi.org/10.1007/BF01266561>.

⁶³ Keller, “The Ecological Edges of Belligerency,” 70.

⁶⁴ Ibid.

⁶⁵ Ibid.

⁶⁶ Ibid., 71.

Although more global studies on WWI are emerging, there is still far more to learn and say about the environmental impacts outside of Europe. Indeed, war is primarily associated with battles and soldiers – most of which, during the First World War, were in Europe. However, the process of obtaining the materials needed to set the stage for the European theater of the First World War enables historians to situate the war in a global context, as demonstrated by the environmental damage done in America, Argentina, Chile, and the Malay Peninsula. Moreover, this type of exploration acknowledges the larger machine of war and how dominant European powers – as long as they got the resources they demanded – often cared little about how they impacted territory outside of their own.

Conclusion

The First World War was a detrimental affair to environments all over the world. Whether it was the battlefields of the Western Front, the ecosystems in which proxy wars were fought, or the remnants of nations that were exploited for natural resources, the war left a lasting environmental impact that continues to be felt today. This essay takes a twofold argument: the environmental impact of the First World War was wide-ranging and long-lasting, and looking at the war through an environmental history lens enables us to better grasp the global nature of the war. Also, examining battlefield and non-battlefield environment impacts alongside each other highlights how they accumulated and compounded in ecosystems all over the world. Currently, historians are also increasingly analyzing the First World War through a colonial lens, and future research may enable us to forge a lens that combines colonialism with the environmental impact of WWI. After all, colonialism was an inherent element in many of the examples given above, particularly in Malaysia, Canada, North Rhodesia (Zambia), and even the Middle East could offer similar avenues for analysis (the latter two also being locations of proxy wars). British author H.G. Wells labeled the First World War as the “war to end war” due to the catastrophic damage it caused to armies all over the world. However, as this essay has demonstrated, this same principle should also be applied to the damage that the First World War inflicted on the environment.

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