

A SUFFOCATING NATURE:
ENVIRONMENT, CULTURE, AND GERMAN CHEMICAL WARFARE
ON THE WESTERN FRONT

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ABSTRACT

Ryan Mark Johnson. *A Suffocating Nature: Environment, Culture, and German Chemical Warfare on the Western Front.* (Under the direction of DR. JAY LOCKENOUR)

The story of chemical warfare is that of a relationship between nature, the military, industry, and culture. By the turn of the twentieth century, German industry, especially its chemical companies, came to dominate Europe. Their success brought both considerable economic development and considerable environmental damage from chemical pollution, especially to rivers such as the Rhine and the Emscher. These economic changes made in exchange for landscape degradation conflicted with long-held cultural beliefs in Germany that promoted the beauty of nature and the importance of conserving its aesthetics. The First World War's effect on the environment, including the effects of chemical weaponry, highlighted this paradox on a nationwide scale.

In an effort to win the Great War, German military leaders turned to their chemical industry for answers. Using the flat terrain of Western Europe, winds strong enough to push massive toxic clouds, and their extensive knowledge of chemistry, the Germans chose chemical warfare agents based on meteorological conditions and their ability to overcome the obstacles of trench warfare. Millions of acres were doused in chemical clouds and shells, killing every form of life at the front and all but permanently altering the landscape and soils. This created an atmosphere of total environmental war, where chemicals were intentionally used to contaminate land and kill all life for the sake of military gains. The home front also suffered, as in Germany where the levels of chemical contaminants in their rivers were directly linked to the course of the chemical war. Germans wrote numerous diaries, journals, and memoirs that documented the ecological damage caused by these poisonous agents.

These visceral descriptions of gas warfare and chemical disasters relating to clean up operations helped to solidify a national picture of what the gas war experience was like, and how many Germans came to see warfare and humanity as a destroyer of nature.

Simultaneously, Europeans faced the daunting task of cleaning and repairing their landscapes. Millions of acres of land were contaminated, and tons of chemical ordnance was to be disposed. Yet an antagonistic political climate, steep financial costs, and the German leadership's desire to continue chemical weapons research limited Europeans' ability to restore their land. Their actions resulted in horrific environmental and human consequences, including everything from the contamination of land with buried ordnance to the phosgene cloud catastrophe at Hamburg in 1928. Not only did the damage caused by chemical weaponry force German military officials to rethink military operations and tactics, chemical weapons also compelled the German people to solidify new cultural relationships between war and nature, specifically those which took environmental damage into account when thinking about the war experience. German artistic and written culture at that time reflected the environmental damage through pacifistic and anti-technological lenses, creating a framework where modern environmentalism could take shape.

Ultimately, the use of chemical weapons for military gain shaped German cultural attitudes and changed European landscapes. It ushered in a new form of total war, and demonstrated how the environment directly influenced both the outcome of the chemical war in the field but also German cultural beliefs regarding the relationship between nature and warfare.

For Kate, with all my love

In memory of

Uncle G. Gerald Giblin

and

My Great-Grandfather, Corporal George C. Giblin

Company I, 314th Infantry, American Expeditionary Forces, 1917-1918

Gas victim and recipient of the Purple Heart for wounds sustained

from shell fire in the Argonne Forest, November 2, 1918

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PREFACE

UNFORSEEN CONSEQUENCES

On April 22, 1915, the German army unleashed the first major gas attack of World War I on the French lines at the Second Battle of Ypres.¹ The Germans released 200,000 kilograms of chlorine into the air, forming a deadly yellow-green cloud some thirty to sixty feet high. Propelled by the wind at a rate of five to six miles per hour, the cloud quickly drove the terrified French defenders out of their trenches into full retreat, creating a four mile wide gap in the Allied lines.² In September 1915, the British army retaliated with its own chlorine assault at the Battle of Loos. Although the casualties suffered on both sides were insignificant when compared to the carnage at Verdun or the Somme, the use of poison gas and other toxins changed both the military and environmental landscapes.

Although numerous books on chemical warfare have been published since the end of the First World War, the historian Tim Cook pointed out in 1998 that the topic has “been relegated to the periphery of historical inquiry and understanding by historians.”³ Although more studies have appeared over the last decade or so, few scholars have reexamined chemical warfare’s historical significance. This study approaches the topic of chemical warfare from an environmental perspective of history, adapting a tripartite

¹ Both ironic and coincidental, fifty-five years later on April 22, environmentalists celebrated the first international Earth Day in San Francisco.

² Valerie Adams, *Chemical Warfare, Chemical Disarmament* (Bloomington: Indiana University Press, 1990), 28.

³ Tim Cook, “Creating the Faith: The Canadian Gas Services in the First World War,” *The Journal of Military History*, Vol. 62, No. 4 (October 1998): 755.

model of historical analysis developed by the noted environmental historian Arthur F. McEvoy.

In McEvoy's 1986 study *The Fisherman's Problem* and in a 1988 essay, "Toward an Interactive Theory of Nature and Culture," he postulated that historical environmental changes result from the interaction of three equally important agents: ecology, economy (or what he called "production"), and culture (or what he called "cognition"). According to McEvoy, each of these agents reproduces itself partly according to its own internal logic and partly in reaction to the other two. Ecology, economy, and culture are interconnected. As each one changes, it produces reactions in the other two, which in turn produces counter-reactions. In *The Fisherman's Problem*, McEvoy's study of the California fisheries, he contrasted native fisheries, the fisheries of immigrant Chinese and Italian immigrants in the late nineteenth and early twentieth century, and those of industrial California. Native and immigrant fisheries, McEvoy argued, were less interested in maximizing production than in protecting the stability and longevity of their communities; their resource use, in other words, was embedded in cultural precepts. The intensive resource exploitation of industrial California, McEvoy argued, was also embedded in a new kind of culture - albeit a culture that denied the interconnectedness of ecology, economy, and culture.⁴

War is a form of production. In an industrial economy, capitalists (or the state) direct labor and natural resources to produce commodities and profit. In wartime, the state also directs labor (especially the labor of soldiers) and natural resources to produce

⁴ Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980* (New York: Cambridge University Press, 1986), 6-15; Arthur F. McEvoy, "Toward an Interactive Theory of Nature and Culture: Ecology, Production, and Cognition in the California Fishing Industry," in Donald Worster, ed., *The Ends of the Earth: Perspectives on Modern Environmental History* (Cambridge: Cambridge University Press, 1988), 211-229.

armaments and to win military objectives. In this study, I have substituted war for economic production in McEvoy's model of ecology, production, and cognition. Like the fishing companies McEvoy analyzed, nations and armies used resources according to their cultural understandings. In the First World War, belligerents used chemical weapons towards the "production" of military victories, the seizure of resources and terrain (stocks), and the inflicting of casualties on enemy forces (elimination of the competition). Chemical weaponry thereby elevated the levels of destructive behavior at the expense of nature to unprecedented, total heights. Like the fisherman's use of sonar or larger nets, the use of chemical weapons by militaries was a technological solution to profitability at the environment's expense. As was the case with legislative efforts to promote conservation in California, only after the mutual recognition of environmental (including anthropocentric) devastation did governments and public opinion step in to curb chemical weapon usage through legal and cultural means.

Based on this model of environment, culture, and war, this dissertation is an attempt to answer three fundamental questions. First, what was the environmental impact of chemical warfare on the landscape? Indeed, one may logically conclude that hazardous chemicals are a negative influence on the natural world, but the environmental impact of chemical weapons on the ecosystems of Western Europe is a far more complex problem. Chemical warfare produced both short and long term consequences, some of which still remain with us to this day.

More than any other weapon in a military's arsenal, chemical weapons depend on environmental conditions for their success. For example, vesicant toxins like mustard gas or poison gas clouds of chlorine react differently depending on topographical and

meteorological conditions. The wind was the single most important factor when it came to chemical weapon deployment. It was the gas weapon's propulsion and control mechanism, as once the cloud was formed or the shell was fired, there was little people could do to redirect the incoming gas. Temperature and precipitation could also dictate the state of certain toxins when released. The presence of moisture in the atmosphere also played a vital factor, as hydrolysis would dilute the poison cloud's toxicity. Thus, it is nature that determines a chemical weapon's potency and effectiveness.

An analysis examining the environmental consequences of chemical warfare has yet to be composed. This is for good reason, as Richard Tucker noted in 2004 that "it is very difficult to assess the immediate environmental impact [of chemical warfare] because no one tried to record or measure it."⁵ With this in mind, the first goal of this work is to work towards filling this important historiographical gap in the history of war and the environment.

The second question I seek to answer is whether or not Europeans, especially Germans, recognized and adapted to the environmental devastation around them caused by chemical weapons. Millions of soldiers on both sides of the conflict experienced first-hand poison gas attacks. Aside from the immediate damage to the landscape, evidence of the long-term consequences includes documentation of the effects on species' depletion rates, the contamination of rivers and fields, health risks and consequences of Europeans living in proximity to these weapons, and the amount of chemical stockpiles that remain active in the ground. The physical damage they witnessed was recorded in diaries,

⁵ Richard P. Tucker, "The Impact of Warfare on the Natural World: A Historical Survey," in Richard P. Tucker and Edmund Russell, eds. *Natural Enemy, Natural Ally: Toward an Environmental History of Warfare* (Corvallis: Oregon State University Press, 2004), 29.

memoirs, and reports, which has enabled me to piece together the environmental price European's paid for their new toxic arsenals. In addition, the recognition by military leaders of nature's role in chemical warfare heavily influenced German decision making regarding gas throughout the war.

Lastly, did the use of chemical weapons and the war alter or enhance German cultural perceptions of the environment? I argue that perceptions of the environment in Germany fundamentally changed during the First World War, due in part to the experiences of chemical weapons the men endured at the front. Prior to the war, environmental conservation and protection had not yet become a national political issue in Germany. Although chemical pollution, deforestation, and wasteful mining practices from industrialization had already become serious social concerns among Germans by 1914, the needs of the German military and political pressure suppressed any environmental considerations during the conflict. Yet after experiencing the devastating effects of warfare, German proto-environmental movements experienced a surge in popularity and finally achieved national political attention during the postwar years.

I argue that there are two reasons for this shift. First, millions of Germans experienced first hand the unique, lasting environmental damage caused by the production and use of chemical agents. This was true for those who were in the trenches, but also those who lived near Germany's chemical plants. The levels of pollution in the water increased with the onset of chemical weapon production and, as archival evidence shows, the types of chemicals that contaminated the water were directly linked to the types of poison gases the factories manufactured. Observations at the front and in

Germany, I would also argue, cultivated a set of collective social beliefs concerning warfare and the environment.

Second, in an effort to break the stalemate of trench warfare and achieve victory German military and political leaders during the war rejected their native cultural traditions and beliefs concerning environmental protection and conservation by using chemical weapons. In fact, the very selection of these weapons was due largely to environmental factors taken into account by the military. The flat terrain of Northeastern France and Western Belgium, areas which witnessed the carnage of the Somme, Verdun, and Ypres battles, translated into ideal poison gas cloud country, as the weather and topographical conditions were such that poison cloud attacks were not only possible but effective. After the war, the expansion of German environmental groups in the 1920s and passage of the first national environmental protection laws were due in part to a renewed recognition of nature's fragility by Germans during the First World War. The war was a catalyst for change. Due to poison gas' ability to annihilate virtually all organic life at the front, I would argue that for the Germans chemical weapon production and usage was the most visible and psychologically influential form of environmental destruction levied by the war. For most, the destruction was an overwhelmingly negative experience. However, some of the participants, especially those involved in the lucrative post-war pesticide industry, saw the usage and discoveries associated with chemical warfare as a beneficial opportunity. I will examine how these environmental consequences shaped military and cultural attitudes regarding toxic arsenals and the environment after the Great War.

This project lies between two historiographies: military history and environmental history. The vast majority of early works on chemical warfare focus on military and

cultural aspects. For example, soon after the Great War, a British army officer named Victor Lefebure published *The Riddle of the Rhine: Chemical Strategy in Peace and War*. Lefebure's book was one of the first accounts of chemical warfare during World War I, as it examined the various chemical organizations on both sides and the major military engagements that involved chemical weapons. Unfortunately, the book is not an objective account. Frequently criticizing German chemical activities and industries, Lefebure repeatedly argued that Germany should hand over their chemical manufacturing secrets to the Allies. According to Lefebure, Germany's chemical policy "remains a serious menace" and to not pursue German chemical manufacturing secrets would threaten global peace.⁶ Though the book is poor in terms of quality, the author did highlight a key cultural debate which has been an integral part of all chemical warfare studies to the present: are chemical weapons humane or barbarous? Lefebure argued against the assertion that chemical weapons are uniquely inhumane or barbaric, as the death rates inflicted by gas were far less than those of bullets or artillery.⁷ Other works by veterans appeared throughout the 1920s and 1930s, each following a similar formula of describing

⁶ Regarding the perceived threat to global peace, Lefebure discussed the Haber-Bosch process, a method used by the Germans to boost nitrates production and thereby explosives production. Though a valuable, patented German trade secret, Lefebure wrote "our neglect to use the Treaty [of Versailles] to remove the monopoly [on the process] is a direct menace to peace." Furthermore, to believe that the process is more for peaceful means to create fertilizers "is to threaten the greater ideal of world peace." In truth, Lefebure seemed to want to shut down German chemical plants and acquire the process for reasons other than global harmony; in 1919 he became an employee of the British Dyestuffs Corporation, and knew the secret process could be quite profitable. Disarmament would also weaken German chemical output, providing a greater niche for British chemical firms to fill. Victor Lefebure, *The Riddle of the Rhine: Chemical Strategy in Peace and War* (New York: The Chemical Foundation, Inc. 1923), 214; 244.

⁷ Ibid, 240-241.

the military implications of poison gas and a subsequent argument on the morality of chemical warfare.⁸

Since Lefebure, scholars published little more on World War I chemical warfare until the 1980s. In 1986, the first modern definitive work on the subject was published, L.F. Haber's *The Poisonous Cloud: Chemical Warfare in the First World War*.⁹ The author was the son of Nobel Prize Laureate Fritz Haber, head of the Kaiser Wilhelm Institute (later renamed the Max Planck Society) and leader of Germany's chemical weapons program during the First World War. Unimpressed with Lefebure's biased work (Haber called it "a badly written book"), Haber took a break from writing economic histories and chose to write a new study on the subject of poison gas.¹⁰

Haber's endeavor was a success, so much so that his text remains the definitive scholarly work on World War I chemical warfare. The work is well researched and updated with previously unpublished sources. Despite the benefit of time and his personal connection to the subject matter, Haber's study dealt largely with the same themes as Lefebure's text: the military and moral aspects of the gas war. Haber concluded that chemical warfare was ineffective, and that "gas was a failure."¹¹

Since Haber's landmark work, scholars continued to publish periodically general histories of chemical warfare of varying quality. In 1996, two valuable studies appeared:

⁸ See for example Rudolf Hanslian, *Der chemische Krieg* (Berlin: E.S. Mittler & Sohn, 1927); Hermann Geyer, "Der Gaskrieg," in Max Schwarte, ed. *Der große Krieg 1914-1918, Vierter Band* (Leipzig: Johann Ambrosius Barth, 1922); Charles H. Foulkes, *Gas! The Story of the Special Brigade* (Edinburgh: William Blackwood & Sons Ltd., 1934).

⁹ L.F. Haber, *The Poisonous Cloud: Chemical Warfare in the First World War* (Oxford: Clarendon Press, 1986).

¹⁰ Haber, *Poisonous Cloud*, 1.

¹¹ *Ibid*, 277.

Dieter Martinetz's *Der Gaskrieg 1914/18* and Oliver Lepick's *La Grande Guerre chimique, 1914-1918*.¹² Relying on a variety of sources from multiple languages, especially German archival material, Martinetz's brief but deeply researched and technical study provides an outstanding general history on the subject, especially those looking for a more transnational approach to the material.¹³ Lepick's work also provides an excellent transnational overview of the chemical war, using a variety of different archival resources from both sides. Unlike Haber and Martinetz, Lepick utilized French archival materials, providing a French perspective that is otherwise largely glossed over in Haber and Martinez's studies. The two works are perhaps the two best surveys on the subject since Haber's seminal work, though historians have noted each have their weaknesses.¹⁴

Placing Martinetz's and Lepick's works aside, however, since Haber's text research on the subject slowly began to focus largely on national histories or biographies

¹² Dieter Martinetz, *Der Gaskrieg 1914/18: Entwicklung, Herstellung und Einsatz chemischer Kampfstoffe, Das Zusammenwirken von militärischer Führung, Wissenschaft und Industrie* (Bonn: Bernard & Graefe Verlag, 1996); Olivier Lepick, *La Grande Guerre chimique: 1914-1918*, 2e ed. (Paris: Presses Universitaires de France, 1998).

¹³ The book also contains valuable technological and statistical data on the wartime chemicals. Martinetz, *Der Gaskrieg 1914/18*. For other worthwhile general histories of chemical warfare, see Edward M. Spiers, *Chemical Warfare* (Urbana: University of Illinois Press, 1986), Robert Harris and Jeremy Paxman, *A Higher Form of Killing: The Secret History of Chemical and Biological Warfare* (New York: Random House, 2002), and Jonathan B. Tucker, *War of Nerves: Chemical Warfare from World War I to Al-Qaeda* (New York: Pantheon Books, 2006).

¹⁴ In his 2002 review of recent chemical warfare studies, historian Jeffrey Allan Johnson praised Martinetz's use of East German industrial archival material from the Landesarchiv in Merseburg and the book's analysis of mustard gas production, but noted the absence of primary documentation from corporate archives. With regards to Lepick, Johnson noted that "As a trained historian, Lepick's work reflects solid research and critical analysis." Johnson praised the work for its French perspective, noting that that is "the best examination to date" of the French origins of chemical warfare and their use of non-lethal agents in 1914. Johnson also remarked, however, that disappointingly Lepick offered little in terms of describing French and British use of gas during their final offensives of the war. Jeffrey Allan Johnson, "Chemical Warfare in the Great War: Essay Review" (featuring Albert Palazzo, *Seeking Victory on the Western Front: The British Army and Chemical Warfare in World War I* (Lincoln: University of Nebraska Press, 2000)), *Minerva*, Volume 40, Issue 1 (1 March 2002): 96-98.

of the principle historical agents. In terms of national histories, Britain has seen a recent wave of national chemical warfare books over the last twenty years, including works by Donald Richter and Albert Palazzo.¹⁵ One of the most recent studies on World War I gas warfare is historian Albert Palazzo's *Seeking Victory on the Western Front: The British Army and Chemical Warfare in World War I*. The work relied solely on English language sources and primarily described the military aspects of the war from a British perspective. Unlike Haber, Palazzo argued that chemical warfare made "a significant contribution to the eventual British victory in 1918."¹⁶ Additionally, multiple biographies of Fritz Haber, both popular and scholarly, have recently appeared that provide a more detailed picture of the German chemist and the German chemical weapons program he supervised.¹⁷

During the last twenty-five years, current political events have also influenced scholars' approach to chemical warfare. For example, just prior to the end of the Cold War, British defense specialist Valerie Adams examined NATO and Soviet chemical weapons policy in her 1990 work, *Chemical Warfare, Chemical Disarmament*. The text

¹⁵ Donald Richter, *Chemical Soldiers: British Gas Warfare in World War I* (Lawrence: University Press of Kansas, 1992); Albert Palazzo, *Seeking Victory on the Western Front: The British Army & Chemical Warfare in World War I* (Lincoln: University of Nebraska Press, 2000).

¹⁶ Palazzo, *Seeking Victory on the Western Front*, 2. For a look at the Canadian gas warfare experience, see Tim Cook's excellent work, *No Place to Run: The Canadian Corps and Gas Warfare in the First World War* (Vancouver: University of British Columbia Press, 2000).

¹⁷ Although L.F. Haber correctly proclaimed that no quality biographies of Fritz Haber existed in 1986, three studies have been recently published that fill this gap. See Daniel Charles, *Master Mind: The Rise and Fall of Fritz Haber, the Nobel Laureate Who Launched the Age of Chemical Warfare* (New York: HarperCollins, 2005), Dietrich Stoltzenberg, *Fritz Haber: Chemiker, Nobelpriesträger, Deutscher, Jude: Eine Biographie* (Weinheim: VCH Verlag GMBH, 1994), and Margit Szöllösi-Janze, *Fritz Haber 1868-1934: Eine Biographie* (München: C.H. Beck, 1998). Though voluminous, of the three Szöllösi-Janze's work is the most comprehensive and worthwhile. Other chemists linked to Germany's chemical warfare program have also received biographies, such as Hans-Georg Bartel and Rudolf P Huebener, *Walther Nernst: Pioneer of Physics and Chemistry* (London: World Scientific, 2007).

is largely a political, diplomatic, and military history of chemical warfare, and only the first two chapters provided analysis of the World War I era. The text concluded with a series of now dated suggestions for Soviet chemical disarmament.¹⁸

More recently, the rise of Islamic extremism, as well as the subsequent political and military responses by Western governments, has perpetuated scholarly interest in chemical warfare. One recent example is Jonathan B. Tucker's 2006 work, *War of Nerves: Chemical Warfare from World War I to Al-Qaida*. Similar to Adams' analysis with respect to its brief treatment of the subject, Tucker's work only devoted one chapter to the First World War. No mention is made concerning the storage, disposal, or environmental effects of these weapons.

While these works all discussed the medical effects of chemical weapons on people, none of these studies described the environmental impact of these toxins. However, over the past thirty years several scholars have examined broadly the effect (or potential affects) war has on the natural world. Early scholarship by Arthur Westing and Knut Krusewitz examined just such topics, helping to define the concept of environmental destruction, either intended or not, by military force and the subsequent global response.¹⁹ While Krusewitz tended to focus on the activities of NATO, as well as the German and American militaries during the Cold War, among the topics Westing

¹⁸ Adams, *Chemical Warfare, Chemical Disarmament*, 1-44.

¹⁹ Knut Krusewitz, *Umweltkrieg: Militär, Ökologie und Gesellschaft* (Königstein/Ts.: Athenäum Verlag GmbH, 1985), Arthur Westing, *Environmental Hazards of War: Releasing Dangerous Forces in an Industrialized World* (London: Sage Publications, 1990).

examined were the hazards posed by attacks on nuclear or chemical facilities and the potential subsequent environmental destruction.²⁰

Despite these works, few studies specifically focus on chemical warfare's effects on the environment. Recent scholarship in environmental history, especially the work of Edmund Russell and Richard Tucker, has touched upon this gap in scholarship. Chapters in Russell's *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* and Russell and Tucker's *Natural Enemy, Natural Ally* both briefly analyzed the effects of poison gas on non-human species.²¹ While Russell's work examined the relationship between gas, insects and humans, his work overlooked the broader ecosystems of Western Europe. Tucker examined the impact war had on European forests, specifically how their depletion resulted largely from an insatiable need for lumber by the belligerents during wartime.²²

There are also valuable studies on the use of chemical defoliants in warfare and their ecological impact, notably studies by Arthur Westing and David Zierler that focus on the American use of dioxins such as Agent Orange during the Vietnam conflict.²³ Zierler's work examined the American military's action of intentionally destroying

²⁰ See for example Susan D. Lanier-Graham, *The Ecology of War: Environmental Impacts of Weaponry and Warfare* (New York: Walker and Company, 1993) and J.P. Robinson, *The Effects of Weapons on Ecosystems* (Oxford: Pergamon, 1979).

²¹ Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge: Cambridge University Press, 2001); Richard P. Tucker and Edmund Russell, eds. *Natural Enemy, Natural Ally: Toward an Environmental History of Warfare* (Corvallis: Oregon State University Press, 2004).

²² Richard P. Tucker, "The World Wars and the Globalization of the Timber Industry," in Tucker and Russell, eds. *Natural Enemy, Natural Ally*, 110-141.

²³ Arthur Westing, *Herbicides in War: The Long-term Ecological and Human Consequences* (London: Taylor and Francis, 1984); David Zierler, *The Invention of Ecocide: Agent Orange, Vietnam, and the Scientists who Changed the Way we Think about the Environment* (Athens: The University of Georgia Press, 2011).

Vietnamese landscapes with chemicals for the purpose of military gains, known as Operation Ranch Hand. Rather than the devastation of the atomic bombs during World War II, Zierler stated the environmental damage of herbicides to the terrain in Vietnam was “more visually and ecologically akin to” those of the fields in France during World War I.²⁴ In 1970, the American biologist Arthur W. Galston coined the term “ecocide” to protest and describe the policies, actions, and effects of Operation Ranch Hand.²⁵ I argue that German chemical warfare during World War I demonstrated some similar characteristics to that of Agent Orange usage by American forces during the Vietnam War. Among the most obvious similarities is the targeting of non-human organisms with chemicals for military gain during wartime. In Vietnam, the Americans targeted rainforests with Agent Orange; in World War I, both sides deployed gas with the intention of killing horses or killing vermin. Additionally, both wars witnessed the research and development of vehicles and delivery systems to spray chemical agents over wide areas and the deployment of chemicals to either destroy entire battlefields or at least render them unusable by the enemy. In that sense, the chemical warfare of World War I served as an important foundation to the technological, environmental, and military doctrines of chemical warfare in future conflicts.

In addition, the last decade witnessed the emergence of legal scholarship dealing with the consequences of war and the environment. Specifically, works by Kurt Martin Höchner, Jurgen Brauer, Barry Kellman, and others have examined international law and

²⁴ Zierler, *Invention of Ecocide*, 27.

²⁵ *Ibid*, 15.

the legal ramifications of war's impact on nature.²⁶ However, none of these works examine the First World War, focusing instead the more recent conflicts in Vietnam and later the Persian Gulf. These studies also limit their discussions on traditional chemical warfare in lieu of herbicides such as Agent Orange in Vietnam, the burning of oil facilities by Saddam Hussein's forces during Operation Desert Storm, and the use and potential fallout of nuclear weapons. There are also works that examined the dismantling and cleaning up chemical weapon waste sites during the twentieth century, but these works do not closely examine the cultural impact of the chemical war.²⁷ Tucker and Russell's work aside, there exists little scholarship on the history of war and the environment.

With respect to environmental histories that focus on France or Germany, the subject remains surprisingly underexplored. In a German context, only recently have a few scholars analyzed the role the environment played during the course of Germany's formation, course of modernity, and present standing as a dominant European power.²⁸ The reunification of Germany in 1990 gave historians the chance to finally access East

²⁶ Kurt Martin Höchner, *Schutz der Umwelt im Kriegsrecht* (Dissertation, Universität Zürich: Schulthess Polygraphischer Verlag AG, 1977), Jürgen Brauer, *War and Nature: The Environmental Consequences of War in a Globalized World* (Lanham: Altamira Press, 2009); For an assessment on the legal ramifications for environmental damage, see Barry Kellman, "The Chemical Weapon's Convention: A Verification and Enforcement Model for Determining Legal Responsibility for Environmental Harm Caused by War," in Jay E. Austin and Carl E. Bruch, eds. *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives* (Cambridge: Cambridge University Press, 2000), 579-601.

²⁷ See for example Thomas Stock and Karlheinz Lohs, eds. *The Challenge of Old Chemical Munitions and Toxic Armament Wastes* (Oxford: Oxford University Press, 1997).

²⁸ See Mark Cioc, *The Rhine: An Eco-biography, 1815-2000* (Seattle: University of Washington Press, 2006) or David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: W. W. Norton & Company, 2006).

German archives and fill in valuable gaps within German history.²⁹ This, coupled with renewed interest in the Third Reich generated by the *Historikerstreit* and political gains by the Green Party in the Bundestag, led to an increase in German environmental history publications. For example, Raymond H. Dominick's 1992 study, *The Environmental Movement in Germany*, analyzed environmental conservation efforts between 1871 and 1971. Prior to World War I, the Germans were not only grappling with the growing threat of pollution and its consequences, but also forming national conservation groups that pushed for environmental control and preservation. Yet these ideas were not widely held by those in power, nor were these groups uniform in their environmental attitudes. Indeed, over the last twenty-five years the amount of scholarship that deals with German environmental history has rapidly increased, however, the military aspects of German environmental development have for the most part remained unexplored.³⁰ I therefore see my dissertation helping to fill significant gaps in both military and environmental history.

The first chapter describes the background of chemical warfare and proto-environmental thought in Germany prior to World War I. Influenced by Enlightenment thinkers such as Alexander von Humboldt and Johann Wolfgang von Goethe, Germans

²⁹ Historian Raymond H. Dominick believed that the opening of the archives in the East will offer historians fascinating comparisons between East and West German environmental thought. Indeed, there has been a marked increase in German environmental publications. See the preface to Raymond H. Dominick III, *The Environmental Movement in Germany: Prophets and Pioneers, 1871-1971* (Bloomington: University of Indiana Press, 1992), x.

³⁰ There are several important studies examining German history and the environment published in the last twenty-five years. See for example Franz-Josef Brüggemeier and Thomas Rommelspacher, *Besiegte Natur: Geschichte der Umwelt im 19. und 20. Jahrhundert* (Munich: C.H. Beck, 1987); Franz-Josef Brüggemeier and Thomas Rommelspacher, *Blauer Himmel über der Ruhr: Geschichte der Umwelt in Ruhrgebiet 1840-1990* (Essen: Klartext Verlag, 1992); Axel Goodbody, ed. *The Culture of German Environmentalism: Anxieties, Visions, Realities* (New York: Berghahn Books, 2002); Gert Gröning and Joachim Wolschke-Bulmahn (eds.) *Naturschutz und Demokratie!?* (Munich: Martin Meidenbauer Verlagsbuchhandlung, 2006); Frank. Uekötter, *The Age of Smoke: Environmental Policy in Germany and the United States, 1880-1970* (Pittsburgh: University of Pittsburgh Press, 2009).

developed a strong cultural sense of environmental awareness and defined the place nature held in German society. Nature was seen as both sacred and beautiful, tied directly to the health of the nation and *Volk*. During the second half of the eighteenth century, Germany unified and industrialized. While industries such as chemical, coal, and steel benefited the nation economically and militarily, they would prove detrimental to environmental health and aesthetics. The growth and success of the German chemical industry especially follows this pattern, as the famous chemical giants Bayer, BASF, and Höchst provided tens of thousands of jobs and substantial wealth for the German people, yet their businesses dumped vast amounts of contaminants to the waterways and landscapes of Germany.

The resulting conflicts between Germans seeking a clean, aesthetically beautiful landscape and industrialists and workers seeking economic gains gave rise to the first environmental groups in Germany, and significant gains were made. For example, green energy production, particularly hydroelectric power, had already begun in Bavaria with the construction of the first hydroelectric dams in Germany. As David Blackbourn noted, Germans applauded “white coal” as “cheap, clean, hygienic, and modern, not like smoky, sooty coal.”³¹ By the turn of the twentieth century, German conservation groups had taken shape, such as the League for Nature Conservation in Bavaria and the Nature Park Society. These groups formed what would come to be known as the *Naturschutz* (defense of nature) movement. The movement failed, however, to gain national political momentum prior to World War I. This was due to a lack of cohesive doctrine by the groups, powerful industrial interests, the belief of nature’s ability to clean itself, and

³¹ Blackbourn, *Conquest of Nature*, 217.

rejection by high-level politicians who fretted over economic constraints. Yet by 1914, there was genuine alarm by many Germans concerning the environmental degradation of the landscape.³² It was these grassroots organizations that would later establish the modern German conservation movement. I would argue that although the Naturschutz movement failed politically at a national level, it did not at the local levels of government. There needed to be a catalyst for national action, and the war would provide just that.

Chapter two provides the reader with a brief narrative history of chemical warfare development, manufacturing, and usage during the First World War. This chapter primarily explores the relationship between how chemical weapons affected military decisions during the conflict and how the environment and German military attitudes helped to shape European's decision to use chemical agents. The reader will become familiar with the general progression of gas deployment during the war, including the trends from irritants, to lethal chlorine, to phosgene, to mustards. Additionally, this chapter provides much of the necessary background information relating to World War I chemical warfare, and how these weapons affected human beings. Key figures, such as Fritz Haber and Charles Foulkes are introduced to the reader, as well as the various chemicals created by the belligerents.

Chapter three seeks to answer several key questions. What were the short term environmental consequences of the chemical deployments? How did these gases affect the European ecosystems on the battlefields? What technologies in gas warfare were created due to environmental conditions? How did weather, soil, or plant life determine which gasses were chosen for deployments? Simply put, the environment shaped the

³² Dominick, *Environmental Movement*, 42-78.

chemical war, and the chemical war reshaped the environment. The chemicals chosen for deployment were selected based on their reactions to the environment. For example, choking agents such as chlorine clouds left miles of devastation at the front, often killing all organic life they encountered. Due to their chemical properties and environmental conditions, the effects of choking agents were short term. The gas simply oxidized, evaporated, or naturally detoxified within minutes.

Liquid, vesicant agents such as mustard gas that stick to surfaces, however, remain a problem for far longer. New technological developments, such as the chemical shell, aggravated the problem of chemical contamination and would prove to be the most significant long term environmental consequence of the chemical war. Shells injected with chemical agents were first employed in 1914. Filled with an irritant, these shells were ineffective due to the high temperatures generated by the shell's high explosive core. In 1915, the temperature problem had been solved and the shells were loaded with lethal agents, including chlorine and phosgene. During the war, the belligerents produced over 66 million chemical shells.³³ Of course, not every shell detonated on impact. These shells instead would bury themselves in the earth upon impact, in some cases preserving their deadly contents for years to come.

Additionally, German military leaders learned that the environmental conditions dictated the decision to use poison gas. For example, on the eve of the German spring offensive in 1918, Erich Ludendorff worried that the weather would prevent the use of gas shells for the offensive, and "the strength and direction [of the wind] were by no

³³ Jonathan P. Tucker, *War of Nerves: Chemical Warfare From World War I to Al-Qaeda* (New York: Pantheon Books, 2006), 20.

means very favorable; indeed, it seemed almost necessary to put off the attack.”³⁴

Although the terrain and weather conditions had always been a variable to military leadership, poison gas added a new, unique variable to military calculation. Ultimately, the needs of war outweigh the needs of natural protection, and both soldier and civilian alike paid the price. As a few historians have noted, entire villages were evacuated due to both intentional and uncontrollable chemical attacks.

The Germans intentionally used chemical agents to kill off dozens of square miles of life, although many Germans cared for the ecosystems of Western and Central Europe. This act seems to contradict long-held cultural beliefs towards nature. When it came to the First World War and environmental considerations, the primacy of German militarism, cultivated in Prussia since the early eighteenth century, trumped nineteenth and early twentieth century environmental concern. With the failure of the Schlieffen Plan (an already dubious undertaking from the beginning), the German government and military lacked a solid strategic plan for the war.³⁵ Therefore, as the historian Isabel Hull argued, the Imperial German army resorted to actions that fit military assumptions and expectations from past conflicts. Under the guise of attaining operational or tactical victory, these actions often became increasingly more extreme and violent as wars

³⁴ Erich Ludendorff, *My War Memories: 1914-1918, Volume II* (London: Hutchinson & Co., 1919), 597-598.

³⁵ In his 2004 study on the Battle of Tannenberg, the historian Dennis Showalter summarized the plan's lack of soundness, concluding that "The Imperial army was given – and accepted – the task of planning for a war which its own calculations suggested might well be so destructive as to be unpredictable, uncontrollable, and ultimately unwinnable. . . The Schlieffen Plan was a sophisticated security blanket." Dennis E. Showalter, *Tannenberg: Clash of Empires, 1914* (Washington, DC: Brassey's, Inc., 2004), 34-35.

dragged on longer.³⁶ The initial decision to use chemical weapons reflected the German's desire to achieve rapid victory through destructive, offensive means. The subsequent environmental devastation was seen as an acceptable sacrifice on the altar of victory; in hindsight, it was both catastrophic for the landscapes of Europe and counterproductive for Germany's military aims.

Chapter four describes the environmental aftermath of the chemical war in Europe. Immediately after the war, Europeans began the long clean-up process of chemical agent disposal. Articles 169 to 172 of the Versailles Treaty forbade Germany from producing or possessing chemical warfare agents. As the battlefields of the Western Front rested in Belgium and France, and given the fact that Germany succumbed to a stubborn, chaotic political climate immediately after the war, the task of battlefield clearing was left primarily to the Allies.

This was no small task. Germany produced almost 100,000 tons of gas weapons during the war, more than the arsenals of Britain, France, and the United States combined.³⁷ The Germans therefore faced the problem of disposing of their now illegal chemical weapons. Yet German attempts at clean-up were poor and lackadaisical, and lead to several deadly accidents. After a fatal explosion in a mustard-gas shell factory, French authorities took over the disposal duties in Germany in 1919. The French fared little better. Their disposal techniques were both sloppy and dangerous. For example, one method was to simply release phosgene canisters in a chimney and allow the gas to

³⁶ Isabel V. Hull, *Absolute Destruction: Military Culture and the Practices of War in Imperial Germany* (Ithaca: Cornell University Press, 2005), 325-326.

³⁷ Haber, *Poisonous Cloud*, 170.

empty into the atmosphere. This led to multiple deaths and severe illnesses, among many other long term consequences.³⁸

Although clean-up operations were a messy, dangerous affair, the damage wrought by these weapons was not enough to stop the German military from continuing their gas warfare program. The Germans conducted gas experiments and manufactured agents in secret installations in Russia. In addition, manufacturing and poison gas recycling facilities were also constructed in Hamburg to process military chemicals. The pursuit of these objectives resulted in significant environmental damage, most noticeably in 1928 when a major chemical accident killed ten people and wiped out almost all organic life in a twelve-mile area in and around Hamburg.

Chapter five demonstrates the cultural impact chemical warfare had in Germany during the war and the Weimar Republic. An analysis of veteran's diaries and memoirs shows an acute awareness of the environmental carnage that resulted from poison gas. Soldiers longed to see their homeland, not just because it was away from the danger of the front, but because they longed for its beauty and familiarity. This is especially true of the Rhine River. Despite the Rhine's high levels of industrial pollution, the waterway nevertheless provided the symbol of Germanic environmental splendor. These emotions also translated into literature and art, where Germans fused their disillusionment with war and that of the environmental catastrophe they witnessed at the front. Noted works such as Erich Remarque's *Im Westen nichts Neues* and Ernst Johannsen's *Fronterinnerungen eines Pferdes* were filled with environmental imagery, fostering the construction of a national memory of the trench warfare environment. The artwork of Otto Dix and others

³⁸ A brief account of these incidents may be found in Ibid, 287. Haber does not elaborate on why such carelessness was used by the French, who themselves had hundreds of thousands of chemical shells both above and buried in their nation's battlefields.

provided veterans and the general public a grotesque, visual impression of the desolation and gloom of a gassed landscape. These emotions and cultural attitudes, I argue, helped to facilitate both a growing pacifism and national proto-environmental movement in Germany after the war. Immediately after the war, Germany saw a sharp increase in the membership among conservation and natural protection groups, as well as the government passed numerous national environmental laws, notably including environmental conservation statutes in the Weimar constitution itself. The new constitutional statute was the first of its kind in Europe, and a message to Germany's people that the environment does matter and is worth preserving. German industry, led in part by Germany's chemical companies, adapted new environmental regulations to curb the water pollution which had for so long stained the Rhine's waters and reputation. Despite the new regulations, however, environmental damage and civilian casualties caused by major chemical accidents and weapons in the 1970s and 1980s continued to plague the country. It seemed that the specter of German gas warfare could not be exorcised by merely passing legislation.

The story of chemical warfare is one of military, ecological, and cultural significance. The use of chemical weapons during World War I and their consequences fundamentally altered German military and cultural perceptions of the environment. Due to their ecological effects and the millions of Germans who witnessed firsthand the destruction levied by the war, notably chemical weapon programs, a new cultural value and awareness of ecological issues manifested in Germany after the war. There are no heroes or villains in this tale *per se*; rather it is a story of Germany coming to terms with two of the most dominant historical agents: war and nature. It is also a story of intentional

actions, actions based on the desire for military victory and economic prosperity, while sacrificing that which was collectively held culturally sacred. It is also a story of cultural progression, where the protection of nature went from a largely abstract and local movement, to that of a concrete social issue on a national level. And as the reader will see, like most environmental histories, the story of chemical warfare, culture and nature is one of unintended consequences.

CHAPTER 1

THE PRICE OF MODERNITY?

The origins of modern German environmentalism can be found during the period of rapid German industrialization during the second half of the nineteenth century. Ideas of nature conservation and protection came from a combination of German, romantic-era ideas concerning the relationship between humanity and nature and the environmental damage caused by the new industrializing world. While many among the middle and upper classes of Germany came to develop an idea of environmental conservation or protection by 1914, the process of developing a nationwide call to action did not develop while Germany was ruled by the Kaiser. This was due to a variety of economic and cultural reasons, notably the state placing economic progress and private interests above environmental concern and the failure of the first German conservation groups to successfully lobby for legislative reform to stop the flow of pollution from Germany's industrial revolution.

The nineteenth century was one of rapid change for Germany. After three major wars with Denmark, Austria, and France, Germany became a united empire in 1871 and between 1880 and 1914, Germany emerged as the premier industrial center in Europe. As a result of industrialization, the German population increased dramatically. Between 1890 and 1914 alone, Germany's population jumped from forty-nine to sixty-five million

people; during the same time period, Britain's population only rose by just seven million, and France's population rose by just one million.¹

Germany's population also migrated to the cities. In 1880, two-thirds of the Germans lived in rural areas, but by 1914 the population became two-thirds urban.² In addition to coal and steel, chemicals became a major business. During the second half of the nineteenth century, the German chemical industry expanded by leaps and bounds. Prior to unification in 1871, Germany relied on Britain for much of their chemical materials. This included most of their tar and soda supplies, which were key ingredients in fertilizers and other products. This compelled many German entrepreneurs and chemists to establish their own chemical production facilities. The majority of these new chemical producers chose to establish their factories in the 1850s and 1860s along Germany's numerous rivers.

The Rhine River and its tributaries, one of Europe's largest water networks and a major artery in international commerce, were ideal locations for chemical production. Large amounts of water were needed for chemical processes and waste removal. The streams also provided inexpensive transportation for exporting products and importing raw materials. It was also profitable and efficient to settle near companies which bought the majority of their products, and it was therefore common to build dye and ammonia plants near existing textile and fertilizer companies.

¹ Paul M. Kennedy, "The First World War and the International Power System," *International Security*, Vol. 9, No. 1 (Summer 1984): 10.

² Thomas M. Lekan, *Imagining the Nation in Nature: Landscape Preservation and German Identity, 1885-1945* (Cambridge: Harvard University Press, 2004), 19.

The rapid growth of European populations and the ever increasing demand by European farmers to feed their populations created an enormous demand for fertilizers. Soda (or sodium carbonate) production in Germany was achieved chiefly through the Solvay process, a technique perfected by the Belgian chemist Ernst Solvay in 1863. The process used brine and limestone to produce the soda. Large-scale production plants for soda opened for the first time in Germany during the 1870s. Coal tar, a key ingredient for nitrogen fertilizers and organic chemistry at that time, was also produced. Chemical factories continued to pop up along the Rhine to meet both domestic and foreign demands. By 1875, there were 512 chemical plants in the Rhineland, plus hundreds more along other sectors of the Rhine.³ To meet food production demands, by 1913 Germany used over 600,000 tons of nitrates on their lands, plus 460,000 tons of ammonium sulfate, a type of salt which reduces the acidity (pH level) of soils.⁴ The success of fertilizer production led to a significant boost in agricultural output in Germany. By the turn of the century, Germany produced 40 million tons of potatoes annually, the equivalent of one ton for every adult in their population.⁵

It was also during the second half of the nineteenth century that Germany's powerful dye manufacturers emerged. While humans used natural dyes to color textiles for centuries, it was not until the mid nineteenth century that the synthetic dye industry emerged. Synthetic dyes were initially invented by the British chemist William Perkin,

³ Marc Cioc, *The Rhine: an Eco-Biography, 1850-2000* (Seattle: University of Washington Press, 2002), 116.

⁴ Paul Hohenberg, *Chemicals in Western Europe: 1850-1914* (Chicago: Rand McNally & Company, 1967), 38-39.

⁵ David Blackbourn, *The Long Nineteenth Century: A History of Germany, 1780-1918* (New York: Oxford University Press, 1998), 315.

who in 1857 developed a synthetic aniline purple.⁶ Although France and Britain were initially the largest producers of dyes by 1860, within the decade Germany emerged as the leader in the European dye industry. Prior to this emergence, Germany had a small dye industry, primarily operating in cooperation with their textile industry. Following the footsteps of Perkin's work in Britain, Jäger of Barmen created the first commercial solid aniline red in 1859. Numerous other dye companies established themselves around 1860. For example, Dahms & Barkowsky of Berlin sold several colors successfully across Europe, including two qualities of aniline purple and three qualities of aniline red.⁷ The German dye industry's meteoric rise in the global chemical business was, as the historian L.F. Haber wrote, "the most important event in the history of the chemical industry in the latter part of the nineteenth century."⁸ It would be the dye industries that would not only produce the majority of explosives used by the German armed forces, but also develop most of the chemical weapons during the First World War. Yet long before the global conflict, the 1860s saw the emergence of three major chemical corporations that significantly changed the German landscape.

In 1861, the Chemische Fabrik Dyckerhoff, Clemm & Company was founded in Ludwigshafen on the banks of the Rhine River. There, the small company produced heavy chemicals and alizarin dye. Three years later, the company was incorporated as the Badische Anilin- und Soda-Fabrik (BASF). Due to high demand for aniline and alizarin dyes, production at BASF surged in a matter of only two decades. German unification

⁶ Anthony S. Travis, *The Rainbow Makers: The Origins of the Synthetic Dyestuffs Industry in Western Europe* (Bethlehem: Lehigh University Press, 1993), 13-14.

⁷ Travis, *The Rainbow Makers*, 74.

⁸ L.F. Haber, *The Chemical Industry during the Nineteenth Century: A Study of the Economic Aspect of Applied Chemistry in Europe and North America* (Oxford: Oxford University Press, 1958), 128.

also boosted the German economy, and new dye discoveries in the 1860s enabled BASF to offer twenty-one different categories of dyes and eighty-one total products by 1874.⁹ Production continued to rapidly increase during the remainder of the century, as BASF alizarin production boosted their profits and expanded their workforce. In 1871, BASF produced a modest fifteen tons of alizarin. By 1902, the company was manufacturing 2,000 tons annually.¹⁰

At the turn of the century, BASF was the largest chemical company in the world. They employed 6,300 workers and one hundred forty-seven chemists, plus additional staff and engineers. The BASF compound consisted of 421 factory buildings with 42.6 kilometers of rail lines. The firm consumed 20 million cubic meters of water and 243,000 tons of coal to run their manufacturing facilities.¹¹

BASF's primary dye industry rival during the nineteenth century was the Höchst Farbwerke vorm. Meister, Lucius, and Brüning, located on the banks of the Main River in central Germany. The chemist Dr. Eugen Lucius, along with two merchants, L. August Müller from Antwerp and C.F. Meister from Manchester, founded the company in 1862 after purchasing the plant site in the small village of Höchst near Frankfurt. One year later, there were a total of five workers and one chemist employed by the firm. During the mid-1860s, Höchst developed a variety of different dyes which led to a rapid expansion of their company. By 1867, the company produced thirty different colors and, like BASF,

⁹ Wolfgang von Hippel, "Becoming a Global Corporation – BASF from 1865 to 1900," in Werner Abelshauser, et al., *German Industry and Global Enterprise, BASF: The History of a Company* (Cambridge: Cambridge University Press, 1994), 23.

¹⁰ Haber, *The Chemical Industry*, 130.

¹¹ Jeffrey Allan Johnson, "The Power of Synthesis (1900-1925)," in Abelshauser, et al., *German Industry*, 116.

produced the highly profitable dye alizarin. Seven years later, the company had grown to 370 workers and a dozen chemists.

Profits from dyestuffs expanded the company's manufacturing capabilities and funded research. Resources for research focused primarily on developing a process for indigo synthesis, which Höchst successfully achieved in 1901. During the 1880s, Höchst began to produce chlorine and bleaching powders. The company also became the first dye company to manufacture pharmaceuticals, as they began production of analgesics and pain relievers in 1888. Between 1888 and 1912, the company's workforce had more than quadrupled from 2,062 to 9,046.¹² Among their successful products was Salvarsan, an arsenic compound developed in labs under the direction of Paul Ehrlich. The new compound was a highly effective treatment for syphilis; so much so that demand for the new drug exceeded Höchst's manufacturing capacity.¹³ During the First World War, the company manufactured large quantities of chlorine gas (which they had already been producing for decades) and also used arsenic compounds for weaponry by filling tens of thousands of chemical weapon shells with arsenical agents. The demands brought on by the war would further expand the workforce at Höchst to 16,000.¹⁴

In addition to BASF and Höchst, the other major chemical company to emerge in Germany at that time was the Farbenfabriken Bayer & Company of Elberfeld and Leverkusen, commonly known simply as Bayer. Originally founded in Barmen by Friedrich Bayer and Johann Westkott in 1861, the company's poor location compelled

¹² Haber, *The Chemical Industry*, 132-133.

¹³ Arthur M. Silverstein, *Paul Ehrlich's Receptor Immunology: The Magnificent Obsession* (San Diego: Academic Press, 2002), 131-132.

¹⁴ "No. 7 Report on Certain Sections of the Höchst Farbwerke vorm Meister, Lucius, and Brüning," February 1919, DSIR 36/1967, The National Archives, London-Kew, United Kingdom, 26-27.

Bayer and Westkott to move the company to the small town of Leverkusen, located roughly seven miles north of Cologne on the eastern bank of the Rhine. Like BASF and Höchst, Bayer quickly profited from the production of alizarin, but the product's overproduction and Bayer's small percentage of the dye market relative to their two rivals soon stymied Bayer's growth.

In 1884, however, the chemist Dr. Carl Duisberg joined Bayer and quickly made a name for himself in the company. Having already earned his Ph.D. in chemistry at Jena under the direction of famed chemist Anton Guether, the twenty-two year old was soon an actor on the European chemical stage. Not long after joining Bayer, Duisberg discovered a new fine red cotton dye, the direct red azo dye benzopurpurine, which was superior to any other at that time. During the 1880s, Duisberg designed Bayer's central research laboratory at Elberfeld. The foundation of the facility was laid in 1889, and in 1891 the laboratory officially opened.¹⁵

Rather than focusing on aniline dyes like BASF and Höchst (both of which Bayer lagged behind), Duisberg convinced Bayer's management to instead shift to pharmaceutical production. In 1888, Bayer developed their first pharmaceutical product, a type of pain killer called Phenacetin. Probably the most significant breakthrough achieved by Bayer occurred when the chemist Felix Hoffmann first developed acetylsalicylic acid, or "aspirin." Using a widespread marketing campaign, thousands of German doctors received aspirin samples and the product's sales and popularity soon took off.¹⁶ Another product also boosted Bayer's sales at the turn of the century. On

¹⁵ Travis, *The Rainbow Makers*, 220-221.

¹⁶ Haber, *The Chemical Industry*, 134-135.

August 21, 1897, just eleven days after his development of aspirin, Hoffmann created another powerful drug called diacetylmorphine. Although Bayer could not patent the mixture (it was already known to science), they did patent the name it would be sold under: “Heroin.” The new product was sold as a cough suppressant, as well as a treatment for depression, bronchitis, asthma, and even stomach cancer.¹⁷

With the success of their dye and budding pharmaceutical industries, Bayer required more land to increase production. In 1891 a large tract of land was purchased in Leverkusen and the company began to move departments sporadically until the outbreak of World War I. By that time, the rectangular-shaped site at Leverkusen was 760 acres, divided into four blocks. The block along the river front contained the manufacturing centers for inorganic raw materials such as hydrochloric, nitric, and sulfuric acids, as well as chlorine, caustic soda and oleum. The wharf along the river ran 1,500 yards (1.4 kilometers).¹⁸ Like BASF and Höchst, a sharp increase in Bayer’s workforce reflected both the commercial success of their industries, as well as German dominance in the field of chemical research. In 1900 Bayer employed 1,000 men. By the outbreak of the war, Bayer employed between 9,000 and 10,000, including 7,900 at the Leverkusen site.¹⁹ By 1912, the company’s headquarters had moved to Leverkusen, and Carl Duisberg served as the company’s Management Board Chairman.²⁰

¹⁷ Marco Evers, “Viel Spaß mit Heroin,” *Der Spiegel*, No. 26 (26 March 2000): 184-185.

¹⁸ “Report of the British Chemical Mission on Chemical Factories of Occupied Area of Germany,” 1919, DSIR 36/1966, National Archives, London-Kew, United Kingdom, 26.

¹⁹ Haber, *The Chemical Industry*, 137.

²⁰ “Becoming an International Company, 1881-1914,” July 2008, <http://www.bayer.com/en/1881-1914.aspx>, accessed 8 June 2010.

On the eve of the First World War, Germany boasted the most powerful chemical industry on the planet. Their volume of production of intermediaries and heavy chemicals was second to none, encompassing a variety of products. By 1913, Germany produced 1.6 million tons of sulfuric acid per year. They produced 375,000 tons of dyes each year.²¹ Such figures and other contributions added up to give Germany control of eighty-five point nine percent (85.9%) of the world's dye market. This percentage is even more astonishing when compared to the dye outputs of three of their future World War I enemies: Great Britain produced only two point five percent (2.5%), the United States just one point eight percent (1.8%), and the French with a paltry point six percent (.6%) of the global market.²² By the start of the war in 1914, Germany was selling chemical products to thirty-three different countries worldwide.²³

Coinciding with the rapid expansion of German manufacturing, industrialization became a double-edged sword in the eyes of many among the public. Indeed, the coal, steel, and chemical industries provided thousands of jobs and strengthened the German economy. Yet air and water pollution rapidly went from an environmental nuisance to an environmental killer. Initially, air pollution was the most visible threat. Superphosphate chemical plants were problematic, as the hydrofluoric acid emissions produced lethal smoke that damaged the local forests. In one plant's case, the fumes extended eight hundred meters away from the smokestacks, almost entirely destroying the nearby

²¹ Cioc, *The Rhine*, 117.

²² Dieter Martinetz, *Der Gaskrieg 1914/18: Entwicklung, Herstellung und Einsatz chemischer Kampfstoffe, Das Zusammenwirken von militärischer Führung, Wissenschaft und Industrie* (Bonn: Bernard & Graefe Verlag, 1996), 12.

²³ See the reprinted speech by Dr. Wm. H. Nichols, "The War and the Chemical Industry," 1915, BSDLF PB A8.6./1, p. 9, Unternehmensarchiv der BASF, Ludwigshafen, Germany.

forest.²⁴ Noxious smoke was also a common byproduct of not just the chemical industry, but also coal and steel manufacturing centers. The burning of coal in steam boilers and later power plants creates sulfur dioxide, the primary ingredient in acid rain. Forests and crops along the Rhine were decimated, and the local inhabitants faced numerous potential health hazards associated with breathing in daily the filthy soot of German industrial growth.²⁵

Although citizens in other nations, especially the United States, organized and vocally protested their grievances en masse, environmental historian Frank Uekötter noted that “the pressure of an organized public was almost completely absent in Germany.”²⁶ While individuals often complained about the smoke, demands were often vague. It was also felt by many officials that to punish only a handful of the offenders was not fair, given there were thousands of factories belching toxic smoke. German industrialists simply chose to remain silent about the problem.²⁷

Yet perhaps more devastating to Germany’s environment was the water pollution generated by German industry, especially from the chemical companies. Chemical pollutants finding paths into waterways was not an exclusively German phenomenon. The dumping of deadly acids and arsenics has already become a problem in France. One of the largest dye firms in France, Renard Frères & Franc of Lyon, was found to be responsible for contaminating rivers and wells with arsenic dumping. The poisoned wells

²⁴ Cioc, *The Rhine*, 121.

²⁵ *Ibid*, 77.

²⁶ Frank Uekötter, *The Age of Smoke: Environmental Policy in Germany and the United States, 1880-1970* (Pittsburgh: University of Pittsburgh Press, 2009), 44.

²⁷ *Ibid*, 47; 59.

were found to have killed residents. In 1864, the problem surfaced again and more died of arsenic poisoning. The company was held responsible and the victim's families were compensated.²⁸ In Britain during the 1860s, Parliament was forced to take action against the "Great Stink," an accurate label given to the Thames River that had become so polluted from industrialization and sewage that it required legal intervention. In 1857, industrial water pollution in the Senne in the area by Brussels caused a massive fish kill.²⁹

While Höchst used the Main River for its waste disposal, the Rhine and its tributaries provided BASF and Bayer with a natural dumping ground for their effluents. Within the Bayer plant complex, for example, numerous wells were dug into the underground stream network underneath the plant. Attached to these wells water works were also constructed, to not only provide fresh water for the plant, but to also provide drinking water for the entire village of Leverkusen. Yet the wells also provided an additional dumping area for waste products that directly fed the Rhine even more refuse.³⁰ All effluents from the plant were deposited into the Rhine without treatment, and no effort was made by the company to cleanse the material. Additionally, the state authorities passed no laws which required wastewater treatment of any kind, so the dumping by the three giant chemical producers was perfectly legal at the time.³¹

It would take foreign intervention to draw national attention to the problem of chemical dumping. In 1876, the Dutch government requested that Germany ban the

²⁸ Travis, *The Rainbow Makers*, 119.

²⁹ Thomas Rommelspacher, "Das natürliche Recht auf Wasserverschmutzung Geschichte des Wassers im 19. Und 20. Jahrhundert," in Franz-Josef Brüggemeier and Thomas Rommelspacher. *Besiegte Natur: Geschichte der Umwelt im 19. Und 20. Jahrhundert* (Munich: C.H. Beck, 1987), 43.

³⁰ "Report of the British Chemical Mission," 1919, DSIR 36/1966, The National Archives, 27.

³¹ Von Hippel, "Becoming a Global Corporation," in Abelshauser, et al., *German Industry*, 78.

dumping of arsenic waste into the North Sea because it posed a threat to fisheries. Although the German ambassador successfully convinced the Dutch that greater inspections of dumping would take place, the Bavarian government informed the German consul that BASF had not dumped any barrels into the sea but rather had been dumping their arsenic acids directly into the Rhine since 1868.³² Rhine dumping continued, and in 1885 the Dutch again contacted the Germans to inquire about legal action to stop the influx of waste into the shared waterway. As the historian Arne Andersen pointed out, even though the discharge of harmful chemical into the Rhine could be forbidden, the Bavarian government “did not even consider enforcing the ban against BASF, Germany’s largest coal tar factory.”³³ The dumping therefore continued unabated.

In 1904, the first major conference on the problem was held by the Ministry of Health to determine the degree of pollution in the Rhine and to establish a water monitoring system. Professor Robert Lauterborn, a zoologist from Heidelberg, stated in his official report on the Rhine that based on the samples he collected and analyzed from an area stretching from Speyer to Worms, there was a “total extermination of life near the points of discharge” by the BASF complex. Though Lauterborn demonstrated scientifically that chemical dumping was damaging the environment, political and economic reasons prevented any action. It was instead decided that more studies were needed to confirm the findings.³⁴

³² Arne Andersen, “Pollution and the Chemical Industry: The Case of the German Dye Industry,” in Ernst Homburg, et al. eds. *The Chemical Industry in Europe, 1815-1914: Industrial Growth, Pollution, and Professionalization* (Dordrecht: Kluwer Academic Publishers, 1998), 186-187.

³³ *Ibid*, 189.

³⁴ *Ibid*, 196-198.

The chemical industries, however, were not the only offenders. Recent scholarship by the historians Marc Cioc and Franz-Josef Brüggemeier have chronicled the devastation the coal and steel industries levied on western Germany, in particular the Rhine river and three of its tributaries, the Emscher, the Wupper, and the Ruhr rivers. Located downriver from BASF and Bayer, the once small, rural population of the Ruhr was quickly transformed into an urban industrial center during the mid-nineteenth century. The steel and coal industries were the primary vehicles of this transformation, as the Ruhr's industrial sector provided employment for eighty percent of the working population.³⁵ The Krupp Works in Essen, for example, employed 30,000 workers, and was one of several companies which triggered a massive migration of rural Germans to the cities in search of employment. The total population in the Ruhr numbered some 3 million people by 1914.³⁶

Prior to the chemical industry developments of the 1860s, the coal and steel industries had already made significant changes to the landscape. Steel and coal companies consumed vast amounts of land for mines and production facilities. Large amounts of water were needed for cleaning and production techniques and no regulations existed to curb pollution or degradation to the landscape. By 1913, miners extracted 113 million tons of coal each year in the Ruhr.³⁷

For Krupp and the other major steel and coal industries, the Ruhr and the Emscher Rivers provided the water and dumping ground for a variety of industrial wastes. Water

³⁵ David F. Crew, *Town in the Ruhr: A Social History of Bochum, 1860-1914* (New York: Columbia University Press, 1979), 13.

³⁶ Franz-Josef Brüggemeier, "A Nature Fit for Industry: The Environmental History of the Ruhr Basin, 1840-1990," *Environmental History Review* (Spring 1994): 36.

³⁷ Cioc, *The Rhine*, 83.

was used to wash coal, which was then dumped untreated into the rivers. Flooded mines were also pumped, depositing more sediment, slate, bits of coal, and sludge-filled wastewater into the waterways. For every ton of coal harvested, 1,700 liters of “mine water” were pumped out.³⁸ Each ton of coal overall consumed 3,000 liters of water to process, and the Krupp works used the amount of water comparable to a city of 300,000 residents. Indeed, by the end of the century, water consumption had become a genuine concern. Yet little was done to stop the dumping, only to accelerate the flow of the streams with the hope that the faster the muck moved, the quicker the Rhine could carry it away.³⁹ This led to companies lining their nearby canals with concrete in an effort to streamline the moving waste. Human sewage from local towns and cities was also redirected into the tributaries, which were converted into similar concrete-lined, open-air sewer systems. The combination of human and industrial waste converted the rivers into a black, disease-filled sludge canals.⁴⁰

Water consumption and pollution also took its toll on drinking water supplies, causing water shortages. In an effort to provide enough water and to save money, some of the water works in the Ruhr simply directed the polluted water into the faucets of their residents. In some cases, for example, in 1901 the water works in Gelsenkirchen pumped unfiltered water from the Ruhr into the drinking water pipes. The polluted water caused a typhoid outbreak, killing some 500 people. Other water works likewise injected

³⁸ Ibid, 90.

³⁹ Ibid, 88.

⁴⁰ Brüggemeier, “A Nature Fit for Industry,” 37.

contaminated water into their supplies as well to save money, including a facility by the city of Duisburg.⁴¹

The inevitable toxic agents created by chemical processes in the chemical industry were taking a visible toll on the environment, and the problem only became worse as the German chemical business expanded during the second half of the nineteenth century. At first, complaints from the public derived from the air pollution, for example gasses emitted during the production of sodas. Later, complaints about water quality began to increase concurrently with the increase in aniline dye production. Sizeable amounts of arsenic acid were required to produce various color dyes. For example, one hundred kilograms of pure crystal fuchsine (a shade of magenta) required one thousand kilograms of arsenic acid. After production, six hundred kilograms of the arsenic acid was unrecoverable and dumped directly into the Rhine.⁴² The storage of waste products also became a problem. In the early 1860s, Bayer stored arsenic waste in barrels on site. Over time the barrels cracked and leaked the arsenic into the ground, contaminating nearby wells.⁴³

Another problematic waste product was phenol, a byproduct of coke and coal-tar production. Phenol's stench was well known among the residents of the Ruhr region, as industries dumped 6,000 metric tons per year directly into the water. Phenol caused serious problems with the local fishermen and ruined their harvests. Fish such as salmon

⁴¹ Franz Josef Brüggemeier and Thomas Rommelspacher, *Blauer Himmel über der Ruhr: Geschichte der Umwelt in Ruhrgebiet 1840-1990* (Essen: Klartext Verlag, 1992), 93. Rommelspacher, "Das natürliche Recht auf Wasserverschmutzung Geschichte des Wassers im 19. und 20. Jahrhundert," 55.

⁴² Cioc, *The Rhine*, 121; von Hippel, "Becoming a Global Corporation – BASF from 1865 to 1900," in Werner Abelshauser, et al. *German Industry and Global Enterprise, BASF: The History of a Company* (Cambridge: Cambridge University Press, 2004), 76.

⁴³ Cioc, *The Rhine*, 122.

and eel absorbed phenol into their bodies, contaminating their meat and rendering the catch inedible.⁴⁴ The wasteful practice also hurt the German coking plants from a financial perspective, because phenol did have commercial value. Already by that point, phenol was being marketed in the medical industry as an antiseptic under the name “carbolic acid.” Between 1865 and 1867, the substance became the subject of the groundbreaking work of famed British physician Joseph Lister. Lister used carbolic acid to great effect in the prevention of infection on a series of compound fracture and amputation patients, conditions notorious for septic complications at that time. In Germany, doctors were well aware of Lister and his discoveries. Many of Germany’s most famous physicians, including Ernst von Bergmann, Richard von Volkmann, and Johann Nepomuk von Nussbaum, praised or adopted Lister’s sterilization techniques.⁴⁵ In the end, the wasteful dumping of phenol was pernicious to both the people and the environments involved.

Although citizens did complain to authorities, local government leaders were slow to react to these complaints. City officials in places like Ludwigshafen and Leverkusen were reluctant to attack the companies that employed a sizeable percentage of their residents. In the Ruhr region, where agriculture was extremely difficult due to poor soil, the chemical, coal, and steel industries were the primary employers. Licenses were needed to construct new factories, however authorities rarely denied applications as many still believed that industrial wastes were seldom dangerous to the health of human beings. In addition, the sight of chimneys on the horizon was seen to some as the path to a

⁴⁴ Ibid, 97.

⁴⁵ Zachary Cope, “Joseph Lister 1827-1912,” *The British Medical Journal*, Vol. 2, No. 5543 (1 April 1967): 7-8.

positive future. In his two volume work on the Rhine, University of Bonn Professor F. W. Hacklander wrote that the Rhine had “passed through the impetuous days of its boyhood and youth, and has settled down into a busy domesticated condition, content to look after the rye and the wheat, to be interested in the increase in the lofty smoking chimneys and the clattering railway trains, and to remark with satisfaction the growth of the shipping before the wealthy and busy commercial towns. . .we look around us with astonishment on finding the whole landscape completely changed, as if by the touch of a magic wand.”⁴⁶ Trading progress for pollution, many thought, was a fair deal.

Yet local investigations did occasionally occur and companies made efforts to monitor their pollution output. In 1867, BASF permitted investigators to inspect waste disposal practices in the plant. Although objections were made about the poor storage of arsenic residues, no objections were made about the direct dumping of acidic chlorine-manganese solutions into the Rhine. Despite the findings of the investigators, no restrictions were imposed at that time.⁴⁷

The Reich government was also slow to impose environmental controls on the nation’s waterways. In fact, the legislative steps taken by the government actually accelerated the ecological damage caused by pollution. For example, in 1904, the Reichstag passed the Emscher Cooperative Act. The act was designed to organize the Emscher Valley’s water suppliers and users in an effort to manage the water systems at a local level. The newly formed committees decided how water would be appropriated among the local leaders, with no direct intervention or oversight from Berlin. This meant

⁴⁶ F.W. Hacklander, “Holy Cologne,” in Karl Steiler, et al. *The Rhine: From its Source to the Sea, Volume II*, Translated by G.C.T. Bartley (Philadelphia: Henry T. Coates & Company, 1899), 219.

⁴⁷ Wolfgang von Hippel, “Becoming a Global Corporation,” 77.

local leaders, many of whom had vested interest in major industry, were left to their own discretion when it came to water policy. In sum, the Reich gave the industrialists permission to use the streams and rivers however they saw fit.⁴⁸

Fully aware of their state sanctioned freedom, German industry continued to negligently dispose of their wastes at will. Long before government efforts to curb dumping were passed, the toxins dumped into the water had already discolored the Rhine River, creating a band of color twelve to fifteen meters wide. By 1892, the discoloration stretched six kilometers downriver. BASF increased its dumping under the assumption that the disposal was free, legal, and had no serious effect on the fish or human populations. Between 1892 and 1902, the amount of waste deposited into the Rhine almost tripled, from 300 to 870 liters per second. In other words, the total amount of toxic substances BASF dumped into the Rhine by 1902 was 75,168,000 liters *per day*. The rapid loss of vegetation in and along the river led to the first biological tests being conducted on the water, which confirmed the devastating impact of the waste on the Rhine ecosystem.⁴⁹ Fish populations also suffered largely due to the ever increasing levels of toxins in the water. In 1885, the annual salmon catch was 200,000. By 1905, the total was down to less than 100,000.⁵⁰

Yet it was not just the Rhine that endured chemical dumping. Other rivers and the Rhine's tributaries also became dumping sites. Bayer chemical factories along the Wupper River disposed of their wastes through ninety-five separate drainage pipes that

⁴⁸Cioc, *The Rhine*, 81-82.

⁴⁹ Von Hippel, "Becoming a Global Corporation," in Abelshauser, et al., *German Industry*, 78.

⁵⁰ Marc Cioc, "The Political Ecology of the Rhine," in Christof Mauch, ed. *Nature in German History* (New York: Berghahn Books, 2004), 41.

deposited a continuous flow of dye and acid waste, killing any life in the river.

Metallurgical industries along the Müglitz near Dresden dumped lead oxide into the rivers, turning the water red. Fish populations were wiped out and land wildlife that relied on the river for sustenance died of lead poisoning.⁵¹

Such rampant and unimpeded dumping practices also sickened many of the local human populations. Medical issues were common among those working in the factories, as dye work was extremely hazardous to health. For example, Höchst's main product during the 1870s and 1880s was the synthetic dye alizarin red. The Höchst factory workers called their factory the "Rotfabrik," or red factory, because of the dye stains left on their hands after their daily eighteen-hour shifts. Unfortunately for many, these stains were not just on their hands. In addition to spills and explosions, many employees became permanently sick or died from prolonged exposure to their products in their working environment. Workers suffered from a variety of medical conditions, including chemical burns, ulcerations, cancers, dermatitis, aplastic anemia, epitheliomatous growth, aniline poisoning, and cyanosis.⁵² In addition, there were an estimated 50,000 to 100,000 cases of lead poisoning in the Reich by 1910.⁵³

Smoke from German industry also contributed to an increase in respiratory diseases. An early study in 1882 showed that people living in industrial centers were thirteen times more likely to die from respiratory disease when compared to someone

⁵¹ Raymond H. Dominick III, *The Environmental Movement in Germany: Prophets and Pioneers, 1871-1971* (Bloomington: Indiana University Press, 1992), 14-15.

⁵² Esther Leslie, *Synthetic Worlds: Nature, Art and the Chemical Industry* (London : Reaktion Books Ltd, 2005), 79.

⁵³ Dominick, *The Environmental Movement*, 15.

from a rural area.⁵⁴ It is apparent, given the volume of dumping and the visible effects of the pollution, that the vast majority of Germans knew that the unchecked dumping of chemicals had negative consequences on nature and the general public. The philosopher Friedrich Nietzsche, appalled at the way German industrial progress continued to damage the environment, wrote that “Our whole attitude towards nature, the way we violate nature with the help of machines and the heedless inventiveness of our technologists and engineers, is one of hubris.”⁵⁵ Indeed, national prestige and economic progress trumped the well-being of the people and the environment during the *Kaiserreich*.

Germany was not the only nation that struggled with chemical pollution. British lawmakers began to tackle the problem in 1862, when a Select Committee of the House of Lords began a formal investigation into the effects of Britain’s alkali industry. Due to the stench and “considerable” damage to the area vegetation, Parliament began to curb noxious chemical emissions. Passed between 1864 and 1868, the first set of laws known as the Alkali Acts targeted the air pollution generated by the chemical and copper manufacturing plants. Yet this did not solve the problem, as chemical industries simply dumped the waste into rivers, rather than burning it. By the late 1860s, A.E. Fletcher, an Alkali Act sub-inspector, estimated that 371,000 tons of hydrochloric acid (thirty percent chlorine) was dumped annually in England. The Sankey Canal in Cheshire for example, became so acidic that the use of iron boats was forbidden due to the risk of corrosion! In

⁵⁴ Ibid, 16.

⁵⁵ David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: W.W. Norton & Company, 2006), 180.

1874, a bill was enacted to limit the amount of acid being dumped in the rivers, but it did not ban the practice altogether.⁵⁶

In 1903, a series of articles were published in London's *The Times* relating to the German industrial boom and its effects on the German people. While the articles touched upon the level of waste and pollution generated by the steel and coal industries, the newspaper seemed to target the chemical industries as the most serious environmental offenders. Regarding the chemical plants at Elberfeld, *The Times* noted that while the surrounding environment had sweeping hills and woods that gave the area "natural charm," the river was a different story. After stating all refuse from the factories is dumped into the river, the article says that while the dumping from textile mills was "not so bad," the dumping from the dye and chemical works were the most offensive. As one heads downriver on the Wupper past the chemical plants,

"Every factory adds its shameless contribution – red, blue, yellow, purple – varied by drains carrying the surface water from the town... it is half solid with filth, and its banks are covered with a deposit of black and stinking slime. We have some pretty bad specimens of water pollution in England, but nothing like the Wupper. It is the most abominably ill-used running water in the world. Presumably this inequity is permitted to continue unchecked because those who perpetrate it control the conduct of affairs; but if the chemical works, instead of boasting of the number of chemists they employ and the millions of capital they have invested, would apply the knowledge of the one and some small portion of the other to disposing of their refuse and abating the nuisance they might command more respect than it is possible to pay them at present."⁵⁷

Yet no significant action was taken prior to World War I to curb the chemical dumping. Calls for laws against chemical pollution were rarely made at a national level, and very little legislation was passed on a local level. Economic factors played a

⁵⁶ Haber, *The Chemical Industry*, 208-209.

⁵⁷ "Industrial Conditions in Germany," *The Times*, 8 September 1903, issue 37180, 6.

significant role in this trend. Despite fishermen and farmer's complaints about the damage to their economic well being due to the contaminants in the waterways, many within Germany sided with the industries. It was much easier for a chemical company to define its economic contribution to the state when compared to fishermen. As the German lawyer Konrad Jurisch wrote in 1890 about the chemical industry, "The economic contribution of industries producing wastewater outweighs the contribution of inland fishing in lakes and rivers approximately a thousand times."⁵⁸ While it is unclear how Jurisch reached his approximation mathematically, it nonetheless points to the total lack of compassion for the fishermen who were losing their livelihood.

The public also perceived pollution as simply an unavoidable consequence to industrialization and economic prosperity. As stated earlier, the major chemical firms were invaluable to the economic survival of cities such as Ludwigshafen and Leverkusen. For example, one-quarter of the population of Ludwigshafen worked directly for BASF, not to mention the family members who depended on the income of these employees for survival. BASF also gave generously to the city, including funding towards the construction of schools, public nurseries, hospitals, and the city library.⁵⁹ Bayer also gave back to the community in Leverkusen. Among their contributions was the funding for the creation of their city's popular professional soccer club, Bayer Leverkusen, in 1904. It was therefore not in many of the working classes of Germany's interest to advocate against their employer's policies.

⁵⁸ Brüggemeier, "A Nature Fit for Industry," 47; Rommelspacher, "Das natürliche Recht auf Wasserverschmutzung Geschichte des Wassers im 19. und 20. Jahrhundert," 51.

⁵⁹ Von Hippel, "Becoming a Global Corporation," in Abelshauer, et al., *German Industry*, 113.

Small local groups did form, however, with the hope of combating the increasing pollution crisis. For example, in 1904 several towns along the Emscher River established the Emscher Water Authority (*Emschergenossenschaft*). Initially, the group lobbied local governments for laws punishing mining companies for dumping. So great were their numbers and political clout that the Authority forced towns to pay pollution control fees. By 1909, state leaders wanted to impose additional standards to curb the amount of sewage dumping by mining companies. Yet the Authority objected to the new standards and got their way, promising that the canals would not clog up. There were, therefore, little or no consequences for dumping. Streams which fed into the Emscher were soon lined with concrete in an effort to accelerate the rate of waste water entering the river. So long as the waste kept moving away from the valley, neither the state nor the Emscher River Authority cared about the amount or type of disposal. The lining of the canals and the almost total lack of enforcement meant that the Emscher was, according to historian Franz-Josef Brüggemeier, “legally turned into sewage canals with an almost total destruction of biological life.”⁶⁰ How could such levels of pollution continue to go unopposed? Why did German legislators remain silent?

The reasons were numerous: economic concerns, the belief that the river was self-cleaning, and the abundant scientific ignorance regarding the effect of chemicals on the environment, including plants, animals, and soil. The idea of a self-cleaning river emerged during the 1860s in England, and initially it was contested. For example, an exploratory commission with the British Parliament concluded that the rivers did not clean themselves, but that chemical decomposition was too slow and the rivers too short

⁶⁰ Brüggemeier, “A Nature Fit for Industry,” 39-40.

for the waste to be entirely broken down. The same argument was made by experts from local municipalities in Germany that were struggling with pollution.⁶¹ While scientists, industrialists, and politicians argued over these theories, early biologists conducted groundbreaking work that eventually yielded an answer.

By the 1860s, scientists had already begun to analyze the influence humanity had on the environment. Based on the writings of Charles Darwin, in 1866 the German zoologist Ernst Haeckel coined the term “ecology,” a term which he used to describe “the collective science of the relations of the organism to the surrounding outside world, wherein we can calculate in the broader sense all ‘living conditions.’”⁶² By the 1890s, European biologists discovered that microorganisms account for much of the “self-cleaning” properties of rivers, not dilution or chemical reactions. Of course, if concentrations of the pollutants are too high, the organisms will be killed off and the pollutants will be carried and flushed into the ocean.⁶³

Ironically, these new findings were used by some to assuage the public’s fears about water waste. The discovery of “self-cleaning” properties among rivers was a misunderstood finding, a claim often exaggerated or twisted. For organic waste such as human sewage, one of the most well known public health experts in Germany at that time, Professor Dr. Max von Pettenkofer proclaimed that rivers had an unlimited capacity

⁶¹ Rommelspacher, “Das natürliche Recht auf Wasserverschmutzung Geschichte des Wassers im 19. Und 20. Jahrhundert,” 50.

⁶² “Unter Oecologie verstehen wir die gesammte Wissenschaft von den Beziehungen des Organismus zur umgebenden Aussenwelt, wohin wir im weiteren Sinne alle ‘Existenz-Bedingungen’ rechnen können.” Ernst Haeckel, *Generelle Morphologie der Organismen: allgemeine Grundzüge der organischen Formen-Wissenschaft, mechanisch begründet durch die von Charles Darwin Reformirte Descendenz-Theorie, Zweiter Band: allgemeine Entwicklungsgeschichte der Organismen* (Berlin: Verlag von Georg Reimer, 1866), 286.

⁶³ Rommelspacher, “Das natürliche Recht auf Wasserverschmutzung Geschichte des Wassers im 19. Und 20. Jahrhundert,” 51.

to clean themselves. According to historian Raymond H. Dominick III, Pettenkofer argued that, “miracle-working microbes would recycle the human wastes in short order; thus, only the ignorant would be alarmed by the apparent signs of pollution.” Though worried that their pollutants killed off these wondrous microbes, chemical manufactures chose to largely ignore the evidence, continuing to state that the rivers could take the abuse and clean themselves. Some even argued that the dumping of inorganic pollutants killed the organic toxins and were therefore beneficial to the river’s hygiene.⁶⁴

These incorrect interpretations were seemingly widespread, as the Reich government approved the construction and expansion of chemical plants despite the dangers of water and air pollution. At the national level, the Reich Ministerium für Handel und Gewerbe (Ministry for Commerce and Trade) oversaw the approval of building permits and dealt with complaints that involved, among other enterprises, the chemical industry. The Ministry received and considered citizen grievances, determined the issuance of construction permits based on environmental and safety concerns, and worked with testing agencies and city governments to assess the impact of chemical agents at the local level. For example, in 1911, the Otto Meuer & Co. sought to construct a new chemical plant on the Rhine in Suerth. After explaining that the environmental impact was acceptable, the application was approved on the condition that certain stipulations were met. The Ministry explained in their judgment that despite the complaints they received against the construction, the Ministry believed that there was no “damaging impact” to worry about because the process of arsenic manufacturing already had sufficient “safeguarding regulations” as to not compromise the water from the local

⁶⁴ Dominick, *The Environmental Movement*, 5; Cioc, *The Rhine*, 111.

waterworks in the area. The Ministry also collected and reported the “expert opinions” (often vaguely referred to as “*Gutachten*” in the reports), that stated that the fears held by the city of Cologne that arsenical waste water could enter the groundwater stream and poison the drinking water of the residents were “unquestionably unfounded (*zweifellos nicht begründet*).” The Ministry demanded, however, that the factory abide by both worker and chemical regulations. For example, the Ministry ordered that workers could only work eight hour shifts and must receive daily freshly washed, protective clothing consisting of a jacket, pants, and headwear. The Ministry also mandated that arsenics must be stored only in steel plate containers.⁶⁵ It is unclear, however, to what extent the factory ever abided by the rules.

The Ministry often communicated with the companies, local governments, and the various sub-agencies within the national government to approve applications and handle protests, often citing environmental concerns. For example, residents in the Aachen neighborhoods of Eilendorf and Atsch, as well as the mayor of Würselen, protested to the Ministry’s Koenigliche Technische Deputation für Gewerbe (Royal Technical Deputation for Trade) over the expansion of a chemical factory in Stolberg out of fears over air pollution and the damage caused by the smoke.⁶⁶ City governments also contacted Reich testing offices, such as the Königliche Versuchs- und Pruefungsanstalt für Wasserversorgung und Abwasserbeseitigung (Royal Experimental- and Testing Institute for Water Supply and Sewage Disposal) in Berlin, to examine the potential dangers

⁶⁵ See letter from Königliche Technische Deputation für Gewerbe to the Otto Meuer & Co., 3 October 1911, GStAPK, I. HA Rep. 120 Ministerium für Handel und Gewerbe, BB II a 2, Nr. 14, Bd. 26, Geheimes Staatsarchiv Preußischer Kulturbesitz, Berlin-Dahlem, Germany; The Minister of Commerce and Trade, “Rekursbescheid,” 23 October 1911, Ibid.

⁶⁶ Letter from the Königliche Technische Deputation für Gewerbe to the Firma Siegwark chemisches Laboratorium G.m.b.H, p. 5, Ibid.

chemical waste had to their local water tables and rivers.⁶⁷ The Ministry also considered chemical plants and their potential hazards to fisheries. In one case, despite citizen protests the Firma Siegwerk chemisches Laboritorium GmbH received permission to construct a facility for chemical production in Siegburg, after it was determined from “expert opinions” that the fears surrounding damage to the fisheries in the vicinity of Cologne and Bonn were “unfounded.”⁶⁸ Unfortunately for many Germans, the definitive “expert opinions” proved to be quite the opposite, and issues with chemical pollution continued.

The more fundamental problem, however, was the absence of a collective, cultural belief in regulating shared natural resources. Chemical companies had no qualms about dumping chemicals into the Rhine, even if the effects brought harm to towns or other resources downstream. Any initial regulations at the time were done purely for anthropocentric reasons such as economic cost or public health endangerment, rather than for the preservation of the environment.⁶⁹

Nevertheless, many Germans advocated for legislation to curb environmental pollution, and not solely for public health reasons. Additionally, many Germans viewed nature as invaluable to providing creative and artistic inspiration, a source of rejuvenation of the human spirit and recreational enjoyment, and above all providing aesthetic pleasure. Many of Germany’s finest scholars, philosophers, and artists discussed the

⁶⁷ In February 1912, the mayor of Cologne notified the Ministry that he requested additional tests relating to the construction of the new Otto Meuer & Co. chemical plant. See for example letter from the mayor of Cologne to the Minister for Commerce and Trade, 5 February 1912, Ibid.

⁶⁸ Letter from the Königliche Technische Deputation für Gewerbe to the Minister für Handel und Gewerbe, c. 1914, pgs. 1-5, Ibid.

⁶⁹ Dominick, *The Environmental Movement*, 6.

beauty of nature, either as a theme in their mediums or to make social critiques about German society and culture. In perhaps its most romantic form, the Rhine represented the embodiment and source of the German people's strength.

The early Wilhelmine conservationists were on the center-right on the political spectrum. They were reluctant to attack modern capitalism outright and with it what most in Germany felt was economic progress. As the historian Richard Hölzl put it, "On one hand there was a pseudo-religious sublimation of nature, while on the other hand there was a completely rational, mechanistic and scientific view of the environment that relegated the romantic view to the sphere of private life."⁷⁰ Curbing industrial pollution was also appealing to the conservative, educated middle classes of Germany, who felt culturally threatened by the lower working classes, as well as their rival new industrial elites. Early conservationists, therefore, sought a slow shift in environmental policy against the industrialists with an either aesthetic or nationalistic underpinning.⁷¹

German conservationism prior to World War I was therefore built primarily upon a mixture of spiritual and aesthetic appreciation of the natural world common among the middle and upper classes of German society. Many of the cultural perceptions which influenced German environmental thought can be traced back to the Enlightenment and Romantic eras in Germany. Professor Doctor Walter Schoenichen, an influential leader in German environmentalism during the first half of the twentieth century, explored this idea in his 1953 book, *Naturschutz, Heimatschutz: Ihre Begründung durch Ernst Rudorff*,

⁷⁰ Richard Hölzl, "Nature Conservation in the Age of Classical Modernity: The Landesausschuss für Naturpflege and the Bund Naturschutz in Bavaria, 1905-1933," in Frank Zelko, ed. *From Heimat to Umwelt: New Perspectives on German Environmental History*, Supplement 3, German Historical Institute, Washington, DC, (2006): 30.

⁷¹ John Alexander Williams, *Turning to Nature in Germany: Hiking, Nudism, and Conservation, 1900-1940* (Stanford: Stanford University Press, 2007), 221; 223.

Hugo Conwentz, und ihre Vorläufer. Schoenichen argued that the founding elements of natural conservation in German cultural life originated from romanticism and its poets, notably Schiller and Goethe. “The notion of nature conservation, its substance (*Inhalt*) and its origin (*Herkunft*),” Schoenichen wrote, “is primarily a sprout (*Sproß*) of the Romantic Movement”⁷² Indeed, several of the leading German poets and thinkers at that time, including Friedrich Schiller, Johann Wolfgang von Goethe, and Alexander von Humboldt pioneered the ideological vision of the German conservation movement as it was known up to the First World War. In essence, most conservationists viewed nature through a combination of ideological and aesthetic ideas.

In terms of aesthetics, early conservationists sought to preserve the natural beauty of their landscape described by the German romantic writers of the late eighteenth and early nineteenth centuries. Perhaps the time period’s most famous poet, Goethe, wrote extensively on nature and its relationship with humanity. For Goethe, the beauty of nature was abstract, rather than scientific. He often wrote of its ability to instill spirituality and creativity. Though Goethe objected to a solely rational approach to natural understanding, he nonetheless devoted countless hours to writing and reflecting on the natural world. “Goethe was - although he could not tell a lark from a sparrow -,” one literary critic wrote, “from all evidence a devoted and even an impassioned lover of nature.”⁷³ Goethe believed that there was no boundary between man and nature, and that, “nature was not an object to be analyzed, but part of a seamless web which encompassed human life as

⁷² Walther Schoenichen, *Naturschutz, Heimatschutz: Ihre Begründung durch Ernst Rudorff, Hugo Conwentz, und ihre Vorläufer* (Stuttgart: Wissenschaftliche Verlagsgesellschaft M.B.H., 1954), 1.

⁷³ Charles Sherrington, *Goethe on Nature and Science* (Cambridge: Cambridge University Press, 1949), 37.

well as the natural environment. Nature was to be perceived not only with rational but also with aesthetic tools; indeed, the two were, for Goethe, epistemologically inseparable.”⁷⁴ Goethe’s masterpiece *Faust* demonstrated his affinity for a spiritual human to nature relationship, as the drama climaxes with Faust “bringing the earth back to itself” as he gains total authority over nature.⁷⁵

Nature also became important with respect to historical conservation and German ethnic identity. In terms of a link between peoples’ identity to nature, the noted German traveler and naturalist Alexander von Humboldt argued in his 1808 book *Ansichten der Natur* (*Views of Nature*) that the very destiny of humanity hinged on the natural world. In his introduction to the text, Humboldt directly proclaimed “I have above all pointed out the perpetual influence which physical nature bears on the moral mood (*Stimmung*) of the people and on their destiny.”⁷⁶ According to Humboldt, descriptions of nature “with inimitable truth” by Georg Forster, Goethe and others, acknowledges the “most intimate ties” between “the natural character of the different far reaches of the world” with the history and culture of humankind. In other words, Humboldt believed that a nation’s culture reflected its natural environment. “How powerful the Greek sky affected their works!” Humboldt wrote, “The poetic works of the Greeks and the raspy songs of the northern primitive peoples owe thanks for their peculiar character largely to the forms of plants and animals, to the mountain valleys that surrounded the writer, and the air that

⁷⁴ Colin Riordan, “Green Ideas in Germany: A Historical Survey,” in Colin Riordan, ed. *Green Thought in German Culture: Historical and Contemporary Perspectives* (Cardiff: University of Wales Press, 1997), 6-7.

⁷⁵ Blackbourn, *Conquest of Nature*, 62.

⁷⁶ Alexander von Humboldt, *Ansichten der Natur, mit wissenschaftlichen Erläuterungen* (Tübingen: J.G. Cotta’schen Buchhandlung, 1808), vii.

fanned him.”⁷⁷ Furthermore, Humboldt argued this connection to nature is shared among all humanity. Even if many exotic species like palms or mimosa remain unknown to people in northern regions, Humboldt argued exotic nature stimulates the imagination in art and poetry, enabling people to express their connections to nature beyond their individual areas. Even if the examples of exotic life in local greenhouses provide only “a faint picture of the majesty of tropical vegetation,” Humboldt admitted, “in the construction (*Ausbildung*) of our language, in the glowing fantasy of the poet, in the representative art of the times, [nature] opened a rich source of alternatives (*eine reiche Quelle des Ersatzes*). It creates the lively pictures of an exotic nature for our imagination.”⁷⁸ Clearly, Humboldt believed in a connection between the historical and cultural courses of humanity and the environment.

The romantic movement of the time period embraced nature as something to be cherished, for its spiritual and aesthetic beauty. Preservation of Germanic architecture, lifestyles, and its landscape were seen as defense of Germandom, the nation, and nature. The writings of the conservative historian Wilhelm Heinrich Riehl reflected these attitudes, calling for the defense of the *Heimat* (homeland) during German economic and social progress. Like Humboldt, Riehl believed that the German people were directly tied to their environment, and that the German natural landscape provided reinvigoration for the people’s soul (*Volkscharakter*). This gave the term *Heimat* both environmental but also a conservative political definition, and with it the early German conservation

⁷⁷ “Die Dichtwerke der Griechen und die rauheren Gesänge der nordischen Urvölker verdankten gröstentheils ihren eigenthümlichen Character der Gestalt der Pflanzen und Thiere, den Gebirgsthälern, die den Dichter umgaben, und der Luft, die ihn umwehte.” Ibid, 176-177.

⁷⁸ Ibid, 203-204.

movement.⁷⁹ This attitude, however, never reached the level of mass appeal generated in the Weimar era, a zeal the Nazis would attempt to cultivate and manipulate to their advantage during the Third Reich.⁸⁰ Nevertheless, the idea of a relationship between nationalism and nature nonetheless existed prior to the outbreak of World War I.

The Rhine has especially served as a symbol of the mythical natural origins of Germany in the native literature, poetry, art, and music. Perhaps the oldest and widest known is the medieval German epic *Das Nibelungenslied*. The story revolves around the life of Sifried (or Sigfried), who himself was born in the Netherlands along the Rhine and later ruled Wurms, also located on the Rhine. The poem is filled with references to the river, and Sifried's hunting abilities and conquest of all of the wild beasts of the forests. Whether real (lions, elk, bison, boar, etc. . .) or legendary (dragons), hunting legitimized Sifried as a formidable hero.⁸¹ Sifried is ultimately betrayed by his comrade Hagen, who impaled Sifried with a cowardly spear as he drank from a brook. The poem decries Sifried's murder as the ultimate deception, not just of one person but of anyone from the land. "You have shamed the people born to the Rhine from this day forth" the epic declared, "They're stained by what you have done."⁸² Though the poem was not popular during the Enlightenment (Frederick the Great said it was not worth a "shot of

⁷⁹ Thomas Lekan and Thomas Zeller, eds. *Germany's Nature: Cultural Landscapes and Environmental History* (New Brunswick: Rutgers University Press, 2005), 59; Hölzl, "Nature Conservation," 31-32.

⁸⁰ For an analysis of Nazi environmental thought, see Franz-Josef Brüggemeier, et al. *How Green were the Nazis?: Nature, Environment, and Nation in the Third Reich* (Athens: University of Ohio Press, 2005).

⁸¹ Stanzas 935 through 939 perhaps best showcases Sifried's hunting prowess. *Das Nibelungenlied: Song of the Nibelungs*, translated by Burton Raffel (New Haven: Yale University Press, 2006), 131.

⁸² Stanza 990, *Ibid*, 139.

gunpowder”), the romanticists of the Napoleonic era were highly attracted to it for a number of reasons. Some were drawn to its nationalistic underpinnings, as it provided a Germanic epic for Germans in the face of Napoleonic Europe.⁸³ Yet the depictions of the German people’s ties to the land were quite attractive to those seeing nature in their cultural lives.

More contemporary examples from the Rhineland include works such as Alfred Reumont’s *Rhineland Tales and Stories* (1837) and the tales of the Brothers Grimm. Collections of poetry by Clemens Brentano and Achim von Arnim glorified the beauty of the German castle ruins among the landscape.⁸⁴ Legends like the *Lore Lay*, the story of a beautiful maiden who lured sailors to their doom on the Rhine maintained the tradition of mysticism with the river in German stories.⁸⁵ Music was also inspired by the Rhine River, in particular Richard Wagner’s *Das Rheingold* and one of Germany’s most popular marches at the time, Max Schneckenburger’s *Die Wacht am Rhein*. As one German writer noted in 1851, “Indeed the Rhine is for us a holy river and its shores are the true home of the Germans, the venerable host of all German culture. What the Ganges is to the Indians, so too is the Rhine to the Germans.”⁸⁶ This connection to the Rhine would be maintained and strengthened during the First World War, as countless men crossed it on their way to the Western Front.

⁸³ See the noted Germanist Edward R. Hymes’ introduction to *Ibid*, p. xvi.

⁸⁴ Lekan, *Imagining the Nation*, 26-27.

⁸⁵ For one interpretation, see “Lore Lay,” in A. Hermann Bernard, *Eine Sammlung von Rhein-Sagen* (Wiesbaden: Gustav Quiel, 1870), 231-234.

⁸⁶ Karl Simrock, *Das malerische und romantische Rheinland* (Leipzig: E.A. Haendel’s Verlag, 1851), 4.

Early nineteenth century German painters emphasized themes of nature and humanity's interaction. Numerous German romanticist painters used landscapes to convey this message, including the works of Adrian Ludwig Richter, Adolf Menzel, and Caspar David Friedrich. Like Goethe, these artists attempted to show the blending of humans and nature in their work. This was done, as art historian William Vaughan argued, because "there existed a new response to nature – largely evidenced in landscape painting. . . for nature had a strong mystical element."⁸⁷

Germany's best known romanticist painter remains Caspar David Friedrich. Born in 1774, Friedrich studied painting in Copenhagen before settling in Dresden. He also practiced as a professional topographer, which sharpened his eye for landscapes.

Although Friedrich never attempted to show mysticism or spirituality outright, often his work nonetheless demonstrated the emotional impact of human and nature interaction.

Arctic Shipwreck (1824) depicts man at the mercy of nature, with a ship resting aground on its side against an iceberg.⁸⁸ *Procession at Dawn* (1805) depicts a tranquil, melancholy funeral service among grassy hills.⁸⁹

As the ideas of abstract romanticism began to wane in the 1840s, a more realistic style of painting known as naturalism began. Naturalism is where the artist attempts to recreate natural effects as they would occur in the real world. This differs slightly from many of the earlier romantic landscapes, which over time had become too symbolic in

⁸⁷ William Vaughan, *German Romantic Painting, Second Edition* (New Haven: Yale University Press, 1980), 1.

⁸⁸ Ulrike Finke, *German Painting From Romanticism to Expressionism* (Boulder: Westview Press, 1975), 27.

⁸⁹ Vaughan, *German Romantic Painting*, 81.

their presentations.⁹⁰ The work of Adolph Menzel often used naturalism, especially in his painting *The Balcony Room* (1845). The work depicts a modest room with a breeze gently blowing the curtain on a sunny day.⁹¹ Regardless of how real the depictions were, both styles of art endeavored to instill emotional connections to nature and civilization.

German poetry also reflected strong connections to Germany and its natural landscape. Noted German poet Heinrich Heine expressed his longing for his natural homeland when he wrote,

Ich hatte einst ein schönes Vaterland.
Der Eichenbaum
Wuchs dort so hoch, die Veilchen nickten sanft,
Es war ein Traum.

I used to have the fairest Fatherland
The oak trees there
Were tall, so tall; the violets soft and blue.
A dream – so fair.⁹²

It is not clear if Heine described his thoughts on the degradation of the landscape, although other poets expressed the loss of natural beauty in their work. Friedrich Hebbel used nature as a theme in his work, such as the following lines from the poem *Herbstbild* (Picture of Autumn)

O stört sie nicht, die Feier der Natur!
Dies ist die Lese, die sie selber hält
Denn heute löst sich von den Zweigen nur,
Was vor dem milden Strahl der Sonne fällt.

Oh let no one disturb this harvest feast

⁹⁰ Ibid, 1-2.

⁹¹ Ibid, 121-123.

⁹² Alexander Gode and Frederick Ungar, *Anthology of German Poetry Through the Nineteenth Century, Second Edition* (New York: Frederick Ungar Publishing Company, 1972), 178.

Which Nature all alone anacts this day.
The fruits that fall are from their branch released
By gentle nudging of the sun's mild ray.⁹³

These poems emphasized the beauty of nature, as well as what may be gained or lost in the natural world.

With these cultural ideas in mind, many Germans reacted to the new pollution menace by forming the first homeland and environmental protection groups (*Heimatschutz* and *Naturschutz* groups). In what came to be known collectively as the *Naturschutzbewegung*, or the defense of nature movement, local environmental protection organizations formed and tried to curb human's negative impact on the environment. Although little was actually achieved to curb pollution legislatively at a national level, many nevertheless protested the effect industrialization was having on their country.

Perhaps the most important figure to the founding of the German landscape protection movement was Ernst Rudorff. Born 18 January 1840 in Berlin, Rudorff studied music at the Leipzig Conservatory, eventually becoming a professor of music. In 1880, Rudorff published in the 25th volume of the *Preußischen Jahrbücher* his essay "Über das Verhältnis des modernen Lebens zur Natur" (On the Relationship between Modern Life and Nature).⁹⁴ Rudorff argued that the threat industrialization posed to the environment was a threat to the very roots of German character.⁹⁵ He wrote, ". . . the very

⁹³ Ibid, 220.

⁹⁴ Schoenichen, *Naturschutz, Heimatschutz*, 142. For background on Rudorff, see Schoenichen, *Naturschutz, Heimatschutz*, 116-137.

⁹⁵ Riordan, "Green Ideas," 14.

roots of German character lie in a profound and intimate feeling for nature.”⁹⁶ In order to preserve this character, people needed to recognize that a “co-ownership of God’s Earth” existed and defense of the natural environment was necessary. The connection Rudorff made between the environment, German nationalistic sentiment, and earlier romantic ideals remained at the forefront of his writings and thoughts. Walther Schoenichen, one of the first Germans to explore the origins of environmental thought, concluded in 1954 that these connections were so strong that “Ernst Rudorff knew the mystery of the German people’s soul.”⁹⁷

Rudorff continued to publish works into the next century on the need to prevent damage to nature through industrialization. In 1892, Rudorff published “*Schutz der landschaftlichen Natur und der geschichtlichen Denkmäler Deutschlands*” (Protect Germany’s Natural Landscapes and Monuments). Three years later, another essay appeared in the magazine *Grenzboten*, simply entitled “*Heimatschutz*.”⁹⁸ Though he never advocated outright revolution against the industrial-capitalist machine, Rudorff’s suggestions were nonetheless groundbreaking in their social context.⁹⁹ According to Schoenichen, the articles made an “extremely successful impression” and that a

⁹⁶ Matthew Jefferies, “Heimatschutz: Environmental Activism in Wilhemine Germany,” in Colin Riordan, ed. *Green Thought in German Culture: Historical and Contemporary Perspectives* (Cardiff: University of Wales Press, 1997), 47.

⁹⁷ Schoenichen, *Naturschutz, Heimatschutz*, 298.

⁹⁸ *Ibid*, 152-153.

⁹⁹ William H. Rollins, *A Greener Vision of Home: Cultural Politics and Environmental Reform in the German Heimatschutz Movement, 1904-1918* (Ann Arbor: The University of Michigan Press, 1997), 74-75.

metaphorical flag was created for those who shared ideas of a harmonious human and natural world, a unifying banner at which they could now rally behind.¹⁰⁰

Coinciding with Rudorff's pioneering work in environmental protection, Dr. Hugo Conwentz (1855 – 1922), a botanist, was advocating for government-sponsored conservation in Germany. Unlike Rudorff, who favored a more protective, nationalistic or ethnic approach, Conwentz preferred a conservationist approach through scientific lenses. Conwentz called for the creation of *Naturdenkmal*, or natural monuments, to protect certain landscapes for the sake of their historical and scientific significance. In 1904, Conwentz produced a report for the Prussian government entitled *Die Gefährdung der Naturdenkmäler und Vorschläge zu ihrer Erhaltung (The Endangerment of Natural Monuments and Proposals for their Preservation)* that drew attention to the damage humans inflicted on the environment.¹⁰¹ That same year the success of his essay led to the establishment of the Prussian State Office for Natural Monument Preservation, an agency dedicated to the identification and preservation of scientifically and aesthetically valuable regions.¹⁰²

Also in 1904, together Rudorff and Conwentz founded the *Deutscher Bund Heimatschutz* (German League for the Protection of the Homeland, or DBH) in Dresden. The Bund was one of the first ever national German organizations dedicated to landscape preservation. The organization grew to over 30,000 members by 1914, and 250 member

¹⁰⁰ “Damit was zugleich eine überaus glückliche Prägung gefunden: eine Standarte war aufgerichtet, um die sich alle Freunde der deutschen Landschaft und des ihr gehörenden Menschwerks scharen konnten.” Schoenlichen, *Naturschutz, Heimatschutz*, 153.

¹⁰¹ Riordan, *Green Thought*, 15.

¹⁰² Lekan, *Imagining the Nation in Nature*, 21.

groups by 1916.¹⁰³ The overall objective of the group was to protect the aesthetics of the landscape, as well as the local character of the region. During their campaign to prevent the construction of a hydroelectric dam on the Rhine that would disrupt the natural rapids, the first chairman of the Bund Heimatschutz, Paul Schultze-Naumburg, summarized the DBH's stance towards the current process of German industrialization when he wrote, "For if man were to extract everything which can be extracted by his technology, he would come to realize that the resulting easy life on a disfigured Earth is actually no longer worth living; that we would have grabbed everything that our planet has to offer, but in so doing we would have destroyed it and therefore ourselves as well. It is up to each and every one of us to do our bit to bring about a change before it is too late, everywhere and forever."¹⁰⁴ While modern in its expression, Schultze-Naumburg and the DBH's intentions were not simply the protection of nature for nature's sake. Rather, the purpose was to protect German culture. As the historian Thomas Lekan observed, Rudorff "viewed the landscape as an aesthetic totality that manifested its inhabitants' history, customs, and character."¹⁰⁵ As such, the group advocated for the prevention of landscape disfigurement, historic preservation, protecting indigenous plant and animal species, and preserving local folk art and culture.¹⁰⁶ Despite their size, however, no substantial national legislation was enacted based on their actions. Although Rudorff and Conwentz failed to rally mass support for environmental legislation across Germany prior

¹⁰³ Jefferies, "Heimatschutz," 42; see also Colin Riordan, "Green Ideas," 15. Rollins, *A Greener Vision*, 3.

¹⁰⁴ Cited in Jefferies, "Heimatschutz," 48.

¹⁰⁵ Lekan, *Imagining the Nation in Nature*, 59.

¹⁰⁶ *Ibid.*, 60.

to the outbreak of World War I, early German writers of *Naturschutz* and *Heimatschutz* credit Rudorff and Conwentz as significant German environmental advocates. As Walther Schoenichen concluded, “There are two names that will forever be said in connection with the German natural protection movement: Ernst Rudorff and Hugo Conwentz.”

Other early *Naturschutz* groups included the *Isartalverein*, or the Isar Valley Society, in Munich. The society protested the canalization of the Isar River on the grounds of aesthetic detriment. Their protests ultimately resulted in a compromise of sorts, with the canals being constructed but along the natural curves of the streams.¹⁰⁷ National bird conservation and protection clubs were also created. Founded in 1899, the German League for Bird Protection constructed bird sanctuaries and lobbied for restrictions on hunting certain species. They also lobbied for laws by detailing the essential role birds play in maintaining insect populations and helping agriculture. Significant in size, the group boasted 41,233 members by 1914.¹⁰⁸

By the time World War I broke out, the conservationists had presented a variety of different rationales for the protection and legislation of natural resources. In 1909, for example, a speech given at a town meeting in Rixdorf argued that nature should be protected because the loss of endangered species was irreplaceable, that nature offered recreational and restorative value for the people, that polluted land undermines patriotic allegiance to the homeland, that pollution harms the people and slows worker efficiency, thus harming the economic progress, and lastly that the “moral obligations to future

¹⁰⁷ Williams, *Turning to Nature in Germany*, 225.

¹⁰⁸ Lekan, *Imagining the Nation in Nature*, 52; Dominick, *The Environmental Movement*, 53.

generations demanded the most extensive preservation of Nature's treasures possible."¹⁰⁹ Despite the growing number of *Naturschutz* groups, no significant gains were made towards ending the continued dumping of chemicals into the Rhine.

Despite Germany's worsening levels of pollution, German industry flourished. As we have seen, by 1914 Germany's chemical industry was the largest on the planet. Led by the Krupp steel works, German steel production also ranked first among industrialized nations in Europe. In fact, in 1913 Germany produced 17.6 million tons of steel. In other words, Germany alone produced more steel than Britain, Russia, France, and Japan *combined*. Germany also consumed one hundred eighty-seven million metric tons of coal that year, nearly forty million metric tons more than France, Russia, Italy, and Japan combined.¹¹⁰ As Paul Kennedy has correctly argued, Germany's rapid economic growth was one of the primary causes of the decline in British-German relations during the pre-war years. "Without industrial power and advanced technology Prussia-Germany would have remained an 'insignificant' country;" Kennedy wrote, "instead, it became the strongest and most efficient military state in Europe, capable of taking on at least two of its great power neighbors. . . moreover, this economic expansionism meant that Germany was not only growing out of its European 'skin' but was also acquiring the early attributes of a world power. . ."¹¹¹ Britain felt threatened by the effects of Germany's economic prosperity, among them the expansion of trade in chemicals and steel around the globe, the desire for colonies, and the production of a massive, modern battle fleet

¹⁰⁹ Dominick, *The Environmental Movement*, 7.

¹¹⁰ Kennedy, "The First World War and the International Power System," 13-14.

¹¹¹ Paul M. Kennedy, *The Rise of the Anglo-German Antagonism, 1860-1914* (Amherst, New York: Humanity Books, 1980), 464-465.

that could potentially challenge British naval supremacy. Germany's chemical industry and use of chemicals, therefore, was very much an integral part of Germany's political, economic, and military situation in 1914.

During the Kaiserreich, the Bund Heimatschutz and other groups were never able to stop the negative changes to Germany's waterways. As the historian Thomas Lekan observed, the DBH lack of success prior to 1914 was due to "the German state's unwillingness to infringe on property rights or economic development in the name of environmental protection."¹¹² The groups could not provide a cohesive environmental protection plan that appealed to the government in Berlin, and their largely bourgeois makeup failed to connect with the working classes who depended on the chemical industry for their livelihood. Additionally, outside the DBH, the relatively small number of conservation groups and their local composition made any mass movement for conservation untenable. It would take a nationwide crisis for the concept of environmental conservation in the German public's consciousness to take shape. Yet nobody knew the event would be one of the worst wars in human history.

¹¹² Lekan, *Imagining the Nation in Nature*, 60.

CHAPTER 2

A MARTYRED LANDSCAPE

Among the thousands of books published on the First World War, the topic of poison gas has received considerable attention. This is understandable, as the use of chemical weapons during the conflict fundamentally altered how Europeans perceived warfare and culture. Chemical weapons were dismissed prior to World War I as “cowardly” and “uncivilized.” Germany, France, Great Britain, and other nations signed the Hague Conventions of 28 July 1899 and 18 October 1907, expressly forbidding all projectiles whose sole object was “the diffusion of asphyxiating or deleterious gases” and gases which caused “unnecessary suffering.”¹

Yet the German Empire, not even three months into the conflict, was willing to set aside these promises to gain an advantage in a global conflict with her primary European rivals. What led Germany down such a path? What were the significant turning points during the gas war? This chapter is by no means a comprehensive account of the gas war experience, yet a general history of the use of chemical weapons during the war is necessary for readers unfamiliar with the general narrative. Rather than focusing on the environmental aspects of the conflict at this point, a brief introduction into the story of chemical warfare not only illuminates both the important figures and events of the era, but also introduces the key questions presented in the subsequent chapters.

¹ L. F. Haber, *The Poisonous Cloud: Chemical Warfare in the First World War* (Oxford: Clarendon Press, 1986), 18-19; Hermann Geyer, “Der Gaskrieg,” in Max Schwarte, ed. *Der große Krieg 1914-1918, Viertes Band* (Leipzig: Johann Ambrosius Barth, 1922), 490.

The German's decision to use poison gas was not made in a single meeting, but rather resulted from a combination of economic, military, and scientific factors. From an economic standpoint, chemical weapons were seen as a way to compensate for Germany's inadequate supplies of conventional munitions necessary for industrialized warfare. From the military's point of view, the Schlieffen Plan's failure forced the German General Staff to find a way to avoid a lengthy, static war that ran contradictory to German military culture and strategy. The idea of using chemical weapons, however, falls very much in line with the German military practice of directing maximum firepower on a limited area to achieve a given objective. In the case of poison gas, the objective is to deprive the enemy of a habitable environment. From a scientific point of view, chemical warfare was perhaps the most visible way Germany's scientific community influenced the "total" nature of the Great War.²

During the initial German invasions on the Western Front of Belgium and France, and despite the use of railroads, the German army's advances were repeatedly stalled in urban areas. House-to-house fighting contributed to high casualties and decreased morale among the Germans. Major Max Bauer, an operations officer in the Prussian General Staff, believed gas could be a potential solution to this problem. In October 1914, Bauer described the problem to Dr. Walter Nernst, a physical chemist well known in the German scientific community who was serving at that time as a volunteer at the front in

² For more on the debate surrounding the idea of World War I being a "total" war relating to chemical warfare, see Rolf-Dieter Müller, "Total War as a Result of New Weapons? The Use of Chemical Agents in World War I" in Roger Chickering and Stig Förster, eds. *Great War, Total War: Combat and Mobilization on the Western Front, 1914-1918* (Cambridge: Cambridge University Press, 2000), 95-11. Although Müller argued that chemical weapons "represented neither the means nor the expression of total war," he did assert that "Even more so than the other new weapons, poison gas was a graphic form of industrialized, total war." See Ibid, pgs. 109; 111. How Germans recorded the graphic nature of these weapons and their impact on the environment is explored in chapter five of this study.

the Kaiser's Automobile Corps.³ After the two men decided that irritating agents could be effective, they contacted Dr. Carl Duisberg, the director of Bayer. At that time, Bayer was the largest chemical company in the world. Later, along with another officer, the group began to experiment with non-lethal agents, including smoke, incendiary, tear, sneezing, and even stinking gases at Bayer's testing facilities near Cologne. The agents necessary for their goals had to be potent, but not long lasting as the committee wanted to protect German troops who would not be fully protected from the effects of the gas themselves.⁴

The Germans were not the only ones who had experimented with and used chemical agents during the early stages of the conflict. It was the French, in fact, who were the first to use gas at the front beginning in August 1914.⁵ Originally invented for police usage in 1912, cartridges containing small amounts of tear gas (some 200 grams of liquid or roughly nineteen cubic centimeters of gas per cartridge) were issued to and used by French troops between August and November 1914.⁶ Unfortunately for the French the effects of the irritants on the German troops were negligible. Believing the tear gas could

³ Walther Nernst, "Zur Entwicklung des Gaskampfs," 1934, RH 61/726, p. 1, Bundesarchiv-Militärarchiv, Freiburg im Breisgau, Germany; Jeffrey Allan Johnson, "La mobilisation de la recherche industrielle allemande au service de la guerre chimique," in David Aubin and Patrice Bret, eds., *14-18 Aujourd'hui Today Heute*, special volume entitled *Le sabre et l'éprouvette. L'invention d'une science de guerre, 1914-1939*, (2003): 92.

⁴ Carl Duisberg, et al. "Bericht über die Tätigkeit der von der obersten Heersleitung eingesetzten Spezialkommission, behufs Ausfindigmacheneines Artillerie-Geschosses, das neben seiner artilleristischen Leistung auch chemische Wirksamkeit entfaltet," 201/5.3 Part 6, p. 1-2, Bayer Corporate Archives AG, Leverkusen, Germany; Johnson, "La mobilisation de la recherche industrielle allemande au service de la guerre chimique," 93.

⁵ Olivier Lepick, *La Grande Guerre chimique: 1914-1918*, 2e ed. (Paris: Presses Universitaires de France, 1998), 54-55.

⁶ Ibid, 55; Dieter Martinetz, *Der Gaskrieg 1914/18: Entwicklung, Herstellung und Einsatz chemischer Kampfstoffe, Das Zusammenwirken von militärischer Führung, Wissenschaft und Industrie* (Bonn: Bernard & Graefe Verlag, 1996), 9.

still be effective but on a larger scale, steps were taken by the French military leadership to increase production of tear gas and deploy it through larger chemical shells and hand grenades. Orders for gas hand grenades, as well as 90,000 pairs of goggles were made in the spring of 1915. Like the Germans later on, their intentions were to use non-lethal agents to drive the Germans out of fortified positions. Also, non-lethal agents were chosen by the French so the promises made during the 1899 and 1907 Hague Conventions, could be honored.⁷ The use of these *cartouches suffocantes* would also provide postwar German chemists with a scapegoat when charges of war crimes and violations of the Hague Conventions were levied against Germany for the use of lethal agents that began in April 1915.⁸

In the fall of 1914, the Germans conducted experiments on creating chemical artillery shells. These experiments resulted from the shortage of nitrates needed for high explosives. Believing that the Schlieffen Plan would succeed, the Germans did not maintain large quantities of reserve ammunition and explosives. In addition, the Entente's blockade of Germany further cut into nitrate supplies as shipments from Chile were cut

⁷ L. F. Haber, *The Poisonous Cloud: Chemical Warfare in the First World War* (Oxford: Clarendon Press, 1986), 23-24.

⁸ Postwar German writers were quick to use the French use of tear gas to lay blame on the French for starting the gas war. For example, the German officer Captain Hermann Geyer often wrote in his various analyses of the chemical war that the French were to Blame. In one account, he proclaimed that the "genesis of the gas war (*Ursprung des Gaskrieges*)" came from France and not Germany. Geyer, "Der Gaskrieg," 527. In another, he explained that many people felt that German the German attack in Ypres was the first to use chemical weapons, but to Geyer "this interpretation is thoroughly incorrect (*Diese Darstellung durchaus unrichtig*)." Hermann Geyer, "Denkschrift betreffend den Gaskampf und Gasschutz," no date, Nachlass Hermann Geyer, N 221 23, p. 1, Bundesarchiv-Militärarchiv, Freiburg im Breisgau, Germany.

off.⁹ Yet these experiments proved troublesome, as the explosive used in the shell consistently destroyed the liquid irritant agent upon detonation of the projectile.

Still, by October 1914, the German army had adopted tear gas for military use. The Germans had some, albeit limited, experience in this field of research. In 1906, the German Navy (*Reichsmarine*) experimented with shells filled with the teargases bromaceton and xylyl bromide.¹⁰ In the fall of 1914, Bauer and Nernst developed and produced 3,000 experimental shells containing a sneezing agent codenamed “Ni” (Niespulver, or sneezing powder). As Duisberg developed the “Ni” agent himself, he also saw great potential in the product and its manufacture process.¹¹ Duisberg claimed at one point that his company could produce some 100,000 kilograms per month.¹² After testing the new rounds at Wahn, “Ni” shells were issued to troops on the Western Front. During an engagement near Neuve-Chapelle, the Germans fired at French troops using the new shells. The French troops, however, were unaffected by the low concentration of gas and Bauer and Nernst’s “Ni” bullets failed the practical test. The following month, a second attempt was made using shells designed by the chemist Hans Tappen. Dubbed “T-stoff” after their inventor, the new shells were filled with xylyl bromide, a stronger eye irritant than “Ni.” T-stoff shells, or “T-shells,” were tested and used on both the Eastern and Western fronts. Like Nernst’s “Ni” shells, however, Tappen’s shells failed to generate

⁹ Roger Chickering, *Imperial Germany and the Great War, 1914-1918*, 2nd ed. (Cambridge: Cambridge University Press, 2004), 36-38.

¹⁰ Letter from Farbwerke vorm. Meister Lucius & Brüning, Höchst am Main to the Königliche Kriegsministerium, Allgemeines Kriegs-Department, 10 November 1915, Abteilung Va, Rep. 5, Section B, I, File 515, Part 1 of 3, file page 16, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

¹¹ Johnson, “La mobilisation de la recherche industrielle allemande au service de la guerre chimique,” 94.

¹² See letter from Carl Duisberg to Fritz Haber, 16 November 1914, Abteilung Va, Rep. 5, Section B, III, File 960, p. 5, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

any noticeable advantage.¹³ At this point, Falkenhayn and the German General Staff became skeptical about the plausibility of non-lethal agents.

During the winter, further experiments were conducted by the military and Bayer chemists at the Wahn testing facility located just outside of Cologne and the Kaiser Wilhelm Institute. It was also at the KWI that for the first time the Germans tested lethal agents. Upon the recommendation of the famed chemist Dr. Emil Fischer, German chemical experts began testing a poisonous tear gas mixture (a combination of dichloromethylamine and cacodyl chloride). However, the substance was highly unstable. On December 14 during an experiment with the gas, Professor Gerhard Just poured dichloromethylamine from a test tube into a flask held by another scientist, Dr. Otto Sackur. Without warning, the substance detonated. The blast decapitated Sackur, and blew Just's hand off. After the accident, the death of Sackur ceased all further experiments and research on the compound.¹⁴

In November, the German army recognized that the dream of winning a quick, decisive war was fading. By the end of the year the Germans were already feeling the effects of the war on the home front. Casualties reached appalling levels by any measure. According to historian Roger Chickering, "the Germans lost more than 500,000 casualties in action on the western front and perhaps one-third as many in the east...the

¹³ Max Schwarte, ed. *Die Technik im Weltkriege* (Berlin: Ernst Siegfried Mittler und Sohn, 1920), 273, 279-280; Hans-Georg Bartel and Rudolf P. Huebener, *Walther Nernst: Pioneer of Physics and Chemistry* (London: World Scientific, 2007), 238-239.

¹⁴ Harold Hartley, "Report on German Chemical Warfare Organisation and Policy, 1914-1918," WO 33/1072, p. 34, The National Archives, London-Kew, United Kingdom.

campaigns of 1914 exhausted nearly all the available German stocks of war materials.”¹⁵
For some, gas seemed a viable option to break the stalemate and reduce casualties.

It was at this point that Germany committed to the development and use of lethal agents. The historiography of the decision is filled with errors and speculation, however it is quite clear that the decision made by the German High Command was made relatively quickly, and the initial plans to use lethal gas involved only a handful of men, primarily by the Chief of the German High Command, Erich von Falkenhayn, with assistance and advice from Max Bauer and Dr. Fritz Haber, head of the Kaiser Wilhelm Institute for Physical and Electrochemistry (KWI).

It is also important to point out the decision was made without the consent of civilian or political leaders. The historian Thomas Rohkrämer pointed out that horrific decisions by the German military – the shooting of women and children, the bombing of Paris, and unrestricted submarine warfare, among others - were often made alone by the military, regardless of the non-military consequences. “When the military found a method useful, it was brought into action independent of human (*menschlichen*) and political costs. . .”¹⁶ The decision to use poison gas was no different. When it came to chemical warfare, the Germans did not fully calculate the potential human and political consequences. Based on the surviving records, it can also be added that the environmental consequences such methods could bring were also never considered.

During the fall of 1914, Falkenhayn witnessed first-hand the German failure to take Paris. On September 28, he replaced the depressed and tired Field Marshal Helmuth

¹⁵ Chickering, *Imperial Germany*, 30.

¹⁶ Thomas Rohkrämer, *Eine andere Moderne?: Zivilisationskritik, Natur, und Technik in Deutschland 1880-1933* (Paderborn: Ferdinand Schöningh, 1999), 235.

Moltke as the Chief of the German General Staff in the wake of Germany's defeat at the Marne and subsequent stalemate. Not shy about expressing his feelings, Falkenhayn confessed his frustrations over the Schlieffen Plan's failure during first two months of the war in his diary, stating shortly before his promotion that "Our general staff has totally lost their heads," and "Schlieffen's notes have come to an end and therewith also Moltke's wit."¹⁷ Now in overall command of the Western Front, Falkenhayn was determined to succeed where his predecessor had failed. In short, Falkenhayn decided to employ lethal chemical agents primarily in response to the stalemate. Other German leaders, including the German Kaiser Wilhelm II, shared their approval of the new chemical weapons program.¹⁸ "It is magnificent," the King of Bavaria and his cabinet told Haber in a letter of support, "what German science and technology is accomplishing for the Fatherland at this serious time." The Kaiser also paid attention to chemical warfare developments and issued promotions and decorations based purely on its activities.¹⁹

Perhaps the most significant figure involved with the German chemical warfare program was Fritz Haber. Haber believed that science, especially chemistry, could be used to tip the scales of war in favor of Germany in a variety of areas, including logistics, agriculture, and armaments production. This belief, coupled with a patriotic sense of

¹⁷ Holger H. Herwig, *The Marne, 1914: The Opening of World War I and the Battle that Changed the World* (New York: Random House, 2009), 286.

¹⁸ For example, after the first gas attack at Ypres, the Kaiser promoted the chemical weapon expert Hans Tappen to the rank of Major General. Interestingly, the Habsburg Empire's Kaiser Franz Joseph refused to use gas unless it was used by his enemies first against Austri-Hungary first, despite pleas from his generals advocating for its use. It is unclear when Austria-Hungary began using gas, as the files concerning gas warfare in the Vienna Kriegsarchiv (Abt. 19/9) are missing. Holger H. Herwig, *The First World War: Germany and Austria-Hungary 1914-1918* (London: Arnold, 1997), 169-171.

¹⁹ Letter from the King of Bavaria's cabinet to Fritz Haber, 30 November 1914, 87-1.13, Bayer AG: Corporate History and Archives, Leverkusen, Germany.

national duty to Prussia, compelled Haber to offer his assistance to Falkenhayn. Haber was not unique in his *modus operandi*. Professor Dr. Arthur Binz wrote in 1915 that the German chemist “must find his satisfaction (*Genüge*); he must apply the grand lessons of science to the well-being of the great whole. . .The German chemist resembles therein the officer.”²⁰ Haber was therefore not alone; other German chemists at the time also supported the use of science for military purposes.

Haber’s vision of chemistry winning the war remained throughout the conflict, and he proved early on that his assertion was well founded. In order to produce oil, nitrates, and other strategic materials, the Germans organized an operation known as the *Ersatz* (replacement) program. Haber and his chemists succeeded in overcoming several material deficiencies, including ammonia, nitrates, rubber, and various metals. The Germans also had a process for using wood to create nitrocellulose.²¹

Most significantly, German chemists were able to overcome their deficient supplies of nitrates. One of the most significant discoveries in industrial chemistry during the twentieth century, in the decade leading up to the war Haber discovered a new process that synthetically produced ammonia from nitrogen gas (a process also known as nitrogen fixation). His work earned him promotions and worldwide recognition; he became the director of the KWI in 1911, and received a Nobel Prize for the discovery in 1918. Between 1910 and 1913, the chemist Carl Bosch developed the process on an

²⁰ Arthur Binz, *Der chemische Industrie und der Krieg* (Stuttgart: Deutsche Verlags-Anstalt, 1915), 7.

²¹ Jeffrey Allan Johnson and Roy MacLeod, “The War the Victors Lost: The Dilemmas of Chemical Disarmament, 1919-1926,” in Roy MacLeod and Jeffrey Allan Johnson, eds. *Frontline and Factory: Comparative Perspectives on the Chemical Industry at War, 1914-1924* (Dordrecht: Springer, 2006), 226.

industrial scale. The first large-scale ammonia production plant to use the Haber-Bosch method opened in Oppau on 9 September 1913.²²

Haber and Bosch's method alone saved the German war effort. When oxidized, ammonia can produce nitric acid, a key ingredient in explosives. At the inception of the war, Germany greatly underestimated the amount of ammunition needed for the conflict.²³ During their first major engagement at the first Battle of the Marne, historian Roger Chickering pointed out that "German armies expended more munitions daily than they had during the entire Franco-Prussian War."²⁴ Compounding this problem was the Allied blockade, which prevented the importation of nitrates into Germany. Without Haber, Germany would have been unable to prevent the munitions crisis from gripping their military, causing their forces to run out of ammunition and explosives and with it any chance of victory.²⁵ Although in 1914 the vast majority of nitrates did not originate from the Haber-Bosch process, after the blockade the demand for nitrates (and thereby ammonia) skyrocketed after the outbreak of the war. As a result of the ever increasing demand, during the war the Oppau plant was expanded to produce some 60,000 tons of ammonia per year. By 1917, the single largest source of German nitrates derived from

²² L.F. Haber, *The Chemical Industry 1900-1930: Industrial Growth and Technological Change* (Oxford: Clarendon Press, 1971), 90-95.

²³ As the Germans underestimated their ammunition needs and expenditure, so too did the Entente. For example, in Britain the population were horrified to read newspaper reports of severe shell shortages in France. Facing a panic, the government created under David Lloyd George a new Ministry of Munitions to tackle the problem. Soon afterwards, with the passage of draconian labor statutes with respect to armaments production (among them the seizure of private factories and the prohibition of labor strikes), the shortages largely ceased. Arthur Marwick, *The Deluge: British Society and the First World War* (London: Macmillan, 1965), 59-63.

²⁴ Chickering, *Imperial Germany*, 35.

²⁵ Volker Ullrich, *Die nervöse Großmacht: Aufstieg und Untergang des deutschen Kaiserreichs 1871-1918* (Frankfurt am Main: Fischer Taschenbuch Verlag, 2007), 457.

Haber-Bosch ammonia. The following year, the source represented half of the entire nation's production of nitrogen compounds.²⁶

After the completion of the first ammonia oxidation plant in Oppau, planning and construction of ten additional large nitrate factories began, capable of producing hundreds of tons of nitrates per month.²⁷ Food was also in short supply, and chemistry was used to help create edible alternatives to German dietary needs, including bread and sausage. Over 800 different types of Ersatz sausage were created during the war. By the end of the conflict, the Germans produced some 10,000 different types of Ersatz foods.²⁸ Historian Jeffrey Allan Johnson summed up Haber's attitude toward chemical weapons when he wrote, "The new chemical weapons were to be *Ersatz* themselves – a substitute for conventional munitions."²⁹ For Haber, using poison gas would not only break the stalemate at the front, but also aid in his nation's material shortfalls. After Haber visited the Wahn facility in December 1914 to watch a series of chemical tests, he proposed to the German High Command that chlorine would be a better choice for gas operations and volunteered to help.

Haber recommended chlorine for several reasons. As the element is 2.45 times heavier than air, the greenish-yellow colored gas sinks to the ground and therefore provides a longer saturation period than lighter gases. Its weight also enables the gas to

²⁶ Haber, *The Chemical Industry 1900-1930*, 200-201.

²⁷ For information of the the construction of the first large-scale ammonia oxidation plant, see Johnson, "Power of Synthesis," 163-164. On the number of production factories established, see Florian Schmaltz, *Kampfstoff-Forschung im Nationalsozialismus* (Göttingen: Wallstein Verlag, 2005), 19.

²⁸ Hew Strachan, *The First World War* (New York: Viking, 2003), 218.

²⁹ Jeffrey Allan Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany* (Chapel Hill: The University of North Carolina Press, 1990), 189.

drop into the contours of the trenches and dugouts where enemies are likely to hide. This property would also deceive the enemy into thinking fresh air would be available on the ground, similar to the behavior of avoiding smoke from a fire. Yet diving to the ground is exactly the wrong response. Chlorine is quite toxic, and in certain doses can cause death. Only 240 milligrams per cubic meter causes incapacitation when inhaled, while roughly 7,500 mg/m³ is lethal.³⁰ From a logistical standpoint, chlorine is also extremely inexpensive and easy to create (simply applying electrolysis to table salt). Both Bayer and the BASF routinely produced and sold chlorine before the war, as it was commonly used to create bleaches and dyestuffs.

Due to the inefficient and unsuccessful performance of gas shells thus far in combat, Haber suggested the use of large canisters as the method of deployment. The cylinders would be charged with liquid chlorine. Chlorine liquefies by applying high pressure and temperatures (under forty degrees Celsius, or 104 degrees Fahrenheit) to the element. The chlorine within the high-pressure canisters is released by simply turning a valve that decreases the chlorine canister's pressure. This action simultaneously causes the matter to convert to a gas and forces the material out of the container. The expunged gas would then be pushed naturally by the wind toward the desired target.

Not everyone among the German chemical leadership agreed with Haber's plan. Carl Duisberg, for example, rejected chlorine as an ideal substance. Instead, he enthusiastically advocated the use of phosgene, a colorless, odorless gas several times more toxic than chlorine. Haber argued against such a gas for two reasons. First, the German army had insufficient supplies of effective gas masks at the time. Haber felt

³⁰ Haber, *Poisonous Cloud*, 44.

phosgene would risk the lives of too many German infantry who would follow behind the cloud during the breakthrough. Second, Haber chose chlorine because it was the only gas that Germany had sufficient supply on hand for any potential assault.³¹

There is, however, a key drawback to using chlorine in a canister attack. The weapon's effectiveness relies entirely on the gas' concentration and, more importantly, wind direction. Therefore, environmental conditions must be suitable for any chemical attack to work. Once the gas cloud was created, it was impossible to control. As critics of Haber's plan were quick to note, prevailing winds in Western Europe blow from west to east, making any chemical attack a risky and potentially suicidal undertaking.

The decision to use lethal agents was not without reservations. Some within the German military and chemical leadership hierarchy felt the weapon was cowardly or uncivilized; others felt it was wrong because it would surely open the door for retaliatory attacks by the Entente. Dr. Emil Fischer, a Nobel Prize laureate in chemistry, expressed this notion in a letter to Carl Duisberg when he wrote "if he [Haber] succeeds, the French will soon figure it out and then turn the tables, which will be very easy for them to do."³² Fisher's criticisms, while valid and eventually prophetic, were never acted upon. The General Staff appointed Haber in charge of Germany's new chemical warfare program.

Despite their initial reluctance due to the physical and financial hazards of such an undertaking, German industrial leaders for the most part supported the new strategy.

Along with personal interest in the new branch of chemistry, chemical weapons

³¹ Harold Hartley, "Report on German Chemical Warfare Organisation and Policy, 1914-1918" WO 33/1072, p. 3, The National Archives, London-Kew, United Kingdom. On Haber's choice of chlorine, see also Rudolf Hanslian, *Der deutsche Gasangriff bei Ypern am 22 April 1915: Eine kriegsgeschichtliche Studie* (Berlin: Verlag Gasschutz und Luftschutz, G.m.b.H., 1934), 7.

³² Cited in Johnson, *Kaiser's Chemists*, 190.

development and manufacture would prove to be good for business. With the outbreak of war in 1914, the German chemical giants found themselves in a difficult situation. Blockades and export controls limited German chemical companies in the global market. Using primarily stocks already shipped out of the country, sales of chemicals continued to nations such as the United States, Spain and China, but the loss of Britain and France as both customers and suppliers of raw materials could not be replaced. Additionally, the loss of thousands of workers to the armed forces hampered production.³³ BASF, Bayer, and Höchst all manufactured products for the German chemical weapons program, with Bayer emerging as the primary supplier.

Bayer's director Carl Duisberg took a great interest in Germany's new chemical weapons program, often visiting the testing grounds at Wahn and writing letters to his colleagues about any new developments. For example, in a letter to Emil Fischer in March 1915, Duisberg wrote that "Because these experiments (with gas shells and mines) interest me a lot, we are naturally ready to make new mines and shells for explosive and shooting experiments posthaste."³⁴ Duisberg's personal enthusiasm likely made a significant contribution to the development of these new weapons, as he was willing to see Bayer become the largest manufacturer of chemicals during the war. Under Duisberg's direction, during the war Bayer produced almost every major chemical warfare toxin,

³³Jeffrey Allan Johnson, "The Power of Synthesis (1900-1925)," in Werner Abelshauser, et al. *German Industry and Global Enterprise, BASF: The History of a Company* (Cambridge: Cambridge University Press, 2004), 161.

³⁴ Letter from Carl Duisberg to Emil Fischer, 9 March 1915, 201-5.1, p. 2, Bayer History and Corporate Archives AG, Leverkusen, Germany.

including arsines, xylyl bromide, chloropicrin, phosgene, diphosgene, and mustard gas (dichlorethyl sulfide). Bayer also produced charcoal for the German gas mask industry.³⁵

BASF also made significant contributions, including the production of hundreds of tons of chlorine for Haber's cloud attacks. They also manufactured the vast majority of Germany's phosgene supply throughout the war. In addition, the company also produced many of the intermediates needed for mustard gas. BASF refused, however, to produce mustard gas itself, preferring instead to manufacture only the intermediates and raw materials.³⁶

The first German gas operation from beginning to end took almost four months of preparation. In January 1915 a special chemical warfare unit was created by the General Staff to carry out the chlorine attack. Placed in command of the unit was Colonel Otto Peterson, an officer from the engineering corps. Although he outranked Haber, Haber's expertise and control over the development of the attack gave him a more visible leadership role among the men, and Haber served as the primary instructor of gas technology and tactics. Otto Lummitzch, Peterson's adjutant, recalled after the war that one of the officers in his unit thought "Haber loved Colonel Peterson, like the animal trainer his lions."³⁷ Originally assigned 500 men, the new force were designated Pionierregiment 35, and interestingly codenamed "*Disinfektionstruppe* Peterson." Other German troops had a different nickname for them: the *Stinkpioniere*.³⁸ By April the force

³⁵ See "Manufacture Statistics" in General Vinet's translated report, WO 188/114, R7/G/4, The National Archives, London-Kew, United Kingdom.

³⁶ Johnson, "Power," 165.

³⁷ Otto Lummitzch, "Meine Erinnerungen an Geheimrat Professor Dr. Haber," August 1955, Abteilung Va, 5, Section B, III, 1480, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany, p. 2.

³⁸ Kim Coleman, *A History of Chemical Warfare* (New York: Palgrave Macmillan, 2005) 16.

had grown to 1,600 soldiers and scientists as the operation began to take shape. Among those involved were scientists of the highest professional standing, including of course Haber and Nernst, but also the physicists James Franck and Gustav Hertz and the chemist Otto Hahn. All five of these men received Nobel Prizes in their fields during their lifetimes.³⁹

The sector chosen for the operation was determined by which commander voluntarily accepted the orders to carry out the attack and the topography of the battlefield. All army commanders were asked to volunteer for the mission, and only one agreed to the task. Duke Albrecht of Württemberg, commander of the 4th Army and the German field commander at Ypres, accepted the assignment. At a meeting on 25 January, Falkenhayn ordered the Duke, as well as the Duke's senior officer, General von Deimling of the XV Corps, to carry out the gas attack.⁴⁰

The environment, specifically the region's topography, was also a critical factor. As the land is largely flat in that sector, the Belgian plains eliminated any chance of a natural barrier for the German gas cloud. This fact also played a significant role in the German invasion plans, as the flat terrain facilitated the German invasion of France. As one geographer noted in 1917, "the topographic features of western Europe. . . rendered a swift advance on Paris impossible from the east, but comparatively simple from the north over the broad pathway of the Belgian plain." When the American President Woodrow Wilson asked the Kaiser why the Germans had violated Belgian neutrality, the Kaiser

³⁹ Olaf Groehler, *Der Lautlose Tod: Einsatz und Entwicklung deutscher Giftgase von 1914 bis 1945* (Hamburg: Rowohlt Taschenbuch Verlag GmbH, 1989), 27; Trumpener, "Road to Ypres," 471.

⁴⁰ Deimling's chief of staff and the Duke of Württemberg's chief of staff, Lieutenant General Emil Ilse, also attended. Berthold von Deimling, *Aus der alten in die neue Zeit* (Berlin: Ullstein AG., 1930), 201. Haber, *Poisonous Cloud*, 28-31.

replied honestly that “Belgian neutrality had to be violated by Germany on strategic grounds.”⁴¹ While gas warfare was not conceived of at the time of invasion, it is nonetheless important to point out that the environmental conditions favored by the Germans in their invasion plans facilitated the use of gas later in the war.

The German High Command (*Oberste Heeres-Leitung*, or OHL) originally ordered 6,000 commercial gas cylinders for the operation. The cylinders were roughly one and a half meters tall and weighed eighty-five kilograms, containing forty kilograms of gas. The order proved to be far too ambitious, as only 1,600 large and 4,130 small cylinders were sent to the front. Whereas Haber wanted a total of seven hundred tons of chlorine, he only received one hundred fifty tons. Meanwhile, Haber and Peterson’s new unit practiced releasing chlorine filled canisters at Wahn. For security reasons and, as one German officer commented, “one could hardly afford to have the smell of chlorine spread out for miles and miles,” a full-scale training operation was not performed.⁴² In sum, the cloud created at Ypres would be on a scale never before attempted.

Over the next two months, the cylinders were buried among dirt and sandbags along a seven kilometer front. This was dangerous work, not simply because the cylinders could rupture but because the German trenches were in such close proximity to enemy artillery and machine gun positions. In many cases the cylinders were placed only ten to twenty meters from the enemy trenches.⁴³ On at least one occasion, enemy fire

⁴¹ Douglas Wilson Johnson, *Topography and Strategy in the War* (New York: Henry Holt and Company, 1917), 25.

⁴² Ulrich Trumpener, “The Road to Ypres: The Beginnings of Gas Warfare in World War I,” *The Journal of Modern History*, Vol. 47, 3, (September 1975): 468.

⁴³ Otto Lummitzsch, “Meine Erinnerungen an Geheimrat Professor Dr. Haber,” August 1955, Abteilung Va, 5, Section B, III, 1480, , p. 3, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

ruptured two gas cylinders, causing them to explode. The gas killed three men and poisoned another fifty. After visiting the hospital and speaking with his troops after the incidents, General Deimling admitted that the events profoundly shook (“*schwer erschüttert*”) the confidence of his men.⁴⁴

On April 13, German Private August Jaeger of the 234th Infantry Regiment, 51st Reserve Division, deserted his post, crossed enemy lines, and turned himself into the French near Langemarck. The soldier informed members of the French 11th Division of the coming poison gas attack, and even showed off his protective mask. The commander of the 11th Division, General Edmond Ferry, sent warning notices to British commanders. Rather than being praised, Ferry was reprimanded for not following protocols, and his account was dismissed as “nonsense.” Other clues and a report by Belgian spy warning of a potential gas attack were ignored. Miraculously, the Germans maintained the element of surprise.⁴⁵

On the morning of April 21, Falkenhayn held a meeting with the Duke at the Front to discuss the procedure of the attack. Due to poor weather, German commanders delayed the attack until April 22. The gas was scheduled to be released at 6:45 A.M. When morning came, the Germans found the weather still unfavorable due to a lack of

⁴⁴ Deimling, *Aus der alten in die neue Zeit*, 202.

⁴⁵ For reasons unknown, in a 1932 magazine article recalling the events at Ypres General Edmund Ferry used Jaeger’s real name in the narrative. The German government caught wind of the article, located the German deserter, and arrested him. Jaeger, who had claimed he was legitimately captured so he could return home, was given a ten year prison sentence. When the Nazis took over Germany the following year, Jaeger vanished and was “not heard from again.” Winston Groom, *A Storm in Flanders. The Ypres Salient, 1914-1918: Tragedy and Triumph on the Western Front* (New York: Grove Press, 2002), 100; George Cassar, *Hell in Flanders Fields: Canadians at the Second Battle of Ypres* (Toronto: Dundurn Press, 2010), 93-94.

wind. The attack was rescheduled for the later afternoon.⁴⁶ At 4:00 P.M. local time, the Germans began to release the gas as supporting artillery fire roared overhead.

Like the landscape determining the site, again natural agents came into play. Due to diffusion and the warmth of the ground, the gas began to rise. This created a massive cloud unlike anything seen before. Both German and Allied troops were terrified at the sight. One German pioneer remembered that “the infantry are all very glad to be away from the front-line trench when the cloud is sent over.”⁴⁷ Observing the attack from a distance, British Major G.O. Chambers noted in his diary that he saw “a greenish haze was seen . . . over the country where the battle was raging – being probably another method of German warfare.”⁴⁸ The tanks emptied their deadly contents, forming a yellow-green cloud some ten to thirty meters high.⁴⁹ Propelled by the wind at a rate of five to six miles per hour, the cloud slowly crept westward across no man’s land.⁵⁰ As the cloud approached the perplexed and terrified French and Algerian defenders, the men’s eyes began to water and their throats began to tingle. Once enveloped by the deadly cloud, the men reacted in a variety of ways. Some ran to escape, while others went to the ground in a desperate search for air. Many, however, became paralyzed by the gas. As the

⁴⁶ Reichsarchiv, *Der Weltkrieg: 1914 bis 1918, Die Operationen des Jahres 1915, Achter Band* (Berlin: E.S. Mittler & Sohn, 1932), 28-29.

⁴⁷ Edward M. Spiers, *Chemical Warfare* (Houndmills, UK: The MacMillan Press LTD, 1986), 28.

⁴⁸ G. O. Chambers, Diary, 22 April 1915, File # 02/29/1, Imperial War Museum, London United Kingdom.

⁴⁹ The color of the cloud varies among the historical accounts. For example, the Reichsarchiv’s official history of the war, *Der Weltkrieg*, described the cloud as white-green (*eine weißgelbe Wolkenwand*) in color. *Der Weltkrieg Achter Band*, 40. Another early German account by Captain Hermann Geyer described it as “whitish yellow.” Geyer, “Der Gaskrieg,” 501.

⁵⁰ Valerie Adams, *Chemical Warfare, Chemical Disarmament* (Bloomington: Indiana University Press, 1990), 28.

soldier's lungs filled with the gas, the bronchial tubes in their lungs burned and the men began to suffocate.⁵¹

When the cloud reached the Allied lines, the men who chose not to run inhaled their first breaths of the toxic chlorine to nightmarish effect. Those who were gassed could only speculate as to what hit them. One soldier, Jack Randell, wrote in a letter home that "They had a great screen of sulfur in front of them, and it choked us..[we] died by the score from some devilish compound in the shells [*sic*] which asphyxiated them" Randell died of chlorine poisoning shortly after finishing the letter.⁵² British Private W.

A. Quintin recalled what it was like in the midst of the cloud:

We caught our first whiff of it. No words of mine can ever describe my feelings as we inhaled the first mouthful. We choked, spit, and coughed, my lungs felt as though they were being burnt out, and were going to burst. Red hot needles were being thrust into my eyes. The first impulse is to run. . . We crouched there terrified - -- stupefied. We lay with our noses in the mud, fighting for breath, forgetful of the bursting shells. I felt myself choking, I could not stand it much longer, I would have to get up and run...Had we but known it we were doing about the worst thing we could have done by putting our noses to the ground, for the gas being heavier than air, clung to the earth and hung about in the trenches and hollows, and we were acting as if dealing with smoke.⁵³

Those who managed to escape with their lives did not escape the scene of suffering and the screams of the other victims. In some places pandemonium broke out, particularly among the Algerian colonial troops. Colonel Jean J. Mordacq, a brigade commander of

⁵¹ Jonathan B. Tucker, *War of Nerves: Chemical Warfare from World War I to Al-Qaeda* (New York: Pantheon Books, 2006), 14.

⁵² Randell attributed the gas incorrectly to shells, instead of cylinders. Jack Randell, Letter, 28 April 1915, 5. In the papers of Major R D Russell, File 88/18/1, IWM, London, UK. Randell's death is noted by an unknown writer on the back of the letter in a handwritten note.

⁵³ W. A. Quinton, Memoir, 1929, File #79/35/1, Imperial War Museum, London, United Kingdom. p. 50-51.

the 45th Algerian division watched as soldiers "...running around like madmen, begging for water in loud cries, spitting blood, some even rolling on the ground making desperate efforts to breathe."⁵⁴ Private Quinton recalled "Black in the face, their tunics and shirt fronts torn open at the necks in their last desperate fight for breath, many of them lay quite still while others were still wriggling and kicking in the agonies of the most awful death I had ever seen."⁵⁵ Colonel G. W. G Hughes of the medical corps wrote that "I shall never forget the sights I saw by Ypres after the first gas attacks...Men lying all along the side of the road between Poperinghe and Ypres, exhausted, gasping, frothing from yellow mucus from their mouths, their faces blue and distressed...I have seen no description in any book or paper that exaggerated or even approached in realization the horror, the awfulness of these gassed cases."⁵⁶ Years after the attack, General Deimling avoided chronicling the gruesome effects of the gas on the enemy in his memoirs. He solemnly wrote, "The effect was catastrophic."⁵⁷ Within twenty minutes, the Germans successfully sent two entire divisions, numbering some 10,000 men, in a full, terrified retreat.

At 4:15 P.M., the German infantry carefully began their advance behind the cloud across no man's land.⁵⁸ To provide protection against the gas, the men wore pads dipped in sodium thiosulphate solution over their noses and mouths.⁵⁹ By the end of the evening,

⁵⁴ James L. McWilliams and R. James Steel, *Gas! The Battle for Ypres, 1915* (St. Catherines: Vanwell Publishing Limited, 1985), 48.

⁵⁵ *Ibid*, 51.

⁵⁶ Modris Ecksteins, *Rites of Spring* (Boston: Houghton Mifflin Company, 2000), p. 162.

⁵⁷ Deimling, *Aus der alten in die neue Zeit*, 203.

⁵⁸ *Der Weltkrieg, Achter Band*, 40.

⁵⁹ William Van der Kloot, "April 1915: Five Future Nobel-Prize Winners Inaugurate Weapons of Mass Destruction and the Academic-Industrial-Military Complex," *Notes and Records of the Royal Society of London*, Vol. 58, No. 2 (May 2004): 152.

the Germans secured the villages of Langemark and Pilkem. Approximately 2,000 of the survivors were taken prisoner, the vast majority of whom were the French colonial forces. Additionally, German forces captured a fair amount of equipment, including fifty-one artillery pieces and some seventy machine guns.⁶⁰ It seemed a breakthrough was imminent.

Yet Falkenhayn's skepticism resulted in a failure by the Germans to achieve a total breakthrough. Reserve units of reinforcements to support the initial advance were no longer available. The reserves had been sent to the Eastern Front by impatient generals, who felt the troops were of better service against the Russians on the Austrian-Hungarian Front instead of waiting for the weather to favor a gas attack.⁶¹ In addition, the orders for the advancing Germans said to halt after seizing Langemark and Pilkem. No new orders were sent to the spearheading units on what to do after the initial objectives were met. Additionally, the fear of poisoning their own troops also hung over the German commanders, as they failed to bring up the necessary reserve units needed to continue the advance.

Despite subsequent gas attacks during the next few weeks against Canadian and British forces, the Germans had little to show for their efforts in the sector. Five more gas discharges took place; none of which resulted in a breakthrough. This was due in part to the rapid distribution of protective gas helmets by the Allies among their front line troops. Immediately after the initial attack, the London press urged women to construct and donate cotton masks to distribute to the unprotected troops at the front. The response

⁶⁰ *Der Weltkrieg, Achter Band*, 41; Haber, *Poisonous Cloud*, 34; Tucker, *War of Nerves*, 15.

⁶¹ Haber, *Poisonous Cloud*, 32; Charles, *Master Mind*, 163.

by the British public was substantial. Over 36,000 pads were submitted in the first thirty-six hours alone and distributed in a matter of days to the troops at the front.

Unfortunately, the pads were useless to the troops and failed to stop the gas as discovered during subsequent gas attacks in early May 1915. However, a protective respirator would arrive shortly and all British forces at the front had one by May 20.⁶²

The men did not have to wait long to put the new masks to use. One of the last major chlorine cloud attacks of the battle occurred during the wee hours of May 24. As British Lieutenant General Sir C.F.N. Macready noted in his report after the action, the engagement commenced at roughly 2:45 A.M., when the Germans released a massive gas cloud that engulfed the town of Ypres. The cloud was described as whitish green, and sufficient enough to “blot out houses and trees from view.” Buildings were engulfed in the toxic cloud, and respirators were worn as far back as a mile and a half from the front lines. Traces of the gas were found as far back as six miles, and some claimed the gas reached as many as nine miles behind the trenches.⁶³ Still, despite the intense concentration of the gas, the British troops were prepared. “The respirators and helmets provided,” Macready concluded, “were adequate protection against chlorine if they were properly used.”⁶⁴

Just over a month after the Ypres operation, the Germans unleashed a massive chlorine cloud in the east against the Russians. On May 31, the Germans launched their

⁶² Haber, *Poisonous Cloud*, 45-46.

⁶³ C.F.N. Macready, “Report on Gas Attack, 23rd – 24th May, 1915,” 26 May 1915, WO 32-5169, p. 1, The National Archives, London-Kew, UK.

⁶⁴ *Ibid*, p. 3, The National Archives, London-Kew, UK.

first cylinder chlorine gas attack on the Eastern Front near Nieborow.⁶⁵ Like the assault in Belgium, the gas inflicted heavy casualties on the ill-prepared Russians but the failure to support the attack with infantry translated to no tangible military victory for the Germans.

Haber was both disappointed and furious with the results. After the war Haber and Nernst often claimed in interviews with Allied chemical experts that the attack was only an experiment (*Versuch*), and dismissed the assault's poor implementation.⁶⁶ Still, the attack killed hundreds of Allied soldiers. While no definitive estimates exist, the casualties reported for the battle were between two hundred (German estimates) and six hundred twenty-five (French estimates). The Allied press claimed 5,000 killed and 15,000 wounded, although they had reason to exaggerate the numbers for its propaganda value.⁶⁷

Few believed the German action at Ypres was anything but a strategic failure. This was an almost universally held opinion among both sides, with few on the German side willing to call it a success. One member of the German high command, Erich von Falkenhayn, claimed it was indeed successful, although acknowledged the assault's failure to achieve the desired breakthrough. Falkenhayn had surprisingly little to say about the attack in post-war writings, and went so far as to say "Its surprise effect was very great. Unfortunately we were not in a position to exploit it to the full. The necessary reserves were not ready. The success achieved, however, was considerable. The English

⁶⁵ F. P. Kerschbaum, "Die technische Ausführung. 1. Die Gaskampfmittel," in Schwarte, *Technik im Weltkrieg*, 282.

⁶⁶ See Harold Hartley, notes, "Allierte Kontrollcommission, Untersuchungsprotokolle," Abteilung Va/1/528, p. 9, Archiv zur Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

⁶⁷ Holger H. Herwig, *The First World War: Germany and Austria-Hungary, 1914-1918* (London: Arnold, 1997), 168; Haber, *Poisonous Cloud*, 39.

suffered heavy losses.”⁶⁸ The Kaiser was perhaps the most optimistic regarding the operation, as afterwards he immediately promoted Haber to the rank of Captain and awarded him with the Iron Cross First Class.⁶⁹ While the Allies did suffer heavy casualties, the Germans failed to capitalize on the element of surprise. Now with the Allies aware of German intentions to use such weapons, precautions were immediately taken. The Germans would not recapture the same level of surprise with chemical weapons against the enemy until 1916, when the Germans finally perfected their gas shell construction techniques.

Response to the attack by the Allied soldiers and press was filled with outrage and disgust. In a telegram to the British Expeditionary Force’s commander Field Marshal Sir John French, British Secretary of War Lord Kitchener wrote that the use of asphyxiating gas in warfare by the Germans “show to what depths of infamy our enemies will go in order to supplement their want of courage in facing our troops.”⁷⁰ *The Times* in London decried that “a very barbourous form of attack had been carefully planned by the enemy,” and “demands have been made for reprisals in kind, and a bitter hatred of the Germans is generally expressed, especially by the rank and file.”⁷¹ In addition, the terror instilled by this new form of warfare resonated among troops on both sides. Aside from the gruesome

⁶⁸ Erich von Falkenhayn, *The German General Staff and its Decisions, 1914-1916* (New York: Dodd, Mead and Company, 1920), 94.

⁶⁹ For Haber’s promotion, see Otto Lummitzch, “Meine Erinnerungen an Geheimrat Professor Dr. Haber,” August 1955, Abteilung Va, 5, Section B, III, 1480, p. 6, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany; on the Kaiser’s awarding of the Iron Cross to Haber, see Herwig, *First World War*, 170.

⁷⁰ Lord Kitchener, telegram, 24 April 1915, WO 32-5177, p. 50B, The National Archives, London-Kew, United Kingdom.

⁷¹ “The Poison Gas,” *The Times*, 1 May 1915, Issue 40843, p. 7.; “British Troops and Poison Gas,” *The Times*, 15 May 1915, Issue 40855, p. 8.

nature of someone dying from poison gas, troops simultaneously realized that there was no “escape” or sure-fire method of defense against this new weapon. Underground concrete bunkers will protect you from artillery shells. Sandbags will protect you from bullets. But none of these traditional types of fortifications can protect you from gas.

The primary anti-gas tool used during the war, the gas mask, had existed for decades prior to the First World War. The first modern gas mask and respirator systems were developed during the mid eighteenth century, and by the twentieth century numerous companies were producing masks for the coal and chemical industries, sewer maintenance personnel, fire brigades, and submarine crews. Most of the components and features of the successful masks produced during the war after 1916 had long existed already.⁷² Throughout the course of the war, as mask technology improved, nations strove to develop deadlier gases that either circumvented the mask or penetrated the neutralizing agent (which for most masks was charcoal).

Nevertheless, mask and respirator production during the war by both sides was an extraordinarily large undertaking. For the Allies, the British Anti-Gas Department produced the majority of Allied respirators. During the war, the Department produced some fifty million anti-gas masks of all types, almost all of which were manufactured, assembled, and inspected by women.⁷³ Due to the hazardous nature of the work, the large respirator and mask production facilities sometimes required a bit of creativity in their construction. In Britain, a shortage of manufacturing facilities compelled the British to convert one of their soccer stadiums to a massive gas mask factory. White Hart Lane in

⁷² Ibid, 16-17.

⁷³ M. Carey Morgan, “Report on the Work of Women in Connection with the Anti-Gas Department,” c. 1919, WO 142/263, 4, The National Archives, London-Kew, United Kingdom.

North London, home of the Tottenham Hotspurs football club, became a major manufacturing center for box respirators in July 1916. Sewing machines were installed within the tunnels that ran around the perimeter of the pitch. The newly-sewn respirators then needed to be “doped,” the process by which the mask is dipped in protective chemicals that counteract the toxic gasses. Due to the smell of the chemicals, the stadium’s grand stand was converted into the doping plant and packing facility. The open air seating in the bleachers made for an ideal ventilation system. As one might imagine, the winter months were particularly harsh on the workers. While not a perfect solution, a glass roof was constructed over the stands and hot water pipes were run underneath the workers to provide some shelter and warmth during the cold months. So successful was the plant that a mask repair and recycling facility was added to the grounds the following August in 1917. By then, the grounds employed between 4,000 and 5,000 workers, producing tens of thousands of respirators.⁷⁴ To this day, the ‘Spurs still play their home games on the same grounds at White Hart Lane.

German gas masks evolved rapidly during 1915. The simple protective pads were replaced by a more modern looking, full-facial mask that was secured around the forehead, cheeks, and chin. The new masks were constructed of rubber and used eye pieces to protect the men’s vision. By the end of the year, 1.8 million masks had already been produced for military usage. Production only increased as the war continued. In 1916, 8.6 million were constructed, with some 40,000 masks assembled daily.⁷⁵ By the

⁷⁴ J. Newton Friend, “Historical Report of the Mask Factory at Tottenham,” January 1919, WO 188/3, pgs. 1-3, The National Archives, London-Kew, UK.

⁷⁵ See reprint of Dr. Jos. Wirth, “Kampfstoffkrankungen im Weltkrieg,” 1936, Abteilung Va, Rep. 5, Section B, I, File 532, p. 1, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

end of the war, the Germans were using masks which covered the entire head, and used a charcoal filled drum to filter toxic materials from the air.⁷⁶

Meanwhile, the British found themselves woefully unprepared to wage chemical warfare. The Germans dwarfed the British chemical industry's research and production strength, and a unit that specialized in chemical warfare did not even exist in the British military. Roughly one month after the German attack at Ypres, the British had organized a chemical warfare unit of their own, designated the Special Companies. Like the German "Disinfektionstruppe," the British unit was composed of a mixture of scientists and soldiers, and was placed within the Royal Engineers branch of the army. On May 26, Major Charles Foulkes was appointed head of the unit and immediately began planning the retaliatory attack. The operation took roughly three months to plan, largely under orders from General Sir Douglas Haig, who authorized the operation. Like the German attack in the spring, the British plan was to create a massive chlorine cloud using gas cylinders to achieve a breakthrough.

Preparations for the attack consumed the summer months of 1915. Numerous obstacles had to be overcome. Foulkes required time to train his new units, and the gas itself needed to be produced. When compared to the German chemical industry's production of war gasses, the British capabilities were pathetic. Chlorine would be chosen for the attack, because it was the only war gas the British could produce quickly at that time. It would take some time to produce the gas, as only one company in Britain manufactured liquid chlorine. Their factory produced just one ton per day. Bayer, BASF,

⁷⁶ "Development of German Gas Defence Appliances," 17 December 1918, WO 142/284, pgs. 1-2, The National Archives, London-Kew, UK.

and the other chemical companies were producing some forty tons of liquid chlorine per day.⁷⁷

Coinciding with a planned French offensive, Artois was chosen as the location for the attack, specifically near the mining town of Loos. The terrain at Loos was flat with no obstacles between the lines, and with the westward winds the British felt the gas would work. The British prepared 5,500 cylinders, containing some one hundred fifty tons of chlorine.⁷⁸ After poor weather delayed the attack for ten days, Haig finally gave the order on the evening of September 24 to release the gas at 5:50 A.M. the following morning. On September 25, the signal was given and the men turned the cocks on their cylinders while Stokes mortar men fired smoke bombs. Yet the cylinders that the British used for the operation were of poor quality and betrayed them when it counted. Some of the pipes cracked when the gas was released, some leaked their contents prior to their set up, others refused to open, and some of the valves even froze from the gas discharge.

Lieutenant Charles A. Ashley, member of the Special Company 187 and responsible for a dozen canisters, was shocked to find that of the twelve cylinders he was responsible for, only ten were released on his signal. The others malfunctioned, much to the chagrin of the men who tried repeatedly to release the broken valves. In a desperate attempt to discharge their payload, two of the men lifted their canisters out of the ground and advanced forward, carrying the nearly two hundred pound cylinder. After dropping

⁷⁷ Harold Hartley, "A General Comparison of British and German Methods of Gas Warfare," 26 November 1919, Hartley Papers, Box 33 AI, Folder 6, p. 3, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

⁷⁸ Martinetz, *Der Gaskrieg 1914/18*, 53.

their tanks, they took several steps back from the canisters and then tried to shoot the tanks with small arms fire to release its contents. Their efforts were unsuccessful.⁷⁹

Yet it would be the environmental conditions that day that ultimately determined the fate of the British, rather than simply faulty equipment. The weather conditions became erratic, and the poison cloud soon drifted to mix with the one generated from the smoke barrage. As a result of poor equipment and disagreeable weather, just over half the expected amount of chlorine (around eighty tons) was released. Despite the shifting conditions, forty minutes after the release of the gas British infantry went over the top and into the cloud.⁸⁰ Suddenly, however, the wind died down in the center and right flank of the attack bringing the cloud to a standstill. On the left flank, however, the wind changed to a westward direction, blowing the gas into the advancing British troops.

Wading through their own cloud, the advancing British forces made some territorial gains. Lack of visibility, not the presence of the cloud, compelled the Germans to evacuate their trenches and redeploy. They did with some success, and were able to halt the British advance composed of troops forced to go through their own cloud. Gas casualties among the Germans were light as only 106 men were reported as gas cases, none of whom died of their chlorine inhalation. After redeployment, the wary British could not hold their gains and were forced to retreat back to their trenches.

Despite their losses from those captured or caught by the gas, the Germans were largely unharmed by the chlorine and slaughtered the British troops advancing through

⁷⁹ Lieutenant C A Ashley, Memoir, File # 85/22/1, Imperial War Museum, London, United Kingdom.

⁸⁰ Albert Palazzo, *Seeking Victory on the Western Front: The British Army and Chemical Warfare in World War I* (Lincoln: University of Nebraska Press, 2000), 68.

the cloud. The British captured eighteen guns and took 3,000 German prisoners, but the attack was anything but a success. The poison cloud on which the entire assault depended upon was stagnant and quite deadly for the attackers. Between 25 September and 27 September, the British counted 2,632 gas cases, seven of which were fatal. Combined with those killed by conventional weapons, such as machine guns and artillery, the British suffered a total of 50,000 casualties during the operation.⁸¹ Not surprisingly, there is consensus among both witnesses and historians that the Battle of Loos was a total failure for the British. The historian Donald Richter wrote, “in truth, the British attack at Loos had been an unmitigated failure.”⁸² L.F. Haber, historian and the son of Fritz Haber, simply stated “Gas had failed at Loos.”⁸³ Although considered a failure, valuable lessons were taken from the battle from both sides.

The British realized better training and equipment will be necessary for future operations to limit friendly casualties. Although new masks and better discipline would emerge, men would continue to die at the hands of their own gas for the remainder of the war, due to a number of circumstances, including changes in the wind direction and accidents. For example, fifty-seven British soldiers were killed by their own gas at the Somme in June 1916.⁸⁴ The British were nevertheless undeterred from chemical warfare; fifty-seven men were but a drop in the bucket in terms of the 190,000 total British deaths

⁸¹ Robert Harris and Jeremy Paxman, *A Higher Form of Killing: the Secret History of Chemical and Biological Warfare* (New York: Random House, 2002), 17.

⁸² Donald Richter, *Chemical Soldiers: British Gas Warfare in World War I* (Lawrence: University Press of Kansas, 1992), 86.

⁸³ Haber, *Poisonous Cloud*, 57.

⁸⁴ Harris and Paxman, *Higher Form of Killing*, 21.

at the Somme during the the months of July and August.⁸⁵ The British invested millions into expansion of their chemical warfare program. During the war the British opened thirty-three laboratories, testing 150,000 compounds in search of viable chemical agents.⁸⁶ For the Germans, they now believed gas was not just an *Ersatz* weapon, but rather more of a psychological one to be used along with conventional arms.

By the fall of 1915, the Germans began using deadlier gases in their canister attacks, as chlorine was easily detected and gas defenses had rendered the gas almost worthless. Fritz Haber was adamant throughout the war that his chemists must continue to search for new chemicals for the war effort. “With the length of the war,” declared Haber to a group of industrial representatives during a meeting in May 1918, “grows the requirement of new gas warfare agents.”⁸⁷ Aside from chlorine, the most common gas used was phosgene (COCl_2). During the late nineteenth century, the German dye industry began using phosgene for processing colorfast materials. Around the turn of the century, chemists saw potential in its toxic properties and the compound emerged as an effective pesticide.⁸⁸ The substance is extremely dangerous, as it is roughly six times more toxic than chlorine.⁸⁹ Like chlorine, it is heavier than air (approximately 3.5 times heavier),

⁸⁵ Herwig, *First World War*, 204.

⁸⁶ Edmund P. Russell, “‘Speaking of Annihilation’: the Mobilizing for War Against Human and Insect enemies, 1914-1945,” *The Journal of American History*, Vol. 82, No. 4 (March 1996): 1511.

⁸⁷ “Protokoll der Besprechung mit den Vertretern der Industrie über den Stand der Gaskampfstoffe vom 15. Mai 1918,” Abteilung Va, Rep. 5, 522, p. 5, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany. There is also a copy of this document in “Kampfstoffe und Vorprodukte im I. Weltkrieg, Band I,” P71, Unternehmensarchiv der BASF, Ludwigshafen, Germany.

⁸⁸ James A.F. Compton, *Military Chemical and Biological Agents: Chemical and Toxicological Properties* (Caldwell: The Telford Press, 1987), 119.

⁸⁹ The median lethal dosage (LC_{50}) of chlorine is 19,000 mg-min/m³; for phosgene, just 3,200 mg-min/m³. *Ibid*, 116; 122.

making it ideal for cylinder attacks.⁹⁰ However, phosgene is a colorless gas, making it especially difficult to detect during the daylight hours, let alone at night. Capable of killing virtually all organic life, to this day phosgene remains an ingredient in many herbicides and pesticides. This lethality, along with its delayed physiological response and colorless characteristics, explains why it was the most deadly of all the war gasses. It is estimated that eighty percent of those who died of gas during the war were victims of phosgene inhalation.⁹¹

Upon World War I battlefields, phosgene first appeared on a massive scale at Champagne on October 19, 1915 where it composed one fourth of the total number of gas cylinders used during a massive chlorine-phosgene cloud attack (roughly 125 tons of phosgene).⁹² Larger attacks followed, including one attack on December 19 that created a phosgene cloud eight miles wide that travelled roughly ten miles into the Allied lines before the cloud fully dissipated. Hundreds were gassed, with a total of one hundred and twenty men succumbing to gas poisoning.⁹³ In February 1916, the French became the first nation to use gas shells charged with phosgene when they deployed them against the Germans at Verdun.⁹⁴ That summer, the British began charging chemical shells with the substance, and the new British phosgene shells appeared for the first time at the Battle of the Somme. Phosgene eventually became the main battle gas for the British Army, which

⁹⁰ Rudolf Hanslian, *Der chemische Krieg* (Berlin: E.S. Mittler & Sohn, 1927), 41.

⁹¹ Compton, *Military Chemical and Biological Agents*, 119-120.

⁹² Haber, *Poisonous Cloud*, 57-60.

⁹³ Groom, *Storm in Flanders*, 137-138.

⁹⁴ Lepick, *La Grande Guerre chimique*, 184. Based on the surviving evidence, it is unknown when the French developed and manufactured the new shells. Lepick located, as he described it, an “enigmatic French document (*Un document français sibyllin*)” in the Service historique de l’armée de l’air (Vincennes) that alludes to French phosgene shell testing in January 1916. In any case, the whole story remains unclear.

used it extensively during the battle. The British conducted at least 110 cloud attacks during this battle alone. German newspapers reacted to the attacks with scorn, often highlighting the gas' environmental properties and reactions. "The English and French have fallen so desperately in love with this atmospheric weapon that they incessantly claim its help," the *Vossische Zeitung* declared, and "The plague is steadily getting worse. In the trenches themselves it is particularly unpleasant, because here it settles down and cannot be easily dissipated by the wind. But even in the open country it pursues its course and tortures human beings."⁹⁵ Most of the attacks used a gas the British codenamed "White Star," a mixed gas containing fifty percent chlorine and fifty percent phosgene.⁹⁶

Even more terrifying for the men, however, was the delayed physical reaction victims had after exposure to the gas. Soldiers noted that they had a taste develop in their mouths similar to "hay" when they came in contact with it. After several hours, men became seriously ill, and in many cases death came swiftly and suddenly. One British report after a German phosgene attack in December 1915 noted that twelve hours after the initial cloud attack, a number of men died suddenly, despite showing little sign of any chemical exposure. Of the 1,069 gas cases reported during the attack, 116 were fatal.⁹⁷

Despite phosgene's higher toxicity, however, the modern British and German respirators and gas masks were effective countermeasures. So long as adequate warning was given to the men and the masks were used properly, phosgene casualties could be

⁹⁵ Charles H. Foulkes, *Gas! The Story of the Special Brigade* (Edinburgh: William Blackwood & Sons Ltd., 1934), 126.

⁹⁶ Charles H. Foulkes, "Report of the Activity of the Special Brigade during the War," 19 December 1918, WO 142/337, p. 1, The National Archives, London-Kew, UK.

⁹⁷ "An Account of German Cloud Gas Attacks on British Front in France," WO 142/284, pgs. 7-8, the National Archives, London-Kew, UK.

kept under control. The success of the British anti-gas measures compelled German chemists to develop stronger toxins, either to penetrate the mask itself or harm the enemy in some other fashion. The following year in 1916, other toxins appeared, notably trichloromethylchloroformate (also known as diphosgene or Perstoff), arsenic-based liquids, and chloropicrin.⁹⁸

In sum, the gas cloud attacks of 1914-1916 left much to be desired. As Harold Hartley concluded in the early 1920s, “It was the general opinion of all the experts...that cloud attacks were of little value against well disciplined troops equipped with an efficient respirator, as adequate warning was usually given both by the noise of the discharge (all efforts to prevent this had failed) and by the appearance of the gas.”⁹⁹ Yet just as the use of chemical weapons seemed to be discounted as viable, two major technological breakthroughs were achieved which would have long-lasting consequences on Europe: the chemical shell and the development of mustard gases.

Research continued in Germany on other chemicals for possible use in chemical shell, which up until this point had been unsuccessful. Experiments were conducted on a variety of chemicals, including arsenic-based compounds and dimethyl sulfate, an odorless gas with a delayed reaction period that proved highly lethal in laboratory tests. Although rejected for use in shells, the chemical did lead chemists to experiment with

⁹⁸ Later in the war, the United States Chemical Warfare Service favored chloropicrin, capable of producing some three million pounds of it monthly at the Edgewood Arsenal by the end of the war. Edmund P. Russell, “Speaking of Annihilation,” 1508.

⁹⁹ Hartley, “Report,” p. 4.

other sulfur-based toxins. From these tests emerged dichloroethyl sulfide, more commonly known during the war as mustard gas, “Yellow Cross,” or “Lost.”¹⁰⁰

Oddly, vesicants, or blistering agents, were long-known to the chemical community. Some accounts state that the first form of mustard gas was discovered in 1860. In 1886, the German chemist Victor Meyer first documented the blistering effect mustard gas can have on the skin.¹⁰¹ In addition, the British actually debated the idea of introducing vesicant compounds to their chemical arsenals in 1916.

At that time, the British had set up their primary chemical testing grounds at Porton, located in the southwestern county of Wiltshire, England. The testing facility was under the direction of Professor Major E.H. Starling. In June 1916, Starling hosted a meeting to ascertain the possibility of Germany producing vesicant weapons. During the discussion, one of Starling’s staff members, a biochemist named H.W. Dudley, shared a fascinating story with the group. Prior to the war, Dudley had spent time working with Emil Fischer, the famed chemist who had opposed Haber’s use of chemical agents. While working with Fischer, one of Fischer’s lab assistants was badly burned by a chemical compound known as dichloroethyl sulfide. Fischer said at the time that he “had never seen such bad and slow-healing burns caused by a chemical substance.” After hearing the story, Starling immediately petitioned the Trench Warfare Committee to investigate the possibility of using dichloroethyl sulfide for the war. However, the Committee rejected Starling’s request, believing that the chemical would not act fast enough to cause serious

¹⁰⁰ See Jeffrey Allan Johnson, “La mobilisation de la recherche industrielle allemande au service de la guerre chimique,” 95.

¹⁰¹ Gustav Ryba, *Der Gaskampf und die Gasschutzgeräte im Weltkriege 1914/18* (Teplitz-Schönau: Montanverlag Adolf Becker, 1921), 18.

health effects against the enemy. Furious that the chemicals were rejected, Starling confronted the Prime Minister himself over the matter. Lloyd George refused to go against the Committee's ruling, but promoted Starling to Lieutenant Colonel as a consolation.¹⁰²

Around this same time, however, two German chemists working at the Kaiser Wilhelm Institute and Bayer, Dr. Wilhelm Lommel and Dr. Georg Wilhelm Steinkopf, were developing and testing burning agents. They eventually developed dichlorethyl sulfide that could be mass produced and delivered via chemical artillery shells. Codenamed "Lost" by Fritz Haber (a combination of the two last names of the chemical's developers Lommel and Steinkopf), the Germans new gas underwent field tests and eventually received approval for mass production by the German high command in 1917.¹⁰³

Mustard gas was seen by Haber as a revolutionary toxin, one which had the potential to overcome British anti-gas technology. After the war, Haber recalled that he and his chemists were looking for a chemical agent that "was a toxic body with feeble odor and without irritant effect which would be capable of employment with bombardments of H.E. [high explosive] shell without attracting the attention of the combatants and consequently capable of acting upon their organisms before they had any idea of making use of their mask. Dichlorethyl sulphide appeared to us to fulfill these

¹⁰² Charles Lovett Evans, "An Historical Note on Mustard Gas," 20 November 1967, WO 142/279, The National Archives, London-Kew, UK. See also Victor Lefebure, *The Riddle of the Rhine: Chemical Strategy in Peace and War* (New York: The Chemical Foundation, 1927), 27.

¹⁰³ For the origins of mustard gas' designation, see letter from Lommel to Dr. Johannes Jaenicke, 18 March 1955, Abteilung Va, 5, Section B, III, File 1478, p. 2, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany. For the implementation of production, see Martinetz, *Der Gaskrieg 1914/18*, 80.

conditions.”¹⁰⁴ Although an advocate for its use, Haber still had serious reservations about mustard gas’ deployment. Haber said after the war that he advised the High Command that they should not use it unless they were certain the war would be won within six months. Afterwhich, he warned, “the Allies would have made enough to swamp them.”¹⁰⁵ Despite Haber’s misgivings, mustard gas quickly became the primary chemical agent used by the Germans by the end of 1917, and by the end of the war, more mustard gas was produced than any other gas.

This was due in part to the development of the liquid-filled chemical shell which German researchers had struggled to perfect for years. As stated earlier, the older shell often destroyed the toxic contents, and many of the shells leaked their cargo. Despite these failings, experiments with T-shells continued well into 1916 at Wahn.¹⁰⁶ Yet in early 1917, German scientists developed a special diaphragm to separate the high explosive and gas. This simultaneously helped to seal the shell as well as enabled the toxin to survive. Mustard gas shell production was also a complicated process in Germany because Bayer, who manufactured that bulk of German mustard gas, refused to charge the shells in the factories due to safety concerns. The gas was therefore shipped from Leverkusen to filling plants at Adlershof and later Breloh. During peak production times, the Adlershof plant was filling over 1,000 7.7 centimeter rounds per hour.¹⁰⁷

¹⁰⁴ “Dichlorodiethyl Sulfide,” WO 142/284, 15, The National Archives, London-Kew, UK.

¹⁰⁵ Jocelyn Thorpe, “Notes on Conversations with Fritz Haber,” 23 November 1924, Box 31, File 4, Part III, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom, p. 2.

¹⁰⁶ For example, one experiment in April 1916 involved firing 250 fifteen centimeter T- and Perstoff shells in a forest area. See “Kurze Notizen über die Schiessversuche am 8. April in Wahn und am 11. April in Markendorf,” 1916, 200-5.2, Bayer History and Corporate Archives AG, Leverkusen, Germany.

¹⁰⁷ Haber, *Poisonous Cloud*, 189-190.

Gas production in other nations also increased dramatically. Recall that the British chemical industry at the start of the gas war in 1915 had one operational plant that produced seven tons of liquid chlorine per week. The Germans, by comparison, could produce forty times that amount. During the course of the war, however, the British would somewhat close the production gap, but would never achieve the production levels of the Germans. Poison gas production in the United Kingdom skyrocketed from 860 total tons of gas in 1915, to 5,150 tons in 1916, 18,500 tons in 1917, and 15,500 in the first ten months of 1918.¹⁰⁸

The Germans, on the other hand, were producing some 2,000 tons of poison gas for shells, plus an additional 1,000 tons of liquid chlorine per month. In other words, The Germans had an average poison gas output of 36,000 tons per year, roughly double British production figures.¹⁰⁹ Bayer alone produced on average 7,000 tons of just chlorine per year during the war, almost half of the average annual Allied production of all chemicals during the war.¹¹⁰ These figures are even more remarkable given the fact that thousands of workers in the factories were volunteering or being drafted into the services. BASF alone lost over 8,000 employees to the armed services.¹¹¹

¹⁰⁸ Harold Hartley, "Chemical Warfare," 1919, Hartley Papers, Box 33 AI, Folder 4, Part I, p. 7, CAC. For Comporable statistics, see also Harold Hartley, "A General Comparison of British and German Methods of Gas Warfare," 26 November 1919, Hartley Papers, Box 33 AI, Folder 6, p. 3, CAC.

¹⁰⁹ Harold Hartley, "A General Comparison of British and German Methods of Gas Warfare," 26 November 1919, Hartley Papers, Box 33 AI, Folder 6, p. 6, CAC.

¹¹⁰ "Report of the British Mission Appointed to Visit Enemy Chemical Factories in the Occupied Zone Engaged in the Production of Munitions of War," February 1919, WO 142-244, 14. The National Archives, London-Kew, United Kingdom.

¹¹¹ "Die BASF im ersten Weltkrieg, 1914-1918," undated, BSDF PB A8.6./1, Unternehmensarchiv der BASF, Ludwigshafen, Germany.

In addition to mustard gas shell, “Yellow Cross,” the Germans also developed in 1917 “Blue Cross” and “Green Cross” shells. Green Cross shells, which came in several variants, were chemical shells charged primarily with either phosgene or diphosgene.¹¹² Green Cross was often fired by the Germans in combination with other chemical shells, although on their own Green Cross could cause significant casualties. While testing hundreds of different arsenic-based compounds, the Germans decided to begin charging chemical shells with diphenylchlorarsine. The new shells were dubbed “Blue Cross.” The Blue Cross shells, however, became more famous for their nuisance than lethality. The shell contained seventy-five percent explosives and twenty-five percent diphenylchlorarsine. Although diphenylchlorarsine is a powerful and highly toxic chemical that causes respiratory failure when inhaled, the amount of explosives to effectively disperse the chemical was never perfected on the testing range.

Not surprisingly, the results of Blue Cross deployments were mixed at best. Blue Cross was often fired with another type of shell, normally high explosive or Green Cross. If Green Cross was selected, the target area would be heavily shelled with Blue Cross in an effort to surprise the enemy. Immediately after this barrage, gunners fired Green Cross shells into the same area. In theory, the Blue Cross shells would cause the enemy to sneeze or choke, making it difficult to impossible to keep the respirator secured. Given Green Cross’s high toxicity, severe poisoning or death would be a significant possibility. Unfortunately for the Germans, this theory never panned out. More often than not, when the Blue Cross shell exploded it failed to form an effective cloud that could set up the

¹¹² For example, “Green Cross 1” shells were a mixture of diphosgene and chloropicrin. “List Showing the Composition of the Various German Shell and Bomb Fillings,” WO 142/284, p. 1, The National Archives, London-Kew, UK.

Green Cross *coup de grace*.¹¹³ The explosion dispersed uneven fragments of the agent, rather than fine particles capable of penetrating enemy gas masks or forming a cloud. The Germans fired millions of Blue Cross shells during the war with negligible effects.¹¹⁴

Upon successful field tests at Wahn, the Germans had successfully combined the technological advancement of gas shells with the chemical proficiency of mustard gas production. The new mustard gas shells first appeared on the Western Front on 12 July 1917 when the Germans fired Yellow Cross shells in the Ypres sector during the Third Battle of Ypres. The new chemical shells were mysterious in their deployment, as they did not explode like a regular high explosive shell. The Germans used a burster charge that would release the toxin from the shell. The result was a shell that did not explode like a regular artillery round, but instead made a unique plopping noise. “The shell used to burst with a PLOP,” one British Sergeant said, “that’s all you heard. The shell burst open and liquid came out and the moment it met the air it became gaseous.”¹¹⁵ During the engagement in Ypres that summer, the Germans deployed a total of 125 tons of mustard gas against the Allies.¹¹⁶

Mustard gas was a substance unlike anything previously unleashed during the war. Chlorine, phosgene, and the other war gases have a short period of activity until diffusion, water solubility, and a variety of other natural reactions render the gas

¹¹³ B.C. Goss, “An Artillery Gas Attack,” *The Journal of Industrial and Engineering Chemistry*, Vol. 11, 9, (September 1919): 830.

¹¹⁴ Summarizing his thoughts on blue cross, historian Albert Palazzo referred to the Blue Cross shells as “one of the great gas fiascoes of the war” and in the index as “as greatest German failure.” See Albert Palazzo, *Seeking Victory on the Western Front*, 123-124; 233; Haber, *Poisonous Cloud*, 189.

¹¹⁵ Nigel Steel and Peter Hart, *Passchendaele: The Sacrificial Ground* (London: Cassell & Co., 2000), 80.

¹¹⁶ Hans Günter-Brauch, *Der chemische Alptraum, oder gibt es einen C-Waffen-Krieg in Europa?* (Berlin: Verlag J.H.W. Dietz Nachf., 1980), 70.

harmless. Depending on temperature, mustard gas can remain active for weeks. An oily substance, it sticks to any surface, including weapons, walls, grass, and wildlife. Its fumes also have the ability to permeate most surfaces on a World War I battlefield, including terrain, uniforms, boots, leather gloves, and trenches. This means that even the gas mask cannot prevent casualties when men are exposed. Exposure was often detected by the stench of the gas, similar to garlic, lamp oil, horse radish, or a strong mustard smell (hence its common label).¹¹⁷

The name itself is also a bit of a misnomer, as it is in actuality a liquid that was dispersed as a fine mist cloud. After deployment, in cool temperatures the liquid droplets remain active until warm enough to evaporate and give off toxic fumes. This means that during the winter months or during the middle of the night the gas will remain almost indefinitely active.

Unlike the chlorine based gases which attacked the respiratory system, mustard gas was a far more effective toxin because it attacked every part of the body. Exposure to mustard vapors causes temporary to permanent blindness. The fumes are also enough to destroy bronchial tubes, causing suffocation. Worse is exposure to the liquid itself. Immediate inflammation and tissue damage occur on contact to the skin, causing blisters and severe burns. In high concentrations, exposure to the skin alone can cause death. Absorption of the liquid into the blood stream destroys white blood cells, which weakens the immune system. The human body does, however, naturally detoxify the agent (albeit

¹¹⁷ Joel A. Vilensky, *Dew of Death: The Story of Lewisite, America's World War I Weapon of Mass Destruction* (Bloomington: Indiana University Press, 2005), 15.

slowly), so long as the dosage is not enough to cause death.¹¹⁸ Oddly, mustard gas has no corrosive effect on metal objects, making it harder to detect the substance on objects or uniforms until it is too late.¹¹⁹

To make matters worse, there is also a latent period of several hours before symptoms of exposure to the fumes or liquid develop. Initially, the Allies were often fooled into removing their respirators too quickly, as all one could sense was a mustard-like or garlic smell in the air. It was not until several hours later that the troops began to have trouble breathing, losing their voices, and even their sight. Sometimes men slept through a deployment, only to wake up hours later and find that they were blind and suffering from severe burns. Common short-term effects of mustard gas exposure are blisters and severe burns on any area of exposed skin, loss of voice, and lesions appearing on the eyes. Mustard gases are also infamous for their serious long-term effects, such as pneumonia, chronic bronchitis, and even lung cancer.¹²⁰

During the Third Battle of Ypres, the Germans implemented a technique that became standard tactical doctrine with mustard gas: saturation barrages. In mid July for a period of two weeks, the Germans methodically swamped several areas in the Ypres Salient, including trenches, roads, and even villages. During one shelling on the evening of 20-21 July, the town of Armentières was targeted. The result was some 6,400

¹¹⁸ H. S. Raper, "History of the Anti-Gas Department," 30 January 1919, WO 142-254, pgs. 13-14, The National Archives, London-Kew, UK...

¹¹⁹ "Procedure Recommended for Adoption in the Dockyards for Dealing with the Menace of Attack and Subsequent Contamination by Mustard Gas in all its Aspects," WO 188/67, The National Archives, London-Kew, UK.

¹²⁰ Sharon Reutter, "Hazards of Chemical Weapons Release during War: New Perspectives," *Environmental Health Perspectives*, Vol. 107, No. 12 (December 1999): 985.

casualties, including 675 civilians.¹²¹ The intention was to contaminate the landscape to the point of inhabitability for military gains.

Harold Clegg, a twenty-year-old rifleman with the Liverpool Regiment of the 57th Division, was one of the casualties. The gas barrage caught Clegg as he marched through the town. Quick to put his mask on, Clegg thought that he escaped the poison and removed the mask when the clear signal was given. Yet the mustard gas had clung to uniforms and contaminated food carried by the troops. As he sat and sipped a cup of tea:

Our eyes began to feel irritated...the tea was instrumental in making all and sundry commence to vomit. After being violently sick . . . I began to scrape the accumulation of mud from my accoutrements. While doing so I heard several men complain about pain in their eyes, some even complained of going blind. Before leaving the billet, I noticed that it had been inhabited by civilians, but now the old couple [who lived there] were stretched out gasping for breath, their young daughter was transfixed as if in a trance, staring at her dead child, which was only several days old...Outside this house were strewn all over the road a seething mass of humanity, civilians and military. Women and children wailing and groaning in their agony; everyone vomiting; some dead and many unconscious. Two hard worked doctors from the R.A.M.C. and several orderlies did what they could; drops were injected into the eyes of everyone in turn, after which attention they were passed along into a garden to await vehicles to convey them to the rear. The drops completely dimmed my eyesight and by 11 A.M. I was totally blind.¹²²

Clegg regained his sight four days later, but would be plagued by lung problems for years. He

did not fully recover from his gassing until 1926.

After capturing several unexploded specimens of the new German shells during the battle, British scientists were quick to identify the mysterious substance and take immediate steps to counter the effects. The most common way to counter the effects of

¹²¹ Haber, *Poisonous Cloud*, 193.

¹²² H Clegg, Memoir, File # 88/18/1, Imperial War Museum, London, United Kingdom, p. 62.

contamination was to cover the polluted area with chloride of lime or a bleaching powder, as it broke down the mustard gas into sulfur chlorides and ethylene dichloride. Soldiers then covered the powder with earth to bury the bleach because aerial reconnaissance or fighter planes could spot the white powder and take action.¹²³ Bleaching powder was poured on nearly everything – dugouts, ammunition, and men used it to clean their rifles. The German high command took several precautions to protect their own men from mustard gas poisoning. Chloride of lime was laid down in German trenches regularly, as well as around doorways and under dugout curtains. Mustard gas shell depots normally had boxes of chloride of lime at the ready in the event of an explosion or accident. Yellow Cross gunners also wore protective gloves or mittens in case a shell cracked or leaked its contents.¹²⁴

After four years of trench warfare and the recent entry of the United States into the conflict, Germany realized the chance of victory was slipping away. In March 1918, the Germans attempted a desperate offensive with the hope of finally breaking through the Allied lines. On March 21, the first day of the offensive, forty-six German divisions attacked the Allied lines between Arras and Le Fère.¹²⁵ Chemical weapons were used heavily in the initial bombardment. The salvo on 21 March 1918 that broke the British front at St. Quentin opened up at 4:40 A.M. and lasted continuously for five hours. Herbert Sulzbach, a German artillery officer, wrote in his diary on March 21 that “with a crash our barrage begins from thousands and thousands, it must be tens of thousands, of

¹²³ Haber, *Poisonous Cloud*, 201.

¹²⁴ “Development of German Gas Defence Appliances,” 17 December 1918, WO 142/284, pgs. 5-6, The National Archives, London-Kew, UK.

¹²⁵ J.M. Winter, *The Experience of World War I* (New York: Oxford University Press, 1989), 105-106.

gun barrels and mortars, a barrage that sounds as if the world were coming to an end. For the first hour, we only strafe the enemy with alternate shrapnel, Green Cross and Blue Cross.”¹²⁶ During the barrage 6,608 guns fired 3,200,000 rounds; over 1,000,000 of which were gas shells.¹²⁷ German troops poured across no man’s land, taking the stunned Allies by surprise. By April 1918, each German division carried between twelve and fourteen tons of chemical shells, ready to be deployed at a moment’s notice.¹²⁸

In support, the German chemical companies continued to manufacture war gasses on a large scale throughout the remainder of the war. Bayer, BASF, Höchst, Meister Lucius & Bruning, and other smaller firms produced dozens of different varieties of gasses and intermediates for poison gas production, totaling several hundred tons per month. For example, Bayer hired an additional 1,500 workers during the war, with a total workforce exceeding 10,000 people. Roughly 9,500 workers, chemists, and other personnel reported to the Leverkusen works; an additional 1,000 workers were stationed at their pharmaceutical works at Elberfeld. An additional plant, created for explosives and shell production, was constructed at Dormagen and production began in the summer of 1917.¹²⁹ The following are production figures from Bayer alone during the war for four major gasses:

¹²⁶ Herbert Sulzbach, *With the German Guns: Four Years on the Western Front, 1914-1918* (London: Leo Cooper Ltd., 1973), 150.

¹²⁷ Van der Kloot, “April 1915,” 158.

¹²⁸ Herwig, *The First World War*, 414.

¹²⁹ “Report of the British Mission Appointed to Visit Enemy Chemical Factories in the Occupied Zone Engaged in the Production of Munitions of War,” February 1919, WO 142/244, 13. The National Archives, London-Kew, United Kingdom.

Table 1. Production of Poison Gases at Bayer during World War I

Gas	Average Tons/Month	Total Production (Tons)
Chlorine	641	14,047
Diphosgene	395	7,952
Chloropicrin	277	2,671
Mustard Gas	642	6,709

Compared to Britain, France, and the United States as a group, during the war Bayer alone produced almost double the amount of mustard gas the three powers manufactured combined (3,400 tons to 6,709 tons).¹³⁰

In addition, research and development of new chemical shells continued. During the late summer of 1918, the Germans developed a new type of Yellow Cross shell, dubbed “Yellow Lorraine Cross” or “Yellow Double Cross.” The shell contained the same mustard gas material as a standard Yellow Cross shell, but the shell itself was different. Rather than a bursting charge, the shell contained a heavy explosive charge. The shell’s design was such that the explosion did not destroy the chemical contents, but rather dispersed it in an upward direction. Thus, the Germans developed a shell that had the best of both worlds: a shell that could create the damage of high explosives, but also the persistent toxic effects of Yellow Cross.¹³¹

Such investment and effort in chemical weapons highlights three features of German military thought during the war. First, we see that chemical weapons had become

¹³⁰ Haber, *Poisonous Cloud*, 157-158; 170.

¹³¹ B.C. Goss, “An Artillery Gas Attack,” *The Journal of Industrial and Engineering Chemistry*, Vol. 11, 9, (September 1919): 836.

a significant part of German strategic and tactical planning by 1918. Second, that the German high command had successfully integrated Germany's industrial-chemical potential towards the war effort. Lastly, the significant production levels and continued research demonstrate a seemingly unwavering faith held by the German high command that poison gas could significantly contribute to eventual victory in the war.

This faith was demonstrated in the astounding volume of chemical shells deployed in the German spring offensive of 1918. During the five major German attacks between March and July 1918, the ratio of gas shells to high explosive shells fired by the Germans was four point five (4.5) to one (1) for counter battery attacks, and one to one for all other operations. The number and variety of shells were used not to just kill the enemy, but prevent the Allies from using areas of the battlefield. Gas attacks could be used to "prepare the enemy front for assault and secure the flanks." Later, at the Battle of Amiens, the Allies refined this tactic into combined doctrine, using lethal phosgene gas to protect the flanks while simultaneously pushing tanks through the center in between the clouds. Only through contamination of the battlefield with mustard gas did the Germans prevent a breakthrough.¹³²

The only cases where high explosive shells outnumbered gas rounds during the Spring Offensive, however, occurred on days where the weather was unfavorable to chemical ordinance.¹³³ As a result, Allied gas casualties skyrocketed during the offensive. Although thousands were poisoned by direct contact with mustard gas liquid, post-war analysis by Allied chemical experts concluded that the majority of these casualties were

¹³² Rolf-Dieter Müller, "Total War as a Result of New Weapons?," 104-105.

¹³³ Harold Hartley, "Report on German Chemical Warfare Organization and Policy, 1914-1918," WO 33/1072, p. 10, The National Archives, London-Kew, United Kingdom.

caused by mustard gas vapors from the landscape. A.J. Allmand wrote in 1941 that “the proportion of casualties caused by vapour emanating from previously shelled areas was large.” Others agreed. “The majority of mustard gas casualties in the last war were due,” H. McCrombie wrote, “to men being exposed to vapour arising from the H [mustard gas] on the ground.”¹³⁴

In pursuit of the retreating Germans, Allied gas shell crews adopted similar saturation barrage tactics. French gunners began shelling targets behind German lines in an effort to seal up escape routes. Sulzbach complained in his diary in July 1918 that “A recent, and disagreeable development is the French tendency to fire Yellow Cross gas shells into the rear area.”¹³⁵ Despite the heavy barrage and initial German successes, the Allies successfully rallied at the Second Battle of the Marne and launched a massive counteroffensive in July.

Indeed, Haber’s concerns about the Allies someday using mustard gas against his side proved warranted. The Allies deployed thousands of pounds of the agent during the Allied counteroffensive. There was little the Germans could do to counteract the onslaught. Haber knew the potential problem mustard gas could bring if the Allies were to successfully turn it against him, but he never found a solution. During a meeting in May 1918 with members of Germany’s chemical and military leadership, Haber emphatically stressed on more than one occasion the importance of mustard gas preparation and finding solutions to its toxicity. Haber stated that based on experiences in

¹³⁴ See the letter exchange entitled, “For the Information of the Chairmen of Sub-Committees. (Informal Conference)” Box 35, Folder 19, pgs.1-2, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

¹³⁵ Herbert Sulzbach, *With the German Guns: Four Years on the Western Front, 1914-1918* (London: Leo Cooper Ltd., 1973), 199.

the field it was “imperative to find an absolutely impeccable destructive agent for mustard gas” in the event of enemy shelling.¹³⁶ There appears to be no evidence that an efficient-enough neutralizing agent was ever discovered. Indeed, the Germans chose to use a plague to which there was no antidote.

Allied aircraft also launched air raids on German chemical facilities, hoping to destroy and disrupt chemical and explosives production. At the BASF facilities in the Ludwigshafen area, Allied air raids began in May 1915. By the end of the summer of 1918, the Allies continued to launch sorties against chemical and explosive factories in Ludwigshafen and Oppau. According to one German report, air attacks took place on September 20, October 21 and 23, and even November 10, 1918, just one day before the declaration of the armistice. During the entire war, a total of thirteen direct air attacks occurred against the BASF facilities, with the air raid siren being used sixty times. A total of 484 bombs were dropped by Allied aircraft. The attacks killed six and wounded sixteen BASF personnel.¹³⁷

Ultimately, the Allied counteroffensive’s success was due in part to the favorable environmental conditions that favored the Allies during the months of June and July. In June, the winds were unusually erratic, often blowing in an easterly direction that favored Allied gas attacks and neutralized German ones. One report stated that a German gas shell barrage on June 10 inflicted more friendly casualties than enemy losses due to the blowback from these shifting wind patterns. Compounding problems for the Germans,

¹³⁶ “. . . es dringend notwendig ist, ein absolut einwendfreies Vernichtungsmittel für Lost zu finden . . .” See “Protokoll der Besprechung mit den Vertretern der Industrie über den Stand der Gaskampfstoffe vom 15. Mai 1918,” Abteilung Va, Rep. 5, 522, p. 7; 10, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

¹³⁷ Dr. Voigtländer-Tetzner, “Die Fliegerangriffe auf Ludwigshafen und Oppau,” BSDF PB A8.6./1, p. 9, Unternehmensarchiv der BASF, Ludwigshafen, Germany.

the following month of July saw constant, heavy rains which neutralized German gas attacks and defensive mustard gas bombardments, enabling the Allies to more rapidly push forward. Thanks in no small part to meteorological factors, the successful Allied offensive ended any chance of a German triumph.¹³⁸ The war came to an end that November, and the victorious Allies were left to decide the immediate fate of Germany's chemical weapon future.

It can be said with certainty, however, that German actions largely determined the course of the gas war. The initial use of lethal gases, the introduction of chlorine, phosgene, mustards, and a variety of other gases were introduced by the German side. In that sense, much of the gas war is marked by German advancements, followed by Allied counters. Victor Lefebure, a senior chemical expert during the war, reflected in 1921 when he wrote, "Who held the initiative throughout the war in offensive chemical warfare? It was Germany. Chlorine failed and gave place to phosgene. This was countered, and followed by mustard gas, another German thrust beneath our armour, and never really countered."¹³⁹ Despite their initial, overwhelming superiority with respect to chemical warfare, the Germans never achieved the breakthrough or victory through chemistry their military leaders envisioned at the end of 1914.

The story of chemical warfare, however, has another side besides the effect on human beings. Poison gas changed more than nations, wars, and people. The circumstances to use chemical warfare, as well as the ultimate choice to deploy chemical ordinance, hinged almost exclusively on the battlefield environment. And of course the

¹³⁸ Robert DeC. Ward, "Weather Controls Over the Fighting during the Summer 1918," *The Scientific Monthly*, Vol. 7, No. 4 (October 1918): 297.

¹³⁹ Victor Lefebure, "Chemical Disarmament," 27 January 1921, Box 33 AI, Folder 7, p. 6, Churchill Archives Centre, Cambridge, UK.

weapon's potency rested entirely on environmental forces such as terrain and weather conditions. Beyond the influence of weapons on humans, chemical warfare changed the European landscapes, and created environmental consequences that were never imagined by the belligerents during the Great War. In the next chapter, I will examine the destructive relationship between this style of industrial war and the natural world.

CHAPTER 3
SILENT CASUALTY

*Then that Gas attack at Loos and Hulloch
When the wind turned and blew it down South.
We carried down large numbers of wounded
Foaming blood and green froth from the mouth.*

- Sergeant Major Thomas Davies, 16th Irish Division¹

When the Germans introduced large scale chemical attacks, fundamental assumptions about warfare changed. Now it was not just the enemy which could kill, but the environment itself. The ground soldiers clutched to for survival during machine gun strafing or artillery bombardments, the water collected for hygiene and hydration, and the dugouts where men spent their precious hours asleep were all now potential hazards. Even the air they breathed became a potential killer. The battlefield, therefore, was more than simply ground where the belligerents fought. The battlefield was the environment itself.

It is this fact that made life at the front both an unprecedented and terrifying experience. The constant fear of gas, coupled with the devastation it wreaked on all life at the front, pushed many men to the brink of psychological collapse and others beyond it. Soldiers on both sides constantly complained about having to wear their gas masks almost all the time. “An instrument of torture,” the British signaler Dudley Menaud-

¹ Thomas Davies, “Memories of Some Incidents in my Life Arranged in Verse,” File# 06/120/1, Imperial War Museum, London, United Kingdom.

Lissenburg wrote of his mask in 1916.² Friedrich Lehmann, a German infantryman, described the mask he had been carrying for three years as “*unbequemen Ballast* (uncomfortable dead weight).” Interestingly, his attitude changed after a gas assault; he soon understood both its value and its deficiencies. During the attack, Lehmann groped his way half-blind through the trench, finding it very difficult to breathe, wanting to tear it off his face. He couldn’t seek shelter from the hazardous air. The dugouts were especially dangerous, Lehmann recalled, because the heavier-than-air gas sank and collected in their shelters. He warned his colleagues not to touch the gas, as the grey vapors collected into various funnels and slots. Two days later, ten of the men suddenly discovered they had trouble breathing, and soon developed skin burns. “The cause was easy to find,” Lehmann wrote. One man claimed he had simply lain in the grass, coming in contact with the toxin. Though the gas is never identified, the symptoms and the delayed responses point to mustard gas as the culprit. An angered Lehmann concluded that he hoped his men learned a lesson for the future; hopefully they would not be as careless when dealing with the new realities of modern warfare.³

The human toll and the price of war can not be calculated solely by personal stories or casualty reports. The changes to the environment and how humans adjusted to these alterations is the focus of this chapter. What was the environmental price of chemical warfare during the war? What were the environmental effects, including those on non-human species and the ecosystems of Western Europe, from the research,

² Peter Hart, *The Somme: The Darkest Hour on the Western Front* (New York: Pegasus Books, 2008), 540.

³ Friedrich Lehmann, *Wir von der Infanterie: Tagebuchblätter eines bayerischen Infanteristen aus fünfjähriger Front- und Lazarettzeit* (Munich: J.F. Lehmanns Verlag, 1929), 179-180.

development, and deployment of these gasses? How did humans react to this new environment brought about by industrialized warfare? The use of chemical weapons was a form of what I call “total environmental warfare,” where the use of weapons capable of killing all life were chosen and used, at the expense of soldiers, civilians, and their surroundings. The choices were made primarily due to the natural conditions the belligerents faced, including the chemical properties of the weapons developed, as well as the meteorological and topographical characteristics of Europe.

When compared to conventional weaponry, chemical weapons are unique in terms of their relationship to the environment. Bullets or artillery rounds can be aimed, fired, and forgotten with a reasonable assurance that once the bullet or explosive shell leaves the barrel, it cannot come back to harm its sender. Poison gas and chemical shells, however, can come back to harm the sender. They permeate and blanket terrain, and are shaped by the contours of the environment. While a soldier in a dugout may be protected from shrapnel and bullets, gas can still enter shelters and trenches. As Fritz Haber pointed out in a lecture to German officers at the Reichswehr Ministry in 1920, “The advantage of gas munitions especially thrives in trench warfare because gas weapons penetrate behind every earthwork and every hole, where flying iron splinters cannot find entry.”⁴ In addition, unlike the moving bullet or exploding charge, gas’s ability to harm the enemy does not disappear after a few seconds. It can last for hours, weeks, or even years. In sum, it is the environment of World War I that provided gas its greatest asset and greatest burden.

After the first German attack at Ypres in 1915, the Allies knew very little about what had hit them. Officers at the battle were quick to identify the fact that the Germans

⁴ Fritz Haber, *Fünf Vorträge aus den Jahren 1920-1923* (Berlin: Julius Springer, 1924), 37.

had used poison gas, but specific information was lacking. Allied officials did not identify the gas immediately, let alone proper medical treatments or countermeasures that should be employed. The two primary sources of information which answered these questions were the biological changes endured by those who made contact with the cloud, and observations made regarding the environmental changes in the trenches. This information was then used to educate soldiers regarding the effects of gas for future attacks.

For example, changes in animal behavior and discoloration of the land or materials were sure signs of gas. Soldiers could identify the gas type not just by smell, but by the gas' effects on metallic objects. For example, within fifteen minutes of exposure to chlorine, anything made of brass, aluminum, steel, silver, copper or other metals would corrode and turn a shade of green. Corrosion can even cause weapons to rust or artillery pieces to permanently jam.

Even after their first chlorine attack against the Allies, German officers at the front appear to have been ignorant of the effect the gas had on equipment or metals. Only after the British sent gas towards the Germans at Loos in September 1915 did German military commanders surprisingly notice the changes. An after action report from the German Fourth Army stated on September 27 that "The following new experience has been gained. At 1500 meters from the enemy trenches the artillery was in great danger from gas. Breech-blocks became unusable, and it was impossible to give orders."⁵ According to the German Sixth Army War Diary, "The formation of rust on the metal parts of the weapons, which had not been observed hitherto, made the guns and machine

⁵ Charles H. Foulkes, *Gas! The Story of the Special Brigade* (Edinburgh: William Blackwood & Sons Ltd., 1934), 82.

guns useless.”⁶ Subsequently, field commanders stressed the constant cleaning of weapons and oiling metallic equipment. Ammunition was to be kept in boxes, and each round was to be inspected after an attack for any signs of corrosion. Buttons, wrist watches, and weaponry would be checked for corrosion and discoloration.⁷

These changes provided immediate information to those who were directly involved in the attack and its aftermath. Perhaps the first member of the Entente to identify the gas was a Canadian Sanitary Corps officer who noticed men who fell under the gas attack on April 22 had tarnished green buttons. With a background in chemistry, he was able to identify the gas and countermeasures were implemented. In the event of a future gas attack, the men were ordered to urinate into a cloth or handkerchief and hold it against their mouths and noses. The ammonia in the urine would neutralize at least some of the gas.⁸

British chemists also noticed the corrosive effects. Professor H. B. Parker, a chemist at the Imperial College in London, was sent to France to investigate the German gas attack. Soon after his arrival, Parker spoke with a Canadian gas victim on his death bed in a field hospital on April 29. Parker wrote in his diary that the soldier spoke of “how the cloud of gas came. . . and how the Canadians, he was one of them, had stuck it out. He was very bad, poor chap, before he had finished, but the doctor said it would do him no harm to talk. He said his buttons were all tarnished, and I cut them off to analyze

⁶ Ibid, 83.

⁷ “Defence against Gas,” WO 142-270, p. 86, The National Archives, London-Kew, United Kingdom.

⁸ Winston Groom, *A Storm in Flanders. The Ypres Salient, 1914-1918: Tragedy and Triumph on the Western Front* (New York: Grove Press, 2002), 100.

the deposit.”⁹ Parker had suspected chlorine from the start, but his button analysis contributed to his conclusion that it was chlorine which killed the young man and his comrades.

Other soldiers testified to the gas’ corrosive characteristics. One soldier wrote after a German chlorine attack in December 1915 that “The gas was so strong that it turned all our buttons olive green, stopped our wrist watches and turned the rats out of their holes by the scores. The gas soon passed over and I was very relieved to get my helmet off.”¹⁰ German soldiers noticed these changes, and were recorded in diaries and memoirs. One German officer wrote after a French gas attack that, “Many men were dead. The gas had been so intense that the buttons on my uniform and the ring on my finger had turned black.”¹¹

Yet far more striking than the gas’ effect on equipment was its effect on the natural and organic environment. On living tissue, such as humans, insects or other animals, the war gasses had a variety of effects. Within the bodies of individual species, such as humans, different parts of the body reacted differently to different chemicals.

Such is the case with cloud gases such as chlorine or phosgene. As choking agents, chlorine and phosgene attack primarily the respiratory system, and cause little to no skin irritation. When inhaled, the gas’ atomic structure reacts to the hydrogen bonds in the hydrocarbon compounds that compose lung tissue. The invading chlorine atoms displace the oxygen and carbon in the tissue structure, causing it to break apart. Phlegm

⁹ H. B. Parker, Diary, 29 April 1915, WO 142/281, The National Archives, London-Kew, UK.

¹⁰ Captain E E Simeons, Diary, 19 December 1915, File # 94/28/1, IWM, London, UK, 11.

¹¹ William Hermanns, *The Holocaust: From a Survivor of Verdun* (New York: Harper & Row, 1972), 113.

forms around affected areas, as dead tissue and liquids slowly fill the lungs. This causes the victim to choke. Severe coughing can rupture capillaries in the lungs, causing bleeding inside the lung's air sacks (alveoli).¹² In humans and other species, such as horses or dogs, chlorine strips the lining of the bronchial tubes and lungs. The damage to lungs by chlorine is both permanent and accumulative.¹³

Phosgene, or carbonyl chloride, is easily prepared from chlorine and carbon dioxide under pressure. Like chlorine, the gas primarily affects the respiratory system, but can also cause mild eye irritation. When inhaled, phosgene attacks lung capillaries and penetrates the blood stream. This causes the lungs to fill with fluid over time, giving the gas a latent lethality trait not seen in chlorine. It was thus commonplace for a phosgene victim to never know they were gassed until it was too late. Even worse is the fact that the gas is permanent and does not naturally detoxify within the body. In other words, one large dose can kill, or several seemingly harmless exposures over a long period of time can also cause respiratory failure. Depending on the exposure, death can occur a full twenty-four hours after first exposure. Tests during the war proved that the gas kills almost all organic life, including mammals, insects, reptiles, and even broad leaf plants and trees.¹⁴

Left to the belligerents' mercy, as early as April 1915 Western European landscapes were annihilated by the new chemical weapons. Generally speaking, cloud

¹² For a detailed description of the chemical and physiological effects of choking agents, see Eric R. Taylor, *Lethal Mists: And Introduction to the Natural and Military Sciences of Chemical, Biological Warfare and Terrorism* (Commack: Nova Science Publishers, 1999), 82-83.

¹³ James A. F. Compton, *Military Chemical and Biological Agents: Chemical and Toxicological Properties* (Caldwell: The Telford Press, 1987), 114-115.

¹⁴ *Ibid*, 119-121.

gases, such as chlorine and phosgene had an immediate and devastating effect on the environment. However, the poisonous effect of the gas would largely disappear within a matter of hours. Gases deployed by chemical shells, especially mustard gas, had the opposite effect: their deployment had little immediate environmental effect, but would prove harmful for a much greater period of time. This sort of inverted phenomenon was due to the chemical properties of the substances and the methods of deployment.

In terms of cloud attacks by chlorine and phosgene, the scale of the cylinder attacks were enough to create clouds which killed all life they encountered. The massive German phosgene attack on December 19, 1915 killed off a total of almost eight square miles of vegetation, including all grass, trees, plants and crops.¹⁵ In a British after action report from a cloud attack on April 30, 1916, for example, the officer noted that “the grass and crops over which the gas-stream passed had been bleached and more or less destroyed. . . It is reported that several cows and pigs and a considerable number of rats were killed.”¹⁶ In June 1916, the British created a mixed chlorine and phosgene cloud during their offensive at the Somme. The cloud ran along a seventeen mile front, and drifted twelve miles into the German lines. Although the vast majority of German troops were protected by their masks, the cloud killed virtually everything in its path. Plants, rodents, insects, and birds were wiped out. Trees lost all of their leaves, creating a barren, lifeless landscape. German troops noticed the environmental devastation, and recorded it in their reports or diaries. For example, a captured member of the 12th Bavarian Reserve Regiment at the battle reported that “Vegetation was burnt up to a depth of eight

¹⁵ Groom, *A Storm in Flanders*, 138.

¹⁶ Andy Thomas, *Effects of Chemical Warfare: A Selective Review and Bibliography of British State Papers* (London: Taylor and Francis, 1985), 16.

kilometers” into their lines. A member of the 5th Bavarian Reserve Division observed that “All rats and mice were killed and the birds dropped dead from the trees. . .Stables had to be evacuated and the horses became ill.”¹⁷ German newspapers also reported the scene. In August 1916 a reporter for the *Frankfurter Zeitung* described the carnage at the Somme:

All the pets in the trenches suffer from gas attacks. The guinea pigs are the first to scent the gas, and the cats also complain at once. Many dead mice and rats are found in the trenches after gas attacks. Owls are greatly excited. Behind the front, fowls and ducks are said to become restless a quarter of an hour before the gas cloud approached; and the gas kills ants and caterpillars, beetles and butterflies. I found a hedgehog and an adder both killed by gas. The only birds that seem indifferent to gas are the sparrows.¹⁸

In some cases, the destruction to the vegetation gave away the location of the attackers. By 1918, the British began using massive gas cloud attacks called “beam” attacks, which involved loading railroad cars with gas cylinders, hauling them by train and deploying the cylinders electronically from the cars themselves. This type of attack had many advantages, including minimizing the number of personnel near the gas and cutting down on the time spent setting up the attack at the front. The train could also move safely away with the empty containers, leaving seemingly no trace of the source of the gas. Initially, the Germans had no idea where the gas from these sorts of attacks was coming from. Eventually, however, they figured out that by observing and charting the dead vegetation after an attack, they could determine its source. As Charles Foulkes wrote, “the Germans appear to have been considerably puzzled as to how and where the

¹⁷ Foulkes, *Gas!*, 132.

¹⁸ *Ibid*, 109.

clouds originated, as they attempted to solve the problem by means of observation balloons and low-flying aircraft. Accurate indications were, of course, available a few days later from air photographs, as the paths of the clouds could be easily traced from the bleached vegetation. . .”¹⁹

Not only were environmental effects noted in the field, but also in laboratories across Europe. Animal testing was commonplace in laboratories working for both sides. In some cases, the experiments were designed to test already existing toxins. Other tests were conducted to test the viability of a new gas or to ascertain if a type of chemical could work as a weapon.

To ascertain the physiological effects of experimental toxins, chemists and military scientists on both sides also conducted numerous tests on humans. In Germany, cats and mice were the first species chosen. The animals were placed in containers, ranging in size from one to forty cubic meters. Later, similar experiments were carried out on rabbits, dogs, and monkeys. The results of these experiments had a direct influence in determining the chemicals used during the war. For example, German chemists believed that hydrocyanic acid could be used for a new type of chemical shell. A prototype shell was constructed and fired on a flock of sheep on a testing range. The sheep were unharmed, and the Germans considered the shell useless for battlefield deployment. Later in 1916 at the Battle of the Somme, the Allies poisoned German troops with hydrocyanic acid attack. Startled at this development, the Germans revisited the gas, ran more tests, but ultimately decided to reject the compound as ineffective.²⁰

¹⁹ Ibid, 295.

²⁰ See subsection “Hydrocyanic Acid” in “III. Methods of Testing Gases and the Results Obtained,” WO 142/284, pgs. 19-20, The National Archives, London-Kew, UK.

Nevertheless, the initial animal tests compelled the Germans to examine other chemical agents.

British scientists conducted similar experiments, with field tests conducted at their facility at Porton under the direction of Professor Major E. H. Starling. An entire breeding farm was established in 1917 to breed animals specifically for testing war gasses. Animals such as horses, cats, dogs, monkeys, goats, sheep, and guinea pigs were placed in simulated trench environments, complete with fences and sandbags, and exposed to chemical clouds.²¹ Individual testing was also conducted by both the Central Powers and the Entente, including the application of toxins through injections or sprays. For example, one experiment by the German scientist Dr. Emil Impends at Elberfeld looked at the lethal effects of a variety of gasses on cats. After gassing cats with small amounts of Chlorine, Phosgene, K-Stoff, diphosgene, and dimethyl, tables were drawn up showing the lethal dosage given and the time it took for the animal to expire.²² In other cases, animals were cut open to expose organs to gases or other toxins. Other times, mustard gas would be applied to open wounds. The incisions would then be stitched up and observations were made on the effects.²³

Scientists conducting these experiments obtained vast amounts of new information regarding the effects of poison agents, especially mustard gas. One of the most bizarre discoveries was the lethality of the gas without showing any lesions or

²¹ For example, at Porton British scientists placed dogs, cats, and rats in a simulated trench and exposed them to gas in August 1917. The effects were recorded and plotted on a map of the trench. See "Papers Concerning Gas Trials Conducted at the Royal Engineers Experimental Station, Porton, First World War," Misc 225, Item 3227, Imperial War Museum, London, UK.

²² Emil Impens "Giftigkeit verschiedener Reizstoffe," 15 October 1915, 201-5.2, Bayer.

²³ Harris and Paxton, *Higher Form of Killing*, 42.

bronchial damage before death. Goats and rabbits, for example, rarely exhibited any throat damage when exposed to gas, while only twenty-five percent of cats and monkeys succumbed without any respiratory damage. In addition, Scientists learned of the “accumulated” effect of mustard gas, as repeated gassings on the same animal with small amounts of gas showed a stark decrease in the animal’s vitality. As one British scientist named Barcroft wrote in one medical report, “It is our general experience that those who are frequently experimenting with H.S. [mustard gas] and so being exposed to small repeated doses of vapour develop a degree of general malaise and tiredness of body and mind which seems to be quite incompatible with an otherwise healthy mode of life without any considerable stress.”²⁴

German scientists performed thousands of experiments in a number of locations. These experiments were largely done at the testing facilities at Breloh and Wahn, as well as the Kaiser Wilhelm Institute’s Pharmacological, Electro- and Physical Chemistry Institutes in Berlin. Tests ranged from the individual dosing of an animal, to gassing large groups of creatures. The quantities of gas used also varied greatly. Initial tests with mustard gas consisted of doses measuring in the milligrams. But by November 1916, the KWI were ordering Yellow Cross by the hundreds of tons.²⁵

From an economic perspective, the price of such quantities can add up fast. Based on contracts with the War Ministry, by the end of 1917 Bayer was selling Yellow Cross at around three to four marks per kilogram. This meant that the starting cost for a single

²⁴ J. Barcroft, “Observations indicating that that H.S. is Poisonous apart from its action on the Skin and Respiratory Apparatus,” Box 40, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

²⁵ In preparation for a single “large experiment” (*Grossversuches*), a Dr. Kerschbaum at the KWI inquired about an order for around “6-800 kg of ‘Lost.’” Letter from Dr. Kerschbaum to the management of Farbenfabriken vorm. Friedr. Bayer & Co., 11 November 1916, 201-6.3, Vol. 1, pt. 4, Bayer.

experiment using 800 kilograms of mustard gas would cost around 3,000 Marks, or the equivalent of a dozen chemical factory employee's wages for an entire year.²⁶ This does not include numerous other expenses, including man power, animals, and equipment. While the cost may pale in comparison to other expenditures, it becomes dubious when one considers that by the fall of 1917, Germany had already accumulated tens of billions in war debt and mass hunger had already set in among the majority of the German civilian population. Soup kitchens in Hamburg alone served some 6,000,000 meals in April 1917.²⁷ Yet the war, including the experimentation and production of chemical weapons, came first.

One of these large experiments took place during the summer of 1917, when scientists simulated a mustard gas bombardment on multiple targets. On a large field at Posen, scientists reconstructed an Allied position and placed one thousand (!) cats and dogs along the target firing area. After the animals had been secured, the scientists fired five hundred 7.5 cm mustard gas shells at the position. All of the animals were affected – some instantaneously, others suffered due to exposure after the shelling had long since ceased. Thrilled with the results of the experiment, on July 12 the German High Command authorized the use of saturation mustard gas shelling for the first time on humans.²⁸

²⁶ See memo from Fritz Haber to Farbenfabriken vorm. Friedr. Bayer & Co., 5 October 1917, 201-6.3, Vol. 1, pt. 4, Bayer. For wage indexes, see Roger Chickering, *Imperial Germany and the Great War, 1914-1918* (Cambridge: Cambridge University Press, 1998), 109. The wage index for a male chemical industry worker in 1918 was 252. By Feb 1918, the price of Lost had dropped to M 2.75 per kilogram; by April 1918 it was just two marks per kilogram. See "5. Auftrag," 27 February 1918, 201-009, Bayer; "7. Auftrag," 16 November 1918, 201-009, Bayer.

²⁷ Chickering, *Imperial Germany*, 141.

²⁸ Wachtel, *Chemical Warfare*, 106-107.

Such large quantities of gas and numbers of animals testify to the seriousness and thoroughness of German scientists with respect to testing and utilization of chemical weapons. There was no limit to the number of animals that could be sacrificed upon the altar of “science,” let alone the altar of ultimate victory in the war. Yet it was not just non-human species who suffered from these chemical experiments.

Human experimentation was also common among both the Germans and the British chemical services. In Britain, tests were carried out on volunteers (called “observers” by the scientists at Porton) who would simply see how much the subject could take of a given chemical. In some cases, the subjects (usually employees who already worked at Porton in other capacities) did not volunteer but were ordered into the testing chambers. As one report noted, “cooks, orderlies, and clerks were frequently pressed into service for experiments.” Even the highest ranking officials in Britain’s Chemical Warfare Service, including Professor Colonel William Watson, head of the Allies central chemistry lab in France, and Colonel E.F. Harrison, head of the British Chemical Warfare Committee, died as a result of self experimentation.²⁹

At the front, British commanders would intentionally expose their men to small amounts of mustard gas for training purposes. This was done through the construction and use of special training “shelters.” Inside the shelter, mustard gas would be intentionally spilled on the ground and soldiers would be brought into the shelter “so that officers and N.C.O.’s [non-commissioned officers] and if possible other ranks, may be

²⁹ Harris and Paxton, *Higher Form of Killing*, 41.

given practical experience in recognizing ground and dugouts contaminated with Yellow Cross shells.”³⁰

In a post-war questionnaire to Allied military leaders, a German official declared that any experiments on humans were not “employed to ascertain the effects of the poisons, but simply to test the nature and strength of the effects of irritants” and when “. . . testing substances injurious to the skin, the experiments on men were only used to check those made upon animals.”³¹ Such claims are, at best, misleading regarding the testing conducted on humans by the German chemists. German scientists conducted experiments on people because the effects are often different than those on animals. Dr. Curt Wachtel, founder of the Pharmacological Section of the Kaiser Wilhelm Institute and conductor of hundreds of experiments on animals stated after the war that “The sensitivity to poisons among animals is not uniform and it differs from that of man.” As to the use of humans as test subjects, who often were the chemists themselves, Wachtel declared that “almost every chemist in the field was willing to serve his fatherland by voluntary participation in these experiments.”³² For example, one experiment involved some forty “specialists,” a banal term for the men who exposed themselves to poison gasses in testing chambers. A typical experiment involved multiple people entering a laboratory chamber. The test subjects wore different types of gas masks to compare their effectiveness against a toxin. To serve as a control, one unlucky man wore no protection. Observations were made and recorded. For health reasons, specialists were only gassed once per day. While it is

³⁰ Harold Hartley, memo regarding yellow cross casualties and gas discipline, 10 May 1918, RG 9 III-C-3, 4187, 3, 10, Library and Archives of Canada, Ottawa, Ontario, Canada.

³¹ “Chemical Questionnaire,” 5 July 1921, Hartley Papers, Box 31, Folder 10, 3-4, Churchill Archives Centre, Churchill College, Cambridge, UK. The question responses were signed by a Müller.

³² Wachtel, *Chemical Warfare*, 101-102.

uncertain what long-term effects these test subjects experienced, at least one subject died directly due to a phosgene test. When testing was considered complete and if the gas was deemed effective, the experiments would move from the lab to outdoor field trials with animals.³³

British scientists also held human trials involving gas. For example, an experiment by a British chemist C. L. Reed in October 1918 attempted to accurately determine the effects of mustard gas on humans, which had still not been determined. The experiment involved two test subjects: one identified as “P.B.,” the other being the author of the report himself. Both men entered a 10,000 liter-size gas chamber wearing their khaki uniforms without the blouses. A fan then blew into the chamber a mixture of mustard gas and absolute alcohol. The men then waited and reported any feelings or bodily effects. The dosage varied, as well as exposure time. During the first experiment, the men were exposed to just .0012 milligrams per liter. Within eight minutes, the men began to feel nasal irritation.³⁴

However, long after the author left the gas chamber, complaining of only heavy eyelids and a husky voice, the author began to suffer significant health effects. Six hours after their initial exposure, the subjects developed “severe conjunctival irritation with photophobia and belpharospasm, which increased in severity until, at the end of 12 hours, it was impossible to see anything.” While his sight eventually returned, the pain was so extreme that the author could not sleep for thirty hours. Over the next few weeks, wheals

³³ “Methods of Testing Gases and the Results Obtained,” WO 142-284, 10-12, The National Archives, London-Kew, UK.

³⁴ C.I. Reed, “Report #308: The Minimum Concentration of Mustard Gas Effective on Man (Preliminary Report),” 26 October 1918, WO 142-15, 1, The National Archives, London-Kew, UK.

came and went on his legs and thighs, and more long term effects included suffering from hypersensitivity to light between five and six weeks, and the conjunctival infection still had not cleared up after a month.³⁵ Based on his self-experimentation and experimenting on others, the author drew up a table, showing the amount of dosage, number of subjects, length of time exposed, followed by the physical effects. Below is a sampling of his findings:

Table 2. Summary of Human Poison Gas Testing Results³⁶

Dosage (mgm/l)	# of Subjects	Length of Time	Effects
.0001	2	50 minutes	Slight but distinct conjunctival injection
.0005	8	30 minutes	Two subjects developed conjunctivitis, marked skin burn
.001	1	45 minutes	Very severe conjunctivitis, photophobia, skin burns, mucosal exfoliation in naso-pharynx

The Americans also experimented on humans. One bizarre test held at the American University Experiment Station in Washington, DC wanted to “determine if negroes, as a

³⁵ The conjunctiva is the clear membrane which rests in between your eyelid and eyeball that produces a mucus that lubricates the eye. Photophobia is suffering from acute light sensitivity. Blepharospasm is a condition where the eyelids involuntary remain closed. C.I. Reed, “Report #308: The Minimum Concentration of Mustard Gas Effective on Man (Preliminary Report),” 26 October 1918, WO 142-15, 2, The National Archives, London-Kew, UK.

³⁶ C.I. Reed, “Report #308: The Minimum Concentration of Mustard Gas Effective on Man (Preliminary Report),” 26 October 1918, WO 142-15, 4, The National Archives, London-Kew, UK.

class, are much more resistant than white men.” The dosage was much higher than Reed’s test, and the mustard gas was applied directly to the skin. An entire company of eighty-five black soldiers had a one percent and a point one (.1) percent solution applied to their forearms. The results were then compared to tests previously carried out on white units. The two prior experiments were held at the American University and Edgewood Arsenal. The first at American University tested 347 men; the second, at Edgewood, tested 1,282! The experiment concluded that seventy-eight percent of the African-American subjects were “resistant” to the gas. It is never explicitly defined in the report what “resistant” actually meant. Rather, the scientists simply observed the patients’ arms for any kind of visible trauma.³⁷

Both in Berlin and at the front, German gas specialists ran gas warfare schools, exposing men to chemical warfare agents as part of their training. In Berlin, thousands of German officers were ordered to the KWI for chemical warfare training. Every ten days, 400 officers would attend the gas warfare school run by four German professors (who were also reserve army officers). There were four courses at the school: a course for company commander and junior officers, a course for staff officers and those above the rank of *Hauptmann* (Captain), for gas officers, and for gas non-commissioned officers. In other words, the course you took was catered to the duties and rank of the student. Until 1917, courses were also held at the Bayer facilities in Leverkusen.³⁸

³⁷ E. K. Marshall, Jr., “Individual Variation in Susceptibility to Mustard Gas V (The Susceptibility of Negroes),” 31 October 1918, WO 142-15, 4, The National Archives, London-Kew, UK.

³⁸ Harold Hartley, “Report on German Chemical Warfare Organization and Policy, 1914-1918,” WO 33/1072, p. 28, The National Archives, London-Kew, United Kingdom.



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Figure 1. Artist's Rendition of a Gas Cylinder Discharge at Wahn (circa 1915)³⁹

³⁹ An artist's rendition of an early gas cylinder discharge at the Wahn testing range as part of an officer training course, late 1915 or early 1916. Notice the personnel on the left casually taking notes and chatting, wearing no gas protection. The artist clearly made a point to show the cloud's effects, complete with macabre, poisoned trees. The author wishes to thank Jeffrey Allan Johnson for originally bringing this image to my attention. Lommel Papers, "Die Tätigkeit der Farbenfabriken vorm. Friedr. Bayer & Co. auf dem Gebiete des 'Gasschutzes' während des Weltkrieges," 1931, Bild 24, Seite 33, 329-504, Bayer History and Corporate Archives AG, Leverkusen, Germany.

The officers would learn about a variety of topics, including meteorology, chemical agents, and anti-gas equipment. The men were exposed on more than one occasion to deadly gasses. Fritz Nagel, a lieutenant in the 82nd Flak Battery, recalled in his memoirs the times he was forced to be exposed to poison gas during the gas warfare course:

To prove the effectiveness of our latest gas mask model, we were led into a room containing a lethal dose of phosgene gas. We remained inside for a few minutes without ill effect. The course ended with a field exercise showing how a gas attack should be mounted. In order not to contaminate our uniforms, overalls were issued and we had to walk through a cloud coming toward us.⁴⁰

The result of both human and animal research led to impressive anti-gas technologies. Reliable gas masks were available on both sides by 1916. As for non-human species, both Britain and Germany designed and produced reliable masks and respirators to protect their natural allies. At Porton, by July 1915 Professor Colonel Watson was conducting experiments with chlorine gas and new respirators for horses.⁴¹ Horses served a number of functions at the front, including reconnaissance, transport, and communications. As a result, horses were often targeted with chemical barrages, as to impair the movement of troops and supplies. This was an effective strategy, and the slaughter of the enemy's horses could translate into tangible military gains. For example, on April 8 and April 9 1917, British batteries shelled German positions at Monchy-le-

⁴⁰ Fritz Nagel, *Fritz: The World War I Memoirs of a German Lieutenant* (Huntington: Blue Acorn Press, 1995), 97-98.

⁴¹ Diary entry, 9 July 1915, Lt. Col. V.M. Fergusson, File PP/MCR/111, Imperial War Museum, London, United Kingdom.

Preux with high concentrations of mustard gas, forcing their withdraw. The British killed forty transport horses the first night, and another eighty the following night.⁴²

The British first unveiled their horse respirator in 1916. It consisted of a flannelette bag impregnated with detoxifying chemicals. As horses breathe solely through their noses, the apparatus fit snugly above the mouth, with a protective piece of canvas inside the mouth to prevent the animal from chewing through the device. The masks were not perfect, as the horses found them uncomfortable and their work efficiency and speed was reduced while they wore the respirator. Horse trainers and chemists worked together to train the animals to become accustomed to the new headgear, and the Germans clearly held a firm belief in the importance of horses and the war. For example, the German chemical specialist Dr. Rudolf Hanslian wrote after the war that defense systems and procedures for horses was critical. "Horse training in gas defense," Hanslian declared, "is of quite essential importance (*wesentlicher Bedeutung*)."⁴³ As the chemicals evolved from choking gases like chlorine to vesicant agents like mustard gas, other types of protective gear were designed and constructed to adapt to the changes. Leg and hoof coverings were also developed and produced to protect horses from mustard gas contamination. Yet if the horse came into contact with mustard gas, the entire animal had to be thoroughly washed, as well as the saddle and any other equipment that was in

⁴² "Report on the effects produced by Gas Shells on the night of April 8/9 on the Third Army Front," April 1917, Hartley Papers, Box 33 AI, Folder 3A, Churchill Archives Centre, Churchill College, Cambridge, UK.

⁴³ Rudolf Hanslian, *Der chemische Krieg*, 303.

contact with the animal.⁴⁴ So successful was the design that the British produced and used 700,000 units during the war.⁴⁵

The Germans also constructed horse respirators. Like the British system, the German version fit around the nostrils of the horse, secured by a leather and metal harness. The membranes which line a horse's eyes were sufficient to protect them from tear and other early war gasses. Therefore, many mask designs, including those of the British, French, and Germans, left the eyes unprotected. Other masks, such as the Russian "Lawinowitsch" and "Gontarew" models, were designed to cover the entire face of the animal, including the eyes. They therefore bore close resemblance to those devices worn by their human comrades. The Germans produced four different sizes of masks to accommodate different size horses.⁴⁶ The respirator itself was impregnated with potassium carbonate and hexamine.⁴⁷

Both sides developed respirators not only for horses, but also dogs and carrier pigeons. Dogs became a common feature at the front, serving a variety of functions, including messengers, mascots, guard duty, and even search and rescue operations for wounded, buried, or missing soldiers. The Germans appear to have developed the first dog mask. The unit covered the entire head of the dog, and at first glance seems to have been more comfortable to wear than their human counterpart. This is because the areas

⁴⁴ See subsection 40, entitled "Protection of Animals" in "Defence Against Gas," WO 142-270, The National Archives, London-Kew, UK.

⁴⁵ H. S. Raper, "History of the Anti-Gas Department," 30 January 1919, WO 142-254, pp.7; 12, The National Archives, London-Kew, UK.

⁴⁶ Rudolf Hanslian, *Der chemische Krieg*, 204-205.

⁴⁷ B. Mouat Jones, "German Horse Respirator," 21 August 1918, Box 44. Churchill Archives Centre, Cambridge, United Kingdom.

around the ears and neck were lined with rabbit fur. Such a luxury was presumably to limit potential irritation for the dog. The dog would instinctually try to pull the mask off, not knowing that the outside air would be deadly. The unit strapped securely around the neck with two straps and buckles, which could be adjusted to fit different sizes of canines. The unit also had a loop sewn to the strap to accommodate a chain or leash.⁴⁸

Allied chemists also designed and built masks for dogs. These devices seem to copy the German design in many ways. For example, the American mask also used a fur-lined covering, except mole fur was used instead of rabbit. Also like the German version, the mask was secured around the dog's neck, covering the entire head and ears. The mask's construction consisted of eight layers of cloth, each soaked in a protective solution. The oval-shaped eye pieces were made of cellulose acetate, and were large enough to accommodate several different species of dogs. The lenses were either taped or sewn on; no metal was used around the eyepieces. After testing, allied chemical experts concluded that, when worn properly, the dog felt little resistance to breathing, and the animals sense of sight and smell seemed to remain strong. However, the dogs did require some training and time to adjust to the new devices. At first, the dogs would try to pull the masks off with their front paws, but over time the dogs became used to the accessory.⁴⁹

⁴⁸ J.A. Carpenter, "German Dog Respirator," August 3, 1918, Box 44, Churchill Archives Centre, Cambridge, United Kingdom.

⁴⁹ Clinton D. Abraham, "Gas Mask for Dogs," 9 November 1918, WO 142-115, 5, The National Archives, London-Kew, United Kingdom.



Figure 2. Example of Gas Mask for a Dog⁵⁰

By the spring 1916, both sides were already using protective respirator boxes that afforded adequate protection for homing pigeons. One of the oldest forms of battlefield communication, due to their speed and range of flight pigeons were used by the ancient Romans, Greeks, and Egyptians by the military to deliver orders or correspondence. Their usage continued through the millennia; Julius Caesar first reported the conquest of Gaul to the Rome via carrier pigeon, and one of the Duke of Wellington's birds was the first to deliver news of Napoleon's defeat at Waterloo in 1815 to England's shores. Depending on weather conditions, pigeons are capable of flying at astonishing speeds, anywhere between 880 to 2,000 yards per minute with a range of several hundred miles.⁵¹ Even with electric telecommunications, pigeons' natural abilities made them ideal

⁵⁰ An example of the American gas mask for dogs. Notice the large eye pieces and the circular ear pockets designed to accommodate the different shapes of dogs' ears. 1918, WO 142-115, 5, The National Archives, London-Kew, United Kingdom.

⁵¹ Hugh S. Gladstone, *Birds and the War* (Strand, UK: Skeffington & Son, Ltd., 1919), 3.

messengers across the front during the Great War. They could fly above poison gas clouds, mines, barbed wire, and any other man-made obstruction. Their speed made them almost impossible to hit by gunfire. Pigeons were therefore a valuable asset to both sides, and though capable of flying over toxic clouds, the birds nevertheless needed protection from enemy gas.

Both sides constructed devices to protect their avian messengers. The Germans appear to have been the first to recognize the military importance of pigeons during the war, and launched an all out war on France and Belgium's pigeon populations. In November 1914, the Germans issued decrees to lands under their occupation in France "forbidding civilians from keeping live pigeons of any breed."⁵² Tens of thousands of the birds were slaughtered. Clearly, the massacre of this particular species was to achieve a military objective: to hinder or deprive the enemy of the ability to communicate. To further protect their pigeon service advantage, after the first gas attack the following year the Germans developed the first pigeon gas defense system in 1915.

The German pigeon baskets were primitive but effective. Wooden protective containers were designed and experiments were conducted with gas-tight pigeon boxes at Bayer testing facilities. The boxes were small but bulky, could hold multiple birds, and could be carried using a sling. On one side of the box, an attachment module was installed to accommodate a standard gas mask filter cylinder.⁵³ The British also

⁵² Ibid, 7.

⁵³ "Development of German Gas Defence Appliances," 17 December 1918, WO 142/284, p. 6, The National Archives, London-Kew, United Kingdom.

constructed similar baskets and boxes for their birds, although the British did not begin using pigeons on the Western Front until March 1916.⁵⁴



Figure 3. Gas Protection Basket for Pigeons⁵⁵

The German army seemed seriously dedicated to the idea of protecting their animal allies, as photographs taken with pigeon boxes and horse respirators include

⁵⁴ One after action report from a German gas attack at the end of April 1916 noted that “Baskets were covered by respirators and birds were not affected.” See “Notes on Gas Attacks by Enemy on First Army Front on 27th and 28th April, 1916,” 8 May 1916, RG 9 III-C-3, 4115, File 1, Folder 15, p. 2. LAC; Gladstone, *Birds and the War*, 5.

⁵⁵ Notice the Iron Cross First and Second Class on the soldier’s tunic, probably the most recognizable military decorations in Germany at that time. The soldier is also wearing the Prussian spiked helmet, the *Pickelhaube*. Although issued to troops in the field in 1914, the helmet’s attention-getting spike made them less than ideal headwear for those in the trench looking to avoid an enemy sniper’s eye. The helmets eventually disappeared at the front and become ceremonial, replaced with a stronger, more inconspicuous steel helmet in 1916. “Figur 124. Gasschutzkasten für Brieftrauben,” undated, Abteilung Va, 5, Section B, I, File 518, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

officers or highly-decorated personnel. This perhaps indicates the photos were to be also used for propaganda or publication purposes.

The Allies also constructed protection systems for carrier pigeons. If no boxes were available, British troops were ordered to simply release all the pigeons in the event of an attack to save them, as they could fly above the poisonous clouds. In addition to protective boxes the French experimented, with modest success, with an oil-cloth bag inside a canvas covering designed to hold their birds.⁵⁶ Ultimately to protect the carrier pigeons, the British manufactured some 2,000 protective pigeon basket covers.⁵⁷

As we have seen with anti-gas technologies for animals, by 1917 it had long become clear that poison gas could be used to kill anything the enemy could use to their advantage. It had also become accepted practice by both sides to target trails, roads, and fields where horses and dogs often traveled. While poison gas largely was designed to incapacitate or kill human enemies, both the Germans and the Allies developed poison gasses to specifically target non-human species for the purpose of military gain or to reduce casualties among their troops. In that sense, chemical warfare is unique when compared to standard ordinance. It can and was custom tailored to kill some species, while others remained unaffected.

Of all non-human species, insects have received the most attention. While many people think of rats when one thinks of pests at the front, insects wreaked considerable havoc among trench inhabitants, especially lice and other disease-spreading organisms.

⁵⁶ Taken from a translation of a report by a Dr. Banzet, "Compte-Rendu d'une Experiences de Protection des Pigeons," dated 11 March 1918. See "Protection of Pigeons," 17 April 1918, WO 142-172, The National Archives, London-Kew, United Kingdom.

⁵⁷ H. S. Raper, "History of the Anti-Gas Department," 30 January 1919, WO 142-254, p. 12, The National Archives, London-Kew, United Kingdom.

Over the past three decades, scholars such as John H. Perkins and Edmund D. Russell have noted the motivations and advancements in pesticides, many of which originated in the same chemical labs as those which were developing chemical agents for the enemy. As the historian Edmund P. Russell argued, “In the first half of the twentieth century, the science and technology of pest control sometimes became the science and technology of war, and vice versa.”⁵⁸

Indeed, as the reader has already seen with phosgene gas, many of the toxins chosen were long known to possess properties which made them ideal herb- or pesticides. French chemists experimented with hydrogen cyanide charged shells at the Somme, because for decades farmers used the same compound to exterminate insects in their orchards and buildings.⁵⁹ The Americans followed the trend of experimenting with pesticides and applying it to battlefield applications by adopting arsenic based toxins. Some discoveries were purely by accident. For example, during the war explosives manufacturers discovered that one of the byproducts they produced was PDB (paradichlorobenzene), a chemical which entomologists later converted into an insecticide.⁶⁰ Arsenics were the most commonly used poison in American pesticides, and American farmers were forced to cope with arsenic pesticide shortages due to their extensive usage at the front.⁶¹

⁵⁸ Edmund P. Russell, “‘Speaking of Annihilation’: the Mobilizing for War Against Human and Insect Enemies, 1914-1945,” *The Journal of American History*, Vol. 82, No. 4 (March 1996): 1508.

⁵⁹ *Ibid*, 1511.

⁶⁰ Russell, “‘Speaking of Annihilation’,” 1508.

⁶¹ Edmund P. Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge: Cambridge University Press, 2001), 42.

During the war, Germany recognized the importance of controlling pests on both the home and battle front. On the home front, of particular concern were mill moths, pests which fed on grains and infested flour mills across Germany. Prior to the war, these insects caused considerable damage by eating grain stocks and even damaging equipment, causing mill owners significant monetary losses. On average the moths inflicted some 1,000,000 Marks in damage annually. To make matters worse, during the war smaller mills closed down and merged with others. This was done for a variety of reasons, either intentionally or when the millers volunteered or were drafted for military service. The centralization of the mills contributed to the infestation of even greater size stocks. Unfortunately, all known methods of pest control were ineffective: sorting by hand or with machines, introducing natural moth predators like wasps into the mills, and a variety of chemical products failed to solve the infestation problems.⁶²

At the front, insect and rodent populations were on the rise. Several different species of rodents and insects wrecked havoc in the trenches, especially rats and lice. Rats fed on everything from exposed rations to corpses. At times growing to the size of cats, the unwelcome rodents in the trench struck about as much fear as a bullet or artillery shell. One soldier recalled that “life in the dugouts would not have been so bad had it not been for the fearful rodents.”⁶³ The rats were a constant problem, and often moved in packs. Attacks on humans by rats were common, and soldiers used anything as a weapon,

⁶² Margit Szöllösi-Janze, *Fritz Haber 1868-1934: eine Biographie* (Munich: C.H. Beck, 1998), 374-375; Margit Szöllösi-Janze, “Pesticides and War: The Case of Fritz Haber,” *European Review*, Vol. 9, Issue 1, (2001): 98-100.

⁶³ Gustav Ebelshauser, *The Passage: A Tragedy of the First World War* (Huntington: Griffin Books, 1984), 63.

including rifle butts, clubs, and sharpened entrenching tools or shovels. One soldier wrote in January 1916:

Lights out. Now the rats and the lice are masters of the house. You can hear the rats nibbling, running, jumping, rushing from plank to plank, emitting their little squeals behind the dugout's corrugated metal. . . And then it's the lice and fleas that begin to devour me.⁶⁴

Bed bugs, flies, mites, beetles, fleas, nits, and lice were ubiquitous pests on the western front. Lice were especially problematic. Lice laid eggs not just on the scalps of the men, but inside garment seams and other nooks.⁶⁵ One German soldier recalled lice infestation when he wrote,

. . . It was impossible to get rid of them. Many were the sleepless nights caused by these parasites, feeding and sucking the blood of their victims. When hostilities seemed suspended for a while, noiselessly but just as tenaciously another war was constantly being waged beneath the surface between man and all sorts of animals. . . Since man had invaded their territory the animals were rebelling, waging a continuous battle against the intruders.⁶⁶

Capable of spreading diseases such as typhus, both sides' chemical communities experimented and modified war gases in an effort to find effective pesticides for both agriculture and military purposes. Although little could be done chemically to kill rats, insects could be killed with chemicals with seemingly little risk to humans. German health and chemical experts already recognized the potential problem lice posed to the soldiers at the front. In 1912, a French military physician named Nicolle had proven lice embedded in clothing could transmit typhus.⁶⁷ During the war, Nicolle's findings would

⁶⁴ Modris Eksteins, *Rites of Spring*, 150.

⁶⁵ Ibid, 149.

⁶⁶ Gustav Ebelshauser, *The Passage*, 64.

⁶⁷ Wilhelm His, *A German Doctor at the Front (Die Front der Ärzte)* (Washington DC: National Service Publishing Company, 1933), 35.

be proven many times over, as lice were never fully eradicated from the trenches. Soldiers encountered them in the folds of shirts, collars, suspenders, identification tags, and pocket books. Even the wounded were not spared the agony of infestation, as surgical dressings were also a common habitat for the parasites.

Nevertheless, as early as the fall of 1914 the German military, medical, and chemical communities searched for delousing agents. Roughly two-hundred delousing agents were produced and tested in Germany during the war, many of them available over the counter for public purchase. By December 1914, delousing chemicals had become hot sellers among Christmas shoppers. In an effort to boost sales, many of the chemical agents went by humorous names. One German medical officer declared that remedies “such as ‘louse-death’ and ‘Nich-o-louse’ [a pun on Santa Claus’ true name] were favorite Christmas presents in 1914.” Despite their popularity, the officer concluded, “all were useless” against the legions of lice.

German entomologists traveled to both fronts to conduct research on lice, many of whom worked closely with the Kaiser Wilhelm Institute. The chief of the medical department within the Reich War Ministry, Surgeon General (*Feldsanitätschef*) Dr. Otto von Schjerning sent Professor Albrecht Hase, a well-known entomologist to the Eastern Front to study lice. Hase conducted research and experiments, monitoring lice reproduction, habitation, and locomotion habits. He discovered that lice can survive in trench boards and loose soil, can crawl several meters per hour, and can move under walls and doors to find prey.⁶⁸ In addition, as the lice problem initially was widespread on the Eastern Front, German rhetoric often included racial overtones, as many declared

⁶⁸ His, *A German Doctor at the Front*, 37.

the problem of pests in the east as a result of Slavic and Jewish peoples in the East spreading the pests.⁶⁹

Only a bath or shower could clear the body, while hot steam and Lysol treatments could clear lice from clothing and footwear. Delousing stations (*Sanierungsanstalten*) were set up at the front and at major railway centers. With their patience expired regarding lice infestation, the men enthusiastically took advantage of the new amenities. Furthermore, the Reich War Ministry passed regulations to prevent the spread of the vermin to the home front. Delousing was mandatory for all men going on furlough. The new anti-lice stations were hailed by the men, and songs grew out of the procedure:

*With confidence go in this house,
'Tis life for man, but death for louse.*⁷⁰

The delousing measures taken by the German military were expensive, both in manpower and in financial expenditure. The showers, chemicals, medical treatments and research costs added up. During the war, the Medical Department of the War Ministry spent approximately 250 Million Marks combating lice alone.⁷¹ Ultimately, it was recognized that an organization was needed to combat the pest problem. Coincidentally at that time, entomologists and German chemical companies were already forming relationships with the hopes of solving Germany's pest problems. The primary entomologists association was the *Deutsche Gesellschaft für Angewandte Entomologie* (German Association for Applied Entomology), founded by Karl Escherich in May 1913. The group advocated the gassing of entire mills with hydrocyanic acid to clean infested

⁶⁹ Szöllösi-Janze, *Fritz Haber*, 375.

⁷⁰ His, *A German Doctor at the Front*, 36.

⁷¹ Szöllösi-Janze, *Fritz Haber*, 377.

mills. To this end, during the war Escherich formed an alliance with the *Deutsche Gold- und Silberscheideanstalt* (abbreviated “Degussa”) a chemical firm based in Frankfurt that mass produced hydrocyanic acid for gold refining. Providing equipment and chemicals free of charge, entomologists under Escherich began experiments.

Given the health and food situation in Germany and at the Front by 1917, the Reich Health Office (*Gesundheitsamt*) were adamant that the new techniques be brought into action as soon as possible. In a letter to Degussa on March 30 of that year, the Reich Gesundheitsamt declared, “. . . in Germany no more time should be lost to take up the fight against vermin by means of fumigation through hydrocyanic acid vapors.”⁷² The government did not have to wait long; the first mass gassing of a mill took place at Würzburg in April 1917. Also by then, the entomologist’s efforts had already caught the German military’s attention. Two more tests using an alternate method of gassing with the same chemical were also carried out in Elmhorn and Maisdorf (Herz) the following month.⁷³

By 1916, Fritz Haber had also recognized the importance of pest control, and throughout the year he held meetings with entomologists and zoologists, notably Professor Albrecht Hase. Hase had volunteered to be the liaison between the War Ministry and the German Association for Applied Entomology. Realizing that gas research would be necessary after the war, Haber and the other leaders formed a new organization designed to continue poison gas research for civilian applications, even

⁷² See letter from the Reich Gesundheitsamt to Prof. Dr. Rosh of Degussa, 30 March 1917, BArch R 86/5246, Das Bundesarchiv, Berlin-Lichterfelde, Germany.

⁷³ See copy of Dr. Walter Rasch, “80 Jahre Mehlmotten 40 Jahre Mehlmottenbekämpfung: Ein geschichtlicher Rückblick,” 1956, Abteilung Va, Rep. 5, 545, p. 5, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

though their agents could very well be used for military purposes. On February 15, 1917, Haber, the Entomology Association, Reich government offices such as the Reichswirtschaftsamt, and representatives from the German chemical industry formed the *Technischen Ausschuß für Schädlingbekämpfung* (the Technical Committee for Pest Control, abbreviated Tasch).⁷⁴ On April 12, 1917, Haber was placed in charge of the new committee. Escherich was not pleased with Haber's position and activities, but as Szöllözi-Janze pointed out, "under the conditions of war, he was forced to cooperate."⁷⁵

The institute included a variety of scientists and medical personnel, including veterinarians, entomologists, chemists, and pharmacologists. Using Escherich's hydrocyanic acid ideas, Tasch oversaw the conversion of the delousing stations from water to the acid to delouse trains and uniforms. Teams of experts under Tasch's direction traveled from mill to mill clearing out infestations as well as military installations for the army and warships for the German navy.⁷⁶ While not discrediting the importance of the entomologist side of the operation, Haber believed the military should handle the gassing operations, and as such he recruited many of the experts from his old Gas Pioneers. Tasch even used the chemical training center at Breloh to practice their disinfecting techniques with hydrocyanic acid.⁷⁷ With their expertise at the front against humans, the technology and application required was a natural shift and the men needed

⁷⁴ See letter from Haber to the State Secretary of the Reichswirtschaftsamt, 16 February 1918, BArch R 3602/2172, Bundesarchiv, Berlin-Lichterfelde, Germany.

⁷⁵ Szöllözi-Janze, "Pesticides and War," 103.

⁷⁶ See for example Dr. Gagezow, "Bericht über die Durchgasung von zwei Torpedobooten der VIII. Torpedobootsflottille in Kiel, Kaiserswerft am 21. März 1918," 1918, BArch R 86/5246, Bundesarchiv, Berlin-Lichterfelde, Germany

⁷⁷ See letter from Tasch to the Kaiserliches Gesundheitsamt, 5 September 1917, BArch R 86/5246, Bundesarchiv, Berlin-Lichterfelde, Germany.

but a miniscule amount of training. By July 1917, Tasch had cleared 438,095 cubic meters of space in cities across Germany, including Frankfurt, Berlin, Wiesbaden, Duisburg, Bochum, and Kiel.⁷⁸ In a letter to the State Secretary of the Interior, Tasch proudly declared that with a variety of different types of vermin, the use of fumigation with hydrocyanic acid had been to that point “very effective” (*sehr erfolgreich*).⁷⁹ By the end of the war, the teams had purged over 150 mills, as well as several military structures and hospitals.⁸⁰ By the end of March 1919, Tasch had cleared some 3,102,000 cubic meters of mill space in Germany.⁸¹

Part of Tasch’s success was due to the chemical knowledge Haber acquired directly from the war. For example, during a meeting of Tasch leaders on July 9, 1917, Haber endorsed the use of hydrocyanic acid by addressing the question of the dangers of hydrocyanic acid in the mills. Haber compared the effects of hydrogen cyanide gas on the troops and foods at the front to those quantities in the mills, and stated that there was no detriment (*ohne Nachteil*).⁸²

⁷⁸ “Seit Bestehen des Tasch bis zum 9. Juli 1917 einschliesslich erfolgte Durchgasungen,” 9 July 1917, BArch R 3602/2172, Das Bundesarchiv, Berlin-Lichterfelde, Germany.

⁷⁹ Letter from Tasch to the Staatssekretär des Innern, 8 November 1917, BArch R 86/5246, Bundesarchiv, Berlin-Lichterfelde, Germany.

⁸⁰ Szöllözi-Janze, “Pesticides and War,” 100-104. For Haber’s attitudes regarding the roles of the military and entomology with respect to the fumigating operations, see “Niederschrift der Verhandlungen in der Sitzung des Technischen Ausschusses für Schädlingsbekämpfung am 9. Juli 1917 in den Räumen des Kriegsministeriums,” 9 July 1917, Abteilung I, IA, 1971, p. 6, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany. There is also a copy of this document in BArch R 3602/2172 and R 86/5246, Das Bundesarchiv, Berlin-Lichterfelde, Germany.

⁸¹ Albrecht Hase, “Die Bedeutung von Prof. F. Haber als Förderer der angewandten Zoologie; besonders der Entomologie,” no date, Abteilung Va, Rep. 5, Section B, I, File 547, p. 7, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

⁸² “Niederschrift der Verhandlungen in der Sitzung des Technischen Ausschusses für Schädlingsbekämpfung am 9. Juli 1917 in den Räumen des Kriegsministeriums,” 9 July 1917, Abteilung I, IA, 1971, p. 4, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

Lines which once separated institutions, technologies, and equipment for pest control and chemical warfare continued to blur. For his efforts and subsequent success, Haber was rewarded with a new title by the German Government by the end of the war: the Reich Commissioner for Pest Control (*Reichskommissar für Schädlingsbekämpfung*).⁸³ The Reich and the KWI also sponsored experiments with the Kaiserlich Biologische Anstalt für Land- und Forstwissenschaft that tested hydrocyanic acid concentrations on different species of pests and cocoons, tests similar in nature to those done on cats and rabbits with chemical weapons designed against humans.⁸⁴ It is clear that Haber took great interest in this new line of work that blended chemistry, entomology, and military cultures. Haber perhaps best summarized his attitude about this topic in a letter to the President of the Kaiser Wilhelm Society for the Advancement of Science, Adolf von Harnack. After emphasizing the importance of pest control and the work of Haber's Kaiser Wilhelm Institute for physical and electrochemistry with the entomological and biological areas, Haber declared the work to be "perhaps the most promising area of development that began in the war."⁸⁵

The search for pesticides also led to the development of new gases to be used on human targets. Indeed, the metaphor of humans being killed by poison gas like exterminators killing vermin was contemplated by German minds during the chemical war, even if the idea was repulsive. General of the XV Army Corps Berthold von

⁸³ Letter from Albrecht Hase to the Generalverwaltung der Max-Planck-Gesellschaft, 11 September 1956, Abteilung Va, Rep. 5, Section B, I, 541, p. 1, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

⁸⁴ See "Anlage 2" and "Anlage 3", no date, Abteilung I, IA, 1971, file pages 70-76, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

⁸⁵ Letter from Fritz Haber to Adolf von Harnack, 18 September 1917, Abteilung I, IA, 1971, p. 9, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

Deimling, who oversaw the entire German gas operation in the Ypres sector in 1915, stated after the war in his memoirs that “I must admit, that the duty (*Aufgabe*) that enemies should be poisoned like rats, to me internally went against the grain. . .” Yet these misgivings did not stop the general from concluding that through the use of poison gas at Ypres, victory could be achieved. “For such high aims,” Deimling wrote, “all must keep silent their inner concerns (*inneren Bedenken*).”⁸⁶ In that sense, the killing of humans with chemicals could be seen as a comparable operation to killing vermin, but the image was not repulsive enough to warrant the prohibition of poison gases. Victory came first on the list of the General Staff’s priorities.

Chemical warfare and its relationship to non-human species at the front tell us much about chemical warfare’s relationship to humans. Chemical agents’ effects on insects, mammals, and other creatures significantly determined the route humanity’s chemical war took between 1914 and 1918. The testing, development, and deployment of chemical agents against non-human species demonstrated a new level of warfare, beyond simply killing the enemy or seizing a capital city. It demonstrates an attempt by the belligerents to control nature itself, an idea long held by Europeans for centuries. While we tend to think of Europeans changing the landscape to fit agricultural purposes, in this case we see Europeans manipulating the environment and science for military gains. In that sense, chemical warfare fits well into European cultural attitudes towards nature at that time.

Up to 1917, the negative effects of a chemical attack were relatively short term, albeit highly destructive. But in that year, with the development of mustard gas, an

⁸⁶ Deimling, *Aus der alten in die neue Zeit*, 201.

unprecedented era of environmental contamination was born. As stated in the previous chapter, mustard gas' persistence meant that those near the front could no longer trust the ground they walked on for fear of coming in contact with the new toxin.

The Germans chose gas shells as the means to introduce the toxin to the Allies. Gas shelling for the purposes of environmental destruction was nothing new to German chemical strategy. As early as 1915, German shelling with experimental T-stoff and K-stoff shells were intentionally used to render the landscape almost uninhabitable with their chemical payloads. In a report dated 6 August, 1915, the German commanders specifically state that the T-stoff shelling is used "against a position or an area, the use of which is to be denied to the enemy for some time," but that the ground unfortunately cannot be occupied by friendly forces after the bombardment.⁸⁷ Yet unlike mustard gas, the time it takes for T- and K-stoff to degrade is far shorter.

In preparation for their attack, the German high command struggled to control the danger of filling, or "charging," chemical shells. In addition, Europe's climate influenced the types of chemicals the belligerents could use. For example, gas shells tended not to be charged exclusively with phosgene, due to its low boiling point of just eight degrees Celsius (forty-six degrees Fahrenheit). During the European summer, outside temperatures and air pressure could cause the shell's phosgene to boil, potentially causing the shell to burst or leak. Therefore, Green Cross shells almost always contained another

⁸⁷ Erich von Falkenhayn, "Memorandum Regarding the Employment of Gas Shells," 6 August 1915, Hartley Papers, Box 33 AI, Folder 3A, Churchill Archives Centre, Churchill College, Cambridge, UK, 1.

agent. Diphosgene, although not as toxic as phosgene, was often chosen due to its stability to the outside world.⁸⁸

At first, chemical shells were produced at various depots at the front. Yet these shells were often unstable, compelling the Germans to try and centralize their chemical shell production into one area that would specialize in manufacturing this particular type of ordnance. This model would also improve the quality of the shells, as they could be built by specialists in military controlled factories specifically designed for the dangerous work. The shells would then be transported to the front.

Originally, the plan was to construct these gas facilities close to Berlin, specifically Berlin-Aldershof. The decision to build a plant at Aldershof made sense for a number of reasons, chiefly the proximity of the weapon's program to the War Ministry and Haber in Berlin-Dahlem. However the negatives far outweighed the positives. The ever increasing demand for chemical shells at the front meant that a new facility at Breloh would cut down on shipping time to the Western combat zones.⁸⁹ Above all, the potential threat of experimental chemicals or poisonous clouds contaminating the urban landscape and poisoning the civilian populations around Berlin was too great for Germany's military leaders. Based on these reasons, the decision was made to build a major factory at Breloh. However, the high demand for gas shells compelled the Germans to construct a smaller factory at Aldershof as well. Research and production of gas masks would remain in Berlin, however, as Breloh lacked the sufficient skilled workforce to

⁸⁸ Diphosgene boils at 123 degrees Celsius (253.4 degrees Fahrenheit). "Phosgene and Diphosgene," WO 142/284, 15, The National Archives, London-Kew, UK.

⁸⁹ "A report on the work of the gas depot at Breloh, Munsterlager," Hartley Papers, Box 31, Folder 10, 1-2.

manufacture the intricate masks.⁹⁰ Other shell filling factories were constructed, such as a major Blue Cross shell plant in Dormagen, which could produce between 25,000 and 30,000 shells per day.⁹¹

The facility at Breloh was massive. The depot measured 6,340 hectares. Along the edges of the depot ran two shell production facilities. One factory, which was never completed, was a refrigeration facility designed to produce liquid phosgene. The other factory charged phosgene and mustard gas shells. A laboratory and experimentation building was located in the center of the depot. Next to the lab was a nine kilometer firing range, where shells and clouds were tested. The range also included extensive woodlands.⁹²

Unintended discharges and accidents were commonplace in both German and Allied chemical factories. To neutralize spilled toxins such as mustard gas, containers of water and chloride of lime were kept next to shell filling machines. On at least one occasion, a massive fire broke out in the Breloh filling plant, destroying the entire stock of ammunition. In the spring of 1917, another explosion, this time at the Adlershof plant near Berlin, destroyed the ammunition stockpiles and all the filling equipment. The explosion's shockwave tore the roofs off of the local inhabitants' homes a mile away.⁹³

⁹⁰ Ibid, 5.

⁹¹ "Report of the British Mission Appointed to visit Enemy Chemical Factories in the Occupied Zone Engaged in the Production of Munitions of War," February 1919, DSIR 36/1967, p. 7, NA.

⁹² Report of the British Mission Appointed to visit Enemy Chemical Factories in the Occupied Zone Engaged in the Production of Munitions of War," February 1919, DSIR 36/1967, p. 4, NA.

⁹³ Curt Wachtel, *Chemical Warfare* (Brooklyn: Chemical Publishing Co., Inc., 1941), 221.

Luckily, no one was killed by the blast or the gas. Although no one lost their life, numerous casualties still occurred at the German shell filling facilities.⁹⁴

In the United States, an explosion at the Experiment Station at the American University created a cloud which blew into a residential area, located just across the street from the grounds. Former United States Senator Nathan B. Scott of West Virginia, his wife, and sister, who were staying in their “sometime residence” at the time, were all exposed to the cloud and “lightly gassed.” The senator and his sister were hospitalized and treated by chemical warfare medical personnel from the station. Others in the area also stated they smelled the gas as well, but nobody reported any health problems. In the wake of the incident, Scott complained about the experiments, and in October the D.C. Board of Commissions submitted a formal request to cease testing operations. By then, however, the war was all but over, and testing ceased.⁹⁵

The British and French also endured their share of industrial accidents and spills. The majority of Allied mustard gas was produced in France, at Roussillon. Civilian employees at the factory could be listed as casualties by any definition, as ninety percent of the workforce lost their voices and almost everyone developed conjunctivitis. Burns were also common.

Yet the environmental effects of these chemical weapons also negatively affected the average citizen living in the vicinity of the German chemical companies. This was perhaps most noticeable in the quality of their drinking water. For example, much of the

⁹⁴ Harold Hartley, “Report on German Chemical Warfare Organization and Policy, 1914-1918,” WO 33/1072, p. 22, The National Archives, London-Kew, United Kingdom.

⁹⁵ Martin K Gordon, et. al, “Chemical Testing in the Great War: The American University Experiment Station,” *Washington History*, Vol. 6, No. 1 (Spring/Summer 1994): 35-36.

drinking water in Leverkusen came from the Rhine, a river which had also been the primary waste disposal system used by Bayer, BASF, and other German chemical companies for decades. Already polluted by years of uncontrolled chemical dumping, the Rhine was by 1915 a dubious source for quality drinking water. Still, water from the water works in Leverkusen was widely consumed. Data collected by Bayer scientists from the water works between 1912 and 1919 demonstrate a disturbing decline in water quality. In addition, efforts by Bayer to collect this data testify to both their sensitivity and concern over their pollution practices. After all, they would not bother collecting samples or scientific data if chemical production and dumping was incapable of causing trouble.⁹⁶

As Bayer produced more and more chemical agents for the war, levels of harmful chemicals directly associated with those agents – chemicals such as chlorine and sulfur trioxide – dramatically increased in the drinking water. For example, chlorine concentrations jumped from 31.9 milligrams per liter of water in September 1914 to 61 milligrams per liter by January 1917. Sulfur trioxide (sulfites), a byproduct of mustard gas production and an ingredient in acid rain, jumped from 44.2 milligrams per liter in September 1914 to 83.1 milligrams per liter by June 1918. Below is a chart showing the increases in chemical concentrations in the Rhine. The scale on the y-axis is based on milligrams per liter:

⁹⁶ Bayer's archives contain numerous reports detailing water samples and analysis of its content. For example, see "Besichtigung und Untersuchung des Rheines auf der Strecke von Rolandseck bis unterhalb Düsseldorf," 26 June 1913, 58-9.4.2, Bayer History and Corporate Archives AG, Leverkusen, Germany.

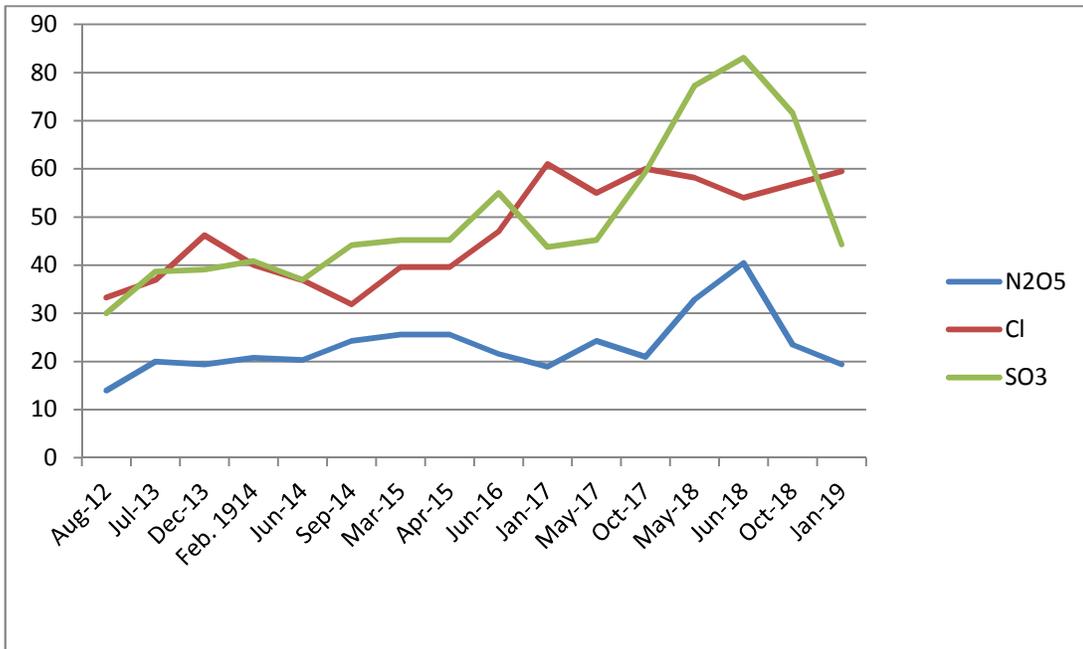


Figure 4. Chemical Concentrations in Water at Beyer Water Works (1912-1919)⁹⁷

Notice that the concentrations of chlorine begin to rise considerably during the spring of 1915. This is not a random occurrence. Rather, the increase in chlorine contamination coincides with the first German chlorine attacks in April of that year. In addition, one can clearly see concentrations of sulfur trioxide escalate during the summer of 1917. Again, this trend seems to be directly correlated to the development and mass production of mustard gas at that same time. It is also important to point out that the levels of other potentially dangerous chemicals that did not increase until the end of the war, such as dinitrogen pentoxide (N_2O_5 , a compound that breaks down into the toxic gas nitrogen dioxide as it decomposes and reacts with water to produce nitric acid) were nonetheless still in the water.

⁹⁷ "Hauptanalysezahlen der sämtlichen Wasseranalysen von 1912-1920 vom Wasserwerk Leverkusen," 1920, 58-9.2, Bayer.

When compared to modern health standards, the toxicity of the water is quite shocking. For example, the United States' Environmental Protection Agency (EPA) declares that drinking water contaminated with chlorine at any level above four milligrams of chlorine per liter of water can be potentially hazardous to your health. Thus, the water was approximately fifteen times the safe level. Safe nitrates levels are set by the EPA at one milligram per liter. Therefore, the nitrogen-oxygen compounds contained in the Rhine were highly toxic and could cause serious illness or death.⁹⁸

Meanwhile, the level of patience residents had farther along the Rhine regarding the level of chemical pollution in their waters had finally given out, especially with those around Ludwigshafen. The concentration of sulfur compounds in the river by BASF's dumping actually began to damage boats on the Rhine and poison the crews with toxic vapors, and resulted in public protests. An effective, new treatment facility was required, but would not be constructed until 1921. Even then, there would be no signs of desulfurization until the spring of 1926.⁹⁹

Despite the number of accidents and environmental degradation, German industrialists and scientists continued to advocate for and produce ever more hazardous chemicals. Carl Duisberg eagerly reviewed production statistics and casualty reports resulting from his company's products. He even had friezes painted in anterooms in the Bayer factories. One room was decorated with illustrations depicting war gasses being produced, gas masks being assembled, and even one painting of gas shells being

⁹⁸ Environmental Protection Agency, "National Primary Drinking Water Regulations," 11 January 2011, <http://water.epa.gov/drink/contaminants/index.cfm>.

⁹⁹ Jeffrey Allan Johnson, "The Power of Synthesis (1900-1925)," in Werner Abelshauser, et al. *German Industry and Global Enterprise, BASF: The History of a Company* (Cambridge: Cambridge University Press, 2004), 155.

loaded.¹⁰⁰ Such décor not only stunned the Allied weapon inspectors and chemists who would later see them after the war still hanging proudly in the offices, but also demonstrated the mentality of Bayer's senior administrator regarding his work.

Unlike the efficient and glorified depiction of chemical production seen on Duisberg's walls, those who worked within the German gas factories suffered greatly. Worker casualties were almost immediate, as the manufacture of choking gases inflicted heavy casualties among the civilian workforces. Women were forbidden from working with the dangerous chemicals. These injuries would continue, as the toxins became gradually more dangerous to handle and to work with. For example, at Höchst's diphosgene plant, several small explosions occurred and a large number of poisonings were reported. Workers were equipped with gas masks in the event of an emergency, but did not regularly wear them on the production floor. Despite their masks, a post-war analysis revealed that numerous employees developed heart and chest conditions. Many of the men received large, cumulative doses due to their length of time in the factory. The employees often remained working at the same positions in the factory, as the company "wished to retain those who could stand it." At times, as many as one third of the workforce were unable to work due to poisoning, and two or three men actually died during production. When questioned, Höchst officials at the time did not acknowledge that the men's deaths were a result of poisoning.¹⁰¹

British civilians also suffered, especially those working in the chemical plants. During one period of six months, 160 accidents and 1,000 burns were reported,

¹⁰⁰ James F. Norris, "The Manufacture of War Gases in Germany," *The Journal of Industrial and Engineering Chemistry*, Vol. 11, 9, (September 1919): 818.

¹⁰¹ *Ibid.*, 823-824.

presumably a certain number were never disclosed.¹⁰² While it will remain unknown how many accidents occurred, between 15 June and 15 December 1918, 5,600 total attendances were made at the factory hospital, among a working staff of around 1,100.¹⁰³ This means that the average worker experienced multiple gassings and/or health conditions. Medical reports testified to the vast amount of detrimental health effects suffered by the workers. The effects reported ranged from the minor, such as erythmia, iritis, and leukodermia (redness or inflammation) to the more severe, such as gastric pain or mental inertia. One of the most serious conditions reported was purulent-broncho pneumonia, an irreversible and fatal lung condition where the lungs fill with fluid, causing the victim to drown in puss.¹⁰⁴

Yet more disturbing than the chemical effects on the home front was the German military's policy of gas bombardment as a form of collective, environmental destruction. This was often done to the point of counter-productivity. The official German manual for gas shelling, entitled *Gasschiessen der Artillerie (Gas Bombardment by Artillery)*, explained that the objective of gas shells was not necessarily to just kill the enemy's troops. The first line of the manual states that "the purpose of gas shelling is to annihilate or harm living targets and the disruption of the fighting ability of the enemy."¹⁰⁵ The manual goes on to recommend that "positions can be made unusable through

¹⁰² Edward M. Spiers, *Chemical Warfare* (Houndmills, UK: The MacMillan Press LTD, 1986), 27.

¹⁰³ "Section 9. Types of Illnesses Arising out of 'H.S.' Manufacture," 1918, WO 142/227, 6, The National Archives, London-Kew, UK

¹⁰⁴ *Ibid*, 1-2.

¹⁰⁵ "Das Gasschiessen bezweckt die Vernichtung oder Schädigung lebender Ziele und die Störung der kampftätigkeit des Feindes." See "Gasschiessen der Artillerie," 1 December 1917, M 635/1, 990, p. 1, Landesarchiv Baden-Württemberg, Stuttgart, Germany.

contamination (*Verseuchung*) with gas.”¹⁰⁶ Here I argue is the essence of total environmental war: the targeting of non-human agents and the landscape to inhibit the enemy or achieve military gains.

As alluded to earlier, Falkenhayn had already established gas shelling procedures two years prior, when the Germans experimented with T-Stoff and K-Stoff shells. Although the shells proved to have little effect on the battlefield, Falkenhayn’s methods seem to have established the standard German gas shelling protocols. In a memorandum dated August 6, 1915, Falkenhayn explained the composition of T- and K-Stoff shells, as well as how they should be used. Situational tables were included, composed of a battlefield situation and the appropriate gas procedure. The memorandum’s recommendations would prove a sign of events to come, as it authorized the shelling of civilian areas and natural targets to achieve military aims. For example, Falkenhayn declared that gas shells were to be used “to make an enemy, entrenched in farms or small woods, withdraw from his positions” and to form “barrages over whole tracts of country to prevent the arrival of reserves or to cut off the enemy’s retreat.” He then went on to add that “in order to make full use of the explosive effect of gas shells. . . zones must be selected in which points of d’appui situated in rear, camps, depots, and exits from villages, can be made to feel the effects of our fire.”¹⁰⁷ Although the memo does not specifically order the targeting of civilians, the authorization to fire on farms, large tracts of countryside, and close to, if not directly on, villages, established a deadly precedent the

¹⁰⁶ Ibid.

¹⁰⁷ Erich von Falkenhayn, “Memorandum Regarding the Employment of Gas Shells,” 6 August 1915, Hartley Papers, Box 33 AI, Folder 3A, pgs. 2-3, Churchill Archives Centre, Churchill College, Cambridge, UK.

German gas units employed against both Allied military and civilian personnel during the war.

Since, as indicated above, the decision to use chemical weapons relied almost entirely on meteorological conditions, both sides committed extensive resources into monitoring temperature, humidity, precipitation, and wind. For example, immediately after the first German gas attack in 1915, British military officials conducted research on European weather patterns. Tables were drawn up in an effort to predict future German attacks, some of which were compiled on annual weather data collected since prior to the turn of the century. For example, charts demonstrated the number of days per month winds blew in certain directions over the past twenty years, how many times per month the winds traveled at favorable gas attack speeds, and what months winds may be most favorable for German attacks.¹⁰⁸

Massive offensives involving gas often revolved around the timing of favorable winds. For example, in January 1916 the Germans planned for a massive offensive in the area of the Somme involving 14,000 gas canisters, each weighing one hundred pounds. However, winds were unfavorable, and as one of the senior commanders of the operation, General Georg von der Marwitz described in his diary, “Now we are waiting for the Eastern wind, that alone enables the gas’ effects; otherwise we will poison our entire trench.” The wind direction never changed, but the offensive took place anyway without the gas support.¹⁰⁹

¹⁰⁸ J. Annesley, “Statistics and Remarks Regarding the Direction and Strength of Wind in the South of Belgium and North of France which could Prove Useful if Asphyxiating Gases are to be Employed by Us,” 20 May 1915, WO 158/122, 1-3, The National Archives, London-Kew, UK.

¹⁰⁹ Georg von der Marwitz, *Weltkriegsbrieft* (Berlin: Steiner-Verlage, 1940), 156.

In addition to wind patterns, humidity and air pressure were also monitored, as forces also influence the density and movement of the cloud. Ideally, forty to fifty percent humidity was seen as optimal for gas attacks, as the humid air facilitates the formation of the cloud and helps pin the gas to the ground. Fog is also seen as advantageous, as it can obscure an oncoming cloud.¹¹⁰

German gas instructions and manuals emphasized primarily gas defense and meteorological conditions from the beginning and remained, for the most part, consistent in their instructions. Leaflets distributed to troops read like biblical commandments, with simple lists of commands, such as “1. Trust your mask; 2. Trust the application (*Einsatz*) of it and do not alter it during a gas attack; 3. Pay attention to the wind and weather” tried to explain in the most basic of terms how to approach these terrifying new weapons.¹¹¹ Meteorological conditions were always stressed, as German commanders trained their men to pay more attention to environmental conditions that could potentially be used to the enemy’s advantage during offensives. The simplistic language and emphasis on mask discipline points to a genuine concern among officers that the psychological effects of the gas had taken hold. Panic translated into casualties when the air itself could not be trusted.

By the end of the war, German troops recognized and understood the importance environmental factors play regarding gas attacks. In some cases, the men prayed for environmental shifts to spare them gas poisoning. For example, Max Heinz recalled in his

¹¹⁰ ¹¹⁰ B.C. Goss, “An Artillery Gas Attack,” *The Journal of Industrial and Engineering Chemistry*, Vol. 11, 9, (September 1919): 831.

¹¹¹ “Dienstvorschrift für den Gaskampf und Gasschutz (D.f.Gask.), II. Teil: Gasschutz,” July 1917, Bestand M635/1, Bestellnummer 969, Anlage 1, p. 53. Landesarchiv Baden-Württemberg, Stuttgart Germany.

memoirs surviving a British mustard gas barrage. The barrage was so intense, that “outside the whole landscape was plunged into a white sea. Only the tops of the hills still protrude out.”¹¹² Heinz began to feel the effects of the gas as it crept down into his trench. Knowing hot air will drive gas fumes upward, he and his men built a fire in their shell crater to raise the air temperature. Knowing he was in trouble, he begged for nature to save him and his comrades. “Only sun and wind can still help us, otherwise it is the end.”¹¹³ He soon struggled to breath, developed a cough and fatigue. After evacuating the shell hole with his comrades, Heinz collapsed and was evacuated to a field hospital. He lost his sight for several days and developed ulcers on his body. Despite the “unbearable” agony, he survived. Nevertheless, his gassing was severe enough to end his service at the front for good.¹¹⁴

In addition, any gas attack ordered by a German army commander all but required the consultation of meteorological and geographical experts. According to the German gas warfare manual regarding the weather services, in preparation for gas attacks, “it is of the greatest importance to have expert opinion on the condition of weather and the terrain in every individual case, especially in rough country.”¹¹⁵ By 1916, every front line German battalion on the Western Front included a three-man

Frontwetterbeobachtungsstation, (literally “Front weather observation station).

¹¹² Max Heinz, *Loretto: Aufzeichnungen eines Kriegsfreiwilligen* (Berlin-Zehlendorf: Rembrandt-Verlag, 1929), 314.

¹¹³ *Ibid*, 315.

¹¹⁴ *Ibid*, 318-334.

¹¹⁵ Taken from a translated German gas manual entitled, “Service Regulations for Gas Warfare (Attack and Defence): Part IV: Meteorological Service (Forward Weather Observation Stations),” WO 188/114, pgs. 4-5, The National Archives, London-Kew, UK. See also the original manual, “Dienstvorschrift für den Gaskampf und Gasschutz, IV. Teil: Frontwetterdienst,” M 635/1, Bestellnummer 972, Landesarchiv Baden-Württemberg, Stuttgart Germany.

Nicknamed “Frosta,” the Frostas monitored and recorded temperature, wind direction, and other meteorological data every hour.¹¹⁶ To ensure their measurements and instruments remained accurate, the Frosta’s equipment were inspected weekly by another group attached to the division, a *Frontbeobachtungspatrouillen*, (Front observation patrol, or “Fropa”), usually composed of two Lance Corporals.¹¹⁷ These teams were highly skilled and amazed both the German and Allied High Commands with their accuracy.

During the war, the Entente were stumped as to how the Germans could make such accurate weather forecasts, given that data from enemy territory, specifically regions surrounding Ireland and Britain, were necessary in predicting accurate weather maps of the Western part of the continent. One English meteorological expert speculated that the Germans used U-Boats, rather than spies, to record weather data and transmitted their findings via wireless communication systems to German scientists.¹¹⁸ Indeed, an examination of the German gas manuals confirms that the German naval command did relay weather observation information to their ground forces at the front. As one Allied official concluded, “It is perfectly clear that the German meteorologists have made very careful study of wind and weather before launching such gas attacks, and their success, in a large majority of cases, shows how well their weather forecasts were made.”¹¹⁹

¹¹⁶ “Der Gaskampf,” 1916, M 635/1, 1361, p. 5, Landesarchiv Baden-Württemberg, Stuttgart Germany.

¹¹⁷ Harold Hartley, “Report on German Chemical Warfare Organization and Policy, 1914-1918,” WO 33/1072, p. 31-32, The National Archives, London-Kew, United Kingdom.

¹¹⁸ Ward, “Weather Controls,” 33.

¹¹⁹ *Ibid*, 29.

In addition to emphasizing meteorology, the German gas manual also discussed the different types of bombardment, and how the topography played into which kind to use. For example, bombardments designed to surprise the enemy (*Der Gasüberfall*), could not be conducted if the wind is still or moving less than three meters per second, if the sun is out, or if it is raining heavily.¹²⁰ Intense sunshine generates vertical air currents, pushing the gas into the atmosphere. Heavy rains not only dilute the toxin but can also push the clouds downward to the ground, rendering them “ineffective.”¹²¹ Muddy terrain also disrupts shell detonation on impact, as the soft terrain absorbs the higher velocity shells. In addition, the water-saturated ground can also act as a decontaminant if the shell’s gas casing cracked or opened upon impact. And as stated earlier, meteorological conditions involving the wind are also potentially detrimental to chemical shelling because they can cause friendly casualties through blow back.

Perhaps the most devastating type of chemical shelling implemented by the Germans was contamination bombardments (*Verseuchungsschiessen*). The purpose of this bombardment is to use Yellow Cross to saturate the terrain with enough mustard gas as to render the environment uninhabitable. The gas manual suggests that these types of bombardments are especially effective if the area chosen still has enemy units in the target area, because they will feel the effects of both the incoming shells to the ground (*Bodenwirkung*) and the vapors released from the gas (*die Wirkung der Gelbkreuzschwaden*).¹²²

¹²⁰ “Gasschiessen der Artillerie,” 1 December 1917, M 635/1, 990, p. 10, Landesarchiv Baden-Württemberg, Stuttgart Germany.

¹²¹ Ibid, 17.

¹²² Ibid, 11-12.

In addition to weather, topography was also a significant concern among the German gas specialists. For example, areas of higher elevation tended to have stronger wind currents. Elevation also determined which gas to utilize for an attack. Chlorine cloud attacks were useless against positions of higher elevation, as the gas hugs the ground. It would, therefore, fail to climb up hill without the aid of a fortuitous wind. In addition, ground friction manipulated the dispersal of the cloud. Friction is, of course, highest on the ground, as vegetation, earth, buildings and other materials slow the progression of the gas and break up its concentration. As elevation increases, friction declines and becomes virtually non-existent. This, coupled with higher wind speeds at higher altitudes, meant that gas clouds moved faster at higher altitudes, rather than lower ones, creating a wave effect.¹²³

Geological and topographical conditions also played major roles. Depending on the permeability of the soil, temperature, and amount of gas deployed, surface run-off can also occur if the toxin is a liquid, such as mustard gas at a cold temperature. For example, forests, buildings, and corn fields would slow down the evaporation of chemicals, as the trees and buildings provided shade from the sun and cover from strong winds. As one German gas memorandum declared, “The firing procedure is applicable in every terrain. Forests, *Buschwerk*, and cornfields, the *Reizstoffe* remain effective for many hours.”¹²⁴ Chemical specialists were, however, careful to mind larger geographical obstacles such as valleys and hills. Cases were reported of cloud attacks where the gas funneled into

¹²³ Taylor, *Lethal Mists*, 190-191.

¹²⁴ “Der Gaskampf,” 1916, M 635/1 Bestellnummer 1361, p. 5, Landesarchiv Baden-Württemberg, Stuttgart Germany.

curved valleys. Propelled by the natural air currents, the gas turned and inflicted friendly casualties.¹²⁵

The soil on which the men fought also played a role in determining the effectiveness of a chemical attack. Soil characteristics, such as their surface area, temperature, moisture content, and pH level influence the detoxification rates of chemical weapons. An example of soil effect can be deduced from the first time Germans deployed Yellow Cross shell on July 12, 1917 in the Ypres salient. Along with high explosive rounds, the Germans fired a mixture of Green and Yellow Cross shell in a punishing nine-hour barrage that finally ceased between 4:00 A.M. and 5:00 A.M. on the 13th. That day, the wind was all but still (only one to two miles per hour). Yet the temperature was warm and the ground moisture levels were perfect. The earth was unusually dry that day, as it had not rained for several days.¹²⁶ The dry land created a hard surface for the toxic liquid to rest upon. This, coupled with the warm temperatures that facilitated evaporation of the toxin, created an awful scenario for those in the bombarded area.

Additionally, subterranean organisms, including rodents, worms, or other burrowing creatures create tunnels and pockets within gassed areas that remain buried. The gas may then be released at a later time, so long as the environmental conditions maintained the integrity and toxicity of the compound. Other, non-living organic materials such as humic acids enable soils to absorb higher levels of toxin.¹²⁷ Biological

¹²⁵ B.C. Goss, "An Artillery Gas Attack," *The Journal of Industrial and Engineering Chemistry*, Vol. 11, 9, (September 1919): 831.

¹²⁶ Harold Hartley, "Report on the Gas Shell Bombardment of Ypres, Night of 12/13 July, 1917," 19 July 1917, RG 9 III-C-3, 4121, File 2, Folder 9, p. 1, LAC.

¹²⁷ Ralf Trapp, *The Detoxification and Natural Degradation of Chemical Warfare Agents* (London: Taylor & Francis, 1985), 25-26.

degradation can also occur if microorganisms use the chemical for sustenance. Although little data is available, some bacteria contain the exoenzymes necessary to transform mustard gas molecules, but the vast majority of microorganisms cannot survive the toxicity of mustard gas.¹²⁸

Between July 1917 and June 1918, British chemical officials published a monthly pamphlet to update troops at the front regarding gas technologies and counter-gas tactics.

In the first issue, the hazards of mustard gas were summarized:

The persistence of dichlorethyl sulphide is considerable. Several hours after a bombardment has ceased, casualties may be caused by the vapor given off from the ground. The gas persists in dug-outs and cellars for a long time, and casualties have been caused by working parties returning to cellars without being warned that a bombardment had taken place. A number of men had blisters on their buttocks, presumably from sitting down on the ground after a gas shell bombardment had taken place. Experiments have shown that the liquid may remain in the ground for several days in sufficient quantity to cause blistering when samples of earth are kept in contact with the skin.¹²⁹

British officials continued to issue additional warnings regarding the persistence of mustard gas in the soils through their monthly pamphlets. In September 1917, *Gas Warfare* warned that the “liquid from gas shell may remain on the ground and give off vapour, especially when the ground is warmed by the sun or is disturbed by digging. . .when possible, men should be moved to areas which have not been shelled, but care must be taken that respirators are put on if men return to an infected place.”¹³⁰

¹²⁸ Ibid, 34.

¹²⁹ “New Enemy Gas Shell,” *Gas Warfare: Monthly Summary of Information*, (July 1917): 5-6. Pamphlet within the papers of Auld, A J M Lt. Colonel, File 75/101/1, Imperial War Museum, London, UK.

¹³⁰ *Gas Warfare*, (September 1917): 7. Auld Papers, File 75/101/1, Imperial War Museum, London, UK.

Two months later, the pamphlets suggest troops should sprinkle chlorine of lime to neutralize areas contaminated with mustard gas. Yet British experts did not know for sure if chloride of lime would actually work. The pamphlet further recommended against spreading too much chloride on the contaminated area, as the smell of the chlorine would overtake that of the mustard gas, making detection of Yellow Cross contamination more difficult.¹³¹ Oddly, the pamphlet seemed to contradict official decontamination procedures, as one British report recommended using thirty pounds of chlorine as the necessary amount to decontaminate *one* fifteen centimeter gas shell and that “treatment should only be attempted in exceptional circumstances. . . .”¹³²

In sum, decontamination was a constant labor at the front. Troops who came into contact with the substance were forced to conduct thorough decontamination procedures on their uniforms and equipment. British troops experimented with a variety of methods, including treating the clothing with chloride and hot steam. Appearing to be fed up with the cleaning experiments, British military officials seemed to simply give up as they declared, “As very heavily contaminated or directly splashed clothing cannot be effectively cleared without damage to the cloth, it is advisable that no attempt should be made to clear such clothing, which should be buried.”¹³³

German troops faced a more serious problem with mustard gas contamination, because they could not replace their equipment as easily as the Allies. For minor gas

¹³¹ *Gas Warfare*, (November 1917): 8. Auld Papers, File 75/101/1, Imperial War Museum, London, UK.

¹³² “Destruction of Mustard Gas in Dugouts,” 1918?, WO 142/267, 1-2. The National Archives, London-Kew, UK

¹³³ “Destruction of Mustard Gas in Clothing,” 1918?, WO 142-267, p. 1, The National Archives, London-Kew, UK.

cases, the Germans had detailed cleaning protocols for uniform decontamination. Uniforms had to be washed three times over in warm water, each time with a fresh tub of clean water (contaminated water from the previous wash was not to be touched again). Boots had to be scrapped clean of dirt and washed, with particular care given to the laces, which could absorb the mustard liquid like a sponge.¹³⁴ However, often gassings were too severe to save the equipment, and the uniform or gasmask was rendered useless. The loss of equipment further strained the German logistical organizations, already struggling to feed and cloth their forces. The damage rendered by Allied (and friendly) mustard gas attacks was so severe that in a post-war interview, Fritz Haber stated “If the war had continued into 1919, you would have won by gas alone. We were at the limit of the protection given by our respirator and the replacement of clothing after mustard gas would have been impossible for us.”¹³⁵ While Haber may have exaggerated the strength of the Allied gas warfare capability in 1918, given the shortages of food, let alone war materials the Germans faced in 1918, Haber’s statement is a valid one. The loss of equipment due to mustard gas’ tenacity should not be overlooked.

Personnel who were hit with the liquid were scrubbed with chloride of lime and water. Medical officers held training classes at the front to train and practiced decontamination procedures. In addition, to protect against both mustard liquid and vapor, packets of bicarbonate of soda were distributed to soldiers. In the event contact with mustard gas occurred, soldiers were told to mix the packet with their water ration

¹³⁴ Erich Ludendorff, “Concerning Defence Against Yellow Cross,” 6 June 1918, Box 44, p. 2-4. Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

¹³⁵ Harold Hartley, “Fritz Haber,” Box 44, p. 14. Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

and apply the solution to their eyes and skin. They were also instructed to gargle the solution as well as snort and drink the solution to help clear out their respiratory and digestive tracts.¹³⁶ German troops powdered their staircases leading into their dugouts and trenches with chloride of lime to prevent the spread of mustard gas residue left on the bottoms of the men's boots.¹³⁷

In an effort to solve the problem of mustard gas contaminated environments, full chemical suits were designed and constructed. For example, the Americans created a suit out of cotton sheeting impregnated with linseed oil, castor oil, and paraffin wax. The suit successfully repelled the mustard agent for roughly sixty to ninety minutes. Other suits experimented with waterproof gelatin and rosin oil. Due to their lack of ventilation, the suits were unpopular with those who were forced to wear them, mainly mustard gas decontamination crews. Their lack of flexibility, as well as logistical cost and transport, caused Allied experts to place aside the idea of issuing suits to the men at the front.¹³⁸

By December 1917, the Germans continued to refine their tactics with mustard gas shelling, to great psychological effect. French troops claimed that the Germans had added time fuses to their shells, enabling them to be detonated in mid air, creating a fog or rain effect on the Allied trenches. After the shell exploded, mustard gas mist would slowly descend on the troops, and sink into the soil.¹³⁹ These claims were not true; the

¹³⁶ See secret memo numbered "VI Corps:- A/5650," 28 May 1918, RG 9 III-C-3, 4138, Folder 4, File 16, Library and Archives Canada, Ottawa, Ontario, Canada.

¹³⁷ "Destruction of Mustard Gas in Clothing," WO 142/267, 2, The National Archives, London-Kew, United Kingdom.

¹³⁸ "General Conclusions Regarding Protective Gloves and Clothing, Relative to the Employment of Mustard Gas," WO 142/267, 2-3, The National Archives, London-Kew, UK.

¹³⁹ *Gas Warfare*, (December 1917): 7. Auld Papers, File 75/101/1, Imperial War Museum, London, UK.

Germans never developed a successful proximity or time fuse during the war.¹⁴⁰ Purple, yellow, blue, and red dyes were used to designate areas where mustard gas had been deployed, so German commanders knew what areas to avoid when attacking. It also created a bizarre looking technicolor kaleidoscope effect on an otherwise muted, dreary battlefield. These colorful battlefields would last for some time, as even after the fighting had ceased in the Ypres salient, one British soldier recalled in a letter dated March 1919 that “For some yards around the [gas shell] holes where they had exploded the grass is now a bright yellow color. It was in this district where the Germans used an immense amount of gas and being of recent date. The discoloration had not been effaced.”¹⁴¹ This tactic was particularly useful in winter conditions. So long as the temperature of the ground remained freezing, the toxin could not evaporate and would contaminate the snow-covered fields indefinitely.¹⁴² Once the Allied General Staff received word of this, commanders warned their troops to be on the look out for these colorful but potentially fatal hazards.

Food and water contamination was also a major problem. In the weeks and months that followed the Germans’ use of mustard gas in 1917, casualties continued to escalate from the consumption of contaminated food and water. By January 1918,

¹⁴⁰ Haber, *Poisonous Cloud*, 193.

¹⁴¹ Arthur A. Long, letter to Mrs. A. A. Long, 3 March 1919, File # 06/30/1, p. 14, Imperial War Museum, London, United Kingdom

¹⁴² *Gas Warfare*, (December 1917): 8-9. Auld Papers, File 75/101/1, Imperial War Museum, London, United Kingdom.

soldiers were forbidden from eating uncovered food after a gas attack. Soldiers were also told not to use the water from shell craters for drinking, cooking or washing.¹⁴³

The new gas also made life at the front anything but comfortable. To protect themselves, men were forced to cover their entire bodies with uniforms, goggles, masks, leggings, coats, gloves, and boots. Ronald Schweder, a British artillery officer, complained in his diary that “One can’t see out of one’s damned gas helmet (if one wears it), and if one tries to walk about in it one falls into every hole; if one doesn’t wear it one’s eyes become dreadfully sore as well as one’s chest, and of course one runs the risk of getting properly gassed.”¹⁴⁴

Both sides found the use of mustard gas shelling an effective tool to contaminate the enemy’s supplies. The ability to deprive the enemy of resources is especially critical during a war of attrition, where the failure to maintain supply routes would result in defeat. Both sides used mustard gas to contaminate intersections and supply routes, targeting horse trains and stables. In some cases, battles were won or lost on the health of the horses. For example, in November 1917, a German report by a commander of the First German Army stated that his men lost the Arras because entire teams of horse transport suppliers were wiped out by hostile gas. The General wrote that the “horses [were] greatly affected by gas. In many cases the failure of the ammunition supply is to be attributed to this.”¹⁴⁵

¹⁴³ “Precautions in Connection with Food and Water,” *Ibid*, 10.

¹⁴⁴ Ronald Schweder, letter, 11 August 1917, File # 86/65/1, IWM, London, UK, 256-257. This letter is contained in the bound collection of his letters entitled, “The Line.”

¹⁴⁵ Gas Warfare, (January 1918): 5. Auld Papers, File 75/101/1, Imperial War Museum, London, United Kingdom.

Gas shelling had escalated during the summer and fall of 1917. The following spring, during the German offensive of March 1918, gas bombardments were on a scale unlike anything ever seen. This makes sense, as numerous German and Allied officials noted after the attack began that weather was the primary reason the Germans timed the attack when they did. In an article published in July 1918, the noted Harvard climatologist Robert DeCourcy Ward stated that “From all evidence that has so far come to hand it is clear that the time must have been carefully chosen after consultation with the meteorological experts” and “all meteorological factors were in favor of the enemy.”¹⁴⁶

With little apparent regard for civilian casualties, the Germans shelled almost indiscriminately. Between July 1917 and May 1918, the Germans targeted villages and military personnel alike, subjecting Belgian and French villages to some of the heaviest gas shelling of the war. Civilian casualties mounted rapidly, as numerous towns were drenched in mustard toxin. On the night of July 27-28, 1917, Armentières was heavily shelled and resulted in 675 civilian gas casualties, eighty-five of which were fatal. In 1918, the British were forced to evacuate the contaminated towns of Givenchy, Liévin, and Annequin after one week of intentional German chemical shell bombardment. Over 4,400 people could no longer survive in their homes.¹⁴⁷ On 7 and 15 April 1918, the towns of Annequin, Givenchy, and Liévin in the Région Minière were gassed, resulting in 230 civilian gas casualties, of whom nineteen died. According to one report of the

¹⁴⁶ Robert DeC. Ward, “Weather Controls Over the Fighting during the Spring of 1918,” *The Scientific Monthly*, Vol. 7, No. 1 (July 1918): 24-25.

¹⁴⁷ Andy Thomas, *Effects of Chemical Warfare: A Selective Review and Biography of British State Papers* (London: Taylor and Francis, 1985), 20-21.

bombardments, “the civilian population of the Région Minière was subjected to very heavy bombing by special shells. . . More than 100,000 shells, mostly yprite [mustard gas] ones, fell on Givenchy and Liévin. . . on average, there was one shell hole per square metre.” Smaller bombardments of only a few hundred shells also inflicted heavy casualties up until the end of the war. In October, the towns of Neuville, Inchy, Haussy, and Famars all suffered civilian casualties. On October 27/28, the town of Avelghem, Belgium was shelled, resulting in over 350 civilian gassings. On November 5, only six days before the end of the fighting, the town of Leers was shelled, again resulting in many civilian victims.¹⁴⁸

Also by 1918, civilian casualties were no longer disregarded or ignored by Allied military leaders. Charles Foulkes, commander of the British Special Brigade, now took into account potential civilian losses when planning gas attacks, whereas prior British attacks did not fully account for potential civilian losses. For example, prior to a massive chlorine assault planned for March 1918 (an assault eventually called off because of the German surprise offensive on the 21st of that month), Foulkes discussed potential civilian casualties with British military and civilian leaders. Foulkes confessed that “this is a discharge of dangerous concentrations – as far as it concerns the civilian occupants of the enemy’s back areas. . .the safety of the civilians in occupied territory will be the main consideration in any project put forward for a gas attack on a phenomenal scale; and I have recently had a proposal of my own of such a nature rejected by an army commander for this reason.”¹⁴⁹ This did not mean, however, that the British opposed releasing gas in

¹⁴⁸ Thomas, *Effects of Chemical Warfare*, 20-21.

¹⁴⁹H.F. Thuillier, “The Minister,” letter, 27 May 1918, WO 32/5178, 2-3. The National Archives, London-Kew, United Kingdom.

areas potentially inhabited by civilians. During a conference chaired by Winston Churchill, the General staff were asked by the chairman if civilians were being taken into consideration for gas attacks. Foulkes replied that “We can limit the penetration by the amount of gas we let off.”¹⁵⁰ This is hardly an adequate solution to the problem, given the lack of human control with respect to a gas cloud’s movements.

The following month, on March 21, the Germans commenced their massive offensive with the firing of hundreds of thousands of gas and artillery rounds at Armentières, Bailleul, and in the Ypres and Cambrai salients. Their targets were villages, Allied battery positions, and communication lines. During the just the first four nights of the attack, the British estimated that the Germans fired some 150,000 Yellow Cross shells in the Cambrai salient alone. One British report stated towns as far back as “six or eight miles” from the front lines were shelled.¹⁵¹ The report went on to warn that, “Roads passing through villages, woods or valleys are specially liable to be affected by [Yellow Cross] gas shelling.”¹⁵²

During the next three weeks, mustard gas shelling continued up and down the lines. On the nights of 7 – 8 April and 8 – 9 April, Armentières and Houplines were heavily bombarded again with Yellow Cross; some 20,000 gas shells were fired into Armentières, which had already been heavily shelled the previous summer. The amount of mustard gas was such that the gutters of the town’s structures were flowing with

¹⁵⁰ “Minutes of Proceedings at a conference to consider the supply of gas for 1919 as affected by the Policy of the General Staff,” 18, March 1918, WO 32/5178, P. 7. The National Archives, London-Kew, United Kingdom.

¹⁵¹ *Gas Warfare* (March 1918): 7.

¹⁵² *Ibid*, 9.

mustard gas liquid.¹⁵³ The town was so heavily contaminated, that on the 10th the German commanders ordered their troops to avoid entering the town “for a fortnight.”¹⁵⁴ Meanwhile, those who survived the initial bombardment survived only to endure the agonies of mustard gas poisoning. Herbert Minchin, a machine gunner of the British 54th Battalion, recalled that on April 9, 1918, he woke up to discover the building his unit was sleeping in had been completely saturated in Yellow Cross shell. The majority of the men were exposed with mixed effects. Some suffered simply loss of voice, while others were severely burned on their legs and bodies. “The Germans absolutely drenched the town for twelve hours with gas,” Minchin recalled, “and men were being carried away wholesale. . .”¹⁵⁵ Despite warnings to avoid the town, the Germans took heavy casualties from the bombardment as well. On April 10, the winds shifted from west to east, pushing mustard gas fumes into the German lines. Four entire regiments of Prussian Guards were hit with their own gas.¹⁵⁶

Problems with controlling these massive mustard concentrations compelled Ludendorff and the German High Command to revise the ordered safe distance allotment for German troops in the vicinity of gas shelling. With winds blowing westward, three hundred meters away was considered safe. In reality, the close proximity of both sides to one another during the offensive and the enormous quantities of gas being deployed

¹⁵³ Harold Hartley, “A General Comparison of British and German Methods of Gas Warfare,” 26 November 1919, Hartley Papers, Box 33 AI, Folder 6, p. 8, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

¹⁵⁴ *Gas Warfare* (March 1918):, 8.

¹⁵⁵ Herbert Minchin, “Recollections of the Great War,” H I Minchin, File 06/54/1, p. 13, Imperial War Museum, London, United Kingdom.

¹⁵⁶ Ward, “Weather Controls Over the Fighting during the Spring of 1918,” 28.

meant “safe zones” were illusory. Nevertheless, even as late as June 1918, Ludendorff re-emphasized that to reduce friendly gas casualties “special importance must again be attached to meteorological observation in the forward area, mainly as to wind direction.”¹⁵⁷

German leaders also underestimated the tenacity of mustard gas contamination. One German manual from 1917 stated that land surrounding the area shelled with mustard gas could be traversed in a matter of hours. The book recommended six hours after shelling during the summer, and twelve hours during the winter. Depending on temperature, this amount of time is insufficient to prevent friendly casualties. Still, despite this misinformation, the manual reemphasized the importance of weather monitoring. “Local conditions are however (nature of the ground, vegetation), of considerable importance” and consultation of the weather service is required before any movement is undertaken.¹⁵⁸

The French village of Vermelles, which had already been devastated by the summer of 1915, was also heavily shelled with Yellow Cross for three days. According to Captain Alan Angus of the Northumberland Fusiliers, the effects of the bombardment on civilians and military personnel were similar to those at Armentieres. After a three day bombardment, the assault had gassed nearly everyone in the town and resulted in

¹⁵⁷ “Translation of Three German Documents on the Use of Gas Shell,” 6 June 1918, Hartley Papers, Box 33 AI, Folder 19, p. 1, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

¹⁵⁸ “Extract from the Manual on Tactics, Part 14, Gas Bombardment by the Artillery,” 1 December 1917, Box 36, Folder 24, 18-19. Hartley Papers, Churchill Archives Centre, Churchill College, Cambridge, United Kingdom.

numerous cases of conjunctivitis, loss of voice, and permanent lung damage.¹⁵⁹ In a three hour span on the 13 April, the village of Douchy and areas around Alette were bombarded with about 10,000 Yellow Cross shells. “The concentration was so high,” British officials reported, “that men were affected 500 yards from the area bombarded, and gas could be smelt a mile down wind.”¹⁶⁰ Villages continued to be hit for the duration of the German offensive, with Allied reports of villages being shelled coming in well into May.¹⁶¹

As the German army retreated, mustard gas was used often and in heavy quantities to slow down the allied advance. Pastures, roads, and entire forests were drenched in mustard gasses to inhibit the Allied counter-offensives during the summer of 1918. Herbert Sulzbach, a German artillery commander, expressed his approval of his saturation mustard gas shell bombardments when he wrote in his diary, “...The engineers and technicians at home are working away all the time, improving and improving – to say nothing of the perfection achieved in chemical research and development! Our new Yellow Cross gas is a nasty one; we fire it sometimes in shells, and it holds out in the ground for weeks. Incidentally, we are under orders to fill the great forest of Villers-Cotterets with gas, and then to skirt around it.”¹⁶²

¹⁵⁹ Alan Angus, “Reminisces of the Great War,” 1974, Captain A Angus, File 88/65/1, p. 22, IWM, London, UK. While stationed in the town of Vermelles in July 1915, Robert Graves noted in his memoir, *Goodbye to All That*, “Not a single house has remained undamaged in the town, which once must have had two or three thousand inhabitants.” Robert Graves, *Goodbye to All That* (reprint, London: Penguin, 1960), 118-119.

¹⁶⁰ Gas Warfare (April 1918): 12.

¹⁶¹ See Canadian Corps report on the German gas bombardment of the village of Longeau, 23 May 1918, RG 9 III-C-3, 4187, Folder 3, File 10, Library and Archives of Canada, Ottawa, Ontario, Canada.

¹⁶² Herbert Sulzbach, *With the German Guns: Four Years on the Western Front, 1914-1918* (London: Leo Cooper Ltd., 1973), 191.

The Germans began to use mustard gas to contaminate their own trenches as they retreated. For example, retreating Germans would use smoke generating tubes to contaminate the ventilation systems of tunnels. After the German loss at Amiens in August 1918, the Germans shelled the Allies with Green, Blue, and Yellow Cross in an attempt to create a wall of gas to shield their retreat. Canadian troops in their sector used dirt and lime to decontaminate shell craters to push forward.¹⁶³ The Germans also placed booby traps using live, unspent mustard gas shells that were set up in dugouts. Using a small amount of explosive, a shell was detonated in the dugout. The explosion was not enough to damage the dugout, but enough to flood the area with a high concentration of gas and render the entire area uninhabitable. Traps like these, while rarely documented, were likely numerous enough as general staff officers were aware of the practice and warned their men to apply caution when investigating areas once occupied by the enemy.¹⁶⁴

Due to the amount of mustard gas deployed and its persistence, it quickly became one of the primary reasons for casualties between 1917 and 1918. For example, among the American Expeditionary Force, 70,000 men were killed or wounded by mustard gas. In sum, one in four of all American losses during the Great War were caused by mustard gas alone.¹⁶⁵ If one includes the other war gasses used by Germany, during the war one out of every three American casualties were caused by German gas.¹⁶⁶ Although it is hard

¹⁶³ Tim Cook, *No Place to Run: the Canadian Corps and Gas Warfare in the First World War* (Vancouver: University of British Columbia Press, 1999), 191.

¹⁶⁴ M.C. Festing, Memo to 3rd Canadian Division, 17 August 1918, RG 9 III-C-3, 4187, Folder 3, File 11, Library and Archives Canada, Ottawa, Ontario, Canada.

¹⁶⁵ Harris and Paxton, *Higher Form of Killing*, 33.

¹⁶⁶ Geyer, "Der Gaskrieg," 527.

to surmise how many casualties were gas casualties, it is estimated that one in six of all casualties during the last eighteen months of the war were due to gas.¹⁶⁷ This number, however, is likely low, as many minor cases were never reported.

In conclusion, it can be said the environmental cost of chemical warfare was steep. Environmental factors, such as meteorology and topography played a significant role in shaping the gas war. The chemical properties of the war gases generated different environmental effects, both in the short term and the long term. As will be seen in the next chapter the environmental degradation was noticed by many who served at the front. This was especially true of those who witnessed mass cloud attacks and mustard gas shelling, where the entire environment changed before their very eyes. These experiences fundamentally changed the way Europeans, especially Germans, felt the fragility and beauty of nature.

As the guns fell silent on November 11, Europeans almost at once began to take note of the environmental destruction they had wrought. Of particular notice was the natural destruction by their weaponry, and especially that of chemical shells and gasses. Germany had produced almost 100,000 tons of gas weapons during the war, more than Britain, France and the United States combined.¹⁶⁸ Over 66 million chemical shells were produced and fired during the war, but many never detonated. It is estimated that twelve million chemical shells remain buried in French soil, waiting to be uncovered.

¹⁶⁷ Harris and Paxton, *Higher Form of Killing*, 29.

¹⁶⁸ Haber, *Poisonous Cloud*, 170.

As one British soldier prophetically wrote in a letter over a year before the war ended, “There are many thousands of things [shells] lying about, and what will happen when the inhabitants return and commence to plough up their land and rebuild their homes, I do not care to think, for there will be many accidents, especially among the children I am thinking . . .”¹⁶⁹

¹⁶⁹ H. J.C. Leland, “War Letters from France,” 29 April 1917, File#96/51/1, p. 99, Imperial War Museum, London, United Kingdom.

CHAPTER 4

THE AFTERMATH

When the war concluded in November 1918, the chemical war ended as well. Yet the effects of the gas war remained for years. Tens of thousands of men lay in hospital and medical stations with gas-related injuries and illnesses. Millions of gas shells and canisters littered the battlefields. Forests and wildlife were devastated. And despite the end of chemical agent production, numerous shell-filling factories and chemical ammunition stockpiles remained. The seriousness and scale of the problem, and the political, social, and financial climates in post-war Europe condemned cleanup operations from their inception. Germany, France and Belgium failed to restore the land to pre-war condition, not in the sense of replanting trees or restoring aesthetics, but the basic ability to walk on the terrain safely, without fear of death from unexploded ordnance or hidden chemical stocks. Whether buried or stockpiled chemicals, or the millions of chemical shells in the earth, recovery from the chemical war became a decades-long process that still goes on today. Ultimately, like the plant and wildlife that endured chemical warfare, those residents who live in the contaminated warzones or old chemical warfare manufacturing sites were forced to adapt to their new surroundings, living each day with the threat of chemical weapon exposure.

In 2009, William Storey's *The First World War: a Concise Global History* touched upon the state of the landscape in 1918. In Northeastern France, Storey argued, "the landscape was completely ruined. Trenches and craters scarred the land. Woodlands

were destroyed, drainage systems were damaged, and unexploded shells and decomposed corpses lay under the ground.” Yet after heavy French investment and restoration efforts, Storey argued, “. . . on the whole the Western Front has recovered.”¹ Upon closer analysis, however, this argument fails to hold up. Millions of people have been forced to confront chemical warfare’s legacy, including large financial costs and medical care. The lands that comprised the Western Front to this day remain a dangerous and scarred place, as millions of chemical and explosive shells remain active in the landscape. Though Storey’s work did not focus on Germany, I argue in this chapter that the aftermath of German chemical war experience created unforeseen environmental hazards and subsequent catastrophes, most notably the 1928 phosgene explosion in Hamburg. The human and environmental effects of chemical weapons during the 1920s and 1930s left lasting impressions of chemical warfare on the German people, many of whom protested the future use of such weapons. As was the case during the First World War, during the interwar years public opinion and environmental consequences were again suppressed by the aims of the German government and military, which not only maintained but strengthened their chemical weapons programs at the expense of nature. In sum, despite environmental disasters, the cultural recognition of poison gas’ effects on the landscape, and the condemnation of chemical weapons by many in German society, chemical weapons remained a fixture in German arsenals. Neither a proto-environmental nor an anti-gas movement was able to overcome the aims of Germany’s military and political leadership.

¹ William Kelleher Storey, *The First World War: A Concise Global History* (Lanham: Rowman & Littlefield Publishers, Inc., 2009), 162.

The specter of the post-war cleanup job loomed long before the war ended, as soldiers wondered how on earth the landscape could ever be the same again. In August 1916, a British soldier named Clive Watts looked over the battered landscape before him. Summing up his sense of wonder, in a letter to his sister he wrote, “How ever they will get it smoothed out again is more than I can imagine.”² On continental Europe, the immediate response to environmental contamination and cleanup needs were chaotic and inadequate because of the political and financial climates in France and Germany between the world wars.

In Germany, defeat in the Great War was cataclysmic. As the German trench system on the Western Front collapsed in 1918, by October so too had German society itself imploded. Food riots broke out among starving citizens in Berlin, German naval personnel mutinied at their headquarters in Kiel, triggering a revolution by civilians across the city. The Kaiser, seeing defeat before him, abdicated his throne on November 9, 1918, an act that removed the symbol of leadership in the country.³ That same day Philipp Scheidemann, leader of Germany’s Social Democratic Party (SPD), proclaimed the new German republic, a move which eventually led to the founding of the Weimar Republic in the summer of 1919. Two days later, the war ended after nearly four and a half years of fighting. Despite the political collapse, the authoritarian government gave way to the birth of a new democratic system favored by the Allies, and the Entente never set foot on German soil during the entire war. With these developments in mind, most Germans felt the impending peace terms would be fair.

² Paul Fussell, *The Great War and Modern Memory* (London: Oxford University Press, 1975), 69.

³ Eric D. Weitz, *Weimar Germany: Promise and Tragedy* (Princeton: Princeton University Press, 2007), 17-19.

Such was not to be the case, as the harshness of the terms handed to the Germans thoroughly stunned their delegation. Among the treaty's many articles, Germany was to lose ten percent of its territory, pay stiff war reparations, and, most glaring and hurtful of all, take full responsibility for the war. In addition, the treaty severely restricted Germany's military by limiting its army to only 100,000 men, and all but eliminating their air and naval forces. Chemical weapons were to be turned over to the Allies, and their methods of production to be turned over to Allied chemical experts. This was not the treaty the German foreign ministry, let alone the frustrated German public, expected. As the historian Richard Evans wrote, "These provisions were almost universally felt in Germany as an unjustified national humiliation. Resentment was hugely increased by the actions taken, above all by the French, to enforce them."⁴ The German delegates, having few options, signed the treaty on June 28. The treaty's signing inflicted a significant social trauma against the German people, and spawned deep felt hatred toward the Allies, especially the French, for forcing such terms on their nation.

In the wake of the monarchy's collapse and military defeat, many within the German public believed their army had been stabbed in the back by politicians and blamed the new democratic government for the Treaty of Versailles. Immediately the new government faced a horrific economic situation. The Allies demanded reparations of \$132 billion goldmarks. Unable to raise taxes on an already strained workforce, the Germans turned to printing money to combat rising prices and pay off debts. With no gold reserves or foreign credit, currency inflation was all but inevitable. The hyperinflation Germany endured in the early 1920s rendered their currency virtually

⁴ Richard J. Evans, *The Coming of the Third Reich* (New York: The Penguin Press, 2004), 60.

worthless; one American dollar was worth 4,300,000,000,000 marks on the exchange market in November 1923.⁵ Unemployment skyrocketed, plunging Germany into a fiscal depression unlike anything they had ever seen. Though not responsible for the fiscal calamity, the new government became scapegoat for the Treaty of Versailles, high unemployment, and military defeat. Fear, hatred and violence became commonplace across the country. Such was the state of postwar Germany, and it comes as no surprise that Germany provided little official help cleaning the French landscape after the war.

Though the political and economic climate was not nearly as catastrophic as that of Germany, France also had their share of social problems. The war inflicted devastating losses on the population. The French people suffered 1,327,000 total military deaths during the war; less than thirty percent of all French servicemen survived the war unscathed. When compared to Germany, Britain, and the United States, their casualties represent the highest percentage of a nation's population killed during the war.⁶ The French were also strapped with significant war debt after the war. By 1922, the French had accrued \$27.758 billion in debts.⁷ In an effort to pressure the Germans into payment of war reparations, in 1923 the French army began a military occupation of the Ruhr, Germany's center of heavy industry. Unwilling to give into French demands, German workers went on massive strikes, protesting the French demands and occupation. The combination of sour Franco-German relations, massive financial strain and debt, and few

⁵ Weitz, *Weimar Germany*, 132-135.

⁶ Jean-Jacques Becker, *The Great War and the French People* (Leamington Spa: Berg Publishers, Inc., 1993), 6; Winter, *The Experience of World War I*, 202.

⁷ Niall Ferguson, *The Pity of War* (New York: Basic Books, 1999), 422.

highly-trained chemical ordnance experts available to help cleanup the terrain, the process of clearing France's battlefields was set to be a slow one.

In addition, the environmental pollution caused by the destruction of shells by fire or explosives proved disastrous to the landscape. Sloppy procedures resulted in decades-long soil and water table contamination in Germany and Western Europe. For example, between 1992 and 1999, scientists conducted soil tests in Löcknitz, Germany, where chemical warfare agent stockpiles from World War I were stored and destroyed by fire and reaction with sodium hypochlorite after World War II. The soil samples revealed a number of arsenic-based compounds had permeated the soils, including diphenylarsine, methylphenylarsine, diphenylchloroarsine, triphenylarsine, and triphenylarsine sulfide. High concentrations of arsenic ions were also found.⁸ Scientists also argue that numerous different species of millions of bacteria are resistant to the arsenic. These microorganisms inhabit the soil and devour either phenyl- or alkyl arsenic compounds, contributing to the release of arsenic ions in the ground. Not surprisingly, scientists have noticed similar effects with soil samples taken from farm land that was exposed to arsenic-based pesticides.⁹

Aside from destruction by fire or other means, the belligerents also buried or dumped their chemical stockpiles. To save time and money, the Americans, British, and the French often threw their surplus chemical ordinance overboard into the waters around the continent, including the Atlantic Ocean, Baltic, and North Seas. Each nation produced

⁸ Manfred Köhler, et al. "Bacterial Release of Arsenic Ions and Organoarsenic Compounds from Soil Contaminated by Chemical Warfare Agents," *Chemosphere*, Vol. 42, (2001): 426; Jen-How Huang, et al. "Organic Arsenic in the Soil Environment: Speculation, Occurrence, Transformation, and Absorption Behavior," *Water, Air, and Soil Pollution*, Vol. 219, Iss. 1-4 (July 2011): 403.

⁹ Manfred Köhler, et al. "Bacterial Release of Arsenic Ions," 426-428.

enormous quantities of chemical ordnance during the war. For example, the United States had enough gas by November 1918 to produce nine million chemical rounds.¹⁰ Ocean dumping was the fastest, cheapest, and safest way (at least for the humans) to dispose of these vast amounts. In March 1919, for instance, the United States dumped 200,000 shells and several large containers of gas off the coast of Maryland.¹¹ In 1919, the French dumped roughly 1,000 mustard gas drums and 20,000 phosgene and chlorine cylinders, metal and all, into the Mediterranean Sea.¹² The Allies then repeated these procedures after the Second World War. After World War II, the United States dumped 250,000 tons of captured German gas in the North Sea, as well as dumping their own surplus stockpiles off the coasts of Alaska, Florida, and California. The practice would continue for some time, as the American government ultimately banned the practice of dumping chemical weapons into the sea in 1972.¹³

This form of “disposal” became problematic for years to come, because the temperature of the ocean water and the metal casing of the shell or cylinder prohibited the toxin from diluting. For example, lab tests have shown that it takes only 110 minutes for a saturated mustard gas solution at twenty degrees Celsius (sixty-eight degrees Fahrenheit) to dissolve. However, mustard gas that has been stored, dumped, or disposed of in cold temperature locations, such as the bottom of oceans, can remain active for

¹⁰ Richard Albright, *Cleanup of Chemical and Explosive Munitions: Locating, Identifying Contaminants, and Planning for Environmental Remediation of Land Sea Military ranges and Ordnance Dumpsites* (Norwich: William Andrew Publishing, 2008), 52.

¹¹ “War Gas Dumped Far Out at Sea,” *The New York Times*, 9 March 1919, Vol. LXVIII, No. 22,324, 18.

¹² “Report on the Destruction of Gas Material,” 15 December 1920, WO 142-284, p. 34. The National Archives, London-Kew, UK.

¹³ David A. Koplow, *By Fire and Ice: Dismantling Chemical Weapons while Preserving the Environment* (Amsterdam: Gordon and Breach, 1997), 160.

decades.¹⁴ It comes as little surprise, therefore, that reports of fishing vessels catching crates or chemical ordnance shells occurred as recently as the summer of 2010. Between 1985 and 2005, Danish government officials reported at least 400 casualties among fishermen resulting from “dumped explosives or chemicals.”¹⁵ In June 2010, four American fishermen off the coast of Massachusetts found a Yellow Cross shell within their catch of clams. After dumping the shell overboard, one of the fisherman said the shell “smelled strange” and that it emitted a “strong chemical odor that just didn’t seem right.” Upon return to port, the four men went to the hospital and were treated for burns and eye irritation. The entire catch, roughly eighty bushels, also had to be destroyed due to mustard gas contamination concerns.¹⁶

In some cases, however, even ocean dumping was not an option. If the shells were too unstable to transport and dispose in the water, large amounts of bleaching powder were spread by the Allies over the battlefield site.¹⁷ The bleaching powder would kill any plant and wildlife, and contaminate the soil. In essence, for environmental degradation it was a practice of stealing from Peter to give to Paul. The process destroys the gas, but also kills the living organisms.

The Germans also had their share of disposal problems. Already knowing the occupation was imminent, German chemical experts began destroying documents in an effort to hide or erase evidence of their activities and research. In addition, by the end of

¹⁴ Ralf Trapp, *The Detoxification and Natural Degradation of Chemical Warfare Agents* (London: Taylor and Francis, 1985), 17.

¹⁵ J.P. Cecil, “CW & UWUXO: The Baltic Seas’ Lethal Legacy,” *Strategy & Tactics*, n. 264, (Sep.-Oct. 2010) : 47.

¹⁶ Peter Schworm and Beth Daley, “Weapons are Common Catch, Fishermen Say: Crew Injury Shows Danger of Dumping,” *The Boston Globe*, 9 June 2010, http://www.boston.com/news/science/articles/2010/06/09/weapons_are_common_catch_fishermen_say/.

November 1918 entire train loads of chemical ordinance still sat on the tracks across Germany. German military leaders ordered these trains cleared away immediately, and the trains were redirected and shipped to the German chemical testing grounds at Breloh. That way, the material could be collected and transported to a safe area for destruction. Once these trains were redirected, the Germans waited for Allied instructions. Although there are no firm statistics, by the end of 1918 at Breloh there were at least eighty-five railcars containing 150,000 shells, 40,000 cylinders, and 638,000 glass bottles filled with various chemical agents. All told, at the end of January 1919 there remained some 201 trains filled with Green, Blue, and Yellow Cross scattered across Germany.¹⁸ With a daunting task ahead of them, the Germans slowly off-loaded the material and the disposal process began. Oddly enough, records were not kept regarding the amounts destroyed, making it difficult to surmise the fate of much of the chemical stockpiles. Despite initial efforts by the Germans to collect the materials for disposal, with the war still fresh in their minds there existed a genuine lack of interest by the Germans towards giving in to Allied demands or assisting them with regards to the chemical weaponry problem. With little motivation, the Germans left the messy duty to their occupiers.¹⁹

In addition to the ordinance disposal process, within weeks of the end of the war Allied chemical experts also began the process of disarming Germany's major chemical industries, including Bayer, BASF, and Höchst. French and British forces forced the German companies to dispose of their vast chemical weapon supplies at the factories, although the Germans had already disposed of much of their stocks on site or by shipping

¹⁸ Margit Szöllösi-Janze, *Fritz Haber 1868-1934: eine Biographie* (Munich: C.H. Beck, 1998), 468.

¹⁹ Haber, *Poisonous Cloud*, 286-287.

it to Breloh. Just as the Germans were reluctant to help the Entente with the disposal process, the defeated Germans were often also reluctant to help the victorious Allies with the industrial disarming process.

For the German chemical giants, their fates were directly connected to the Paris Peace Conference. While clean-up operations were underway, the Allied leaders met in Paris to discuss the terms for Germany's surrender. At the conference, the banning of poison gas altogether was discussed as early as March 1919. However, both British and French military leaders were reluctant to ban poison gasses due to their military importance. Some even argued that chemical agents were a more "humane" weapon than machine guns or artillery because its victims had a higher probability of survival. British politicians led by Winston Churchill, military leaders including Major Generals Charles Foulkes and Henry Thuillier, and chemists led J.B.S. Haldane were particularly adamant about chemical warfare's usefulness. The then Secretary of War Churchill stated in 1919 that "pointing out the effects of gas were no more cruel than the effects of modern high explosive shell" and "gas is a more merciful weapon than high explosive shell."²⁰ Thuillier argued this position for years, stating in 1939 that "Statistics, all drawn from official sources, show that the ratio of deaths and of permanent disablement, among men gassed is only about one-seventh of the ratio of deaths and permanent disablement among men wounded by other weapons of war."²¹ Haldane stated in 1919 that lachrymatory gas was "the most humane weapon ever invented."²² Of course, Foulkes and Thuillier had

²⁰ Marion Girard, *A Strange and Formidable Weapon: British Responses to World War I Poison Gas* (Lincoln: University of Nebraska Press, 2008), 182; Valerie Adams, *Chemical Warfare, Chemical Disarmament* (Bloomington: Indiana University Press, 1990), 48.

²¹ Sir Henry F. Thuillier, *Gas in the Next War* (London: Geoffrey Bles, 1939), 132-135.

²² Adams, *Chemical Warfare*, 48.

personal motivations to make these claims, even if the statistics were of suspicious validity. Plus, as logic dictates, the chances of being killed or wounded by high explosives during the war were higher because more high-explosives were used than poison gas.

Yet despite the arguments on both sides, the British decided to compromise with the other powers regarding the future of chemical warfare. In addition to a total ban regarding the possession or manufacture of chemical weapons in Germany, on April 15 the British proposed to the Allied council that Germany must also disclose the research and practices they used during the war to create their chemical arsenals. The American Secretary of State, Robert Lansing, opposed this move. He saw the proposal as economic exploitation, rather than military necessity. The resulting articles of the Versailles Treaty which deal with chemical warfare reflect these discussions and this debate.²³ Ultimately, the Allies decided to accept British demands of acquiring the German research, but refused to ban chemical warfare as a practice. In addition, the Allies agreed to confiscate Germany's chemical ordnance and prohibit any further manufacture of such weapons. Article 171 forbade the Germans from producing or importing asphyxiating or poisonous gasses. It reads, "The use of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices being prohibited, their manufacture and importation are strictly prohibited in Germany." Article 172 stated that Germany must also within a period of three months "disclose to the Governments of the Principal Allied and Associated Powers the nature and mode of manufacture of all explosives, toxic substances or other like chemical preparations used by them in the war or prepared by

²³ Edward M. Spiers, *Chemical Warfare* (Houndmills: MacMillan, 1986), 34-35.

them for the purpose of being so used.”²⁴ This information would be acquired through plant inspections by a group of Allied chemical experts, designated the Military Inter-Allied Commission of Control (MICC). After the Germans signed the Treaty of Versailles and the inspections began, some Allied leaders wanted to take over the major chemical plants as collateral towards war reparations. However, the Allies decided instead to simply inspect the plants and confiscate research and existing chemical stocks.²⁵

The inspections began in 1919, and were largely completed at the end of 1922. The tours and inspections, however, would continue until 1927.²⁶ The first major inspections began across Germany on February 1, 1919. Bayer and Höchst were located in the British zone of occupation. BASF, located upstream from Bayer on the Rhine, was located in the French occupied zone. During the two week long program, the inspections conducted at the facilities were for the most part uniform in their process. Their tour’s objectives consisted of two parts: first, to inspect and determine the facilities’ production capabilities during the war and to obtain the methods of production themselves, and second, to determine the extent to which the German chemical industry contributed to the German war effort. To comply with the demand, German chemical companies provided a

²⁴ The Principal Allied and Associated Powers, *Treaty of Peace with Germany* (Washington, DC: Government Printing Office, 1919), 199; 201.

²⁵ Haber, *Poisonous Cloud*, 289.

²⁶ Jeffrey Allan Johnson, “The Power of Synthesis (1900-1925),” in Werner Abelshauser, et al. *German Industry and Global Enterprise, BASF: The History of a Company* (Cambridge: Cambridge University Press, 2004), 188. For an in depth analysis on the Allied inspections, see Jeffrey Allan Johnson and Roy MacLeod, “The War the Victors Lost: The Dilemmas of Chemical Disarmament, 1919-1926,” in Roy MacLeod and Jeffrey Allan Johnson, eds. *Frontline and Factory: Comparative Perspectives on the Chemical Industry at War, 1914-1924* (Dordrecht: Springer, 2006), 221-240.

fairly substantial, if carefully selected, amount of data to the Allies. The information included manufacturing techniques, wartime production statistics, and plant schematics.²⁷

Upon inspection of the facilities, the British compiled a report of their findings. The inspectors stated that the Germans clearly had a “well organized dye and fine chemical industry” which was of “great military value.”²⁸ Interestingly, the subject of waste disposal was discussed. No objections were raised by the Allies with respect to the chemical firm’s dumping policies, and Bayer continued to dump all of its waste into the Rhine without treatment.²⁹ The report found the Rhine to be an ideal dumping ground for chemical wastes. The Allied analysis stated that:

In the works adjoining the Rhine there does not seem to be any difficulty in the disposal of the drainage. The volume of water passing down the river is so large, and the water itself of such hardness, that even the vast amount of acid liquids, etc., received from the works on its banks is quickly diluted and neutralized, so that no objection is taken to this method of disposal. . .

The report went on to say that Bayer had purchased both the land along the banks near their plants and the fishing rights to the river. The report surmised that these actions were taken “to make themselves secure against any interference from the public” and that the Rhine “is not confined to transit and water supply, but extends to its use as a

²⁷ See for example the completed questionnaire and data sent by the Verein zur Wahrung der Interessen der chemischen Industrie Deutschlands. E.V. to Dr. Stock, pertaining to the Chemischen Fabrik Griesheim Electron, Frankfurt a/M and Höchst’s methods of wartime Zyklon production, 7 August 1922, BArch R 3101/20565, Das Bundesarchiv, Berlin-Lichterfelde, Germany.

²⁸ “Report of the British Mission Appointed to visit Enemy Chemical Factories in the Occupied Zone Engaged in the Production of Munitions of War,” February 1919, DSIR 36/1967, p. 7, The National Archives, London-Kew, UK.

²⁹ “Report of the British Chemical Mission on Chemical Factories in the Occupied Area of Germany,” 1919, DSIR 36/1966, p. 28, The National Archives, London-Kew, UK.

receptacle for waste liquors.”³⁰ Based on the report, it is clear that the Allies would do little to solve the German chemical pollution problem.

Their German hosts were not thrilled with the Allied inspections, especially the inspection of BASF’s Oppau plant, the location where Haber and Bosch pioneered their industrial process for ammonia synthesis. During a preliminary visit by the Allies to Bayer between January 24 and January 28, Carl Duisberg and another Bayer director, Dr. Quincke, flatly denied Allied accusations that the Germans instigated chemical warfare in the first place. When pressed about the fact that the use of chemical ordinance was strictly forbidden by the rules of war, one Allied official wrote that the Bayer leaders “had nothing to say.”³¹ Thus, the tone was set early by the Germans with respect to their compliance to Allied inquiries. One Allied report noted Carl Duisberg’s efforts to downplay the level of poison gas production at his plants, stating that the manufacture of poison gas was a “secondary and insignificant part of their work.” The Allies were also told that all of the facilities which produced poison gas, with the exception of phosgene and chloropicrin, were already dismantled.³² While Duisberg complied with the Allied order to dismantle Bayer’s mustard gas facility prior to the Allied inspector visit, Duisberg’s statement about poison gas manufacturing was at best misleading; his position as chairman of Bayer provided him extensive knowledge of its gas operations, and we

³⁰ Ibid, 20.

³¹ “Report on War Work for German Gas Service Carried Out at the Leverkusen Works of the Farbenfabriken Vorm. Friedrich Bayer, Elberfeld,” 1919, Box 31, Folder 12, p. 1, Churchill Archives Centre, Cambridge, UK.

³² James F. Norris, “Report on the Inspection of Chemical Plants in the German Territory Occupied by the British, French, and American Armies,” 10 March 1919, WO 142-49, 16, The National Archives, London-Kew, United Kingdom.

have already seen Bayer's production statistics that testify to their considerable war gas manufacturing activity.

In addition to suspicious statements, German chemists and industrialists had already destroyed documents and taken steps to hide their discoveries. Some claimed ignorance, others simply stood in silent defiance. Despite resistance to the Allied chemical officials, the Germans maintained, as one Allied official stated, "a polite but sullen attitude."³³ Notwithstanding their well-mannered composition, letters from Allied experts to the German chemical personnel were often filled with complaints regarding vague or insufficient information disclosure. For example, in a letter from Dr. Hugh E. Watts, co-leader of the chemical section of the Sub-commission of Armaments of the MICC, to Dr. Wilhelm Walter of BASF regarding an information questionnaire the German chemists were forced to complete, the commission complained that "the information contained in the answers is not sufficiently full" and that "the rough sketches sent with them are not satisfactory." The MICC official also complained that the answers "lack in detail and have not been drawn up on the same lines as the specimen answer which I prepared."³⁴

Privately many British leaders were frustrated that throughout the process the Germans frequently withheld information and dodged questions. The Chemical Warfare Committee within the British War Office concluded in 1921 that after two Allied inspection tours, "the information furnished by the Germans has been very incomplete

³³ Victor Lefebure, *The Riddle of the Rhine: Chemical Strategy in Peace and War* (New York: The Chemical Foundation, 1927), 208.

³⁴ Letter from Dr. Hugh E. Watts to Dr. Wilhelm Walter, 27 June 1921, 202-19, Bayer Corporate History and Archives AG, Leverkusen, Germany.

and of little value. . .”³⁵ One member of the Committee noted that although the Germans were willing to give information, much of the data was either incorrect or disguised in some way to prevent the disclosure of the full truth.³⁶ Seemingly furious at the lack of progress, the Secretary of the British Chemical Warfare Committee, Captain J. Davidson Pratt, wrote later in 1921 that whenever possible, the Germans were looking for excuses for not following the treaty. “One important point they always seem to overlook and which should be brought home to them very forcibly,” Pratt declared, “is the fact that we won the war [his underline], and that is therefore not to them to say how they propose to carry out the peace treaty.”³⁷ Despite the fiery rhetoric, the Germans’ campaign to frustrate the British to the point of bureaucratic surrender was successful.

Their success was a result of multiple factors. As the historians Jeffrey Allan Johnson and Roy MacLeod argued, the Germans kept their answers short and consistent, and gave just enough information perceived as valid to satisfy the Allied inspector’s needs. As time went on, an amicable relationship developed between the inspectors and the German chemists, who wanted to keep the current batch of inspectors. After all, they could be replaced by more aggressive officials if the Allied leaders saw fit. The Germans refused to provide the Allies many of their primary, commercially-viable patents relating to raw materials or intermediates (nitrates, ammonia, etc. . .), emphasizing that Article 172 only applied to chemical warfare agents. The Allied inspectors, who were uncomfortable with accusations of industrial espionage, and did not press the Germans

³⁵ See the minutes to the “Conference to Consider the Application of the Articles 168, 169, and 172 of the Peace Treaty,” 14 January 1921, WO 32-5786, p. 1, The National Archives, London-Kew, UK.

³⁶ Ibid, p. 2.

³⁷ J. Davidson Pratt, “P.S. to D. of A.,” letter, 12 July 1921, WO 32-5786, The National Archives, London-Kew, UK.

for this information so long as the Germans cooperated in the dismantling of chemical warfare agent plants.³⁸

The Germans' efforts to resist paid off, as the MICC inspections ground to a halt in 1923. Hyperinflation had gripped the German economy, and they failed to make their war reparation payments to the French. In response, the French sent troops into the Ruhr in search of compensation. In protest to the French occupation, the Germans' use of passive resistance, intimidation, and sabotage stifled the inspection process. Only after the situation stabilized in 1924 did the last of the inspections commence, until finally the MICC pulled out entirely in 1927.³⁹ The Allies obtained a sizable amount of information on the military and manufacturing aspects of Germany's chemical weapons program; the MICC inspected some 7,000 factories and conducted a total of 33,381 visits.⁴⁰ However, the Germans' careful response to the inspection effort enabled them to protect many of their commercial patents and chemical installations. As a result, many of Germany's chemical secrets remained as such, enabling Germany to one day rearm and chemical weapon research and development to continue.

In addition to inspections, overseeing the German disarmament was the Military Inter-Allied Commission of Control. Initially, the Commission appointed a French company, the *société l'évaporator*, to oversee the disposal process in Germany. Their orders were, if possible, to salvage the cylinders for scrap metal and dispose of the gas. Yet at the various German stockpiles in their area of occupation, the French were clumsy

³⁸ Johnson and MacLeod, "The War the Victors Lost," 235-236.

³⁹ Ibid, 237.

⁴⁰ Statistics from Ibid, 229.

with the shells and cylinders and their dismantling procedures were extremely dangerous. For example, the French method of disarming a phosgene shell was to unscrew the cap inside a large chimney, with the intent of using the updraft to send the gas into the air. Of course, the gas did not always blow upward. Given the highly toxic levels of phosgene, the French workers were poisoned. Vegetation in the areas of disposal was also killed off, and after numerous accidents the practice ceased.⁴¹ Their method of destroying Yellow Cross shells was not much safer. The process was to tie groups of shells together and blow them up with a single explosive charge. The area was then doused in nitro glycerin and ignited to destroy the toxin. Such maladroit methods often resulted in accidents, contamination, and gassings of the work staff.

Frustrated with the entire matter, the French turned the disposal work over to a German chemist and industrialist named Dr. Hugo Stoltzenberg, who volunteered to take the problem off the French's hands. Born 27 April 1883 in Strengen, Stoltzenberg attended school in Vienna, Leipzig and East Cambridge before attending graduate school at Halle. After completing his dissertation in 1911, he went to the University of Breslau to work under the chemist Heinrich Biltz.⁴² During the war, Stoltzenberg worked with Fritz Haber at the Kaiser Wilhelm Institute, the gas shell plant at Aldershof, and helped establish and lead the mustard gas shell filling factory at Breloh.⁴³

⁴¹ "Report on the Destruction of Gas Material," 15 December 1920, WO 142-284, p. 33. The National Archives, London-Kew, UK.

⁴² Henning Schweer, *Die Geschichte der Chemischen Fabrik Stoltzenberg bis zum Ende des Zweiten Weltkriegs. Ein Überblick über die Zeit von 1923 bis 1945 unter Einbeziehung des historischen Umfeldes mit einem Ausblick auf die Entwicklung nach 1945* (Diepholz: Verlag für Geschichte der Naturwissenschaften und der Technik, 2008), 15.

⁴³ Margit Szöllösi-Janze, *Fritz Haber 1868-1934: eine Biographie* (Munich: C.H. Beck, 1998), 467; Schweer, *Die Geschichte der Chemischen Fabrik Stoltzenberg*, 100.

Given his extensive expertise in chemical shell design and construction, the French agreed to turn over clean-up operations in Germany to Stoltzenberg. Starting in 1919, Stoltzenberg oversaw the dismantling of the chemical weapon stockpiles at Breloh. Under his direction, German chemists recycled hundreds of shell casings and cylinders. All told, Stoltzenberg and his teams disposed of 1,303 tons of gas at the German facility.⁴⁴

With the environmental risks and fears the toxin would contaminate the soil in mind, the disposal teams decided to destroy the Yellow Cross shells last. Their job was also made more difficult when disaster struck on 24 October 1919. On that day, the mustard gas shell filling station at Breloh suddenly exploded. The blast destroyed forty-eight buildings, and the remains of over a million gas grenades and forty gas tanker train cars were scattered over an area of three kilometers.⁴⁵ After the blast, only the chimney remained of the shell-filling plant structure. Although no casualties were reported and a large portion of the Yellow Cross shells were destroyed, Stoltzenberg and his men still had 100,000 mustard gas rounds slated for disposal, not to mention the now severely contaminated working area. An official MICC report stated that regarding the Yellow Cross shells, “no solution has yet been found” to safely destroy the material, though the report ultimately recommended ocean dumping as the proper course of action.⁴⁶ Ultimately, Stoltzenberg saw a potential business opportunity in his new position and had other ideas for the leftover gas.

⁴⁴ Schweer, *Die Geschichte der Chemischen Fabrik Stoltzenberg*, 15; Haber, *Poisonous Cloud*, 287.

⁴⁵ Szöllösi-Janze, *Fritz Haber 1868-1934*, 468.

⁴⁶ “Report on the Destruction of Gas Material,” 15 December 1920, WO 142-284, p. 35-36. The National Archives, London-Kew, UK.

Although large quantities were destroyed, Stoltzenberg did not dispose of all the gas. Instead, Stoltzenberg eventually set up his own chemical company, the Chemische Fabrik Stoltzenberg, and sold vast amounts of gas from the stockpiles he was originally ordered to destroy to foreign governments. One of Stoltzenberg's customers in the second-hand poison gas market was the Spanish government, who in 1921 purchased and used his gas to crush a rebel uprising in Morocco.

Unsurprisingly, the German military also soon became interested in Stoltzenberg's activity. General Hans von Seeckt, the Chief of the new German armed forces (the *Reichswehr*), felt chemical warfare would play an important role in a future war, as he envisioned the potential deployment of gas via aircraft bombing.⁴⁷ Stoltzenberg's business ventures, and the Reichswehr's desire to circumvent military restrictions imposed by the treaty of Versailles, ultimately led to meetings between Stoltzenberg and the Army Armaments Office (*Heeres-Waffenamt*) in January 1923. The minutes of the meeting detail the plans by the German government to contract Stoltzenberg to begin construction of a new gas production facility in Hamburg, with Green, Yellow, and Blue Cross manufacturing capability and a gas projectile filling station. Stoltzenberg claimed at the meeting that once given the order, he could produce at the new factory six tons of phosgene and mustard gas daily within three months, plus an additional six tons of Blue Cross three months after that. Stoltzenberg also stated he would also provide other materials, including chlorine, alcohol, and arsenic. With respect

⁴⁷ "Giftgas und der kommende Krieg," *Die Rote Fahne*, 25 May 1928, No. 122, p. 15. The article cited here summarizes a speech made by von Seeckt in April 1928, however the historian James Corum located in the Bundesarchiv-Militärarchiv a lecture by von Seeckt in 1923, where the general ensured "the Truppenamt [the Reichswehr's General Staff] that money for gas research and production would be made available." James S. Corum, *The Roots of Blitzkrieg: Hans von Seeckt and German Military Reform* (Lawrence: University Press of Kansas, 1992), 106; 231.

to the stocks already at Breloh to be destroyed, Stoltzenberg advised the government to postpone or delay their destruction, and not provide a reason to the International Military Control Commission. Lastly, Stoltzenberg wanted the Reich to pay for the new instillation. The government was not opposed to his plan; so long as the area in Hamburg was adequate, the costs would be negotiated and facilities would be paid for “as far as can be obtained in quietude.”⁴⁸ Stoltzenberg and the German chemical weapons industry were back in business.

In addition, by 1923 the Soviet Union became interested in constructing a secret chemical weapons factory with the help of the German government. When approached for suggestions, Fritz Haber recommended Stoltzenberg for the job to the Weimar government and the Soviets. Stoltzenberg was chosen, and began construction of a secret mustard gas factory along the Volga at Troszk. In addition, the Germans also conducted chemical experiments and chemical warfare training programs near the Russian plant using Soviet manufactured gas. However, when the costs of finishing the construction the plant escalated, Stoltzenberg ran out of funding. This angered the Russians, who claimed they were cheated out of their money. Haber was forced to step in, and with the help of the German government, Stoltzenberg was able to settle his debts and the Russian factory was never completed.⁴⁹ These illicit operations, however, would not remain secret for long.

⁴⁸ “Die Vobereitung einer Neuproduktion von Giftgas. Besprechung des Heeres-Waffenamtes mit Dr. Stoltzenberg am 26./27. Januar 1923.” This document was reproduced in Hans Günter Brauch and Rolf-Dieter Müller, eds. *Chemische Kriegführung – Chemische Abrüstung: Dokumente und Kommentare* (Berlin: Berlin Verlag Arno Spitz, 1985), 94-95.

⁴⁹ Daniel Charles, *Master Mind: The Rise and Fall of Fritz Haber, the Nobel Laureate who Launched the Age of Chemical Warfare* (New York: HarperCollins, 2005), 194; James Corum, *Roots of Blitzkrieg*, 106-107; Dietrich Stoltzenberg, *Fritz Haber*, 337-346.

In June 1925, residents living near Stoltzenberg's Hamburg plant learned first-hand the potentially hazardous chemicals managed by the facility. On the evening of June 23, several people were poisoned by a mysterious cloud that drifted from the facility into the Wilhelmsburg district of Hamburg. After the incident, residents complained to the borough manager (*Bezirksvorsteher*) that the chemicals came from Stoltzenberg's factory. The manager then composed a report and notified the city government. Although it is unknown what specific chemical the residents came in contact with, the health effects people were forced to endure are all too familiar for those familiar with chemical war agents. In a report about the incident to the city, the borough manager described resident complaints involving skin burns, as well as painful eye and nasal irritation. One woman suffered from a fainting spell; others were stricken with bouts of heavy vomiting. The report also noted the environmental changes caused by the gas. The manager wrote that the gas came in a northwesterly direction, affecting the trees and bushes. "The leaves and bushes," the manager noted, "are brown and dry. . ."⁵⁰ Although no deaths were reported, the authorities continued to receive complaints about the chemical pollution.

In 1926, the complaints appeared to be increasing in number. In a memorandum from the city police headquarters (*Polizeiverwaltung*) to the police department, the police administration stated that almost daily complaints were being heard about the "Hamburg plant on the Peute." People were sickened, blossoms fell off the trees, and animals were dying. Among the dead were horses, rabbits, and even a cow. The animals appeared to have died as a result of consuming contaminated fruits and vegetables. Local

⁵⁰ Letter from Bezirksvorsteher H. Kampmann to the District Office (*Landratsamt*) in Harburg, 25 June 1925, SS-HA 131-4, 1928 A 59/2, Staatsarchiv Hamburg, Hamburg, Germany.

veterinarians blamed the deaths on arsenic poisoning.⁵¹ In spite of the complaints, Stoltzenberg's facility remained operational.

In December 1926, the secrecy rapidly began to fade. By that point, the Allied governments were aware of the German's undisclosed rearmament activities in Germany and abroad.⁵² In addition, the British newspaper *Manchester Guardian* ran articles in early December 1926 that reported secret armaments dealings involving the construction of German aircraft in Russia under the direction of the Reich War Ministry and the Junkers Werks aircraft company. On December 3, the paper reported the Germans had made arrangements with the Russians for the construction of chemical weapons manufacturing works that would produce poison gas for both countries, although no specific details were provided in the article. The Reich government denied the report.⁵³ Just a few weeks later in January 1927, Stoltzenberg's chemical warfare activities in Russia were explained in detail when a Social Democratic Party (SPD) member of the Reichstag, Franz Künstler, published an article in the SPD newspaper *Vorwärts*. Based

⁵¹ Although it is a strong possibility, it is not known for certain if the poisons involving these cases came from Stoltzenberg's factory or another chemical plant in the area, such as the Norddeutsche Affinerie. Regardless of where the toxins originated, through it all Stoltzenberg's plant remained open and running. Report by the städtische Polizeiverwaltung to the Polizeibehörde, 7 October 1926, SS-HA 131-4, 1928 A 59/2, Staatsarchiv Hamburg, Hamburg, Germany; In a separate report to the to the city magistrate that investigated the death of a horse, the veterinarian board (*Veterinärtrat*) concluded the cause of death was "poisoning through arsenic." 1 October 1926, SS-HA 131-4, 1928 A 59/2, Staatsarchiv Hamburg, Hamburg, Germany.

⁵² During the 1920s Allied spies were active in Germany monitoring, among other operations, chemical weapon research. See for example a 1923 report describing an Allied agent's findings relating to chemical weapons in Berlin. The report noted that the spy declared "experiments concerning poison gases were certainly carried out in Dahlem. . ." The spy also noted that gas was also being manufactured in another location in Germany. "Manufacture of Poison Gas in Berlin," 22 August 1923, WO 188/757, R7/G/34, p. 1, The National Archives, London-Kew, UK.

⁵³ "Cargoes of Munitions from Russia to Germany: Secret Plan between Reichswehr Officers and Soviet," *Manchester Guardian*, 3 December 1926, p. 9; For more on aircraft and German denial of the December 3 report, see "Berlin Military Transactions: Munition Supplies from Russia," *Manchester Guardian*, 6 December 1926, p. 9. Based on the fact that both articles appear on page nine, the reports were likely not a major story at that time in England.

on the testimony of two employees that worked in Stoltzenberg's factory during the first half of 1926, the article described how the factory, designated the Gesellschaft zur Förderung gewerblicher Unternehmen, or Gefu, was actually a front company for the Reichswehr's new secret poison gas production facility.⁵⁴ The workers testified that the plant not only produced phosgene and mustard gas, but also Green and Blue Cross. The facility also housed a gas shell filling station, capable of producing a million gas shells.⁵⁵ Despite the setback for Stoltzenberg in Russia, in addition to the compound in Troszk Stoltzenberg also designed and installed chemical facilities for foreign governments in Brazil, Yugoslavia, and Spain.⁵⁶ The Germans officially ceased chemical weapon experiments abroad on 21 July 1933, when the Reich War Minister, Werner von Blomberg, ordered all future experiments in the chemical field be carried out only in Germany.⁵⁷

Despite the destruction of the majority of Germany's chemical arsenal and the revelations of chemical agent manufacturing, Stoltzenberg's activities continued. The result was environmental disaster. A second major chemical weapons catastrophe in Germany occurred in 1928, almost ten years after the Breloh mustard gas plant explosion in 1919. At some point between 4:00 P.M. and 5:00 P.M. on Sunday, May 20, a massive phosgene containment tank began to leak its deadly contents at the Industrie- und

⁵⁴ Hans Günter Brauch and Rolf-Dieter Müller, eds., *Chemische Kriegführung – Chemische Abrüstung*, 97.

⁵⁵ Franz Künstler, "Die Giftgasfabrik in Trotzsk," *Vorwärts*, Nr. 16, (11 January 1927), reproduced in *Ibid*, 109.

⁵⁶ Peter Rabel, "Stolzenberg-Skandal" *Hamburger Abendblatt*, 15 September 1979.

⁵⁷ Letter from Walther von Reichenau, 21 June 1933, Reproduced in Hans Günter Brauch and Rolf-Dieter Müller, eds., *Chemische Kriegführung – Chemische Abrüstung*, 130.

Handelsgesellschaft Müggenberg GmbH, on the island of Peute near Hamburg. The company was a subsidiary to none other than the Chemische Fabrik Stoltzenberg, also located on the banks of the Elbe River.⁵⁸ Among the chemicals stored in significant quantities in Stoltzenberg's plant was phosgene. The inventory consisted of no fewer than 3,000 bottles and three large storage tanks, one of which being the source of the disaster.⁵⁹ After several hours, the ruptured canister ejected thirteen cubic meters of phosgene, and produced a cloud that according to one report was "sufficient in quantity to wipe out Hamburg's entire population."⁶⁰

Pushed by a northerly breeze, the cloud moved over the harbor and claimed its first victims. Two boys fishing together in a rowboat in the harbor, the twenty year-old Peter Meyer and his fourteen year-old younger brother, Hans, were fatally gassed. The phosgene then drifted over populated areas, where people mysteriously began falling ill. Police and fire companies were called in, and soon discovered the hissing tank. Without proper respirators, a group of brave police- and firemen filled the container with water and pushed the canister into the harbor to neutralize the gas. Ten of these men, five firemen and five police officers, were seriously gassed and rushed to the hospital.⁶¹ At the

⁵⁸ "Was tut Herr Dr. Hugo Stoltzenberg bei der Müggenburg m.g.H.?" *Hamburger Echo*, 22 May 1928, Nr. 141.

⁵⁹ Astrid Lütje and Thomas Wohlleben, "Chemiefabrik Stoltzenberg – Zwei Katastrophen ohne Schuldige?" in Arne Andersen, ed. *Umweltgeschichte: Das Beispiel Hamburg* (Hamburg: Ergebnisse-Verlag, 1990), 135.

⁶⁰ "Giftgas-Explosion auf der Peute. Die Schreckensnacht," *Hamburger Echo*, 21 May 1928, Nr. 140; "An Extraordinary Accident," *The Times*, 23 May 1923, Issue 44900, 17.

⁶¹ "Wer trägt die Verantwortung?" *Hamburger Echo*, 22 May 1928, Nr. 141.

nearby St. Georg Hospital, in addition to emergency personnel, some ninety people were brought in with gas poisoning.⁶²

By this point, the cloud had become dangerously large. Panic began to set in among Hamburg's residents, as civilians fled southward to escape the cloud. Over the next several hours, fire crews began to spray ammonia and water into the air in an attempt to neutralize the poison. But it was a losing battle. Life on the south shore of the city was annihilated. The trees and bushes shriveled and died. Cattle, chickens, and hogs from nearby livestock areas were wiped out. The cloud then shifted again, towards Wilhelmsberg.

As the toxic fog approached Wilhelmsberg, it floated into a pleasure resort, where a wedding was taking place. The reception was interrupted, however, when the guests noticed something was amiss when the food began to taste odd and became "repugnant." Suddenly the guests began to collapse one by one from the gas.⁶³ It remains unclear how many were affected across the city, but initial estimates put the death toll at six, with 120 sickened.⁶⁴ The next day, that figure jumped to eight dead, and 200 poisoned.⁶⁵ As the hours continued to tick by, the number of citizens taken to the nearby hospital eventually jumped to 250. The last fatality occurred on June 2, which brought the death toll to ten.⁶⁶

⁶² "Giftgas-Explosion auf der Peute. Die Schreckensnacht," *Hamburger Echo*, 21 May 1928, Nr. 140. This article, among dozens of others on the Gas explosion, can also be found in SS-HA 135-1 I-IV, 4069 Band 1, Staatsarchiv Hamburg, Hamburg, Germany.

⁶³ "An Extraordinary Accident," *The Times*, 23 May 1928, Issue 44900, 17.

⁶⁴ "Giftgas-Explosion auf der Peute. Die Schreckensnacht," *Hamburger Echo*, 21 May 1928, Nr. 140.

⁶⁵ "Wer trägt die Verantwortung?" *Hamburger Echo*, 22 May 1928, Nr. 141.

⁶⁶ Some newspaper accounts give the incorrect number of fatalities. For example, the *Vossische Zeitung* reported eleven were dead on May 24th, when in fact the tenth fatality did not occur until June 2. See "Gift," *Vossische Zeitung*, 24 May 1928, Nr. 123, p. 1; "Ein neues Todesopfer der Phosgene-

The death toll could have been worse. The fact that the accident occurred on a Sunday meant the factories in the area were abandoned, although watchmen and porters were among the dead.⁶⁷

The citizens of Hamburg, however, miraculously caught a break when the weather shifted in their favor. By the evening, the wind had turned and pushed the cloud back over the harbor. The city was saved when rain began to fall, and after a steady downpour the chemicals were neutralized.⁶⁸ Yet the damage was done. Plant and animal life in the area was wiped out. The cloud traveled a total of twelve miles. All food within a five mile radius of the cloud's path was contaminated and had to be destroyed. Of course, the environmental effects and path of the poison cloud were easy to track and record. The people simply walked until the bushes and trees were no longer shriveled or dead.⁶⁹ "One can clearly look at the path of the cloud on the vegetation," the *Hamburger Fremdenblatt* reported.⁷⁰ Due to the rain and other atmospheric conditions diluting the

Katastrophie," *Hamburger Fremdenblatt*, 2 June 1928, Nr. 152, SA-HH 135-1 I – IV, 4069 Band 2, Staatsarchiv Hamburg, Hamburg, Germany.

⁶⁷ "An Extraordinary Accident," *The Times*, 23 May 1923, Issue 44900, 17.

⁶⁸ "Wer trägt die Verantwortung?" *Hamburger Echo*, 22 May 1928, Nr. 141; "11 Killed, Many Ill in Hamburg Before Rain Ends Terror," *The New York Times*, 22 May 1928, Vol LXXVII, No. 25686, 1-2; "Zur Giftgas-katastrophe auf der Veddel," *Hamburger Fremdenblatt*, 22 May 1928, No. 142a, p. 4.

⁶⁹ The communist newspaper *Die Rote Fahne* stated the food must be "officially confiscated and destroyed" ("*amtlich beschlagnahmt und vernichtet*"). "Die Giftgaskatastrophe in Hamburg," *Die Rote Fahne*, 23 May 1928, No. 20. See also "Reich Army Linked to War Gas Deaths," *The New York Times*, 23 May 1928, Vol. LXXVII, No. 25678, pp. 1, 5.

⁷⁰ "Die Phosgen-Katastrophe. Folgen, Möglichkeiten und Lehren," *Hamburger Fremdenblatt*, 22 May 1928, No. 142.

cloud, all of the fatalities occurred within a two kilometer radius from the leaking container. Still, poisonings of residents were reported as far as seven kilometers away.⁷¹

In addition, the psychological trauma the cloud inflicted on the population is difficult to imagine, and newspapers reported the surreal, terrifying experience. “The characteristic accompaniment of gas poisoning has,” London’s *The Times* reported, “given the scene of the disaster something of the appearance of a plague stricken area, where men and women, haggard from sleeplessness, walk about haunted by fear that they will yet be victims of the invisible peril.”⁷² Berlin’s *Vossische Zeitung* went further, arguing that civilian deaths like this from poison gas would also occur in the next war.⁷³ Famed Hamburger pacifist and future Nobel Peace Prize recipient Carl von Ossietzky declared “this poison gas attack on the great city of Hamburg, brought through the irresponsible stupidity (*Dummheit*) of the public authorities and the criminal profiteering of business-savvy former military brass (*kommerzbegabter Exmilitärs*)” is an “obvious education: - so the next war will be! So it will be!”⁷⁴ The *Hamburger Echo* agreed with their journalism counterparts in Berlin, as they declared, “We all have now a taste of the cruelty and ruthlessness (*Unbarmherzigkeit*) of an upcoming war.”⁷⁵

The environmental damage and risk to public health was also brought into the forefront of the issue. Newspapers described how the gas killed off plant life,

⁷¹ Ernst Gillert, *Die Kampfstoffverletzungen (Kampfstoffkrankungen): Erkennung, Verlauf und Behandlung der durch chemische Kampfstoffe verursachten Schäden* (Berlin: Urban & Schwarzenberg, 1944), 11-12.

⁷² “The Poison Disaster,” *The Times*, 23 May 1928, Issue 44900, 16.

⁷³ “Giftgas im nächsten Kriege,” *Vossische Zeitung*, 23 May 1928, Nr. 122, 2.

⁷⁴ Carl von Ossietzky, “Gasangriff auf Hamburg,” *Die Weltbühne*, No. 22 (29 May 1928): 814.

⁷⁵ See the section entitled “Gaskrieg” under the main article, “Die bittere Lehre. Was hat uns die Phosgen-Explosion gezeigt?” *Hamburger Echo*, 23 May 1928, Nr. 142.

contaminated livestock, and poisoned groundwater in the area. For “many hundreds of meters” *Die Rote Fahne* reported:

. . .One can clearly observe the yellow coloration on the grass, where the gas had rolled in the direction of Georgwerder. . . one can also follow the path of the gas cloud in the grass and the vegetation. . .The trees in the way of the protracted cloud are completely atrophied, bushes and blades of grass charred.⁷⁶

The *Hamburger Fremdenblatt* painted an even more sinister picture of a desolated landscape. The journalist seemed to print a diary entry of their experience:

Darkness is falling. Danger is rising. . . At last daylight one saw just how yellow the meadows and leaves became, how chickens and dogs and pigs toppled over into heaps. With this impression into the night, into the emergency shelter. Between wild rumors and cruel facts. The most terrible, the most eerie night, that ever lain over the island.⁷⁷

After the investigation began, reports of other hazardous materials were reported. The *Hamburger Echo* reported “dilapidated barrels” containing arsenics were located, contaminating lands and groundwater.⁷⁸ Despite the obvious danger, some local officials were careless with their response. The Harburg borough’s health offices declared incorrectly that food which had come in contact with the gas was “not a danger to health” (*nicht gesundheitschädlich*).⁷⁹ It is unknown how many people may have been poisoned by ingesting the chemicals, rather than through inhalation. The prophecies many made regarding chemical weapons and the nature of future conflicts, as well as the graphic

⁷⁶ Georgswerder is a small island located in the Elbe River by the plant. “Am Orte der Giftgaskatastrophe,” *Die Rote Fahne*, 25 May 1928, No. 122.

⁷⁷ “Giftgasexplosion auf der Veddel,” *Hamburger Fremdenblatt*, 21 May 1928, No. 141.

⁷⁸ “Nachspiele – Vorspiele?: Zur Phosgenkatastrophie” *Hamburger Echo*, 28 May 1928, No. 145.

⁷⁹ “Noch immer Phosgen,” *Hamburger Echo*, 29 May 1928, No. 146. Harburg is located just south of Wilhelmsburg.

perspectives of the environmental catastrophe, demonstrate the recognition by the Germans of the consequences these chemicals can have on humans and the environment.

Within hours of the accident, government officials began a formal investigation. The ruling Social Democrats and the press demanded answers from the police and government officials. Among the questions posed were: Did the police know that such quantities of deadly gasses were stored there?, and who was responsible? The local newspaper *Hamburger Echo* declared “For the authorities the question arises, how in the future can such severe disasters (*schweren Unglücksfälle*) like this be prevented.”⁸⁰ Yet the German civilians never received the answers they sought.

To the press and local officials, Stoltzenberg declared the entire episode an accident, and that he was innocent of any safety violations. The company released a statement, claiming the storage tank that burst had just passed “the official pressure test” in June 1927.⁸¹ When asked by local officials where the gas came from, Stoltzenberg claimed it was left over from the war and was about to sell it to buyers in the United States and Czechoslovakia. Facing a public relations nightmare of almost boundless proportions, Stoltzenberg suggested the entire stock of remaining gas in the facility be dumped in the North Sea. Yet Stoltzenberg soon became mum on the subject when the Weimar government investigators arrived from Berlin. Upon the arrival of government officials, Stoltzenberg refused to disclose both how he acquired the material and for what purpose it was to be used.

⁸⁰ “Wer trägt die Verantwortung?” *Hamburger Echo*, 22 May 1928, No. 141.

⁸¹ “7 Todesopfer der Phosgen-katastrophe,” *Hamburger Nachrichten*, 22 May 1928, No. 235, p. 1.

Given their past relationship, Stoltzenberg's sheepish reaction was lock step with that of the Reich War Ministry, who were also silent on the matter. On May 24, an official hearing sponsored by the government to investigate the issue commenced. The meeting was chaired by the Minister of Commerce, Dr. Julius Curtius. Neither the German Defense Minister Otto Gessler nor the Reichswehr's Commander-in-Chief, General Hans von Seeckt, testified at the hearing. Questions about the gas's origins or Stoltzenberg's intentions were pushed aside, as the Reich seemed to want the entire disaster swept under the rug.⁸² The government also showed little interest in helping the city pay for the damages incurred by the accident. While the military assisted in the clean up, the city of Hamburg took a substantial financial hit when the Reich declined to help pay for the damages. In a letter from the Reich Chancellory addressed to the president of the city senate and the mayor of Hamburg, Reich Chancellor Hermann Müller stated the phosgene was solely the property of Dr. Stoltzenberg, and not the Reichswehr. "I therefore regret to have to come to the conclusion," Müller wrote, "that that the Reich government is not in the position to share in the incurred costs (*entstandenen Kosten*) from the phosgene accident."⁸³ The official report declared the 3,400 gallon phosgene canister had a defective seam which could no longer withstand the pressure. With the German government and military uninvolved with respect to the causes of the accident, the foreign press bought the story that the gas was not for war use and foreign

⁸² Lincoln Eyre, "Reich Says War Gas was Not for Army," *The New York Times*, 25 May 1928, Vol. LXXVII, No. 25689, 6.

⁸³ Letter from Reich Chancellor Hermann Müller to the President of the Senate of Hamburg and the Mayor Dr. Peterson, 1 September 1928, SS-HA 131-4, 1928 A 59/1, Staatsarchiv Hamburg, Hamburg, Germany.

governments showed little interest in taking any action. No legal or safety violations were found by German authorities, and the case was closed.⁸⁴

The political fallout would carry on, however, as the chemical accident drove deeper wedges between political parties in Germany. The moderate-left leaning newspaper *Hamburger Echo* linked Stoltzenberg to the German Communist Party (KPD), declaring that his employees knew about Stoltzenberg's phosgene operations and Russian enterprises as far back as the late fall of 1923. The *Vossische Zeitung* also refreshed German memories when they dug out their old stories about Stoltzenberg's Russian activities as well, providing articles that described once again Franz Künstler's article and the Reichswehr's secret chemical weapons program.⁸⁵ The communists countered, when their official newspaper *Die Rote Fahne* blamed the democratic government and Social Democratic Party for the accident, depicting them as hypocritical enemies of global peace in the post-Great War world. The gas is "an armaments stock for the new German imperialism" and "the SPD press. . . satisfies itself with deliberate dishonesty with this provocation against Soviet Russia."⁸⁶ The KPD also responded to the SPD claims that they knew about the war gasses in Stoltzenberg's possession by asserting the weapons were for projects with no military aims. Stoltzenberg himself claimed that his war

⁸⁴ "Hamburg Gas Tragedy was 'Pure Accident'," *The New York Times*, 3 June 1928, Vol. LXXVII, No. 25698, 9.

⁸⁵ "Die KPD. hat um Stoltzenberg gewußt," *Hamburger Echo*, 30 May 1928, No. 147; "Die Hintergründe," *Vossische Zeitung*, 23 May 1928, No. 122, p. 2; "Schicksale eines Kriegschemikers," *Vossische Zeitung*, 24 May 1928, No. 123, p. 2.

⁸⁶ "Die Giftgaskatastrophe in Hamburg," *Die Rote Fahne*, 23 May 1928, No. 120. In the same issue, the paper elaborated on the lies of the SPD's publication, *Vorwärts*, describing the SPD political connections to I.G. Farben, "the largest poison gas production site on earth," and stating they would defy the lies and deploy "against the German poison gas and international Bourgeoisie" and "the threat of war. . ." See "Das Giftgas des neudeutschen Imperialismus: 'Vorwärts'-Lügen und freche Fälschungen zur Verteidigung der deutschen Rüstungspolitik," *Die Rote Fahne*, 23 May 1928, No. 120.

chemicals, notably arsenics, would have been used for pest control and medical purposes, specifically for the production of Salvarsan and chemicals for use against cotton boll weevils.⁸⁷ The gas involved in the accident, however, was certainly collected for financial gains and may or may not have eventually been used in a military capacity, but there is no evidence that Stoltzenberg intended peaceful, medical aims with his phosgene.⁸⁸ Political cartoonists on both sides went to work, lampooning, accusing, and slandering their opponents with artistic criticisms like those shown below:



Figure 5. Communist Newspaper Cartoon Regarding Stoltzenberg Disaster⁸⁹

⁸⁷ See secret memorandum by Colonel Waring to the Director of Military Operations and Intelligence, 3 May 1924, WO 188/758, R7/G/62, p. 3. The National Archives, London-Kew, UK.

⁸⁸ Schweer, *Die Geschichte der Chemischen Fabrik Stoltzenberg*, 72-73.

⁸⁹ This cartoon from the communist newspaper *Die Rote Fahne* has a SPD caricature saying “No danger for the Soviet Union and World Peace, Communist Overstatements!!! Germany is completely disarmed!” The skull which is belching the gas is labeled “Chemical Trust.” *Die Rote Fahne*, 22 May 1928, No. 119.



Figure 6. Cartoon Printed in *Hamburger Echo* Regarding Stoltzenberg Disaster⁹⁰

While the press slugged one another with prose and cartoons, the remaining chemical stock, some 50,000 kilograms of gas, was ordered destroyed. In their final report, the government stated that Reichswehr personnel loaded the canisters on freighters destined for the Atlantic where it could be dumped “without danger to ocean traffic or to the fish.”⁹¹ German newspapers made a point to describe the process to reassure the public there would be little to no additional environmental damage due to the

⁹⁰ This cartoon from the social democratic leaning *Hamburger Echo* is entitled “Death by Phosgene,” showing a red-star wearing, communist representation of death. The sub caption at the bottom of the cartoon reads, “The Spirit of Moscow: ‘Now I will pretend I am indignant over the manufacturing of poison gas.’” “Bersol” and “Trotzk” were the two names of the factory Stoltzenberg helped construct in the USSR. *Hamburger Echo*, 23 May 1928, No. 142, p. 6. The cartoon was also published in *Vorwärts* on the same day. See *Vorwärts*, 23 May 1928, Nr. 240, SS-HA 135-1 I-IV, 4069 Band 1, Staatsarchiv Hamburg, Hamburg, Germany.

⁹¹ “The Hamburg Phosgene Explosion,” *The Times*, 2 June 1928, Issue 44909, 12.

disposal process. Papers described the upcoming tedious process of gas mask-wearing workers loading the phosgene stocks onto a ship to be sunk in the North Sea, and that there was no danger for the surroundings (*Umgebung*) and that poisoning of the fish would be only “slight.” Four days after the accident, the *Hamburger Echo* finally concluded that “The danger to life no longer exists.”⁹² Other papers were not so optimistic. The *Vossische Zeitung* reported that due to the tedious task of spreading a neutralizing agent known as natron over the contaminated area, it would take fourteen days to three weeks to eliminate the danger. The *Hamburger Nachrichten* estimated at least two weeks for the clean-up process.⁹³ The gas was indeed destroyed; the last remaining bottles of gas were dumped on evening of June 17 into the Atlantic Ocean. Several months later, the press reported the dumping operations, providing dramatic pictures of cylinders splashing onto the water, a map of the dumping site, and a congratulatory letter from the Reich War Minister Groener to *Kapitän zur See* Geyer of the Reichsmarine, who led the ocean disposal operation, as well as the officers and men of the local 6th Infantry Regiment who also helped on the ground.⁹⁴

With no legal action taken, Stoltzenberg was free to continue his chemical work in Hamburg. Less than a year after the accident, on February 1, 1929 Stoltzenberg applied for a permit to build a new chemical laboratory on Schnackenburg Allee,

⁹² “Vernichtung der Phosgen-Vorräte,” *Hamburger Echo*, 24 May 1928, Nr. 143; “Das Schicksal des Phosgens,” *Hamburger Echo*, 1 June 1928, No. 150. ; On the fish, see “Unschädlichmachung der Phosgengas-Vorräte,” *Hamburger Nachrichten*, 25 May 1928, No. 241.

⁹³ “Natron gegen Phosgen: Langsam Beseitigung der Gefahr,” *Vossische Zeitung*, 24 May 1928, No. 123, p. 2; “Unschädlichmachung der Phosgengas-Vorräte,” *Hamburger Nachrichten*, 25 May 1928, No. 241.

⁹⁴ C. F. Josephi, “4000 Zentner Giftgas an Bord” *Hamburgischer Correspondent*, 1 January 1929, No. 1. SS-HA 135-1 I-IV, 4069 Band 3.

located in the Eidelstedt neighborhood of Hamburg. For reasons that remain unclear, the permit was approved just eight days later!⁹⁵ Such a short approval time either testifies to the lack of care shown by the authorities regarding permit applications and the hazards chemicals in Stoltzenberg's possession posed, the political influence the Reichswehr had on military-related policies at the local level, or both. Big business and military aims, it seems, continued to triumph over environmental or health concerns.

By the early 1930s, Germans who read the news understood that Germany's chemical weapons program was alive and running in a seemingly blatant violation of the Treaty of Versailles, much to the chagrin of those among the anti-gas movement. For whatever reason, the actions reflected an attitude in direct opposition to the general public's sentiment. Many in Hamburg, though, would never forget the name Stoltzenberg and the disaster on that Sunday. Phosgene was now well known among the public, and articles in the local Hamburg paper described in great detail the chemical properties of the gas and its use in warfare.⁹⁶

As for any actions taken by the Allied powers, the situation in Germany was such that few actions could actually be taken. Because of its variety of industrial uses, the possession of phosgene, for example, was not a violation of the Versailles Treaty. Stoltzenberg's factory rested outside the occupation zone of the Allied powers, and the Germans were quick to not only publicly investigate, but also publicly destroy the gas. When asked if the League of Nations would launch any investigation about the explosion, British Secretary of State for Foreign Affairs Sir Austin Chamberlain, the 1925 co-

⁹⁵ Dierk Strothmann, "Der Herr der Todesgifte," *Hamburger Abendblatt*, 5 September 2009, p. 19.

⁹⁶ See for example "Was ist Phosgen?" in *Hamburger Echo*, 23 May 1928, Nr. 142; "Was ist Phosgen?" *Hamburger Nachrichten*, 22 May 1928, No. 236.

recipient of the Nobel Peace Prize and half-brother of future British Prime Minister Neville Chamberlain, said that “it would be premature to express any comment about the course that the cabinet will adopt on this issue,” and claimed he knew only what had been published in the newspapers so he could not form an opinion on it until he had more information.⁹⁷ Evidently, Chamberlain never got around to learning more about it or simply felt the problem was solved, as several days after the accident at a League of Nations meeting on June 3 in Geneva, the Hamburg explosion was brushed aside and no actions were ever taken. The London *Times* concluded “its [the Stoltzenberg phosgene’s] burial in the Atlantic Ocean is considered to have buried it also as an international question. . .”⁹⁸ With no significant domestic or international consequences, German military and chemical facilities, including Stoltzenberg’s chemical factories, proceeded to test and develop deadlier gasses. As one might expect, the German authorities’ failure to learn from the Hamburg disaster would have significant environmental consequences down the road.

When the war ended in 1918, the Allies began the Sisyphean task of cleaning up the lifeless moonscape that now covered much of Northeastern France and Belgium, with the hope that it could once again resemble something familiar. Forests and meadows were shredded and poisoned, converted to muddy cesspools, with hundreds of miles of debris fields and human remains scattered about. In addition to the annihilated forests near the battlefields, during the war the belligerents also leveled thousands of acres of forests to

⁹⁷ See “Chamberlain will sich genauer informieren,” *Hamburger Fremdenblatt*, 24 May 1928, No. 144a, p. 1; “House of Commons,” *The Times*, 24 May 1928, Issue 44901, p. 8.

⁹⁸ See “The Hamburg Explosion” subheading under the main article, “Work of League Council: To-Day’s Meeting,” *The Times*, 4 June 1928, Issue 44910, p. 13.

harvest timber for the war effort. At the front, the French Forestry Service estimated that some 350,000 hectares of woodlands were destroyed by the war, the equivalent of sixty years worth of harvests.⁹⁹ In some areas, such as Verdun or the Somme, the devastation was all but total. Prior to the German retreat at the Somme, the Germans destroyed almost every building, bridge, tree, and fence in the sector, a rectangular area covering roughly sixty-five by twenty miles.¹⁰⁰ In some cases, the destruction of the trees was not caused by weaponry, but by lumberjacks and forestry officials trying to meet the heavy timber demands of the war. In Britain, for example, an astounding 450,000 acres were cut and cleared during the war, or roughly half of the country's total forest area. The Germans also took advantage of their natural resources of timber and wildlife, killing livestock and hunting the last of Europe's wild bison population to the brink of extinction to provide food for the starving population.¹⁰¹

Compared to Germany, however, the situation in France and Belgium was far more complicated. After the war ended, the process of clearing and filling trenches began. In many cases across Belgium and northeastern France, work crews often buried chemical and explosive ordnance as they began to smooth out the terrain to make it suitable for farming and construction again. Despite over three years of exposure to chemical pollution and soil contamination, life began to reappear in these areas, even those such as the Cambrai and Ypres salients. Grass was quick to return, and scientific

⁹⁹ Richard P. Tucker, "The World Wars and the Globalization of the Timber Industry," in Tucker and Russell, eds. *Natural Enemy, Natural Ally*, 113.

¹⁰⁰ Richard P. Tucker, "The Impact of Warfare on the Natural World: A Historical Survey," in *Ibid*, 29.

¹⁰¹ The same practice was carried out by the Germans during World War II, however the species managed to survive that slaughter as well. Stockholm International Peace Research Institute, *Warfare in a Fragile World: Military Impact on the Human Environment* (London: Taylor & Francis Ltd, 1980), 57.

journals noted the recovery of bird populations. Although the forests that once occupied large areas around the Somme were now entirely destroyed, large fields of scarlet poppies and pink rosebay willowherbs had returned, covering the once desolate battlefield as early as July 1917.¹⁰²

In addition, scientists also noted that birds seemed to adapt to the wartime environment. Observations were made of canaries remaining calm under fire, pigeons ignoring gunfire to deliver messages, and even some species becoming used to the sound of explosions. As the journal *Nature* reported in 1919, “At home the consensus of opinion of trustworthy observers shows that birds were at first much upset by air raids. As these, however, became more frequent, their fears diminished.” The journal went on to report that migration patterns did not appear to be interrupted, however the largest problem the birds now faced was “the lack of forests and woods.” The journal noted that arboreal birds such as woodpeckers and owls vanished in areas where forests once stood prior to the war.¹⁰³

During the war, soldiers noticed birds living in destroyed buildings and thriving in the trench environments. For example, in France a doctor attached to an ambulance corps counted thirty-five different species of birds in the immediate area nesting in trenches or the ruins of buildings. During a German gas cloud attack in 1916, soldiers could hear robins and starlings chirping above the white poison cloud, creating a bizarre juxtaposition of soothing sounds in the air amidst a deadly environment on the ground.¹⁰⁴

¹⁰² A.W. Hill, “The Flora of the Somme Battlefield,” *Nature*, No. 2520, Vol. 100, (14 February 1918): 476-477.

¹⁰³ Hugh S. Gladstone, “Birds and the War,” *Nature*, No. 253, Vol. 102, (20 February 1919): 488-489.

¹⁰⁴ Gladstone, *Birds and War*, 130-131.

As we have seen, owls enjoyed the abundance of rats in the trenches and in no man's land. Other birds also took advantage of the spikes in trench-friendly species' numbers. Insectivorous birds such as swallows, martins, and swifts dined well on the seemingly endless numbers of vermin insects. Worms and grubs exposed by gas or high explosive shell fire that loosened or churned up soils provided instant meals for hungry birds overhead.¹⁰⁵ Of course, depending on the chemical, the contaminated insect could very well have its revenge when the bird dies of poison consumption.

Insect populations also seem to have been seriously affected. An article in *American Miller* magazine noted that the "scarcity of insect pests around Rheims is attributed to the use of poison gases in that region during the World War."¹⁰⁶ While never completely eradicated, clearly chemical warfare negatively impacted even insect species with the most rapid of reproduction abilities.

Humans also began to return to the battlefields. Despite the danger of traveling in the war-torn regions, battlefield tour guides were already available. In 1920, Michelin published a travel guide for Ypres, including a tour of the salient and its major landmarks from the war. The guide includes numerous photos which document the level of environmental and urban destruction. Trees are killed off; craters and rubble are strewn where villages used to be. The guide summed up the scene when it stated, "Ypres is now but a memory."¹⁰⁷ Still, the images show grasses and bushes already returning. What cannot be seen, however, is that the grass that survived remained discolored for months.

¹⁰⁵ Ibid, 103-107.

¹⁰⁶ Edmund P. Russell, "'Speaking of Annihilation': the Mobilizing for War Against human and Insect enemies, 1914-1945," *The Journal of American History*, Vol. 82, No. 4 (March 1996): 1512.

¹⁰⁷ *Ypres and the Battle of Ypres* (Clermont-Ferrand, France: Michelin & Cie, 1920), 69.

In the spring of 1919, a British soldier named Arthur Long took a tour of the Ypres salient. While on his journey between France and Belgium, Long visited several towns. Among them were Ypres, Loere, and Bailleul. In a letter to his wife chronicling his trip, Long described the area around Ypres as he took one of these battlefield tours. Long noted that the grass remained a bright yellow color from the German gas shelling. While resting in the town of Bailleul, Long wrote that, “The destruction of Bailleul is almost as complete as Ypres. . . I could not look upon the devastation of the countryside without thinking of all the slaughter and bitter suffering resulting from the awful events which had occurred in the area visited. And one is forced to reflect that man has indeed sunk very low to use his superior intellect in fashioning means of dealing death and destruction all around.”¹⁰⁸

In sharp contrast to battlefield tourism, the French and Belgian governments were faced with an unprecedented environmental catastrophe: ground contaminated with millions of tons of chemical and high explosive ordnance. The millions of acres of land which became the location of the Western Front’s battlefields flourished before the war. Recently, a study by the geographer Hugh Clout has illuminated the scale of the battlefield contamination problem for the local inhabitants. According to Clout, some 6.5 million people resided in the battlefield area before the war. Among the hundreds of settlements are several cities, including Lille, Nancy, Reims, and Amiens. Although when Northern France comes to mind one normally thinks of rural landscapes, one third of France’s industrial output derived from these areas. There were, however, vast expanses

¹⁰⁸ Arthur A. Long, letter to his wife Mrs. A. A. Long, 3 March 1919, A A Long, 06/30/1, p. 14-17, Imperial War Museum, London, UK.

of rural countryside. While factories and coal mining provided jobs for many of the residents, ninety-six percent of the area was designated for farming or forestry. Specific numbers of farms are unknown, however a report by the French government that counted the farms across the nation in 1892 counted 669,351 farms in what would be the future war zone.¹⁰⁹ Yet four and a half years of war had changed all of this, as entire villages and thousands of farms would be annihilated during the war. On 11 November 1918, only 2,075,060 people were left residing in the area, many of whom fled the war zone as refugees or were moved by military actions.¹¹⁰

To solve this problem, both nations' governments immediately evacuated civilians and cordoned off zones deemed too dangerous to occupy. In France, assessments of post-war terrain were conducted and colored zones were placed on maps designating the level of danger. Blue was used for relatively safe areas, and yellow for those areas too contaminated for usage but had the possibility of being cleared within several years. The red zones were by many at the time deemed too hazardous to enter; many believed that the cost of clearing the land and the devastation level was so great that the area would never be reclaimed.¹¹¹ This resulted in the closing off of some 16,000,000 acres of land, or roughly one percent of their entire country. Fences were constructed with warning signs stating *TERRAIN INTERDIT*, or forbidden ground. The French logically refer to the area as the *Zone Rouge*.¹¹²

¹⁰⁹ Hugh Clout, *After the Ruins: Restoring the French Countryside of Northern France after the Great War* (Exeter: University of Exeter Press, 1996), 8-17.

¹¹⁰ Ibid, 52.

¹¹¹ Ibid, 28.

¹¹² Donovan Webster, *Aftermath: The Remnants of War* (New York: Vintage Books, 1996), 13.

Despite their precautions and proactive stance towards quarantining millions of acres of territory, hundreds of Belgian and French people have been killed over the past ninety-five years as a direct result of leftover or subterranean ordnance. Both nations have created specialized ordnance disposal groups, entrusted with the dangerous task of cleansing their landscape of poison gas and explosive shells. In most cases, the ordnance is discovered by civilians, usually farmers. In some cases, it is simply a single explosive; other times, large caches are discovered. For example, a Belgian farmer in 2001 discovered a sizable British stockpile while plowing his field, containing some 1,100 explosives. The farmer discovered it when his tractor sunk in the mud, striking one of the shells. Fortunately, he was unharmed. Unfortunately, not everyone is as lucky. In 1991 alone, thirty-one French farmers were killed by striking shells in their fields.

Between 1954 and 1972, the Belgian military routed collected ordnance to stockpiles and regularly dumped them into the Bay of Biscay. On average, the Belgians dumped forty-five tons of chemical and explosive material annually. In 1980, the Belgians were forced to cease this method of disposal, as the Belgian government signed international agreements banning the dumping of wastes into the ocean.

By the 1980s, the Belgians were falling behind. The cessation of sea dumping initially created an ever-accumulating amount of toxic materials that required proper disposal. Due to budget restrictions and the necessary training required for the work, the people charged with cleaning the countryside are few in number. By the mid 1980s, just an eighty-two man disposal team defused ordnance across the country. With such a small number of workers, the clean-up effort will take decades to complete. The work requires a high level of expertise, and there are obvious significant risks involved, including

severe gas poisoning from active chemical shells or death. In 1986 alone, four Belgians were killed during disposal operations.

Despite their losses and the incalculable stress, their efforts continued. Despite the loss of four comrades, the Belgian teams unearthed eighteen tons of chemical ordnance in 1986. One of the most active teams is the squad based out of Houthulst in West Flanders, located in the heart of the Ypres sector. Known as the “blue berets,” they are the Second Intervention Task Force and Toxic Platoon of the Belgian Army. Known among the locals as the *Dovos*, a Flemish term that translates as “the men of explosive devices,” the men work on a strictly voluntary basis. They are paid little for their bravery and exposure to danger; in 1999 they were paid just eleven pounds more per week when compared to the salary of a normal soldier. On average, each day the group receives thirty new requests, but unfortunately the *Dovos* only have time to respond to half that number. Appointments to remove a shell must, therefore, be made well in advance.¹¹³

The amount of hazardous material the *Dovos* remove per year is astonishing. In 1986, the *Dovos* recovered 15,000 shells, and each year thousands more are recovered.¹¹⁴ In 1989, the Belgian Defense Minister Guy Coeme authorized the construction of a new automated dismantling facility, costing some \$4 Million.¹¹⁵ In 2000, some 175 tons of ordnance were removed.¹¹⁶ Despite these impressive numbers, the Belgian government

¹¹³ Kevin Pilley, “Deadly Harvest of an Unending War: the First World War Continues to Claim Victims Among Those Who Farm the Fields of Flanders,” *Financial Times*, 6 November 1999, 10.

¹¹⁴ Martin Du Bois, “Belgians Still Reap Deadly Harvest from World War I – Still Intact Poison Gas Shells, Conventional Explosives Litter Ypres Battlefield,” *The Wall Street Journal*, 10 March 1989, 1.

¹¹⁵ *Ibid*, 1.

¹¹⁶ Stephen Castle, “Great War Explosives Dump is Unearthed by Belgian Farmer,” *The Independent*, 20 March 2001, p. 13.

was forced to take additional measures. By the end of the twentieth century, the ever growing stockpile of recovered chemical shells forced the government to build a robotic disposal facility specifically for chemical shell disposal. The £9 million (\$14.6 million) facility at Steenstraat began to process some 250 tons of chemical ordnance that had accumulated between 1979 and 1999.¹¹⁷ Due to the extreme danger, the facility is only able to destroy thirty-five chemical shells per day. The shells are cleaned with carbon dioxide pellets, x-rayed for cracks, and disarmed by human specialists in special concrete bunkers. The materials are then turned over to the robotic disposal units.

The teams will continue to work for some time. At their current pace of disposal, Belgium officials predict they will be free from chemical ordnance contamination sometime during the year 2149, well over two centuries after the first chemical shells fell on Belgian lands. Regarding the clean-up efforts, in 1999 Dovers member Sergeant Major Dirk van Parijs summed up their overwhelmed but confident feelings: “Belgium is still a battlefield. . . It will be a long battle. But it is a battle we shall win. One day.”¹¹⁸

In France, the government immediately went to work clearing ordnance, filling trenches, and clearing the fields of debris and barbed wire. Initially, the efforts were led by the *Service des Travaux de Première Urgence* (STPU), the government agency ordered by the state to remove “shells or suspect equipment.” The organization was quite large, numbering some 18,000 workers by March 1919. The shortage of manpower convinced the French to employ anyone they could find, including 6,732 French civilians, 9,450 German Prisoners of War, and even thousands of Chinese migrant

¹¹⁷ Pilley, “Deadly Harvest,” 10.

¹¹⁸ Ibid.

laborers. The group continued to expand its workforce in the months that followed. By April, 22,525 POWs were assigned battlefield cleaning duties.¹¹⁹ Although hundreds of thousands of shells were cleared and some 2,000,000 hectares were cleared for farming, numerous workers and civilians continued to be killed or maimed by the leftover chemical ordnance. Still, by 1921 5,779,132 people lived in the former war zones, nearly eighty-nine percent its pre-war level.¹²⁰

The task of cleaning the former battlefields eventually fell under the administration of the government's *Département du Déminage*, or the Department of Mine Clearance, in 1946.¹²¹ Despite the millions of chemical shells still active in the earth, land mines took special priority after World War II because it would improve the weakened agricultural and industrial output of the country. Just as they had done after World War I, the French again used German Prisoners of War to assist in the clean-up operations.

While figures are not available for post-World War I clean-up, the historian Chris Pearson recently discovered figures for the post-World War II efforts. Pearson described how 52,000 German prisoners were put to work clearing mines across the country. Such tasks were a violation of the Geneva Convention, as they “exposed prisoners to dangerous work.” As the soldiers had military training, and the social belief at that time was that German lives were not as valuable as French ones, the French put the Germans to work anyway. In at least one case, a detachment of prisoners was forced to walk across

¹¹⁹ Clout, *After the Ruins*, 89-90.

¹²⁰ Ibid, 151.

¹²¹ Webster, *Aftermath*, 19.

land potentially containing mines to explode “those individual mines which escaped the checks of landmine clearers.”¹²² Just as clearance work after World War I was a deadly affair, so too it was after the second Great War. Although Pearson concluded that “removing mines and other explosives from French soil was a largely successful operation,” the price in lives was steep. As explosive shells and chemical ordnance from the First World War took a back seat to the more widespread threat of standard land mines, the ultimate results of the clean-up operations immediately after the war are debatable.

In terms of lives lost, hundreds of French and Germans were killed between 1944 and 1950 clearing ordnance. During that six year span, 471 French mine clearers and 738 German prisoners of war were killed. Thousands more were injured; for example, 2,988 German prisoners were wounded while clearing the French countryside.¹²³

By 1996, the department consisted of eighteen districts spread across France, and employed only one hundred twenty-three specialists, known as *démineurs*.¹²⁴ From Normandy to Verdun to the Somme, every day *démineurs* painstakingly excavate, disarm, or destroy chemical and other types of ordinance at the risk of their own lives. Like the Belgian specialists, the work is all too often deadly. Since the department began its mission, over 630 *démineurs* have lost their lives, including two disposal experts at Vimy in 1998.¹²⁵

¹²² Chris Pearson, *Scarred Landscapes: War and Nature in Vichy France* (New York: Palgrave Macmillan, 2008), 126-129.

¹²³ Pearson, *Scarred Landscapes*, 129.

¹²⁴ Webster, *Aftermath*, 19.

¹²⁵ John Tagliabue, “France to Evacuate 15,000 Living Near Old Ammunition Dump,” *The New York Times*, 14 April 2001, Vol. CL, No. 51,723, A5.

Worse still, due to the sensor limits of metal detectors, even areas considered safe were only cleared of surface or near the surface levels. This makes the problem a seemingly eternal environmental catastrophe. As the soil slowly erodes, once deeply entrenched, harmless ordnance rises to the surface to pose new difficulties. Civilians, usually farmers, continue to be killed or injured by live chemical and explosive shells. In 1991 alone, hidden ordnance killed thirty-six and injured another fifty-one people across the country.¹²⁶ In many cases, civilians call the disposal department from their homes directly to have a shell removed from their garden or yard. The department receives some two million requests of this nature annually.¹²⁷

In 1996, the journalist Donovan Webster spent time with the *démineurs* investigating their day to day activities. When Webster asked the work team what their least favorite type of shell was, the workers all agreed that chemical ordnance was the worst. “First, you never know how solid the skins are,” explained Henry Bélot, then a twenty-year veteran who on at least one occasion was severely gassed by a live chemical shell. “They are often rusty, so they may leak gas and kill you as you lift them. . .we have to take special precautions. It is very difficult.”¹²⁸ Stationed at Verdun, Bélot’s team find and remove on average thirty tons of chemical ordnance per year.¹²⁹ Collected shells from around the country are transported to a demolition facility at La Crotoy, located by tidal flats along the English Channel. To limit the risk to the general public, excavated

¹²⁶ Webster, *Aftermath*, 19.

¹²⁷ *Ibid*, 37.

¹²⁸ *Ibid*, 23.

¹²⁹ *Ibid*, 24.

chemical shells are transported during the night in special trucks with sealed cargo bays. The trucks are unmarked as to not scare the public.¹³⁰

Despite every precaution, accidents continued to occur, even at La Crotoy. In 1996, an explosion at La Crotoy destroyed a small depot. Although nobody was injured, two hundred area homes were evacuated. Security has also been reported as poor, and many of the shells awaiting destruction leak their toxic payloads.¹³¹ Such was the case most recently in April 2001, when 15,000 people were evacuated from the Vimy area. French officials noticed several crates of Yellow Cross shells and Green Cross shells had rotted and were leaking their contents.¹³² The crates were stored at the Vimy depot, a facility which at that time held some one hundred seventy-three tons of ordnance; the majority containing chemical agents. Fears that the ammunition had become unstable forced the French authorities to take emergency measures. Five entire villages were evacuated, including Farbuf, Willerval, Acheville, Arleux-en-Gohelle, and Vimy. Police went door to door rounding up the residents, and placing them on buses. The operation involved 3,500 firemen, police and soldiers, as well as fifty bomb disposal experts. After ten days, the area was deemed secure and the citizens were permitted to return to their homes.¹³³

Once the ordnance is collected, the demolition process begins. Upon arrival to the beaches by La Crotoy, *démineurs* dig large pits on the beach when the tides are out at the water line. Once the chemical shells arrive, they are buried under regular high-explosive

¹³⁰ Ibid, 54-58.

¹³¹ Paul Webster, "Blast Fear at French Arms Dump," *The Guardian*, 31 December 1996, 3.

¹³² "Evacuation as French Fear WWI Gas Blast," *Sunday Herald Sun*, 15 April 2001, p. 33.

¹³³ Paul Webster, "Mustard Gas Leak Town Evacuated," *The Guardian*, 14 April 2001, p. 3.

shells, creating stacks in the pits. After a few hours, the tide comes in and the stack is then detonated safely underwater. The tidal flats were chosen at the site because the amount of sea life in the area is minimal and the natural movement of sediment on the sea floor provides a consistent surface platform for more detonations. Ordnance is detonated only one week per year. The other fifty-one weeks are spent collecting the material to be destroyed. It remains a slow process; in 2009, the French Interior Ministry estimated that over 12 million shells remain in hills and forests in the area around Verdun alone.¹³⁴ In sum, it is clear that the French continue to struggle with the environmental impact of the war. As one *démineur* declared, “To this day, the First World War is a nightmare for France. It killed a generation of our men. But that wasn’t all. As you wipe those men away, you also destroy our farms and fields, you destroy our homes. Everything.”¹³⁵

Despite the already apparent environmental devastation, those politicians who advocated for a ban of chemical weapons after World War I did so primarily for other reasons. The two most common were the fear that such weapons could be used against civilian populations via aerial bombs; the second being the cultural perception that the use of poison gas was “uncivilized.” The first formal conference on the subject occurred in 1922, when the Conference on Limitation of Armament, or the Washington Arms Conference, was held in Washington D.C. Representatives from the United States, Japan, France, Italy, and Great Britain met to create a universal treaty to answer the American congressional demands for arms control, protection of civilians during wartime, and a ban on the use of poison gas or chemicals in a future war. At the conclusion of the conference

¹³⁴ Jonathan Olley, “The Forbidden Forest: Where the Great War Continues to Generate Casualties,” *Orion*, Vol. 28, Issue 2 (March 2009): 40.

¹³⁵ Webster, *Aftermath*, 43.

a treaty was drawn up, and among the articles was one that banned the use of chemical weapons. It read, “The use in war of asphyxiating, poisonous, or other gases and all analogous liquids, materials or devices, having justly been condemned by the opinion of the civilized world. . .this prohibition shall be universally accepted. . .” Yet another article in the treaty restricted the use of submarines, a topic which the French were not willing to concede. The French never ratified the treaty, and the agreement fell apart.¹³⁶

Three years later, a larger conference concerning the same issues was held by the League of Nations in Geneva. The original intent of the conference was to restrict or abolish international arms trading. The American delegation again sought to pass a ban on the use of chemical weapons. The drive behind this move stemmed from an American advisory committee to the delegation which queried the American general public about their attitudes towards chemical warfare. The poll found that nineteen people favored either retention of gas warfare or retention with some restrictions; 367,000 people favored banning chemical weapons altogether. The Protocol at Geneva, using almost verbatim the article from the Conference on Limitation of Armament, officially banned the use of both chemical and biological weaponry. The Geneva Protocol was both signed and ratified by the Germans, French, and British in 1925. Ironically, the Americans failed to ratify the Protocol in the Senate, much to the chagrin of President Coolidge and the American delegation.¹³⁷ There were a number of reasons for this, including policies of isolationism and infighting among members of the Senate. Those who voted against ratification felt that the ban would leave the United States unprepared for a future war if

¹³⁶ Sir Henry F. Thuiller, *Gas in the Next War* (London: Geoffrey Bles, 1939), 132-135.

¹³⁷ The United States ultimately ratified the Geneva Protocols in 1975. Victor A. Utgoff, *The Challenge of Chemical Weapons: An American Perspective* (New York: St. Martin's Press, 1991), 14-18.

the enemy were to use chemical agents. There was also significant push back from veteran and chemical industry groups who also warned of the potential vulnerability to a military that abandoned chemical warfare altogether.¹³⁸

These arguments in the end were moot, as the Geneva Protocol did not ban the possession, manufacture, or purchasing of chemical weapons. If anything, the 1920s and 1930s saw a rapid development of chemical warfare technologies and toxins. Despite the inspections and restrictions imposed by the Entente, the Germans expanded their chemical research for the dual purpose of military and civilian gains. The combination of civilian and military enterprises was nothing new, as Germany as often used the military as a means of constructing products or technologies for civilian usage during the *Kaiserreich*. As the historian Michael Epkenhans has argued, “there is some evidence that the military served as a conduit for the transfer of technologies to the civilian economy. The development of the diesel engine, the steam turbine, and the telegraph are some examples.”¹³⁹ During World War I, the technologies associated with gas warfare (gas masks, cylinders, etc. . .), as well as some of the agents (chlorine or phosgene) originated from from civilian circles. However, after the war the techniques and toxins developed during the conflict were often applied to civilian applications, notably pest control.

Hugo Stoltzenberg was not the only German chemist who had visions of profit in the chemical industry after the war. Fritz Haber built upon his various war experiences to

¹³⁸ David A. Koplow, *By Fire and Ice: Dismantling Chemical Weapons while Preserving the Environment* (Amsterdam: Gordon and Breach, 1997), 44.

¹³⁹ Michael Epkenhans, “Military-Industrial Relations in Imperial Germany, 1870-1914,” *War in History*, Vol. 10, No. 1 (2003): 12.

branch out into other scientific endeavors related to chemical weapons. As his colleague Professor Freundlich later observed, “His [Haber’s] varied war experiences had led him to appreciate the great value of cooperation between the different sciences.”¹⁴⁰ Haber’s work in the war and with Tasch compelled him to form a new organization, designed to continue poison gas and chemical research under the guise of a civilian organization dedicated to solely pest control. Founded by Haber on April 1, 1918, the *Deutsche Gesellschaft für Schädlingsbekämpfung* (German Company for Pest Control, abbreviated as Degesch) was similar to the Tasch in that it combined the minds of various scientific disciplines at the KWI.¹⁴¹ Foremost among the leadership was of course Haber, but also Albrecht Hase and Dr. Ferdinand Flury from the KWI’s Pharmacological Department. The following year, Haber helped restructure the *Biologische Reichsanstalt für Land- und Forstwirtschaft* (Biological Institute for Agriculture and Forestry). The Reichsanstalt’s director, Otto Appel, had directly participated in gas operations in Russia during the war and was willing to adopt Haber’s pest control initiatives. Degesch soon worked closely with Appel, inviting him to experiments at their testing grounds and sharing their results.¹⁴² Appel had experience with pesticides, as he conducted experiments relating to the effects chlorine and phosgene had on pests and vegetation on the Eastern Front.¹⁴³

¹⁴⁰ “Interview with Professor Freundlich,” 22 May 1934, Abteilung Va, Rep. 5, 5, Section B, III, File 1438, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

¹⁴¹ Albrecht Hase, “Die Bedeutung von Prof. F. Haber als Förderer der angewandten Zoologie; besonders der Entomologie,” no date, Abteilung Va, Rep. 5, 547, p. 7, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

¹⁴² See for example a message from Degesch to Dr. Appel, inviting him to attend a large experiment in Neustadt targeting hayworms and vine moths, 23 April 1920, BArch R 3602/2266, Das Bundesarchiv, Berlin-Lichterfelde, Germany.

¹⁴³ See for example Dr. Otto Appel, et al. “Bericht über eine im Auftrage des Königl. Kriegsministeriums ausgeführte Studienreise an die Ostfront zwecks Feststellung der Wirkung von

Two departments were established within the Reichsansalt, where basic and applied research on pest control took place.

Meanwhile, experiments continued to take place at the KWI's Pharmacological Department, many of them highly illegal. For example, tests that involved chemists exposing insects such as cockroaches and weevils to mustard gas and other war gasses were conducted, a clear violation of the Treaty of Versailles. In another large experiment, Haber detonated bombs filled with arsenic powder in a forest near Guben with the hope of killing off pine lampett moths. The illegal research ceased, however, when the Military Inter-Allied Control Commission were about to inspect the institute. Terrified the Allies would discover their work and close the institute, the research was halted. Instead of quitting entirely, however, Hase and Flury moved to the Reichsansalt, and operations secretly continued within the agency's Physiological Zoology department. Haber's Degesch was a subsidiary of Degussa, and he subsequently moved Degesch to Frankfurt from Berlin in 1920 to cut down on travel and chemical shipment expenses.¹⁴⁴

Degussa's legitimate pest control undertakings in Germany bred a successful company. Between 1920 and 1923, Degesch cleared 613 mills across the country, fumigating some 6.3 million cubic meters of space.¹⁴⁵ In 1921, Haber made Degesch a public company, followed by an expansion of the company across the continent including eight new branches of Degesch opened in the Balkans. Using his wartime expertise and

Kampfgasen auf die Vegetation," 21 May 1918, BArch R 3602/2172, Das Bundesarchiv, Berlin-Lichterfelde, Germany.

¹⁴⁴ Margit Szöllözi-Janze, "Pesticides and War: the Case of Fritz Haber," *European Review*, Vol. 9, Issue 1, (2001): 104-106.

¹⁴⁵ See copy of Albrecht Hase, "Walter Heerdt," *Rundschau*, 1957, Abteilung Va, Rep. 5, Section B, I, File 555, p. 90, Archiv der Max-Planck-Gesellschaft, Berlin-Dahlem, Germany.

connections, Haber found himself by 1922 in control of a quite successful international pest control company.¹⁴⁶

Ultimately, German pesticide research led to the discovery of two of the most well known poison gasses. After the war in 1936, a German scientist named Gerhard Schrader created tabun gas while researching organic phosphorous compounds in an effort to build a more potent pesticide. The first nerve gas ever invented, tabun is colorless and odorless, capable of killing through inhalation or contact with the skin.¹⁴⁷

Though not as toxic, the other chemical developed left a much larger historical footprint. During the war, German chemists developed a new arsenical delousing agent called Zyklon. The chemical was used to fumigate a variety of locations, including submarines, barracks, and prison camps.¹⁴⁸ In the early 1920s, Hase, Flury and company were creating large quantities of cyanide in search of new mill cleaning agents. Further experiments by Haber's chemists at Degesch led to the creation of a solid crystalline cyanide substance dubbed Zyklon B.¹⁴⁹

By the mid 1920s, some American chemists were working closely with their German counterparts on the new compound, sharing experimental findings and data. One such chemist was Dr. Hugo Hartnack, who was fluent in German and a member of the *Gesellschaft für angewandte Entomologie*. In 1925, Hartnack set up his own pest control company based out of Chicago, the Dr. Hartnack Exterminating Service. Among their

¹⁴⁶ Margit Szöllözi-Janze, "Pesticides and War," 104.

¹⁴⁷ Kim Coleman, *A History of Chemical Warfare* (New York: Palgrave Macmillan, 2005), xvii.

¹⁴⁸ Peter Hayes, *Industry and Ideology: IG Farben in the Nazi Era* (Cambridge: Cambridge University Press, 1987), 362.

¹⁴⁹ Szöllözi-Janze, "Pesticides and War," 107-108.

chemical stocks, Hartnick used Zyklon B in his operations in the United States. Not everyone was thrilled with the idea of using this new, but by reputation especially dangerous, poison. Hartnick received a letter dated 28 July 1928 from the outside company that stored his Zyklon B supply that they “do not approve our storing this ZYKLON ‘B’ in our Chicago warehouse, particularly for the summer months. This is due to the fact, as you know, that the gas, if liberated, is deadly poisonous and leaky cans, while not expected, may nevertheless develop. . . as heat develops considerable pressure within the cans.”¹⁵⁰ The fears surrounding the chemical were well-founded; in Germany people had already been poisoned from Zyklon B after room fumigations. In 1924, two people in Wiesbaden were severely gassed simply because a maid had opened a door to a room too soon after it had been fumigated. One of the victims eventually died from the gas. Later, across the border in Prague, Czechoslovakia, a police officer died when he entered an area cleared with Zyklon B that had not been properly ventilated.¹⁵¹ Neither Haber, Hartnick, nor anyone else for that matter knew, however, that Zyklon B would become perhaps the most infamous chemical in history, as it was to be the primary chemical agent used by the Nazis in the extermination camps at Auschwitz, among others.

By 1927, with the help of Haber and substantial secret funding from the Reichswehr, an animal breeding farm and a brand new lab facility at the Reichsanstalt was completed for the purpose of poison gas and pesticide research. In addition,

¹⁵⁰ See letter from W.C. Nissen to Hartnack Exterminating Service, 28 July 1928, BArch R 3602/2266, Das Bundesarchiv-Lichterfelde, Berlin Lichterfelde, Germany.

¹⁵¹ “Abschrift, ‘Desinfektion’,” May 1924, BArch R 3602/2262, Das Bundesarchiv-Lichterfelde, Berlin Lichterfelde, Germany; Memo from Degesch to the Minister of People’s Welfare (*Volkswohlfahrt*), 12 August 1927, BArch R 86/2852, Das Bundesarchiv-Lichterfelde, Berlin Lichterfelde, Germany.

Germany also constructed secret chemical facilities in Russia, and would expand its chemical warfare program after the Nazi seizure of power in 1933. Because he was Jewish, Haber emigrated and ultimately died the next year on January 29 in Basel, Switzerland.

Yet during the 1920s and 1930s, what remained in the minds of many civilians were not the political ramifications of chemical warfare, but the psychological and environmental effects. In Germany, the men returning from the front brought home experiences of desolation and visions of lifeless landscape. Accidents and disasters like the “Stoltzenberg-Skandal” refreshed their minds, and illuminated those of civilians, to the ecological consequences regarding chemical weapons. Just as we saw during the war, military and political aims overrode any environmental legislative push by the public. How these perceptions of war and the environment manifested within environmental thinking will be seen in the next chapter.

CHAPTER 5

WAR, ENVIRONMENT, AND THE CULTURAL RESPONSE

“The road and surrounding fields were one mass of earth and bore the horrors of secret and silent suffering.”

- Gustav Ebelshauser, 17th Bavarian Infantry Regiment¹

The Great War, including the chemical warfare experience, fundamentally shifted European’s cultural perceptions about war and the environment. The environmental devastation levied by gas and other weapons was unlike anything seen in prior conflicts. Trenches, mud, barbed wire, corpses, rats, and lifeless landscape became the public’s image of the Great War, constructed through a variety of literature and visual media. How this collective image was fashioned, and how Germans perceived and imbibed these changes in the land, is the subject of this chapter.

The fears of environmental destruction, as well as the recognition of World War I’s devastating effect on the landscapes of Europe, were manifested in German culture during and after the war. Historian George Mosse highlighted the fact that “the war was accompanied by a heightened awareness of nature. . .” Although Mosse used this fact to describe the construction of myths surrounding the war experience and nature, I argue the heightened awareness of nature also cultivated a new sense of reality towards war,

¹ Gustav Ebelshauser, *The Passage: A Tragedy of the First World War* (Huntington: Griffin Books, 1984), 57.

specifically the cultivation of perceptions relating to poison gas at the front.² Public awareness and attitudes towards war and the environment extended well beyond the war years, as German artists, writers, and poets described and depicted their impressions. This escalation of awareness is especially acute at the end of the 1920s, when visual images of the war's effects in poetry and paintings reached the broad audiences of Germany, as well as the publication of the war's most famous literature, notably Erich Remarque's *Im Westen nichts Neues* (All Quiet on the Western Front). By 1935, the vast majority of Germans knew very well, at least aesthetically, the impact chemical and industrial warfare had on the landscape.

During the war and the immediate post-war decade, German writers unintentionally fashioned a universal experience of the trench war among the general public. German soldiers wrote countless letters home, kept diaries, and penned post-war memoirs. Within the pages of their writings, the men often commented on the natural devastation they witnessed. "The land about us has become desert," one soldier recalled. "No tree, no bush, no steeple, no house. A chaos of rumpled earth, over which ran the front, under which lay buried every life."³ William Hermanns recalled in the summer of 1915 that upon his arrival near the village of Apremont, he was shaken by the environmental devastation:

The Argonne Forest lay before us, but we saw none of the saturated verdure of the lush summer. We heard no woodpeckers, nor did we see wild pigs or deer running through thickets. We saw none of the animals

² George L. Mosse, "War and the Appropriation of Nature," in Volker R. Berghahn and Martin Kitchen, eds. *Germany in the Age of Total War* (London: Croom Helm Ltd, 1981), 102-122.

³ Helmut Stellrecht, *Trotz Allem! Ein Buch der Front* (Munich: J.F. Lehmanns Verlag, 1931), 179.

that had made the forest famous as a royal hunting ground. The mighty trees, centuries old, stood beheaded.⁴

Later, Hermann linked his psychological trauma to the environment in a letter to his sister Greta. He wrote, “I have come here loyal to the Kaiser and Reich, but something happened to me that makes me feel that I have been spiritually mutilated, like the miserable, broken, bare trees here in the forest.”⁵ Infantryman Friedrich Lehmann wrote after surveying the field before him that “not a puff of life remains; the tree stumps are dead, the grassy surface of the land is burned, the ground is churned up to four meters deep, plowed, slashed (*zerschunden*), martyred, grey and dead; exactly like the many friend and foe that still lay unburied.”⁶

More significant, however, is the fact that the men also pointed out the bizarre juxtaposition or conflict between a beautiful natural landscape and the hellish nightmare witnessed so often in the trenches. Recalling a night he was assigned to a watch patrol, Helmut Stellrecht recalled in his memoirs one particular evening at the front. “The quiet of the falling night leaves me looking amazed (*erstaunt*) on watch,” Stellrecht poetically wrote. Only the sounds of long range ordnance could be heard, but when the firing stopped silence resumed. With the sounds of war gone, Stellrecht took his thoughts to the landscape for peace, longing for a break from the fighting. The silence of the guns and the cover of fog hid the trauma inflicted on his surroundings. “The mountains change

⁴ William Hermanns, *The Holocaust: From a Survivor of Verdun* (New York: Harper & Row, 1972), 31.

⁵ *Ibid*, 35-36.

⁶ Friedrich Lehmann, *Wir von der Infanterie: Tagebuchblätter eines bayerischen Infanteristen aus fünfjähriger Front- und Lazarettzeit* (Munich: J.F. Lehmanns Verlag, 1929), 104.

with caps of fog, as if they want to sleep. Curtains of clouds settle in that cover the tired world. . .The world returned back to itself.”⁷

Gustav Ebelshauser, who likened the battles soldiers and rats waged in the trenches with one another, recalled one morning where nature seemed to continue to rebel against man’s devastating influence. “Soon a broad glimmer of pink-yellow color brightened the sky, bathing the eastern horizon in a magnificent iridescence of light. Nature was awakening,” Ebelshauser wrote, “. . .In spite of the picture of desolation that struck the eyes, one could hear the twittering and chirping of birds. As the sun rose they went on with their singing and morning greetings in defiance of the flying bullets.”⁸ Like Stellrecht and others, nature struggled and rebelled against the devastation of war.

Other soldiers wrote their thoughts in relating to nature and war more explicitly, directly comparing their experiences to nature. Some saw the natural destruction akin to the massive slaughter of their comrades. Ernst Toller, a Jewish volunteer who later went on to become one of Germany’s most well known dramatists, saw the destruction of the woods in front of his trench like that of his comrades. “A forest is like a people,” Toller observed, “A devastated forest is like a massacred people. The limbless trunks stare blackly at the day. . .”⁹ Others felt the same way. In a letter dated May 16, 1915, Georg Stiller wrote:

It is Sunday; elsewhere there is rest and peace; here the murdering goes on- everlasting shells, shrapnel and rifle fire. Nature wears its most beautiful spring dress, the sun laughs from the blue tent of heaven, but through blossoming green-growing Nature fly the shells, destroying the

⁷ Helmut Stellrecht, *Trotz Allem! Ein Buch der Front* (Munich: J.F. Lehmanns Verlag, 1931), 70.

⁸ Gustav Ebelshauser, *The Passage*, 88.

⁹ Toller later fled Germany with the rise of the Nazis, who burned his works. Ernst Toller, *I was a German: the Autobiography of a Revolutionary* (New York: Paragon House, 1991), 80.

trees and fresh bushes, tearing deep holes in the earth, and annihilating young, blossoming human lives.¹⁰

Relaxing with a bottle of wine and admiring the moonlight, another German soldier stationed just north of Verdun, Herbert Jahn, wrote:

Yesterday evening I was sitting in the ivy-arbor outside our dugout. . . It was the first time that I noticed that there could be some beauty in war. . . Since then I have felt happy; I have realized that the world is just as beautiful as ever; that not even this war can rob us of Nature, and as long as I still have that I cannot be altogether unhappy!¹¹

Three days later, Jahn again noted the comparison between Nature and war when he stated:

I had at last a beautiful view back over the valley, across the river to the heights on the farther bank where our and the French trenches are. If from that direction one had not now and then heard the thunder of guns or the sound of rifle fire, one could have forgotten all about the war, the landscape looked so peaceful.¹²

Some soldiers tried to improve their immediate environmental surroundings to brighten their moods. “Would you be some kind as to send me some flower seeds?” one soldier wrote in 1916, “There is nothing very nice to look at around my billet. . . I want to grow some flowers.” The soldier went on to request sunflowers, flax, mignonette, sweet-peas, convolvulus. He finished his letter stating his primary objective: “I want to cover the unsightly earth with verdure.”¹³

¹⁰ Stiller was killed in action less than two weeks later on May 29. Georg Stiller, letter, 16 May 1915. Reproduced in A.F Wedd, ed. *German Students' War Letters* (Philadelphia: Pine Street Books, 2002), 126.

¹¹ Ibid, 176.

¹² Ibid, 176-177.

¹³ Ibid, 301.

German soldiers' letters and diaries also frequently described a longing to see their homeland again or the joys of seeing German landscapes on their way to the front or coming home on leave. The Rhine was often mentioned in this context. On his way to the front in 1914, Ernst Toller recalled the exact moment his train crossed the Rhine. An officer in the train called the men to attention as they slept. "Achtung!" was screamed, as the windows were opened and the men rushed to the side of the train. The officers flourished their swords towards the river, and the saluting men began singing *Die Wacht am Rhein* as they crossed over in the dead of night, beating the butts of their rifles to keep the beat.¹⁴

Despite its polluted waters, the appearance of the sacred waterway sharply contrasted to the lifeless No Man's Land, and the men on leave or those sent home wounded from the front were often deeply moved. Letters and diaries contain a sort of environmental nostalgia for Germans, where soldiers longed to return to their native landscapes. Subsequently, during the war a new appreciation of nature and its beauty can be seen within German soldiers' wartime writings.

Soldiers articulated these feelings in a number of different ways. For example, Herbert Sulzbach wrote of his elation at seeing the Rhine while on leave. He wrote, "How splendid, a thousand times splendid, it is to travel along the Rhine! . . . How heavenly my well-beloved Germany looked: the Rhine is Germany for me."¹⁵ On his way back to the Somme, Sergeant Paul Hub in a letter to his parents wrote that he "took the

¹⁴ Toller, *I was a German*, 65.

¹⁵ Herbert Sulzbach, *With the German Guns: Four Years on the Western Front, 1914-1918* (London: Leo Cooper Ltd., 1973), 228.

most beautiful images of our homeland with me. Our countryside is so lovely. We crossed the Rhine at Mainz. . . God the Rhine looked beautiful.”¹⁶

Still, even at the Rhine, some soldiers could not escape thinking about the front. While passing through Koblenz on his way to the front with the 17th Bavarian Infantry Regiment, Gustav Ebelshauser took strolls along the beloved waterway to pass the time. He “strolled for hours along the Rhine” and he “felt safe.” However, Ebelshauser remarked in melancholy that “Just as picturesque and inspiring was the savage beauty of the river from the German shore, except for the presence of so many uniforms.”¹⁷ For many men destined for the front, the Rhine was a symbol of the German landscape and national strength.

Soldiers also discovered and declared a newfound love of nature. Helmut Zchuppe, who before the war was a philosophy student, soon found himself lying in a hospital bed recovering from a critical wound. After staring out his window, he wrote about his epiphany:

I rejoice in the beauties of Nature; in the summer-like Renoir autumn of the canal and the Aisne; in the ever-shimmering, ever-rustling avenue of elms. The hedge-bordered meadows take on a bluish tinge from the rising mist on the brink of the water. . . sometimes one sees here the ‘classic’ landscape of Poussin or Böcklin. I realize how art is determined by landscape.¹⁸

German poets also described the war’s effect on landscape. One common motif among German authors was that of the apocalypse; the use of fear and terrifying language

¹⁶ Eventually promoted to *Leutnant*, Hub was killed by shrapnel at the Somme in 1918. He left behind his wife of just two months, and his parents had now lost the third of four sons to the war. Paul Hub, letter, 2 June 1916. Reprinted in Svetlana Palmer and Sarah Wallis, eds. *Intimate Voices from the First World War* (New York: William Morrow, 2004), 192.

¹⁷ Gustav Ebelshauser, *The Passage*, 25.

¹⁸ A.F. Wedd, ed. *German Students’ War Letters* (Philadelphia: Pine Street Books, 2002), 367.

to convey a world transformed through industrial war. Even before the war, the German poet Georg Heym seemed prophetic when he compared the start of a future war to that of a demon rising out of the earth to destroy everything, including the moon. Heym wrote in 1912:

*Aufgestanden ist er, welcher lange schlief,
Aufgestanden unten aus Gewölben tief.
In der Dämmerung steht er, groß und unbekannt,
Und den Mond zerdrückt er in der schwarzen Hand.*

He is arising, who is long asleep,
Arising from vaults deep down below
He stands in the dusk, immense and unknown,
And the moon he crushes in his black hand.¹⁹

During the war, other poets held similar sentiments: that war was a terrifying force, creating an environment of hostility and lifelessness. August Stamm, who served as a Captain in the German army on the Eastern Front, described his fear of the landscape in *Patrouille*:

*Die Steine feinden
Fenster grinst Verrat
Äste würgen
Berge Sträucher blättern raschlig
Gellen
Tod.*

The stones hostility
Window grins treachery
Branches strangle
Mountain bushes whispering
Screaming
Death.

The poem works on a number of levels. Its simplicity sends a clearer message.

The word play in the first line, referring to the stones' "hostility" implies even the ground

¹⁹ Georg Heym, "Der Krieg," in Patrick Bridgwater, ed. *Twentieth Century German Verse* (Mitcham: Penguin, 1963), 106.

he walks upon is malicious. The “branches strangle” and the “bushes whispering” implies the ominous nature of the landscape, and the abruptness at the end of the poem is that of a soldier’s instant death at the front. Stamm himself was killed September 1, 1915.²⁰

While stationed in France, Rudolf Binding also kept a diary and wrote poetry based on his time at the front. Like Stamm, he also compared nature’s aesthetics and devastation to his own peril. In the first two stanzas of his poem *Erste Gräber* (First Trenches or First Graves) he described destroyed earth emerging like macabre flowers blooming:

*Zwischen Gras
schwarzes Blühn
lockerer Erde*

*wie ein Lenz
nie gesehen
in den Feldern*

Between grass
black blooms
of loose earth

Like a springtime
Never seen
in the Fields²¹

Germans also described poison gas’ effects on the landscape, keenly aware that the new weapon killed indiscriminately. In the fall of 1916, William Hermanns composed

²⁰ August Stamm, “Patrouille,” in *Ibid*, 25; Patrick Bridgwater, “German Poetry and the First World War,” *European Studies Review*, Vol. 1, No. 2, (April 1971): 172-173.

²¹ Rudolf G. Binding, *Dies war das Maß: Die gesammelten Kriegsdichtungen und Tagebücher* (Potsdam: Rütten & Loening Verlag, 1940), 17.

a poem for his sister on the back of a piece of birch bark. The second stanza of the poem explains the dead surroundings he encountered near Verdun:

*There is a guttural sound in the air:
You are not the tree and the tree is not you.
Bullets punched holes through the air
And the tree and I had no more air to breath.*

*The silver helmet of the moon was dyed black by poisoned winds,
The branches charred, each leaf shriveled
And hung on the limbs like spider webs.
My arms shrunk and hung at my sides like two signed stumps.²²*

Hermanns' choice of words, "the silver helmet of the moon was dyed black," is a curious one. A soldier's helmet corroded from gas would surely look like it had been dyed black. Clearly, Hermanns was disturbed by the loss of nature, and he stated in his memoirs that at that time, "the countryside we saw had not a stone, tree, or a single weed to remind us that once houses, meadows, and people had been there."²³

German poets also recognized the uncontrollable nature of gas as a weapon due to its reliance on environmental conditions. Arnold Ulitz, who served as an officer on the Eastern Front, described the role wind plays in a gas attack:

*Wir trafen einen Wind, der sich unserm Zorne verschwor,
Da entriegelten wir dem Gase das stählerne Tor.
Bleichsüchtig, grün, tierhaft, vampirhaft, mit Schneckenbauch,
Ausgehungert von finsterner Kerkerhaft,
Verdorrt und durstig nach lebendigem Saft,
Kriecht er hervor, molluskischer Leib aus Rauch.
Wind spornt die Bestie. Sie stinkt nach Chlor.*

*Das Gasraubtier kriecht
Feuchtfingrig tastend, auf weichen, leisen Pfoten.*

We met a wind, that plotted our wrath,

²² Hermanns, *The Holocaust*, 66.

²³ *Ibid*, 84.

There we released the steel door to gas.
Bleached, green, animalistic, vampiric, with a snail's belly
Starved from grim incineration,
Withered and thirsty after living juice
He creeps forth, molluskish body from smoke.
Wind spurs the beast. It smells of chlorine.

This gas beast of prey creeps
Moist fingering groping, into soft, quiet paws.

As the literary scholar Martin Löschnigg pointed out, Ullitz felt that gas was a “beast, that, after man had opened the ‘cage door’ to it, an uncontrollable momentum developed.”²⁴ The poem uses metaphors from nature to convey the emotional terror gas instilled in the men, the fear they were being stalked by an insatiable creature.

Perhaps the best known German poet from the war is Anton Schnack, whose poem *Nächtliche Landschaft* (Nocturnal Landscape) is considered by some critics to be “perhaps the most impressive single poem produced by a front-line poet in German.”²⁵ Schnack, who served on the Western Front, used the themes of the apocalypse, death, nature, and the darkness of night to convey his attitude towards the war. In stanza eleven of *Nächtliche Landschaft*, Schnack wrote:

*Schlachtet sie Tod, um unter Kräutern zu liegen, gewichtig,
Versteint, Hände voll Spinnen, Mund rot von Schorf,
Augen voll urtiefem Schlaf, um die Stirne den Reif der Verdunk-
lung, blau, wächsern, faul werdend im Rauche der Nacht*

*Death slaughters them, leaving them lying among weeds, weighty, fossilized
Hands full of spiders, mouths crusted brown,
Eyes full of bottomless sleep, on their brows the bloom of obfuscation, blue
Waxen, decaying in the smoke of night.*²⁶

²⁴ Martin Löschnigg, *Der Erste Weltkrieg in deutscher und englischer Dichtung* (Heidelberg: Universitätsverlag C. Winter, 1994), 160-161.

²⁵ Bridgwater, “German Poetry,” 166.

²⁶ Ibid, 167; Anton Schnack, “Nächtliche Landschaft,” in Patrick Bridgwater, ed. *Twentieth Century German Verse* (Mitcham: Penguin, 1963), 168-169.

Schnack also described gas and its effects in multiple war poems. After witnessing firsthand the carnage at Verdun, Schnack wrote his interpretation with his poem “Verdun”:

*Sein Name: Schmerz, Verblutung, tausendfacher Tod,
Geschwür, Mordstätte, Grab, Gemetzel, böses Labyrinth;
...
Und ohne Mond, nur überfallen von den Leuchtern, die aus den Wäldern
stachen, groß, gemacht, gemein, Nur
überschwollen von Kanonen, alt, gewaltig, ewig; dick überschwelt von Bränden,
Schwefel, Gas und Chlor²⁷*

His name: pain, draining of blood, thousand fold death,
Ulcer, murder sites, trench [or ‘grave’], butchery, evil Labyrinth;
...
And without Moon, only attacks from the candlesticks, that pierce from the
woods, large, slow, mean, only
drowned out by cannons, old, massive, eternal; thick smoldering from fires,
sulfur, gas and chlorine.

Notice Schnack uses chlorine to both describe the events and perpetuate the rhyme and measure of the poem. He also accurately described the overwhelming nature of artillery and gas at night, smothering out light and perpetuating the slaughter in the “evil labyrinth” of Verdun. In yet another poem, a piece entitled “Im Graben,” Schnack describes the contrast between the peaceful sky and the desolate land He also depicts mustard gas and the environmental shift when it contaminates the area:

*Alles verweht; nur Tod bleibt übrig, Lauern. Alles ging zur Vergessenheit:
Heimat, gelbe Mondnacht, Kirmestanz, Alles entschwand. Wir sind Verlorene, wir
sind Gezeichnete vom roten Todmund, wir sind so dunkel und alt,
Klein wie Zwerge. Wir staunen, dass manchmal noch Sterne gehen über den Plan
der Nacht hinunter unter den Wald, Blau und verwachsen, dass noch eine Blume blüht,
keusch, unter den leuchtenden Knochen am Drahtverhau.*

²⁷ Anton Schnack, *Tier rang gewaltig mit Tier* (Berlin: Im Ernst Rowohlt Verlag, 1920), 30.

...
*Wenn die Not zu gross ward, wenn sich alles häufte: Heimweh und die
 Beschiessung, wenn Gas heraufwuchs Würgend, mit gelbem Gift, wann einer zu Grunde
 ging plötzlich*
unter geheimnisvoller Stille, leise, lautlos, ermattet
. . .Aber wenn eine Rakete ins Nächtliche blühte, Grün, schön und schwebend,
dachte (wer?) ich: an seltsame Brunnen, rotmarmorn in Lattich und Buchs, In fernen
Schlössern, südlich; bis unter Flammenschein, hellweissen, ich in den Schlaf, ins Stroh
hinfiel von Traurigkeit und Schwermut Schwarz beschattet.²⁸

Everything scattered; only death remains, lying in wait. Everything went to oblivion:

Homeland, yellow moonlight, Kermis dance, all vanished. We are lost, we are marked from the red mouth of death, we are so dark and old, small like dwarves.

We are astonished, that sometimes stars still go down over the night's plan under the forest, blue and crooked, that still blow a flower, virginal, under the luminous bones on barbed wire.

...
 When the distress became too great, when everything heaps up: Homesickness and the bombardment, when gas forms up caps, with yellow poison, when one collapsed suddenly under mystic still, quiet, silent, worn down

. . .but when a rocket blows into the night, green, beautiful and floating, I (who?) thought about odd fountains, red marble in lettuce and beech trees, in palaces, south; until under the glow of flames, white light, I rock to sleep, fallen over into straw from sadness and melancholy
 black unshaded.

The shift is both aesthetic and psychological. He sees the gas (yellow poison) consume the area and people, and as such he longs for home, thinking of happier places, sickened by what he has seen. He also sees nature trying to fight back against the war, with a flower still poking through bones and barbed wire in silent protest.

Although these poets received widespread acclaim and readership, the memoirs and literature of former soldiers at the front contributed more to the public's image of a World War I landscape. Oddly, much of the material which heavily influenced

²⁸ It is unknown what specific year "Im Graben" was composed. However, according to the literary scholars Raymond Furness and Malcolm Humble, Schnack began publishing poetry in 1915, but his first war poem was his 1917 piece, "Schwester Maria." "Im Graben" was first published in 1920. Anton Schnack, *Tier rang gewaltig mit Tier* (Berlin: Im Ernst Rowohlt Verlag, 1920), 39; Raymond Furness and Malcolm Humble, *A Companion to Twentieth-Century German Literature* (London: Routledge, 1991), 250.

Europeans' ideas and perceptions of World War I appeared almost a decade after the conflict ended. This was, as the historian Modris Ecksteins argued, because authors and publishers believed the war would never sell, and that the general public wanted to simply forget what they had experienced during the Great War. However, during the second half of 1929 and in early 1930, war novels, plays, paintings, and films became the best selling forms of media in Europe.²⁹

German authors wrote extensively about trench life and their surroundings. Although similar to their British counterparts, the tone used by German authors is different than that of British writers. Unlike British authors, who tend to describe nature's destruction as a tragedy (Wilfred Owen or Siegfried Sassoon, for example), German post-war authors, like those who kept diaries at the front during the conflict, tended to paint the environmental destruction as terrifying or apocalyptic. Authors such as Felix Salten, Ernst Johannsen, Ernst Jünger and Erich Remarque tend to use horrifying imagery to depict their surroundings, rather than reflect upon its loss. Lingering fear and immediate moments of terror are also common in German writings.

An excellent example of such a work is that of Ernst Johannsen. Johannsen's novel, *Vier von der Infanterie* (Four Infantrymen), follows the lives of four infantrymen from different backgrounds, among them a married, cynical veteran whose marriage is falling apart and the experienced yet jolly sergeant. Most interesting among the characters, however, is the young college student. The novel depicts him as a lover of poetry, advocate against the death penalty, and on more than one occasion, a "man who

²⁹ Modris Eksteins, "All Quiet on the Western Front and the Fate of a War," *Journal of Contemporary History*, Vol. 15, (1980): 345-346.

founded societies for the prevention of cruelty to animals.”³⁰ The juxtaposition of the student and the war is a recurring theme; the idealistic, young, well educated superimposed against the pessimistic, aging, barbaric war.

The novel is filled with gas attacks and descriptions of their effects on humans and the environment. Chemical weapons and equipment appear on no fewer than nine separate occasions in the text.³¹ Like his contrasting of youth and destruction of people in the novel, Johannsen’s depictions of gas are often tied to graphic descriptions of war to nature’s suffering or overcoming the war’s devastation. In one scene, the men encounter the bodies of four Frenchmen, presumably after an attack. One of the men, still with his gas mask on, provided a disturbing picture of death:

The fourth died in his gas mask. Like some fantastic creature he lies there on one side and seems as though he were gazing through the goggles of his mask at his neighbor, whose eyes have been shot away. The stench in the immediate neighborhood is appalling. One whiff, and all the nerves bristle. . . Great black beetles crawl upon the bodies. Besides the last one in the row lie a couple of dead rats. But it is best not to look at him.³²

Later, Johannsen described a couple of soldiers who have brought a cat to live with them in the trench on several occasions. “They pet it and look after it most astudiously,” Johannsen explained. He then described the student’s impression of the war and the reason the cat is there, revealing how he views the war as a revelation to an appreciation of nature:

“It looks to me as though it is really their own life that they fondle and cherish, by proxy, in the cat. They hope to be sheltered, and cared for in

³⁰ Ernst Johannsen, *Four Infantrymen*, trans. by A.H. Wheen (New York: Alfred H. King, 1930), 67.

³¹ Johannsen, *Four Infantrymen*, 126, 164-165, 179, 189, 192, 195-196, 207, 210, 214.

³² *Ibid*, 126.

the same way that they have cared for their mascot”. . . he falls into profound meditation. At length he gives it as his considered opinion that it may very well be so; but that strictly one should first ask whether the two had any interest in animals before they came to the front.³³

In a greater sense, Johannsen’s student sees the perpetuation and survival of nature as that of humanity. The student also wonders if this connection was recognized by the men before the war, or if the event was a revelation to attitudes about animals never before felt or expressed.

The book’s climax involves a massive French attack on the German trenches. During the assault, a French shell hits a German chemical shell ammunition dump, detonating all types of chemical shells. The author even referred to the shells by their specific color types, which demonstrates extensive knowledge of German gas warfare. The men then unsuccessfully scramble to adapt to the contaminated environment:

Then a French shot lands right on the dump of gas shells. The gun crews are panic-stricken; all who can leave everything where it stands, and bolt for it.

“Stretcher-bearers! Stretcher-bearers! Lime! Chloride of lime! Where the hell is the lime!”

“There you are. Pitch it on. Lime here! Tread it in. Throw lime into the shell- holes.”

“Are they dead already, sergeant?”

“Yes, lad.”

Their own blue-cross, green-cross, yellow cross, strange instantaneous shells among them, high velocity: Hell is complete.³⁴

Later, a massive gas and explosive shell barrage provides the most poignant passage of the book regarding the environmental price of war and gas. Johannsen wrote:

The ground quakes. Thousands upon thousands of splinters plow the air and the earth. The last remnants of woods vanish. . .The whole landscape changes; hills are carried away; streams alter their courses; even the

³³ Ibid, 148-149.

³⁴ Ibid, 179.

chemical composition of the soil has been changed – it is richer in iron. .
.Heavy torpedoes have demolished the barbed wire. Gas has poisoned
thousands of rats. And when the day dawns almost all life is
extinguished.³⁵

Tens of thousands of Germans read Johannsen’s work. The book was quite successful commercially; within two weeks of its publication, the book had already sold six to ten thousand copies, with no fewer than thirty-two different newspapers securing advanced publications.³⁶

The most widely read German work to emerge from the war is surely Erich Remarque’s *Im Westen nichts Neues*, a book largely responsible for the spark that ignited an explosion of World War I literature at the end of the 1920s and early 1930s.³⁷ Born in 1898 in Osnabrück, Remarque was drafted in November 1916 and saw his first action in June 1917 in Flanders. After the war, he became a free-lance journalist and writer.³⁸ In 1928, the Berlin based, liberal-leaning newspaper *Vossische Zeitung* published the work originally in serialized form. The book was first published in book format the following year.

Remarque tells the story of the young German infantryman Paul Bäumer and his experiences at the front. As time goes by, his friends are killed off, both physically and mentally, until a sense of inevitable death takes hold of Paul. As the historian Modris

³⁵ Ibid, 192.

³⁶ These statistics are printed in an advertisement for *Vier von der Infanterie* in another Ernst Johannsen novel, *Fronterinnerungen eines Pferdes*. Both books were printed by the same publisher, Fackelreiter-Verlag, located in Hamburg-Bergedorf. Ernst Johannsen, *Fronterinnerungen eines Pferdes* (Hamburg-Bergedorf: Fackelreiter-Verlag, 1929), 55.

³⁷ The historian Modris Eksteins stated that *All Quiet* was “a novel which stood at the centre of the war boom, in popularity, in spirit, and as a source of controversy. . . *All Quiet* clearly triggered the explosion of war material in 1929. . .” Eksteins, “All Quiet,” 346.

³⁸ Ibid, 347-348.

Eksteins noted, “The simplicity and power of the theme – war as a demeaning and wholly destructive force – are reinforced by a style which is basic and even brutal.”³⁹ Although Eksteins focuses his critique on the effects the war had on humans, the same is true about European landscapes. The war was indeed a wholly destructive force, and Remarque’s descriptions of the trench environment formed indelible images in the readers mind.

Remarque is quick to use nature and space as a means to propel the story. When describing Paul’s instincts for survival, the author chooses the environment as his main character’s most beloved friend, with which he trusts his life. Remarque wrote, “From the earth, from the air defensive strength (*Abwehrkräfte*) pours into us – mostly from the earth. For nobody does the earth mean so much as for a soldier. When he presses himself down upon her long, powerfully; when he buries his face and his limbs deep in her from the fear of death by fire, then she is his only friend, his brother, his mother; he moans his terror and his screams in her silence and security; she takes him and releases him for ten seconds to live and to run, seizes him again, and sometimes forever. Earth – Earth – Earth!”⁴⁰ Remarque draws attention to the suffering of non-human life. Upon hearing the cries of wounded horses, which Paul describes as “the misery of the world,” one of the Germans screams for the wounded animals to be shot, as to deliver them from their suffering. Other horses are already dead. Remarque’s tone is quite visceral, as he described one horse as having its belly ripped open and its intestines hanging out.⁴¹

³⁹ Ibid, 349.

⁴⁰ Erich Remarque, *Im Westen nichts Neues* (Frankfurt am Main: Ullstein GMBH, 1966), 44-45.

⁴¹ Ibid, 50.

There is perhaps no section of the text which does a better job of combining the elements of chemical warfare, environment, and war than the graveyard gas attack scene. As Paul's unit heads toward their trench, they come under a shell and gas attack. Remarque chooses the location of the attack by a forest and a graveyard "with black crosses." Forests have always been places of darkness and evil in German literature and folklore, used as the setting for everything from the brothers Grimm fairy-tales' witchcraft to the slaying of the mighty Siegfried in the medieval epic *Das Nibelungenslied*. Graveyards, of course, imply death and instill a sense of unease. As the gas moves in, the men are only able to find shelter by climbing inside exposed coffins.⁴² The use of environment to terrify the reader, both in its appearance and destruction, is a common fixture in the German war novel. As the scholar Ann Linder argued, ". . .the German landscapes of World War I characteristically are calculated to horrify the reader, not to evoke the sense of devastating loss and pity typical of the British landscapes."⁴³

In addition, some critics view the protagonist not as Paul, but instead the entire generation sent to the front. Literary critic Thomas F. Schneider pointed out that Remarque often uses the pronoun "we" rather than "I" when Paul is referring to his experiences. Therefore, the suffering experienced by Paul is not individual, but collective. "The protagonist of the book is not a single figure, but the group," Schneider wrote, referring to the generation destroyed by the war.⁴⁴ The same can be said about the

⁴² Ibid, 53-54.

⁴³ Ann P. Linder, "Landscape and Symbol in the British and German Literature of World War I," *Comparative Literature Studies*, Vol. 31, No. 4 (1994): 360.

⁴⁴ Thomas F. Schneider, "Das virtuelle Denkmal des unbekanntes Soldaten: Erich Maria Remarques *Im Westen nichts Neues* und die Popularisierung des Ersten Weltkriegs," in Barbara Korte, et al. *Der erste Weltkrieg in der populären Erinnerungskultur* (Essen: Kartext Verlag, 2008), 91.

landscape's destruction Remarque depicted. It is not an issue of the individual, but a collective problem.

Remarque's work became an instant bestseller in Germany when it first appeared in bookstores in January 1929. Within three months, the book had sold 640,000 copies and had already been translated and published in French and English. By April 1930, twenty separate editions had been published, with over 2.5 million copies in print.⁴⁵ By the summer of 2006, some twenty to forty million copies of the work had been published in at least fifty-four different languages. It is therefore not only an integral part of the Germans' memory of World War I, but of humanity's memory of the conflict.⁴⁶

Published in 1920, Ernst Jünger's *Im Stahlgewittern* (Storm of Steel) also became one of the most widely read accounts of the First World War. This was due in no small amount to his popularity among the National Socialists, who applauded Jünger's militaristic tone and tales of sacrifice on the battlefields. Similar to Remarque, Jünger depicted the trench environment with nightmarish imagery, complete with dead bodies and beasts which haunt the trenches' inhabitants. "Following a torrential downpour in the night, all the traverses came down and formed a grey sludgy porridge with the rain, turning the trench into a deep swamp," Jünger wrote. He continued, "The crumbled trench walls exposed a line of bodies left there from the previous autumn's fighting. . . Rats we go after with steel traps. Admittedly, the beasts are so strong that they try to take

⁴⁵ Eksteins, "All Quiet," 353.

⁴⁶ Schneider, "Das virtuelle Denkmal des unbekanntes Soldaten," 89.

the traps with them; their noisy efforts bring us charging out of our dugouts to finish them off with clubs.”⁴⁷

Jünger, who was poisoned on multiple occasions by chlorine and mustard gas, recalled how environmental changes entered his psyche. After a British chlorine attack at the Somme, Jünger recalled that “I looked at all the little animals lying in the pit of the trench, killed by chlorine, and thought, ‘The barrage is bound to start up again any moment, and if you continue taking your time, you’ll be caught in the open, like a mouse in a trap’.”⁴⁸

Later, Jünger described in great detail the effects of a chlorine attack near the village of Douchy. He wrote,

The next day we were able to marvel at the traces the gas had left. A large proportion of the plants had withered, snails and moles lay dead, and the horses that were stabled in Monchy for use by the messengers, had watering eyes and muzzles. The shells and ammunition splinters that lay all over the place had a fetching green patina.⁴⁹

Like Johannsen, Schnack, and other writers, we see again the juxtaposition between the beautiful aspects of nature and the war’s malicious influence. Jünger witnesses not only the death of numerous creatures and plants, but notices despite the visual imagery a pleasant smell of his surroundings.

Although Remarque and Jünger wrote extensively on the trench environment, one of the best examples literature as an indictment against war’s assault on the environment is Felix Salten’s 1923 book, *Bambi: Eine Lebensgeschichte aus dem Walde* (Bambi: A

⁴⁷ Ernst Jünger, *Storm of Steel*, trans. by Michael Hofmann (New York: Penguin, 2004), 53-54.

⁴⁸ *Ibid*, 79-80.

⁴⁹ *Ibid*, 82.

Life in the Woods). Born to a Jewish family in Budapest in 1869, Salten moved to Vienna to become a writer in the mid-1880s. After the defeat of Austria-Hungary in the war and the subsequent dismemberment of the Habsburg Empire, Salten used *Bambi* to critique humanity and war via a metaphor of life in the forest, where creatures live in constant fear of death of mankind's destructive power.⁵⁰

The book is filled with images of death to the natural world by the actions of man, an idea only reinforced by the war and its associated cultural impact. As the scholar Matt Cartmill argued, “. . .what gives Salten's *Bambi* its particular misanthropic force is that it depicts the human presence as not only dangerous but corrupting.”⁵¹ Through much of the book, Salten describes humanity, who Salten labeled as “Him” in the book, as a relentless hunter of nature – the ultimate villain who is feared by all in the hollow. For example, in one scene, Bambi is warned by Friend Hare of the terrifying nature of man.

Friend Hare gasped for breath. “We are surrounded,” he said in a lifeless voice. “We can't escape on any side. He is everywhere.”

At the same instant they heard His voice. . .It was wracking and terrifying. A distant twisting and rending of parted bushes rang out. There was snapping and cracking of broken boughs.

He was coming.

He was coming into the heart of the thicket. . . A pheasant rose from under His very feet. . . there was a loud crash like thunder. Then silence. Then a dull thud on the ground.

“He is dead,” said Bambi's mother, trembling. . .the young doe, Marena, said, “In this very hour, many of us are going to die. Perhaps I shall be one of them.” No one listened to her, for a mad terror had seized them all.⁵²

⁵⁰ Matt Cartmill, “The Bambi Syndrome,” in *A View to a Death in the Morning: Hunting and Nature through History* (Cambridge: Harvard University Press, 1993), 162-163.

⁵¹ *Ibid*, 164.

⁵² Felix Salten, *Bambi: A Life in the Woods* (New York: Simon & Schuster, 1928), 135-136.

Salten's prose is both poetic and disturbing. The metaphor of the inevitable death by man's hand facing the animals in the forest was for many no different than the emotions felt by the troops at the front.

After Bambi's mother is killed by "Him," the deer is taken in by his father, dubbed the "old stag," who, like a sergeant at the front taking in a new recruit, teaches Bambi the ways of the forest and "His" deceptive tactics. In one scene, Bambi believes he has heard Faline, his love interest, call to him. The old stag, however, stops Bambi before he charges ahead. Reluctantly, the old stag agrees to take Bambi to the call, as to prove to him that it is not really Faline calling him, but something else. Bambi is amazed at how silently and adept the stag crept toward the sound. Like a combat veteran, the old stag turns to Bambi as they approach the call and says, "Watch everything I do and act just as I do, cautiously. And don't lose your head."⁵³ Once the deer reach close enough to see Him, they creep away and survive. The lesson is learned by Bambi.

It is not just the individual characters which suffer or are killed. The forest itself becomes a victim. For example, the chopping down of a sacred oak tree is viewed by the creatures as if part of their souls were killed off as well. After Bambi is wounded by a hunter, he flees the forest and leaves everyone behind. Ultimately, though, he returns to the hollow to find it very different. Storms and the winter had torn "the last leaves from the branches. Then the trees stood stripped."⁵⁴ A sacred old oak tree, which housed many of the creatures and Bambi had known his whole life had been chopped down. The

⁵³ Ibid, 186-191.

⁵⁴ Ibid, 263.

squirrels cried in agony, and Bambi's "very soul" had felt sorry for the loss of a tree he had known his whole life.⁵⁵

At the end of the novel, Bambi encounters with the old stag a dead poacher in the woods. The old stag tells Bambi that:

" . . .Do you see how He's lying there dead, like one of us? Listen, Bambi. He isn't all-powerful as they say. Everything that lives and grows does not come from Him. He isn't above us. He's just the same as we are. He has the same fears, the same needs, and suffers in the same way."⁵⁶

Despite the book's international popularity, most people by the end of the 1940s thought of the 1942 Disney animated picture when the name Bambi was mentioned, rather than the book. Nevertheless, the film arguably sends an even stronger message of humanity's devastating power. The only antagonist, the only source of any death in the film is by man. In fact, the film's story editor ordered that the only predator in the film be human because, as he saw it, "there's nobody swooping down and eating someone else and their one common enemy is man. That's the conflict there – and keep it simple."⁵⁷ Also, the writers at Disney added for the climax a massive forest fire sequence not in the original text. The fire only seems to exacerbate the message of human's destructive capability.

Indeed, the message was quite clear and understood by the viewing public. The National Audubon Society in the United States issued a statement after the film's release declaring "the message of Bambi is sweeping the country. . . To a child, in his simplicity, the life of an innocent, harmless, and beautiful animal is just as precious as that of a

⁵⁵ Ibid, 263-264.

⁵⁶ Ibid, 286.

⁵⁷ Cartmill, "Bambi Syndrome," 171.

human being, so many of whom do not appear altogether innocent and harmless and beautiful.”⁵⁸

The powerful metaphor of man’s malicious influence on nature is perhaps best seen in another book by Ernst Johannsen, his 1929 novel *Fronterinnerungen eines Pferdes* (Front Recollections of a Horse). As we have seen, Johannsen used images of nature and the battlefield to show the gruesomeness of war in his 1928 book, *Vier von der Infanterie*. However, *Fronterinnerung* takes this approach to a different level, as the novel is not from the perspective of a person, but of a horse. Johannsen literally wrote a memoir of the war for nature, and the work enabled him to express his pacifism and repugnance towards environmental loss. This message comes across before the story even begins; the dedication page reads, “To the memory of the 9,586,000 horses that fell prey to the World War.”⁵⁹

The main character of the story, Liese (Lisa), begins the book as a supply horse. Liese cannot speak to the humans, but she can talk to other horses and can hear what the humans are saying to her. This makes her character an observer to the human world, often commentating to other horses or herself about the war’s destructive impact on all parties involved. In one early scene, her column is strafed by a fighter plane. Liese survives the attack, but witnesses the deaths of her “comrades.” Johannsen’s graphic descriptions are on par with those in *Vier von der Infanterie*, except this time they come from the mind of a horse, a mind from the natural world.

⁵⁸ Ibid, 180.

⁵⁹ Although there is no citation for this figure in the book, such an exact figure leads one to believe the author conducted research on animals and the war prior to the project. Ernst Johannsen, *Fronterinnerungen eines Pferdes*, dedication page.

The horse experiences the war as a person would, both physically and emotionally. She sees combat, assists with logistics, and endlessly marches, all-the-while coping with fear and becoming disillusioned with the war. Although gas is only mentioned a few times, the author does allude to the fear and total devastation the weapon can bear. In preparation for the spring offensive, Liese hears a man ominously warn, “they have not yet experienced something like this. . . the gas will kill them all.”⁶⁰ The author is also keen to the uniquely cruel experiences of a horse with sincere emotional impact. This is perhaps best seen when Liese sees a suffering horse be put down.

And in the beam of the flashlights I saw a pistol propped up on the head of my comrade. I closed my eyes. It makes a loud bang, but I am not shocked, given that I knew what would come. The gelding still lived, though he didn't scream any more. The head heaving, he said to me with a sad look, 'Liese, good bye, great wide pastures. Keep me in mind. Powerful is God. . .but more powerful is man.'⁶¹

The passage is not only powerful in an emotional sense; the characters could have been swapped for human actors and the scene would still bring tears to reader's eyes. Yet the author is also commenting on the war's ability to show off man's seemingly omnipotent power over nature, the ultimate determinant in life and death within the natural world.

Near the end of the book, the author comments on the public's lack of understanding regarding the true horror of war. After participating in the German spring offensive of 1918, Lisa is given a new “stall-mate,” a young horse just purchased at an auction eager to do his part. “I do not know why you speak so poorly about man and his

⁶⁰ “. . .das Gas macht sie alle kaputt.” Ibid, 50.

⁶¹ A “gelding” (*Wallach* in German) is a castrated horse or donkey used for labor. The animal is castrated to make the animal more docile and to facilitate obedience. Ibid, 14-15.

war. I became fat, it was beautiful. . . Now possibly I can once again pull the plow. No, my dear, long live the war.”⁶² We see the argument that the war is not the glorified act those away from the front believe it to be.

We never learn Liese’s fate. The book concluded with her reciting to the reader a prayer that she often spoke at the front. Like Salten’s *Bambi*, here again we see a truly misanthropic vision of the war, a clear indictment of humanity’s relationship to nature:

Great Stallion and God Hi-hi-hu, who you are on the transcendent meadow, hear the cry of a mare, liberate the earth from her sickness, from humanity. . . Great Stallion and God Hi-hi-hu, hear the cry of a mare, liberate the creatures from the God, Satan, and fool of this earth. Destroy humanity! Destroy humanity! . . . Deliver us! Deliver us! Give us again the freedom of wide pastures, your distress, your danger, and your happiness. Almighty Stallion, deliver us.⁶³

In addition of the graphic depictions of landscape and death on the page, artists provided numerous visual depictions of war’s effect on the environment. Painting is often especially effective at provoking thought because it can leave more to the imagination than a photograph. A depiction of no man’s land on film has a different effect on the psyche when compared to an expressionist painting. In terms of German artists, perhaps the three most visible were George Grosz, Max Beckmann, and Otto Dix. Of the three, Dix was, and remains, the most prominent painter of the period.

Yet can art accurately and adequately depict the landscapes of World War I? The historian Jay Winter, who has written extensively on memory and the Great War, believes it is impossible. “No one could capture directly what the war was really like,”

⁶² Ibid, 53.

⁶³ Ibid, 54.

declared Winter, “those who tried usually trivialized the subject.”⁶⁴ Indeed, photographs of no man’s land are common and numerous, but those pictures do not fully describe the environment. How the landscape reaches the human senses cannot be duplicated. Conjuring the simultaneous sensations of the stench of gas and bodies to the nose, the muddy land’s feeling to the touch, the terror of seeing life consumed by a poisonous cloud is a difficult, if not impossible, task. Whether or not it is possible to reconstruct what the environment and the war was really like, artists, normally through post-expressionism, produced some of the most memorable images from the war

Though influenced by the expressionists at the turn of the century, the work of Grosz, Beckmann, and Dix may not be classified as Expressionist. Art scholars tend to classify these men as part of the greater *Neue Sachlichkeit* (New Objectivity) movement. The movement relied on the artist going in different directions including the use of different media or imagery, taking an “objective” view of industrial society’s malevolent influence on the world. Fear and hostility towards technology were also common themes of the movement, making chemical warfare an ideal vehicle for artistic expression.

The three artists had much in common. All volunteered in 1914 and served during the war, and all left disillusioned with the entire experience. The war is the key to understanding their work. “What characterized them and what made them famous did not originate before the First World War, as with the Expressionists, but in the years afterward,” art historian Matthias Eberle wrote, “their art, their world view, was

⁶⁴ Jay Winter, *Sites of Memory, Sites of Mourning: The Great War in European Cultural History* (Cambridge: Cambridge University Press, 1995), 159.

fundamentally formed by their war experience.”⁶⁵ Given that all of them depicted gas in their work, to some extent their work reflects an anti-technology motif, showing environmental damage or the price industrial weaponry inflicted on humanity during the war. Their anti-war message was also tinged at times with anti-capitalistic rhetoric, blaming companies like the chemical industry for profiting off of the misery they helped to generate at the front. As another German artist Emil Nolde wrote regarding that time, “the shareholders of the steel, oil, and poisonous gas companies, they all celebrated dark, devilish triumphs. In all countries it was the same cruel game.”⁶⁶

The artists’ bizarre and traumatic images struck a chord with Germans, and became widely circulated. Their works were familiar to the German public, as throughout the 1920s and 1930s, their paintings and sketches hung in numerous art institutions and collections across Germany, including museums in Berlin, Dusseldorf, Munich, and Dresden. Later, the National Socialists labeled much of their art as “degenerate” due to its strong anti-war message. The designation only had the opposite effect the Nazis intended. The pieces received even more attention by the public, as they were centerpieces in Hitler’s infamous 1937 Exhibition of Degenerate Art at the Munich House of German Art.⁶⁷

Born in Berlin in 1893, George Grosz studied art for three years at the Dresden Academy of Art. When the war broke out, he joined the Second Kaiser Franz Regiment

⁶⁵ Matthias Eberle, *World War I and the Weimar Artists: Dix, Grosz, Beckmann, Schlemmer* (New Haven: Yale University Press, 1985), vii.

⁶⁶ Emil Nolde, *Welt und Heimat: Die Südseereise 1913-1918, geschrieben 1936* (Cologne: Verlag M. DuMont Schauberg, 1965), 140.

⁶⁷ Linda F. McGreevy, *The Life and Works of Otto Dix: German Critical Realist* (Ann Arbor: UMI Research Press, 1981), 79.88.

of Grenadier guards, before he was transferred to a reserve unit. He was later medically discharged due to surgery related to a sinus infection. He was ultimately conscripted after his initial discharge, only to be committed to a sanatorium for a mental breakdown on his way to the front. He was permanently disqualified for military service in May 1917. Resentful of his treatment, he took his macabre view of the war to paper and canvas. Though he never saw combat, his use of war imagery and sense of his surroundings shaped much of his art during the war. “At every opportunity I would express my disillusionment in small drawings” Grosz recalled, “Everything I disliked in my environment I would sketch. . . I wanted to retain everything that was laughable and grotesque in my environment. . . I thought the war would never end, and I think it never really did end.”⁶⁸ Some of his works use apocalyptic imagery to send his message, such as his infamous take on chemical warfare, his 1924 sketch *Christ with Gas Mask*, depicting a crucified Jesus wearing a gas mask and combat boots. His 1941 painting, *A Piece of my World*, shows ravaged soldiers wading through a poison gas cloud, seemingly decaying alive.

Other German artists invoked gas in their works, among them perhaps the greatest German painter of the twentieth-century, Max Beckmann.⁶⁹ The youngest of three children, Beckmann was born in Leipzig in 1884. He graduated from the Art Academy in Weimar, and in the years leading up to the war Beckmann became well known in European art world, receiving awards such as the Italian Villa Romana Prize and praise

⁶⁸ George Grosz, *A Little Yes and a Big No: the Autobiography of George Grosz*, translated by Lola Sachs Dorin (New York: the Dial Press, 1946), 161.

⁶⁹ In his analysis of the Weimar artists, Matthias Eberle stated that “It is probably no exaggeration to say that Beckman is the greatest German painter of the twentieth century.” Eberle, *World War I and the Weimar Artists*, 105.

from critics for his 1912 work, *The Sinking of the Titanic*. In 1914, he volunteered as a medical orderly.⁷⁰

In 1915, after witnessing the effects industrial warfare and poison gas had at the front, Beckmann's nerves cracked and he suffered a mental breakdown. Shortly thereafter he was medically discharged. After the war, he went on to teach at the Städel Kunstinstitut, before he was dismissed from his post after the Nazis seized power. In 1937, he left Germany altogether, spending the war years in the occupied Netherlands. He eventually settled in the United States in 1947.

Though his earlier works, such as *The Sinking of the Titanic*, are a model of expressionism, after Beckmann's time at the front his imagery shifted dramatically to something closer to the Neue Sachlichkeit. Poison gas was something Beckmann became familiar with at the front, as he was at Ypres in 1915 when the first German gas attack occurred. His drypoint plates, known as *Die Grenate* (The Shell; pictured below), shows an explosion with men choking to death under a dark haze, victims of lethal technology.

⁷⁰ Frances Carey and Antony Griffiths, *The Print in Germany 1880-1933: The Age of Expressionism* (New York: Harper & Row, 1984), 157.



Figure 7. Max Beckmann, *Die Grenate* (1915)



Figure 8. Max Beckmann, *Die Grenate* (1916)

As art critics have noted, Beckmann struggled to get the image he wanted correct. There are five versions of the image, two of which are seen in Figures 7 and 8. The first (Figure 7) was from 1915, the second (Figure 8), from 1916. Though chemical shells had not been used at Ypres, the image was an eerie precursor of what was to come. One can see the soldiers grasping their throats, choking to death on the fumes which swirl around the bodies and into the air. During the war, Beckmann complained to his wife that he had recurring nightmares of world destruction in his sleep – this may explain why in 1918, he began producing landscapes and peaceful urban scenes in an effort to combat his darker visions of his surroundings.⁷¹

Though Beckmann and Grosz remain prominent figures in the art world, no artist in Germany is more associated with the war than Otto Dix. He was born December 2, 1891 in Untermhaus, located outside of Gera in Thuringia. After working four years as an apprentice house painter, Dix attended art school in Dresden. When the war broke out, he served as a machine gunner and saw extensive action at the Somme. During lulls in the fighting, Dix often sketched out his sights on the back of postcards. Shaken by his surroundings, Dix recorded in his diary his environmental impressions in 1915: “Lice, rats, barbed wire entanglements (*Drahtverhau*), fleas, shells, bombs, holes, dead bodies (*Leichen*), blood, schnapps, mice, cats, gasses, cannons, muck (*Dreck*), bullets, mortar, fire, steel - this is the war! All the devil’s work! (*Alles Teufelswerk!*)”⁷² After the war, he

⁷¹ See for example his 1917 work, *Landschaft mit rotem Luftballon* (Landscape with Red Balloon) or his 1922 work *Landschaft bei Frankfurt* (Landscape near Frankfurt). Hans-Jürgen Buderer, *Neue Sachlichkeit: Bilder auf der Suche nach der Wirklichkeit Figurative Malerei der zwanziger Jahre* (Munich: Prestel-Verlag, 1994), 23; 90.

⁷² The entry is estimated to be from 1915, but the entry has no set date. Given his use of the word “gasses,” 1916 is more likely. Cited in Rainer Rother, ed. *Die letzten Tage der Menschheit: Bilder des Ersten Weltkrieges, Eine Ausstellung des Deutschen Historischen Museums, Berlin, der Barbican Art*

returned to Dresden as a student and then later became an instructor at the art academy. During the 1920s and early 1930s, Dix sketched and painted extensively about the realities of the war experience. By mixing expressionism with realism, Dix's work took the form of a nightmarish testament to the war environment.⁷³

One of his earliest works about the war was an anthology of sketches about his combat experience. Fifty of these sketches were compiled and published in five portfolios by Dix between 1923 and 1924. Entitled *Der Krieg* (The War), the sketches often focused on the desolate landscape.



Figure 9. Otto Dix, *Sturmtrupp geht unter Gas vor* (Etching, 1924)

Gallery, London, und der Staatlichen Museen zu Berlin – Preußischer Kulturbesitz (Berlin: Deutsches Historisches Museum, Ars Nicolai, 1994), 90.

⁷³ See Kurt J. Fickert's introduction to Otto Dix, *Der Krieg: 24 Offsetdrucke nach Originalen aus dem Radierwerk* (New York: Garland Publishing, 1972), 5-7.

Works such as *Sturmtrupp geht unter Gas vor* (Stormtroops Going Forward Under Gas), *Bei Langemarck, Februar 1918* (Near Langemarck, February 1918), and *Pferdekadaver* (Horse Cadaver) depicted terrifying landscapes, the alien-like atmosphere of gas warfare, and the price nature paid during the war.⁷⁴

In terms of painting, some of Dix's most famous works include *Der Schützengraben* (1923) and *Krieg* (1932).⁷⁵ *Der Schützengraben* shows contorted and mangled bodies among a chaotic landscape, bathed in a haze like that of poison gas. Corpses held up by steel beams show the technological and industrial nature of World War I, and the haze shows the ubiquity of gas warfare.

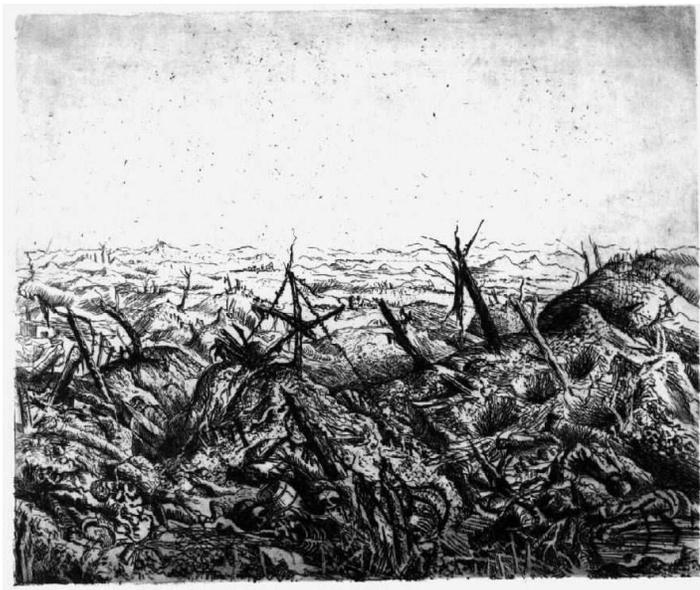


Figure 10. Otto Dix, *Bei Langemarck, Februar 1918*, (Etching, 1924)

⁷⁴ Otto Dix, *Der Krieg* (Berlin: Verlag Karl Nierendorf, 1924).

⁷⁵ Phillip Gutbrod, *Otto Dix. Lebenskunst* (Ostfildern: Hatje Cantz Verlag, 2009), 91.

Dix's most famous work, however, is his panel triptych simply entitled *Der Krieg* (See Figure 11).⁷⁶ Dix painted the work between 1929 and 1932, and the piece was soon thereafter displayed in Dresden. Similar to *Der Schützengraben*, the work consists of four panels: first, an image showing a procession of machine gun soldiers marching to the front, the second, a panel depicting the battlefield; third, the panel underneath showing the burial of a corpse; and the last panel, an image showing two blue-toned figures, one helping the other up.

⁷⁶ Gutbrod, *Otto Dix. Lebenskunst*, 96-97.



Figure 11. Otto Dix, *Der Krieg* (Triptych, 1929-1932)

This panel could be interpreted as the two figures' souls emerging from their bodies. Interestingly, Dix painted himself as the soldier helping up his comrade. Again, the landscape is that of annihilation, with mists that may be lethal gas clouds and the land given shades of dark green to represent the rotting landscape.⁷⁷

Critics compared Dix's landscapes to those Romanticist landscapes of the eighteenth and nineteenth centuries. Compared to Caspar David Friedrich, Dix's paintings were hailed as masterpieces of landscape art. As one German critic wrote in 1941, "No artist since C.D. Friedrich has succeeded in bringing the countryside to life in such a vivid fashion."⁷⁸ Dix's acceptance in the greater art world demonstrated both an interest and understanding of his work.

What also made Dix's work significant was its realism. Not in a literal sense, but in a topical one. Sexuality, economic hardship, and psychological disillusionment were all themes explored by Dix and his art during the Weimar era, an era remembered by the Germans for all of these trends. As the art historian Brigid S. Barton argued, "'Dix is an excellent model for the study of realism in the Weimar Republic because at the very heart of his work there is a concern for social problems, and this in turn is characteristic of much of the art in Germany at this time."⁷⁹ After the Nazis seizure of power in 1933, Dix became the target of harassment over his anti-war views. Nevertheless, his work endured, and remains very much a part of the collective image of World War I in Germany.

⁷⁷ Cited in Linda F. McGreevy, *The Life and Works of Otto Dix: German Critical Realist* (Ann Arbor: UMI Research Press, 1981), 79.

⁷⁸ Eva Karcher, *Otto Dix* (New York: Crown Publishers, 1987), 69.

⁷⁹ Brigid S. Barton, *Otto Dix and Die neue Sachlichkeit, 1918-1925* (Ann Arbor: UMI Research Press, 1981), 11.

There was another painter during the war who also documented the environmental catastrophe as it occurred. Serving with a Bavarian infantry unit, he painted several watercolor landscapes during the war. Among his wartime artworks are 1916's "The Trail" (pictured below) and "Tank Battleground," which depict desolated landscapes, complete with shell craters, patches of grassland, and eviscerated, dead trees:



Figure 12. Adolf Hitler, *The Trail* (Watercolor. 1916)

In 1918, the painter was gassed at the front, and after the war chose to follow other avenues besides art. His name was Adolf Hitler.⁸⁰

The theatre arts, both live drama and film, also showcased German attitudes towards poison gas and nature. Anti-war playwrights, many of whom served during the war, provided another medium with which to showcase their displeasure with chemical warfare. Similar to their painting counterparts, playwrights such as the above mentioned Ernst Toller, Georg Kaiser, and later Peter Martin Lampel, used gas to make strong anti-technology, anti-war arguments. Kaiser and Lampel took these arguments farther, as they extended them into proto-environmentalism thinking.

One of the most famous German playwrights of the twentieth century, Ernst Toller was born to a Jewish family on December 1, 1893 in the small city of Samotschin (Szamocin), then located in the Prussian province of Posen. Swept up in the euphoria of 1914, Toller volunteered for service with a Bavarian unit.⁸¹ “I was proud. . .,” he later admitted, “We were living in a state of emotional delirium.”⁸²

After serving thirteen months on the Western Front, Toller broke down, at first mentally, then physically. Suffering from stomach and heart illnesses, Toller was sent to Strassburg for treatment. Deemed unfit for service, the army discharged him several weeks later.⁸³ By the end of the war, Toller had become an activist-pacifist. He participated in anti-war protests, gave speeches, and read his compositions in public.

⁸⁰ See Charles E. Snyder, “Adolf Hitler Original Watercolor Artworks,” <http://www.snyderstreasures.net/pages/hartworks.htm#wji>. Accessed 2 September 2012.

⁸¹ Andreas Lixl, *Ernst Toller und die Weimar Republik, 1918 – 1933* (Heidelberg: Carl Winter Universitätsverlag, 1986), 29-30.

⁸² Toller, *I was a German*, 64; 65.

⁸³ *Ibid*, 91.

During the 1920s, his growing number of successful plays and public activities generated quite a bit of attention. Soon, Toller was well known not just in Germany, but around the world. By 1935, translations of his work were available in a dozen different editions in more than twenty languages. At that time his plays were performed in London, Dublin, Helsinki, Tokyo, Prague, Paris, Vienna, Moscow, and New York City, among others.⁸⁴ Two of his earliest plays, *Die Wandlung* (Transformation) and *Die Maschinenstürmer* (The Machine Wreckers) rely heavily on the themes of anti-technology and anti-war. *Die Maschinenstürmer* follows a group of Nottingham luddites in 1812 England. Despite the setting, there are lines which very much applied to the First World War, even if spoken from aggressive luddites. After several characters smash an engine, the engineer warns the luddites their acts are futile:

Hihuhaha!
I say but to you all, the engine is not dead...
It lives! It lives!. . . It reaches out a claw
To clutch the hearts of men. Hihuhaha!

The engineer later continued,

Hihuhaha! Hihuhaha!
The greedy jaws of war will gape for men
And nations will be fodder – brothers foes,
And justice outlawed'd, order piled in dust!
Against their Mother Earth her children rise
To slay her creatures and uproot her weeds,
Her godlike creatures and her godlike woods,
And shame her motherhood – the end is dust!⁸⁵

⁸⁴ Lixl, *Ernst Toller und die Weimar Republik*, 21.

⁸⁵ From Act V, Scene III. Ernst Toller, *The Machine Wreckers, a Drama of the English Luddites in a Prologue and Five Acts*, by Ernst Toller. English Version by Ashley Dukes (New York: Alfred A. Knopf, 1923), 95.

Toller's most famous work was his first: *Die Wandlung*. Toller began writing the play in 1917, but was arrested for participating in a public anti-war protest before he completed it. He ultimately finished the work while serving time in a military prison in 1918. The play is composed of a prologue, followed by six stations with a total of thirteen scenes (what Toller numbers as "*Bild*," or pictures). The scenes roughly follow Friedrich, a German war volunteer who is wounded at the front. In the third station, entitled "*Die Krüppel*" ("The Cripples" or "The Gimps"), Friedrich and a group of wounded soldiers are introduced to a Professor, white coat and all, who is delighted to share with the men the "benefits" science can give them. "Yes, gentlemen. . . We could call ourselves the positive branch, the negative is the armaments industry. In other words: we are representatives of synthesis. . . the chemists and engineers, they want to forge quietly weapons, and fabricate unheard of gasses; we keep up. Their war service will be credited to them." The Professor then parades seven models in front of the men who have received treatment. Each of them has black, mechanical limbs in place of flesh.⁸⁶

Among the wounded is a gas victim. After seeing the horrors in front of them, he meekly tells the Professor, "My breathing is a sparrow, it always goes 'Pip'. . . My lungs are a sparrow's nest. . . Can you tell me? Also there must be sparrows that fly south when the winter comes. Pip. . . pip. . ." ⁸⁷ There is a clear comparison between the wheezes of a gas victim to that of a bird's chirping. But what makes the scene more powerful is that there is no scientific answer to gas poisoning, no prosthetic for the lungs. The victim's hopes that his "sparrows" will someday fly south may never come to fruition.

⁸⁶ Ernst Toller, *Die Wandlung: Das Ringen eines Menschen* (Potsdam: Gustav Kiepenheuer Verlag, 1925), 39-40.

⁸⁷ *Ibid*, 44.

Upon his return home, Friedrich is in his art studio when his lover, Gabriele, informs him she is leaving him. She tells him her father would disown her if she remained with him, that she would lose her “clod of earth” (*Scholle*). Although at first taken back, Friedrich replies that he also has “rootage” (*Wurzeln*) and possesses a clod rooted with his lifeblood “My clod is the Fatherland. The whole great Fatherland. You are small, Gabriele, you are small.”⁸⁸ The ties to his country, a mystical connection between the people and the land, drive Friedrich’s attitude. The war seemed to strengthen this ideal in Friedrich. The play successfully combined poison gas, nature, and the culture of German ties to the land to form a powerful anti-war message.

Another well known playwright at that time was Toller’s friend Georg Kaiser. Kaiser was born in Magdeberg in 1878. Despite lacking a college education, during his early life he read constantly, his favorite works being those of Plato. After suffering for years with health complications from malaria while working in Argentina, Kaiser became a prolific writer with twenty-one published works to his credit by 1911. After the war in 1919, Kaiser met Toller and the two became friends despite their different personalities. As the scholar Renate Benson noted, Toller was a charismatic and revolutionary spirit; Kaiser was more sober and not as political. By that point, however, Kaiser had penned one of his most significant works, his 1918 play entitled *Gas*. More than any other play, *Gas* is a direct protest to poison gas, the war, and a pacifistic call to return to nature, where people can rediscover their humanity.⁸⁹

⁸⁸ Ibid, 51.

⁸⁹ Renate Benson, *German Expressionist Drama: Ernst Toller and Georg Kaiser* (New York: Grove Press, Inc., 1984), 93-99.

In an ironic twist, the story of *Gas* takes place in a society where gas is a source of energy for the world. The plant which manufactures and controls the gas is run by the main character, known as “the billionaire’s son.” Aside from its military uses, in *Gas*’ world toxic gas is harnessed to power the city, as the means of transportation, and has essentially become the fuel of human civilization. However, the gas soon becomes unstable and explodes, destroying the factory and killing many among the citizenry. In the wake of the disaster, the billionaire’s son realizes that technology like gas is not the answer. When asked if he is going to rebuild the plant, the son negatively replies, “Do you want to return to the white horror? Does it quiver your fingers already again?”⁹⁰

Instead, the son decides to clear out the ruins of the factory, and convert the area into a green, organic civilization. He designs the new society and shows his plans to the old gas plant’s engineer:

“You are all blind – colorblind to the eternity of your monotony until this day! Now a new vernal day comes to meet you all. Open your eyes and sweep over the region: around you all is the colorful earth here!”

(Retracing the plans)

“Green lines – streets lined with trees. Red, yellow, blue rings – plazas grown over with plants that blossom from grassland. Squares that accommodate houses with small areas of property!”⁹¹

The billionaire’s son also firmly connects gas to environmental and human devastation and the inevitability of human disaster caused by industry. When the workers demand the plant be rebuilt, the son vows “Never again will chimneys snarl here! Never rumbling machines! Never whoosh the howling screams of those struck by the inevitable

⁹⁰ Georg Kaiser, *Gas, Schauspiel in Fünf Akten* (Berlin: Gustav Kiepenheuer Verlag, 1931), 28.

⁹¹ *Ibid*, 44.

explosion.”⁹² This anti-technology, proto-environmentalism angle is then mixed with the desires of the military and economic realities.

When the son refuses to rebuild the plant, the workers protest. In a last ditch effort to compel the masses to see reason, the son declares:

“Space is yours – and everything in space that houses you all! You all are humanity within it! Human beings – with every wonder known to you – unflinching to every development! In all of you roars the sky and floods the planes with the grass’s color! The workday is great – with new inventions unto you – but you are not inventions!. . . Tomorrow you will all be humans with unity and wealth. Our new regions will be common pastures (*Triften*), broad in green! Resting over rubble and ashes the settlements will extend. You are all released from drudgery and profit! Settlers with the smallest requirement – and last wage – Humanity!”⁹³

The son’s green vision was not to be. The army and government move in, and tell the son that his plans will not be carried out because the gas is too important. A government agent tells the son, “the entire armaments industry is arranged on gas (*auf Gas eingerichtet*). . . We are preparing for a war. Without the raw power from gas the armaments program will be unfeasible. Based on these serious reasons, the Government can no longer bear a long disruption in the supply of gas to the weapons factories.”⁹⁴ The son is forced to give up his fight, and sorrowfully declares, “Where is humanity?”⁹⁵ For the son, the loss of nature is the loss of our identity as human beings.

This cynical view of the future continued in *Gas*’ three-act sequel, *Gas II* or *Gas, Zweiter Teil*. In *Gas II*, a global war has broken out between two sides, designated as the “blue figures” and the “yellow figures.” Losing the war and fortified within a dome,

⁹² Ibid, 69.

⁹³ Ibid, 93-94.

⁹⁴ Ibid, 109.

⁹⁵ Ibid, 116.

among the blue forces is the grandson of the billionaire's son from *Gas* (here known as the "billionaire worker"). With his grandfather in mind, the billionaire worker is reluctant to increase gas production for the war.⁹⁶ Instead, when the enemy forces surround the city, the billionaire asks both sides for peace, and convinces the blue forces to open the dome and to ask for peace, as well as giving up the gas. The dome is opened, but the enemy refuses to give up the gas and moves in.⁹⁷ Despondent with humanity's refusal to change ("Our voice can wake up the desert – [but] man became deaf in front of it"), the billionaire throws a sphere filled with poison gas that kills everyone in the dome. Subsequently, the enemy shells the city, leveling the building where the gas bomb went off. When the enemy forces move in and see the dead (the gas reduced the people to skeletons), they kill themselves in a suicidal apocalypse.⁹⁸

Kaiser's work is reflective of the events after World War I with respect to not only the rise of German pacifism and anti-technology sentiments, but also the relationship between poison gas, humanity, and the environment. In the end of *Gas I*, the workers and government were not content with the son's new plans for civilization. As we have seen throughout this study, this is a case of art imitating life. The German people demanded economic prosperity (i.e. jobs) and the German military leadership demanded poison gas. In the play and in Germany during the 1920s, these matters took priority over concerns regarding nature. Economics and military aims overrode concerns of nature.

⁹⁶ Georg Kaiser, *Gas, Schauspiel in Drei Akten: Zweiter Teil* (Reprint. Berlin: Gustav Kiepenheuer Verlag, 1930), 21-23.

⁹⁷ *Ibid*, 36-45.

⁹⁸ *Ibid*, 66-67.

In addition to Toller and Kaiser, Peter Martin Lampel also made a significant impression on the German public. When the infamous Hamburg phosgene disaster took place in 1928, Lampel was living in Hamburg and bore witness. Born in Schönborn, located in the Prussian province of Liegnitz, Lampel served during the First World War as a Lieutenant in the air corps, flying numerous missions on the Western Front as an observer in zeppelins and bombers. He went on to study law and theology, ultimately becoming a member of the Freikorps and the *Schwarze Reichswehr* (Black Reichswehr), a paramilitary group under the Reichswehr control. Later, he became a staunch anti-war advocate. In response to the Stoltzenberg affair in Hamburg, Lampel chose to compose a play with poison gas as its focus.⁹⁹

Set in 1935 (the last year the French were to occupy the Rhineland), the play begins in downtown Berlin, where a canister of poison gas explodes in a secret military poison gas factory. The cloud kills thousands of men, women, and children, causing panic across the city. So angered by the gas, the citizens stage a revolution that seizes control of the government in a blood-soaked urban civil war.¹⁰⁰

Given the obvious anti-military message and graphic content, and with the Hamburg debacle still fresh in his mind, Hans von Seeckt, the Chief of Staff of the Reichswehr, learned of the play and vowed to censor it if it ran. Though the Weimar Constitution had no censorship law, the authorities could prevent the play if it posed a threat to public order. In defiance of Seeckt's threat, Lampel pressed on, and the play was

⁹⁹ "Ein Mann kam aus dem Wartsaal," *Der Spiegel*, Vol. 29 (14 July 1949): 27.

¹⁰⁰ Monty Jacobs, "'Giftgas über Berlin': Geschlossene Vorstellung im Theatre am Schiffbauerdamm," *Vossische Zeitung*, 7 March 1929, No. 57.; "Berlin Officials ban play on Poison Gas," *The New York Times*, 3 March 1929, p 16.

scheduled to run anyway on March 6, 1929 at the Theater am Schiffbauerdamm, a theatre that still stands in downtown Berlin. Even under the cloud of cancelation, the venue continued to advertise for the show in local newspapers, such as the sizable ad pictured below:



Figure 13. Advertisement for the Premier of *Giftgas über Berlin* (1929)¹⁰¹

Due in part to the advertisements, Reichswehr and police officials knew about the play in advance and arrived at the theatre before the audience could enter the building, but after the actors, crew, director, Lampel, and his wife had arrived. As expected, the police chief declared the show a “danger to public order and security.”¹⁰² That night, in

¹⁰¹ Ad for the “Premier” (*Uraufführung*) of Lampel’s *Giftgas über Berlin*. See *Vossische Zeitung*, 3 March 1929, No. 54. Note the ad ran three days before the show’s debut. The advertisements for the show ran as late as 6 March. See *Vossische Zeitung*, 7 March 1929, No. 57.

¹⁰² Monty Jacobs, “‘Giftgas über Berlin’: Geschlossene Vorstellung im Theatre am Schiffbauerdamm,” *Vossische Zeitung*, 7 March 1929, No. 57.

the show's one and only "public" performance at the theatre, Lampel sat with his wife in the audience and watched the play. Programs were printed for the show, and contained a detailed three-page history of chemical warfare and gas defenses, describing the types of necessary preparations needed for a civilian gas war. Interestingly, the history concluded by warning that in a future war one must be aware that both explosives and gas bombs from the air "will be deployed."¹⁰³ Seeckt did not see the show; his reserved seat remained empty for the show. The play was then rescheduled for two performances: one for the police, Reich Foreign and War Ministries; the second, for the press and invited guests. Those who had already bought tickets were given refunds, and the theatre was placed under police guard.¹⁰⁴ After the private shows, the production was cancelled later that week.

The local press panned the show, more so for its content than presentation. Monty Jacobs, a critic for the *Vossische Zeitung*, wrote: "We would like to thank God on our knees, that we will finally be freed from the back and forth of the noise about this production. Lampel's play dictated hatred." The reviewer described Lampel's clear hatred of the Reichswehr and decried the primary plot vehicle, a poison gas attack. "the gassing of an entire city, our city," Jacobs declared, "eight thousand dead – a shiver had to flow from the stage. . .The performance is unbecoming. . ." It seems the horrific

¹⁰³ "Giftgas über Berlin," Peter Martin Lampel, undated, German Theater and Movie Programs, Collection Number 0077, Box 1, Folder 2, The University of Southern California Libraries: Feuchtwanger Memorial Library, Los Angeles, California, United States of America. The author would like to thank the staff of the Feuchtwanger Memorial Library for providing me a copy of the program.

¹⁰⁴ "Lampel-Kalender," *Vossische Zeitung*, 7 March 1929, No. 57; "Poison Gas Play in Berlin," *The Times*, 4 March 1929, Issue 45142, p. 15; "Ein Mann kam aus dem Wartsaal," *Der Spiegel*, No. 29, (14 July 1949): 27.

depiction of mass murder was simply too much to take at that time. Jacobs did, however, praise the acting.¹⁰⁵

Several months after the debacle, Lampel was arrested in his apartment on November 8 on suspicion of participating in a murder of a *Freikorps* “*Oberland*” member named Fritz Köhler.¹⁰⁶ After his release from jail on bail on November 29, the murder charge against Lampel was ultimately dropped the following summer, when the Reichstag passed an amnesty bill that granted pardons to all those charged with political crimes and acts of treason against cabinet ministers.¹⁰⁷ Given the small number of people who saw it, the story of *Giftgas über Berlin* would have likely faded from the public’s memory if not for the efforts of the communist filmmaker Michail Dubson.

While plays remained a popular form of entertainment, the motion picture industry expanded dramatically during the Weimar era. War films were a significant part of its success. The number of movie theatres in Germany increased dramatically during the decade. Between 1920 and 1929, the number of theatres increased from 3,700 to 5,000.¹⁰⁸

After reading *Giftgas über Berlin* and believing in its pacifist message, Dubson wanted to convert it to a film. With Dubson’s help, Lampel and the writer Nathan Sarchi composed a screenplay based on the drama. Filming began immediately. The silent

¹⁰⁵ Monty Jacobs, “‘Giftgas über Berlin’: Geschlossene Vorstellung im Theatre am Schiffbauerdamm,” *Vossische Zeitung*, 7 March 1929, No. 57.

¹⁰⁶ “Der Dramatiker Lampel verhaftet,” *Vossische Zeitung*, 9 November 1929, No. 268, p. 6.

¹⁰⁷ Reichstag Passes Wide Amnesty Bill,” *The New York Times*, 3 July 1930, p. 8.

¹⁰⁸ Klaus Kreimeier, *The UFA Story: The History of Germany’s Greatest Film Company, 1918-1945* (Translated by Robert and Rita Kimber, Berkeley: University of California Press, 1999), 112.

motion picture, simply entitled *Giftgas*, premiered on November 13, 1929, just eight months after the stage version was shut down.

The film bears little resemblance to the original drama. Rather than a gruesome accident at the start of the show that leads to revolution, the story instead revolves around a young chemist, Horn, who works for a chemical company that is producing poison gas. Although the film has a strong pacifist message, the primary enemy in the film is the chemical company (a change that was surely acceptable to the communist director!). Ultimately, one of the storage tanks ruptures in the factory, killing nearly every character in the end, including Horn who commits suicide by removing his gas mask upon seeing his poisoned, deceased wife.¹⁰⁹ Though the first half of the film shows little of the environmental impact of poison gas, the climax of the film is filled with disturbing imagery of what becomes of nature and civilization when poison gas is introduced. For example, a boy who is shown throughout the film riding a toy horse, is gassed. His lifeless body shown next to the still horse showcased the end of innocence, youth, and adventure. At the end of the film, images of the desolated World War I landscapes are shown, complete with dead trees and ghostly figures wading through foggy mists. In the screenplay of the film, the author described in detail the environmental impact of the gas:

And stiller and stiller it became over the land, and the horror chilled through all walls. . .A sick, ghostly night laid over the land. The trees stand defoliated. All life was withered and dead.¹¹⁰

As *Giftgas* demonstrated, film could also contribute to the public's image of poison gas and nature. Critics thought the film had too many clichés; the critic for the

¹⁰⁹ Nathan Sarchi, *Giftgas: Ein Film nach dem Bühnenwerk von P.M. Lampel "Giftgas über Berlin"* (Berlin: Verlag von Schmidt & Co., 1930), 73.

¹¹⁰ *Ibid.*, 76.

Vossische Zeitung commented, “We know this old song.” Still, the same reviewer admitted that a few of the scenes were successful; and the acting of Vera Baranovskaya was “impressive” in the “great tradition of Russian film interpretations.”¹¹¹ Fritz Olinsky from the *Berliner Börsen-Zeitung* said that one cannot deny the artistic tone, and “The representation. . . must be considered downright gleaming (*geradezu glänzend*).”¹¹² Among the theatres *Giftgas* played was the Marmorhaus, the famous marble-faced theatre still located on the Kurfürstendamm in the heart of Berlin. The Marmorhaus held hundreds of movie goers when *Giftgas* premiered.



Figure 14. Advertisement for the film *Giftgas* (1929)¹¹³

¹¹¹ “Giftgas,” *Vossische Zeitung*, 15 November 1929, No. 273.

¹¹² From Fritz Olinsky’s film review in the *Berliner Börsen-Zeitung*, 14 November 1929, cited in Deutsches Historisches Museum, “Giftgas,” <http://www.dhm.de/kino/kassandra.html>. Accessed February 2012.

¹¹³ An advertisement for *Giftgas* at the Marmorhaus in Berlin. *Vossische Zeitung*, 13 November 1929, No. 271, p. 7.

Aside from *All Quiet on the Western Front*, perhaps the most famous German World War I film is *Westfront 1918*.¹¹⁴ The motion picture is an adaptation of Johannsen's *Vier von der Infanterie*. Along with Johannsen, the script was co-authored by the now famous Peter Martin Lampel. The film bears some resemblance to the source material. Some of the characters and scenes are similar, such as the "Student" or the final attack sequence; other scenes and characters were invented for the film. *Westfront 1918*'s cinematography captures the landscapes of the war with horrifying detail, with wide-angle shots that survey lifeless terrain. Similar to the book, there are also subtle but obvious references to the plight of nature in the war. In one scene, a messenger dog beloved by everyone in the trench is killed delivering a message; a similar sequence is in the novel as well. Also similar to the novel is the film's climax, a massive battle sequence depicting a French attack on the German lines. In the film, the attack coincides with a massive poison gas discharge. Although black and white, the haze of the gas can clearly be seen across the fields, creating a foggy, eerie atmosphere for the French tanks and infantry to wade through.

It is clear that by the end of the 1930s, Europeans understood that the Great War inflicted severe damage to the landscapes of Western Europe. The popularity of poetry and literature such as Erich Remarque's *Im Westen nichts Neues* not only reinforced the universal experiences of those who were alive during the war, but also generated an image of the war to Europe's youth who were too young to either experience first-hand or construct a clear image of the conflict. The war and its cultural backlash also sent a very clear reminder to Germans that modern warfare and industrialization, when unchecked by

¹¹⁴ *Westfront 1918*, VHS, directed by Georg Wilhelm Pabst (1930; Burbank, CA: Hollywood's Attic, 1996).

wartime objectives and prerogatives, can have the worst of consequences for their surroundings. The work of artisans and writers such as Otto Dix and Felix Salten, among others, provided pacifistic declarations, and even indictments, against war's impact on the landscapes. The cultural response to chemical weapons, therefore, did not stop with the end of the First World War. So long as poison gas remained a military option, public animosity towards it also persisted. Through written, artistic, and cultural interpretations, the Germans constructed a collective image of the war and the environmental consequences, an image of an apocalyptic landscape of desolation and constant terror, a landscape destroyed by the actions of humanity.

CONCLUSION

THE “NATURE” OF CHEMICAL WARFARE

While the Great War and chemical weapons provided a grim picture to Germans regarding humanity's destructive relationship to nature, the environmental movement in Germany did not solidify until after the Third Reich, during the 1960s and 1970s. This does not mean that the Great War did not influence German environmental attitudes during the Weimar and Third Reich eras, nor does it mean that these attitudes did not manifest concrete results. Rather, the public awareness of environmental degradation gradually increased political pressure for the German governments to take action. The Weimar government took significant steps legislatively to protect and preserve German landscapes, even placing an article in the new German constitution specifically recognizing the need for environmental regulations. In the case of the Third Reich, where a radical dictatorship placed the ideology of racial purity above all others, the Nazis saw environmental conservation as not simply protecting wildlife and forests, but more importantly maintaining their native living space, a space from which spiritual support and strength could be found. The better the land was maintained, the better it would suit the *Volksgemeinschaft*, or racial community. By the 1950s, with a new democratic government in place, German environmental groups continued their efforts for landscape preservation and pollution controls. Through the help of scientific studies, government cooperation, and public demand, Germany witnessed a sea change in their attitudes towards water and air pollution during the 1960s and 1970s.

The Weimar government between 1919 and 1933 responded to environmental concerns immediately. One of the first signs the German government was serious about environmental issues appeared in the new Weimar constitution itself. Article 150 of the German constitution states that, “The monuments of history and of Nature as well as the countryside enjoy the protection and care of the state.” Thus, the Germans were the first nation to constitutionally mandate environmental protection.¹ *Naturschützer* were elated with this radical step, and their ideas of environmental protection and conservation were solidified in a number of ways over the next decade. Some of these methods included the formation and expansion of *Naturschutz* groups to nationwide organizations, as well as the passage of landscape protection and conservation legislation.

Even groups who did not necessarily support the new government used public impressions regarding humanity’s influence on nature to their advantage. After World War I, nature was used as a theme in propaganda posters such as this *Freikorps* one pictured below. The poster emphasized defense of the Fatherland and preservation of its beautiful, productive landscape in the face of urbanization or violence. The poster reads, “Do you all want this?” in bold lettering. After asking the reader to volunteer for a grenadier battalion, the poster concludes by demanding, “Protect Your Country.”

¹ Raymond H. Dominick III, *The Environmental Movement in Germany: Prophets & Pioneers, 1871-1971* (Bloomington: Indiana University Press, 1992), 82.



Figure 15. German Recruitment Poster (circa 1919)²

During the 1930s the Nazis passed laws against woodland devastation, the killing of wildlife (Animal Protection Law of 24 November 1933 and the Reich Hunting Law of July 1934), cruelty to animals, and posing advertisements in certain rural areas.³

Ultimately, these measures culminated on June 25, 1935 with the passage of the *Reichnaturschutzgesetz* (Reich Nature Protection Law, or RNG). The law consisted of twenty-seven provisions, categorized under seven main articles. The articles covered a variety of topics, including regulations for nature protection administration, the

²“Propaganda Posters – Germany,” <http://www.firstworldwar.com/posters/germany.htm>. Posted 29 August 1999. Accessed 7 June 2011.

³ Lekan, *Imagining the Nation in Nature*, 159.

conservation of areas, plants, and animals, and of course the punishments for violations. The law's subsections include landscape planning statutes and ordered federal, state and local nature protection authorities are "obligated to receive permission prior to any undertaking or planning, that can lead to basic changes (*wesentlichen Veränderungen*) to the free landscape" (Provision 20).⁴ Under the new law, conservation administration fell under the jurisdiction of the Reich Nature Protection Office (*Reichsabteilung für Naturschutz*, or RAN). Later, the Reich Protection Agency was renamed the *Bundesansalt für Naturschutz und Landschaftspflege* (Federal agency for Nature Protection and Landscape Preservation) in 1953. Today, the agency still remains the supreme conservation authority in Germany, now known as the *Bundesamt für Naturschutz* (Federal Agency for Nature Protection).⁵

In addition to federal legislation, another sign that the war generated a greater public interest in environmental issues is the fact that the numbers of Germans participating in environmental groups significantly increased during the 1920s, and then exploded during the 1930s. For example, the largest of all the groups at the start of World War I was the Society for Bird Protection. Although the group stagnated at 30,000 members during the 1920s, their membership had climbed sharply to 55,000 by 1943. Other groups, such as the League for Nature Conservation in Bavaria dramatically increased right after the war. Numbering only 535 in 1918, their membership grew to

⁴ G. Mitzschke, ed. *Das Reichnaturschutzgesetz vom 26. Juni 1935, nebst Durchführungsverordnung vom 31. Oktober 1935 und Naturschutzverordnung vom 18. März 1936 sowie ergänzenden Bestimmungen* (Berlin: Verlagsbuchhandlung Paul Parey, 1936), 22.

⁵ Frank Uekoetter, *The Green and the Brown: A History of Conservation in Nazi Germany* (Cambridge: Cambridge University Press, 2006), 190.

fifteen times their original size by 1925.⁶ Pre-war leaders and members of *Natur-* and *Heimatschutz* groups returned from war with a strengthened sense towards environmental defense. These attitudes were compounded by the economic misery Germany faced in the years following the end of the war, and apprehension that economic priorities would once again trump natural preservation.

As the decades passed after World War II, chemical weapons continued to be a point of interest on not only the German but international stage. By the early 1990s, the newly unified German government promoted a global ban. In December 1992, the new German Foreign Minister Dr. Klaus Kinkel addressed the 47th General Assembly meeting of the UN. He called on states that had not renounced chemical weapons by recognizing the Geneva Protocols to do so.⁷ One month later, in January 1993, representatives from 149 different states came together in Paris to sign the “Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction.” Germany was among the original signatories; there are now 188 states that have become parties to the agreement.⁸ In his speech to the assembly, Kinkel optimistically declared that with the ostracism of chemical weapons an especially “insidious and cruel category of weapons of mass destruction will disappear from military arsenals. . . today we have found the strength to proscribe poison as an agent of

⁶ Dominick, *The Environmental Movement*, 83.

⁷ See excerpt of Klaus Kinkel’s speech before the 47th UN General Assembly in *Auswärtigen Amt, Außenpolitik der Bundesrepublik Deutschland: Dokumente von 1949 bis 1994* (Cologne: Verlag Wissenschaft und Politik, 1995), 878-879.

⁸ United Nations Treaty Collection, “CHAPTER XXVI. DISARMAMENT, 3. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction,” 3 September 1992.
http://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVI-3&chapter=26&lang=en. Accessed 27 May 2012.

war.” The German chemical industry from the beginning supported the Geneva hearings, and continue to respect the protocols to this day.⁹

The story of chemical warfare is that of a relationship between nature, war, and culture. In chapter one, we saw how German industry, especially its chemical companies, came to dominate Industrial Europe. With a growing population and some of the finest chemical minds in the world, firms such as BASF and Bayer exercised hegemonic control over the global chemical market. Their success brought both prestige and considerable economic development and wealth to the nation. Yet like its cousins in the steel and coal industry, Germany’s chemical plants wreaked considerable environmental damage, especially to rivers such as the Rhine and the Emscher. Pollution from factories turned once lively, diverse ecosystems into concrete sewer systems and poisoned the water the citizens drank and the air they breathed. Many Germans accepted this exchange of environmental harm for economic and social prosperity, and thereby ideologically shifted themselves away from the German Romanticist visions of aesthetics and natural beauty.

Others, however, disagreed with this bargain. These economic changes conflicted with long-held cultural beliefs in Germany that promoted the beauty of nature and the importance of conserving its aesthetics. Stemming from Romanticist thinkers such as Alexander von Humboldt, many Germans came to see nature as an inseparable part of the German people, a symbolic representation of their nation’s greatness. Despite the clear, obvious damage unchecked chemical dumping caused to the country’s rivers and streams, German intellectuals led by Hugo Conwentz and Ernst Rudorff failed to spark a

⁹ See Klaus Kinkel’s speech under “Internationales Übereinkommen zur Ächtung chemischer Waffen,” in *Auswärtigen Amt, Außenpolitik der Bundesrepublik Deutschland: Dokumente von 1949 bis 1994*, 891-893.

significant, national environmental movement. Their objectives were thwarted for a number of reasons. In addition to their misguided belief that the rivers could clean themselves and their ignorance regarding the true damage pollution caused the human body, Germans, from industrial and political leaders to members of the general public, desired greater industrial and economic prosperity and were willing to sacrifice the cleanliness of their surroundings upon the altar of progress. Nature influenced dramatically the shifting cultural and economic conditions in Germany prior to the war, and, indeed, economics and culture shaped the way Germans treated their environment.

As seen in chapter two, the German faith in its industry was again revealed when the Schlieffen Plan failed to achieve victory on the Western Front in August 1914. Desperate to break the stalemate, German military leaders turned to their chemical industry for answers. The decision to use chemical weapons hinged in part on Germany's chemical dominance, but more so because the environmental conditions and cultural attitudes of German military leaders made these weapons an appealing choice. Using the flat terrain of Western Europe, winds strong enough to push massive toxic clouds, and their extensive knowledge of chemistry, the Germans chose chemicals based on meteorological conditions and their ability to overcome the battlefield environment. Chlorine, for example, was chosen in part because it was heavier than air and could reach into trenches and dugouts, killing enemies no bullet could possibly reach.

When chemical weapons were unleashed, the landscape endured devastation on an immense scale. Millions of acres were doused in chemical clouds and shells, killing every form of life at the front and all but permanently altering the landscape and soils. Soldiers came to know the environmental changes caused by the gases and were forced to

adapt their tactics and behavior at the front. As the weapons' performance and lethality hinged entirely on natural conditions, the introduction of deadlier chemicals and more efficient delivery systems were more about conquering the natural obstacles which made the gas less effective than overcoming a man-made barrier. Gas shells were an attempt to overcome wind conditions. Mustard gas was favored for its tenacity and long-term effects. In that sense, the war was also one against natural obstacles which hindered the military's ability to kill the enemy and win the war.

As a result, for a variety of reasons Germany invested billions of marks into animal research involving massive breeding farms, simulated trench environments, and hundreds of different chemicals. Animal testing was seen as a way to test battlefield conditions, search for more effective toxins, and combat non-human entities such as fleas and lice. Anti-gas technologies for their natural allies and poisons for their natural enemies emphasize the ways in which nature controlled the chemical war. Massive chemical attacks were launched to contaminate the countryside or to prevent the enemy from seizing territory, ushering in a new form of total warfare on the environment. The war was very much one of adaptation to the new chemically-altered landscapes.

In addition to the destruction of life at the front, Germany's waters on the home front continued to absorb chemical pollution. As we have seen, the levels of chemical contaminants were directly linked to the course of the chemical war. When chlorine attacks were common, chlorine levels in the Rhine increased. When the military adopted mustard gas to its arsenal, the river witnessed an increase in mustard gas-related chemicals like sulfur trioxide. Chemical accidents haunted workers across Europe, as the goal of victory in the war trumped environmental or health concerns. During the war,

both sides embraced the idea that the winner of the chemical war would be the side which could successfully adapt to or contaminate the new battlefield environment. It was, in other words, the side which could carry out and adapt to total environmental warfare, where the air, earth, and water could kill. Although the Allies won the war, there were no winners of the chemical conflict. Both developed gasses capable of killing all life they encountered, and both developed countermeasures. Gas was not, however, the primary reason for Allied victory or for German defeat. Both sides resorted to measures that contaminated the environment and their populations suffered as a result (and in some cases, continue to suffer). The contaminated landscapes, however, are another tragedy of the war. Like the human tragedy of the Great War, the environmental catastrophe continues to haunt the continent through buried ordnance or poisoned livestock. The environment has no political, military, or social aims with respect to warfare. It is a silent casualty during the war, a martyred landscape in the name of human “progress.” Only after the war did Germans seem to come to grips with the affects industrialized war has on their natural surroundings.

Haber and the German chemists’ research expanded throughout the war and into the Weimar era, where military objectives continued to dictate a desire to control the battlefields of the future with chemicals. The military objectives and research involving chemical warfare meshed with aims in the civilian sector, notably in the application of poison gas research towards pest control. Unfortunately, the work of German chemists would have far reaching, often unforeseen consequences, including the Nazis’ use of their discoveries to facilitate the extermination of millions during the Holocaust.

After the war, veterans returned home and brought with them their experiences at the front. Numerous diaries, journals, and memoirs documented the ecological damage caused by chemical warfare. In Germany, poets often wrote of the way nature seemed to lurk like a grim specter over their lives, and how their emotions were tied directly to the condition of the landscapes before them. These visceral descriptions of gas warfare and chemical disasters relating to chemical weapon clean up operations helped to solidify a national picture of what the gas war experience was like, and how many Germans came to see warfare and humanity as a destroyer of nature. Works like Ernst Johannsen's *Fronterinnerungen eines Pferdes* drew comparisons of the dangers people faced at the front to those of animals at the front. The paintings of Otto Dix provided a macabre, visual symbol of the gas war and nature's annihilation in Northeastern France and Belgium. The plays relating to gas at that time protested war and technology as a means for human cultural advancement.

Simultaneously, Europeans faced the daunting task of cleaning and repairing their landscapes. Millions of acres of land were contaminated, and tons of chemical ordnance remained active and lethal. Yet an antagonistic political climate and steep financial costs limited Europeans' ability to restore their land. In addition, the military and financial desires of many Germans during the Weimar Republic included the desire to continue chemical weapons research. Their actions of course had the worst of consequences, including the contamination of land with buried ordnance to the phosgene cloud catastrophe at Hamburg in 1928.

Germany's problems, however, pale in comparison to those of Belgium and France after the war. Hundreds have died clearing and disposing of chemical weapons, and the peoples of Western Europe have been forced to adapt to their new landscape.

Farmers drive tractors with armor-plated seats, and areas remain fenced off and all but forgotten, still too dangerous to inhabit. The daily activities of the *Dovos* and the *Démineurs* provide a constant reminder of the steep environmental price of warfare. For the French, psychologically the damage was traumatic but not insurmountable, and someday the land will truly be cleared.

Ultimately, the First World War and the Weimar era provided a turning point for the conception of modern German environmental thinking. The use of chemical weapons for military gain shaped German cultural attitudes and changed European landscapes. Not only did the damage caused by chemical weaponry force German military officials to rethink military operations and tactics, chemical weapons also compelled the German people to develop new and alternative cultural understandings of war and nature, specifically those which took environmental damage into account when thinking about the war experience. German artistic and written culture during the 1920s and 1930s reflected the chemical war's environmental damage through pacifistic and anti-technological lenses, creating a framework where modern environmentalism could take shape. The use of ecologically pernicious chemical agents ushered in a new form of total war, and demonstrated how the environment directly influenced both the outcome of the chemical war in the field but also German cultural beliefs regarding the relationship between nature and warfare. Above all, the cultural and military consequences Germany endured as a result of chemical warfare, whether seen or unseen, short or long term, demonstrate nature's significant place in its history.

EPILOGUE

CONSEQUENCES REVEALED

On November 30, 1972 near his home in Hamburg, a grade school boy was spotted by the police in the woods behind the dilapidated remnants of one of Hugo Stoltzenberg's chemical plants. After confronting the boy, the officers noticed he had removed several baggies from the grounds containing a mysterious white and grey powder. In an effort to ascertain what the boy had found, the police officials contacted the city's Economic and Order Office (*Wirtschaft- und Ordnungsamt*) and the factory's owner, Martin Leuschner. The powder turned out to be a mixture of chloride of lime and magnesium oxide known as "Losantin." The chemical was manufactured under contract for the Belgian government, and was designed to be a skin treatment for mustard gas burns. After some searching, some fifteen years after it was buried the remaining stockpile of losantin was located. The authorities noted that the fencing around the plant grounds had long fallen apart, and therefore the property was virtually open to anyone curious enough to enter. Leuschner promised at that time to repair the fence to prevent a similar incident from happening again.¹ Probably because nobody was harmed, the incident passed by without much fanfare, and the authorities never acted to ensure that Leuschner kept his promise of securing the hazardous area. The fence was never repaired.

¹ Peter Rabels, "Bericht des Untersuchungsführers gemäß Senatsauftrag vom 13./18. September 1979 'Stoltzenberg-Skandal'," SA-HH, A 902/0407-03, p. 37, Staatsarchiv Hamburg, Hamburg, Germany.

As the years passed, adventurous local children continued to easily find holes in the rusted barriers and infiltrate the grounds. Among the children were the sons of a Hamburg taxi cab driver, the twelve year old Thomas Ludwig, and his younger brother Oliver. On September 7, 1979, Thomas, Oliver, and Thomas' friend, Stefan Behrman, were playing in the basement with explosives and chemicals they had found in the old Stoltzenberg factory grounds and brought home.

Without warning, a massive explosion tore through the building, and severely damaged Thomas' residential complex located just across the street from the old factory. The blast tore the hinges off doors and shook the entire structure. At the epicenter of the blast were the three boys. Stefan lost his right hand, and Thomas was also severely injured.² Oliver was killed in the blast. He was only eight years old.

The genesis of the second "Stoltzenberg-Skandal," as it came to be known, reaches back to when Hugo Stoltzenberg and the Reichswehr continued the chemical weapons development. After the subsequent 1928 phosgene catastrophe, Stoltzenberg remained in Hamburg for decades until his death in 1974. During the Third Reich, Stoltzenberg joined the Nazi party and experimented with nerve agents and other potential chemical weaponry. On January 1, 1969, Stoltzenberg sold his chemical factory and its contents to a man named Martin Leuschner.³ As the decades passed, the factory became dilapidated and ultimately abandoned.

The incident created an immediate firestorm of political controversy in Hamburg and made national headlines. Public officials seemed just as shocked as the city residents.

² Herbert Schütte, "Beim Streit um Gift war der tote Junge schnell vergessen," *Die Welt*, 16 March, 1981.

³ Schweer, *Die Geschichte der Chemischen Fabrik Stoltzenberg*, 91.

“My vocabulary unfortunately doesn’t suffice to explain what happened there,” admitted the Social Democrat chief Ulrich Hartmann.⁴ Articles were quick to point out the location of the factory grounds and its proximity to Hamburg’s attractions. Most glaring and disturbing was the fact that the factory grounds were only a five minute walk from Hamburg’s soccer stadium at that time, the Volksparkstadion. Home of the German League’s popular Hamburger SV (HSV) soccer club, the stadium regularly held some 55,000 to 60,000 spectators on game days. That year, the stadium would have been especially crowded, as HSV won their first of three league championships in 1979. The facility also hosted a number of other non-sporting events, such as rock and pop concerts.⁵ With so much activity involving hundreds of thousands of people, how could these chemicals have still remained around, sitting just a block away? Where were the city inspectors, whose responsibility it was to ensure hazardous industrial materials were properly disposed of?

To be sure, there were numerous warning signs over the decades after the 1928 disaster that went unheeded. By the end of the 1940s, at least twenty-one fires were reported on the grounds. At late as 1968, the fence which surrounded the facility had broken down.⁶ And of course it was also not the first time children were discovered to have obtained chemical materials from the old factory grounds.

⁴ “11. Sept. 1979: Der Stoltzenberg-Skandal wird aufgedeckt,” *Die Welt*, 11 December 1999.

⁵ During the summer of 1998, the stadium was torn down. It was eventually replaced with the new Volksparkstadion, located on the same site. “Zahlen und Fakten,” 2010, <http://www.imtecharena.de/arena/zahlenundfakten>, accessed 20 February 2012.

⁶ Rabels, “Bericht des Untersuchungsführers gemäß Senatsauftrag vom 13./18. September 1979 ‘Stoltzenberg-Skandal’,” p. 49.

Yet all of these warnings were of little help for those children and the neighborhood in 1979. Just like Stoltzenberg's 1928 chemical disaster, the days that followed were chaotic. For six days police evacuated residents and federal and local governments moved in to clean up after the catastrophe. An official clean-up program was put into place and officially began on May 12.⁷ Over the next forty weeks and working under heavy pressure, teams of Bundeswehr chemical experts and employees of the private chemical disposal company Philip Holzmann cleared roughly 7,500 square meters of land, digging two and a half meters deep with excavators and shovels in search of buried ordnance. Their pace was slow but their work was thorough. By June 4, only 350 of the 7,500 square meters were cleared and no dangerous ordnance had been found.⁸ As the teams progressed, however, their fortunes changed and their search yielded astonishing results. On June 27, White Cross, Blue Cross, mustard gas and chloropicerin were uncovered.⁹ The only casualties suffered during the clean-up operation occurred when workers from the University of Hamburg's Hygiene Institute uncovered a toxic green powder. The powder quickly took to the air when disturbed, and poisoned eleven people: six workers, two police officers, and three firefighters. Thankfully, none of the victims died.¹⁰ By September 23, over a year after the accident, clean-up crews still had 3,000 square meters to clear.¹¹ When clean-up operations concluded, the Bundeswehr's

⁷ "Stoltzenberg: Die Räumung beginnt," *Die Welt*, 12 May 1980, Nr. 110.

⁸ "Keine gefährlichen Funde," *Die Welt*, 4 June 1980, Nr. 128.

⁹ "Immer neues Gift bei Stoltzenberg," *Hamburger Abendblatt*, 27 June 1980, Nr. 147.

¹⁰ "Das grüne Pulver war pures Gift," *Hamburger Abendblatt*, 29 July 1980, Nr. 171; Wieder Unfall bei Stoltzenberg: 11 Hamburger vergiftet," *Hamburger Morgenpost*, 29 July 1980, Nr. 170.

¹¹ "Ohne Pause graben die Giftschrüfer Hamburgs boden um," *Hamburger Abendblatt*, 23 September 1980, Nr. 219.

findings were astonishing. Among the twenty-four different toxins discovered were seventeen kilograms of tabun gas (capable of killing thousands of people if released) and eleven kilograms of strychnine. A total of eighty tons of chemical agents were found.¹² The authorities closed the plant and tore down the factory buildings.¹³

The evacuation order was limited, creating a bizarre combination of environmental catastrophe and normal, everyday life within an area of just one of Hamburg's neighborhoods. Just five days after the explosion, while fully-equipped Bundeswehr personnel were busy disposing of chemical weaponry, the Volksparkstadion hosted HSV's game against 1. FC Kaiserslautern for their scheduled league match in front of 50,000 spectators. The danger is difficult to comprehend – the Hamburg newspaper *Die Zeit* perhaps best summed up the situation when they reported the discovery of eight nerve gas grenades on the factory grounds. In just one minute of exposure time, just 400 milligrams per cubic meter of the nerve gas could have killed everyone in the stadium.¹⁴ As of 2004, much of the grounds remained a swampy, untidy area filled with weeds and cattails. HSV still play in the same location, just blocks from what was once perhaps one of the most contaminated areas of chemical ordnance in all of Germany.

Like the first affair, the political fallout was intense yet short-lived; dramatic yet anti-climatic. On September 13 the official government investigation began, lead by the Staatsrat Dr. Peter Rabels. The investigation lasted five days. On September 24, Rabels

¹² "11. Sept. 1979: Der Stoltzenberg-Skandal wird aufgedeckt," *Die Welt*, 11 December 1979.

¹³ Schweer, *Die Geschichte der Chemischen Fabrik Stoltzenberg*, 94.

¹⁴ "Nervengas im Hinterhof," *Die Zeit*, 28 September 1979, Nr. 40, p. 25.

submitted his official report to the city's Senate and mayor, Hans-Ulrich Klose. The sixty-five page report contained a description of the event and its historical context in great detail an explanation of Stoltzenberg's background, wartime activities, the 1928 disaster, and subsequent problems with the plant between 1930 and 1979. These problems included fires, air pollution complaints, and the previously mentioned incidents involving children.¹⁵ Demands by the opposition Christian Democratic Party (CDU) for Klose's resignation were rejected by the majority SPD, and, as the *Hamburger Abendblatt* made clear, "Nobody was held accountable."¹⁶ The authorities declared Mr. Martin Leuscher, the sixty-eight year old owner of the property, unfit for trial due to ill health.

In March 1983, Karsten Plog of the *Stuttgarter Zeitung* declared that the accident demonstrated the inadequacy of German environmental law with respect to chemical ordnance. "The law for explosives does not suffice in the opinion of the state district attorney office for an arraignment, and offenses against environmental laws are not being accounted for."¹⁷ In 1984, Hamburg's *Die Zeit* stated its surprise that despite the good will of the people and Green Party members rising to parliamentary levels, so far environmental protection efforts to this point had a "poor result." The paper demanded more regulations, such as imposing a duty on the dumping of heavy metals and arsenics. Such actions would form a significant "bridgehead" (*Brückenkopf*) in the environmental-

¹⁵ Rabels, "Bericht des Untersuchungsführers gemäß Senatsauftrag vom 13./18. September 1979 'Stoltzenberg-Skandal'."

¹⁶ "Zur Rechenschaft gezogen wurde niemand." Ernst Gerhardt Scholz, "Stoltzenberg-Skandal – zuerst starb ein Kind," *Hamburger Abendblatt*, 7 September 2004.

¹⁷ See Kristen Plog, "Fall Stoltzenberg zu den Akten," *Stuttgarter Zeitung*, 11 March 1983, reprinted in Hans Günter Brauch and Rolf-Dieter Müller, eds., *Chemische Kriegführung – Chemische Abrüstung*, 359.

political arguments regarding economics and environmental protection. The article concluded with the hope that after the Stoltzenberg disaster regulations would in part make problems with disposal of highly poisonous toxic waste easier. In addition, although some chemical substances are banned, these bans have been “no detriment” to the chemical industry.¹⁸ As the former State Councilman (*Staatsrat*) Peter Rabel stated in 2004, the Stoltzenberg incident was “a very important milestone, a propelling charge for environmental politics.”¹⁹

¹⁸ “Im Zweifel die Umwelt” *Die Zeit*, 23 March 1984, No. 13.

¹⁹ Quoted in Ernst Gerhardt Scholz, “Stoltzenberg-Skandal – zuerst starb ein Kind,” *Hamburger Abendblatt*, 7 September 2004.

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As many a historian has discovered before my time, I learned after arriving in Germany that tracking down primary sources on Germany during the First World War is a difficult task. On April 14, 1945, an Allied bombing raid over Potsdam destroyed much of the German military archive, incinerating the vast majority of files from World War I. In addition, files dealing with German chemical warfare are even more difficult to find, given the measures German chemists and industrialists took to cover their tracks from Allied chemical inspectors immediately after the conflict. Fritz Haber himself participated in this cover up. When asked by the Allies to turn over all of his documents from the war, Haber claimed a fire had come through his roof and burned all of his documents. In reality, they had been moved to Potsdam, where they burned with most of the other Great War papers in that air raid of April 1945. Still, corporate and scientific archives have retained numerous documents from the era and have remained surprisingly intact. Although few deal with environment and war per se, they provided a nice foundation of primary sources of the chemical war. I am especially grateful for their permission and access to these materials.

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